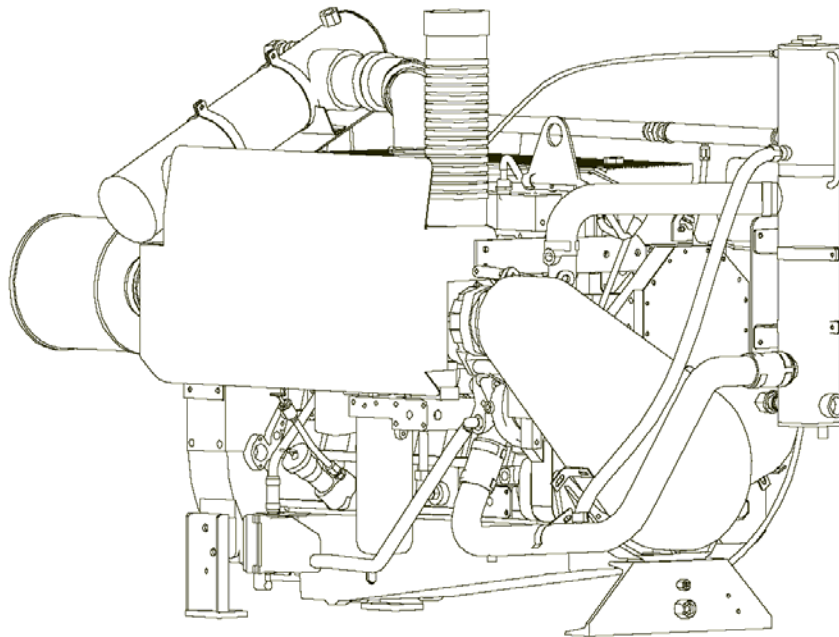


CFP11E SERIES

Operation & Maintenance Manual Fire Pump Drive Engines



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.



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Section 1 – Introduction

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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:

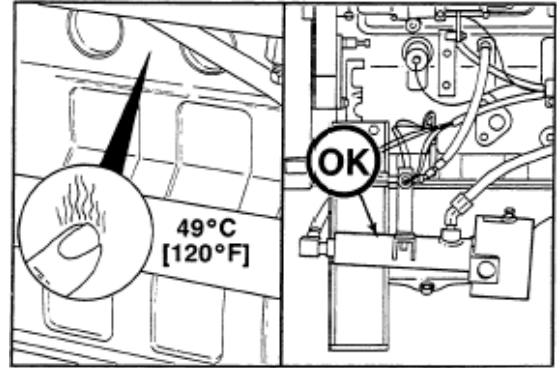
	WARNING. Serious personal injury or extensive property damage can result if the warning instructions are not followed.
	CAUTION. Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are not followed.
	INSPECTION is required.
	Refer to another 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.

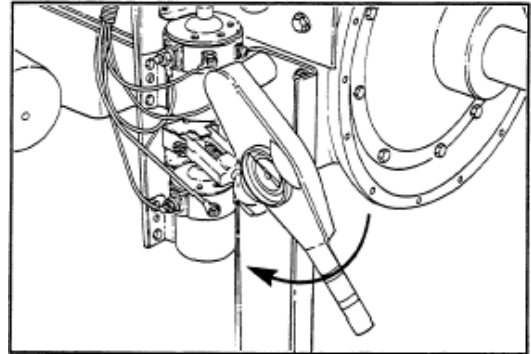
Some of the illustrations are “generic” and might not look exactly like the engine or parts used in your application.

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



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



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.



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.



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.



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 use bead blasting cleaning methods on aluminum pistons skirts or the pin bores in any piston, piston skirt or piston crown. Small particles of the media will embed in the aluminum or other soft metal and result in premature wear of the cylinder liner, piston rings, pins and pin bores. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.



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



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.



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.



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.



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.



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.



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



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

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

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.



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 of 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 ₂ O	Water	US	United States of America
Hg	Mercury	V	Volt
HP	Horsepower	VS	Variable Speed

Section 2 - Engine Identification

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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.

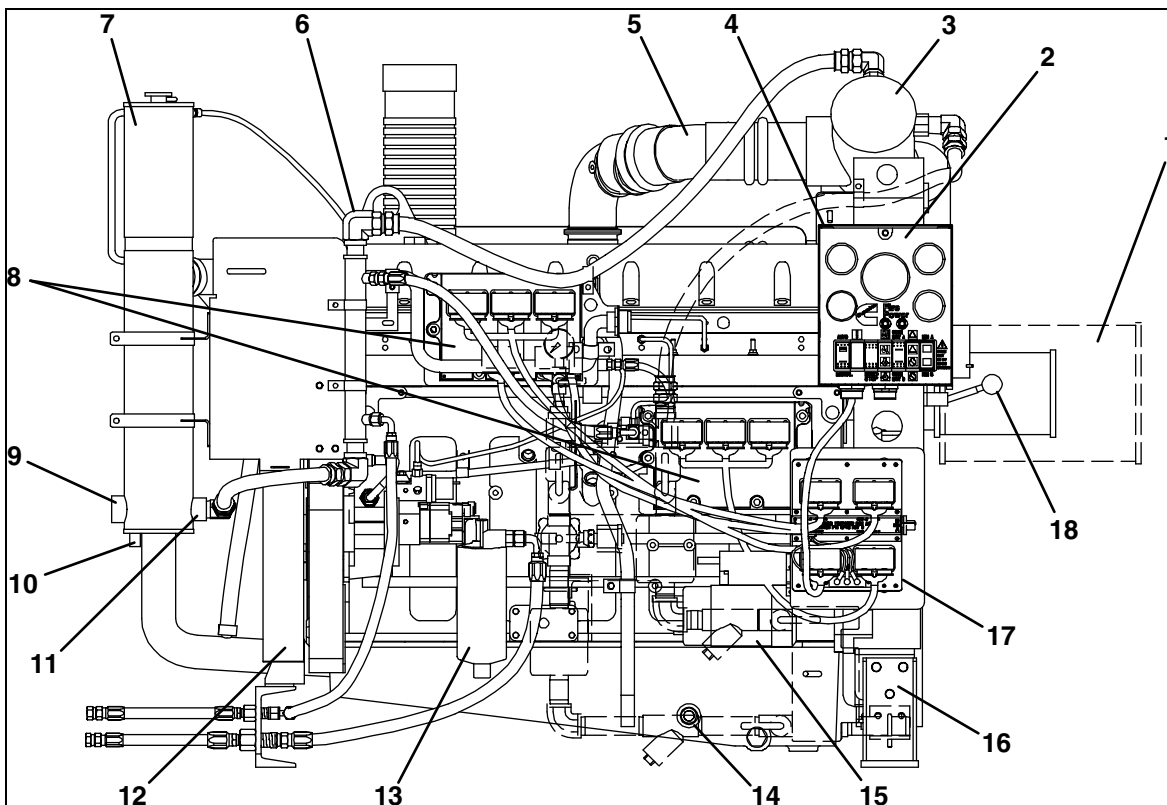
Sequential starting is available for multiple-pump installations to keep all pumps from starting simultaneously.

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

External Engine Components and Views

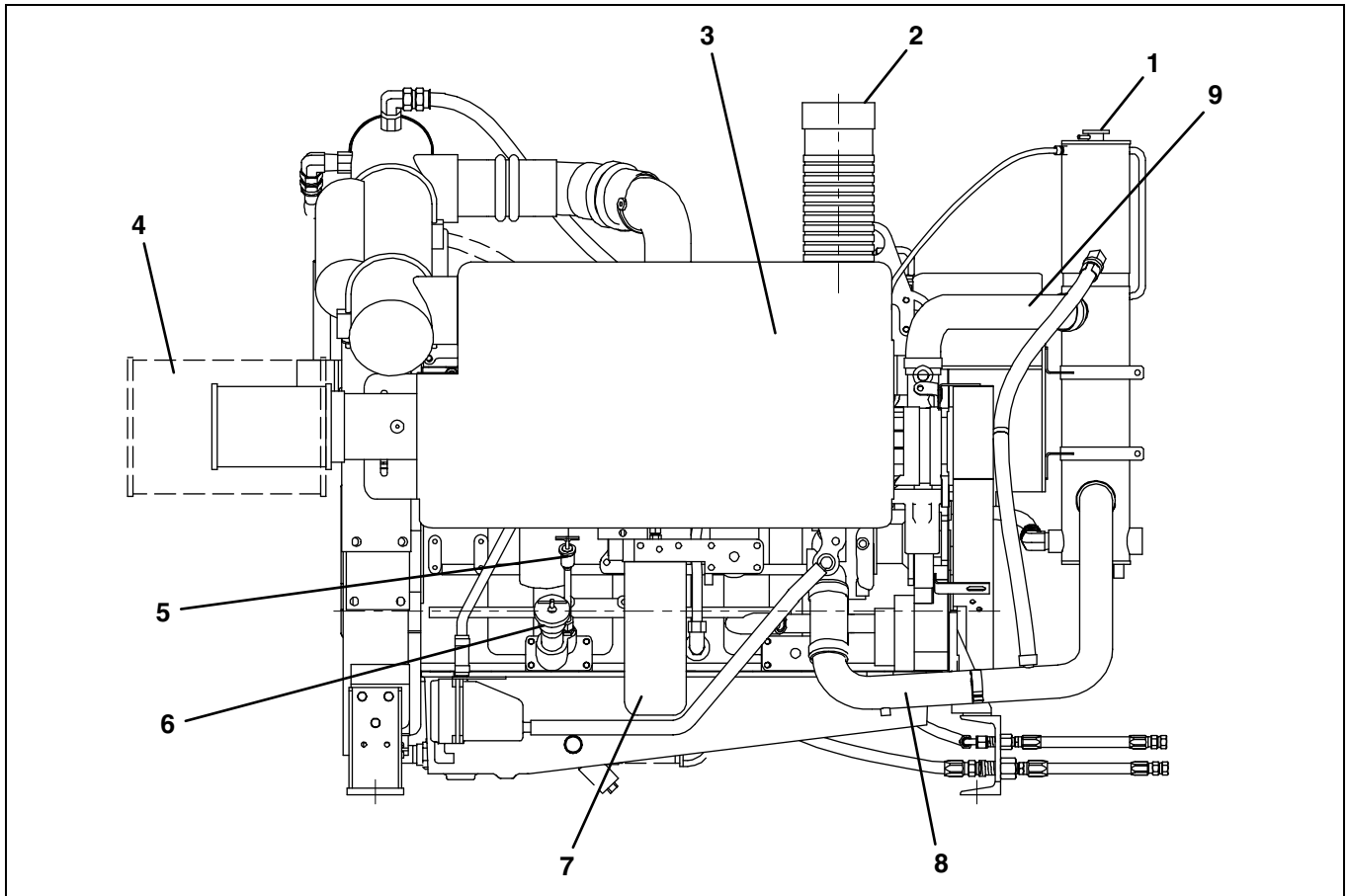
The following illustrations show the locations of the major external engine components, and other service and maintenance points. Some external components will be at different locations for different engine models.

Instrument Panel Side



- | | | | |
|----|------------------------------------|-----|-----------------------|
| 1. | Air Cleaner Element | 10. | Zinc Plug |
| 2. | Instrument Panel | 11. | Raw Water Inlet |
| 3. | Charge Air Cooler | 12. | Pulley Guard |
| 4. | Terminal Box | 13. | Fuel Filter |
| 5. | Charge Air Cooler Pipe | 14. | Oil Pan Drain |
| 6. | Water Piping for Charge Air Cooler | 15. | Engine Support |
| 7. | Heat Exchanger | 16. | Starter Motor |
| 8. | Electronic Control Module (ECM) | 17. | ECM Switch Holder Box |
| 9. | Raw Water Outlet | 18. | Manual Start Lever |

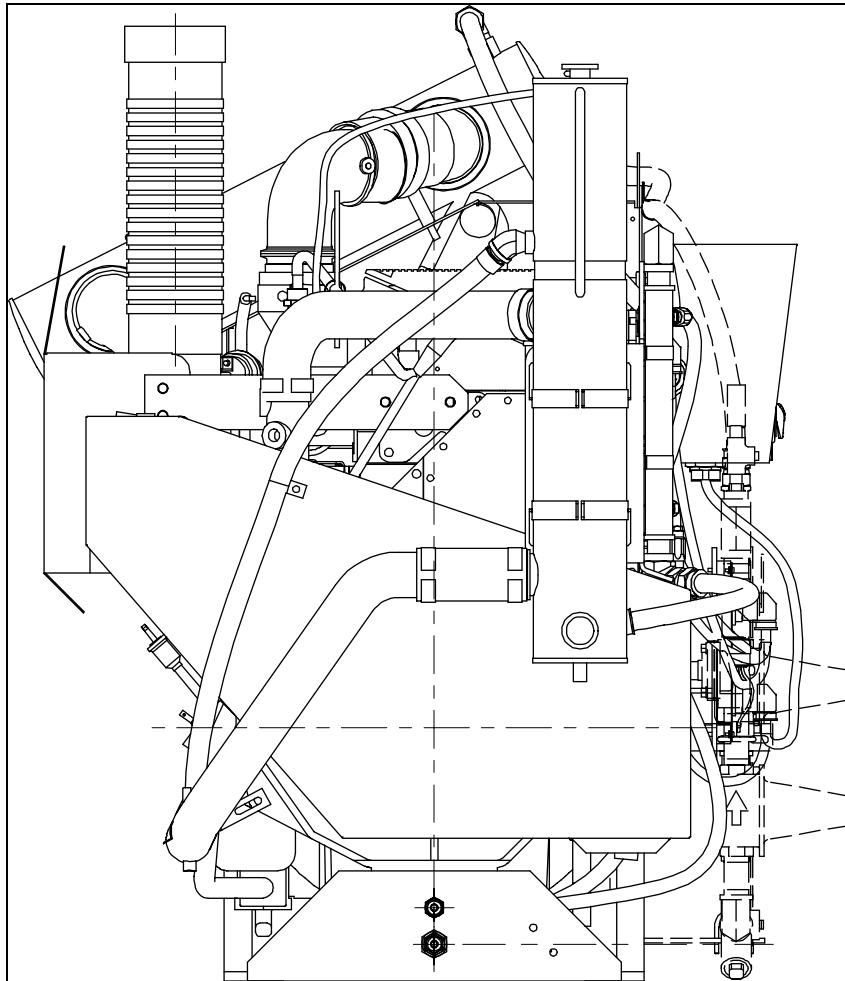
Turbocharger Side



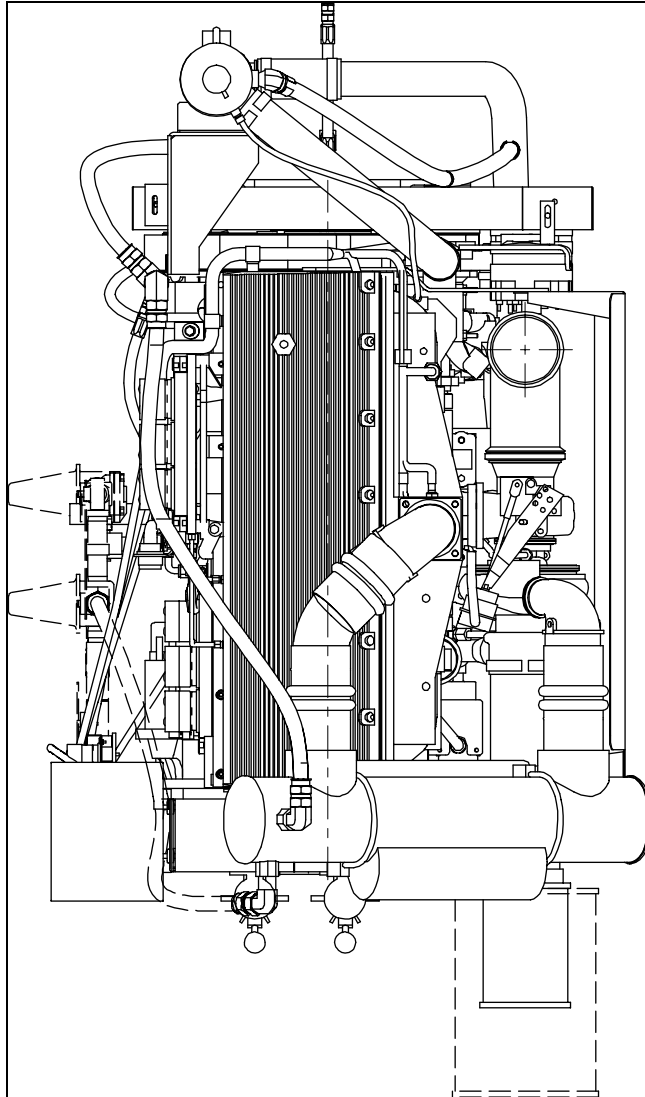
1. Top Tank Fill
2. Exhaust
3. Turbocharger and Exhaust Shield
4. Air Cleaner Element
5. Dipstick

6. Lubricating Oil Fill
7. Lubricating Oil Filter
8. Lower Water Hose/Tube
9. Upper Water Hose/Tube

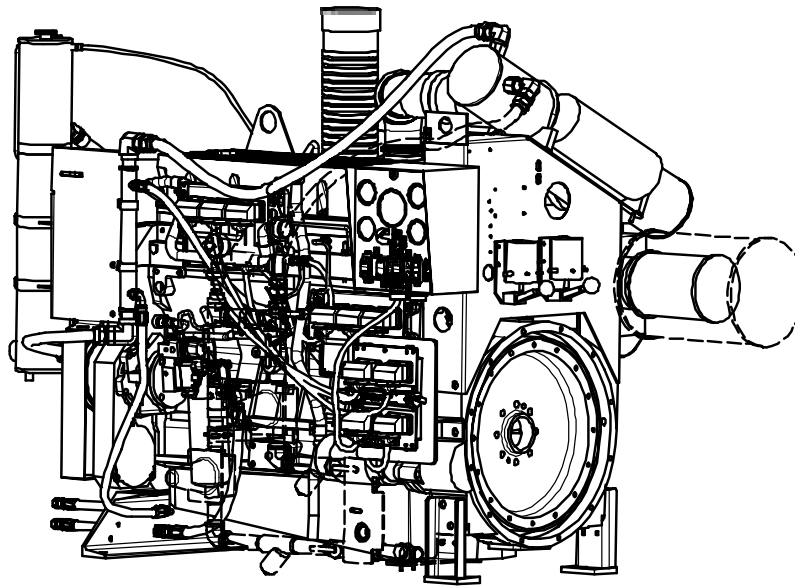
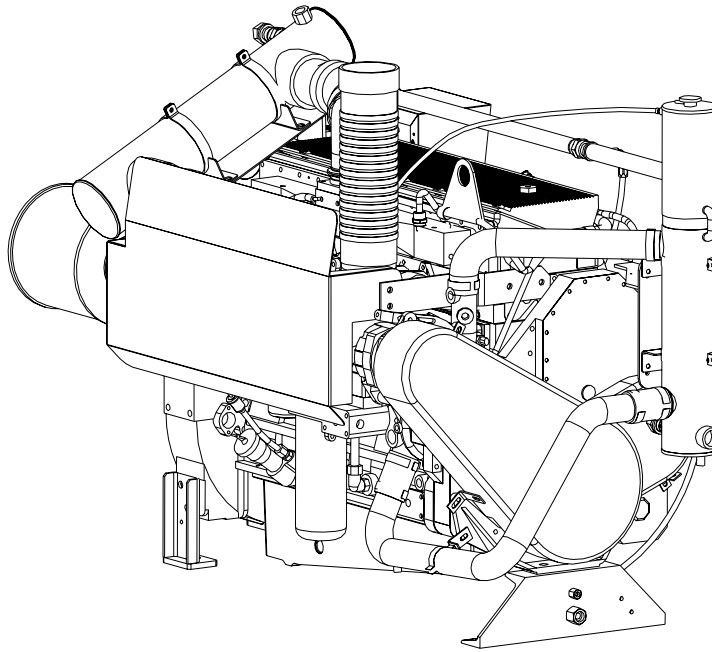
Front View



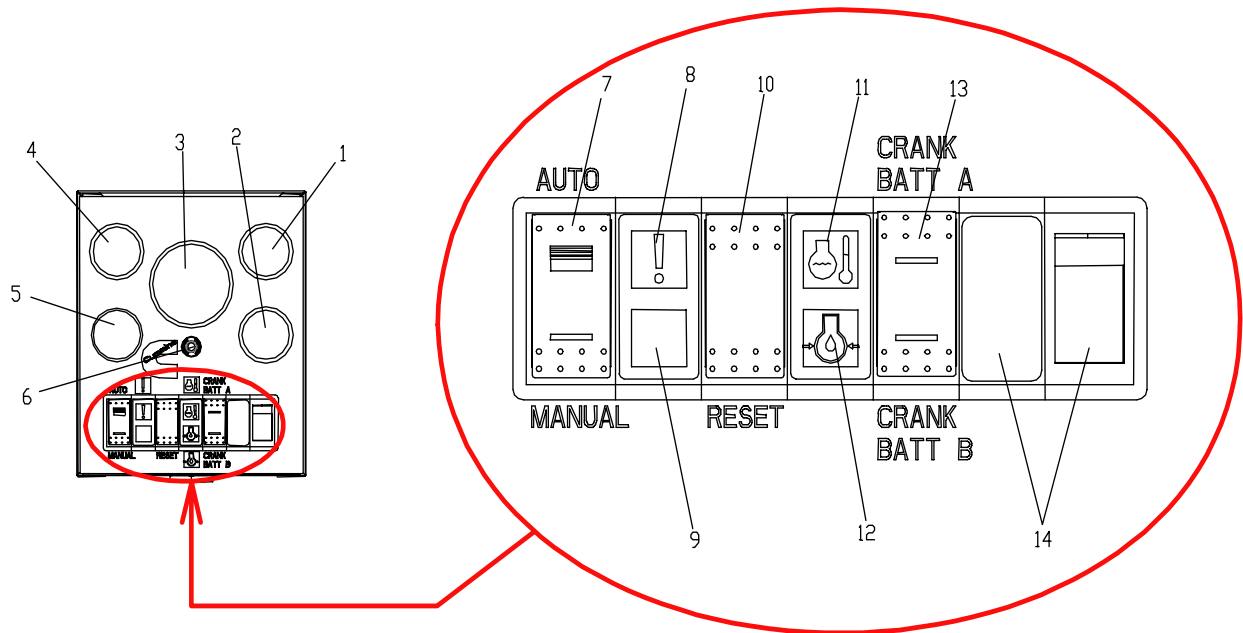
Top View



Isometric Views



Instrument Panel

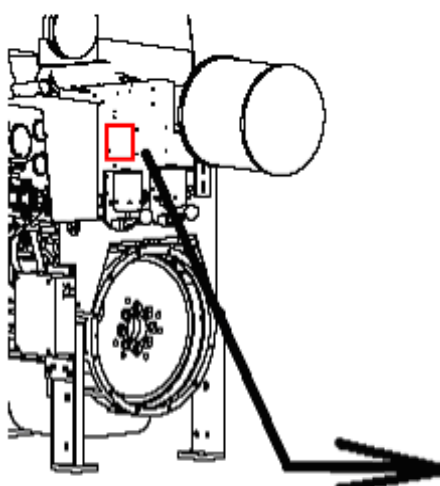





- | | | | |
|----|--------------------------------|-----|---|
| 1. | Battery "A" Voltmeter | 8. | Overspeed Warning Light |
| 2. | Battery "B" Voltmeter | 9. | Not used |
| 3. | Tachometer (with hour-meter) | 10. | Overspeed Reset Switch |
| 4. | Water Temperature Gauge | 11. | High Water Temperature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

Fire Pump Identification

The fire pump dataplate 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.



⊕ WWW.CUMMINSFIREPOWER.COM ⊕ CUMMINS FIRE POWER A DIVISION OF CUMMINS NPOWER, LLC DE PERE, WI 54115	
MFD. DATE: _____	MODEL: "see table"
SERIAL #: _____	YEAR: _____
RATED SPEED: "see table"	
HP OUTPUT: "see table"	
SPEED RANGE IF APPLICABLE MIN. HP @ SPEED: "see table" 0.75 TYP. MAX HP @ SPEED: "see table"	
HORSEPOWER RATINGS WITHIN THE SPECIFIED SPEED RANGE ARE TO BE DETERMINED BY THE USE OF LINEAR INTERPOLATION BETWEEN HORSEPOWERS DEVELOPED AT MINIMUM AND MAXIMUM SPEEDS.	
 LISTED	 
INTERNAL COMBUSTION ENGINE FOR DRIVING CENTRIFUGAL FIRE PUMP 19ZG	
⊕ CERTIFIED FOR USE OF SAE J192	⊕ FUEL ONLY PER SAE J313 MAR92

"Part number"

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.

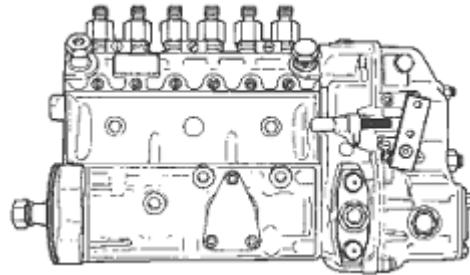
This tag identifies to rated operating speed at the rated horsepower. It also provides the over speed switch setpoint. Both values are set at the factory.

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

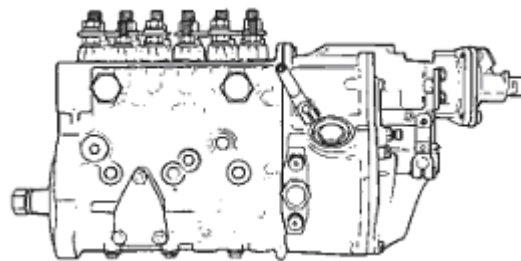
○ FACTORY SETTING ○	
ENGINE SPEED SETTING: (⊕ HP SETTING)	_____
OVERSPEED SWITCH SETTING:	_____
○	○

Fuel Injection Pumps, Inline

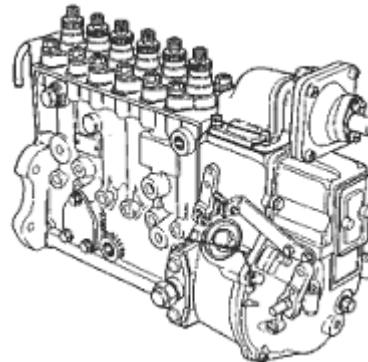
Bosch® In-Line Pump Identification Use Bosch® A pump with RSV governor for an industrial application. The A pump will use the RQV governor for automotive engines. Some industrial engines will use RQV governors.



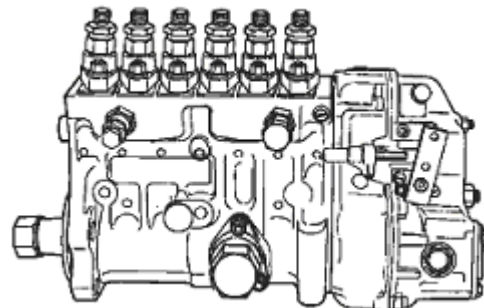
Use Bosch® MW pump with RQV governor for an automotive engine. The MW pump will use the RSV governor for industrial applications. Some industrial engines will use RQV governors.



Shown here is the Bosch® P7100 pumps with RQV-K governor for an automotive B or C Series engine.



Shown here is the Nippon denso EP-9 pump with RSV governor for marine and some industrial C Series ratings.



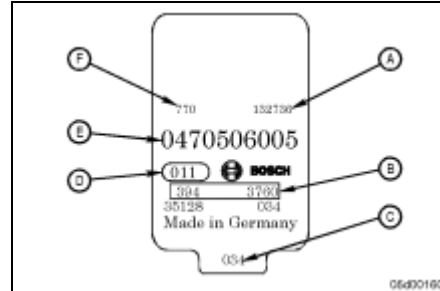
Fuel Injection Pump Dataplate

The injection pump dataplate is located on the side of the injection pump. It provides information for fuel injection pump calibration.

The Cummins part number for the fuel injection pump and governor combination is located on the governor 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



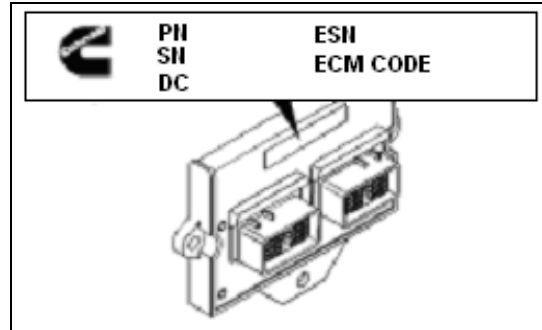
ECM Dataplate

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.



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Section 3 – Installation and Operation

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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 CFP11E GEN in Section 13 for the general fire pump and engine layout.

Refer to Drawing 8712 in Section 13 for the general fire pump engine power module assembly.



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.

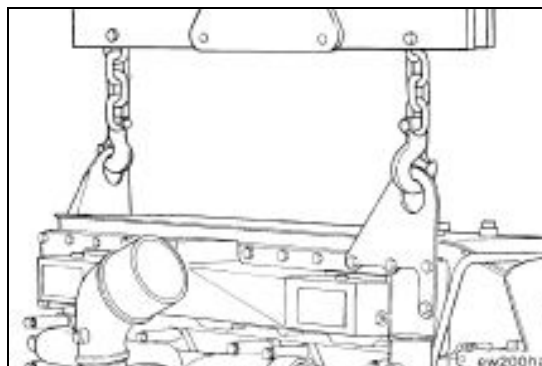
Provide engine support as required to support the wet weight specified in General Engine Data in Section 10.

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.

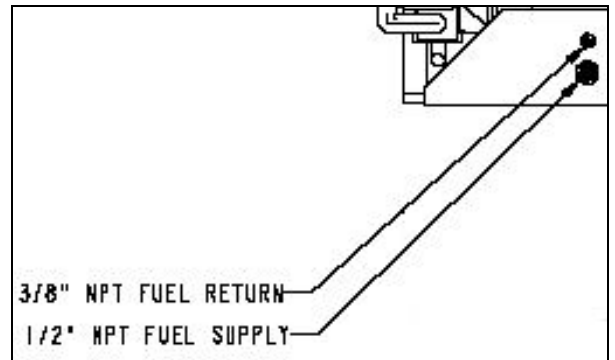
Install an elevated Diesel # 2 fuel tank or other fuel supply arrangement that meets the specifications listed in Fuel System Specifications in Section 10.

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 return line. Route this line to the bottom of the fuel tank in order to minimize the return head.

Install a 1/2" NPT (minimum) fuel supply line to the fire pump engine.

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 water system. Refer to Cooling System Specifications in Section 10 for pipe size requirements.

Refer to Drawing 9659 in Section 13 for the optional raw water piping manifold that is available from Cummins FirePower.

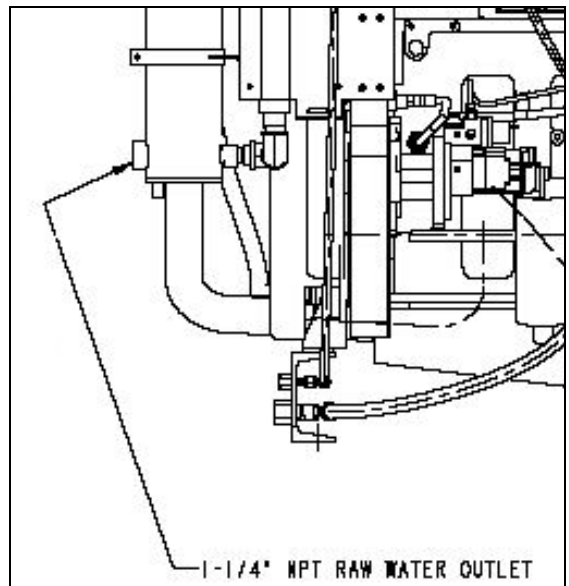
If the piping supplied by the customer, provide raw water supply piping and components equivalent to that can be supplied by Cummins FirePower and as shown in Assembly Diagram, Raw Water Piping in Section 6. Refer to National Fire Protection Association NFPA20-2003 Chapter 11 for installation requirements 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.

Install Raw Water Drain Piping

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

Provide 1-1/4" NPT raw water open waste cone drain at the outlet of the heat exchanger.



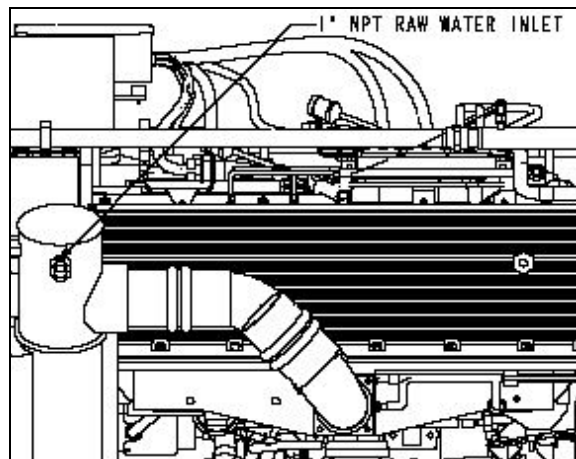
Raw Water Supply Installation (Cont)

Install Raw Water Supply (without Cummins Raw Water Manifold)

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 with all required valves to the inlet of the charge air cooler.

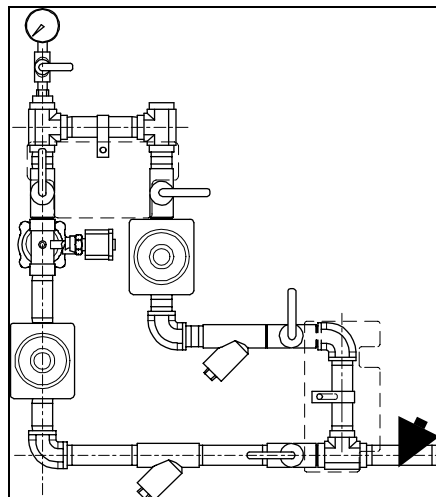


Install Raw Water Supply Piping (with Cummins Raw Water Manifold)

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.



Raw Water Supply Installation (Cont)

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 11048 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. Refer to Drawing 10423 Sheet 1 in Section 13.

Open the normal line inlet and outlet valves.

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

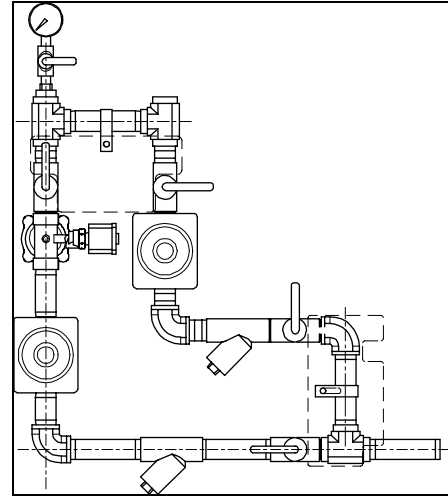
Remove the power jumper and reconnect the wiring.

Re-install the raw water piping from the manifold to the engine.

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 or 24 VDC optional).

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

Batteries may be supplied by Cummins FirePower 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 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 9768 in Section 13.

If purchased, install the optional battery cable kit (Cummins FirePower Part No. 9614). Otherwise, install equivalent customer supplied wiring.

Signal and Control Installation

NOTE: Install signal and control wiring at Terminal Board TB. 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 °C [200 °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

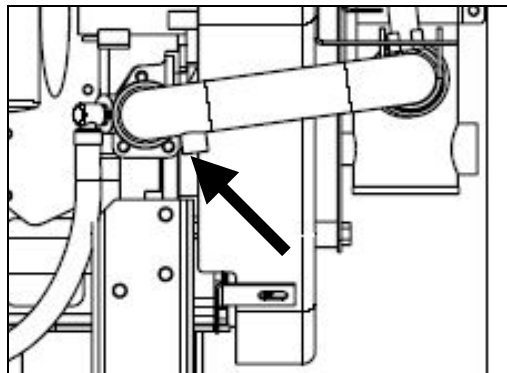
Check Cooling System Integrity



NOTE: Refer to Drawing 8712 in Section 13 for hose arrangement.

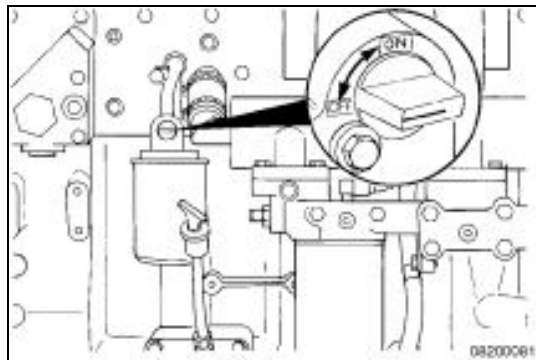
Check that all coolant hoses are properly installed and that the clamps are tight.

Check that the coolant drain petcock is closed.



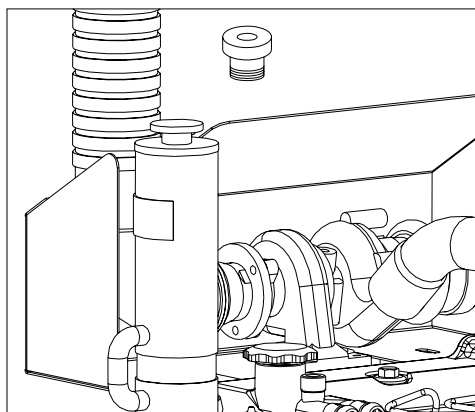
The valve must be in the ON position to prevent engine damage.

Check that the coolant filter valve is open. If required, turn the shutoff to the ON position by rotating the knob from horizontal to vertical.



Add Coolant

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



Coolant System Preparation (Cont)

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

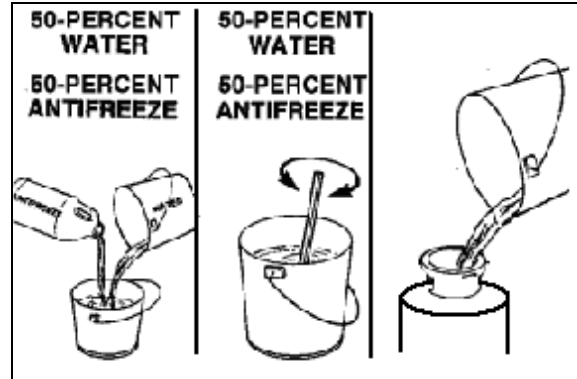


NOTE: Use a mixture of at least 50 percent antifreeze and 50 percent water.

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 on the heat exchanger.



Check Raw Water Supply Lineup



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.

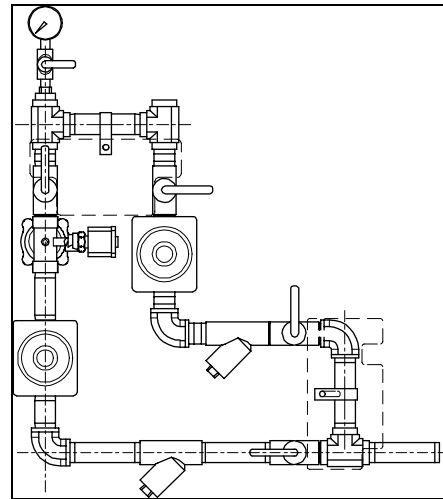
Check that the pressure gauge isolation valve is open.

NOTE: The right line is the bypass line. The left 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.

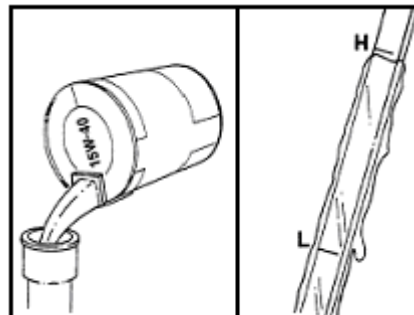


Lubricating Oil System Preparation

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



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.

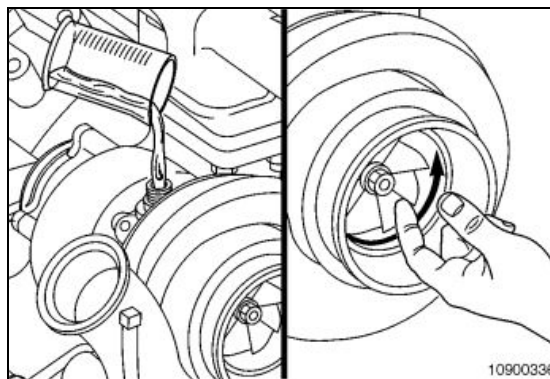
Lubricate the bearings by pouring 59 to 89 ml [2 to 3 oz] of clean engine lubricating oil into the turbocharger oil supply line fitting.

Reconnect the turbocharger oil inlet line.

Tighten the two oil supply line capscrews.

Torque Value: 20 N•m [15 ft-lb]

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

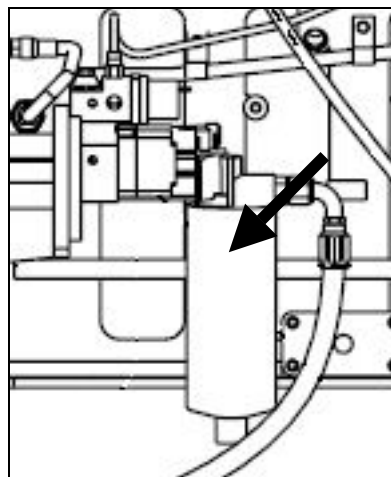


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Fuel System Preparation

Fill the Fuel Filter

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



If open, close the air/water separator drain cock.



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 diesel fuel.

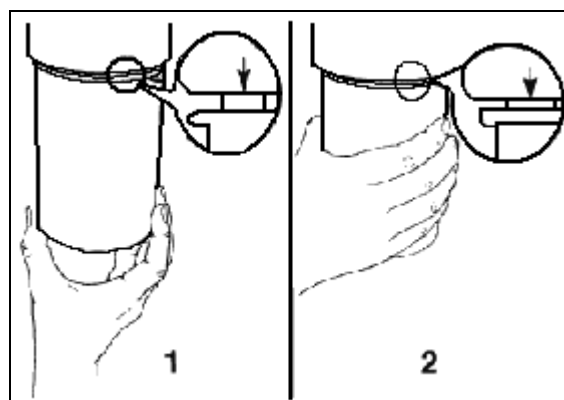


Mechanical over-tightening will distort the threads, filter element seal or filter can.

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.



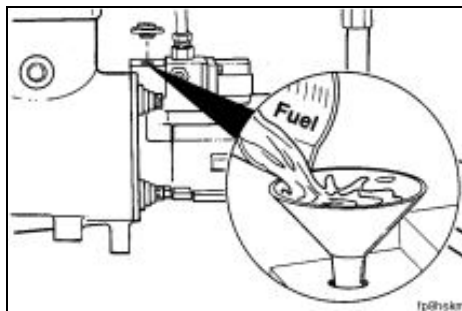
Fuel System Preparation (Cont)

Prime the Fuel Pump

Remove the filter cap from the top of the front support.

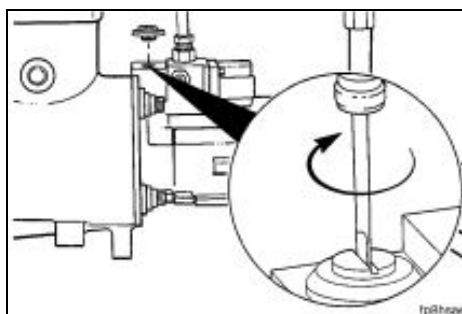
NOTE: Refer to Fuel Recommendations and Specifications in Section 10 for fuel requirements.

Fill the pump with clean fuel oil.



Install and tighten the filter cap.

Torque Value: 16 N•m [142 in-lb]



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.

Pre-Start Inspections

Perform a visual inspection as follows:

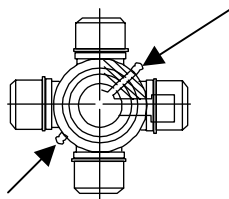
- Check that there is no apparent damage and that all components are installed.
- Check that the drive belt is properly installed.
- Check that all hoses and tubes are properly installed.
- Check that all electrical connections are properly installed.
- Check that the fire pump is properly installed 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.

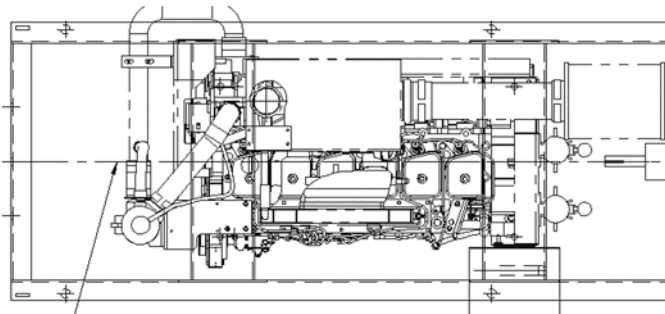
Grease zerk fittings as shown.

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



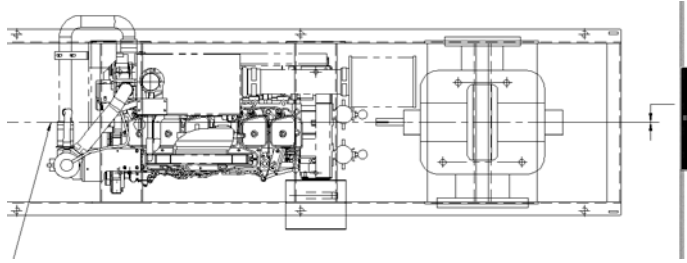
Check Engine to Pump Alignment

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

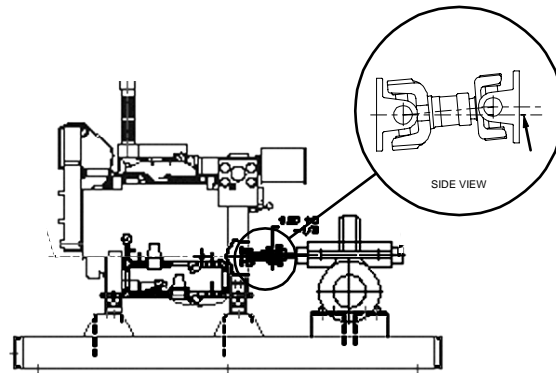


Check Engine to Pump Alignment (Cont)

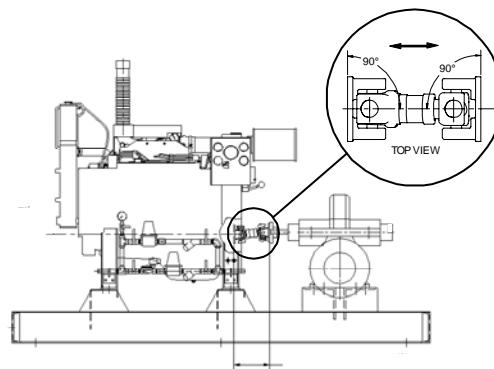
Align engine centerline to pump centerline within $\pm 1/32$ "



The pump centerline to the engine crank centerline (in vertical plane) is to be $\frac{1}{2}$ " $\pm 0, -1/4$ " offset.



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

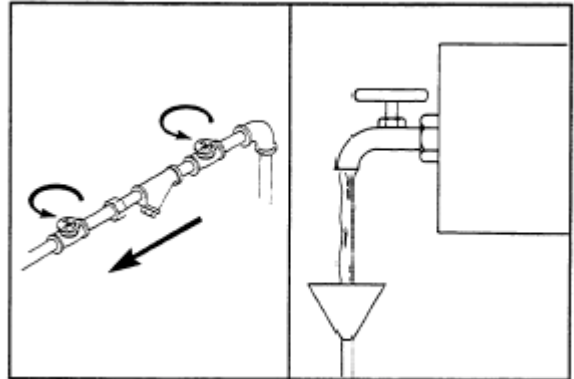


Initial Start-Up

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

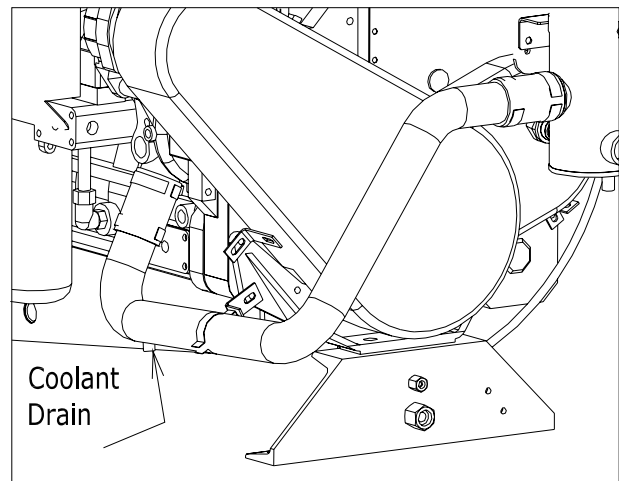


The raw water lines to and from the fire pump must be open, and there must be sufficient water to the heat exchanger when the engine has started. Insufficient water supply will cause overheating, resulting in engine failure.

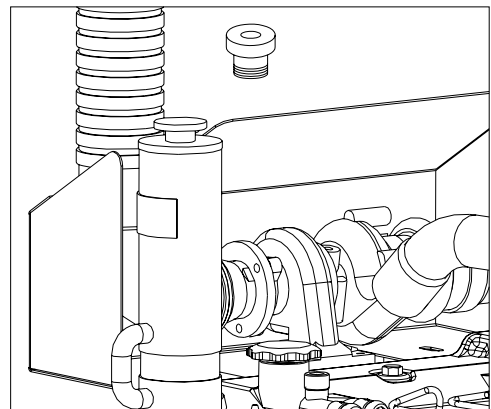


Close all cooling system drains.

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



Remove the coolant tank cap.



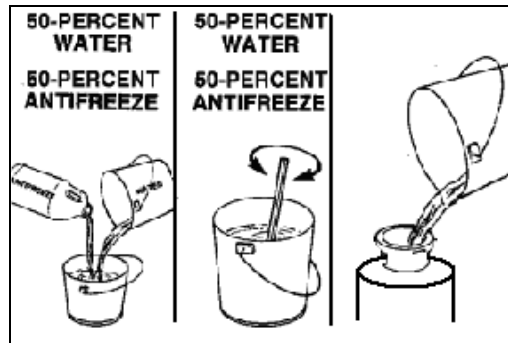
Initial Start-Up (Cont)

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.

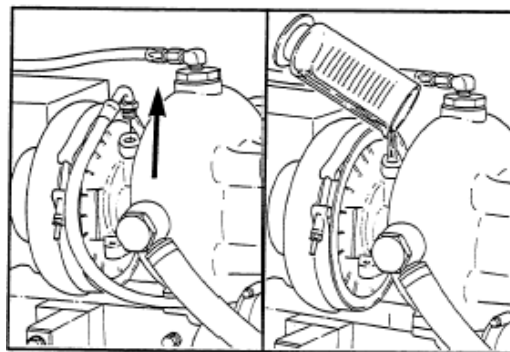
Check the injectors to be sure they are properly adjusted.

Prime the lubricating system:

Fill the crankcase to the "L" (low) mark on the dipstick. See Lubricating Oil Specifications, 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.

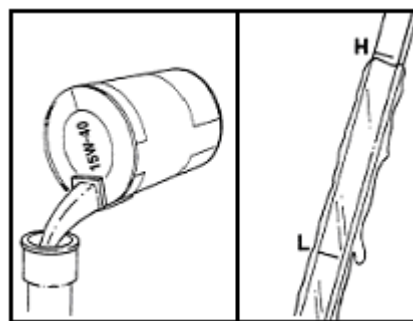


New turbochargers must be pre-lubricated before startup. Failure to pre-lube the turbochargers will result in turbocharger bearing failure.

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].



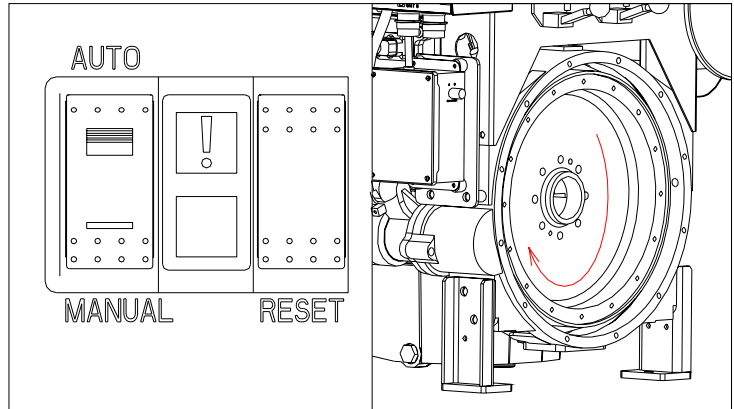
Initial Start-Up (Cont)

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

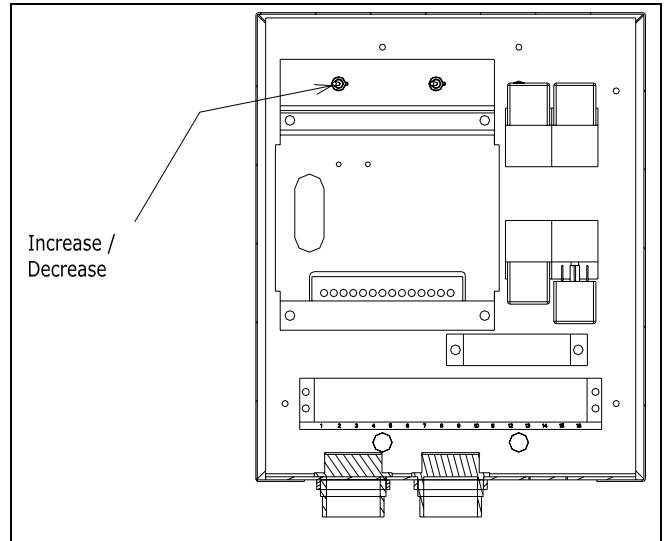
No change in oil viscosity or type is needed for new or newly rebuilt engines.

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.

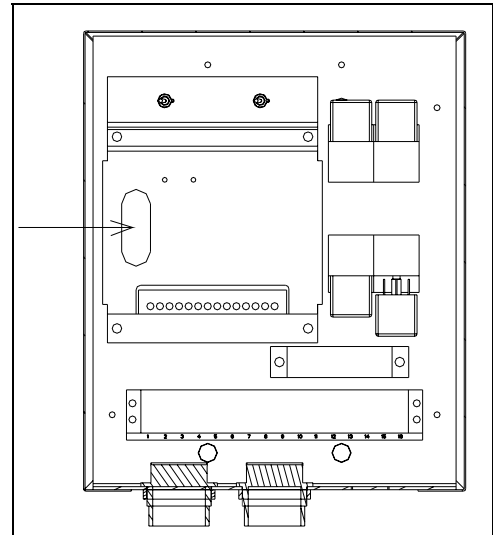
Adjust the raw water pressure regulator to obtain the required pressure.

Readjust the engine speed if necessary.

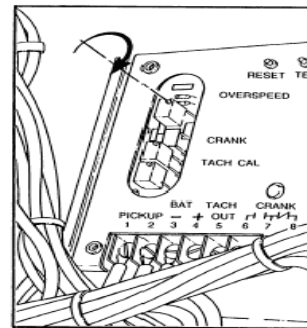
Initial Start-Up (Cont)

Adjustment procedure:

Remove the calibrating screw cover from the electronic overspeed switch.

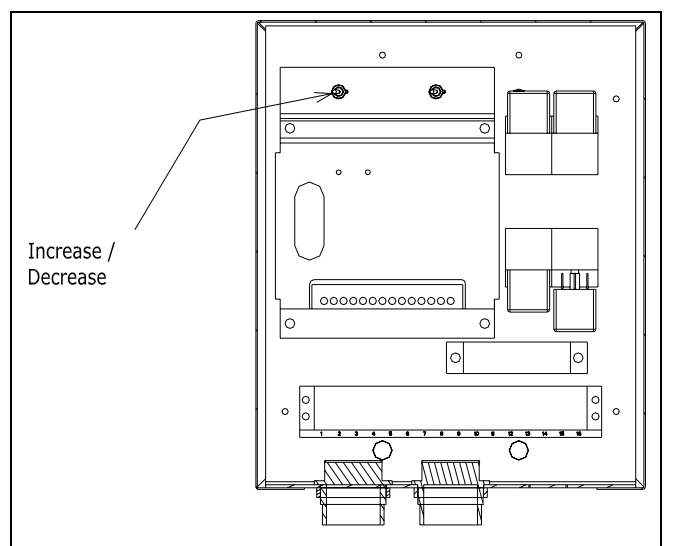


Turn the small screw on the potentiometer near the word "OVERSPEED" clockwise to increase trip speed.



Turn the screw shown to half of speed.

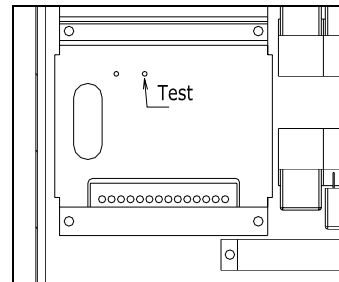
Start the engine and turn the screw to the lowest position.



Initial Start-Up (Cont)

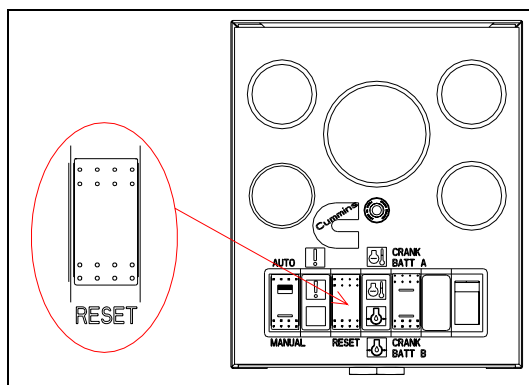
Depress the “TEST” button push-button on the back of the panel. Turn the screw to increase speed.

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.

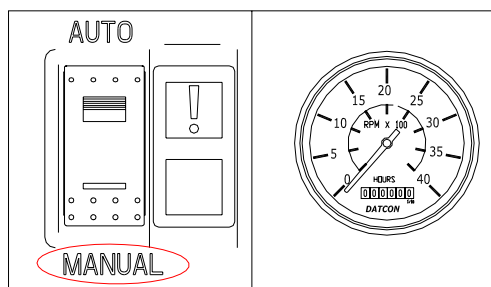


Start the engine.

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.

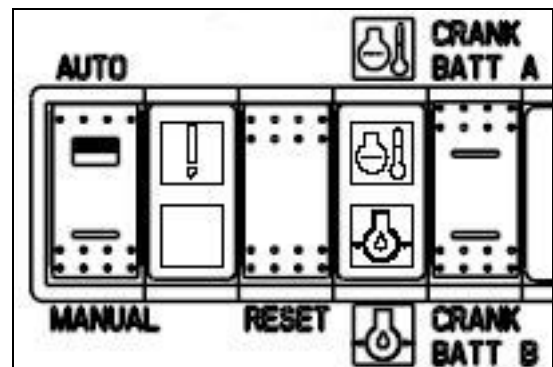
NOTE: Rated speed is displayed on the Factory Setting Tag described in Section 2.

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.

○	FACTORY SETTING	○
ENGINE SPEED SETTING: _____		
(@ HP SETTING)		
OVERSPEED SWITCH SETTING: _____		
○		○

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

Check that the engine starts and operates at 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).

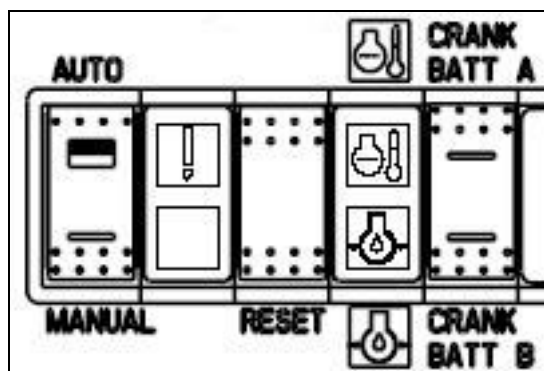
Check that raw water is flowing through the heat exchanger.

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.

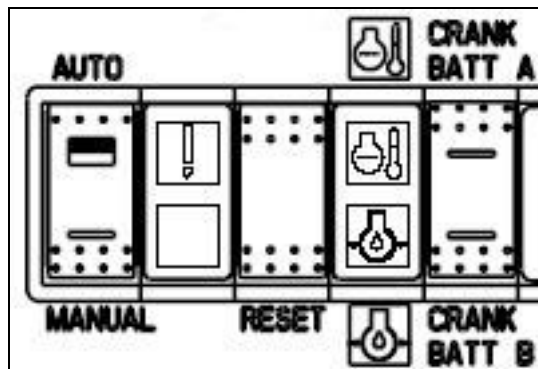
Second Start

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 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.



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 °C [180 and 203 °F].

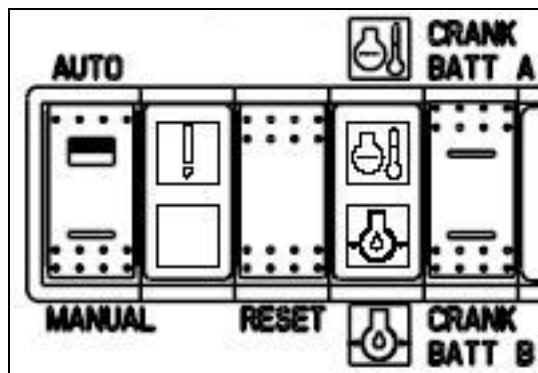
Stop the engine by pressing the RESET button.

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

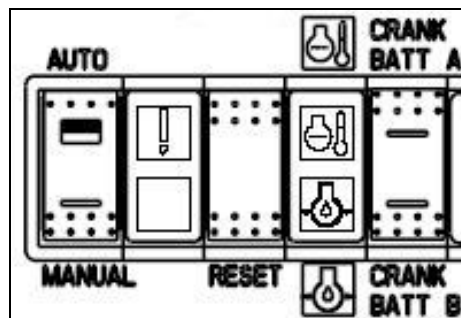
NOTE: If required, use this section to adjust the normal operating speed to the nameplate value.

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

<input type="radio"/>	FACTORY SETTING	<input type="radio"/>
ENGINE SPEED SETTING: _____		
(@ HP SETTING)		
OVERSPEED SWITCH SETTING: _____		
<input type="radio"/>		<input type="radio"/>

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.

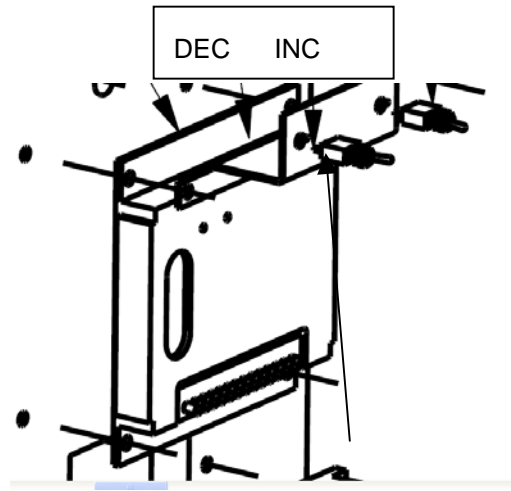
Rated Speed Setpoint Adjustment (Cont)

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.



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:	_____
○	○

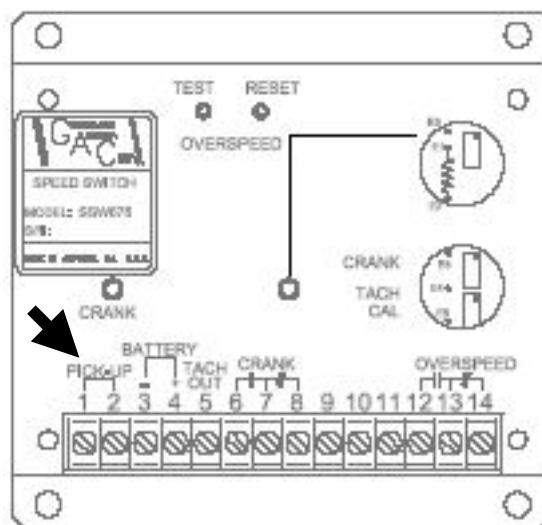
Adjust the Speed Switch:

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:

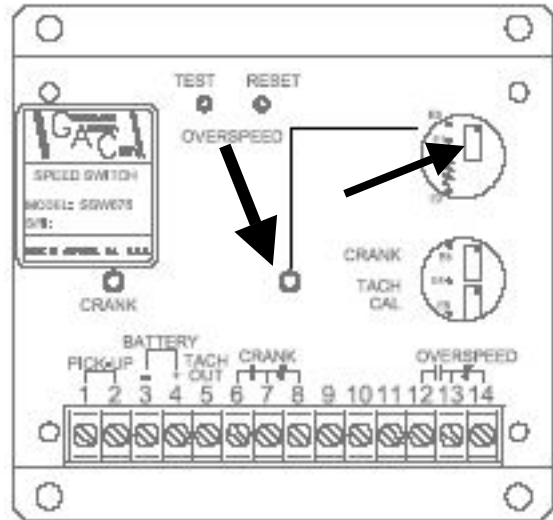
Replace the screw cover at the potentiometer.

Disconnect the signal generator.

Reset the light.

Reconnect the speed sensor input.

Perform the [Test Procedure](#) below 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.

○ FACTORY SETTING ○	
ENGINE SPEED SETTING: (@ HP SETTING)	_____
OVERSPEED SWITCH SETTING:	_____
○	○

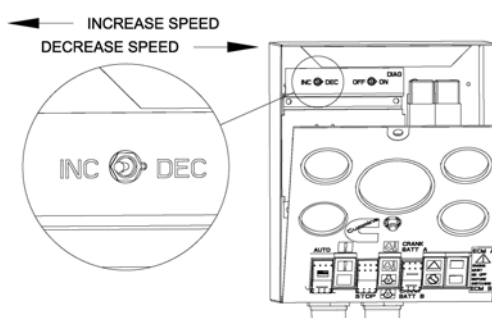
Start the engine.

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.

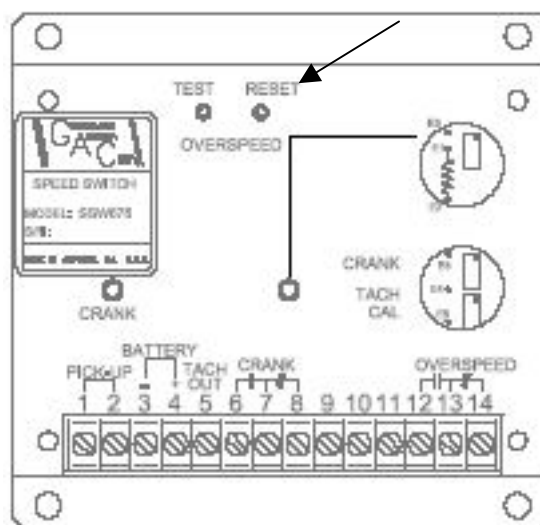
Verify that the engine tripped at a speed between 115 and 120% of rated speed.

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.



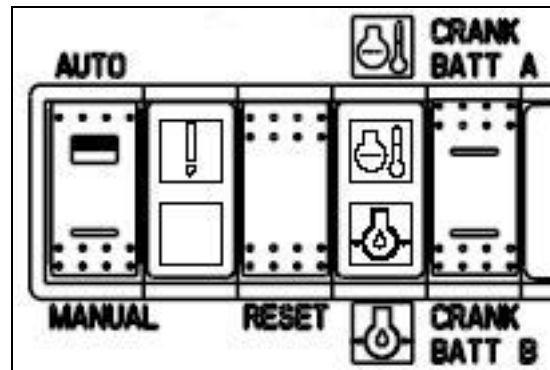
Overspeed Setpoint Adjustment and Testing (Cont)

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

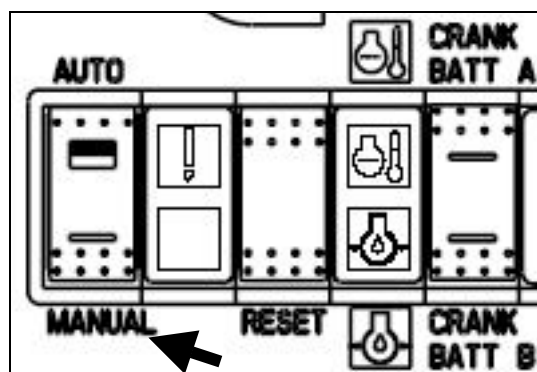
NOTE: The crank terminate signal to the remote fire pump controller informs the controller that the engine has started. This allows the controller to terminate the selected crank signal to the engine. This crank terminate signal is produced by the overspeed switch in the engine's local control panel. 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.

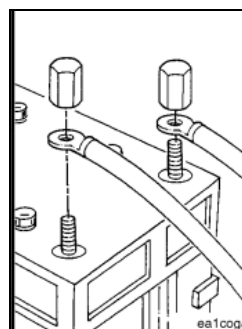


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

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.

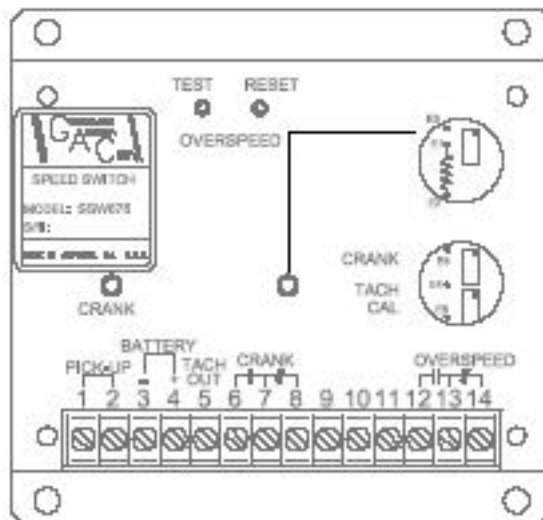
Connect a signal or pulse generator to the switch inputs with the same signal polarity.

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.

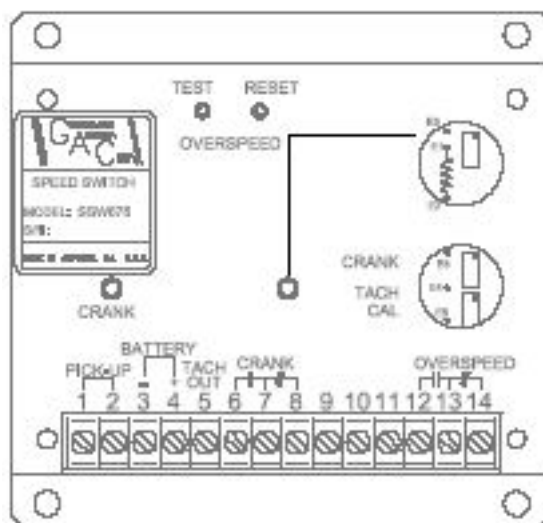


Replace the cover on the speed switch.

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.

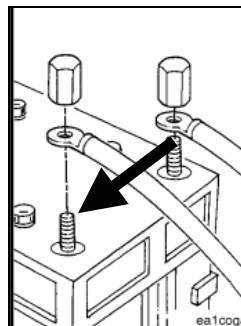


Crank Terminate Adjustment and Testing (Cont)

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.

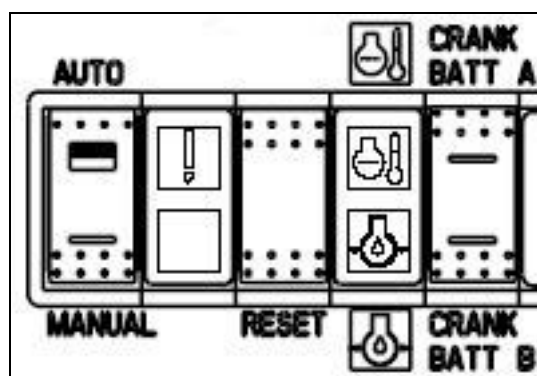
Observe that the CRANK terminal LED on the speed switch is illuminated.

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 FirePower Start-Up Inspection (SUI) Checklist. This is available on the Cummins FirePower 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.

General Operating Information

Cummins fire pumps are tested before being shipped from the factory and are ready to put to work in application regarding to fire emergencies.

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

Follow the daily maintenance checks listed in Maintenance Guidelines, Section 4.

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

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



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.

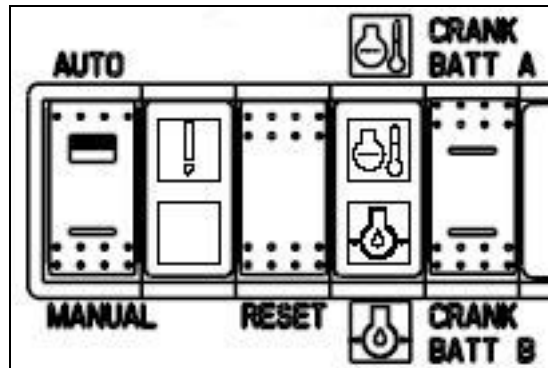
Observe the battery voltages displayed on the engine control panel. Use the battery with the highest indicated voltage.

NOTE: Depress the selected switch for up to 15 seconds or until the engine starts. Repeat up to three times if necessary.

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

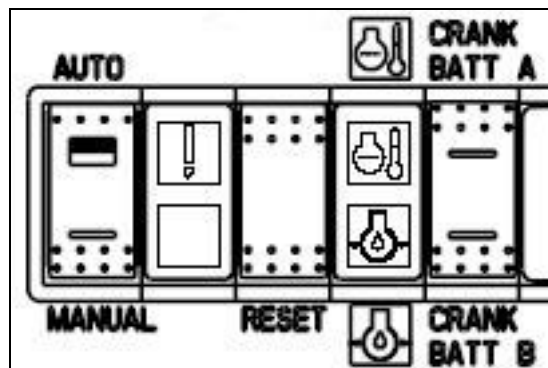
NOTE: If the engine does not start after three attempts, check the fuel supply system. Absence of blue or white exhaust smoke during cranking indicates no fuel is being delivered.

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.



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.

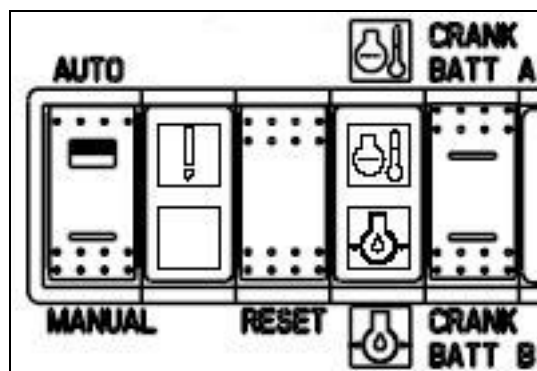


To prevent damage to the starter, do not engage the starting motor more than 15 seconds. Wait 15 seconds between each attempt to start (electrical starting motors only).

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.

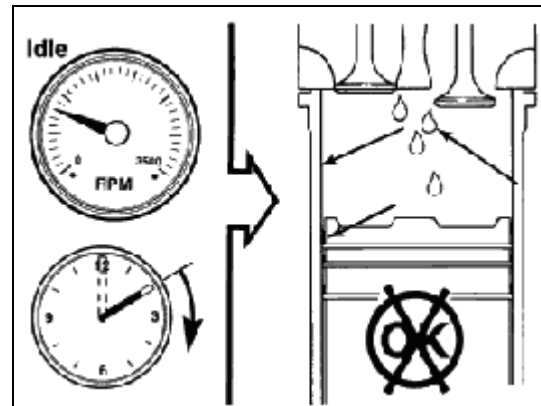
Engine oil pressure must be indicated on the gauge within 15 seconds after starting.



Normal Local Starting Procedure (Cont)



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 instructions 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.



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.

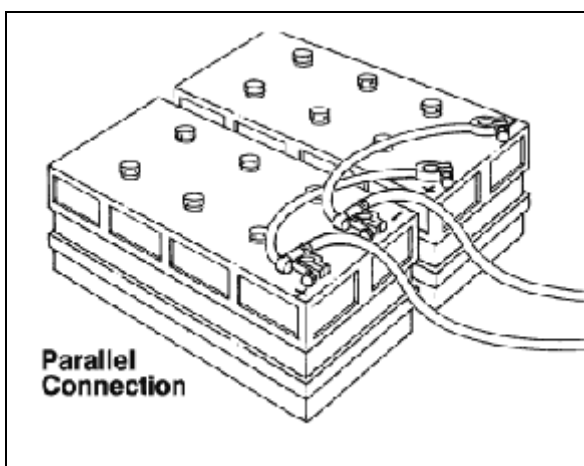


When using jumper cables to start the engine, make sure to connect the cables in parallel: Positive (+) to positive (+) and ground (-) to ground (-).

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.

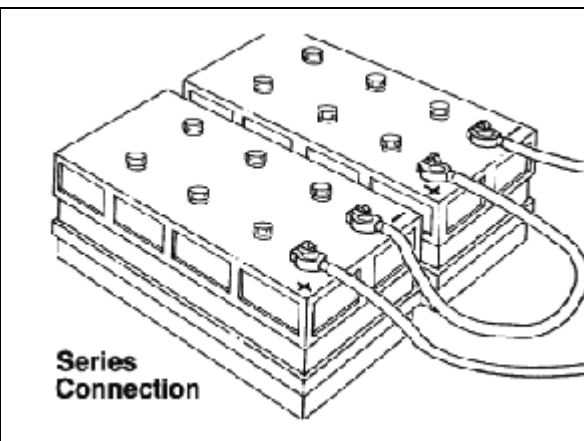
For a 24 VDC system, two or more 12 VDC batteries are connected in the parallel connection as shown. If jumpering a 24 VDC battery setup, another 24 VDC battery pair is required as the source.



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 (or radiator cap) must meet the minimum pressure of 48 kPa [7 psi].



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.

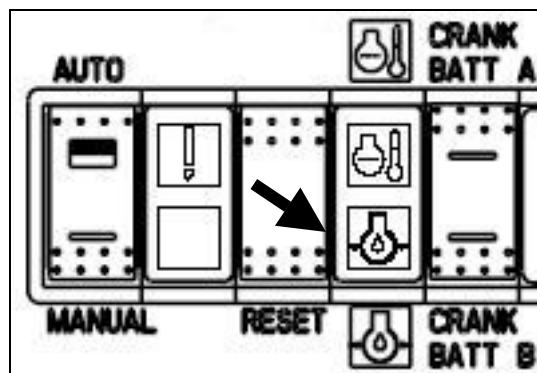
Additionally, manual means are available to start the engine in the event of some local failures. This procedure requires the manual operation of the raw water valves and the use of the manual starting lever on either of the two starting solenoids.

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.

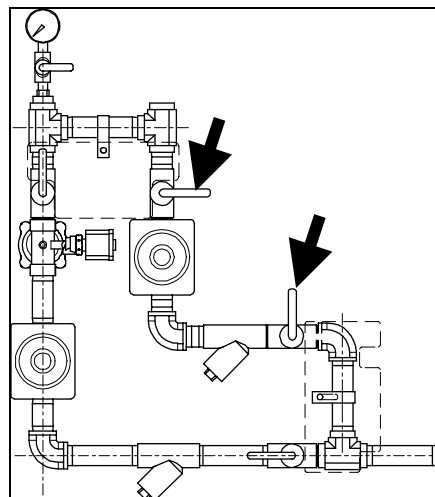
Also, if the fuel shutoff valve is known to be faulted, attempt an Emergency Manual Mode Non-Electrical Start.



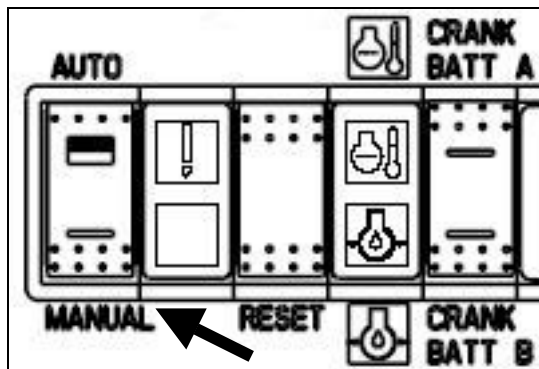
Emergency Manual Mode Electrical Start or Non-Electric Start

Starting the Engine

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



Press the MANUAL position on the AUTO/MANUAL rocker switch. By placing the control in the manual mode, the key switch is bypassed and ECM is now powered up by battery switch.

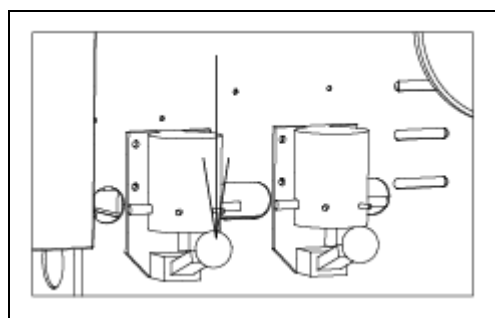


NOTE: Use the lever on either solenoid. If one does not crank the engine, then use the other.

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

When the engine starts, release the lever.

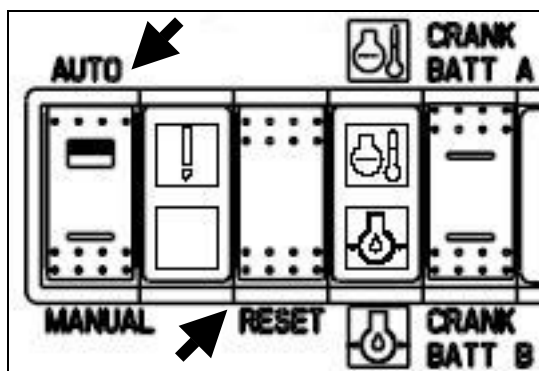
If the engine cranks but does not start, try the [Cummins Engine Troubleshooting and Repair Manual](#) for this engine model.



Emergency Manual Mode Electrical Start or Non-Electric Start (Cont)

Stopping the Engine

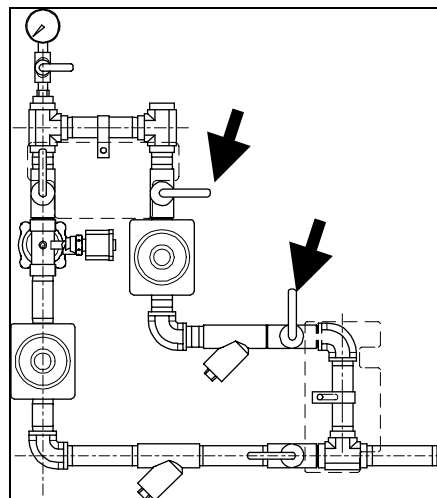
When emergency operation is done, stop the engine by pressing the AUTO position on the AUTO/MANUAL rocker switch and then press the RESET switch.



Emergency Manual Mode Non-Electrical Start

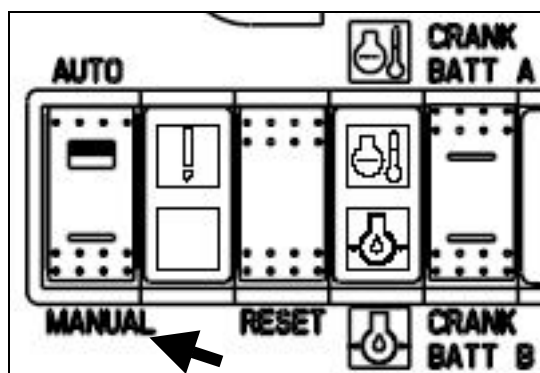
Starting the Engine

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



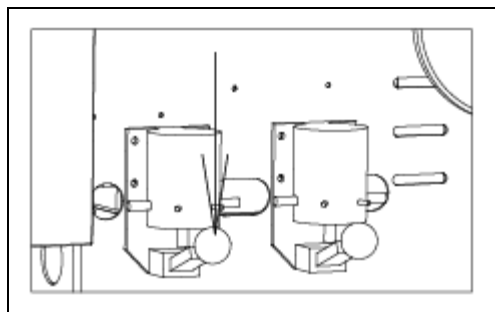
Prepare: Place the fire protection system in a safe mode for engine service.

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



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.

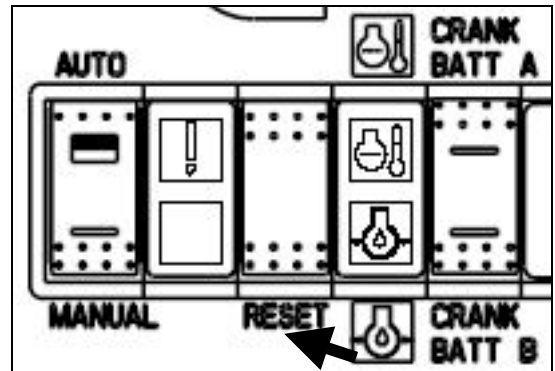


Emergency Manual Mode Non-Electrical Start (Cont)

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 the 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:

Pump 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.

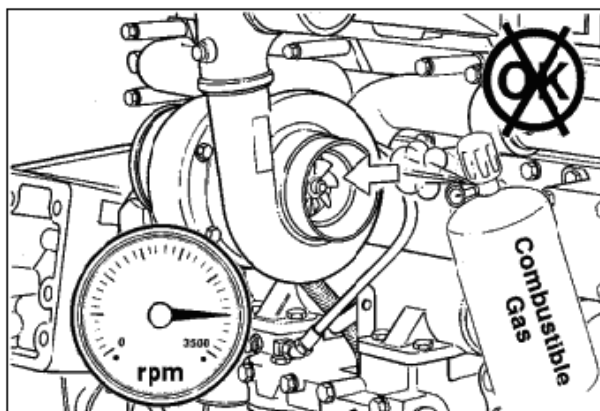
If required, vent the fuel system. Refer to Air in Fuel in Section 7.

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 Control 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 heavy-duty diesel engine applications utilize accessories (CB radios, mobile transmitters, and so forth) 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 electronically 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 FCC legal requirements.

System EMI Radiation Levels

Your Cummins product has also been designed and tested to emit minimum electromagnetic energy. Testing has shown that the fuel system, when properly installed on engines, meets or exceeds by a wide margin Part 15 of the FCC Rules and SAE J1551 specifications. Other accessories should be designed with the proper filtering to reject electromagnetic noise emission from their system. Experience has shown that the electronically controlled fuel system on engines will not interfere with onboard communication equipment for urban and suburban background electromagnetic noise levels; however, the system, if used with accessories that are not installed properly or do not utilize adequate filtering designs, can interfere with onboard communications equipment in rural applications where background radio frequency noise levels are very low.

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 (exhaust stacks, and so forth).

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

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

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

	Page
Overview	4-3
Tool Requirements	4-4
Maintenance Schedule	4-5
Maintenance Record Form.....	4-6

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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	5-5
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	5-13
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
Grease Shaft on Output			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	5-31
Check Overspeed Switch Operation						x				x				x	31	5-32
Check Drive Belt, Tensioner Bearing and Belt Tension						x				x				x	32	5-32
Check Valve Lash Clearance						x				x				x	33	5-37
Inspect Turbocharger										x					34	5-41
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

[illegible]

Section 5 - Maintenance Procedures

Section Contents

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Weekly	5-9
Every Three Months or 250 Hours	5-12
Every Six Months or 500 Hours	5-23
Every Year or 1000 Hours	5-32
Every Two Years or 2000 Hours	5-42
Every Four Years or 5000 Hours	543

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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.

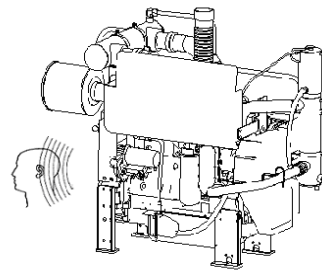
Comparison and intelligent interpretation of the daily report, along with a practical follow-up action, will eliminate most failures and emergency repairs.

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.



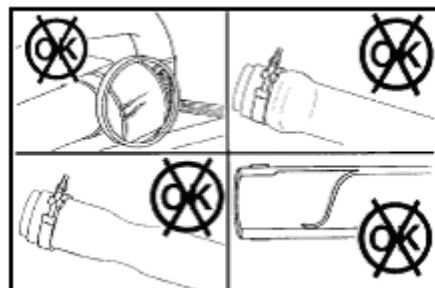
Disassemble and clean, as required. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.



Torque loosened clamps.



Torque Value: 8 N•m [72 in-lb]



Procedure 2

Check Coolant Level



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.



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.



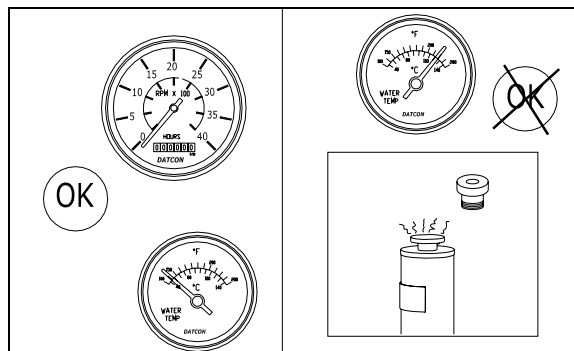
Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50°C [120°F] before adding coolant.

Press down, unscrew and remove the (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.

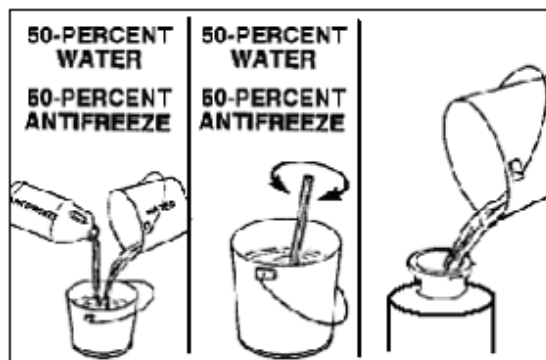
Check coolant level.



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.

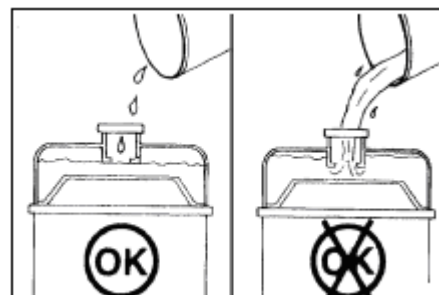
Coolant specifications can be found in Coolant Recommendations and Specifications in Section 7.

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).



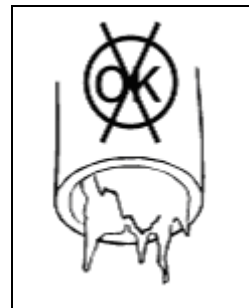
Procedure 3

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



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.

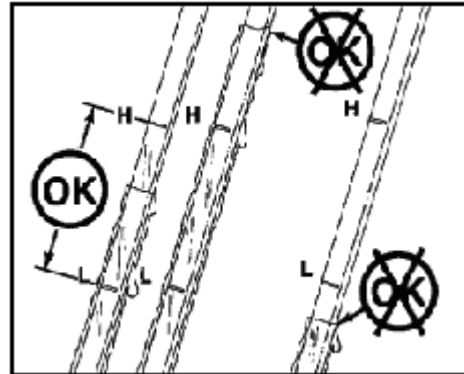
If the lube oil level is greater than the high mark, drain the excessive oil. Refer to [Drain Oil in Change Lubricating Oil and Filters](#) in Section 7.

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.



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.

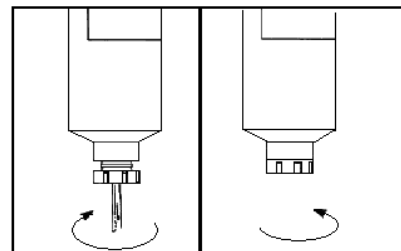
Drain the filter sump until clear fuel is visible.



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.

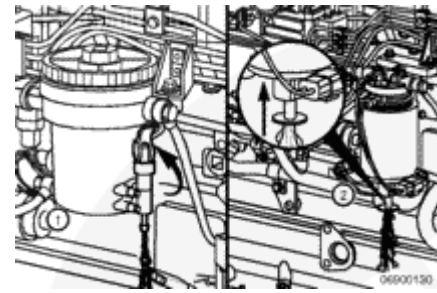


Canister Type

Shut off the engine.

Pull up on the drain valve lever until fluid drains out of the drain tube. Drain the filter sump until clear fuel is visible.

Push up on the drain valve until fluid drains out of the drain tube.



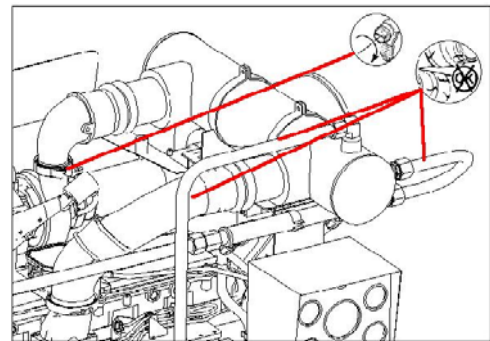
Procedure 6

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.

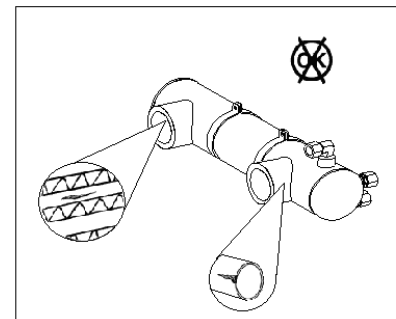
Torque Value: 8 N•m [72 in-lb]



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.

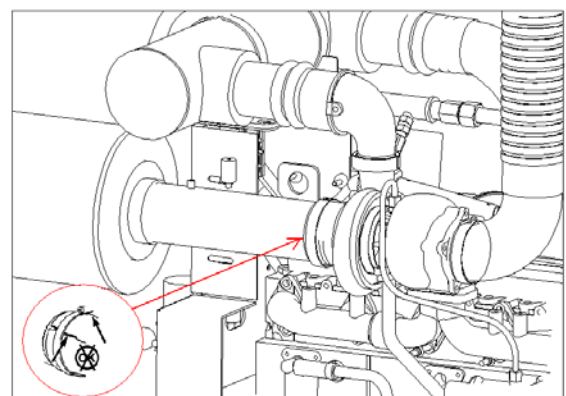


Inspect the intake piping daily for wear points and damage to piping, loose clamps, or punctures that can damage the engine.

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.

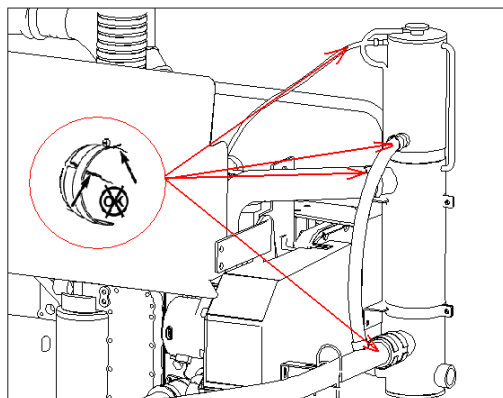


Procedure 7**Check Coolant Heat Exchanger Piping**

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



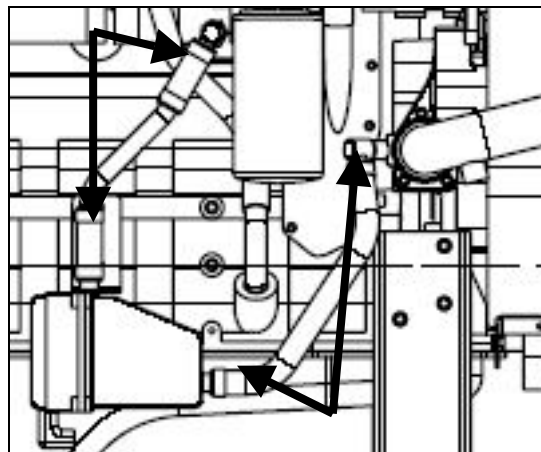
Replace damaged tubes, clamps, or pipes, and tighten loose clamps, as necessary, to prevent the coolant system from leaking. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.

**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

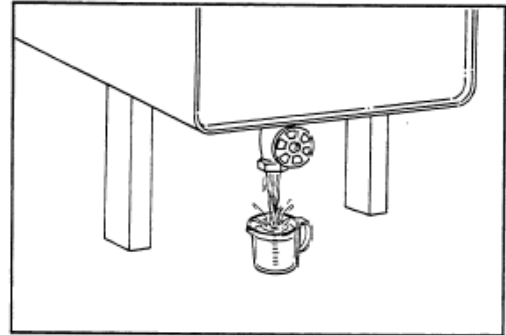
Bleed Fuel Tanks

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

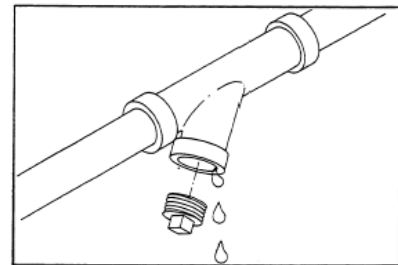
Clean Raw Water Strainers

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.

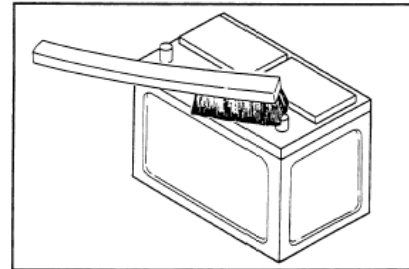


Procedure 11

Check Battery Condition

Inspect the condition of the batteries.

Refer to Section 7 for inspection and maintenance procedures.



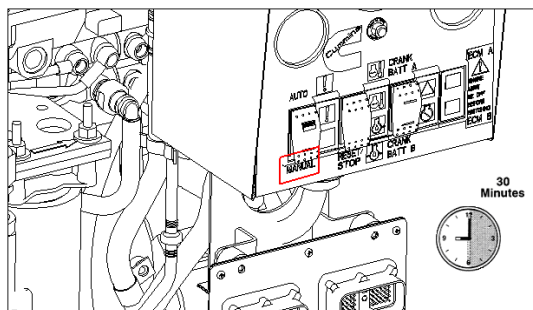
Procedure 12

Test Run Engine

Start Test Run

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

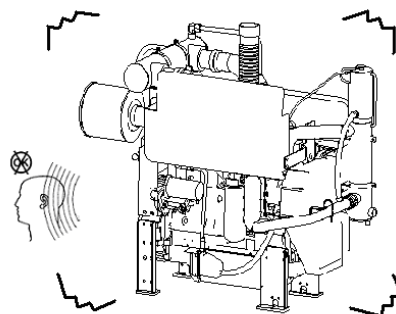
Press the **CRANK A** or **CRANK B** switch.

**Check Unusual Engine Noise**

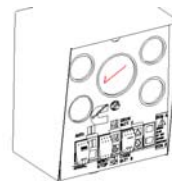
Run the engine no less than 30 minutes to attain normal running temperature.

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

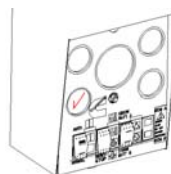
Check running indications.



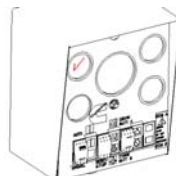
Observe that the engine is operating at test speed as follows:



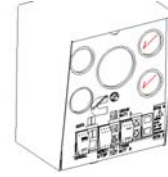
Check oil pressure is greater than 10 PSI



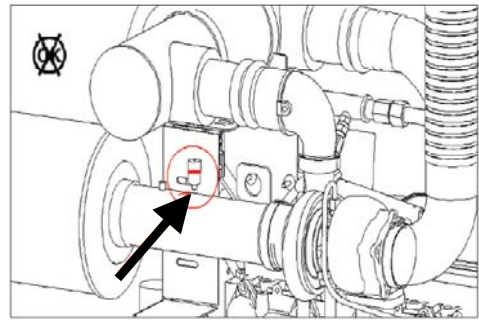
Check coolant temperature is between 140°F and 212°F.



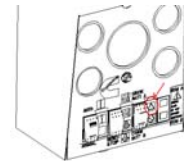
Check that both battery voltmeters indicate 12 VDC standard (24 VDC optional) depending upon the application.



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

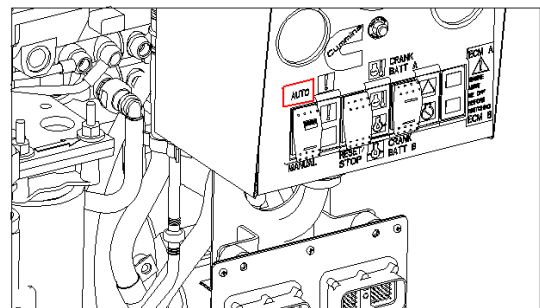


Check that the Fuel Injection Failure (F.I.F.) light is not turned on.



End Test Run

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



Every Three Months or 250 Hours

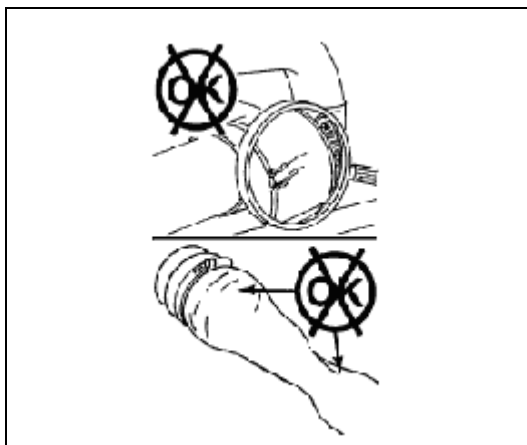
General Information

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.



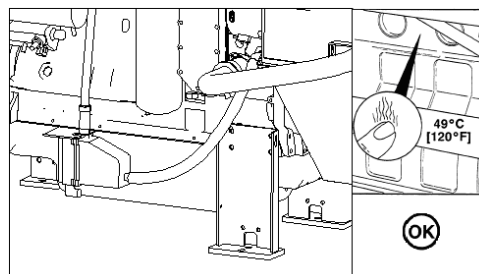
Procedure 14

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.

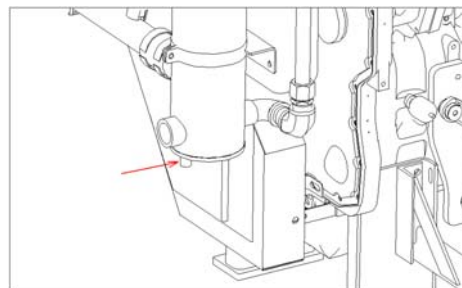


Procedure 15

Inspect Heat Exchanger Zinc Plug

Remove the zinc plug.

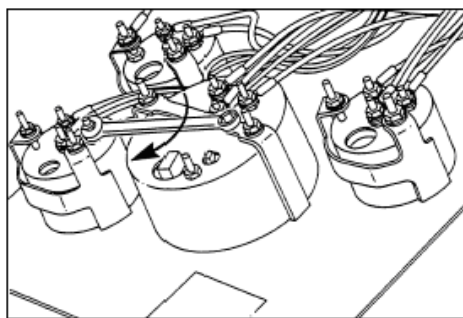
Inspect the plug. If it has eroded over 50 percent, replace the plug (Cummins Fire Power Part No. 9750) and brass fitting (Cummins Fire Power Part No. 9751).



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.

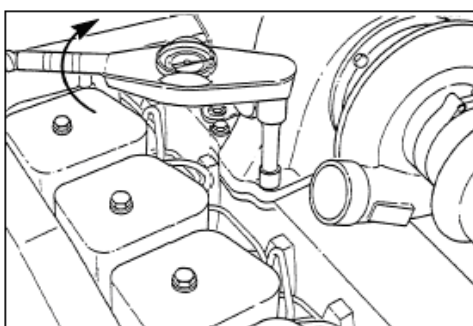


Procedure 17

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

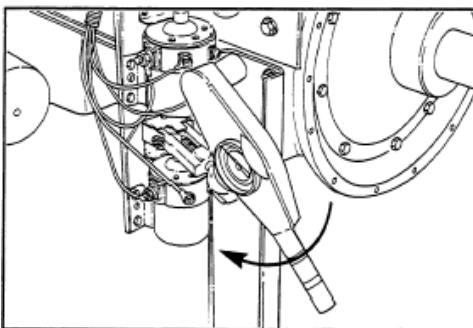


Damaged engine mounts and brackets can cause engine misalignment. Driveline component damage can result in vibration complaints.

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



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**

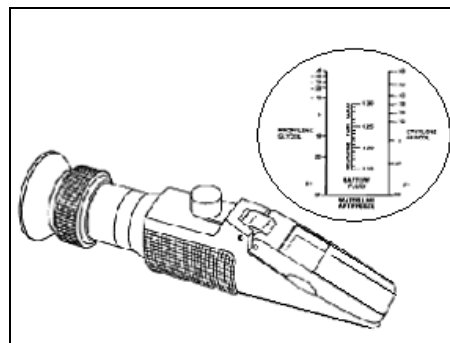
Over concentration of antifreeze or use of high-silicate antifreeze can damage the engine.

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**

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.

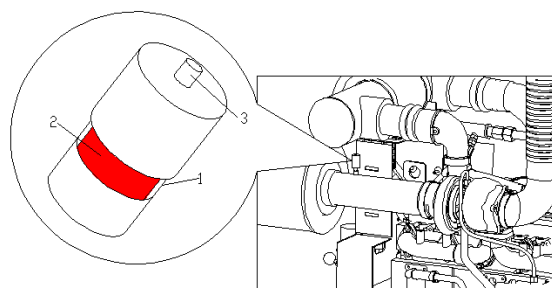
Check the air cleaner service indicator, if equipped.

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

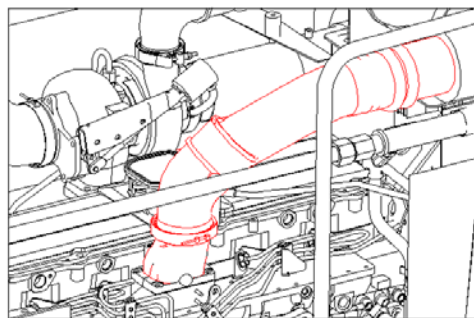
Inspect Air Intake System Piping

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.

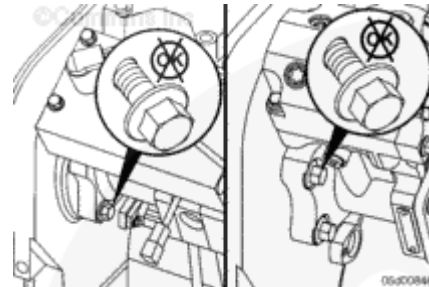
Disassemble and clean as required.



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



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



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.



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.



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

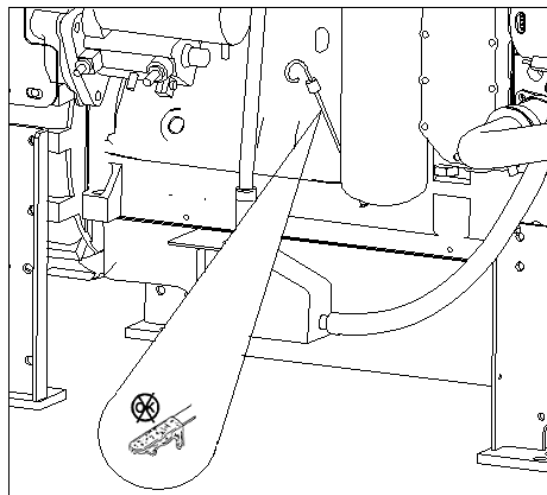
Engine oil becomes contaminated and essential oil additives are depleted with use. The amount of contamination is related to the total amount of fuel and oil consumed.

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.



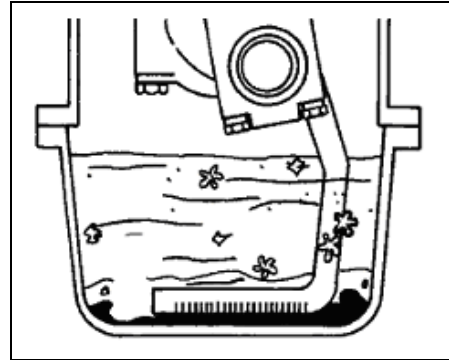
Drain



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.

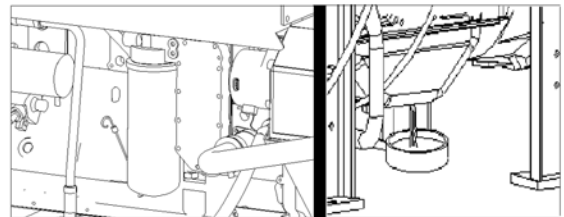


Change the oil and filters to remove the contaminants suspended in the oil.

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



Hot oil can cause personal injury.



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

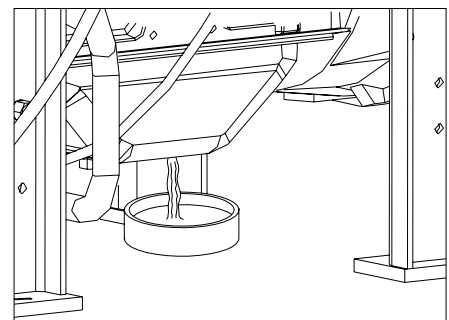
Shut the engine off.

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.

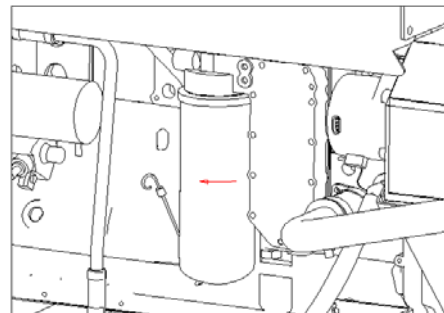
Drain the oil immediately to make sure all the oil and suspended contaminants are removed from the engine.



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**

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.

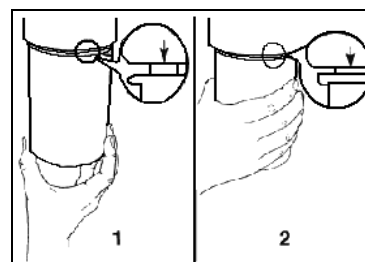
Fill the filter with clean 15W-40 oil.



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.

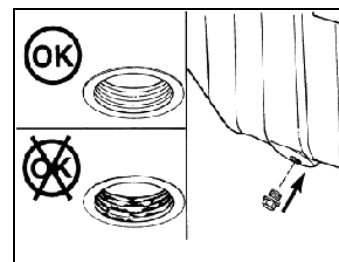
Install the filter as specified by the filter manufacturer.



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

Install the oil drain plug.

Torque Value: 50 N•m [37 ft-lb]



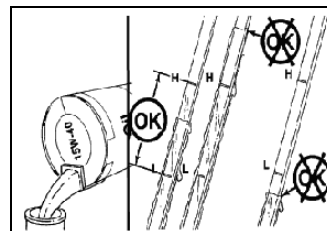
NOTE: Use a high-quality 15W-40 multiviscosity lubricating oil, such as Cummins Premium Blue®, or its equivalent, in Cummins engines. Choose the correct lubricating oil for your operating climate as outlined in Section 5.



Fill the engine with clean oil to the proper level.

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

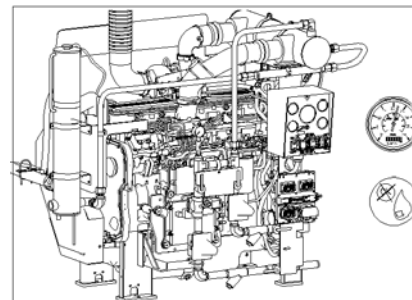
NOTE: When filling the oil pan, use the fill tube on the side of the engine rather than on top of the rocker lever cover.



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.

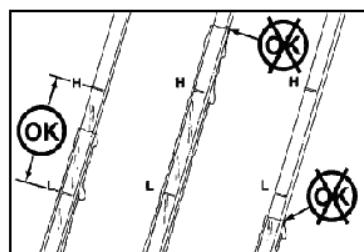


Stop the engine.

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)



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.



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.



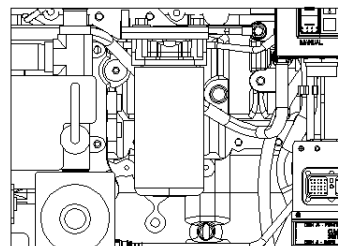
Mechanical overtightening can distort the threads as well as damage the filter element seal or filter canister.

Remove

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

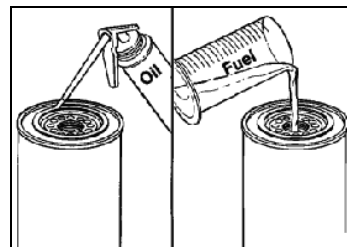
Clean the area around the fuel filter head. Remove the filters. Clean the gasket surface of the filter head.

Replace the o-ring.

**Install**

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

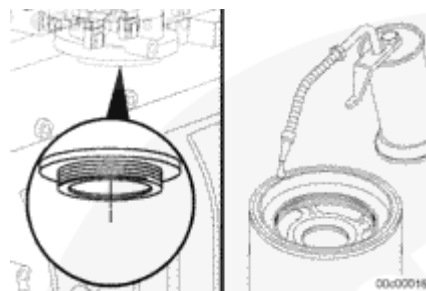
Fuel-water separator - used in single-filter applications.



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.

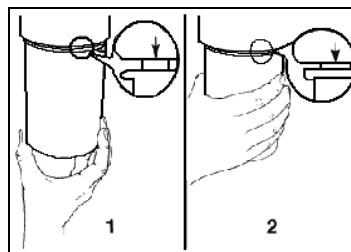
Be sure the center seal ring is installed onto the filter spud.





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

Install the filter as specified by the filter manufacturer.

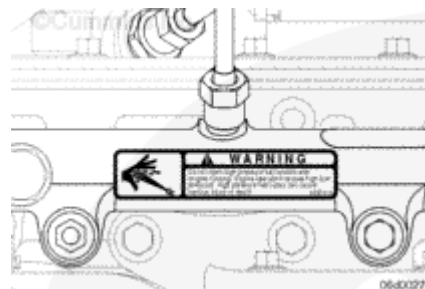


Prime



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.

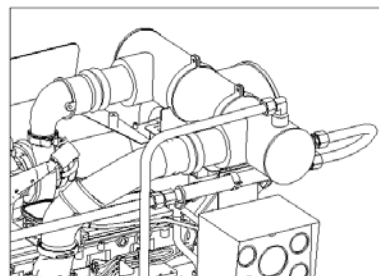
Procedure 25

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.



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.



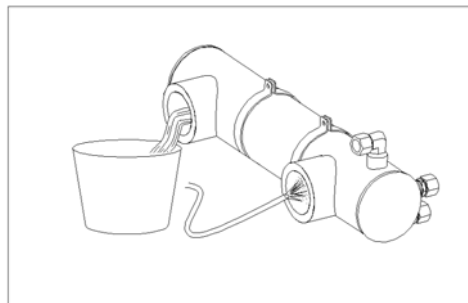
Do not use caustic cleaners to clean the charge air cooler. Damage to the charge air cooler will result.

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.

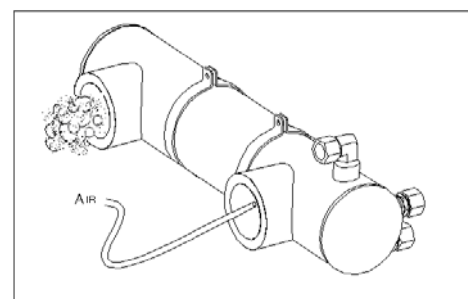


After the charge air cooler has been thoroughly cleaned of all oil and debris with solvent, wash the charge air cooler internally with hot, soapy water to remove the remaining solvent.

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.



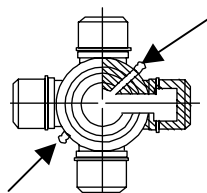
Procedure 26

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

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



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

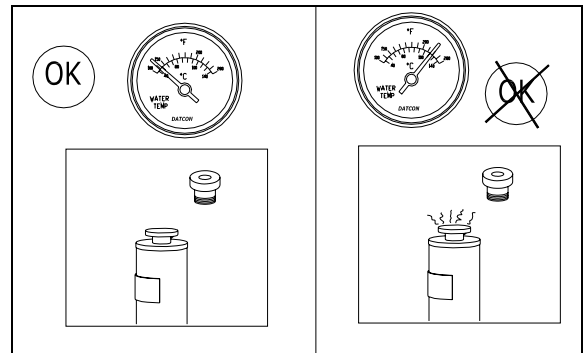


Wait until the temperature is below 50°C [120°F] before removing the coolant system pressure cap (Cummins Fire Power Part No. 11407). Failure to do so can cause personal injury from heated coolant spray.

Avoid excessive contact - wash thoroughly after contact.

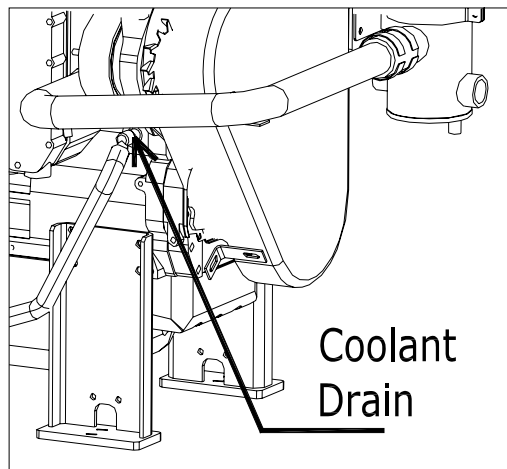
Keep out of reach of children.

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.



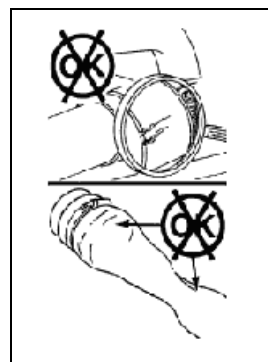
Coolant
Drain

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.

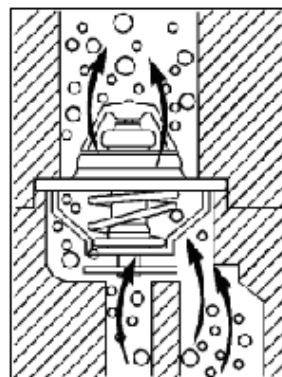


Flush



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.

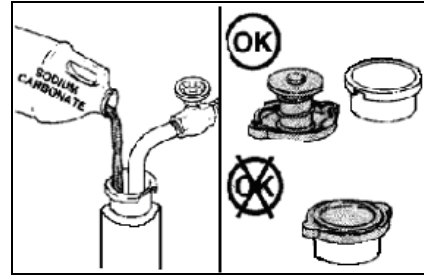
NOTE: Adequate venting is provided for a fill rate of 10 liters/minute [2.6 gal/min].



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

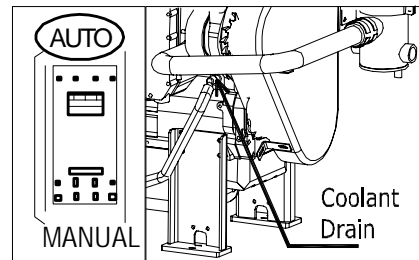
Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent).

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].

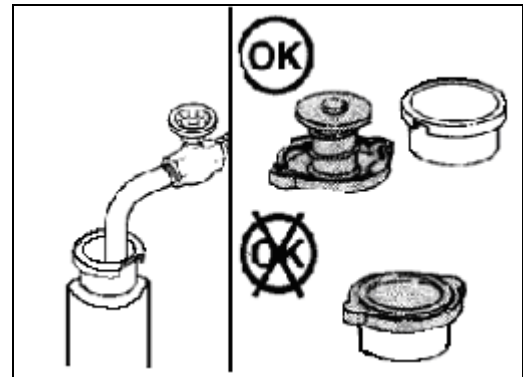
Shut the engine off, and drain the cooling system.



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.

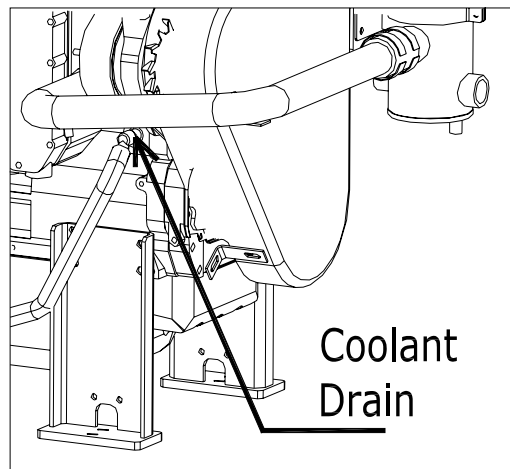


Operate the engine for 5 minutes with the coolant temperature above 82°C [180°F].

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.

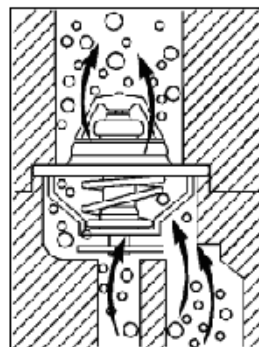


Fill



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

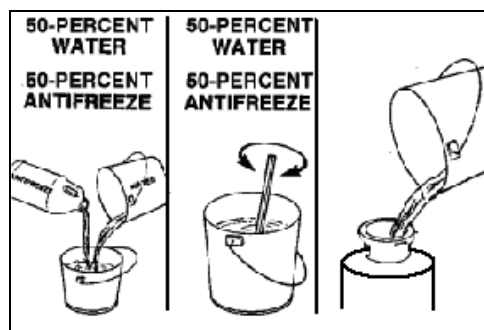
The system has a design fill rate of 10 liters/minute [2.8 gal/min].



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]





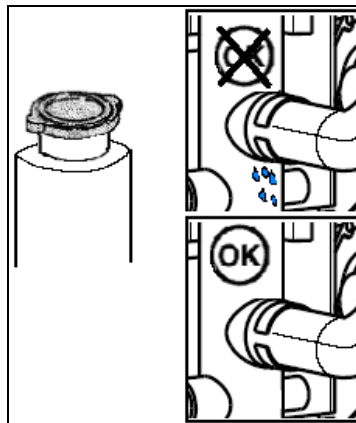
WARNING

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

Remove

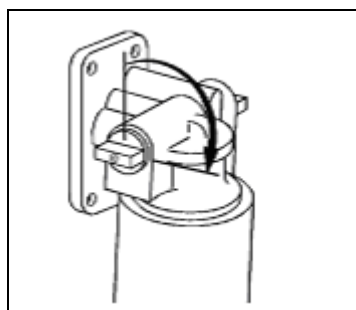


WARNING

Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Remove the coolant system pressure cap and close the shutoff valve before removing the coolant filter. Failure to do so can result in personal injury from heated coolant spray.

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

Turn the shutoff valve to the OFF position by rotating the knob from vertical to horizontal in the direction shown.



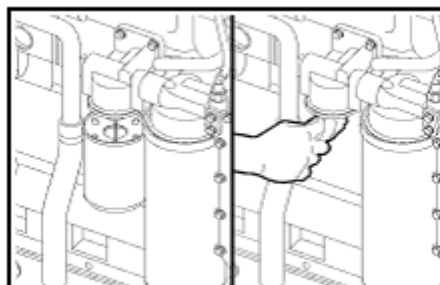
WARNING

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.



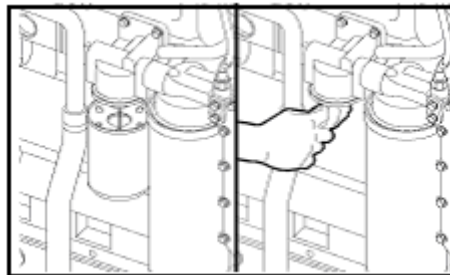


Use caution when draining coolant that coolant is not spilled or drained into the bilge area. Do not pump the coolant overboard. If the coolant is not reused, it must be discarded in accordance with local environmental regulations.

Remove and discard the coolant filter.

Clean

Clean the gasket surface.



Install



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

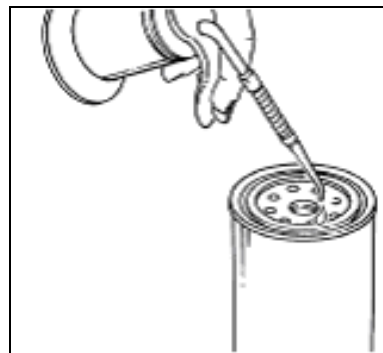


Mechanical over-tightening can distort the threads or damage the filter head.

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.

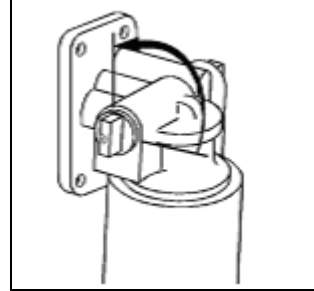
Tighten the coolant filter an additional 1/2 to 3/4 of a turn, or as specified by the filter manufacturer.





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 in the direction shown.



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)

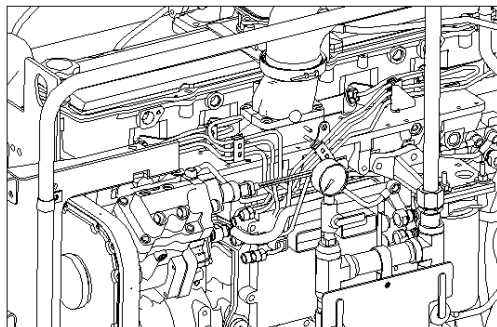
Open the vent screw.

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)

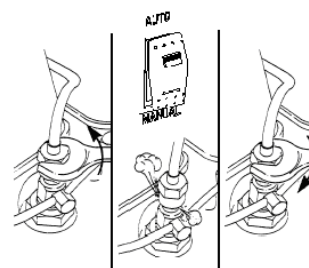
The low pressure fuel lines are bled by pumping the hand lever on the filter head.

**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.

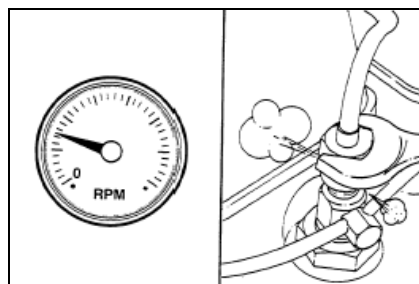
Venting is accomplished by loosening one or more fittings at the injectors and cranking the engine to allow entrapped air to bleed from the lines.



WARNING

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

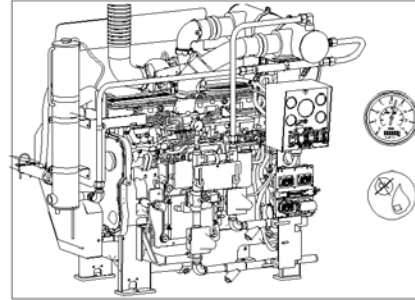
With the engine at idle, vent one line at the time until the engine runs smoothly.



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.

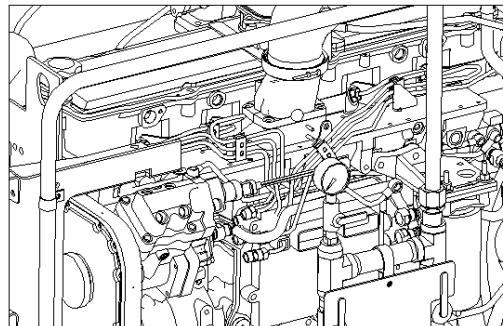


WARNING

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.



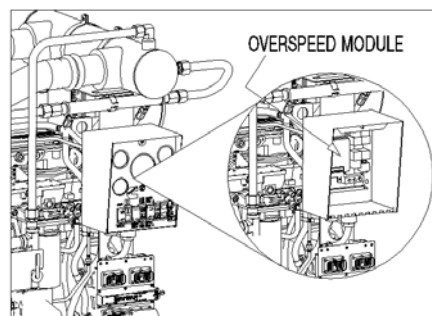
Every Year or 1000 Hours**General Information**

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.

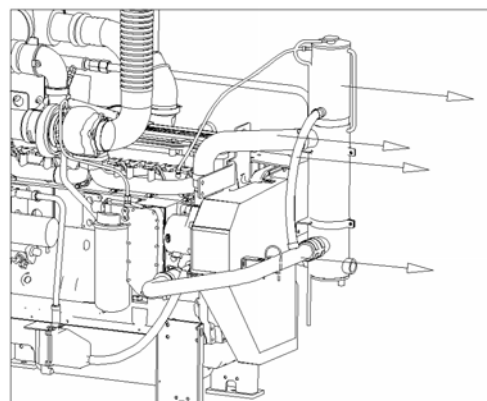
Procedure 31 Check Overspeed Switch Operation

Check the overspeed switch for operation.

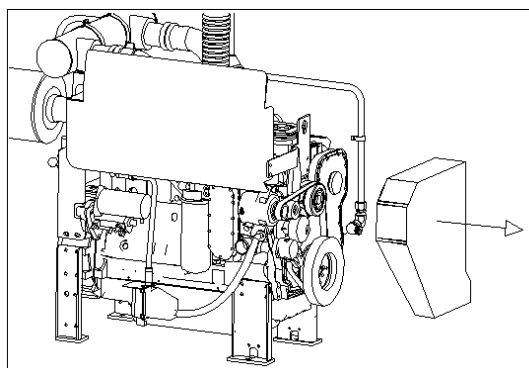
Refer to Operating Instructions in Section 3 of the Operational Manual for settings.

**Procedure 32 Check Drive Belt, Tensioner Bearing and Belt Tension****Inspect**

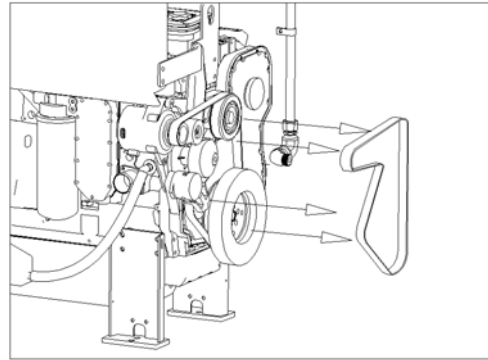
Remove heat exchanger, piping and hoses



Remove the belt guard.



Remove the drive belt.



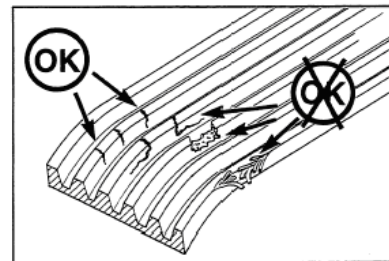
Poly-Vee Belt

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

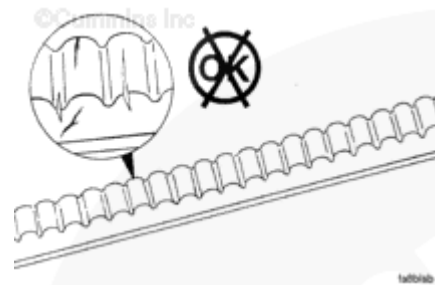
Incorrect size or length

Pulley misalignment

Incorrect installation

Severe operating environment

Oil or grease on the belts

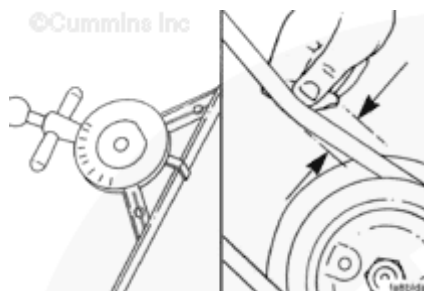


Measure the belt tension in the center span of the pulleys.

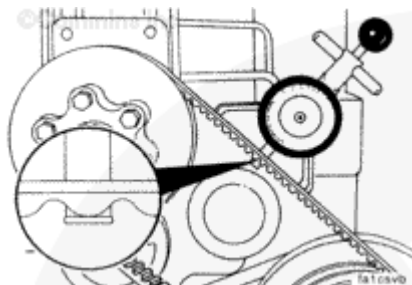
Refer to the Belt Tension Chart in Section V for the correct gauge and tension value for the belt width used.

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.

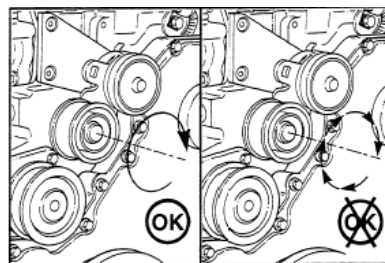


For cogged belts, make sure that the belt tension gauge is positioned so that the center tensioning leg is placed directly over the high point (hump) of a cog. Other positioning will result in incorrect measurement.



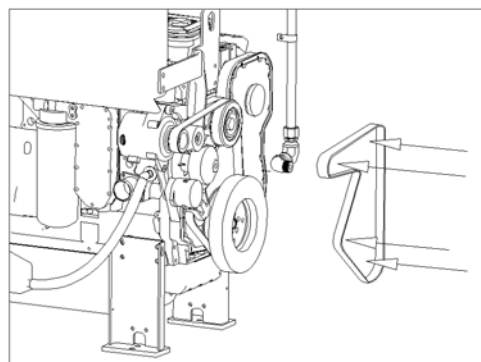
Check the tensioner bearing.

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

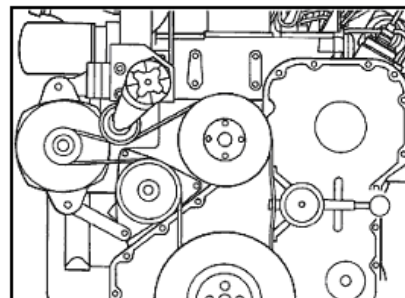


Replace tensioner or bearing if defective.

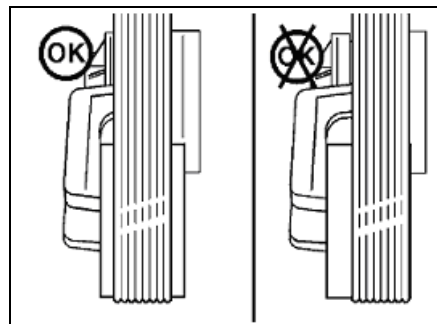
Install the drive belt.



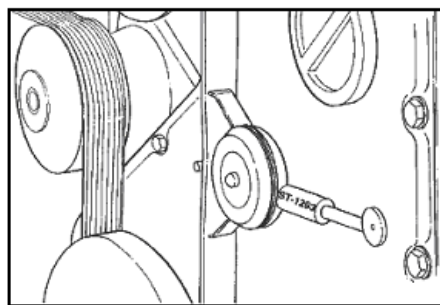
**Torque Value: Tension Limit: 360 to 490 N•m
[266 to 361 ft-lb]**



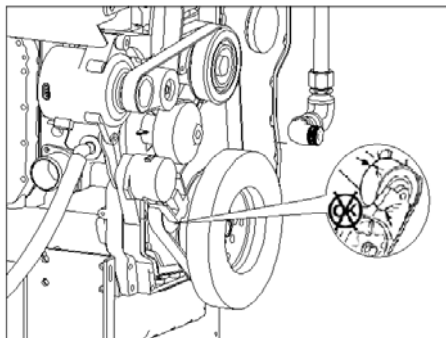
Check the location of the drive belt on the belt tensioner pulley. The belt should be centered on, or centered close to the middle of, the pulley. Unaligned belts, either too far forward or backward, can cause belt wear, belt roll-off failures, or increase uneven tensioner bushing wear.



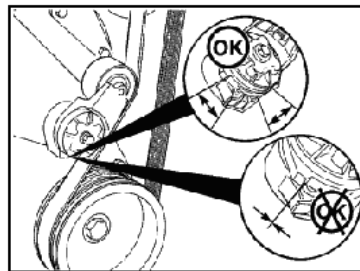
Use the Cummins belt tensioner gauge, Part No. 3822524, to measure the tension in the drive belt. This needs to be in the range of 360 to 490 N•m [266 to 361 ft-lb].



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.



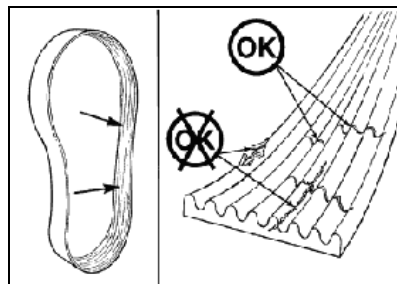
Remove the drive belt, and check the torque of the tensioner capscrew. After checking the torque, use a breaker bar with a 3/8-inch ratchet to rotate the tensioner slowly away from the area of belt contact. If the arm rotates with any roughness or hesitancy, replace the tensioner.

Torque Value: 43 N•m [32 ft-lb]



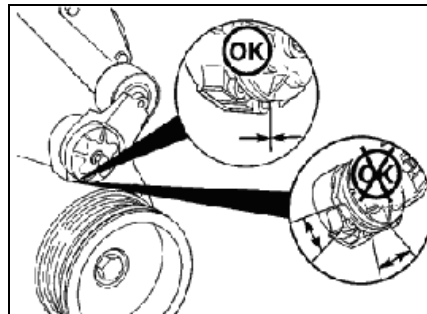
Check the belt for damage. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of the belt length) cracks that intersect with transverse cracks are not acceptable.

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.



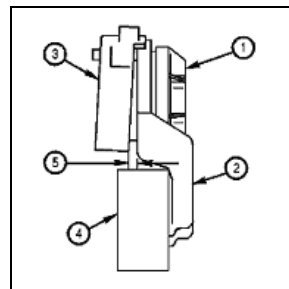
Measure the clearance between the tensioner spring case and the tensioner arm to verify tensioner wear-out and uneven bearing wear.

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.

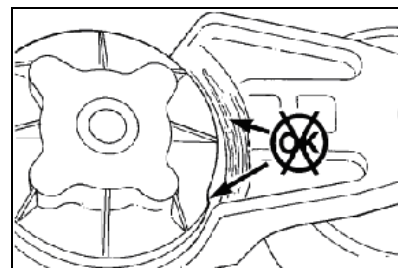
1. Tensioner cap
2. Tensioner arm
3. Spring case
4. Tensioner pulley
5. Clearance gap



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.

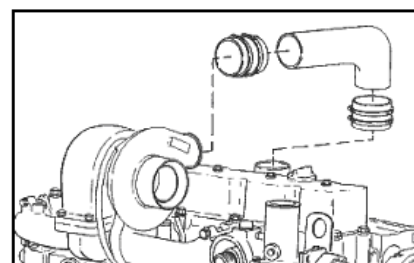


Procedure 33

Check Valve Lash Clearance

Adjust

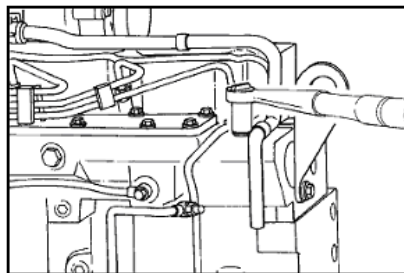
Remove the air crossover tube from the engine if equipped.



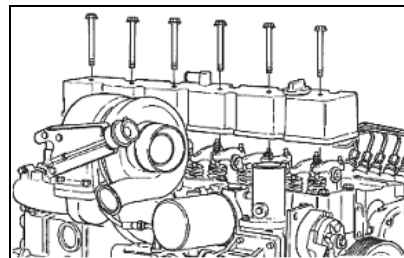
Disconnect the support clamps, hose clamp, and wastegate sensing line.



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

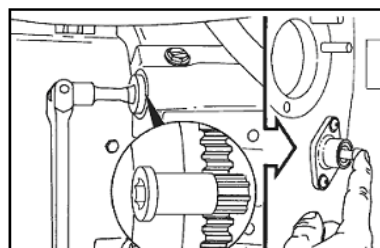


Remove valve cover.

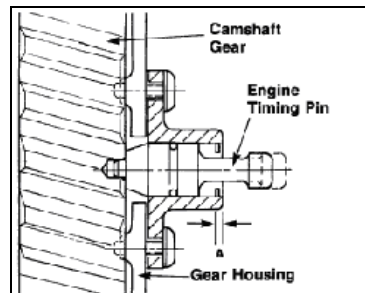


Locate top dead center for cylinder No. 1 by rotating the crankshaft slowly while pressing on the engine timing pin.

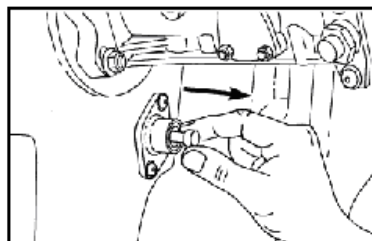
The barring gear inserts into the flywheel housing and engages the flywheel ring gear. The engine can then be rotated by hand using a 1/2-inch ratchet or breaker bar.



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



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

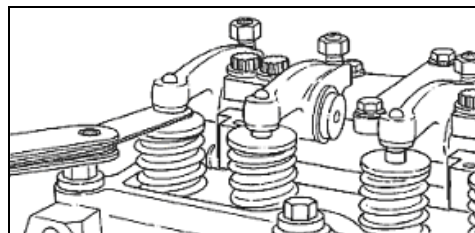


Intake clearance: 0.30 mm [0.012 in]

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.

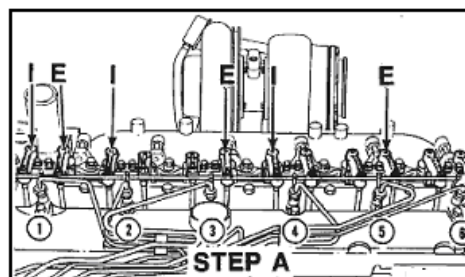


Locate top dead center for cylinder No. 1.

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

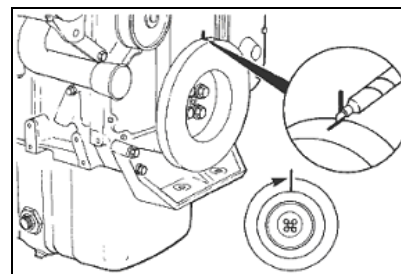
After tightening the rocker lever locknut, check the valve clearance to make sure the valve clearance has not changed.

Torque Value: 24 N•m [212 in-lb]



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

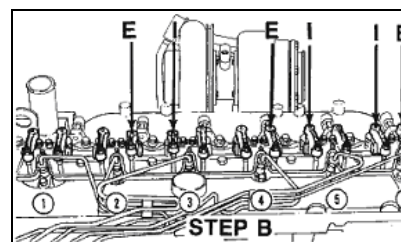
Mark vibration damper and rotate the crankshaft 360 degrees.



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.

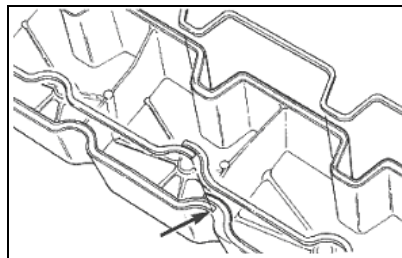
If the seal is damaged, install a new seal.

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.

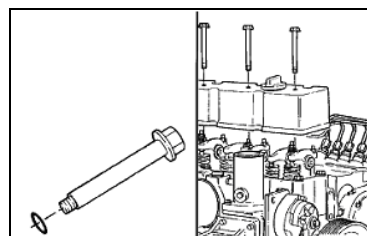
If the seal has more overlap than shown in the illustration, trim the length to provide the correct overlap.



Install new sealing o-rings on the capscrews.

Install the valve cover and wastegate sensing tube.

Torque Value: 24 N•m [212 in-lb]

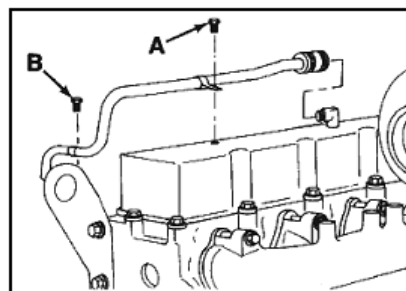


Install the crankcase vent tube, and secure with the support clamps and hose clamp.

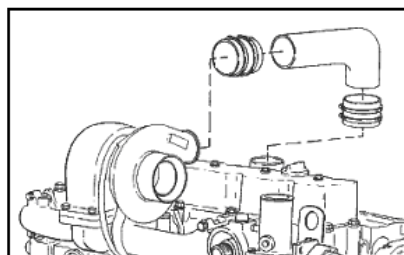
Torque Values:

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.



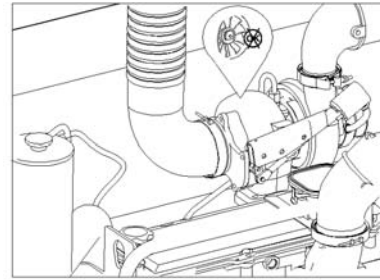
Procedure 34

Inspect Turbocharger

Remove the air intake and the exhaust piping.

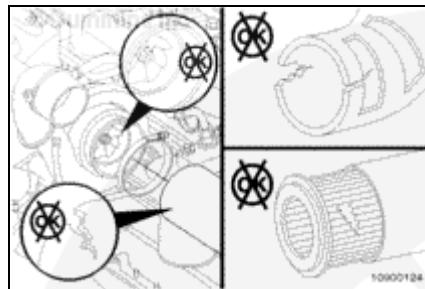
Look for damaged or cracked compressor or turbine blades.

Check to see that the turbocharger shaft spins freely.



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

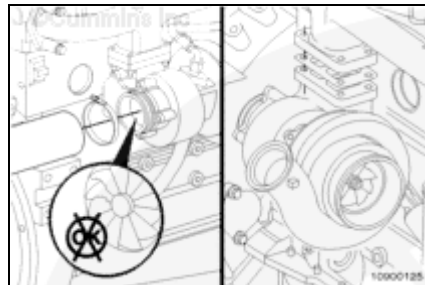
Repair any damage before operating the engine.



Remove the exhaust pipe from the turbocharger.

Inspect the turbine wheel for damage.

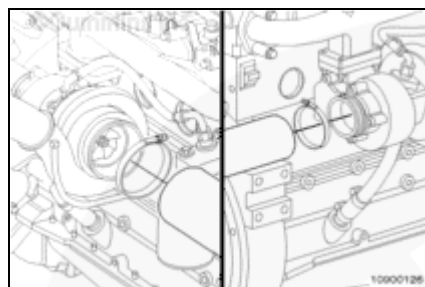
Replace the turbocharger if damage is found. Contact a Cummins Authorized Repair Location for replacement.



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**

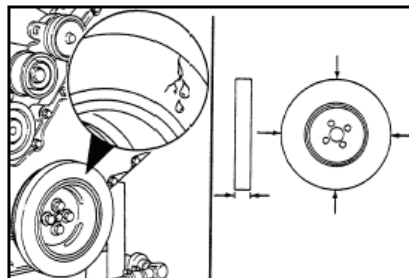
The silicone fluid in the vibration damper will become solid after extended service and will make the damper inoperative. An inoperative vibration damper can cause major engine or drivetrain failures.

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.

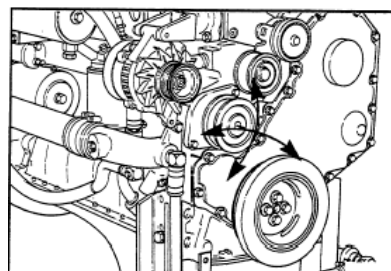
Viscous dampers have a limited life. The maximum damper life specifications are located in Maintenance Specifications.

**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.

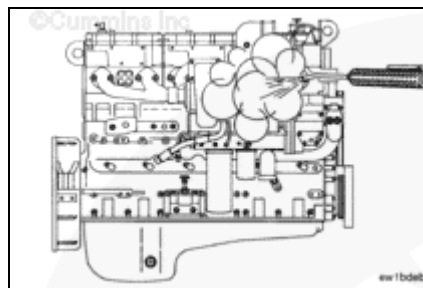
Refer to the Troubleshooting and Repair Manual for more information.

**Procedure 37****Engine Steam Cleaning**

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.

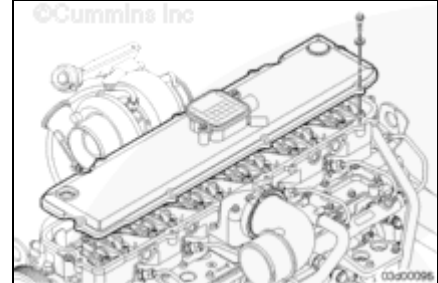


Remove the variable geometry turbocharger actuator air supply line, if equipped.

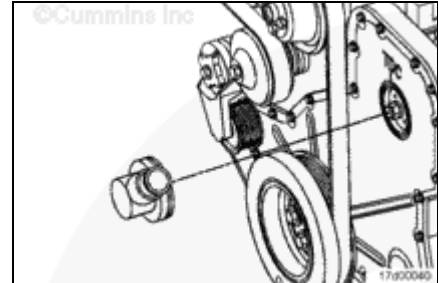
Remove the capscrews.

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.

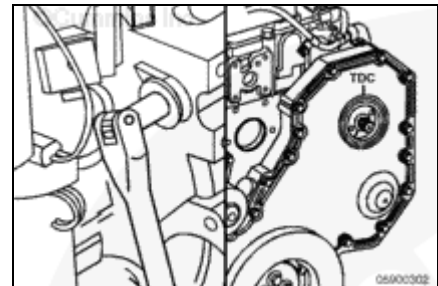


Adjust



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.

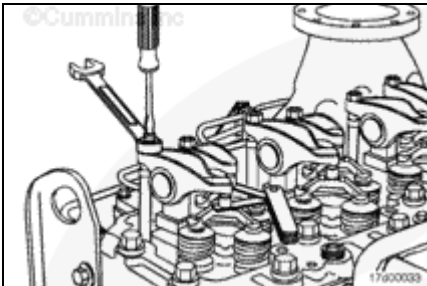


With the engine in this position, lash can be checked on the following rocker arms: 1I, 1E, 2I, 3E, 4I, and 5E.

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.



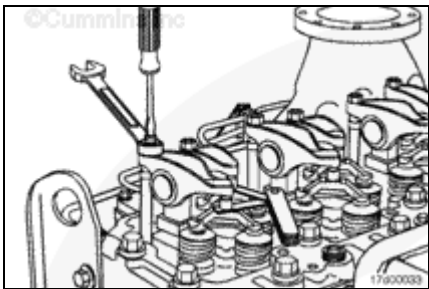
Lash Reset Specifications

	mm		in
Intake	0.305	NOM	0.012
Exhaust	0.559	NOM	0.022

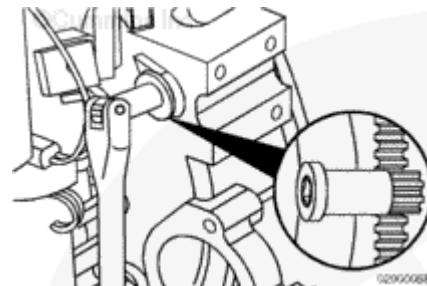
NOTE: Lash resets are only required at the interval specified in the Maintenance Schedule, when lash is measured and found out of specification, or when engine repairs cause removal of the rocker arms and/or loosening of the adjusting screws.

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.



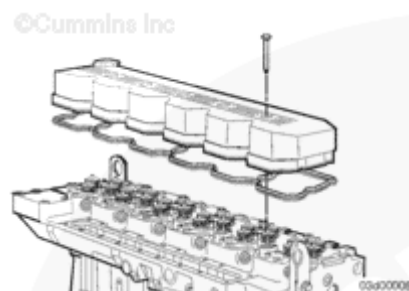
Finishing Steps

Center Bolted Rocker Lever Cover

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

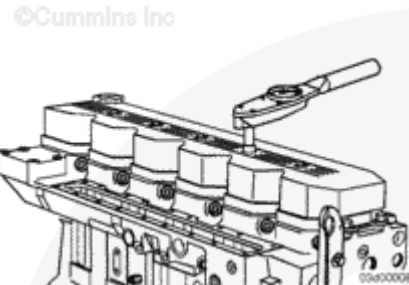


Install the rocker lever cover and capscrews.



Tighten the capscrews.

Torque Value: 12 N•m [106 in-lb]



Perimeter Bolted Rocker Lever Cover

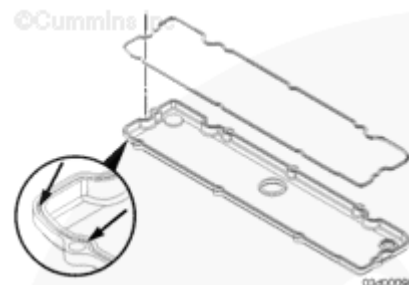
NOTE: If the gasket has been removed from the rocker lever cover, a new gasket must be used.

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

Press the molded gasket into the corners of the rocker lever cover.

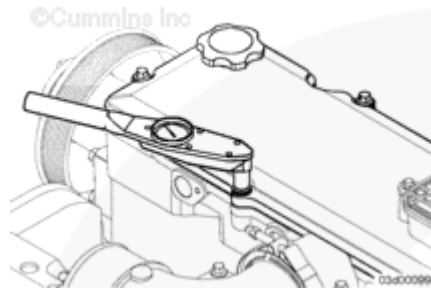
Press the gasket around the capscrew mounting holes.

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

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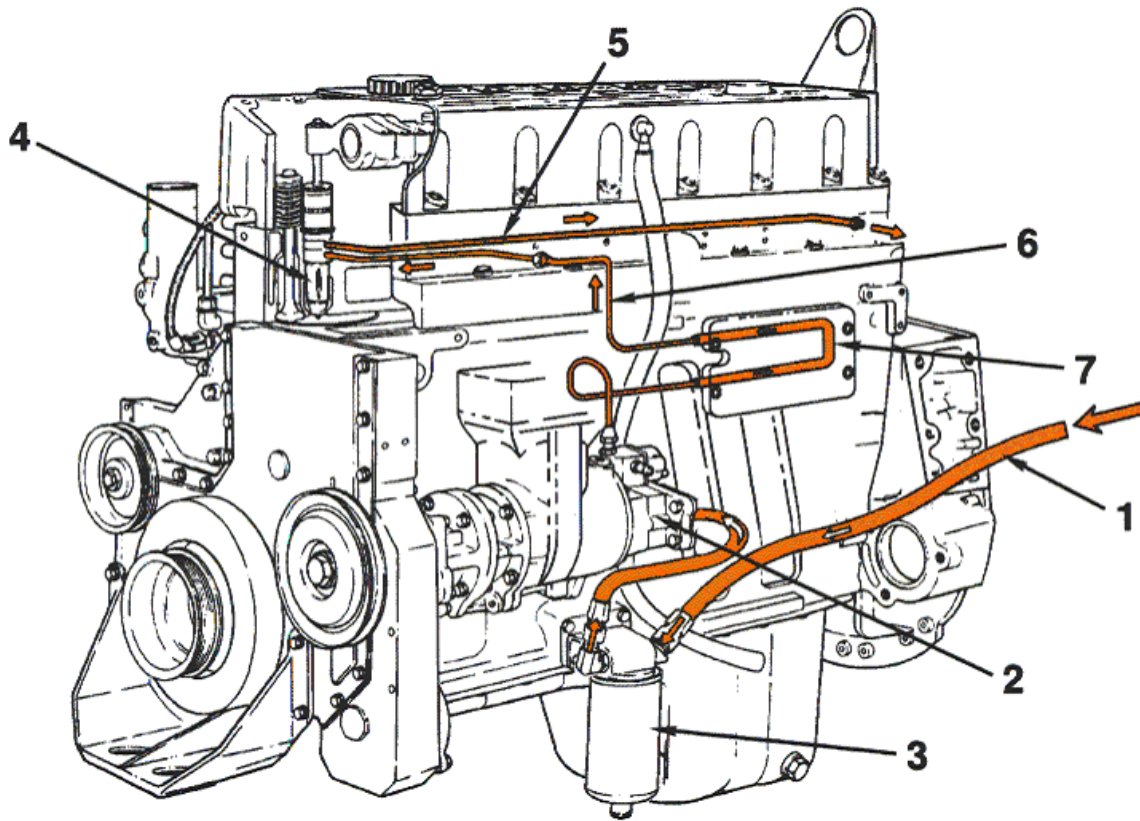
General Information

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 as follows:

- Fuel System
- Fuel System Operation
- Lubricating Oil System
- Cooling System
- Air Intake System
- Exhaust System
- Raw Water Piping

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

Flow Diagram, Fuel System

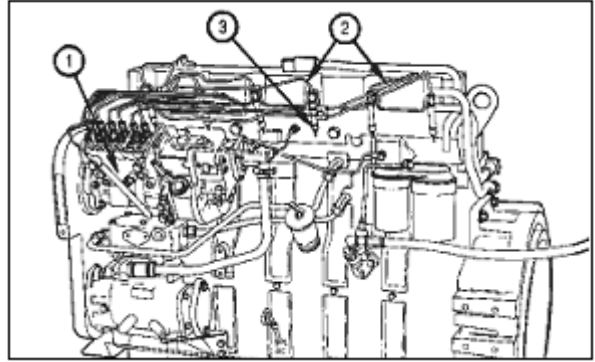


- | | | | |
|----|-------------------|----|-------------------|
| 1. | Fuel Inlet Supply | 5. | Fuel Drain Return |
| 2. | Fuel Pump | 6. | Fuel to Injector |
| 3. | Fuel Filter | 7. | ECM Cooling Plate |
| 4. | Injector | | |

Fuel System Operation

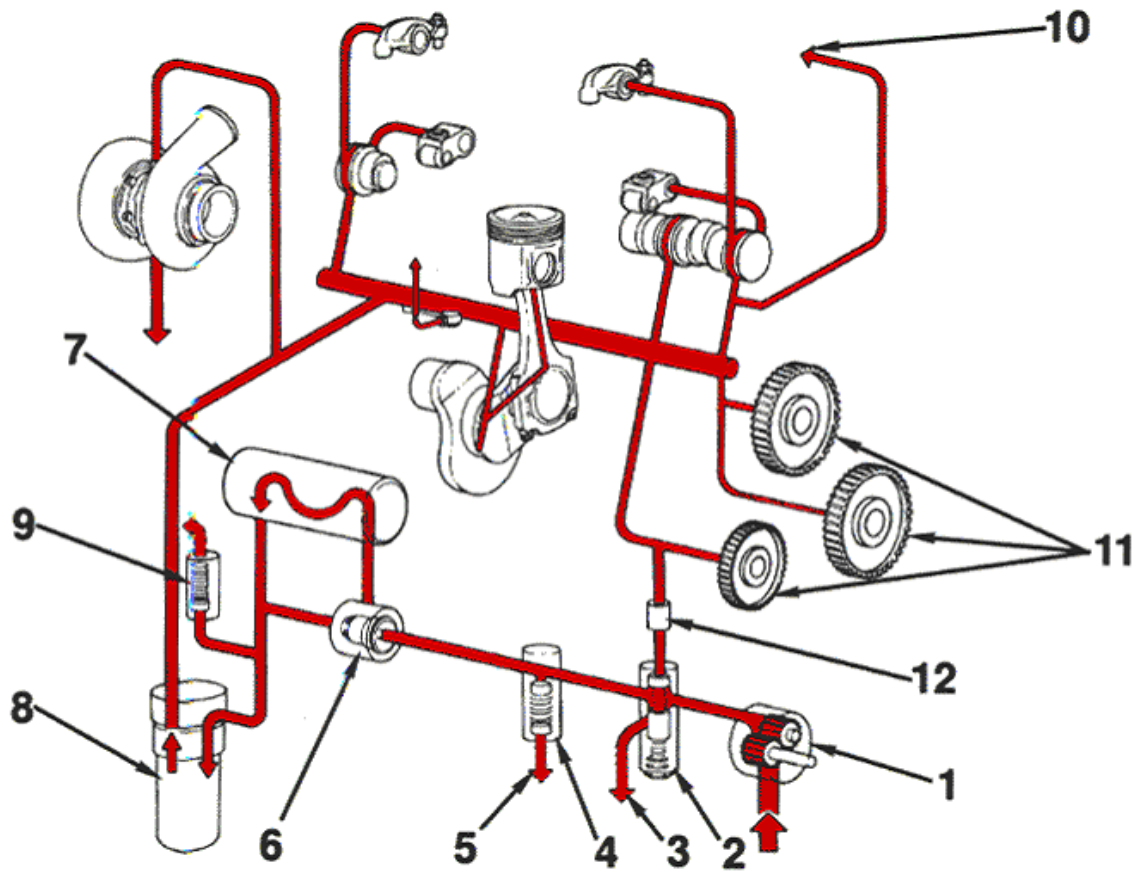
The function of the fuel system is to inject a metered quantity of clean atomized fuel into the engine cylinders at a precise time near the end of the compression stroke. The components of the fuel system contribute to the delivery of fuel to the cylinders.

The fuel transfer pump is mechanically driven by a plunger running against a special lobe on the camshaft. The fuel transfer pump contains a pumping piston and check valves to control the flow of fuel and bleed back during engine shutdown.



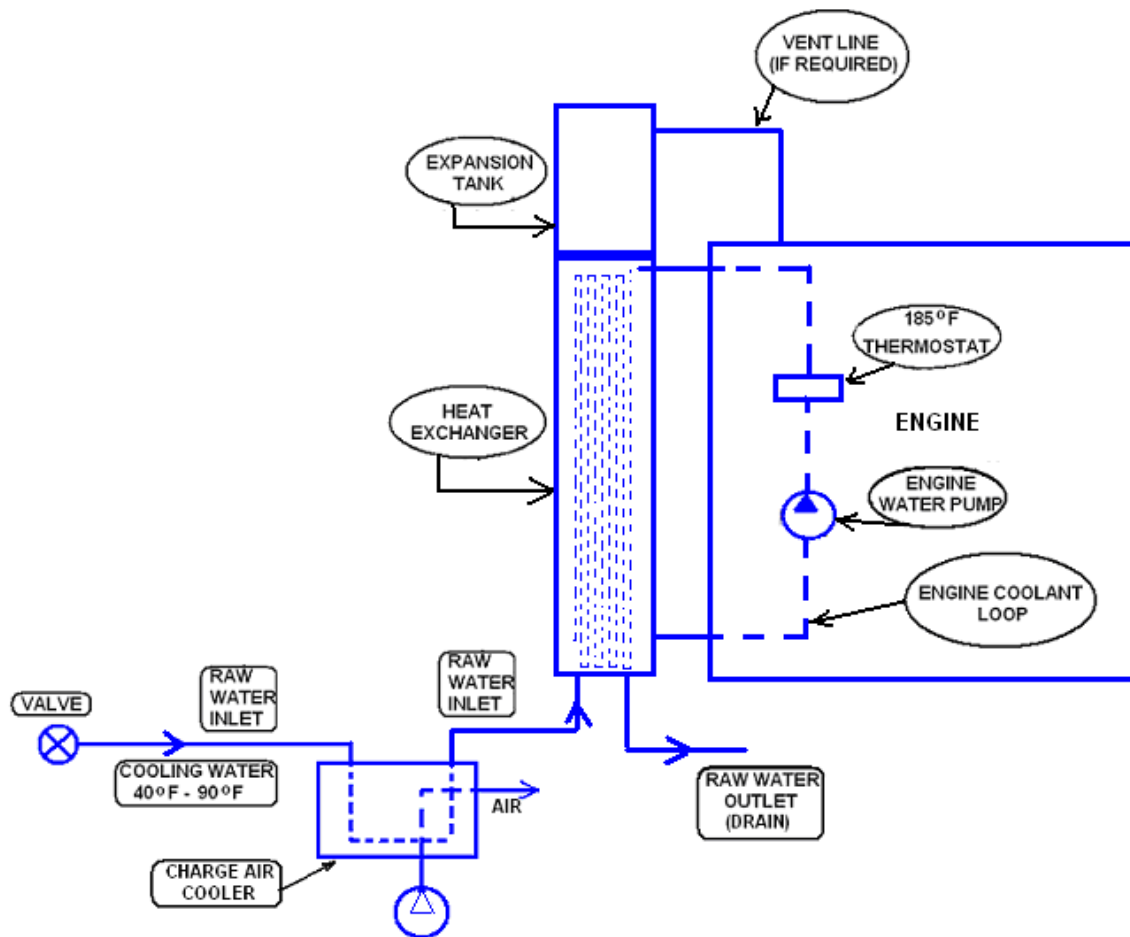
- Fuel injection pump
- High-pressure fuel lines
- Injectors

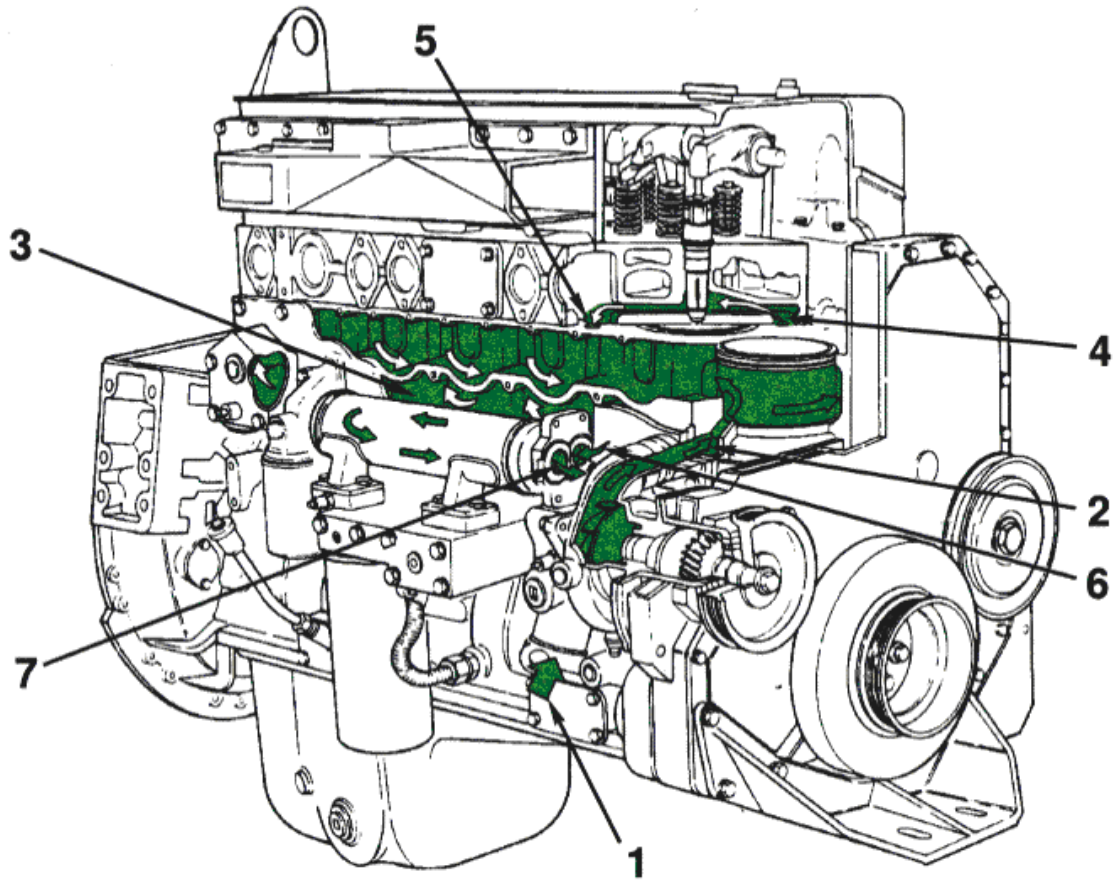
Flow Diagram, Lubricating Oil System



- | | | | |
|----|----------------------------|-----|--------------------------------|
| 1. | Oil Pump | 7. | Oil Cooler |
| 2. | Pressure Regulator Valve | 8. | Combination Oil Filter |
| 3. | Oil Return to Pan | 9. | Filter Bypass Valve |
| 4. | High Pressure Relief Valve | 10. | Accessory Drive/Air Compressor |
| 5. | Oil Return to Pan | 11. | Idler Gears |
| 6. | Oil Thermostat | 12. | Viscosity Sensor |

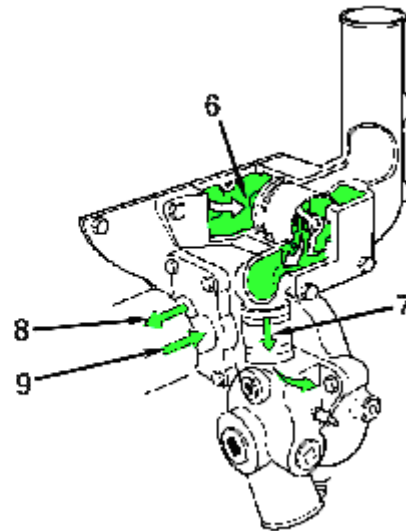
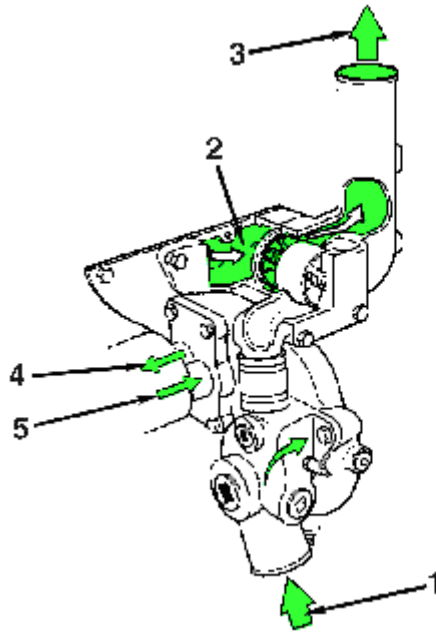
Flow Diagram, Cooling System



Flow Diagram, Cooling System (Cont)

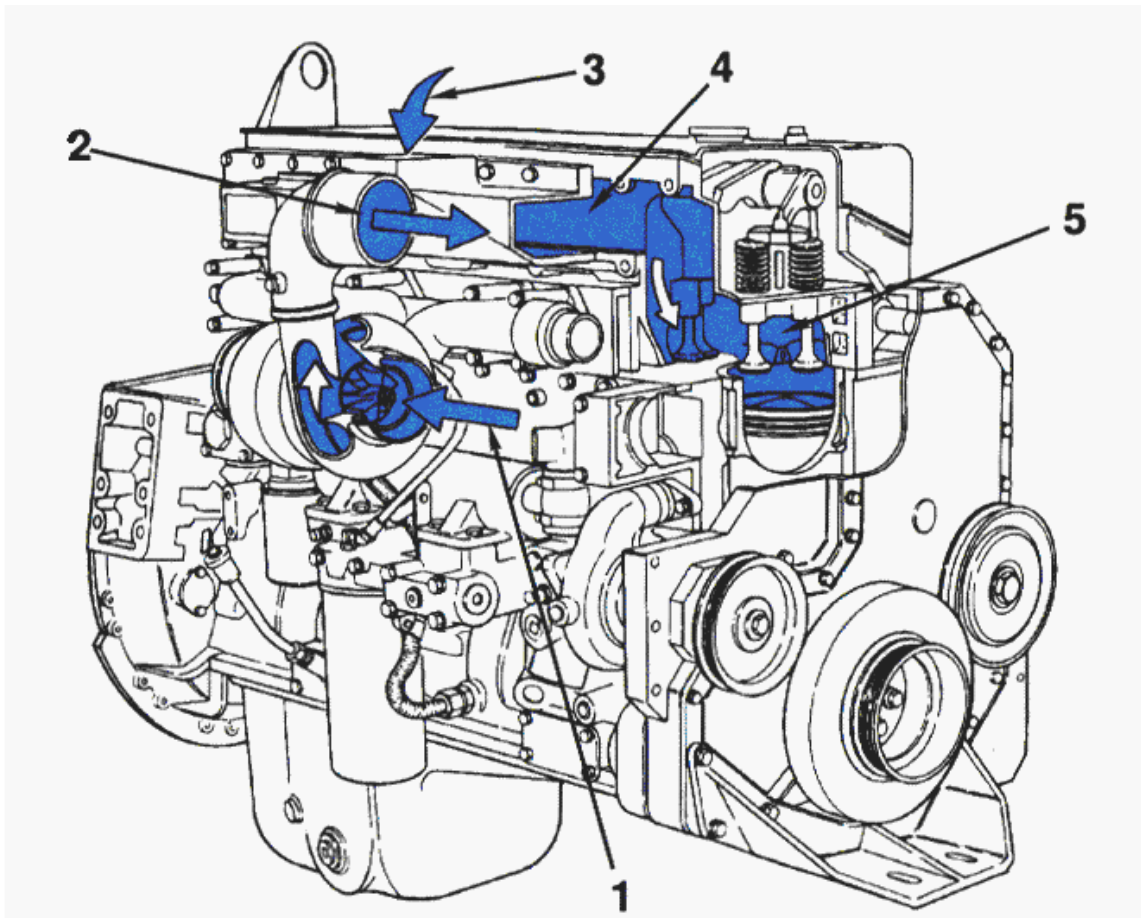
- | | | | |
|----|--|----|--------------------------------------|
| 1. | Water Pump Coolant Inlet | 5. | Coolant to Upper Manifold Cavity |
| 2. | Coolant to Lower Manifold Cavity | 6. | Lower Manifold Coolant to Oil Cooler |
| 3. | Coolant to Cylinder Liner Block Cavity | 7. | Oil Cooler to Upper Manifold Cavity |
| 4. | Coolant to Cylinder Head | | |

Flow Diagram, Cooling System (Cont)



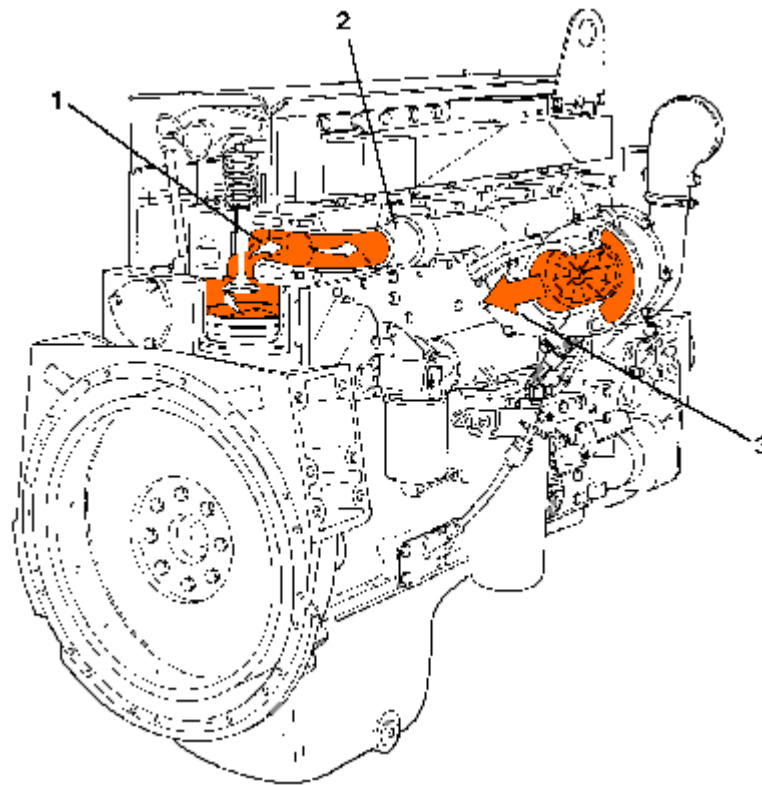
- | | | | |
|----|---|----|---|
| 1. | Water Pump Coolant Inlet | 6. | Upper Manifold Cavity (coolant to thermostat) |
| 2. | Upper Manifold Cavity (coolant to thermostat) | 7. | Coolant Bypass (return to water pump) |
| 3. | Coolant Outlet | 8. | Lower Manifold Cavity to Cooler |
| 4. | Lower Manifold Cavity to Cooler | 9. | Cooler to Upper Manifold Cavity (before thermostat) |
| 5. | Cooler to Upper Manifold Cavity (before thermostat) | | |

Flow Diagram, Air Intake System



- | | | | |
|----|---|----|--------------------|
| 1. | Filtered Intake Air to Turbocharger | 4. | Intake Manifold |
| 2. | Turbocharger Air to Charge Air Cooler | 5. | Intake Valve Ports |
| 3. | Charge Air Cooler Intake Air to Intake Manifold | | |

Flow Diagram, Exhaust System

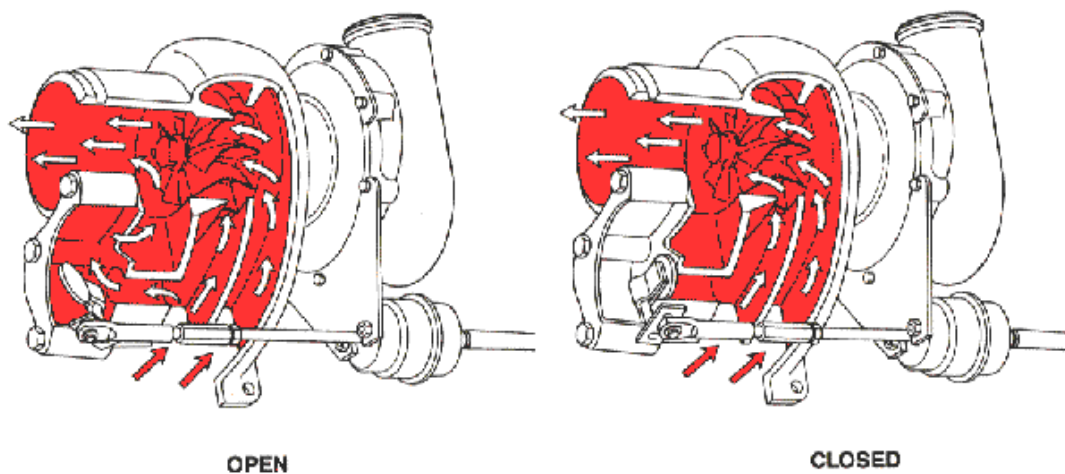


1. Exhaust Valve Ports

3. Turbocharger Exhaust Outlet

2. Exhaust Manifold

Flow Diagram, Exhaust System (Cont)

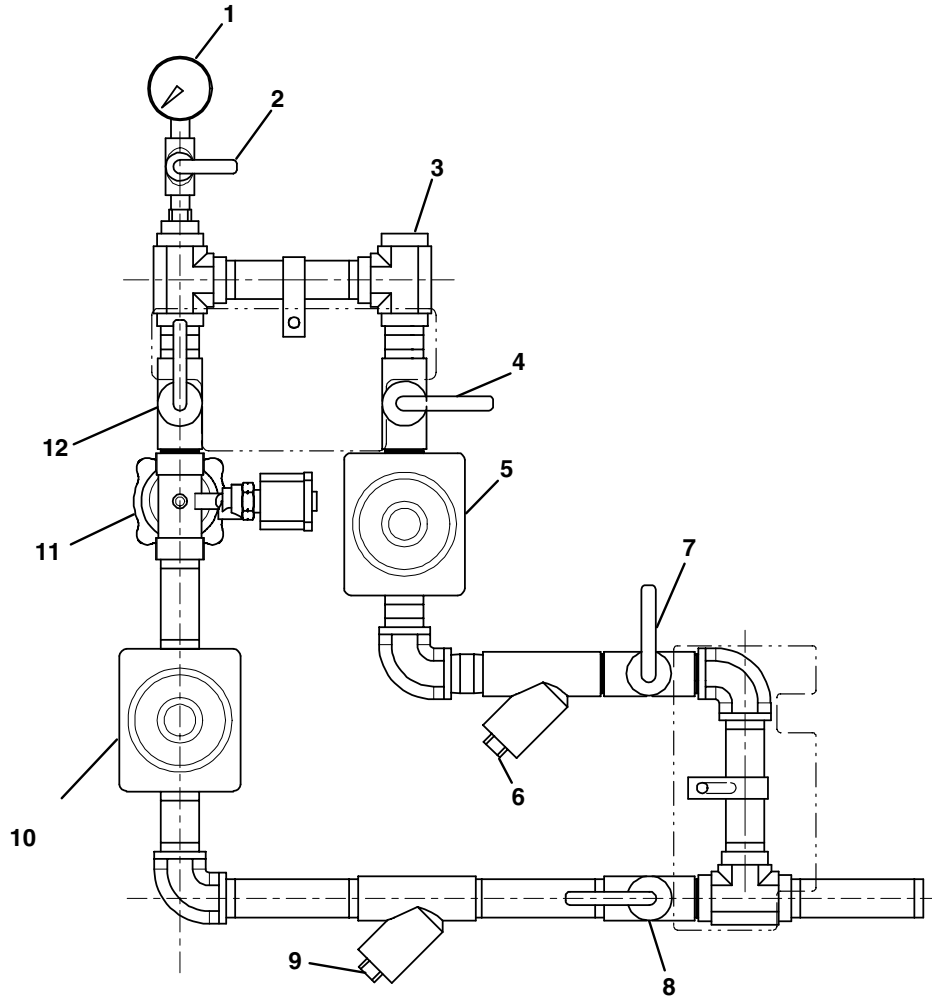


Wastegate Actuation

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 NPower Part No. 9659). 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. | 1" supply to the heat exchanger |

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Section 7 – Adjustment, Repair and Replacement

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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. 3666322-02, ISM, ISMe, and QSM11 Troubleshooting & Repair Manual.

The electronic engine control module and associated components are addressed in Cummins Manual No. 3666266-01, ISM and QSM11 Electronic Control System Troubleshooting and Repair Manual.

Refer to Service Literature 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 Section 9 for qualified service assistance.

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.



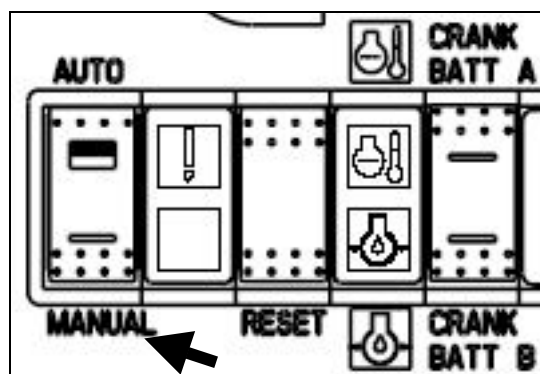
WARNING

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.

Prepare

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

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

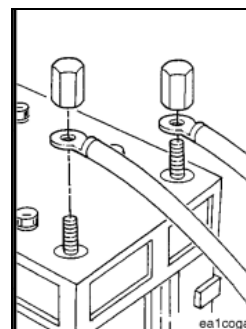


REMOVE BATTERY POWER BEFORE
SERVICING ENGINE OR CONTROLS.

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.

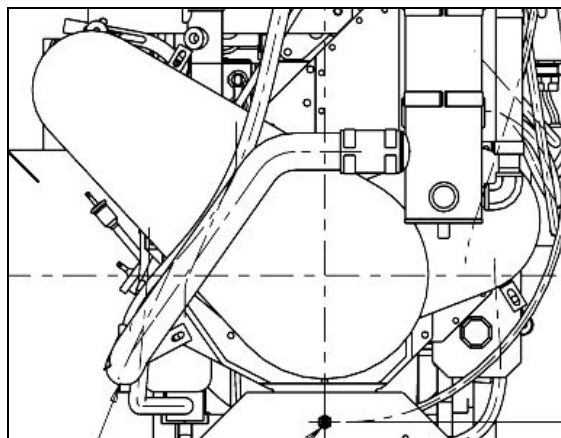
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Belt Guard Removal/Installation (Cont)**Remove**

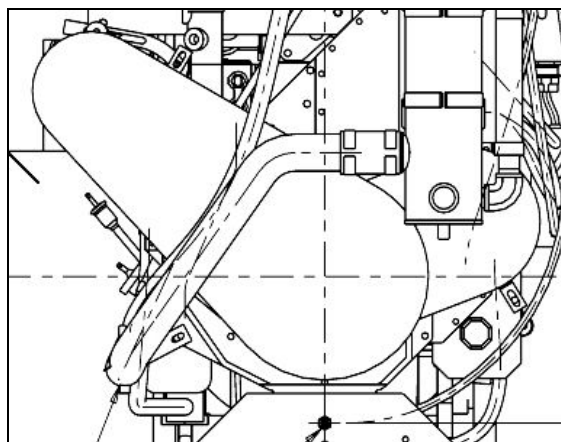
Remove the bolts and the belt guard.

**Install**

NOTE: Install only Cummins approved replacement belt guard (Cummins Fire Power Part No. 9632) or equivalent.

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

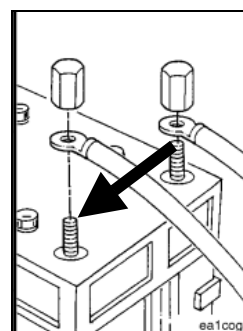
Torque as per Capscrew Markings and Torque Values in Section 10.



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.



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

Ensure that repairs are completed satisfactorily.

Stop the engine.

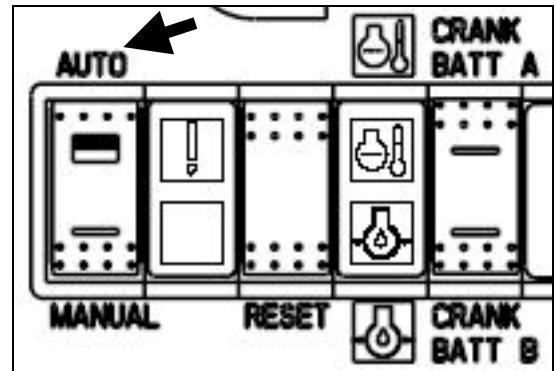


Belt Guard Removal/Installation (Cont)

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

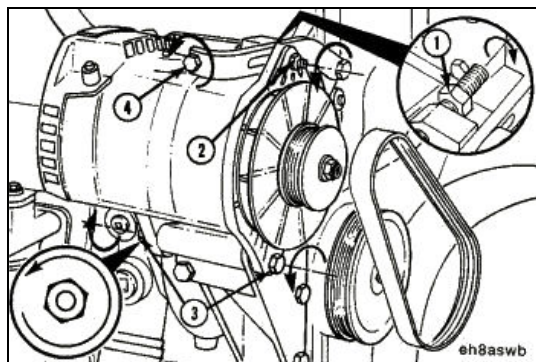
Loosen the adjusting screw locknut (1).

Loosen the adjustment link locking capscrew (2).

Loosen the alternator mounting capscrew (3).

Turn the adjusting screw (4) counterclockwise to release tension.

Remove the alternator belt.



Install

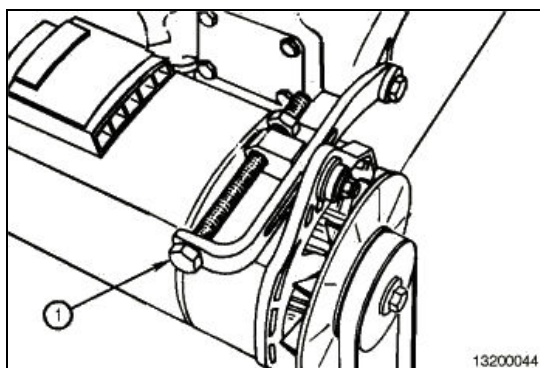


To prevent damage, do not roll a belt over the pulley or pry it on with a tool.

NOTE: Install only Cummins approved replacement v-ribbed belts (Cummins Part No. 3037425) or equivalent.

Install a new belt on the alternator pulleys.

NOTE: Turn the adjusting screw (1) clockwise to increase belt tension; counterclockwise to decrease belt tension.

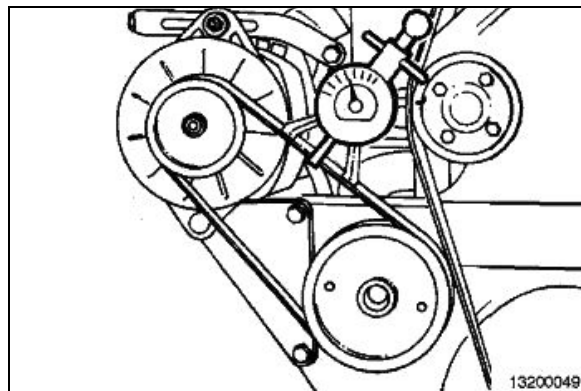


NOTE: Use belt tension gauge, Cummins Part Number ST-1293, to measure the belt tension.

NOTE: A belt is considered used if it has been in operation for 10 minutes or longer.

Measure the belt tension. Refer to [Drive Belt Tension](#) in Section 10 for the correct tension value for the alternator belt.

Turn the adjusting screw (1) to obtain the correct belt tension.



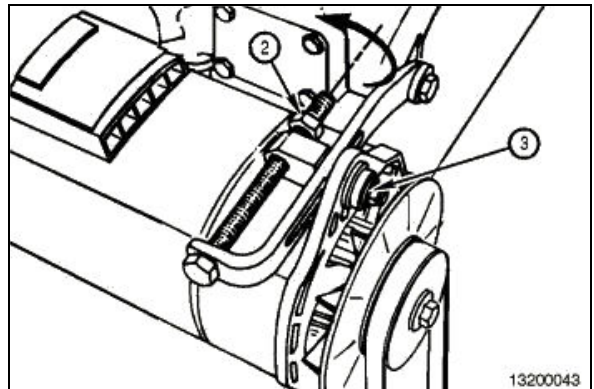
Belt Removal/Installation (Cont)

Tighten

Tighten the adjusting screw locknut (2) against the retainer.

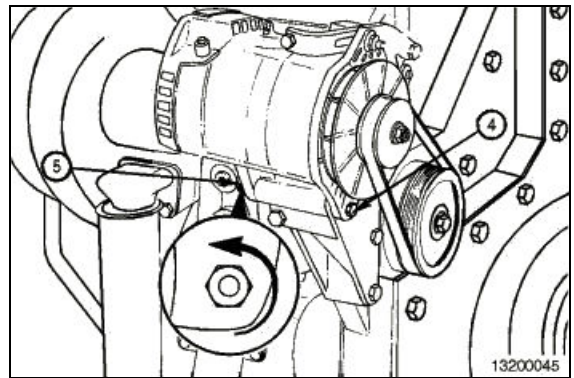
Tighten the adjustment link locking capscrew (3).

Torque Value: 80 N•m [59 ft-lb]



Tighten the pivot capscrew (4) and nut (5).

Torque Value: 47 N•m [35 ft-lb]

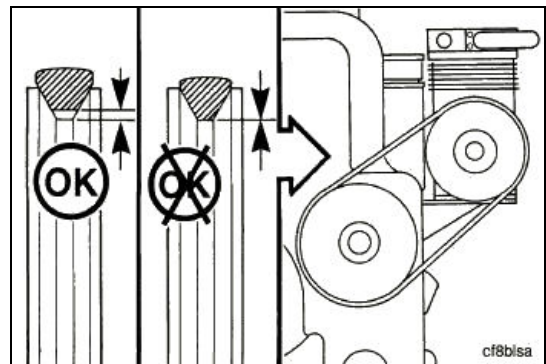


Check Belt Placement

NOTE: The belt Must not touch the bottom of the pulley grooves nor protrude more than 3 mm [3/32 in] above the top of the groove.

Verify the belt placement.

If both the correct tension and placement cannot be obtained, replace the belt.



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.



Adjust Alternator Drive Belt Tension

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.

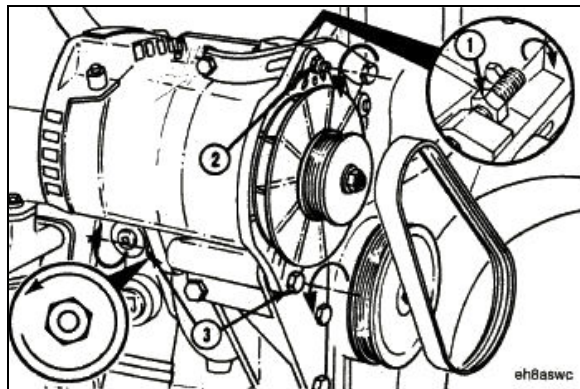


Adjust

Loosen the adjusting screw (1).

Loosen the adjustment link locking capscrew (2).

Loosen the pivot capscrew and nut (3).



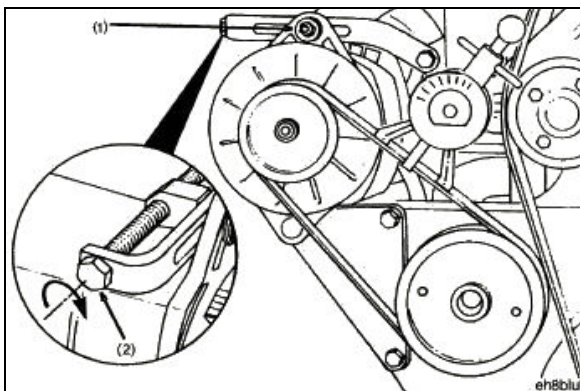
NOTE: Use belt tension gauge, Cummins Part Number ST-1293, to measure belt tension.

NOTE: Turn the alternator adjusting screw clockwise to tighten the belt.

NOTE: A belt is considered used if it has been in operation for 10 minutes or longer.

Measure the belt tension. Refer to [Drive Belt Tension](#) in Section 10 for the correct tension value for the alternator belt.

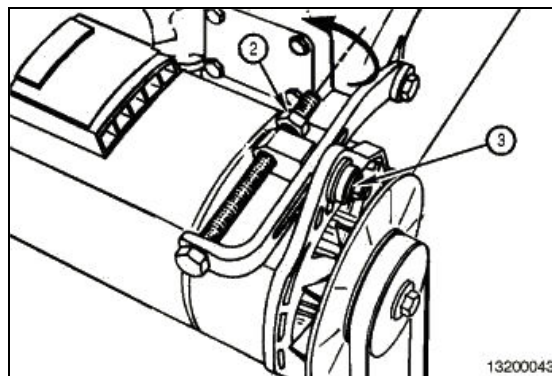
Turn the adjusting screw to obtain the correct belt tension.



Tighten the adjusting screw locknut (2) against the retainer.

Tighten the adjustment link locking capscrew (3).

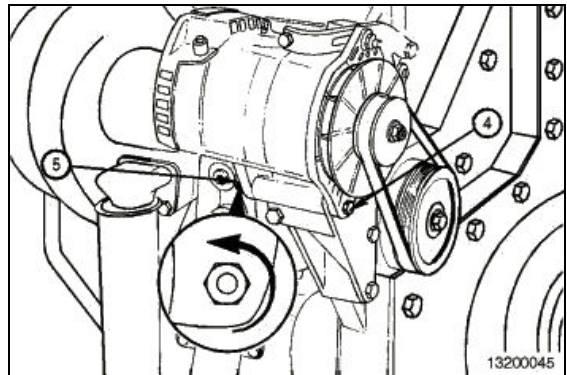
Torque Value: 80 N•m [59 ft-lb]



Adjust Alternator Drive Belt Tension (Cont)

Tighten the pivot capscrew (4) and nut (5).

Torque Value: 47 N•m [35 ft-lb]

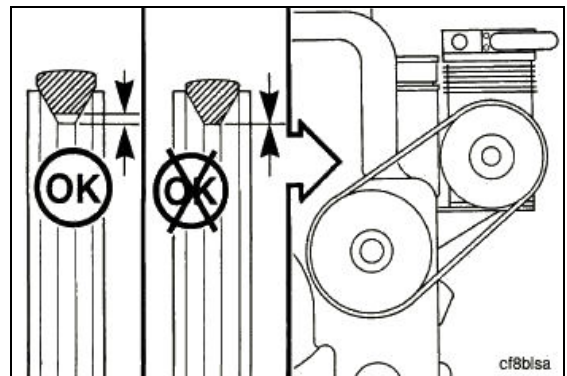


Check Belt Placement

NOTE: The belt Must not touch the bottom of the pulley grooves nor protrude more than 3 mm [3/32 in] above the top of the groove.

Verify the belt placement.

If both the correct tension and placement cannot be obtained, replace the belt. Refer to Belt Removal/Installation in this section.



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.

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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.



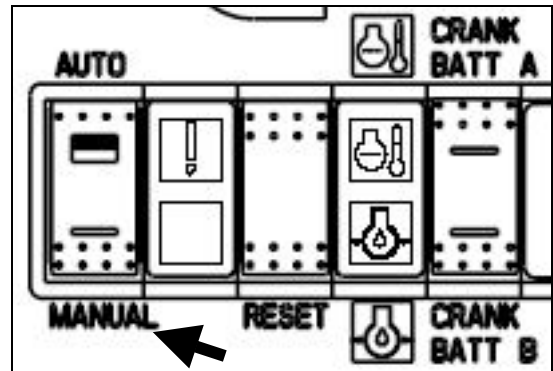
WARNING

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 (Cummins Fire Power Part No. 11407). 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.



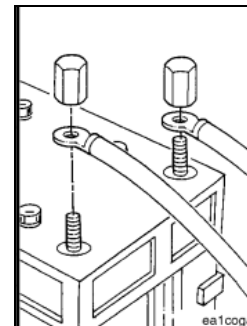
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.



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.

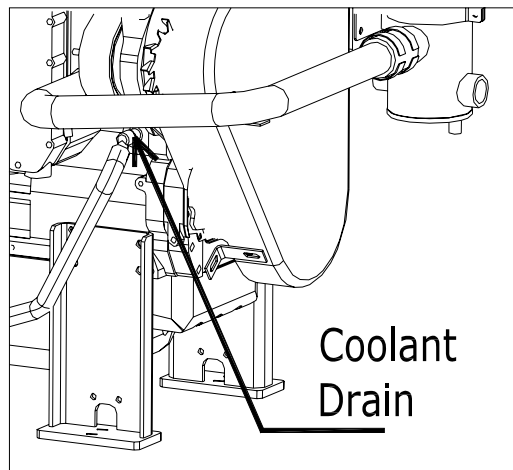


Coolant Heat Exchanger Removal/Installation (Cont)

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

Remove the engine coolant pressure cap (Cummins Fire Power Part No. 11407).

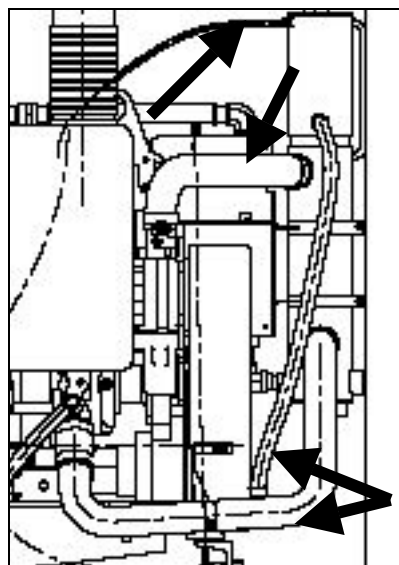
Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 5.



Remove the Upper Engine Coolant Hose from the heat exchanger.

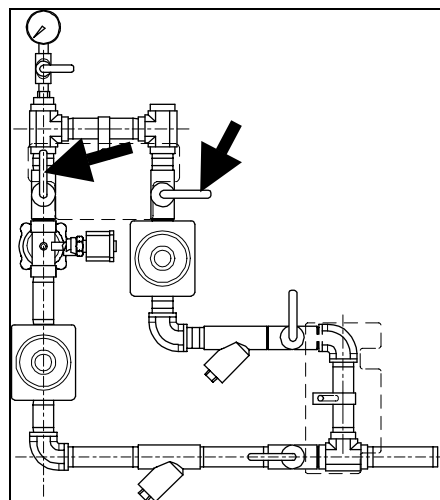
Remove the Lower Engine Coolant and Fill Hose from the heat exchanger.

Remove the Coolant Vent 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.



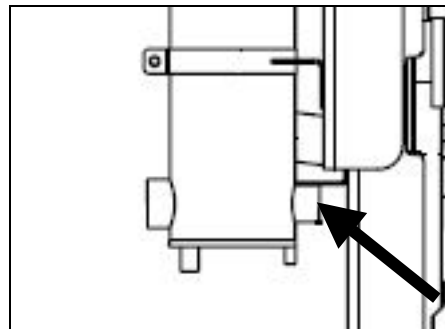
Coolant Heat Exchanger Removal/Installation (Cont)

NOTE: If using piping supplied by Cummins Fire Power, refer to Drawing 11048 in Section 13 for raw water supply piping details.



Remove the 1" NPT raw water inlet piping from the charge air cooler manifold to the heat exchanger.

Also, remove any customer-supplied raw water outlet fittings from the heat exchanger. 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 in order to prevent leaks.

Install a 1-1/4" 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 1" 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.

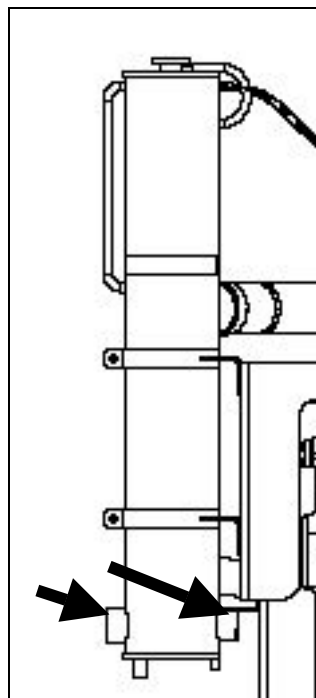
Apply air pressure at 621 kPa [90 psig].

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.



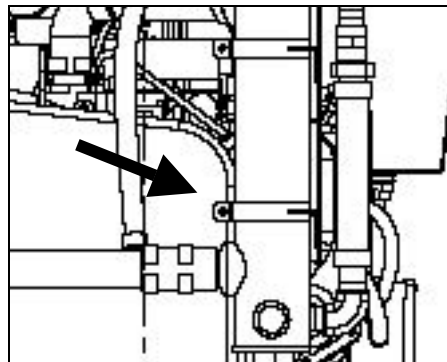
Coolant Heat Exchanger Removal/Installation (Cont)

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.

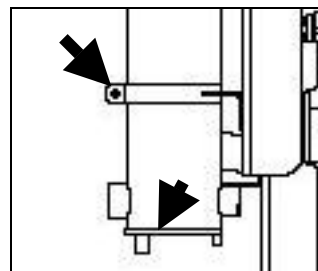
Remove the heat exchanger and clamps from the engine.



Disassemble

If required for replacement, remove the two front sets of nuts and bolts at the coolant heat exchanger clamps.

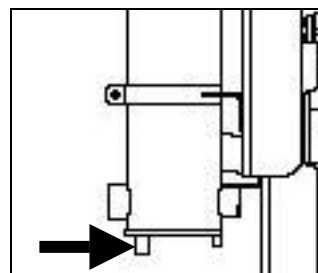
If required for replacement, remove the zinc plug and other pipe fittings from the heat exchanger.



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.

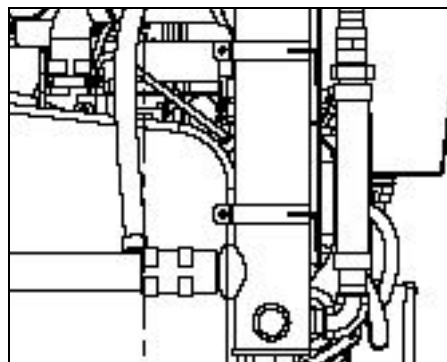


Torque Values: As per capscrew markings and torque values in Section 10.

If missing, install the pipe fittings removed from the original heat exchanger. Refer to [Drawing 8792](#) in Section 13 for component information.

Torque Values: As per capscrew markings and torque values in Section 10.

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 8792](#) 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.

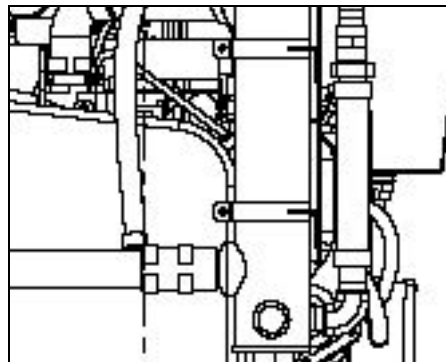
Position the heat exchanger and clamps on the engine's mounting bracket and start the four bolts.

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.

Torque Values: As per capscrew markings and torque values in Section 10

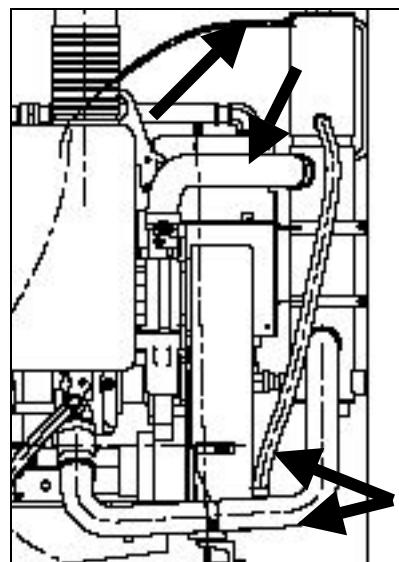


Follow-Up

Install the Upper Engine Coolant Hose at the heat exchanger.

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

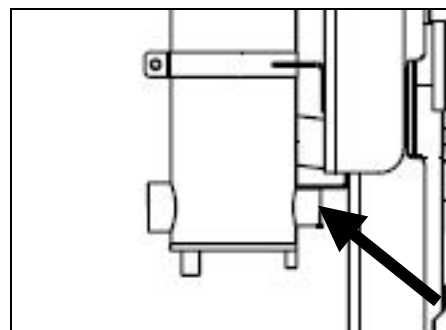
Install the Coolant Vent Hose at the heat exchanger.



NOTE: If using piping supplied by Cummins Fire Power, refer to Drawing 11048 in Section 13 for raw water supply piping details.

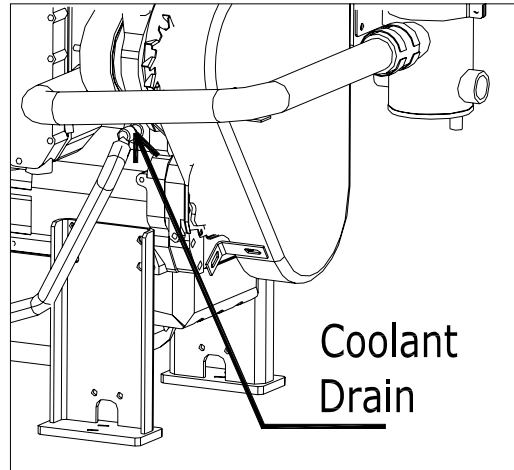
Install the 1" NPT raw water inlet piping from the charge air cooler manifold to the heat exchanger.

Also, install any customer-supplied raw water outlet fittings from the heat exchanger.



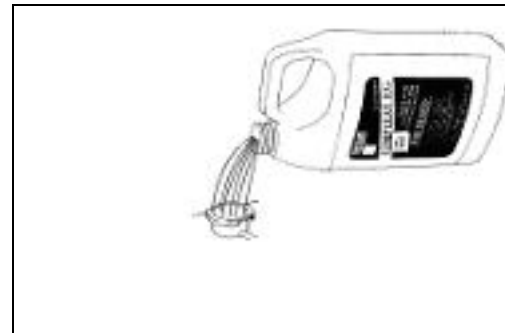
Coolant Heat Exchanger Removal/Installation (Cont)

Close the coolant drain valve.



Refill engine coolant as required Refer to Drain and Flush Coolant System in Section 5.

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



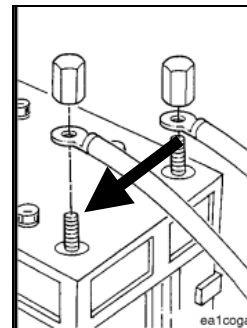
Reconnect the coolant heater power supply.



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.



Coolant Heat Exchanger Removal/Installation (Cont)

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.



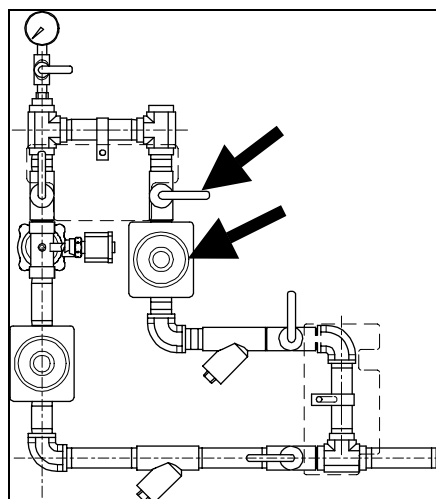
When establishing raw water flow, ensure that the raw water pressure does not exceed 414 kPa (60 psig) at the heat exchanger. Adjust the pressure regulators as required.

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.

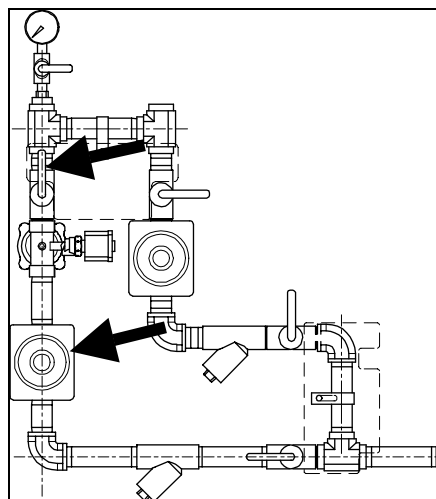


When establishing raw water flow, ensure that the raw water pressure does not exceed 414 kPa (60 psig) at the heat exchanger. Adjust the pressure regulators as required.

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.



Coolant Heat Exchanger Removal/Installation (Cont)

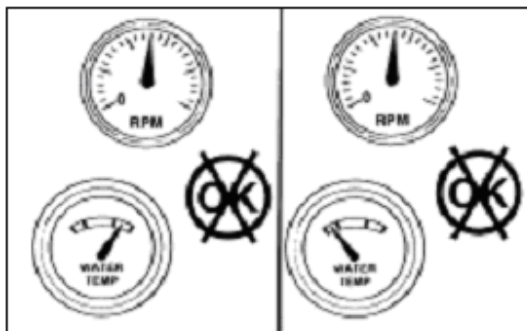
NOTE: If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Troubleshooting Section 12.

Check that engine operating temperature stabilizes between about 82 and 93 °C [180 and 200 °F].

Check that no coolant hoses are collapsed.

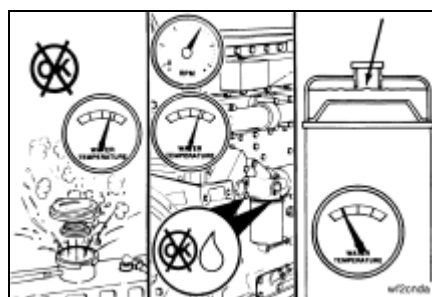
When temperature has stabilized, stop the engine.

Ensure that repairs are completed satisfactorily.



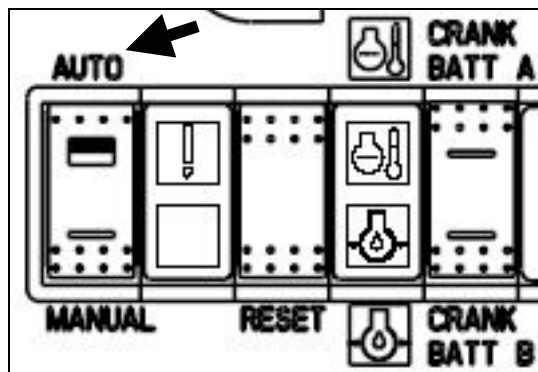
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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.



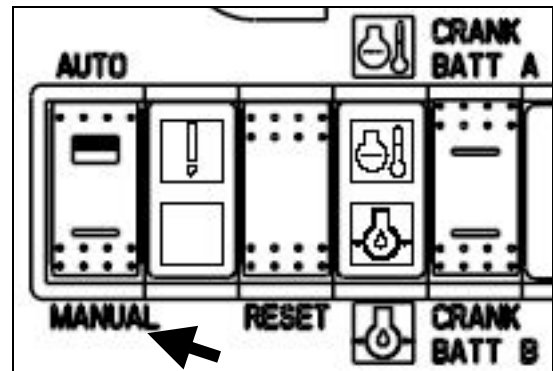
WARNING

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 (Cummins Fire Power Part No. 11407). 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.



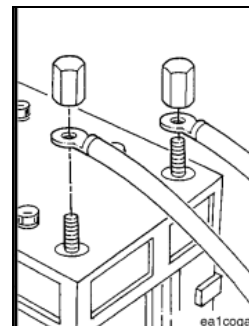
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS



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.

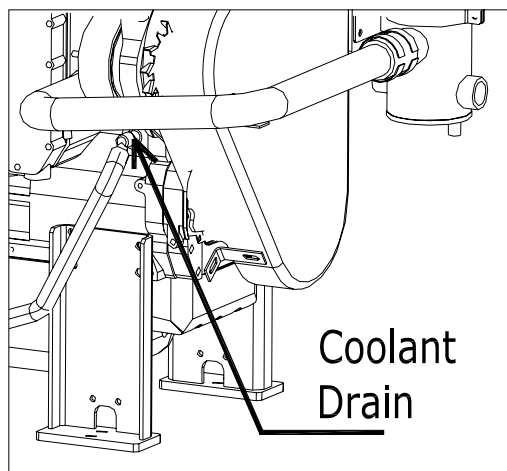


Coolant Heater Removal/Installation (Cont)

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

Remove the engine coolant pressure cap (Cummins Fire Power Part No. 11407).

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

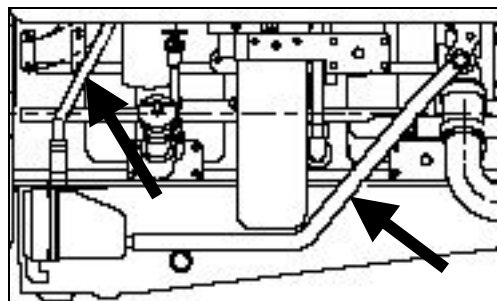


NOTE: Collect the remainder of the coolant in the heater hoses.

NOTE: Refer to Drawing 8950 in Section 13 for detailed component information.

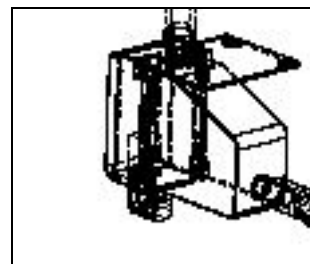
Remove the Upper Coolant Heater Hose.

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.

**Install**

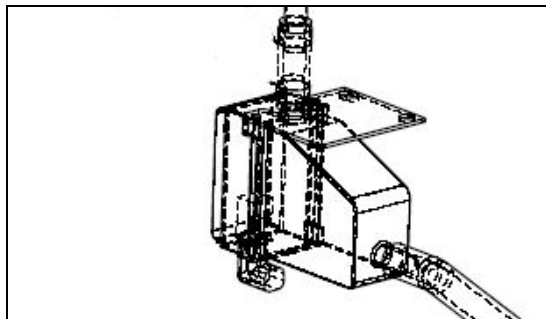
NOTE: Refer to Drawing 8950 in Section 13 for detailed component information.

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.

Verify fastener count.



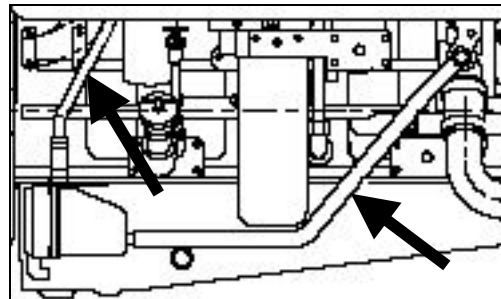
Coolant Heater Removal/Installation (Cont)

Follow-Up

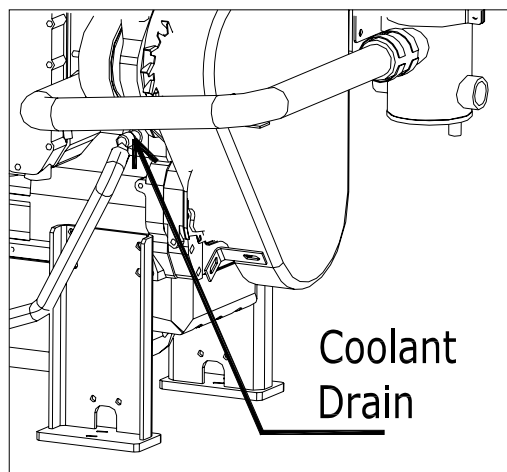
NOTE: Refer to Drawing 8950 in Section 13 for detailed component information.

Install the Upper Coolant Heater Hose.

Install the Lower Coolant Heater Hose.

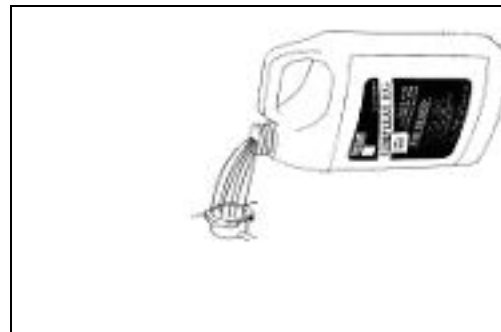


Close the coolant drain valve.



Refill engine coolant as required. Refer to Drain and Flush Coolant System in Section 5.

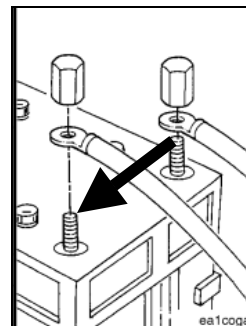
Install the coolant system pressure cap (Cummins Fire Power Part No. 11407).



For safety reasons, both batteries must be reconnected 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.



Coolant Heater Removal/Installation (Cont)

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.

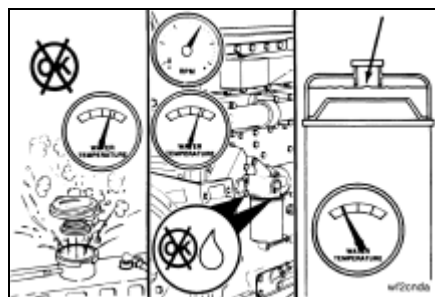
Stop the engine.



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 (Cummins Fire Power Part No. 11407). 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.

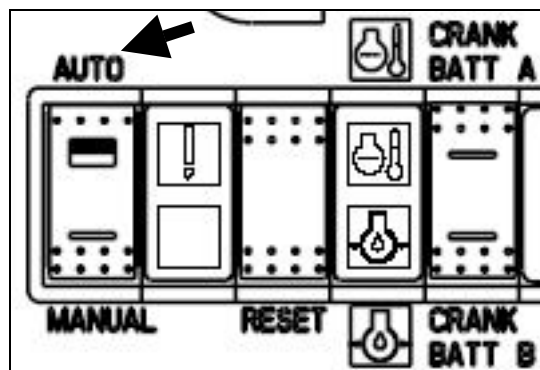
Check that the engine block remains warm to the touch.



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



Return the fire protection system to operating status.



Coolant Hose Removal/Installation

Identify hose clamps and add manufacturer's torque value.

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.

Prepare



WARNING

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



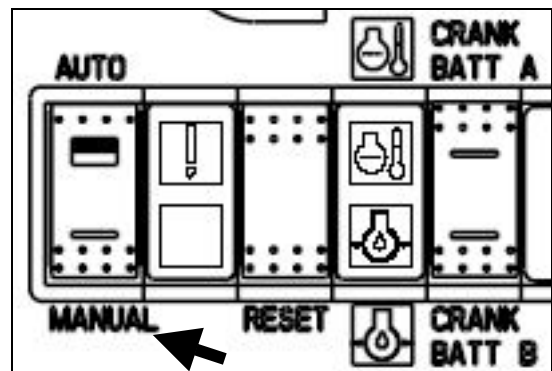
WARNING

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 (Cummins Fire Power Part No. 11407). 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.



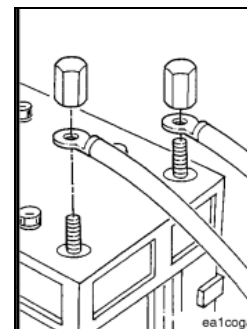
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.



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.

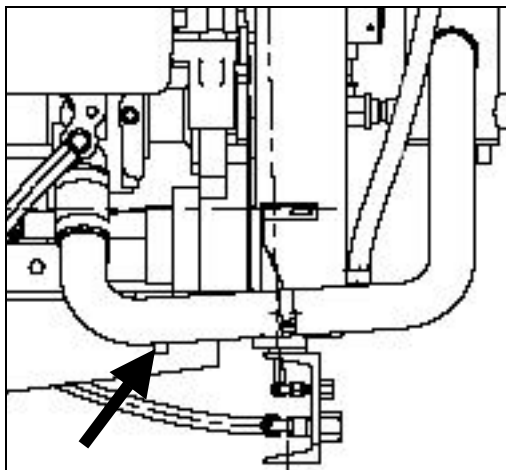


Coolant Hose Removal/Installation (Cont)

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

Remove the engine coolant pressure cap (Cummins Fire Power Part No. 11407).

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

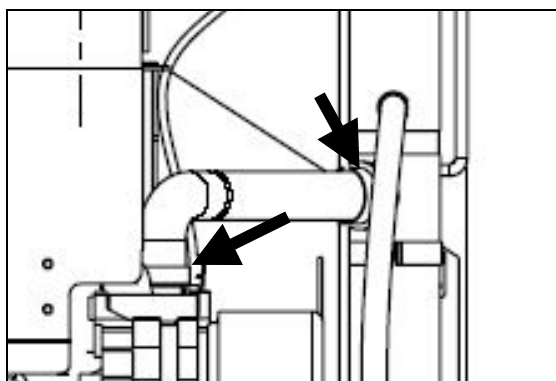
**Remove the Upper Engine Coolant Hose**

NOTE: Refer to Assembly Drawing 8792 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 Hose**

NOTE: Refer to Assembly Drawing 8792 in Section 13 for detailed construction.

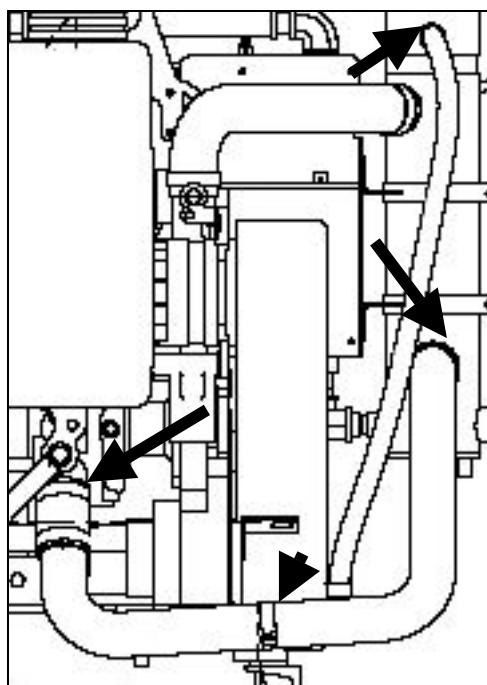
Remove the clamp supporting the lower engine coolant hose.

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 8950 in Section 13 for detailed construction.

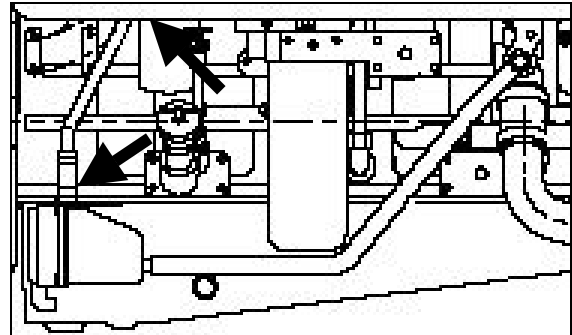
NOTE: Be prepared to collect the coolant remaining in the hose.

Loosen the hose clamp at the engine.

Loosen the hose clamp at the coolant heater.

Pull the hose and tubing from the connections.

Disassemble additional components if this is required for inspection or repairs.



Remove the Lower Coolant Heater Hose

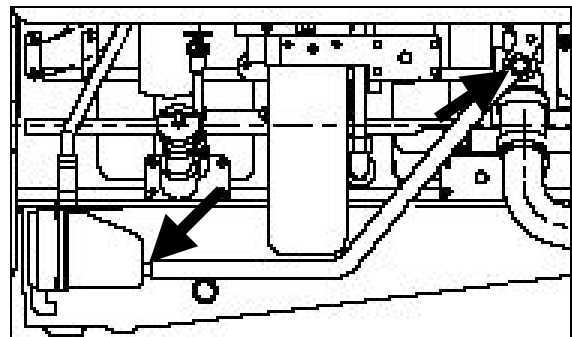
NOTE: Refer to Assembly Drawing 8950 in Section 13 for detailed construction.

NOTE: Be prepared to collect the coolant remaining in the hose.

Loosen the hose clamp at the engine.

Loosen the hose clamp at the coolant heater.

Pull the hose and tubing from the connections.



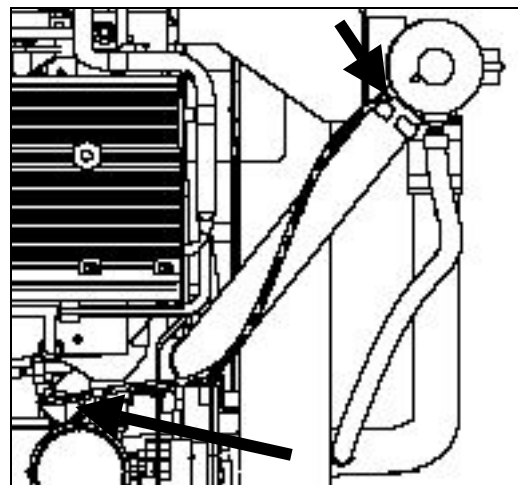
Remove the Coolant Vent Hose

NOTE: Refer to Assembly Drawing 9543 in Section 13 for detailed construction.

Loosen the hose connection at the heat exchanger flair adapter.

Loosen the hose connection at the engine coolant vent flair adapter.

Remove the hose.

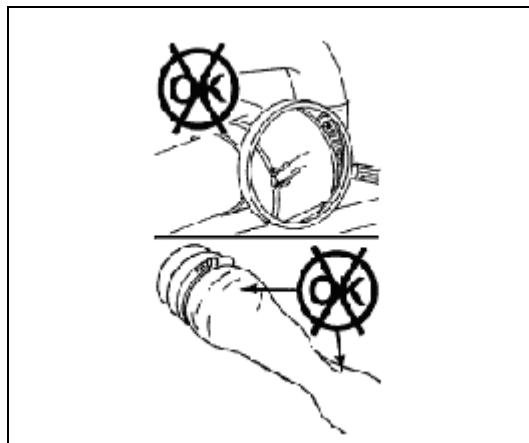


Coolant Hose Removal/Installation (Cont)**Inspect**

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.

**Install the Upper Engine Coolant Hose**

Do not re-install worn or damaged hoses or corroded clamps.

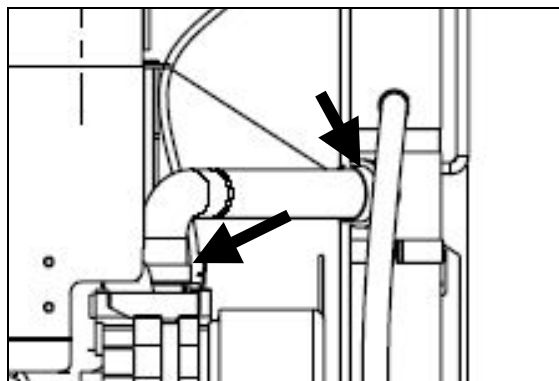
NOTE: Refer to Assembly Drawing 8792 in Section 13 for detailed construction.

Push the hose onto the heat exchanger and engine.

Tighten the hose clamp at the heat exchanger.

Tighten the hose clamp at the engine.

Torque Value: As per capscrew markings and torque values in Section 10



Coolant Hose Removal/Installation (Cont)

Install the Lower Engine Coolant and Fill Hoses



Do not re-install worn or damaged hoses or corroded clamps.

NOTE: Refer to Assembly Drawing 8792 in Section 13 for detailed construction.

Position the hoses at the heat exchanger and engine.

Position and tighten the lower engine coolant hose clamp at the engine.

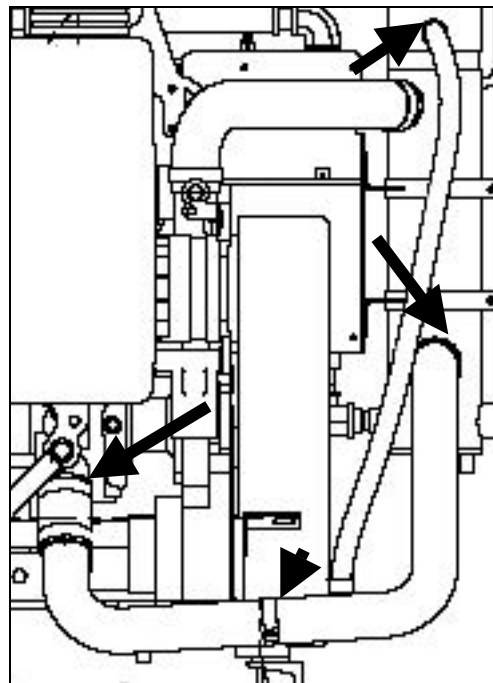
Position and tighten the lower engine coolant hose clamp at the heat exchanger.

Position and tighten the upper fill hose clamp at the heat exchanger.

Torque Values: As per capscrew markings and torque values in Section 10

Install the clamp supporting the lower engine coolant hose. Torque as per Capscrew Markings and Torque Values in Section 10.

Need updated art for belt guard, tube, and U-clamp.



Install the Upper Coolant Heater Hose



Do not re-install worn or damaged hoses or corroded clamps.

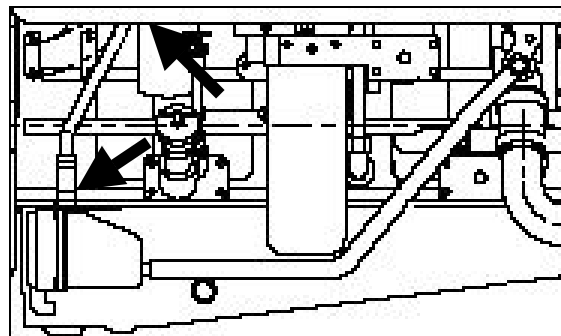
NOTE: Refer to Assembly Drawing 8950 in Section 13 for detailed construction.

Position the hose and hose clamp on the fitting at the coolant heater.

Position the hose and hose clamp on the fitting at the engine connection.

Position and tighten the hose clamps.

Torque Values: As per capscrew markings and torque values in Section 10



Coolant Hose Removal/Installation (Cont)**Install the Lower Coolant Heater Hose**

Do not re-install worn or damaged hoses or corroded clamps.

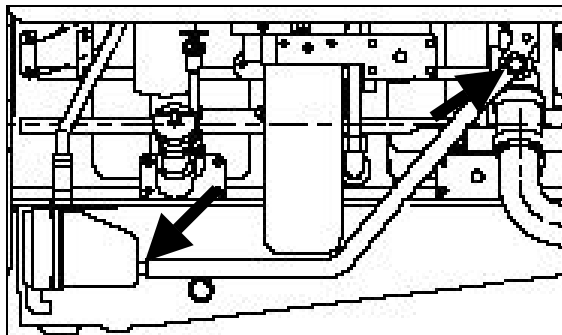
NOTE: Refer to Assembly Drawing 8950 in Section 13 for detailed construction.

Position the hose and hose clamp on the fitting at the heater.

Position the hose and hose clamp on the fitting at the water inlet connection.

Position and tighten the hose clamps.

Torque Values: As per capscrew markings and torque values in Section 10

**Install the Coolant Vent Hose**

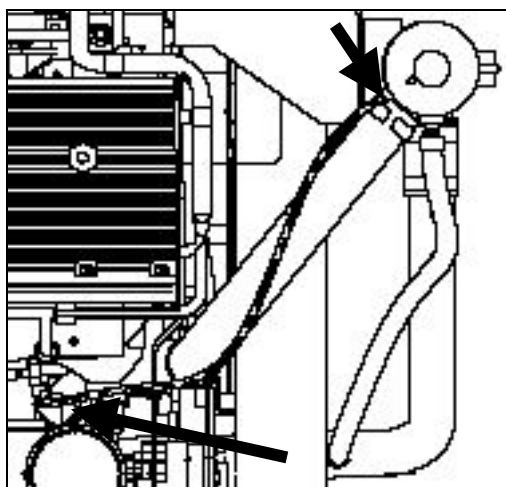
Do not re-install worn or damaged hoses or corroded clamps.

NOTE: Refer to Assembly Drawing 9543 in Section 13 for detailed construction.

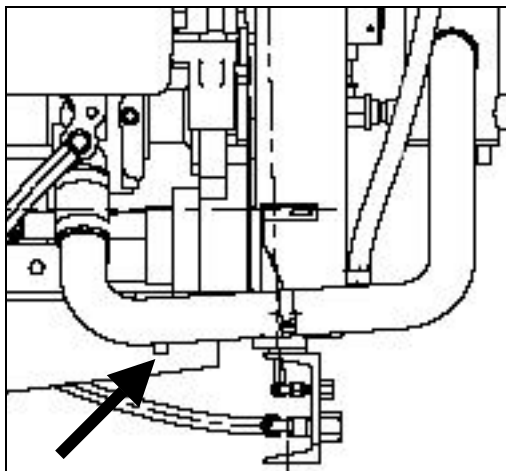
Connect the hose flair connector at the heat exchanger.

Connect the hose flair connector at the engine coolant vent connection.

Torque Values: As per capscrew markings and torque values in Section 10

**Follow-Up**

Close the coolant drain valve.

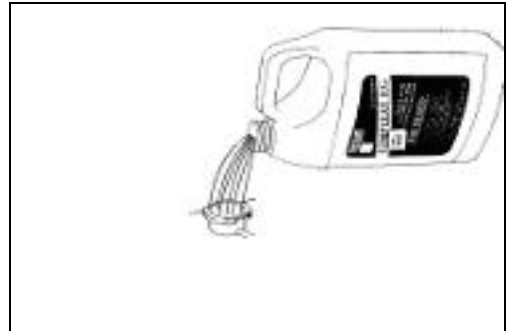


Coolant Hose Removal/Installation (Cont)

Refill engine coolant as required Refer to [Drain and Flush Coolant System](#) in Section 5.



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



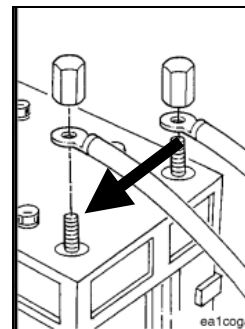
Reconnect the coolant heater power supply.



For safety reasons, both batteries must be reconnected 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.

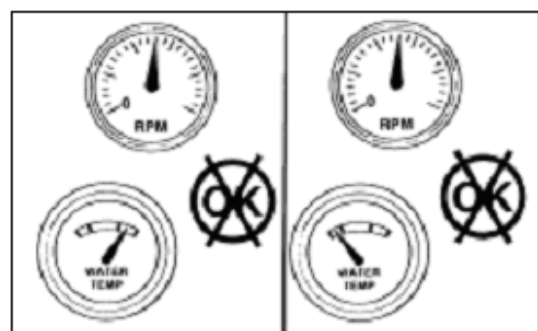
Check that engine operating temperature stabilizes between about 82 and 93 °C [180 and 200 °F].



Check that no coolant hoses are collapsed.

When temperature has stabilized, stop the engine.

Ensure that repairs are completed satisfactorily.



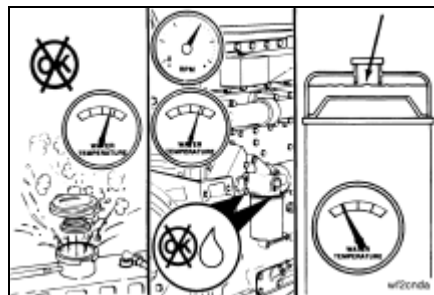
Coolant Hose Removal/Installation (Cont)



WARNING

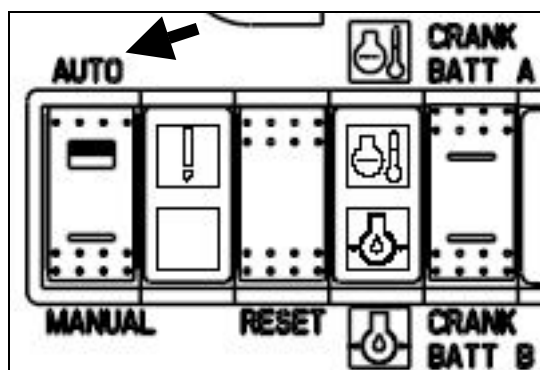
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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.

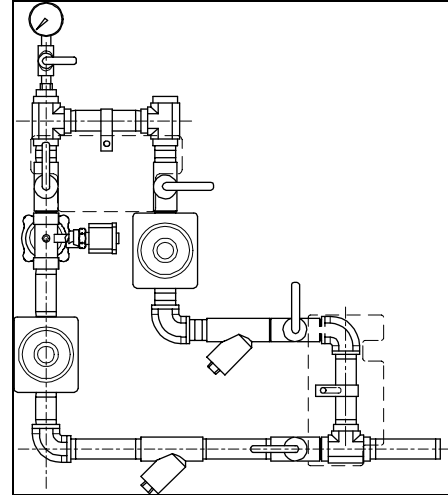
NOTE: This section applies to both the normal and bypass lines.

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.

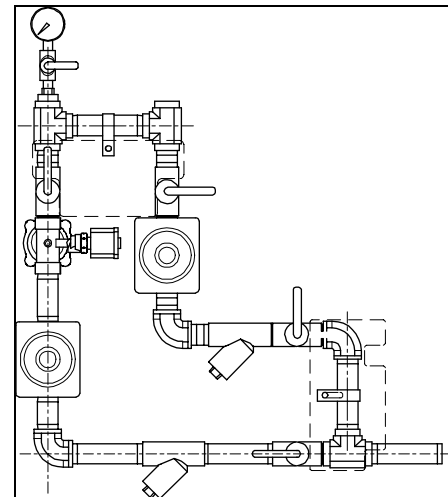


Prepare (Normal Line)

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.



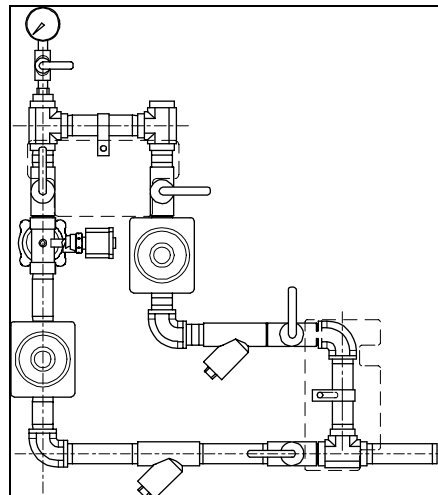
Raw Water Pressure Regulator Removal/Installation (Cont)

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.

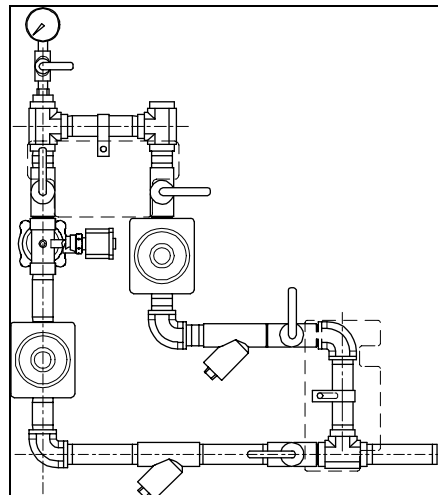


Remove (Normal Line)

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)

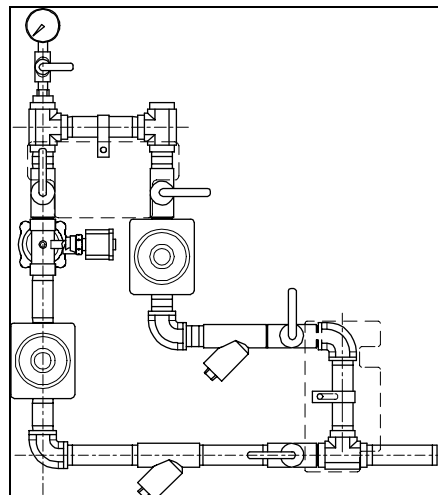
When the pressure regulator is repaired or replaced, prepare it for installation.

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.



Raw Water Pressure Regulator Removal/Installation (Cont)

Install (Normal Line)

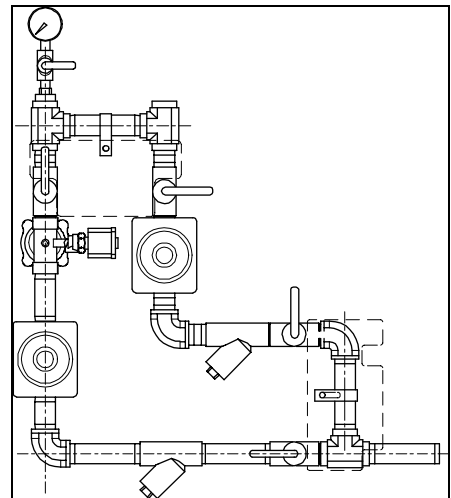
When the pressure regulator is repaired or replaced, prepare it for installation.

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.

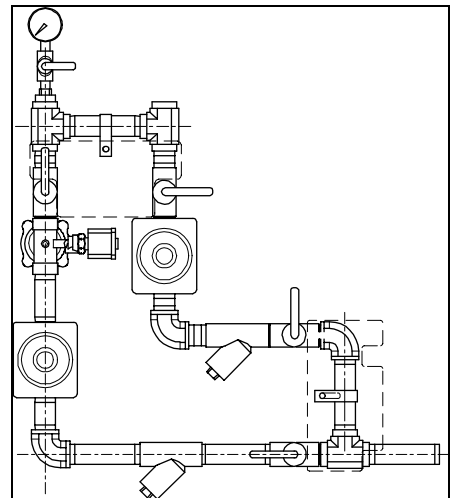


Follow-Up (Bypass Line)

Check the pressure regulator setpoint (refer to instructions in Section 3). Add to Section 3 for bypass line. Block the line to the HX and adjust pressure below rating.

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.

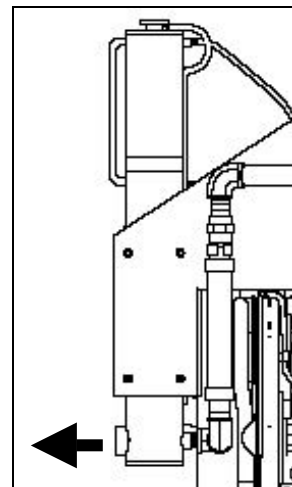
When flow is verified, close the bypass line outlet valve.

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)

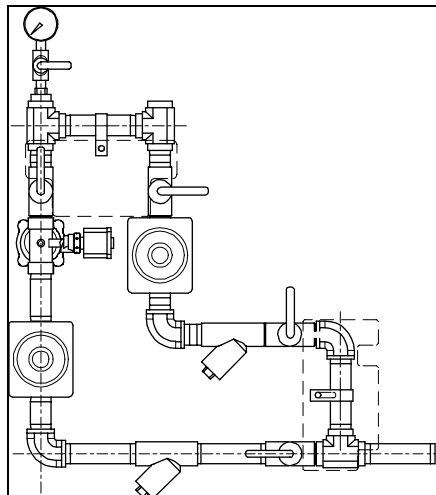
Check the pressure regulator setpoint (refer to instructions in Section 3). Add to Section 3 for normal line. Block the line to the HX and adjust pressure below rating.

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. Refer to Normal Local Starting Procedure in Section 3).

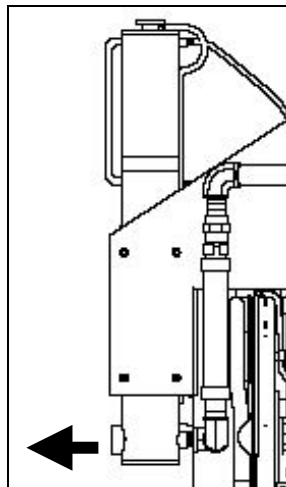
Verify that raw water flow is established through the heat exchanger.

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.



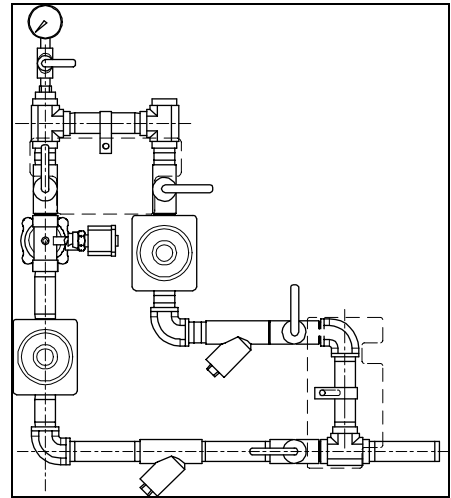
Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the compartment before servicing the batteries. To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

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.

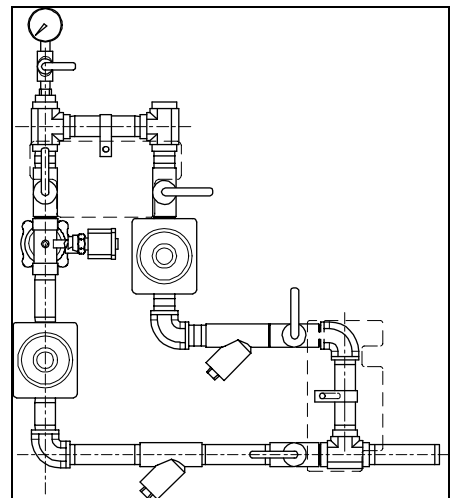


Loosen the union fitting between the solenoid valve and the pressure regulator.

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. 8210G4-12VDC (12 VDC) or 8210G4-24VDC (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.

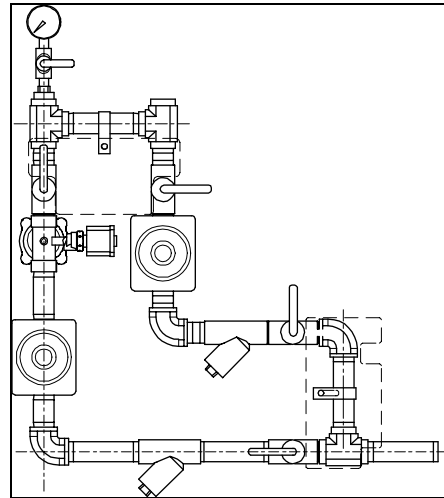
Thread the valve until it is tight and so that the electrical housing is facing up.

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.

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

Check for leaks. Repair any leaks.

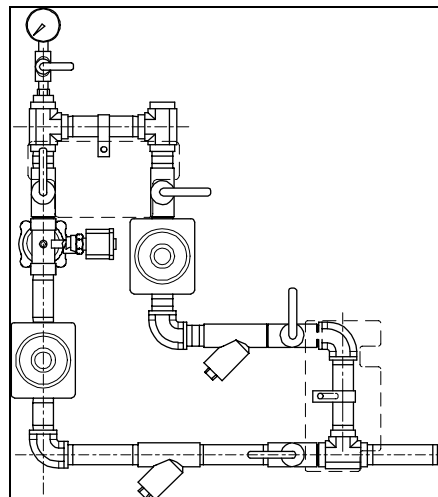
Check that raw water flow starts when the engine starts.

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 instructions in Troubleshooting Section 12.



Water Temperature Gauge Removal/Installation

Prepare

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.



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.

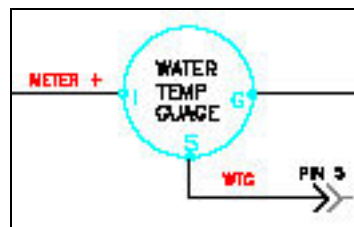
Remove the single black ground wire from the [G] terminal on the gauge.

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.

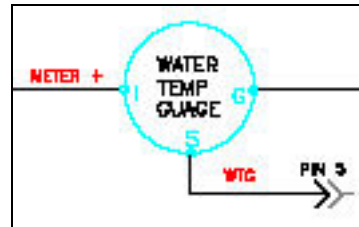
Tighten the nuts hand tight plus a full turn.

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 instructions in Troubleshooting, Section 12.

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

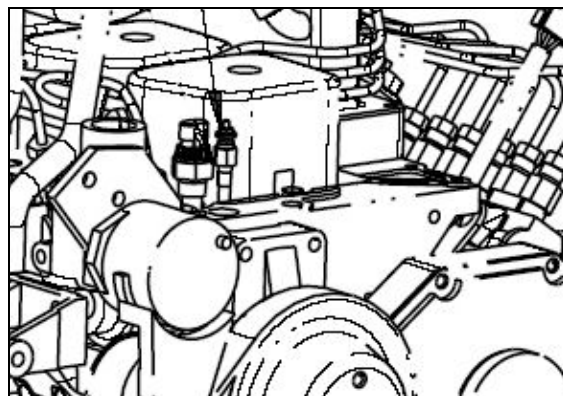
Do not remove the pressure cap from a hot engine. Wait until the temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.



Remove

Disconnect the temperature sensor wiring.
Remove the temperature sensor.



Install

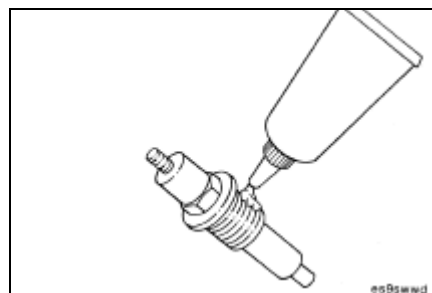
NOTE: Apply liquid teflon sealant to the threads when installing the temperature sensor.

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.



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

Check for leaks. Repair any leaks.

Check that engine operating temperature stabilizes between 82 and 94 °C [180 and 201 °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.

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

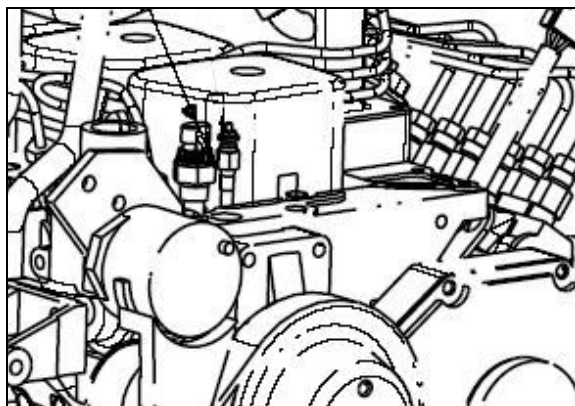
Do not remove the pressure cap from a hot engine. Wait until the temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.



Remove

Disconnect the temperature switch wiring.
Remove the temperature switch.



Install

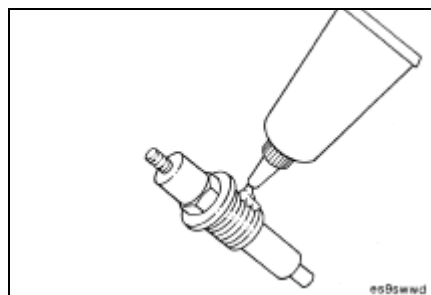
Apply liquid teflon sealant to the threads when installing the temperature switch.

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.



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

Check for leaks. Repair any leaks.

Check that engine operating temperature stabilizes between 82 and 94 °C [180 and 201 °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.

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.

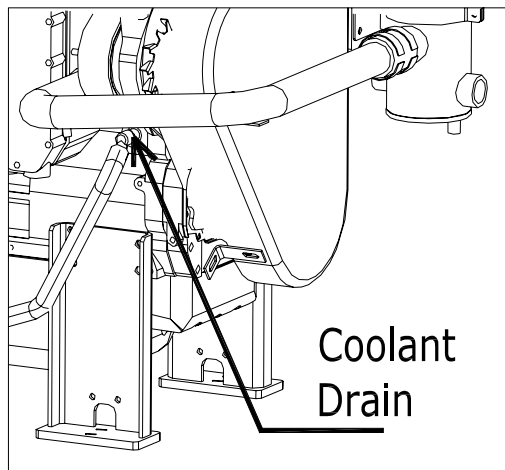
**WARNING**

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, (Cummins Fire Power Part No. 11407). 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.

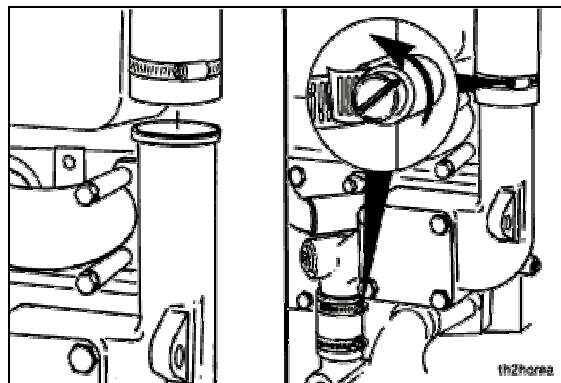
Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.



Remove

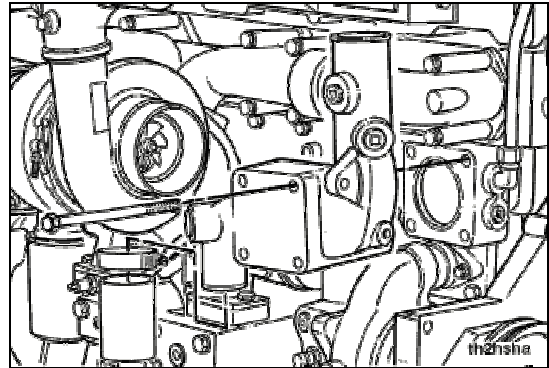
Remove the water outlet hose. Refer to Remove Upper Engine Coolant Hose in this section.

Loosen the coolant bypass hose clamps.

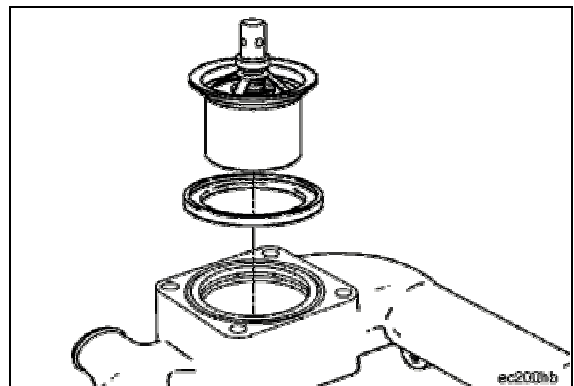


Coolant Thermostat Removal/Installation (Cont)

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



Remove the thermostat and old seal from the housing.



Install



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.

Install the thermostat (Cummins Part No. 3335550) in the housing.

Install a new o-ring seal (Cummins Part No. 3335548) in the groove on the thermostat housing mounting surface.



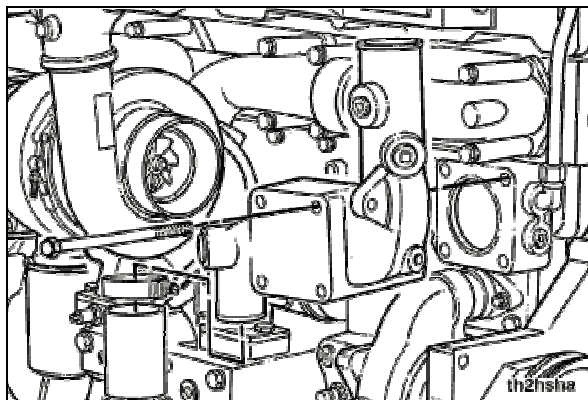
Coolant Thermostat Removal/Installation (Cont)

Install the hose on the thermostat housing bypass outlet.

Install the thermostat housing and four mounting capscrews.

Tighten the mounting capscrews.

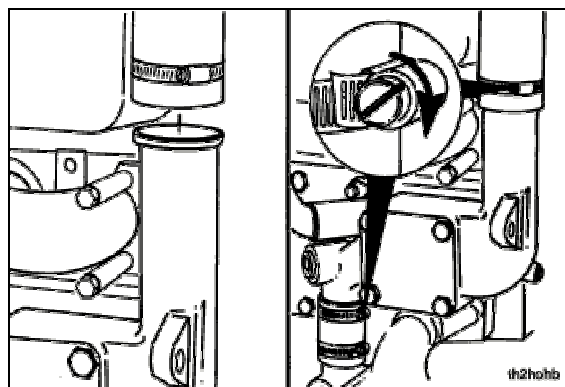
Torque Value: 54 N•m [40 ft-lb]



Install the water outlet hose. Refer to Install Upper Engine Coolant Hose in this section.

Tighten the coolant bypass hose clamps.

Torque Value: 3 N•m [27 in-lb]



Follow-Up

Fill the cooling system. Refer to Drain and Flush Cooling System in Section 5.

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

Check for leaks. Repair any leaks.

Check that engine operating temperature stabilizes between 82 and 94 °C [180 and 201 °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.

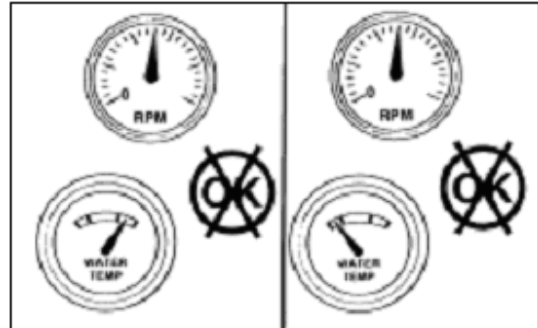


Coolant Thermostat Tests

Coolant Thermostat Leak Test



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.

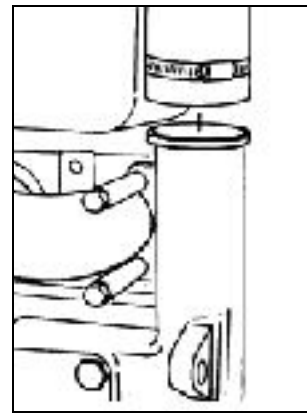


Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

Allow the engine to cool well below 83 °C [181 °F].

Place the AUTO/MANUAL Switch at the local panel in the MANUAL position.

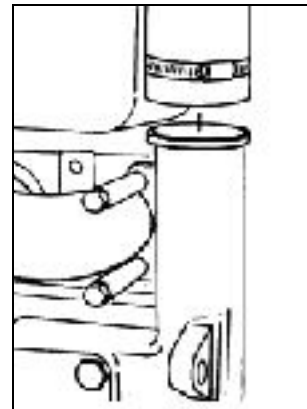
Loosen the hose clamp on the Upper Engine Coolant Hose. Remove the hose from the thermostat housing.



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.



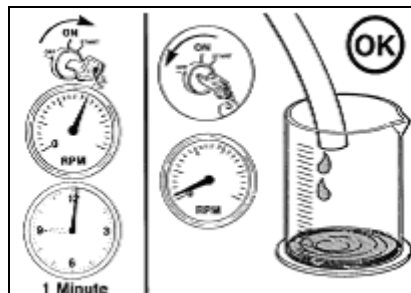
Coolant Thermostat Tests (Cont)

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

Operate the engine at rated rpm for 1 minute.

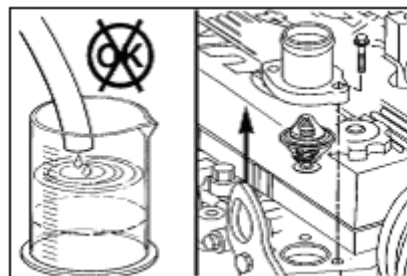
Shut off the engine and measure the amount of coolant collected in the container.

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. Refer to Local Starting Procedure for Test in Section 3.

NOTE: Monitor water temperature on the water temperature gauge on the engine control panel.

Allow the engine to approach operating temperature.

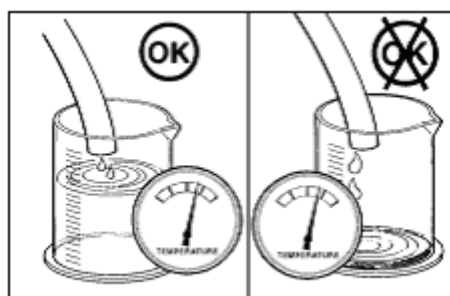
Monitor the operation of the thermostat.

Thermostat Initial Opening Temperature

- **MIN: 81 °C [178 °F]**
- **MAX: 83 °C [181 °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.

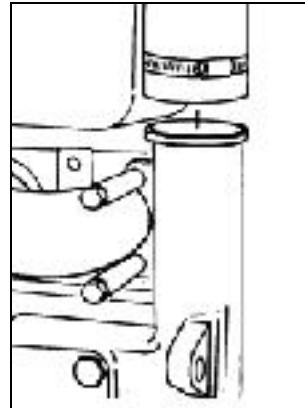


Coolant Thermostat Tests (Cont)

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.

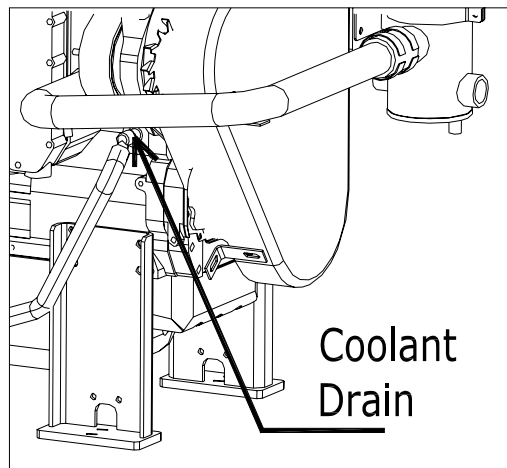
**WARNING**

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

Remove the pressure cap when the engine is cool.

Drain engine coolant as required for the intended service. Refer to Drain and Flush Coolant System in Section 5.

NOTE: If the coolant is not going to be reused, dispose of used coolant and antifreeze in accordance with federal, state, and local regulations.



If installed, remove the Belt Guard. Refer to Belt Guard Removal/Installation in this section.



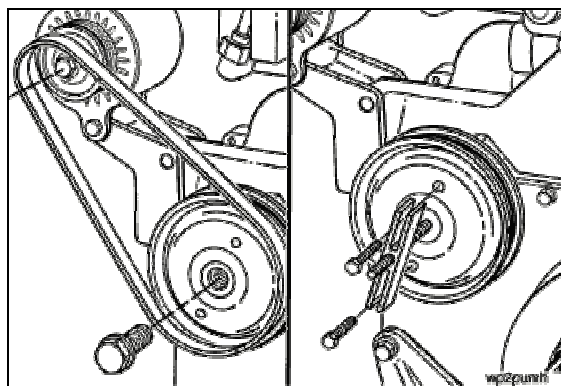
If installed, remove the Drive Belt. Refer to Belt Removal/Installation in this section.

Remove

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

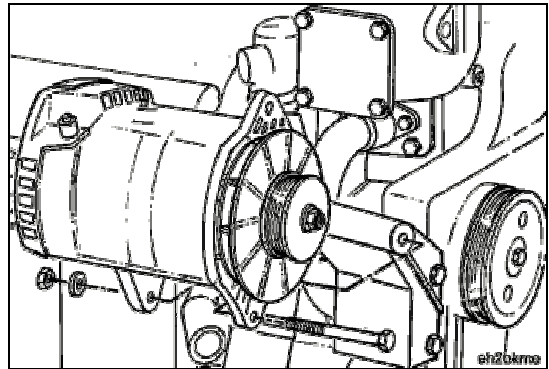
NOTE: Be sure the puller capscrews are threaded all the way through the puller before applying pressure to the puller screw.

Remove the water pump pulley retaining capscrew.



Coolant Water Pump Removal/Installation (Cont)

Remove the alternator.

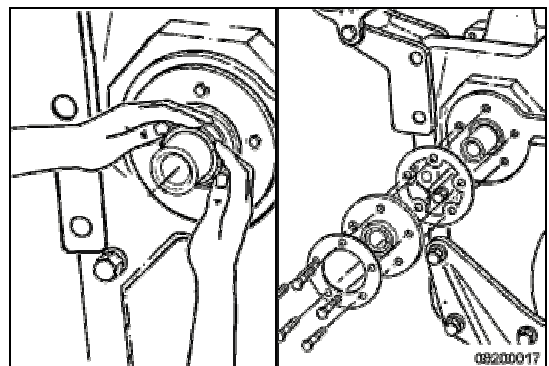


Remove the dust seal.

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

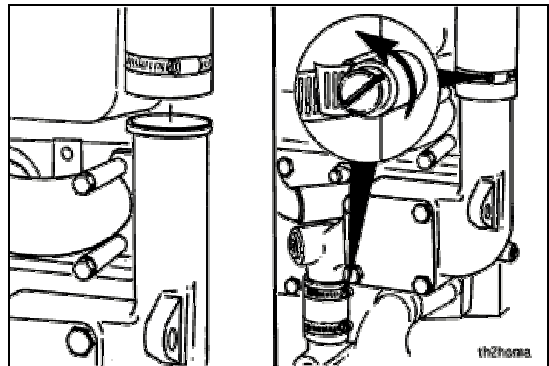
NOTE: Remove the dust seal as the seal carrier is removed, or use a heel bar, or similar tool, to pry the dust seal away from the seal case. Then remove the dust seal by hand.

Discard the oil seal and dust seal.

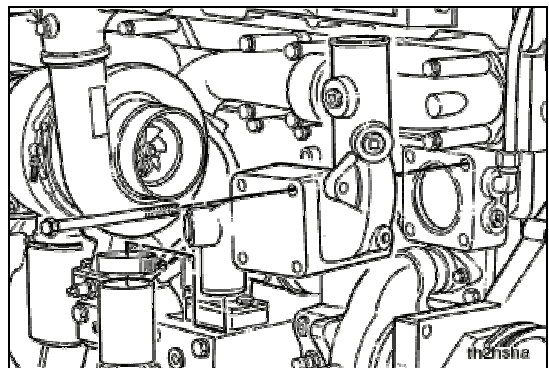


Loosen the coolant bypass hose clamps on both the upper and lower hoses.

Remove the upper coolant hose from the thermostat housing.



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



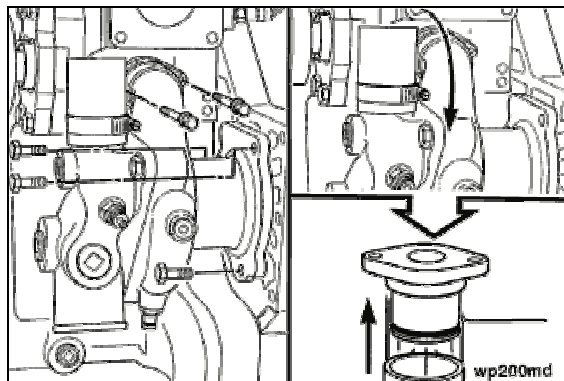
Coolant Water Pump Removal/Installation (Cont)

Remove the two water pump water transfer connection capscrews.

Remove the three water pump mounting capscrews.

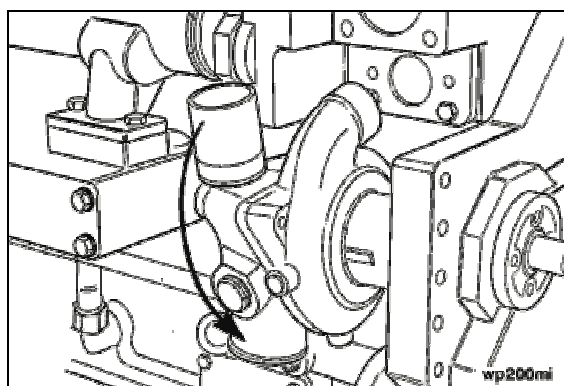
Rotate the water pump outward so the water transfer connection can be removed from the water pump.

Remove the water transfer connection from the water pump.



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

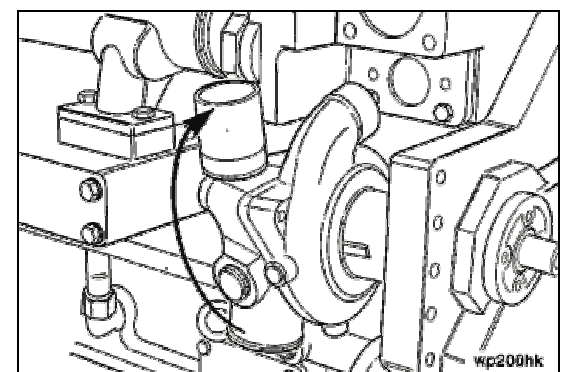
Remove the water pump.

**Install**

Install a new o-ring (Cummins Part No. 3882774) on the water pump mounting flange.

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

Install the water pump (Cummins Part No. 3800737 or reconditioned equivalent).



Coolant Water Pump Removal/Installation (Cont)

Install a new o-ring (Cummins Part No. 3892095) on the water pump water transfer tube.

Install the connection into the water pump.

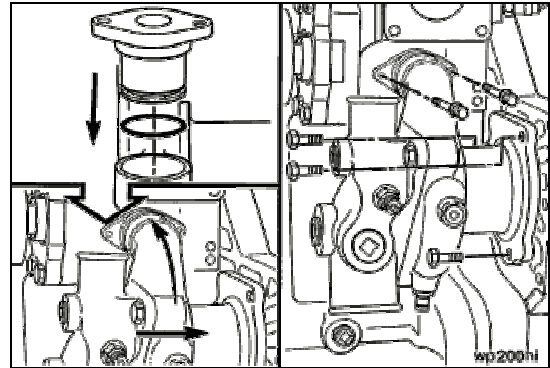
Twist the water pump inward, and install the three water pump mounting capscrews.

Torque Value: 47 N•m [35 ft-lb]

Install a new gasket (Cummins Part No. 3027924) on the water pump water transfer connection.

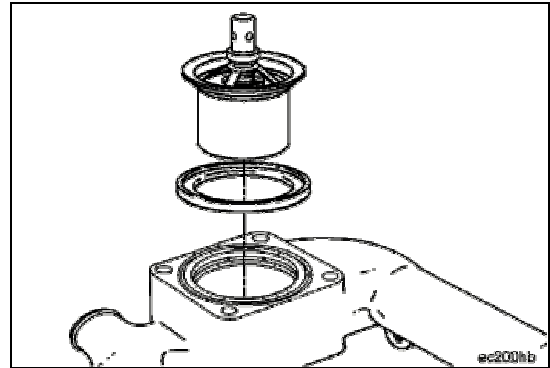
Install and tighten the two water transfer connection capscrews.

Torque Value: 25 N•m [221 in-lb]



Install the thermostat in the housing.

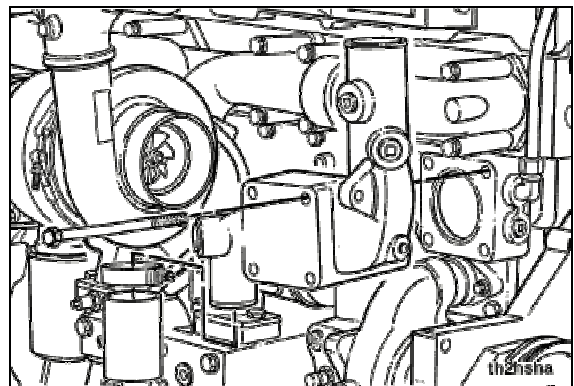
Install a new seal (Cummins Part No. 3335548) in the groove on the thermostat housing mounting surface.



Install the hose on the thermostat housing bypass outlet.

Install the thermostat housing and four mounting capscrews.

Torque Value: 54 N•m [40 ft-lb]



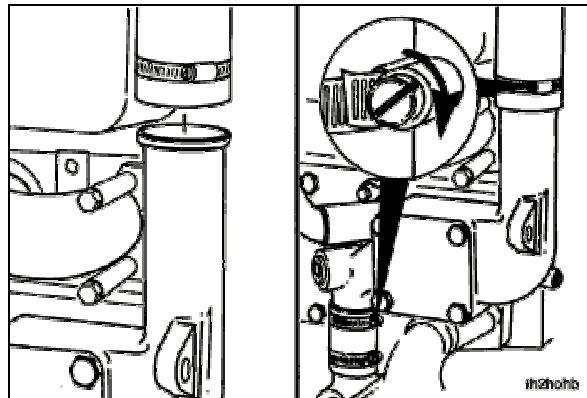
Coolant Water Pump Removal/Installation (Cont)

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

Torque Value: 3 N•m [27 in-lb]

Install the upper coolant hose. Refer to the OEM's specifications for the correct torque value.

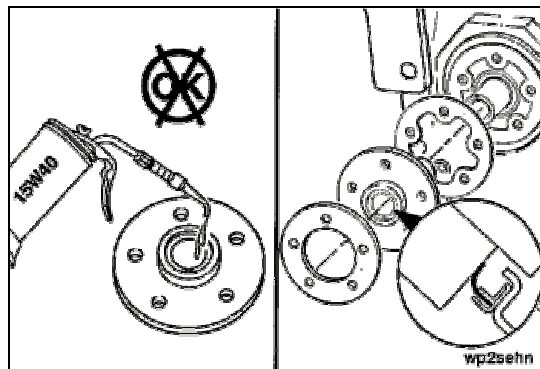
Install the lower coolant hose. Refer to the OEM's specifications for the correct torque value.



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

NOTE: Use the installation sleeve provided with the new seal to install the seal.

Install the new carrier gasket (Cummins Part No. 3328759) and oil seal (Cummins Part No. 3161772).



NOTE: The capscrew threads must be coated with thread sealant (Cummins Part No. 3823494) to prevent oil leakage.

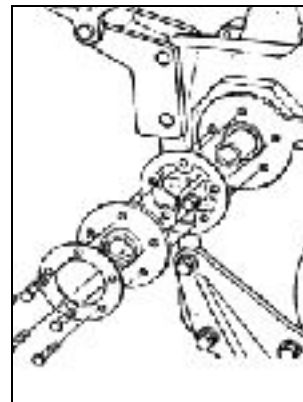
Coat the capscrew threads with sealant.

NOTE: Tighten the capscrews in a star pattern with two passes.

Install the five water pump oil seal capscrews.

Torque Value:

- 1st Pass: 7 N•m [62 in-lb]
- 2nd Pass: 20 N•m [177 in-lb]

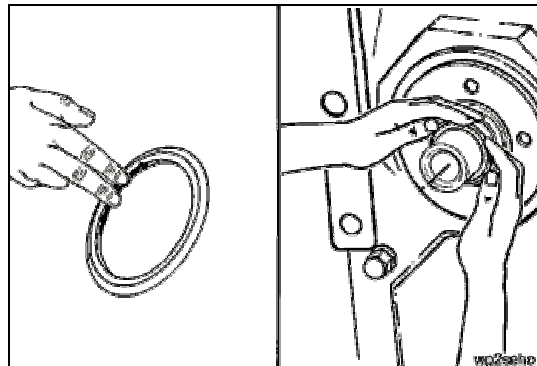


Coolant Water Pump Removal/Installation (Cont)

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

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

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

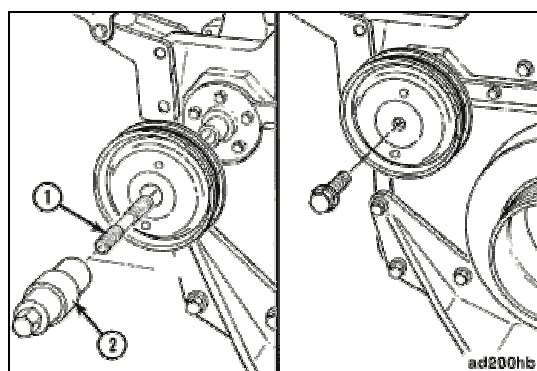


NOTE: Use Cummins Part Number 3377401, pulley pusher adapter (1), and Part Number 3376326, pulley pusher (2), to install the pulley.

Install the pulley

Install the capscrew in the shaft.

Torque Value: 75 N•m [55 ft-lb]



Follow-Up

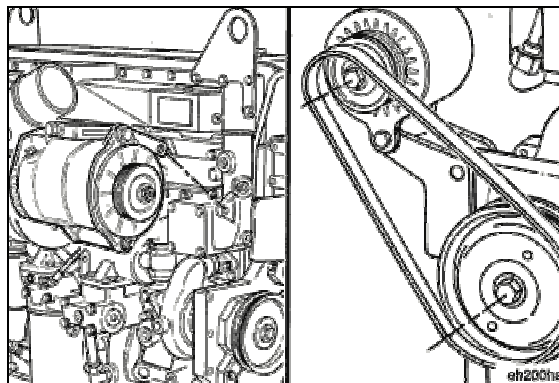
Install the alternator. Refer to [Alternator Removal/Installation](#) in this section.

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.

Close the drain valves.

Install all hoses previously removed.



Refill engine coolant as required. Refer to [Drain and Flush Coolant System](#) in Section 5.



Coolant Water Pump Removal/Installation (Cont)

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



Check for leaks. Repair any leaks.

Check that the alternator is charging.

Check that engine operating temperature stabilizes between 82 and 94 °C [180 and 201 °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. Refer to Local Starting Procedure for Testing in Section 3).

Ensure that repairs are completed satisfactorily.

Check that the AUTO/MANUAL Switch at the local panel is in the AUTO position and that the low lube oil pressure light is illuminated.

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 (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.



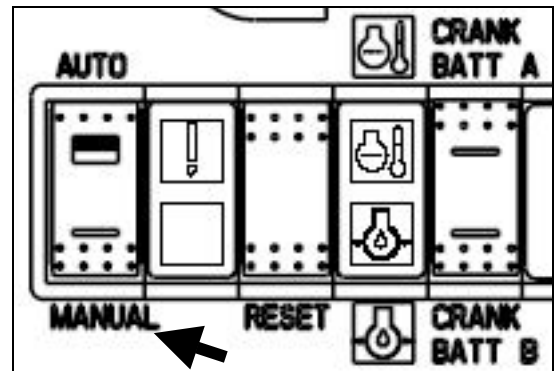
WARNING

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.



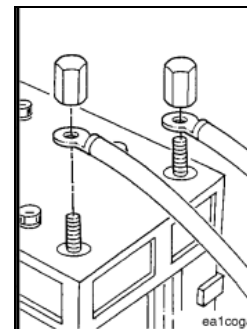
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.



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.

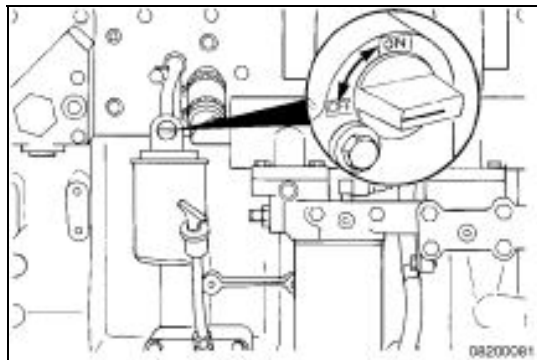


Coolant Filter Assembly Removal/Installation (Cont)

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



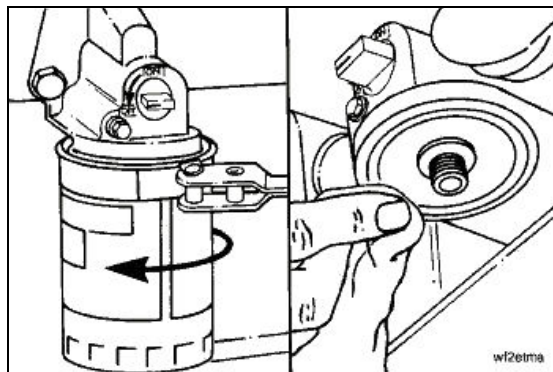
Turn the coolant filter shutoff valve to the OFF position by rotating the knob from vertical to horizontal in the direction shown.

**Remove**

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**

Do not allow oil to get into the filter.

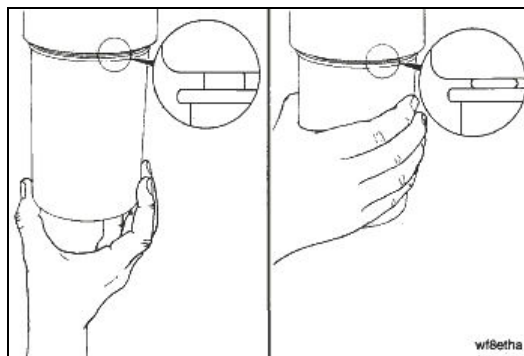
Apply a thin film of lubricating oil to the gasket sealing surface before installing the new coolant filter.



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.

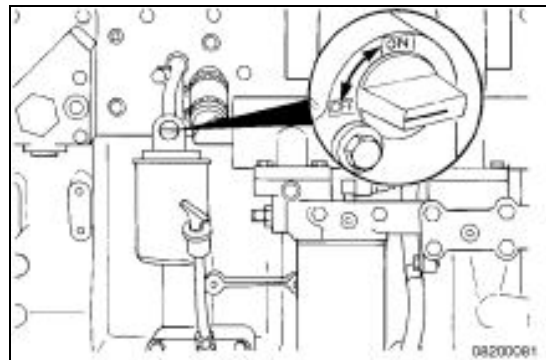


Coolant Filter Assembly Removal/Installation (Cont)



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.



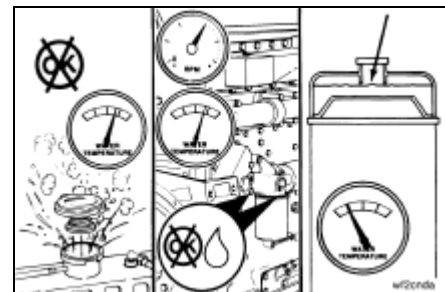
Follow-Up

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

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.



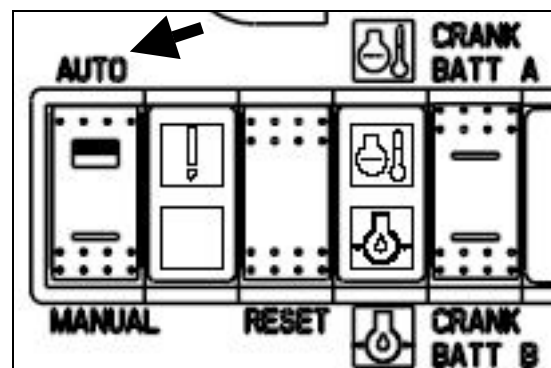
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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 9768 in Section 13 for schematic details.



Batteries can emit explosive gases. To reduce the possibility of personal injury, always ventilate the battery compartment before servicing the batteries.



To reduce the possibility of arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last.

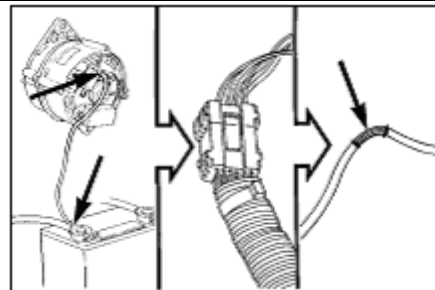
Check the battery and all wiring connections for damage. Refer to Battery Cables and Connections in this section.

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 Checks and Testing (Cont)

Alternator Mechanical Check

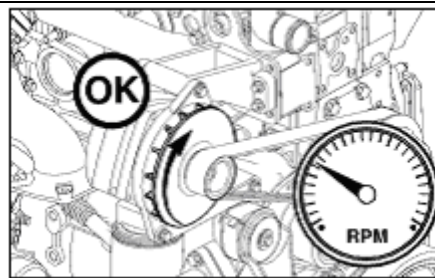
Start the engine. Refer to Normal Local Starting Procedure in Section 3.

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 Voltage Output Test



Batteries must have been satisfactorily load tested and must be charged with a resting voltage of more than 12.4 Volts for this testing.



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.

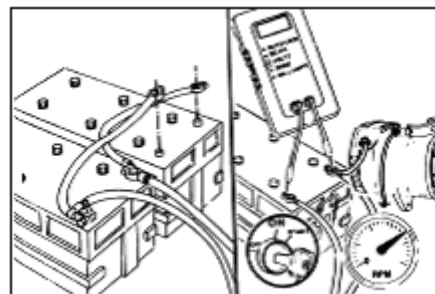
NOTE: Voltage should not exceed 15.5 V (for a 12 VDC system) or 31 V (for a 24 VDC system).

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.

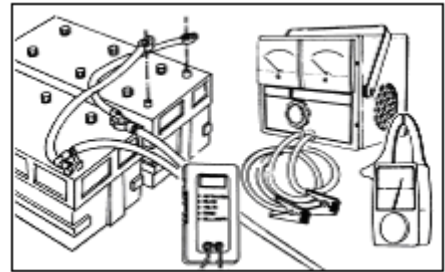
Adjust the carbon pile for maximum indication.

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.

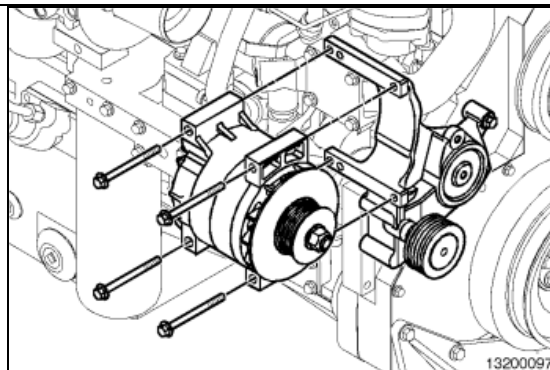


Remove

Pad Mount

Remove the four alternator mounting capscrews.

Remove the alternator from the alternator bracket.

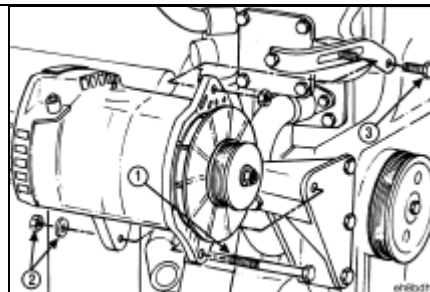


Remove

Spool Mount

Remove the adjusting link mounting capscrew (3) and the adjusting link.

Remove the alternator mounting capscrew (1), nut, washer (2), and alternator.



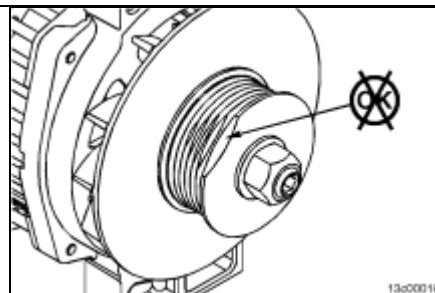
Alternator Removal/Installation (Cont)

Clean and Inspect for Reuse



Inspect the alternator pulley for cracks or broken grooves.

Replace the pulley if damage is found.



Install



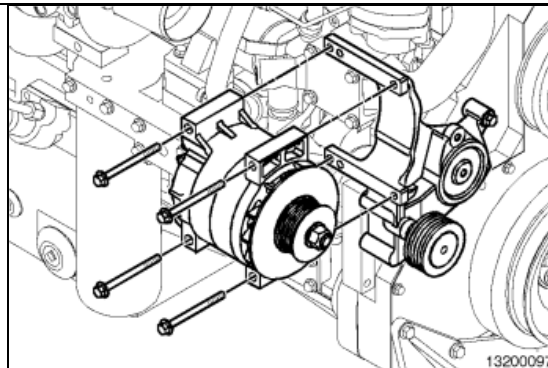
Pad Mount

Install the alternator and the four mounting capscrews.

Tighten the capscrews.

Torque Value: 36 N•m [27 ft-lb]

No alignment adjustment is required for the alternator to the alternator bracket.



Install



Spool Mount

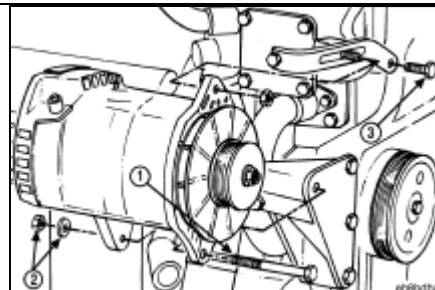
Install the adjusting link and mounting capscrew (3).

Tighten the mounting capscrew.

Torque Value: 47 N•m [35 ft-lb]

Install the alternator, capscrew (1), washer, and nut (2) to the mounting bracket and adjusting link.

Do not tighten the capscrews and nuts until the alternator belt is adjusted.



Alternator Removal/Installation (Cont)

Follow-Up



NOTE: Refer to Drawing 8513 Sheet 1 in Section 13 for wiring harness information.

Connect the 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 drive belt. Refer to Procedure 013-005 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322.

Remove the alternator. Refer to Procedure 013-001 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322.

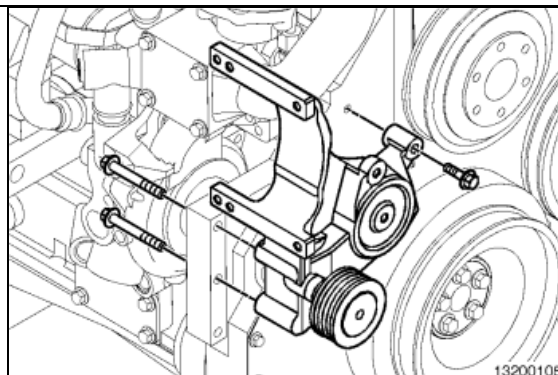
Remove the belt tensioner. Refer to Procedure 013-021 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322.



Remove

Remove the belt tensioner from the alternator bracket.

Remove the three alternator bracket mounting capscrews and remove the alternator mounting bracket.



Inspect for Reuse

Inspect the alternator mounting bracket for cracks.

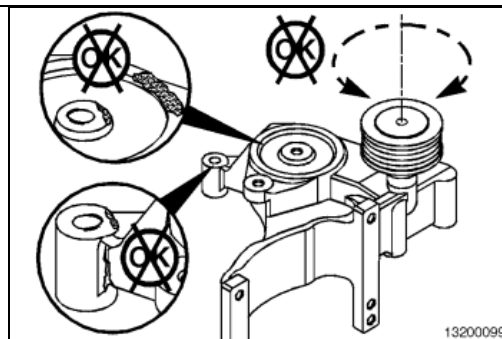
Replace if cracked.

Inspect underneath the alternator and belt tensioner for wear.

If wear is found, replace the alternator bracket.

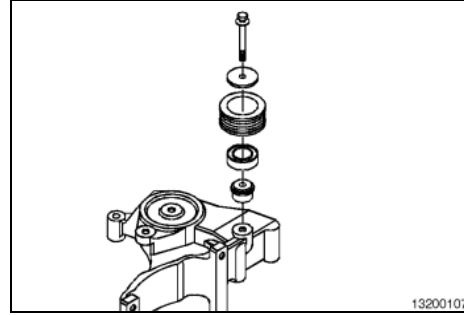
Check the idler pulley. The pulley must spin freely.

Replace the idler pulley if damage is found.



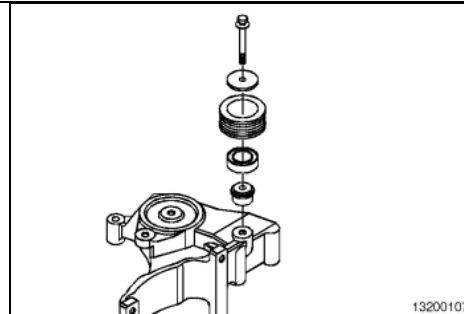
Alternator Bracket Removal/Installation (Cont)**Disassemble**

Remove the capscrew, cover plate, axle shaft and the idler/bearing assembly.

**Assemble**

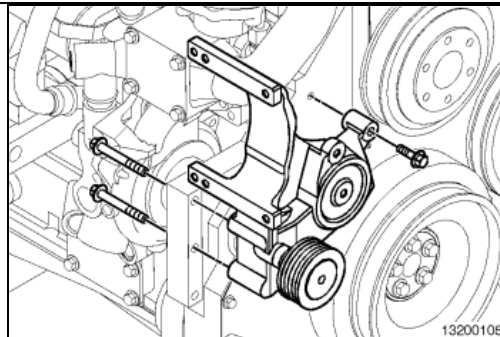
Install the axle shaft, the idler/bearing assembly, the cover plate and tighten the capscrew.

Torque Value: 47 N•m [35 ft-lb]

**Install**

Install the alternator bracket and tighten the capscrews.

Torque Value: 47 N•m [35 ft-lb]



Alternator Bracket Removal/Installation (Cont)

Follow-Up



Install the belt tensioner. Refer to Procedure 013-021 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322.

Install the alternator. Refer to Procedure 013-001 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322

Install the alternator belt. Refer to Procedure 013-005 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322.

Alternator Drive Pulley Removal/Installation

Prepare



Remove the belt guard. Refer to [Belt Guard Removal/Installation](#) in this section.

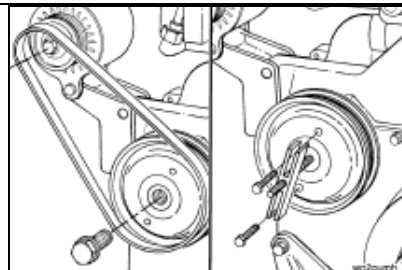
Remove the drive belt. Refer to [Belt Removal/Installation](#) in this section.

Remove



Remove the pulley retainer capscrew.

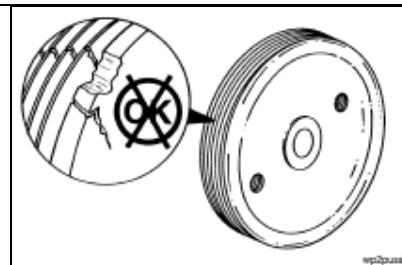
Use pulley puller, Part Number ST-647, and two 5/16 x 18 x 2 capscrews to remove the pulley.



Inspect for Reuse



Inspect the pulley for nicks, cracks, excessive wear in the belt grooves or other damage.



Install

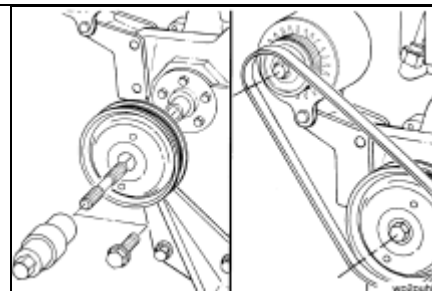


The pulley must be installed with the deep dished side of the pulley facing away from the engine.

Use pulley installation tool, Part Number 3376326, and pulley pusher adapter, Part Number 3377401, to install the alternator drive pulley.

Install and tighten the retaining capscrew.

Torque Value: 75 N•m [55 ft-lb]



Alternator Drive Pulley Removal/Installation (Cont)

Follow-Up

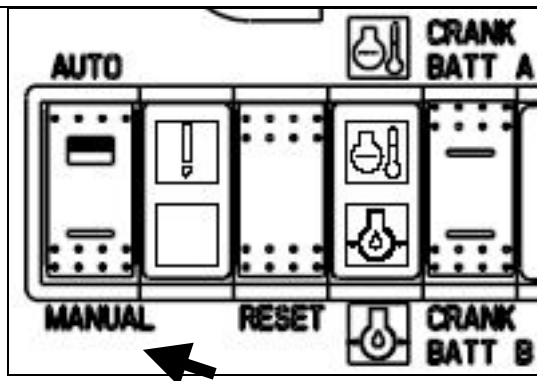
Install and adjust the alternator drive belt. Refer to Procedure 013-005 in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engine, Bulletin 3666322

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.



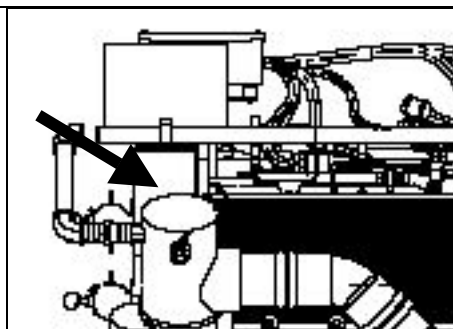
NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for disconnecting the battery cable clamps.

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 located behind the control panel.



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.

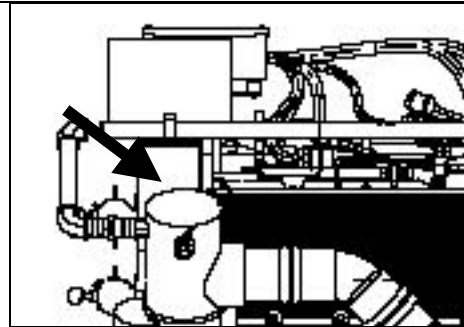


Install

Align and position the battery isolator on the four mounting studs located behind the control panel.

Install the four mounting nuts.

Torque Values: As per capscrew markings and torque values in Section 10



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.

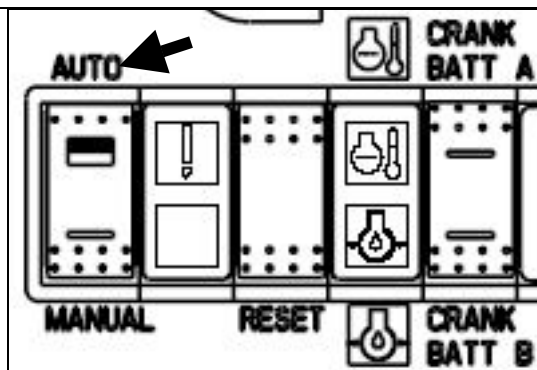
Terminal E indicates battery voltage.

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.



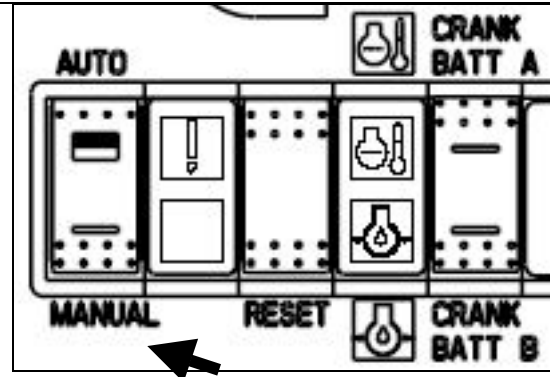
Engine Harness Removal/Installation

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.

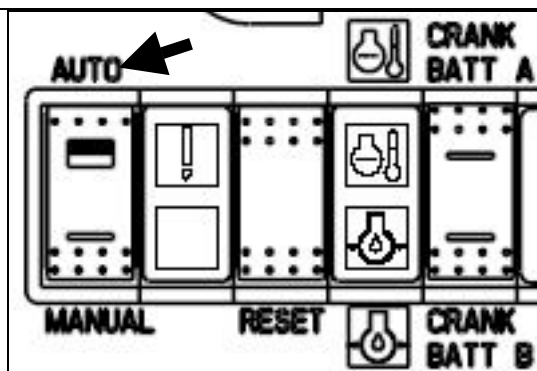
Observe that the engine starts with no unusual noises or vibrations.

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.

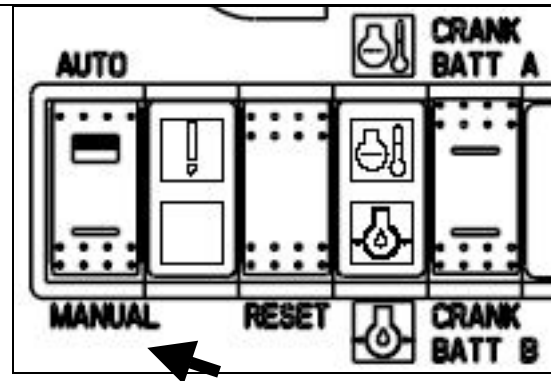


Voltmeter Removal/Installation

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!

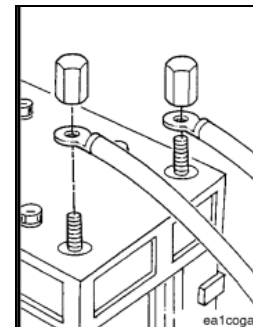
Next, disconnect both batteries at their terminals.

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

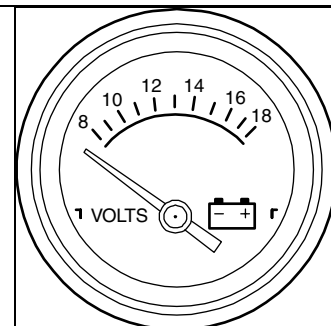
NOTE: Refer to [Drawing 10423 Sheet 1](#) in Section 13 for electrical schematic details.

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**

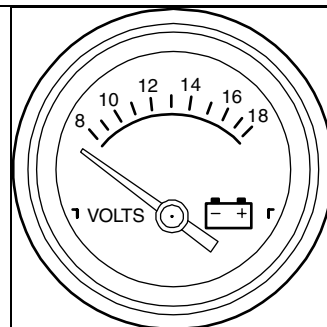
Orient the voltmeter in the cutout in the electrical panel.

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.

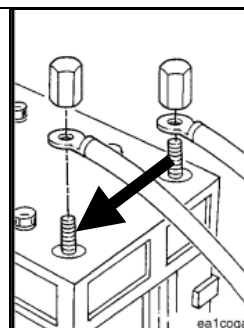
Tighten the nuts on the studs.



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

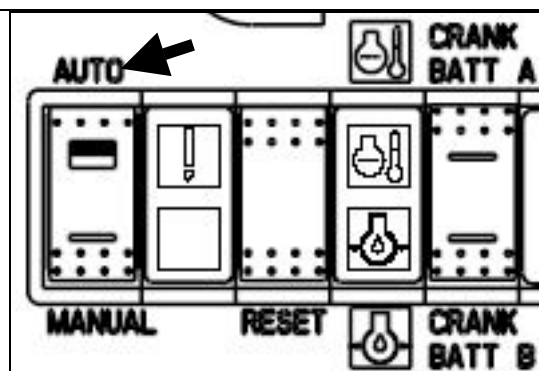
Wear safety glasses when reconnecting batteries!

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



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.



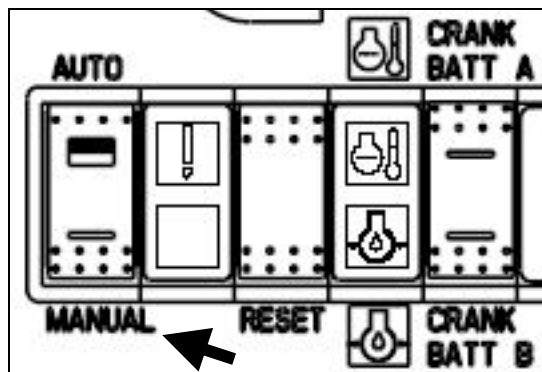
Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a strong tank of soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to avoid serious burns.

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.



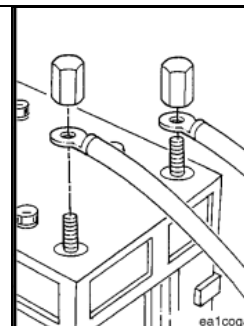
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.



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.



Do not overfill the cell. Fill only to the level indication.

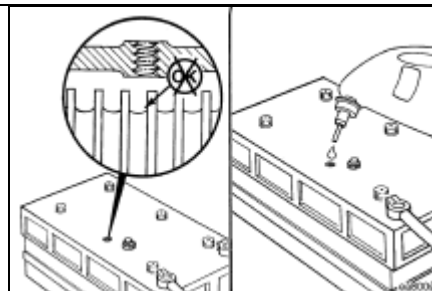


If a syringe type filler is used, use care to prevent overflow or splashing of acid from the cell.

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*

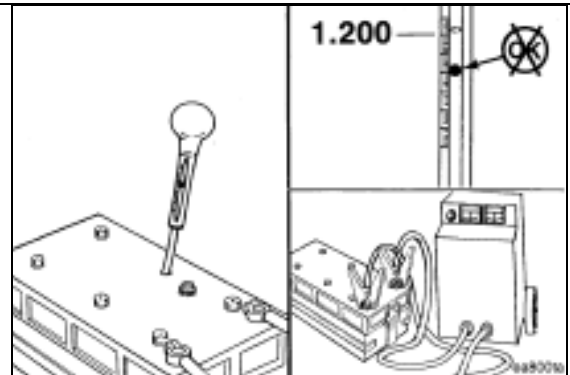
% Charged	Non-Tropical	Tropical
100%	1.265	1.225
75%	1.225	1.185
50%	1.190	1.150
25%	1.155	1.115
0%	1.120	1.080

- 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



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.

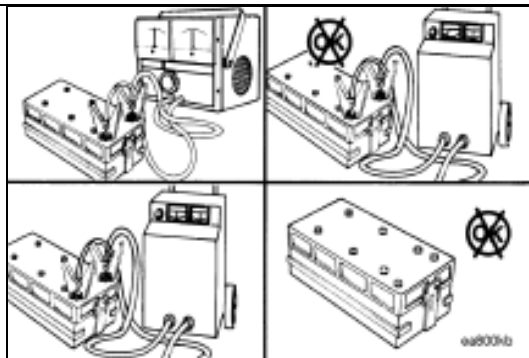
NOTE: The required battery output in cold cranking amperes is provided in Electrical System Specifications in Section 10. Use the listed value for the system voltage.

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.

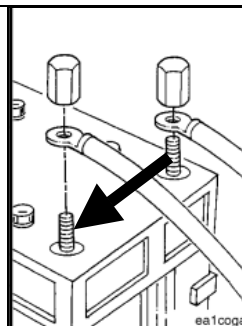
Replace the battery if it will not charge to the manufacturer's specifications or will not maintain a charge.



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!

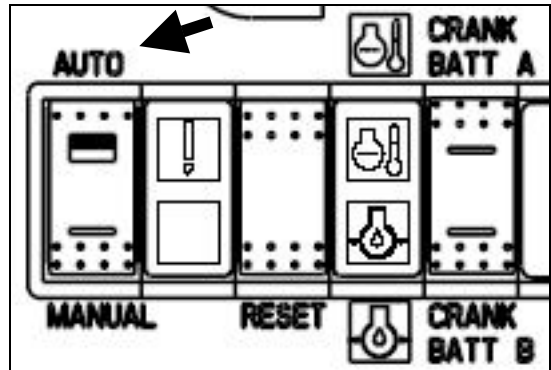
Reconnect the batteries at their terminals after all service work has been completed.



Battery Testing (Cont)

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

Return the fire protection system to operating status.



Battery Removal/Installation



Batteries can emit explosive gases. To avoid injury, always ventilate the compartment before servicing the batteries.

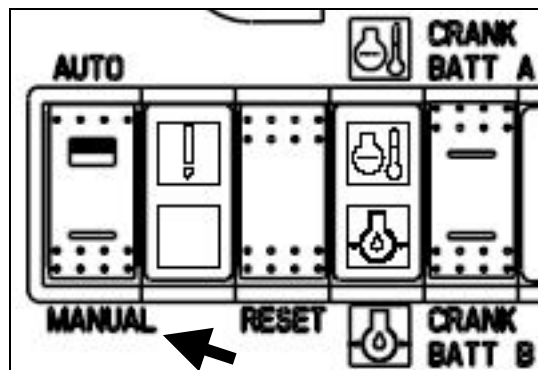


Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a strong tank of soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to avoid serious burns.

Prepare

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

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

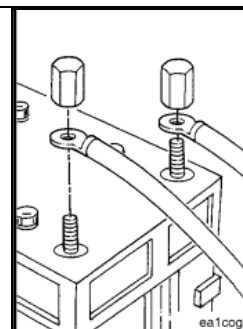


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.



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 first.



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.



Do not tip the battery and spill the acid.

Using a battery carrier, carry and position the battery.



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.

Torque Values: As per capscrew markings and torque values in Section 10

Install any battery support hardware.

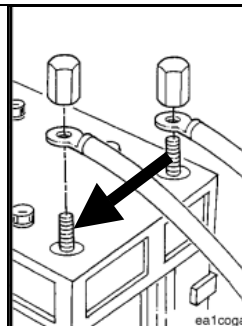
Follow-Up

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!

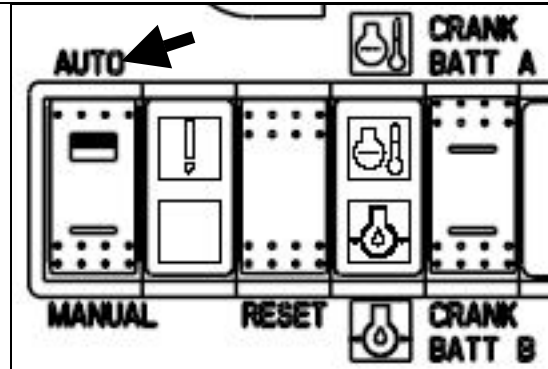
Reconnect the batteries at their terminals after all service work has been completed.



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.



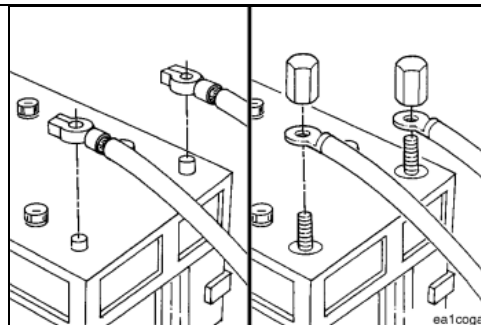
WARNING

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:

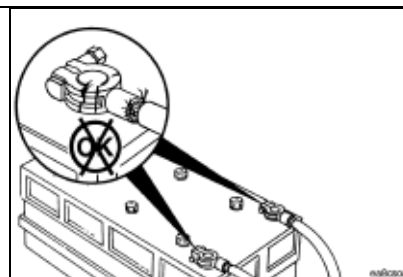
Battery terminal and clamp

Threaded battery terminal and nut



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

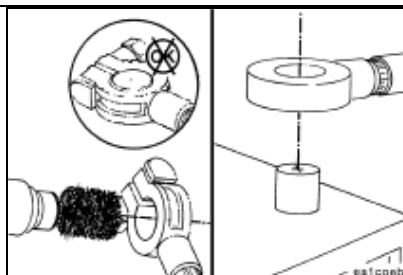
Replace broken terminals, connectors, or cables.



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.

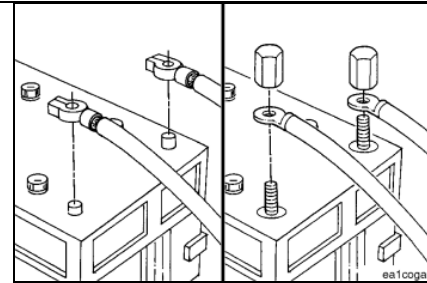
Brush or wipe all residue or debris from the terminals.



Check Battery Cables and Connections (Cont)

NOTE: Coat the terminals with a high temperature grease to prevent corrosion.

Install the cables and tighten the battery connections.

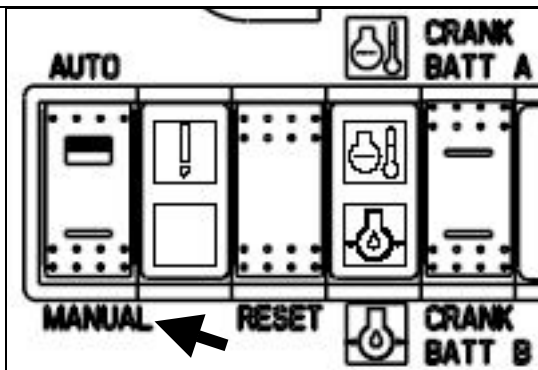


Starter Motor Assembly Removal/Installation

Prepare

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

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

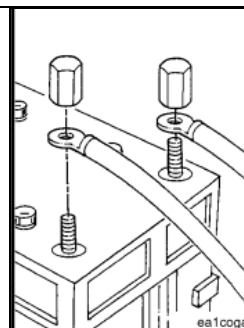


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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

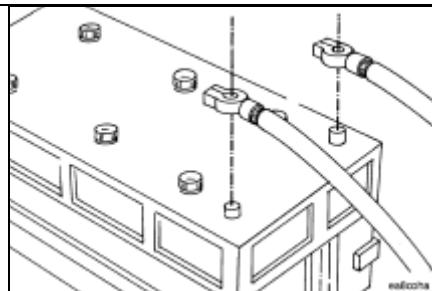


WARNING

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

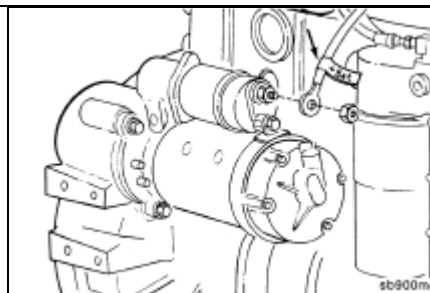
NOTE: The starting motor mounting capscrews can be metric or standard thread sizes. Make sure to install the same-size capscrews that were removed.

Remove the electrical connections from the batteries.

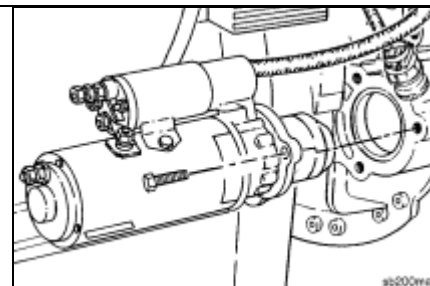


Starter Motor Assembly Removal/Installation (Cont)

Tag and remove the electrical connections from the starting motor.



Remove the three capscrews and the starting motor.



Install

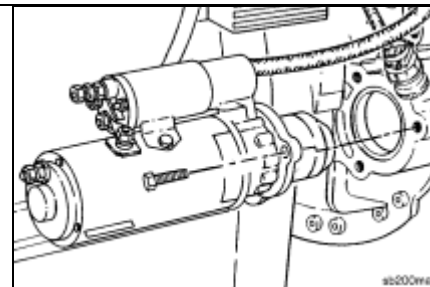
NOTE Before installing the starting motor, make sure the capscrews are the correct size and grade.

NOTE: Use only the Delco 39MT replacement starter Cummins Part No. ST9370 / 3971603 (12 VDC) or Cummins Part No. ST9258 / 3957598 (24 VDC).

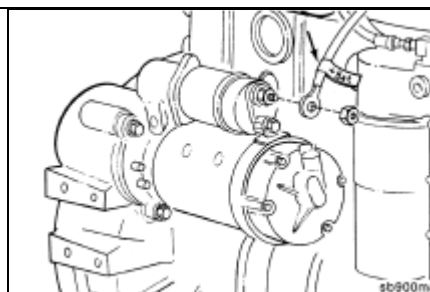
Align and install the starter motor.

Install and tighten the three mounting capscrews.

Torque Value: 90 N•m [66 ft-lb]



Install and tighten the electrical connections to the starting motor.



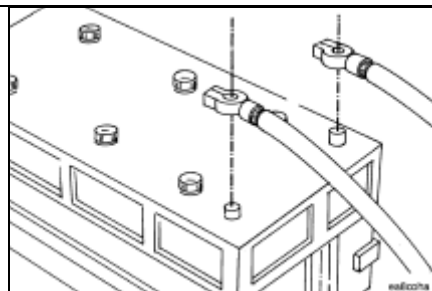
Starter Motor Assembly Removal/Installation (Cont)



WARNING

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

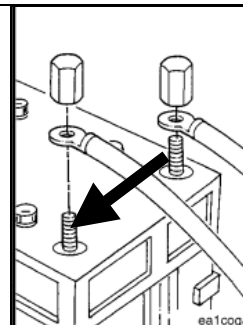
Install and tighten the battery electrical connections.



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.



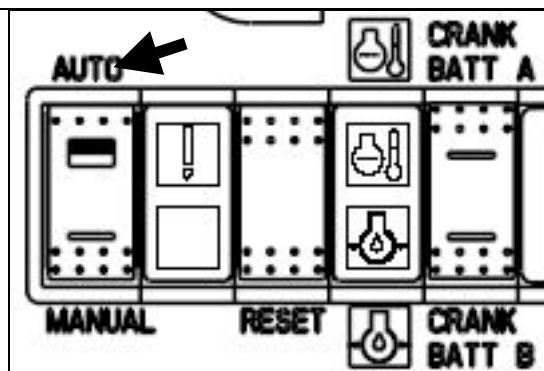
Start the engine. Refer to Normal Local Starting Procedure in Section 3.

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.



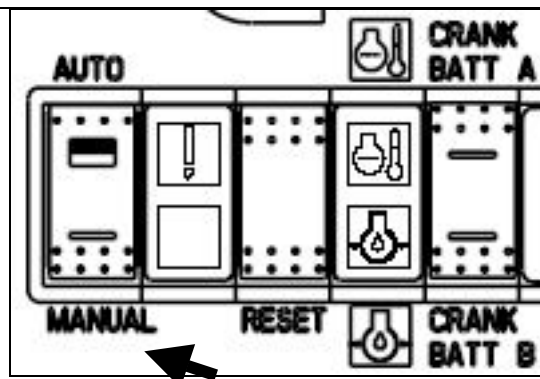
Crank Solenoid Assembly Removal/Installation

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.

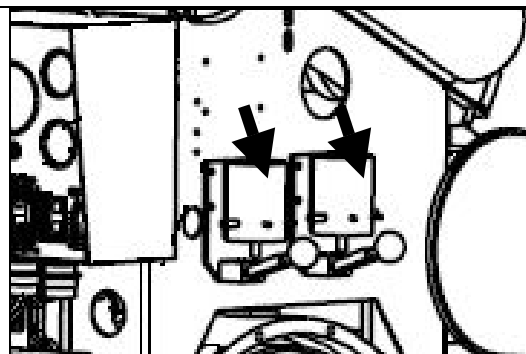
NOTE: Observe the location of flat and lock washers for ease of reconnection.

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.

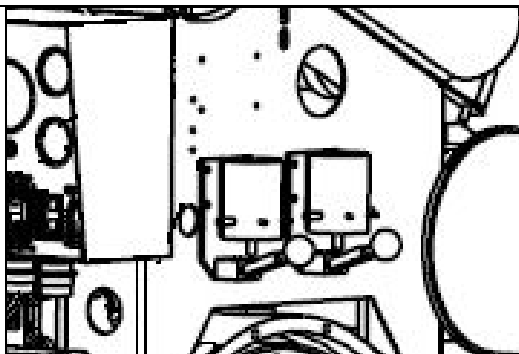
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for crank solenoid schematic information.

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.

Torque Values: As per capscrew markings and torque values in Section 10

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.

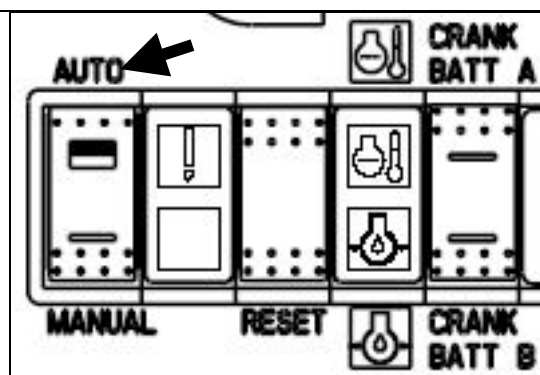
Start the engine manually from the crank solenoid lever handle. Refer to Normal Local Starting Procedure in Section 3.

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.

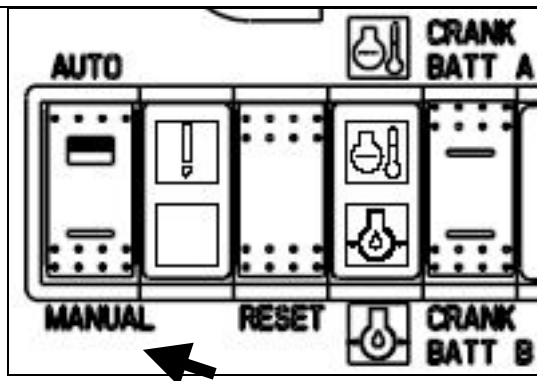


Control Panel Fuse Replacement

Prepare

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

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



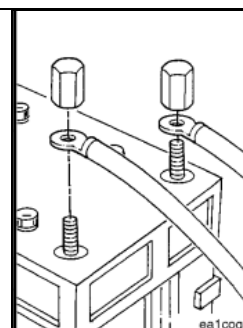
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.



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!

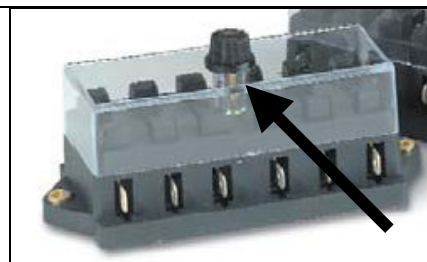
Next, disconnect both batteries at their terminals.



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.

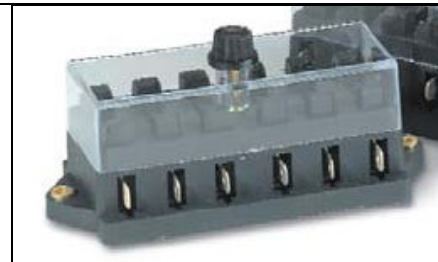


Install

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.

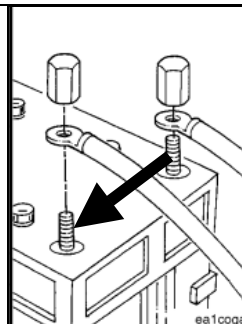


Control Panel Fuse Replacement (Cont)

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.



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.

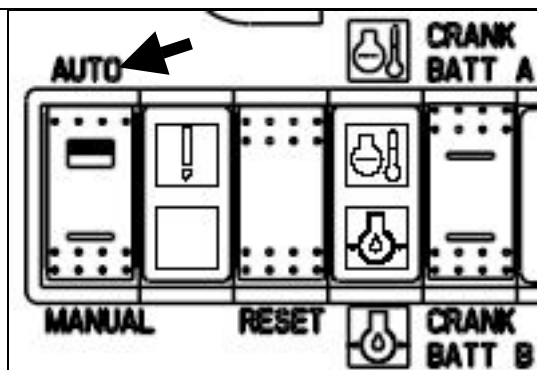
Observe that engine speed is indicated.

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.



Exhaust Manifold Removal/Installation

Prepare



Remove the heat shield. Refer to instructions in this section.

Remove the air intake piping from the turbocharger. Refer to instructions in this section.

Remove the air outlet piping from the turbocharger. Refer to instructions in this section.

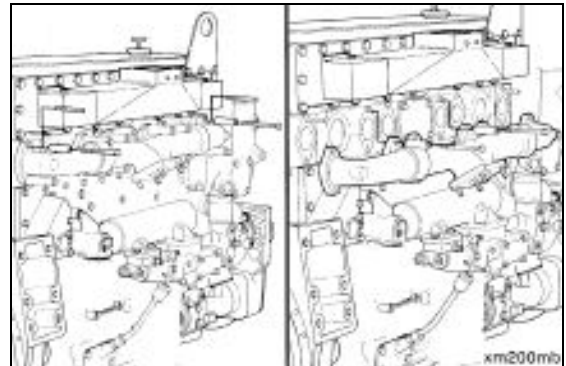
Remove the exhaust outlet piping from the turbocharger. Refer to instructions in this section.

Remove the turbocharger. Refer to instructions in this section.

Remove



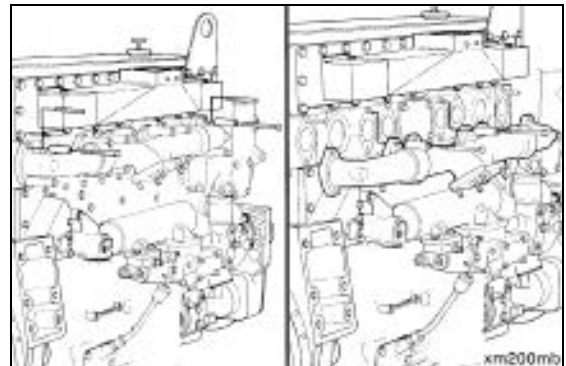
Refer to Exhaust Manifold, Dry (35-011-007) in ISM, ISMe, and QSM11 Troubleshooting and Repair Manual, Bulletin Number 3666322-02.



Clean



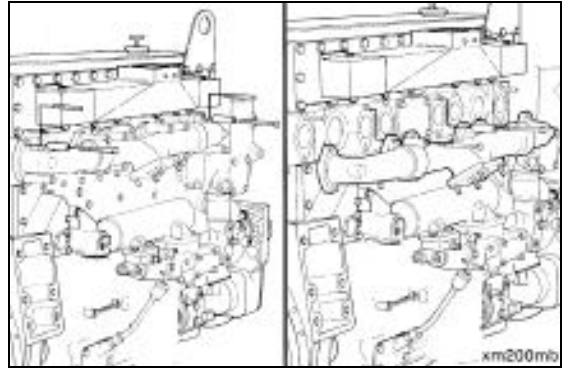
Refer to Exhaust Manifold, Dry (35-011-007) in ISM, ISMe, and QSM11 Troubleshooting and Repair Manual, Bulletin Number 3666322-02.



Exhaust Manifold Removal/Installation (Cont)

Install

Refer to Exhaust Manifold, Dry (35-011-007) in ISM, ISMe, and QSM11 Troubleshooting and Repair Manual, Bulletin Number 3666322-02.



Follow-Up

Install the turbocharger. Refer to instructions in this section.

Install the exhaust outlet piping at the turbocharger. Refer to instructions in this section.

Install the air outlet piping at the turbocharger. Refer to instructions in this section.

Install the air intake piping at the turbocharger. Refer to instructions in this section.

Install the heat shield. Refer to instructions in this section.

Exhaust Restriction Measurement

Measure

NOTE: The maximum acceptable exhaust restriction is listed in Exhaust System Specifications in Section 10.

NOTE: A new pressure tap in the customer-supplied exhaust piping may be required.

Install pressure gauge, Cummins Part Number ST-1273, in the exhaust piping at the connection to the fire pump.

Operate the engine at rated speed and load. Refer to Normal Local Starting Procedure in Section 3.

Observe the exhaust restriction.

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

Remove the pressure gauge and plug the pressure tap.

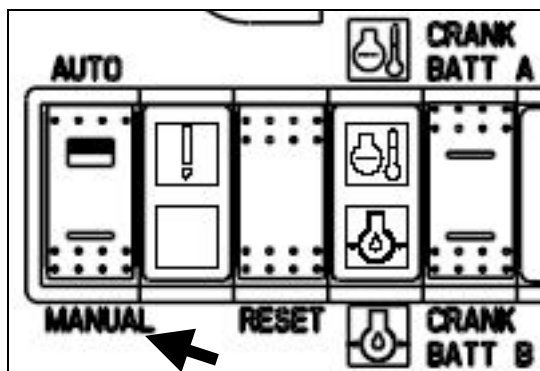
If the backpressure exceeds specification, modify the exhaust piping accordingly.

Exhaust Shield 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.

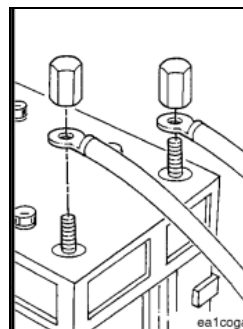


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS

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.

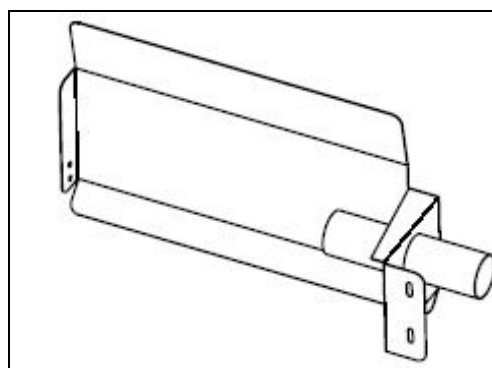
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Remove

Remove the exhaust shield and fasteners. Refer to [Drawing 9515](#) in Section 13.

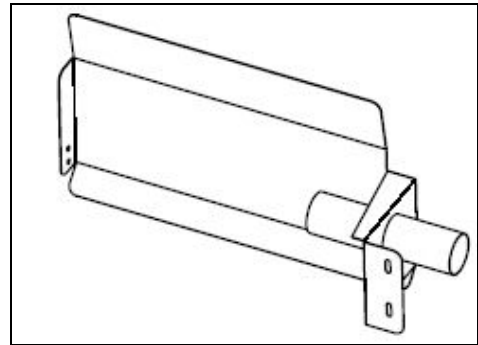


Exhaust Shield Removal/Installation (Cont)

Install

Install the exhaust shield and fasteners. Refer to Drawing 9515 in Section 13.

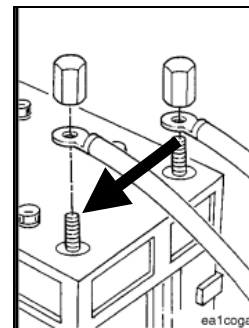
Torque Values: As per capscrew markings and torque values in Section 10.



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

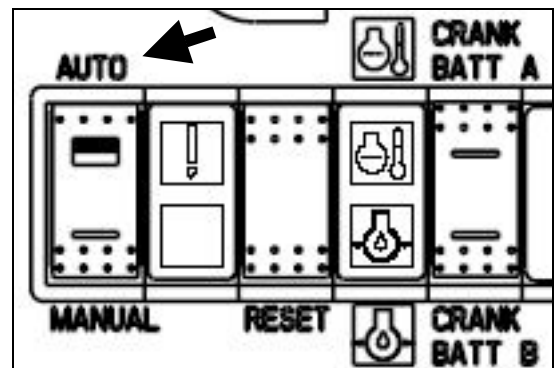
Wear safety glasses when reconnecting batteries!

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



If functional components were removed, repaired, or replaced, perform the appropriate installation checks and engine starts as listed in Section 3. Verify that the components operate properly.

If testing is completed, place the AUTO/MANUAL rocker switch in the AUTO position.



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Air in Fuel

General Information



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.



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:

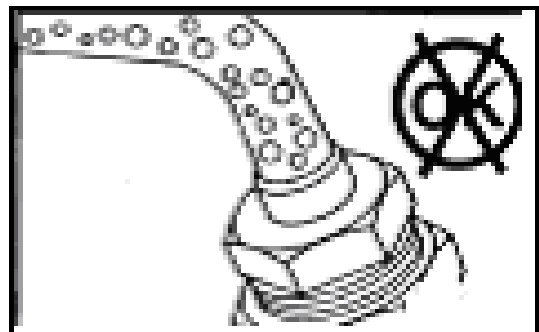
Leave engine outside in cold environment for at least 12 hours.

Perform outlined test.

If the system fails to meet test criteria, replace the fuel lift pump.

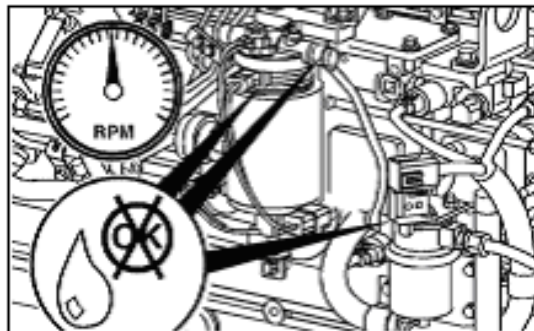
Discussion

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)

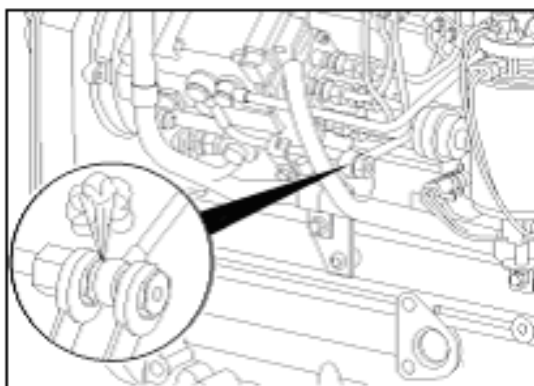
Since the fuel lift pump provides positive pressure through the fuel filter and supply line to the fuel injection pump, loose connections or defective seals can show as a fuel leak, not as an air leak.



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.

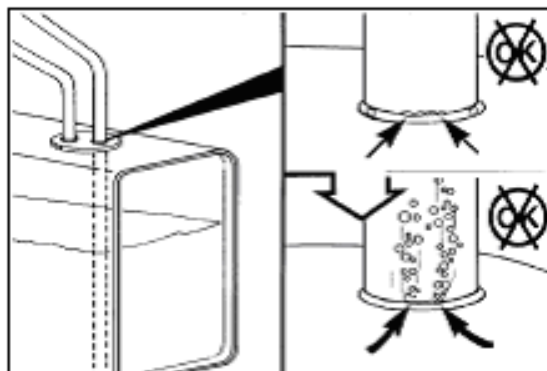


If air continues to bubble out of the system for several minutes, then an air leak is present.

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

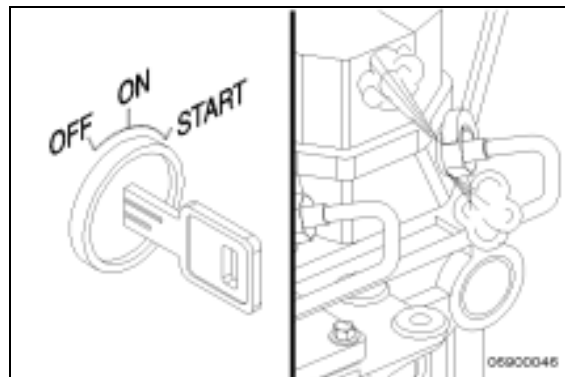


Keep hands and body parts away from the high-pressure fuel lines. Fuel coming from the high-pressure fuel lines is under extreme pressure and can cause serious injury by penetrating the skin.

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]

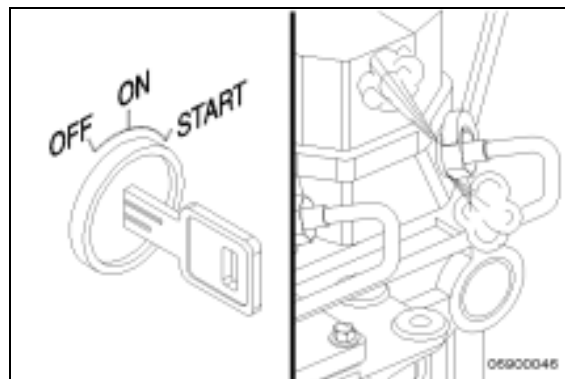


Do not bleed the fuel system on a hot engine; this can cause fuel to spill onto a hot exhaust manifold, which can cause a fire.

Operate the engine.

Vent one line at a time until the engine runs smoothly.

Stop the engine.



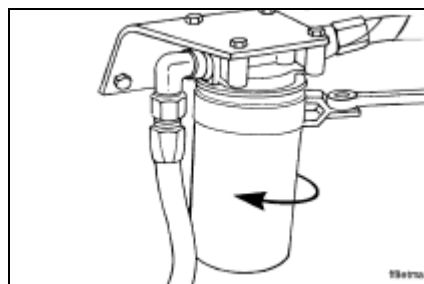
Fuel Filter Removal/Installation

Prepare

Remove

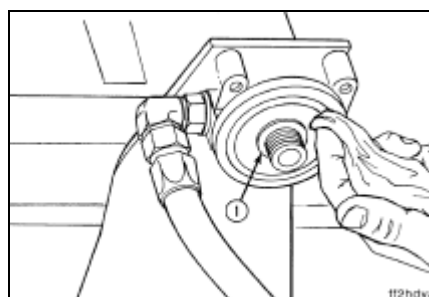
Clean the area around the fuel filter and fuel filter head.

Remove the fuel filter with filter wrench, Part Number 3376807, or equivalent.



Remove the thread adapter sealing ring (1).

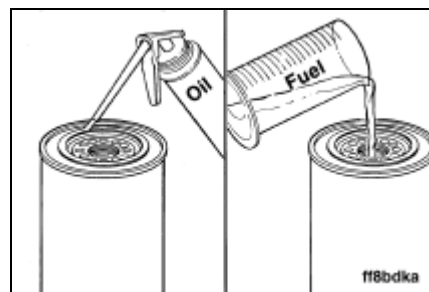
Use a clean, lint-free towel to clean the gasket surface on the fuel filter head.



Install

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

Use correct filters for the engine. Refer to Procedure [018-024](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.

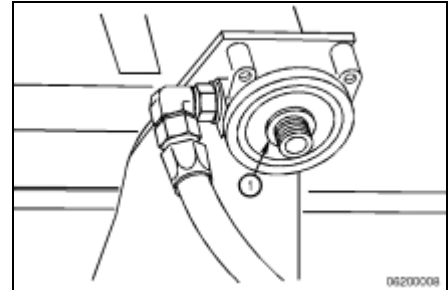


Efficiency	Water Removed
98.7% at 10 microns	Free = 95%
96% at 8 microns	Emulsified = 95%
86% at 5 microns	

Fuel Filter Removal/Installation (Cont)

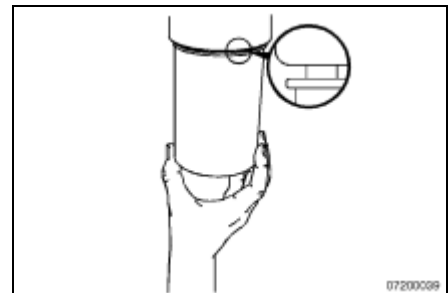
NOTE: A 10-micron fuel filter is required with Centinel™ equipped engines.

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



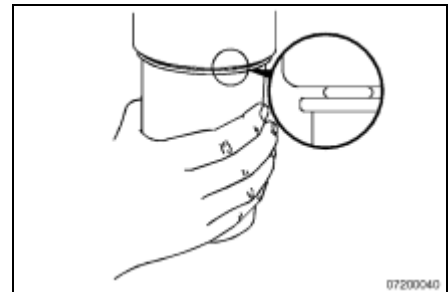
Install the filter on the filter head.

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



Mechanical over-tightening of the filter can distort the threads and damage the fuel filter seal.

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



Follow-Up

Static Injection Timing

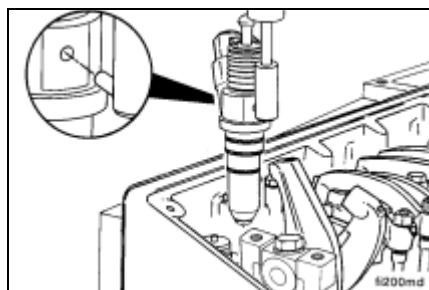
Prepare

Setup

Remove the rocker lever cover. Refer to Procedure [003-011](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.

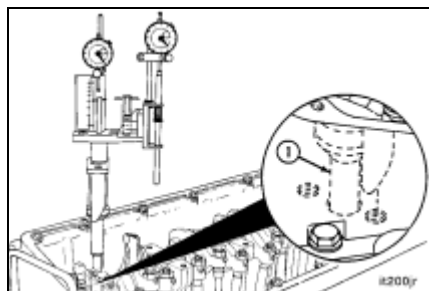
Remove the injector from cylinder number one. Refer to Procedure [006-026](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322..

NOTE: It is not necessary to remove all injectors; however, engine rotation will be easier with all injectors removed.



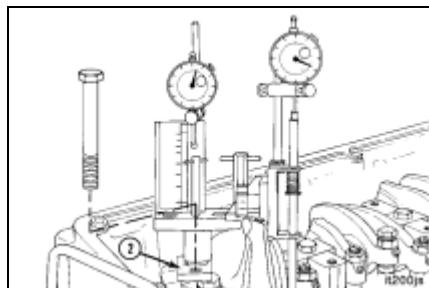
The timing tool, Part Number 3824942, can be installed without removing the rocker housing.

Install the piston plunger rod (1) in the injector bore of number one cylinder.



Align the swivel bracket (2) with the injector hold-down capscrew hole.

Install capscrew, Part Number 3823600, through the swivel bracket. The capscrew is included with the timing tool kit.

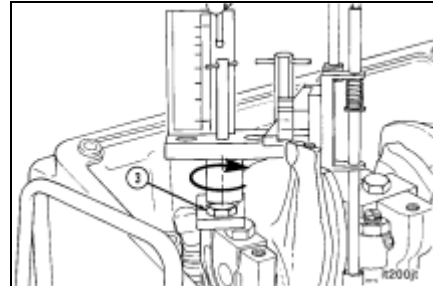


Static Injection Timing (Cont)

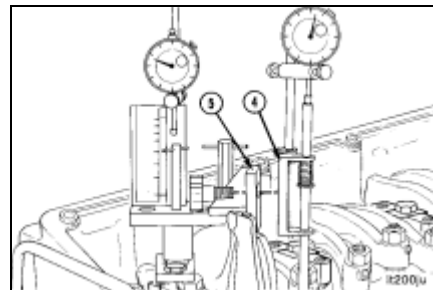


Do not tighten the capscrew too tightly. The capscrew can be damaged.

Tighten the capscrew (3) enough to hold the timing fixture rigidly.

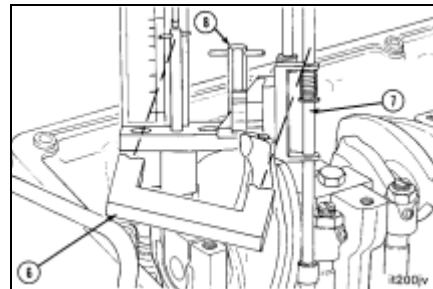


Position the timing tool push tube plunger bracket (4) on the backside of the center bracket (5).



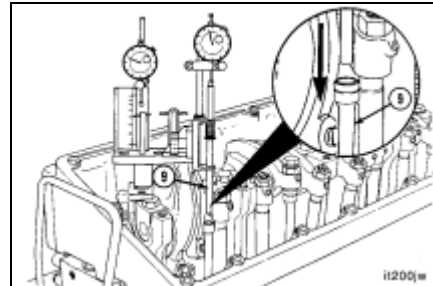
Use the alignment tool (6), Part Number 3376180, to align the push rod plunger rod (7).

Be sure to tighten the clamp handle (8) after the plunger rod is aligned, and remove the alignment tool.



Install the injector push rod (9) between the injector camshaft follower and the plunger rod.

The push rod (9) must be vertically aligned with the plunger rod. If it is not, incorrect timing values will result. Be careful not to drop the push rod into the engine.



Static Injection Timing (Cont)

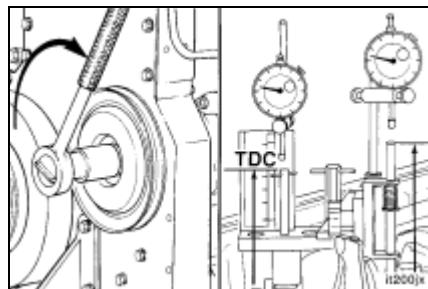
Measure



Use the accessory driveshaft to rotate the crankshaft. If another method is used, the injection timing will not be correct, or the engine can be damaged.

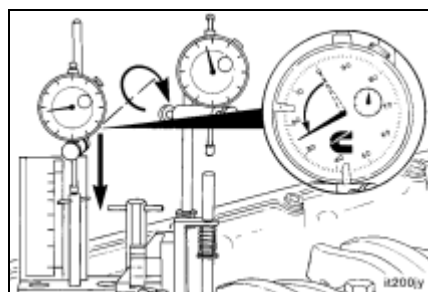
Determine the piston top dead center on the compression stroke by rotating the accessory driveshaft clockwise.

The piston is on the compression stroke when both plungers move in an upward direction at the same time. Top dead center is indicated by the maximum clockwise indicator position of the piston travel indicator pointer.

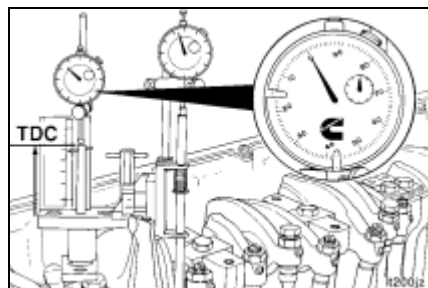


Both indicators must have a travel range of at least 6.35-mm [0.250-in], or the indicators will be damaged.

Position the gauge contact tip in the center of the plunger rod, and lower the gauge to within 0.63-mm [0.025-in] of the fully compressed position.

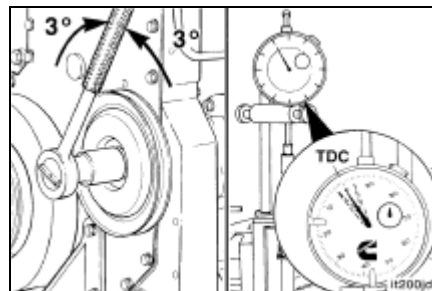


Set the dial indicator over the piston plunger rod to zero "0" when the piston plunger rod has reached maximum upward movement top dead center.



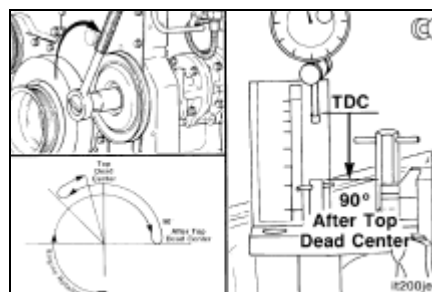
Static Injection Timing (Cont)

Rotate the accessory driveshaft back and forth, before and after the zero "0" indicator reading, for approximately 3 degrees to be sure the piston is at top dead center.



Rotate the accessory driveshaft clockwise to 90-degrees after top dead center.

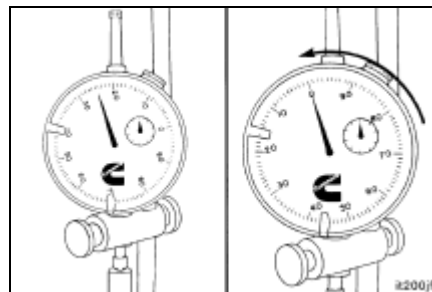
The piston plunger will be at the "L10 90 degree" mark on the timing fixture.



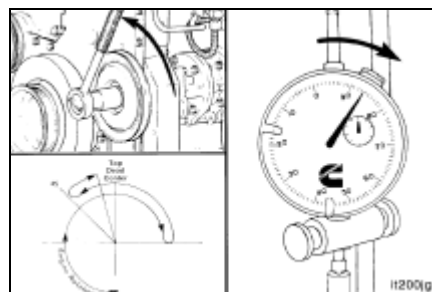
Position the push rod dial indicator contact tip in the center of the plunger rod, and lower the gauge to within 0.63 mm [0.025 in] of the fully compressed position.

Set the push rod dial indicator to zero "0."

Rotate the accessory driveshaft counterclockwise to top dead center.

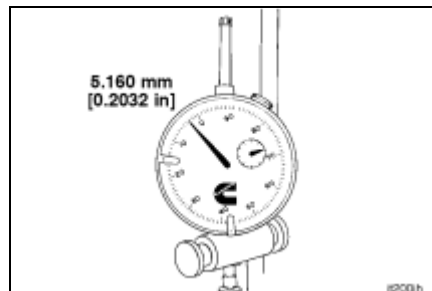


Continue to rotate the accessory driveshaft counterclockwise until the crankshaft is at 45-degrees before top dead center. This step is necessary to remove gear backlash in the engine.



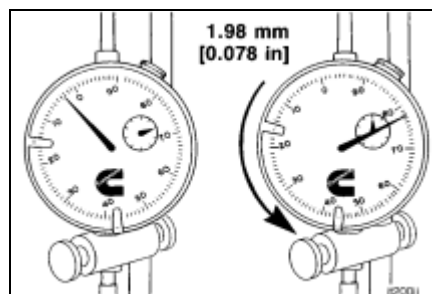
Static Injection Timing (Cont)

Rotate the accessory driveshaft clockwise slowly until the piston travel gauge is at 5.160-mm [0.2032-in] before top dead center.

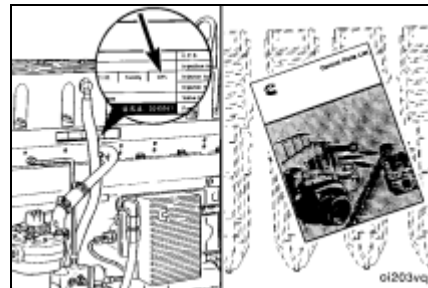


If the crankshaft is rotated beyond the 5.160-mm [0.2032-in] before top dead center position, the crankshaft must be rotated counterclockwise back to the 45-degrees before top dead center mark.

Read the push rod travel gauge counterclockwise from zero "0." This travel represents the injection timing value. In the example shown, the value is 1.98-mm [0.078-in].



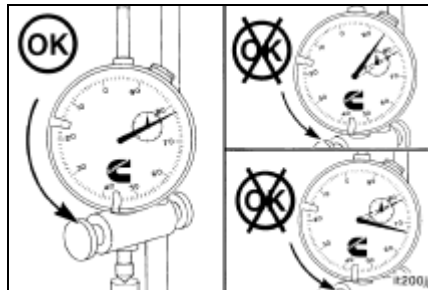
To verify the correct injection timing for a particular engine, check the Control Parts List (CPL) number on the engine dataplate. Refer to the CPL Manual, Bulletin [3379133](#). Timing codes are listed as two alphabetical characters.



If the indicator reading is lower than the specification, the timing is advanced.

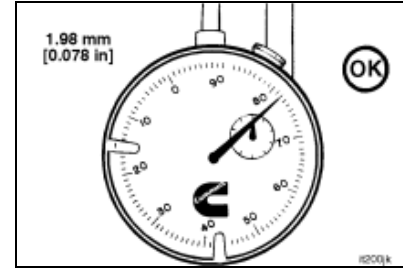
If the indicator reading is higher than the specification, the timing is retarded.

The push rod must be vertically aligned with the plunger, or incorrect timing values will result. Repeat the procedure if in doubt.



Static Injection Timing (Cont)

Injection timing can be changed by removing the camshaft gear and installing an offset key. Refer to Procedure [001-012](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.



The accompanying table lists offset keys by part number and degree of offset.

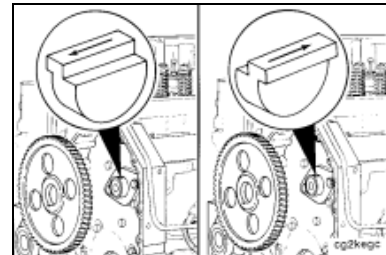
Never advance injection timing beyond the specification limits. The engine's durability will be diminished.

Camshaft Keys			
Key Part No.	Degree of Offset (To the Camshaft)	Change in Push Rod Travel	
		mm	in.
3009953	0.00	0.000	0.0000
3030893	0.25	0.051	0.0020
3009948	0.50	0.102	0.0040
3030894	0.75	0.152	0.0060
3009949	1.00	0.203	0.0080
3030895	1.25	0.254	0.0100
3009950	1.50	0.305	0.0120
3030896	1.75	0.356	0.0140
3009951	2.00	0.406	0.0160
3030897	2.25	0.457	0.0180
3030898	2.50	0.508	0.0200

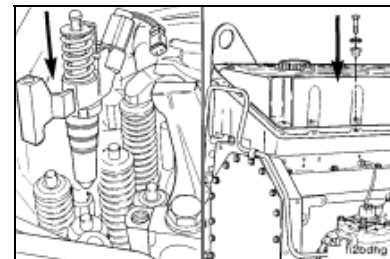
If the arrow on the key is pointing toward the engine, the timing is retarded.

If the arrow is pointing away from the engine, the timing is advanced.

After installing a new timing key, always recheck the timing to be sure the timing is within the specifications.



Install the injector(s). Refer to Procedure [006-026](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.



Install the rocker lever cover. Refer to Procedure [003-011](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.

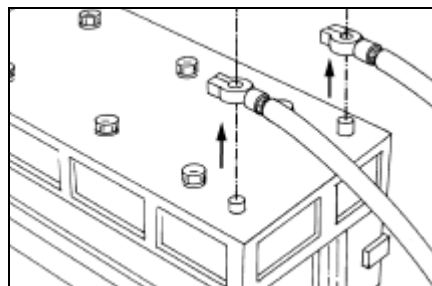
Follow-Up

Fuel Injection Pump Removal/Installation

Prepare

Remove

Disconnect the battery cables. Disconnect negative (-) cable first.



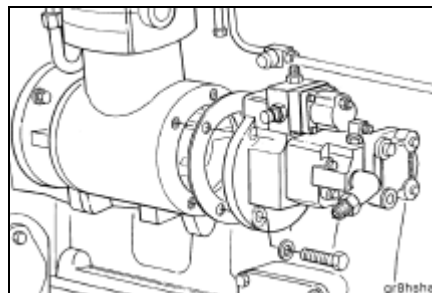
Clean the supply pump and the surrounding area.

Remove the electric wire to the fuel shutoff solenoid.

Remove the fuel plumbing.

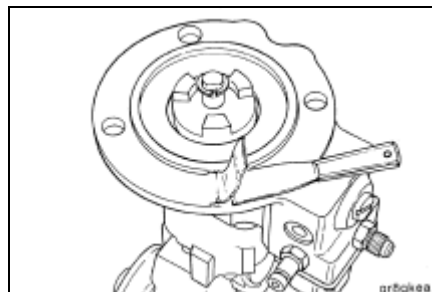
Remove the two support bracket capscrews from the cylinder block bracket.

Remove the four fuel pump mounting capscrews and remove the fuel pump.



Clean

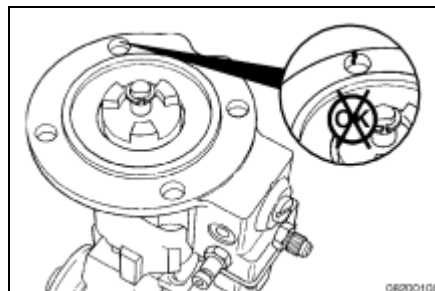
Clean the gasket surfaces of the fuel pump and the air compressor or accessory drive.



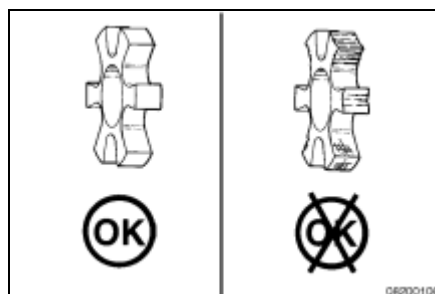
Fuel Injection Pump Removal/Installation (Cont)

Inspect for Reuse

Inspect the mounting surfaces for damage.



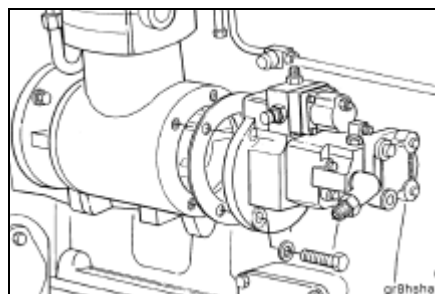
Inspect the jaw coupling spider and the jaw coupling hub for damage or wear.



Install

Install the jaw coupling spider, mounting gasket, and fuel pump.

Install the four mounting capscrews.



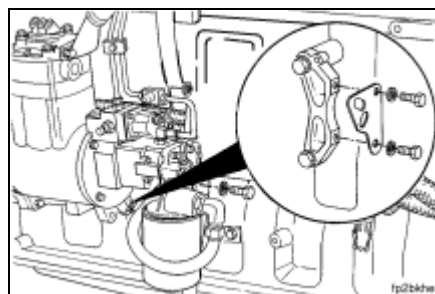
Install the two fuel pump support brackets to cylinder block bracket capscrews.

Tighten the support bracket to engine mounting capscrews.

Torque Value: 47 N•m [35 ft-lb]

Tighten the fuel pump mounting capscrews.

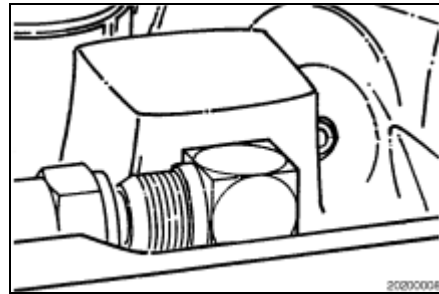
Torque Value: 47 N•m [35 ft-lb]



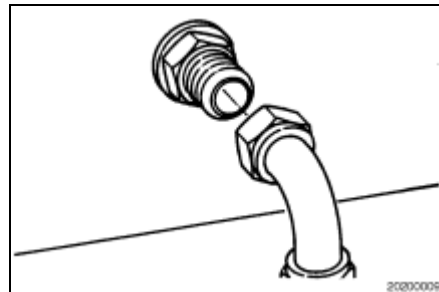
Fuel Injectors Removal/Installation

Remove

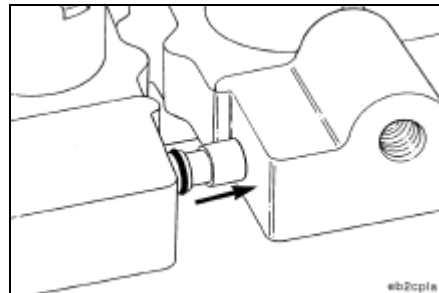
Disconnect the internal oil supply hose connection.



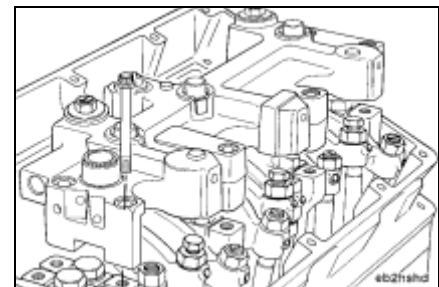
Remove the external oil supply hose.



Use finger pressure or a screwdriver to press the engine brake housing oil connector into the front brake housing to allow clearance for the housing removal.

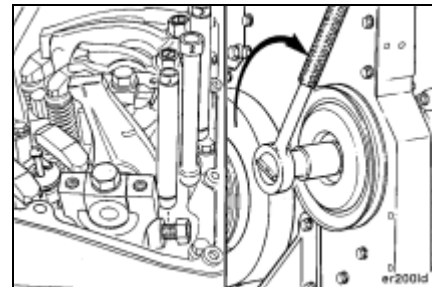


Remove the 16 engine brake mounting capscrews and both engine brake housings.



Fuel Injectors Removal/Installation (Cont)

Loosen the injector and valve adjusting screws, and remove the push rods and push tubes on the cylinder requiring injector replacement.

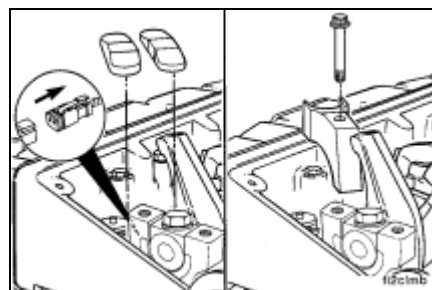


Some push rods are under compression due to the valves being open. Rotate the crankshaft clockwise with the accessory drive pulley to relieve the spring tension.

Mark the position of the push rods and push tubes as they are removed. Due to wear patterns on the cam follower sockets and adjusting screws, the push rods and push tubes must be installed in the same position as from which they are removed.

Hold the push rod with one hand to prevent it from falling into the engine. Loosen each adjusting screw, and remove the push rod.

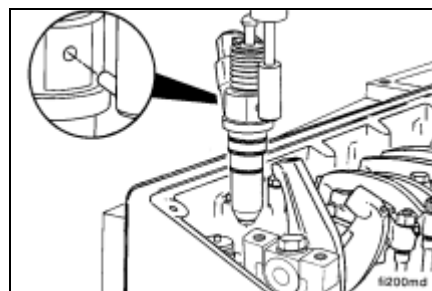
Remove the crossheads. Mark the position and orientation of the crossheads as they are removed. Due to wear patterns, they must be installed in the same position from which they were removed.



Disconnect the injector wires. Number the injector electrical connections as they are removed. They must be connected to the same cylinder when they are installed.

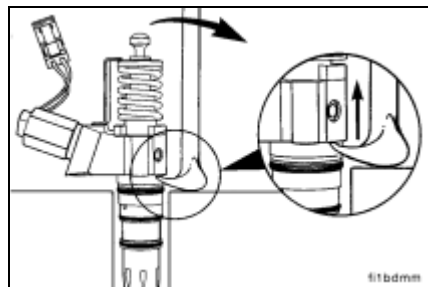
Remove the clamp capscrew and injector hold-down clamp.

Remove the injectors using injector tool, Part Number 3823579. Insert the pin of the tool into the hole provided in the body of the injector.



Fuel Injectors Removal/Installation (Cont)

If injector puller, Part Number 3823579, is not available, carefully use a pry bar. Pry upward on the injector against the cylinder head.



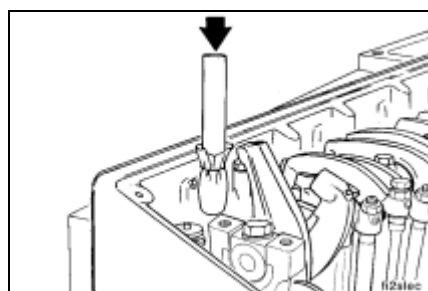
Install



To avoid injector sleeve damage, do not use anything metal to scrape the copper injector sleeves.

Use a clean wooden stick with a clean cloth wrapped around the end to remove all the carbon from the copper injector sleeves in the cylinder head.

Use chip removing unit, Part Number 3823461 or ST-1272-11, to remove the carbon from the top of the piston.



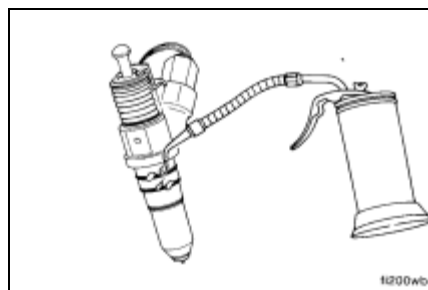
It is important that three new o-rings be installed and oriented correctly on the injector when installing the injectors.

Install three new o-rings on each injector. Do not twist the o-rings.



Part Number	Location	Color Code
3070136	Top	Red
3070137	Middle	White
3070138	Bottom	Blue

Lubricate the o-rings with clean 15W-40 lubricating oil before installation.



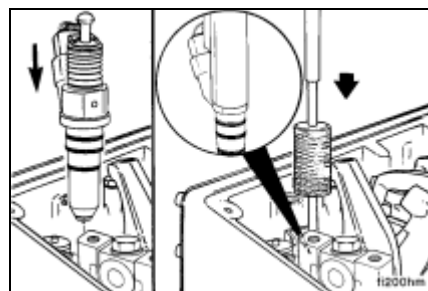
Fuel Injectors Removal/Installation (Cont)



Do not drive the injector in by striking the solenoid valve area. This can damage the solenoid or cause the injector to be out of alignment in the bore, which will result in o-ring damage.

Place the injector in the cylinder head injector bore with the injector solenoid valve toward the intake port. Align the injector equally between the valve springs.

Use injector tool, Part Number 3823579, to seat the injector in the bore.

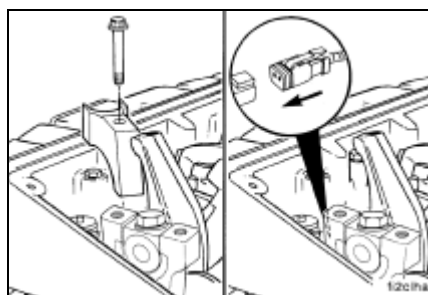


The injector must be fully seated before installing the hold-down clamp. The hold-down clamp can not pull the injector into the bore. Engine damage can occur if the injector is not fully seated.

Install the injector hold-down clamp capscrew.

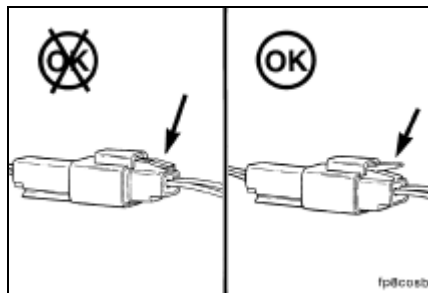
Torque Value: 75 N•m [55 ft-lb]

Connect the injector wires. Make sure the wires are connected to the same cylinder they were removed from.



Check the wire connector to make sure the connector is properly locked in position.

If the wire connector will not properly lock into position, refer to the Troubleshooting and Repair Manual, CELECT™ Plus Fuel System, ISM Engines, Bulletin [3666266](#).



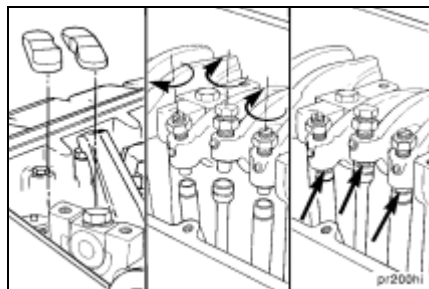
Fuel Injectors Removal/Installation (Cont)

Install the crossheads on the intake and exhaust valves.

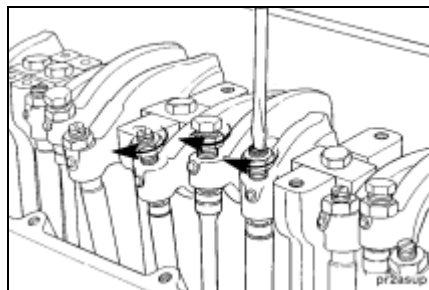
The crossheads must be installed in the same position from which they were removed.

Rotate the rocker levers down, and install the push rods and push tubes.

It is necessary to bar the engine over and install the push rods and push tubes as camshaft position allows.

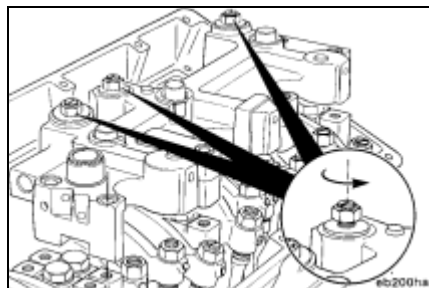


Adjust the valves and injectors. Refer to Procedure [003-004](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.



Loosen the locknuts on the engine brake slave piston. Make sure the slave pistons are fully retracted.

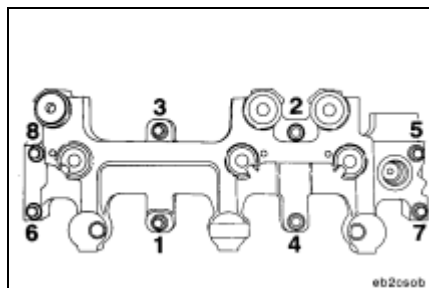
Install the engine brake housing on the rear rocker lever supports.



Use clean 15W-40 oil to coat the bottom side of the capscrew heads and threads.

Install the capscrews in the rocker lever supports. Tighten the capscrews in the sequence shown.

Torque Value: 81 N•m [60 ft-lb]



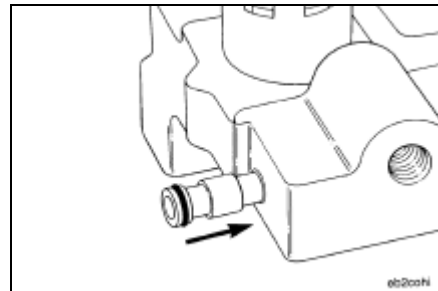
Fuel Injectors Removal/Installation (Cont)

Install new o-rings on the brake oil connector.

Use clean 15W-40 oil to lubricate the o-rings on the oil connector.

Press the connector all the way into the front housing by hand.

When installing the front housing, be sure the oil connector and o-ring are in position to be pushed into the rear housing.

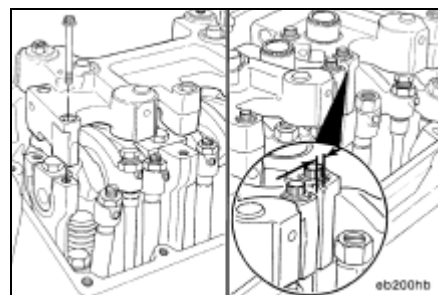


Install the front engine brake housing on the front rocker lever supports.

Center the oil connector between the front and rear housings before tightening the capscrews.

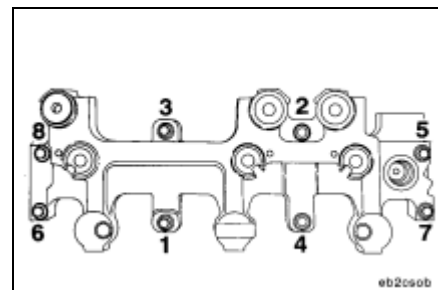
Use clean 15W-40 oil to coat the bottom side of the capscrew heads and threads.

Install the capscrews in the rocker lever supports.

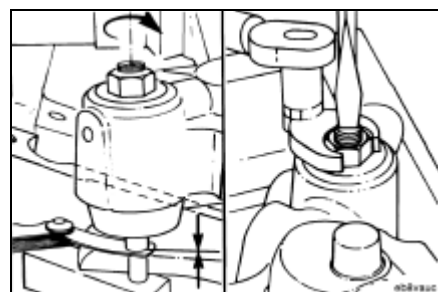


Tighten the capscrews in the sequence shown.

Torque Value: 81 N•m [60 ft-lb]

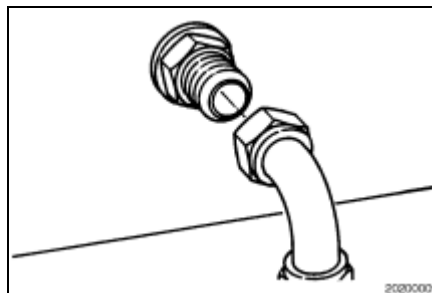


Adjust the engine brakes. Refer to Procedure [020-024](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.

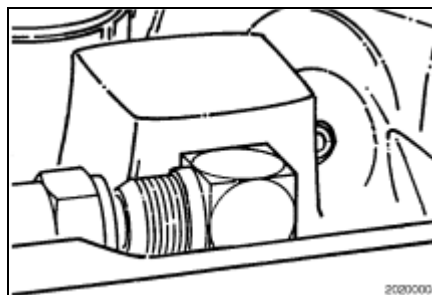


Fuel Injectors Removal/Installation (Cont)

Install and tighten the external oil supply hose fitting to the front brake housing.



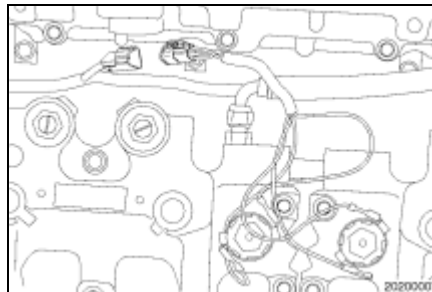
Install the internal oil supply hose.



Install the engine brake terminal electrical leads on the outside of the spacer.



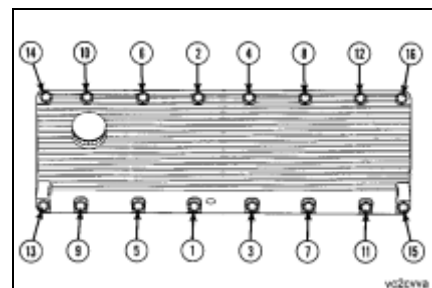
Connect the two solenoid electrical wires to the terminals on the inside of the spacer.



Install the rocker housing cover.

Install the 16 isolators and capscrews. Tighten the capscrews in the sequence shown.

Torque Value: 15 N•m [130 in-lb]



Fuel Injectors Removal/Installation (Cont)

Follow-Up



Install the crankcase breather tube.

Install the air piping from the charge air cooler to the intake manifold. Refer to the manufacturer's specifications for the correct hose clamp torque value.

Connect the battery cables.

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)

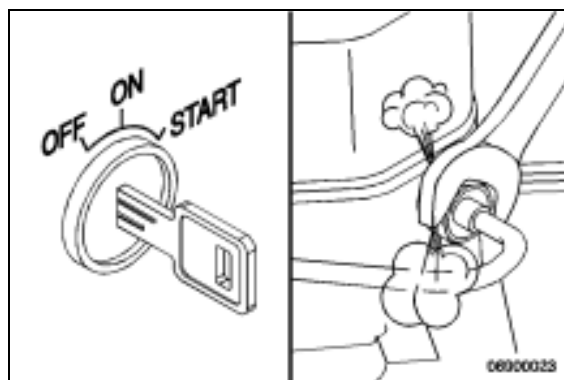


WARNING

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.

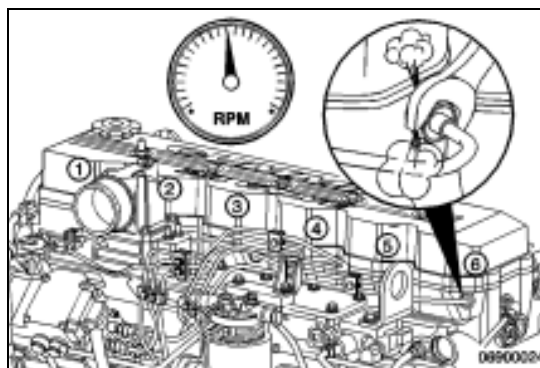
Torque Value: 40 N•m [30 ft-lb]



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.

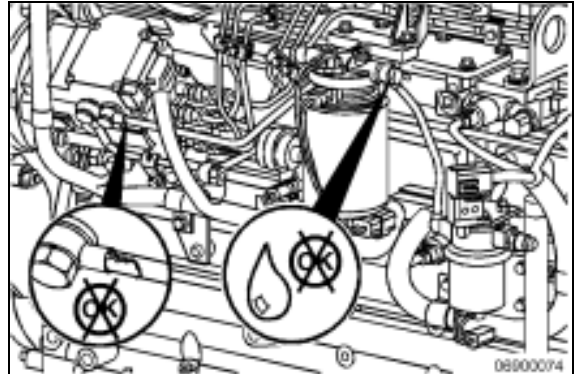
Operate the engine, and vent one line at a time until the engine runs smoothly.



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

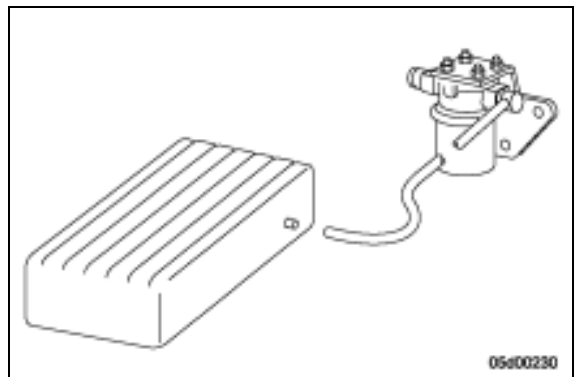
Fuel is flammable. Keep all cigarettes, flames, pilot lights, arcing equipment, and switches out of the work area and areas sharing ventilation to reduce the possibility of severe personal injury or death when working on the fuel system.



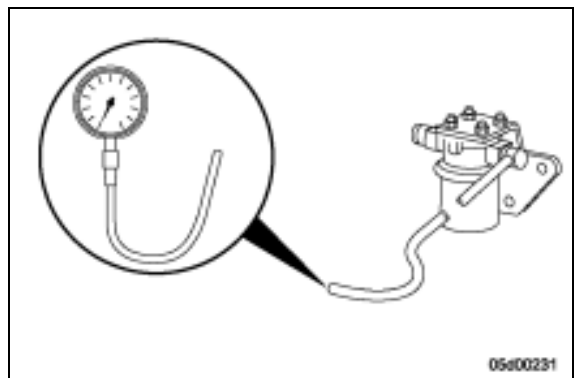
WARNING

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.

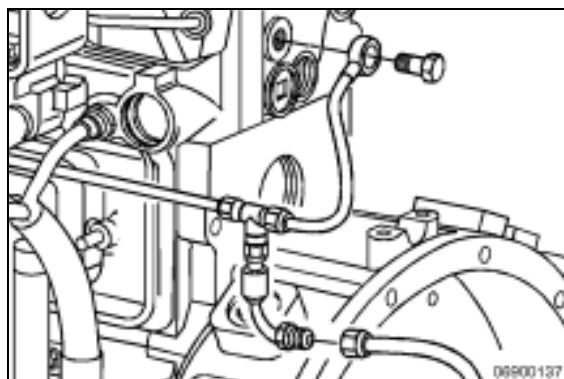


Connect the vacuum gauge plastic tubing to the fuel supply line.



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.

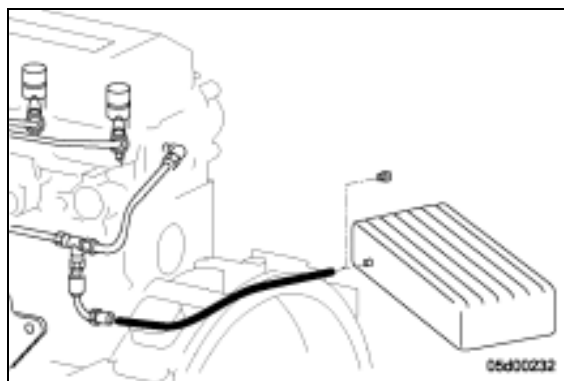
NOTE: All fuel must be drained from all fuel lines, if observed.

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.

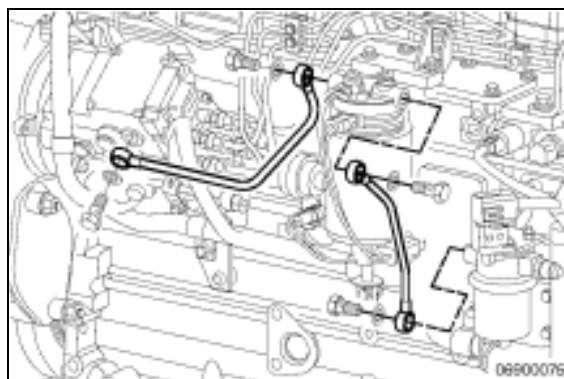
If the system does not hold vacuum (the reading on the gauge does not hold and reduce to 0 mm Hg [0 in Hg], then there is a leak in the fuel system.



Remove

Remove supply lines, banjo capscrews, and sealing washers.

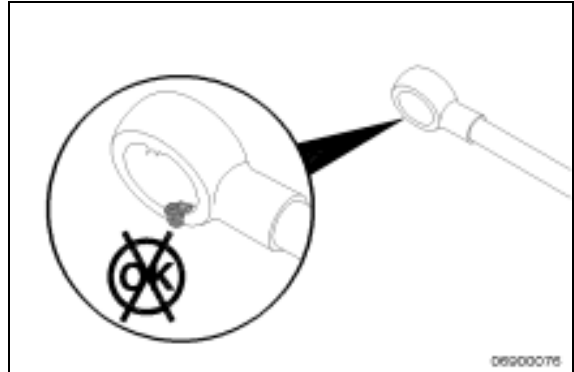
Discard sealing washers.



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.

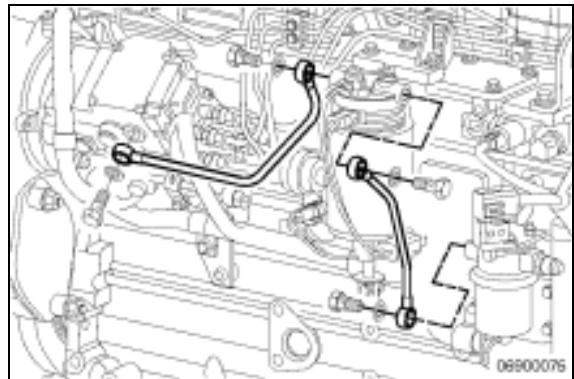


Install

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.



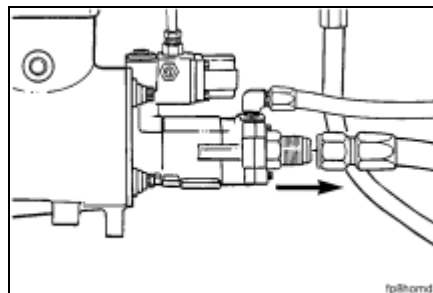
Follow-Up

High Pressure Fuel Supply Lines Removal/Installation

Prepare

Remove

Remove the fuel line or fuel hose.

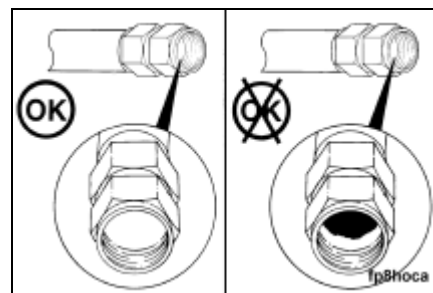


Inspect for Reuse

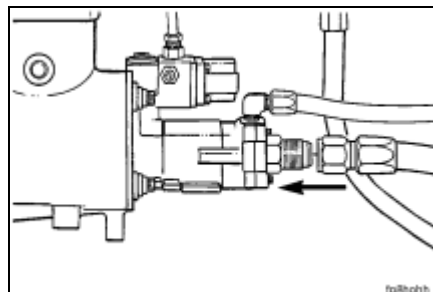
Inspect the inside of the fuel hose.

The inner lining of the hose can separate from the center hose section.

A separation or flap can cause a restriction in the fuel flow.



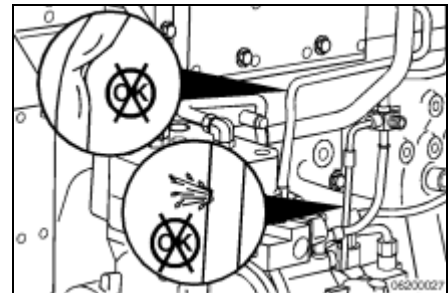
Replace the fuel hose if damage is found.



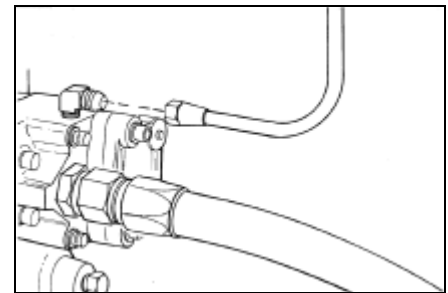
High Pressure Fuel Supply Lines Removal/Installation (Cont)

Check for cracks that can cause a pressure loss.

Check the metal fuel lines for sharp bends that can cause a pressure restriction.



If a line(s) is damaged, replace the line(s).



Install



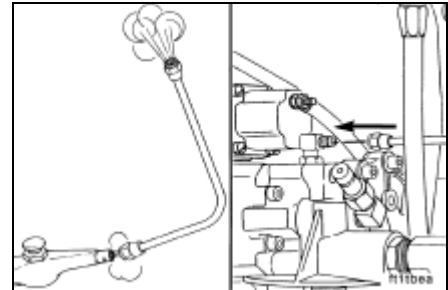
WARNING

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

Use compressed air to flush the lines and remove any loose dirt particles.

Install the fuel lines.

Install any brackets that were in place on the fuel plumbing.



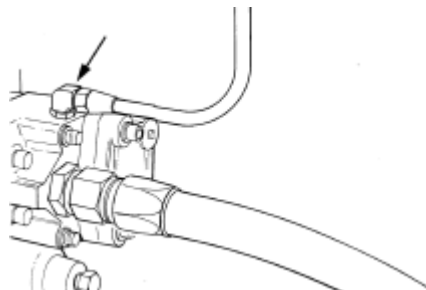
Follow-Up

Fuel Pump Gear Pump Check Valve Removal/Installation

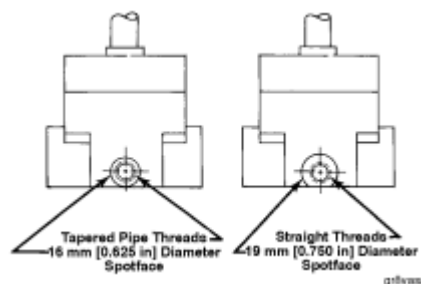
Prepare

Inspect

If the check valve in the gear pump return elbow stays open or closed, replace the elbow.



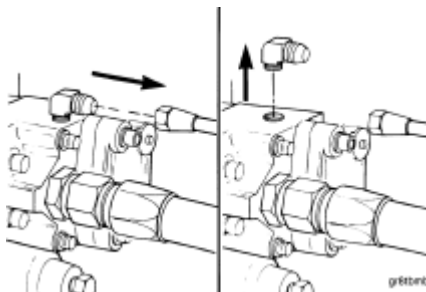
Check the elbow threads. Do not install an elbow that has straight machine threads in a hole that has a pipe tap thread. A gear pump that has a straight thread will have a 19-mm [0.750-in] spotface in the valve area. A gear pump that has a pipe tap thread will have a 16-mm [0.625-in] spotface or no spotface.



Remove

Remove the drain line.

Remove the check valve elbow.



Fuel Pump Gear Pump Check Valve Removal/Installation (Cont)

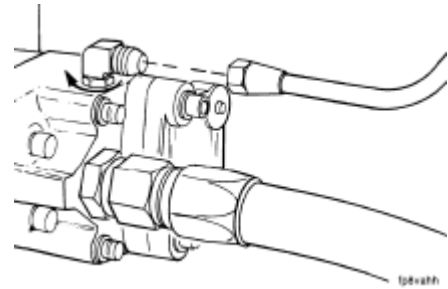
Install

Install the check valve elbow.

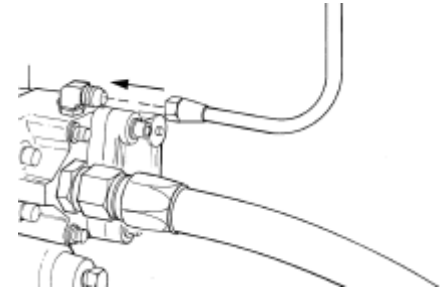
If the check valve elbow has machine threads to the maximum thread depth, turn the elbow out until it is pointed toward the drain line. Tighten the jam nut.

Torque Value: 6 N•m [50 in-lb]

If the check valve has a pipe thread, install the elbow until it is tight and pointed toward the drain line.



Install the drain line.



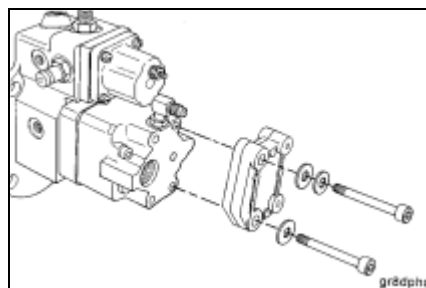
Follow-Up

Fuel Pump Pulsation Damper Inspection

Prepare

Inspect

Remove the fuel inlet connection and pulsation damper or the filter head damper assembly. Discard the rubber o-rings.

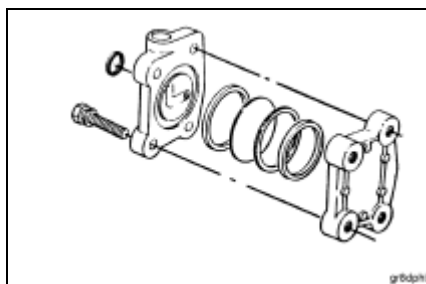


Remove the housing from the cover. Remove the spring steel diaphragm. Discard the o-rings. Inspect the nylon washer and discard it, if it is damaged.



Check for corrosion, wear, or cracks in the cover or the diaphragm. Replace the damaged parts.

To check the diaphragm for hidden cracks, drop it on a flat hard surface. It must have a clear ring. If it has a flat sound, replace the diaphragm.



Install new o-rings in the grooves and a new nylon washer.

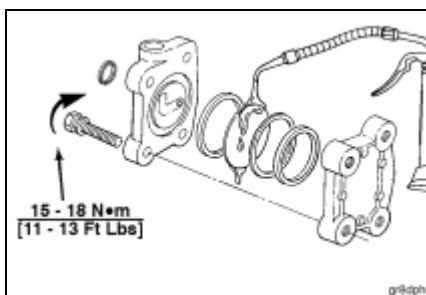


Clean the diaphragm. Coat the diaphragm with clean engine oil. Install the diaphragm in the cover.



Assemble the cover to the housing. Tighten the capscrews.

Torque Value: 18 N•m [13 ft-lb]



Fuel Pump Pulsation Damper Inspection (Cont)

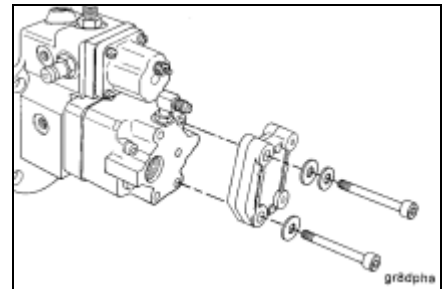
Remove the two damper mounting capscrews.
Install the damper assembly with a new o-ring
on the gear pump. Tighten the capscrews.

Torque Value: 18 N•m [13 ft-lb]

NOTE: If a fuel filter and damper assembly are
mounted on the gear pump, remove the four
mounting capscrews.

Install the fuel inlet connection. Be careful not to
let dirt enter the fuel pump.

Check for free rotation of the gear pump.



Follow-Up

Fuel Pump Shutoff Valve Tests

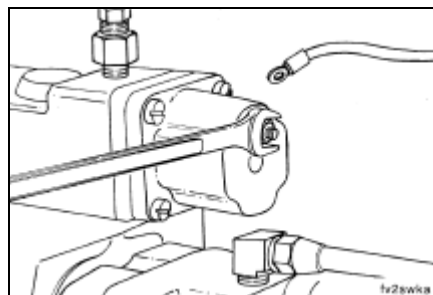
Resistance Check

Remove the wire. Make sure the remaining wire connection nut is tight. Tighten the nut.

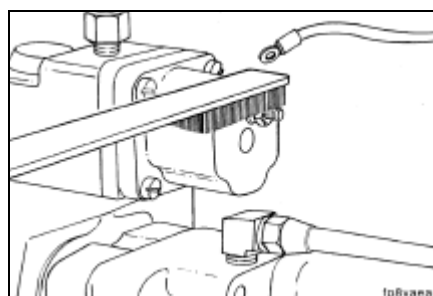
Torque Value: 3 N•m [25 in-lb]

Make sure the post is tight and secure in the coil.

NOTE: Only single post coils can be used on the fuel system. Two post coils will interfere with the cooling line.



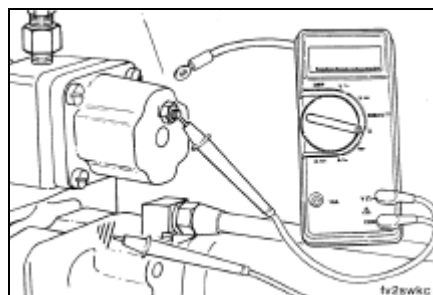
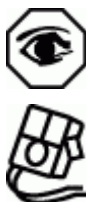
Use a wire brush to clean any corrosion from the coil terminal.



Make sure the coil wire is not connected before checking the coil resistance.

Measure the coil resistance with a multimeter, Part Number 3377161, or equivalent.

Fuel System Shutoff Valve Solenoid Specifications



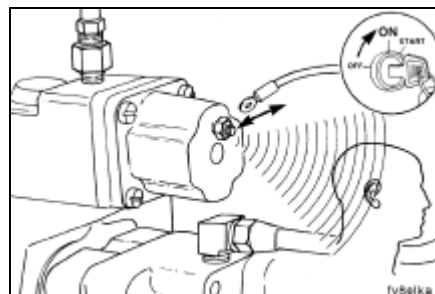
Voltage	Resistance Minimum (Ohms)	Resistance Maximum (Ohms)
6 VDC	1	5
12 VDC	6	15
24 VDC	24	50
32 VDC	42	80
36 VDC	46	87
48 VDC	92	145
74 VDC	315	375
115 VAC	645	735

Fuel Pump Shutoff Valve Tests (Cont)

NOTE: If the solenoid shows 0 ohms, there is an electrical short in the coil.

Replace the coil if the resistance does not meet the specifications.

Turn the vehicle keyswitch to the ON position. Listen for the valve to click when the wire is touched to the coil terminal. If the valve does not click, repair or replace the fuel shutoff valve.



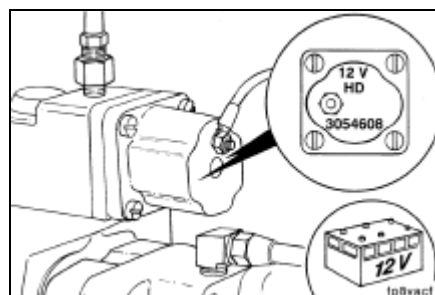
Voltage Check



To avoid damage to the ECM, connect only one wire to the fuel shut off solenoid.

Connect the wire. Make sure the shutoff valve coil is the correct voltage.

The coil voltage and part number are cast into the terminal connection end of the coil.

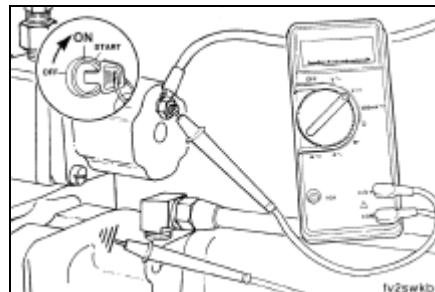


Turn the vehicle keyswitch to the ON position.

Check the voltage to the coil with a multimeter, Part Number 3377161, or equivalent.

The voltage must be the same as the battery voltage.

Turn the vehicle key switch to the OFF position.



Fuel Pump Shutoff Valve Removal/Installation

Prepare

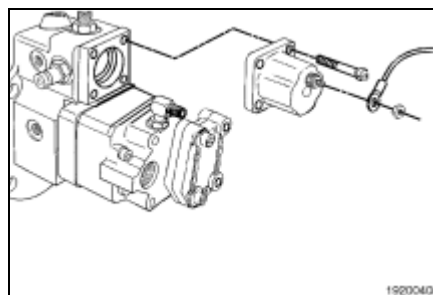
Remove

Clean the fuel shutoff valve and surrounding area.

Disconnect the fuel shutoff valve signal wire from the actuator harness.

Remove the mounting capscrews.

Remove the fuel shutoff valve.



Install

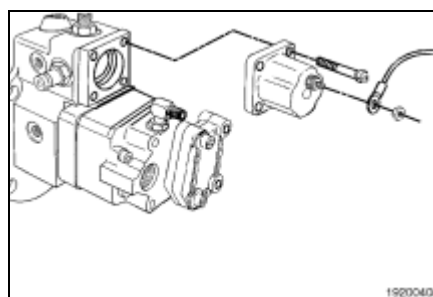
Install the new o-ring on the fuel shutoff valve.

Install the fuel shutoff valve and the capscrews.

Torque Value: 4 N•m [36 in-lb]

Connect the fuel shutoff valve to the actuator harness.

Torque Value: 3 N•m [25 in-lb]



Follow-Up

Fuel Pump Pressure Regulator Check

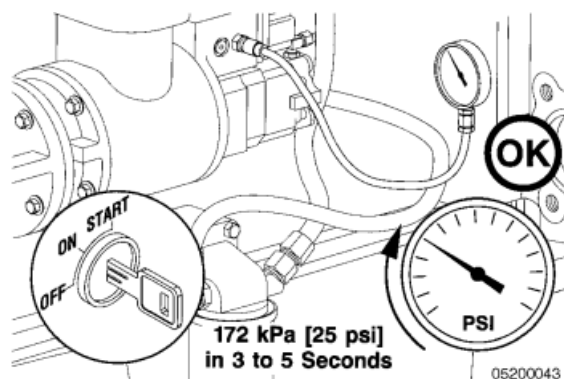
Prepare

Check

To check for a sticking pressure regulator, install a pressure gauge on the Compuchek® fitting in the side of the fuel shutoff valve.

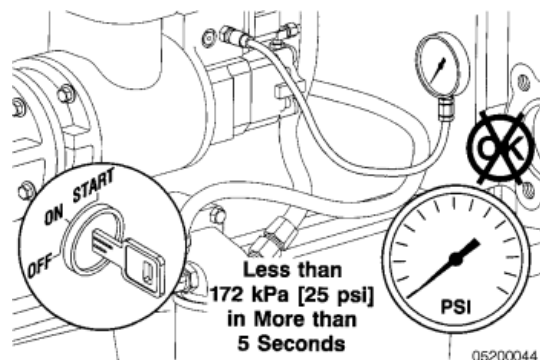
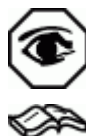
Start cranking the engine.

The pressure gauge must start moving immediately and increase rapidly until the engine fires (approximately 172 kPa [25 psi]). This can take 3 to 5 seconds.



If the pressure gauge does not move or increases very slowly for more than 6 seconds, the regulator plunger is stuck open and will not let pressure build up quickly for a normal start. This can be caused by dirt, rust, or burrs on the plunger, or burrs on the plunger bore.

If the plunger is sticking, the gear pump must be replaced with a new or ReCon® unit. Refer to the Shop Manual, M11 Series Engines, Bulletin No. [3666075](#).



Follow-Up

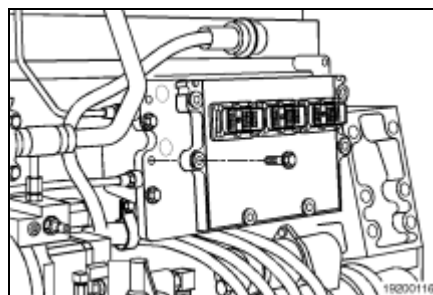
Fuel Cooled ECM Cooling Plate Removal/Installation

Prepare

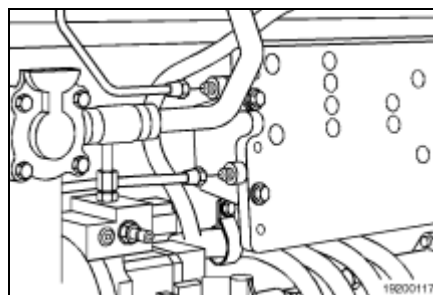
Remove

Disconnect the engine wiring harness from the electronic control module (ECM).

Remove the six ECM mounting capscrews.
Remove the ECM from the cooling plate.



Remove the inlet and outlet fuel plumbing from the cooling plate.

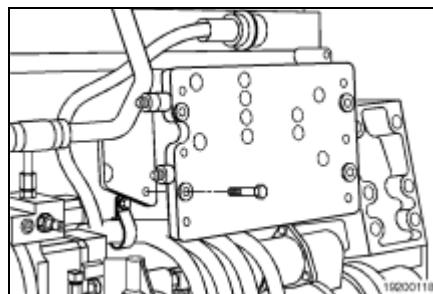


Remove the four cooling plate mounting capscrews.

Do not lose any of the heat-resistant grommets.
They are on both sides of the cooling plate.

One of the mounting locations has heat-resistant star washer grommets on both sides of the cooling plate.

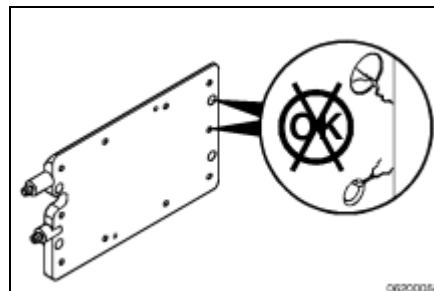
Remove the cooling plate.



Fuel Cooled ECM Cooling Plate Removal/Installation (Cont)

Inspect for Reuse

Inspect the cooling plate for cracks or damage.
Replace the cooling plate if damaged.



Install

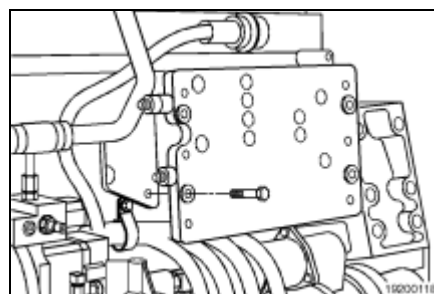
Install a new cooling plate.

Install the heat-resistant grommets on both
sides of the cooling plate.

Install the two heat-resistant star washer
grommets at the same mounting location.

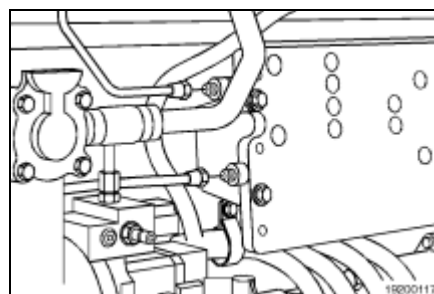
Tighten the four capscrews.

Torque Value: 40 N•m [30 ft-lb]



Connect and tighten the inlet and outlet
plumbing to the cooling plate.

Inspect for paint or grease on the cooling plate.

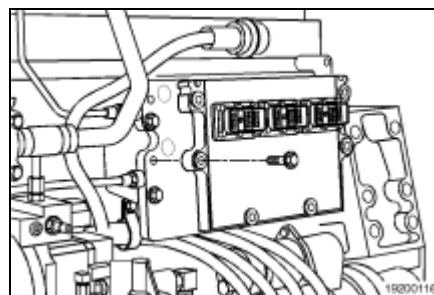


**Do not paint the cooling plate. Make sure
there is no grease or dirt between the ECM
and the cooling plate.**

Install the ECM on the cooling plate.

Install the six capscrews.

Install the star washer under one of the
capscrews.



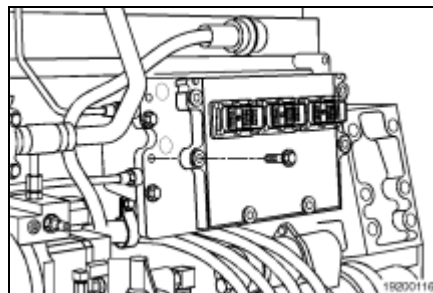
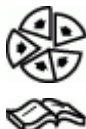
Fuel Cooled ECM Cooling Plate Removal/Installation (Cont)

Tighten the six capscrews.

Torque Value: 20 N•m [177 in-lb]

Connect the engine harness and OEM harness connectors to the ECM.

Refer to Procedure [019-031](#) in the Troubleshooting and Repair Manual, Came Electronic Control System, ISM Engines, Bulletin [4021381](#) or Troubleshooting and Repair Manual, Electronic Control System, ISM and Gismo Series Engines, Bulletin [3666266](#).



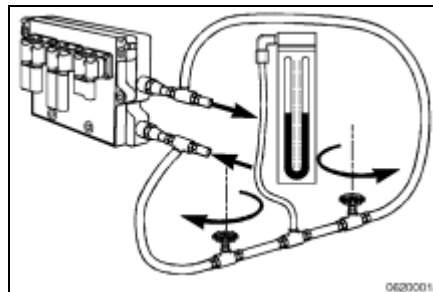
Close the valve on the inlet side of the manometer. Open the valve on the outlet side of the manometer. Record the vacuum reading on the manometer.



Cooling Plate Restriction

Maximum 25 mm-hg [1 in-hg]

If the restriction is greater than the value given, clean or replace the cooling plate.



Follow-Up

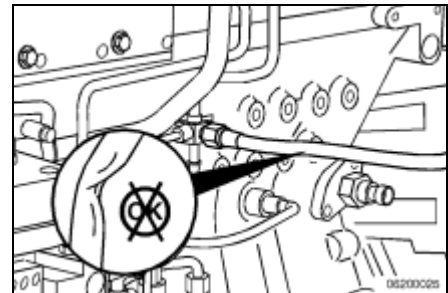
Fuel Drain Line Restriction Measurement

Prepare

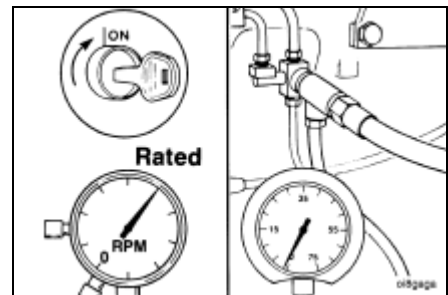
Measure

Inspect the drain lines, and make sure the lines do not have any loops and are not kinked.

Remove the fuel drain line, and install the mercury manometer, Part Number ST-1111-3

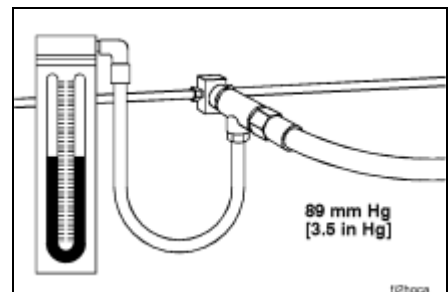


Operate the engine at rated speed and no load.



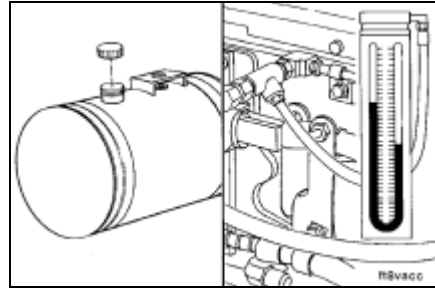
Observe the reading on the manometer. Hold the manometer at the same level as the connection.

Maximum Fuel Drain Line Restriction
89 mm-hg [3.5 in-hg]



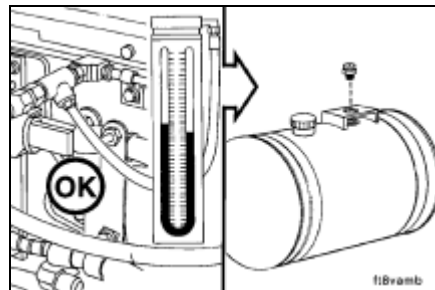
Fuel Drain Line Restriction Measurement (Cont)

If the restriction is above the maximum specifications, remove the fuel tank fill cap and check again.



If the restriction is below the specifications when the cap is removed, replace the tank vents.

If the restriction is still above the specifications, inspect the drain lines for restrictions.



Follow-Up

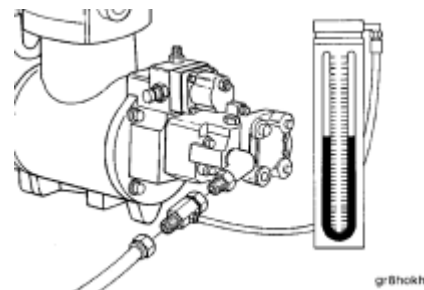
Fuel Inlet Restriction Measurement

Prepare

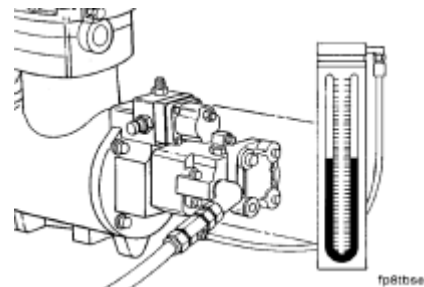
Measure

Remove the fuel supply hose to the gear pump, and install the manometer, Part Number ST-1111-3. Use the appropriate hose adapter for the specific engine as described in the Service Tools list.

NOTE: If the gear pump inlet fitting has a Compuchek® fitting, the manometer can be installed there.



Hold the manometer at the same level as the gear pump connection.



Operate the engine at rated speed and no load.
Observe the reading on the manometer.

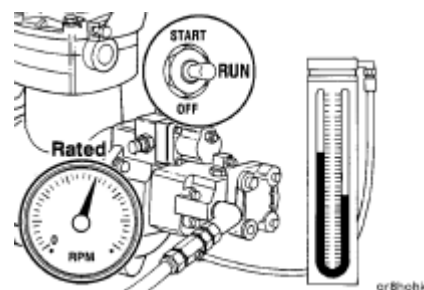
Maximum Fuel Inlet Restriction

Clean Filter 152 mm-hg [6 in-hg]

Dirty Filter 254 mm-hg [10 in-hg]

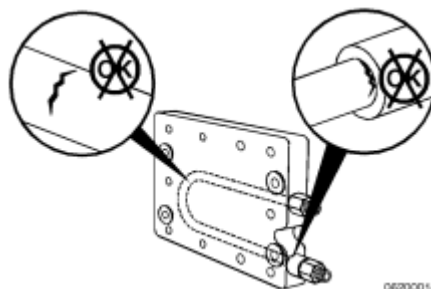
Correct the restriction, or replace the fuel filter.

NOTE: The cooling plate on M Series engines has about 25.4-mm Hg [1-in Hg] restriction.



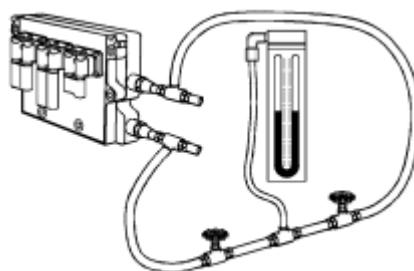
Fuel Inlet Restriction Measurement (Cont)

Inspect the cooling plate for restriction, porosity, and leakage. To inspect for porosity and leakage, examine the cooling plate for fuel leaks. If any leaks are found, replace the cooling plate. Refer to Procedure [006-006](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.



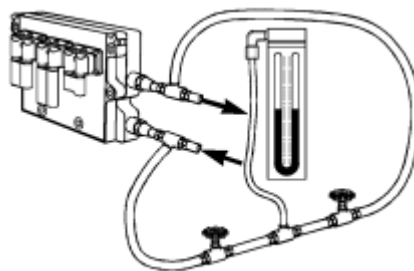
06200014

Install the mercury manometer, Part Number ST-1111-3, line to a tee fitting. Connect one on and off valve at either side of the tee. Attach the hose and appropriate fittings.



06200015

Remove the fuel line from the rear of the cooling plate (fuel in). Install one side of the manometer hose into the fuel line. Connect the line to the cooling plate. Connect the other side of the manometer hose into the line from the front of the cooling plate (fuel out). Make sure both valves are closed.



06200016

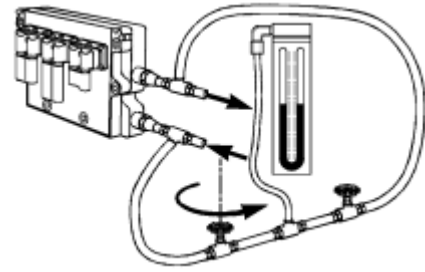
Start the engine, and operate it at rated rpm and no load.



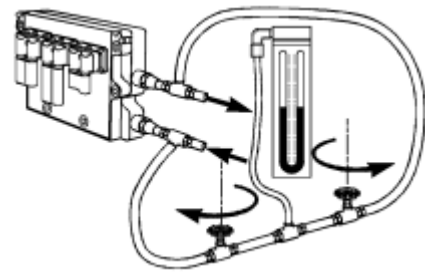
018011kp

Fuel Inlet Restriction Measurement (Cont)

Open the valve on the inlet side of the manometer, and read the vacuum on the manometer. Record the vacuum reading.



Close the valve on the inlet side of the manometer. Open the valve on the outlet side of the manometer. Record the vacuum reading on the manometer.



Maximum Cooling Plate Restriction 25 mm-hg [1 in-hg]

If the restriction is greater than the value given, clean or replace the cooling plate.

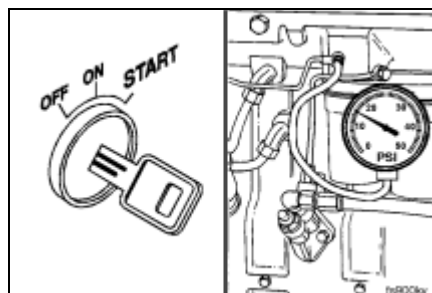
Follow-Up

Fuel Pressure Test

Prepare

Pressure Test

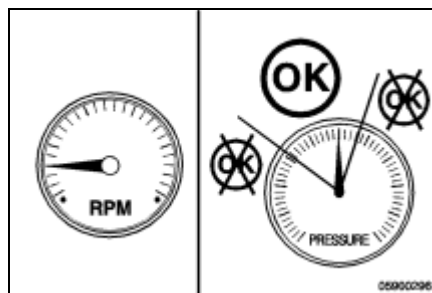
Install a pressure gauge that has a range of at least 0 to 138 kPa [0 to 20 psi], to the outlet side of the fuel filter head.



Run the engine at high-idle speed. Fuel supply pressure must read as follows:

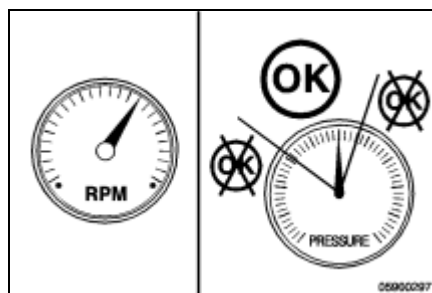
Outlet side of the filter equals 21 kPa [3 psi] minimum

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISMe and QSM11 Engines, Bulletin 3666322.



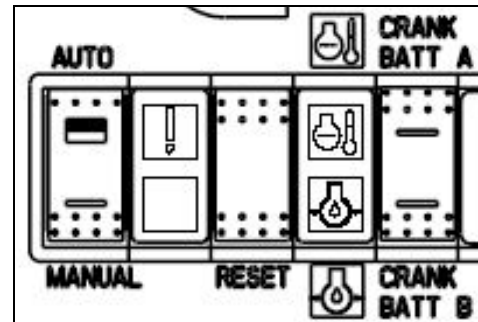
Follow-Up

Fuel Cooler Removal/Installation

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



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



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



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



Remove the Upper and Lower Coolant Hoses on each end of the cooler by loosening the fitting on each end of the fuel cooler.

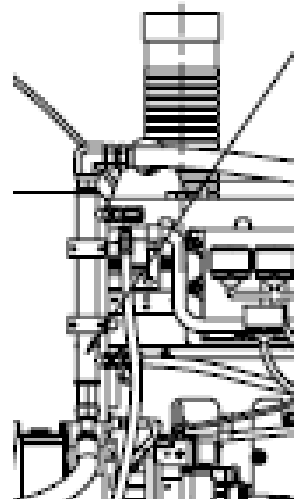


NOTE: Refer to Assembly Drawing 11048 in Section 13 for detailed construction.

Remove fuel lines from the fuel cooler in two locations.

Loosen and remove the hose clamps on the oil cooler.

Replace the defective fuel cooler. Use loctite 242 type lubricant for each fitting connection for reassembly.

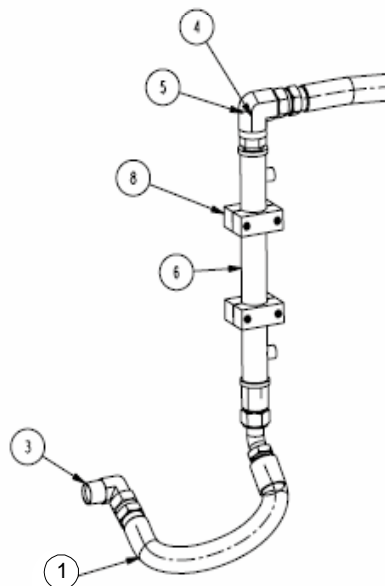


Fuel Cooler Removal/Installation (Cont)

In reverse order, Re-assemble the components per Assembly Drawing 11048 in Section 13.

Check for water leaks at the coolant hose connections.

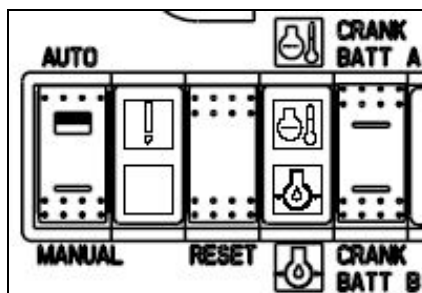
Check for oil leaks at the fuel hose line connections.



Place the fire protection system back into service.



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



Air Leaks, Air Intake and Exhaust System Checks

Prepare

Initial Check



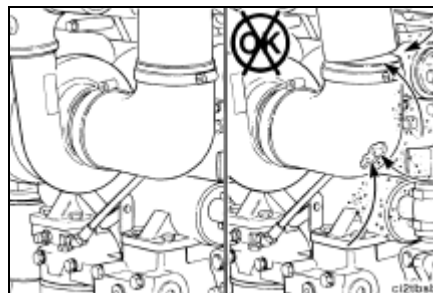
Engine intake air must be filtered to prevent dirt and debris from entering the engine. If intake air piping is damaged or loose, unfiltered air will enter the engine and cause premature wear.

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.

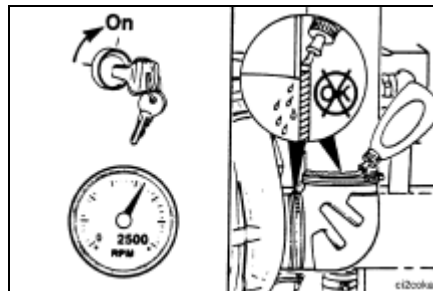
Torque Value: 8 N•m [71 in-lb]

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.

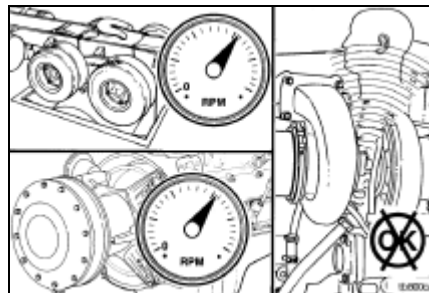
If an air leak exists, the soap bubbles will be drawn in with the air.



Air Leaks, Air Intake and Exhaust System Checks (Cont)

Operate the engine at full throttle and rated rpm with maximum load.

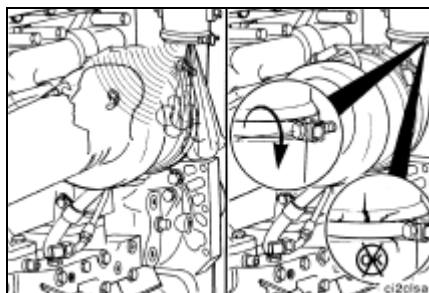
Listen for a high-pitched whistling noise from the turbocharger near piping and connections.



The noise can be caused by an air leak from the turbocharger to discharge elbow connection.

Inspect for damage. Tighten loosen clamps.

Torque Value: 8 N•m [71 in-lb]

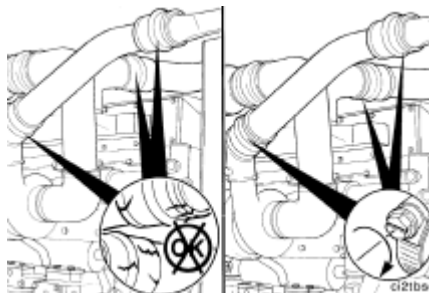


The noise can be caused by an air leak from the charge air cooler tubing connecting hoses.

Inspect the hose and tubing for damage.

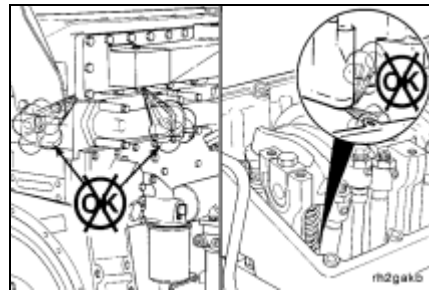
Tighten the hose clamps.

Refer to the manufacturer's specifications for the torque value.



The noise can be caused by an air leak from the rocker housing and intake manifold gaskets.

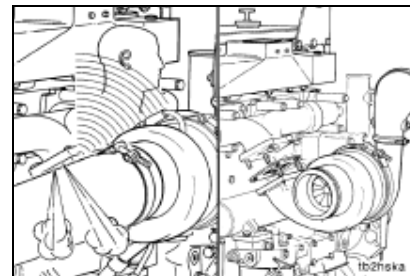
Inspect the intake manifold and rocker housing to cylinder head gasket joint. Replace the gasket if leaks are found. Refer to Procedure [003-013](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Air Leaks, Air Intake and Exhaust System Checks (Cont)

The noise can be caused by an air leak from the turbocharger exhaust manifold mounting gasket.

Replace the gasket. Refer to Procedure [010-033](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322 for turbocharger removal and installation.

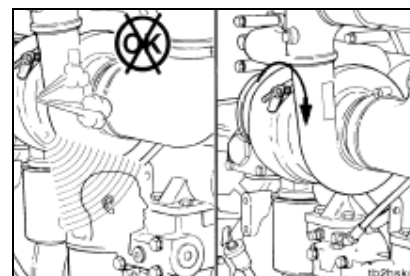


The noise can be caused by an air leak from the turbine housing sealing surface exhaust leak.

Tighten the turbine housing capscrews or v-band clamps.

Capscrews Torque Value: 14 N•m [124 in-lb]

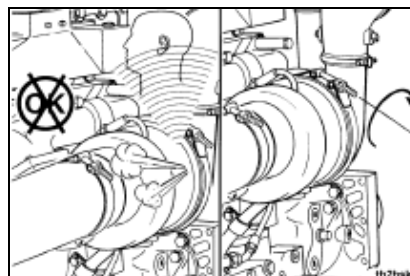
V-band Torque Value: 9 N•m [80 in-lb]



The noise can be caused by an air leak from the compressor housing sealing surface.

Tighten the compressor housing v-band clamp nut.

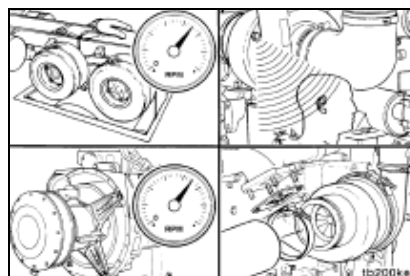
Torque Value: 9 N•m [80 in-lb]



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, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Follow-Up

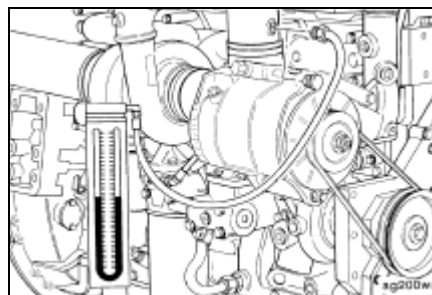
Air Intake Restriction Measurement

Prepare

Measure

Install a vacuum gauge or water manometer in the intake air piping.

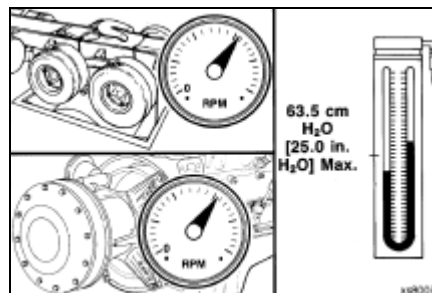
The gauge adapter must be installed at a 90-degree angle to the airflow in a straight section of pipe, one pipe diameter before the turbocharger.



Operate the engine at full throttle and rated rpm with maximum load.

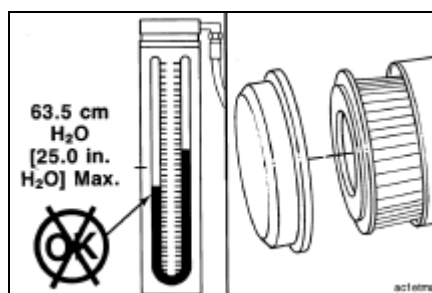
Record the data on the gauge or manometer.

Maximum Inlet Air Restriction 63.5 mm-H₂O [25.0 in. H₂O]



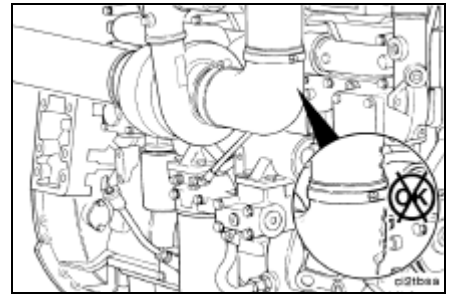
If restriction exceeds specifications:

Replace or clean the air filter element. Refer to the equipment manufacturer's instructions.

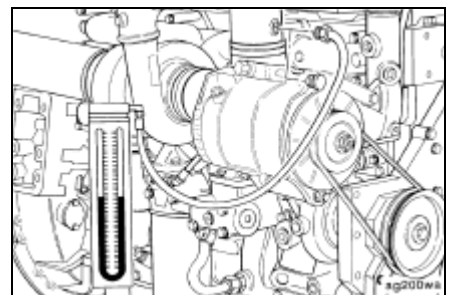


Air Intake Restriction Measurement (Cont)

Inspect the intake piping for damage. Refer to the equipment manufacturer's repair instructions.



Remove the test equipment.



Follow-Up

Air Intake Connection Removal/Installation

Prepare

Remove or disconnect the following:

Charge-air cooler connection. Refer to Procedure [010-027](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Intake manifold air temperature sensor connector from the engine harness.

Air compressor inlet tube from the EGR mixer. Refer to Procedure [012-109](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

EGR connection tube from the EGR mixer. Refer to Procedure [011-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

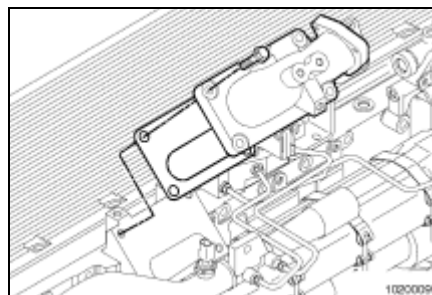
EGR mixer. Refer to Procedure [011-021](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Remove

Remove the four capscrews holding the air intake connection to the intake manifold.

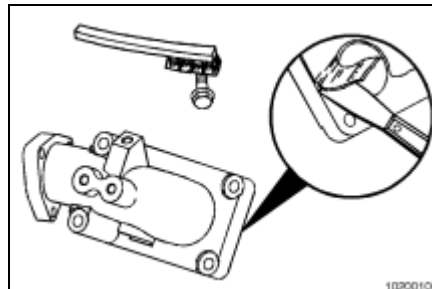
Remove and discard the gasket.



Clean and Inspect for Reuse

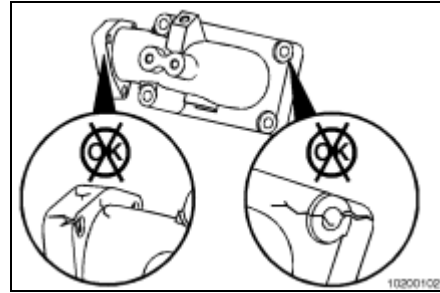
Clean the air intake connection flange.

Clean the air intake connection mounting capscrews.

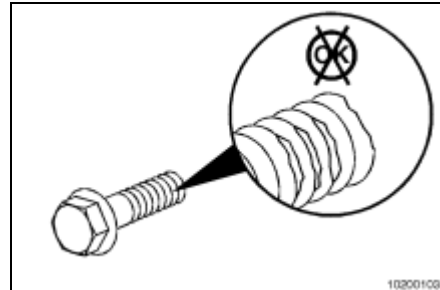


Air Intake Connection Removal/Installation (Cont)

Inspect the air intake connection for cracks or other damage. Replace if damaged.



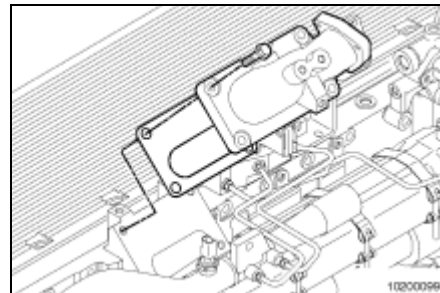
Inspect the air intake connection capscrews for stripped threads or other damage. Replace the capscrews, if damaged.



Install

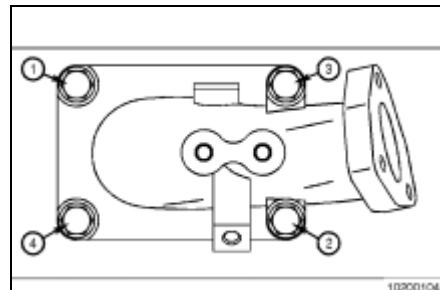
Install a new gasket between the intake manifold and the air intake connection.

Install the four capscrews finger tight.



Tighten the capscrews according to sequence shown.

Torque Value: 45 N•m [33 ft-lb]



Air Intake Connection Removal/Installation (Cont)

Follow-Up

Install or connect the following:

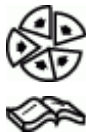
EGR mixer. Refer to Procedure [011-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

EGR connection tube to the EGR mixer. Refer to Procedure [011-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

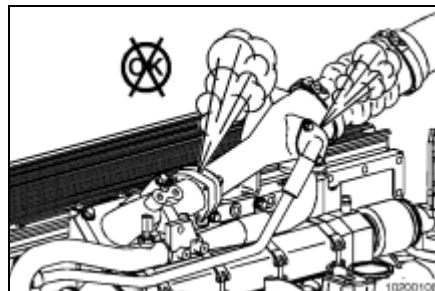
Air compressor inlet tube to the EGR mixer. Refer to Procedure [012-109](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Intake manifold air temperature sensor connector to the engine harness.

Charge-air cooler connection. Refer to Procedure [010-027](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Operate the engine to normal operating temperature and check for air and exhaust leaks.



Air Intake Cleaner Element Removal/Installation

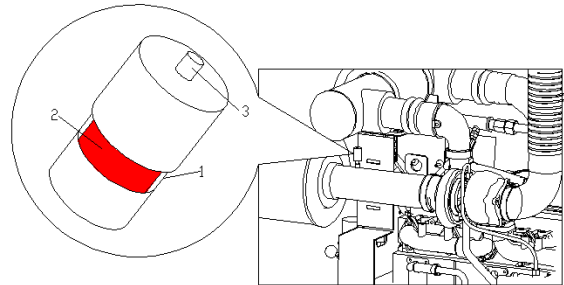


Never operate the engine without an air cleaner. Unfiltered foreign objects could cause engine damage.

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](#) 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.

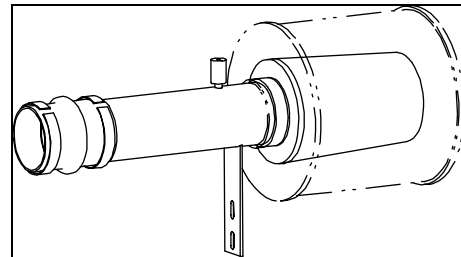
Remove the air cleaner element.

Clean and Inspect for Reuse

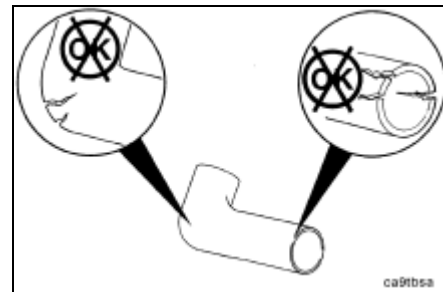
Inspect the air cleaner for cuts, cracks, holes, or excessive debris.

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 Inlet Connection Removal/Installation

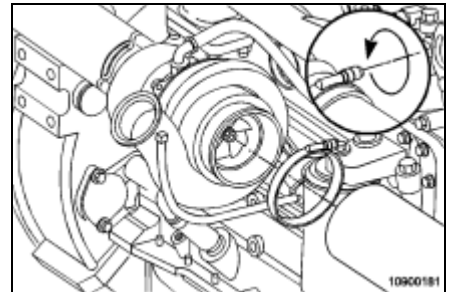
Refer to Air Inlet Connection (53-010-022) in ISB/QSB/QSB/QSB/QSB and QSB5.9 Base Engine Troubleshooting and Repair Manual, Bulletin Number 3666193.

Prepare

Remove

Loosen air inlet clamps.

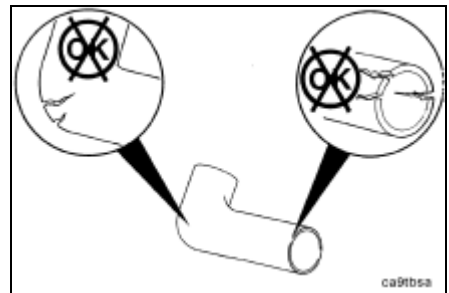
Remove the air inlet connection.



Clean and Inspect for Reuse

Inspect the air inlet connection for cuts, cracks, holes, or worn sections.

Replace if necessary.

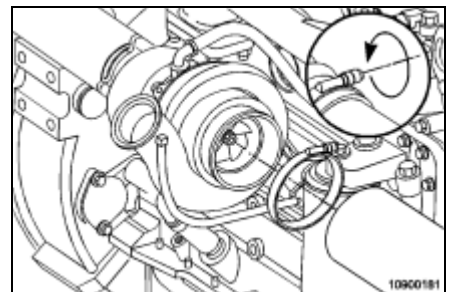


Install

Install the air inlet connection.

Tighten air inlet clamps.

Torque Value: 8 N•m [71 in-lb]

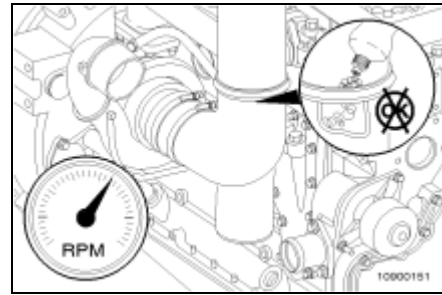


Air Inlet Connection (Cont)

Follow-Up

Operate the engine and check for leaks.

If an air leak exists, the soap bubbles will be drawn in with the air.



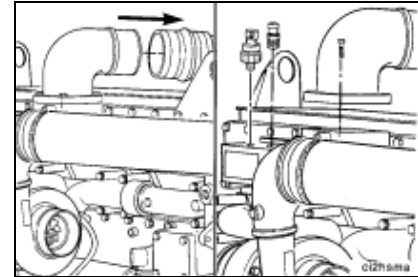
Air Intake Manifold Removal/Installation

Prepare

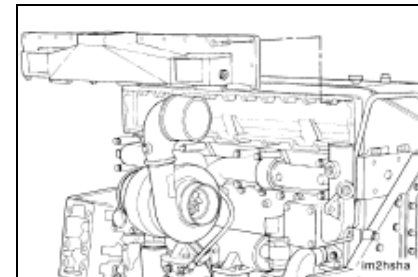
Remove

Disconnect the air pipe from the charge air cooler to the inlet air connection.

Remove the inlet air connection and the sensors from the air manifold.



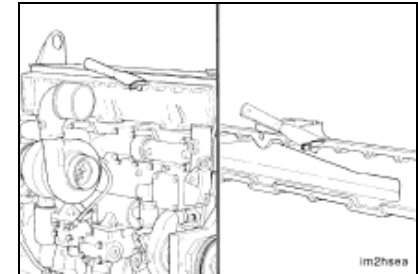
Remove the mounting capscrews and the air intake manifold.



Clean and Inspect for Reuse

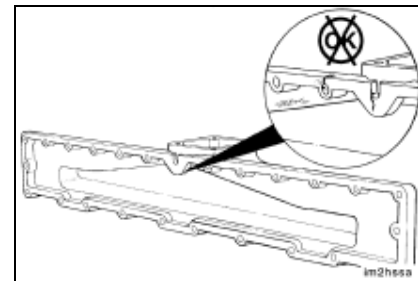
Clean the intake manifold to rocker housing surface.

Clean the intake manifold gasket surface.



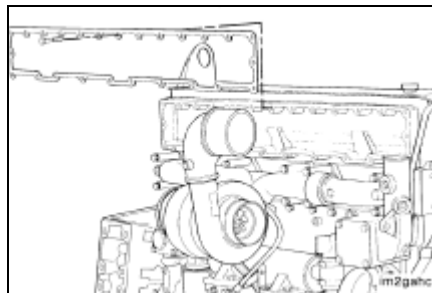
Inspect the intake manifold for cracks or other damage.

NOTE: When inspecting the intake manifold for oil or debris from an air system failure, also inspect the intake ports in the rocker housing and cylinder head for oil debris.



Air Intake Manifold Removal/Installation (Cont)**Install**

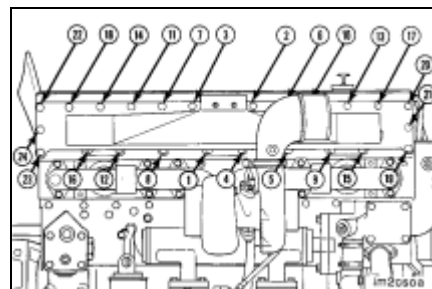
Install two guide pins in the rocker lever housing before installing a new gasket.



Install the intake manifold and capscrews.

Tighten the capscrews in the sequence shown.

Torque Value: 47 N•m [35 ft-lb]



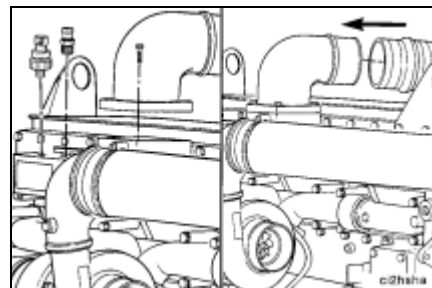
Use a new gasket, and install the inlet air connection.

Torque Value: 41 N•m [30 ft-lb]

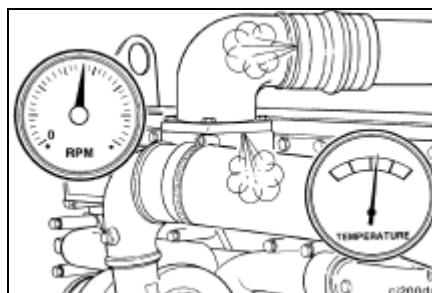
Install the sensors.

Install the air pipe from the charge air cooler to the intake connection.

Tighten the clamps. Refer to the manufacturer's specification for the correct torque value.

**Follow-Up**

Operate the engine to normal operating temperature and check for air leaks.



Turbocharger Oil Drain Line Removal/Installation

Prepare



WARNING

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

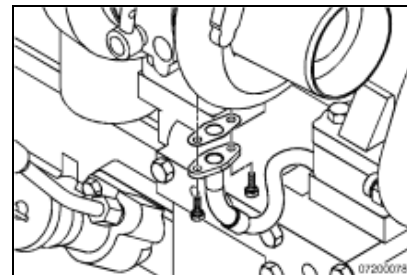
Disconnect the batteries.



Remove

Use a second wrench to hold the oil drain line coupling while loosening line.

Remove the turbocharger oil drain line and discard the gasket.



Clean and Inspect for Reuse



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.



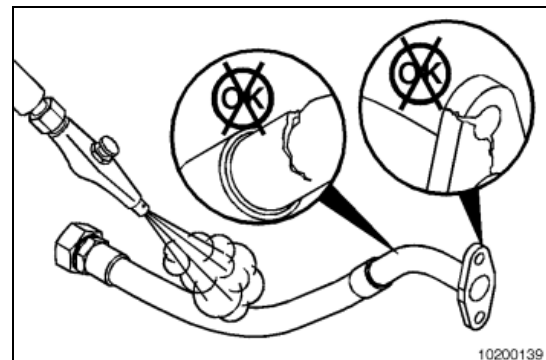
WARNING

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

Clean the turbocharger oil drain lines with solvent.

Dry the line with compressed air.

Check the turbocharger oil lines for cracks or other damage. Replace if damage is found.



Turbocharger Oil Drain Line Removal/Installation (Cont)**Install**

Do not bend or kink hose while tightening.
Doing so can possibly damage line.



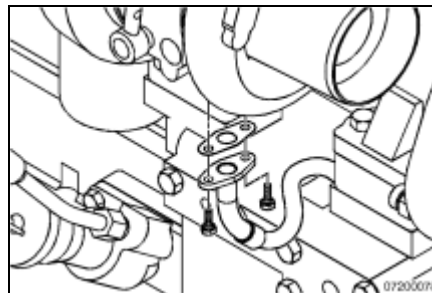
Check the face of oil supply fitting on engine
and on turbocharger to ensure o-ring is in
place and is not damaged. A damaged or
missing o-ring will result in an oil leak.

Use a second wrench to hold the oil drain line
coupling while tightening line.

Connect the bottom of drain tube to the block.

Install the turbocharger oil drain line with a new
gasket.

Torque Value: 20 N•m [177 in-lb]

**Follow-Up**

Connect the batteries.

Start the engine and check for leaks.



Turbocharger Oil Supply Line Removal/Installation

Prepare



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

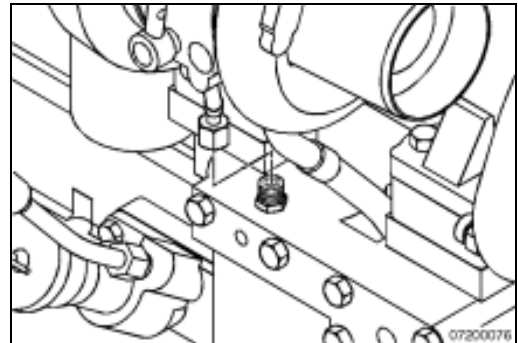
Disconnect the batteries.



Remove

Use a second wrench to hold the fitting while loosening the line fitting.

Disconnect the turbocharger oil supply line from the oil filter head and the turbocharger.



Turbocharger Oil Supply Line Removal/Installation (Cont)**Install**

Do not bend or kink the hose while tightening. Doing so can possibly damage the line.

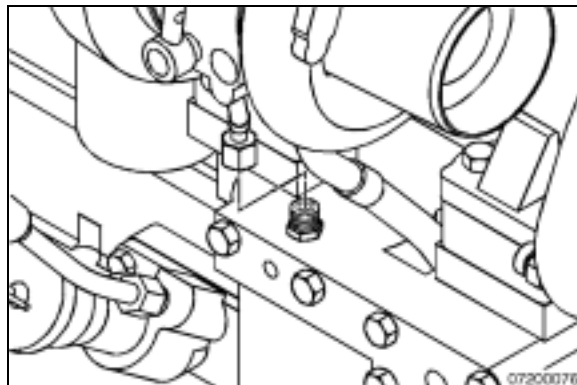


Check the face of the oil supply fitting on engine and on the turbocharger to ensure the o-ring is in place and is not damaged. A damaged or missing o-ring will result in an oil leak.

Use a second wrench to hold the oil supply line coupling while tightening the line.

Install the turbocharger oil supply line with new o-rings.

Torque Value: 20 N•m [177 in-lb]

**Follow-Up**

Connect the batteries.

Start the engine and check for leaks.



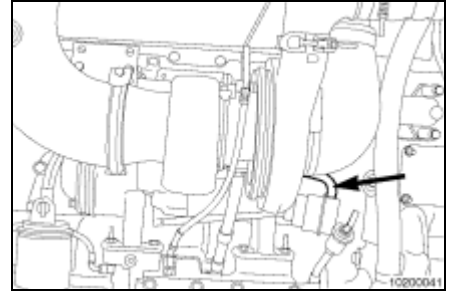
Turbocharger Wastegate Actuator Checks

Prepare

Check

Some M Series engines are equipped with wastegate turbochargers to limit the peak boost level and increase engine response at low rpm.

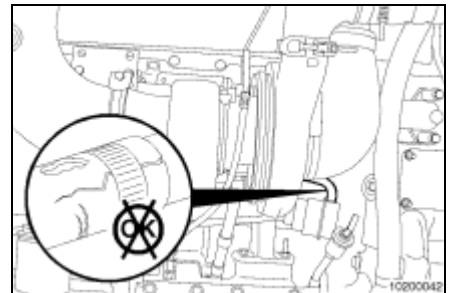
The wastegate actuator hose takes boost pressure from the intake manifold via the control valve to the wastegate capsule.



Inspect the wastegate actuator hose for cracks or holes.



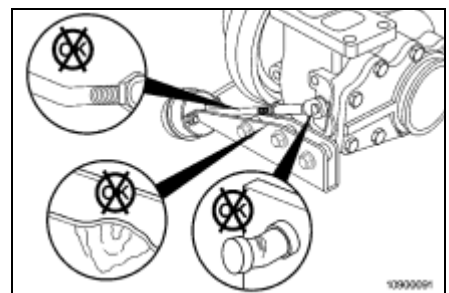
Replace the hose if damaged.



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.



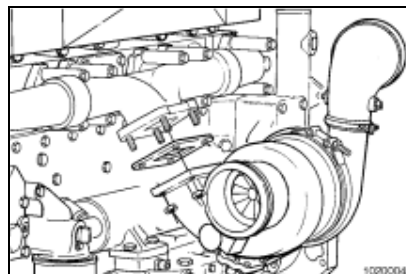
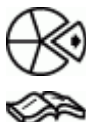
Follow-Up

Turbocharger Wastegate Actuator Removal/Installation

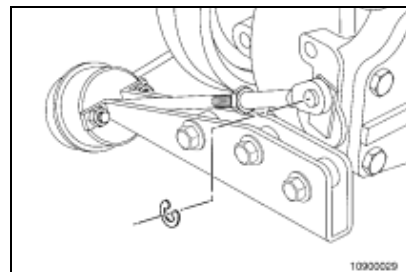
Prepare

Remove

In most 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, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Remove the retaining clip from the control lever.



WARNING

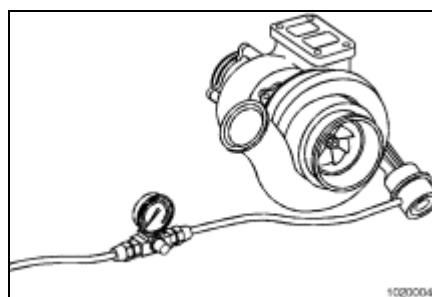
Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.



CAUTION

Be careful not to bend the control lever. A bent wastegate mounting bracket, actuator rod, or control lever can cause improper operation.

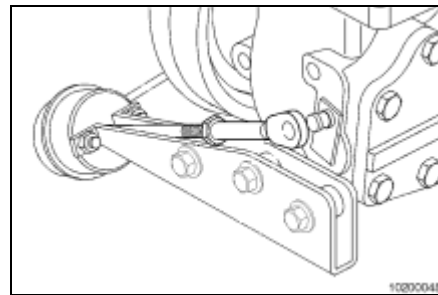
Disconnect the boost capsule actuator rod end from the turbocharger wastegate lever. This can be accomplished by slowly applying regulated air pressure to the boost capsule until the control rod is activated. A maximum of 310 kPa [45 psi] can be used.



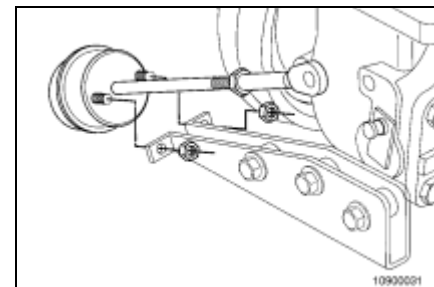
Turbocharger Wastegate Actuator Removal/Installation (Cont)

NOTE: If the boost capsule diaphragm material is ruptured and will not hold air pressure, it can be required to 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 while applying air pressure.

Disconnect the control rod from the turbocharger wastegate lever pin.



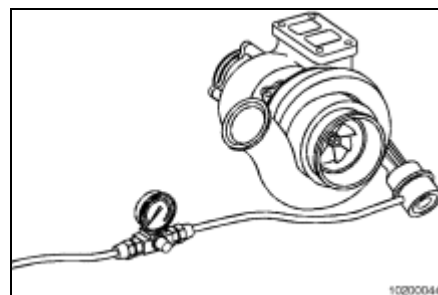
Loosen the boost capsule mounting capscrews, disconnect the wastegate actuator hose, and remove assembly from the mounting bracket.



Test

In most applications, the turbocharger must be removed in order to test the wastegate actuator. Refer to OFF engine test.

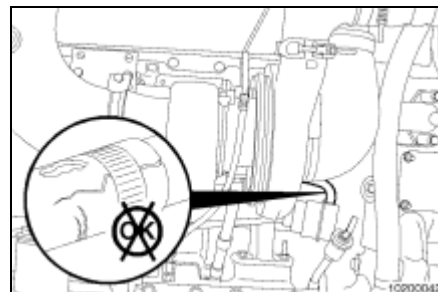
In some cases it may be possible to test the capsule while the turbocharger is installed on the engine. Refer to ON engine test.



Procedure for on engine test

A new hose clamp, Part Number 3914419, will be required to reinstall the signal line.

Disconnect the actuator hose from the wastegate actuator by cutting the crimped hose clamp.

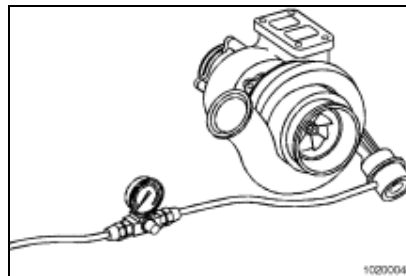


Turbocharger Wastegate Actuator Removal/Installation (Cont)

No air will be heard (i.e., leaking noise) through a functional wastegate capsule.

Connect clean regulated air pressure and a pressure gauge to the actuator.

Apply a maximum of 310 kPa [45 psi] to make sure the wastegate is functioning properly.

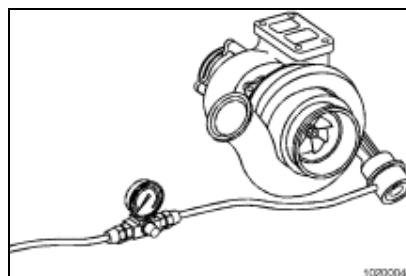


The actuator rod will extend approximately 0.05 in when 45 psi air pressure is applied.

If less than 0.05 in or no movement of the actuator rod and lever is detected, remove the turbocharger from the engine and perform the off engine test.

No air will be heard (i.e., leaking noise) through a functional wastegate capsule.

Refer to Procedure [010-033](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322 for turbocharger removal.

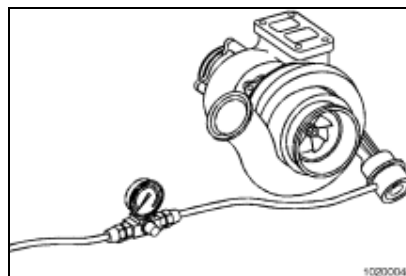


Procedure for off engine test

Connect clean, regulated air pressure and a pressure gauge to the actuator.

Apply a maximum of 310 kPa [45 psi] to make sure the wastegate is functioning properly.

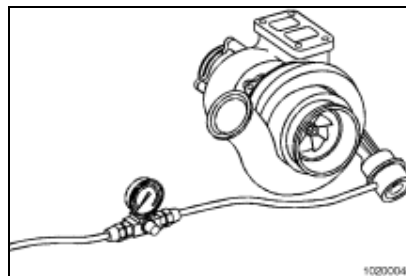
The actuator will extend approximately 0.05 in when 45 psi air pressure is applied.



If less than 0.05 in or no movement of the actuator rod and lever is detected, remove the actuator rod from the pin. Refer to Procedure [010-050](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Actuate the wastegate lever by hand.

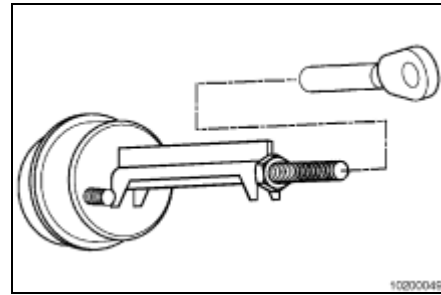
If the lever moves, replace the actuator, if the lever does not move, replace the turbocharger.



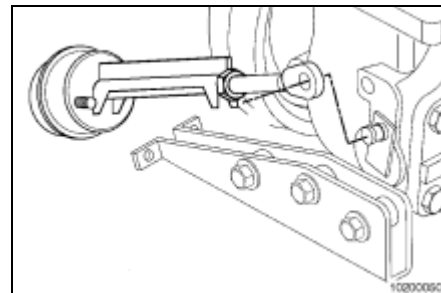
Turbocharger Wastegate Actuator Removal/Installation (Cont)

Install

If a new actuator is being installed, install the adjusting end-link onto the shaft of the pre-calibrated wastegate actuator assembly.

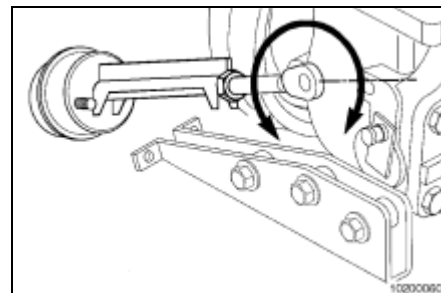


Fit end-link over turbocharger wastegate lever pin. With spine of spacer visible and turbocharger wastegate lever pushed toward the rod, lay the actuator alongside the mounting bracket.

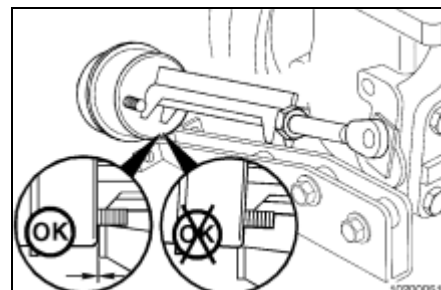


NOTE: Do not fit the two studs into the mounting holes at this time.

Adjust the length of the actuator assembly by rotating the end-link, and re-fitting until the underside of the actuator will just fit over the mounting bracket.



The setting is correct when the underside of the actuator will just fit over the mounting bracket with less than 0.20-in (0.5-mm) gap.

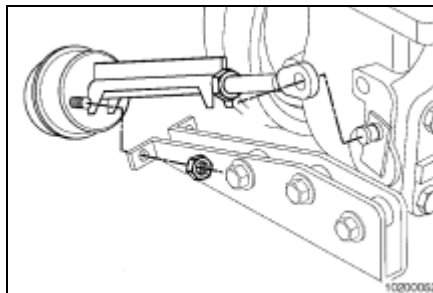


Turbocharger Wastegate Actuator Removal/Installation (Cont)

Fit the actuator mounting studs into the holes in the bracket, and install both actuator mounting capscrews.

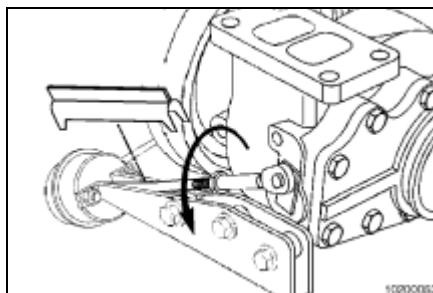
Refit end-link onto the wastegate lever pin. Install the control rod retaining clip.

Torque Value: 8.5 N•m [75 in-lb]



Snug the control rod jam nut against the end-link. Cut the tie wrap, remove and discard tie wrap and spacer piece. Continue turning jam nut in the same direction, and tighten against end-link.

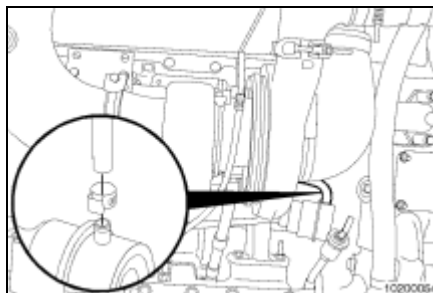
Torque Value: 8.5 N•m [75 in-lb]



NOTE: New hose clamps are not included in new actuator kits.

The hose clamp will need to be crimped for proper installation.

Refit the wastegate actuator hose to the actuator using a new hose clamp, Part Number 3914419.



Follow-Up

Turbocharger Wastegate Valve Body Inspection

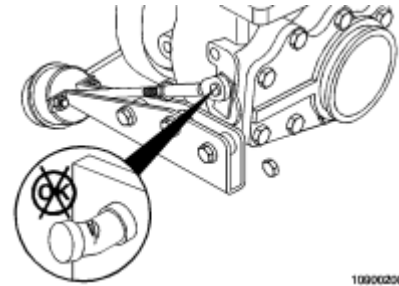
Prepare

Inspect

The wastegate actuator end-link must be removed to inspect the turbocharger wastegate. Refer to Procedure [010-050](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Inspect the lever pin.

If the lever pin is worn excessively, replace the turbocharger. Refer to Procedure [010-033](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



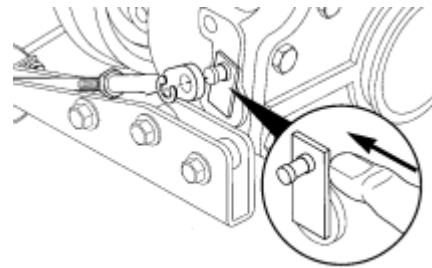
10900250

Actuate the lever by hand to verify 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](#).

Maximum allowable clearance is 0.003-in. If the clearance is determined to be above the maximum allowable, replace the turbocharger. Refer to Procedure [010-033](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



10900250

Follow-Up

Turbocharger Wastegate Controller Removal/Installation

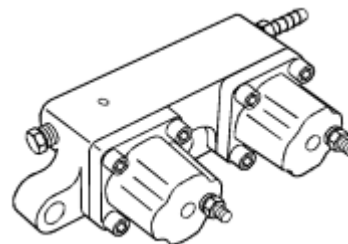
Prepare

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.



10200095

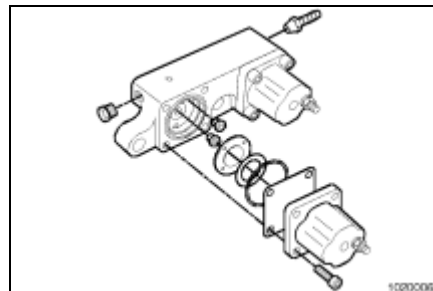
Disassemble

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.



10200095

Turbocharger Wastegate Controller Removal/Installation (Cont)

Inspect for Reuse



Controller orifices can not be removed from the controller housing. Attempting to remove orifices can result in damage to the housing or orifice.

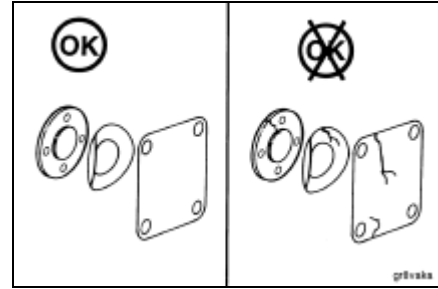
Check for plugged orifices in the controller housing. All of the parts except the coil assembly can be cleaned using mineral spirits.

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.

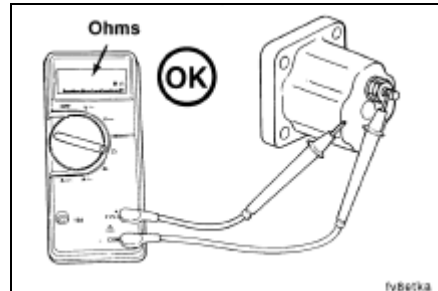
Replace the coil if not within specifications.

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**

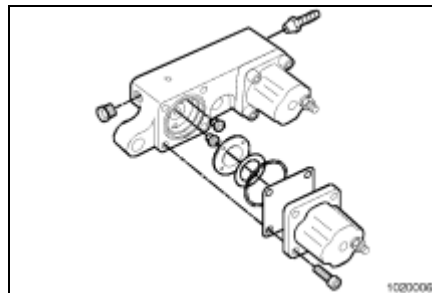
Assemble the valve as shown.

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.



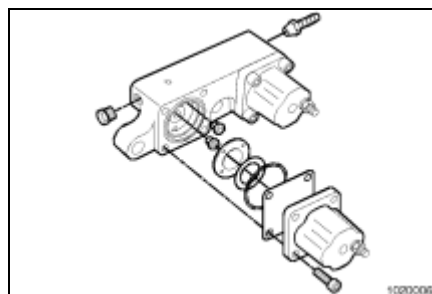
The coil must be orientated with the electrical connection post at the three o'clock position, when the controller is installed on the engine.

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]

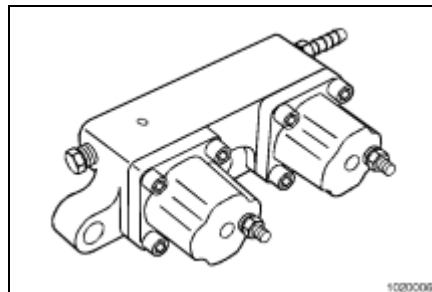
Refit the wastegate actuator hose to the wastegate controller.

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

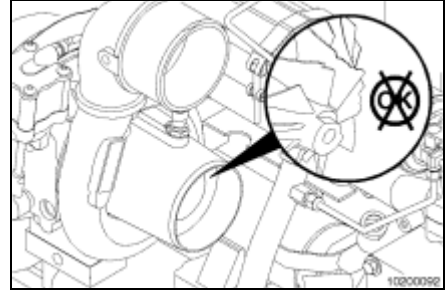
Initial Check

If turbocharger blade damage is suspected:

Remove the air intake pipe from the turbocharger.

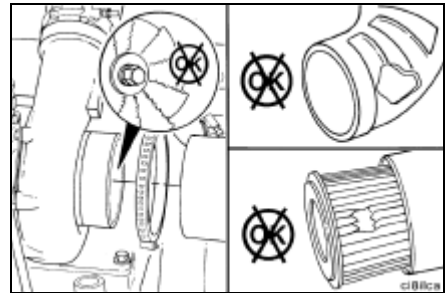
Inspect the turbocharger compressor impeller blades for damage.

Replace the turbocharger if damage is found.



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

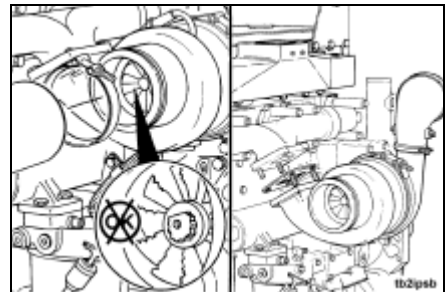
Repair any damage before operating the engine.



Remove the exhaust pipe from the turbocharger.

Inspect the turbine wheel for damage.

Replace the turbocharger if damage is found.

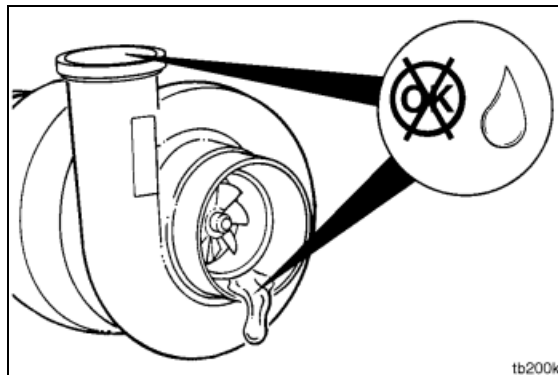


Turbocharger Checks (Cont)

If turbocharger compressor seal leak is suspected:

Inspect the compressor intake and discharge for oil.

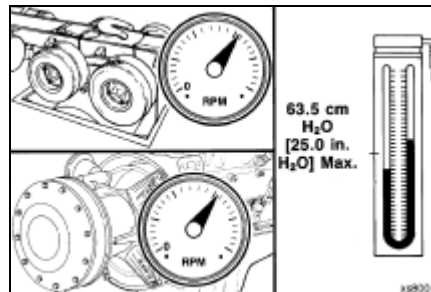
If oil is present in the compressor intake, as well as in the discharge, check upstream from the turbocharger for the source of the oil.



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, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

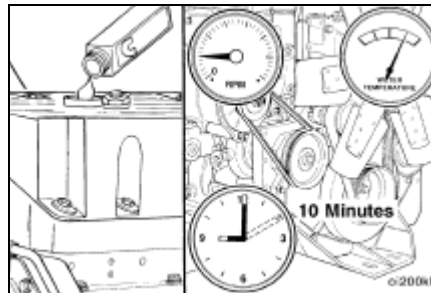
If no intake restriction is found, replace the turbocharger.



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.

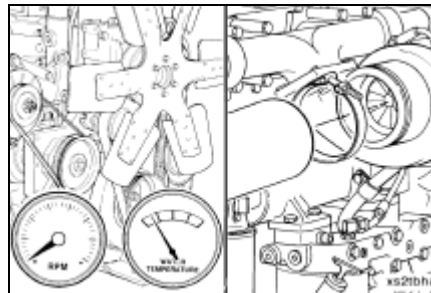
Operate the engine at low idle for 10 minutes.



Shut off the engine.

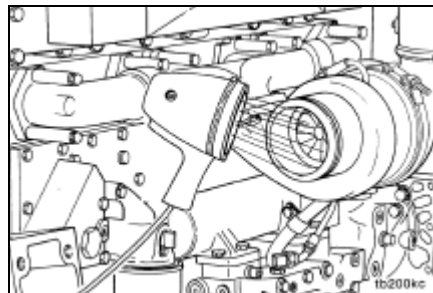
Allow the turbocharger to cool.

Remove the exhaust pipe from the turbine housing.



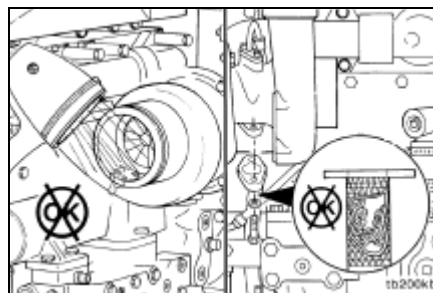
Turbocharger Checks (Cont)

Use a high-intensity black light, Part Number 3377253 or 3377394, to inspect the turbine outlet for leaks.



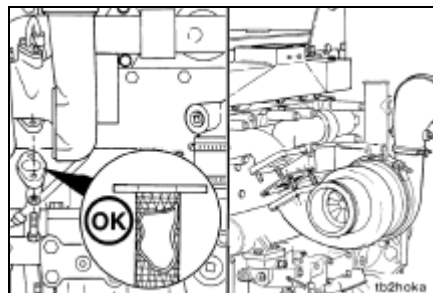
A dark blue glow indicates a fuel leak. Refer to Procedure [007-044](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322. A yellow glow indicates an oil leak.

If oil is found on the turbine housing, remove the oil drain line and check for restrictions.

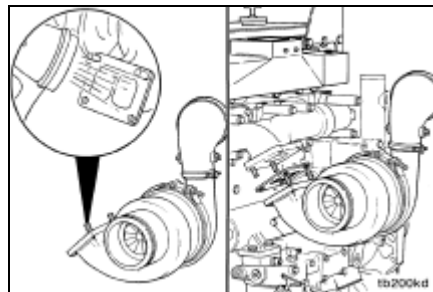


Clear any restrictions found or replace the damaged components, as required.

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.

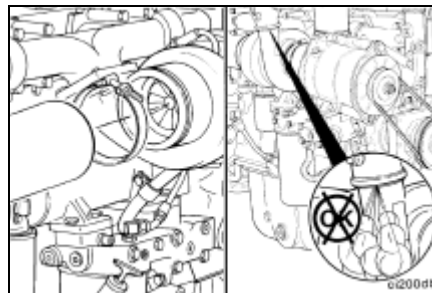
If a yellow glow is not seen in the turbine inlet, replace the turbocharger.

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.

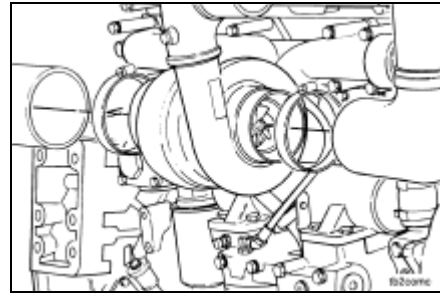


Follow-Up

Turbocharger Removal/Installation

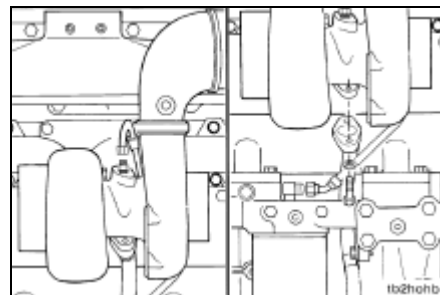
Prepare

Remove the intake and exhaust pipes from the turbocharger.



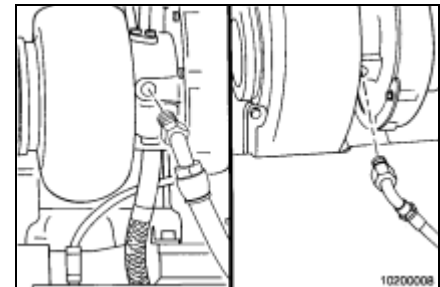
Remove the oil supply line from the turbocharger.

Remove the oil drain line from the turbocharger.

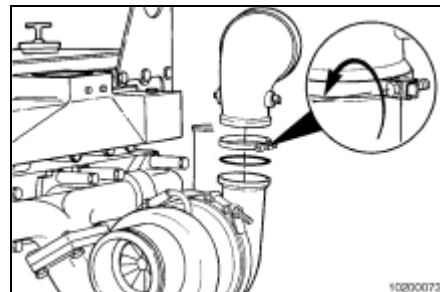


NOTE: Some applications use water-cooled turbochargers.

If a water-cooled turbocharger is used, drain the cooling system, and remove the water supply and return lines from the turbocharger.



Remove the v-band clamp, discharge elbow, and o-ring from the turbocharger compressor discharge outlet.

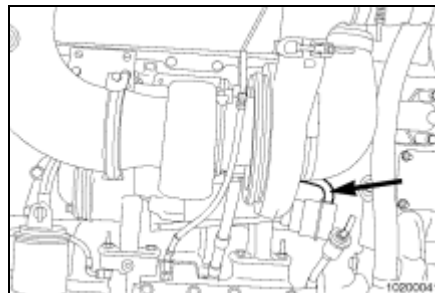


Turbocharger Removal/Installation (Cont)

NOTE: Some applications use wastegated turbochargers.

A new hose clamp, Part Number 3914419, will be required to reinstall the signal line.

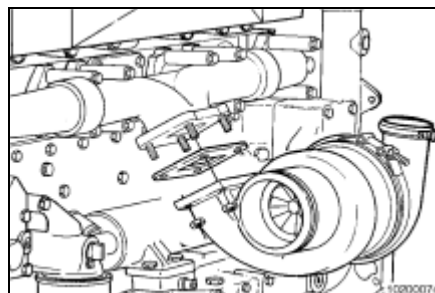
If a wastegated turbocharger is used, remove the wastegate actuator signal line by cutting the crimped hose clamp.



Remove

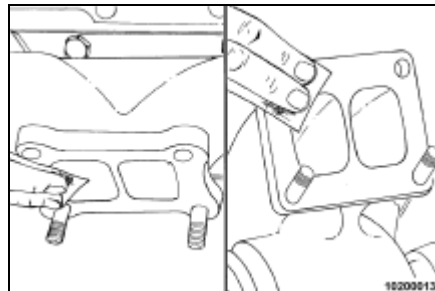
Remove the four turbocharger mounting nuts.

Remove the turbocharger and gasket.



Clean

Clean the turbocharger and exhaust manifold gasket surfaces.



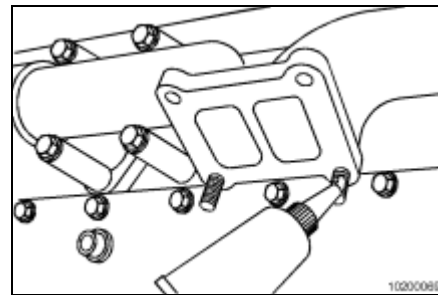
Inspect for Reuse

Refer to Turbocharger Wastegate Actuator Checks in this section.

Turbocharger Removal/Installation (Cont)

Install

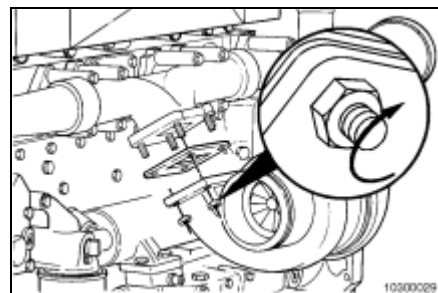
Apply a film of anti-seize lubricant, Part Number 3824879, to the turbocharger mounting studs.



Use a new gasket when installing the turbocharger.

Install and tighten the four mounting nuts.

Torque Value: 61 N•m [45 ft-lb]



Follow-Up

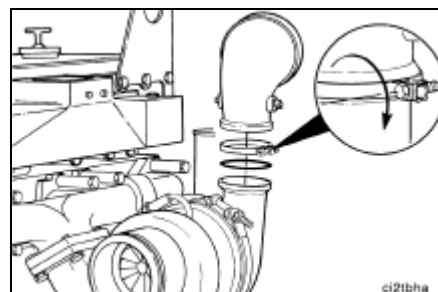
Install a new o-ring seal on the turbocharger compressor discharge outlet.

Install the discharge elbow and v-band clamp.

Be sure the elbow is seated properly before the v-band clamp is tightened.

Tighten the clamp.

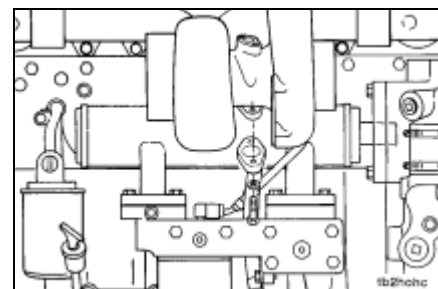
Torque Value: 8 N•m [71 in-lb]



Install a new gasket on the turbocharger oil drain line connection, and install the drain line to the bottom of the turbocharger.

Tighten the two turbocharger oil drain line mounting capscrews.

Torque Value: 27 N•m [20 ft-lb]

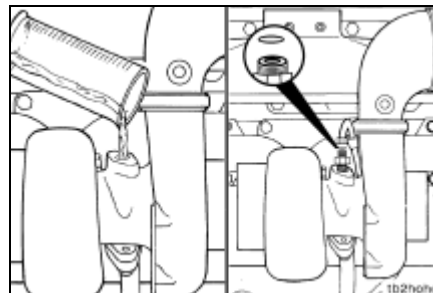


Turbocharger Removal/Installation (Cont)

Pour 50 to 60 cc [2.0 to 3.0 oz] of clean engine oil in the turbocharger oil supply inlet.

Install and tighten the turbocharger oil supply line.

Torque Value: 20 N•m [15 ft-lb]

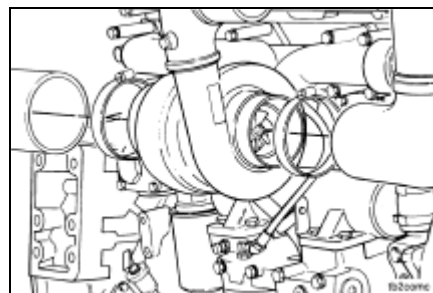


Install the intake pipe, and tighten the clamp.

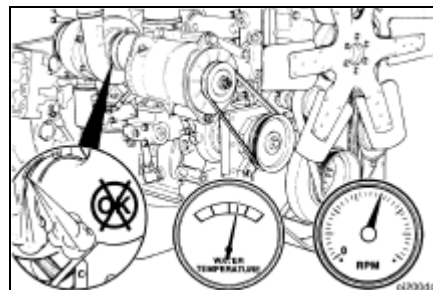
Torque Value: 8 N•m [71 in-lb]

Install the exhaust pipe, and tighten the clamp.

Torque Value: 8 N•m [71 in-lb]



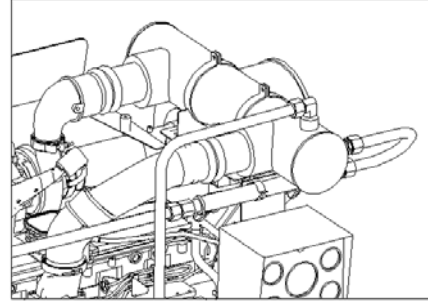
Operate the engine until it reaches a temperature of 71°C [160°F] and check for air leaks.



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 8969 and 11048 in Section 13.

Disconnect the CAC Air Outlet Piping Assembly from the CAC.

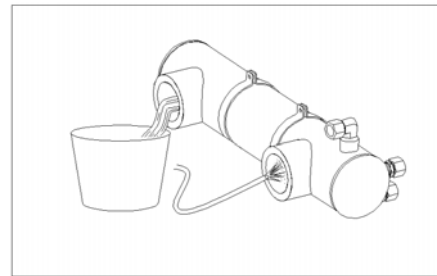
Disconnect the CAC Air Inlet Piping Assembly from the CAC.

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.

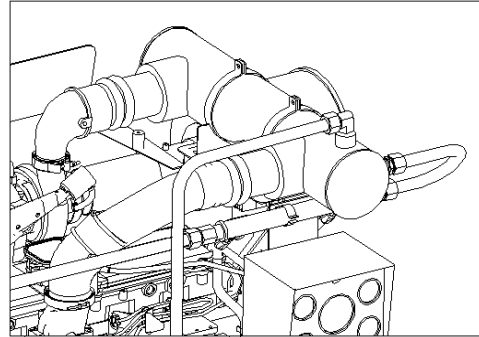
NOTE: Apply Teflon tape or pipe sealant to the
threaded fittings as the raw water piping is
reinstalled.

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.



Charge Air Cooler Checks

Clean

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 the charge air cooler piping and charge air cooler from the vehicle. Refer to the manufacturer's instructions.



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.

NOTE: Be sure the tubes are in the vertical direction when flushing.

If the debris cannot be totally removed from the charge air cooler, the charge air cooler must be replaced.

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 through the inside of the charge air cooler in the opposite direction of normal air flow until the charge air cooler is dry internally.



The charge air cooler must be rinsed, dried, and free of solvent, oil, and debris or engine damage will result.

Charge Air Cooler Checks (Cont)

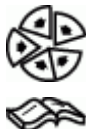
Inspect for Reuse

Inspect the charge air cooler for cracks, holes, or damage.

Inspect the tubes, the fins, and the welds for tears, breaks, or other damage. If any damage causes the charge air cooler to fail the air leak check mentioned earlier in this procedure, the charge air cooler must be replaced.

Install the charge air cooler and charge air cooler piping on the vehicle. Refer to the manufacturer's instructions.

NOTE: Always clean and inspect the charge air cooler piping and hoses prior to installation.



Leak Test

To check the charge air cooler for cracked tubes or header, remove the inlet and outlet hoses from the cooler. The charge air cooler does not have to be removed from the chassis.



WARNING

To prevent possible injury if either plug blows off during the test, secure safety chains on the test plugs to any convenient capscrew on the radiator assembly. This test must not be performed without securely fastened safety chains.

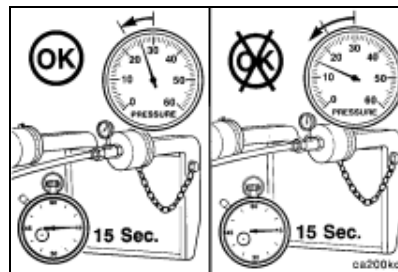
Install a plug or cap over the outlet side of the cooler. Install a pressure gauge and a regulated shop air supply line with a shutoff valve to the inlet side of the cooler.

Apply air pressure to the cooler until the pressure gauge reads a steady 207 kPa [30 psi] of air pressure.

Shut off the airflow to the cooler, and start a stopwatch at the same time. Record the leakage at 15 seconds.

If the pressure drop is 34 kPa [5 psi] or less in 15 seconds, the cooler is functioning properly.

If the pressure drop is greater than 34 kPa [5 psi] in 15 seconds, re-check all connections.



Charge Air Cooler Checks (Cont)

Determine if the pressure drop is caused by a leak in the charge air cooler or from a leaky connection. Use a spray bottle filled with soapy water applied to all hose connections, and watch for bubbles to appear at the location of the leak.

If the pressure drop is caused by a leaky connection, repair the connection, and repeat the test. If the leak is within the charge air cooler, repeat the test to verify the accuracy of the pressure drop measurement. Similar pressure drop readings must be obtained at least three consecutive tests before the reading can be considered accurate.

NOTE: If a charge air cooler leaks more than 34 kPa [5 psi] in 15 seconds, it will appear as a major leak in a leak tank.

If the pressure drop is greater than 34 kPa [5 psi] in 15 seconds, the charge air cooler must be replaced.



Refer to the manufacturer's repair manual for replacement instructions.

NOTE: Charge air coolers are not designed to be 100-percent leak free. If the pressure drop is less than 34 kPa [5 psi] in 15 seconds, then the charge air cooler does not need to be replaced.

Temperature Differential Test



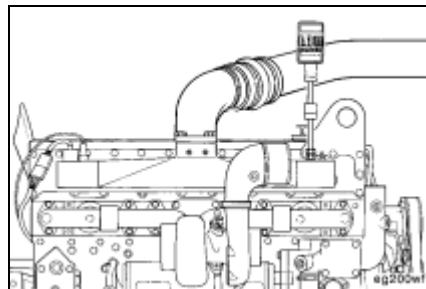
Inspect the charge air cooler fins for obstructions to airflow. Remove obstructions such as a winterfront or debris. Manually lock shutters in the open position if equipped.

Lock the fan drive in the ON mode to prevent erratic test results. This can be done by installing a jumper wire across the temperature switch.

Charge Air Cooler Checks (Cont)

Install Fluke digital thermometer, Part No. 3822666, and thermocouple wire kit, Part No. 3822988, into the intake manifold at the 1/8-inch NPT tap near the air horn connection with the intake manifold.

Install another thermocouple at the air cleaner inlet to measure ambient air temperature.



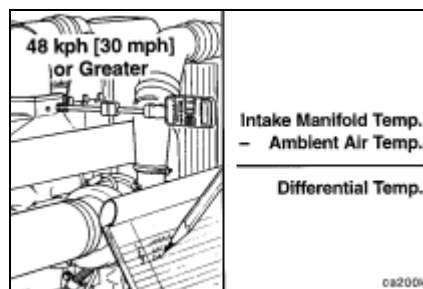
Perform a road test with the engine at peak power and a vehicle speed of 48 kph [30 mph] or greater.

Record the intake manifold temperature and the ambient air temperature.

Calculate the differential temperature:

Intake Manifold Temperature – Ambient Air Temperature = Differential Temperature

Maximum Differential Temperature: 28°C [50°F]



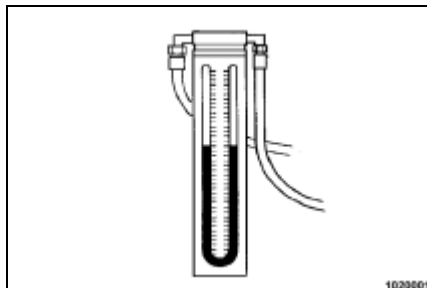
If the temperature differential is greater than the specifications, check the charge air cooler for dirt and debris on the fins and clean as necessary. If the problem still exists, check the charge air cooler for debris in the fins or between the charge air cooler and radiator. Confirm full fan engagement.



Pressure Differential Test

Preferred Method

Measure the charge air cooler system pressure drop with a mercury manometer, Part No. ST-1111-3.

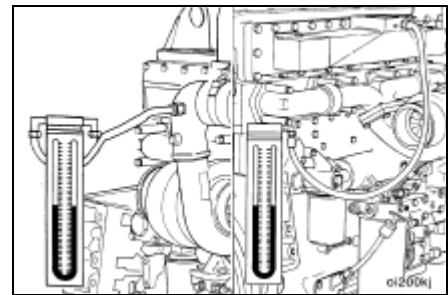


Charge Air Cooler Checks (Cont)

Install one end of a mercury manometer to the fitting in the turbocharger compressor outlet elbow.

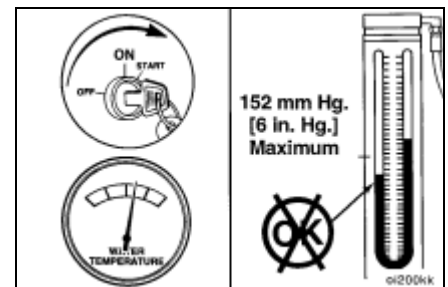


Install the other end of the mercury manometer to the intake manifold.



Operate the engine at rated rpm and load.
Record the readings on the manometer.

If the differential pressure is greater than 152 mm Hg [6 in. Hg], check the charge air cooler and associated piping for plugging. Clean or replace if necessary.



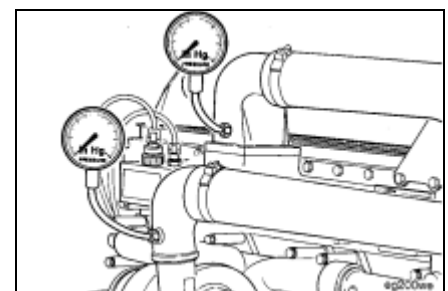
Pressure Differential Test

Optional Method

Obtain two (2) pressure gauges, Part No. ST-1273. Check both gauges on the same pressure source at 206 kPa [30 psi] for consistency.

Install pressure gauge, Part No. ST-1273, to the 1/8-inch fitting in the turbocharger compressor outlet elbow.

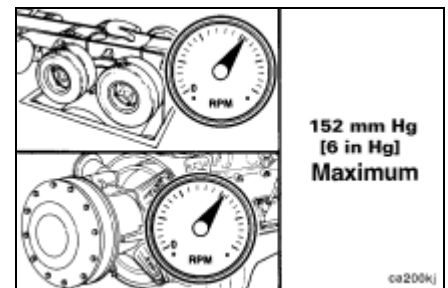
Install the other pressure gauge in the intake manifold.



Operate the engine at rated rpm and load.
Record the readings on the two gauges.

If the differential pressure is greater than 152 mm Hg [6 in. Hg], check the charge air cooler and associated piping for plugging, restrictions, or damage.

Clean or replace if necessary.



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Lubricating Oil Filter Assembly Removal/Installation

Prepare

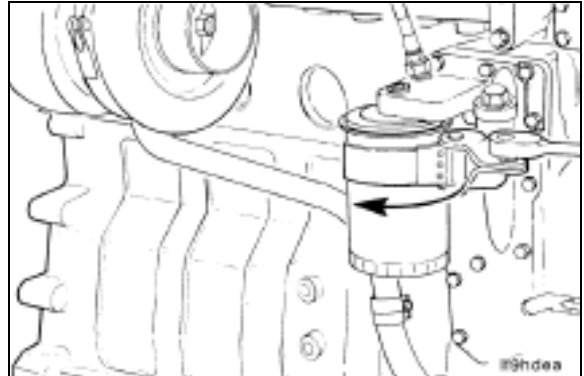
Remove

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.



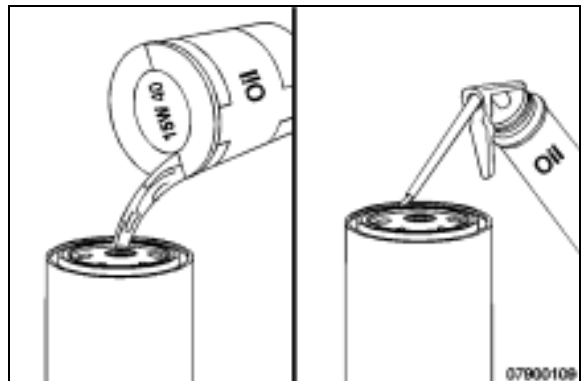
Install



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)

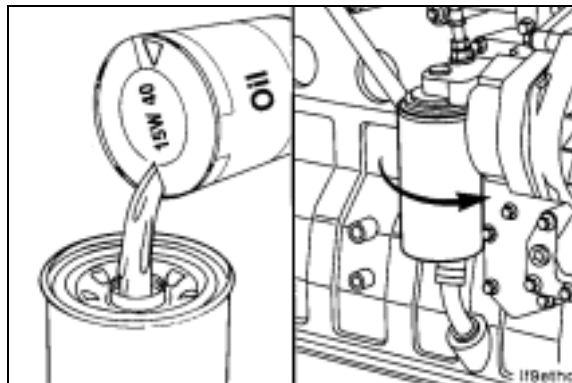


Mechanical over-tightening of the filter can distort the threads or damage the filter element seal.

Oil Filter Wrench, Part Number 3375049

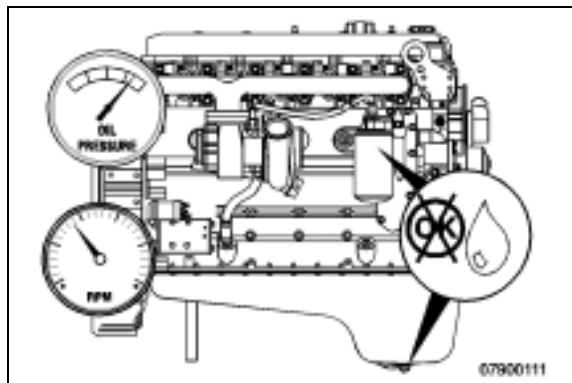
Install the filter on the oil filter head. Tighten the filter until the gasket contacts the filter head surface.

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



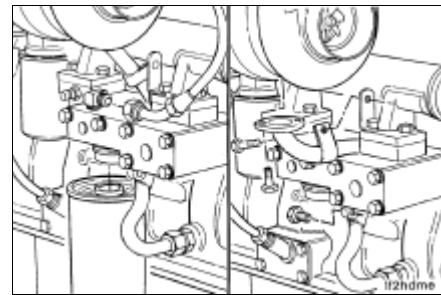
WARNING

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, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

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 (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

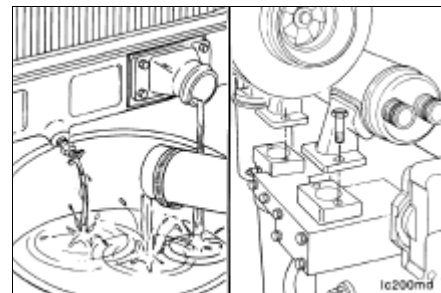


WARNING

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Remove the lubricating oil cooler. Refer to Procedure [007-003](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

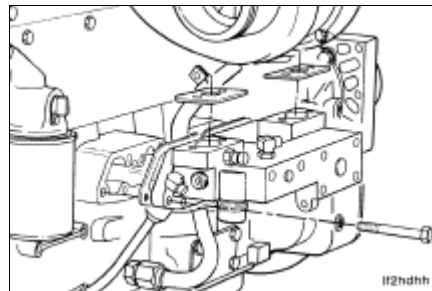


Lubricating Oil Filter Head Removal/Installation (Cont)

Remove

Remove the nine filter head capscrews and the filter head.

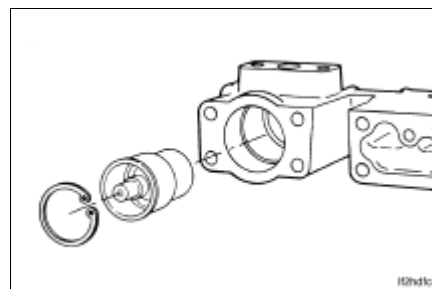
Remove and discard the gaskets.



Disassemble

Use snap ring pliers to remove the snap ring in the thermostat bore.

Remove the lubricating oil thermostat.



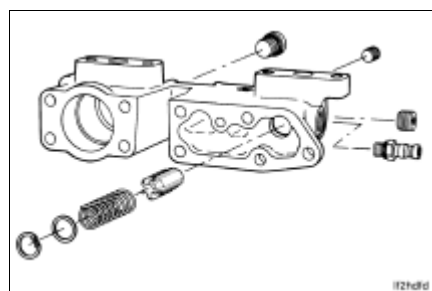
WARNING

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.

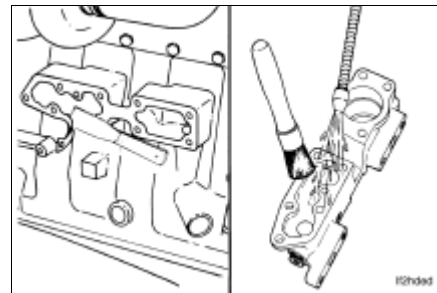


WARNING

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.

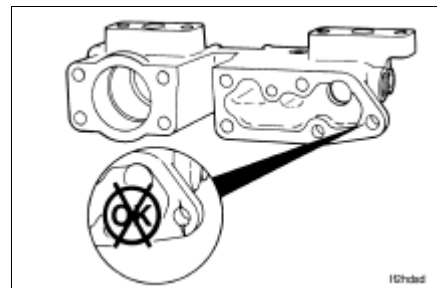
Use solvent to clean the filter head. Dry with compressed air.



Inspect for Reuse

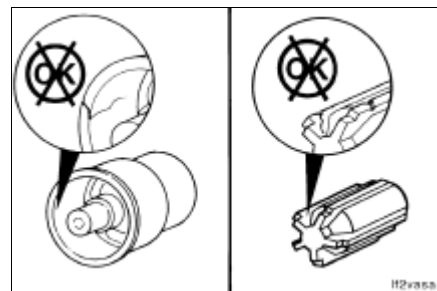
Inspect for cracks or other damage.

Inspect the lubricating oil thermostat. Refer to Procedure [007-039](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Inspect the thermostat and bypass valve for cracks or other damage.

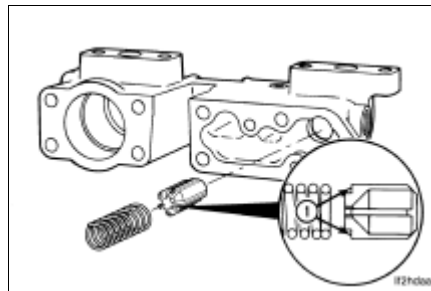
If the bypass valve or thermostat is damaged, it must be replaced.



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.

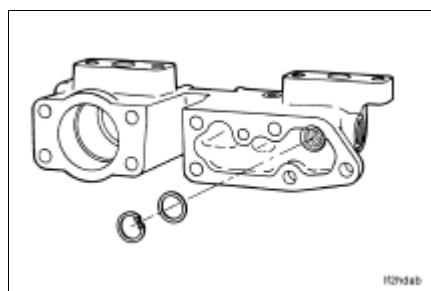
Insert the spring into the bore. Check to be sure the spring is properly located over the notched end of the valve (1).

**WARNING**

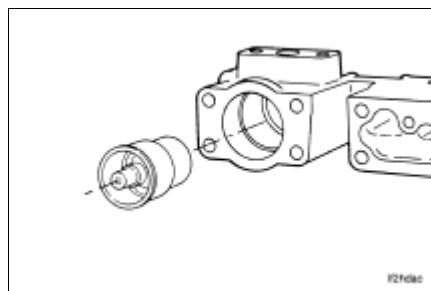
The valve spring must be compressed to install the snap ring. To avoid personal injury, wear face and eye protection.

Place the washer on top of the spring.

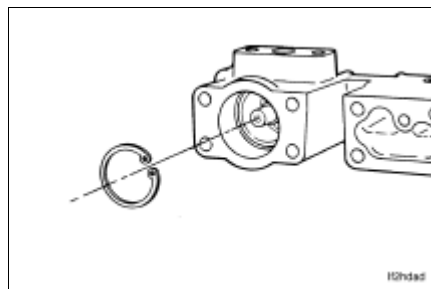
Using snap ring pliers, install the snap ring into the groove inside the bore.



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)

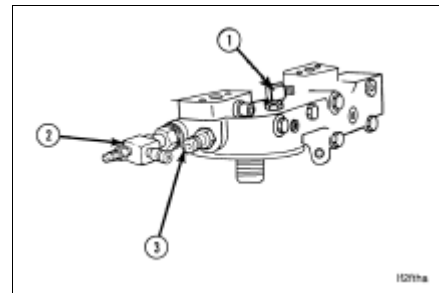
Install the following fittings into the filter head.

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]

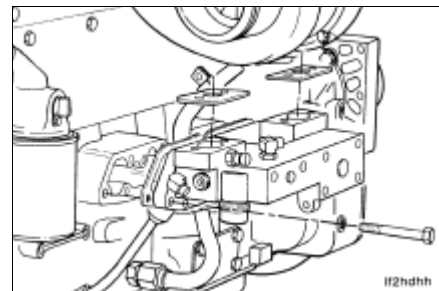


Install

Use a new gasket and install the filter head to the cylinder block.

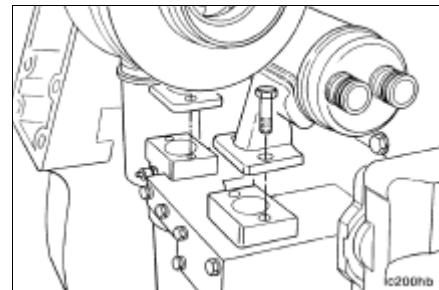
Install the nine capscrews and tighten.

Torque Value: 47 N•m [35 ft-lb]

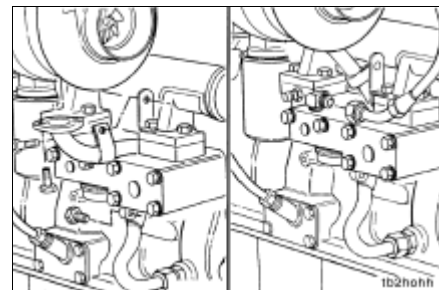


Follow-Up

Install the lubricating oil cooler. Refer to Procedure [007-003](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



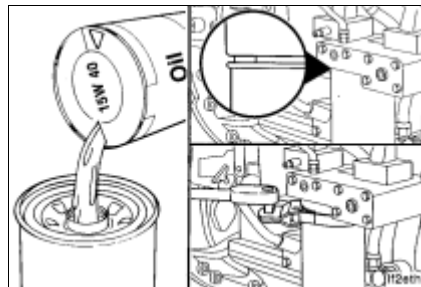
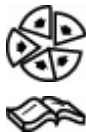
Install the turbocharger oil supply and drain lines and support brackets.



Lubricating Oil Filter Head Removal/Installation (Cont)

Install the lubricating oil filter. Refer to Procedure [007-013](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

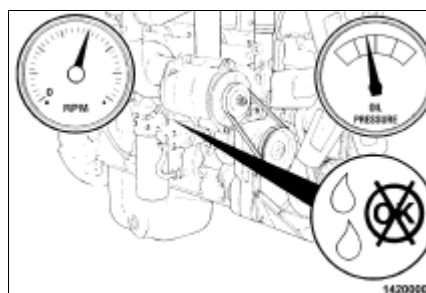
Filling the cooling system. Refer to Procedure [008-018](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



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.

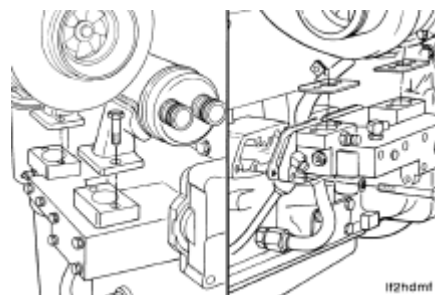


Lubricating Oil Thermostat Removal/Installation

Prepare

Remove

Remove the lubricating oil filter head. Refer to Procedure [007-015](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Inspect for Reuse

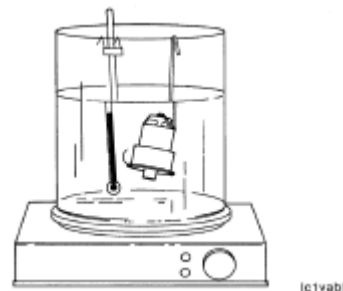


WARNING

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.

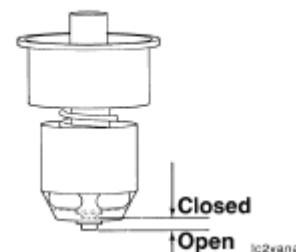
Suspend the thermostat and a 116°C [240°F] thermometer in a container of new lubricating oil. Do not allow the thermostat or the thermometer to touch the sides of the container.

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].

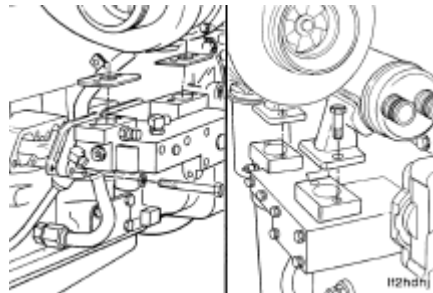
Replace the thermostat if it does not operate as described.



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, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

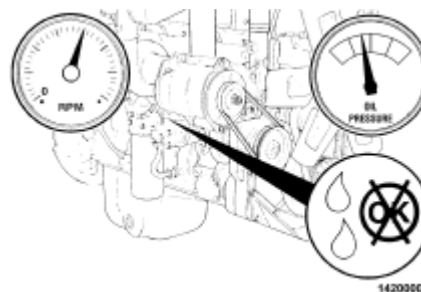


Follow-Up



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

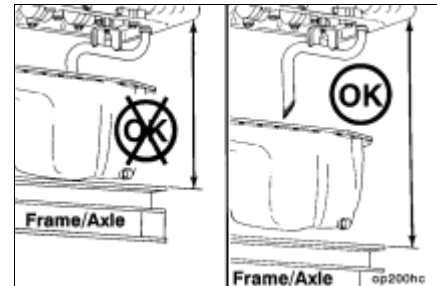
Drain

Remove

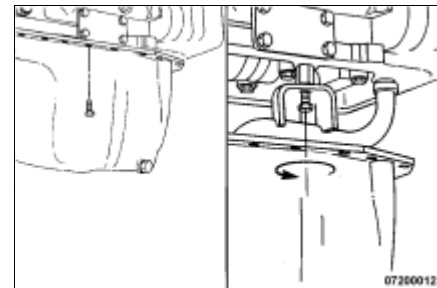
Front Sump Pan

Front sump oil pans have a block-mounted suction tube, which requires approximately 610-mm [24-in] clearance between the vehicle frame or axle and the cylinder block oil pan mounting flange to remove the oil pan.

If an application will not allow the oil pan to be lowered that much, the suction tube must be removed from the cylinder block before the oil pan can be removed from the chassis.

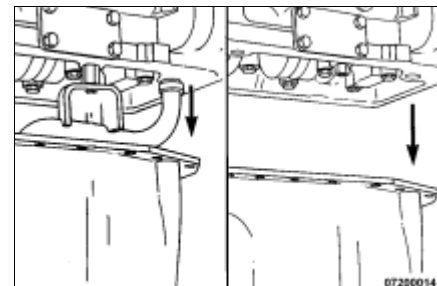


Remove the oil pan mounting capscrews. Lower the oil pan far enough to allow one hand to reach inside the engine and remove the suction tube mounting capscrew.



Remove the suction tube from the cylinder block, and let it drop into the oil pan.

Remove the oil pan from the chassis.

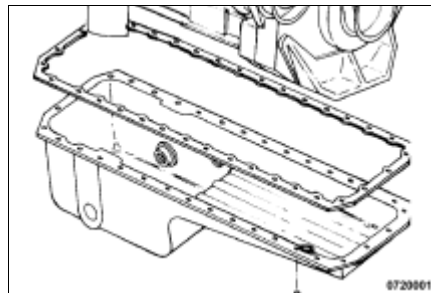
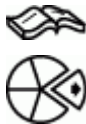


Lubricating Oil Pan Removal/Installation ((Cont))

Remove

Rear Sump Pan

Remove the capscrews and the oil pan.



Clean



WARNING

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

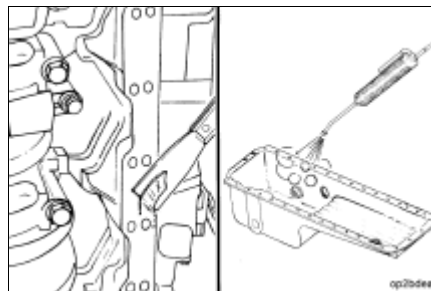


WARNING

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

Remove all gasket material from the cylinder block and oil pan surfaces.

Steam-clean the oil pan and dry with compressed air.



Lubricating Oil Pan Removal/Installation ((Cont))

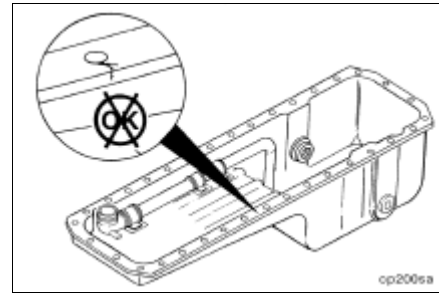
Inspect for Reuse

Inspect the oil pan, suction tube, and tube braces for cracks or damage.

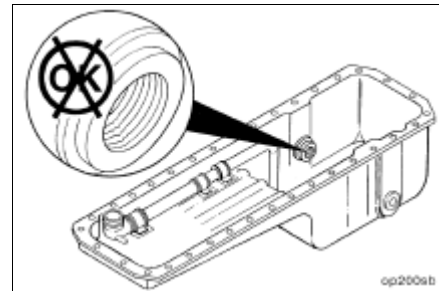
If cracks are found, replace the damaged part. Do not attempt to repair the oil pan by welding.

Inspect the oil transfer tube. Refer to Procedure [007-040](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Inspect the threaded holes for damage. Damaged threads can be chased with the following taps.



cp200sa



cp200sb

Oil Pan Threaded Holes

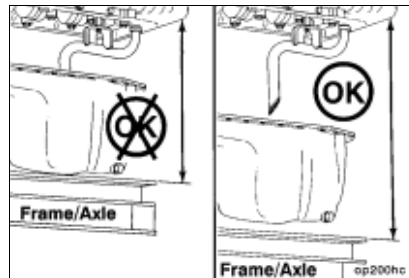
Thread Location	Tap Size
Temperature Gauge	3/8 in NPTF
Oil Sump Heater	1-18 NS-3B
Oil Drain	1 in NPTF

NOTE: If the threaded holes cannot be repaired with the taps listed above, the oil pan must be replaced.

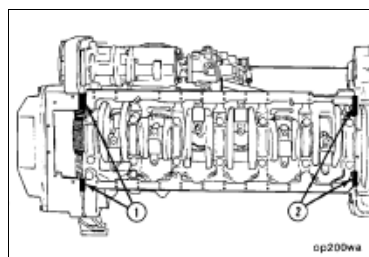
Lubricating Oil Pan Removal/Installation ((Cont))**Install****Front Sump Pan**

On front sump oil pans, if the application does not allow approximately 610 mm [24 in] clearance between vehicle frame or axle and the cylinder block oil pan mounting surface during installation, the suction tube and oil pan will need to be installed together as an assembly. Installation requires approximately this much clearance to maneuver the oil pan over the frame or axle and under the block-mounted suction tube when installing the pieces separately. Follow all the steps as outlined on the following pages.

If the application does allow approximately 610-mm [24-in] clearance, install the suction tube first by itself, then the oil pan.



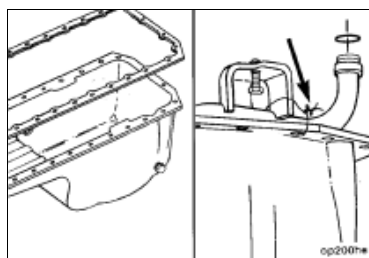
Apply a 2-mm [1/16-in] bead of sealant, Part Number 3823494, to the oil pan mounting surfaces at the cylinder block to gear housing joint (1) and flywheel housing to cylinder block joint (2).



Install a new o-ring to the oil suction tube. Use clean 15W-40 engine oil to lubricate the o-ring.

Place a new gasket on the oil pan mounting flange.

Attach the suction tube to the oil pan mounting flange with a piece of wire. This will hold the suction tube and oil pan together as one assembly until the tube is fastened to the cylinder block.

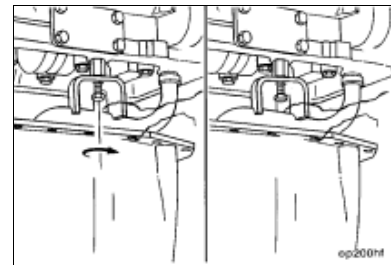


Lubricating Oil Pan Removal/Installation (Cont)

Maneuver the assembly into place under the engine in the chassis.

Align the suction tube with the cylinder block suction tube hole. Reach inside the engine and start the capscrew into the mounting hole to hold the suction tube in place.

After the capscrew is started in the mounting hole by several threads, the wire holding the suction tube to the oil pan can be removed and the oil pan can be lowered to allow more hand clearance to complete the suction tube installation.

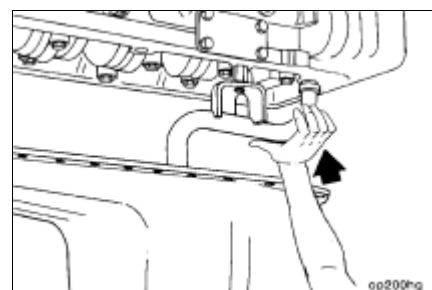


Do not use the capscrew to pull the suction tube into place during installation. Doing so will cause misalignment of the suction tube, which can cause damage to the engine.

Reach inside the engine, and push the suction tube completely up into place in the cylinder block suction tube mounting hole by hand.

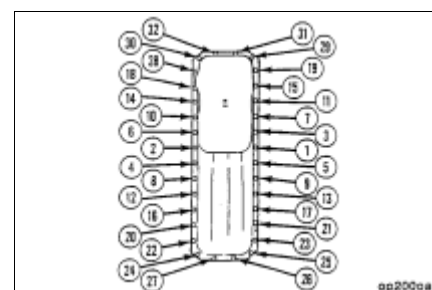
Complete the suction tube retaining capscrew installation.

Torque Value: 61 N•m [45 ft-lb]



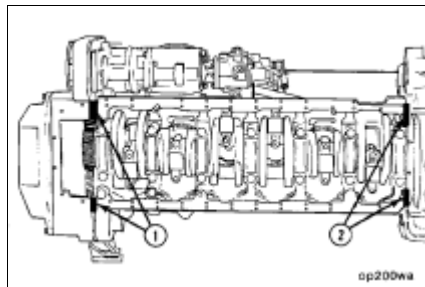
Install the oil pan. Tighten the capscrews in the sequence shown.

Torque Value: 47 N•m [35 ft-lb]

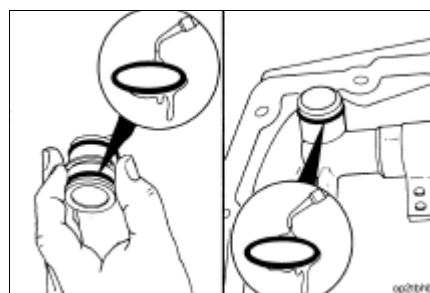


Lubricating Oil Pan Removal/Installation (Cont)**Install****Rear Sump Pan**

Apply a 2-mm [1/16-in] bead of sealant, Part Number 3823494, to the oil pan mounting surfaces at the cylinder block to gear housing joint (1) and flywheel housing to cylinder block joint (2).



Install new o-rings on the oil transfer tube.
Use clean 15W-40 oil to lubricate the o-rings.
Install the transfer tube in the oil pan.

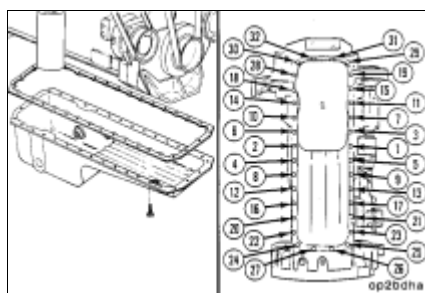


Be sure the transfer tube is aligned with the cylinder block suction tube hole when installing the oil pan.

Use a new gasket, and install the oil pan.

Install and tighten the capscrews in the sequence shown.

Torque Value: 47 N•m [35 ft-lb]

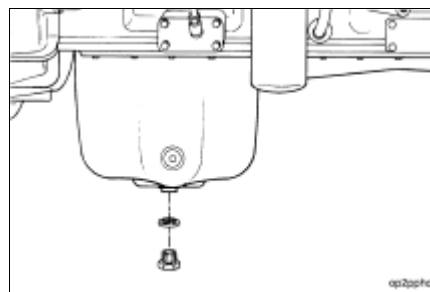
**Fill**

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

Install the oil drain plug in the lubricating oil pan.

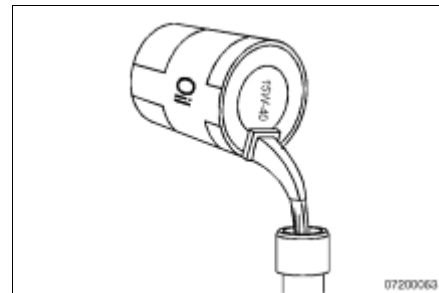
Torque Value: 88 N•m [65 ft-lb]

NOTE: Check the torque of the side and bottom drain plug to be sure both are tight.



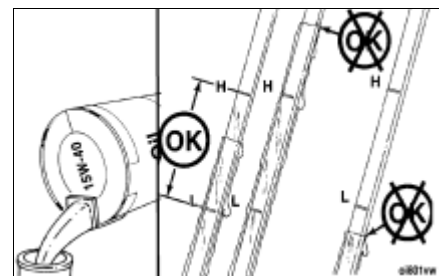
Lubricating Oil Pan Removal/Installation (Cont)

Fill the engine with clean 15W-40 oil. Choose the correct oil for your operating climate as outlined in Section V, in the Operation and Maintenance Manual, ISM Series Engines, Automotive/Transit Buses, Bulletin [3666319](#).



Fill the engine with clean oil to the H (high) mark on the dipstick. Total system capacity including filter is approximately 39 liters [10.3 gal].

The oil pan capacity is 34 liters [9 gal].

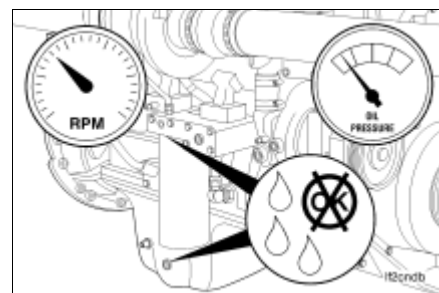


Follow-Up



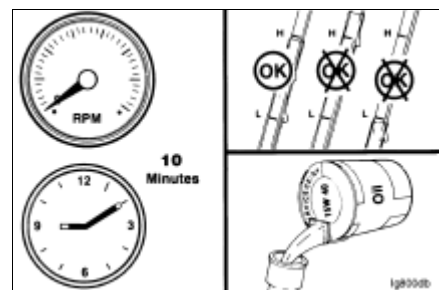
Engine oil pressure must be indicated on the gauge within 15 seconds after starting. If oil pressure is not registered within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level in the oil pan.

Operate the engine at idle speed to inspect for leaks at the filter(s) and the drain plug.



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

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

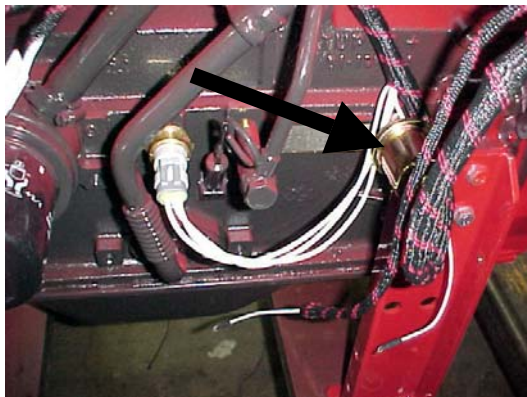


Oil Pressure Sender Removal/Installation

Prepare

Remove

Disconnect the oil pressure sensor wiring.
Remove the sender.



Install

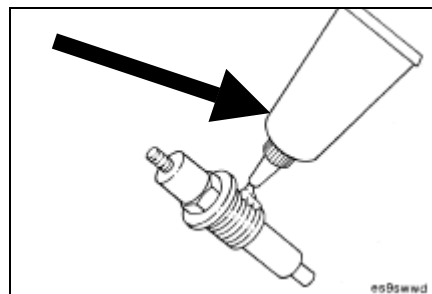
NOTE: Apply liquid teflon sealant to the threads when installing the temperature sensor.

Install the temperature sensor.

Torque Value:

- (Cast Iron) 50 N•m [37 ft-lb]
- (Aluminum) 30 N•m [22 ft-lb]

Reconnect the wiring.



Follow-Up

Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

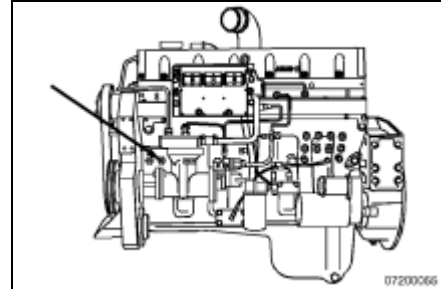


Oil Pressure Gauge Test

Prepare

Remove

The combination oil pressure and oil temperature sensor is located on the engine block directly above the accessory drive.

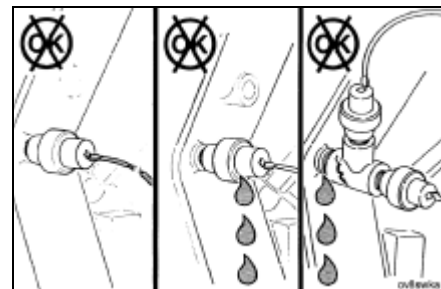


Check the following for defects:

Electrical wiring broken

Sending unit malfunction

Plumbing loose or broken



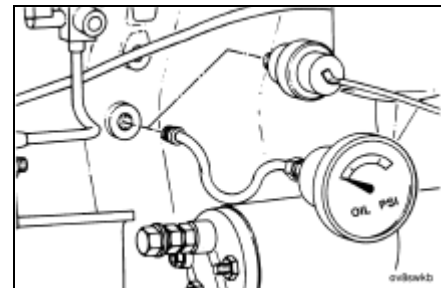
To check for a sending unit malfunction:

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

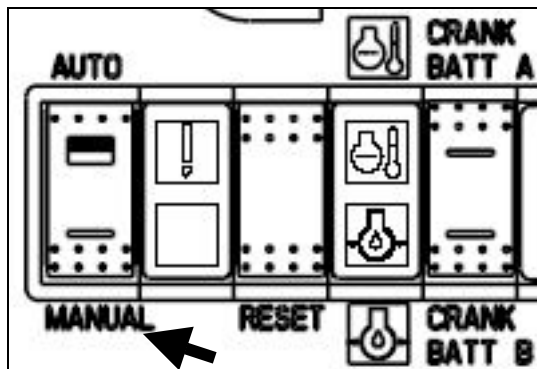
Oil Pressure Gauge Removal/Installation

Prepare

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



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



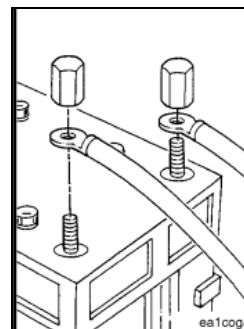
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.



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

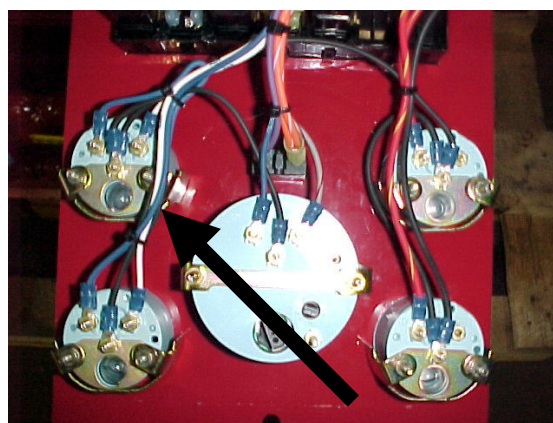
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for electrical schematic details.

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

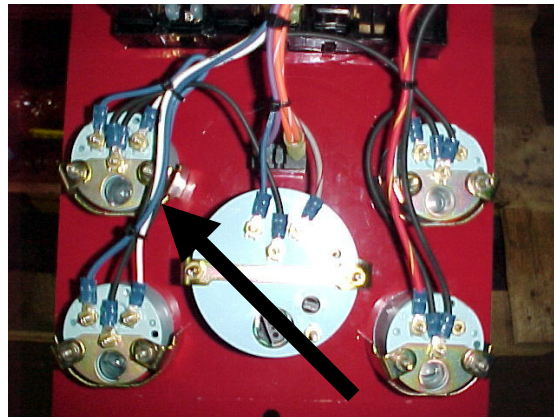
Orient the gauge in the cutout in the electrical panel.

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.

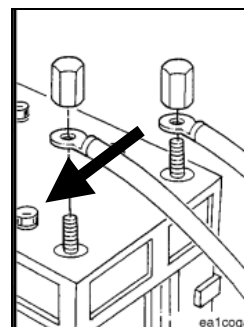


Follow-up

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

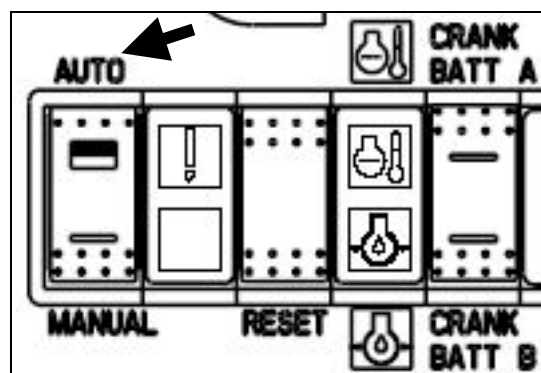
Wear safety glasses when reconnecting batteries!

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

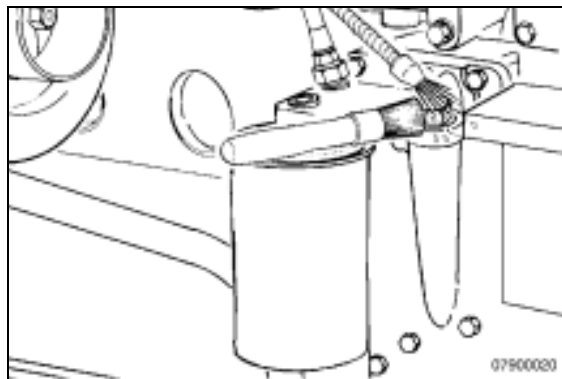
Remove



WARNING

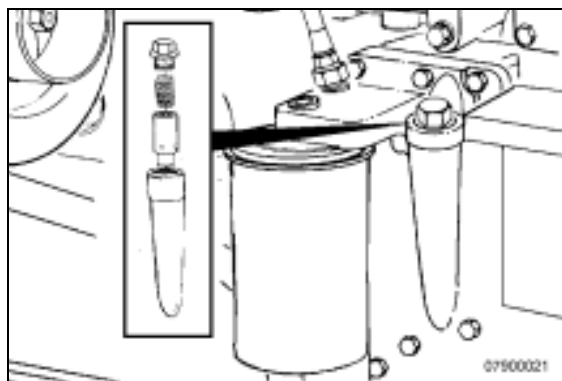
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to prevent personal injury.

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



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.

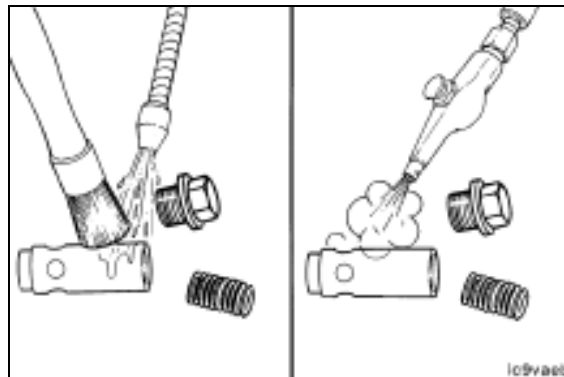


Compressed air used for cleaning/drying should not exceed 207 kPa [30 psi]. Use only with protective clothing and goggles.

Use solvent to clean the spring, plunger, plug, washer, and pressure regulator valve housing.

Dry the parts with compressed air.

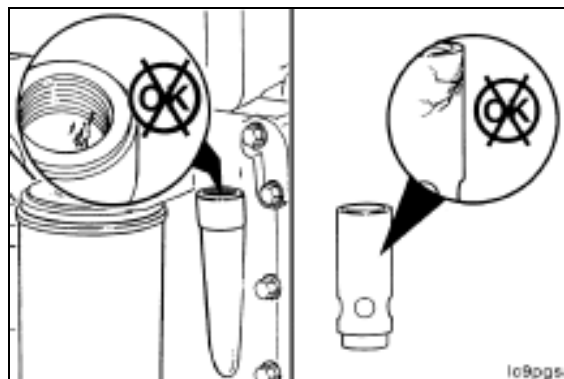
NOTE: If the plunger bore requires cleaning, remove the housing so as not to flush debris into the engine.



Inspect for Reuse

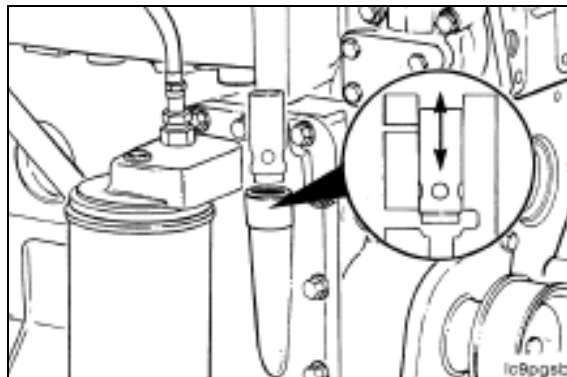
Inspect the plunger and plunger bore for nicks or scratches.

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.

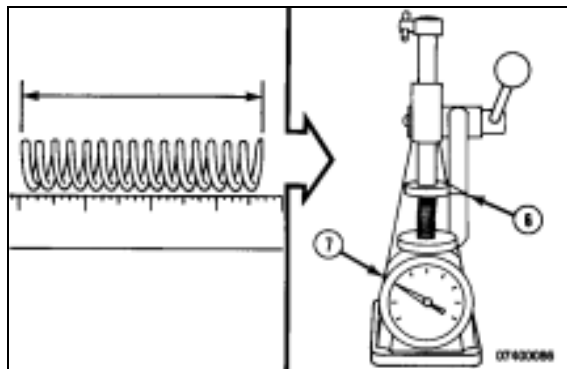


Measure the pressure regulator spring at the following heights.

**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.

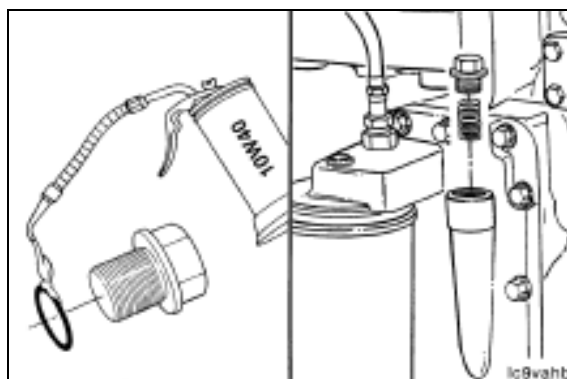
**Install**

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

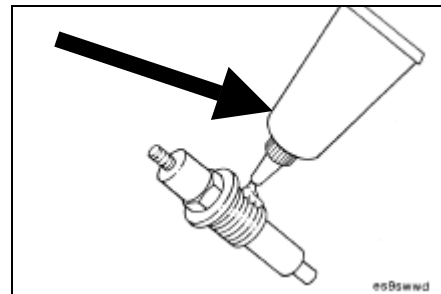
NOTE: Apply liquid teflon sealant to the threads when installing the temperature switch.

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.

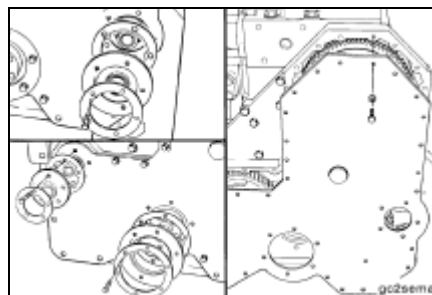
Check for leaks. Repair any leaks.



Lubricating Oil Pump Removal/Installation

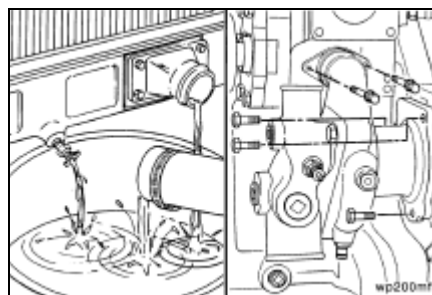
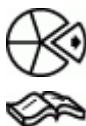
Prepare

Remove the gear cover. Refer to Procedure [001-031](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



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 (Cummins Fire Power Part No. 11407). 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.

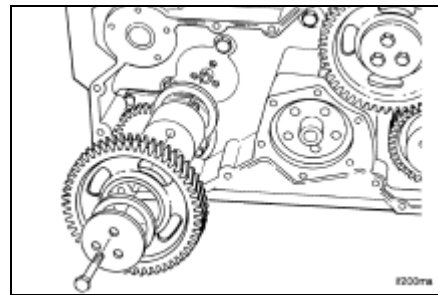
The water pump must be removed to remove the water pump idler gear.

Drain the cooling system. Refer to Procedure [008-018](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Remove the water pump. Refer to Procedure [008-062](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Lubricating Oil Pump Removal/Installation (Cont)

Remove the water pump idler gear. Refer to Procedure [001-040](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



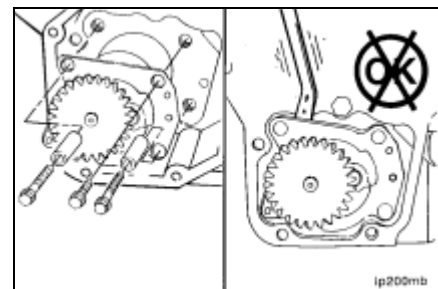
Remove



Do not pry on the gear or pump flange. This can result in damage to the pump.

Remove the three mounting capscrews and spacers.

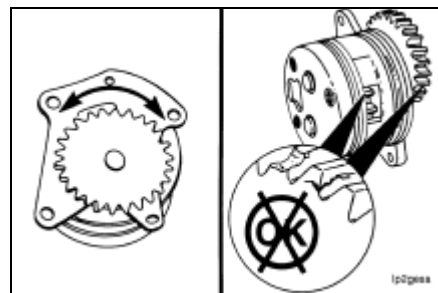
Use both hands to pull, or insert, two capscrews (M8 X 1.25) into the puller holes to push the pump from the engine.



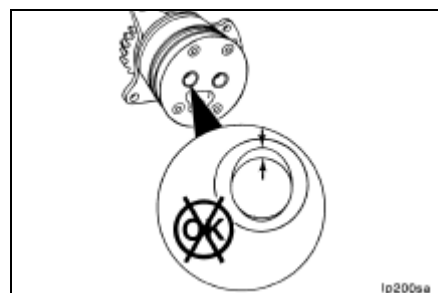
Inspect for Reuse

Turn the main drive gear by hand to check the gears for freedom of rotation.

Inspect the gears for cracked, worn, or broken teeth.



Inspect the rear cover plate shaft bores for excessive wear or discoloration due to overheating or shaft seizure.



Lubricating Oil Pump Removal/Installation (Cont)

Measure the driveshaft and driven shaft end clearance.

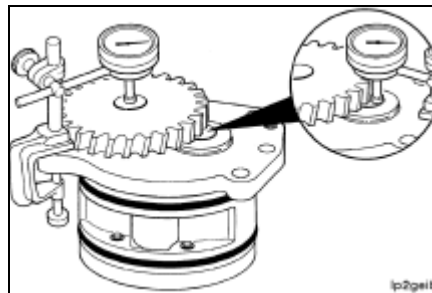


Driveshaft End Clearance

Minimum 0.064 mm [0.0025 in]

Maximum 0.269 mm [0.0106 in]

If the gears are damaged, the shaft does not turn freely by hand, or the end clearance is not within the specifications given, the oil pump must be replaced.



Install



WARNING

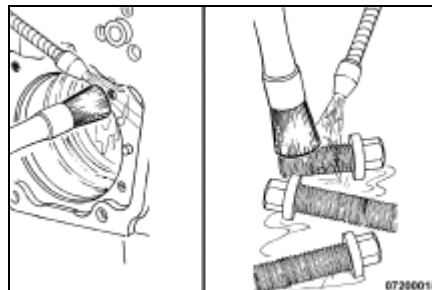
When using solvents, acids, or alkaline materials for cleaning, follow the manufacturer's recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.



WARNING

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

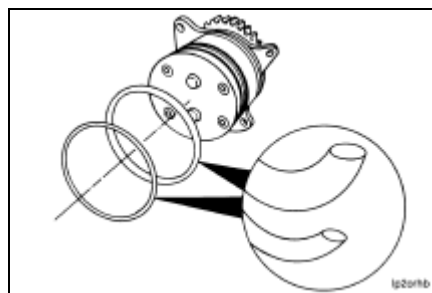
Clean the threaded lubricating pump mounting holes in the cylinder block and capscrew threads with solvent. Dry with compressed air.



Do not lubricate the two oil pump body o-rings. The o-rings will swell, and the pump can not be installed.

Install two new o-rings on the oil pump body.

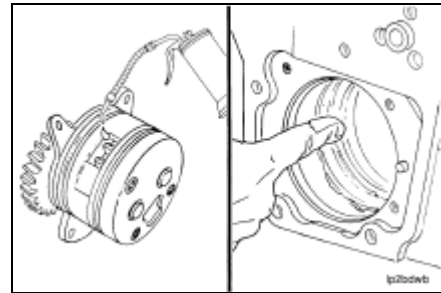
Install the thickest o-ring into the groove nearest the oil pump drive gear.



Lubricating Oil Pump Removal/Installation (Cont)

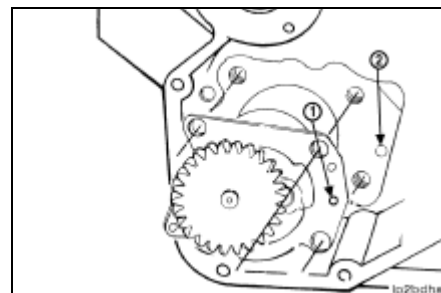
Use clean 15W-40 oil to lubricate the oil pump gears.

Apply a film of grease to the oil pump bore in the cylinder block.



The dowel pin bore in the oil pump flange (1) must be aligned with the dowel pin in the cylinder block (2) to prevent damage to the oil pump flange during installation. Do not use the mounting capscrews to pull the oil pump into the bore. This can damage the mounting flange of the oil pump.

Install the oil pump by hand.

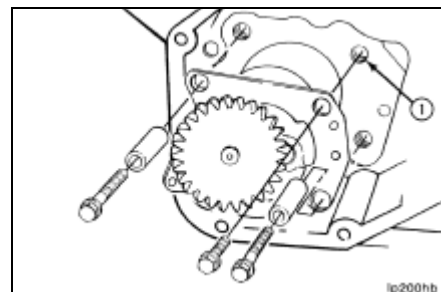


The shorter flange head capscrew must be used in the upper right-hand mounting hole (1) to prevent the idler gear from contacting the head of the capscrew and causing damage to the lubricating oil pump.

Sealant, Part Number 3824038, or equivalent, must be used to coat the threads of the three mounting capscrews to prevent air from being drawn past the capscrews during engine operation.

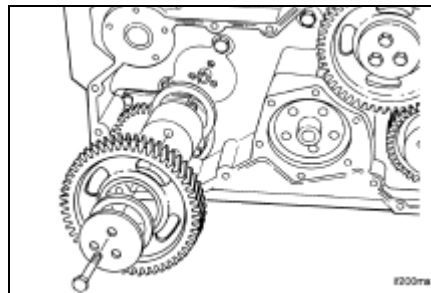
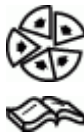
Install the three capscrews and spacers. Use the short flange head capscrew in the upper right hand mounting hole (1). Use the longer flange head capscrews and spacers in the other two holes.

Torque Value: 41 N•m [30 ft-lb]

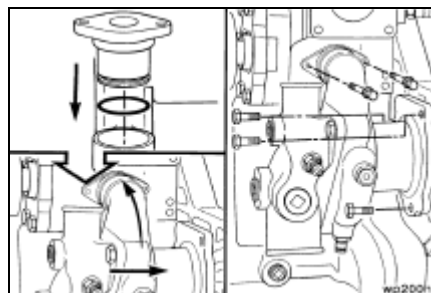


Lubricating Oil Pump Removal/Installation (Cont)**Follow-Up**

Install the water pump idler gear. Refer to Procedure [001-040](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



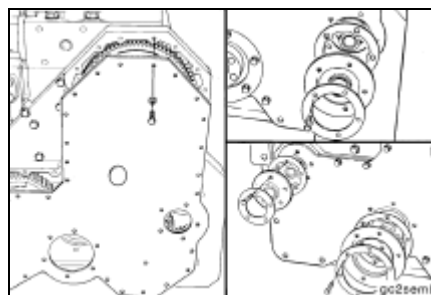
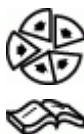
Install the water pump. Refer to Procedure [008-062](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Fill the cooling system. Refer to Procedure [008-018](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



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



Install the gear cover. Refer to Procedure [001-031](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Operate the engine and check for leaks.

Lubricating Oil High Pressure Relief Valve Depth Check

Initial Check

Drain the lubricating oil. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Remove the oil pan. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

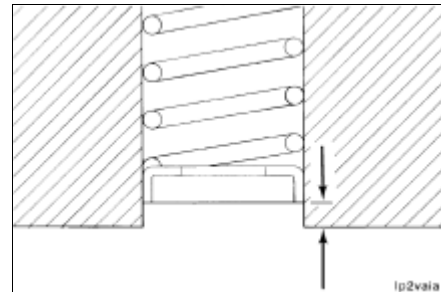
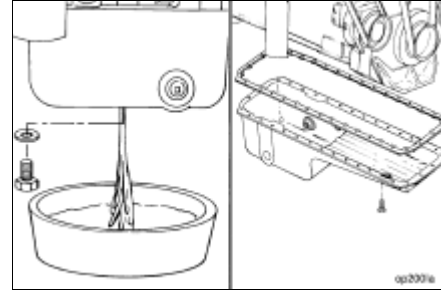
Measure the installed depth of the relief valve retainer cup plug.

Relief Valve Retainer Installed Depth:

Minimum:-8.03 mm-[0.316 in]

Maximum:-8.53 mm-[0.336 in]

NOTE: If the plug depth is not within the specifications given, remove the high-pressure regulator assembly and inspect the parts.



Lubricating Oil High Pressure Relief Valve Removal/Installation

Prepare

Remove

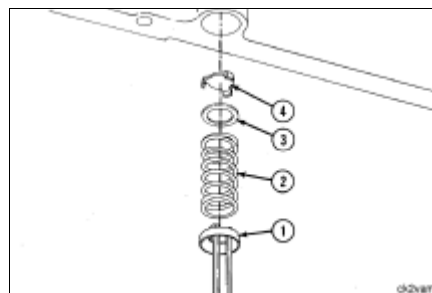


WARNING

Use caution while removing the retainer plug (1). The pressure relief valve spring (2) is under compression. Personal injury can result. Wear face and eye protection.

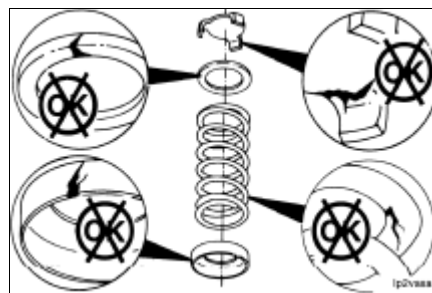
Use light-duty puller kit, Part Number 3375784, or equivalent to remove the retainer plug (1).

Remove the pressure relief valve spring (2), washer (3), and valve disc (4).



Inspect for Reuse

Inspect the parts for damage.



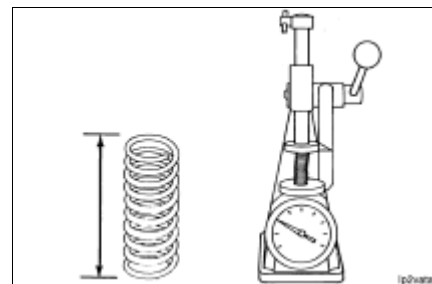
Use a spring compression tester, Part Number 3375182, to measure the relief valve spring tension.

Compress the spring to 29.1-mm [1.15-in] height. The force required to compress the spring must be:

Force Required to Compress Spring to 29.1 mm [1.15 in]:

Minimum:-263 n-[59 lbf]

Maximum:-322 n-[72 lbf]



Lubricating Oil High Pressure Relief Valve Removal/Installation (Cont)

Measure the relief valve seat depth in the cylinder block.

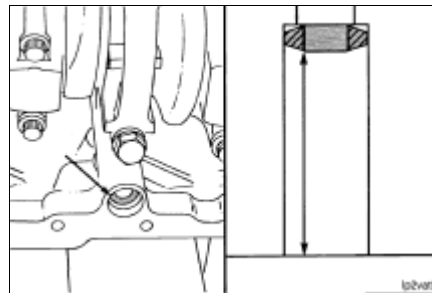
Relief Valve Seat Depth:

Minimum:-62.62 mm-[2.465 in]

Maximum:-63.62 mm-[2.505 in]

If the relief valve seat is not at the specified depth or is loose or not level in the cylinder block, the seat must be removed and inspected. Use puller kit, Part Number 3375784, to remove the seat.

If the seating surfaces are free of indentations, the seat can be reused. If the surfaces have indentations, the seat must be replaced. Use relief valve seat driver, Part Number 3376486, to install the seat.



Install



WARNING

Use caution while installing the retainer plug (1). The pressure relief valve spring (2) is under compression. Personal injury can result. Wear face and eye protection.

Install the valve disc (4), washer (3) and spring (2).

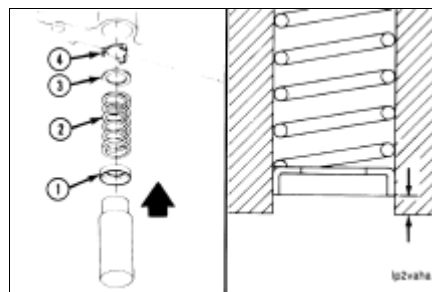
Use flat washers equal to 5 mm [0.197 in] with plug driver, Part Number 3376489, to install the new retainer cup plug (1).

Measure the retainer plug depth in the cylinder block.

Relief Valve Retainer Installed Depth:

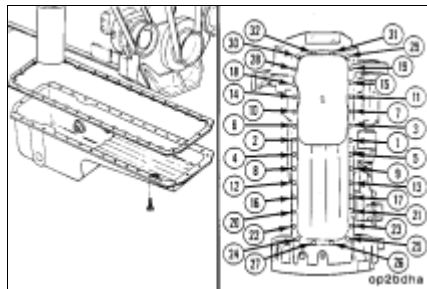
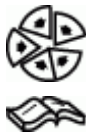
Minimum:-8.03 mm-[0.316 in]

Maximum:-8.53 mm-[0.336 in]

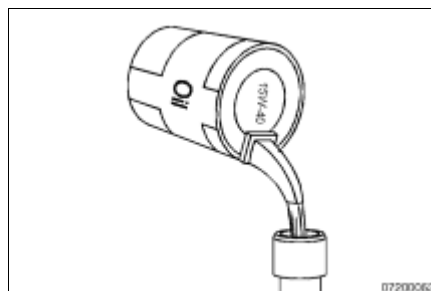


Lubricating Oil High Pressure Relief Valve Removal/Installation (Cont)

Install the oil pan. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

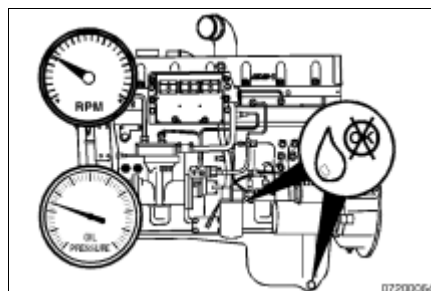


Fill the engine with clean 15W-40 oil. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

**Follow-Up**

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.



Lubricating Oil Leak Check

Prepare

Check



WARNING

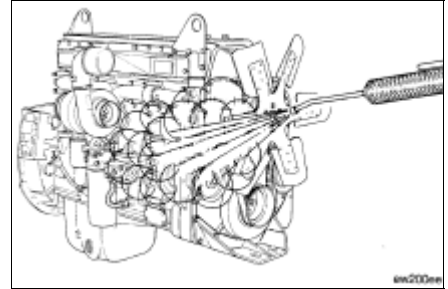
When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.



WARNING

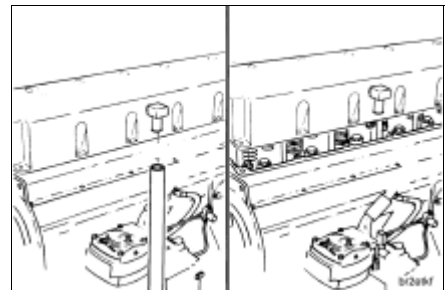
Wear appropriate eye and face protection when using compressed air. Flying debris and dirt can cause personal injury.

Use a steam cleaner or high-pressure washer to clean the engine. Dry with compressed air.

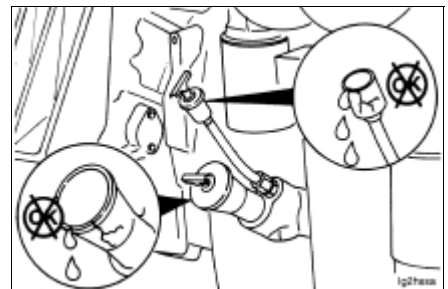


Inspect the internal crankcase breather, hose, and tube for restriction. Refer to Procedure [003-002](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

The rocker lever housing cover must be removed to inspect the internal engine crankcase breather.



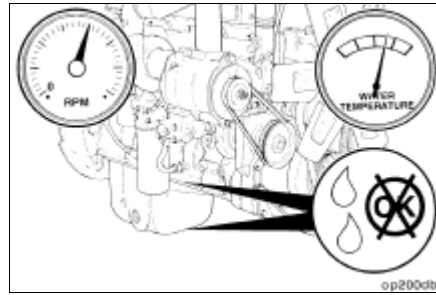
Check for a loose, damaged or missing oil dipstick tube, dipstick, or oil filler cap.



Lubricating Oil Leak Check (Cont)

Operate the engine to normal operating temperature, and inspect the exterior of the engine for leaking gaskets, seals, o-rings, pipe plugs, or fittings.

NOTE: Before replacing any gaskets, check the capscrews to be sure they are tightened to the correct torque values. Refer to Section V for the specific component capscrew torque specifications.



Follow-Up

Lubricating Oil and Filter Analysis

Prepare

Change filter and oil. Refer to instructions in this section.

Take lubricating oil sample and send to Cummins N Power.

Inspect lubricating oil filter.

Analyze Oil

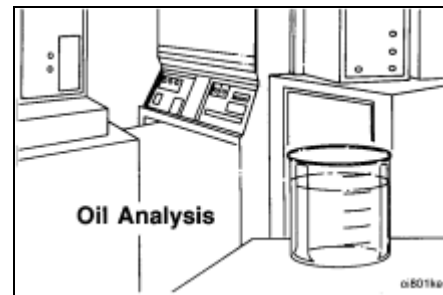
A used oil analysis can help diagnose internal damage and determine the cause, such as one of the following:

Intake air filter malfunction

Coolant leaks

Oil diluted with fuel

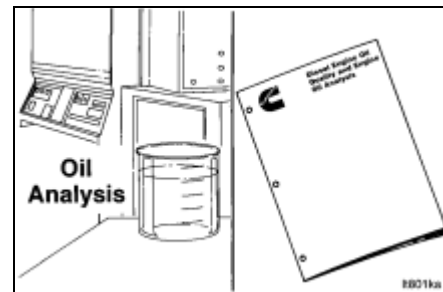
Metal particles causing wear.



NOTE: Do not disassemble an engine for repair based only on the results of an oil analysis. Inspect the oil filters also. If the oil filter shows evidence of internal damage, find the source of the problem and repair the damage. See the appropriate section(s) of this manual based on the following oil filter inspection.



For additional oil analysis information, refer to Cummins Engine Oil Recommendations, Bulletin 3810340.



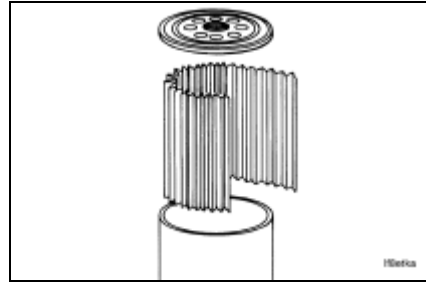
Metal	Possible Source
Copper	Bearings and Bushings
Chromium	Piston Rings
Iron	Cylinder Liners, Overhead Components
Lead	Bearing Overlay Material
Aluminum	Piston Wear or Scuffing

Lubricating Oil and Filter Analysis (Cont)

Inspect Filter

Use tube cutter, Part Number 3376579, to open the combination oil filter.

Inspect the filter element for evidence of moisture or metal particles.



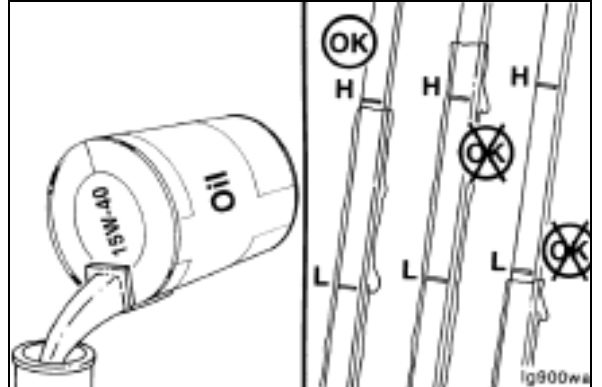
Follow-Up

Perform corrective actions as appropriate to the observations.

Check Oil Level

Fill the engine with clean lubricating oil to the proper level.

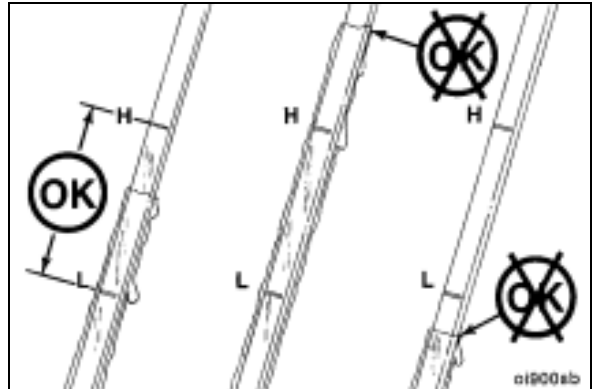
Idle the engine to inspect for leaks at the drain plug.



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 as 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.

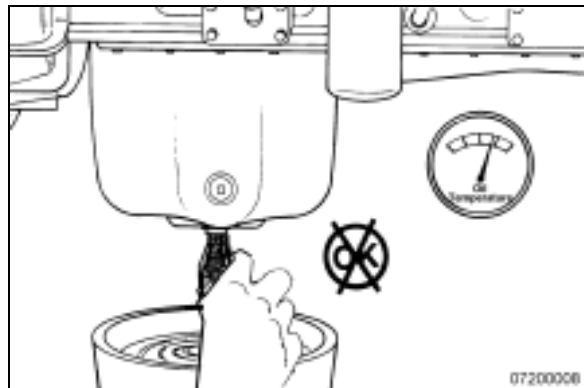


WARNING

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.



07200006

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.



pl800gb

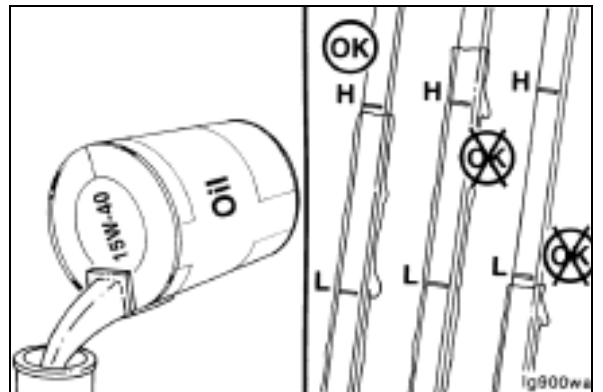
Drain and Fill Lubricating Oil (Cont)

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.

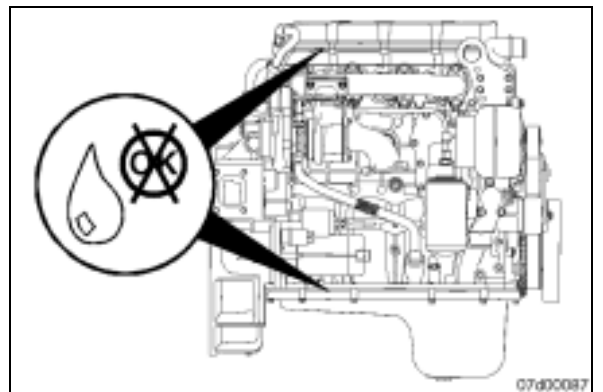
NOTE: If the engine is not equipped with a side-fill, wait at least 3 minutes before measuring the oil level with the dipstick to allow the oil to drain to the pan.



Idle the engine to inspect for leaks at the drain plug.



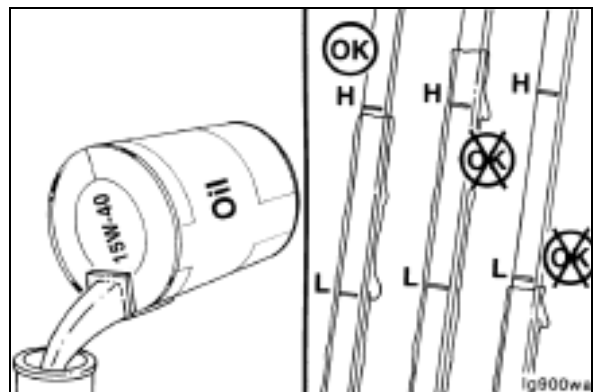
NOTE: Engine oil pressure must be indicated on the gauge within 15 seconds after starting. If oil pressure is not registered within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm that the correct oil level is in the oil pan.



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.

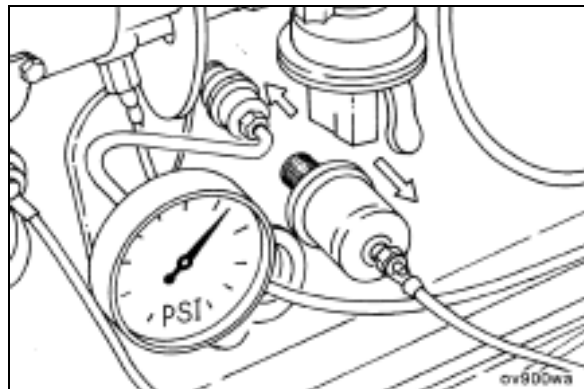
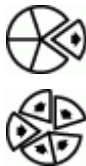


Drain and Fill Lubricating Oil (Cont)**Measure**

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.

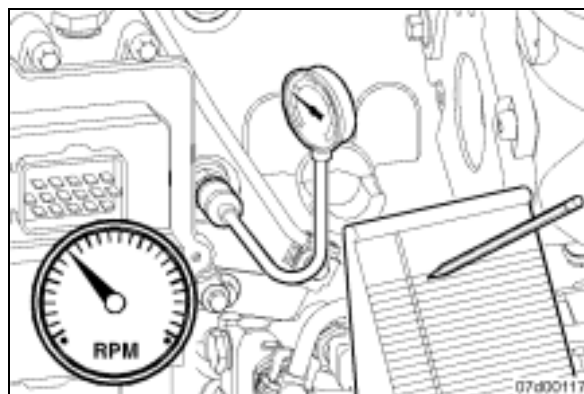


If the lubricating oil pressure does not develop within 15 seconds, shut off the engine to reduce the possibility of internal engine damage.

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]

Lubricating Oil Pressure Regulator Removal/Installation

Prepare

Remove



WARNING

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

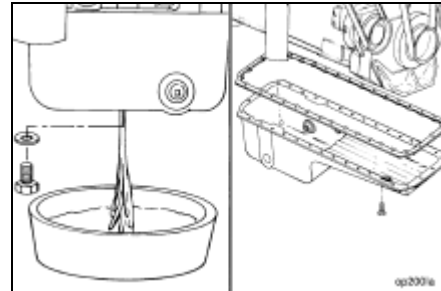


WARNING

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.

Drain the lubricating oil. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Remove the oil pan. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

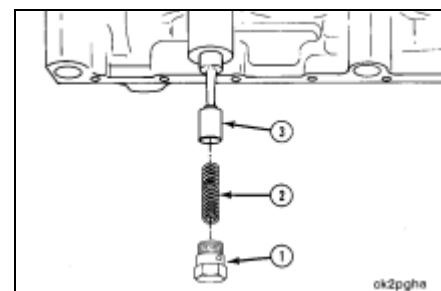


WARNING

Carefully remove the retainer plug. The pressure regulator spring is under compression. Personal injury can result. Wear face and eye protection.

Remove the retainer plug (1), regulator spring (2), and regulator plunger (3).

Remove the orifice from the plunger.



Lubricating Oil Pressure Regulator Removal/Installation (Cont)

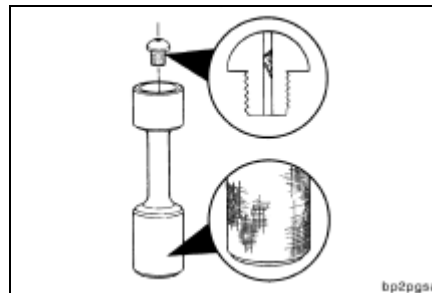
Inspect for Reuse

Inspect the regulator plunger for scratches or scoring. If scratches are deep enough to be felt with a fingernail, the plunger must be replaced.

Check the orifice in the plunger to make sure it is not plugged. If the orifice is plugged, clean it before replacing.

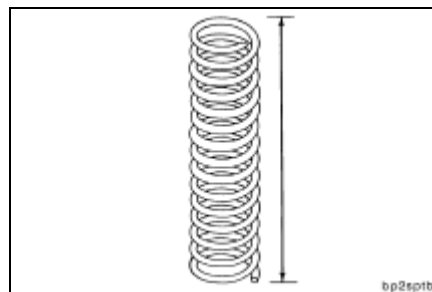
The orifice is threaded into the plunger.

Torque Value: 1 N•m [6 in-lb]



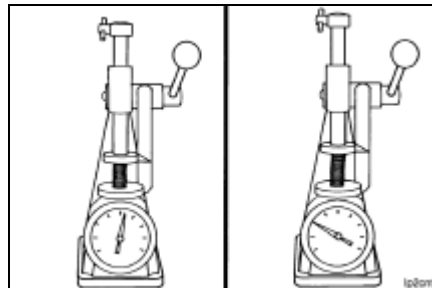
Measure the free length of the regulator spring.

Nominal Regulator Spring Free Length 84.1 mm
[3.31 in]



Use a spring compression tester to determine if the spring is defective.

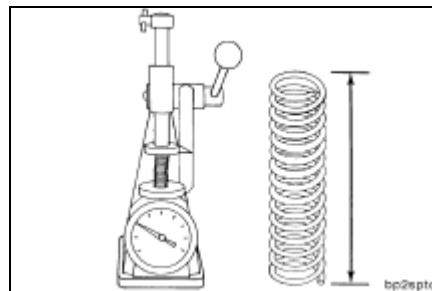
Replace the spring with a new spring if it is defective.



**Main Oil Pressure Regulator Spring Load at
48.3 mm [1.90 in]**

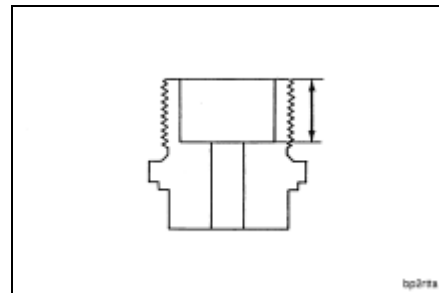
Minimum 91.1 n [20.50 lbf]

Maximum 94.7 n [21.30 lbf]



Lubricating Oil Pressure Regulator Removal/Installation (Cont)

Measure the retainer plug to determine if it is defective. If it does not meet the specification, replace it with a new one.



Main Oil Pressure Regulator Retainer Plug

Minimum 11.1 mm [0.44 in]

Maximum 13.4 mm [0.53 in]

Install



WARNING

The regulator spring must be compressed to install the retainer plug. Personal injury can result. Wear face and eye protection.

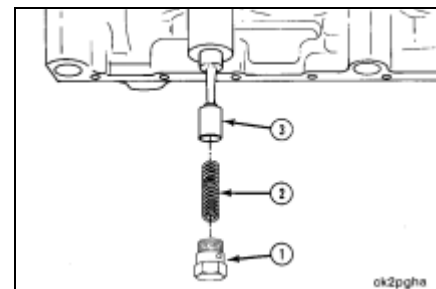
NOTE: A counterbore plunger and orifice is unique to engines with a viscosity sensor. Low oil pressure will result if a solid plunger is used with a viscosity sensor.

Install the regulator plunger (3) and regulator spring (2).

Install and tighten the retainer plug (1).

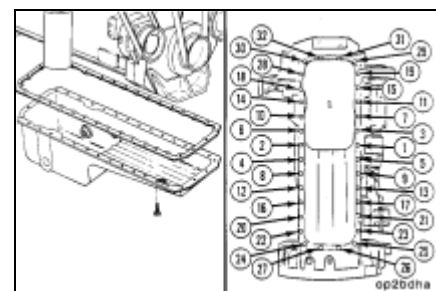
Rear Sump Oil Pan 75 N•m [55 ft-lb]

Front Sump Oil Pan 122 N•m [90 ft-lb]



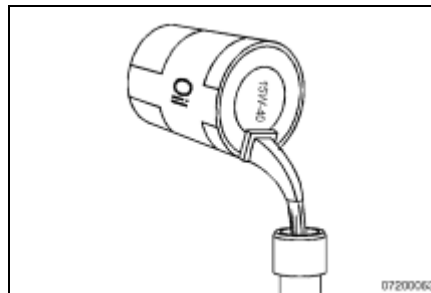
Follow-Up

Install the oil pan. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



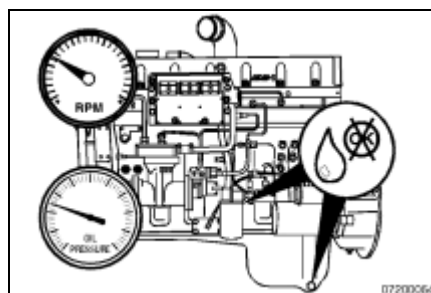
Lubricating Oil Pressure Regulator Removal/Installation (Cont)

Fill the engine with clean 15W-40 oil. Refer to Procedure [007-025](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



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.

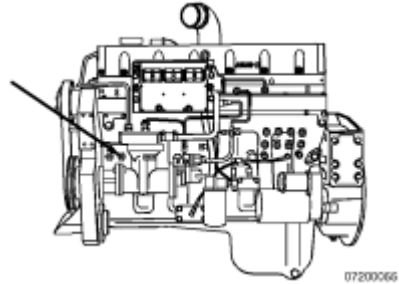


Lubricating Oil Temperature Gauge Test

Prepare

Test

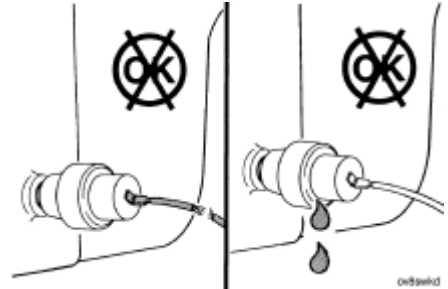
The combination oil pressure and oil temperature sensor is located on the engine block directly above the accessory drive.



Check the following for defects.

Electrical wiring broken

Sending unit malfunction



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



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.

Lubricating Oil Temperature Gauge Test (Cont)

To check for a sending unit malfunction:

Use a master gauge of known accuracy to verify the reading of the suspect gauge.

Drain the oil pan.

Remove the pipe plug on the side of the oil pan, and install the master oil temperature gauge sending unit.

Fill the oil pan with 15W-40 oil.

Replace the sending unit if it is defective.

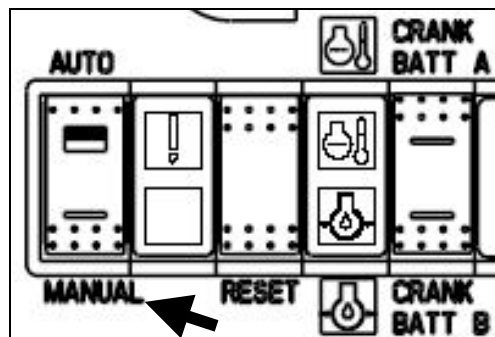
Follow-Up

Speed Sensor or Mag Pick-Up Sensor Removal/Installation

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



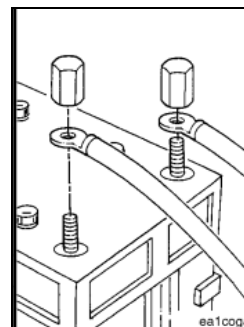
Place the AUTO/MANUAL rocker switch in the MANUAL position.



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.



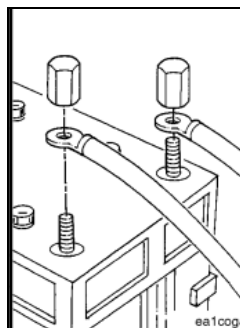
Install the Mag Pick-Up by threading it into the bell-housing until its tip is bottomed out against the flywheel. Then back out the Mag Pick-Up $\frac{1}{2}$ turn. Reconnect the 2-wire cable. Reconnect the batteries.

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!

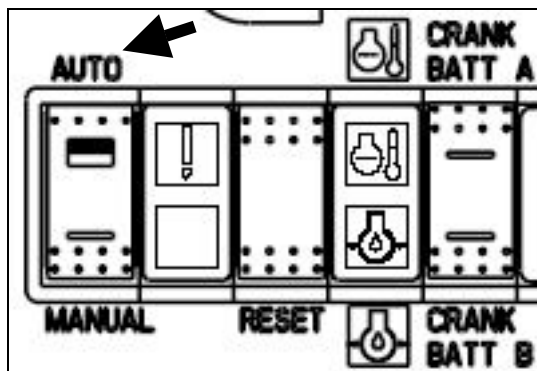
Reconnect the batteries at their terminals after all service work has been completed.



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.

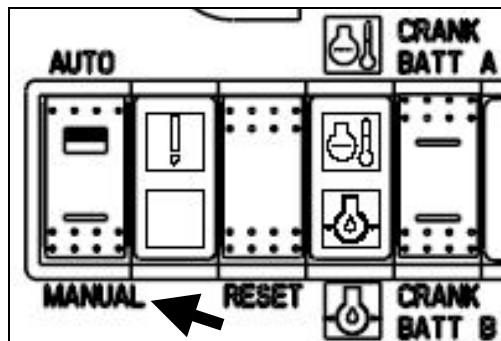


Tachometer Removal/Installation

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



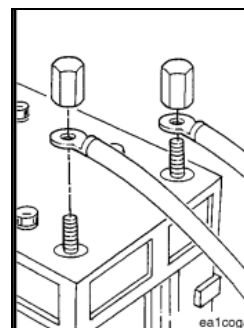
Place the AUTO/MANUAL rocker switch in the MANUAL position.



REMOVE BATTERY POWER BEFORE
SERVICING ENGINE OR CONTROLS.



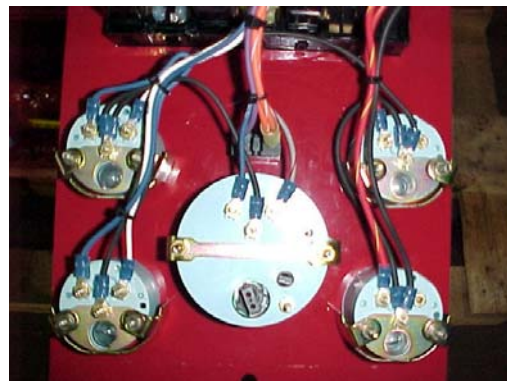
For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.



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.

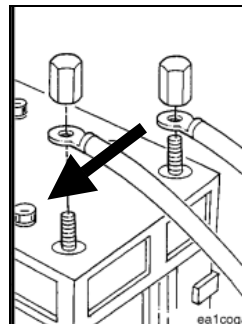
Tachometer Removal/Installation (Cont)

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!

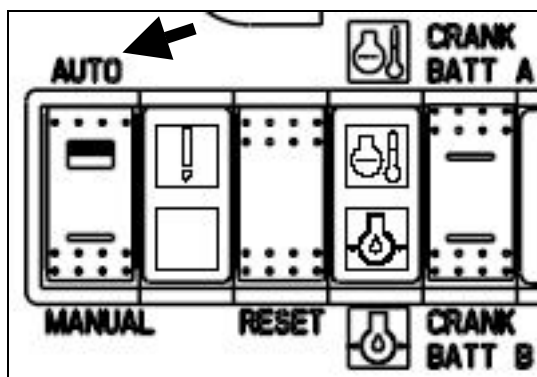
Reconnect the batteries at their terminals after all service work has been completed.



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

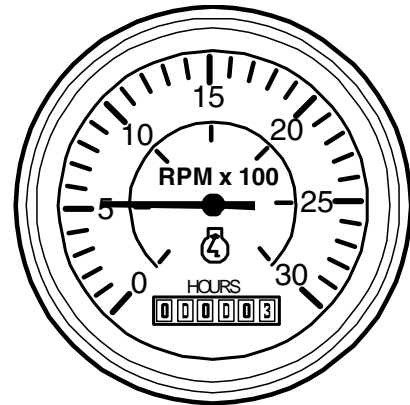


Return the fire protection system controller back to operating status.

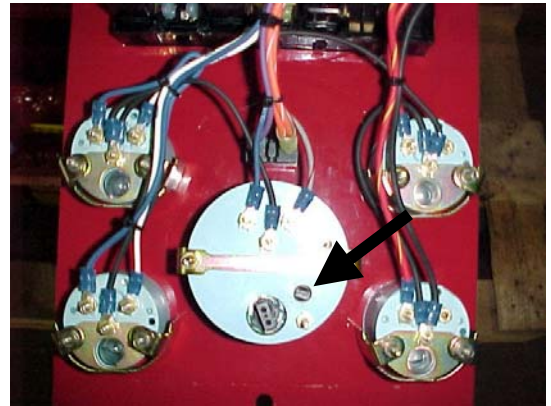


Tachometer Calibration

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.



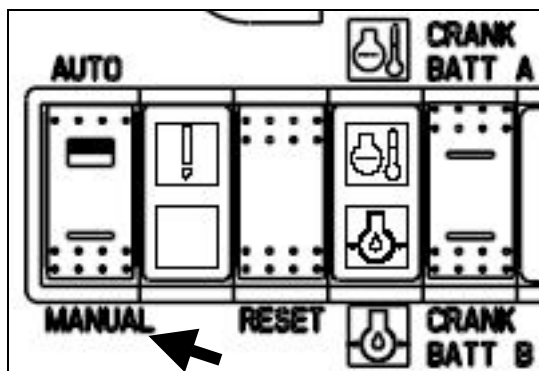
With a small flat-blade screwdriver, turn the trim pot, located on the back of the tachometer, until its indicator agrees with the engine speed.



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.

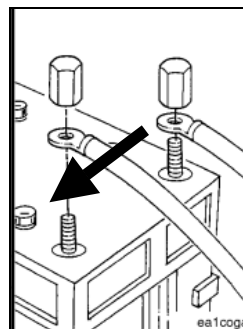


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.

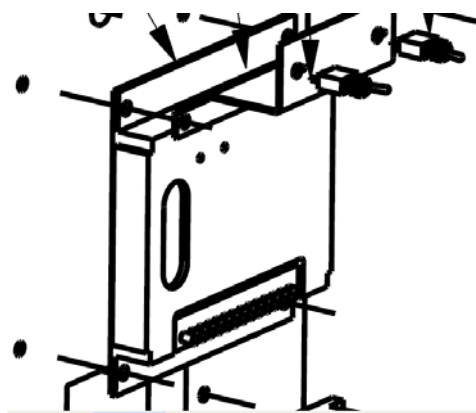
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



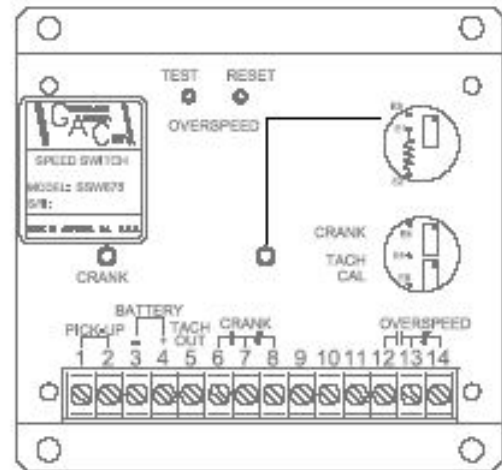
Begin removing the Speed Switch by first documenting the wires that are connected to its terminals. If necessary, place a piece of masking tape on each wire, noting the terminal number that it's connected to.

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.

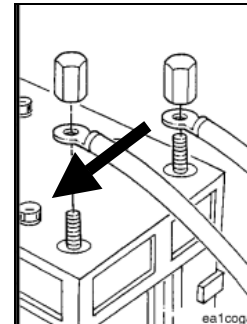


For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.



Wear safety glasses when reconnecting batteries!

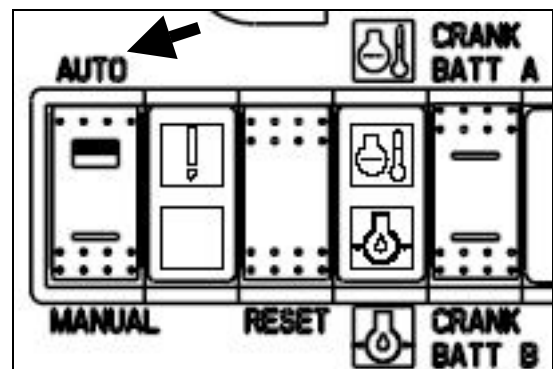
Reconnect the batteries at their terminals after all service work has been completed.



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 Description

- [Base Control System Description](#)
- [Programmable Features](#)
- [Engine Speed Control](#)
- [Diagnostic Fault Codes](#)
- [Fault Code Snapshot Data](#)
- [Circuit Breakers](#)
- [Engine Protection System](#)
- [Illuminated Indicator Symbols](#)

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 Description (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

Electronic Controlled Fuel System Description (Cont)

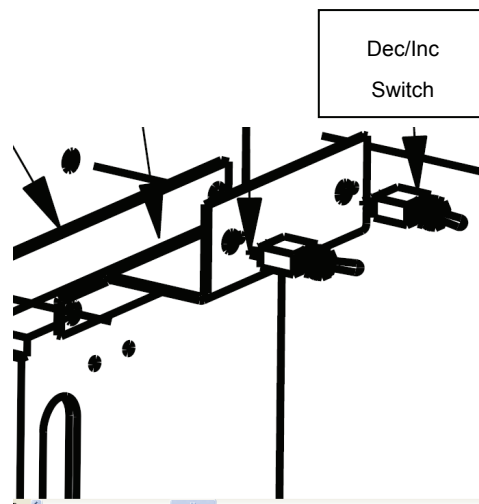
Programmable Features

Engine Speed Control

The engine speed can be increased or decreased with the “INC/DEC” switch, which is located inside the engine control panel.

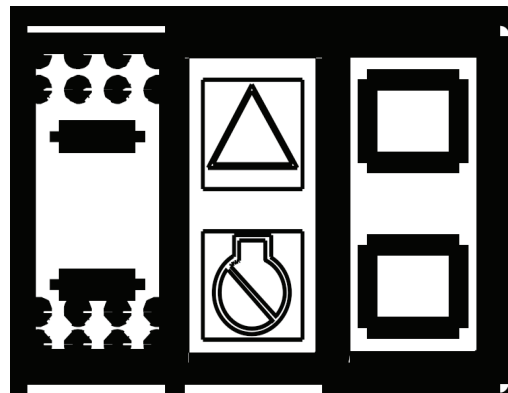
With the engine running, the engine speed can be increased by 25 rpm every time the INC/DEC switch is momentarily switched to the “INC” position. Likewise, the engine speed can be decreased by 25 rpm every time the INC/DEC switch is momentarily switched to the “DEC” position.

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.

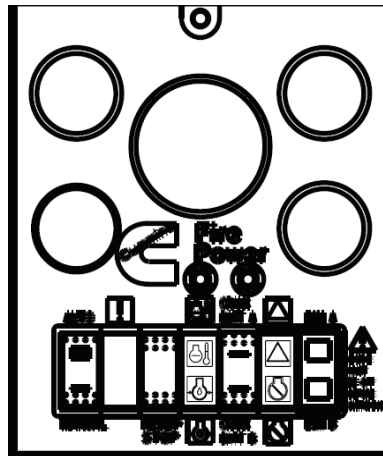


Electronic Controlled Fuel System Description (Cont)

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.

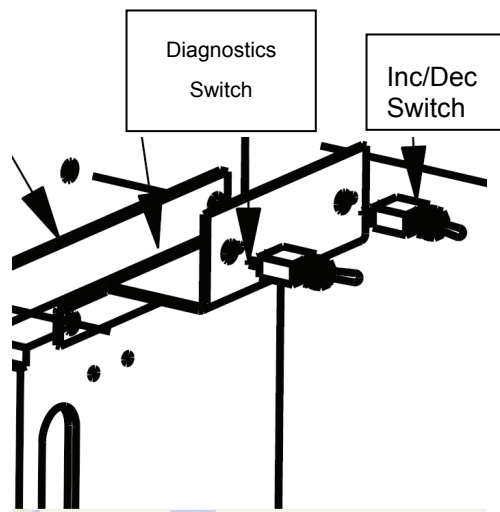


To increment to the next fault code, switch the “INC/DEC” switch to the “INC” position once. If there is another fault code present, then a new code will be blinked out.

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.

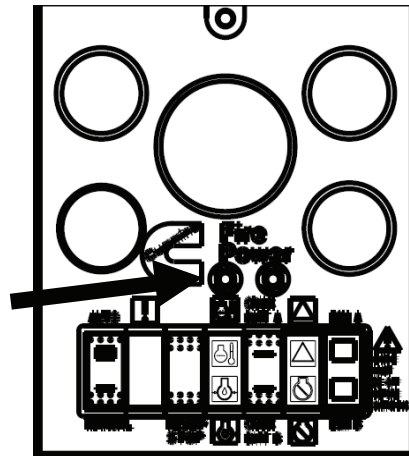
At engine start-up, the ECM conducts a diagnostic test. The yellow and red lamps will light sequentially, remain lit for about 1 second, then turn off.



Electronic Controlled Fuel System Description (Cont)

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.



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:

- 1) Engine Overspeed
- 2) Engine Low Oil Pressure
- 3) Engine High Water Temp
- 4) Alternate ECM
- 5) 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:

Electronic Controlled Fuel System Description (Cont)

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:

- 1) The Overspeed Lamp on the Engine Control Panel will illuminate.
- 2) A HIGH signal (B+) will appear at Terminal #3 on the Engine Terminal Block.

2. 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:

- 1) The Low Oil Pressure Lamp on the Engine Control Panel will illuminate.
- 2) A LOW Signal (gnd) will appear at Terminal #4 on the Engine Terminal Block.

Electronic Controlled Fuel System Description (Cont)

3. 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:

- 1) The High Temperature Lamp on the Engine Control Panel will illuminate.
- 2) A LOW Signal (gnd) will appear at Terminal #5 on the Engine Terminal Block.

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:

- 1) The ECM B Lamp on the Engine Control Panel will illuminate.
- 2) A LOW Signal (gnd) will appear at Terminal # 301 on the Engine Terminal Block.

Electronic Controlled Fuel System Description (Cont)

5. Fuel Injection Failure (FIF)

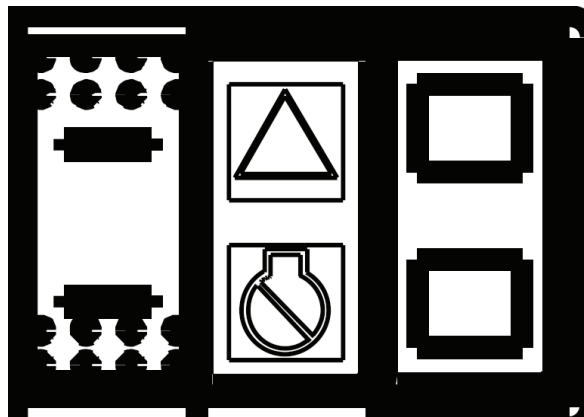
Fuel Injection Failure Annunciation is controlled by the engine ECM. When an FIF condition exists, annunciation will occur as follows:

- 1) The ECM will illuminate the Red engine shutdown lamp on the Engine Control Panel.
- 2) 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.



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.

Electronic Controlled Fuel System Description (Cont)

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, ISM and QSM11 Series Engines, Bulletin 3666322, 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, ISM and QSM11 Series Engines, Bulletin 3666322, for oil pressure specifications.



Service Tools and Hardware – Overview

General Information

Bench Communication Setup

ECM bench calibration base harness (parent cable)

Power supply

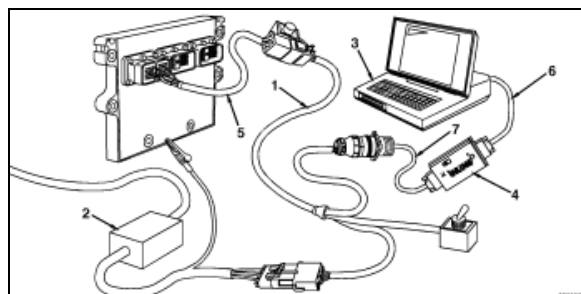
PC with INSITE™

Datalink adapter

ECM-specific calibration cable/ROM boot cable

PC serial cable

Datalink adapter cable

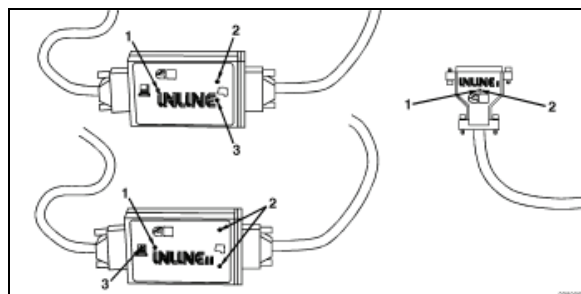


Datalink Adapter Identification Diagram - INLINE™, INLINE™ I, and INLINE™ II

Power light

Communication light

To PC light



Serial Cable Pinout Diagram, Part Number 3824594

Open

Transmit data

Receive data

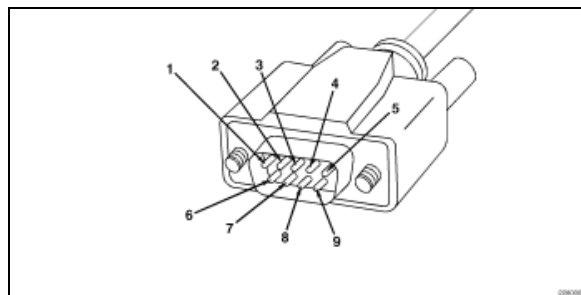
Data terminal ready (+5 VDC)

Signal ground

Open

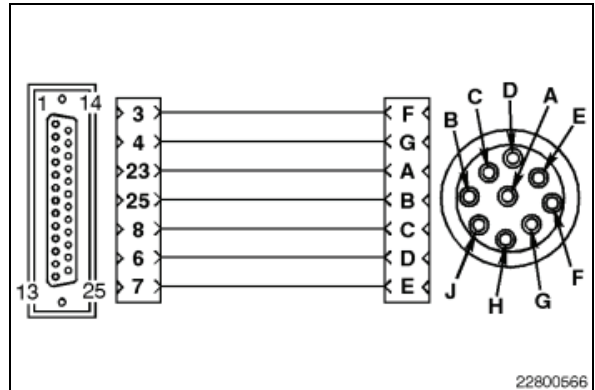
Request to send (+5 VDC)

Clear to send



Service Tools and Hardware – Overview (Cont)

9-Pin Datalink Cable, Part Number 3162848



9-Pin In-Cab Datalink Connector

Ground

Unswitched battery (+)

J1939 datalink (-)

J1939 datalink (+)

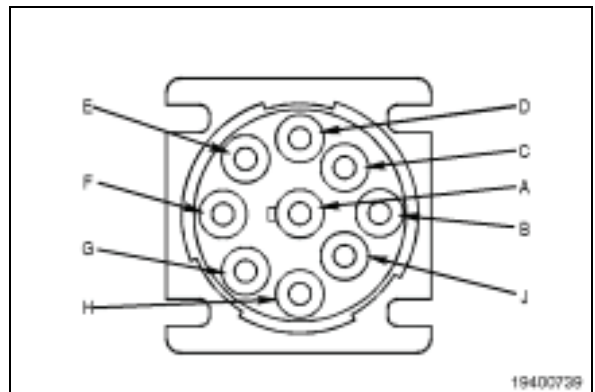
J1939 datalink (shield)

J1708 datalink (+)

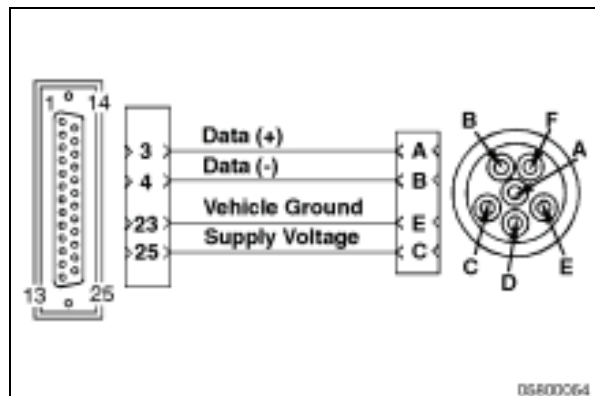
J1708 datalink (+)

Open

Open



6-Pin Datalink Cable, Part Number 3824439



Service Tools and Hardware – Overview (Cont)**6-Pin In-Cab Datalink Connector**

J1708 datalink (+)

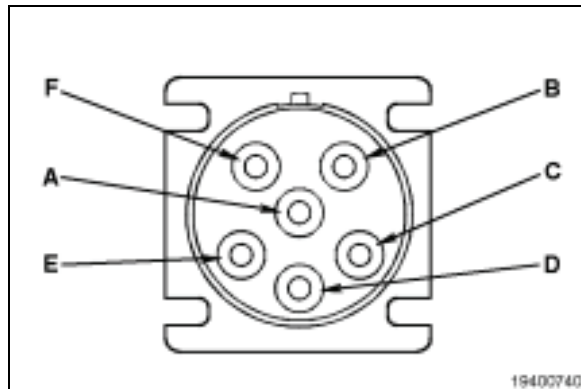
J1708 datalink (-)

Unswitched battery (+)

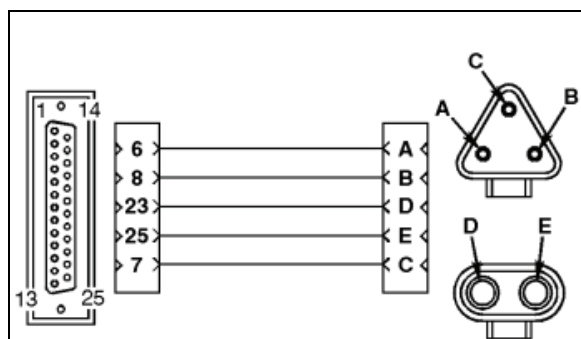
Open

Ground

Open



19400740

3-Pin Datalink Cable, Part Number 3162847

22800668

3-Pin On-Engine Datalink Connector

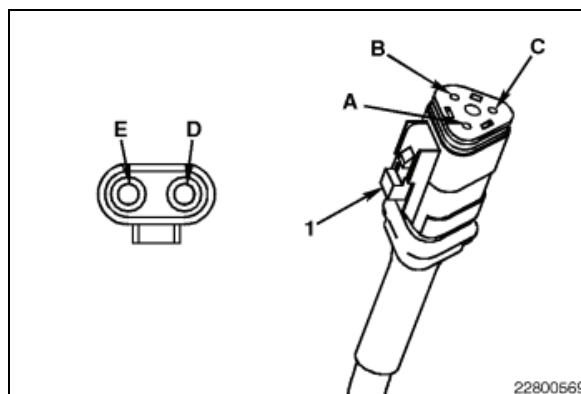
J1939 datalink (+)

J1939 datalink (-)

J1939 datalink (shield)

Ground

Unswitched battery (+).



22800669

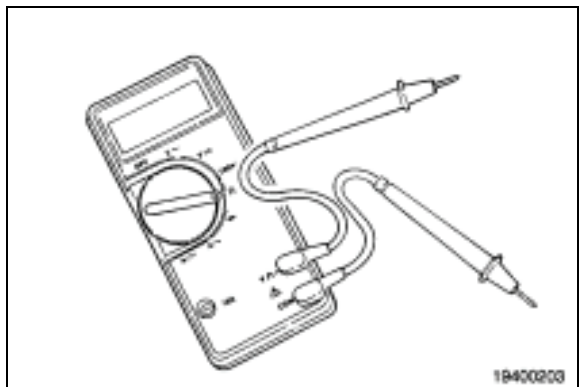
Electronic Engine Controls - Overview

- [How to Use a Multimeter](#)
- [Use of Special Test Leads](#)
- [How to Measure Amperage](#)
- [How to Measure Voltage](#)
- [How to Measure Resistance](#)
- [How to Find the Internal Resistance of the Meter](#)
- [How to Test for Continuity](#)
- [Connector Pins - Checking](#)
- [Bent or Expanded Pins](#)
- [Corroded Pins](#)
- [Pushed Back Pins](#)
- [Short Circuit to Ground - Check](#)
- [Short Circuit from Pin to Pin - Check](#)
- [Voltage Checking](#)
- [Polarity Check](#)
- [Continuity Check](#)
- [Resistance Check - Coil](#)

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.

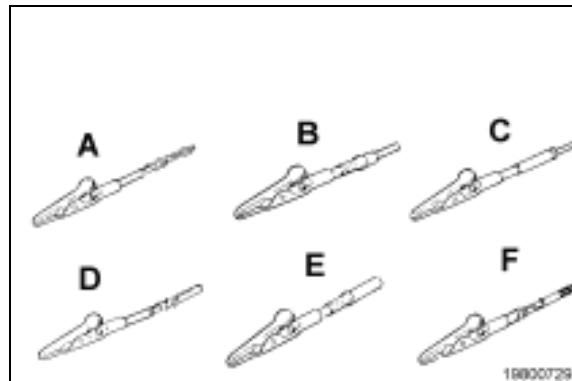


Electronic Engine Controls – Overview (Cont)**Use of Special Test Leads**

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**

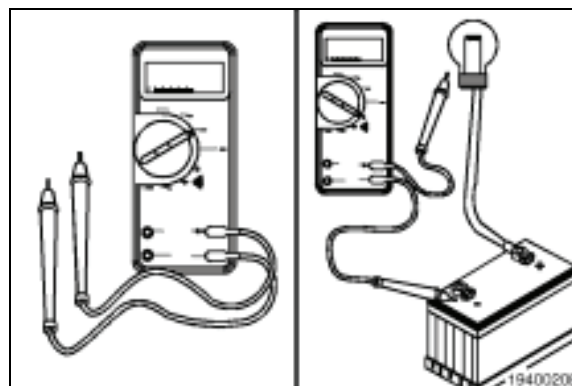
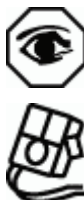
Make an open circuit at the place where the current is to be measured.

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.



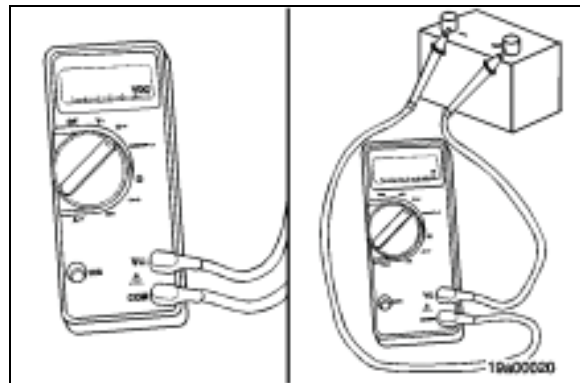
Electronic Engine Controls – Overview (Cont)

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.

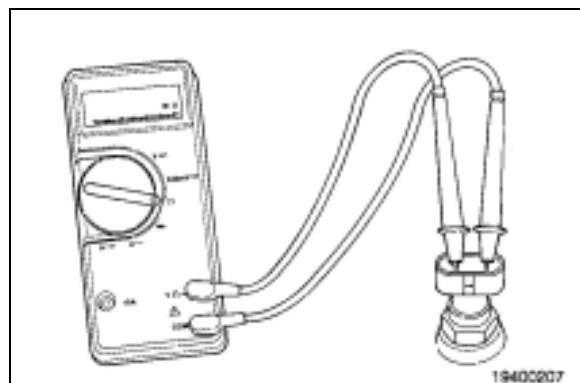


How to Measure Resistance

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

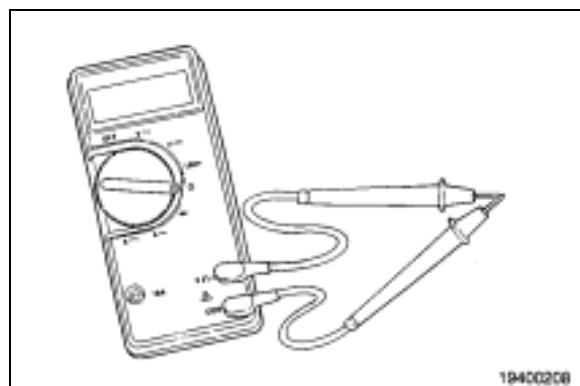
It is important to know the internal resistance of the meter when measuring small resistances. To measure small resistances accurately, the internal resistance of the meter must be subtracted from the measured resistance.

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)

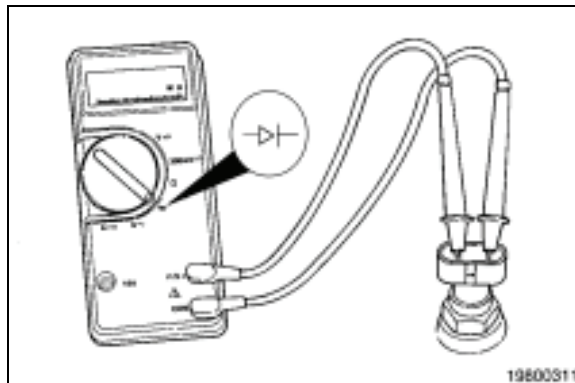
How to Test for Continuity

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.

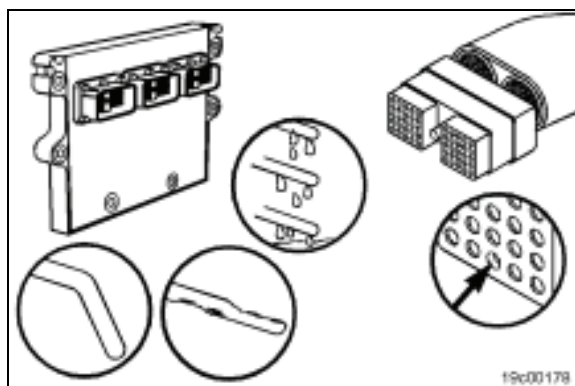


Connector Pins – Checking

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.

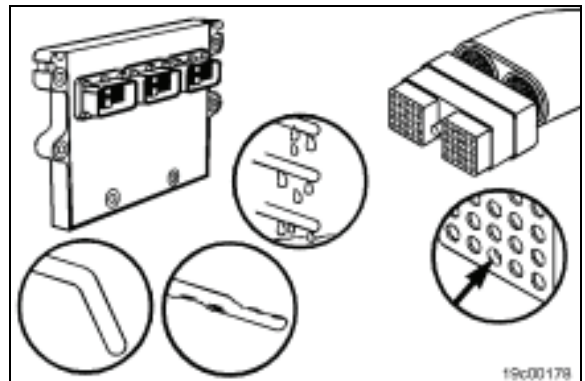
NOTE: Do not blow compressed air in the ECM ports or connector. Compressed air can contain moisture due to condensation.



Electronic Engine Controls – Overview (Cont)

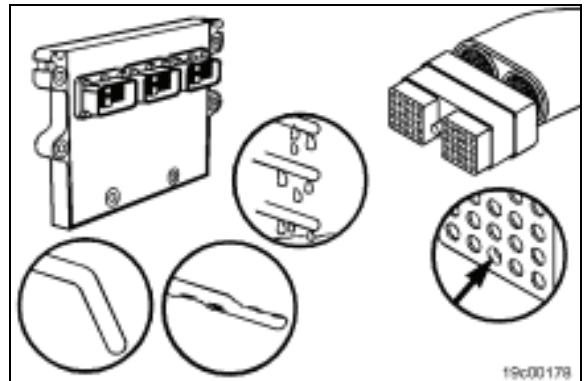
Bent or Expanded Pins

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.



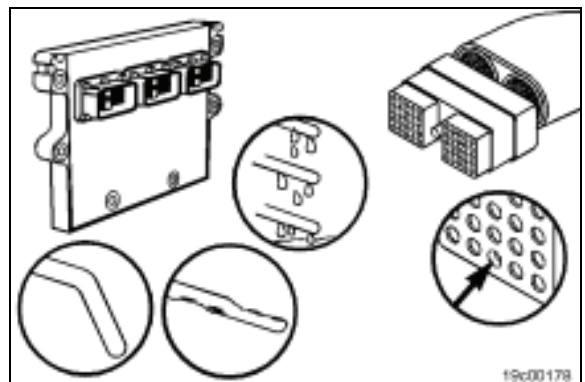
Corroded Pins

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)

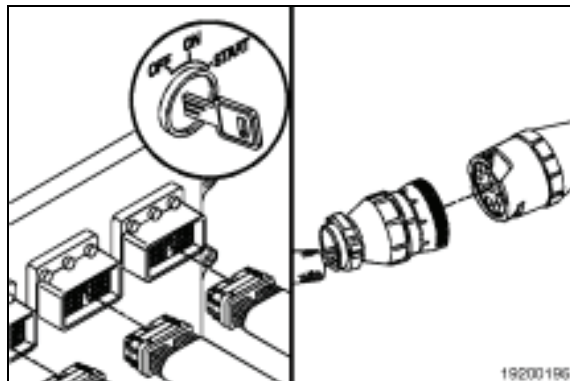
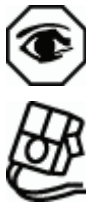
Short Circuit to Ground - Check

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.



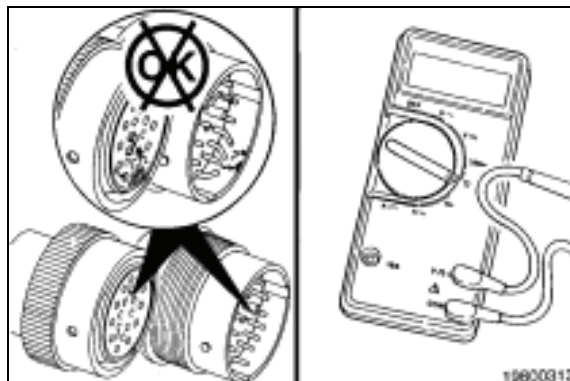
When testing a sensor, only the sensor connection is required to be disconnected.

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.

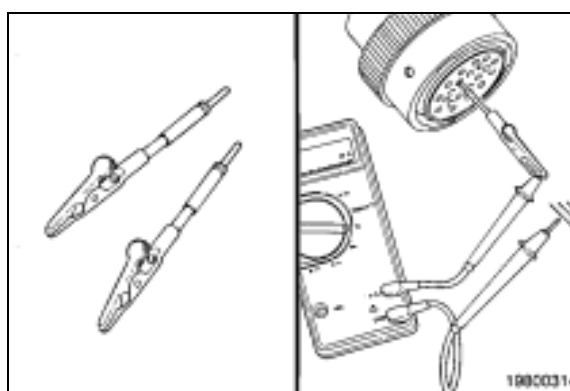
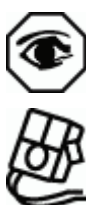


Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

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.

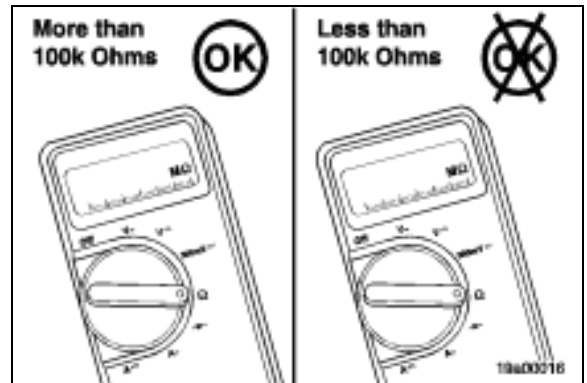


Electronic Engine Controls – Overview (Cont)

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.

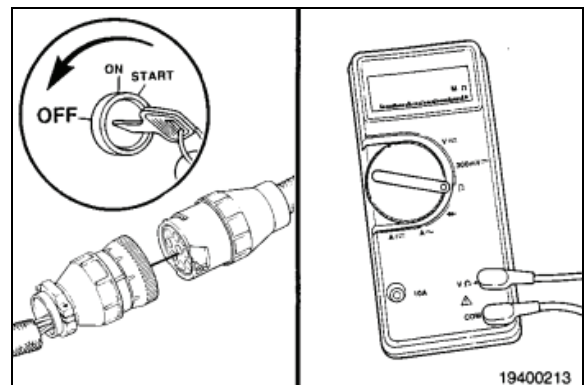
The procedure for checking short circuit from pin to pin is as follows:

Turn keyswitch OFF.

Disconnect the connector that are to be tested.

Identify the pins that are to be tested.

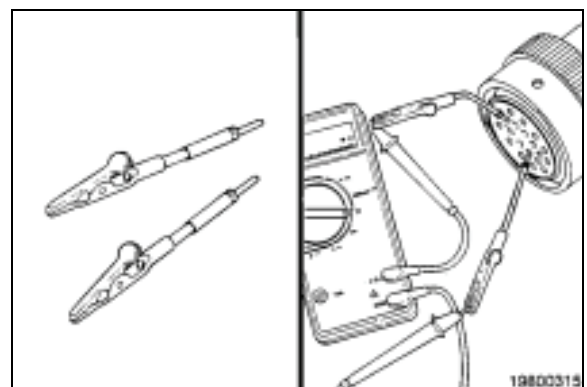
Adjust the multimeter to measure resistance.



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.

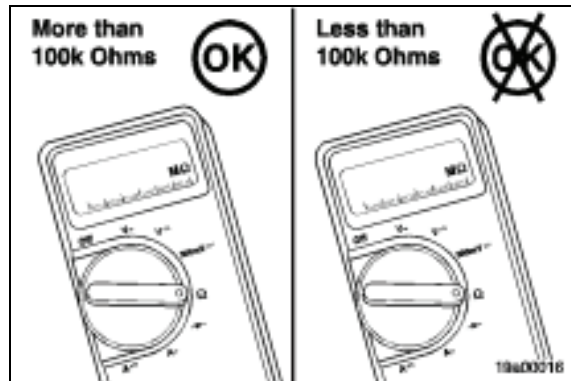
The multimeter must read greater than 100k ohms, which is an open circuit.

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.

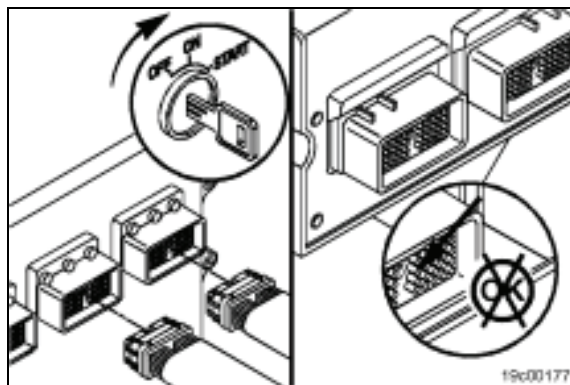
The procedure for checking voltage is as follows:

Disconnect the connectors that are to be tested.

Turn keyswitch ON.

Identify the pins that are to be tested.

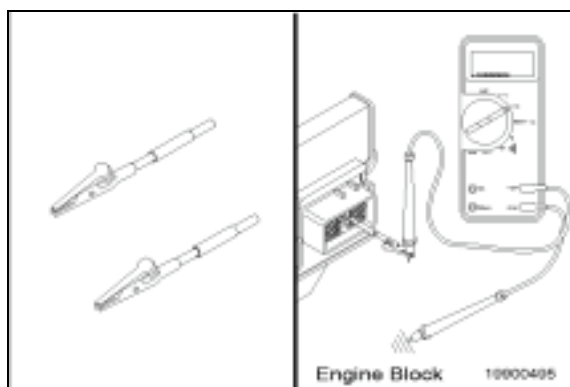
Adjust the multimeter to AC voltage (V+) or DC voltage (V-).



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.

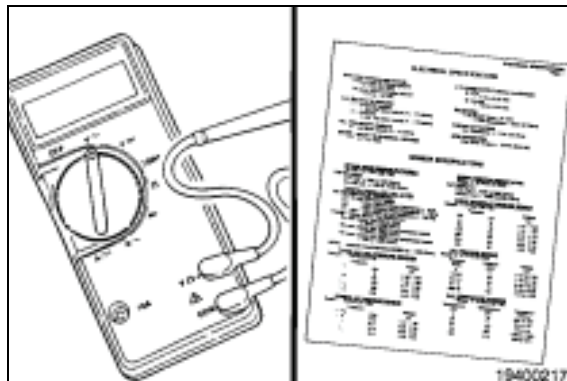
Touch the other multimeter probe to a clean, unpainted surface on the engine block or to the appropriate return pin.



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.

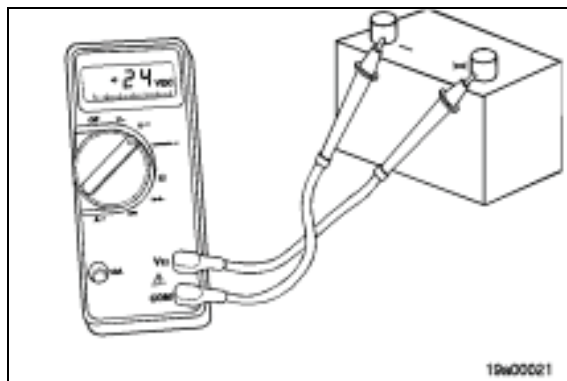
If the measured value falls outside of the
specified range, check the repair procedure for
the electrical system that is being checked for
the appropriate action.



Polarity Check

A battery will be used as an example to check
polarity of a circuit.

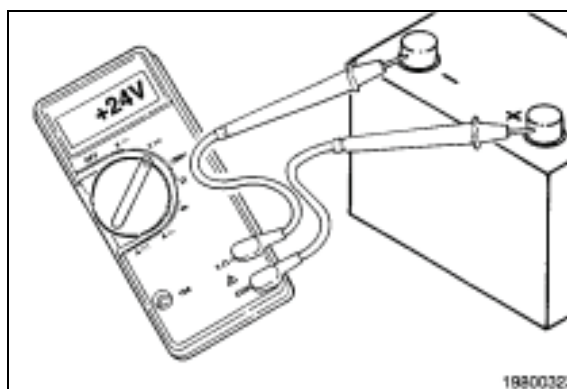
The terminals of a battery are marked for
polarity. The multimeter displays the voltage
difference of the positive (+) probe (red) to the
negative (-) probe (black).



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.

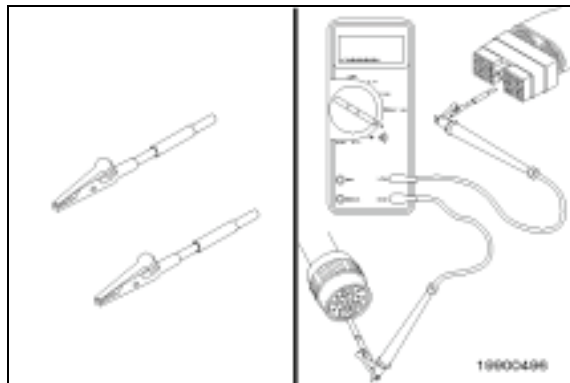
If the multimeter probes are reversed, the
multimeter displays negative voltage.



Electronic Engine Controls – Overview (Cont)**Continuity Check**

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.

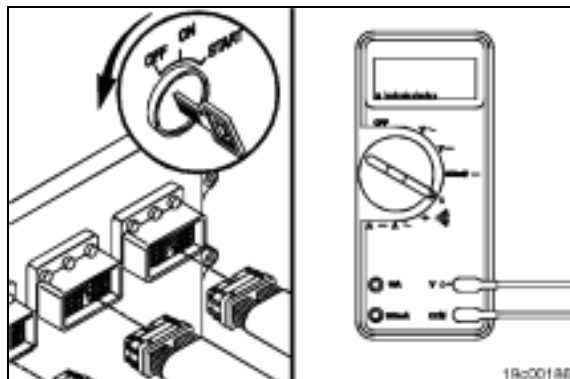


The procedure for checking continuity is as follows:

Turn keyswitch OFF.

Disconnect the harness connectors that are to be tested.

Adjust the multimeter to measure resistance.

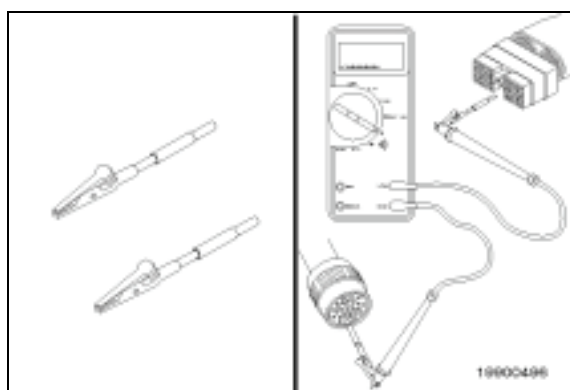


Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

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.



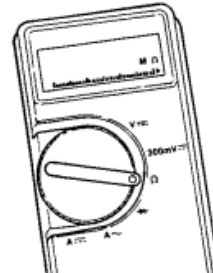
Electronic Engine Controls – Overview (Cont)

The multimeter must display less than 10 ohms for wire continuity.

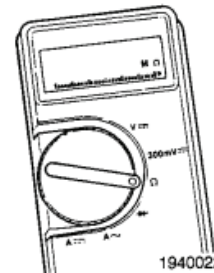
If the multimeter displays greater than 10 ohms, the wire must be repaired or the harness replaced.



Less than
10 Ohms



More than
10 Ohms



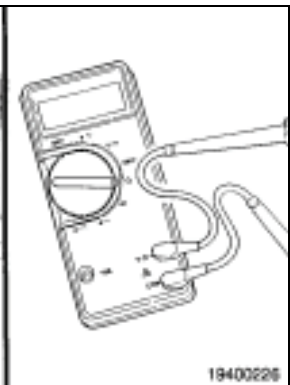
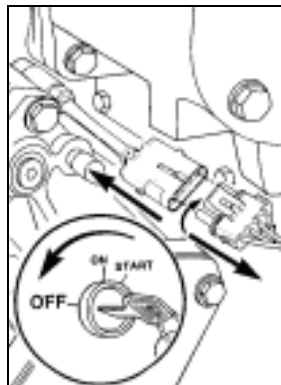
19400225

Resistance Check - Coil

Turn keyswitch OFF.

Disconnect the harness from the coil.

Adjust the multimeter to measure resistance.



19400226



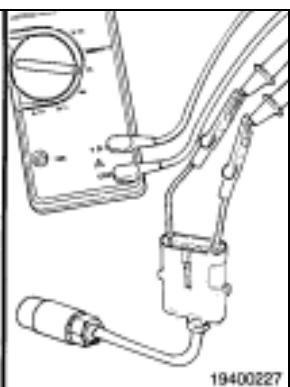
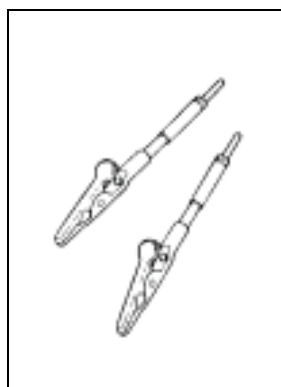
Use the appropriate test leads from the wiring harness repair kit, Part Number 3824904, to avoid damage to the connector pins.

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.



19400227

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.

Engine Position Sensor (CAM)

Torque = 20 N•m [15 ft-lb]

Coil Resistance:

First Coil = 1000 to 2000 Ohms

Second Coil = 1000 to 2000 Ohms

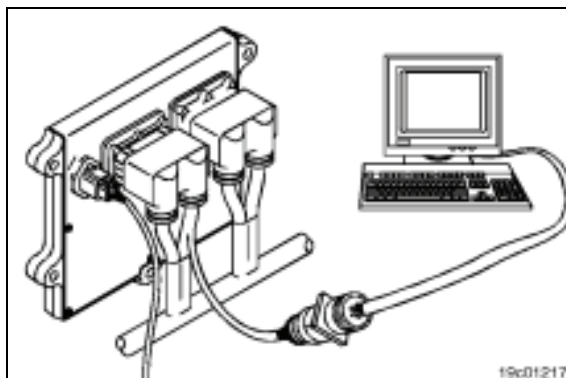
1940C083

ECM Calibration Code Information

Prepare

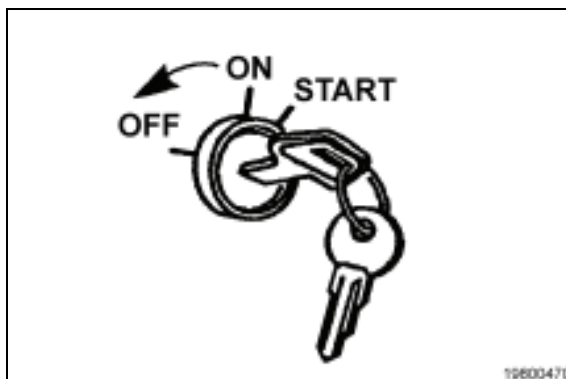
General Information

Electronic control module (ECM) calibrations can be performed by INSITE™ electronic service tool.



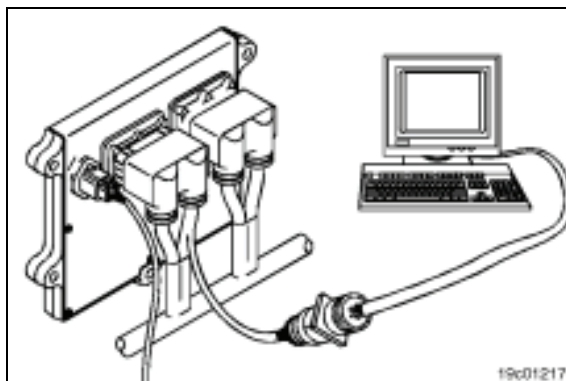
The ECM calibration process occurs with the keyswitch turned on. Always follow the instructions on the service tool screens.

NOTE: If the tool will not communicate with the keyswitch in the ON position, cycle keyswitch and try again.



Connection

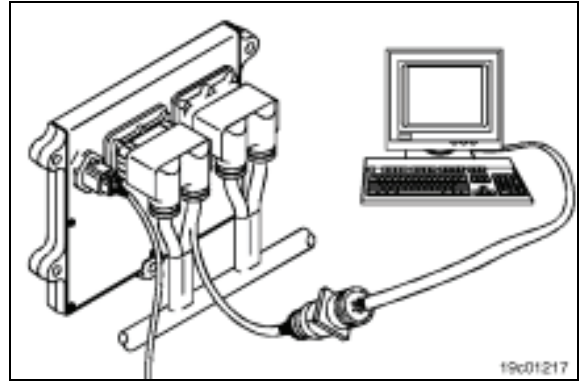
Connect the electronic service tool to the service tool data link, which is located on the engine or in the cab.



ECM Calibration Code Information (Cont)

Calibration

Refer to the help section within INSITE™ electronic service tool for detailed ECM calibration procedures.



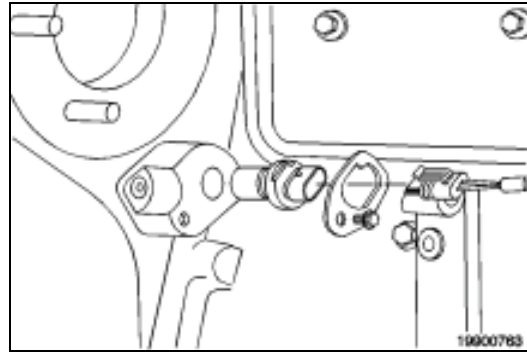
Follow-Up

Engine Position Sensor Removal/Installation

Prepare

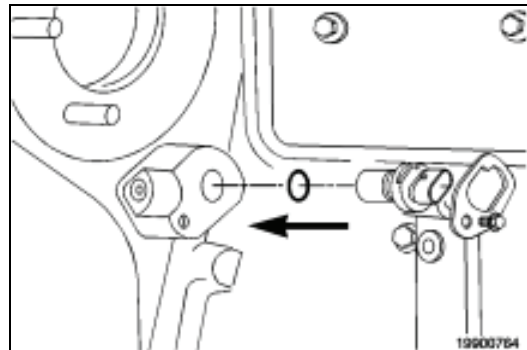
Remove

Disconnect the sensor from the engine harness.
Remove the EPS from the cylinder block.

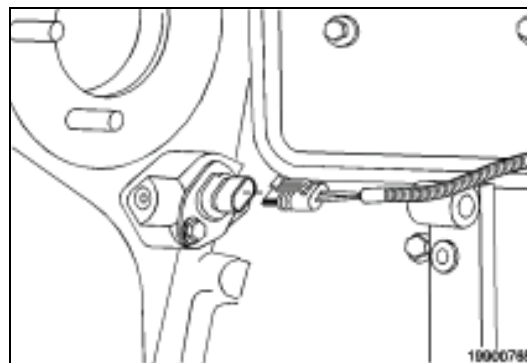


Install

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

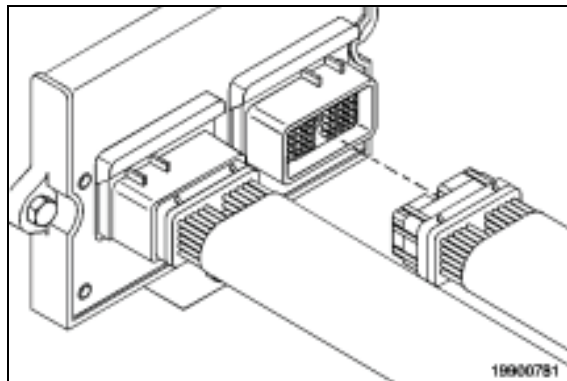
Resistance Check

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.

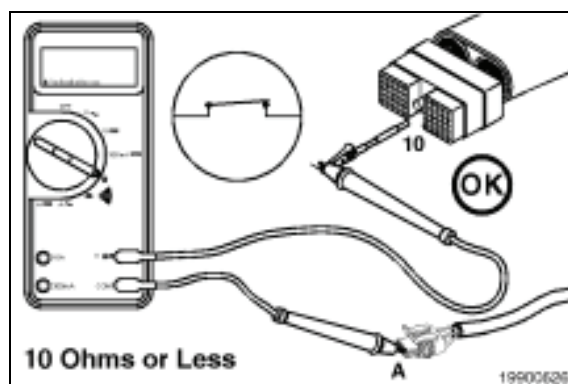
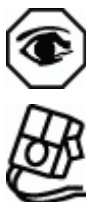


+5-VDC Supply Wire Resistance – Checking

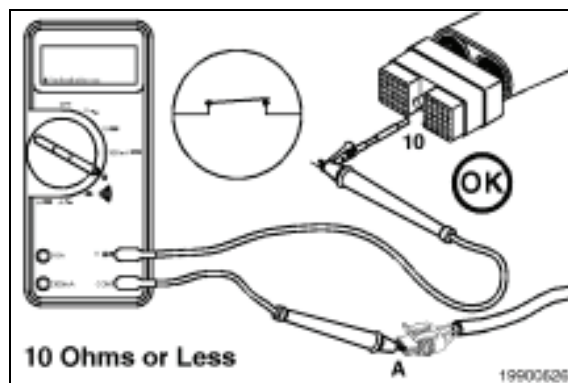


Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins of the connector.

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

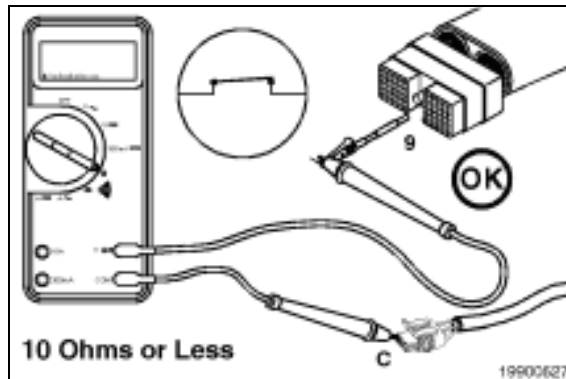


Engine Position Sensor Circuit Testing (Cont)

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.

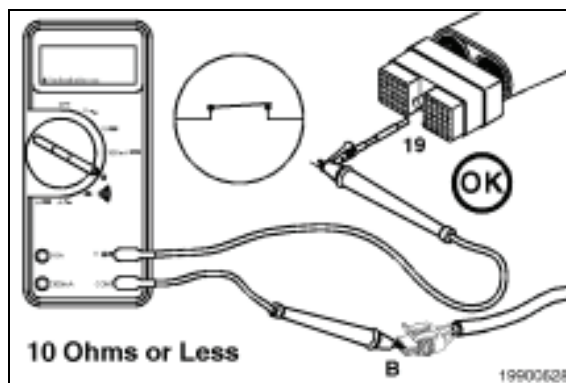
Measure the resistance. The multimeter must show a closed circuit (10 ohms or less). If more than 10 ohms are measured, there is an open circuit in the signal wire. Repair the signal wire, or replace the engine harness. Refer to Procedure [019-250](#), [019-203](#), or [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



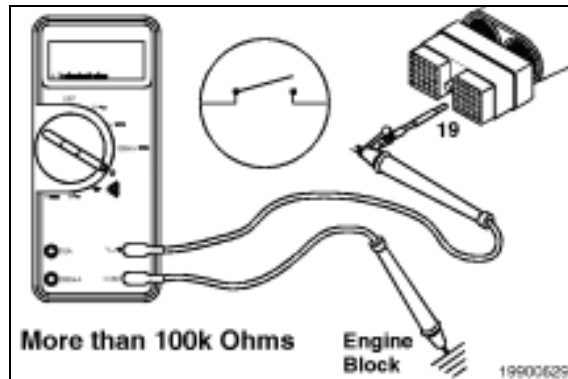
Engine Position Sensor Circuit Testing (Cont)

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

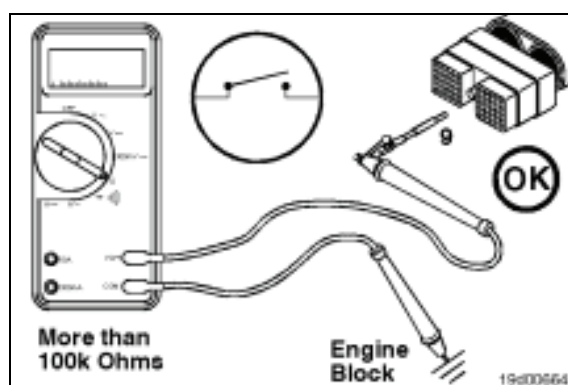


Signal Wire – Checking

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



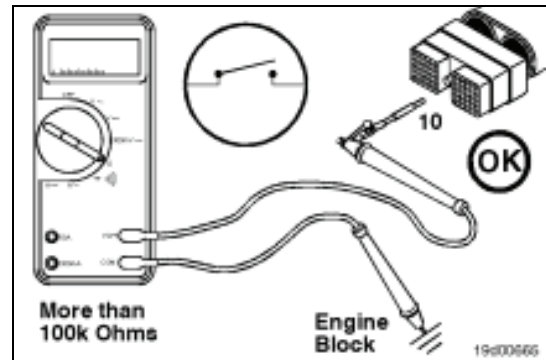
Engine Position Sensor Circuit Testing

+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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

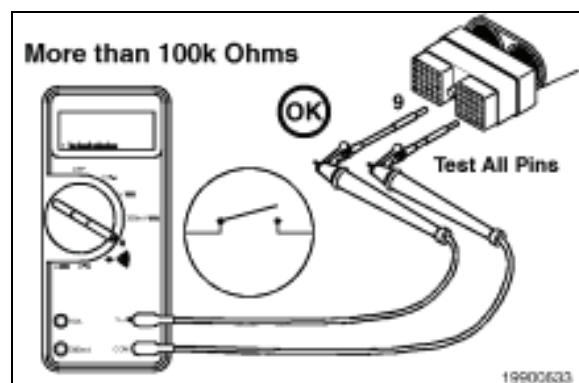


Check for Short Circuit from Pin to Pin

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

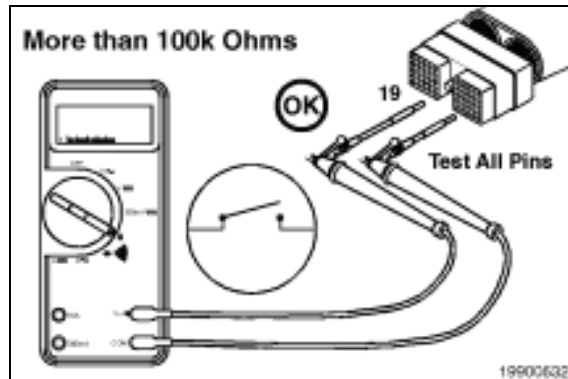


Engine Position Sensor Circuit Testing (Cont)

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.

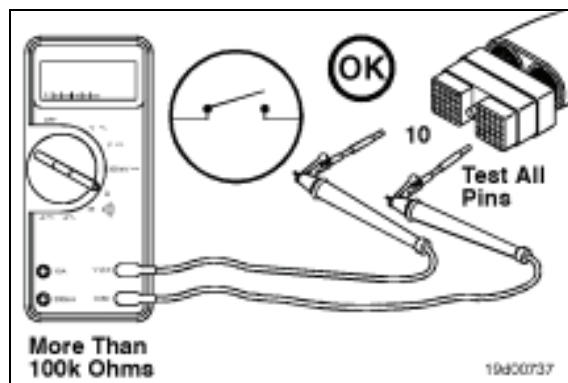
Measure the resistance. The multimeter must show an open circuit (more than 100k ohms). If the circuit is not open, there is a short circuit between the return wire and any pin that measures a closed circuit. Repair or replace the engine harness. Refer to Procedure [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



+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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



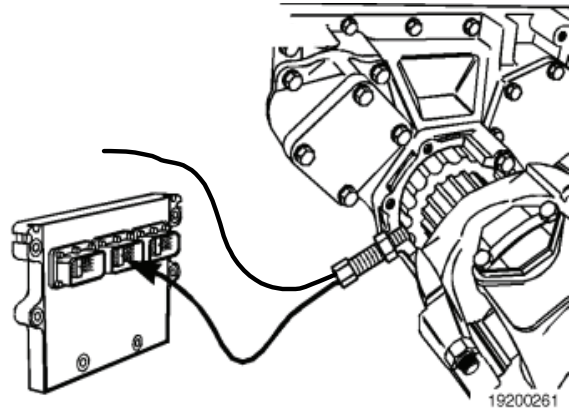
Follow-Up

Shaft Speed Sensor, Magnetic Pick Up Removal/Installation/Checks

Prepare

General Information

The shaft speed sensor senses the speed of the shaft by counting gear teeth. The ECM then calculates the shaft speed based on the number of teeth per revolution. The auxiliary governor can control the engine fueling to maintain a constant shaft speed.

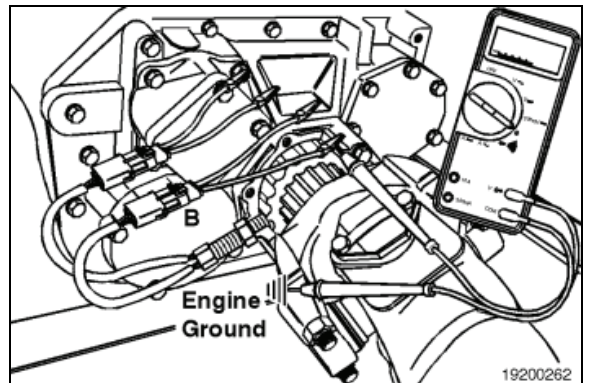


The shaft speed sensor has two coils. One coil is connected to the ECM and the other coil may be connected to some other vehicle device.



NOTE: Sensor design varies with the application. Refer to the equipment manufacturer's manual to understand which type of shaft speed sensor is being used in a given location.

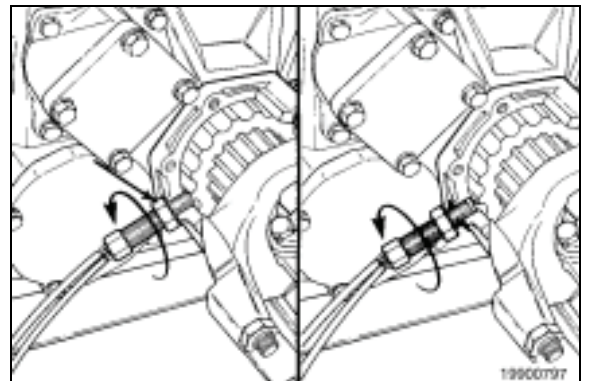
NOTE: Some applications may use only one connector.



Remove

Disconnect the engine harness from the shaft speed sensor.

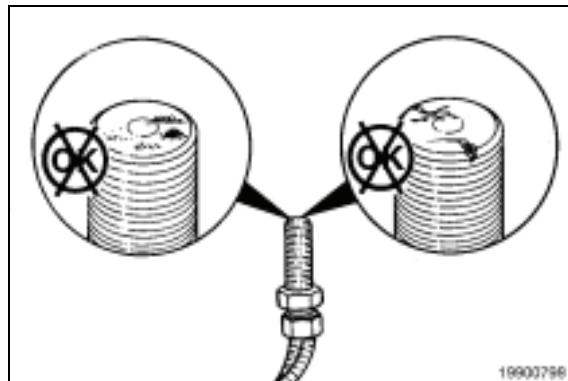
Loosen the locknut. Turn the shaft speed sensor out of the housing.



Shaft Speed Sensor, Magnetic Pick Up Removal/Installation/Checks (Cont)**Inspect for Reuse**

Inspect the tip of the shaft speed sensor for dirt, debris, or physical damage (cracked potting, and so forth).

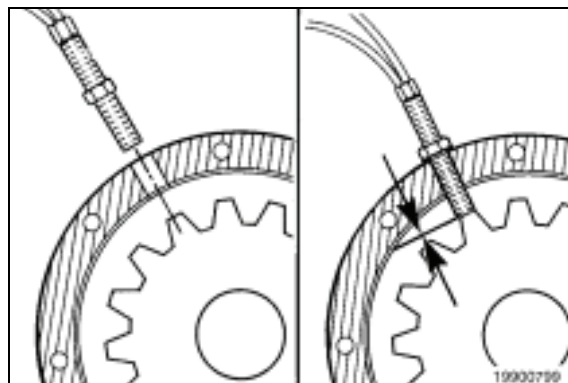
Clean the tip if it is dirty, or replace the shaft speed sensor if it is damaged.

**Install**

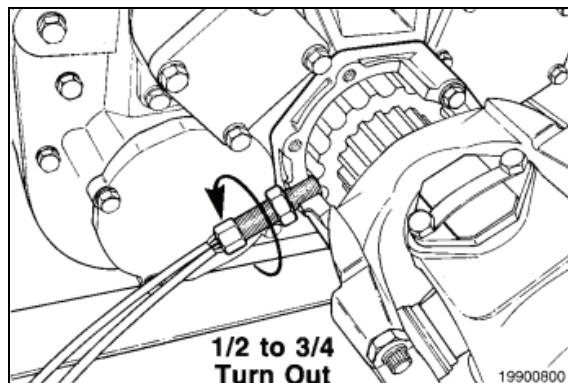
Make sure a gear tooth is aligned with the hole in the housing.

Install the shaft speed sensor into the hole until it touches the gear tooth.

NOTE: If the shaft speed sensor does not turn in with finger pressure, check the housing hole threads and the sensor threads for dirt or damage.



Turn the shaft speed sensor out 1/2 to 3/4 of a turn.



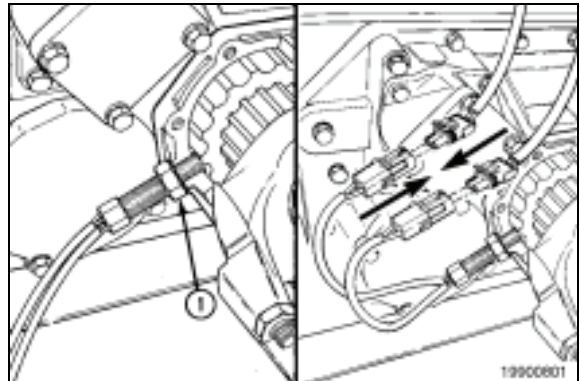
Shaft Speed Sensor, Magnetic Pick Up Removal/Installation/Checks (Cont)

Tighten the locknut against the housing.

Torque Value: 47 N•m [35 ft-lb]

Install both of the connectors together until connectors "snap" into position. The connectors can be interchanged with each other without changing the performance of the system.

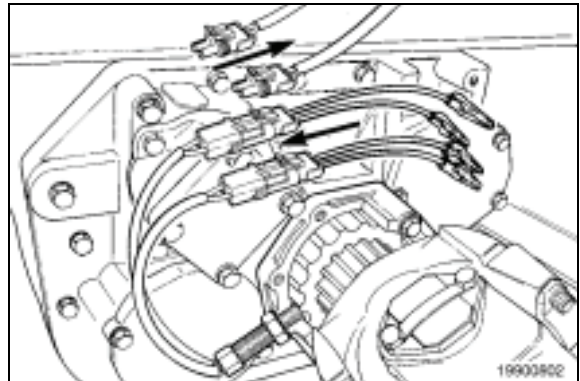
NOTE: Some applications may use only one connector.



Resistance Check

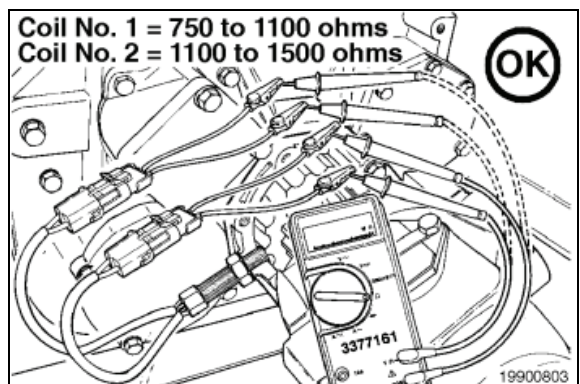
Lift the tab on the connectors and pull them apart.

NOTE: When measuring the resistance value of the shaft speed sensor coils, use two female test leads, Part No. 3822996. This will allow the electrical leads of the sensor to be softly flexed to check for damaged or partially broken wire strands under the insulation.



Use a multimeter to measure the resistance between the two pins of each connector on the shaft speed sensor. The resistance value of one coil must be 750 to 1100 ohms. The resistance value of the other coil must be 1100 to 1500 ohms (although the resistance values are different, the coils are interchangeable).

If the resistance is not correct, replace the shaft speed sensor. If the resistance value is correct, the shaft speed sensor must still be checked for a short circuit to ground and a short circuit between coils.

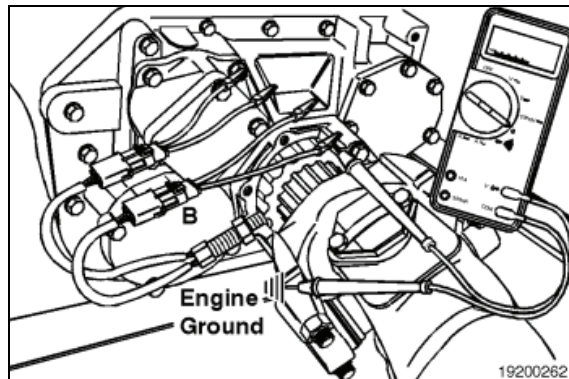


Shaft Speed Sensor, Magnetic Pick Up Removal/Installation/Checks (Cont)

Check for Short Circuit to Ground

Measure the resistance between pin B of one of the connectors and the engine block. The multimeter must show an open circuit (100k ohms or more).

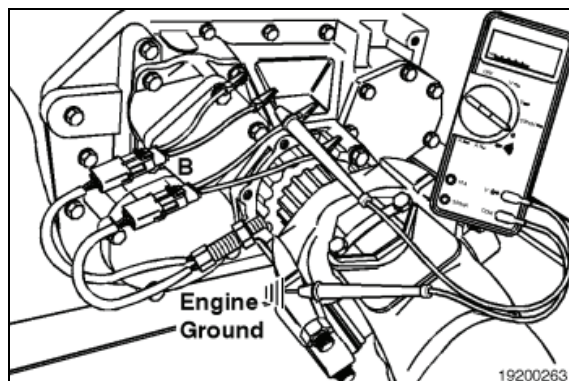
NOTE: The open circuit specification (100k ohms or more) for the shaft speed sensor is higher than the open circuit specification used throughout the manual due to the sensitivity of the shaft speed sensor signal.



Measure the resistance between pin B of the other connector and the engine block. The multimeter must show an open circuit (100k ohms or more).

If the circuit is not open (100k ohms or more) in either of these checks, the shaft speed sensor has failed.

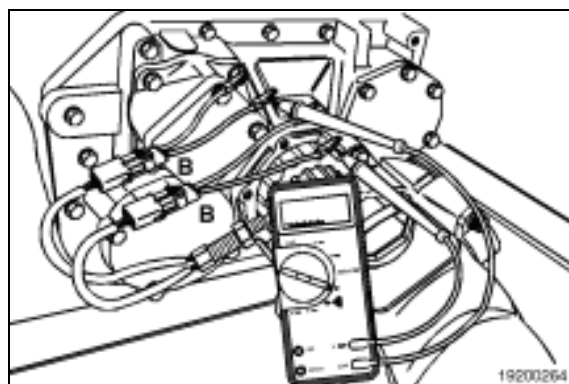
Replace the shaft speed sensor.



Check for Short Circuit between Coils

Use a multimeter to measure the resistance between pin B of one of the connectors and pin B of the other connector. The multimeter must show an open circuit (100k ohms or more).

If the circuit is not open, replace the shaft speed sensor.



Follow-Up

Shaft Speed Sensor Circuit Checks

- Resistance Check
- Check for Short Circuit to Ground
- Check for Short Circuit from Pin to Pin

Prepare

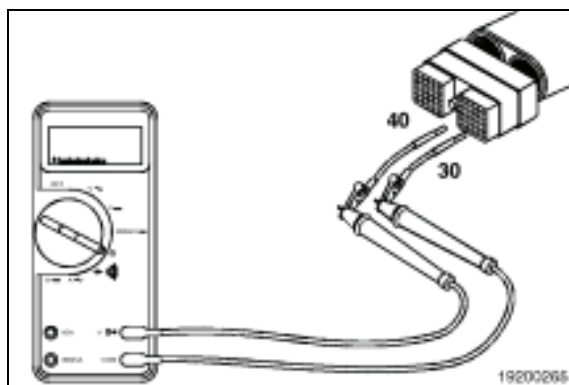
Resistance Check

Disconnect the actuator harness connector from the ECM. Make sure the shaft speed sensor is connected to the OEM harness.



Do not use probes or leads other than Part Number 3822758. The OEM harness will be damaged. The leads must fit tightly in the connector without expanding the pins in the connector.

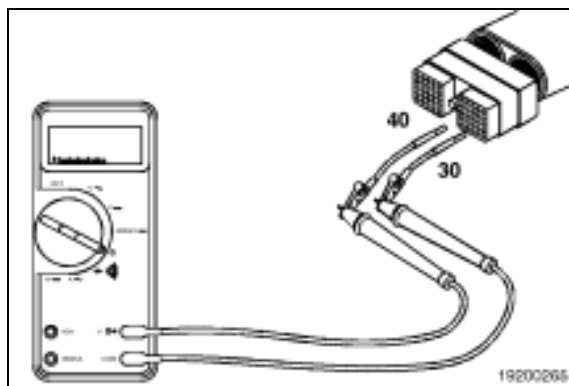
Insert a test lead into pin 40 of the actuator harness connector. Insert the other lead into pin 30 of the connector.



Connect the two alligator clips to the two probes of the multimeter. Adjust the multimeter to the resistance setting and measure resistance. The resistance value must be 750 to 1500 ohms. If the value is not correct, there is a problem with the actuator harness, provided that the shaft speed sensor has been previously checked.

Repair or replace the actuator harness or the OEM harness, depending on the location of the damage. Refer to Procedure [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

If the value is correct, the circuit must still be checked for a short circuit to ground and a short circuit from pin to pin.



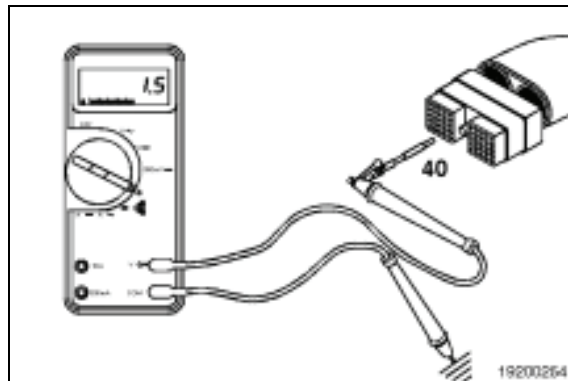
Shaft Speed Sensor Circuit Checks (Cont)

Check for Short Circuit to Ground

Check for a short circuit to ground. Insert the multimeter probe with attached test lead into pin 40 of the actuator harness connector. Touch the other multimeter probe to the engine block. Measure the resistance. The multimeter must show an open circuit (100k ohms or more).

If the circuit is not open, there is a short circuit to ground in the shaft speed sensor circuit in the actuator harness or OEM harness.

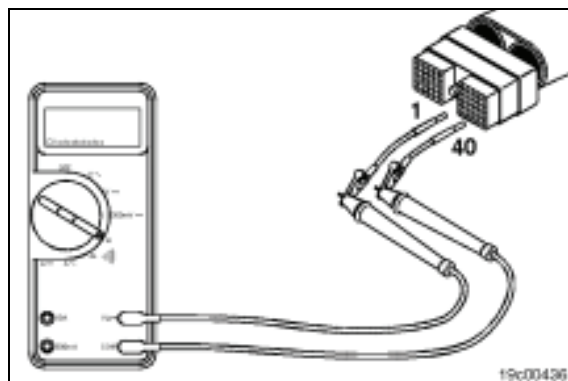
Repair the wires which are shorted in the circuit according to the vehicle manufacturer's procedures.



Check for Short Circuit from Pin to Pin

Check for a short circuit from pin to pin. Insert the multimeter probe with attached test lead into pin 40 of the actuator harness connector. Insert the other test lead into pin 1 of the connector. Measure the resistance. The multimeter must show an open circuit (more than 100k ohms).

Measure the resistance. The multimeter must show an open circuit (more than 100k ohms).

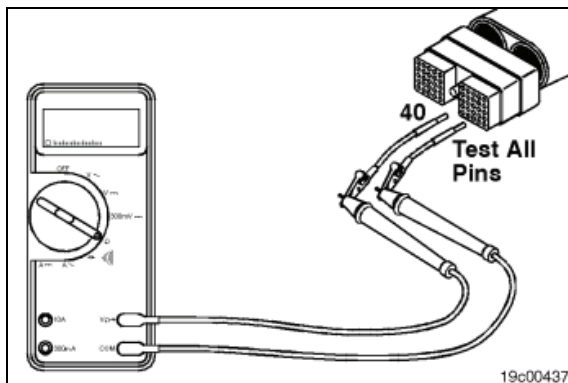


Remove the test lead from pin 1 and test all pins in the connector.

Measure the resistance from pin 40 of the actuator harness connector to all other pins in the connector, one at a time. The multimeter must show an open circuit (more than 100k ohms) at all pins.

NOTE: If the values are correct for all of the circuit checks, the shaft speed sensor circuit is good.

Connect all components after completing the repair.



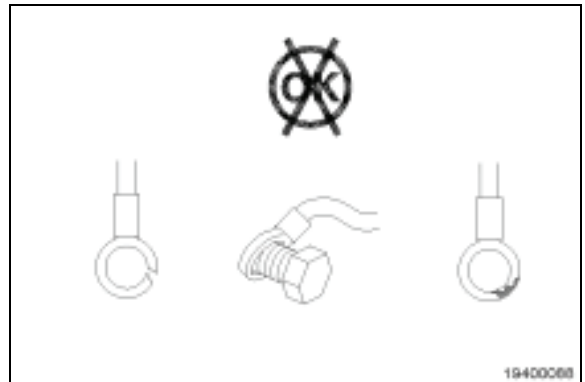
Follow-Up

Battery Ground Circuit Voltage Check

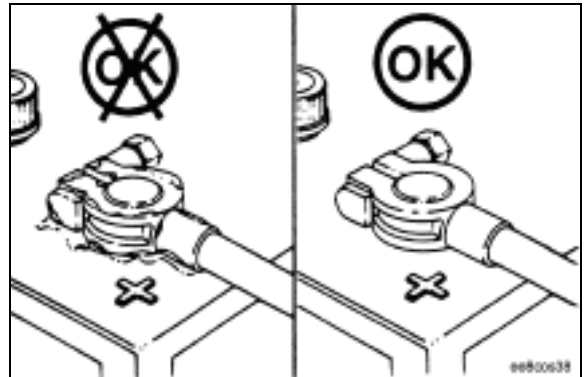
Prepare

Check

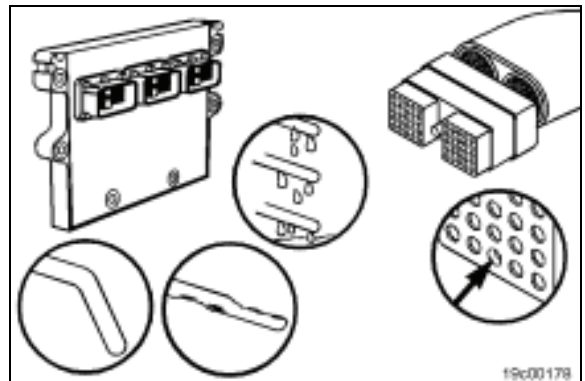
Check the engine harness ground connection for loose, corroded, or broken connections.



If the resistance value is not correct, check the batteries, cables, and cable connections. Repair or replace the parts as required.



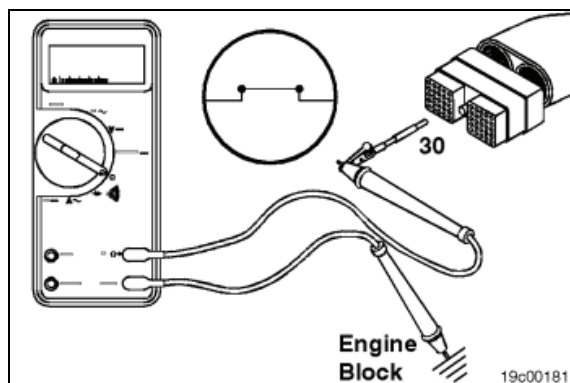
Check the battery return wires in the engine harness for proper grounding. Disconnect the OEM harness from the ECM. Check for damaged pins in the ECM and the harness.



Battery Ground Circuit Voltage Check (Cont)

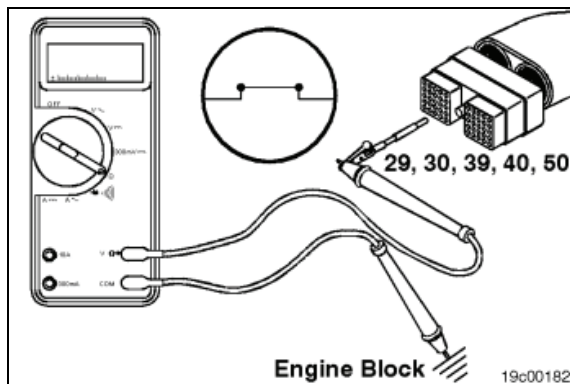
Do not use probes or leads other than Part No. 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the pins in the connector.

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

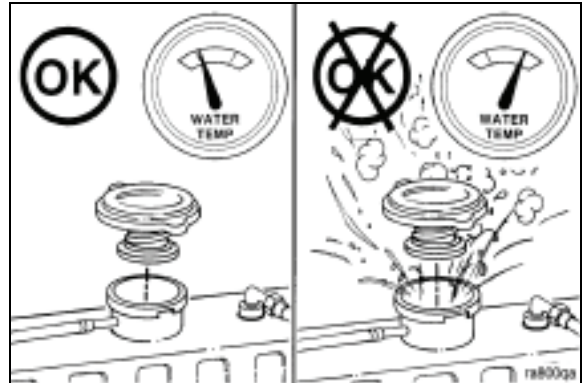
Remove



WARNING

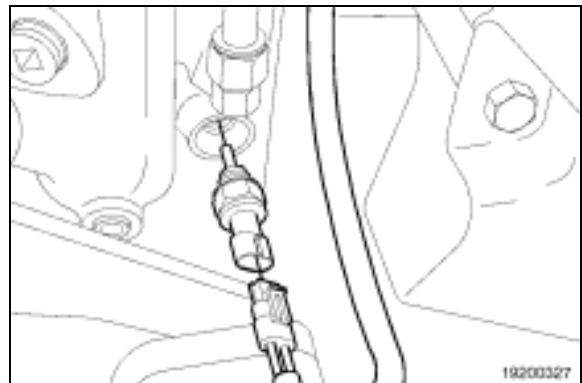
Do not remove the pressure cap from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

Drain the cooling system. Refer to Procedure [008-018](#) in the ISM and QSM11 Engines Troubleshooting and Repair Manual, Bulletin 3666322.



Lift up on the locking tab and pull the electrical connectors apart.

Remove the sensor.



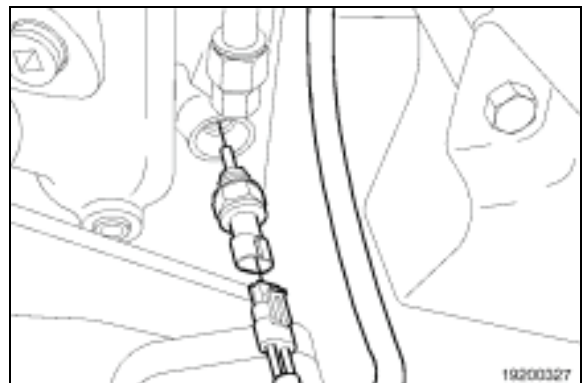
Install

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.

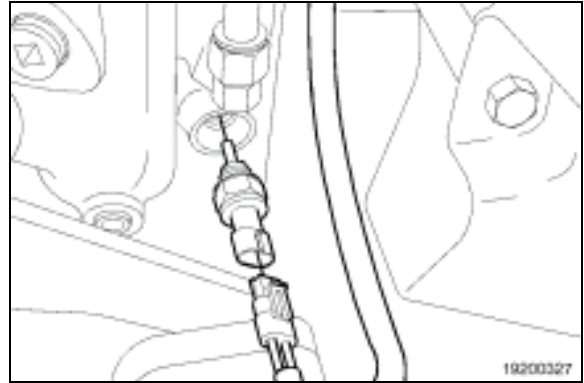
Torque Value: 14 N•m [124 in-lb]



Engine Coolant Temperature Sensor Removal/Installation (Cont)

Push the connectors together until they lock.

Fill the cooling system and operate the engine to check for leaks. Refer to Procedure [008-018](#) in the ISM and QSM11 Engines Troubleshooting and Repair Manual, Bulletin 3666322.

**Follow-Up**

Engine Wiring Harness Removal/Installation

Prepare

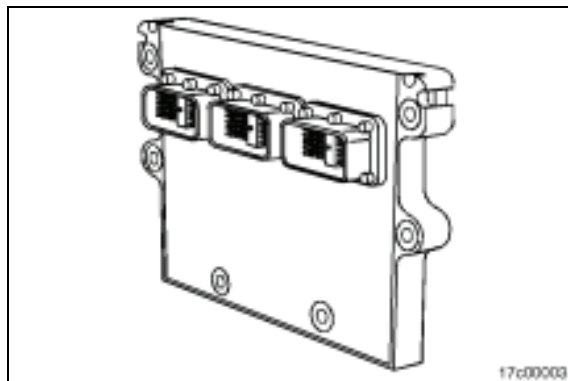
General Information

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

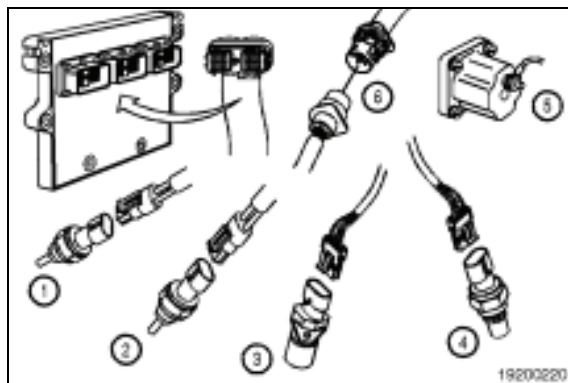
Intake manifold temperature sensor

Crankshaft or camshaft position sensor

Coolant temperature sensor

Fuel shutoff solenoid

15-pin pass-through connector



Centinel™ connector (if equipped)

Ambient air pressure sensor

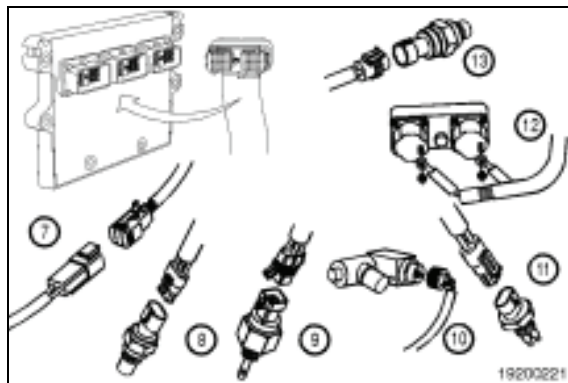
Oil pressure/temperature sensor

Wet tank pressure sensor

Water-in-fuel sensor

Wastegate controller

Fuel inlet restriction sensor (if equipped).



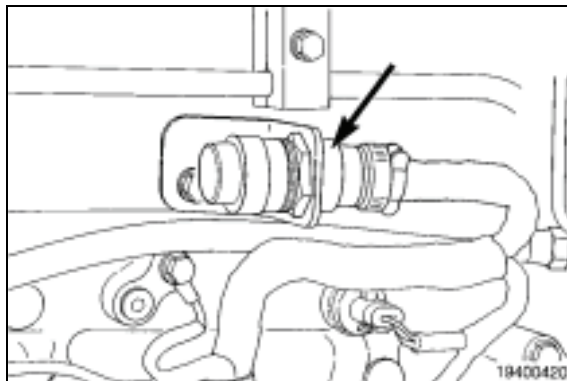
Engine Wiring Harness Removal/Installation (Cont)

Disconnect the 31-pin Deutsch connector from the OEM side of the wiring harness.



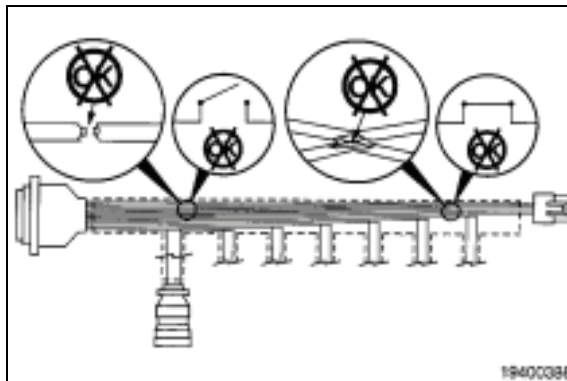
Remove the harness clamps from the support bracket of the engine block.

Disconnect the engine harnesses from the ECM.



Inspect for Reuse

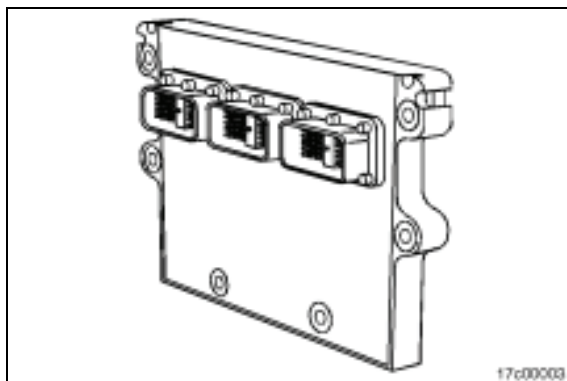
Replace or repair the engine harness if there is an open circuit or a short circuit found under the protective covering of the harness body.



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

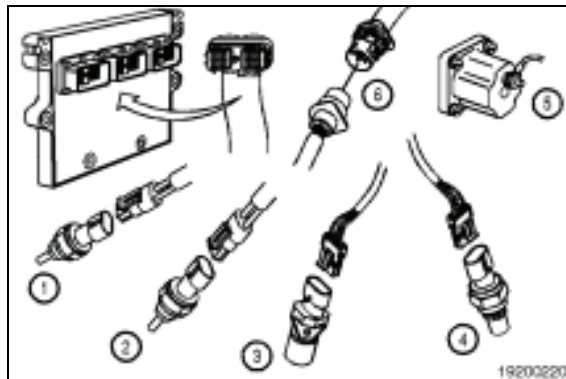
Intake manifold temperature sensor

Crankshaft or camshaft position sensor

Coolant temperature sensor

Fuel shutoff solenoid

15-pin pass-through connector



Centinel™ connector (if equipped)

Ambient air pressure sensor

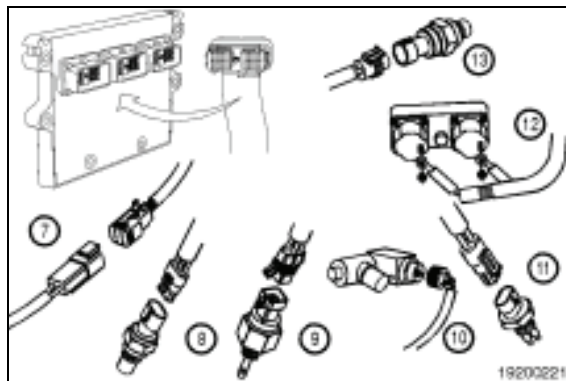
Oil pressure/temperature sensor

Wet tank pressure sensor

Water-in-fuel sensor

Wastegate controller

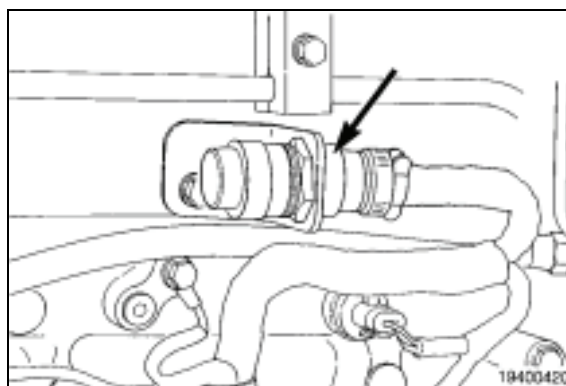
Fuel inlet restriction sensor (if equipped).



Connect the 31-pin Deutsch connector to the engine harness.



Install the harness clamps that hold the engine harness to the block.



Follow-Up

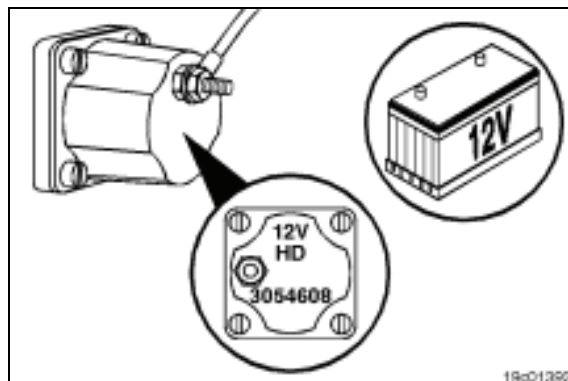
Fuel Shutoff Valve Circuit Checks

Prepare

General Information

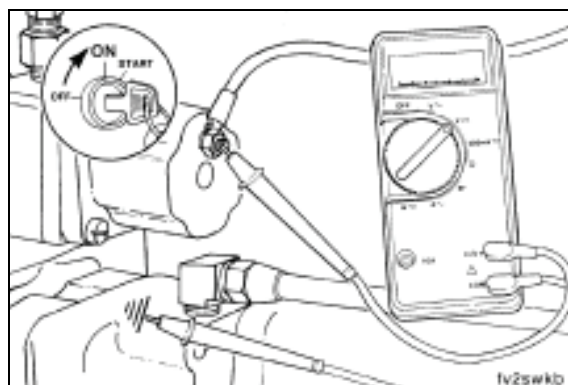
The fuel shutoff solenoid valve located on the fuel system housing. The solenoid is controlled by the ECM.

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.

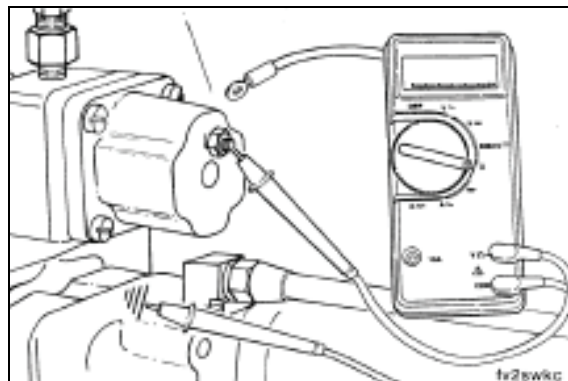


Resistance Check

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.

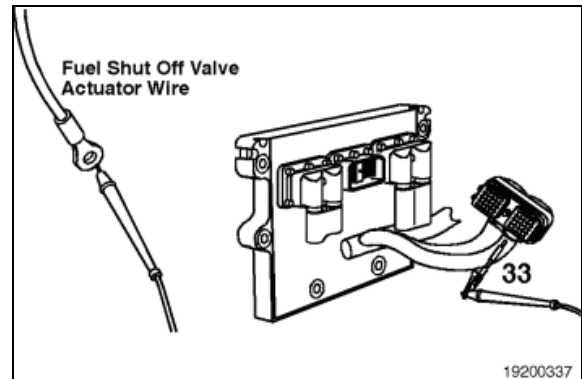


Fuel Shutoff Valve Circuit Checks (Cont)



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.

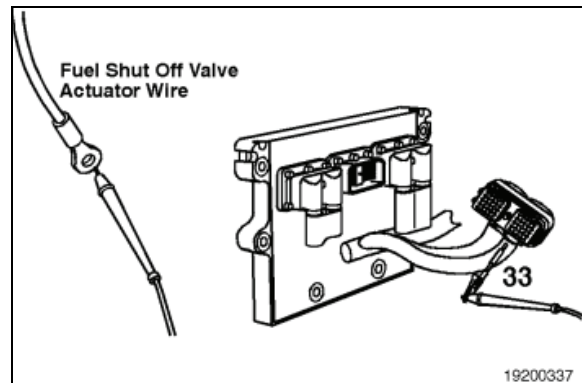
Insert a test lead into pin 33 of the actuator harness connector. Connect the alligator clip to the multimeter probe.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

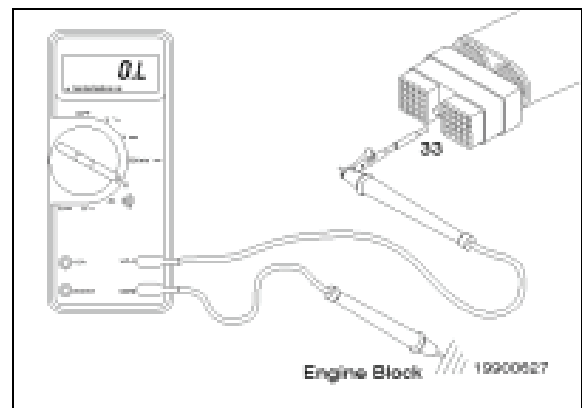
If the circuit is closed, it must still be checked for a short circuit to ground and a short circuit from pin to pin.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

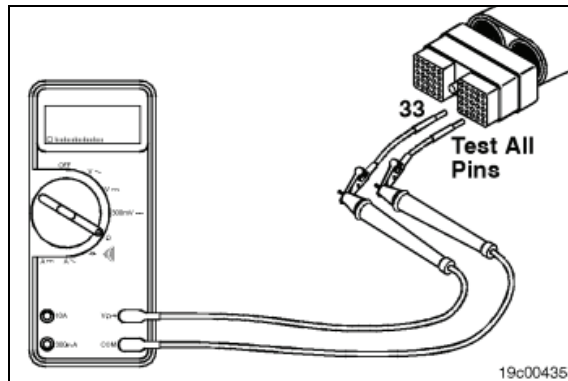


Fuel Shutoff Valve Circuit Checks (Cont)

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.

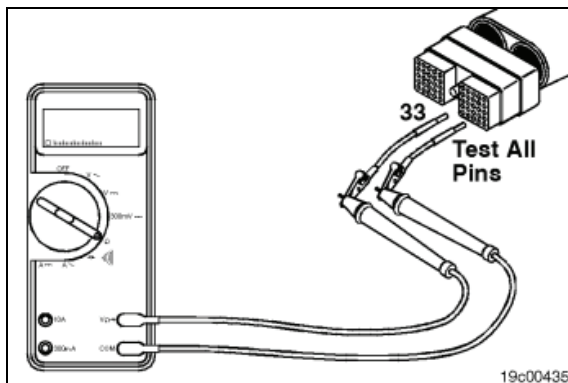


19c00435

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Connect all components after completing the repair.



19c00435

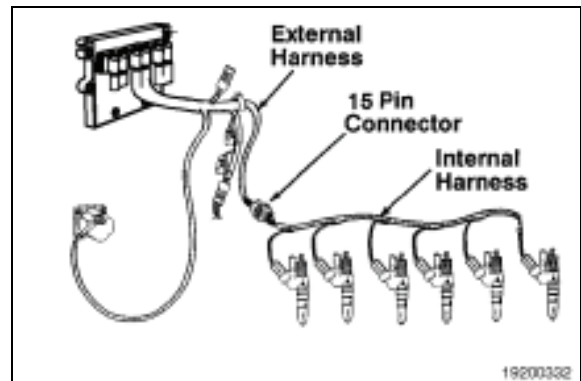
Follow-Up

Injector Solenoid Check

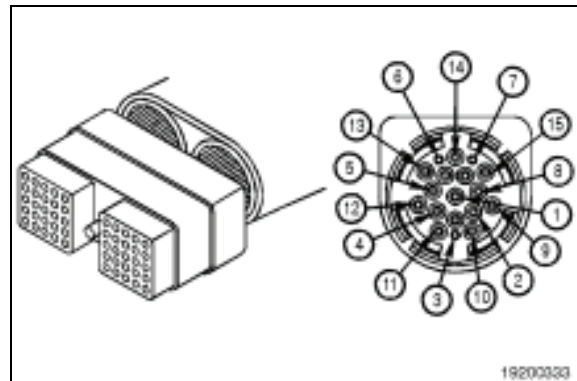
Prepare

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.



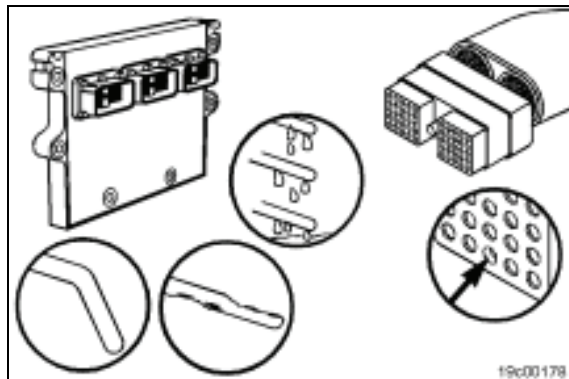
The pins of the circuits are as follows:



Cyl. No.	Supply Pin			Return Pin		
	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.



19c00179

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.

**Injector Solenoid Resistance**

Very Low Value

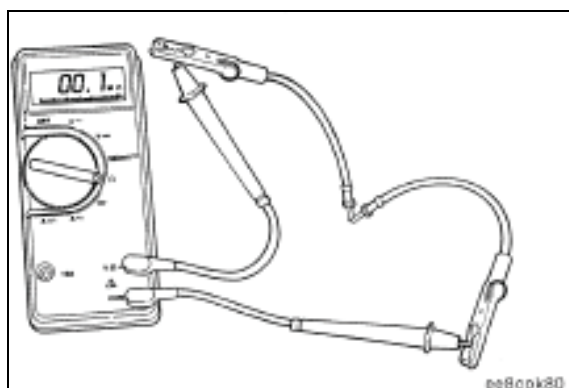
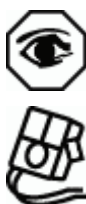
Temperature Sensitive

19800481



Use a multimeter for this procedure. Use Cummins multimeter, Part No. 3377161, or a meter with the same accuracy of $\pm 1/2$ 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.



22800080

Follow-Up

Injector Solenoid Circuit Checks

Prepare

Resistance Check

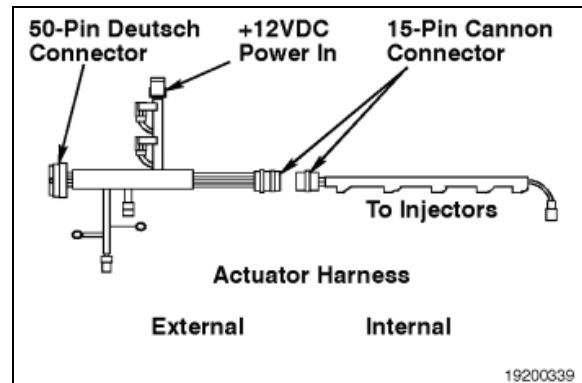


The injector solenoids receive high voltage when the engine is operating. To reduce the possibility of personal injury or death from electrical shock, do not wear jewelry or damp clothing, and do not touch the injector solenoids or the solenoid wires when the engine is operating.

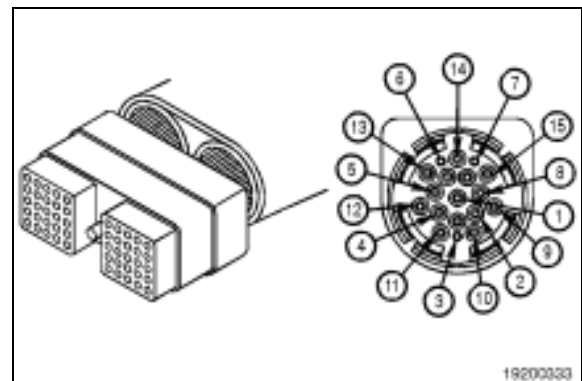


Do not use probes or leads other than Part Number 3822758. The connector will be damaged. The leads must fit tightly in the connector without expanding the connector pins.

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.



The pins of the circuits are as follows:



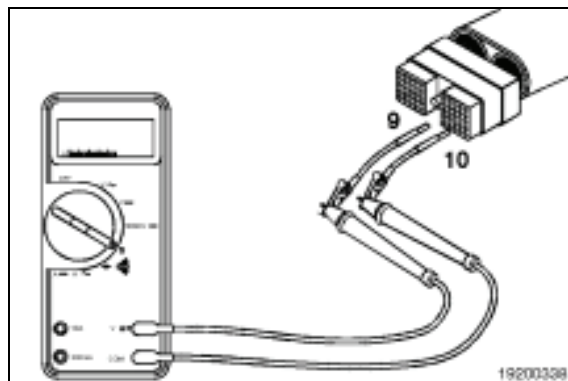
Injector Solenoid Circuit Checks (Cont)

Cyl. No.	Supply Pin			Return Pin		
	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.



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).

$$\begin{array}{r}
 1.3\Omega \text{ Measured resistance (Step 2)} \\
 - .1\Omega \text{ Ohm meter test lead measurement (Step 1)} \\
 \hline
 1.2\Omega \text{ True measured value}
 \end{array}$$

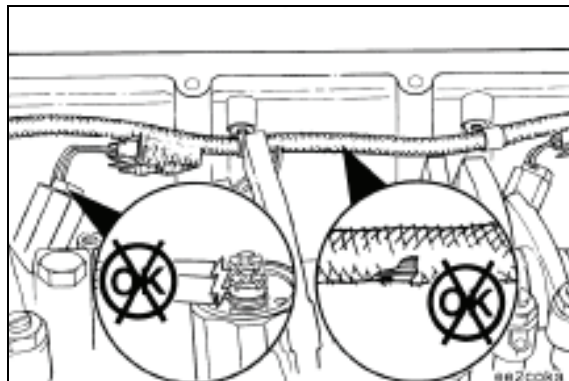
01801k07

Injector Solenoid Circuit Checks (Cont)

Resistance Value Below Specifications

Remove the valve cover.

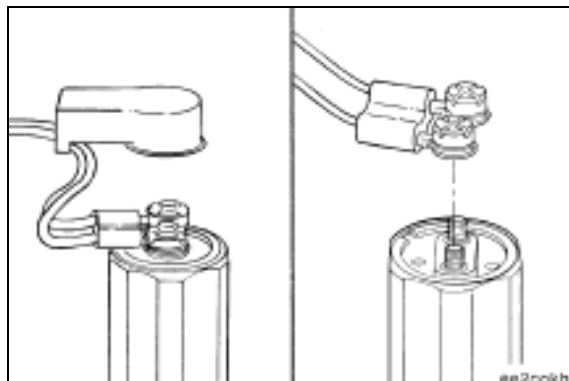
Inspect the injector solenoid wires for short circuits between the wires. If the wires are damaged, replace the wires. Refer to Procedure [019-057](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



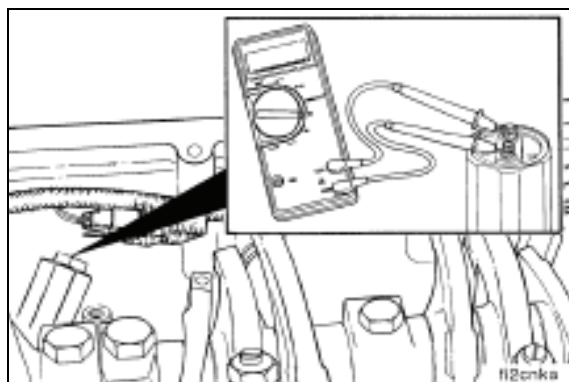
Disconnect the injector supply and return wires from the solenoid of the problem cylinder.

Use a small screwdriver to remove the protective cover from the solenoid.

Remove the captive nut assembly from the injector solenoid.

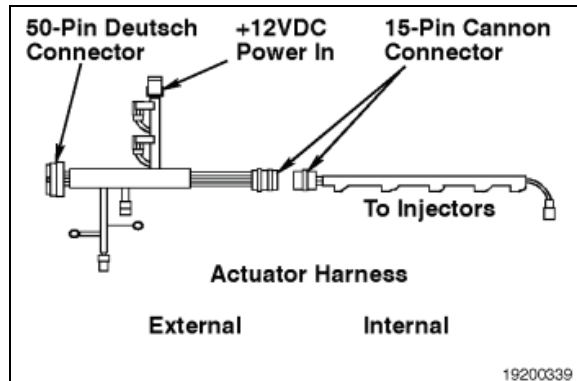


Measure the resistance between the two posts or the connection of the injector solenoid. Subtract the multimeter resistance. The true injector solenoid resistance must be 0.5 to 1.5 ohms. If the resistance value is not correct, replace the injector. Refer to Procedure [006-026](#) in the Troubleshooting and Repair Manual, ISM and QSM11 Engines, Bulletin 3666322.



Injector Solenoid Circuit Checks (Cont)

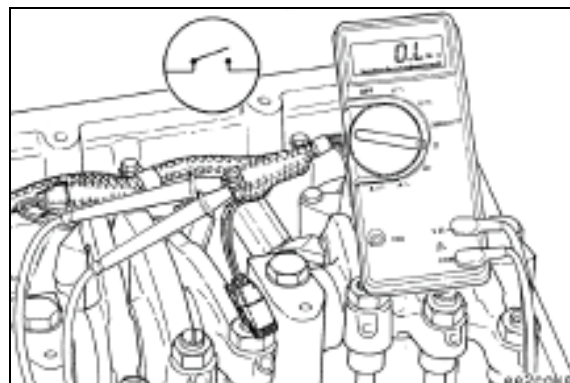
If the resistance value of the injector solenoid is correct, the problem is in the internal or external actuator harness. Isolate the problem by checking each harness separately.



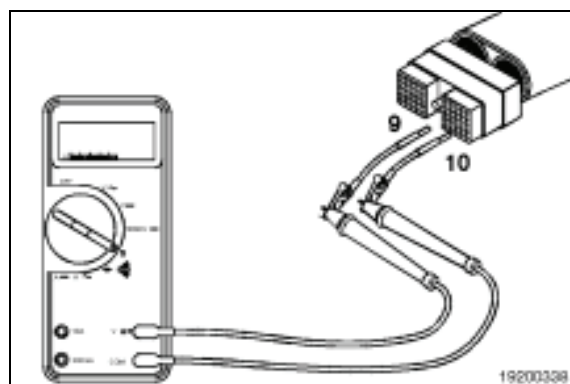
Disconnect the connector inside the head.

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322. Do not repair the internal actuator harness.

Connect the 15-pin connector when the repair is completed.



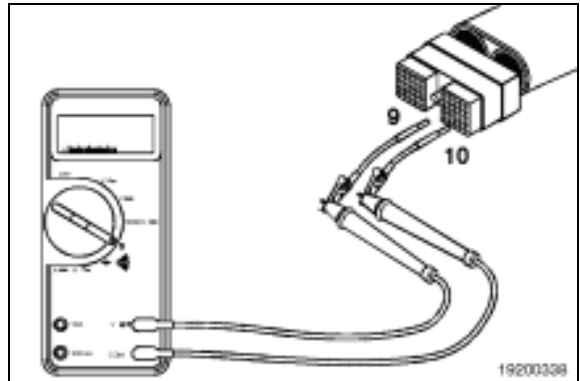
Check the external actuator harness. Make sure that the 15-pin connector is still disconnected. Insert the test lead into the supply pin (pin 10 in this example) of the actuator harness connector. Insert the pin of the other lead into the return pin (pin 09 in this example) of the actuator harness connector. Connect the alligator clips to the multimeter probes.



Injector Solenoid Circuit Checks (Cont)

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

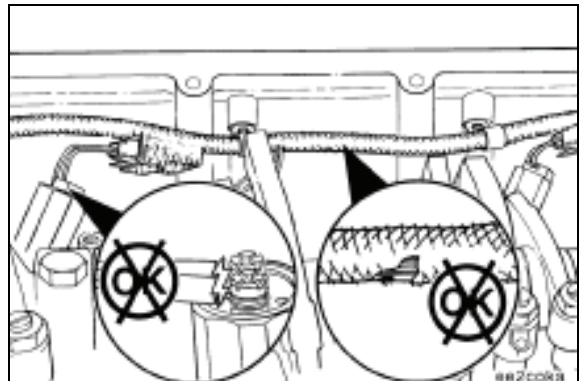
Connect the 15-pin connector when the repair is completed.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322. Do not repair the wires.

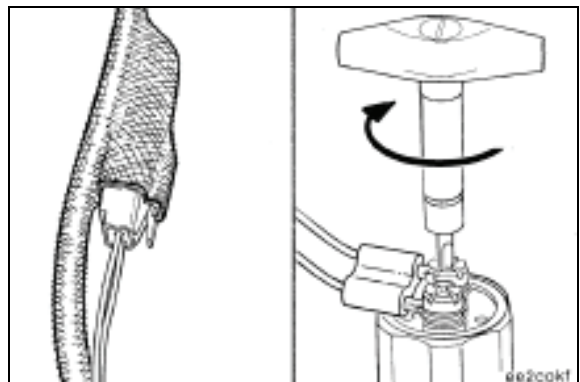


Check the 2-pin connector of the injector solenoid wires for proper connection.

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.

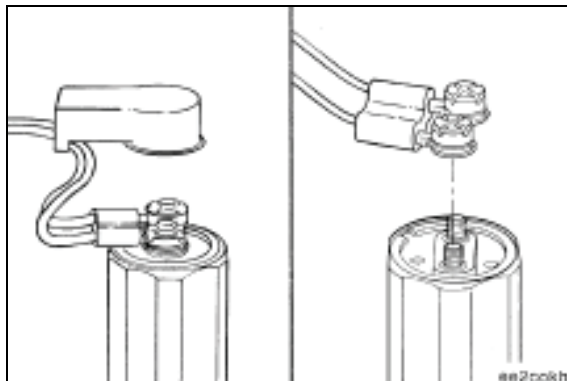
Torque Value: 1.6 N•m [14in-lb]



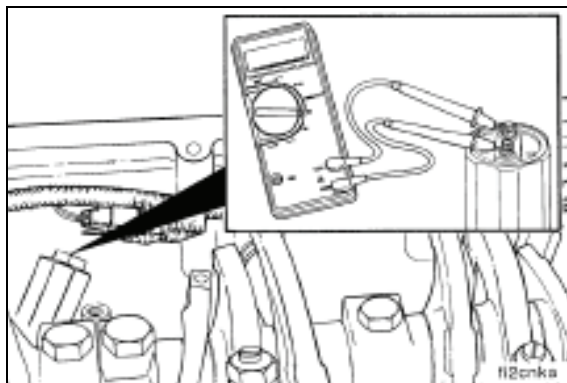
Injector Solenoid Circuit Checks (Cont)

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.

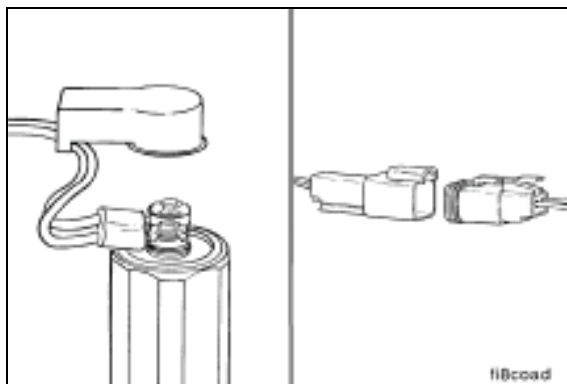


Measure the resistance between the posts or the connection of the injector solenoid. Subtract the multimeter resistance. The true injector solenoid resistance must be 0.5 to 1.5 ohms. If the resistance is not correct, replace the injector. Refer to Procedure [006-026](#) in the Troubleshooting and Repair Manual, ISM and QSM11 Engines, Bulletin 3666322.



If the resistance is correct, check the solenoid wires for an open circuit.

Disconnect the 2-pin connector of the injector solenoid wires.

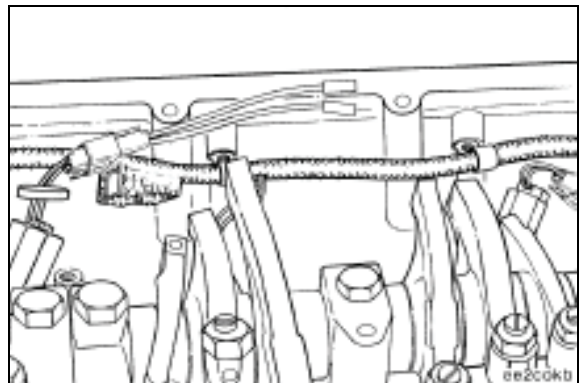


Injector Solenoid Circuit Checks (Cont)

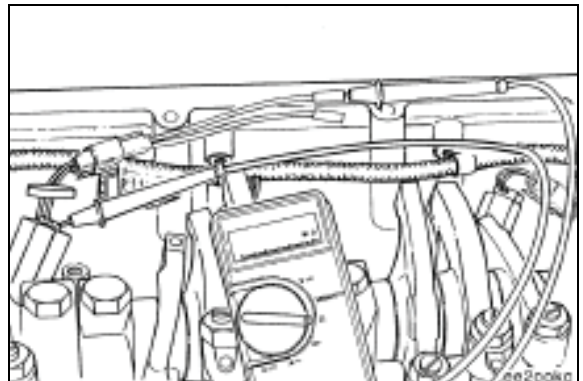


Do not use probes or leads other than the mating connector. The connector will be damaged. The leads must fit tightly in the connector without expanding the connector pins.

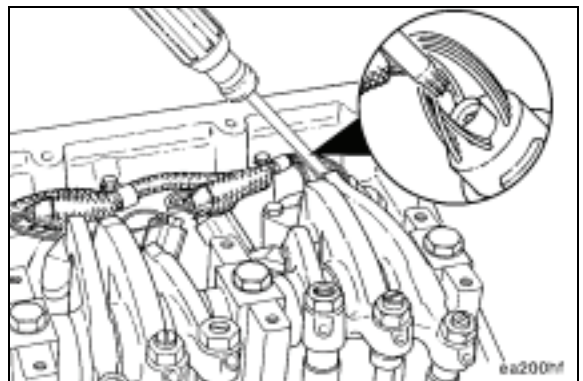
Connect a mating connector with short lead extensions to the injector side of the 2-pin connector.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322. Do not repair the wires.



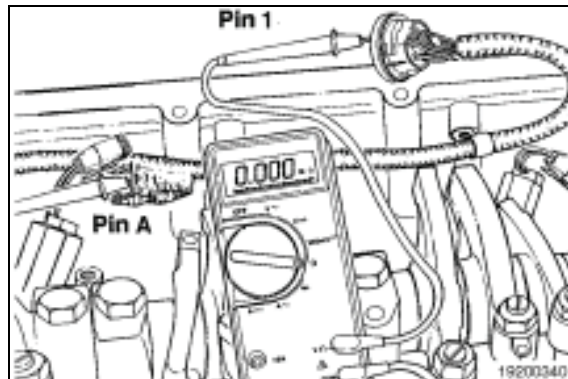
Disconnect the 15-pin connector to separate the internal and external actuator harness.



Injector Solenoid Circuit Checks (Cont)

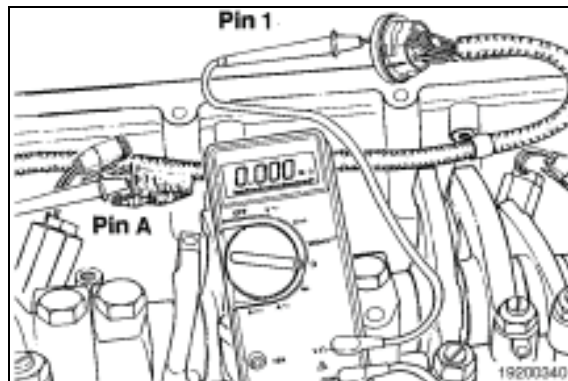
Refer to the accompanying chart at the beginning of this section for the pins of the injector circuit of the problem cylinder.

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.

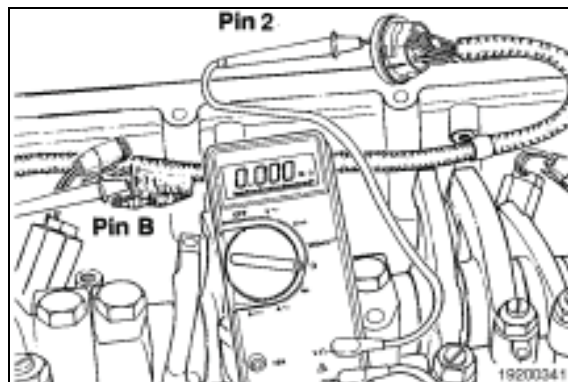


Touch the other multimeter probe to the supply pin (pin 01) at the 15-pin connector, internal actuator harness side. Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, replace the internal actuator harness. Refer to Procedure [019-063](#). Do not repair the wire.

Connect the 15-pin connector when the repair is completed.



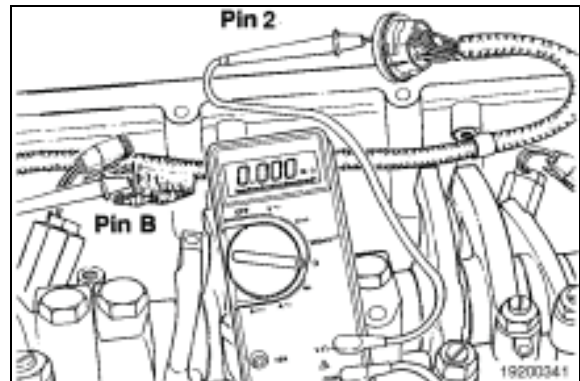
Check the return wire for an open circuit. Touch one multimeter probe to the return pin (pin B) at the injector 2-pin connector, internal actuator harness side. Touch the other multimeter probe on the return pin (pin 02) of the 15-pin connector, internal actuator harness side.



Injector Solenoid Circuit Checks (Cont)

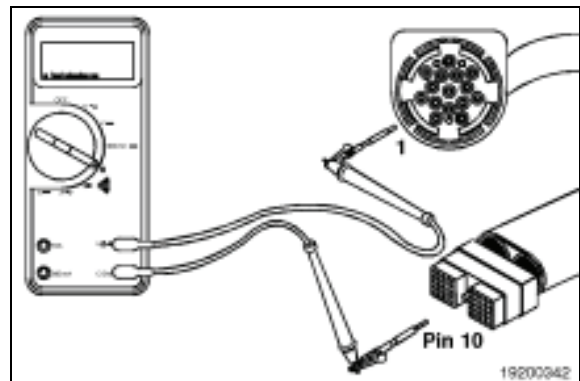
Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, replace the internal actuator harness. Refer to Procedure [019-063](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322. Do not repair the wires.

Connect the 15-pin connector when the repair is completed.



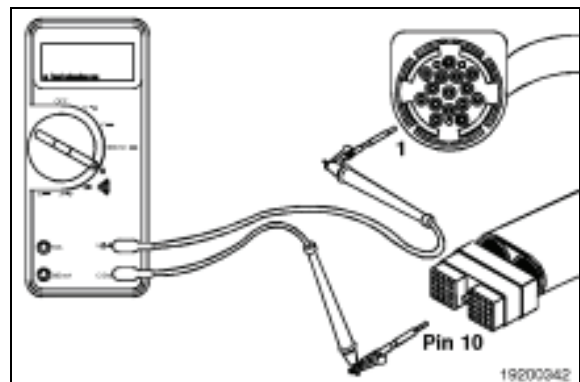
Check the external actuator harness for an open circuit. Refer to the accompanying chart at the beginning of this section for the pins required.

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.



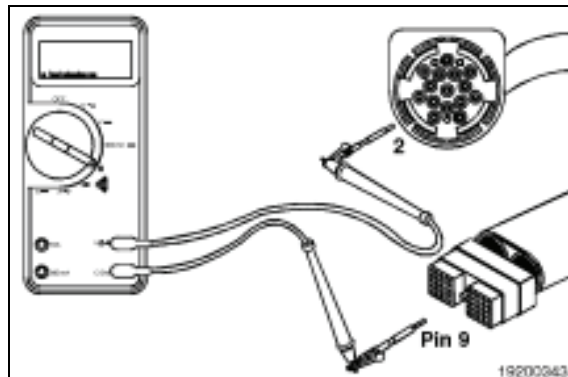
Insert the other multimeter probe on the supply pin (pin 01) at the 15-pin connector, external actuator harness side. Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, repair the wire or replace the actuator harness. Refer to Procedure [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Connect the 15-pin connector when the repair is completed.

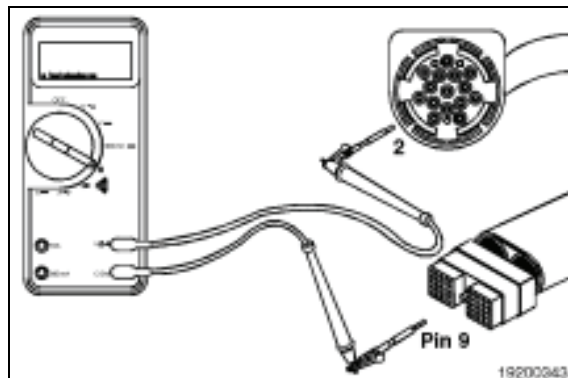


Injector Solenoid Circuit Checks (Cont)

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.



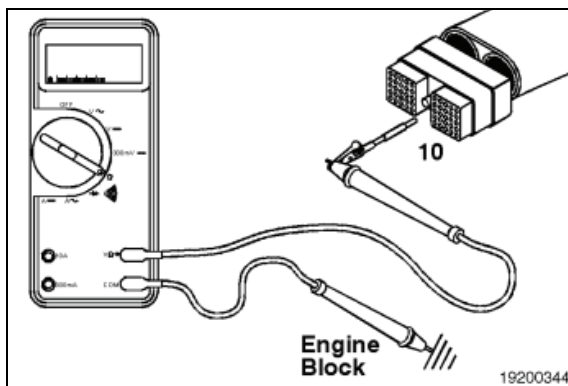
Measure the resistance. The resistance must be less than 10 ohms. If more than 10 ohms are measured, repair the return wire or replace the actuator harness. Refer to Procedure [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Connect the 15-pin connector when the repair is completed.

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.



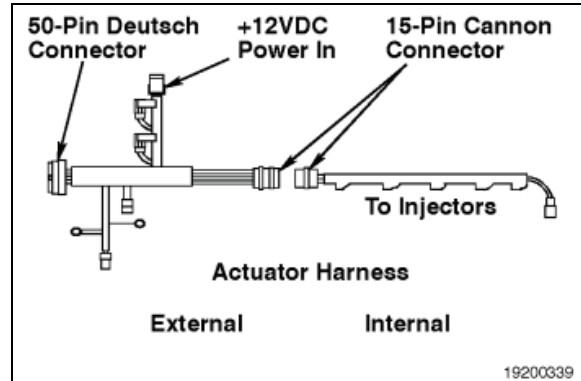
Injector Solenoid Circuit Checks (Cont)

Check for Short Circuit to Ground

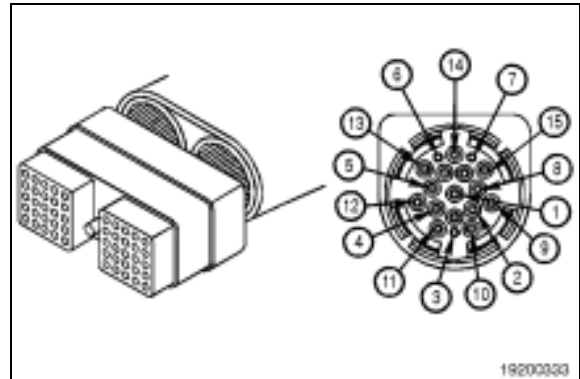


The injector solenoids receive high voltage when the engine is operating. To reduce the possibility of personal injury or death from electrical shock, do not wear jewelry or damp clothing, and do not touch the injector solenoids or the solenoid wires when the engine is operating.

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.



The pins of the circuits are as follows:



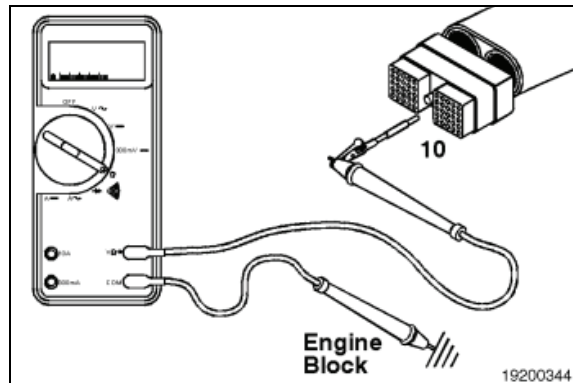
Cyl. No.	Supply Pin			Return Pin		
	ECM Conn.	15-Pin Conn.	Inj. Pin	ECM Conn.	15-Pin Conn.	Inj. Pin
1	10	01	A	09	02	B
2	08	03	A	07	04	B
3	06	05	A	16	06	B
4	26	07	A	36	08	B
5	04	09	A	03	10	B
6	02	11	A	01	12	B

Injector Solenoid Circuit Checks (Cont)

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.

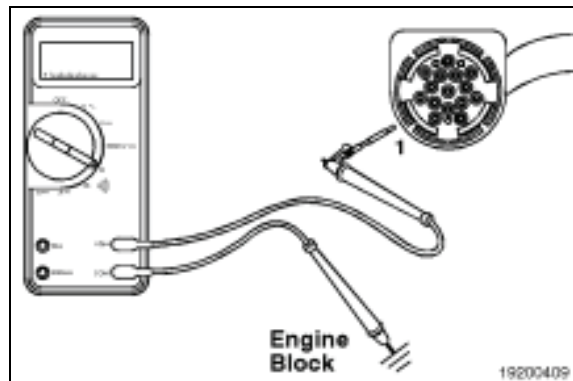


19200344

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322. If the circuit is open, repair or replace the external actuator harness.



19200409

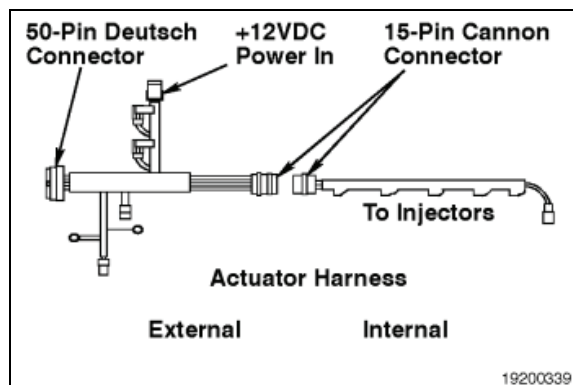
Check for Short Circuit from Pin to Pin



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.

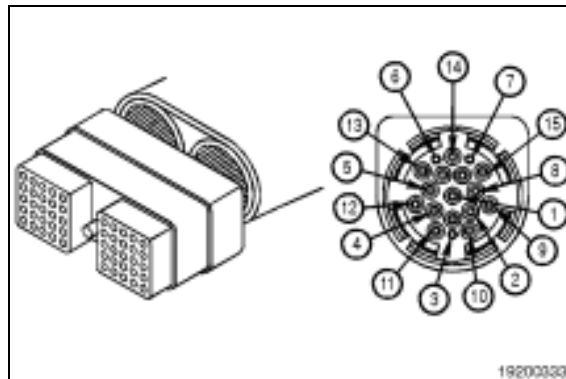
Check for a short circuit from pin to pin. Refer to the accompanying chart for the pins required. Cylinder Number 1 will be used as an example.



19200339

Injector Solenoid Circuit Checks (Cont)

The pins of the circuits are as follows:

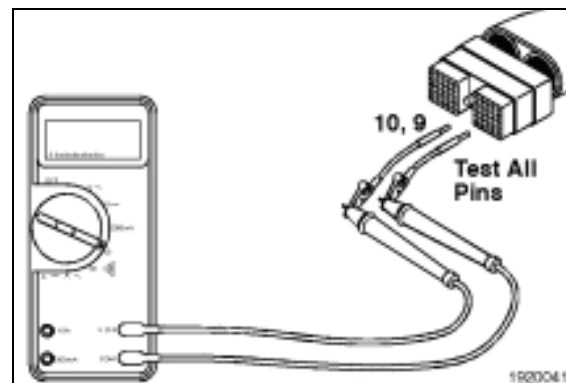


Cyl. No.	Supply Pin			Return Pin		
	ECM Conn.	15-Pin Conn.	Inj. Pin	ECM Conn.	15-Pin Conn.	Inj. Pin
1	10	01	A	09	02	B
2	08	03	A	07	04	B
3	06	05	A	16	06	B
4	26	07	A	36	08	B
5	04	09	A	03	10	B
6	02	11	A	01	12	B

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

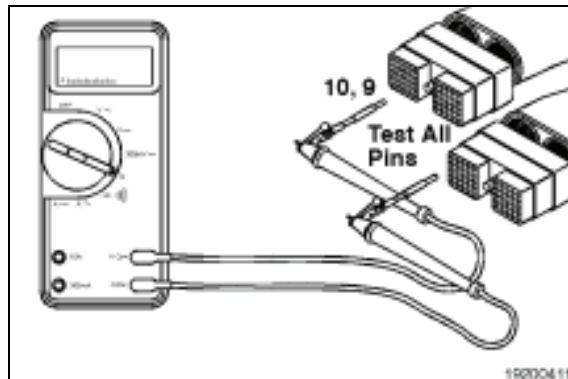


Injector Solenoid Circuit Checks (Cont)

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

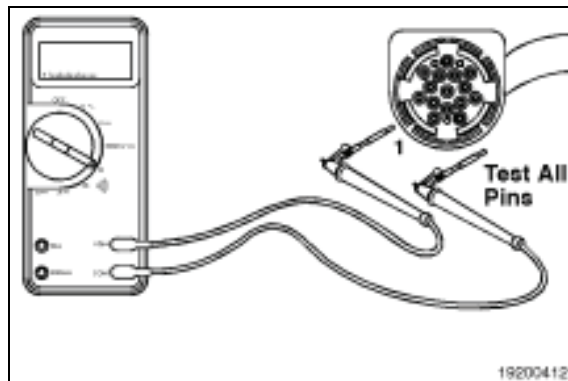


Check for a short circuit from pin to pin in the 15-pin pass-through connector. Disconnect the internal harness from the injector solenoid.



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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

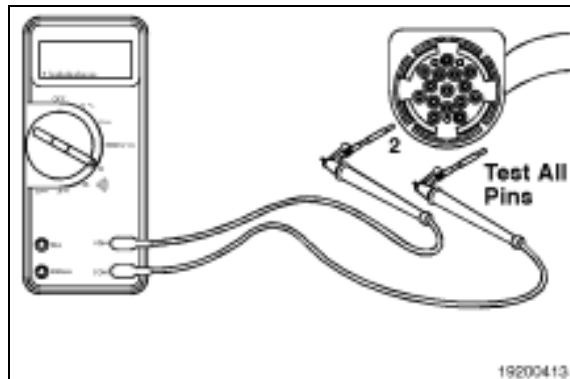


Injector Solenoid Circuit Checks (Cont)

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](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Connect all components after completing the repair.



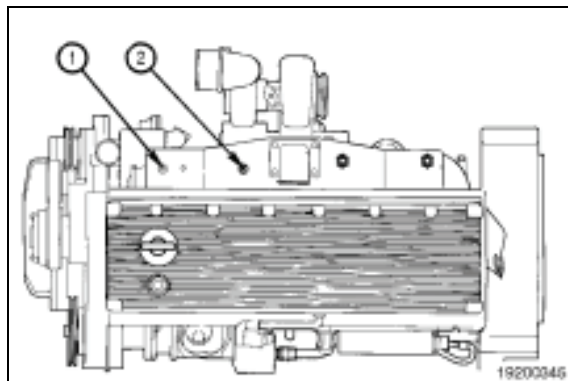
Follow-Up

Intake Manifold Air Temperature Sensor Removal/Installation

Prepare

General Information

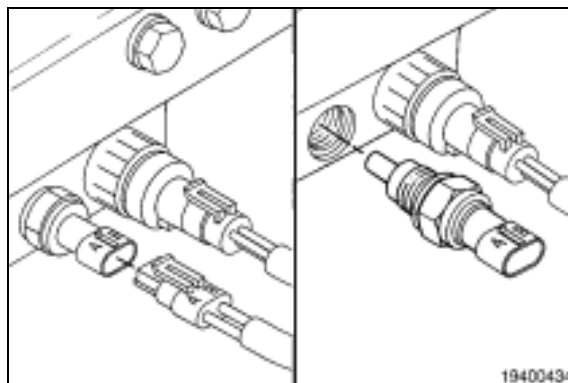
The intake manifold air temperature (2) and intake manifold air pressure (1) is located on the top front half of the intake manifold. The ECM uses this information for the engine protection system.



Remove

Lift up on the locking tab and pull the electrical connectors apart.

Remove the sensor from the engine.

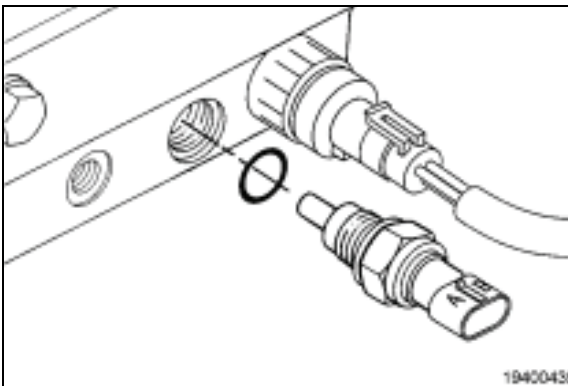


Install

Make sure the new sensor has an o-ring.

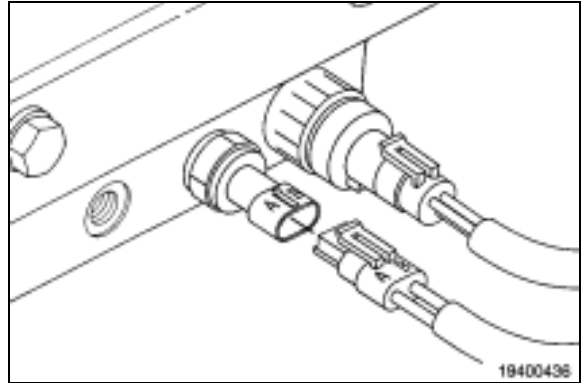
Install the new sensor into the engine. Tighten the sensor.

Torque Value: 14 N•m [124 in-lb]



Intake Manifold Air Temperature Sensor Removal/Installation (Cont)

Push the connectors together until they lock.



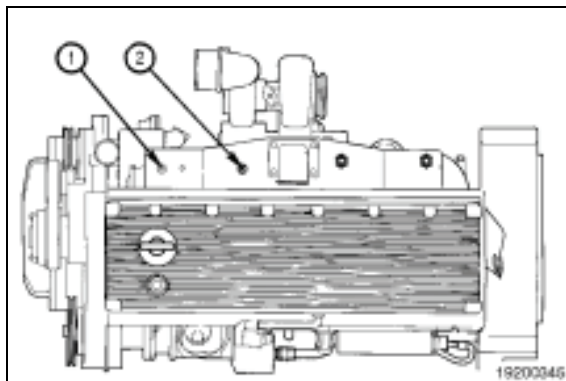
Follow-Up

Intake Manifold Pressure Sensor Removal/Installation

Prepare

General Information

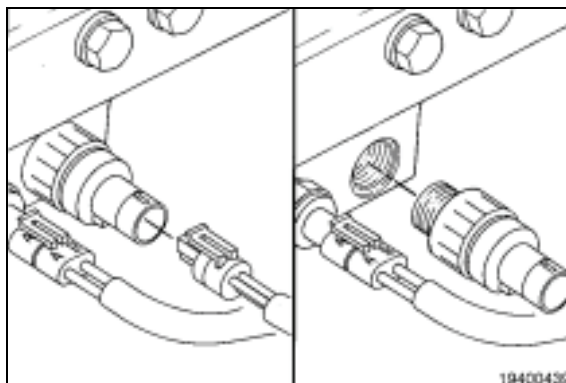
The intake manifold air pressure (1) and intake manifold air temperature (2) is located on the top front half of the intake manifold. The ECM uses this information for the engine protection system.



Remove

Lift up on the tab and disconnect the connector from the sensor.

Remove the sensor from the air intake manifold with deep flank drive socket, Part No. 3823843.

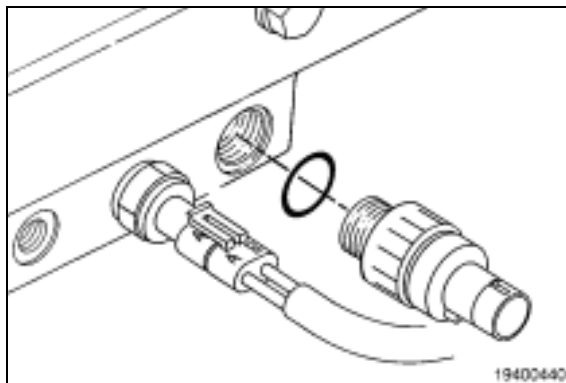


Install

Make sure the new sensor has an o-ring around the surface where it seals against the air intake manifold.

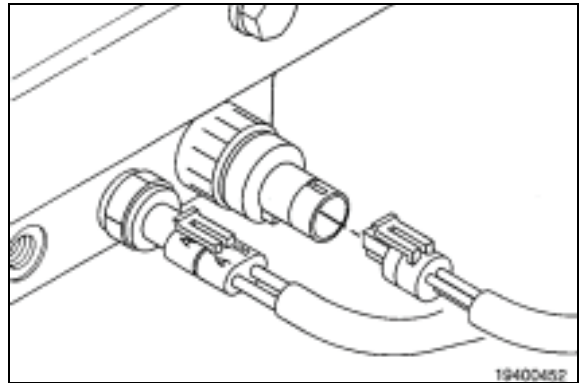
Install the sensor into the air intake manifold by turning it clockwise.

Torque Value: 14 N•m [124 in-lb]



Intake Manifold Pressure Sensor Removal/Installation (Cont)

Push the harness connector into the sensor until it locks.



Follow-Up

Internal Actuator Wiring Harness Removal/Installation

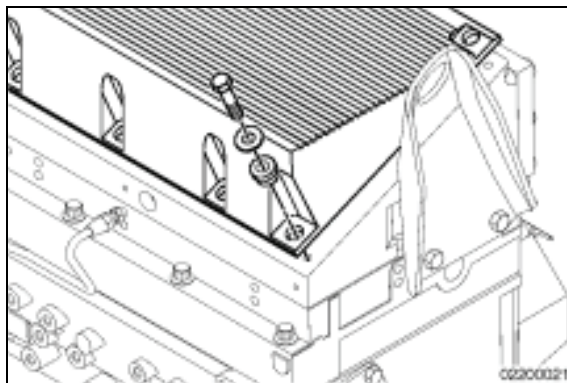
Prepare

Remove

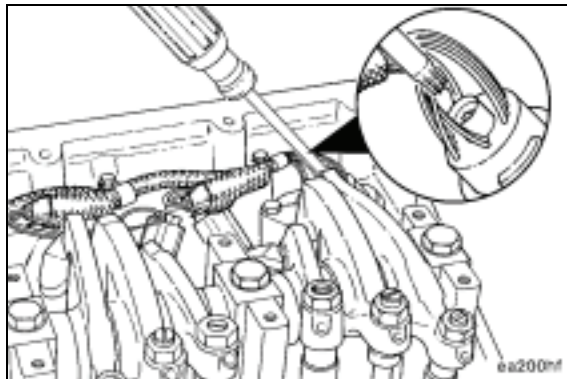
Remove the rocker lever cover.

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.

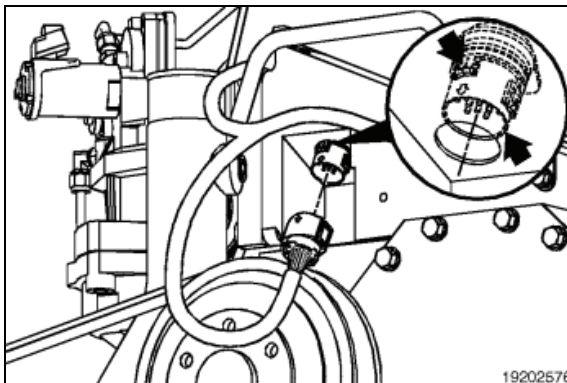


If equipped, use a Torx® screwdriver to remove the locking capscrew that holds the Metri-Pack 12-pin connectors together.



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.

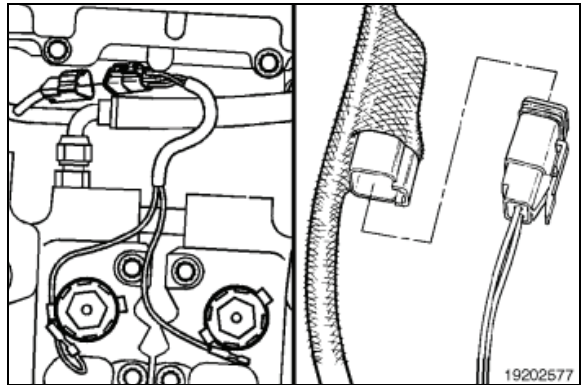


Internal Actuator Wiring Harness Removal/Installation (Cont)

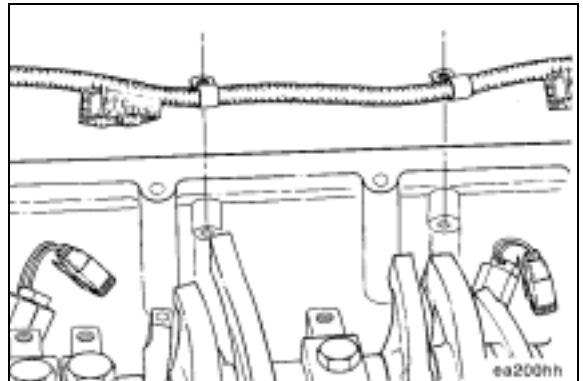
If equipped disconnect the engine brake harness from the engine brake solenoids.

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.

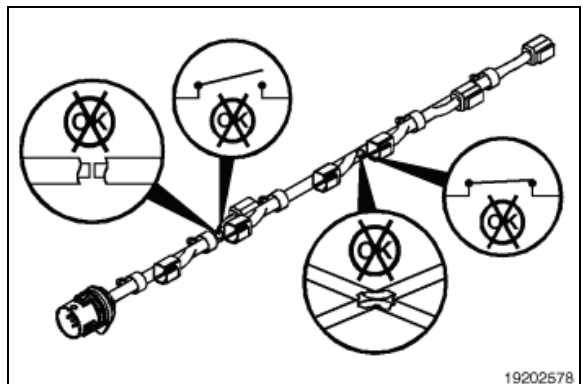


Remove the five hold down capscrews securing the internal actuator harness to the rocker lever housing.



Inspect for Reuse

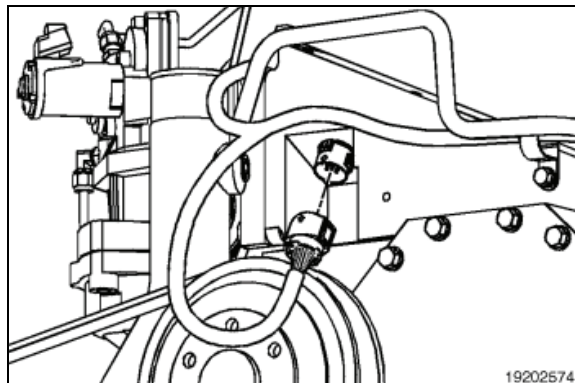
Replace or repair the internal actuator harness if there is an open circuit or a short circuit found under the protective covering of the harness body.



Internal Actuator Wiring Harness Removal/Installation (Cont)

Clean the connector bore in the rocker lever housing.

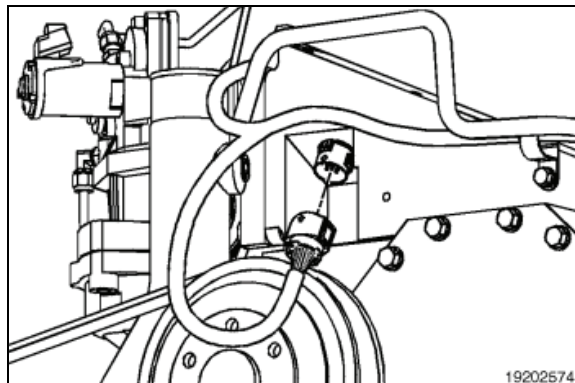
Apply Lubriplate™, multi-purpose lubricant, to the external sealing ring to ease assembly.



Install

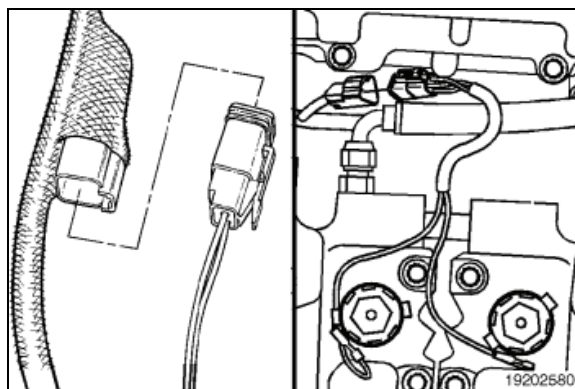
Push the internal actuator harness connector through the rocker lever housing until the locking tabs lock into position on the front of the rocker lever housing.

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.



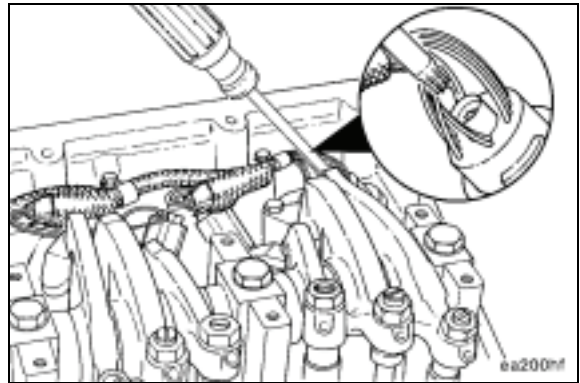
Internal Actuator Wiring Harness Removal/Installation (Cont)

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.

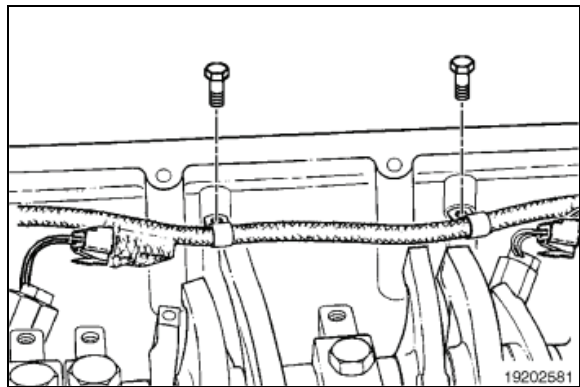
Torque Value: 1 N•m [9 in-lb]



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.

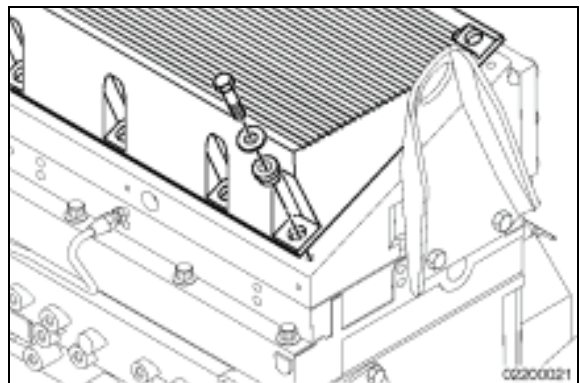
Torque Value: 20 N•m [180 in-lb]



Install the rocker lever cover.

For the 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, SELECT™, SELECT™ Plus Models), Bulletin 3666139.

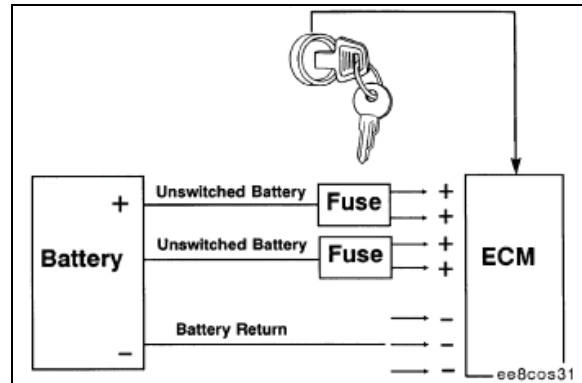


Follow-Up

Key Switch Battery Supply Circuit Voltage Check

Prepare

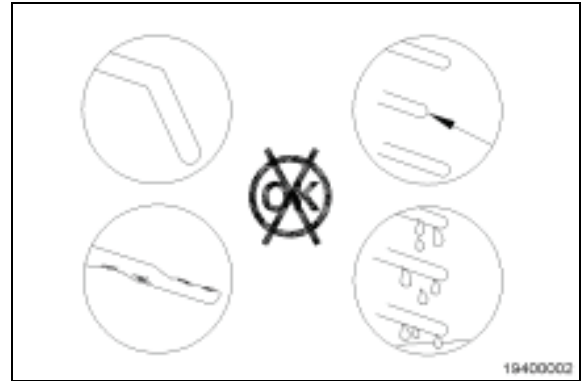
The keyswitch supplies an input signal to the ECM that turns the ECM on or off.



Turn the keyswitch to the OFF position.

Disconnect the OEM harness connector from the ECM.

Inspect the connector pins.



Key Switch Battery Supply Circuit Voltage Check (Cont)



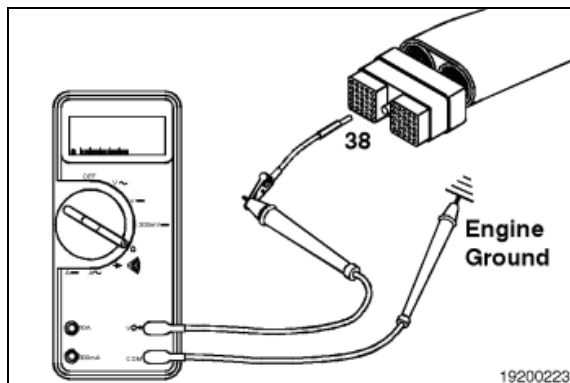
Use the appropriate test leads from wiring harness repair kit, Part No. 3162899, to avoid damage to the connector pins.

Adjust the multimeter to measure voltage.

Touch the positive (+) multimeter probe with attached lead to pin 38 of the OEM harness connector. Touch the other probe to the engine block ground.

Turn the keyswitch to the ON position.

The measured voltage must show battery voltage. If the measured voltage is more than 0.5 VDC below battery voltage, continue with the next step.



Connect the OEM harness connector. Disconnect the bulkhead connector. Inspect the connector pins. Refer to the OEM troubleshooting and repair manual for the proper procedure.

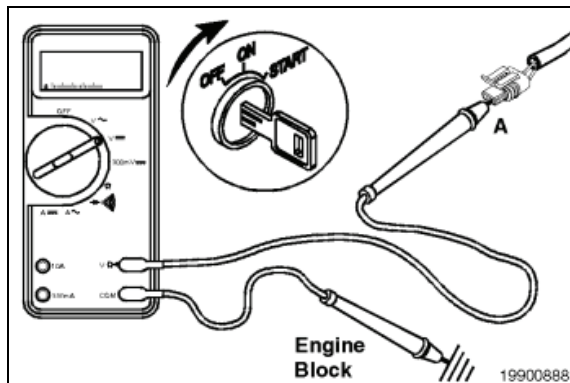
Touch the positive (+) multimeter probe to the pin on the OEM side of the bulkhead connector.

Touch the other probe to the engine block ground.

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 5A fuse, keyswitch, or battery connection.

Repair or replace the OEM harness 5A fuse or keyswitch, or check the battery connections.



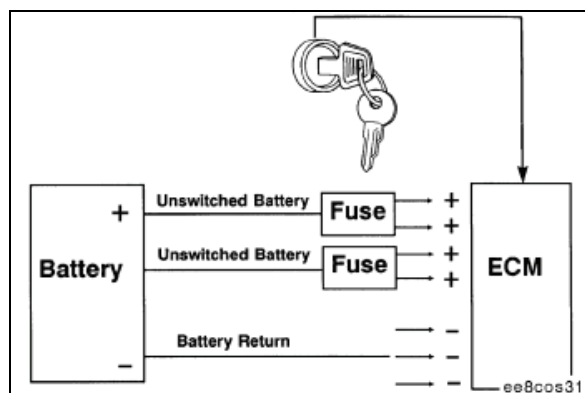
Follow-Up

Unswitched Battery Supply Circuit Checks

Prepare

General Information

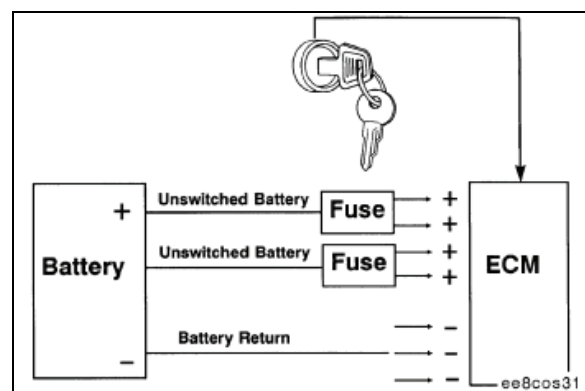
The ECM receives constant voltage from the batteries through the unswitched battery wires that are connected directly to the (+) positive battery post. There are two in-line 15-amp fuses in each of the unswitched battery wires to protect the ECM. The ECM receives switched battery input through the switch 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.

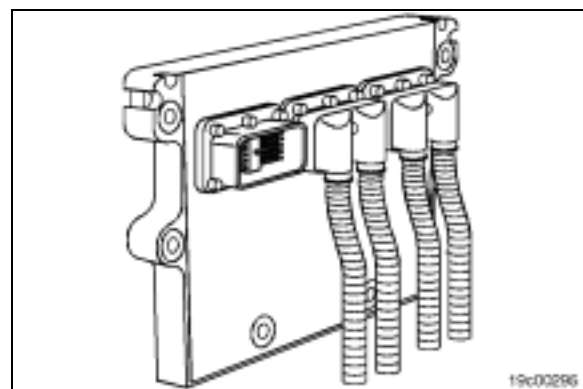
Always check the unswitched battery supply fuses when troubleshooting the ECM and power supply circuits.

Check the battery voltage. Refer to Procedure [019-008](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Resistance Check

Disconnect the OEM harness from the ECM.

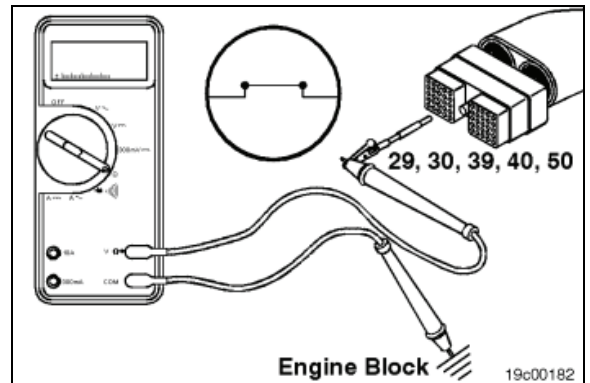


Unswitched Battery Supply Circuit Checks (Cont)

Adjust the multimeter to measure resistance.

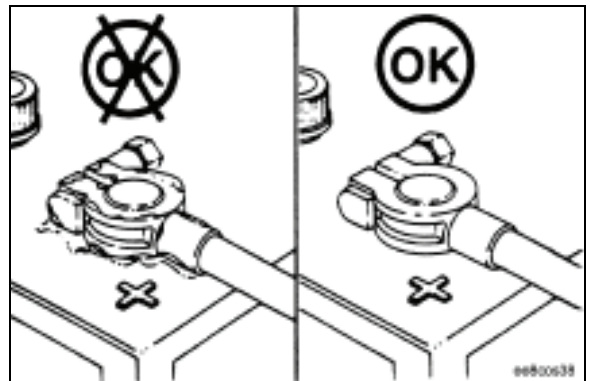
Insert one test lead into pin 29 of the OEM harness connector and connect it to the multimeter probe. Touch the other multimeter probe to the engine block ground and measure the resistance. The multimeter must show a closed circuit of 10 ohms or less.

Test pins 29, 30, 39, 40, and 50 in the same manner.

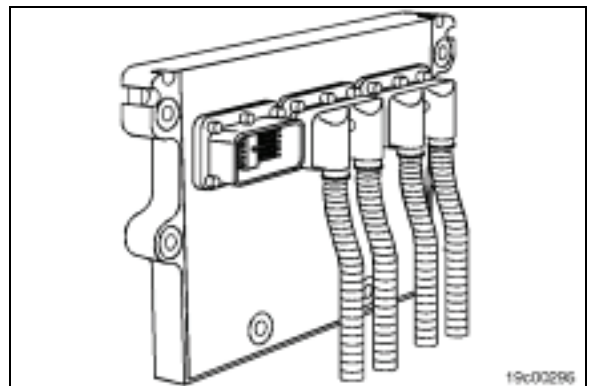


If the resistance value is not correct, check the batteries, cables, and cable connections.

Repair or replace the parts as required.

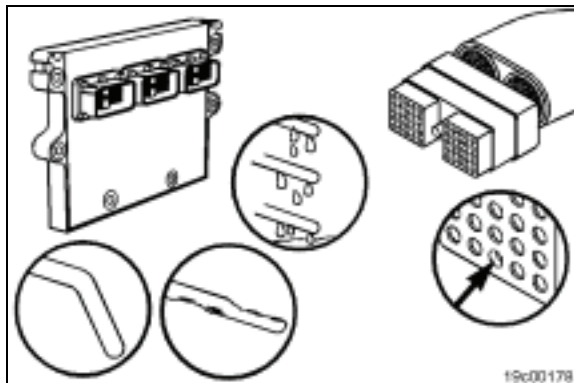


When the checks have been completed, connect the OEM harness connector to the ECM.



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.

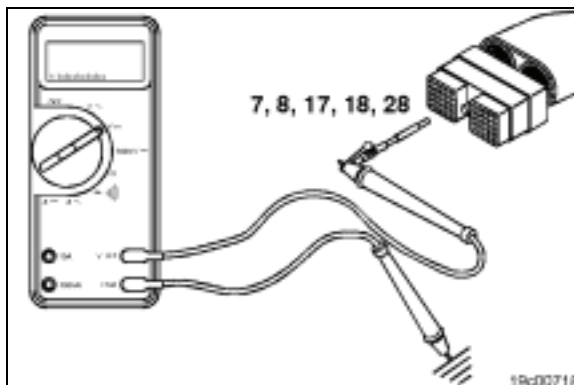
**Voltage Check**

Check the battery voltage supply at the 50-pin OEM harness connector.

Turn the switch 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**

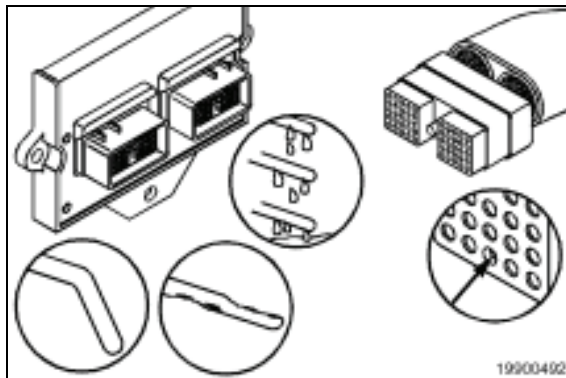
Oil Pressure/Temperature Sensor Checks

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.

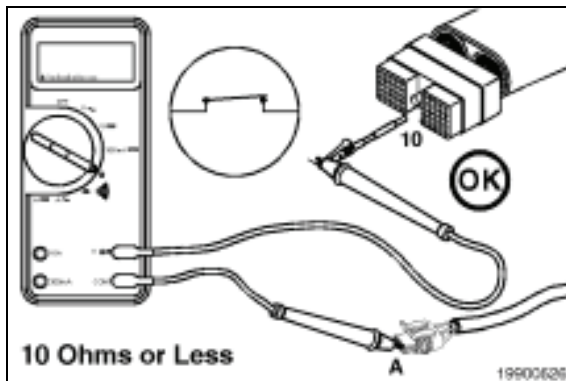


+5-VDC Supply Resistance - Checking



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.

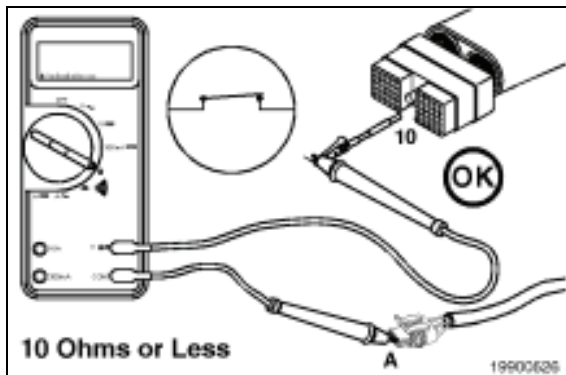
Insert the test lead into pin 10 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to pin A of the lubricating oil pressure sensor connector, harness side.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



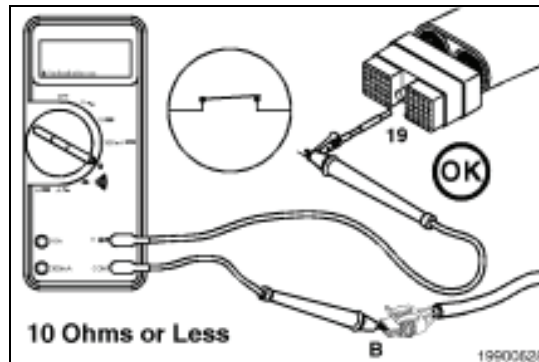
Oil Pressure/Temperature Sensor Checks (Cont)

Return Wire Resistance - Checking



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.

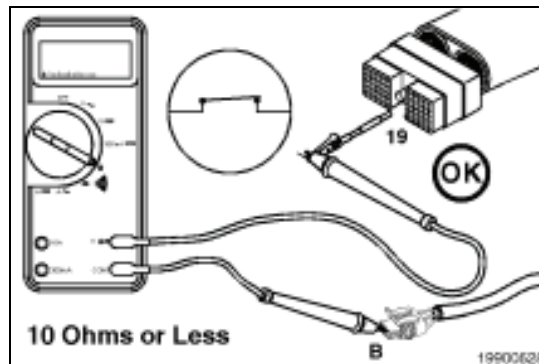
Insert the test lead into pin 19 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to pin B of the lubricating oil pressure sensor connector, harness side.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Signal Wire Resistance – Checking

Insert the pin of a lead into pin 33 of the engine harness connector.

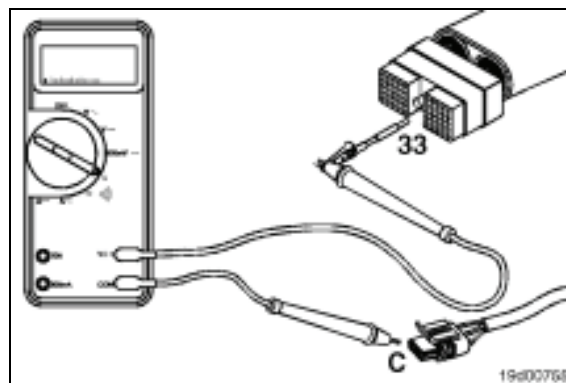
Connect the alligator clip to the multimeter probe.

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Oil Pressure/Temperature Sensor Checks (Cont)

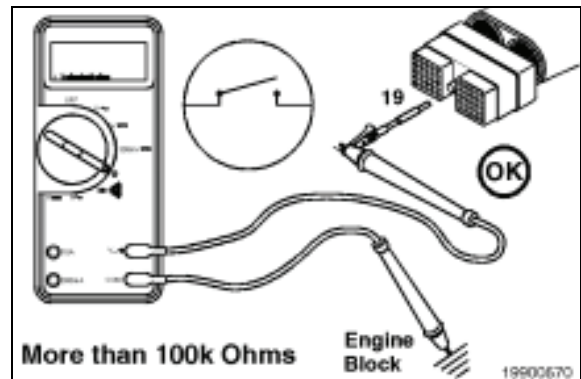
Check for Short Circuit to Ground

Return Wire Short – Checking

Disconnect the lubricating oil sensor from the wiring harness.

Disconnect the engine harness from the ECM.

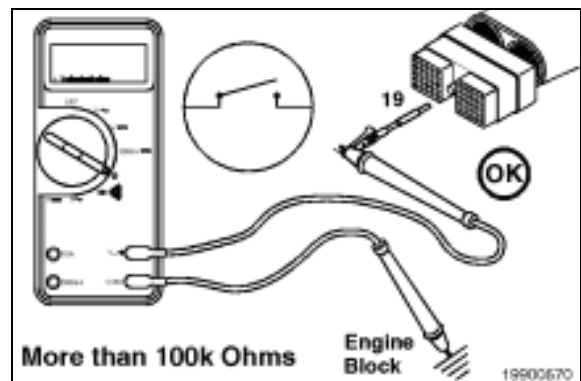
Insert the test lead into pin 19 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to engine block.



Measure the resistance.

The multimeter must show an open circuit (more than 100k ohms).

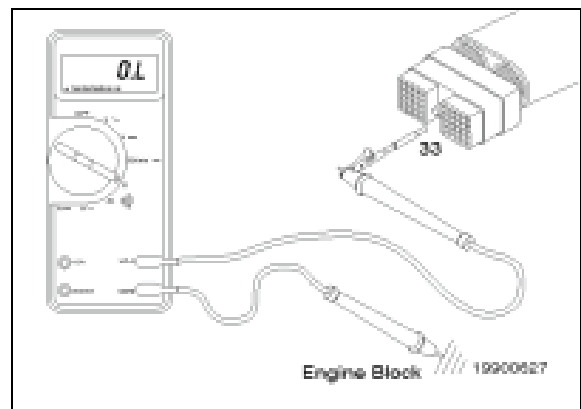
If the circuit is not open, there is a short circuit to ground in the return wire. Repair the wire, or replace the engine harness. Refer to Procedure [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



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.

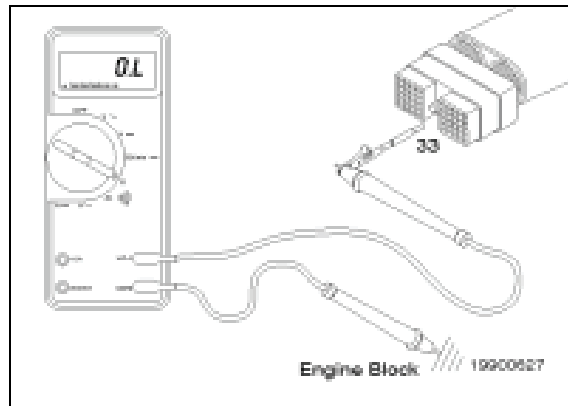


Oil Pressure/Temperature Sensor Checks (Cont)

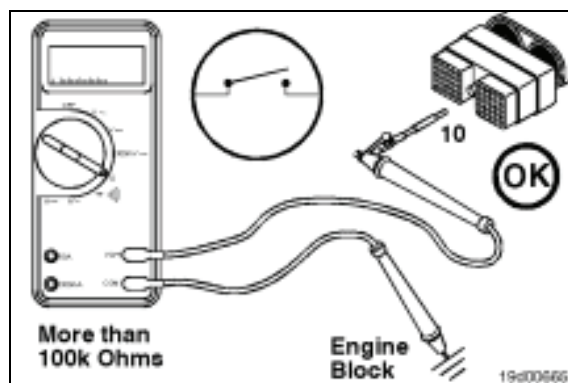
Measure the resistance.

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 signal wire. Repair the wire, or replace the engine harness. Refer to Procedure [019-043](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

**+5 VDC Supply Wire Short – Checking**

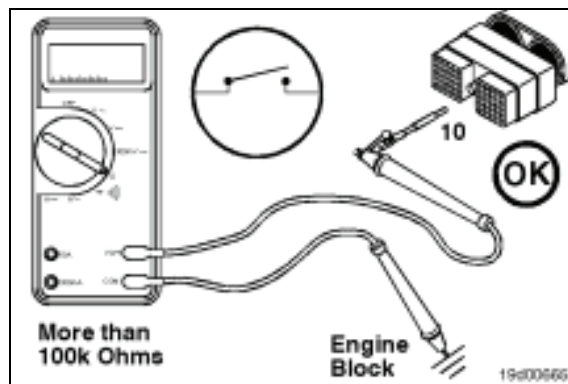
Insert the test lead into pin 10 of the engine harness connector. Connect the alligator clip to the multimeter probe. Touch the other multimeter probe to engine block.



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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Oil Pressure/Temperature Sensor Checks (Cont)

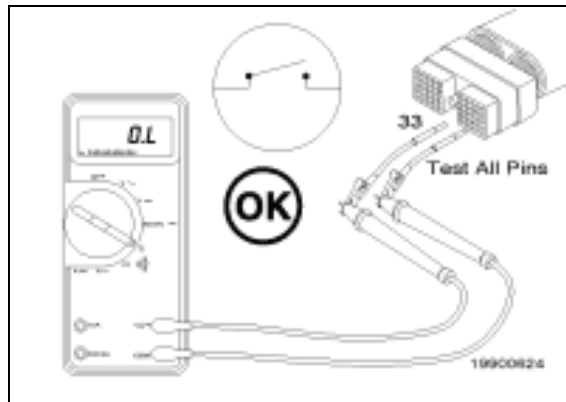
Check for Short Circuit from Pin to Pin

Signal Wire Short – Checking

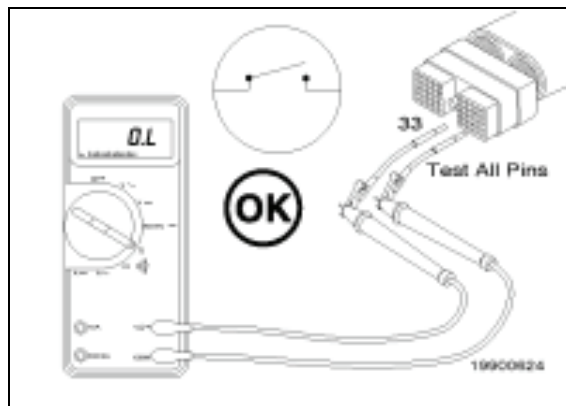
Disconnect the lubricating oil sensor from the engine harness.

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 Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.



Follow-Up

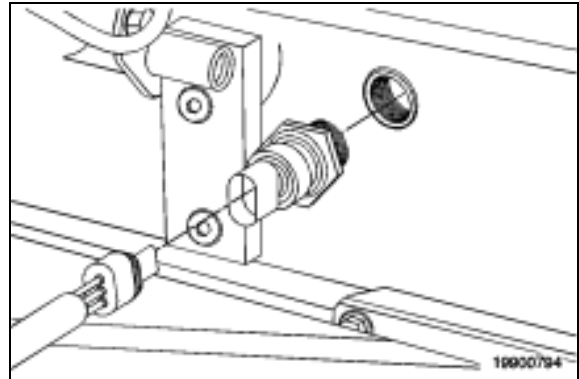
Engine Oil Pressure Removal/Installation

Prepare

Remove

Disconnect the lubricating oil pressure sensor from the engine harness.

Remove the oil pressure sensor.

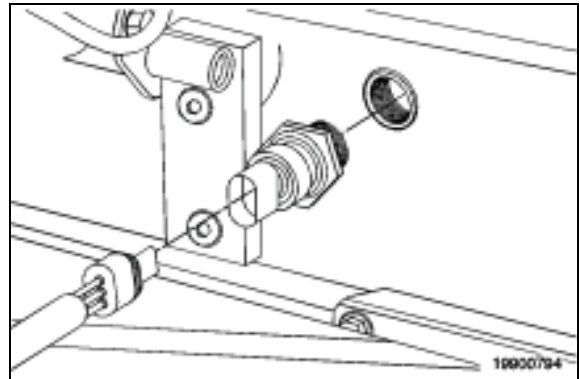


Install

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

Oil Pressure/Temperature Sensor Removal/Installation

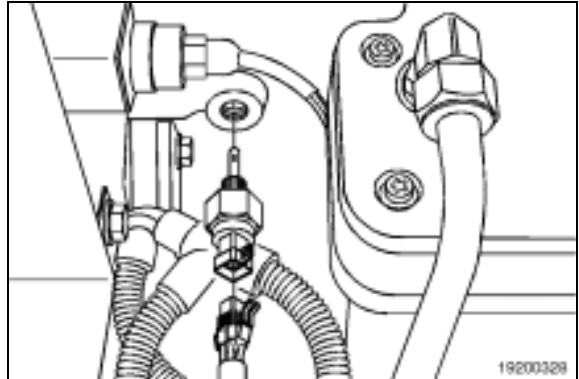
- [Remove](#)
- [Install](#)

Prepare

Remove

Disconnect the oil pressure/temperature sensor from the sensor harness.

Remove the sensor.

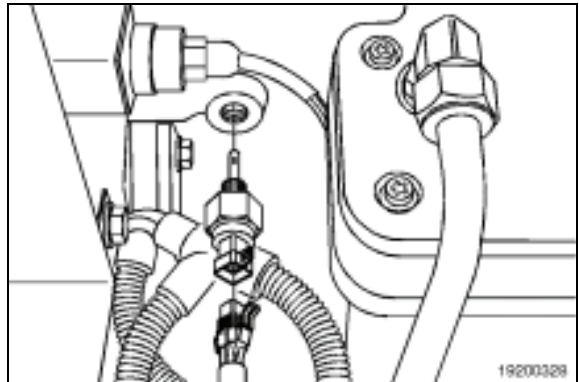


Install

Install the oil pressure/temperature sensor.

Torque Value: 14 N•m [124 in-lb]

Connect the sensor to the sensor harness. An audible 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 SELECT™ 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.

Engine Datalink Information (Cont)

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.

Description	Adapter Kit Part Number	Service Tool Instruction Sheet Part Number
INLINE™	3163099	3377728
INLINE™ I	3163682	3377845
INLINE™ II	3163094	3377728

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

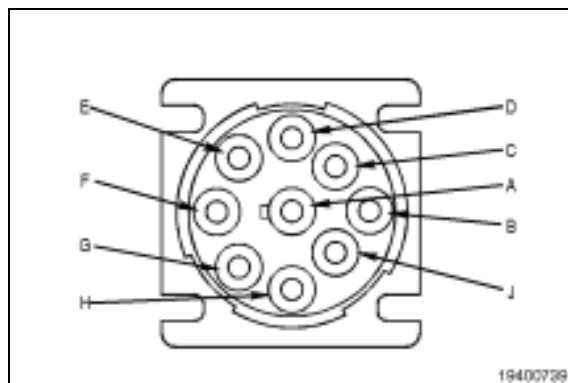
The INLINE™ II adapter has software within the adapter that may need to be updated periodically. The software is referred to as Firmware. When a new Firmware version is available, it will be distributed on the INCAL™ CD ROM. Refer to the instruction with the CD ROM to download the new Firmware version into the INLINE™ II.

Engine Datalink Information (Cont)

Datalink Connectors

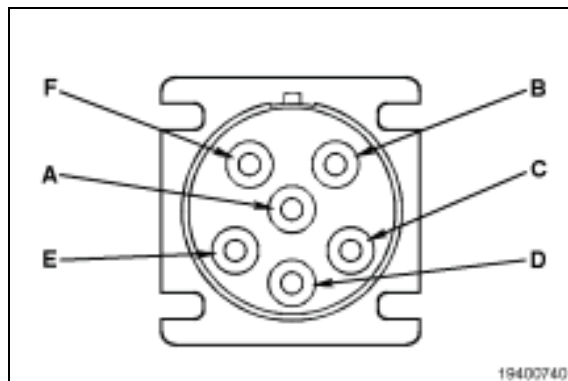
The recommended datalink connector for Cummins engines is a 9-pin Deutsch connector, Part Number 3824018. This connector can supply SAE J1587/SAE 1708 and SAE J1939 communications, and battery voltage. The following are pin-outs for the 9-pin connector:

Pin	Signal
A	Ground
B	Unswitched Battery
C	J1939 datalink (+)
D	J1939 datalink (-)
E	J1939 datalink (shield) (not applicable for Marine)
F	J1708 datalink (+)
G	J1708 datalink (-)
H	Open
J	Open



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:

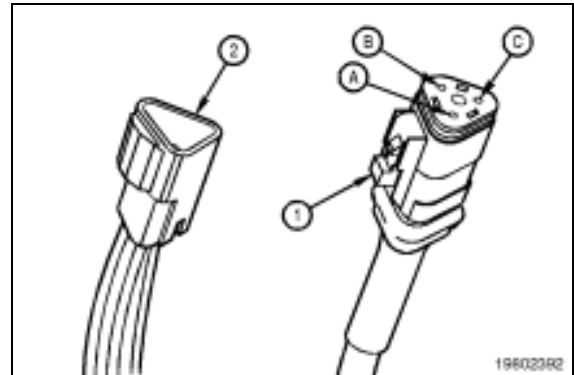
Pin	Signal
A	J1708 datalink (+)
B	J1708 datalink (-)
C	Unswitched battery (+)
E	Ground
F	Open
D	Open



Engine Datalink Information (Cont)

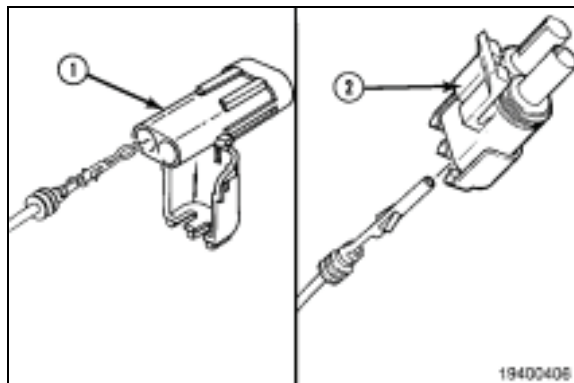
The 3-pin SAE J1939 Deutsch connectors are also found on Cummins engines. Two possible types of 3-pin connectors can be present: A 3-pin plug (1), Part Number 3824288; and a 3-pin receptacle (2), Part Number 3284290. The 3-pin connectors only supply the Society Automotive Engineers (SAE) J1939 support (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)



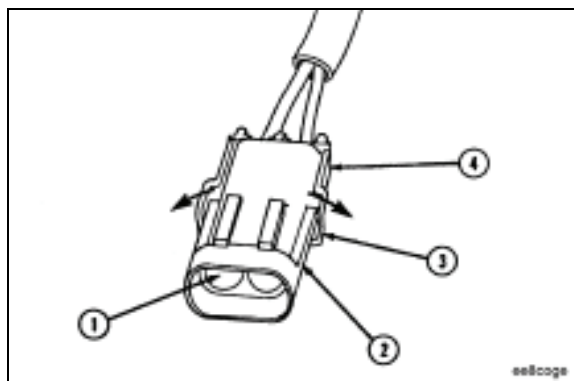
The 2-pin connector is on many older engines, it only supplies SAE J1587/J1708 support (no battery voltage supply). The following are the pin-outs for the 2-pin connector:

Pin	Signal
A	J1587/J1708 datalink (+)
B	J1587/1708 datalink (-)



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 (-)



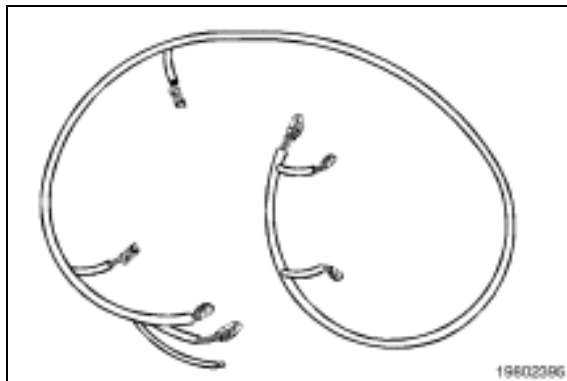
Engine Datalink Information (Cont)

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.

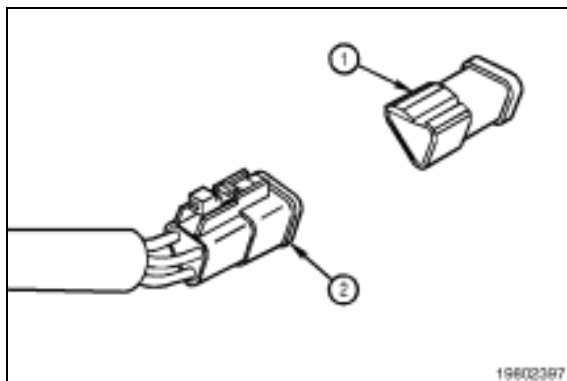
The main component of an SAE J1939 system is a backbone harness. The harness can be up to 40 m [131 ft] long. The backbone harness is terminated at each end with 120 ohm resistor.

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.

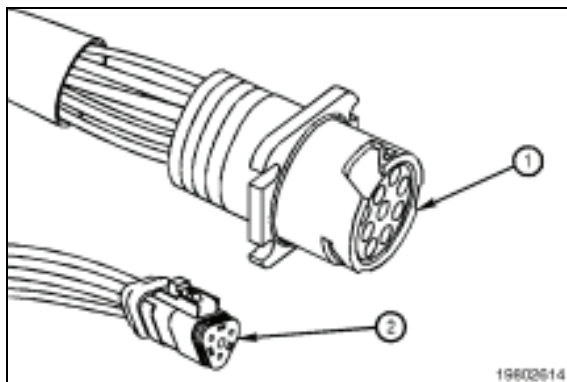


The terminating resistor caps (1) must be in place on the backbone harness plugs (2) to maintain proper communication. Each resistor is 120 ohms and is located in a removable cap. This resistance is required when communicating with INSITE™ over the J1939 datalink.

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.

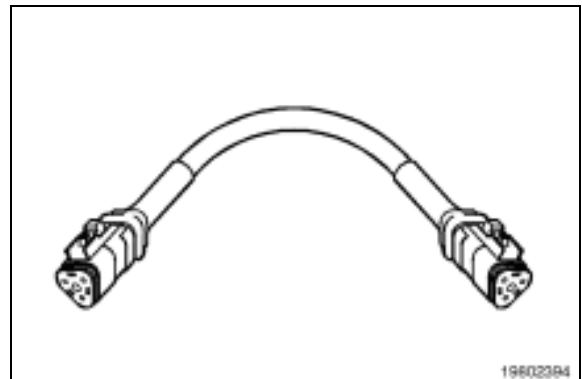


Some OEMs will choose to provide a complete SAE J1939 backbone harness. If this is supplied, connection to INSITE™ is accomplished either by a 9-pin datalink connector (1), Part Number 3824018, or a 3-pin plug (2), Part Number 3824288.



Engine Datalink Information (Cont)

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 mini-backbone harness must be added. The Cummins INLINE™ II adapter kit, Part Number 3163682, supplies a mini-backbone harness, Part Number 3163096.



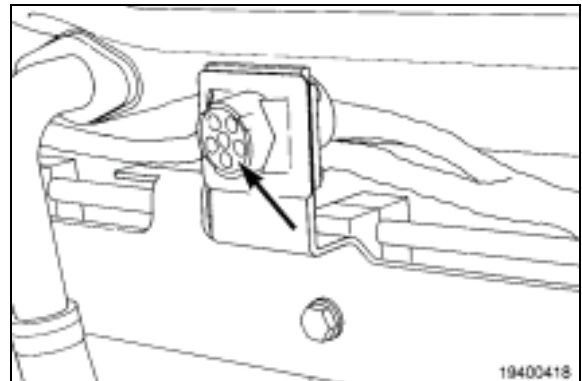
Look for a 6-pin datalink connector in the cab or helm of the vessel.

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 SELECT™ Plus engines, do not use the in-cab 6-pin datalink connector to calibrate the ECM. Use the datalink connector found on the engine.



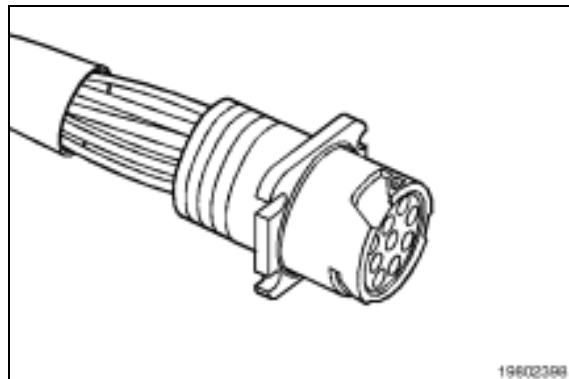
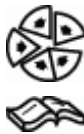
Engine Datalink Information (Cont)

Look for a 9-pin datalink connector in the cab or helm of the vessel.

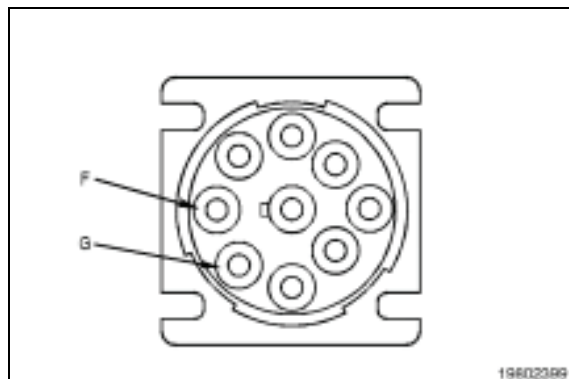
The 9-pin datalink connector supports both the SAE J1587/SAE J1708 and the SAE J1939 datalinks. Any INLINE™ datalink adapter can be used in conjunction with this connector. Use INLINE™ cable, Part Number 3162848, when connecting to the 9-pin connector.

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.



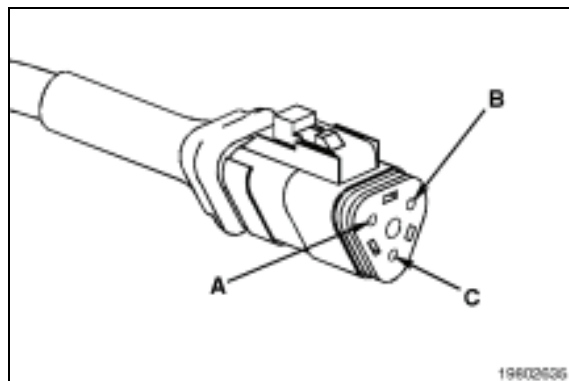
To use the INLINE™ or INLINE™ I with the 9-pin connector, verify that pins F and G are populated. If pins F and G are not populated you must use an INLINE™ II and communicate via the SAE J1939 datalink.



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.



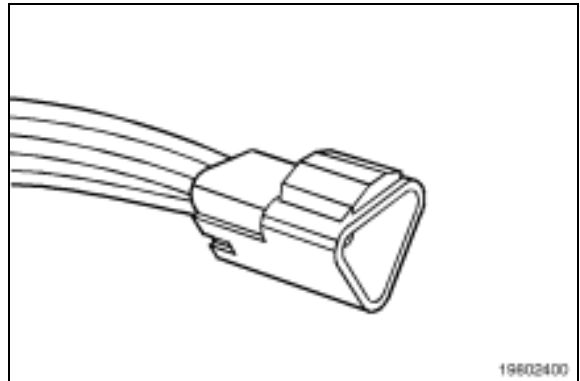
Engine Datalink Information (Cont)

On an ISB (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 mini-backbone 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 in a Dodge Ram pickup truck, the 3-pin plug connector is located near the fuel pump on the front gear housing.

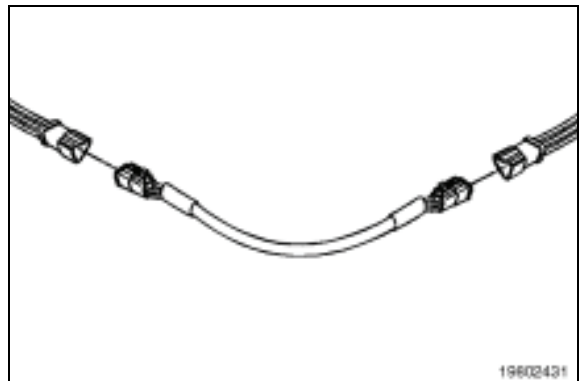


Other engines have this connector in locations chosen by the OEM.

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 mini-backbone 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.

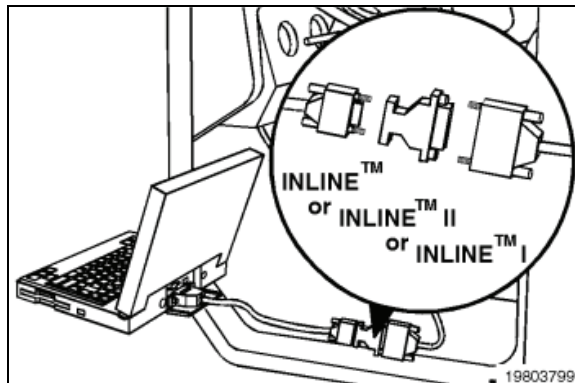
NOTE: If there is 60 ohm resistance measured between pins A and B of the 3-pin connector, then a backbone is on the datalink.



Engine Datalink Information (Cont)

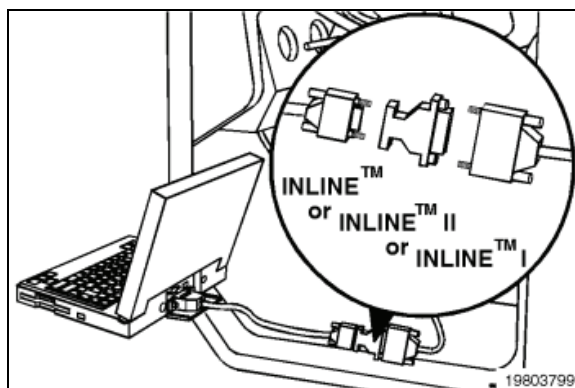
Possible configurations using a 9-pin connector:

- 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™



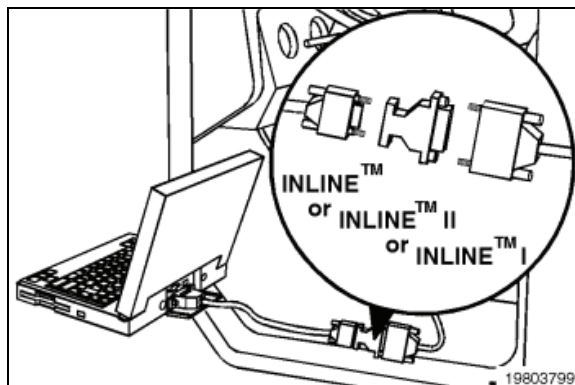
Possible configurations using a 6-pin connector:

- 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:

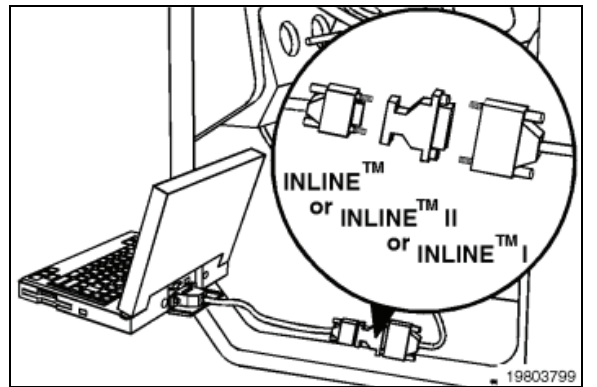
- On engine, SAE J1939, INLINE™ II



Engine Datalink Information (Cont)

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

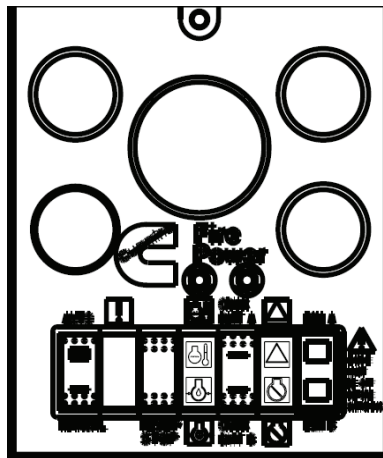
Initial Check

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

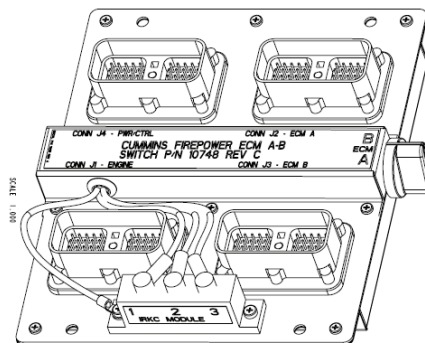


Turn the switch to the OFF position.

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

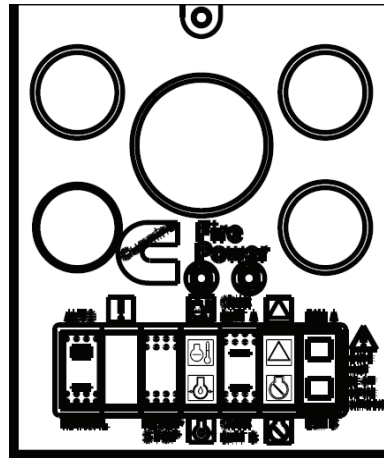
Initial Check

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

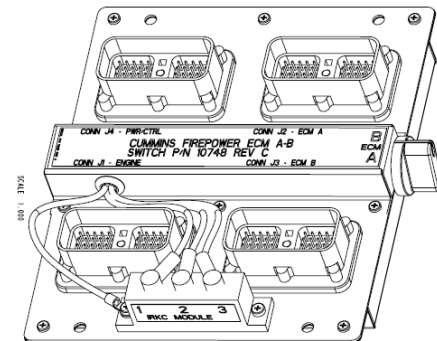


Turn the switch to the OFF position.

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.



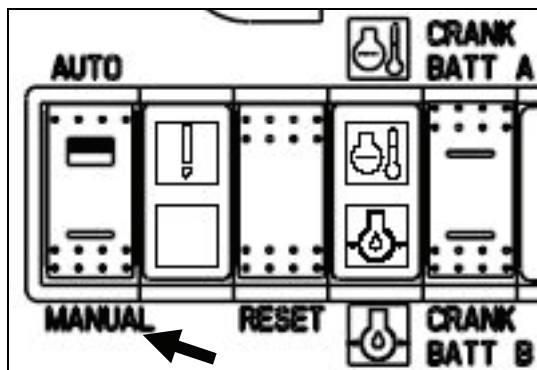
Follow-Up

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.

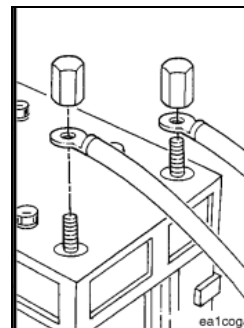


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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!

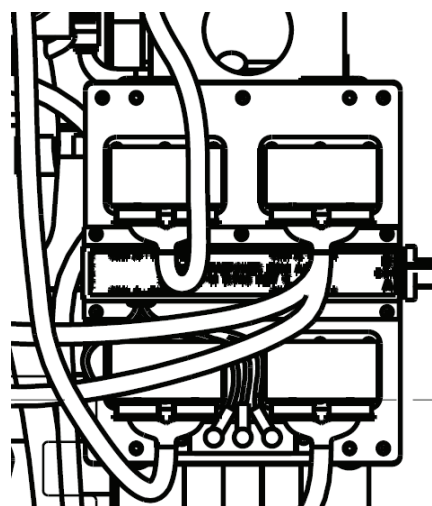
Next, disconnect both batteries at their terminals.



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.



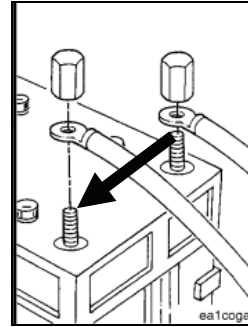
ECM Switch Printed Circuit Board Removal/Installation (Cont)

Follow Up

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

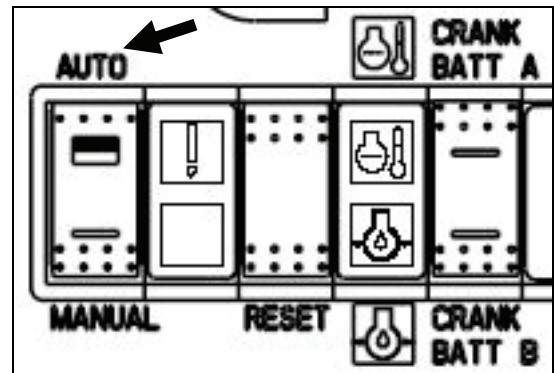
Wear safety glasses when reconnecting batteries!

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.

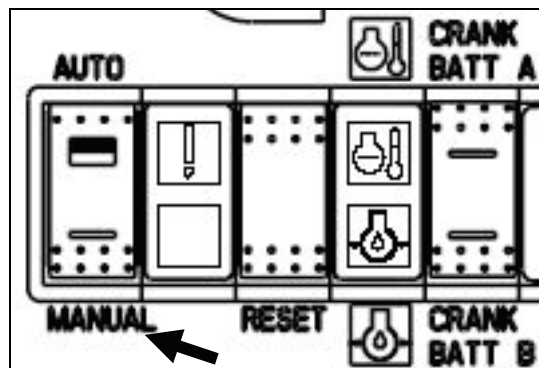


ECM A/B Switch Removal/Installation

Prepare

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

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

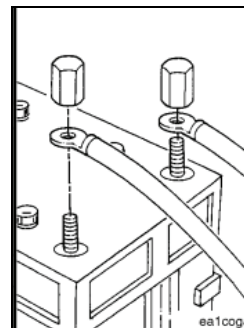


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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!

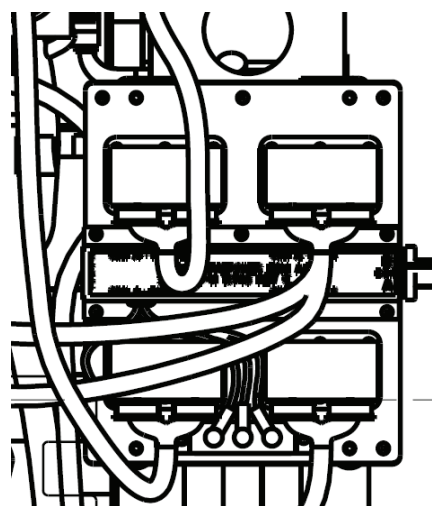
Next, disconnect both batteries at their terminals.



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.

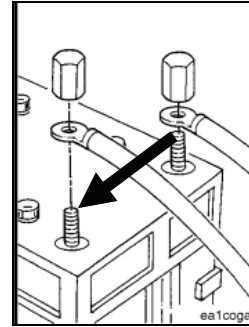


ECM A/B Switch Removal/Installation (Cont)

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

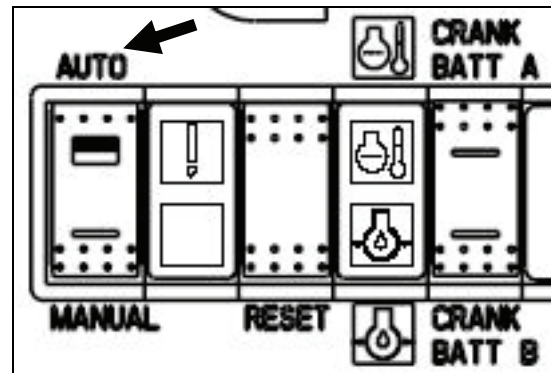
Wear safety glasses when reconnecting batteries!

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 to operating status.

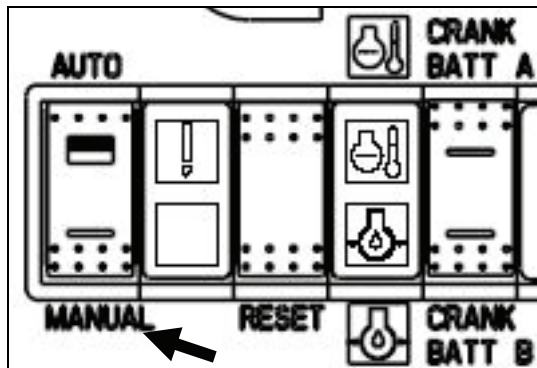


ECM Selector Switch Harness Removal/Installation

Prepare

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

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

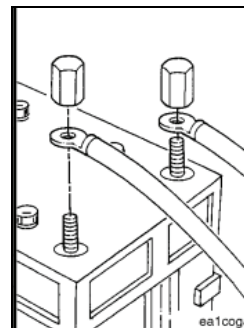


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.

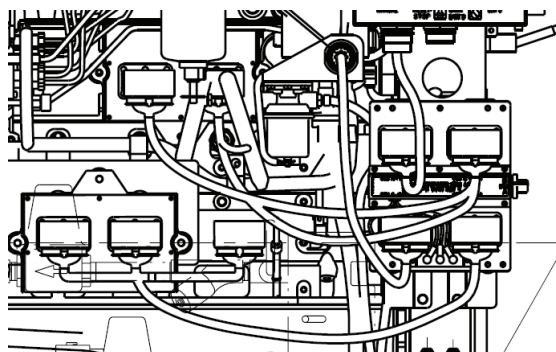
Wear safety glasses when disconnecting batteries!

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.

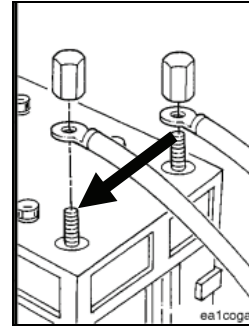


ECM Selector Switch Harness Removal/Installation (Cont)

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

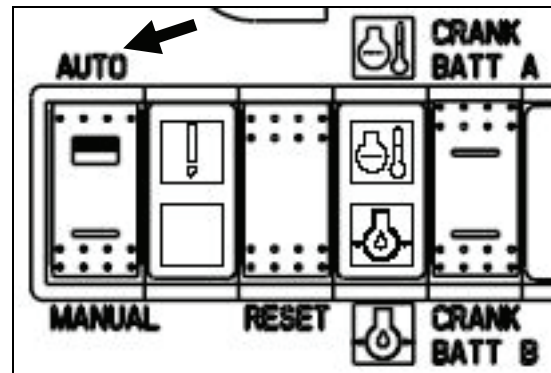
Wear safety glasses when reconnecting batteries!

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

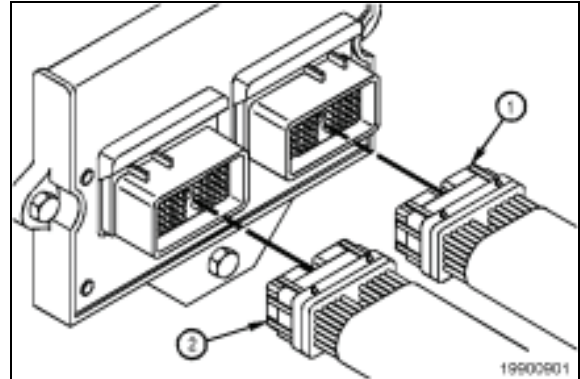
Prepare

General Information

The QSM11 engine uses two separate wiring harnesses to control the engine and some of the vehicle operations.

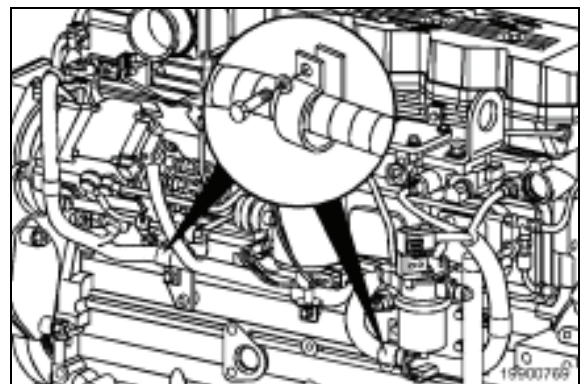
Engine Harness

OEM Harness

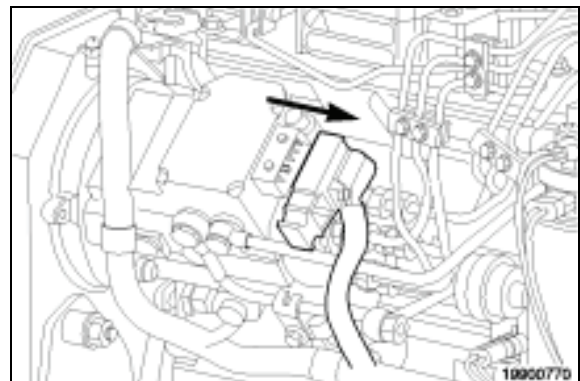


Remove

Remove the harness clamps from the support bracket of the engine block.

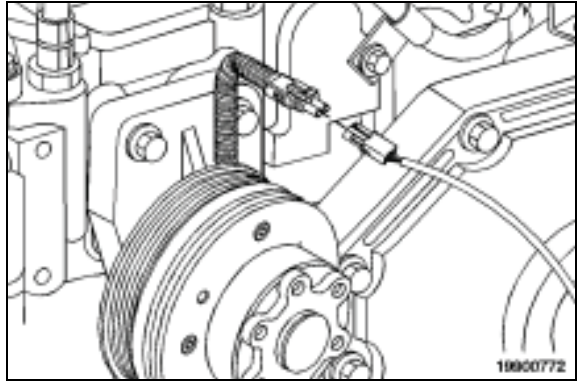


Disconnect the 9-pin AMP connector from the fuel pump.

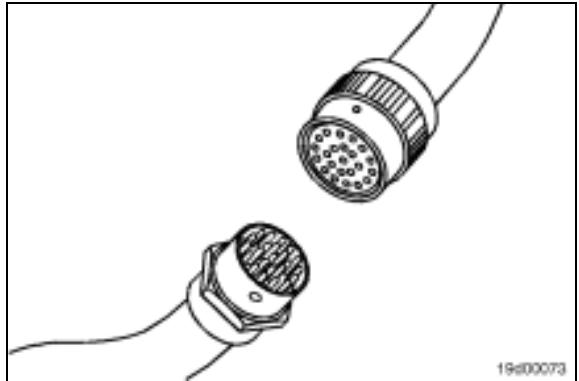


Redundant ECM Wiring Harness Removal/Installation (Cont)

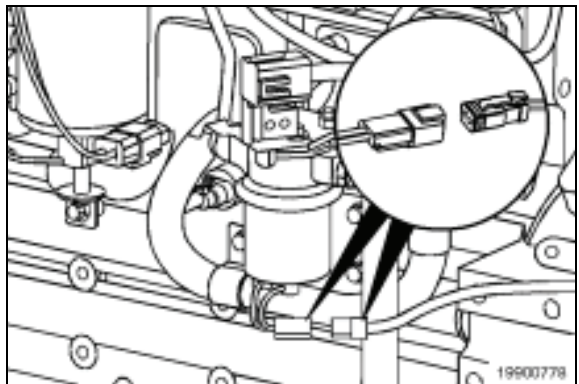
Disconnect the fan clutch control wire, if used, from the engine harness.



Disconnect the 23-pin OEM interface connector.



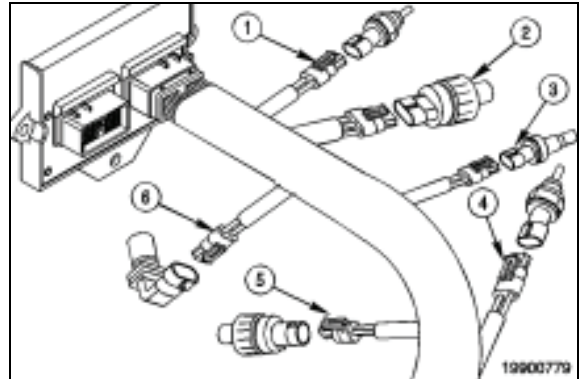
Disconnect the fuel lift pump connector.



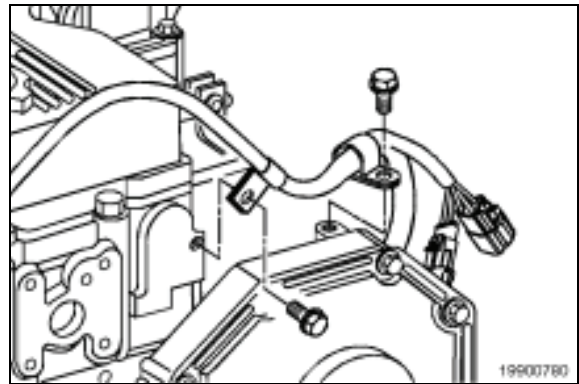
Redundant ECM Wiring Harness Removal/Installation (Cont)

Disconnect the harness from the following sensors:

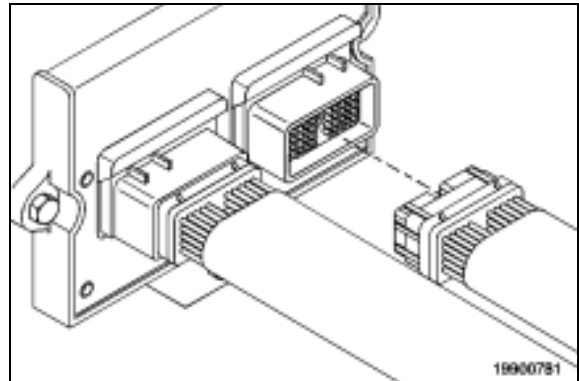
- Engine Coolant Temperature Sensor
- Oil Pressure Sensor
- Engine Position Sensor
- Intake Manifold Temperature Sensor
- Intake Manifold Pressure Sensor
- Engine Speed Sensor



Disconnect the datalink connector from its bracket.



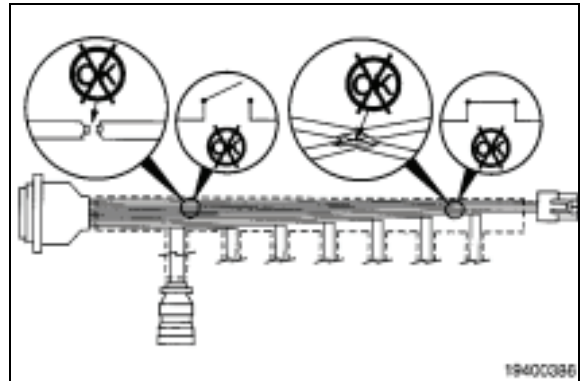
Disconnect the engine harness from the ECM.



Redundant ECM Wiring Harness Removal/Installation (Cont)

Inspect for Reuse

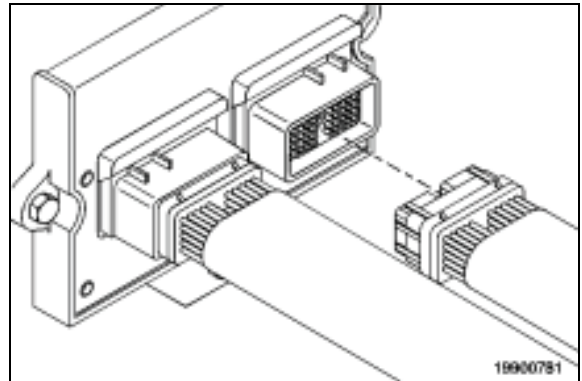
Replace or repair the engine harness if there is an open circuit or a short circuit found under the protective covering of the harness body.



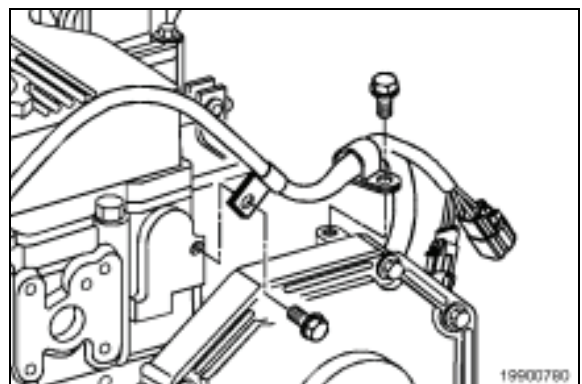
Install

Connect the engine harness to the ECM.

Torque Value: 2.8 N•m [25 in-lb]



Connect the datalink connector to its bracket.



Redundant ECM Wiring Harness Removal/Installation (Cont)

Connect the harness to the following sensors:

Engine Coolant Temperature Sensor

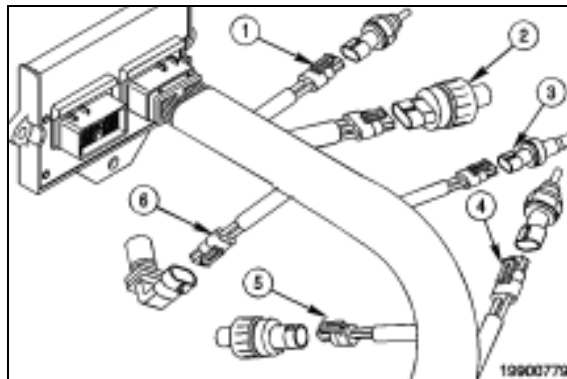
Oil Pressure Sensor

Engine Position Sensor

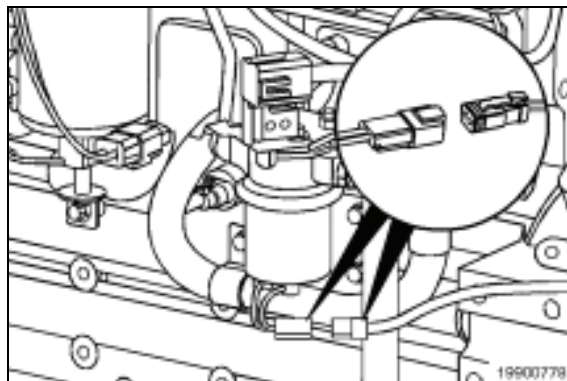
Intake Manifold Temperature Sensor

Intake Manifold Pressure Sensor

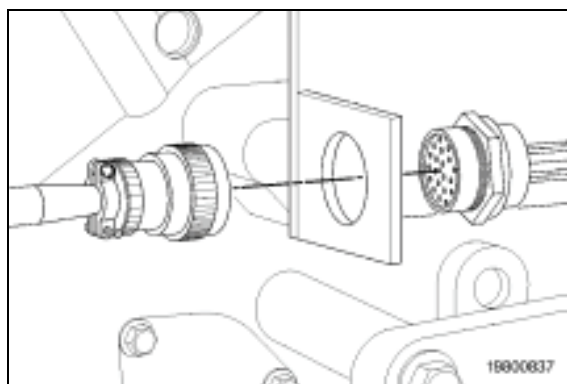
Engine Speed Sensor



Connect the fuel lift pump connector.

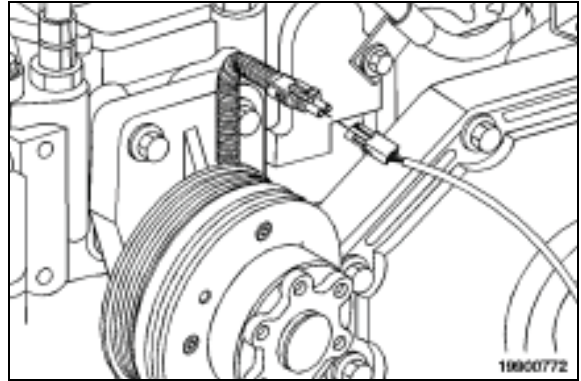


Connect the 23-pin OEM interface connector.

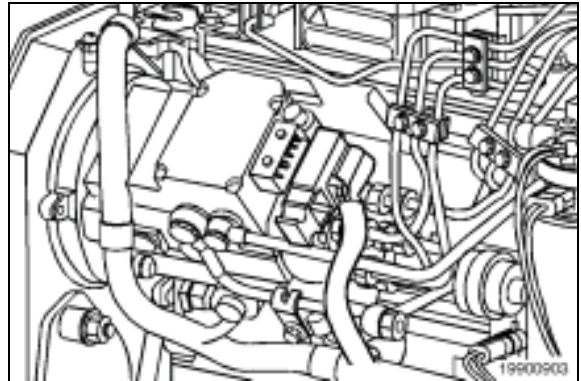


Redundant ECM Wiring Harness Removal/Installation (Cont)

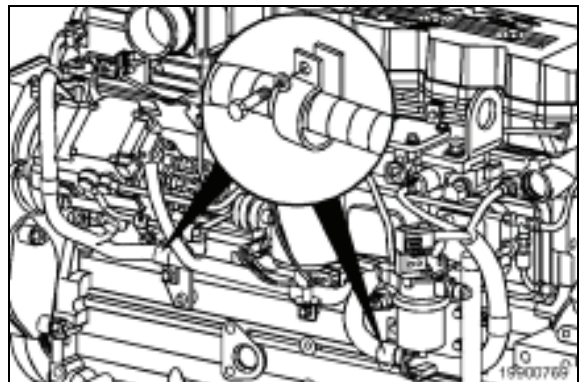
Connect the fan clutch control wire, if used, to the engine harness.



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

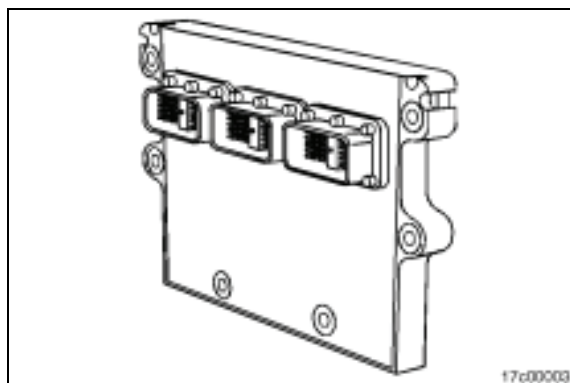
Remove



Record all programmable parameters, features, and calibration information from the old ECM before disconnecting the harness connectors. This information will be needed to program the new ECM.

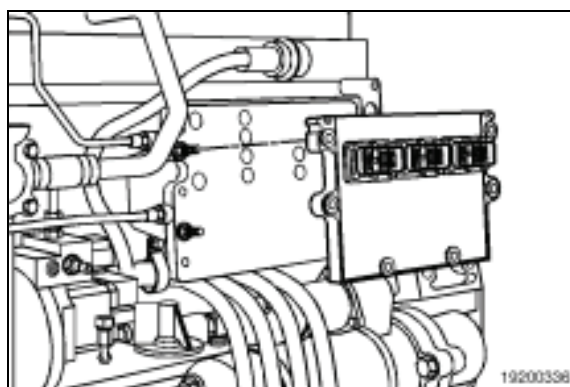
See the INSITE™ Manual under “Save as a Template” for information on how to electronically save and restore ECM parameters.

Disconnect the actuator, sensor, and OEM harness connectors from the ECM, if they are not already removed.



Remove the metric capscrews that secure the ECM to the cooling plate on the engine block.

Remove the ECM from the cooling plate.

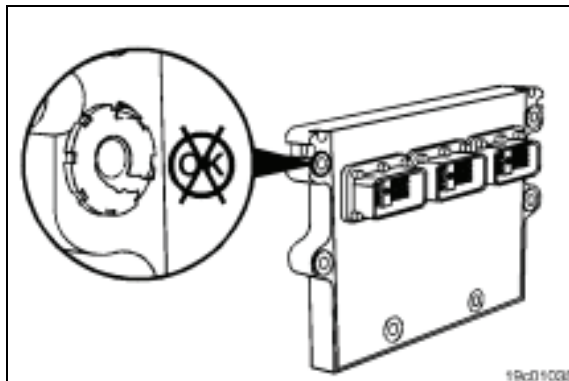


Primary ECM (A) Removal/Installation (Cont)

Install

Make certain that the star washer is in place on the ECM upper-left mounting hole.

The star washer must be free of cracks or damage that will prevent a proper ground connection to the engine block.



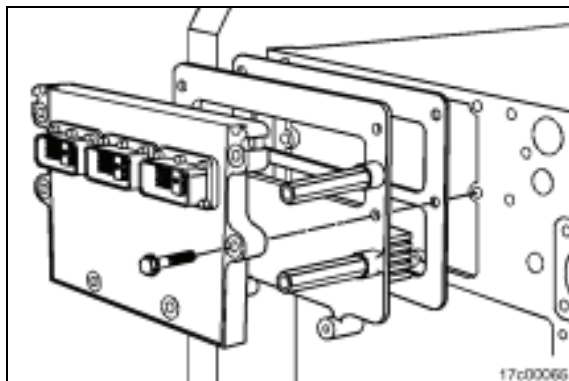
CAUTION

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 to the cooling plate.

Tighten the capscrews.

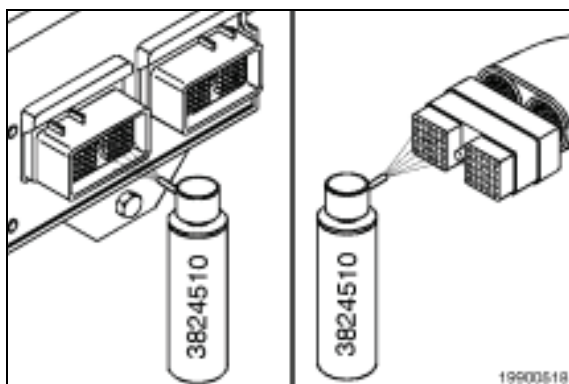
Torque Value: 20 N·m [177 in-lb]



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 Number 3824510, to remove all dirt and moisture from the ECM connector ports and the harness connectors.

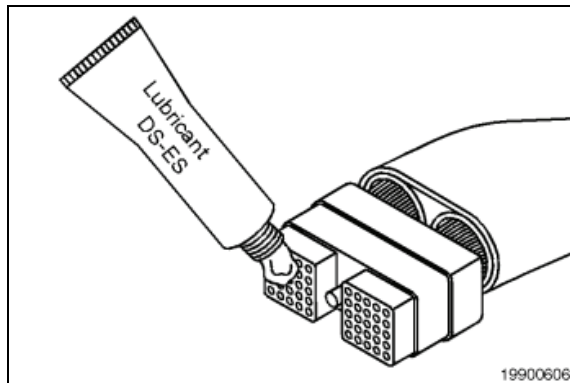


Primary ECM (A) Removal/Installation (Cont)



Use only Cummins-recommended lubricant DS-ES, Part Number 3822934. Other lubricants, such as lubricating oil or grease, in the connectors can cause ECM damage, poor engine performance, or premature connector wear.

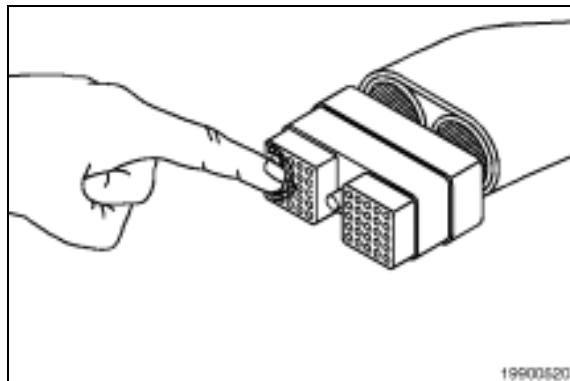
Apply a thin coating of lubricant to the nosepiece of the connectors.



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Spread the lubricant across the nosepiece so it enters every pin hole and lubricates the contacts.

Lubricant must not be visible on the surface of the nose piece.

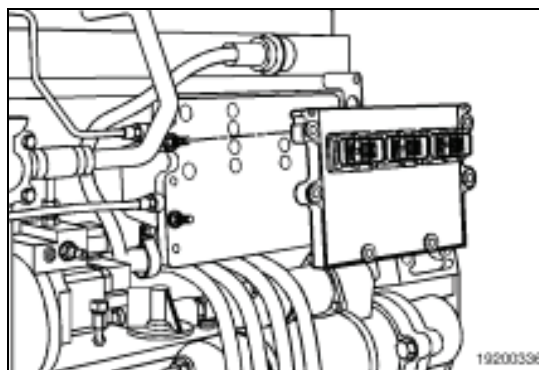


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Connect the actuator, sensor, and OEM harness connectors to the ECM ports.

Tighten the connector capscrews to the ECM.

Torque Value: 2.8 N•m [25 in-lb]



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Follow-Up

NOTE: When an ECM is replaced, the new ECM must be calibrated. Refer to Procedure [019-032](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

Secondary ECM (B) Removal/Installation

Prepare

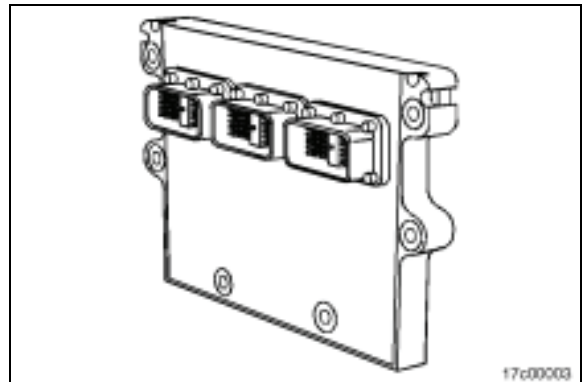
Remove



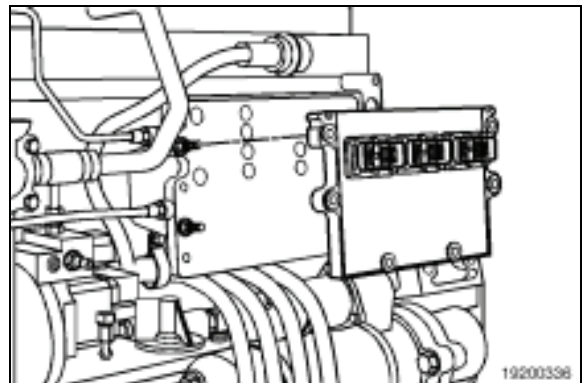
Record all programmable parameters, features, and calibration information from the old ECM before disconnecting the harness connectors. This information will be needed to program the new ECM.

See the INSITE™ Manual under “Save as a Template” for information on how to electronically save and restore ECM parameters.

Disconnect the actuator, sensor, and OEM harness connectors from the ECM, if they are not already removed.



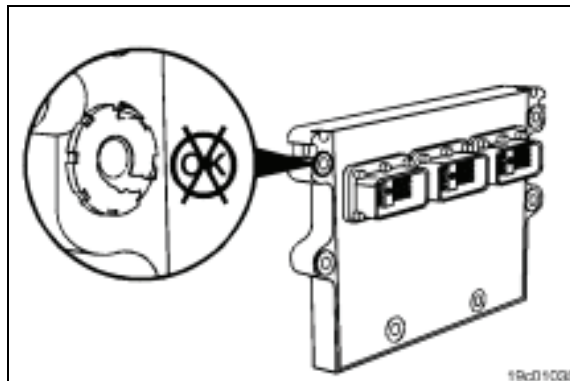
Remove the metric capscrews that secure the ECM to the cooling plate on the engine block.
Remove the ECM from the cooling plate.



Secondary ECM (B) Removal/Installation (Cont)**Install**

Make certain that the star washer is in place on the ECM upper-left mounting hole.

The star washer must be free of cracks or damage that will prevent a proper ground connection to the engine block.

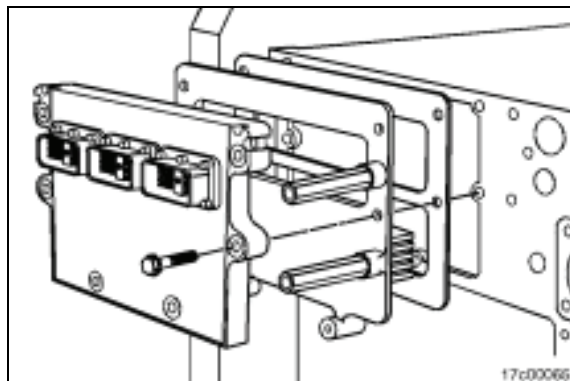


Do not paint the backside of the ECM. Make sure no grease or dirt is between the ECM and the engine block.

Install the new ECM to the cooling plate.

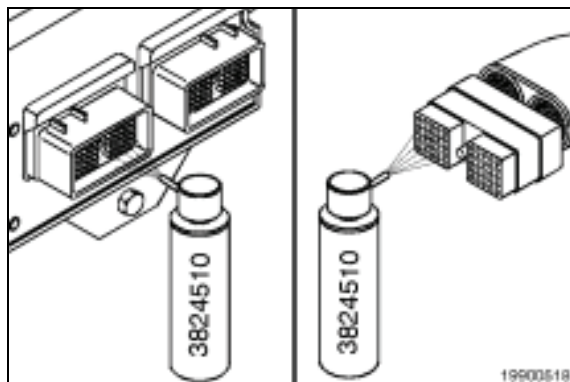
Tighten the capscrews.

Torque Value: 20 N•m [177 in-lb]



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 Number 3824510, to remove all dirt and moisture from the ECM connector ports and the harness connectors.

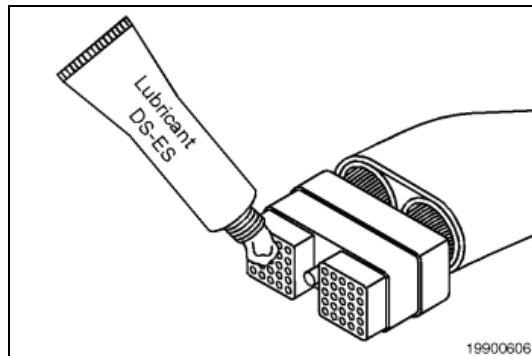


Secondary ECM (B) Removal/Installation (Cont)



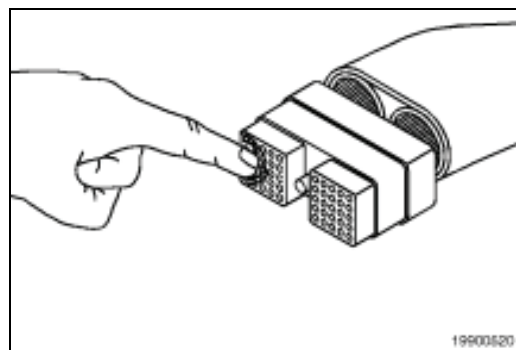
Use only Cummins-recommended lubricant DS-ES, Part Number 3822934. Other lubricants, such as lubricating oil or grease, in the connectors can cause ECM damage, poor engine performance, or premature connector wear.

Apply a thin coating of lubricant to the nosepiece of the connectors.



Spread the lubricant across the nosepiece so it enters every pin hole and lubricates the contacts.

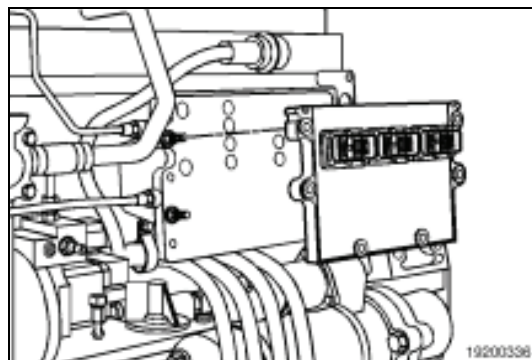
Lubricant must not be visible on the surface of the nose piece.



Connect the actuator, sensor, and OEM harness connectors to the ECM ports.

Tighten the connector capscrews to the ECM.

Torque Value: 2.8 N•m [25 in-lb]



Follow-Up

NOTE: When an ECM is replaced, the new ECM must be calibrated. Refer to Procedure [019-032](#) in the Cummins Engine Troubleshooting and Repair Manual, ISM, ISM3 and QSM11 Engines, Bulletin 3666322.

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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

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
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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.

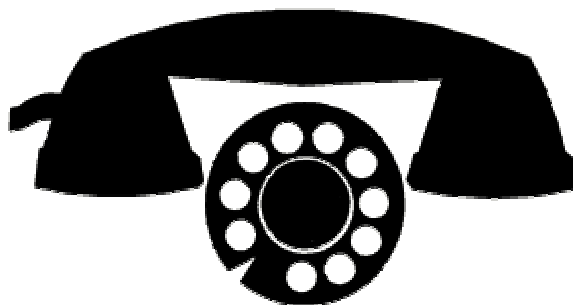
If assistance is required, call Toll-Free:

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



01800v1

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

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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 9726 and Data Sheet Drawing 9727 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 8).

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:	16.3:116.3:1
Valves per cylinder: Inlet/Exhaust	1 / 1
Cummins Base Engine Fuel Rating	FR - 20091
Cummins Engine Co. Base Engine	QSM11-G2
Installation Drawing	8712 (See <u>Section 13</u>)
Configuration Number	D353014CX03
Fuel System	Cummins Celect
Aspiration	Turbocharged, Charge Air Cooled

	Metric	US
Bore	125 mm	4.92 in.
Stroke	147 mm	5.79 in.
Displacement	10.8 liter	661 in. ³
Intake Valve Clearance	0.36 mm	0.014 in.
Exhaust Valve Clearance	0.69 mm	0.027 in.
Dry Weight lb (kg)	980 kg	2160 lb
Wet Weight lb (kg)	1063 kg	2343 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 0.015-in] intake valve lash and 0.381- to 0.762-mm [0.015- to 0.030-in] exhaust valve lash.

Fuel System Specifications

Fuel	Type Number 2 Diesel Only
Recommended primary fuel filter	Fleetguard 3882986

	Metric	US
Minimum supply line size	12.7 mm D.	0.5 in. D.
Minimum drain line size	9.5 mm D.	0.375 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	102 mm Hg	4 in. Hg
Maximum restriction @ lift pump-inlet - with dirty filter	204 mm Hg	8 in. Hg
Maximum return line restriction - without check valves	63 mm Hg	2.5 in. Hg
Minimum fuel tank vent capability	0.85 m ³ /hr	30 ft ³ /hr
Maximum fuel temperature @ lift pump inlet	71 °C	160 °F

Lubricating Oil System Specifications

Recommended lube oil filter	Fleetguard 3101869
-----------------------------	--------------------

	Metric	US
Oil pressure range at rated	276-414 kPa	40-60 PSI
Oil capacity of pan (high - low)	34-30 liter	9.0-8.0 U.S. Gal
Total system capacity	36.7 liter	9.7 U.S. Gal.

Cooling System Specifications

Recommended Coolant Filter	Fleetguard
----------------------------	------------

	Metric	US
Maximum raw water working pressure range at heat exchanger	414 kPa	60 PSI
Recommended minimum water supply pipe size to heat exchanger	25.4 mm D.	1.0 in. D.
Recommended minimum water discharge pipe size from heat exchanger	31.2 mm D.	1.25 in. D.
Coolant water capacity (engine side)	9.5 liter	2.5 U.S. Gal.
Modulating thermostat range	82-93 °C	180-200 °F
Minimum raw water flow with water temperatures to 90 °F (32 °C)	2.5 liter/s	40 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) K&N (Optional) Donaldson
---------------------------------	--

	Metric	US
Maximum temperature rise between ambient air and engine air inlet	15 °C	30 °F
Maximum inlet restriction with dirty filter	635 mm H ₂ O	25 in. H ₂ O

Exhaust System Specifications

	Metric	US
Maximum exhaust back pressure imposed by complete exhaust system	10.2 kPa	40.8 in. H ₂ O
Exhaust pipe size normally acceptable	127 mm D.	5 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 (standard) or 24 V (optional) 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⁾	1400 Amps	700 Amps
Minimum recommended battery reserve capacity	400 Minutes	800 Minutes
Maximum resistance of starting circuit	0.001 Ohms	0.0017 Ohms
Typical cranking speed	120 RPM	120 RPM
Alternator (standard), internally regulated	130 Amps	70 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



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



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

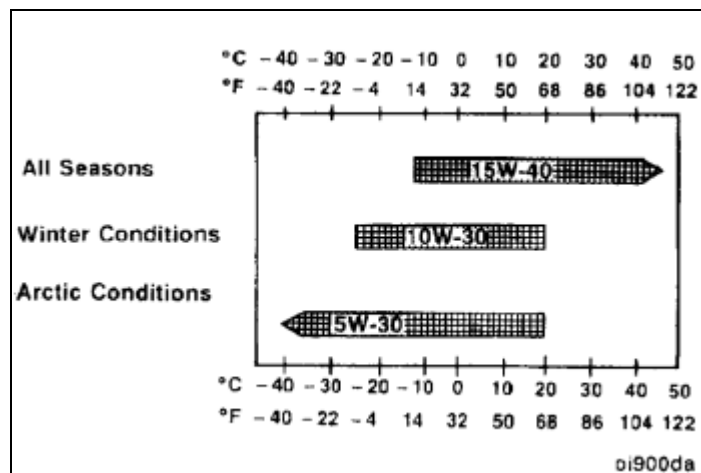
The oil change interval for turbocharged engines is every 6 months or 250 hours.

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

40% = -23°C [-10°F]

50% = -37°C [-34°F]

60% = -54°C [-65°F]

68% = -71°C [-90°F]

Propylene Glycol

40% = -21°C [-6°F]

50% = -33°C [-27°F]

60% = -49°C [-56°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
Oil Pan Drain Plug	1-1/4	88	65
Turbocharger Mounting Nuts	16 mm	68	50
Fan Drive Idler Pulley Shaft Locknut		165 to 190	120 to 140
Injector/Valve Adjusting Screw Locknut	3/4 in.	61	45
Engine Brake Adjusting Screw Locknut		50	40
Fuel Pump Mounting Capscrews	7/16 in	47	35
Fuel Pump Bracket to Cylinder Block		47	35
Fuel Pump Bracket to Fuel Pump Housing	7/16 in	11	95 in-lb
Rocker Lever Cover Capscrews	13 mm	15	130 in-lb
Injector Hold-down Clamps		75	55

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



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



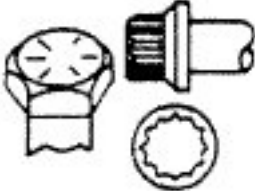
Class:	8.8				10.9				12.9			
Diameter	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	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

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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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Troubleshooting Procedures and Techniques

General information

This guide describes some typical engine operating problems, their causes, and some acceptable corrections to those problems.



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



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. Replace any defective batteries.
OK ↓	
The internal voltage regulator in the alternator is malfunctioning.	Test the alternator electrically. Refer to <u>Alternator Checks and Testing</u> in Section 7. If required, replace the alternator. Refer to <u>Alternator Removal/Installation</u> in Section 7.
OK ↓	
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.
OK ↓	
Alternator rotor is not turning.	<p>Test the alternator mechanically. Refer to <u>Alternator Checks and Testing</u> in Section 7.</p> <p>If the alternator shaft does not spin freely because of a bad bearing, replace the alternator (refer to <u>Alternator Removal/Installation</u> in Section 7).</p> <p>If the alternator does not turn because of a bad drive belt, replace the drive belt (refer to <u>Belt Removal/Installation</u> in Section 7).</p> <p>If the alternator does not charge because of poor drive belt tension, adjust belt tension (refer to <u>Adjust Alternator Drive Belt Tension</u> in Section 7).</p> <p>If the alternator pulley spins freely on the shaft because of a broken key, replace the alternator (refer to <u>Alternator Removal/Installation</u> in Section 7).</p>
OK ↓	
Battery Isolator input has faulted.	<p>Test continuity from the alternator to the battery isolator input (refer to <u>Drawing 10423 Sheet 2</u> in Section 13). Repair any open circuit.</p> <p>Test continuity through the battery isolator. If an internal open circuit is detected, replace the battery isolator (refer to <u>Battery Isolator Removal/Installation</u> in Section 7).</p>
OK ↓	

Neither Battery is Charging with the Engine Running (Cont)

Cause	Correction
Alternator excitation is lost.	<p>Test the alternator electrically. Refer to <u>Alternator Checks and Testing</u> in Section 7.</p> <p>If required, replace the replaceable diode. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.</p> <p>If required, locate and repair the open circuit or short to ground in the alternator excitation wiring.</p>
<p style="text-align: center;">OK ↓</p>	
Alternator internal voltage regulator is malfunctioning.	<p>Test the alternator electrically. Refer to <u>Alternator Checks and Testing</u> in Section 7.</p> <p>If required, replace the alternator. Refer to <u>Alternator Removal/Installation</u> Section 7.</p>
<p style="text-align: center;">OK ↓</p>	
Battery temperature is above specification.	Position the batteries away from heat sources.
<p style="text-align: center;">OK ↓</p>	
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. <u>Refer to Battery Testing</u> in Section 7. If the battery has failed, replace the failed battery units. <u>Refer to Battery Removal/Installation</u> in Section 7.
OK ↓	
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.
OK ↓	
Battery isolator has failed.	Remove the battery isolator. <u>Refer to Battery Isolator Removal/Installation</u> in Section 7. Test the internal diodes for open circuit or short to ground. <u>Refer to the Schematic, Electrical Wiring, 10423 Sheet 2</u> in Section 13. If required, obtain a replacement battery isolator. Install the battery isolator. <u>Refer to Battery Isolator Removal/Installation</u> in Section 7.
OK ↓	
Voltmeter is providing false indication.	Go to Voltage Indications Differ in this section.
OK ↓	
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.	<p>Check battery condition. Replace failing battery elements.</p> <p>Check wiring for corrosion. Ensure good electrical contact.</p> <p>Charge discharged batteries by running the engine or with an external battery charger.</p> <p>If the battery does not charge with the engine running, go to <u>Only One Battery is Charging with the Engine Running</u>.</p>
OK ↓	
Fuse 1 or Fuse 2 is open. (Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.)	<p>Check for apparent wire damage or shorts to grounds.</p> <p>Replace the failed fuse. Refer to <u>Fuse Replacement</u> in Section 7.</p> <p>If the fuse operates again, locate and correct the overload or repair the short circuit.</p>
OK ↓	
Open circuit or short to ground in indicator wiring.	Locate and repair the electrical fault. (Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.)
OK ↓	
Voltmeter has failed.	<p>Remove wiring at the voltmeter and apply test voltage.</p> <p>If necessary, replace the faulted voltmeter. Refer to <u>Voltmeter Removal/Installation</u> in Section 7.</p>
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Coolant Contamination

Cause	Correction
Coolant is rusty and has debris.	<p>Drain and flush the cooling system. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p> <p>If the drained coolant has excessive rust or debris, change the coolant more frequently or contact a Cummins Authorized Repair Facility.</p> <p>Otherwise, refill with correct mixture of antifreeze and water. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p>
OK ↓	
Lubricating oil cooler is leaking oil into the coolant. Coolant begins to have the texture and color of chocolate pudding.	<p>Drain and flush the cooling system. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p> <p>Check the lubricating oil cooler for coolant leaks and cracks. Refer to <u>Lubricating Oil Cooler Removal/Installation</u> in Section 7. Replace the oil cooler gasket or other parts.</p> <p>Refill with correct mixture of antifreeze and water. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p> <p>If the problem persists, the cylinder block may be cracked or porous. Contact a Cummins Authorized Repair Facility.</p>
OK ↓	

Coolant Contamination (Cont)

<p>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.</p>	<p>Drain and flush the cooling system. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p> <p>Remove Coolant Heat Exchanger. Refer to <u>Coolant Heat Exchanger Removal/Installation</u> in Section 7.</p> <p>Perform a pressure test of the raw water side of the heat exchanger. Refer to <u>Coolant Heat Exchanger Removal/Installation</u> in Section 7. If the heat exchanger leaks, it should be replaced.</p> <p>Install a known good Coolant Heat Exchanger. Refer to <u>Coolant Heat Exchanger Removal/Installation</u> in Section 7.</p> <p>Check and adjust raw water pressure regulator setpoints. Refer to <u>Raw Water Piping, Lineup, and Configuration</u> in Section 3.</p> <p>Check and, if required, replace the Zinc Plug. Refer to <u>Inspect Heat Exchanger Zinc Plug</u> in Section 5.</p> <p>Refill with correct mixture of antifreeze and water. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p>
<p style="text-align: center;">OK ↓</p>	
<p>Coolant is inadvertently contaminated with unknown liquids.</p>	<p>Drain and flush the cooling system. Refill with correct mixture of antifreeze and water. Refer to <u>Drain and Flush Cooling System</u> in Section 5.</p>
<p style="text-align: center;">OK ↓</p>	
<p>Contact an Authorized Cummins Repair Facility.</p>	

Excessive Coolant Loss




Cause	Correction
Adequate coolant was not added following previous maintenance activities.	Check the coolant level. Refer to <u>Check Coolant Level</u> in Section 5. Add coolant as required and check engine operation. If coolant loss persists, check for other problems.
OK ↓	
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.
OK ↓	
Cooling system hose is leaking.	Inspect the hoses. Refer to <u>Check Hose Condition</u> in Section 5. Replace and/or tighten loose hose clamps. Replace any damaged hoses. Refer to <u>Coolant Hose Removal/Installation</u> in Section 7. Add coolant as required and check engine operation.
OK ↓	
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.
OK ↓	
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 ↓	

Excessive Coolant Loss (Cont)

Engine is overheating.	Refer to the <u>Coolant Temperature Above Normal</u> symptom tree.
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 <u>Drawing 9659</u> in Section 13). Align flow if required.
	
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 <u>Check Raw Water Pressure Regulator Setpoints</u> in Section 3.) If pressure is not indicated or is excessively low, go to <u>Raw water solenoid has failed</u> in this table.
	
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 <u>Raw Water Solenoid Valve Fails to Operate</u> in this section. If the solenoid valve operates, replace the pressure regulator. (Refer to <u>Raw Water Pressure Regulator Removal/Installation</u> 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 <u>Raw Water Pressure Regulator Removal/Installation</u> in Section 7).
	


Coolant Temperature Above Normal (Cont)

Cause	Correction
Raw water piping or heat exchanger is plugged.	<p>Check the raw water strainer for blockage. Refer to <u>Drawing 9659</u> in Section 13. Clean the strainer if necessary.</p> <p>Check the Cummins supplied raw water piping for blockage. Refer to <u>Drawings 9659</u> and <u>11049</u> in Section 13. Clean the piping if necessary.</p> <p>Check the customer supplied raw water piping for blockage. Remove any blockage.</p> <p>Check for flow through the heat exchanger. If necessary, replace the heat exchanger. Refer to <u>Coolant Heat Exchanger Removal/Installation</u> in Section 7.</p>
OK ↓	
Coolant level is below specification.	<p>Check the coolant level. Refer to <u>Check Coolant Level</u> in Section 5. Add coolant as required.</p> <p>If coolant level was excessively low, go to <u>Excessive Coolant Loss</u> in this section.</p>
OK ↓	
Cooling system hose is collapsed or restricted.	<p>Inspect the hoses. Refer to <u>Check Hose Condition</u> in Section 5. Replace any damaged hoses. Refer to <u>Coolant Hose Removal/Installation</u> in Section 7.</p>
OK ↓	
Coolant thermostat is malfunctioning.	<p>Remove and test the coolant thermostat. Refer to <u>Coolant Thermostat Removal/Installation</u> in Section 7. Replace the thermostat if it is defective.</p>
OK ↓	
Coolant water pump is malfunctioning.	<p>Remove and inspect the water pump. Refer to <u>Coolant Water Pump Removal/Installation</u> in Section 7. Replace the thermostat if it is defective.</p>
OK ↓	







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 <u>Lubricating Oil Contaminated</u> symptom tree.
OK ↓	
Cooling system hose is collapsed, restricted, or leaking.	Inspect the hoses. Refer to <u>Check Hose Condition</u> in Section 5. Replace any damaged hoses. Refer to <u>Coolant Hose Removal/Installation</u> in Section 7.
OK ↓	
Coolant mixture of antifreeze and water is not correct.	Verify the concentration of antifreeze in the coolant. Refer to <u>Check Cooling System Condition</u> in Section 5. Add antifreeze or water to correct the concentration. Refer to <u>Coolant Recommendations and Specifications</u> in Section 10.
OK ↓	
Lubricating oil level is above or below specification.	Check the oil level. Refer to <u>Check Engine Oil Level</u> in Section 5. Add or drain oil, if necessary.
OK ↓	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to <u>Coolant Temperature Sender Removal/Installation</u> in Section 7.
OK ↓	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to <u>Coolant Temperature Gauge Removal/Installation</u> in Section 7.
OK ↓	

Coolant Temperature Above Normal (Cont)

Cause	Correction
Coolant temperature switch is malfunctioning.	Remove the temperature switch. Refer to <u>Coolant Temperature Switch Removal/Installation</u> 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 <u>Coolant Temperature Sender Removal/Installation</u> in Section 7.
	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to <u>Coolant Temperature Gauge Removal/Installation</u> in Section 7.
	
Coolant is not free to circulate through the heater.	Ensure that the coolant hoses are clear. Refer to <u>Coolant Hose Removal/Installation</u> in Section 7.
	
The coolant heater has failed electrically.	Replace the coolant heater. Refer to <u>Coolant Heater Removal/Installation</u> 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 active 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 <u>Coolant Thermostat Tests</u> in Section 7. If necessary, replace the thermostat. Refer to <u>Coolant Thermostat Removal/Installation</u> in Section 7.
OK ↓	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to <u>Coolant Temperature Sender Removal/Installation</u> in Section 7.
OK ↓	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to <u>Coolant Temperature Gauge Removal/Installation</u> 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 <u>Coolant Temperature Above Normal</u> in this section.
OK ↓	
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 <u>Coolant Heat Exchanger Removal/Installation</u> in Section 7. If pressure is not maintained, replace the heat exchanger.
OK ↓	
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 <u>Raw Water Solenoid Valve Removal/Installation</u> 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 (standard) or 24 VDC (optional), depending upon the model. Apply temporary voltage to the solenoid. If the solenoid fails to operate, replace it. Refer to <u>Raw Water Solenoid Valve Removal/Installation</u> 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.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Relay K1 has failed.	Check de-energized continuity at Relay K1 pin 87 to 30. Replace K1 if the circuit is open.
OK ↓	
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.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Relay K2 has failed.	Check de-energized continuity at Relay K2 pin 87 to 30. Replace K1 if the circuit is open.
OK ↓	
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 is 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.	<p>Check whether Circuit Breaker CB at the local control panel is open. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.</p> <p>If open, reset the circuit breaker.</p> <p>Locate and correct any electrical faults in the control panel.</p> <p>Press the RESET switch on the local control panel.</p>
	
The AUTO/MANUAL Rocker Switch fails to select AUTO mode.	<p>When practical, open Circuit Breaker CB at the local control panel and test switch operation electrically. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.</p> <p>If required, replace the switch or repair other electrical faults.</p> <p>When done, close Circuit Breaker CB at the local control panel and reset rocker switch to AUTO mode.</p>
	


Auto Start Failure – Cranks but does not Start (Cont)

<p>The overspeed switch has failed.</p>	<p>Check power and grounding to the overspeed switch. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13. Repair any electrical faults.</p> <p>If required, test and adjust the overspeed setting. Refer to <u>Overspeed Setpoint Adjustment and Testing</u> in Section 3.</p> <p>Replace the overspeed switch. Refer to <u>Overspeed Switch Removal/Installation</u> in Section 7.</p>
<p>OK </p>	
<p>Contact an Authorized Cummins Repair Facility.</p>	

Auto Start Failure – Engine Starts but Crank Terminate does not Occur

Cause	Correction
The overspeed switch not correctly adjusted or has failed.	<p>When practical, with the engine running, verify speed sensor input to the overspeed switch. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.</p> <p>If signal is not present, go to The speed sensor has failed. The tachometer also indicates zero speed in this table.</p> <p>Adjust the overspeed switch crank terminate setpoint. Refer to instructions in Section 3.</p> <p>If required, replace the overspeed switch. Refer to <u>Overspeed Switch Removal/Installation</u> in Section 7.</p>
OK ↓	
Fuse 3 has opened. The raw water solenoid valve also fails to open.	<p>Open the raw water bypass valves.</p> <p>When practical, replace Fuse F3.</p> <p>Locate and repair any local electrical fault. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.</p>
OK ↓	
The speed sensor has failed. The tachometer also indicates zero speed.	<p>When practical, locate and repair any electrical fault in the speed sensor circuitry. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13.</p> <p>If necessary, replace the speed sensor. Refer to <u>Speed Sensor Removal/Installation</u> in Section 7.</p>
OK ↓	
An electrical fault is present in the Fire Protection System.	<p>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.</p>
OK ↓	
An electrical fault is present between Control Panel TB 2 and the Fire Protection System.	<p>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.</p>
OK ↓	

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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK 	
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.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Solenoid A's switch contact does not close.	Remove and test Solenoid A lever and switch operation. Refer to <u>Crank Solenoid Assembly Removal/Installation</u> in Section 7. If required, replace Solenoid A.
OK ↓	
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.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Solenoid B's switch contact does not close.	Remove and test Solenoid B lever and switch operation. Refer to <u>Crank Solenoid Assembly Removal/Installation</u> in Section 7. If required, replace Solenoid B.
OK ↓	
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 <u>Starter Motor Removal/Installation</u> in Section 7.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Engine is seized.	Bar the engine over to break the seizure.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the switch if faulted.
OK ↓	
Relay K1 fails in the local manual mode.	When practical, test the electrical operation of the Relay K1. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the relay if faulted.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Solenoid A fails to operate.	When practical, test the electrical operation of the Solenoid A. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the solenoid if faulted.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the switch if faulted.
OK ↓	
Relay K2 fails in the local manual mode.	When practical, test the electrical operation of the Relay K2. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the relay if faulted.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Solenoid B fails to operate.	When practical, test the electrical operation of the Solenoid B. Refer to <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the solenoid if faulted.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13. Replace the solenoid if faulted.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
Overspeed switch crank circuit fails to reset with engine shutdown.	If required, test and adjust the crank setting. Refer to <u>Overspeed Setpoint Adjustment and Testing</u> in Section 3. If required, replace the overspeed switch. Refer to <u>Overspeed Switch Removal/Installation</u> in Section 7.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke)

Cause	Correction
Electronic fault codes are active.	NOTE: For instructions on how to read active fault codes, refer to Diagnostic Fault Codes in Section 1. 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 <u>Air in Fuel</u> 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 <u>Change Fuel Filter</u> in Section 7.
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 <u>Fuel Recommendations and Specifications</u> 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 <u>Fuel Adjust Fuel Pump</u> in Section 7.
OK ↓	
Fuel tank is empty.	Fill the fuel supply tank.
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 ↓	
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 ↓	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke) (Cont)

Cause	Correction
Fuel supply is not adequate.	Locate and correct the restriction in the customer-supplied fuel lines to the engine.
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 <u>Fuel Lift Pump Removal/Installation</u> in Section 7.
OK ↓	
Injection pump driveshaft or driveshaft key is damaged.	Repair or replace the injection pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> in Section 7.
OK ↓	
Fuel injectors are plugged.	Replace the fuel injectors. Refer to <u>Fuel Injectors Removal/Installation</u> in Section 7.
OK ↓	
Moisture is in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner Part Number 3824510.
OK ↓	
Throttle linkage misadjusted or damaged.	Adjust or repair the linkage.
OK ↓	
Starting motor rotation is not correct.	Check the direction of crankshaft rotation. Replace the starting motor if necessary. Refer to <u>Starter Motor Assembly Removal/Installation</u> in Section 7.
OK ↓	

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 <u>Starter Motor Assembly Removal/Installation</u> in Section 7.
OK 	
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.
OK ↓	
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.
OK ↓	
The battery is not properly charged or has failed.	Recharge the battery. If the battery does not take the charge, replace it.
OK ↓	
Lubricating oil level is too high.	Check the oil level. Refer to <u>Check Engine Oil Level</u> in Section 5. Drain any excess oil.
OK ↓	
Lubricating oil is the wrong grade or type.	Check the grade and type of oil. Refer to <u>Lubricating Oil Recommendations and Specifications</u> in Section 10. If the wrong type or grade of oil is present, drain and replace it. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7.
OK ↓	
Engine temperature is too low.	Troubleshoot as per Coolant Temperature Below Normal (Engine Off) in this section.
OK ↓	

Engine Cranks Slowly But Does Not Start (Cont)

Starting motor is malfunctioning.	Replace the starting motor. Refer to <u>Starter Motor Assembly Removal/Installation</u> in Section 7.
OK 	
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 instructions in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK ↓	
Fuel tank level is low.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
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 <u>Change Fuel Filter</u> 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 <u>Fuel Recommendations and Specifications</u> 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 <u>Fuel Adjust Fuel Pump</u> in Section 7.
OK ↓	

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 <u>Check Air Cleaner Service Indicator</u> in Section 7. Replace the air filter if required.
OK ↓	
Exhaust air flow is restricted.	Check the exhaust air piping for restriction. Remove any restriction.
OK ↓	
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 <u>Diagnostic Fault Codes</u> 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 <u>Change Fuel Filter</u> 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 <u>Fuel Recommendations and Specifications</u> 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 <u>Fuel Adjust Fuel Pump</u> 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 <u>Fuel Lift Pump Removal/Installation</u> in Section 7.
	
Fuel injectors are plugged.	Replace the fuel injectors. Refer to <u>Fuel Injectors Removal/Installation</u> 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 <u>Check Air Cleaner Service Indicator</u> 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.
OK ↓	
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 <u>Turbocharger Removal/Installation</u> in Section 7.
OK ↓	
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 <u>Charge Air Cooler Removal/Installation</u> in Section 7.
OK ↓	
Refer to a Cummins Authorized Repair Facility.	







Engine Noise Excessive - Mechanical

Cause	Correction
Lubricating oil is thin or diluted.	<p>Check the oil level. Refer to <u>Check Lubricating Oil Level</u> in Section 7. If the oil level is above the high mark, go to <u>Oil Level Rises</u> in this section.</p> <p>Otherwise, ensure that the correct type and grade of lubricating oil is being used. Refer to the <u>Lubricating Oil Recommendations and Specifications</u> in Section 10.</p>
OK ↓	
Lubricating oil pressure is below specification.	<p>NOTE: Oil pressure should range between 69 and 345 kPa [10 to 50 PSI] with the engine running.</p> <p>Check the oil pressure on the local control panel.</p> <p>If the pressure is low, refer to the <u>Lubricating Oil Pressure Low</u> symptom tree in this section.</p>
OK ↓	
Lubricating oil pressure is below specification.	<p>NOTE: Oil pressure should range between 69 and 345 kPa [10 to 50 PSI] with the engine running.</p> <p>Check the oil pressure on the local control panel.</p> <p>If the pressure is low, refer to the <u>Lubricating Oil Pressure Low</u> symptom tree in this section.</p>
OK ↓	
Vibration damper is damaged.	<p>Inspect the vibration damper. Refer to <u>Inspect Vibration Damper</u> in Section 5. If the vibration damper is damaged, contact a Cummins Authorized Repair Facility.</p>
OK ↓	
Engine mounts are worn or damaged.	<p>Inspect the engine mounts. If the engine mounts are worn or damaged, contact a Cummins Authorized Repair Facility.</p>
OK ↓	


Engine Noise Excessive – Mechanical (Cont)

Cause	Correction
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 <u>Coolant Temperature Above Normal</u> symptom tree in this section.
OK ↓	
Drive belt is squeaking due to insufficient tension or high loading.	Check and adjust belt tension. Refer to <u>Adjust Alternator Drive Belt Tension</u> in Section 7.
OK ↓	
Intake air flow is restricted.	Check the air intake system for restriction. Refer to <u>Check Air Cleaner Service Indicator</u> in Section 7. Replace the air filter if required.
OK ↓	
Exhaust air flow is restricted.	Check the exhaust air piping for restriction. Remove any restriction.
OK ↓	
Air leakage between the turbocharger and head.	Tighten the clamp between turbocharger and head. Repair leaks between turbocharger and head.
OK ↓	
Turbocharger does not rotate freely.	Replace the turbocharger. Refer to <u>Turbocharger Removal/Installation</u> in Section 7.
OK ↓	
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 <u>Diagnostic Fault Codes</u> 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 <u>Fuel Recommendations and Specifications</u> in Section 10.
	
Air is 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 <u>Air in Fuel</u> in Section 7.
	
The fuel injection pump's timing is not correct.	Check and adjust the fuel injection pump timing. Refer to <u>Adjust Fuel Pump</u> in Section 7.
	
The fuel injection pump is failing.	Replace the fuel injection pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> 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.	<p>NOTE: For instructions on how to read active fault codes, refer to instructions in Section 3.</p> <p>If fault codes are active, contact a Cummins Authorized Repair Facility.</p>
OK ↓	
Engine is cold.	<p>Allow the engine to warm to operating temperature.</p> <p>If the engine will not reach operating temperature, refer to the <u>Coolant Temperature Below Normal (Engine Running)</u> symptom tree.</p>
OK ↓	
Idle speed is set too low.	Adjust the idle speed.
OK ↓	
Air is present in the fuel system.	<p>Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary.</p> <p>Vent air from the system. Refer to <u>Air in Fuel</u> in Section 7.</p>
OK ↓	
Fuel filter is becoming plugged.	Replace the fuel filter. Refer to <u>Change Fuel Filter</u> in Section 5.
OK ↓	
Fuel supply to the engine is inadequate.	Locate and correct ⁵ 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 <u>Fuel Lift Pump Removal/Installation</u> in Section 7.
OK ↓	
Engine mounts are worn or damaged.	Check the engine mounts. If damaged, contact 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 <u>Fuel Recommendations and Specifications</u> in Section 10.
OK ↓	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK ↓	
Fuel injection pump timing is incorrect.	Check and adjust the injection pump timing. Refer to <u>Adjust Fuel Pump</u> in Section 7.
OK ↓	
Injector is malfunctioning.	Inspect the injectors. Replace the injectors as necessary. Refer to <u>Fuel Injectors Removal/Installation</u> in Section 7.
OK ↓	
Fuel injection pump is malfunctioning.	Remove the fuel injection pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> 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 instructions 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 <u>Coolant Temperature Below Normal (Engine Running)</u> 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 <u>Air in Fuel</u> in Section 7.
OK 	
Fuel filter is becoming plugged.	Replace the fuel filter. Refer to <u>Change Fuel Filter</u> 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 <u>Fuel Lift Pump Removal/Installation</u> 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, contact 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 <u>Fuel Recommendations and Specifications</u> in Section 10.
OK ↓	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK ↓	
Fuel injection pump timing is incorrect.	Check and adjust the injection pump timing. Refer to <u>Adjust Fuel Pump</u> in Section 7.
OK ↓	
Injector is malfunctioning.	Inspect the injectors. Replace the injectors as necessary. Refer to <u>Fuel Injectors Removal/ Installation</u> in Section 7.
OK ↓	
Fuel injection pump is malfunctioning.	Remove the fuel injection pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> 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 <u>Diagnostic Fault Codes</u> in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
	
Fuel level is low in the tank.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
	
Engine idle speed is set too low.	Adjust the idle speed.
	
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 <u>Air in Fuel</u> in Section 7.
	
The fuel filter is plugged.	Replace the fuel filter. Refer to <u>Change Fuel Filter</u> in Section 7.
	
Fuel flow to the engine is not adequate.	Locate and correct the restriction in the customer-supplied fuel lines to the engine.
	
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 <u>Fuel Lift Pump Removal/Installation</u> in Section 7.
	

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 <u>Fuel Recommendations and Specifications</u> in Section 10.
OK ↓	
The fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> 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 <u>Fuel Injectors Removal/Installation</u> 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 <u>Diagnostic Fault Codes</u> 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 <u>Air in Fuel</u> in Section 7.
OK ↓	
The fuel filter is plugged.	Replace the fuel filter. Refer to <u>Change Fuel Filter</u> in Section 5.
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 <u>Fuel Lift Pump Removal/Installation</u> in Section 7.
OK ↓	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine with the required fuel. Refer to <u>Fuel Recommendations and Specifications</u> in Section 10.
OK ↓	
The fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> 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 <u>Fuel Injectors Removal/Installation</u> 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 Vibration Excessive at Rated Speed

Cause	Correction
Electronic fault codes are active.	NOTE: For instructions on how to read active fault codes, refer to <u>Diagnostic Fault Codes</u> in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK ↓	
Engine runs rough or is misfiring.	Refer to the <u>Engine Runs Rough or Misfires Under Load</u> symptom tree in this section.
OK ↓	
Fuel injection pump is adjusted incorrectly.	Adjust or replace the injection pump. Refer to <u>Adjust Fuel Pump</u> and/or <u>Fuel Injection Pump Removal/Installation</u> in Section 7.
OK ↓	
Engine mounts are worn or damaged.	Inspect the engine mounts. Refer to <u>Check Engine Mounting Bolts</u> in Section 5. Replace the engine mounts as needed. Contact a Cummins Authorized Repair Facility.
OK ↓	
Vibration damper is malfunctioning.	Inspect the vibration damper. Refer to <u>Inspect Vibration Damper</u> in Section 5. Replace, if necessary. Contact 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 <u>Alternator Removal/Installation</u> 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 <u>Water Pump Removal/Installation</u> in Section 7.
OK 	
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 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 <u>Diagnostic Fault Codes</u> 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 <u>Drawing 10423 Sheet 1</u> 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 <u>Engine Overspeed Trip</u> 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.
OK ↓	
Fuel tank level is low.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
OK ↓	
Clogged fuel tank air breather hole.	Clean the fuel tank breather.
OK ↓	
Customer-supplied fuel pre-filter is clogged.	Clean the fuel pre-filter. Fill and bleed the fuel lines to the engine.
OK ↓	
Fuel piping to engine is clogged.	Clean and repair the fuel piping to the engine.
OK ↓	
The fuel filter is clogged.	Replace the fuel filter. Refer to <u>Change Fuel Filter</u> in Section 7.
OK ↓	
Air is trapped in the low pressure fuel lines at the engine.	Bleed the fuel lines. Refer to <u>Air in Fuel</u> in Section 7.
OK ↓	

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 <u>Fuel Lift Pump Removal/Installation</u> in Section 7.
	
Fuel injection pump has failed.	Replace the fuel injection pump. Refer to <u>Fuel Injection Pump Removal/Installation</u> 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 <u>Diagnostic Fault Codes</u> 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. Contact 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 instructions in Section 3.
OK ↓	
Fuel shutoff lever (mechanical) partially engaged.	Make sure fuel shutoff lever is in the RUN position. Refer to instructions in Section 3. Replace if necessary. Refer to instructions in Section 7.
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 <u>Tachometer Calibration</u> in Section 7.
Tachometer is malfunctioning.	Replace the tachometer. Refer to <u>Tachometer Removal/Installation</u> in Section 7.
OK ↓	

Engine Will Not Reach Rated Speed (RPM) (Cont)

Cause	Correction
Engine power output is low.	Refer to the <u>Engine Acceleration or Response Poor</u> symptom tree in this section.
OK ↓	
Fuel grade is not correct for the application, or the fuel quality is poor.	Operate the engine with the required fuel. Refer to <u>Fuel Recommendations and Specifications</u> in Section 10.
OK ↓	
Fuel filter is clogged.	Replace the fuel filter. Refer to <u>Change Fuel Filter</u> in Section 7.
OK ↓	
Fuel suction line is restricted.	Check the fuel suction line for restriction.
OK ↓	
Air-fuel tube leaking, wastegate diaphragm ruptured, or wastegate plumbing damaged.	Tighten the fittings, repair plumbing, replace wastegate diaphragm.
OK ↓	
Charge air cooler restricted (if equipped).	Inspect the air cooler for internal and external restrictions. Replace the restricted cooler if necessary.
OK ↓	
Fuel supply is not adequate.	Locate and correct the restriction in the customer-supplied fuel lines to the engine.
OK ↓	

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 <u>Exhaust System Specifications</u> in Section 10. Measure the exhaust back pressure. Correct the problem if 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 <u>Fuel Lift Pump Removal/Installation</u> 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.	<p>NOTE: In the AUTO mode, the fire pump engine stops upon loss of signal power from the fire pump controller.</p> <p>Check the engine stop circuit in the fire pump controller. Correct any faults.</p> <p>Check for short to voltage on the signal wiring from the fire pump controller to the engine control panel. Correct any faults.</p> <p>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.</p>
OK ↓	
Electronic fault codes are active.	<p>NOTE: For instructions on how to read active fault codes, refer to <u>Diagnostic Fault Codes</u> in Section 3.</p> <p>If fault codes are active, contact a Cummins Authorized Repair Facility.</p>
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.	

Engine Will Not Shut Off Locally

Cause	Correction
The AUTOMANUAL Rocker Switch has failed.	<p>NOTE: In the MANUAL mode, the fire pump engine stops when the AUTO/MANUAL switch is returned to the AUTO mode.</p> <p>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.</p>
OK ↓	
Inadvertent power source is present from the fire pump controller.	<p>NOTE: In the MANUAL mode, the fire pump engine stops when the AUTO/MANUAL switch is returned to the AUTO mode.</p> <p>Check for inadvertent voltage on the wiring to TB 1 at the engine control panel. Correct any wiring errors.</p>
OK ↓	
Electronic fault codes are active.	<p>NOTE: For instructions on how to read active fault codes, refer to <u>Diagnostic Fault Codes</u> in Section 3.</p> <p>If fault codes are active, contact a Cummins Authorized Repair Facility.</p>
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.	

Exhaust Smoke Excessive At Idle, White

Cause	Correction
Electronic fault codes are active.	For instructions on how to read active fault codes, refer to <u>Diagnostic Fault Codes</u> in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK ↓	
Engine block heater is malfunctioning (if equipped).	Check the electrical sources and wiring to the cylinder block heater. Replace the block heater, if necessary. Refer to the OEM service manuals.
OK ↓	
Coolant temperature is below specification.	Refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
OK ↓	
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the <u>Coolant Temperature Below Normal (Engine Running)</u> symptom tree.
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 Recommendation and Specifications in Section 10.
OK ↓	
Overhead adjustments are not correct.	Measure and adjust the overhead settings. Refer to Section 5.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Exhaust Smoke Excessive At Idle, Black

Cause	Correction
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.
OK ↓	
Air intake or exhaust leaks.	Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting.
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 drain line restriction.	Check the fuel drain lines for restriction. Refer to the OEM service manual.
OK ↓	
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.
<div> </div>	
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.
<div> </div>	
Poor-quality fuel is being used.	Assure good-quality No. 2 diesel fuel is being used. Refer to <u>Fuel Recommendations and Specifications</u> in Section 10.
<div> </div>	
Intake or exhaust restriction.	Refer to troubleshooting logic for <u>Exhaust Smoke Excessive Under Load</u> in this section.
<div> </div>	
Defective or clogged injection nozzle.	Replace the defective or clogged injection nozzle.
<div> </div>	
Incorrect injection timing.	Adjust injection timing.
<div> </div>	
Injection pump is adjusted incorrectly causing excessive injection.	Adjust or replace the injection pump.
<div> </div>	

Fuel Consumption Is Excessive (Cont)

Cause	Correction
Hour meter is not calibrated.	Check the hour meter. Calibrate or replace the hour meter if necessary.
OK ↓	
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.
OK ↓	
Air intake system restriction is above specification.	Check the air intake system for restriction. Refer to <u>Check Air Cleaner Service Indicator</u> in Section 5. Replace the air filter as necessary.
OK ↓	
Lubricating oil level above specification.	Check the oil level. Refer to <u>Check Engine Oil Level</u> in Section 5. Drain excess oil and correct the deficiency in maintenance processes.
OK ↓	
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 <u>Check Air Cleaner Service Indicator</u> in Section 7. Replace the air filter if required.
OK ↓	
Turbocharger drain line is restricted.	Remove the turbocharger drain line and check for restriction. If required, clean or replace the drain line.
OK ↓	
Turbocharger oil seal is leaking.	Check the turbocharger for oil seals and for leaks. Refer to the <u>Turbocharger Leaks Engine Oil or Fuel</u> symptom tree in this section.
OK ↓	
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 if necessary. Refer to <u>Lubricating Oil Recommendations and Specifications</u> in Section 10. Drain the oil and replace with non-contaminated oil. Also, replace the oil filter. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7.
OK ↓	
Fuel is present in the lubricating oil.	Refer to the <u>Fuel in Lubricating Oil</u> symptom tree in this section.
OK ↓	
Coolant is present in the lubricating oil.	Refer to the <u>Coolant in Lubricating Oil</u> symptom tree in this section.
OK ↓	
Metal is present in the lubricating oil.	Contact an Authorized Cummins Repair Facility.
OK ↓	
Identify unknown lubricating oil contamination.	Analyze the oil and inspect the filters to identify the contamination. Refer to <u>Lubricating Oil and Filter Analysis</u> in Section 7.
OK ↓	
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 ↓	
Top injector o-ring or injector timing plunger is damaged.	Perform the fluorescent dye tracer test to find the bad injector. Replace the injector or o-ring. Refer to Injector (006-026) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Injector adapter wall is damaged behind the balance orifice.	Check the injectors for damage. Refer to Injector (006-026) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Injector cup is damaged or is not correct.	Check the injector cups for damage and for correct part numbers. Refer to Injector (006-026) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Fuel pump gear pump main shaft seals are leaking.	Check the gear pump main shaft and seals. Refer to the Shop Manual, M11 Series Engines, Bulletin 3666075.
OK ↓	


Fuel in the Lubricating Oil (Cont)

Cause	Correction
Cylinder head is cracked or porous.	Remove intake and exhaust manifolds. Check for evidence of coolant leak. If necessary, operate engine at low idle. Pressure-test the cylinder head. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
Contact an Authorized Cummins Repair Facility.	

Coolant in the Lubricating Oil

Cause	Correction
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 ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Air or combustion gases are entering the cooling system.	Check for air or combustion gases in the cooling system. Refer to Cooling System - Air or Combustion Gas Test (008-019) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
EGR cooler is leaking.	Check the EGR cooler for leaks. Refer to EGR Cooler (011-019) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Cylinder head gasket is leaking.	Check the cylinder head gasket. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Cylinder head is cracked or porous, or an injector sleeve is leaking.	Pressure-test the cylinder head and inspect the injector sleeves. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	

Coolant in the Lubricating Oil (Cont)

Cause	Correction
Cylinder liner is corroded or cracked, or the cylinder block is cracked or porous.	Remove the oil pan. Pressure-test the cooling system to check for leaks. Refer to Cylinder Block and Liner Seats (001-027) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Consumption Excessive

Cause	Correction
Verify the oil consumption rate.	Check the amount of oil added versus the operating hours.
OK ↓	
External engine leak is present.	Inspect the engine and its components for seal, gasket, tappet cover, oil cooler, or draincocks leaks. Repair or correct any leaks.
OK ↓	
Crankcase ventilation system is plugged.	Check and clean the crankcase breather and vent tube. Refer to Crankcase Breather (Internal) (003-002) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Turbocharger oil seal is leaking.	Check the turbocharger compressor and turbine seals. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Lubricating oil cooler is leaking.	Check for lubricating oil in the coolant. Refer to the <u>Lubricating Oil in the Coolant</u> symptom tree in this section.
OK ↓	
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7. Use the oil type recommended in <u>Lubricating Oil Recommendations and Specifications</u> in Section 10.
OK ↓	


Lubricating Oil Consumption Excessive (Cont)

Cause	Correction
Lubricating oil drain interval is excessive.	Verify the correct lubricating oil drain interval. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7.
OK ↓	
Piston, cylinder liner, or piston rings are worn or damaged.	Check for air intake system leaks. Refer to Air Leaks, Air Intake and Exhaust Systems (010-024) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Piston rings are not seated correctly (after an engine rebuild or piston installation).	Check blowby. Refer to Engine Testing (Engine Dynamometer) (014-005) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02. 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 ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil in the Coolant

Cause	Correction
Bulk coolant supply is contaminated.	<p>Check the bulk coolant supply. Refer to <u>Coolant Recommendations and Specifications</u> in Section 10.</p> <p>Drain the coolant and replace with non-contaminated coolant. Refer to <u>Drain and Flush Cooling System</u> in Section 7.</p> <p>Replace the coolant filters. Refer to <u>Change Coolant Filter</u> in Section 7.</p>
OK ↓	
Lubricating oil cooler is malfunctioning.	Check the oil cooler. Refer to Lubricating Oil Cooler (007-003) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Cylinder head gasket is leaking.	Check the cylinder head gasket. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Cylinder head is cracked or porous.	<p>Remove intake manifold. Refer to Section 7.</p> <p>Remove exhaust manifold.</p> <p>Check for evidence of coolant leak. If necessary, operate engine at idle. Refer to Section 7.</p> <p>Pressure-test the cylinder head. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.</p>
OK ↓	


Lubricating Oil in the Coolant (Cont)

Cause	Correction
Cylinder block is cracked or porous.	Remove the oil pan. Refer to Section 7. Pressure-test the cooling system to check for leaks. Refer to Cylinder Block and Liner Seats (001-027) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Pressure High

Cause	Correction
Lubricating oil pressure gauge or sensor is malfunctioning.	<p>Check the oil pressure gauge or sensor for correct operation. Refer to Lubricating Oil Pressure Gauge (007-028) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.</p> <p>If required, replace the pressure sensor. Refer to <u>Oil Pressure Sender Removal/Installation</u> in Section 7.</p> <p>If required, replace the pressure gauge. Refer to <u>Oil Pressure Gauge Removal/Installation</u> in Section 7.</p>
OK ↓	
Coolant temperature is below specification.	<p>NOTE: Coolant temperature should not be below 82 °C [180 °F] after the engine has reached operating temperature.</p> <p>Check the coolant temperature indication on the local control panel. If coolant temperature is below specification, refer to <u>Coolant Temperature Below Normal (Engine Running)</u> symptom tree in this section.</p>
OK ↓	
Lubricating oil does not meet specifications for operating conditions.	<p>Change the oil and filters. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7.</p> <p>Use the oil type recommended in <u>Lubricating Oil Recommendations and Specifications</u> in Section 10.</p>
OK ↓	
Main oil pressure regulator is malfunctioning.	<p>Check the main oil pressure regulator assembly. Refer to Lubricating Oil Pressure Regulator (Main Rifle) (007-029) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.</p>
OK ↓	







Lubricating Oil Pressure High (Cont)

Cause	Correction
Viscosity sensor plugged or damaged.	Check the viscosity sensor. Clean or replace if necessary. Refer to Lubricating Oil Viscosity Sensor (007-041) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Pressure Low

Cause	Correction
Electronic fault codes are active or high counts of inactive fault codes are present.	View and troubleshoot the fault codes with INSITE™. Refer to Section TF - Troubleshooting Fault Codes in the Troubleshooting and Repair Manual Electronic Control System ISM and QSM11 Engines, Bulletin 3666266.
OK ↓	
Lubricating oil level is above or below specification.	Check the oil level. Add or drain oil if necessary. Refer to <u>Check Lubricating Oil Level</u> in Section 7.
OK ↓	
Engine angularity during operation exceeds specification.	Refer to <u>General Engine Data</u> In Section 10.
OK ↓	
Lubricating oil is contaminated with coolant or fuel.	Troubleshoot as per <u>Lubricating Oil Contaminated</u> in this section.
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 ↓	
Lubricating oil pressure sensor or gauge is malfunctioning.	Check the oil pressure switch or gauge for correct operation and location. Refer to Lubricating Oil Pressure Gauge (007-028) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	







Lubricating Oil Pressure Low (Cont)

Cause	Correction
Lubricating oil pressure sensor or circuit is malfunctioning.	Check the oil pressure switch or circuit. Refer to Engine Oil Pressure Sensor (019-066).
	
Lubricating oil temperature is above specification.	Refer to the Lubricating Oil Temperature Above Specification symptom tree in this section.
	
Lubricating oil filter is plugged.	Change the oil and filter. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7. Verify the oil change interval is correct.
	
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to <u>Change Lubricating Oil and Filters</u> in Section 7. Use the oil type recommended in <u>Lubricating Oil Recommendations and Specifications</u> in Section 10.
	
Lubricating oil cooler is plugged.	Check the oil cooler. Refer to Lubricating Oil Cooler (007-003) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
Lubricating oil suction or transfer tube is loose or broken, or the gasket or o-rings are leaking.	Remove and inspect the oil pan or suction tube. Refer to Lubricating Oil Pan (007-025) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	


Lubricating Oil Pressure Low (Cont)

Cause	Correction
Piston cooling nozzles are damaged or are not installed correctly.	Check the piston cooling nozzles for damage and correct installation. Refer to Piston Cooling Nozzle (001-046) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
The main oil pressure regulator is malfunctioning.	Check the main oil pressure regulator assembly. Refer to Lubricating Oil Pressure Regulator (Main Rifle) (007-029) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
The lubricating oil high-pressure relief valve is malfunctioning.	Remove and inspect the high-pressure relief valve or lubricating pump pressure regulator. Refer to Lubricating Oil High Pressure Relief Valve (007-021) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Lubricating oil pump is malfunctioning or the o-rings are damaged.	Inspect the lubricating oil pump and o-rings. Refer to Lubricating Oil Pump (007-031) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
OK ↓	
Internal engine damage or internal lubricating oil leak is present.	Analyze the lubricating oil. Inspect the oil filter. Check the main bearings, rod bearings, cam bushings, and rocker lever bushings for excessive wear. Refer to Section 7.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Temperature Above Specification

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes.	View and troubleshoot the fault codes with INSITE™. Refer to Section TF - Troubleshooting Fault Codes in the Troubleshooting and Repair Manual Electronic Control System ISM and QSM11 Engines, Bulletin 3666266.
	
Lubricating oil level is above or below specification.	Check the oil level. Add or drain oil, if necessary. Refer to <u>Check Lubricating Oil Level</u> in Section 5.
	
Coolant temperature is above specification.	Refer to the <u>Coolant Temperature is Above Normal</u> symptom tree in this section.
	
Lubricating oil pressure sensor or gauge is malfunctioning or is not in the correct location.	Check the oil pressure switch or gauge for correct operation and location. Refer to Lubricating Oil Pressure Gauge (007-028) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
Lubricating oil pressure sensor or circuit is malfunctioning.	Check the oil pressure switch or circuit. Refer to Engine Oil Pressure Sensor (019-066).
	
Lubricating oil thermostat is malfunctioning.	Check the oil thermostat. Refer to Procedure Lubricating Oil Thermostat (007-039) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	

Lubricating Oil Temperature Above Specification (Cont)

Cause	Correction
Lubricating oil cooler is malfunctioning.	Check the oil cooler. Refer to Lubricating Oil Cooler (007-003) in Troubleshooting and Repair Manual ISM, ISMe, and QSM11 Engines, Bulletin Number 3666322-02.
	
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 <u>Change Lubricating Oil and Filters</u> in Section 5.
OK ↓	
Fuel is leaking into the oil system.	Troubleshoot as per <u>Lubricating Oil Contaminated</u> in this section.
OK ↓	
Coolant is leaking into the oil system.	Troubleshoot as per <u>Lubricating Oil Contaminated</u> in this section.
OK ↓	
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).
OK ↓	
Lubricating oil does not meet specifications for operating conditions.	Change the oil and filters. Refer to Section 7. Use the oil type recommended in Section 10.
OK ↓	
Lubricating oil drain interval is excessive.	Verify the correct lubricating oil drain interval. Refer to Section 5.
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 ↓	
Lubricating oil is contaminated with coolant.	Check the lubricating oil for coolant. Refer to the <u>Coolant Loss-Internal</u> symptom tree.
OK ↓	
Crankcase ventilation system is plugged.	Check and clean the crankcase breather and vent tube. Refer to Section 7.
OK ↓	
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 in Section 1.
OK ↓	
Lubricating oil or fuel is entering the turbocharger.	Remove the intake and exhaust piping, and check for oil or fuel.
OK ↓	
Turbocharger drain line is restricted.	Remove the turbocharger drain line, and check for restriction. Clean or replace the drain line. Contact a Cummins Authorized Repair Facility.
OK ↓	
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.
OK 	
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 Factory 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.
OK ↓	
Engine actually operated at too great a speed due to configuration error.	Check rated speed setting as specified on the <u>Factory Setting Tag</u> described in Section 2. Refer to <u>Rated Speed Setpoint Adjustment and Testing</u> in Section 3.
OK ↓	
Overspeed switch is set at too low a setpoint.	Check overspeed speed setting as specified on the <u>Factory Setting Tag</u> described in Section 2. Refer to <u>Overspeed Setpoint Adjustment and Testing</u> in Section 3.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13. Replace defective components and repair electrical faults.
OK ↓	
Speed switch failure has occurred.	If the speed switch fails to operate as per <u>Overspeed Setpoint Adjustment and Testing</u> in Section 3, replace the speed switch. Refer to <u>Overspeed Switch Removal/Installation</u> in Section 7.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13. Replace defective components and repair electrical faults.
OK ↓	
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 <u>Drawing 10423 Sheet 1</u> in Section 13. Replace defective components and repair electrical faults.
OK ↓	
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 if it has failed. Refer to <u>Speed Sensor Removal/Installation</u> in Section 7.
OK ↓	
The tachometer has failed.	Check the operation of the tachometer with a pulse generator. Replace the tachometer if it has failed. Refer to <u>Tachometer Removal/Installation</u> in Section 7.
OK ↓	
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 <u>Diagnostic Fault Codes</u> in Section 3. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK 	
Contact an Authorized Cummins Repair Facility.	

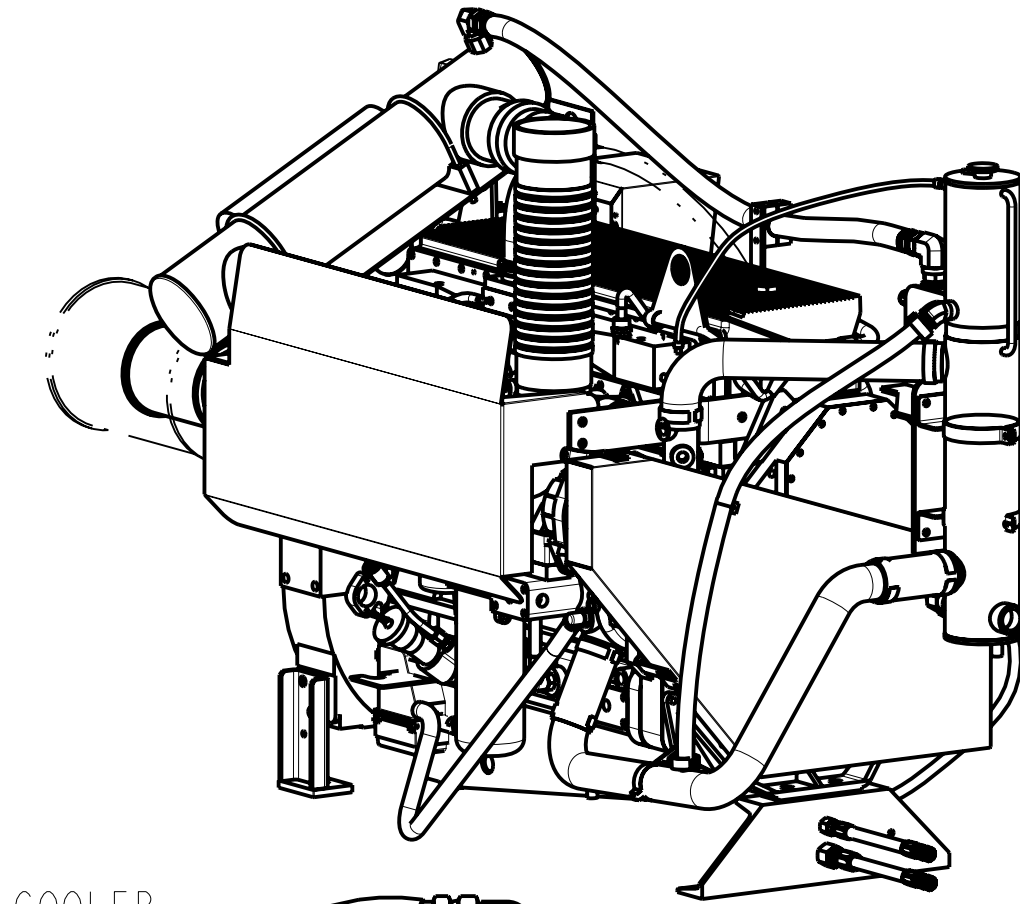
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Section 13 – Assembly Drawings ⁽¹⁾

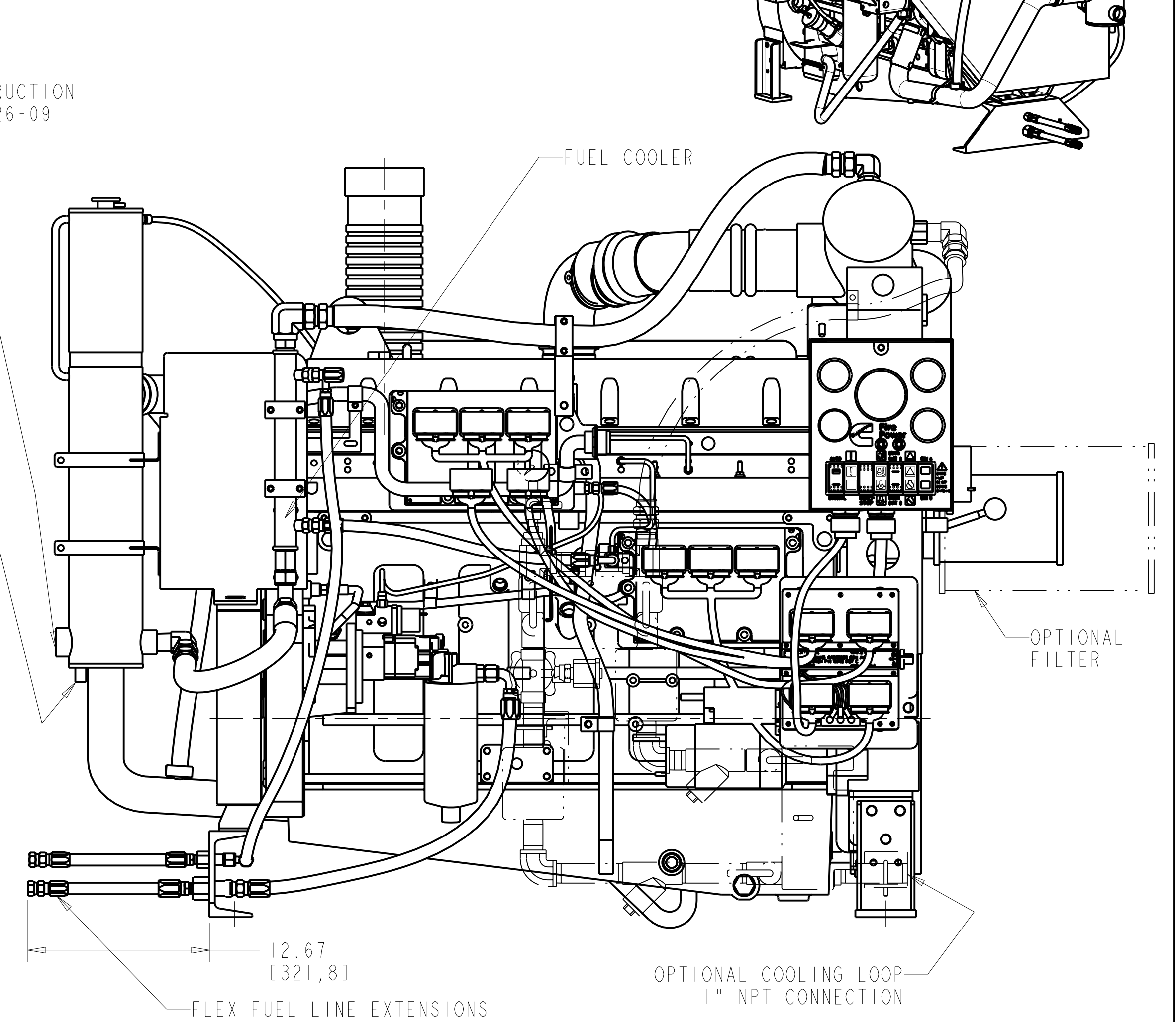
Description	Drawing No.	Sheet No	Revision
Drawing, Installation, FirePump, CFP11E (QSM)	8712		H
Options, Engine, FirePump, G-Drive, CFP11E (QSM)	8740		D
Assembly, Engine Mounting, QSM	8773		C
Leg, Engine Support, Rear	8781		F
Leg, Engine Support, Front	8783		C
Assembly, Heat Exchanger QSM	8792		F
Assembly, Vent Line QSM	9543		
Assembly, Coolant Heater, QSM	8950		C
Assembly, Charge Air Cooling, QSM11	8969		B
Assembly, Plumbing, CAC Heat Exchanger, QSM	11048		C
Hose, Water #16	11086		B
Misc Piping, Cooling Loop, Raw Water	11049		A
Raw Water Manifold QSM	9659		D
Fuel Line, ½" NPT	10233		A
Fuel Line, 3/8" NPT	10234		
Assembly, Heat Shield, QSM11	9515		A
Assembly, Air Filter, QSM11	9518		C
Assembly, Sensor Package, QSM11	9572		A
Assembly, Fuel Supply/Return Lines, QSM11	9594		D
Assembly, Pulley Guard, CFP11E	9631		A
Pulley Guard CFP11E	9632		D
Assembly, Operator Station, QSM11	9510		F
Assembly, Panel, Instrument, 12VDC, Alternate Beginning 09/06	10452		E
Assembly, Panel, Instrument, 12VDC, New Effective Date 09/08	13236		
Assembly, Panel, Instrument, 24VDC, Alternate Beginning 09/06	10453		E
Assembly, Panel, Instrument, 24VDC, New Effective Date 09/08	13237		
Exhaust, 5" Bellows, 5" Flare, QSM11	9514		C
Assembly, Drive Shaft, SAE#1, 1480	10166		
Assembly, Drive Shaft, SAE#1, 1550	10167		
Assembly, Stub-Shaft, SAE #1, 2.25"	9679		A
Kit, Loose Wires; QSM Fire Pump	9768		E
General Layout, FirePump, CFP11E	CFP11E_GEN		F
Assembly, Secondary ECM & Switch, Alternate Beginning 04/07	11057		
Assembly, Secondary ECM Switch, Alternate Beginning 04/07	10748	1-4	D
Bracket, Mounting ECM Switch	11058		C
Harness, CFP11E, Alternate Beginning 04/07	12126-01	1	B
Harness, CFP11E, Alternate Beginning 04/07	12126-02	1-2	B
Harness, CFP11E, Alternate Beginning 04/07	12126-03	1-2	B
Harness, CFP11E, Alternate Beginning 04/07	12126-04	1	B
Assembly, Secondary ECM, CFP11E schematic, Alternate	12126_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	I	ASSEMBLY, ENGINE, QSMII, FIREPUMP	8740
2	I	ASSEMBLY, MOUNTING, ENGINE, CFP1IE, FIREPUMP	8773
3	I	ASSEMBLY, HEAT EXCHANGER, CFP1IE, FIREPUMP	8792
4	I	ASSEMBLY, COOLANT HEATER, CFP1IE, FIREPUMP	8950
5	I	ASSEMBLY, CHARGE AIR COOLER, CFP1IE, FIREPUMP	8969
6	I	ASSEMBLY, OPERATORS STATION, CFP1IE, FIREPUMP	9510
7	I	ASSEMBLY, TURBO GUARD, CFP1IE, FIREPUMP	9515
8	I	ASSEMBLY, AIR CLEANER, CFP1IE, FIREPUMP	9518
9	I	ASSEMBLY, SENSOR PACKAGE, FIREPUMP	9572
10	I	ASSEMBLY, FUEL LINE, CFP1IE, FIREPUMP	9594
11	I	ASSEMBLY, PULLEY GUARD, CFP1IE, FIREPUMP	9631
12	I	COOLING LOOP, 1", UPPER HX ORIENTATION, FIREPUMP	9659
13	I	FUEL LINE, #10, 1/2" NPT X 12" LG	10233
14	I	FUEL LINE, #8, 3/8" NPT X 12" LG	10234
15	I	ASSEMBLY, CAC WATER CONNECTION, CFP1IE, FIREPUMP	11048
16	I	ASSEMBLY, MISC PIPING, CFP1IE, FIREPUMP	11049
17	I	ASSEMBLY, SECONDARY ECM, CFP1IE, FIREPUMP	11057
18	I	FLEX, EXHAUST, 5" W/ ELBOW, FIREPUMP	9514



G	REV PER OP STATION. AIR CLEANER	DAVE N	15DEC06
REV	DESCRIPTION OF REVISION	REV BY	DATE

[illegible]

PN8740
SO35246
ModelQSM11
ConflgD353014CX03

Option	Desc
FIRE 24	QSM11
AD 2061	PULLEY,ACCESSORY
AP 2077	APPROVAL,AGENCY
BB 2712	BLOCK,CYLINDER
BB 2737	PLUMBING,CYLINDE
BR 2033	BREATHER,CRANKCA
BR 2722	PLUMBING,CRC BRE
CH 2021	AID,COO HEATER S
CI 2705	PLUMBING,CPR AIR
CP 2063	COMPRESSOR,AIR
CP 2709	MOUNTING,AIR COM
DA 2078	DAMPER,VIBRATION
DF 2036	DRIVE,FRO GER TR
DL 2031	LOCATION,DRAIN
DO 2374	SOFTWARE,CUS INT
<div>△</div> DO 2422	SOFTWARE,CUS INT
DP 2701	DRIVE,FUEL PUMP
EA 2036	ACCESSORIES,ELEC
EB 2047	BRAKE,ENGINE
EC 2701	THERMOSTAT
EE 2047	ALTERNATOR
<div>△</div> EE2069	Alternator, 12V, 100A, Delco 24SI
EH 2154	MOUNTING,ALTERNA
EH 2735	DRIVE,ALTERNATOR
EM 2038	SUPPORT,FRONT EN
FA 2118	DRIVE,FAN
FCXJ 2	CALIBRATION,FUEL
<div>△</div> FCZ 3	CALIBRATION,FUEL
FF 2241	FILTER,FUEL
FF 2743	FITTING,FUEL PUM
FH 2158	HOUSING,FLYWHEEL
<div>△</div> FP 2954	PUMP,FUEL
FP 2957	COUPLING,FUEL PU
FR 2912	RATING,FUEL
<div>△</div> FR20091	RATING,FUEL
FT20072	PLUMBING,FUEL
FW 2141	FLYWHEEL
GG 2701	COVER,FRONT GEAR
HC 2001	PLUMBING,CABIN H

Option	Desc
IC 2068	CONNECTION,AIR I
IT 2002	CONNECTION,AIR T
LA 2053	ARRANGEMENT,LIFT
LC 2766	HEAD,OIL FILTER
LF 2054	FILTER,FULL FLOW
LG 2066	GAUGE,OIL LEVEL
LP 2711	PUMP,LUBRICATING
LT 2025	LITERATURE
NN 2713	NAMEPLATE
OB 2430	ARRANGEMENT,OIL
OB 2701	COVER,HAND HOLE
OP 2103	PAN,OIL
PH 2017	LOCATION,ENG CNT
PH 2810	MODULE,ENGINE CO
PP 2829	PARTS,PERFORMANC
PP20007	TURBOCHARGER
PU 2002	PULLEY,ACCESSORY
PW 2079	POWER,PROGRAMMAB
RL 2711	LEVER,ROCKER
RP 2708	PLUMBING,RADIATO
SC20698	SOFTWARE,CALIBRA
SK 2003	ARRANGEMENT,SHIP
SK 2705	BRACKET,SHIPPING
SM 2704	MOUNTING,STARTIN
<div>△</div> SS 1097	PAINT
ST 2025	MOTOR,STARTING
TB 2287	ARRANGEMENT,TURB
TB 2723	MOUNTING,EXHAUST
TB 2731	MOUNTING,INTAKE
<div>△</div> TH 2086	HOUSING,THERMOST
TH 2762	PLUMBING,THM HOU
TP 2810	PLUMBING,TURBOCH
VC 2086	COVER,VALVE
WF 2031	RESISTOR,CORROSI
WH 2702	PLUMBING,OIL COO
WP 2020	PUMP,WATER
WP 2703	ARRANGEMENT,WATE
WR 2045	HARNESS,ENG CNT
WR 2732	HARNESS,ETR CNT
XS 2017	CONNECTION,EXHAU

PN8740
SO35246
ModelQSM11
ConflgD353014CX03

Option	Desc
FIRE 24	QSM11
AD 2061	PULLEY,ACCESSORY
<div>△</div> AP 2119	APPROVAL,AGENCY
<div>△</div> BB 2712	BLOCK,CYLINDER
<div>△</div> BB 2816	PLUMBING,CYLINDE
BR 2033	BREATHER,CRANKCA
BR 2722	PLUMBING,CRC BRE
CH 2021	AID,COO HEATER S
CI 2705	PLUMBING,CPR AIR
CP 2063	COMPRESSOR,AIR
CP 2709	MOUNTING,AIR COM
DA 2078	DAMPER,VIBRATION
DF 2036	DRIVE,FRO GER TR
DL 2031	LOCATION,DRAIN
DO 2374	SOFTWARE,CUS INT
DO 2422	SOFTWARE,CUS INT
DP 2701	DRIVE,FUEL PUMP
<div>△</div> EA 2043	ACCESSORIES,ELEC
EB 2047	BRAKE,ENGINE
EC 2701	THERMOSTAT
EE 2047	ALTERNATOR
EE2069	Alternator, 12V, 100A, Delco 24SI
<div>△</div> EG 2706	PANEL,ENGINE INS
EH 2154	MOUNTING,ALTERNA
EH 2735	DRIVE,ALTERNATOR
EM 2038	SUPPORT,FRONT EN
FA 2118	DRIVE,FAN
<div>△</div> FCXL 90	CALIBRATION,FUEL
FCZ 3	CALIBRATION,FUEL
FF 2241	FILTER,FUEL
FF 2743	FITTING,FUEL PUM
FH 2158	HOUSING,FLYWHEEL
FP 2954	PUMP,FUEL
FP 2957	COUPLING,FUEL PU
FR 2912	RATING,FUEL
FR20091	RATING,FUEL
<div>△</div> FT20097	PLUMBING,FUEL
FW 2141	FLYWHEEL
GG 2701	COVER,FRONT GEAR
HC 2001	PLUMBING,CABIN H

Option	Desc
IC 2068	CONNECTION,AIR I
<div>△</div> IT 2003	CONNECTION,AIR T
LA 2053	ARRANGEMENT,LIFT
LC 2766	HEAD,OIL FILTER
LF 2054	FILTER,FULL FLOW
LG 2066	GAUGE,OIL LEVEL
LP 2711	PUMP,LUBRICATING
NN 2713	NAMEPLATE
OB 2430	ARRANGEMENT,OIL
OB 2701	COVER,HAND HOLE
OP 2103	PAN,OIL
<div>△</div> PH 2028	LOCATION,ENG CNT
<div>△</div> PH 2856	MODULE,ENGINE CO
PP 2829	PARTS,PERFORMANC
PP20007	TURBOCHARGER
<div>△</div> PP20056	MOUNTING,CYLINDE
PU 2002	PULLEY,ACCESSORY
<div>△</div> PW 2180	POWER,PROGRAMMAB
RL 2711	LEVER,ROCKER
RP 2708	PLUMBING,RADIATO
<div>△</div> SC20751	SOFTWARE,CALIBRA
<div>△</div> SD 2707	SWITCH,OIL PRESS
SK 2003	ARRANGEMENT,SHIP
SK 2705	BRACKET,SHIPPING
SM 2704	MOUNTING,STARTIN
<div>△</div> SS 2083	PAINT
ST 2025	MOTOR,STARTING
TB 2287	ARRANGEMENT,TURB
TB 2723	MOUNTING,EXHAUST
TB 2731	MOUNTING,INTAKE
TH 2086	HOUSING,THERMOST
TH 2762	PLUMBING,THM HOU
TP 2810	PLUMBING,TURBOCH
VC 2086	COVER,VALVE
WF 2031	RESISTOR,CORROSI
WH 2702	PLUMBING,OIL COO
WP 2020	PUMP,WATER
WP 2703	ARRANGEMENT,WATE
WR 2045	HARNESS,ENG CNT
XS 2017	CONNECTION,EXHAU

BUILT BEFORE JANUARY 1, 2007

△

NOTES:

GENERIC CALIBRATION (DO2374) REPLACED
WITH X-CAL REV F DATED 11/08/2004 BY
CUMMINS FIREPOWER / CUMMINS NPOWER
ON ASSEMBLY LINE

X-CAL REV F REPLACED BY X-CAL REV L
DATED 08/23/2005 TO SOLVE MISFIRE SITUATION


PIR (PRODUCT INCIDENT REPORT) # RGJ051019-01
FILED BY BOB JANQUART

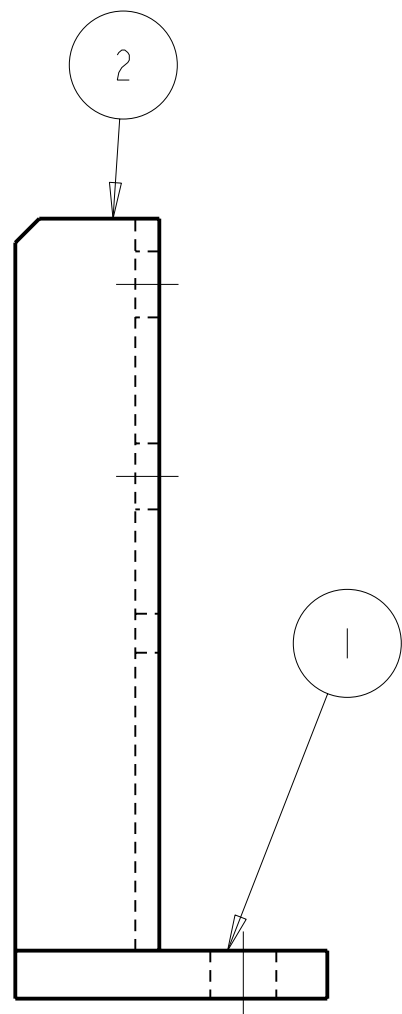
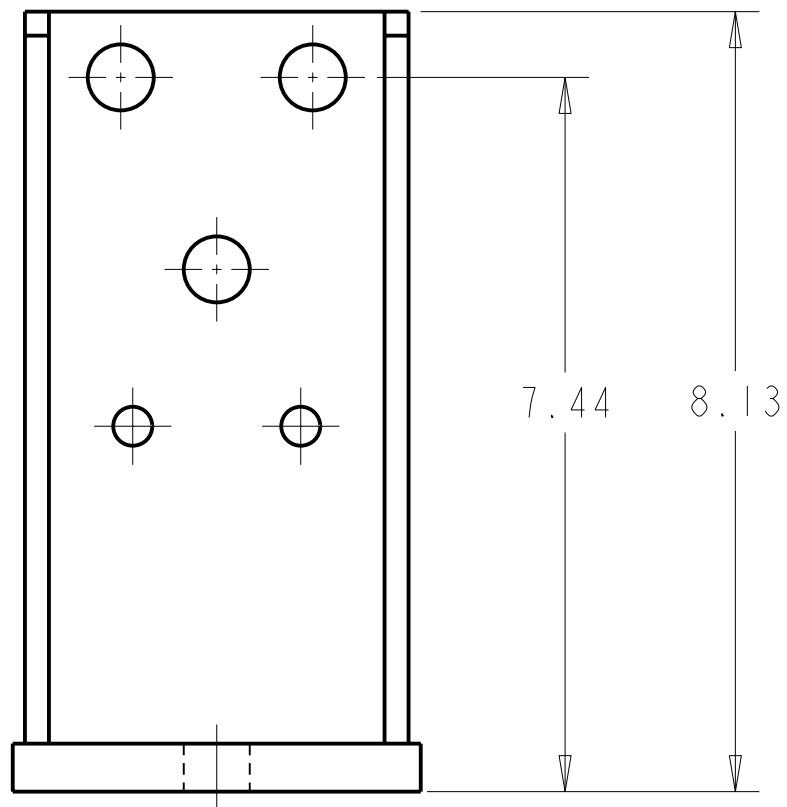
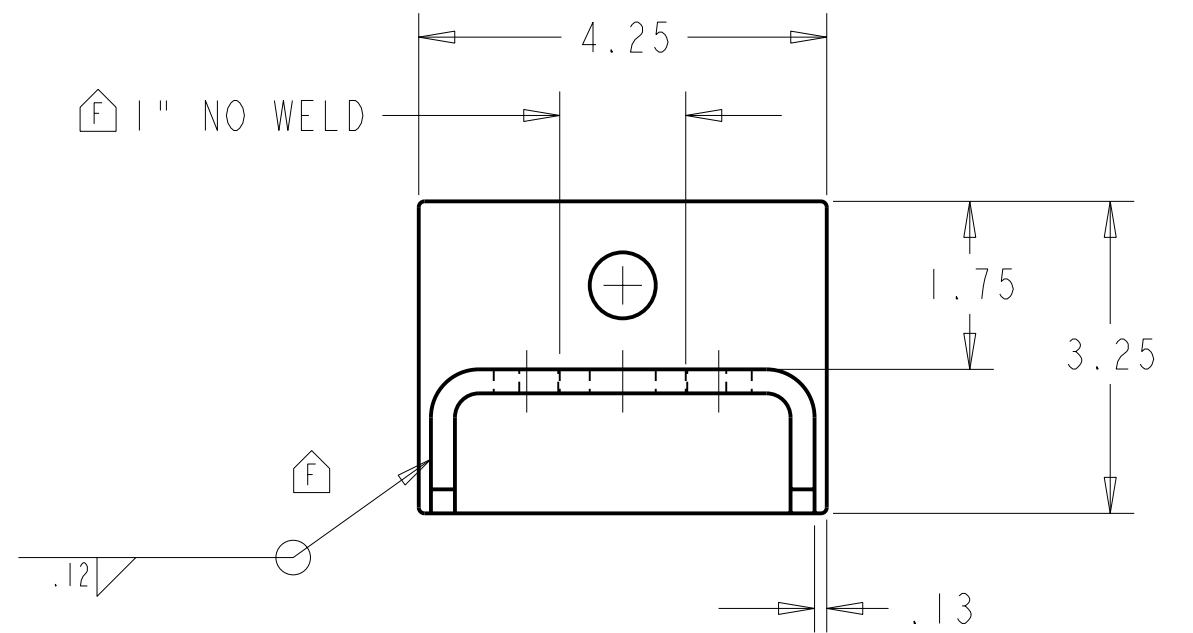
X-CAL REV F REPLACED BY RELEASED INCAL
DO2422 IN SEPTEMBER 2005 INCAL RELEASE

DO2422 REPLACED BY X-CAL REV S DATED 12/20/2005
BY CUMMINS NPOWER / CUMMINS FIREPOWER.
X-CAL REVISION S (FINAL REVISION TO CORRECT
SENSOR GLOBAL DEFAULT ISSUE). X-CAL REV S
SCHEDULED TO BE RELEASED AS DO 2422 REV B
FEBRUARY 2006

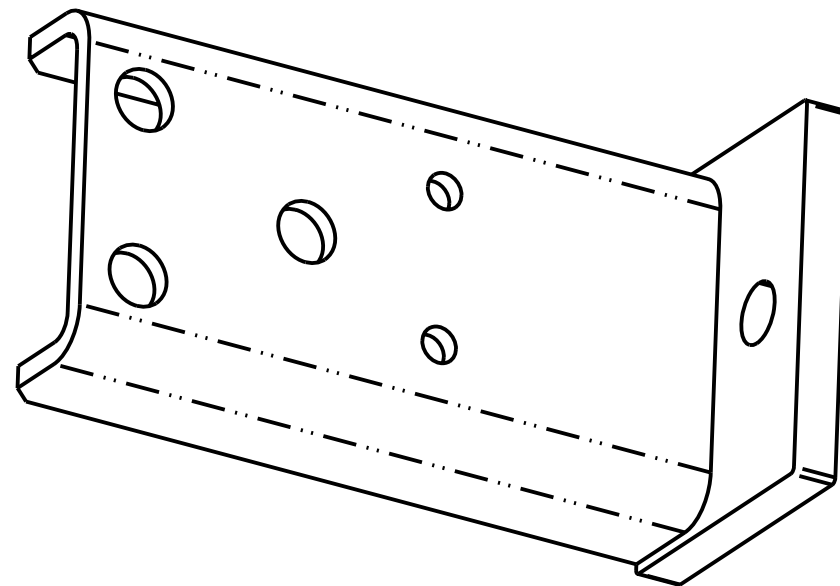
C	UPDATED PER ENGINE SPEC AND DWG BORDER	DAVE N	08JAN2007
B	ADDED CALIBRATION NOTES	DAVE N	24FEB2005
A	REDRAWN PER ENGINE SPEC	DAVE N	16OCT2004
REV	DESCRIPTION OF REVISION	BY	DATE

BUILT AFTER JANUARY 1, 2007

ALL RIGHTS TO MANUFACTURE, COPY OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY CUMMINS NPOWER, LLC		CUMMINS NPOWER CORPORATE OFFICE 1600 BUERKLE ROAD WHITE BEAR LAKE, MN WWW.NPOWER.CUMMINS.COM	CUMMINS FIRE POWER DESIGN CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN WWW.CUMMINSFIREPOWER.COM
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	DWG SCALE: NTS	DRAWN BY: DAVE N	DATE: 23SEP2004
	PLOT SCALE:	APPD BY:	DATE:
	DESCRIPTION ASSEMBLY, ENGINE, QSM11-G2		
	REFERENCE: CFP11E-F10/20		DRAWING NUMBER: 8740C




BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	PLATE, LEG, ENGINE SUPPORT, FIREPUMP	8409
2	1	CHANNEL, SUPPORT, ENGINE, REAR, FIREPUMP, L10	8782

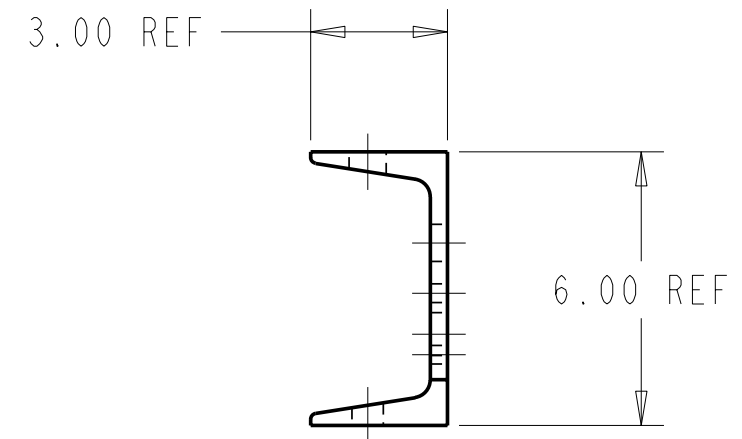
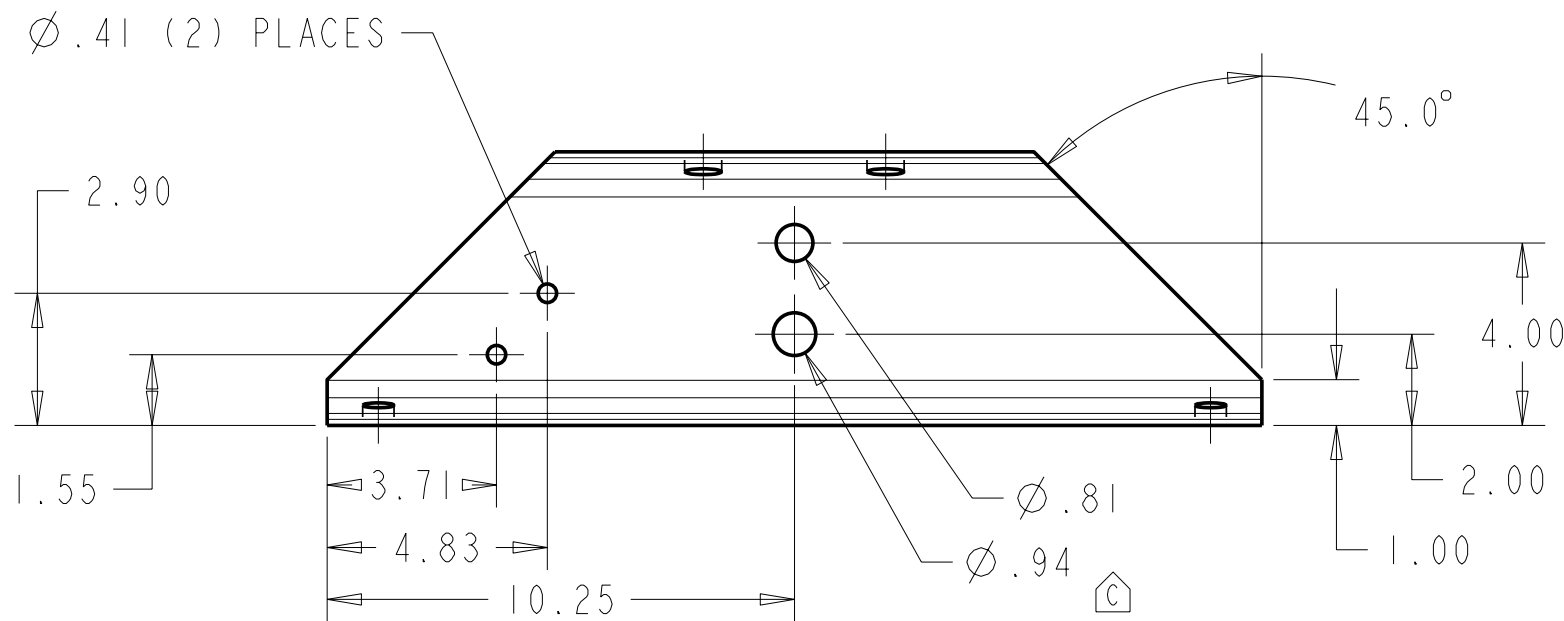
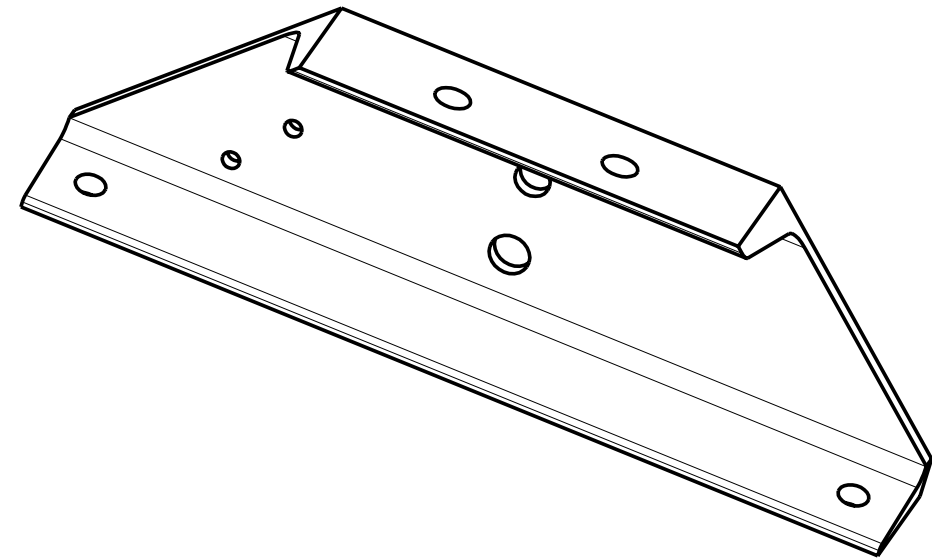
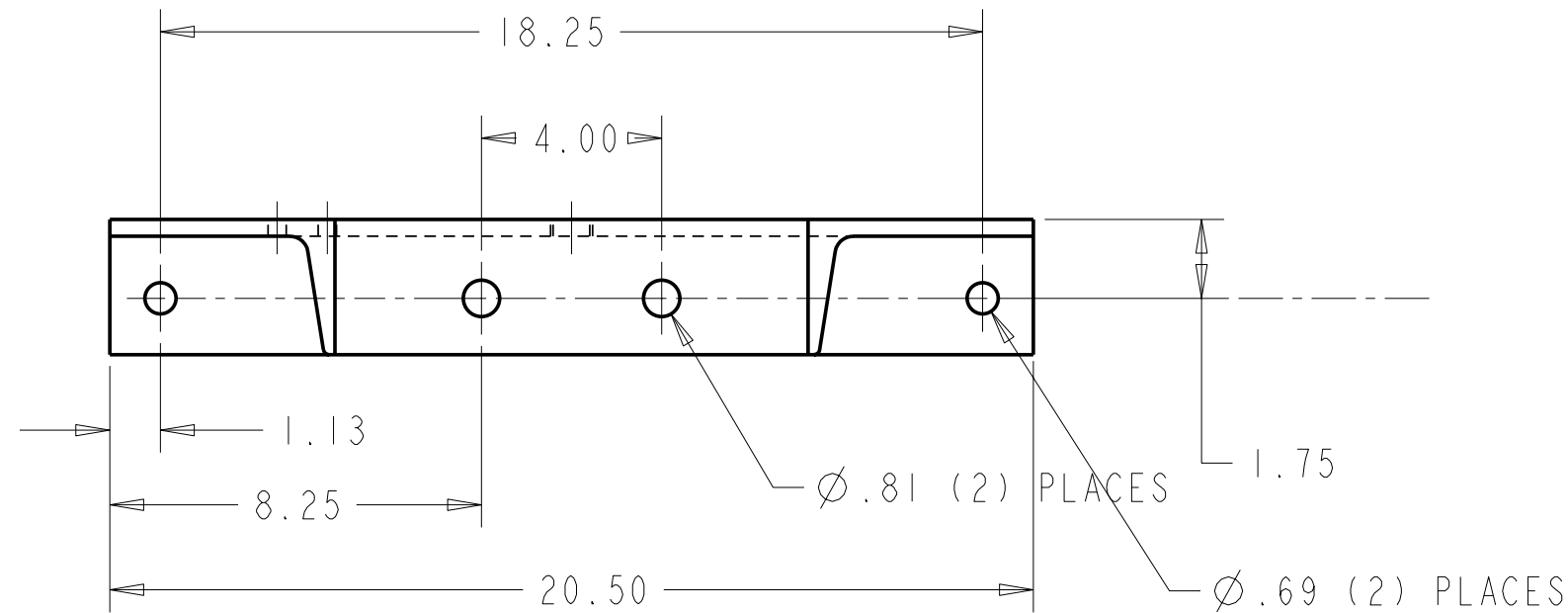


NOTES:

- 1) REMOVE ALL BURS AND SHARP EDGES
- 2) PRIME AND PAINT FIRE ENGINE RED
- 3) CENTER CHANNEL ON PLATE

F	ADDED WELD SYMBOL	JDT	22FEB07
E	REV PER ITEM #2	DAVE N	29JUL03
C/D	REV PER ITEM #2	DAVE N	03NOV04
REV	DESCRIPTION OF REVISION	REV BY	DATE


ALL RIGHTS TO MANUFACTURE, COPY OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY CUMMINS NPOWER, LLC		 NP 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°			TITLE 1: SUPPORT, ENGINE, REAR TITLE 2: FIREPUMP, L10/QSMII					
IMPERIAL UNITS	METRIC UNITS	DWG UNITS: IN/LB/S		DRAWN BY: DAVE N APPD BY:		DATE: 07MAR2004 DATE:		
MACHINE TOLERANCES X : ± 0.06 XX : ± 0.010 XXX : ± 0.001	MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05	EST WEIGHT: 5.131		SCALE: 0.500	DO NOT SCALE	SHEET 10F1	DRAWING NO: 8781	REV: F
WELD TOLERANCES X : ± 0.25 XX : ± 0.12 XXX : ± 0.06	WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50							

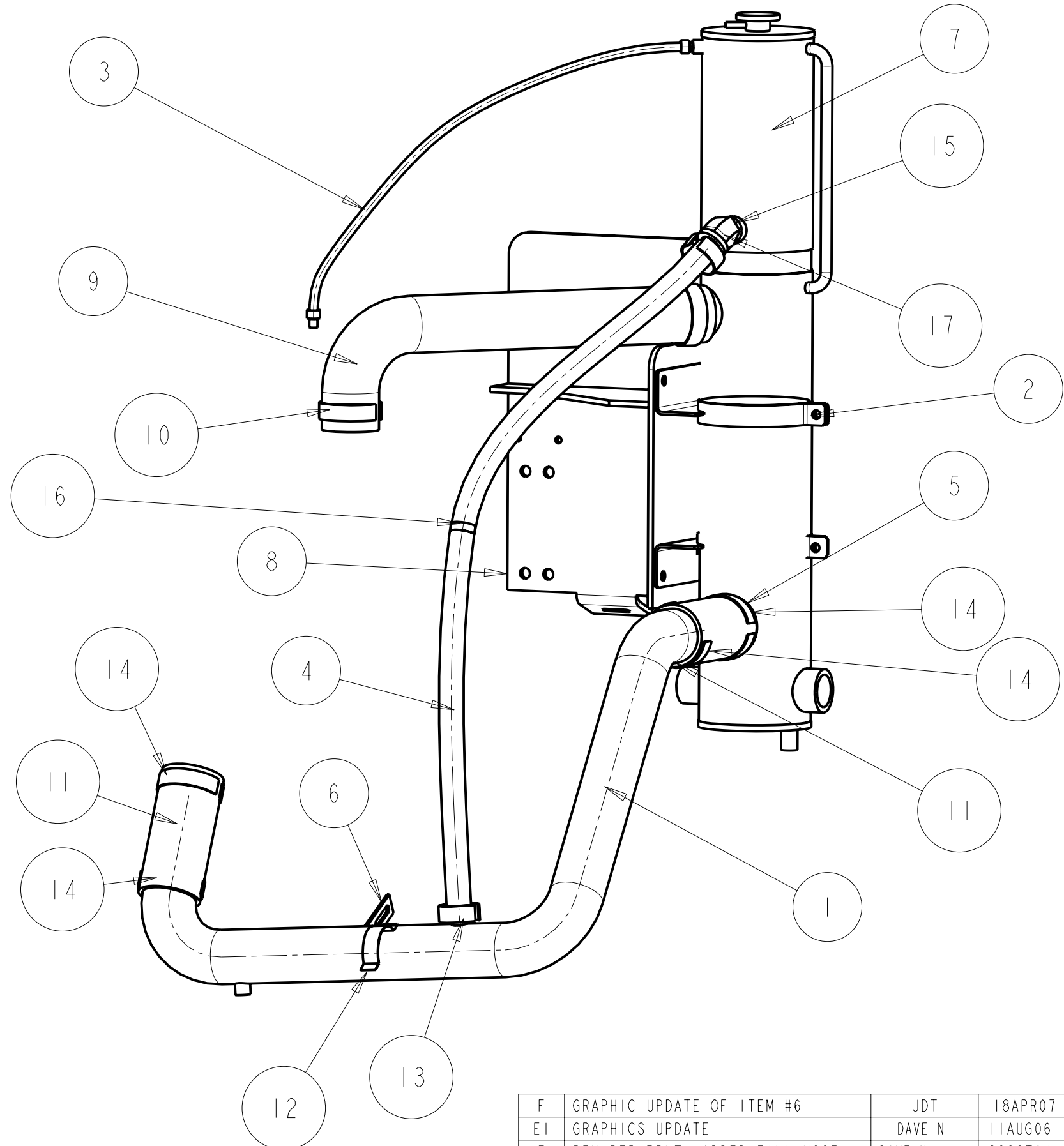


NOTES:

- 1) MATERIAL: CHANNEL, STRUCTURAL, MC6 X 16.3#
- 2) REMOVE ALL BURS AND SHARP EDGES
- 3) PRIME AND PAINT CASE RED

CI	ADDED BACK HOLES	DAVE N	158OCT05
C	REMOVED HOLES. REV HOLE SIZE	DAVE N	03OCT05
B	ADDED HOLES	DAVE N	03SEP04
REV	DESCRIPTION OF REVISION	REV BY	DATE

ALL RIGHTS TO MANUFACTURE, COPY OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY CUMMINS NPOWER, LLC				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°		TITLE 1: BRACKET, SUPPORT, ENGINE, FRONT TITLE 2: FIREPUMP, QSMII													
IMPERIAL UNITS		METRIC UNITS		DWG UNITS: IN/LB/S		DRAWN BY: DAVE N		DATE: 07MAR2004							
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 XX : ± 0.5 XXX : ± 0.05 WELDED TOLERANCES X : ± 5 XX : ± 3 XXX : ± 1.50		EST WEIGHT: 20.861		SCALE: 0.250		DO NOT SCALE		SHEET 10FI		DRAWING NO: 8783		REV: C	



BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	TUBE, WATER OUTLET, QSMII, FIREPUMP	8793
2	2	CLAMP, SUPPORT, HEAT EXCHANGER, CHAMP #300385	8819
3	1	ASSEMBLY, VENT LINE, 3/16" x 32", FIREPUMP	9543
4	1	FILL HOSE, 3/4" ID X 20" LG #70232GL, -	70232GL_8792
5	1	BUSHING, 2.25" X 2.50"	904
6	1	BRACKET, MOUNTING, GUARD, FIREPUMP	8593
7	1	HEAT EXCHANGER, 5", #CM012904-1	8687
8	1	BRACKET, SUPPORT, HEAT EXCHANGER, FIREPUMP	8789
9	1	TUBE, WATER OUTLET, FIREPUMP, L10	8794
10	2	CLAMP, 2-1/2" NOMINAL	8928
11	2	HOSE, CONNECTION, 2.5 ID X 6"	8933
12	1	CLAMP, PIPE, 1-1/4"	9544
13	2	CLAMP, 1.5" NOMINAL, #92216	92216
14	4	CLAMP, 3" NOMINAL, #92236	92236
15	1	STREET ELBOW, BLK, 3/4" NPT, 45 DEG.	E3445
16	1	CLAMP, 1"	LTL-SCPV16627
17	1	ADAPTER, 3/4" NPT X 3/4" OD (#8288)	R-68HB_12-8

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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	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

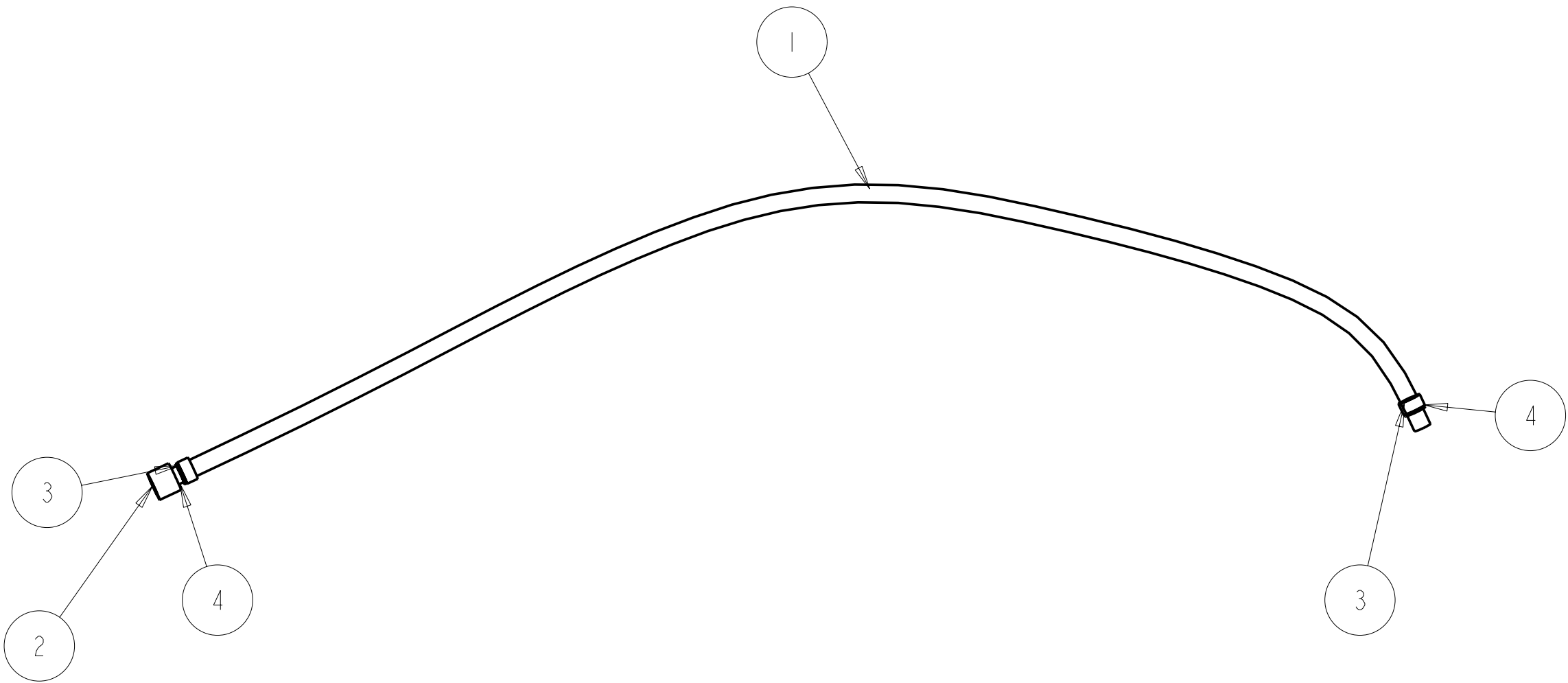
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WHITE BEAR LAKE, MN
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NPowER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, HEAT EXCHANGER, CFPIIE


TITLE 2: FIREPUMP

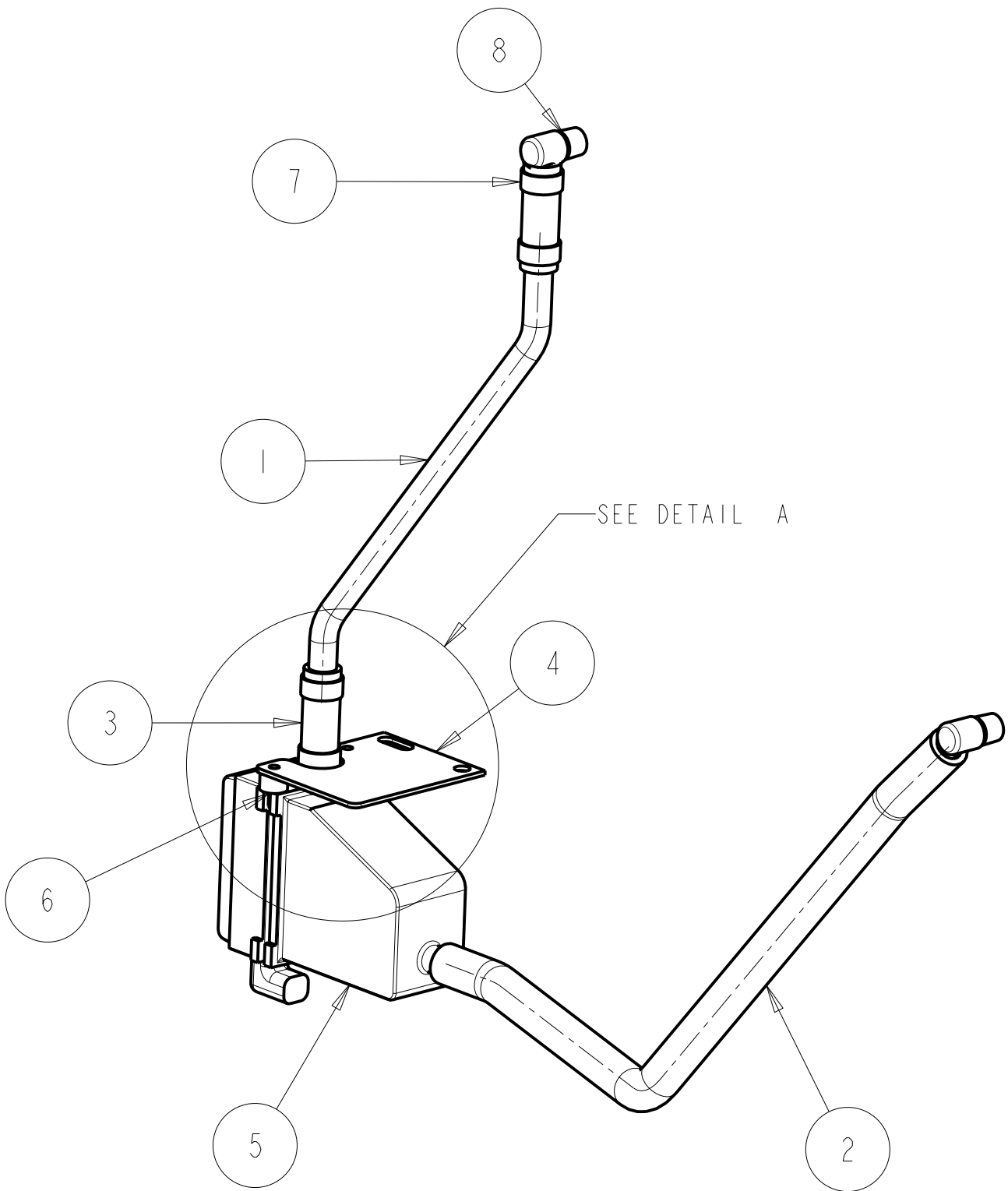
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 07MAR2004
EST WEIGHT: 105.563	APPD BY:	DATE:
SCALE: 0.200	DO NOT SCALE	SHEET 10F1
DRAWING NO: 8792	REV: F	



BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, VENT LINE, #801-4 X 32" LG, FIREPUMP	9543_HOSE
2	1	BUSHING, 1/4" NPT X 1/2" NPT	LTL-SRB-1214
3	2	ADAPTER, FLARED, 1/4" NPT	R-30882-4-4
4	2	ADAPTER, FLARED, 1/4" NPT	R-48F-4-4

REV	DESCRIPTION OF REVISION	REV BY	DATE
A			

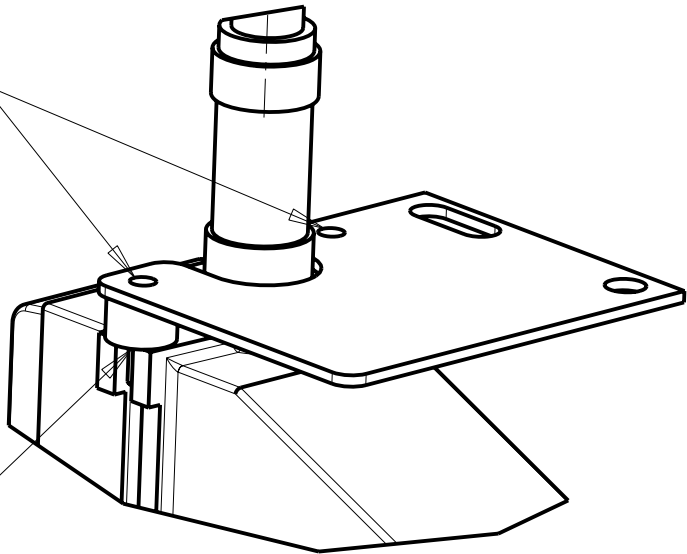
ALL RIGHTS TO MANUFACTURE, COPY OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY CUMMINS NPOWER, LLC			CUMMINS NPOWER, LLC CORPORATE OFFICE 1600 BUERKLE ROAD WHITE BEAR LAKE, MN WWW.NPOWER.CUMMINS.COM			NPOWER SYSTEMS DESIGN CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN			
UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE ANGULAR DIMENSIONS ± 1°			TITLE 1: ASSEMBLY, VENT LINE, 3/16" x 32" TITLE 2: FIREPUMP						
IMPERIAL UNITS		METRIC UNITS		DWG UNITS:		DRAWN BY: DAVE N		DATE: 23AUG2004	
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		IN/LB/S		APPD BY: -		DATE: -	
EST WEIGHT: 42238.628		SCALE: 0.375		DO NOT SCALE		SHEET 10FI		DRAWING NO: 9543	
								REV:	



C

ATTACH HEATER TO BRACKET USING
LOCTITE #425 BLUE ON FASTENERS,
HAND TIGHT + 1/4 TURN.

INSTALL ISOLATORS (2) ON HEATER
USING LOCTITE #425 BLUE, HAND TIGHT



DETAIL A
SCALE 0.500

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	TUBE, COOLANT HEATER, INLET, L10, FIREPUMP	8951
2	1	HOSE, OUTLET, #70232GL X 30" LG, FIREPUMP	8952
3	2	COUPLING, HOSE, 3/4" I.D. #80242GL X 3" LG, FIREPUMP	8562
4	1	BRACKET, MOUNTING, COOLANT HEATER, FIREPUMP	9542
5	1	CIRCULATION HEATER, P&T #3315033, 2250W , 120V , 176° F	9599
6	2	ISOLATOR, STUD MOUNT, 1/4-20, TECH PRODUCTS #51201	13102
7	4	CLAMP, 1" NOMINAL #92216	CLAMP_100
8	2	ADAPTER, 1/2" NPT X 3/4" 90 DEG BARB	R-269HB-12-8

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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



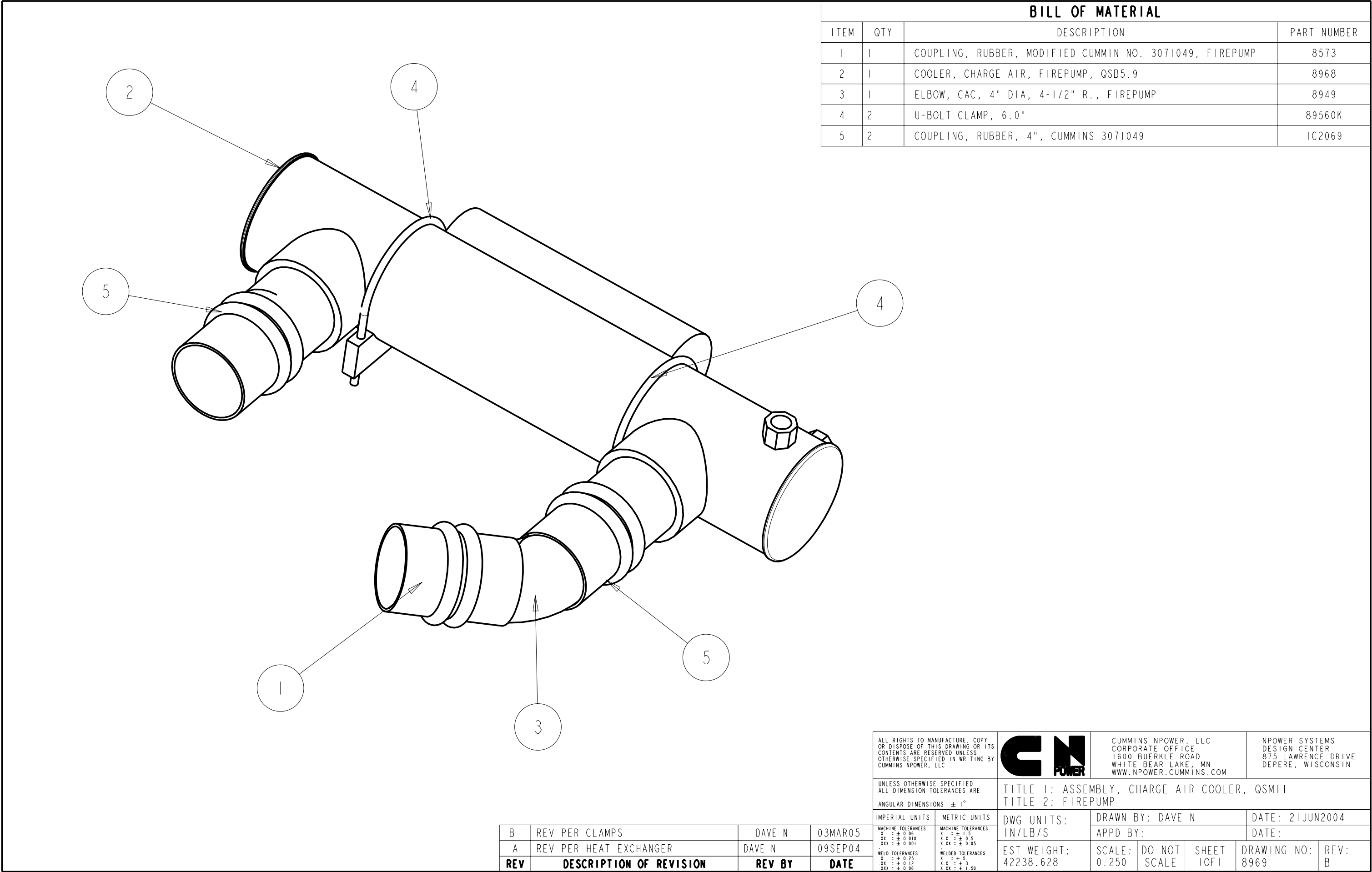
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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, COOLANT HEATER, CP11E
TITLE 2: FIREPUMP


DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 24MAY2004
EST WEIGHT: 9.541	APPD BY:	DATE:
SCALE: 0.250	DO NOT SCALE	SHEET 10F1
DRAWING NO: 8950	REV: C	

REV	DESCRIPTION OF REVISION	REV BY	DATE
C	ADDED ISOLATORS	S DUBICK	18JUL08
B	UPDATED #5 COOLANT HEATER	DAVE N	24NOV04
A	REV AS BUILT	DAVE N	23AUG04

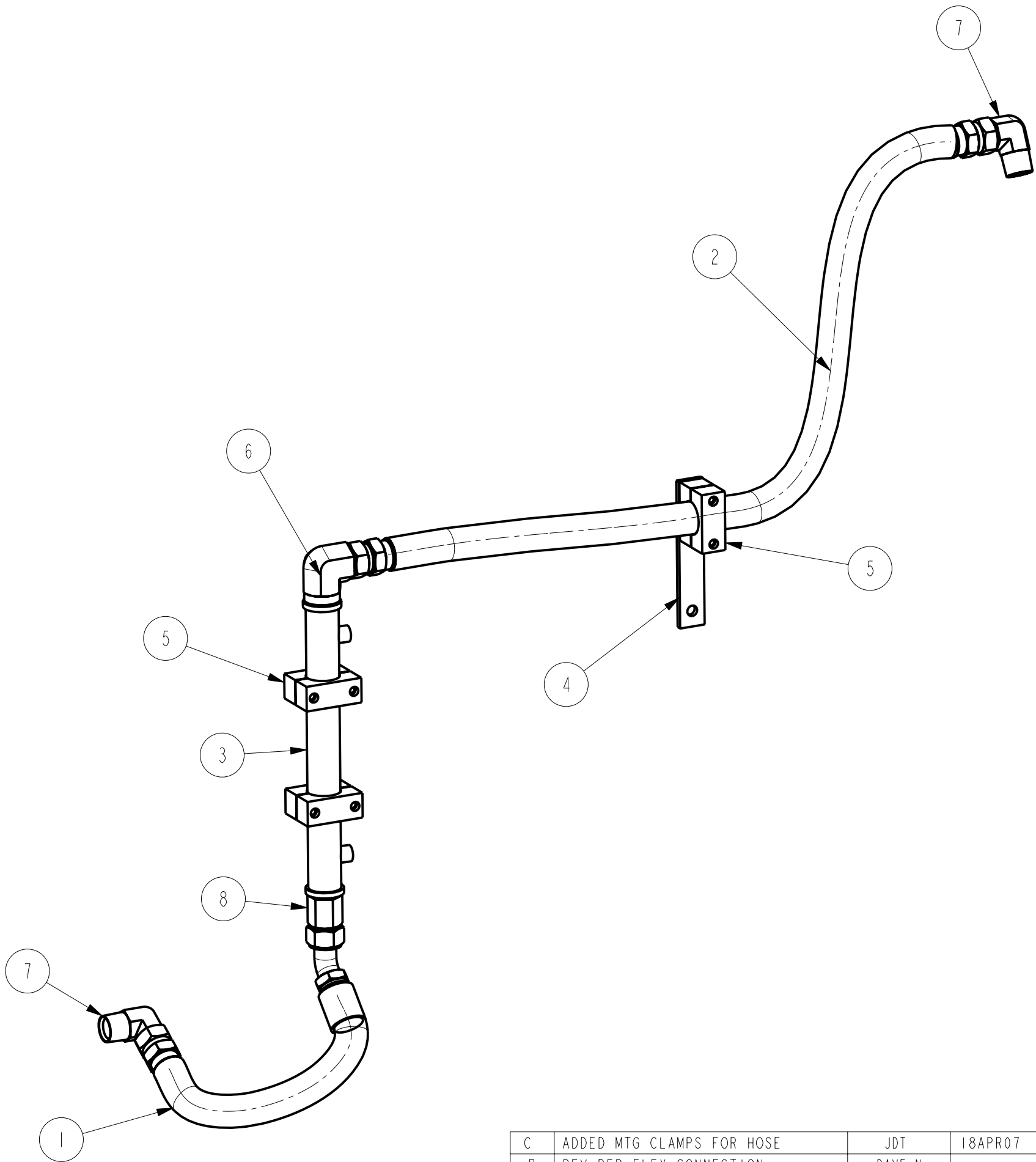


BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	COUPLING, RUBBER, MODIFIED CUMMIN NO. 3071049, FIREPUMP	8573
2	1	COOLER, CHARGE AIR, FIREPUMP, QSB5.9	8968
3	1	ELBOW, CAC, 4" DIA, 4-1/2" R., FIREPUMP	8949
4	2	U-BOLT CLAMP, 6.0"	89560K
5	2	COUPLING, RUBBER, 4", CUMMINS 3071049	1C2069


B	REV PER CLAMPS	DAVE N	03MAR05
A	REV PER HEAT EXCHANGER	DAVE N	09SEP04
REV	DESCRIPTION OF REVISION	REV BY	DATE

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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE ANGULAR DIMENSIONS ± 1°			TITLE 1: ASSEMBLY, CHARGE AIR COOLER, QSM11 TITLE 2: FIREPUMP								
IMPERIAL UNITS		METRIC UNITS		DWG UNITS:		DRAWN BY: DAVE N		DATE: 21JUN2004			
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		IN/LB/S		APPD BY:		DATE:			
EST WEIGHT: 42238.628		SCALE: 0.250		DO NOT SCALE		SHEET 10FI		DRAWING NO: 8969		REV: B	

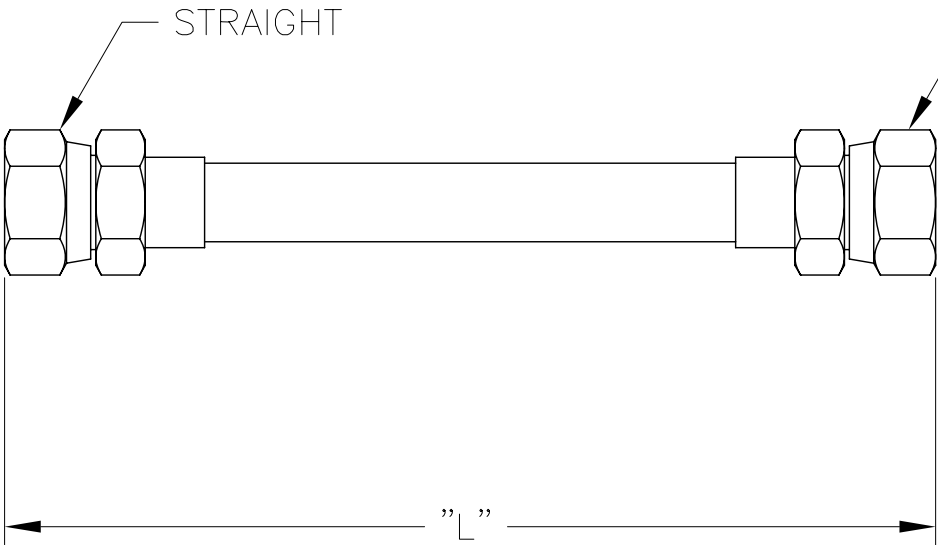
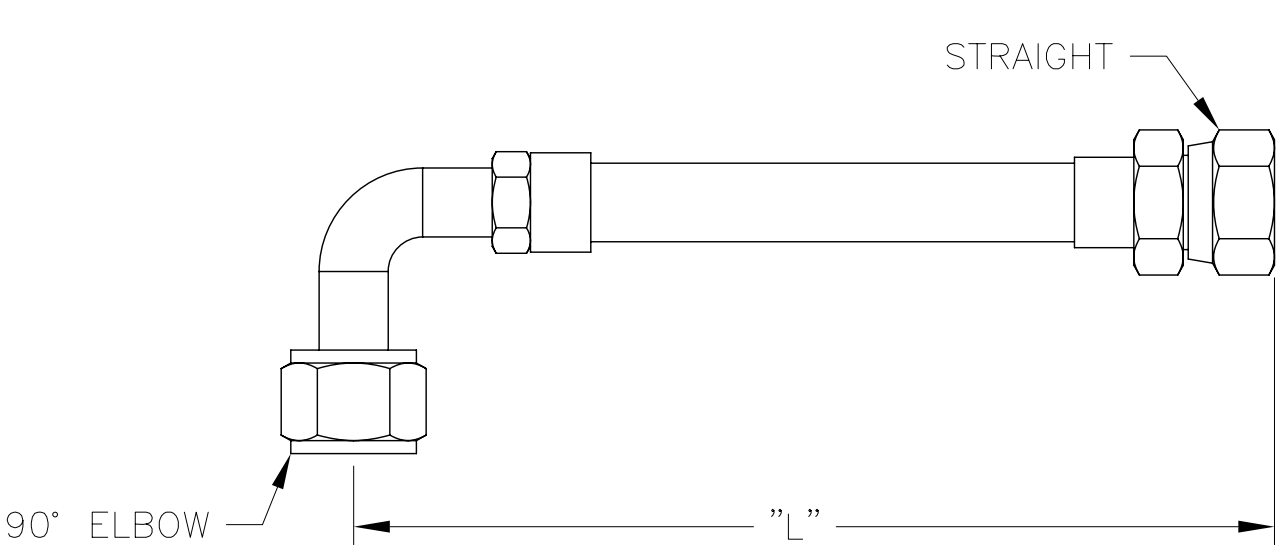
BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, WATER, 16 JIC BOTH ENDS	11086-01
2	1	HOSE, WATER, 16 JIC BOTH ENDS	11086-02
3	1	FUEL COOLER, 1" NPT	9586
4	1	BRACKET,HOSE,SUPPORT,CFPIIE, FIREPUMP	11524
5	3	CLAMP,HOSE,1.50 DIA,PLASTIC	11530
6	1	ELBOW, 1" NPTF X #16 JIC 37 DEG	11586
7	2	ELBOW, 1" NPTM X #16 JIC 37 DEG	11588
8	1	ADAPTER, 1" NPTF X #16 JIC 37 DEG	11592



C	ADDED MTG CLAMPS FOR HOSE	JDT	18APR07
B	REV PER FLEX CONNECTION	DAVE N	
REV	DESCRIPTION OF REVISION	REV BY	DATE

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<div>UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE</div>				<div>TITLE 1: ASSEMBLY, CAC WATER CONNECTION, CFPIIE TITLE 2: FIREPUMP</div>									
<div>ANGULAR DIMENSIONS ± 1°</div>		<div>IMPERIAL UNITS</div>		<div>METRIC UNITS</div>		<div>DWG UNITS: IN/LB/S</div>		<div>DRAWN BY: DAVE N APPD BY: -</div>		<div>DATE: 14DEC2006 DATE: -</div>			
<div>THIRD ANGLE PROJECTION</div> <div></div>		<div>MACHINE TOLERANCES XX ± .010 XX ± .005 FORM TOLERANCES XX ± .030 XX ± .015 FAB TOLERANCES XX ± .000 XX ± .030</div>		<div>MACHINE TOLERANCES X ± .04 .XX ± .02 FORM TOLERANCES X ± .08 XX ± .04 FAB TOLERANCES X ± .3 XX ± .08</div>		<div>EST WEIGHT: 9.905</div>		<div>SCALE: DO NOT 0.188 SCALE</div>		<div>SHEET 10FI</div>		<div>DRAWING NO: 11048 REV: C</div>	

<div><div></div><div>A</div><div></div><div>A</div></div>	ITEM	QTY	DESCRIPTION	END FITTING	END FITTING	LENGTH "L"
	01	A/R	CFP11E FUEL COOLER TO JW HX	45° SWIVEL	STRAIGHT SWIVEL	16"
	02	A/R	CFP11E CAC HX TO FUEL COOLER	STRAIGHT SWIVEL	STRAIGHT SWIVEL	44"
	03	A/R	CFP11E MISC PIPING	STRAIGHT SWIVEL	STRAIGHT SWIVEL	36"
	04	A/R	CFP83 COOLING LOOP CONNECTION	STRAIGHT SWIVEL	STRAIGHT SWIVEL	29"
	05	A/R	CFP83–F40 COOLING LOOP CONNECTION	STRAIGHT SWIVEL	STRAIGHT SWIVEL	30"
	06	A/R	CFP83–F40 CAC WATER CONNECTION	45° SWIVEL <div><div></div><div>A</div><div></div></div>	STRAIGHT SWIVEL	68"
	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

A	45° SWIVEL WAS STRAIGHT, PART LENGTHS	JDT	4APR07
REV	DESCRIPTION OF REVISION	BY	DATE

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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

HOSE, WATER, #16 37° JIC ENDS

DWG UNITS:
IN\LB\S

EST WEIGHT:

DRAWN BY: DAVE N

APPD BY:

DATE: 20DEC2006

DATE:

SCALE: NTS

DO NOT SCALE

SHEET 10F1

DRAWING NO: 11086

REV: A

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

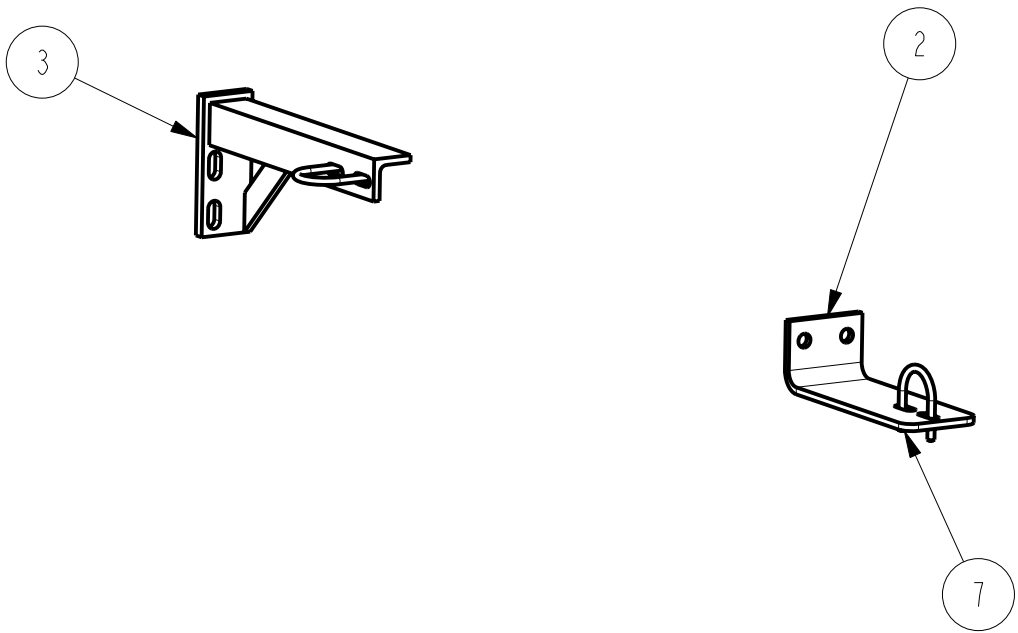
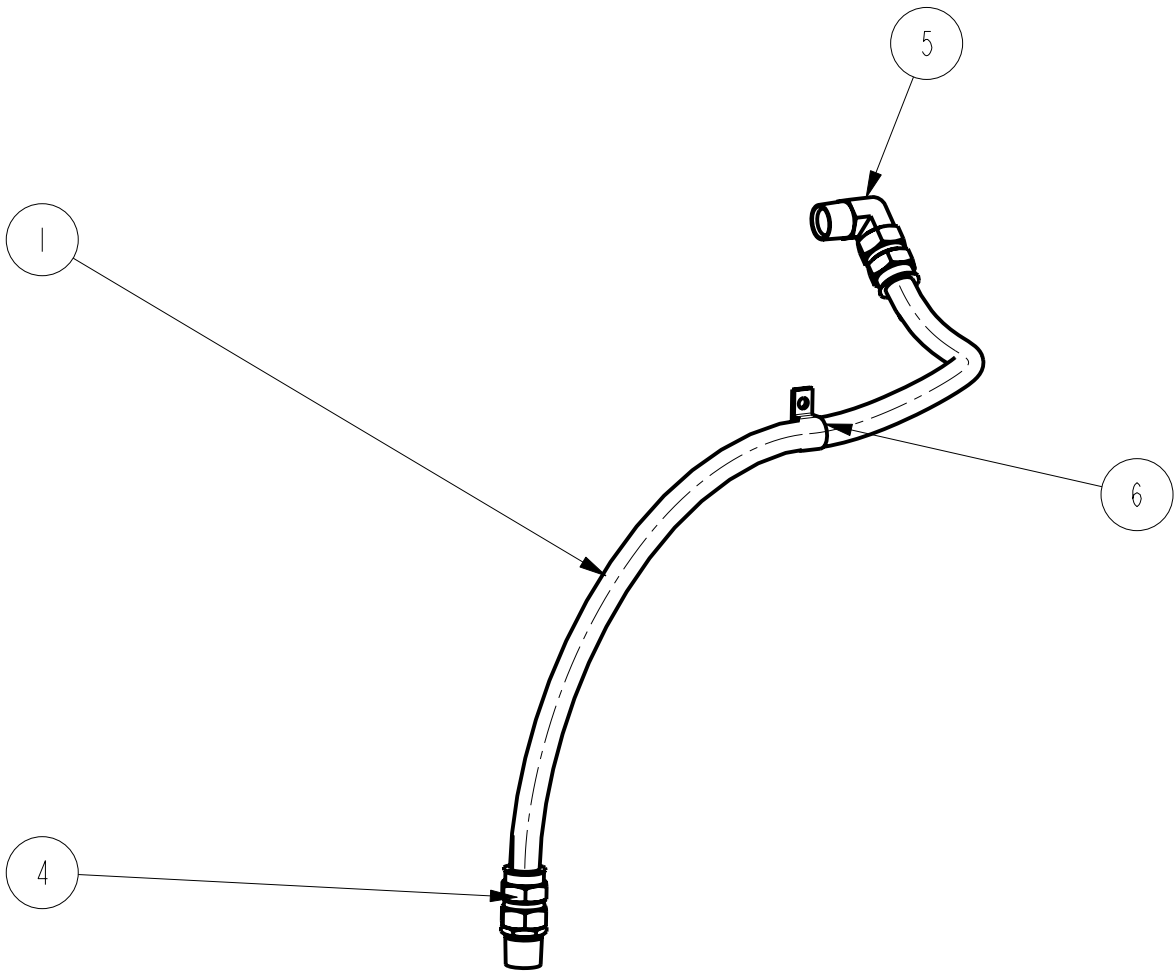
FORM TOLERANCES
XX = ± 0.030
XXX = ± 0.015

FAB TOLERANCES
XX = ± 0.050
XXX = ± 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



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, WATER, 16 JIC BOTH ENDS	11086-03
2	1	BRACKET, RAW WATER COOLING, 8" LG, FIREPUMP	8814
3	1	BRACKET, MOUNTING, COOLING LOOP, M11, FIREPUMP	9755
4	1	ADAPTER, NPTM X JIC 37 DEG	11587
5	1	ELBOW, 1" NPTM X #16 JIC 37 DEG	11588
6	1	CLAMP, 1"	LTL-SCPVI6627
7	2	U-BOLT, FITS 1" NPT	UBOLT_100

B
B

REF. SCALES

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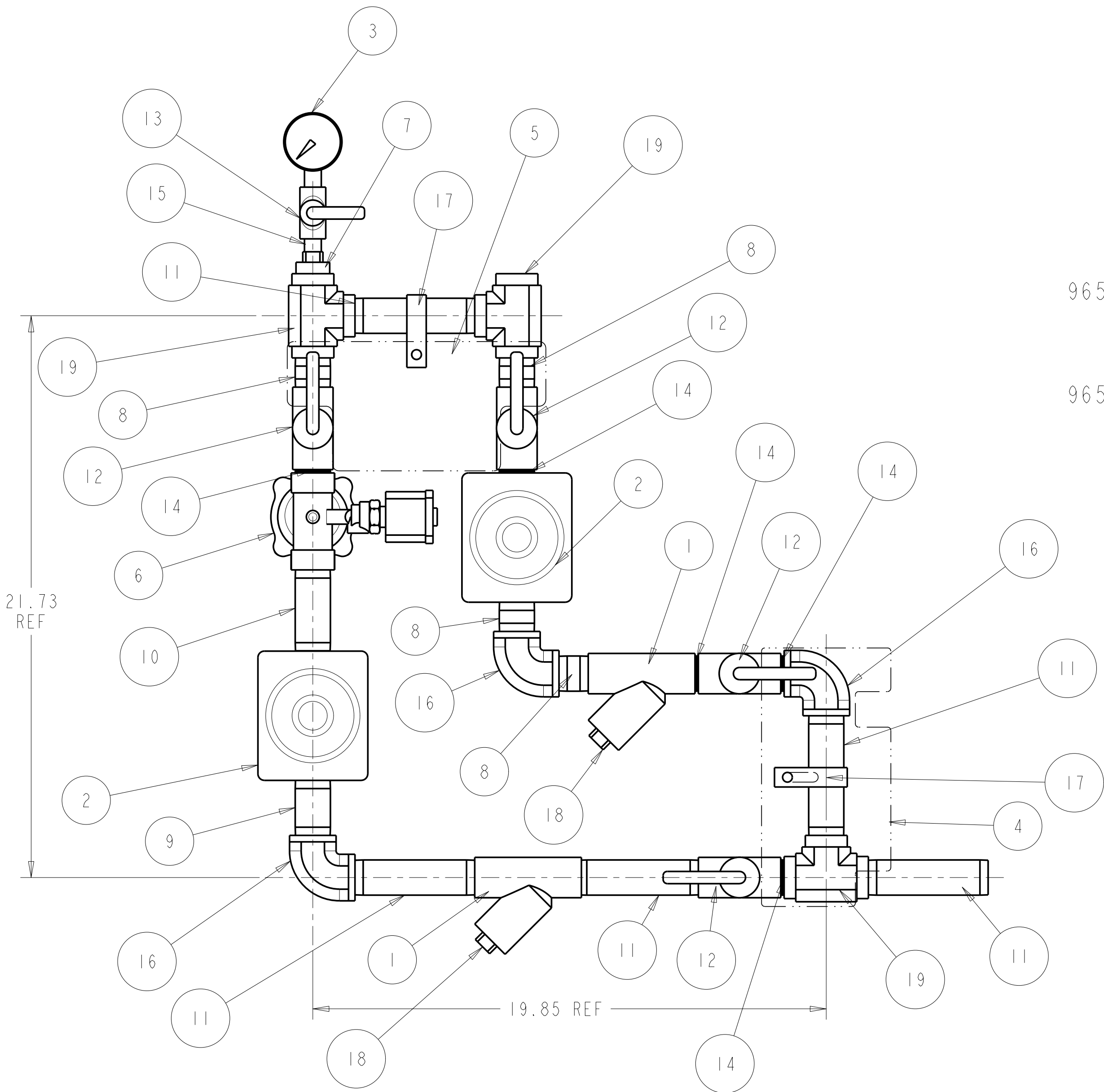
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, MISC PIPING, CFPIIE
TITLE 2: FIREPUMP

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE			DWG UNITS: IN/LB/S		DRAWN BY: DAVE N APPD BY: -		DATE: 14DEC2006 DATE: -	
ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS MACHINE TOLERANCES .XX ± .010 .XXX ± .005 FORM TOLERANCES .XX ± .030 .XXX ± .015 FAB TOLERANCES .XX ± .060 .XXX ± .030	METRIC UNITS MACHINE TOLERANCES .X ± .04 .XX ± .02 FORM TOLERANCES .X ± .08 .XX ± .04 FAB TOLERANCES .X ± .13 .XX ± .08	EST WEIGHT: 6.428	SCALE: 0.150	DO NOT SCALE	SHEET 1 OF 1	DRAWING NO: 11049	REV: B

B	ITEM #4 WAS P/N-16_FTX-S & ITEM #5 WAS P/N-16_CTX-S	JD T	14MAY07
A	CREATED DRAWING	DAVE N	14DEC06
REV	DESCRIPTION OF REVISION	REV BY	DATE

VALVES SHOWN OPEN - NOT IN OPERATING POSITION
FOLLOW HANDLE ORIENTATION



BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	STRAINER, WITH PLUG, 1" NPT	I_77SMI
2	2	REGULATOR, 1" NPT, 400 PSI MAX, 25 TO 75 PSI OUT	I_N45DBU
3	1	GUAGE, PRESSURE, 1/4" NPT, 0-100 PSI RANGE	8892
4	1	TAG, COOLANT LOOP LABEL, VERTICAL MTG	10965
5	1	TAG, COOLING LOOP, HORIZONTAL MTG, -	10966
6	1	VALVE, SOLENOID, 1" NPT, 12VDC, 150 PSI MAX	8210G4-12VDC
7	1	REDUCER BUSHING, BLK, 1" NPT x 1/4" NPT	BBGB
8	4	NIPPLE, BLK, 1 x 2-1/2	BNGL
9	1	NIPPLE, BLK, 1 x 3-1/2"	BNGN
10	1	NIPPLE, BLK, 1 x 4-1/2	BNGR
11	5	NIPPLE, BLK, 1 x 6	BNGU
12	4	VALVE, BALL, 1" NPT	FA60203-1
13	1	VALVE, BALL, 1/4" NPT	FA60204-1
14	5	NIPPLE, BLK, 1 x Close	LTL-CPN1
15	1	NIPPLE, BLK, 1/4 X CLOSE	LTL-CPN14
16	3	ELBOW, BLK, 1" NPT	LTL-E190
17	2	CLAMP, 1-1/2"	LTL-SCPV24627
18	2	PLUG, BLK, 1" NPT	LTL-SCSPI
19	3	TEE, BLK, 1"	LTL-STI

9659-01 FOR VERTICLE TURBINE PUMP:
REMOVE VALVE 8210G4 AND 4.5" LG NIPPLE
REPLACE WITH 9" LG NIPPLE BNGY9

9659-02 FOR 24vdc OPERATION:
REMOVE VALVE 8210G4-12vdc AND REPLACE
WITH #8210G4-24vdc

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ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

MACHINE TOLERANCES	MACHINE TOLERANCES
XX ± 0.005	XX ± 0.005
FORM TOLERANCES	FORM TOLERANCES
XX ± 0.010	XX ± 0.010
FAB TOLERANCES	FAB TOLERANCES
XX ± 0.010	XX ± 0.010

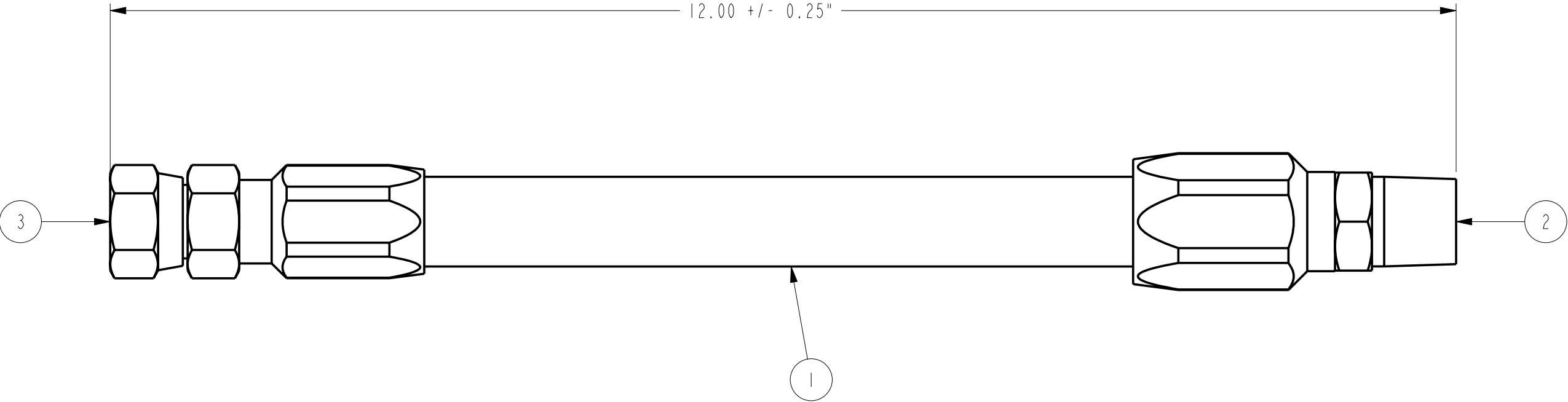
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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: COOLING LOOP, 1", UPPER HX ORIENTATION
TITLE 2: FIREPUMP

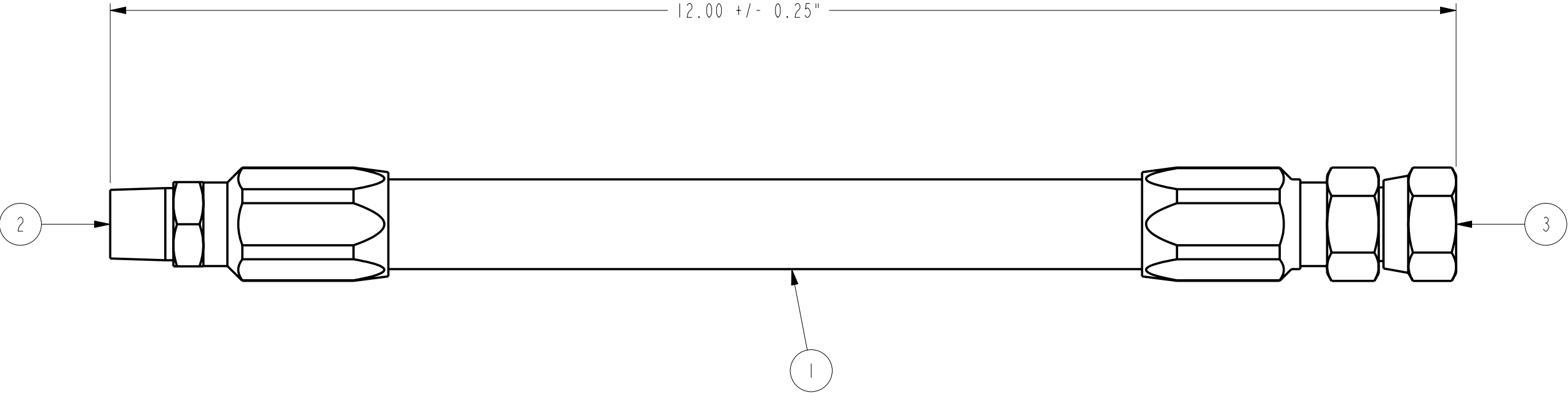
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 06JAN2005
EST WEIGHT: 52.972	APPD BY: -	DATE: -
SCALE: 0.300	DO NOT SCALE	SHEET 10FI
		DRAWING NO: 9659
		REV: D

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, #10-261 x 8.25" LG, -	10233_LINE
2	1	HOSE END, 20 SERIES, 1/2" NPT X #10 HOSE	20120-8-10C
3	1	ADAPTER, HOSE, #10 FEMALE JIC 45 DEG. SWIVEL	20820-10-10




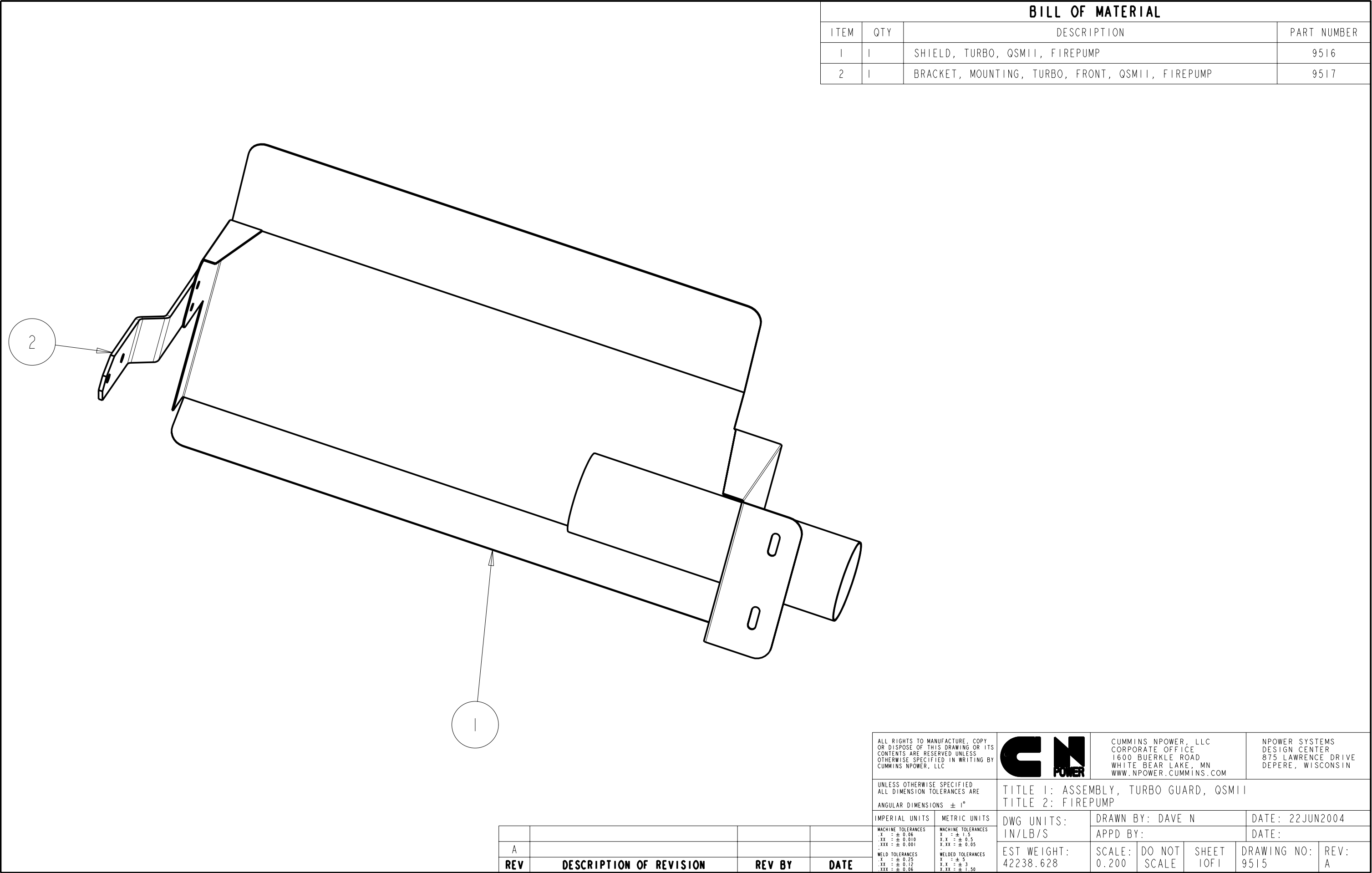
				MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50	IN/LB/S	APPD BY: -			DATE: -	
A	RELEASED	DAVE N	22JUL05			EST WEIGHT: 42238.628	SCALE: 1.000	DO NOT SCALE	SHEET 10FI	DRAWING NO: 10233	REV: A
REV	DESCRIPTION OF REVISION	REV BY	DATE								

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, #8-261 x 8.25" LG, -	10234_LINE
2	1	HOSE END, 20 SERIES, 3/8" NPT X #8 HOSE	20120-6-8
3	1	ADAPTER, HOSE, FEMALE JIC 45 DEG. SWIVEL	20820-8-8




REV	DESCRIPTION OF REVISION	REV BY	DATE
A			

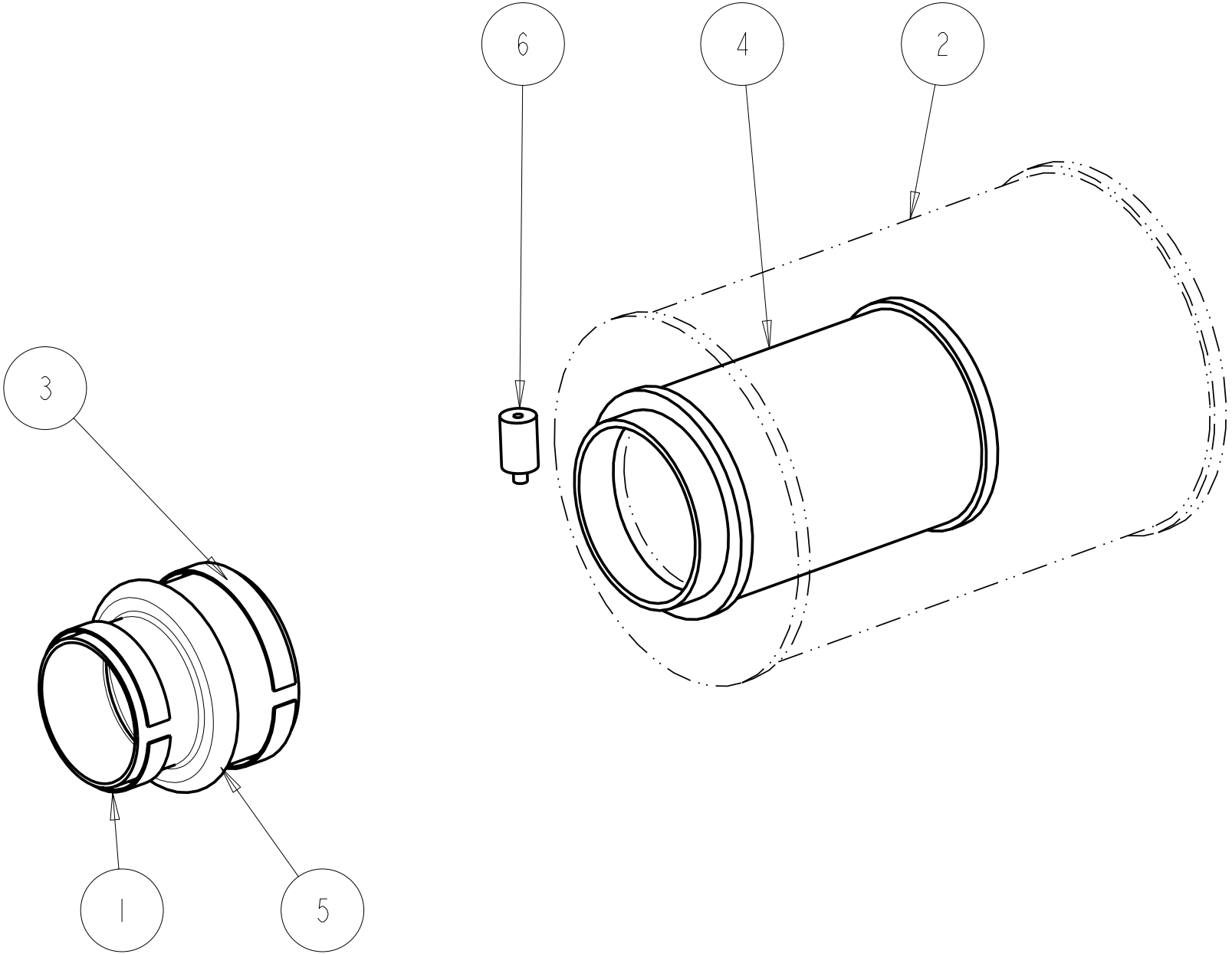
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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE ANGULAR DIMENSIONS ± 1°		TITLE 1: FUEL LINE, #8, 45 DEG FLARE X 3/8" NPT TITLE 2: 12" LONG FLEX EXTENSION													
IMPERIAL UNITS		METRIC UNITS		DWG UNITS:		DRAWN BY: DAVE N		DATE: 22JUL2005							
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001		MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05		IN/LB/S		APPD BY: -		DATE: -							
WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06		WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50		EST WEIGHT: 42238.628		SCALE: 1.000		DO NOT SCALE		SHEET 10FI		DRAWING NO: 10234		REV:	



BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	SHIELD, TURBO, QSM11, FIREPUMP	9516
2	1	BRACKET, MOUNTING, TURBO, FRONT, QSM11, FIREPUMP	9517

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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE ANGULAR DIMENSIONS ± 1°			TITLE 1: ASSEMBLY, TURBO GUARD, QSM11 TITLE 2: FIREPUMP						
IMPERIAL UNITS		METRIC UNITS		DWG UNITS:		DRAWN BY: DAVE N		DATE: 22JUN2004	
MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001		MACHINE TOLERANCES X : ± 1.5 X.X : ± 0.5 X.XX : ± 0.05		IN/LB/S		APPD BY:		DATE:	
WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06		WELDED TOLERANCES X : ± 5 X.X : ± 3 X.XX : ± 1.50		EST WEIGHT: 42238.628		SCALE: 0.200		DO NOT SCALE	
						SHEET 10FI		DRAWING NO: 9515	
								REV: A	

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	CLAMP, 4" NOMINAL, AC400	8815
2	1	AIR CLEANER, 5" HIGH FLOW, DONALDSON P/N B105002	9519
3	1	CLAMP, 5" NOMINAL	9524
4	1	AIR FILTER, 5" DIA. INLET, CFPIIE FIREPUMP	9608
5	1	COUPLING, RUBBER, 4"x5", NELSON #89845K	89845K
6	1	RESTRICTION INDIACOR, 1/8" NPT	RAX00-2352



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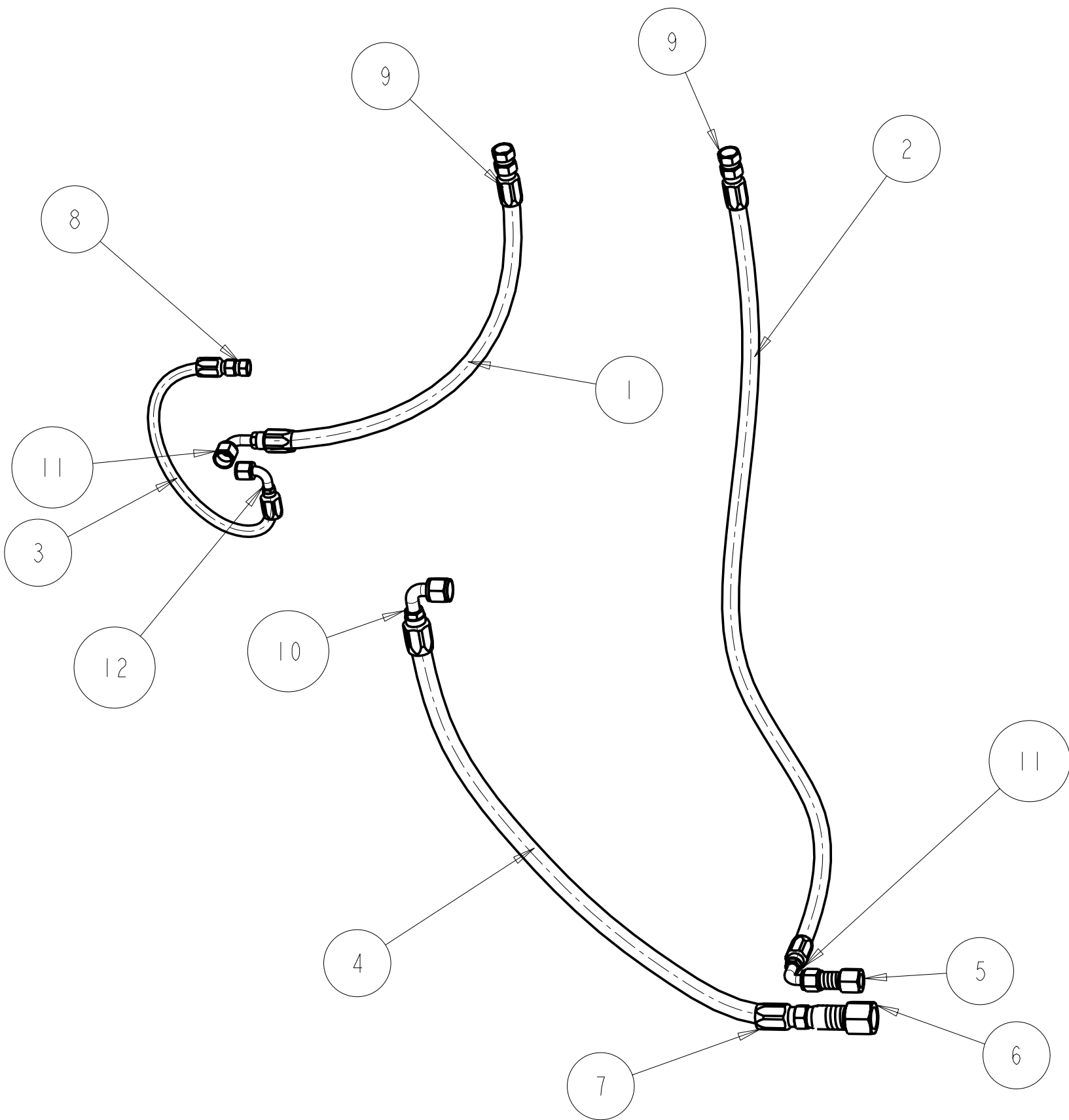
CUMMINS NPOWER, LLC
CORPORATE OFFICE
1600 BUERKLE ROAD
WHITE BEAR LAKE, MN
WWW.NPOWER.CUMMINS.COM

NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, AIR CLEANER, QSM11
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 23JUN2004
EST WEIGHT: 5.901	APPD BY:	DATE:
SCALE: 0.250	DO NOT SCALE	SHEET 1 OF 1
		DRAWING NO: 9518
		REV: C

C	REV PER AIR CLEANER	DAVE N	14DEC06
REV	DESCRIPTION OF REVISION	REV BY	DATE



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, RETURN, 261-8 X 37" LG, FIREPUMP	9594_RETURN
2	1	FUEL LINE, RETURN, 261-8 X 46" LG, FIREPUMP	9594_RETURN2
3	1	FUEL LINE, RETURN, 261-5 X 24.0" LG	9594_RETURN3
4	1	FUEL LINE, SUPPLY, 261-10 X 35" LG, FIREPUMP	9594_SUPPLY
5	1	BULKHEAD, #8 X 3/8" NPT	8_WGTX-S
6	1	BULKHEAD, #10 SAE 37 DEG FLARE	10_WGTX-S
7	1	ADAPTER, #10 FLARE X HOSE	20620-10-10
8	1	ADAPTER, HOSE, FEMALE JIC 45 DEG SWIVEL	20820-5-5
9	2	ADAPTER, HOSE, FEMALE JIC 45 DEG. SWIVEL	20820-8-8
10	1	#10 FEMALE JIC 37 DEG. SWIVEL 90 DEG. ELBOW	23920-10-10
11	2	ELBOW, HOSE, FEMALE JIC 37 DEG.	23920-8-8
12	1	FEMALE_SAE_45_DEG_SWIVEL_90_DEG_ELBOW, #27920-5-5	27920-5-5

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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	MACHINE TOLERANCES X : ± 1.5 XX : ± 0.5 XXX : ± 0.05
WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06	WELDED TOLERANCES X : ± 5 XX : ± 3 XXX : ± 1.50

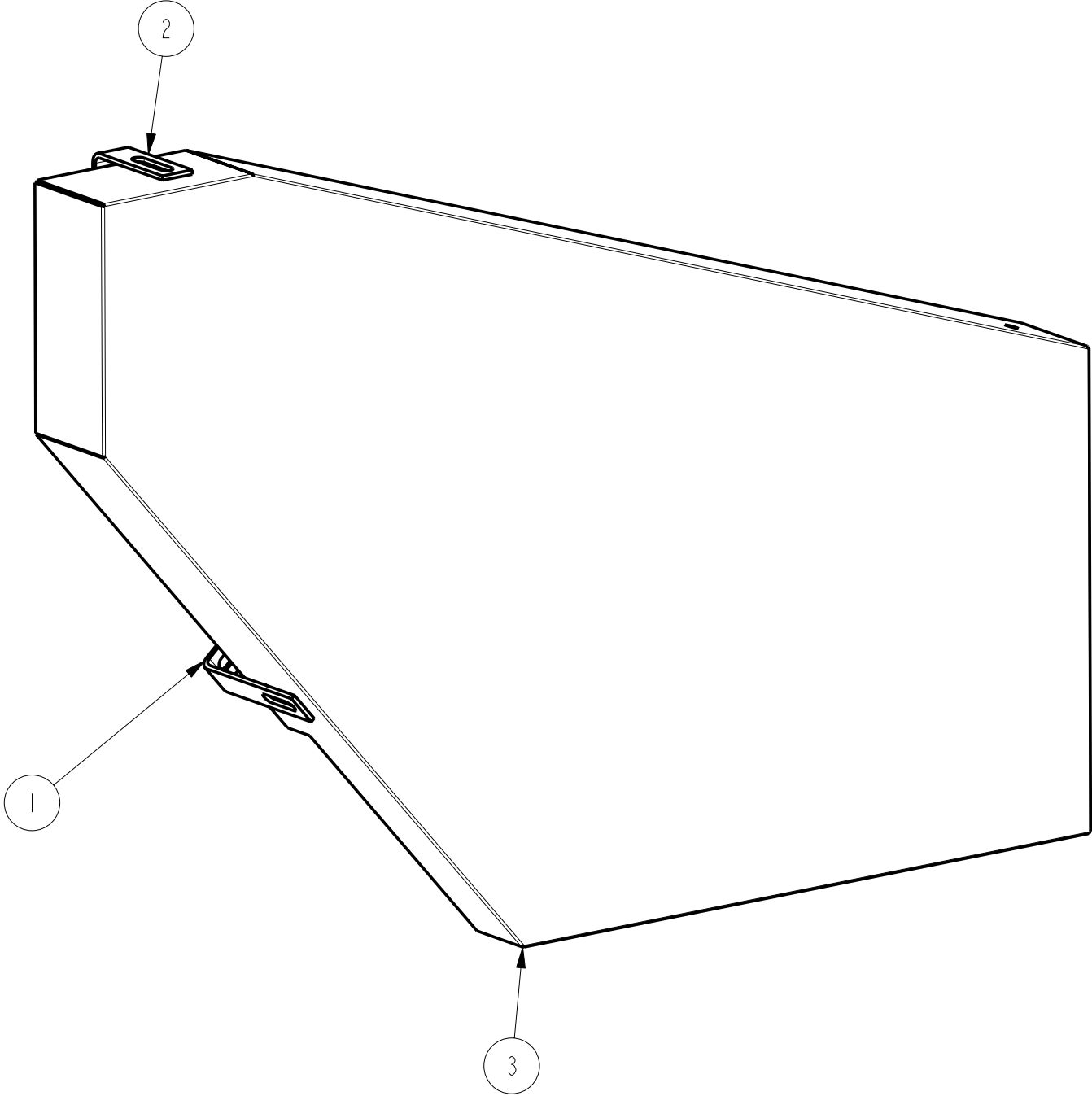
CUMMINS NPOWER, LLC
CORPORATE OFFICE
1600 BUERKLE ROAD
WHITE BEAR LAKE, MN
WWW.NPOWER.CUMMINS.COM

NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, FUEL LINE, CFPIIE
TITLE 2: FIREPUMP


DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 03SEP2004
EST WEIGHT: 42238.628	SCALE: 0.188	DO NOT SCALE
SHEET 10FI	DRAWING NO: 9594	REV: D

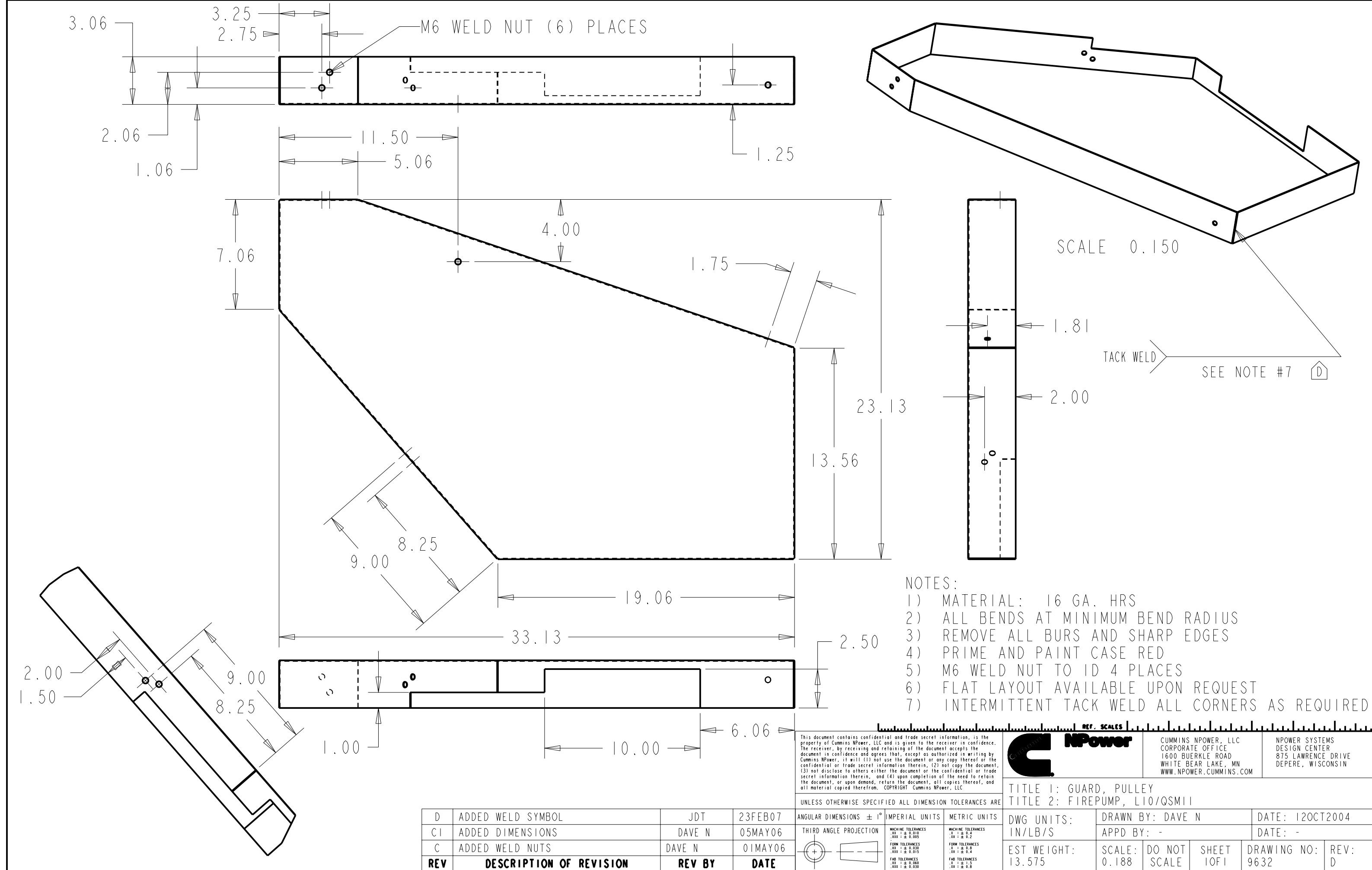
D	REV AS BUILT	DAVE N	19JAN06
C	UPDATED FUEL LINE LENGTHS	DAVE N	28MAY05
B	ADDED ECM PIPING	DAVE N	17MAR05
REV	DESCRIPTION OF REVISION	REV BY	DATE



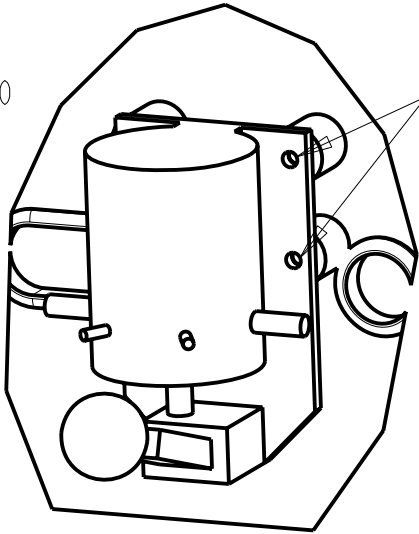
BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	BRACKET, MOUNTING, GUARD, FIREPUMP	8592
2	1	BRACKET, MOUNTING, GUARD, FIREPUMP	8593
3	1	GUARD, PULLEY, FIREPUMP, L10/QSM11	9632

A	RELEASED	DAVE N	25OCT05
REV	DESCRIPTION OF REVISION	REV BY	DATE

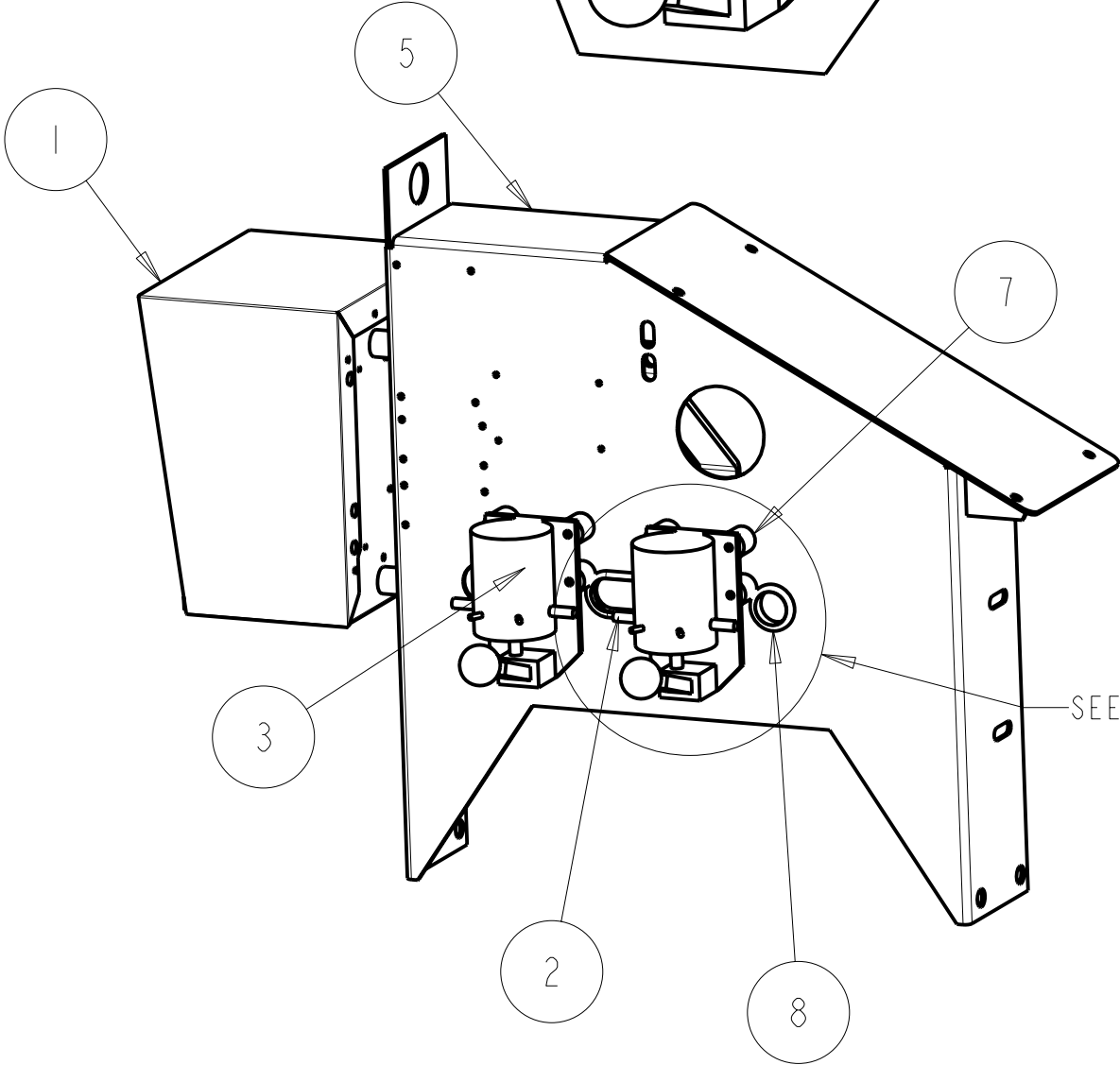
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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE ANGULAR DIMENSIONS ± 1°		TITLE 1: ASSEMBLY, PULLEY GUARD, CFPIIE TITLE 2: FIREPUMP					
IMPERIAL UNITS	METRIC UNITS	DWG UNITS:	DRAWN BY: DAVE N			DATE: 25OCT2005	
MACHINE TOLERANCES .X : ± 0.06 .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	IN/LB/S	APPD BY: -			DATE: -	
EST WEIGHT: 42238.628		SCALE: 0.250	DO NOT SCALE	SHEET 10F1	DRAWING NO: 9631	REV: A	



DETAIL A
SCALE 0.300



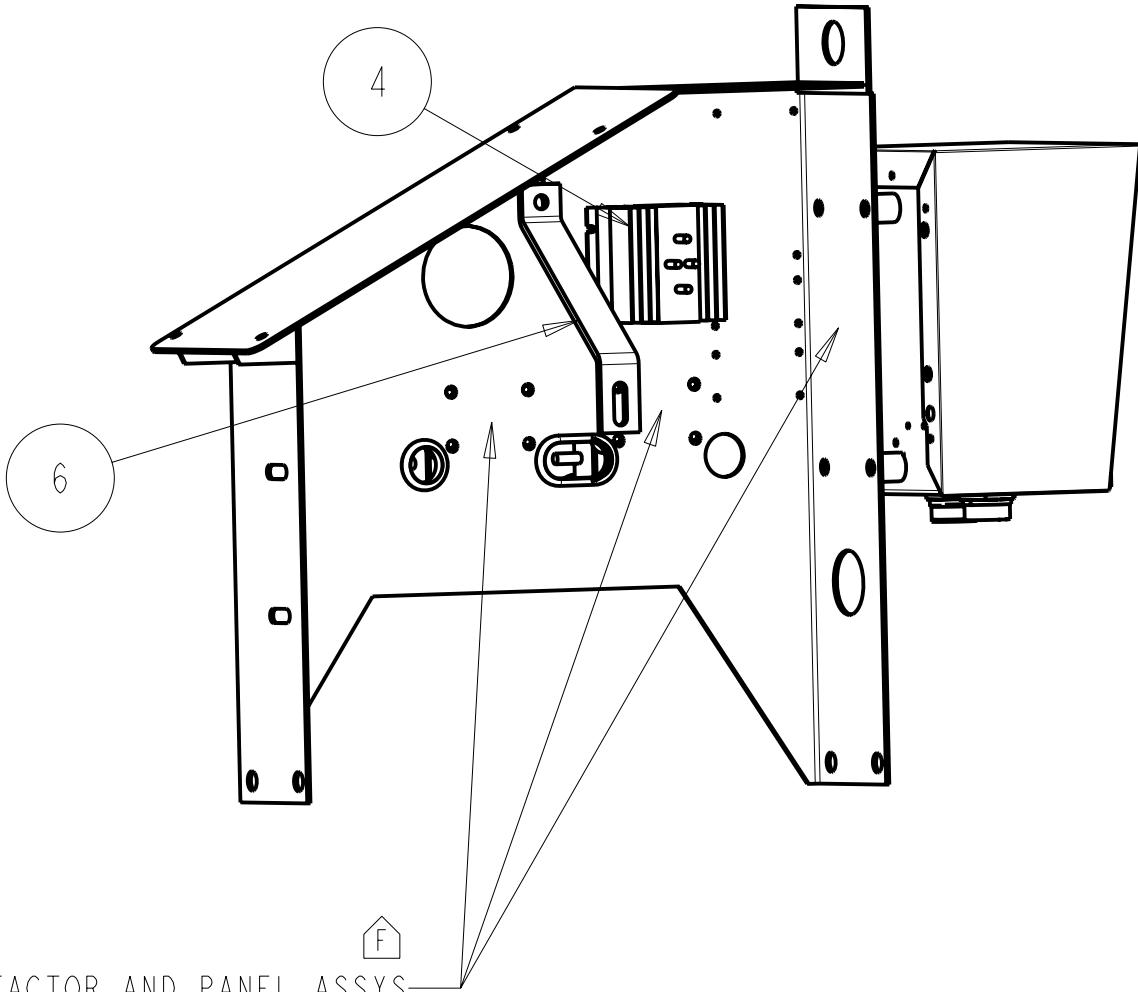
INSTALL ISOLATORS (4)
ON EACH CONTACTOR WITH
LOCTITE #425 BLUE,
HAND TIGHT



SEE DETAIL A

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, INSTRUMENT PANEL, ISOLATED, FIREPUMP	13236
2	1	GROMMET	508-1057
3	2	CONTACTOR, MANUAL OVERRIDE, FIREPUMP	8824
4	1	BATTERY ISOLATOR, FIRE PUMP	8838
5	1	BRACKET, MOUNTING, OPERATORS STATION, QSMII, FIREPUMP	9511
6	1	BRACKET, STIFFENER, OPERATOR STATION, QSMII, FIREPUMP	9512
7	8	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011
8	1	GROMMET, 1.50 DIA HOLE	19447

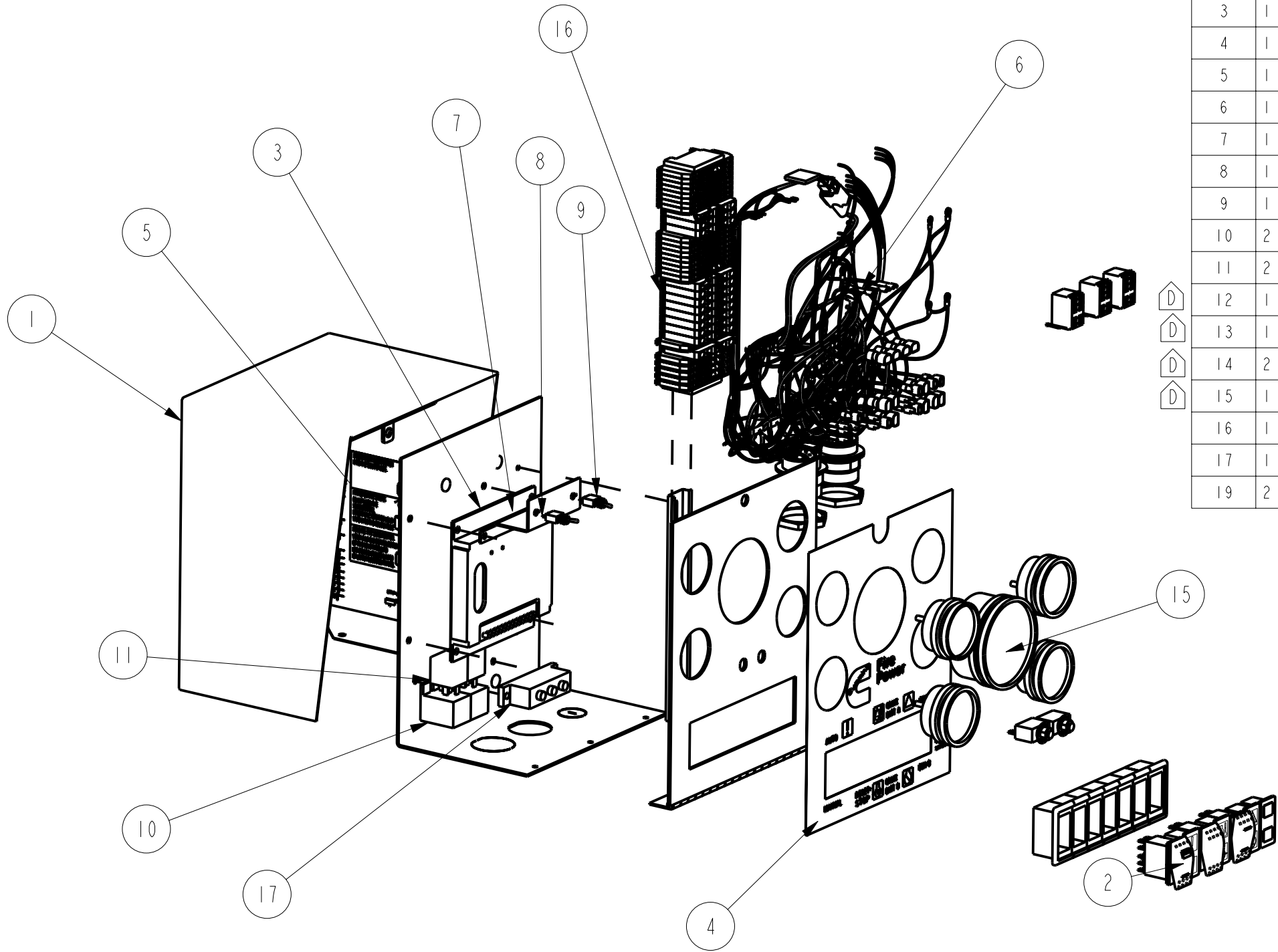


ATTACH CONTACTOR AND PANEL ASSYS
WITH LOCTITE #425 BLUE ON FASTENERS,
HAND TIGHT + 1/4 TURN.

REV	DESCRIPTION OF REVISION	REV BY	DATE
F	MODIFY ISOLATOR MTG SPEC., INST. PANEL	S DUBICK	18JUL08
E	CHANGED ISOLATOR	S DUBICK	28MAY08
D	REV PER OP STATION	DAVE N	14DEC06

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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

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, OPERATORS STATION, CFPII TITLE 2: FIREPUMP			
DWG UNITS: IN/LB/S		DRAWN BY: DAVE N APPD BY:	
EST WEIGHT: 68.309		SCALE: 0.150 DO NOT SCALE	
SHEET 10F1		DRAWING NO: 9510	
REV: F		DATE: 18JUN2004	



E

D

D


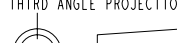
D

D

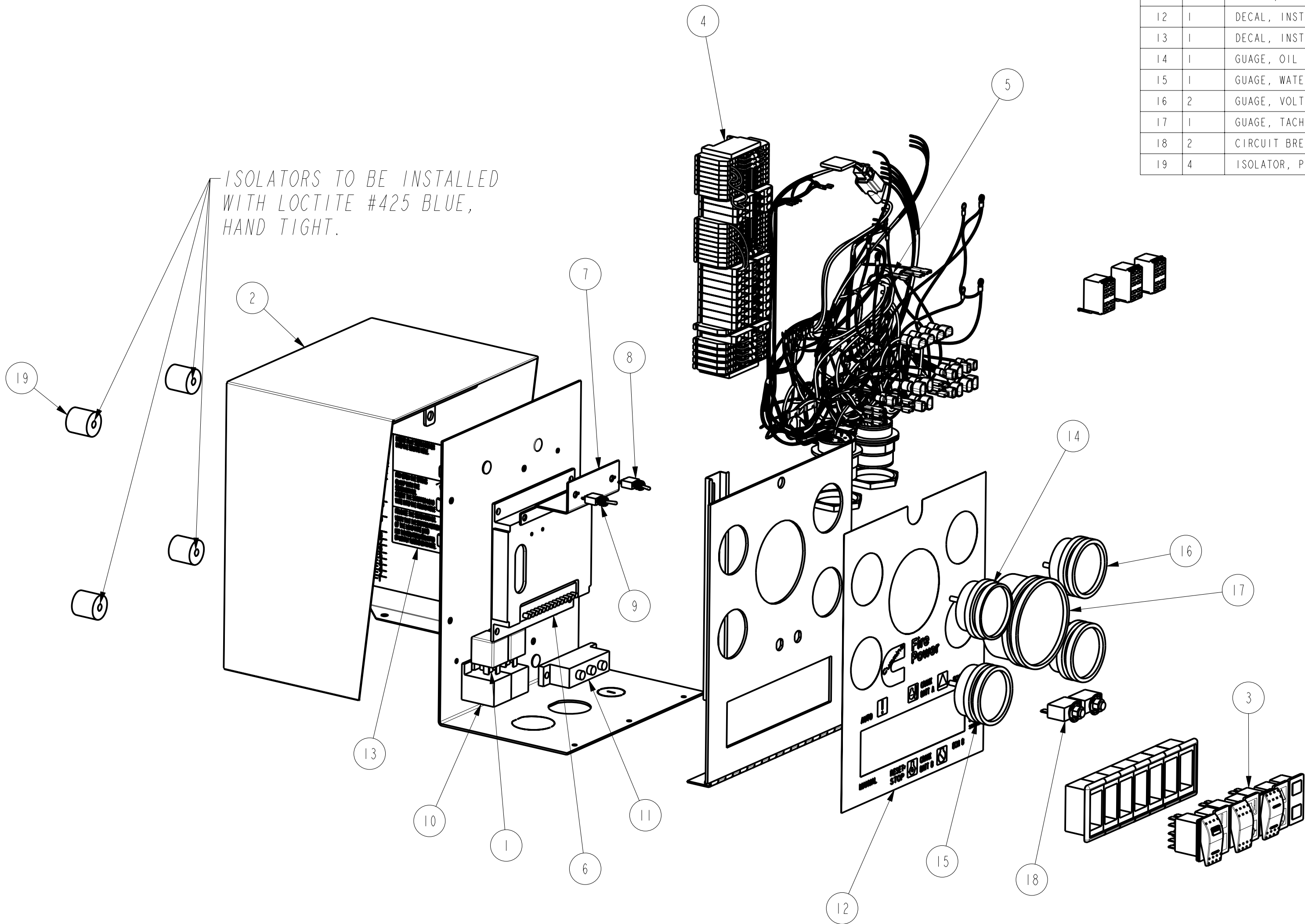
BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
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
12	1	GUAGE, OIL PRESSURE, 0-80 PSI, 12VDC, FIREPUMP	11194
13	1	GUAGE, WATER TEMPERATURE, 12VDC, FIREPUMP	11197
14	2	GUAGE, VOLTMETER 8-18VDC, FIREPUMP	11200
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.

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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE			TITLE 1: ASSEMBLY, INSTRUMENT PANEL 12V TITLE 2: FIREPUMP							
ANGULAR DIMENSIONS ± 1°		IMPERIAL UNITS	METRIC UNITS	DWG UNITS: IN/LB/S		DRAWN BY: S.DANFORTH APPD BY:		DATE: 10JUL2006 DATE:		
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 ± 1.3 XX ± 0.8	EST WEIGHT: 21.524		SCALE: 0.200	DO NOT SCALE	SHEET 10F1	DRAWING NO: 10452	REV: E

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
REV	DESCRIPTION OF REVISION	REV BY	DATE





ISOLATORS TO BE INSTALLED
WITH LOCTITE #425 BLUE,
HAND TIGHT.

BILL OF MATERIAL

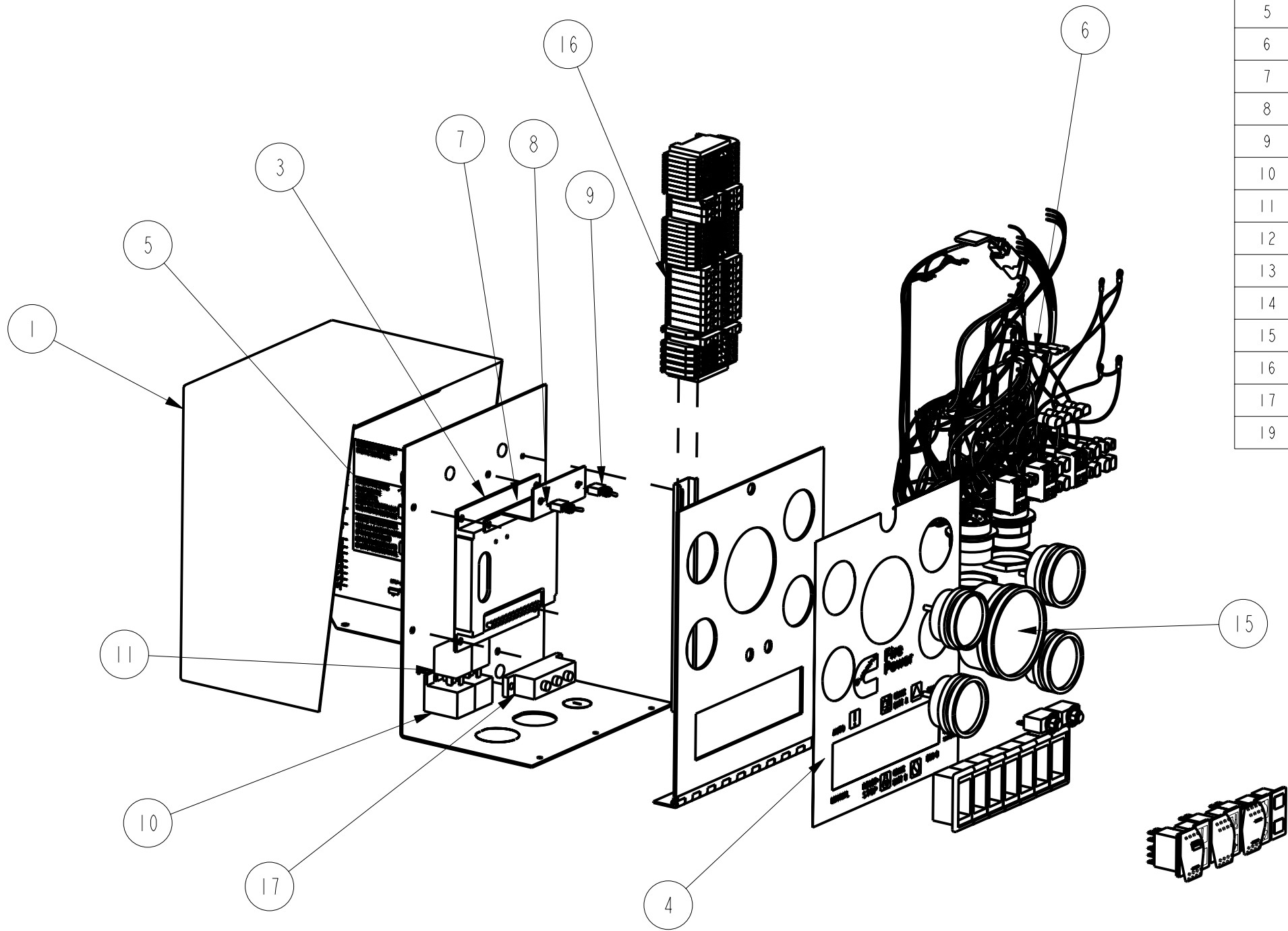
ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
2	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
3	1	ASSEMBLY, SWITCH GANG, FIREPUMP	11084
4	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
5	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
6	1	MODULE, OVERSPEED, FIREPUMP	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.

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TITLE 1: ASSEMBLY, INSTRUMENT PANEL 12V, ISOLATED TITLE 2: FIREPUMP							
UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE							
ANGULAR DIMENSIONS ± 1°		IMPERIAL UNITS		METRIC UNITS			
		MACHINE TOLERANCES X: ± 0.015 Y: ± 0.010 Z: ± 0.005		MACHINE TOLERANCES X: ± 0.4 Y: ± 0.3 Z: ± 0.2			
THIRD ANGLE PROJECTION		FORM TOLERANCES X: ± 0.010 Y: ± 0.015 Z: ± 0.010		FORM TOLERANCES X: ± 0.4 Y: ± 0.3 Z: ± 0.2			
		FORM TOLERANCES X: ± 0.008 Y: ± 0.010 Z: ± 0.008		FORM TOLERANCES X: ± 0.3 Y: ± 0.2 Z: ± 0.1			
		EST WEIGHT: 21.524		SCALE: 0.300		DO NOT SCALE	
				SHEET 10F1		DRAWING NO: 13236	
						REV: -	

REV	DESCRIPTION OF REVISION	REV BY	DATE



E
D

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:
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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
REV	DESCRIPTION OF REVISION	REV BY	DATE

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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 ± 1.3 XX ± 0.8

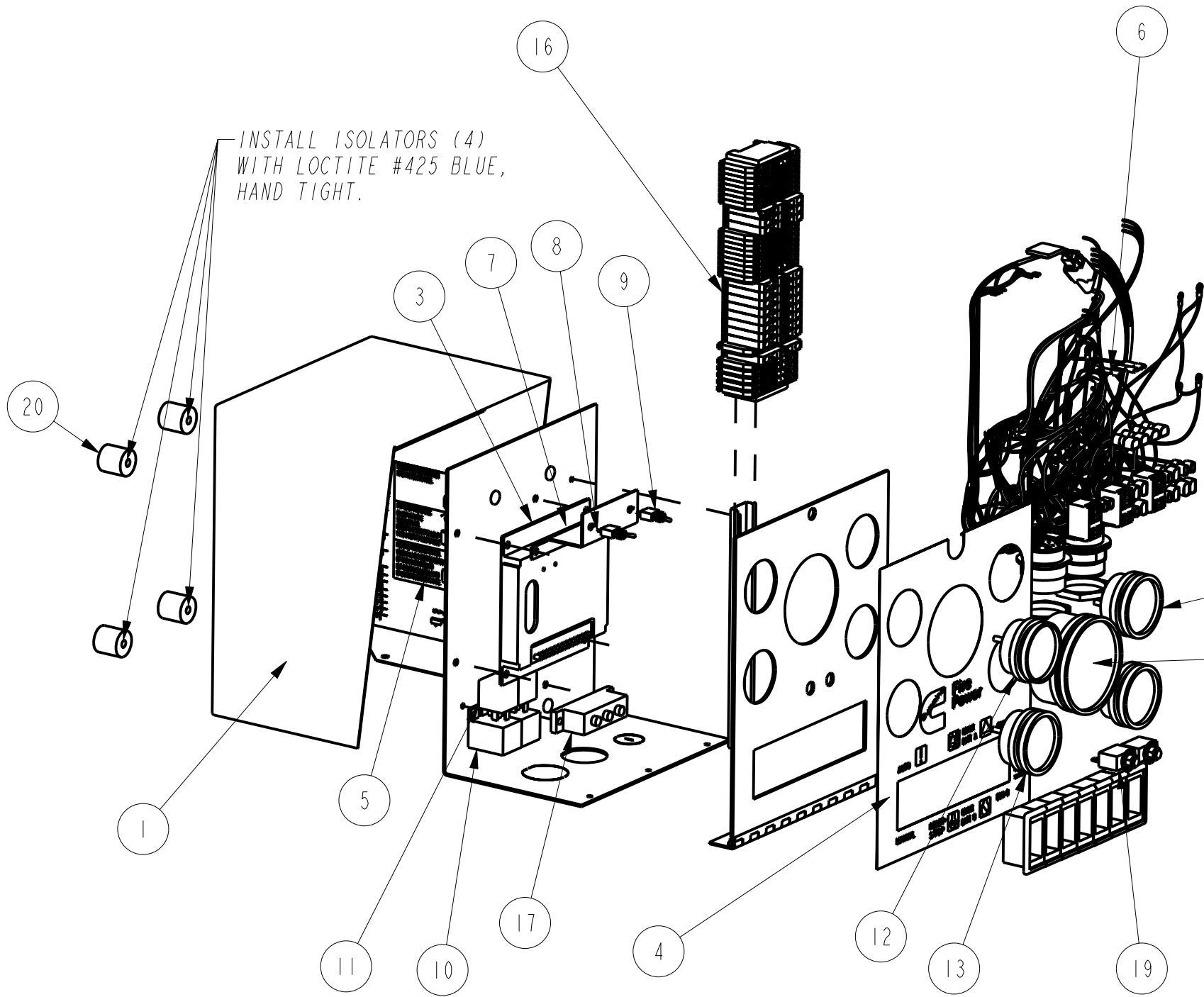


CUMMINS NPOWER, LLC
CORPORATE OFFICE
1600 BUERKLE ROAD
WHITE BEAR LAKE, MN
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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 24V
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH	DATE: 10JUL2006
EST WEIGHT: 20.096	APPD BY:	DATE:
SCALE: 0.200	DO NOT SCALE	SHEET 1 OF 1
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.

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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES XX ± 0.010 XX ± 0.005 FORM TOLERANCES XX ± 0.030 XX ± 0.015 FAB TOLERANCES XX ± 0.004 XX ± 0.020	MACHINE TOLERANCES X ± 0.4 XX ± 0.2 FORM TOLERANCES X ± 0.8 XX ± 0.4 FAB TOLERANCES X ± 1.3 XX ± 0.8

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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 24V, ISOLATED
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S

EST WEIGHT: 20.096

DRAWN BY: S DUBICK
APPD BY:

SCALE: 0.200

DO NOT SCALE

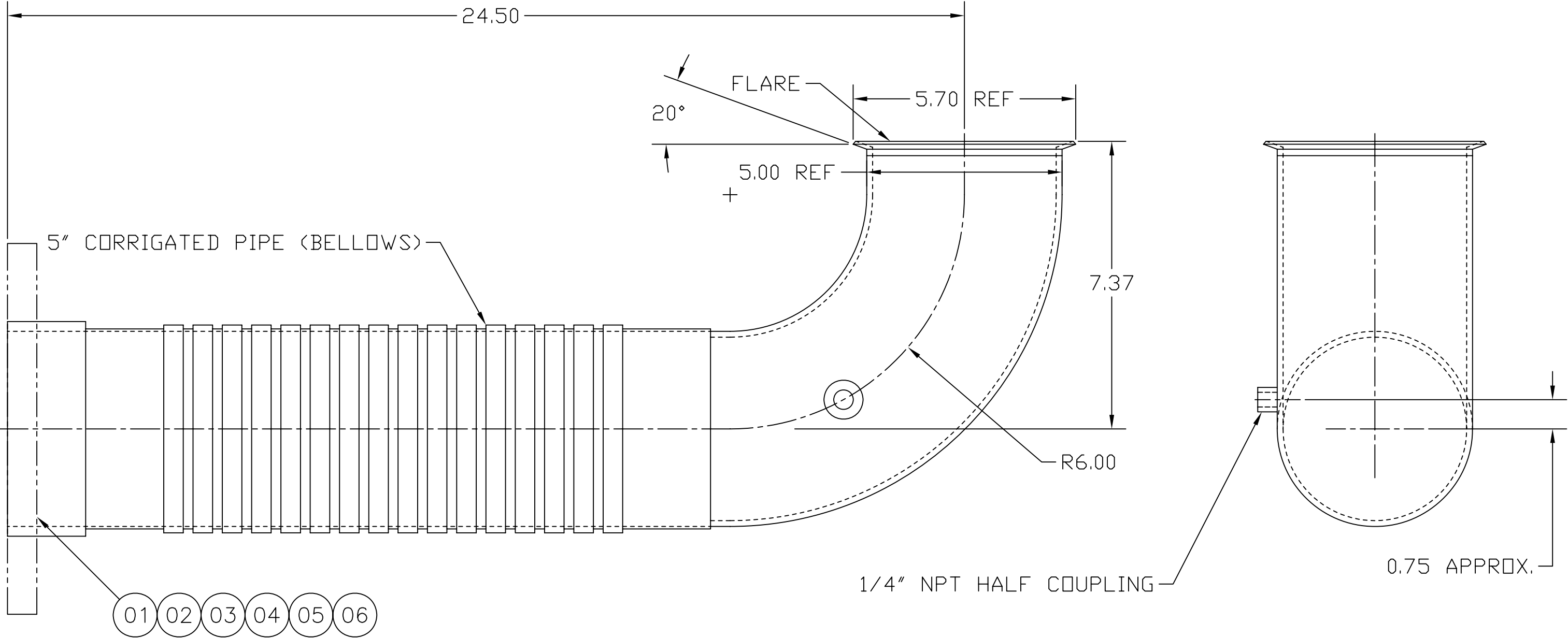
SHEET 1 OF 1

DATE: 08/06/08
DATE:

DRAWING NO: 13237
REV: -

REV	DESCRIPTION OF REVISION	REV BY	DATE

ITEM	QTY	DESCRIPTION	MATERIAL
01	A/R	5" MALE NPT	
02	A/R	5" I.D. CUFF	
03	A/R	5" 125# ANSI FLANGE	
04	A/R	6" MALE NPT	
05	A/R	6" I.D. CUFF	
06	A/R	6" 125# ANSI FLANGE	




C	ADDED 04, 05 & 06	PBS	21JUN2007
B1	REV PER TITLE BLOCK	DAVE N	21JUN2005
B	ADDED HALF COUPLING	DAVE N	21JAN2005
A	REWORKED BOM TO TABULATE END OPTIONS	DAVE N	18NOV2004
REV	DESCRIPTION OF REVISION	BY	DATE

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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 = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

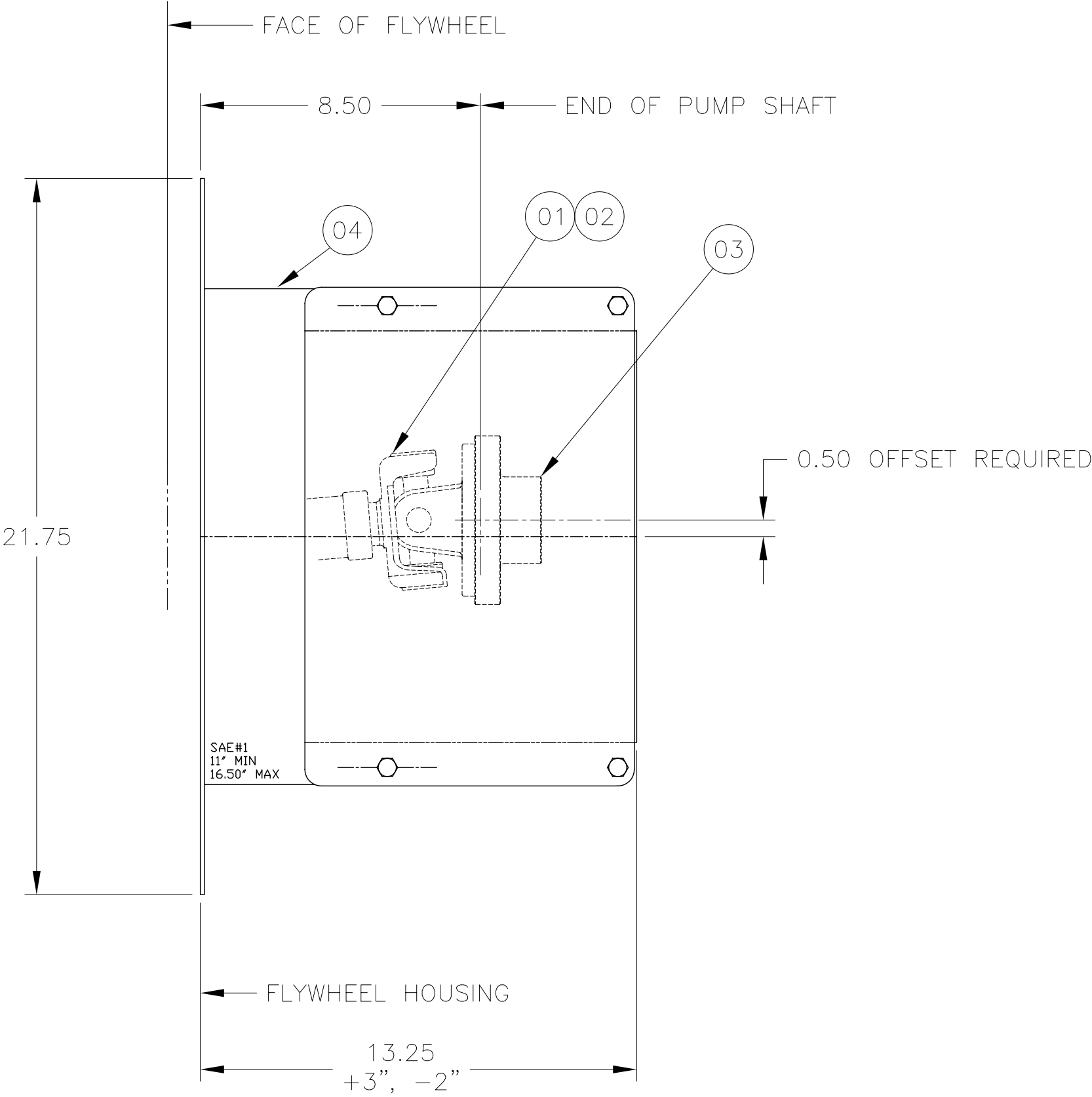



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CUMMINS FIRE POWER
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN
WWW.CUMMINSFIREPOWER.COM

DWG SCALE: 3/8	DRAWN BY: DAVE N	DATE: 23JUN2004
PLOT SCALE:	APPD BY:	DATE:
DESCRIPTION EXHAUST, 90°, HALF MARMON X CUFF		
REFERENCE: FIREPUMP, 5" TURBO OUTLET		DRAWING NUMBER: 9514

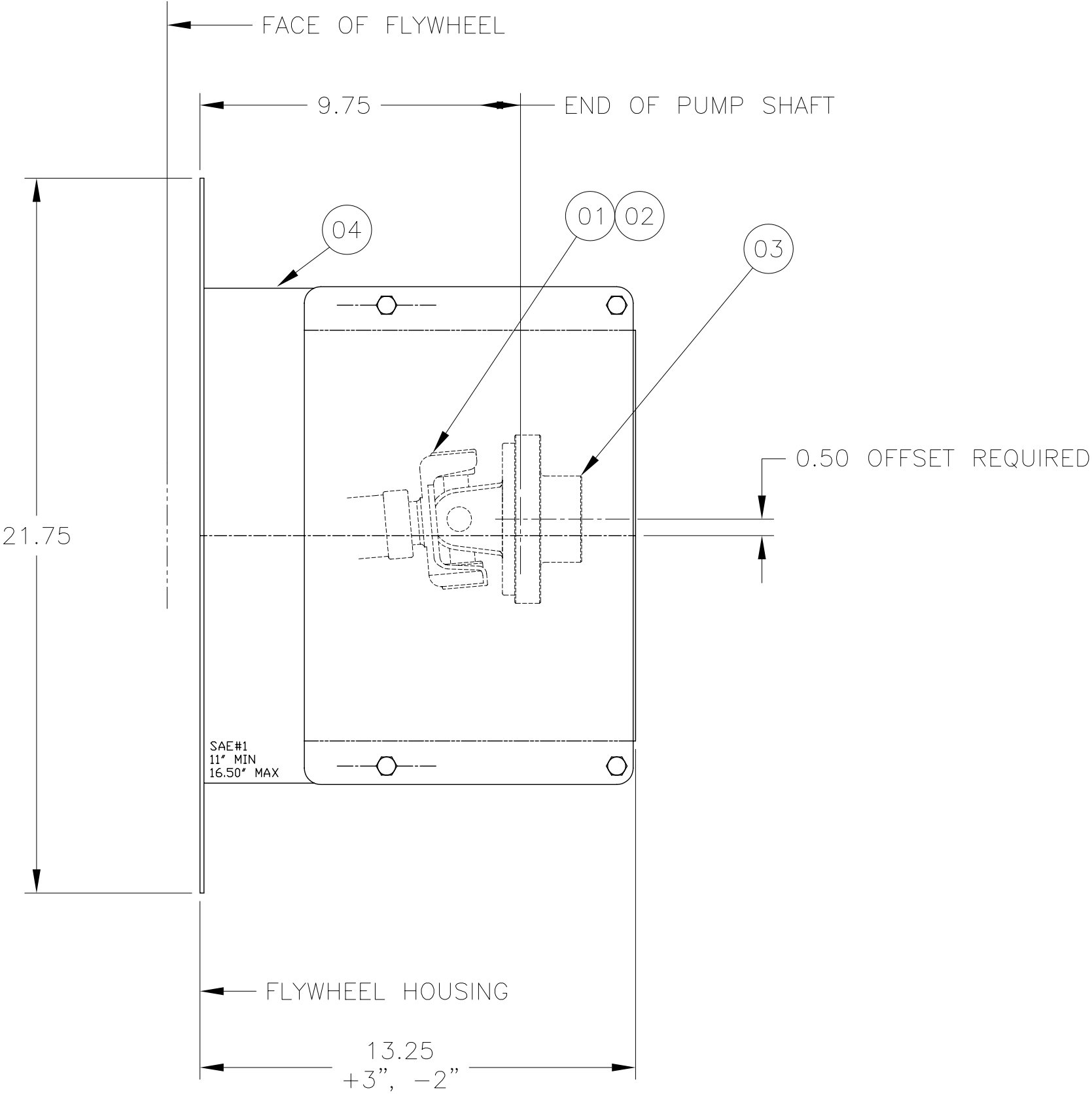
ITEM	QTY	DESCRIPTION	MATERIAL
01	1	U-JOINT ADAPT, SAE#1, HAYES #127755	9654
02	1	DRIVE SHAFT, 1480	8613
03	1	COMPANION FLANGE, SEE WO FOR BORE	8608-__
04	1	ASSEMBLY, TELESOPING GUARD, CFP11E	9497




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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 = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	DWG SCALE: 1/4	DRAWN BY: DAVE N	DATE: 20JUN2005
		PLOT SCALE:	APPD BY:	DATE:
		DESCRIPTION ASSEMBLY, DRIVE SHAFT W/ GUARD		
REFERENCE: CFP11E, 1480 DRIVE SHAFT				DRAWING NUMBER: 10166

REV	DESCRIPTION OF REVISION	BY	DATE
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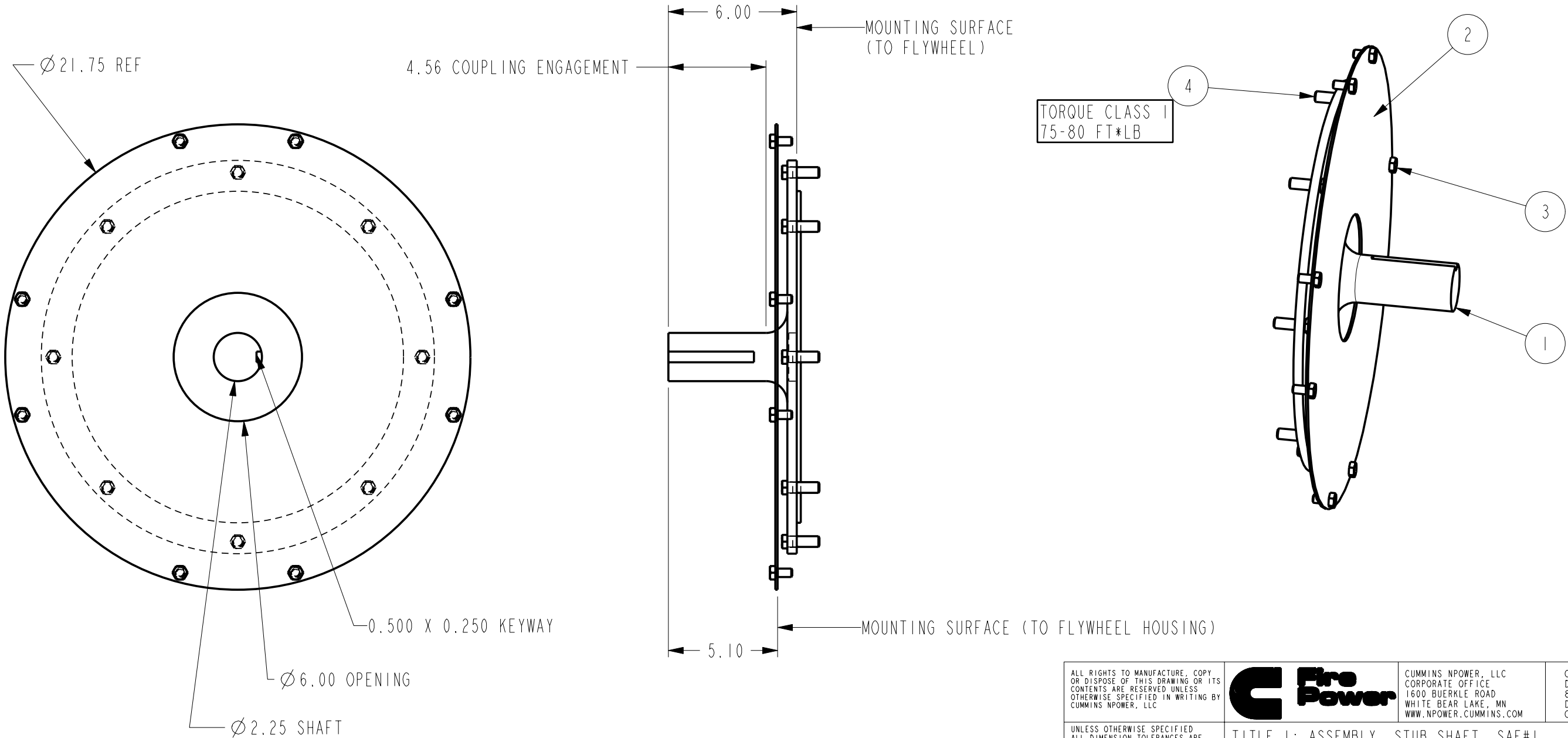
ITEM	QTY	DESCRIPTION	MATERIAL
01	1	U-JOINT ADAPT, SAE#1, HAYES #127830	9842
02	1	DRIVE SHAFT, 1550	9559
03	1	COMPANION FLANGE, SEE WO FOR BORE	8608-__
04	1	ASSEMBLY, TELESOPING GUARD, CFP11E	9497



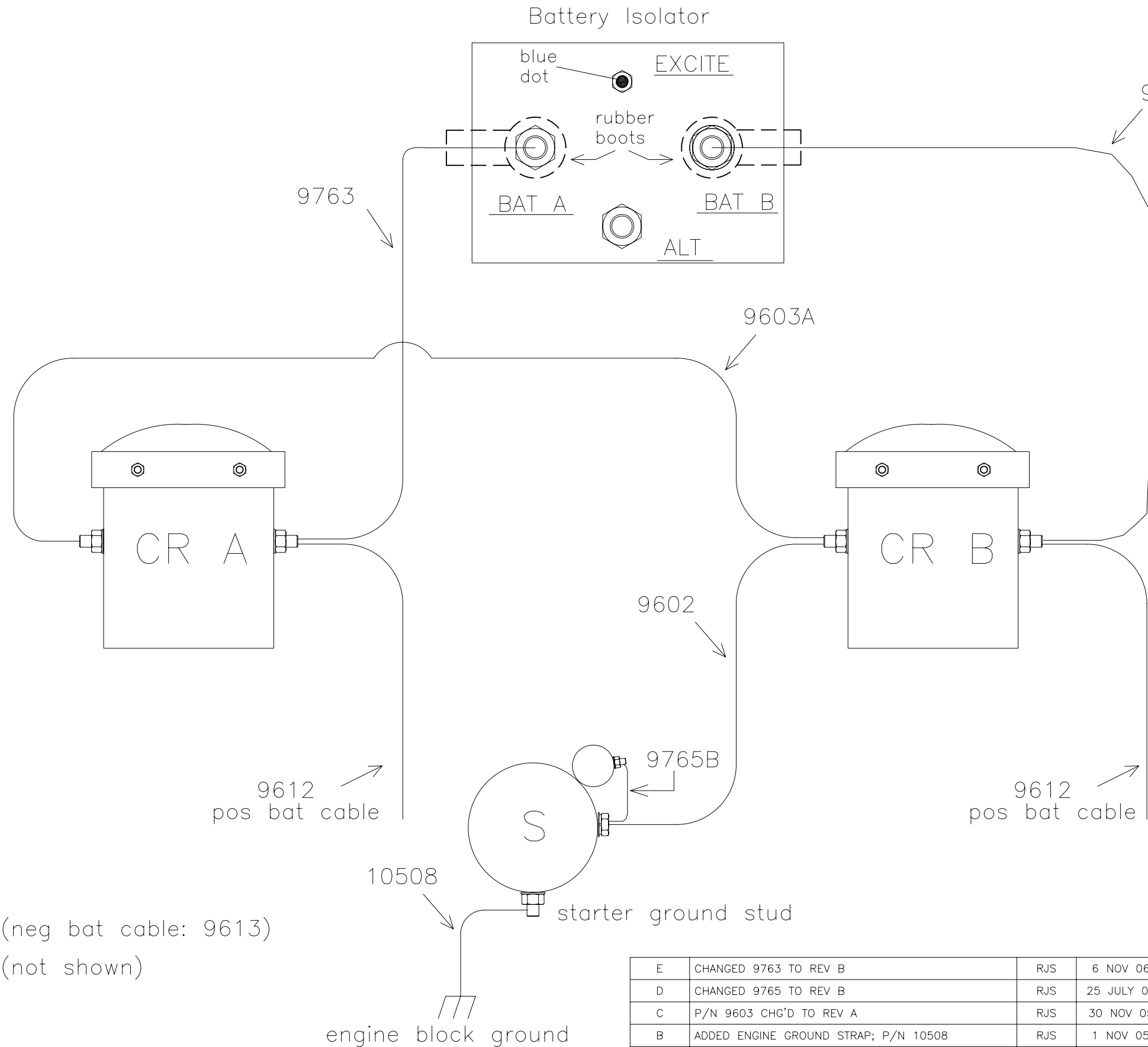
<small>ALL RIGHTS TO MANUFACTURE, COPY OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY CUMMINS NPOWER, LLC</small>	 <div>CUMMINS NPOWER CORPORATE OFFICE 1600 BUERKLE ROAD WHITE BEAR LAKE, MN WWW.NPOWER.CUMMINS.COM</div> <div>CUMMINS FIRE POWER DESIGN CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN WWW.CUMMINSFIREPOWER.COM</div>		
	DWG SCALE: 1/4	DRAWN BY: DAVE N	DATE: 20JUN2005
	PLOT SCALE:	APPD BY:	DATE:
	DESCRIPTION ASSEMBLY, DRIVE SHAFT W/ GUARD		
<small>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</small>	REFERENCE: CFP11E, 1550 DRIVE SHAFT		DRAWING NUMBER: 10167

REV	DESCRIPTION OF REVISION	BY	DATE
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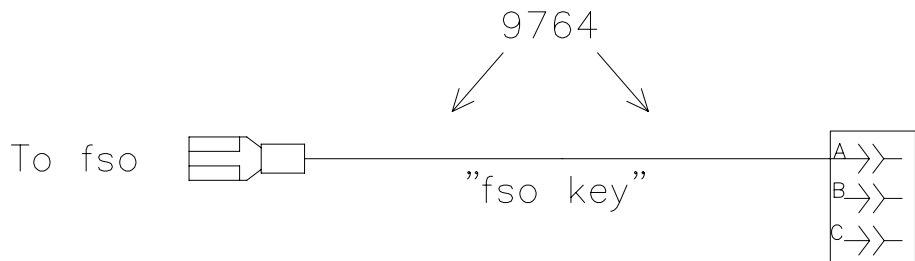
BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	STUB SHAFT, SAE #1, HAYES #127757, FIREPUMP	9556
2	1	PLATE, STUB SHAFT GUARD, SAE #1, HAYES #127807, FIREPUMP	9557
3	8	SCREW, CAP, HEX HEAD, 7/16-14 UNC x 0.75"	HHCS_0437_0075
4	8	SCREW, CAP, HEX HEAD, 1/2-13 UNC X 1.50"	HHCS_0500_0150



				MACHINE TOLERANCES .X : ± 0.06 .XX : ± 0.010 .XXX : ± 0.001		MACHINE TOLERANCES X : ± 1.5 X,X : ± 0.5 X,XX : ± 0.05		IN/LB/S		APPD BY: -		DATE: -		
A	RELEASED DRAWING	DAVE N	21 JUN05					EST WEIGHT: 42238.628		SCALE: 0.200	DO NOT SCALE	SHEET 1 OF 1	DRAWING NO: 9679	REV: A
REV	DESCRIPTION OF REVISION	REV BY	DATE	WELD TOLERANCES .X : ± 0.25 .XX : ± 0.12 .XXX : ± 0.06		WELDED TOLERANCES X : ± 5 X,X : ± 3 X,XX : ± 1.50								



P/N	DESCRIPTION	QTY
9602	Cable, Contactor to Starter	1
9603A	Cable, Battery Contactor Jumper	1
<div>E</div> 9763B	Cable, Isolator to Battery	2
9764	Wire, FSO Connector	1
9765B	Wire, Starter Solenoid Jumper	1
10508	Engine Ground Strap	1
9614	Battery Cable Kit (optional)	1



(neg bat cable: 9613)
(not shown)

E	CHANGED 9763 TO REV B	RJS	6 NOV 06
D	CHANGED 9765 TO REV B	RJS	25 JULY 06
C	P/N 9603 CHG'D TO REV A	RJS	30 NOV 05
B	ADDED ENGINE GROUND STRAP; P/N 10508	RJS	1 NOV 05
A2	MOVED THE CR A-TO-CR B JUMPER	RJS	2 JULY 05
A1	ADDED REV LEVELS TO P/N'S	RJS	17 JUNE 05
A	ADDED WIRING DIAGRAM	RJS	5 JAN 05
REV	DESCRIPTION OF REVISION	BY	DATE

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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 = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06



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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

DWG SCALE:

DRAWN BY: RJS

DATE: 6 DEC 2004

PLOT SCALE:

APPD BY:

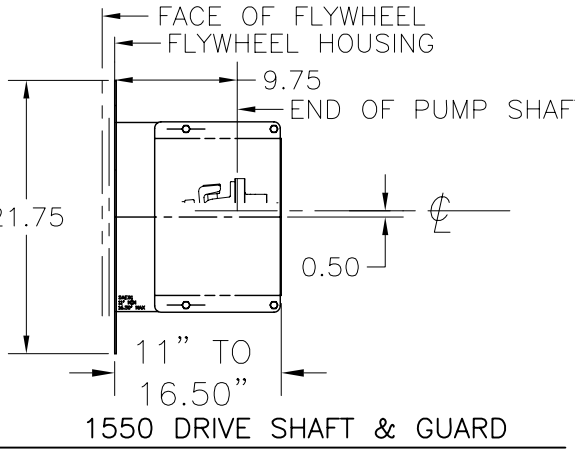
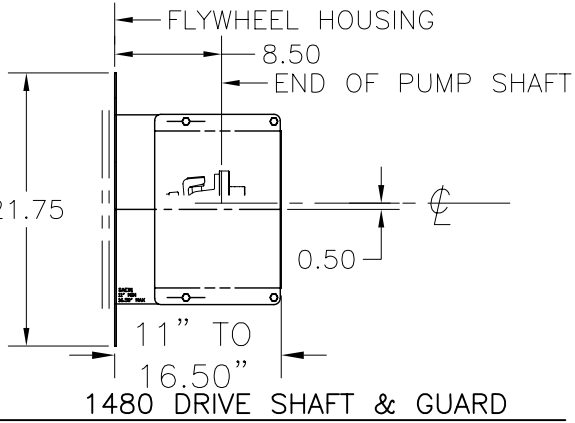
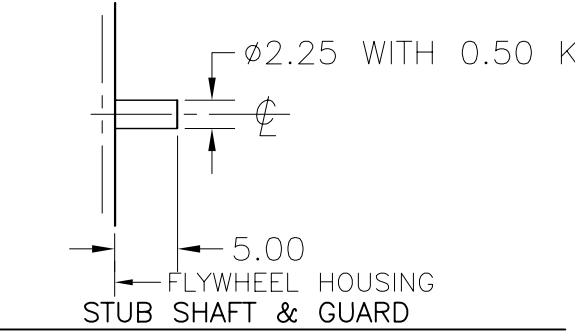
DATE:

DESCRIPTION
KIT, LOOSE WIRES

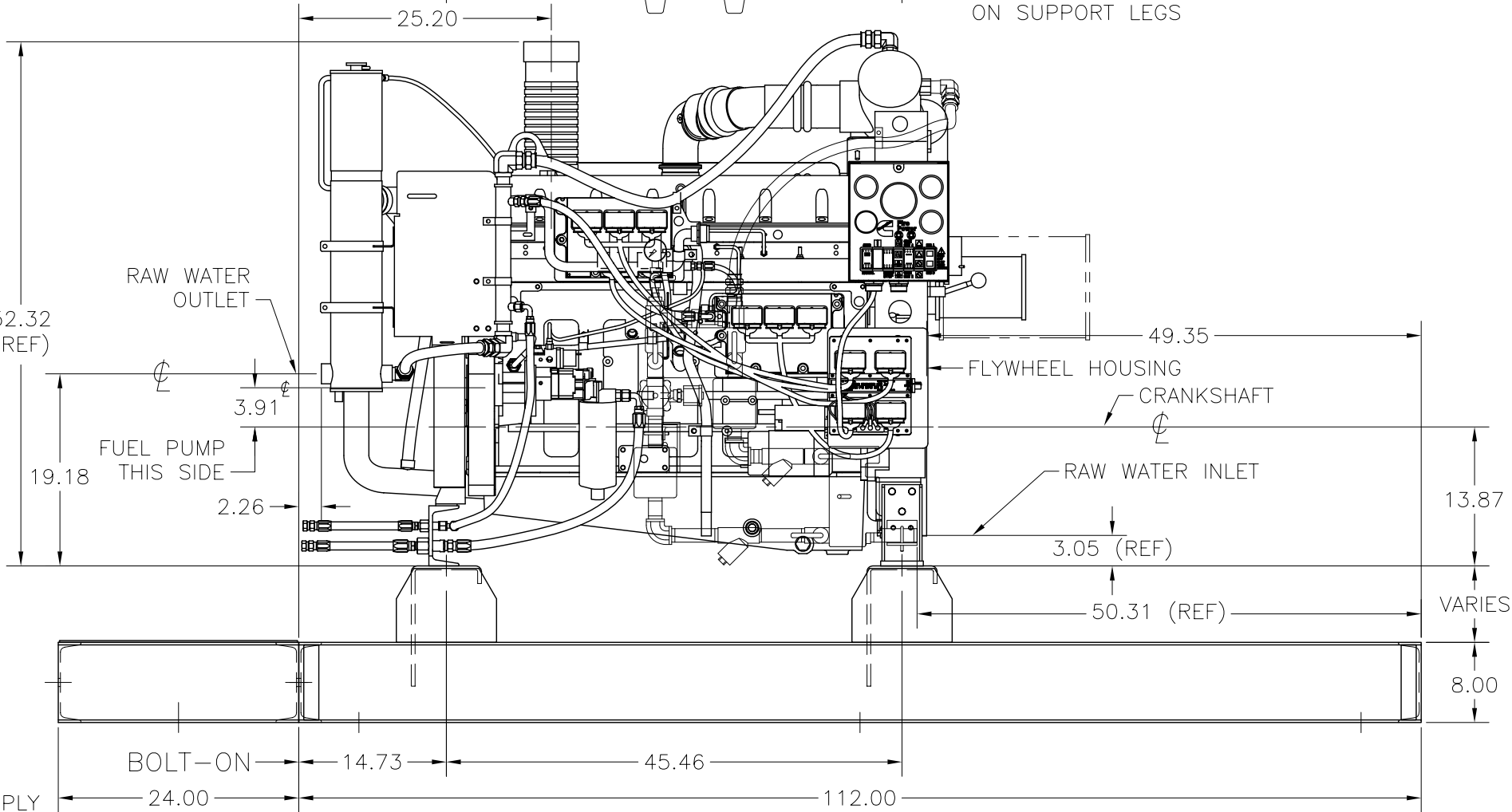
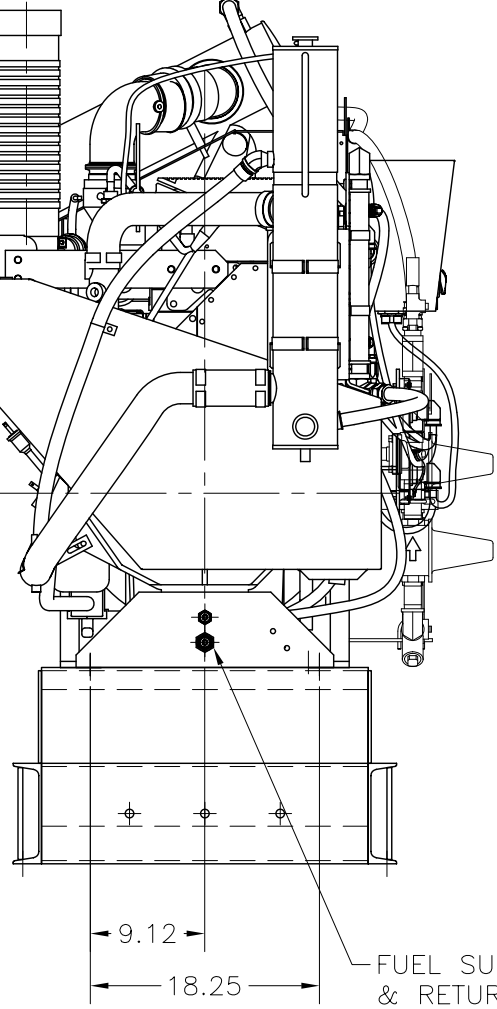
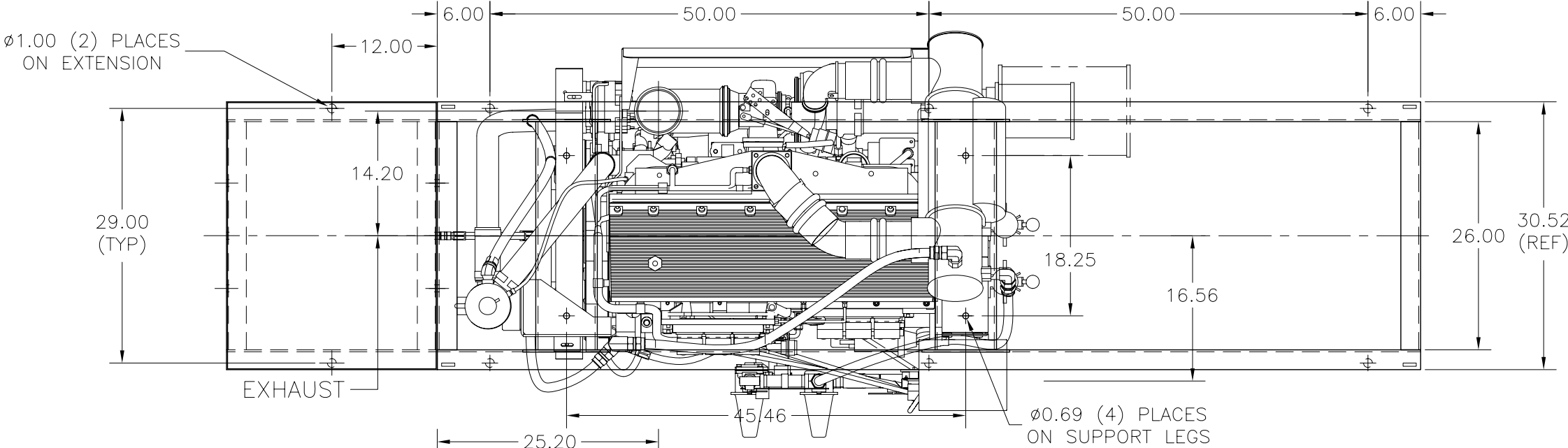
REFERENCE:
L10 & QSM

DRAWING NUMBER:
9768_E


SAE #1	FLYWHEEL HOUSING
1/2" NPT	FUEL SUPPLY
3/8" NPT	FUEL RETURN
1" NPT	RAW WATER SUPPLY
1-1/4" NPT	RAW WATER RETURN
115v. PLUG	COOLANT HEATER
5" DIA.	EXHAUST CONNECTION

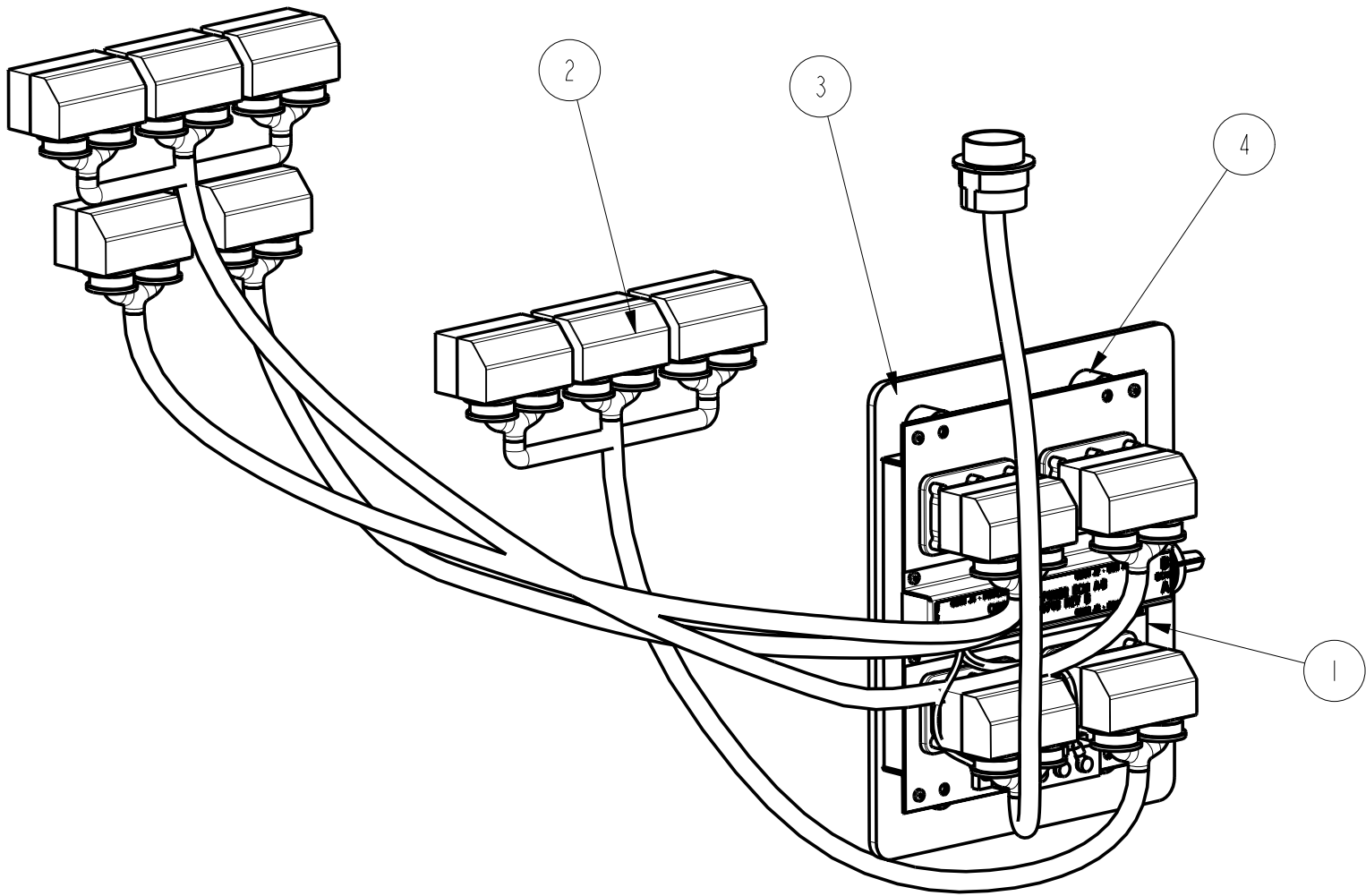


- NOTES
- 1) DETAILS REMOVED FOR CLARITY
 - 2) OPTIONAL COMPONENTS SHOWN
 - 3) SUBJECT TO CHANGE WITHOUT NOTICE
 - 4) LEG EXTENSION LENGTH DETERMINED BY PUMP SIZE
 - 5) SEE ASSEMBLY DRAWING AND DATA SHEET FOR ADDITIONAL INFORMATION
 - 6) DRIVE SHAFT MUST NOT RUN AT 0° ANGLE



F	GRAPHICS UPDATE	DAVE N	12JAN2007
E	REV PER OIL PAN	DAVE N	04AUG2005
REV	DESCRIPTION OF REVISION	BY	DATE

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	PLOT SCALE:	APPD BY:	DATE:
	DESCRIPTION GENERAL LAYOUT, FIREPUMP, CFP11E		
	REFERENCE:		DRAWING NUMBER: CFP11E_GEN



BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, ECM SWITCH	10748
2	1	HARNESS, SECONDARY ECM, QSB5.9, FIREPUMP	10914_CFP11E
3	1	BRACKET, MTG, ECM SWITCH BOX, CFP11E, FIREPUMP	11058
4	4	ISOLATOR, #10 TAP & STUD, #AG-3904930	51156PS

REV	DESCRIPTION OF REVISION	REV BY	DATE
A			

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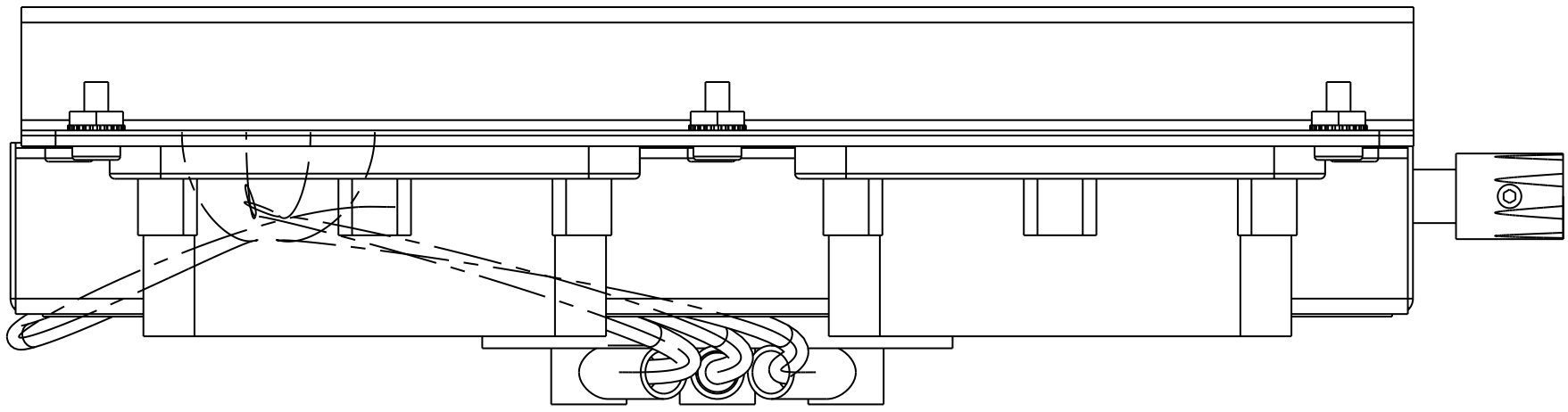
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, SECONDARY ECM, QSM11
TITLE 2: FIREPUMP

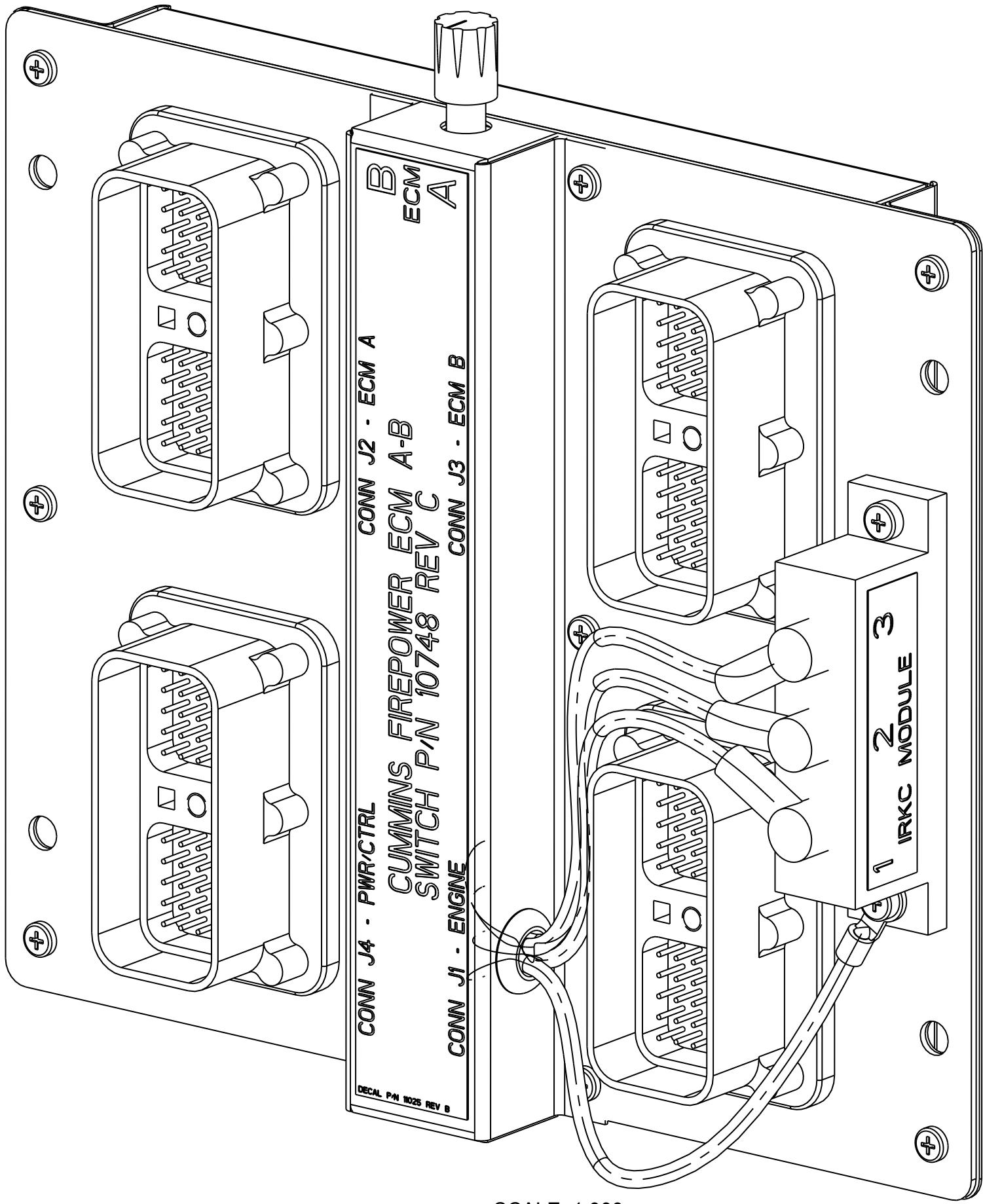
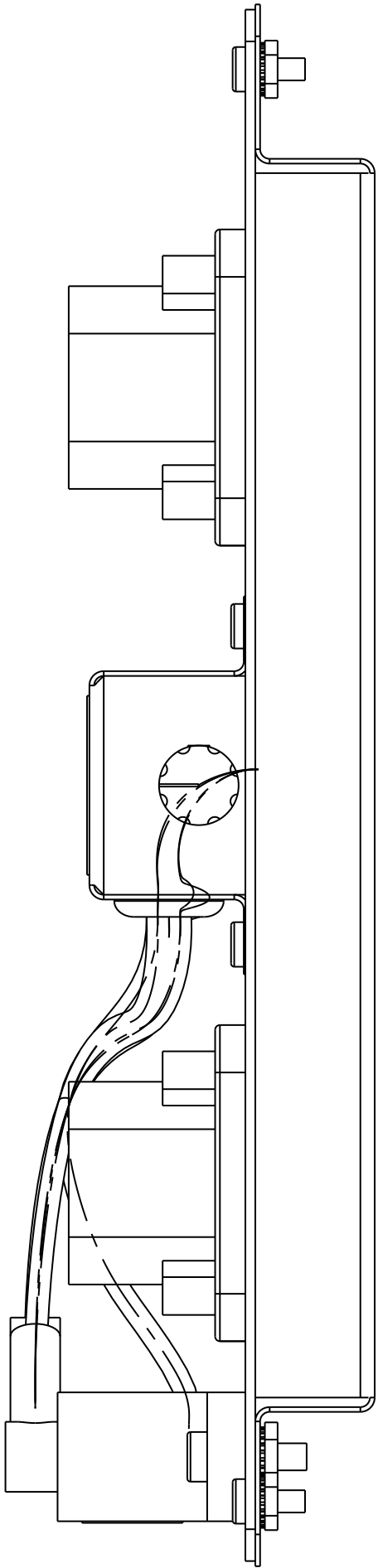
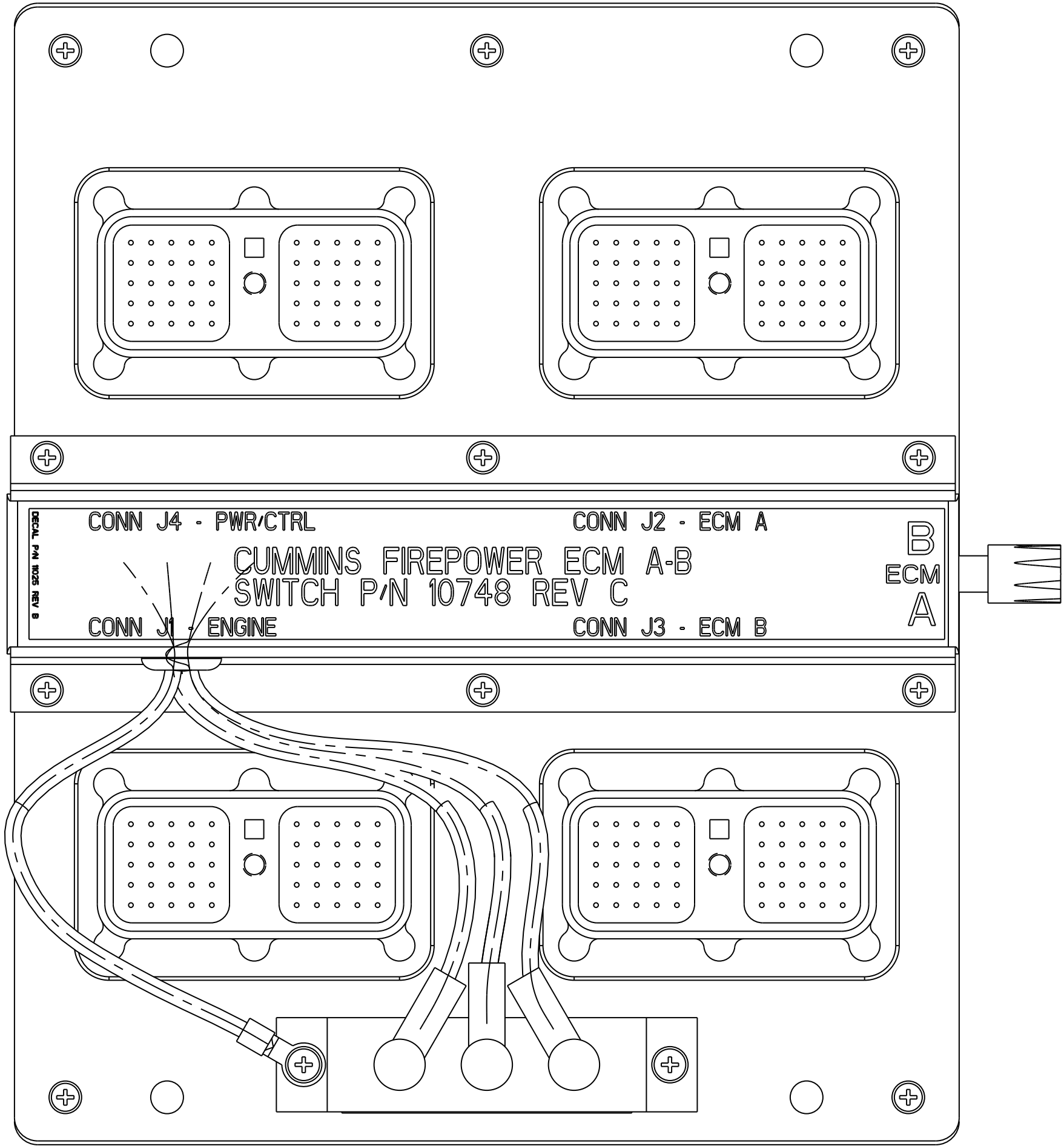
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N	DATE: 09SEP2004
EST WEIGHT: 95599.958	SCALE: 0.250	DO NOT SCALE
	SHEET 10FI	DRAWING NO: 11057
		REV:

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	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 : ± 1.0 .XX : ± 0.6



DESIGN INTELLECTUAL 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



SCALE 1.000

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 INSULATION, RED COLOR	10748_L1
11	1	LEAD 10 AWG, COPPER, GXL INSULATION, BLACK COLOR	10748_L2
12	1	LEAD 10 AWG, COPPER, GXL INSULATION, BLACK COLOR	10748_L3
13	1	LEAD, 10 AWG, COPPER, GXL INSULATION, 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, -.025" 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

C

C

C

C

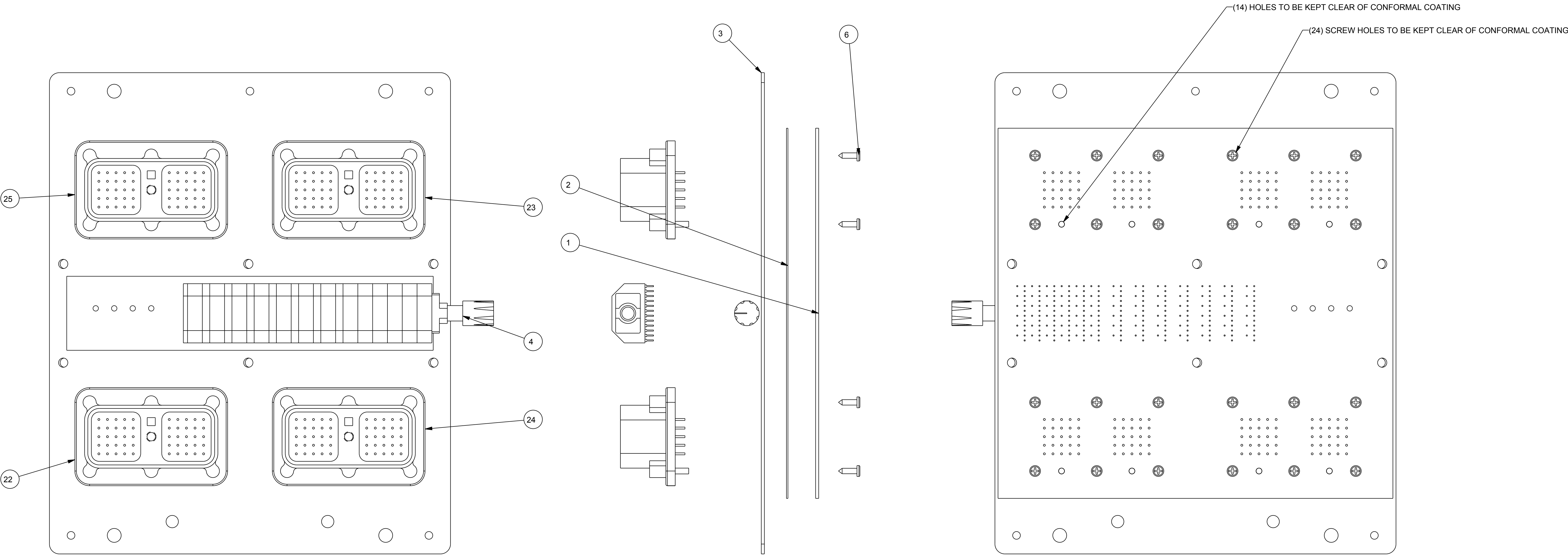
D

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:				REV. SCALES			
ANGULAR DIMENSIONS 1°				DWG UNITS:			
THIRD ANGLE PROJECTION				IN/LB/S			
EST WEIGHT: 6.709				SCALE: 1.000			
DO NOT SCALE				SHEET 10F4			
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
4	1	SWITCH, 78 POLE	10754
6	24	SCREW, SELF-TAPPING, #6 MACHINE SCREW	SCREW_SELF-TAP_NO-6_X_38
7	1	KNOB, 0.50 DIA, 0.25 BORE, MCMASTER #6094K71 OR EQUAL	13626
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

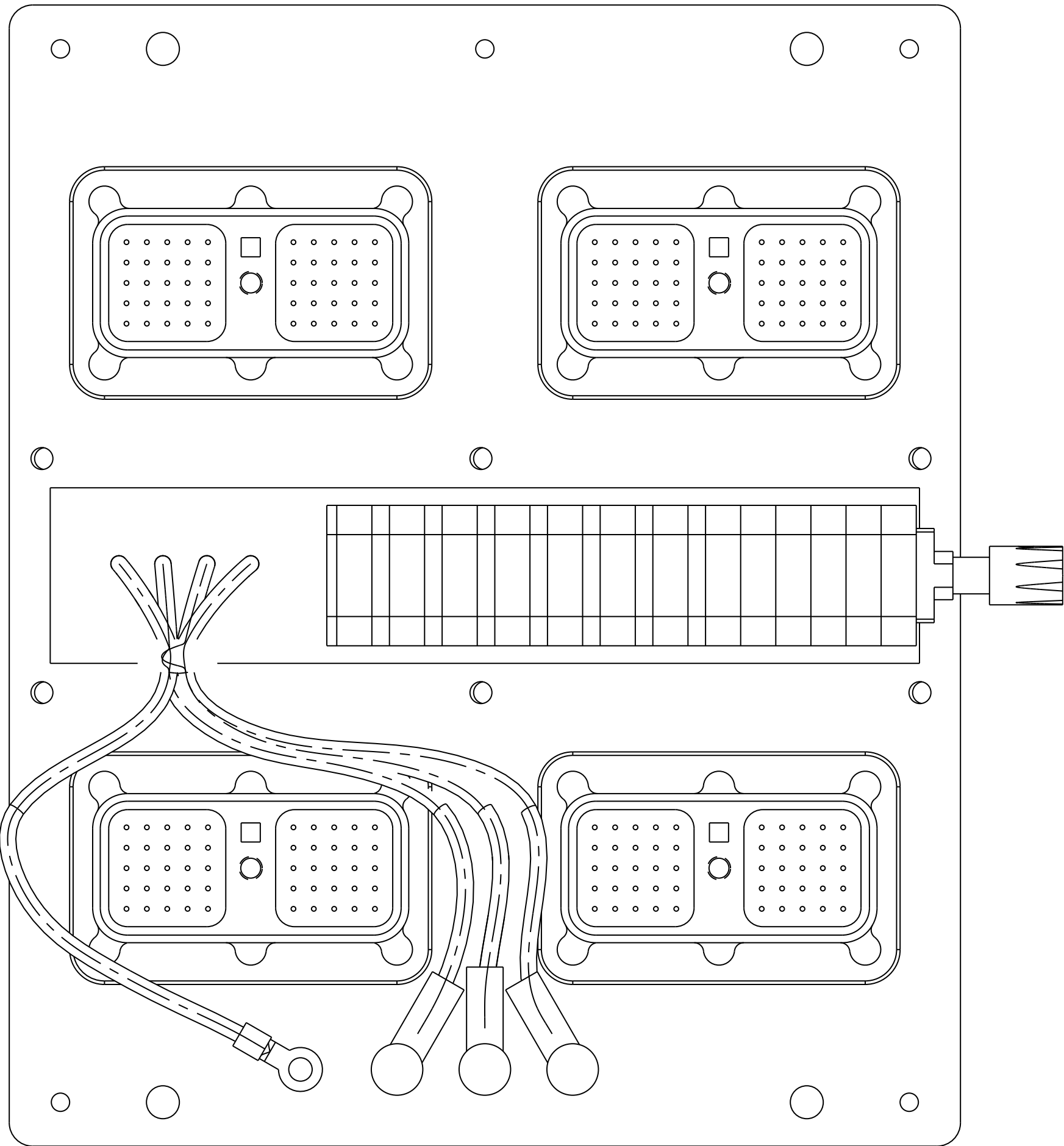
CONFORMAL COAT PCB
USING DOW 3-176S COATING MATERIAL.



SCALE 1.000

THIS VIEW EXPLODED FOR CLARITY OF
ASSEMBLY PROCESS AND COMPONENT LOCATION

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:				REV. SCALES			
ANGULAR DIMENSIONS IN °				REV. SCALES			
THIRD ANGLE PROJECTION				REV. SCALES			
IMPERIAL UNITS				REV. SCALES			
METRIC UNITS				REV. SCALES			
DWG UNITS:				REV. SCALES			
IN/LB/S				REV. SCALES			
EST WEIGHT:				REV. SCALES			
0.750				REV. SCALES			
SCALE:				REV. SCALES			
DO NOT				REV. SCALES			
SCALE				REV. SCALES			
SHEET				REV. SCALES			
20F4				REV. SCALES			
DRAWING NO:				REV. SCALES			
10748				REV. SCALES			
REV:				REV. SCALES			
D				REV. SCALES			



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.

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 INSULATION, RED COLOR	10748_L1
11	1	LEAD 10 AWG, COPPER, GXL INSULATION, BLACK COLOR	10748_L2
12	1	LEAD 10 AWG, COPPER, GXL INSULATION, BLACK COLOR	10748_L3
13	1	LEAD, 10 AWG, COPPER, GXL INSULATION, GREEN COLOR	10748_L4
21	3	BOOT, INSULATING, -.025" 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

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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:

ANGULAR DIMENSIONS ±	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	±.005" (127)	±.13 (3.3)
OTHER DIMENSIONS	±.005" (127)	±.13 (3.3)

Cummins **Fire Power**

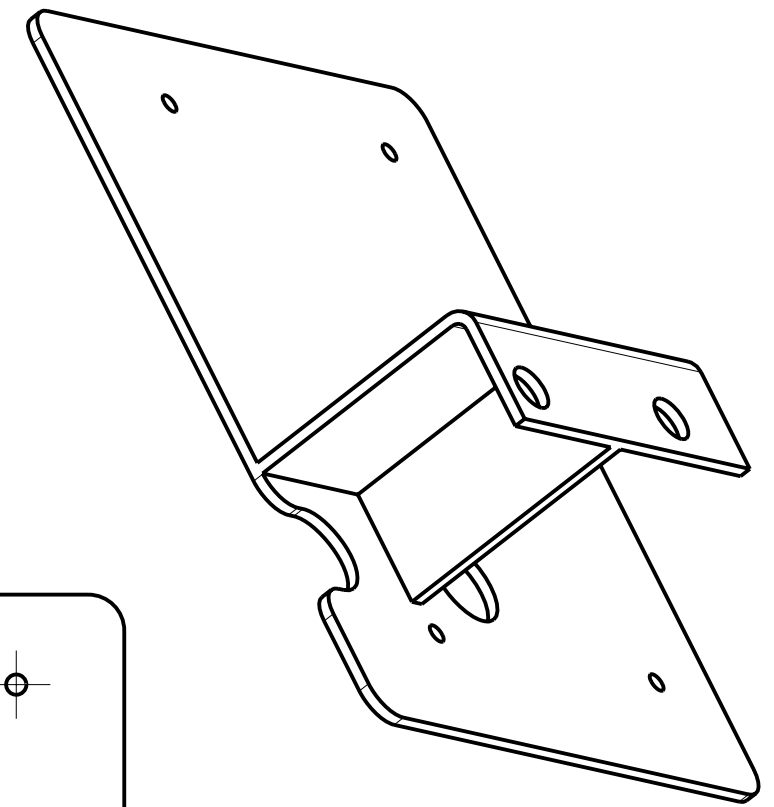
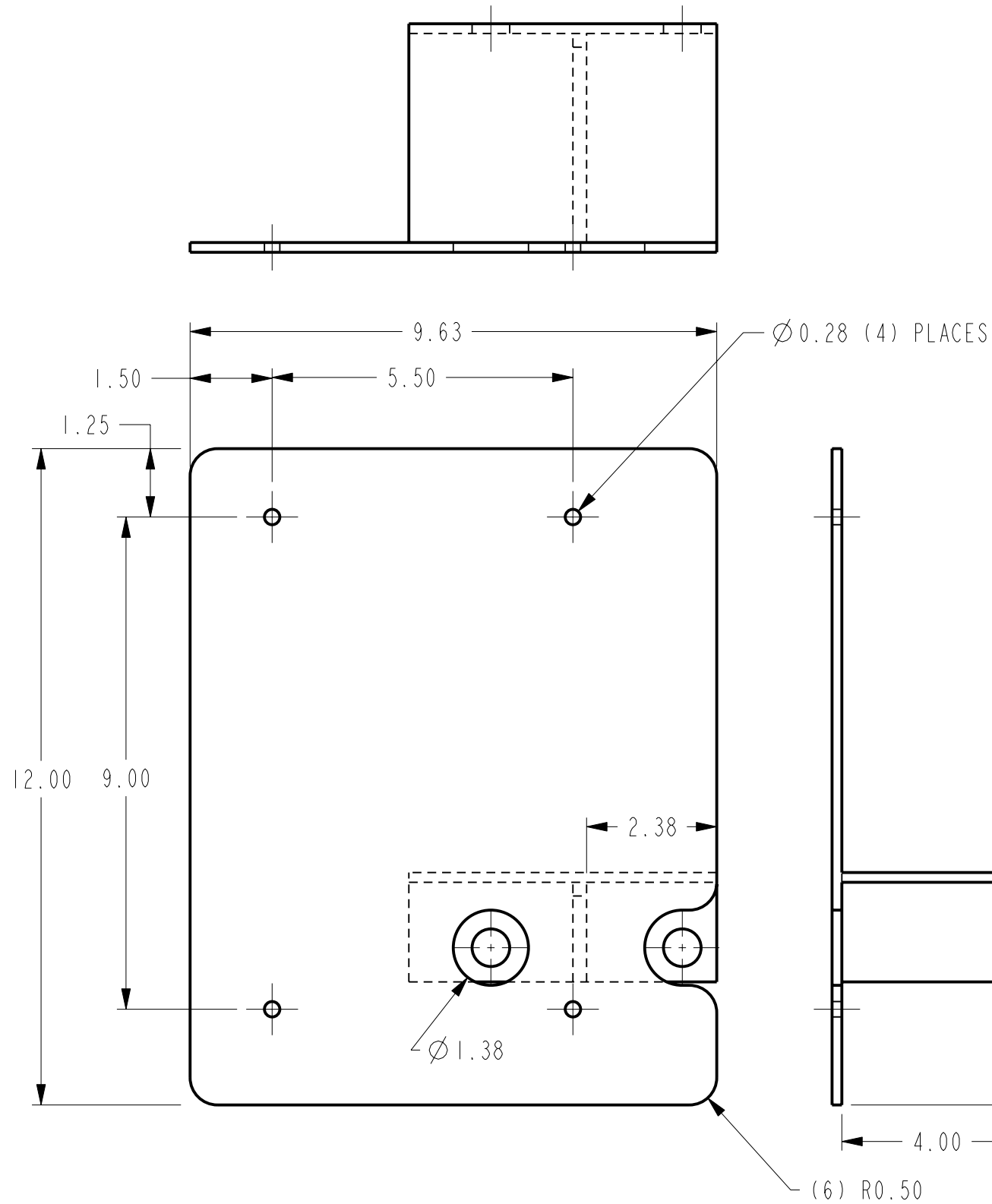
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NPPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, ECM SWITCH


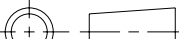
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: SCOTT D	DATE: 21FEB2006
EST WEIGHT: 6.709	APPD BY: -	DATE: -
SCALE: 1.000	DO NOT SCALE	SHEET 30F4
		DRAWING NO: 10748
		REV: D



- NOTES:
- 1) MATERIAL: 7 GA HRS
 - 2) ALL BENDS AT MINIMUM BEND RADIUS
 - 3) REMOVE ALL BURS AND SHARP EDGES
 - 4) PRIME AND PAINT CASE RED

C	OVERALL WIDTH WAS 10"	JDT	17APR07
B	IT WAS 0.25" THICK/ TWO HOLES ADDED	S.D.	
A			
REV	DESCRIPTION OF REVISION	REV BY	DATE

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<p>UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE</p>			<p>TITLE 1: BRACKET, MTG, ECM SWITCH BOX, CFP11E TITLE 2: FIREPUMP</p>			
<p>ANGULAR DIMENSIONS $\pm 1^\circ$</p>		<p>IMPERIAL UNITS</p>	<p>METRIC UNITS</p>	<p>DWG UNITS:</p>	<p>DRAWN BY: DAVE N</p>	<p>DATE: 18JUL2006</p>
<p>THIRD ANGLE PROJECTION</p>		<p>MACHINE TOLERANCES XX = ± 0.010 XXX = ± 0.005</p>	<p>MACHINE TOLERANCES X = ± 0.4 XX = ± 0.2</p>	<p>-</p>	<p>APPD BY: -</p>	<p>DATE: -</p>
		<p>FORM TOLERANCES XX = ± 0.030 XXX = ± 0.015</p>	<p>FORM TOLERANCES X = ± 0.8 XX = ± 0.4</p>	<p>EST WEIGHT: 8.092</p>	<p>SCALE: 0.375</p>	<p>DO NOT SCALE</p>
		<p>FAB TOLERANCES XX = ± 0.060 XXX = ± 0.030</p>	<p>FAB TOLERANCES X = ± 1.3 XX = ± 0.8</p>	<p>SHEET 10FI</p>	<p>DRAWING NO: 11058</p>	<p>REV: C</p>

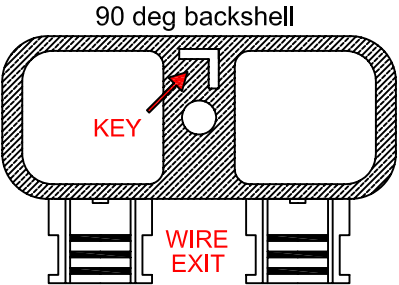
J8
Deutsch; Customized DRC20-50P-03
(In-Line 50-Pin Receptacle) - 1
w/ 0460-202-20141 (pins) - 30

J7
Deutsch; Customized DRC20-50P-02
(In-Line 50-Pin Receptacle) - 1
w/ 0460-202-20141 (pins) - 12

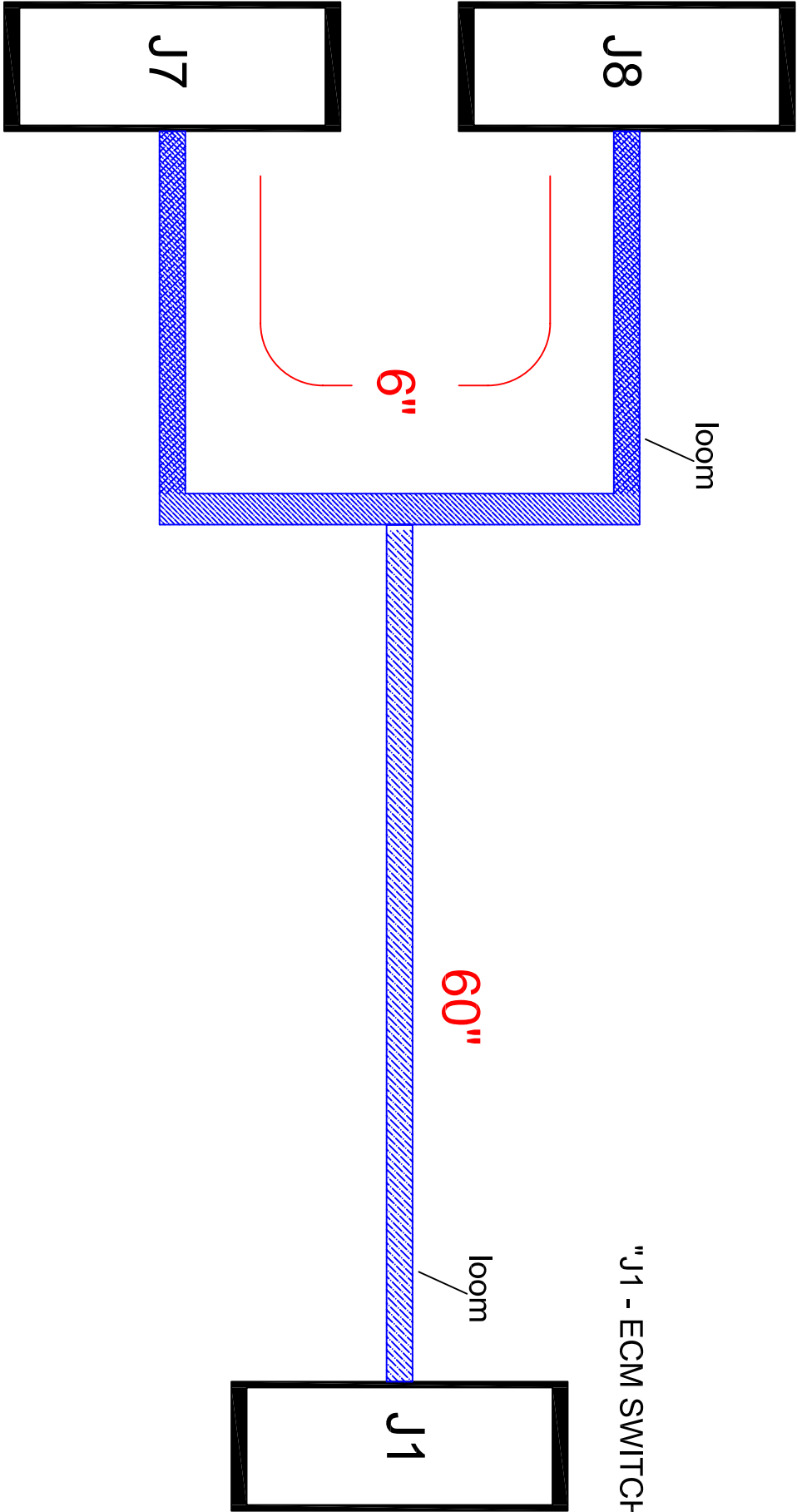
J1
Deutsch DRC26-50S-**01** (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 42

All wire white 18 AWG GXL, or equiv

FROM	TO	WIRE LABEL
J8/02	J1/07	J8/02 - J1/07
J8/03	J1/09	J8/03 - J1/09
J8/04	J1/11	J8/04 - J1/11
J8/05	J1/12	J8/05 - J1/12
J8/06	J1/13	J8/06 - J1/13
J8/11	J1/14	J8/11 - J1/14
J8/13	J1/15	J8/13 - J1/15
J8/17	J1/16	J8/17 - J1/16
J8/21	J1/17	J8/21 - J1/17
J8/27	J1/18	J8/27 - J1/18
J8/29	J1/19	J8/29 - J1/19
J8/30	J1/20	J8/30 - J1/20
J8/31	J1/26	J8/31 - J1/26
J8/32	J1/27	J8/32 - J1/27
J8/33	J1/28	J8/33 - J1/28
J8/34	J1/29	J8/34 - J1/29
J8/35	J1/31	J8/35 - J1/31
J8/37	J1/32	J8/37 - J1/32
J8/38	J1/33	J8/38 - J1/33
J8/39	J1/35	J8/39 - J1/35
J8/40	J1/36	J8/40 - J1/36
J8/41	J1/37	J8/41 - J1/37
J8/42	J1/38	J8/42 - J1/38
J8/43	J1/39	J8/43 - J1/39
J8/44	J1/40	J8/44 - J1/40
J8/45	J1/42	J8/45 - J1/42
J8/47	J1/47	J8/47 - J1/47
J8/48	J1/48	J8/48 - J1/48
J8/49	J1/49	J8/49 - J1/49
J8/50	J1/02	J8/50 - J1/02
J7/33	J1/04	J7/33 - J1/04
J7/01	J1/01	J7/01 - J1/01
J7/02	J1/03	J7/02 - J1/03
J7/03	J1/05	J7/03 - J1/05
J7/04	J1/06	J7/04 - J1/06
J7/06	J1/08	J7/06 - J1/08
J7/07	J1/10	J7/07 - J1/10
J7/08	J1/21	J7/08 - J1/21
J7/09	J1/30	J7/09 - J1/30
J7/10	J1/41	J7/10 - J1/41
J7/16	J1/43	J7/16 - J1/43
J7/26	J1/46	J7/26 - J1/46
J7/36	J1/50	J7/36 - J1/50




"J8 - ENGINE HARNESS SENSORS"

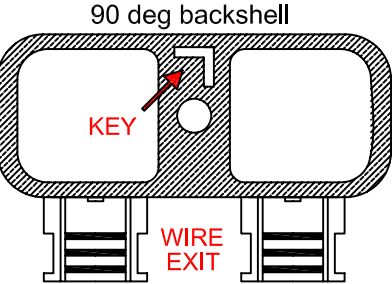
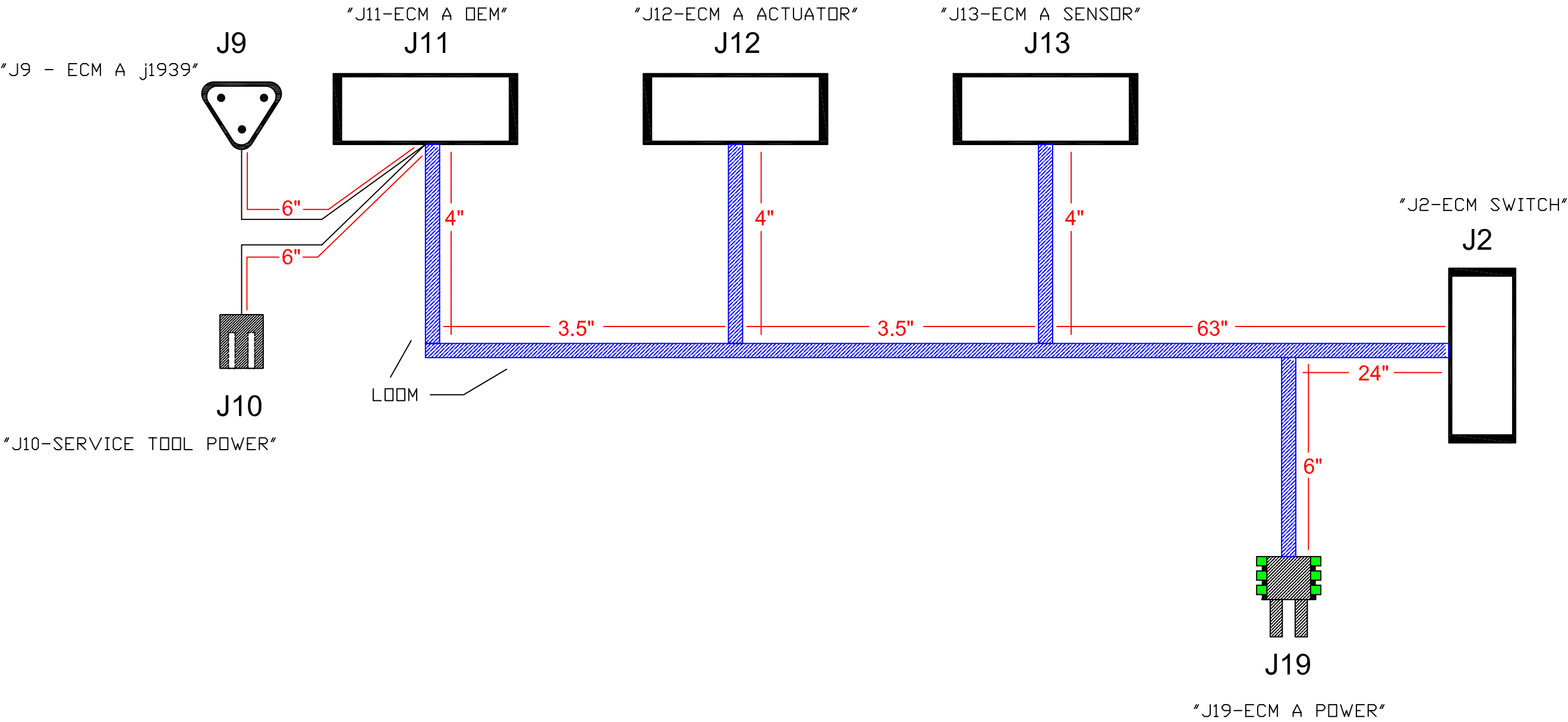


"J7 - ENGINE HARNESS ACTUATORS"


"J1 - ECM SWITCH"

NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.
Prominently label all connectors as "indicated".

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				<div>DWG SCALE: DRAWN BY: RJS DATE: 4 MAY 2006</div> <div>PLOT SCALE: APPD BY: DATE:</div> <div>DESCRIPTION FIREPUMP HARNESS; QSM11 & QSX 15</div> <div>REFERENCE: ENGINE SENSOR/ACTUATOR DRAWING NUMBER: 10914D-01</div>	
D	NO CHANGES TO PAGE 1	RJS	17 OCT 06		
REV	DESCRIPTION OF REVISION	BY	DATE		



NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.
Prominently label all connectors as "indicated".

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UNLESS OTHERWISE NOTED: ALL DIMENSIONS ARE IN INCHES APPLY MACHINE TOLERANCES J11 - ± 0.005 J12 - ± 0.005 J13 - ± 0.005		DWG SCALE: DRAWN BY: RJS		DATE: 4 MAY 2006	
APPLY WELD TOLERANCES J1 - ± 0.005 J2 - ± 0.005 J19 - ± 0.005		PLOT SCALE: APPD BY:		DATE:	
D SEE PAGE 2 OF 2 FOR CHANGES		RJS 17 OCT 06		DESCRIPTION FIREPUMP HARNESS; QSM 11 & QSX 15	
REV DESCRIPTION OF REVISION		BY DATE		REFERENCE: ECM A HARNESS; page 1 of 2	
				DRAWING NUMBER: 10914D-02 pg1	

FROM	TO	LABEL
J2/47	J13/02	J2/47 - J13/02
J2/49	J13/03	J2/49 - J13/03
J2/11	J13/04	J2/11 - J13/04
J2/12	J13/05	J2/12 - J13/05
J2/13	J13/06	J2/13 - J13/06
J2/34	J13/11	J2/34 - J13/11
J2/35	J13/13	J2/35 - J13/13
J2/36	J13/17	J2/36 - J13/17
J2/37	J13/21	J2/37 - J13/21
J2/38	J13/27	J2/38 - J13/27
J2/39	J13/29	J2/39 - J13/29
J2/40	J13/30	J2/40 - J13/30
J2/26	J13/31	J2/26 - J13/31
J2/27	J13/32	J2/27 - J13/32
J2/28	J13/33	J2/28 - J13/33
J2/29	J13/34	J2/29 - J13/34
J2/31	J13/35	J2/31 - J13/35
J2/32	J13/37	J2/32 - J13/37
J2/33	J13/38	J2/33 - J13/38
J2/15	J13/39	J2/15 - J13/39
J2/16	J13/40	J2/16 - J13/40
J2/17	J13/41	J2/17 - J13/41
J2/18	J13/42	J2/18 - J13/42
J2/19	J13/43	J2/19 - J13/43
J2/20	J13/44	J2/20 - J13/44
J2/02	J13/45	J2/02 - J13/45
J2/07	J13/47	J2/07 - J13/47
J2/08	J13/48	J2/08 - J13/48
J2/09	J13/49	J2/09 - J13/49
J2/42	J13/50	J2/42 - J13/50
J2/44	J12/33	J2/44 - J12/33
J2/50	J12/01	J2/50 - J12/01
J2/30	J12/02	J2/30 - J12/02
J2/10	J12/03	J2/10 - J12/03
J2/01	J12/04	J2/01 - J12/04
J2/21	J12/06	J2/21 - J12/06
J2/41	J12/07	J2/41 - J12/07
J2/48	J12/08	J2/48 - J12/08
J2/43	J12/09	J2/43 - J12/09
J2/46	J12/10	J2/46 - J12/10
J2/06	J12/16	J2/06 - J12/16
J2/03	J12/26	J2/03 - J12/26
J12/45	J12/36	J2/45 - J12/36

FROM	TO	LABEL	NOTES
J2/05	J11/06	J2/05 - J11/06	stop lamp
J2/25	J11/16	J2/25 - J11/16	warning lamp
J2/14	J11/44	J2/14 - J11/44	diagnostic switch
J2/04	J11/38	J2/04 - J11/38	key switch
J2/24 (splice)	J11/09	J2/24 - J11/09	ecm return
	J11/23	J2/24 - J11/23	isc 1 spliced to return
J2/22	J11/24	J2/22 - J11/24	diagnostic dec switch
J2/23	J11/14	J2/23 - J11/14	diagnostic inc switch
J19/B (spliced)	J11/29	-----	ECM Ground one 10 awg GREEN wire spliced into six 18 awg GREEN wires
	J11/30	-----	
	J11/39	-----	
	J11/40	-----	
	J11/50	-----	
	J10/B	service tool neg	

J19/A (spliced)	J11/18	-----	ECM unswitched B+ one 10 awg RED wire spliced into six 18 awg RED wires
	J11/28	-----	
	J11/07	-----	
	J11/08	-----	
	J11/17	-----	
	J10/A	service tool pos	

J9/A	J11/46	J9/A - J11/46	j1939 +
J9/B	J11/37	J9/B - J11/37	j1939 -
J9/C	J11/36	J9/C - J11/36	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) - 49

J9

Deutsch DT04-3P (Receptacle) - 1
w/ W3P (wedge) - 1
w/ 0460-202-16141 (pins) - 3

J10

Delphi 12010973 (shroud) - 1
w/ 12089040 (pins) - 2
w/ 12015323 (seals) - 2

J11

Deutsch DRC26-50S-01 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 20

J12

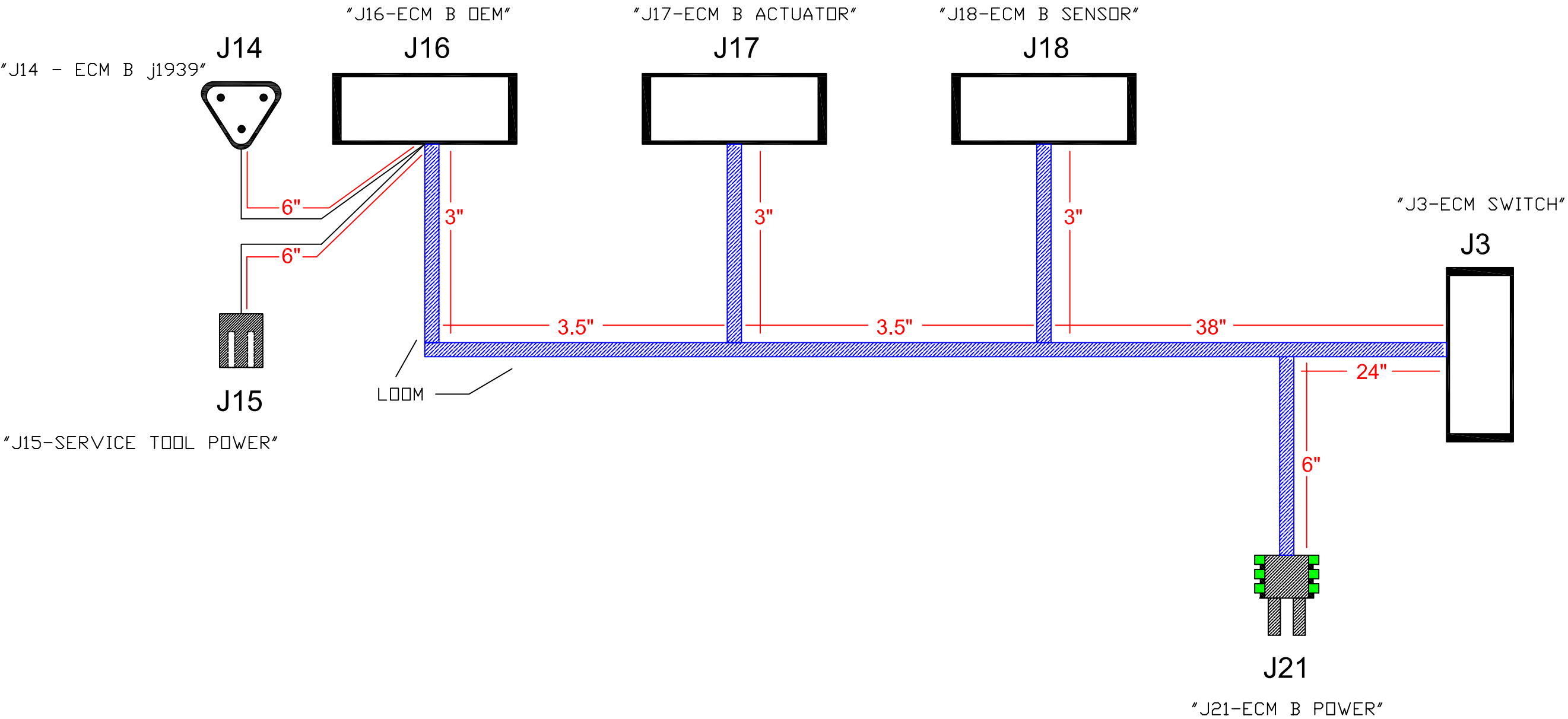
Deutsch DRC26-50S-02 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 12

J13

Deutsch DRC26-50S-03 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 30

J19

Delphi 480 Metri-Pack Female Connector
12052613 (shroud) - 1
w/ 12052139 (terminals) - 2
w/ 12034170 (seals) - 2
w/ 12059897 (TPA) - 1



NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.
Prominently label all connectors as "indicated".

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UNLESS OTHERWISE NOTED ALL DIMENSIONS ARE IN INCHES APPLY MACHINING TOLERANCES .125 = ± .010 .250 = ± .010 APPLY WELDING TOLERANCES .125 = ± .010 .250 = ± .010		DWG SCALE: PLOT SCALE: DRAWN BY: RJS APPD BY: DATE: DATE:		DESCRIPTION FIREPUMP HARNESS; QSM 11 & QSX 15 REFERENCE: ECM B HARNESS; page 1 of 2	
D	SEE PAGE 2 OF 2 FOR CHANGES	RJS	17 OCT 06	DRAWING NUMBER: 10914D-03 pg1	
REV	DESCRIPTION OF REVISION	BY	DATE		


FROM	TO	LABEL
J3/07	J18/02	J3/07 - J18/02
J3/09	J18/03	J3/09 - J18/03
J3/11	J18/04	J3/11 - J18/04
J3/12	J18/05	J3/12 - J18/05
J3/13	J18/06	J3/13 - J18/06
J3/14	J18/11	J3/14 - J18/11
J3/15	J18/13	J3/15 - J18/13
J3/16	J18/17	J3/16 - J18/17
J3/17	J18/21	J3/17 - J18/21
J3/18	J18/27	J3/18 - J18/27
J3/19	J18/29	J3/19 - J18/29
J3/20	J18/30	J3/20 - J18/30
J3/26	J18/31	J3/26 - J18/31
J3/27	J18/32	J3/27 - J18/32
J3/28	J18/33	J3/28 - J18/33
J3/29	J18/34	J3/29 - J18/34
J3/31	J18/35	J3/31 - J18/35
J3/32	J18/37	J3/32 - J18/37
J3/33	J18/38	J3/33 - J18/38
J3/35	J18/39	J3/35 - J18/39
J3/36	J18/40	J3/36 - J18/40
J3/37	J18/41	J3/37 - J18/41
J3/38	J18/42	J3/38 - J18/42
J3/39	J18/43	J3/39 - J18/43
J3/40	J18/44	J3/40 - J18/44
J3/42	J18/45	J3/42 - J18/45
J3/47	J18/47	J3/47 - J18/47
J3/48	J18/48	J3/48 - J18/48
J3/49	J18/49	J3/49 - J18/49
J3/02	J18/50	J3/02 - J18/50
J3/04	J17/33	J3/04 - J17/33
J3/01	J17/01	J3/01 - J17/01
J3/03	J17/02	J3/03 - J17/02
J3/05	J17/03	J3/05 - J17/03
J3/06	J17/04	J3/06 - J17/04
J3/08	J17/06	J3/08 - J17/06
J3/10	J17/07	J3/10 - J17/07
J3/21	J17/08	J3/21 - J17/08
J3/30	J17/09	J3/30 - J17/09
J3/41	J17/10	J3/41 - J17/10
J3/43	J17/16	J3/43 - J17/16
J3/46	J17/26	J3/46 - J17/26
J3/50	J17/36	J3/50 - J17/36

FROM	TO	LABEL	NOTES	
J3/45	J16/06	J3/45 - J16/06	stop lamp	
J3/25	J16/16	J3/25 - J16/16	warning lamp	
J3/34	J16/44	J3/34 - J16/44	diagnostic switch	
J3/44	J16/38	J3/44 - J16/38	key switch	
A	J3/24 (splice)	J16/09	J3/24 - J16/09	ecm return
		J16/23	J33/24 - J16/23	isc 1 spliced to return
	J3/22	J16/24	J3/22 - J16/24	diagnostic dec switch
	J3/23	J16/14	J3/23 - J16/14	diagnostic inc switch
B	J21/B (splice)	J16/29	-----	EMC Ground one 10 awg GREEN wire spliced into six 18 awg GREEN wires
		J16/30	-----	
		J16/39	-----	
		J16/40	-----	
		J16/50	-----	
		J15/B	service tool neg	
	J21/A (splice)	J16/18	-----	ECM unswitched B+ one 10 awg RED wire spliced into six 18 awg RED wires
		J16/28	-----	
		J16/07	-----	
		J16/08	-----	
		J16/17	-----	
		J15/A	service tool pos	
J14/A	J16/46	J14/A - J16/46	j1939 +	
J14/B	J16/37	J14/B - J16/37	j1939 -	
J14/C	J16/36	J14/C - J16/36	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) - 49

J14
Deutsch DT04-3P (Receptacle) - 1
w/ W3P (wedge) - 1
w/ 0460-202-16141 (pins) - 3

J15 
Delphi 12010973 (shroud) - 1
w/ 12089040 (pins) - 2
w/ 12015323 (seals) - 2

J16
Deutsch DRC26-50S-01 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 20

J17
Deutsch DRC26-50S-02 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 12

J18
Deutsch DRC26-50S-03 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 30

J21
Delphi 480 Metri-Pack Female Connector
12052613 (shroud) - 1
w/ 12052139 (terminals) - 2
w/ 12034170 (seals) - 2
w/ 12059897 (TPA) - 1



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	W2	ten 20 awg ORANGE wires from J4/11 - J4/20 spliced together to <u>one</u> 10 awg ORANGE wire called W2	BAT A+	Bat A +12V in
J4/12				
J4/13				
J4/14				
J4/15				
J4/16				
J4/17				
J4/18				
J4/19				
J4/20				
J4/21	W3	ten 20 awg YELLOW wires from J4/21-J4/30 spliced together to <u>one</u> 10 awg YELLOW wire called W3	BAT B+	Bat B +12V in
J4/22				
J4/23				
J4/24				
J4/25				
J4/26				
J4/27				
J4/28				
J4/29				
J4/30				
J4/31	J20(a) & J22(a)	ten 20 awg RED wires from J4/31-J4/40 spliced together to <u>one</u> 10 awg RED wire for J20(a) and <u>one</u> 10 AWG Red wire for 22(a)		Best Bat + to ecm
J4/32				
J4/33				
J4/34				
J4/35				
J4/36				
J4/37				
J4/38				
J4/39				
J4/40				
J4/41	W1 & J20(b) & J22(b)	ten 20 AWG Green wires from J4/41-J4/50 spliced together to <u>one</u> 10 AWG Green wire for W1, <u>one</u> 10 AWG Green wire for J20(b), and <u>one</u> 10 AWG Green wire for J22(b)		Bat gnd
J4/42				
J4/43				
J4/44				
J4/45				
J4/46				
J4/47				
J4/48				
J4/49				
J4/50				

Deutsch DRC26-50S-04 (Plug) - 1
w/ 0528-001-5005 (90 deg backshell) - 1
w/ 0462-201-20141 (sockets) - 49

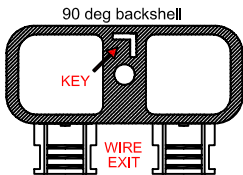
Deutsch HDP26-24-21SN - 1
w/ 0462-201-16141 (sockets) - 9

Delphi 480 Metri-Pack Male Connector - 2
12065863 (shroud) - 1
w/ 12052172 (terminals) - 2
w/ 12034170 (seals) - 2
w/ 12059897 (TPA) - 1
w/ 12020833 (CPA) - 1

10 AWG 7/16" insulated ring terminal

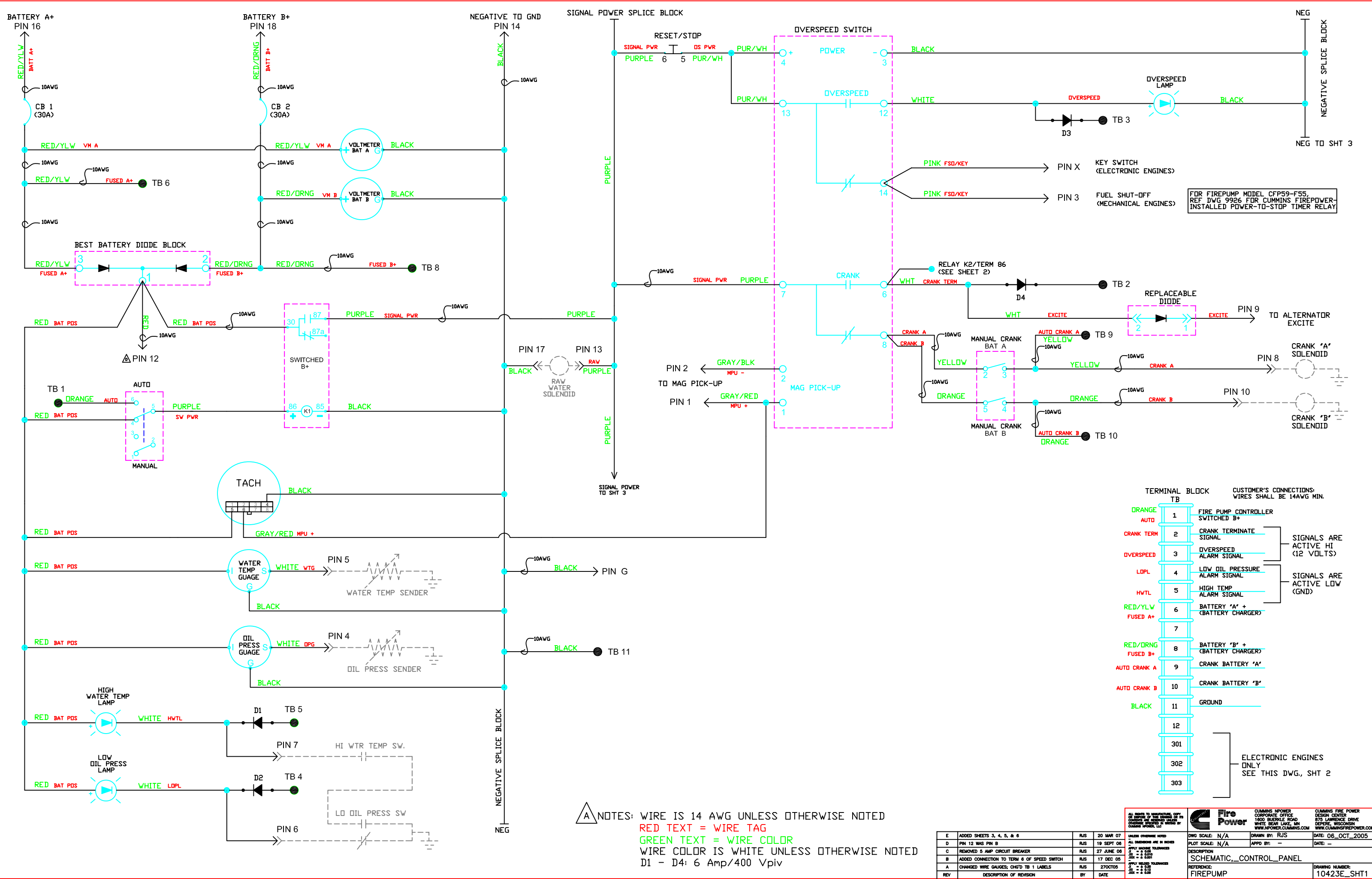
10 AWG 3/8" insulated ring terminal

All wire type GXL or equiv



NOTE: Loom with black nylon braid w/ red tracers; 28 mil minimum.
Prominently label all connectors as "Indicated".

D	J4 KEY; MOVED J20 & J21	RJS	17 OCT 06	APPLY WELDED TOLERANCES X = ± 0.05 Y = ± 0.12 Z = ± 0.08	REFERENCE: PANEL HARNESS	DRAWING NUMBER: 10914D-04
REV	DESCRIPTION OF REVISION	BY	DATE			

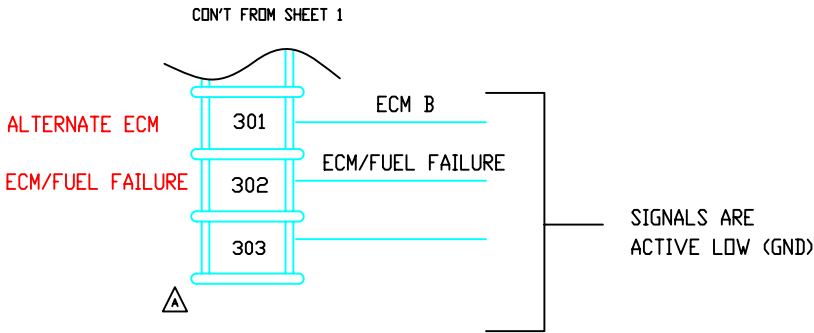
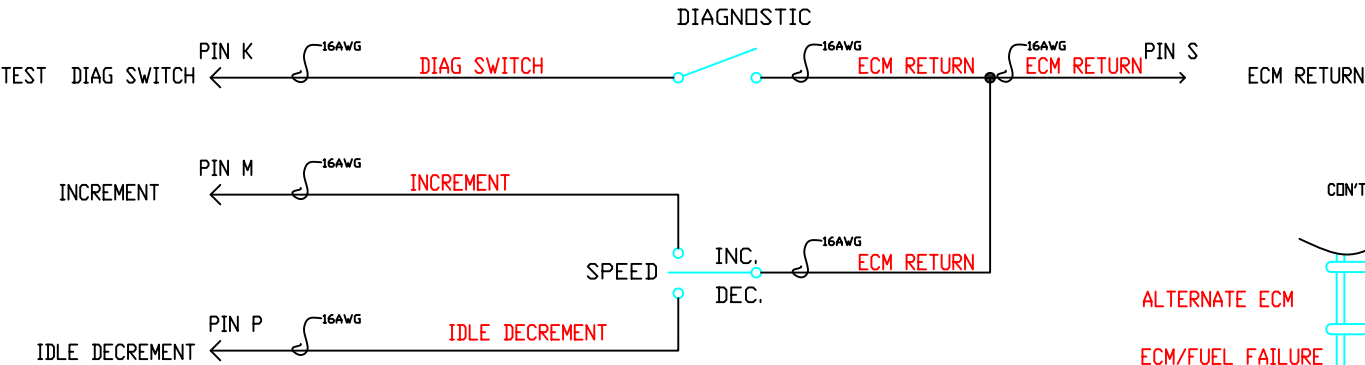
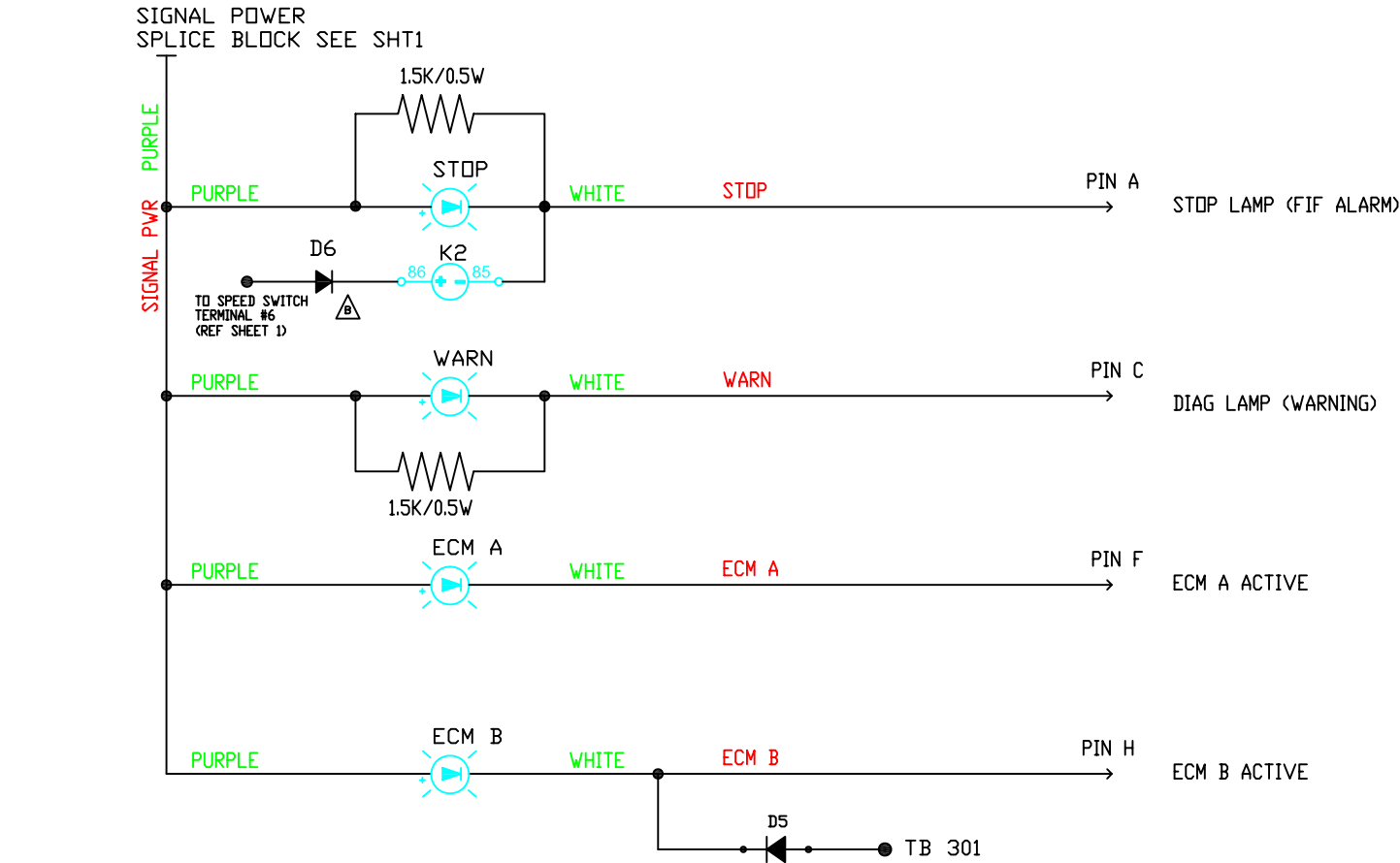


NOTES: WIRE IS 14 AWG UNLESS OTHERWISE NOTED
RED TEXT = WIRE TAG
GREEN TEXT = WIRE COLOR
WIRE COLOR IS WHITE UNLESS OTHERWISE NOTED
D1 - D4: 6 Amp/400 Vpiv

E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07	UNLESS OTHERWISE NOTED ALL DIMENSIONS ARE IN INCHES APPLY MACHINE TOLERANCES 3/16" = 0.001 3/32" = 0.001	DWG SCALE: N/A	DESIGN CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN WWW.CUMMINSFIREPOWER.COM	CUMMINS FIRE POWER CORPORATE OFFICE 1800 BLUEHOLE ROAD WHITE BEAR LAKE, MN WWW.CUMMINSFIREPOWER.COM	DATE: 06_OCT_2005
D	PIN 12 WAS PIN 8	RJS	19 SEPT 06		PLOT SCALE: N/A	APPD BY: RJS		DATE: --
C	REMOVED 5 AMP CIRCUIT BREAKER	RJS	27 JUNE 06					
B	ADDED CONNECTION TO TERM 6 OF SPEED SWITCH	RJS	17 DEC 05	APPLY MFG TOLERANCES 3/16" = 0.001 3/32" = 0.001				
A	CHANGED WIRE GAUGES; CHG'D TB 1 LABELS	RJS	27OCT05					
REV	DESCRIPTION OF REVISION	BY	DATE					

DESCRIPTION	SCHEMATIC, CONTROL PANEL
REFERENCE	FIREPUMP
DRAWING NUMBER	10423E_SHT1

ADDITIONAL CIRCUITS FOR ELECTRONIC ENGINES



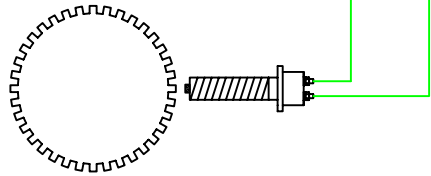
LEGEND:
K2 ECM/FUEL FAIL RELAY
R RESISTOR

NOTES: WIRE IS 14AWG UNLESS OTHERWISE NOTED
RED TEXT = WIRE TAG
GREEN TEXT = WIRE COLOR
WIRE COLOR IS WHITE UNLESS OTHERWISE NOTED
RESISTOR VALUE = 15Kohms, 1/2W
MINIMUM DIODE RATING: 6A/400V

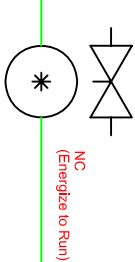
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07	UNLESS OTHERWISE NOTED ALL DIMENSIONS ARE IN INCHES	DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06	APPLY MACHINE TOLERANCES 31 - 2.000 32 - 2.000 33 - 2.000	PLOT SCALE: N/A	APPD BY: --	DATE: --
C	REDREW	RJS	3 JULY 06	APPLY MOLD TOLERANCES 31 - 2.000 32 - 2.000 33 - 2.000	DESCRIPTION SCHEMATIC;_CONTROL_PANEL		
B	CHG'D WIRING OF K2	RJS	17 DEC 05		REFERENCE: FIREPUMP		DRAWING NUMBER: 10423E_SHT2
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05				
REV	DESCRIPTION OF REVISION	BY	DATE				

CONTROL PANEL
CONNECTOR

ALL MODELS EXCEPT:
CFP33-Fxx
CFP55-F55



MECHANICAL ENGINES — 3
ELECTRONIC ENGINES — X

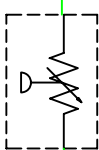


FSO (SW B+); MECHANICAL
KEYSWITCH; ELECTRONIC

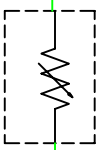
1 < MPU

2 < MPU

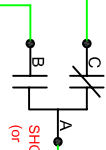
4 < OIL PRES. SENDER



5 < WATER TEMP SENDER

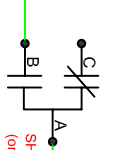


6 < OIL PRES. SWITCH



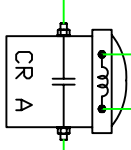
SHOWN IN "LOW OIL PRESS" STATE
(or engine NOT running)

7 < WATER TEMP SWITCH

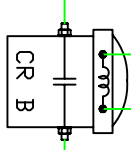


SHOWN IN "NORMAL TEMP" STATE
(or engine NOT running)

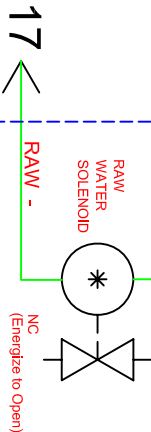
8 < CRANK BAT A



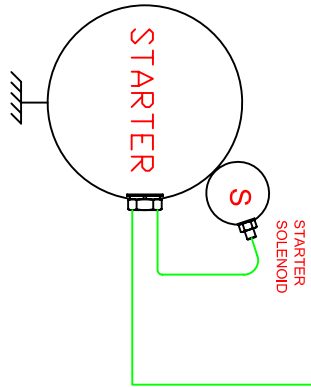
10 < CRANK BAT B



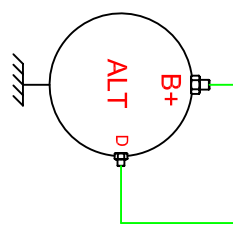
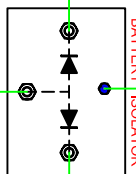
13 < RAW +



17 < RAW -



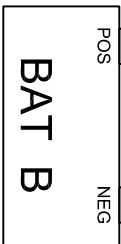
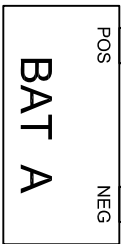
9 < ALT EXC (SW B+)




16 < BAT A

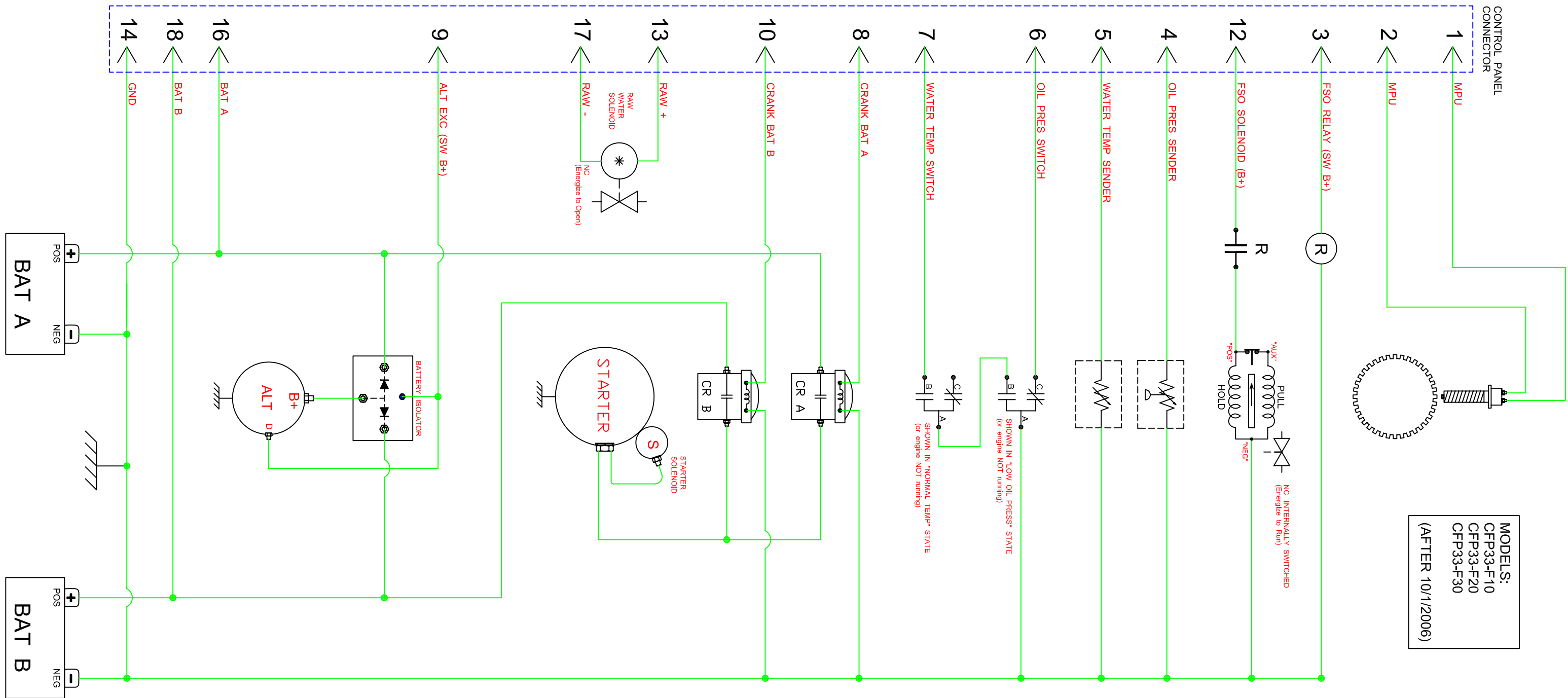
18 < BAT B

14 < GND

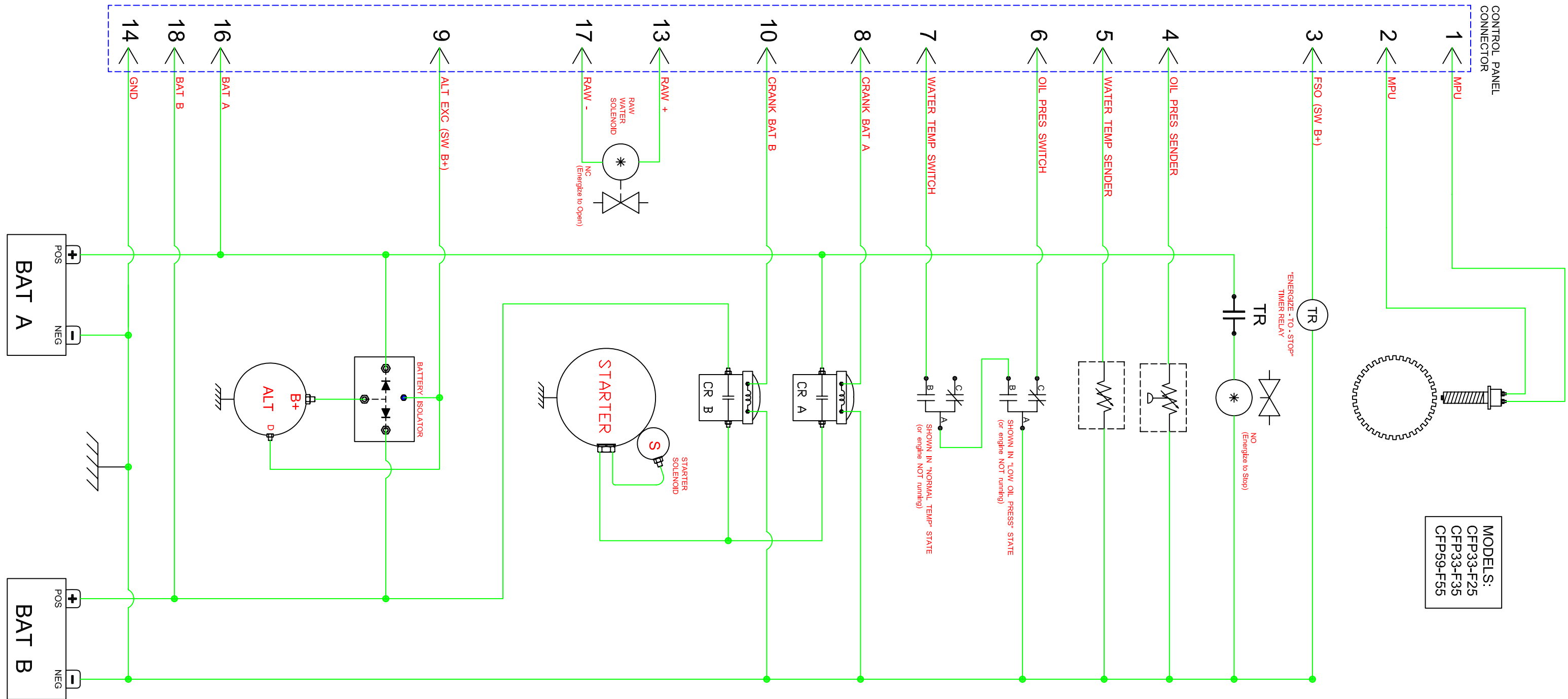


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UNLESS OTHERWISE NOTED ALL DIMENSIONS IN INCHES		DWG SCALE: N/A		DRAWN BY: RJS		DATE: 06_OCT_2005	
UNLESS OTHERWISE NOTED ALL DIMENSIONS IN INCHES		PLOT SCALE: N/A		APPD BY: --		DATE: --	
DESCRIPTION ENGINE_SCHEMATIC							
REFERENCE: FIREPUMP							
DRAWING NUMBER: 10423E_SHT3							

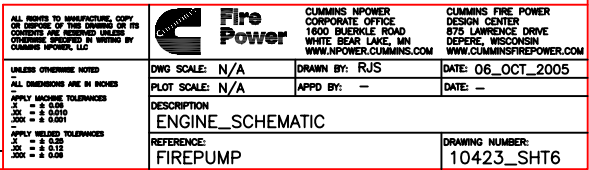
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07	UNLESS OTHERWISE NOTED ALL DIMENSIONS ARE IN INCHES APPLY MACHINE TOLERANCES 3/16" = ± 0.010 1/8" = ± 0.005 APPLY WEELD TOLERANCES 3/16" = ± 0.015 1/8" = ± 0.010 3/32" = ± 0.008
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06	
C	REDREW	RJS	3 JULY 06	
B	CHG'D WIRING OF K2	RJS	17 DEC 05	
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05	
REV	DESCRIPTION OF REVISION	BY	DATE	

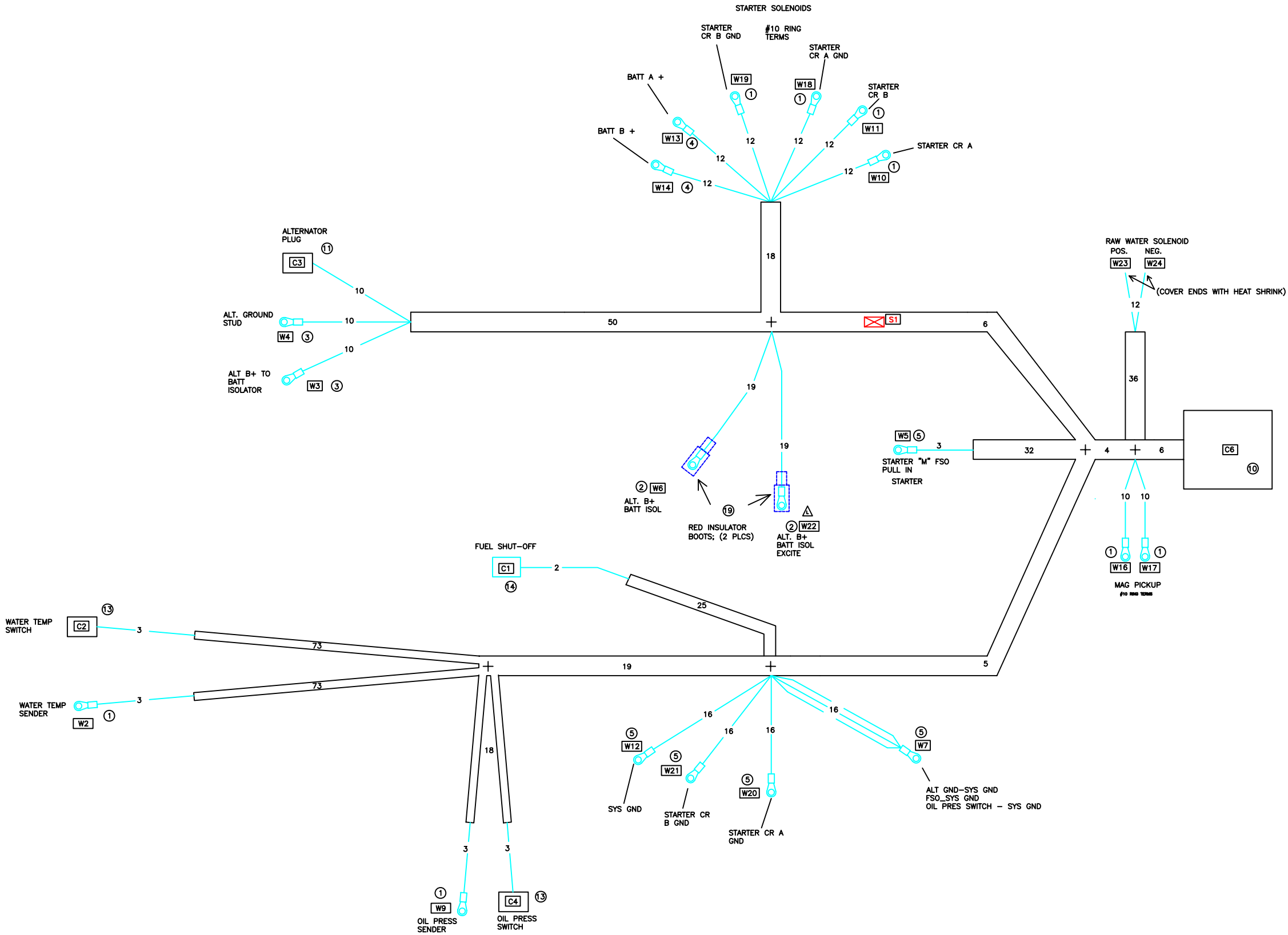


E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07	UNLESS OTHERWISE NOTED	DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06	ALL DIMENSIONS ARE IN INCHES	PLOT SCALE: N/A	APPD BY: --	DATE: --
C	REVIEW	RJS	3 JULY 06	APPLY RELATED TOLERANCES ±.005 = 0.005 ±.006 = 0.006 ±.007 = 0.007	DESCRIPTION ENGINE_SCHEMATIC		
B	CHG'D WIRING OF K2	RJS	17 DEC 05	APPLY RELATED TOLERANCES ±.005 = 0.005 ±.006 = 0.006 ±.007 = 0.007			
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05	APPLY RELATED TOLERANCES ±.005 = 0.005 ±.006 = 0.006 ±.007 = 0.007	REFERENCE: FIREPUMP		DRAWING NUMBER: 10423E_SHT4
REV	DESCRIPTION OF REVISION	BY	DATE				



E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07	UNLESS OTHERWISE NOTED	DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06	ALL DIMENSIONS ARE IN INCHES	PLOT SCALE: N/A	APPD BY: —	DATE: —
C	REVIEW	RJS	3 JULY 06	APPLY MANUFACTURER TOLERANCES ± .0005 ± .0010 ± .0015	DESCRIPTION ENGINE_SCHEMATIC		
B	CHG'D WIRING OF K2	RJS	17 DEC 05	APPLY MIL-STD TOLERANCES ± .0030 ± .0015 ± .0010	REFERENCE: FIREPUMP		
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05				DRAWING NUMBER: 10423E_SHT5
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

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
REV	DESCRIPTION OF REVISION	BY	DATE

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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 = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	DWG SCALE: — PLOT SCALE: — DESCRIPTION WIRING_HARNESS_SCHEMATIC REFERENCE: FIRE_PUMPS_NON-3.3LITER	DRAWN BY: SAH APPD BY: — DATE: 29JUN2004 DATE: — DRAWING NUMBER: 8513SHT1_L

RING HARNESS CONTENT			
REF NO.	SUPPLIER	SUPPLIER PART NO.	QTY.
1			8
2			2
3			2
4			2
5			5
10	DEUTSCH	HDP 26-24-19SN	1
11	PACKARD	12047950/12186566	1
13	PACKARD	12162280	2
14	PACKARD	12015793	1
18			1
19	stella-maris	400N9V02	2

DESCRIPTION
#10 RING TERMINAL
1/4" RING TERMINAL
5/16" RING TERMINAL
3/8" RING TERMINAL
1/2" RING TERMINAL
MAIN CONNECTOR
ALT PLUG CONN. ASMBLY
WTS / OPS CONN. W / SOCKETS & SEAL
FSO CONN. W / SOCKETS
FUSE 6 AMP
RED INSULATOR BOOT

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
REV	DESCRIPTION OF REVISION	BY	DATE

[illegible]