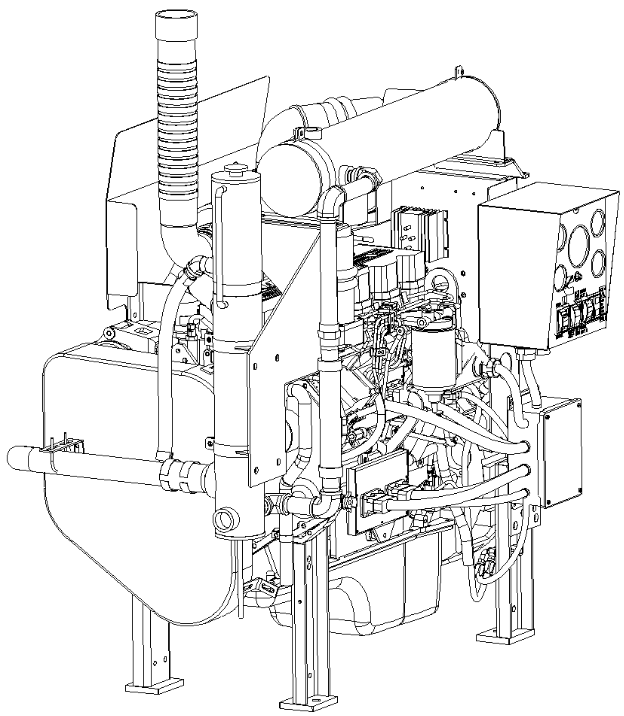
CFP33 SERIES

Operation & Maintenance Manual

Fire Pump Drive Engines



www.cumminsfirepower.com

Foreword

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

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

Keep this manual with the equipment. If the equipment is traded or sold, give the manual to the new owner.

The information, specifications, and recommended maintenance guidelines in this manual are based on information in effect at the time of printing. Cummins Fire Power, Cummins NPower and Cummins Engine Company, Inc. reserve the right to make changes at any time without obligation. If any differences are found between an engine and the information in this manual, contact the local Cummins Authorized Repair Location.

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

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

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Index of Sections

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Section 1 – Introduction

Section Contents

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To the Owner and Operator

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

Keep records of regularly scheduled maintenance.

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

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

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

About the Manual

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

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

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

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

How to Use the Manual

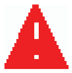
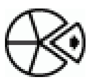
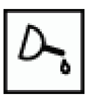
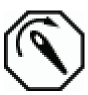
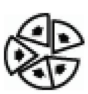
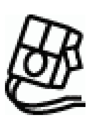
This manual is organized according to intervals at which maintenance on the engine is to be performed. A table that states the required intervals and the checks to be made is located in Section 4. Locate the interval at which maintenance will be performed, then follow the steps given in the referenced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

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

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

Symbols

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

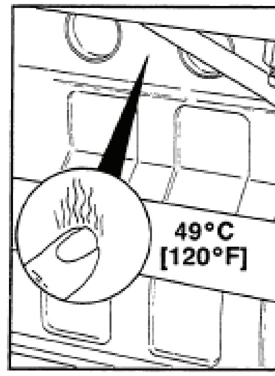
	**WARNING**. Serious personal injury or extensive property damage can result if the warning instructions are not followed.
	**CAUTION**. Minor personal injury can result or a part, an assembly, or the engine can be damaged if the caution instructions are not followed.
	**INSPECTION** is required
	Refer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

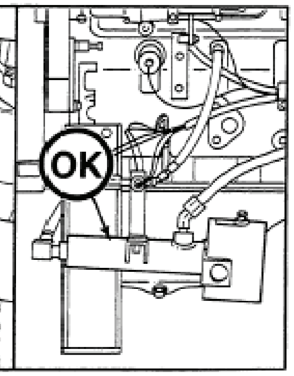
Illustrations

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

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

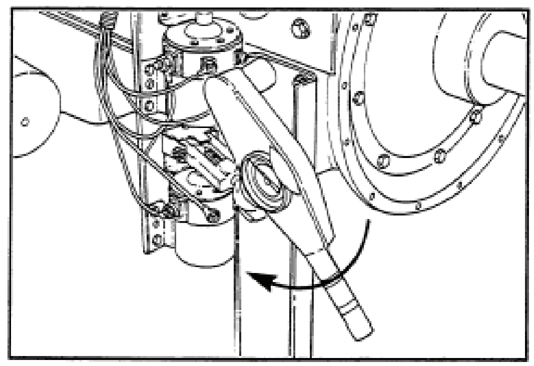
The illustrations can contain symbols to indicate an action required, and an acceptable or not acceptable condition.





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

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



General Safety Instructions

WARNING

Improper practices or carelessness can cause burns, cuts, mutilation, asphyxiation or other bodily injury or death.

- Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that must be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.
- Make sure the work area surrounding the product is dry, well lit, ventilated; free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do not wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Put a "**Do Not Operate**" tag on the controls.
- Use **ONLY** the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do not work on anything that is supported **ONLY** by lifting jacks or a hoist. Always use blocks or proper stands to support the product before performing any service work.
- Relieve all pressure in the air, oil, and the cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To avoid personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks must not be side-loaded.
- Corrosion inhibitor contains alkali. Do not get the substance in your eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. **IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN**.

General Safety Instructions (Cont.)

- Naphtha and Methyl Ethyl Ketone (MEK) are flammable materials and must be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. **KEEP OUT OF REACH OF CHILDREN**.
- To avoid burns, be alert for hot parts on products that have just been turned OFF, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use them before performing any service work. Use **ONLY** genuine Cummins or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of lesser quality if replacements are necessary.
- Do not perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil. Dispose of waste oil in accordance with applicable requirements.

General Cleaning Instructions

WARNING

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

WARNING

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

WARNING

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

WARNING

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

CAUTION

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

CAUTION

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

CAUTION

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

Definition of Clean

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

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

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

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

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

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

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

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

Using Abrasive Pads and Abrasive Paper

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

WARNING

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

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

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

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

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

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

WARNING

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

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

Cleaning Gasket Surfaces

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

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

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

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

Solvent and Acid Cleaning

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

WARNING

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

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

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

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

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

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

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

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

Steam Cleaning

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

WARNING

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

Do not steam clean the following components:

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

Plastic Bead Cleaning

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

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

CAUTION

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

CAUTION

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

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

Plastic Bead Cleaning (Cont)

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

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

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

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

CAUTION

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

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

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

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

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

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

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

Acronyms and Abbreviations

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

Section 2 - Engine Identification

Section Contents

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Fire Pump Engines

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

Overspeed Switches

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

Operating Speed

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

Control System

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

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

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

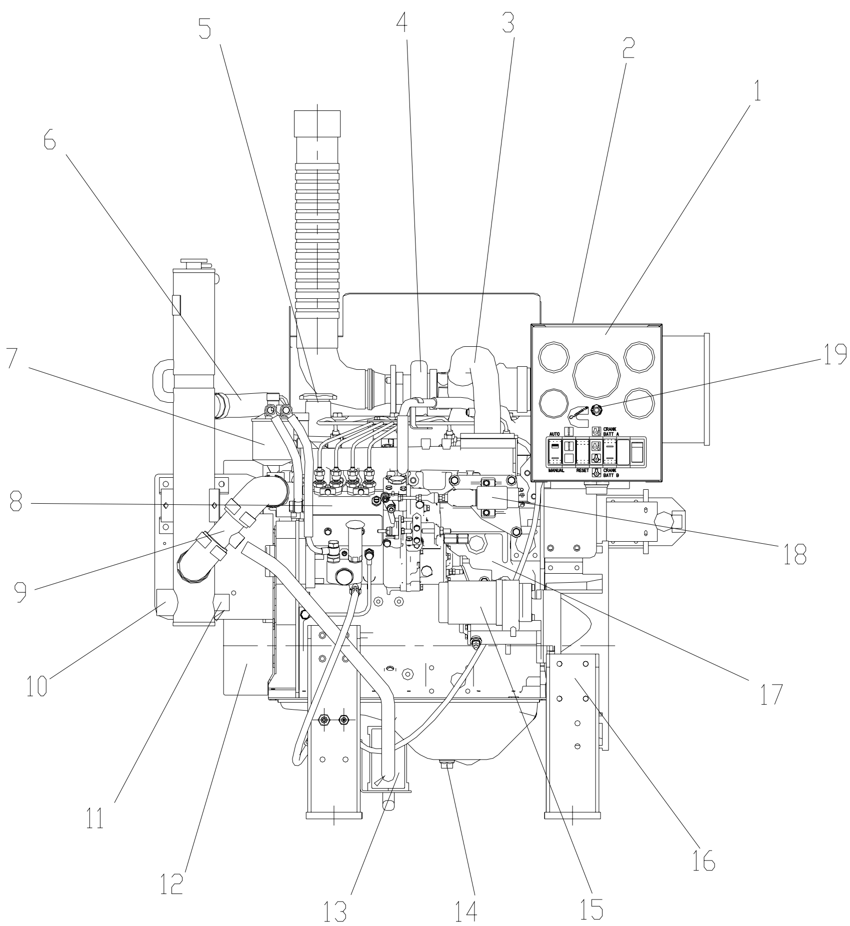
Sequential starting is available for multiple-pump installations to keep all pumps from starting simultaneously.

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

External Engine Components and Views

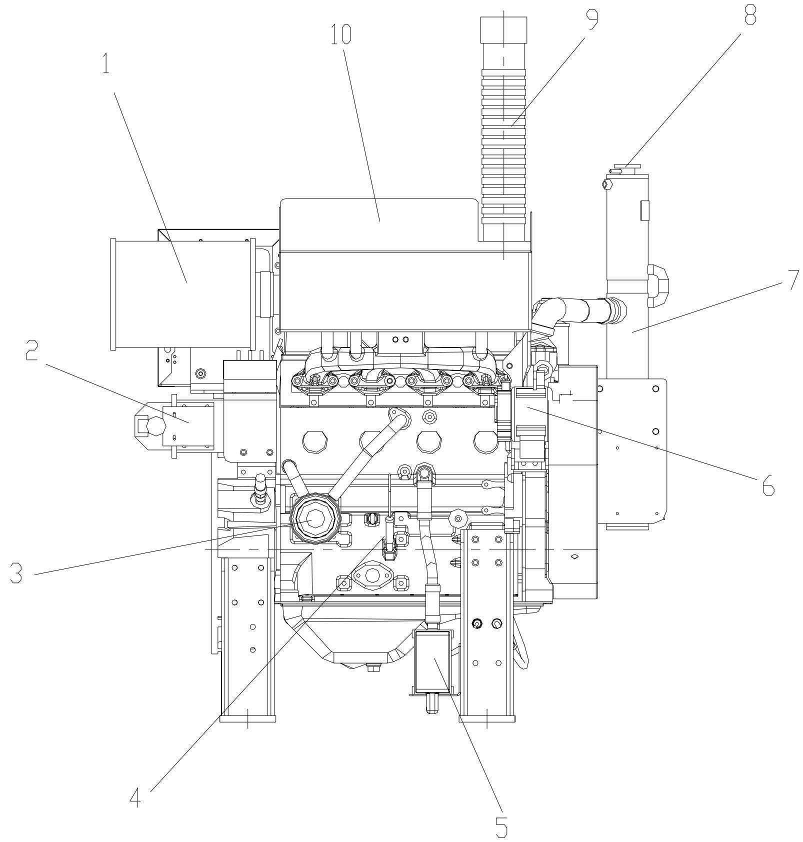
The following illustrations show the locations of the major external engine components, and other service and maintenance points. Some external components will be at different locations for different engine models.

Instrument Panel Side



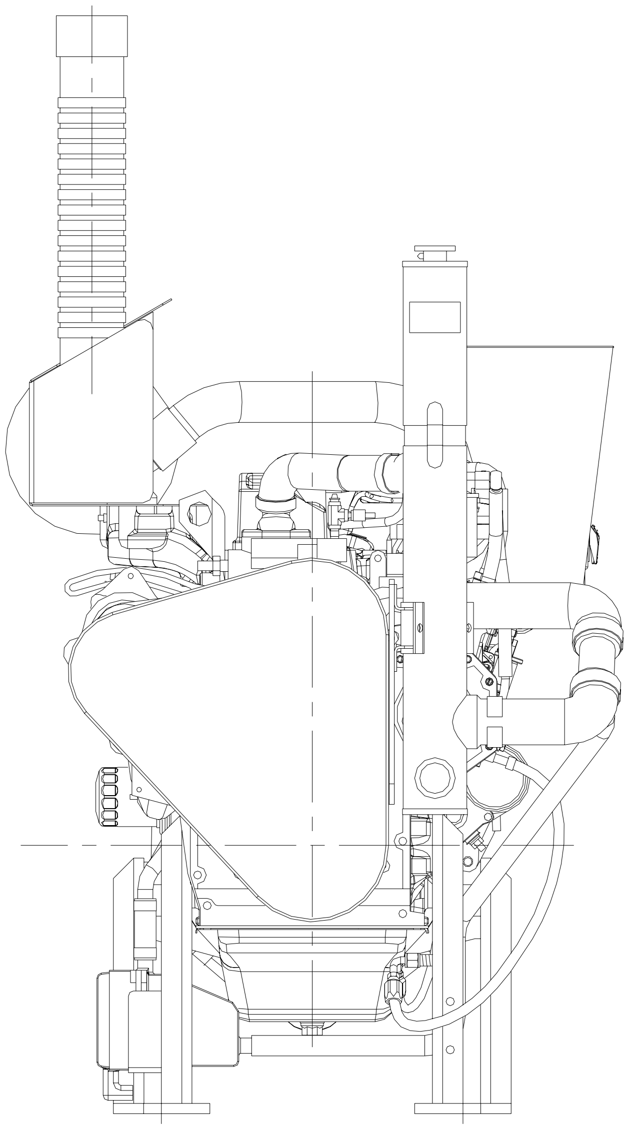
1. Instrument Panel
2. Terminal Box
3. Air Intake Cross-Over Tube
4. Turbocharger
5. Lubricating Oil Fill Location
6. Upper Water Hose/Tube
7. Fuel Filter
8. Fuel Pump
9. Lower Water Hose/Tube
10. Raw Water Outlet (1” NPT)
11. Raw Water Inlet (¾” NPT)
12. Pulley/Belt Guard
13. Coolant Drain
14. Oil Pan Drain
15. Starter Motor
16. Engine Support
17. Fire Pump Dataplate
18. Electric Fuel Solenoid
19. Circuit Breaker

Turbocharger Side

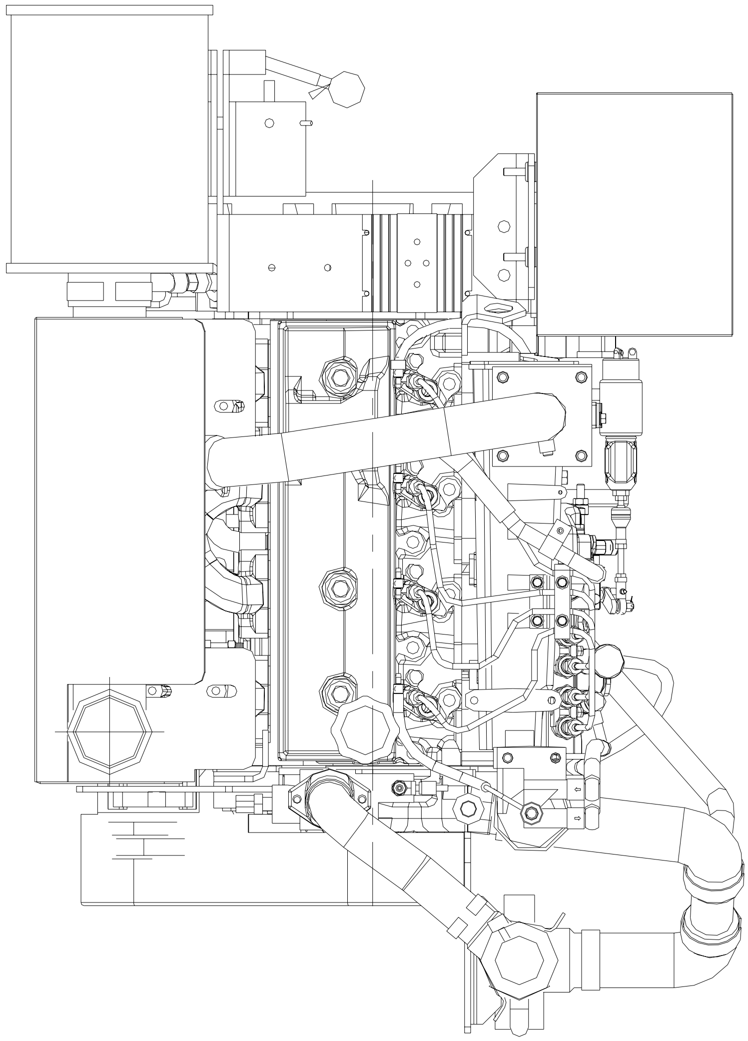


1. Air Cleaner Element
2. Manual Start Lever
3. Lubricating Oil Filter
4. Dipstick
5. Coolant Heater
6. Alternator
7. Heat Exchanger
8. Top Tank Fill
9. Exhaust
10. Turbocharger and Exhaust Shield

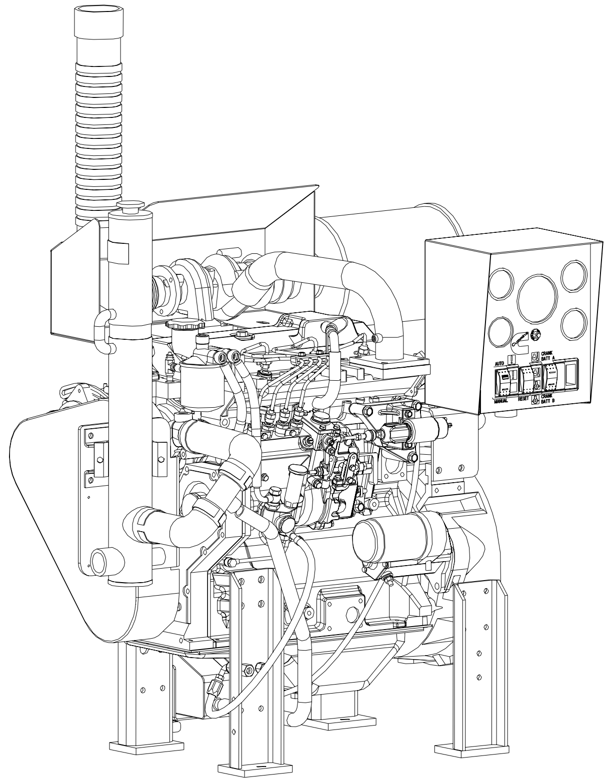
Front View

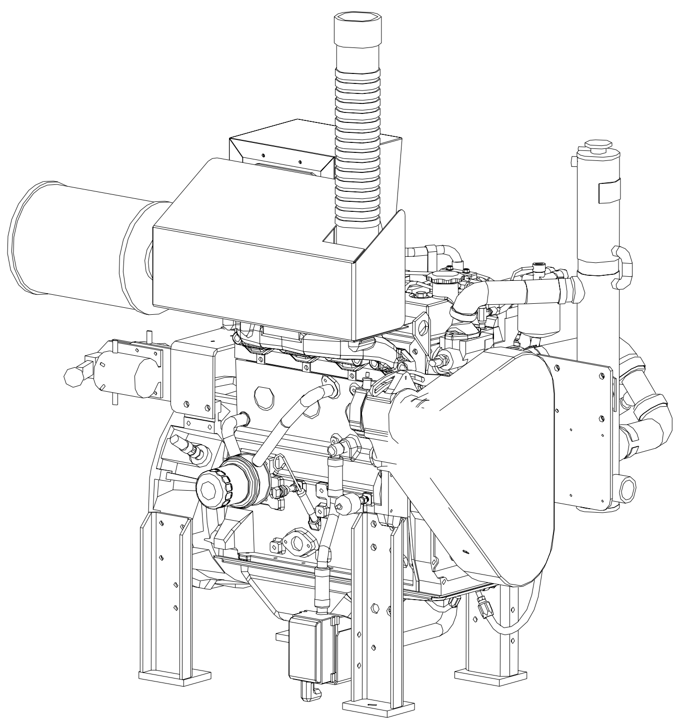


Top View

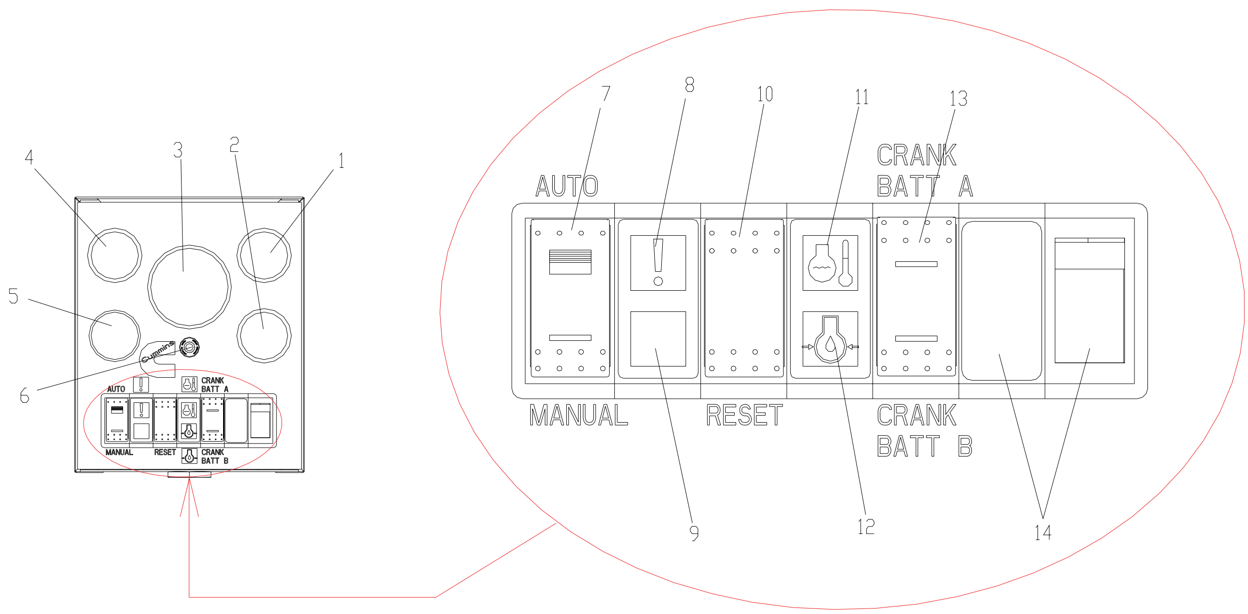


Isometric Views





Instrument Panel

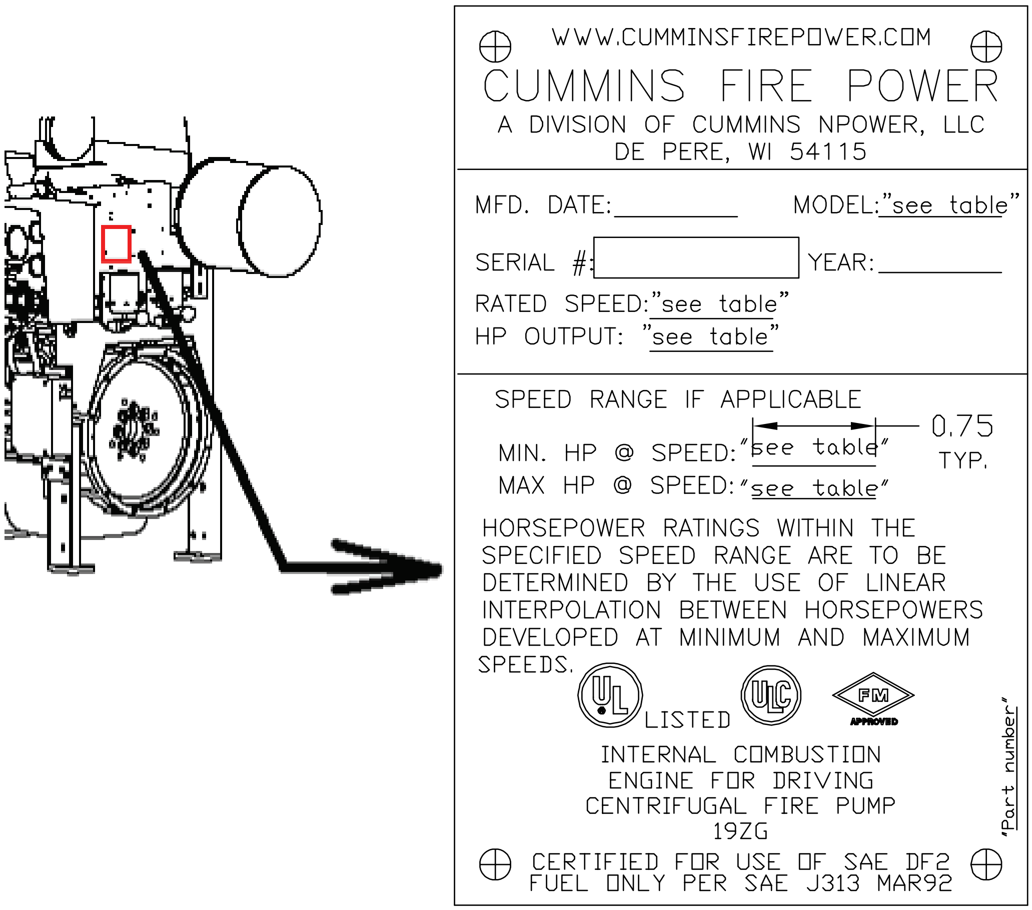


1. Battery “A” Voltmeter
2. Battery “B” Voltmeter
3. Tachometer (with hour-meter)
4. Water Temperature Gauge
5. Lubricating Oil Pressure Gauge
6. Circuit Breaker
7. ON/OFF Switch (AUTO/MANUAL)
8. Overspeed Warning Light
9. Not used
10. Overspeed Reset Switch
11. High Water Temperature Warning Light
12.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

Fire Pump Identification

The fire pump dataplate shows specific information about your engine. The engine serial number (1) and Control Parts List (CPL) (2) provide information for ordering parts and service needs.

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

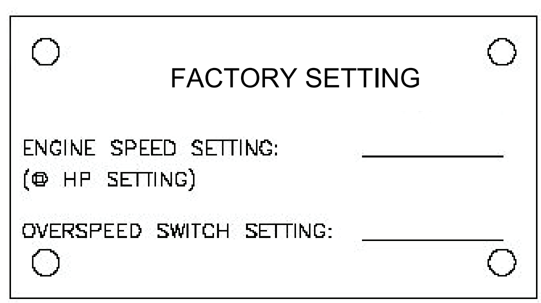


Factory Setting Tag

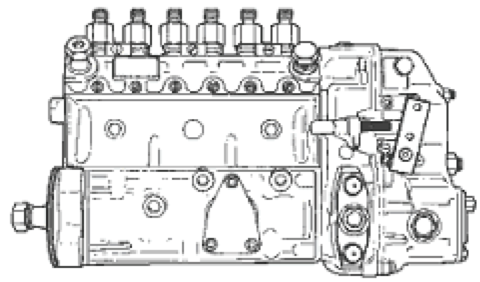
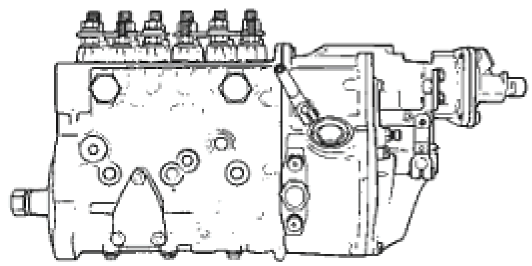
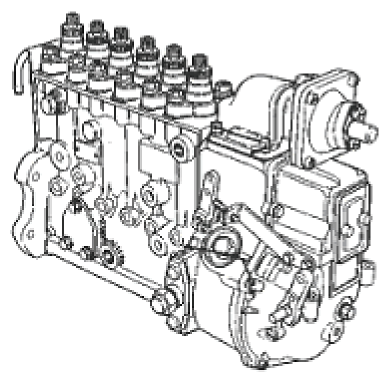
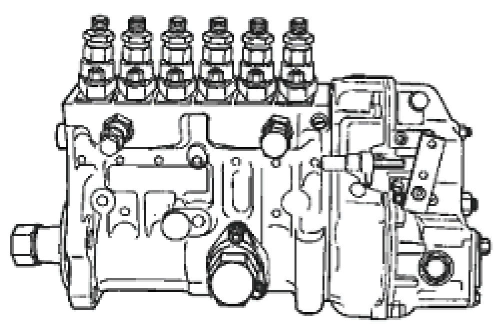
The Factory Setting Tag is located at the pump end of the engine just above the redundant starter solenoids. Refer to Drawing 8704 (CFP59-F10, F20, F40, F50), (CFP59-F15, F25), (CFP59-F45) or (CFP59-F55) in Section 13 for location details.

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.



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.	

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Section 3 – Installation and Operation

Section Contents

Section Contents (Cont)

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 CFP33_GEN in Section 13 for the general fire pump and engine layout.

Refer to the following drawings in Section 13 for the general fire pump engine power module assembly:

Model	Drawing
CFP33-F10, F20, F30	Drawing 8700
CFP33-F25, F35	Drawing 8701

WARNING

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

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

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

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

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

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

Physical Engine Installation (Cont)

Physical Installation

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

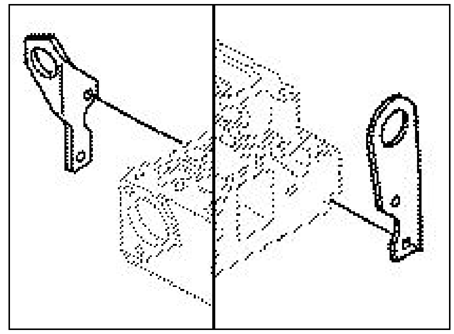
Provide engine support as required to support the wet weight specified in General Engine Data in Section 10.

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.

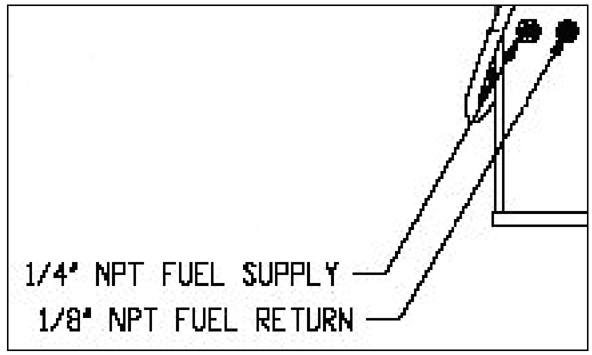
Install an elevated Diesel # 2 fuel tank or other fuel supply arrangement that meets the specifications listed in Fuel System Specifications in Section 10.

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 1/8" NPT (minimum) fuel return line. Route this line to the bottom of the fuel tank in order to minimize the return head.

Install a ¼" 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 weater system. Refer to Cooling System Specifications in Section 10 for pipe size requirements.

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

If the piping supplied by the customer, provide raw water supply piping and components equivalent to that can be supplied by Cummins 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.

Raw Water Supply and Drain Piping without Cummins Raw Water Manifold

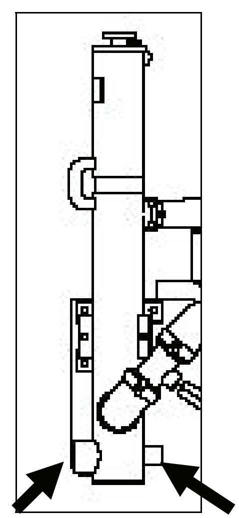
NOTE: Raw water outlet piping from the heat exchanger should be one pipe size larger than the supply piping.

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

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

Provide raw water supply to the engine side of the heat exchanger.

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



Raw Water Supply Installation (Cont)

Raw Water Supply and Drain with Cummins Raw Water Manifold

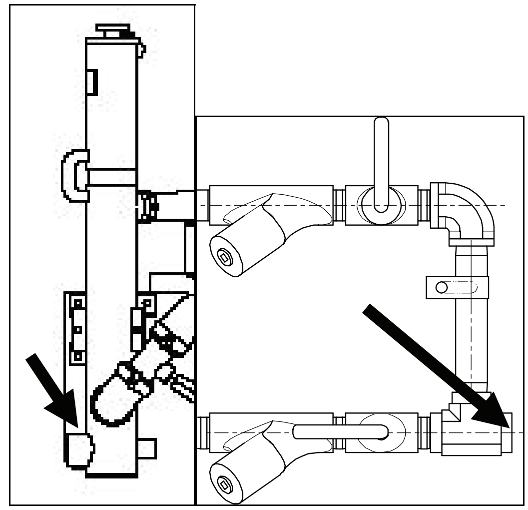
NOTE: Raw water outlet piping from the heat exchanger should be one pipe size larger than the supply piping.

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

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

Provide raw water supply to the raw water manifold inlet.

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



Check Raw Water Pressure Regulator Setpoints

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

Temporarily remove the raw water inlet piping from the engine coolant heat exchanger. Refer to Drawing 9636 in Section 13.

Temporarily remove the raw water supply piping from the fire pump to the manifold.

Temporarily supply an alternate source of raw water to the inlet to the raw water manifold. The temporary water supply pressure should exceed 414 kPa [60 psig].

Provide temporary drain piping at the raw water manifold outlet.

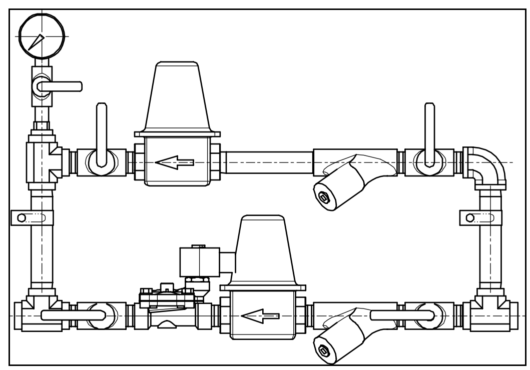
If closed, open the pressure gauge isolation valve.

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.

Apply water pressure to the raw water manifold.



Raw Water Supply Installation (Cont)

NOTE: The heat exchanger is rated at 414 kPa [60 psig].

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) or 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 (standard 12 VDC or optional 24 VDC).

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 either 12 VDC (standard) or 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 9766 in Section 13.

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

Signal and Control Installation

NOTE: Install signal and control wiring at Terminal Board 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 VDC (standard) or 24 VDC (optional) signal is present when the engine is running. This signal indicates that the engine has started and that the crank command from the fire pump controller should stop immediately.

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

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

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

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

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

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

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

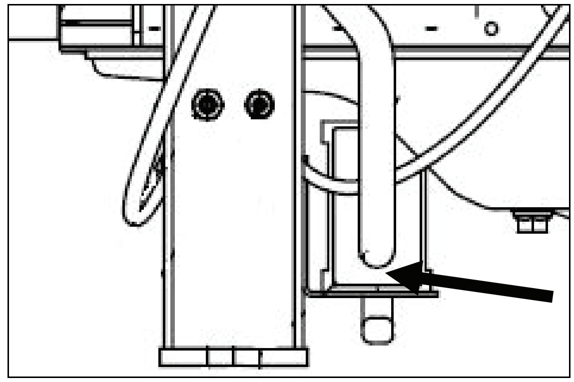
Coolant System Preparation

Check Cooling System Integrity

NOTE: Refer to Drawing 8700 (CFP33-F10, F20, F30) or Drawing 8701 (CFP33-F15, F25) in Section 13 for hose arrangement.

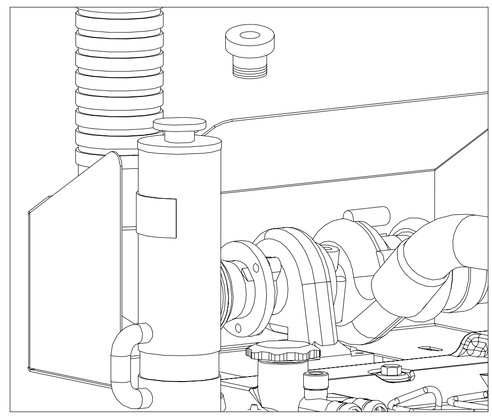
Check that all coolant hoses are properly installed and that the clamps are tight.

Check that the coolant drain petcock is closed.



Add Coolant

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



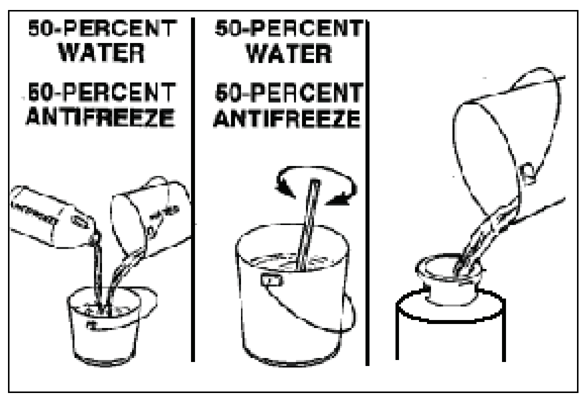
Refer to Cooling System Specifications and Coolant Recommendations and Specifications in Section 10.

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

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

Check for leaks. Correct any leaks.

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



Coolant System Preparation (Cont)

Check Raw Water Supply Lineup

CAUTION

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

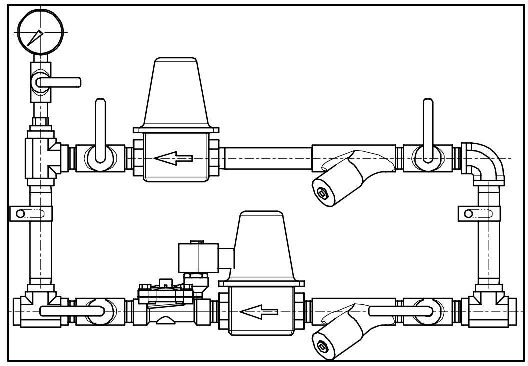
Check that the pressure gauge isolation valve is open.

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

Check that the (upper) bypass line outlet valve is closed.

Check that the normal line inlet valve is open.

Check that the normal line outlet valve is open.

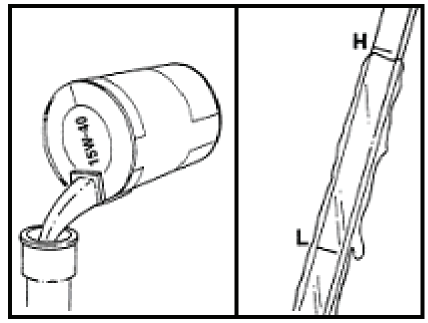


Lubricating Oil System Preparation

Add Lubricating Oil

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

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



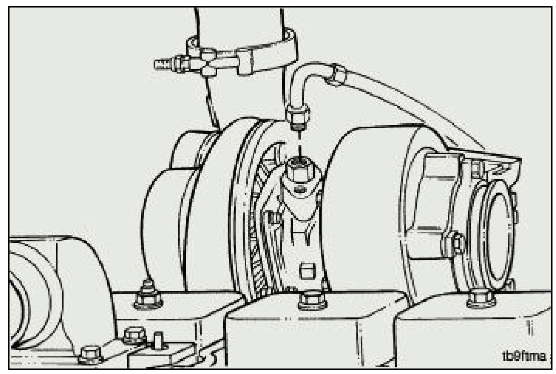
Prime the Turbocharger

CAUTION

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

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

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



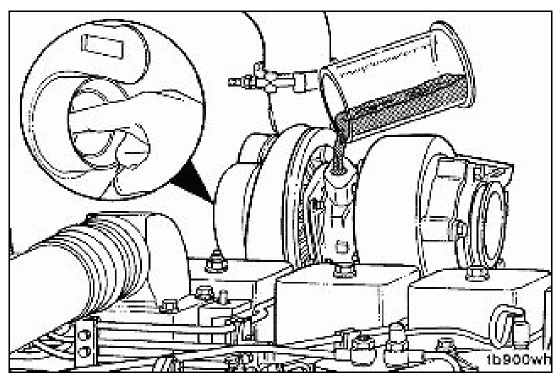
NOTE: Rotate the turbine wheel to allow oil to enter the bearing housing. Any excess oil will drain through the oil drain line.

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

Tighten the oil supply line.

Torque Value: 10 N•m [7 ft-lb]

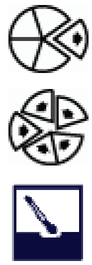
Install the air intake filter assembly. Refer to Intake Air Filter Removal/Installation in Section 7.

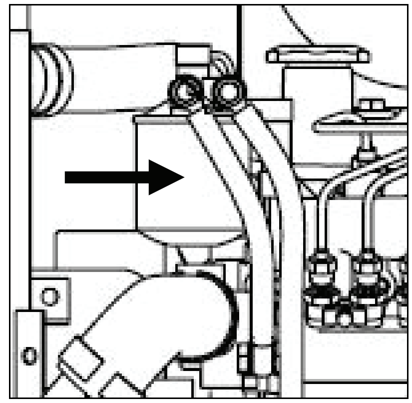


Fuel System Preparation

Fill the Fuel Filter

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



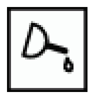


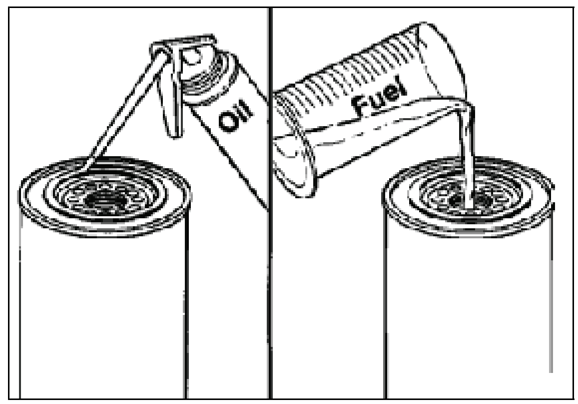
If open, close the air/water separator drain cock.

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.





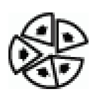
CAUTION

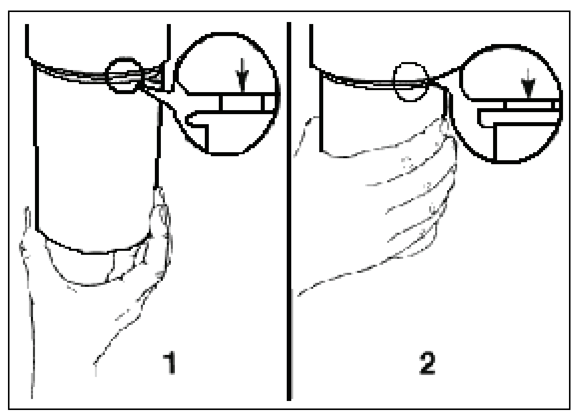
Mechanical over-tightening will distort the threads, filter element seal or filter can.

Install the filter on the filter head.

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

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





Fuel System Preparation (Cont)

Fill the Fuel Tank

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

Ensure that the fuel tank and piping is clean.

Fill the fuel tank with fuel.

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

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

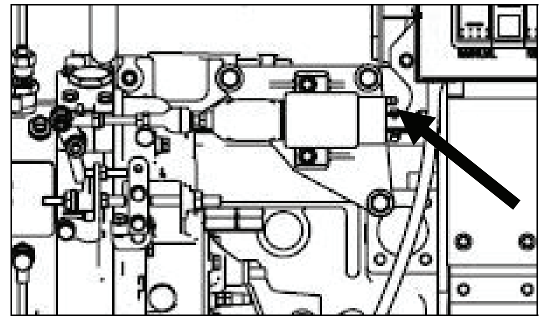
Pre-Start Inspections

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.

Pre-Lubricate the Engine

Disconnect the connector at the electric fuel solenoid (Fuel Shutoff Valve).



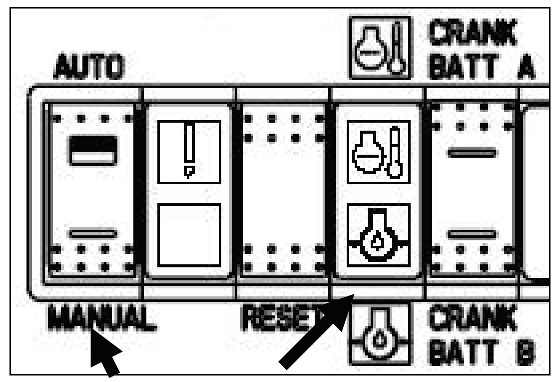
Press the MANUAL position on the AUTO/MANUAL rocker switch.

NOTE: Monitor engine oil pressure on the local control panel. Some pressure indication is expected. Also, the low oil pressure light should go off.

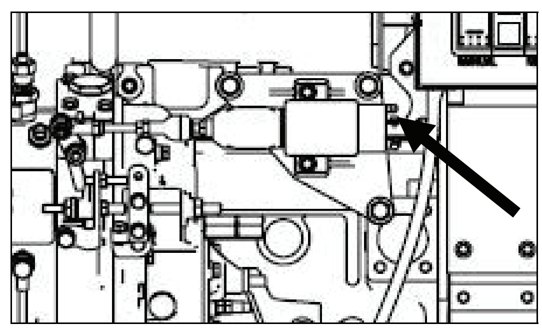
Crank the engine about two revolutions using either the CRANK BATT A or the CRANK BATT B switch positions.

Repeat a second time if oil pressure did not register on the gauge.

NOTE: Troubleshoot as per Lubricating Oil Pressure Low in Section 12 if oil pressure did not register on the gauge.



When pre-lubrication has been accomplished, reconnect the connector at the fuel injection pump solenoid (Fuel Shutoff Valve).

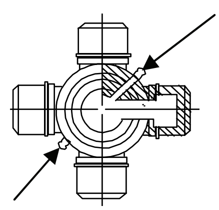


Lubricate Zerk Fittings on Auxiliary Drive Shaft

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

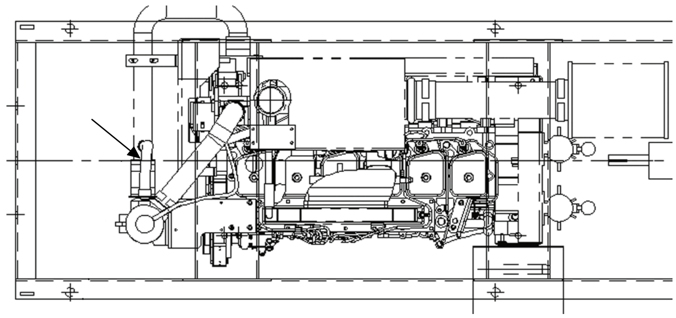
Grease zerk fittings as shown.

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

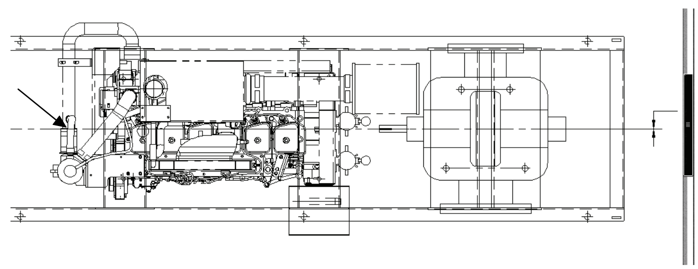


Check Engine to Pump Alignment

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

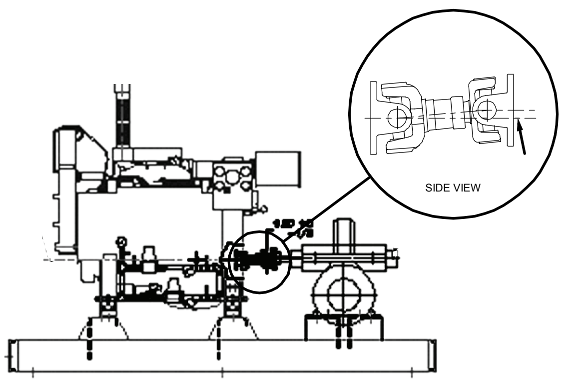


Align engine centerline to pump centerline within +-1/32".

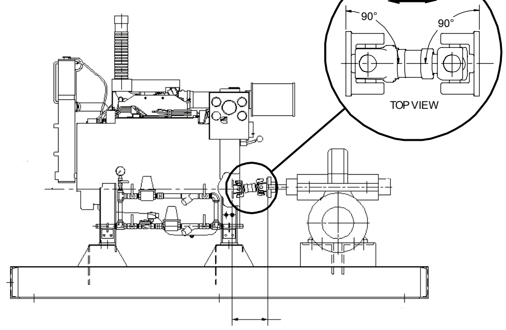


The pump centerline to the engine crank centerline (in vertical plane) is to be ½" +0, -1/4" offset.

NOTE: The slip joint must rest in the middle third of its travel when installed.



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.

Check the Raw Water Valves

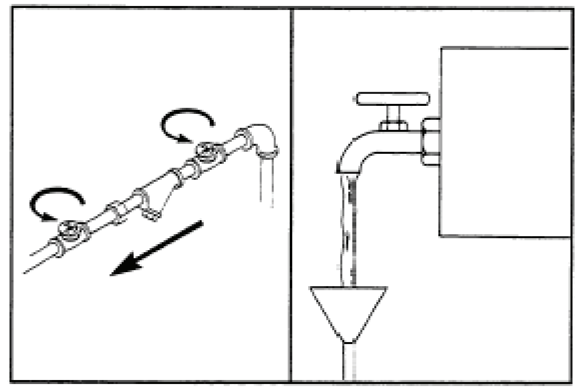
CAUTION

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

Align raw water supply to the raw water supply valves.

Align drainage from the heat exchanger raw water outlet.

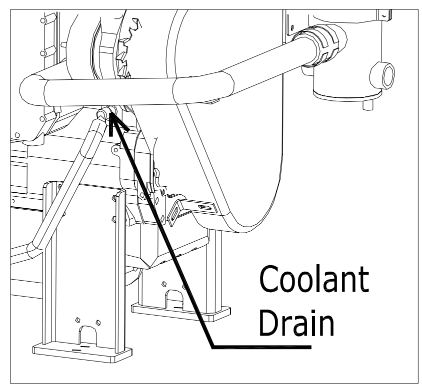
Open the raw water supply valves as shown.



Check the Engine Coolant Supply

Close all cooling system drains.

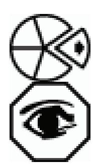
Verify that the vents are opened.

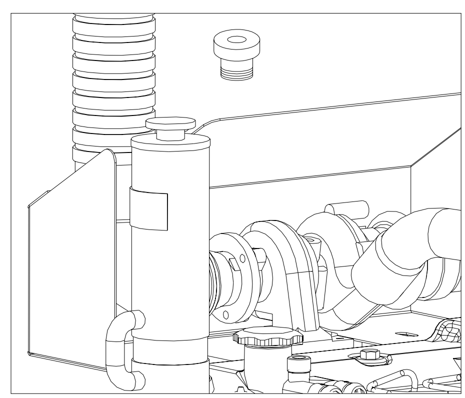


Remove the coolant tank cap.

Check coolant level.

Cold coolant level should be between the bottom of the tube and above the top of the heat exchange coils.



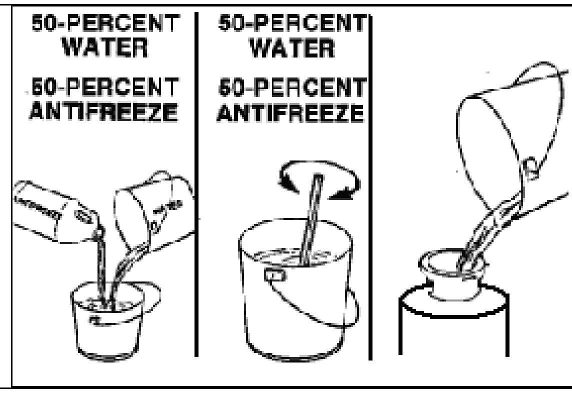


Initial Start-Up (Cont)

Add coolant if necessary. Use a mixture of at least 50 percent antifreeze and 50 percent water.

Replace the coolant tank cap.

Make a visual check for coolant leaks.



Prime the Fuel System:

Fill the fuel filter (see Fuel Recommendations and Specifications in Section 10).

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

Check and fill the fuel tanks.

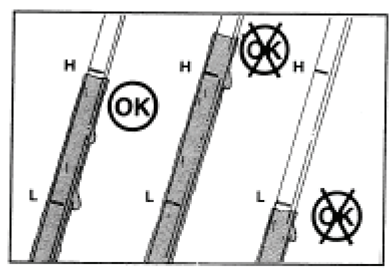
Check the injectors to be sure they are properly adjusted.

Check Initial Crankcase Oil Level:

CAUTION

Never operate the engine with the oil level below the low ("L") mark or above the high ("H") mark on the dipstick

Check the oil level.

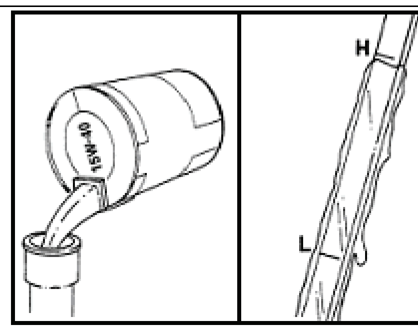


NOTE: No change in oil viscosity or type is needed for new or newly rebuilt engines.

If below the low mark, fill the crankcase to the low "L" (low) mark on the dipstick.

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

See the Lubricating Oil System Specifications for quantity that may be required.



Initial Start-Up (Cont)

Pre-Lubricate the Turbocharger:

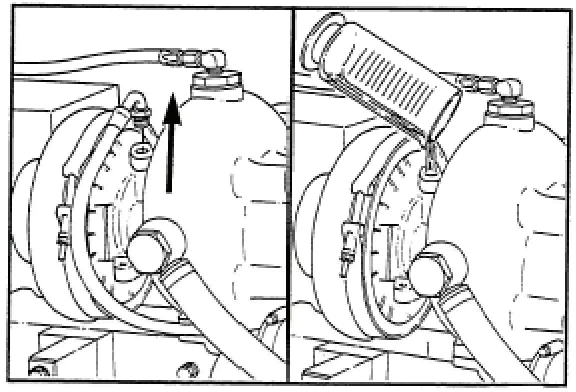
CAUTION

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

Remove the turbocharger oil inlet line.

Pre-lubricate the housing by adding 50 to 60 cc (2 to 3 oz.) of clean engine lubricating oil.

Replace the line.



Pre-Lubricate the Engine

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

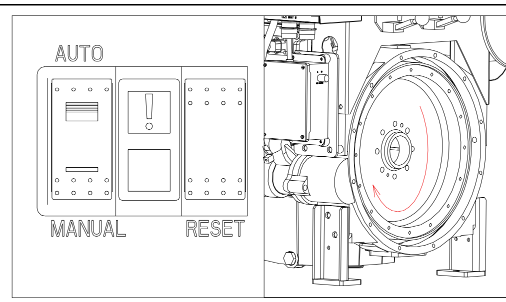
On the top of the fuel pump, disconnect the electric fuel solenoid. Make sure that the fuel pump solenoid wire terminal does not touch the engine.

Close the fuel shutoff valve from the fuel tank to prevent the engine from starting.

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

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

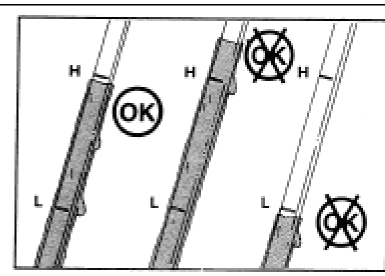
Crank the engine at least 15 seconds, while maintaining the external oil pressure at a minimum of 15 psi [103kPa].



CAUTION

Never operate the engine with the oil level below the low ("L") mark or above the high ("H") mark on the dipstick

Check the oil level again.



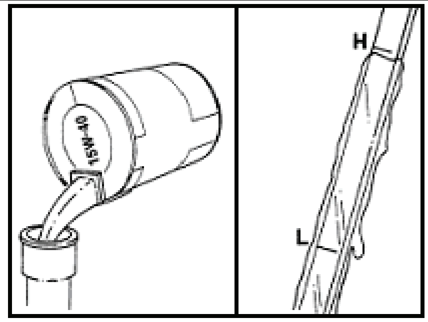
Initial Start-Up (Cont)

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

If below the high mark, fill the crankcase to the high “H” (high) mark on the dipstick.

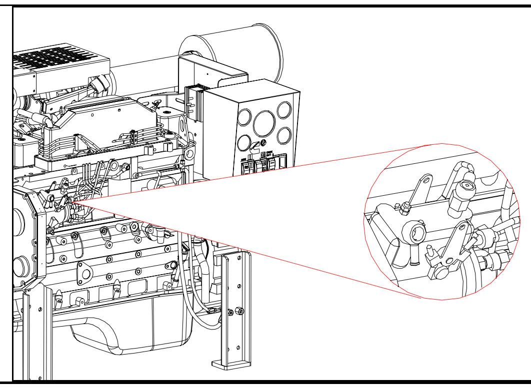
See Lubricating Oil Recommendations and Specifications in Section 10 for oil specifications.

See the Lubricating Oil System Specifications for quantity that may be required.



Initial Test Run

Move the throttle lever to mid-speed position.



Start the engine.

Immediately move the throttle to the low idle position.

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

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

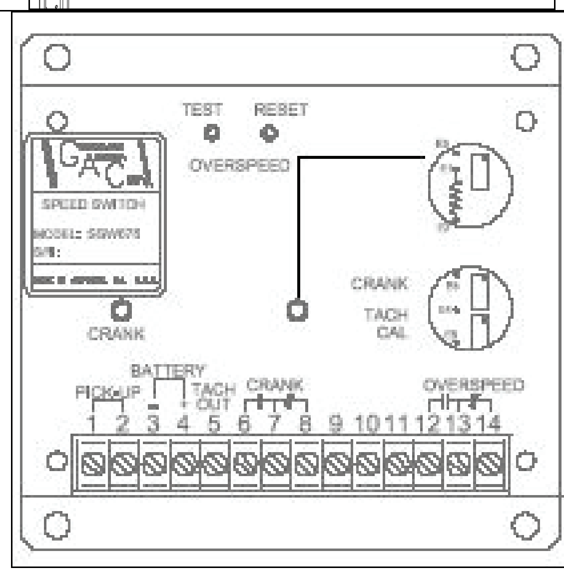
Operate the engine at set point for 8 to 10 minutes.

Check for leaks, unusual noises, or other indications of incorrect operation. Shut off the engine and correct any problems found during the inspection before proceeding.

After 8 to 10 minutes, stop the engine.

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

Clean the raw water strainer.



Initial Start-Up (Cont)

Supplemental Test Run

Start the engine.

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.

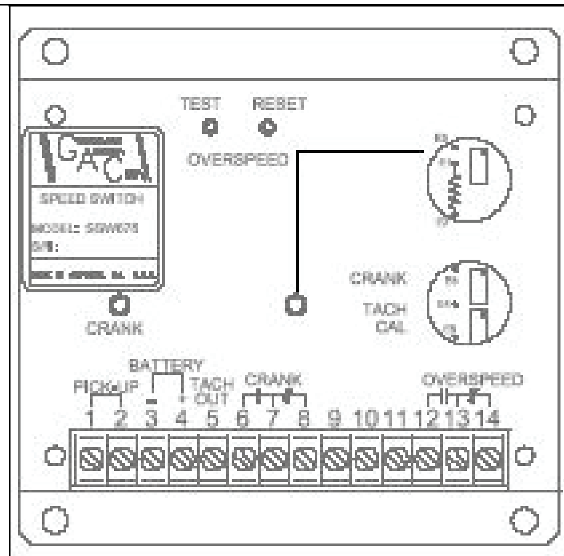
Overspeed Adjustment Procedure:

NOTE: Overspeed is already set at factory.

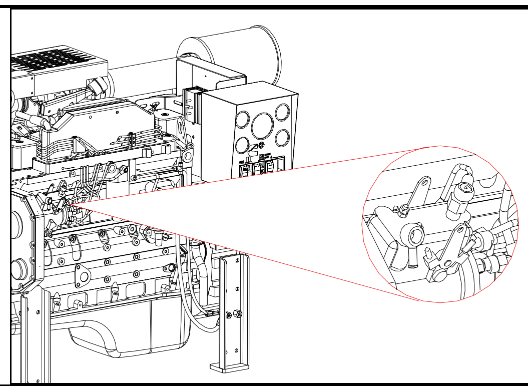
Resolve whether or not overspeed testing as per NFPA 20 is required. Verify that the overspeed is factory set for the specific speed (1760, 2100, 2360, 2600) as per the Factory Setting Tag.

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.



Move the throttle to the half throttle position. Start the engine and move the throttle to the minimum position.



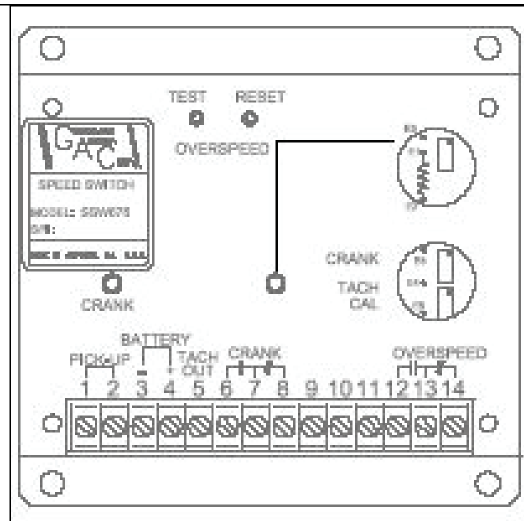
Initial Start-Up (Cont)

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

Depress the “TEST” button push-button on the inside of the panel.

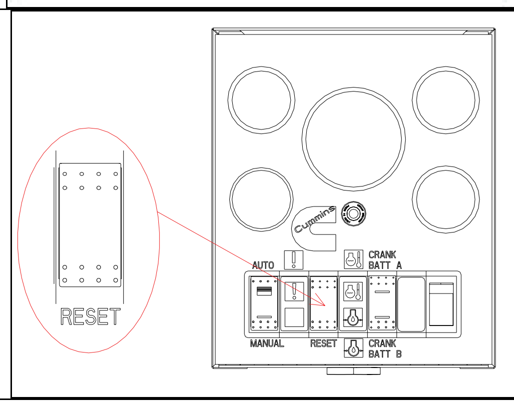
Turn the screw to increase speed.

Verify overspeed trip/indications.



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

Repeat if necessary to further adjust the overspeed stop setting.

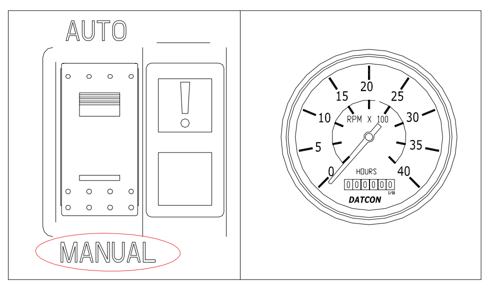


Start the engine.

Check operation at rated speed.

Shut off the engine.

Press the “AUTO” button so the fire pump will be ready to start automatically.



Completion

Support fire pump testing as per NFPA or applicable requirements.

Contact operating personnel responsible for fire protection system that engine is ready for service.

Obtain authorized signature of acceptance.

Initial Start

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.

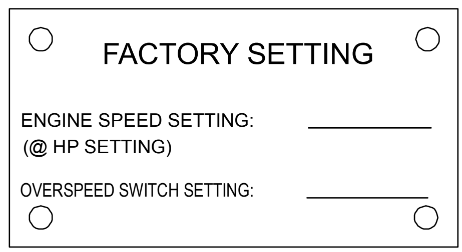
NOTE: If the engine still will not start, troubleshoot as per Engine Cranks But Will Not Start (No Exhaust Smoke) or Engine Difficult to Start or Will Not Start - Exhaust Smoke Present in Section 12.

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.

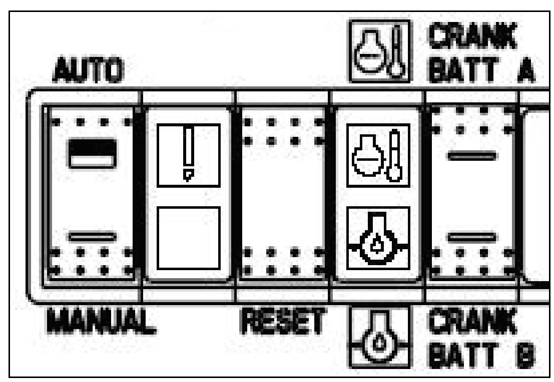
NOTE: Rated speed is displayed on the Factory Setting Tag described in Section 2.

NOTE: If the engine fully loaded, it should operate at rated speed. Unloaded, it may operate about 10% faster. If it becomes necessary to adjust the engine's actual speed to match the rated value, refer to Rated Speed Setpoint Adjustment in this section.



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

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



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.

Initial Start (Cont)

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).

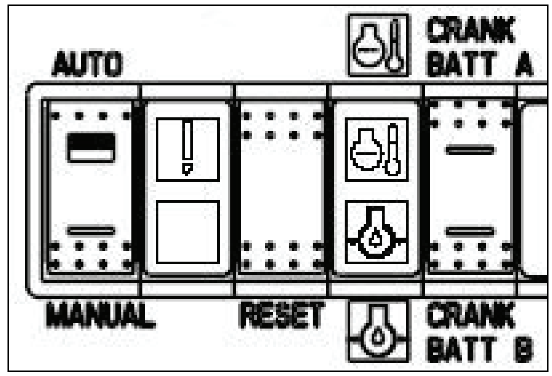
Check that raw water is flowing through the heat exchanger.

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.

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



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

Correct any problems found during the inspection before proceeding.

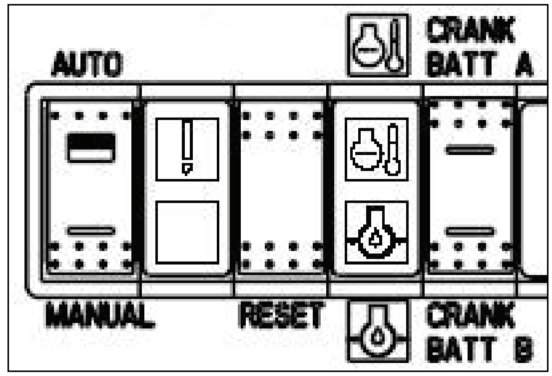
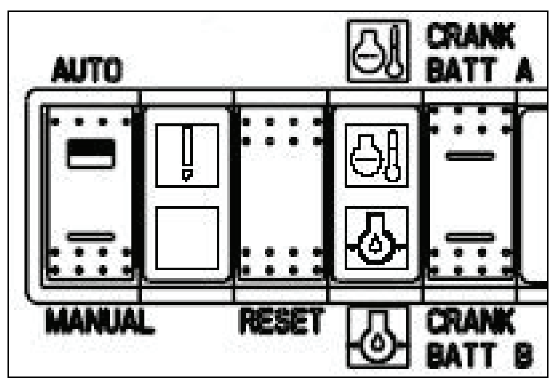
Check the engine lubricating oil level. Refer to Check Lubricating Oil Level in Section 5. Top off if necessary.

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

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

Second Start

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

NOTE: If required, adjust engine operating speed as per Rated Speed Setpoint Adjustment below. Start the engine using either the CRANK BATT A or the CRANK BATT B switch positions. Check that the engine starts and operates at about rated speed.	
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. Check that the oil pressure is as specified in Lubricating Oil System Specifications in Section 10.	
NOTE: If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Troubleshooting, Section 12. Check that engine operating temperature stabilizes between about 82 and 95^{o}C [180 and 203^{o}F].	
Stop the engine by pressing the AUTO position on the AUTO/MANUAL rocker switch and by momentarily pressing the RESET switch.	

Second Start (Cont)

Correct any problems found before proceeding.

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

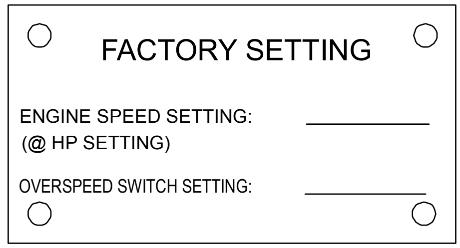
Check the coolant heat exchanger's coolant level. Refer to Check Coolant Level in Section 5. Top off if necessary.

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

Rated Speed Setpoint Adjustment

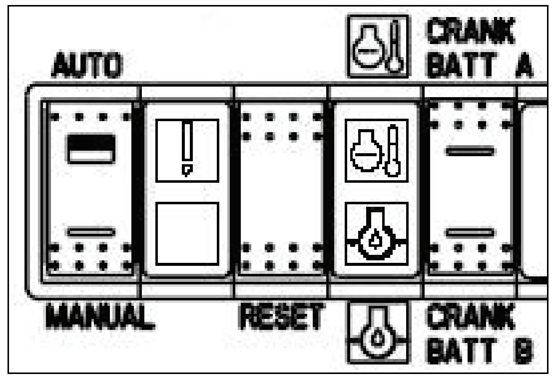
NOTE: If required, use this section to adjust the normal operating speed to the nameplate value.

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



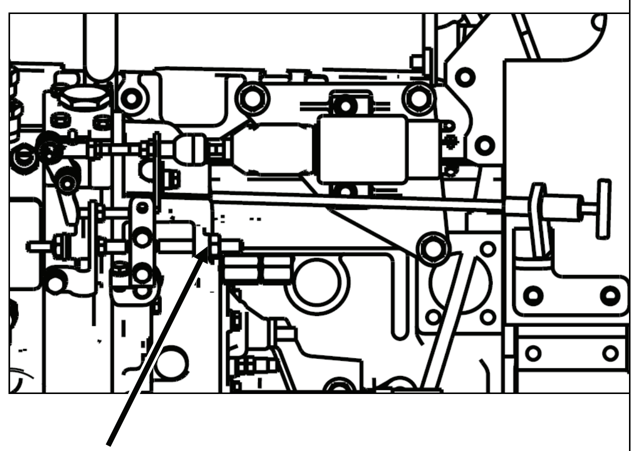
Start the engine.

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



Adjust the speed setpoint to rated speed.

NOTE: Rated speed is adjusted by locating the threaded bolts on each side of the throttle bracket on the fuel pump side of the engine.



Rated speed adjustment

To increase the speed, turn the bolt clockwise on the right side of the throttle bracket. The adjustment of the bolt will pivot the throttle bracket counter-clockwise and will allow more fuel through the pump to speed up the engine.

The bolt on the left side of the bracket is for maximum speed and may also need to be adjusted if maximum speed cannot be reached.

Rated Speed Setpoint Adjustment (Cont)

To increase the speed, turn the bolt clockwise on the right side of the throttle bracket. The adjustment of the bolt will pivot the throttle bracket counter-clockwise and will allow more fuel through the pump to speed up the engine. The bolt on the left side of the bracket is for maximum speed and may also need to be adjusted if maximum speed can not be reached. Loosen lock nut and turn bolt counter-clockwise to increase the speed. When rated speed is correct, tighten lock nut against stop. To decrease the speed, turn the bolt counter-clockwise on the right side of the throttle bracket. The adjustment of the bolt will pivot the throttle bracket clockwise and will allow less fuel to flow through the pump to slow down the engine. When rated speed is correct, tighten the locking nuts against the stops.
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

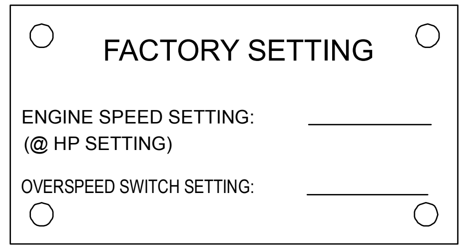
Overview

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.



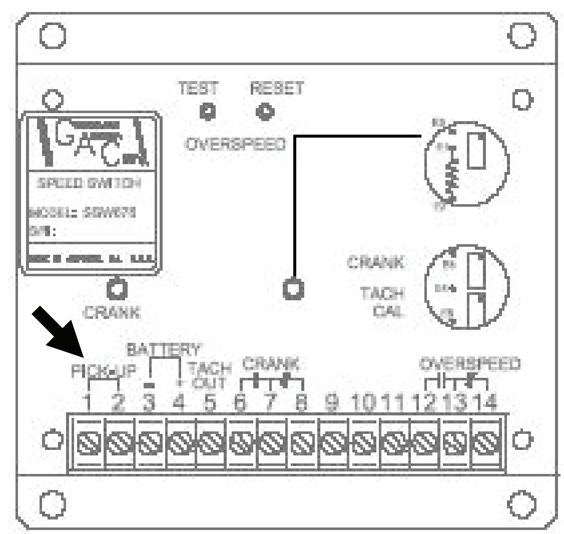
Adjust the Speed Switch:

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

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

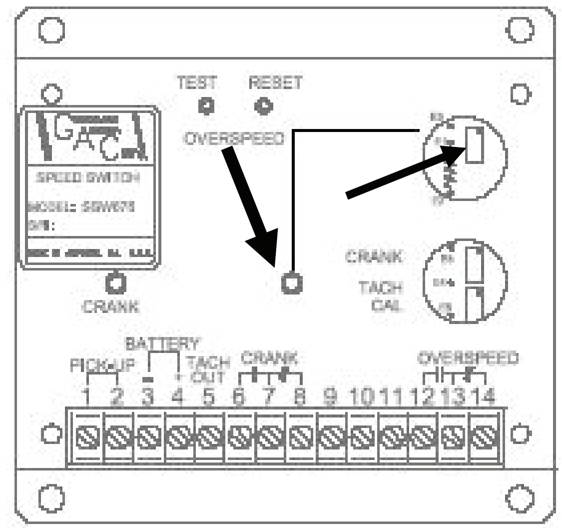
Connect a signal generator capable of providing between 0.25 to 120 VAC RMS signal to the switch. The signal must be proportional to the engine's rated speed.

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.

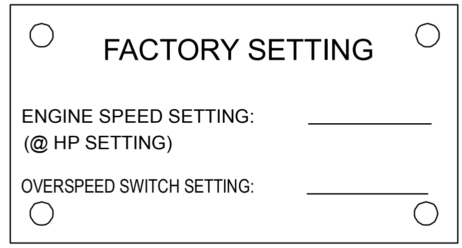
Reconnect the speed sensor input.

Perform the following <u>Test Procedure</u> to check the effect of the adjustment.

Overspeed Setpoint Adjustment and Testing (Cont)

Test Procedure

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



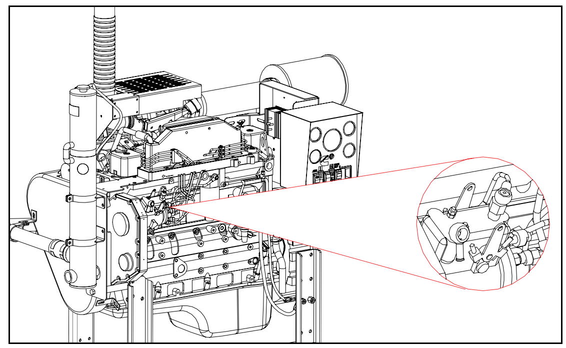
Start the engine.

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

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

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

Adjust the mechanical throttle adjustment to increase engine speed to the setpoint.



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

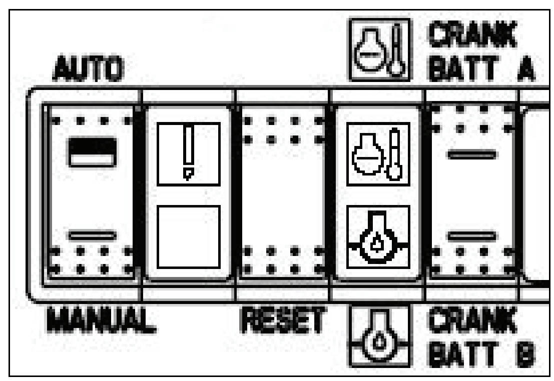
Verify that the engine tripped at a speed between 115 and 120% of rated speed.

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.



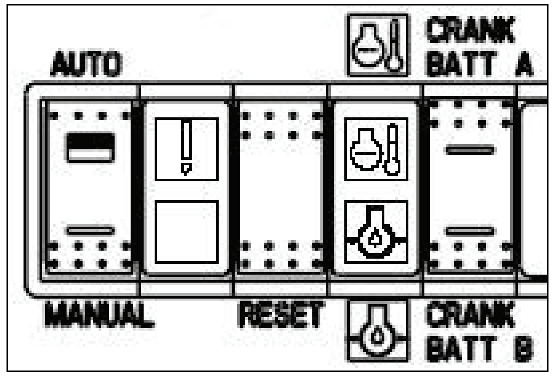
Overspeed Setpoint Adjustment and Testing (Cont)

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

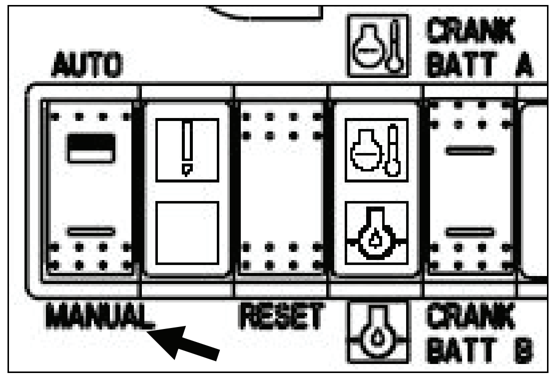
NOTE: The crank terminate signal to the remote fire pump controller informs the controller that the engine has started. This allows the controller to terminate the selected crank signal to the engine. This crank terminate signal is produced by the overspeed switch in the engine's local control panel.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

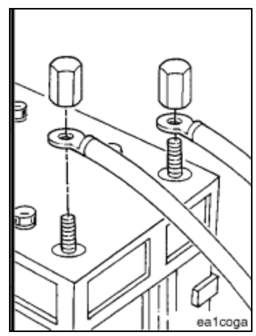


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.

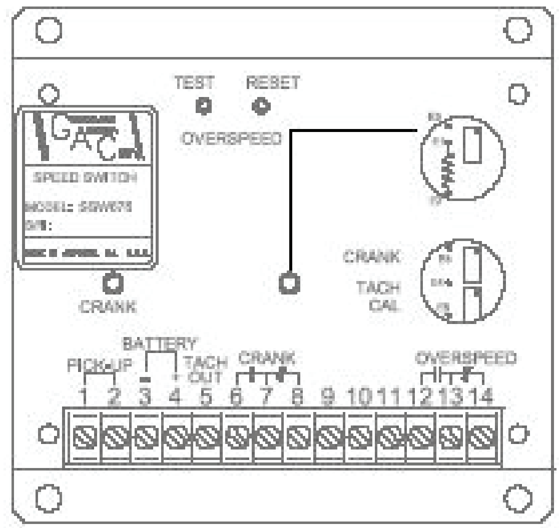
Connect a signal or pulse generator to the switch inputs with the same signal polarity.

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.

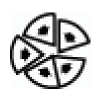


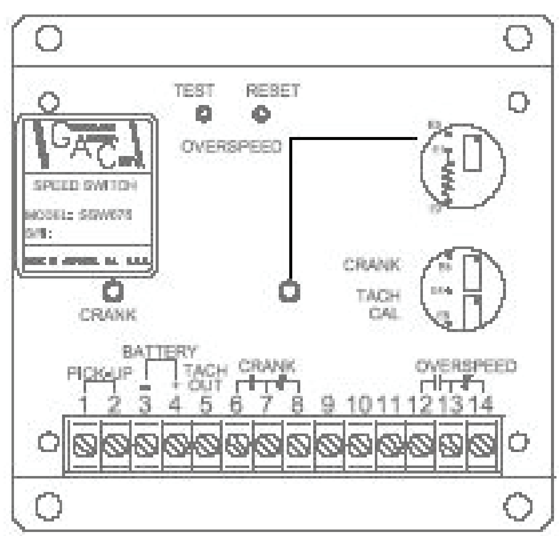
Replace the cover on the speed switch.

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.



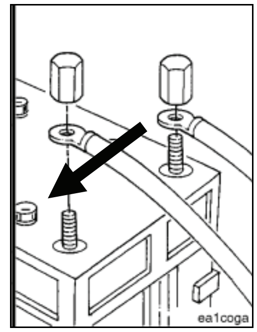


Crank Terminate Adjustment and Testing (Cont)

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.

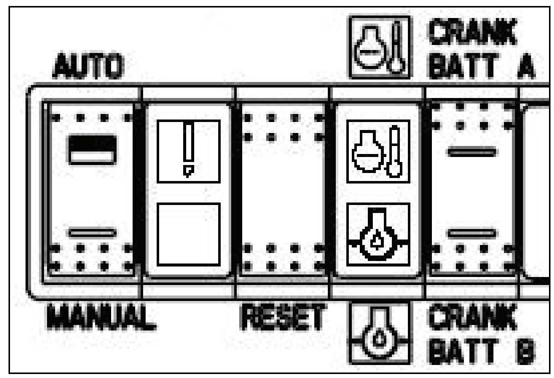
Observe that the CRANK terminal LED on the speed switch is illuminated.

Check that the local digital voltmeter indicates the 12 VDC (standard) or 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.

Integrated Acceptance Testing

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

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

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

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

Complete the Cummins Fire Power Start-Up Inspection (SUI) Checklist. This is available on the Cummins 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.

CAUTION

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

Position the fuel shutoff, electrical switch, or mechanism control to the run position.

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.

Move the throttle position to idle as soon as the engine starts.

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

When starting a cold engine, increase the engine speed (rpm) slowly to make sure adequate lubrication is available to the bearings.

CAUTION

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

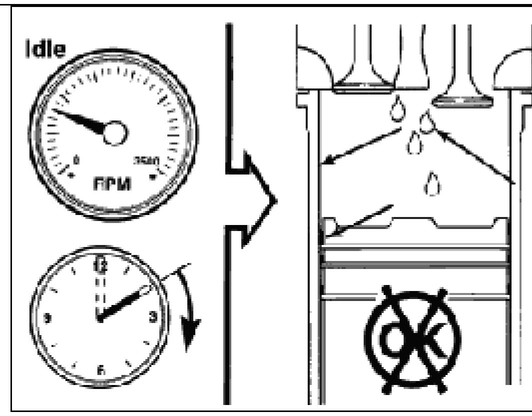
Engines used in fire pumps or standby service are expected to transition from crank to full load within a short period of time.

WARNING

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

CAUTION

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



WARNING

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

Normal Local Starting Procedure

Overview

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

Local Starting Procedure for Testing

CAUTION

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

Start the Engine

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

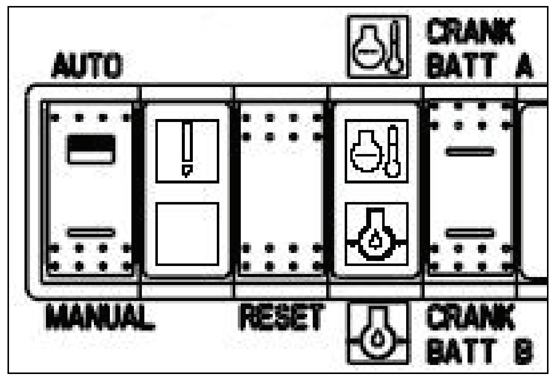
Observe the battery voltages displayed on the engine control panel. Use the battery with the highest indicated voltage.

NOTE: Depress the selected switch 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.

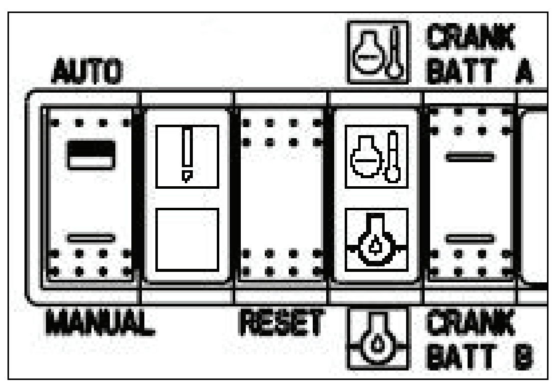
NOTE: If the engine does not start after three attempts, check the fuel supply system. Absence of blue or white exhaust smoke during cranking indicates no fuel is being delivered.

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.

CAUTION

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

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

Manually position the fuel pump at mid throttle position.

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

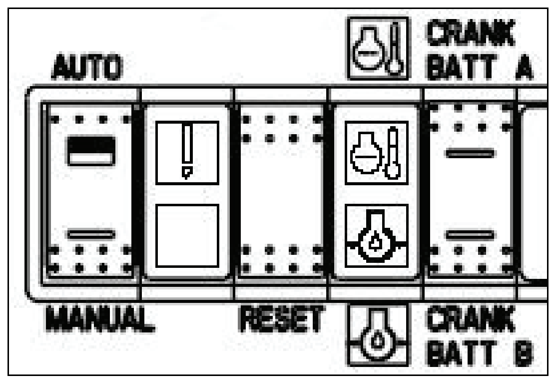
CAUTION

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

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

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

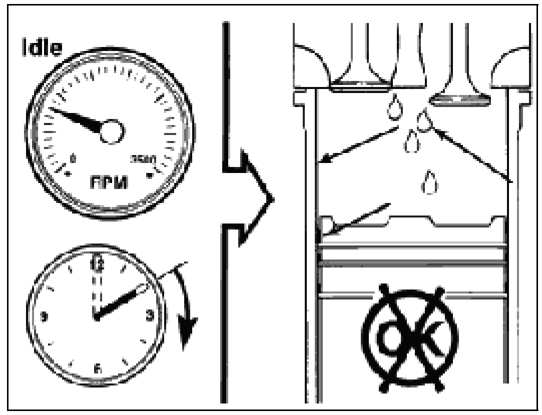
Engine oil pressure must be indicated on the gauge within 15 seconds after starting.



Normal Local Starting Procedure (Cont)

CAUTION

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



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

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

Adjust the engine to operate at rated speed as per 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 N Power, check the state of charge by the measurement of battery cell specific gravity. Refer to Battery Testing in Section 7 for more information.

WARNING

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

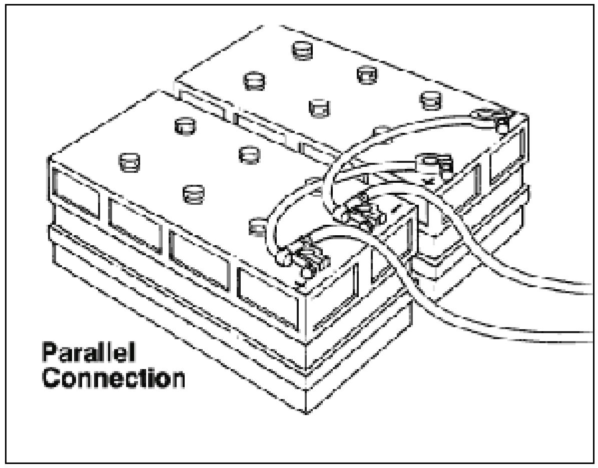
CAUTION

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

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

Use this type of connection to jump start the engine.

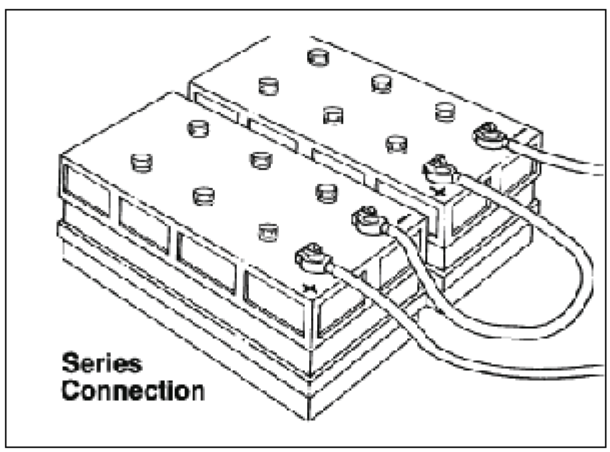
For a 24 VDC system, two or more 12 VDC batteries are connected in the parallel connection as shown. If jumpering a 24 VDC battery setup, another 24 VDC battery pair is required as the source.



The accompanying illustration shows a typical series battery connection.

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

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



Operating the Engine

Monitor Operating Values Frequently

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

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

CAUTION

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

Verify raw water coolant pressure and flow.

Monitor Engine Condition Periodically

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

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

Emergency Manual Starting Procedures

Overview

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

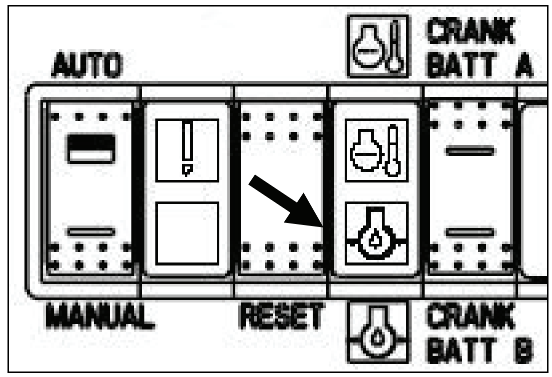
Additionally, manual means are available to start the engine in the event of some local failures. This procedure requires the manual operation of the raw water valves and the use of the manual starting lever on either of the two starting solenoids.

Use the following procedures as specified:

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

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

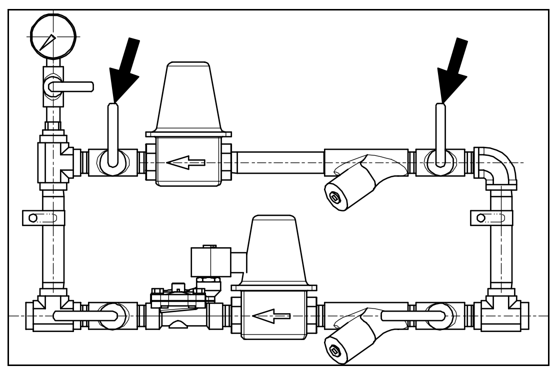
Also, if the fuel shutoff valve is known to be faulted, attempt an Emergency Manual Mode Non-Electrical Start.



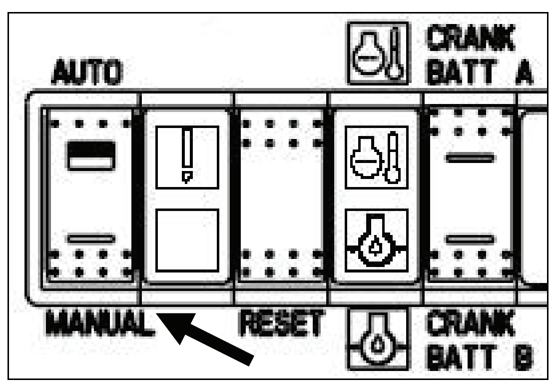
Emergency Manual Mode Electrical Start

Starting the Engine

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



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



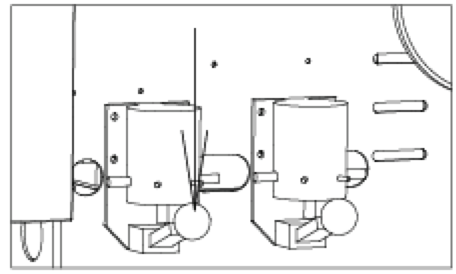
Emergency Manual Starting Procedures (Cont)

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

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

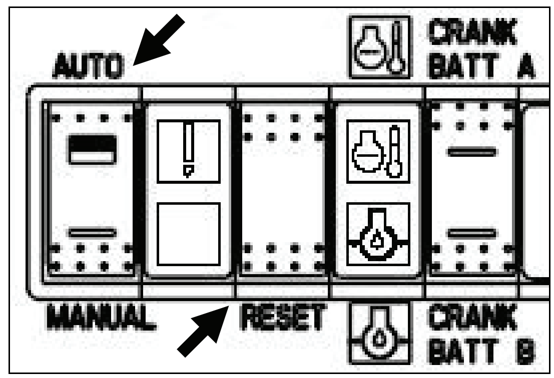
When the engine starts, release the lever.

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



Stopping the Engine

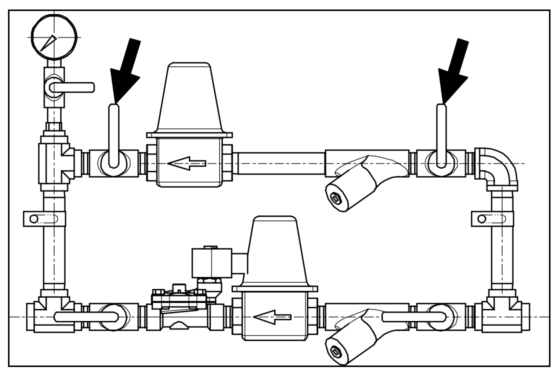
When emergency operation is done, stop the engine by pressing the AUTO position on the AUTO/MANUAL rocker switch and then press the RESET switch.



Emergency Manual Mode Non-Electrical Start (CFP33-F10, F20, F30 only)

Starting the Engine

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

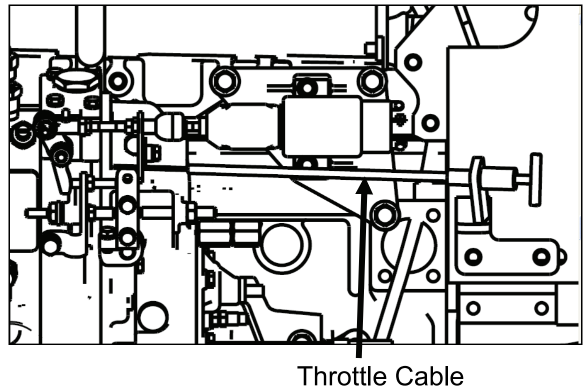


Emergency Manual Mode Non-Electrical Start (CFP33-F10, F20, F30 only) (Cont)

Throttle cable assembly is provided to allow the operator to start the unit in manual mode.

The Throttle cable assembly is located on the fuel pump side of the engine and has a pull handle that is attached to the fuel pump lever which activates the fuel solenoid shut-off (FSO).

The throttle cable assembly is factory installed and is securely fastened to the fuel pump lever in position shown to allow engine to run in closed/automatic mode.

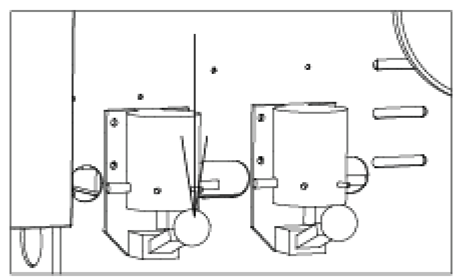


In the event the automatic start is not operational, pull on the throttle handle assembly which will move the lever to the run position to start the engine.

Turn handle assembly to lock throttle cable assembly in position to allow the engine to run in manual mode.

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

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



Stopping the Engine

Once engine is operational in automatic mode, be sure to retract the throttle cable to the closed or automatic position to allow the engine to start in automatic mode.

NOTE: If throttle cable assembly does not retract to correct closed position, manually push the lever to the closed or automatic position and adjust the throttle cable assembly so that when activated, it opens and closes the FSO lever accordingly.

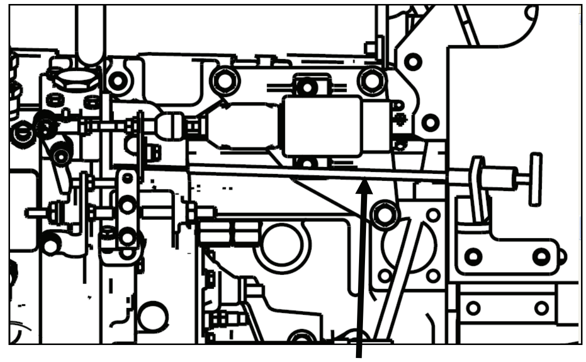
Periodic inspection of the throttle cable assembly is recommended.

Emergency Starting in Automatic Mode with Failed Fuel Shut-Off Solenoid (CFP33-F10, F20, F30 only)

Throttle cable assembly is provided to allow the operator to start the unit in manual mode.

The Throttle cable assembly is located on the fuel pump side of the engine and has a pull handle that is attached to the fuel pump lever which activates the fuel solenoid shut-off (FSO).

The throttle cable assembly is factory installed and is securely fastened to the fuel pump lever in position shown to allow engine to run in closed/automatic mode.



In the event the Fuel Shut-off Solenoid has failed, pull on the throttle handle assembly which will move the lever to the run position to start the engine.

Turn handle assembly to lock cable assembly in position to allow the engine to run.

Stopping the Engine

Retract the throttle cable to the closed or automatic position to allow the engine to stop.

Once engine is operational and fuel solenoid has been replaced, the cable assembly to be restored in the closed or automatic mode. The engine is now ready to run in automatic mode.

NOTE: If throttle cable assembly does not retract to correct closed position, manually push the lever to the closed or automatic position and adjust the throttle cable assembly so that when activated, it opens and closes the FSO lever accordingly.

Periodic inspection of the throttle cable assembly is recommended.

Starting Procedure - After Extended Shutdown or Oil Change

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

Bump the engine. Refer to <u>Pre-Lubricate the Engine</u> in this section.

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

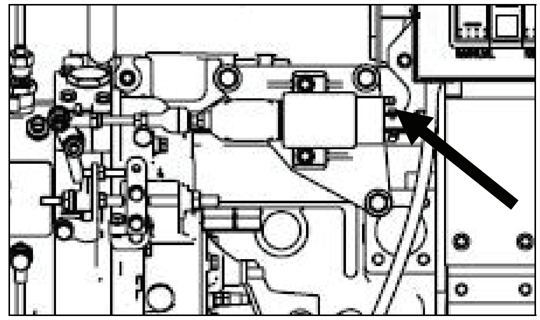
Start the engine. Refer to <u>Normal Local Starting Procedure</u> in this section.

If required, vent the fuel system. Refer to <u>Air in Fuel</u> in Section 7.

Emergency Manual Stopping Procedure

Disconnect the connector at the electric fuel solenoid (Fuel Shutoff Valve).

Reconnect the connector after the engine as stopped.



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Section 4 - Maintenance Guidelines

Section Contents

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Overview

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

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

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

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

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

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

Tool Requirements

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

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

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

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

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

Maintenance Schedule

Activity (as per engine specifications)			Trimonthly													
	Daily	Weekly	1	2	3	4	5	6	7	8	9	10	11	12	Procedure #	Page #
Check Air Intake Filter and Piping.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1	5-4
Check Coolant Level	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	5-4
Check Crankcase Breather Tube	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3	5-5
Check Lubricating Oil Level	x	x	x	x	x	x	x	x	x	x	x	x	x	x	4	5-6
Drain Fuel-Water Separator	x	x	x	x	x	x	x	x	x	x	x	x	x	x	5	5-7
Check Coolant Heat Exchanger Piping	x	x	x	x	x	x	x	x	x	x	x	x	x	x	7	5-8
Check Coolant Heater Piping	x	x	x	x	x	x	x	x	x	x	x	x	x	x	8	5-8
Bleed Fuel Tanks		x	x	x	x	x	x	x	x	x	x	x	x	x	9	5-9
Clean Raw Water Strainers		x	x	x	x	x	x	x	x	x	x	x	x	x	10	5-9
Check Battery Condition		x	x	x	x	x	x	x	x	x	x	x	x	x	11	5-9
Test Run Engine		x	x	x	x	x	x	x	x	x	x	x	x	x	12	5-10
Check Hose Condition			x	x	x	x	x	x	x	x	x	x	x	x	13	5-12
Check Engine Coolant Heater			x	x	x	x	x	x	x	x	x	x	x	x	14	5-12
Inspect Heat Exchanger Zinc Plug			x	x	x	x	x	x	x	x	x	x	x	x	15	5-12
Inspect Electrical Components			x	x	x	x	x	x	x	x	x	x	x	x	16	5-13
Check Turbochargers Mounting Nuts			x	x	x	x	x	x	x	x	x	x	x	x	17	5-13
Check Engine Mounting Bolts			x	x	x	x	x	x	x	x	x	x	x	x	18	5-13
Check Cooling System Condition			x	x	x	x	x	x	x	x	x	x	x	x	19	5-14
Check Air Cleaner Service Indicator			x	x	x	x	x	x	x	x	x	x	x	x	20	5-14
Inspect Air Intake System Piping			x	x	x	x	x	x	x	x	x	x	x	x	21	5-15
Check Fuel Pump															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
Lubrication of Output Shafts															26	5-21
Drain and Flush Cooling System				x		x		x		x		x		x	27	5-22
Change Coolant Filter				x		x		x		x		x		x	28	5-26
Vent Fuel Supply Lines				x		x		x		x		x		x	29	5-28
Vent Injection Pump				x		x		x		x		x		x	30	5-30
Check Overspeed Switch Operation						x				x				x	31	5-31
Check Drive Belt, Tensioner Bearing and Belt Tension						x				x				x	32	5-31
Adjust Valve Lash Clearance						x				x				x	33	5-37
Inspect Turbocharger										x					34	5-39
Inspect Vibration Damper										x					35	5-41
Inspect Water Pump										x					36	5-41
Engine Steam Cleaning															37	5-41
Inspect Overhead Set															38	5-42

Refer to Maintenance Procedures in Section 5 for instructions.

Maintenance Record Form

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

Section 5 - Maintenance Procedures

Section Contents

Page

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DAILY

General Information

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

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

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

Engine Operation Report

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

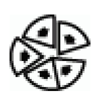
Comparison and intelligent interpretation of the daily report, along with a practical follow-up action, will eliminate most failures and emergency repairs.

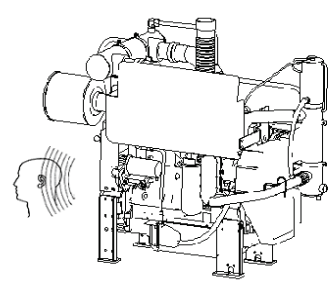
Report to the maintenance department any of the following conditions:

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

Unusual Engine Noise

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





Procedure 1 — Check Air Intake Filter and Piping

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

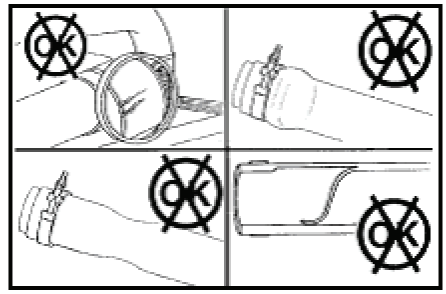
Replace damaged air filter or pipes, and tighten loose clamps, as necessary, to prevent the air system from leaking. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.

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

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

Torque loosened clamps.

Torque Value: 8 N•m [72 in-lb]



Procedure 2 — Check Coolant Level

WARNING

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

CAUTION

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

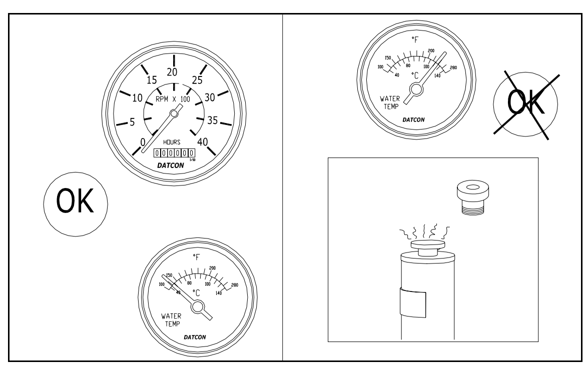
CAUTION

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

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

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

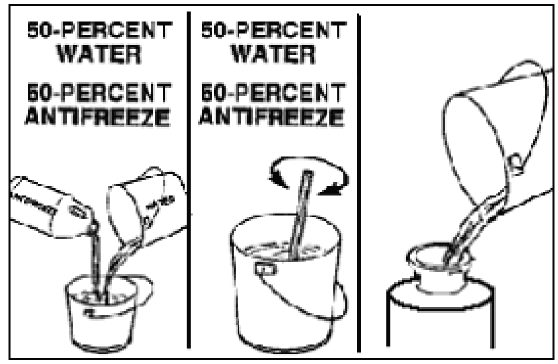
Check coolant level.



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

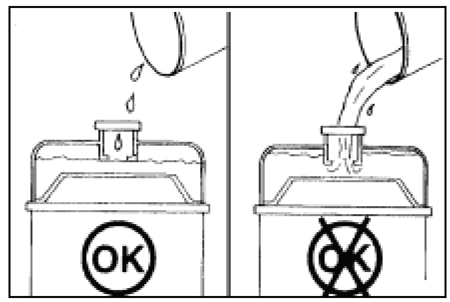
Coolant specifications can be found in Coolant Recommendations and Specifications in Section 7.

If required, prepare a coolant solution.



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

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

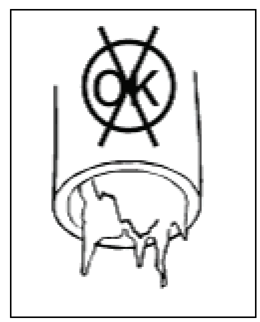


Procedure 3 **Check Crankcase Breather Tube**

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

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

Inspect the tube more frequently in icy conditions.

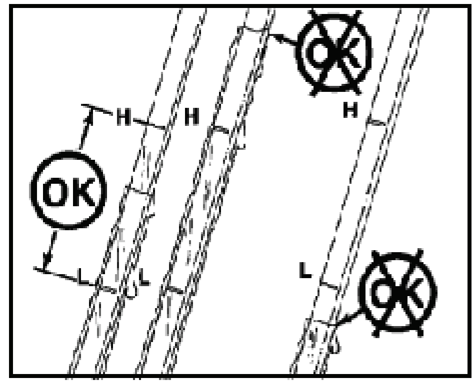


Procedure 4 **Check Lubricating Oil Level**

CAUTION

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

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



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

Check the oil level on the dipstick.

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

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

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

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

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

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

Procedure 5 Drain Fuel-Water Separator

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

WARNING

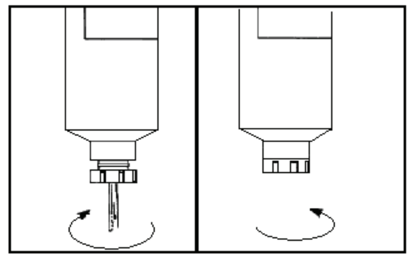
Drain the water-fuel separator into a container and dispose of in accordance with local environmental regulations.

Spin-on Type

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

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

Drain the filter sump until clear fuel is visible.



CAUTION

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

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

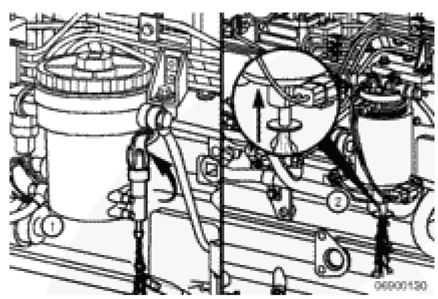
If required, refill the filter. Refer to Change Fuel Filter later in this section for removal and installation instructions.

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.

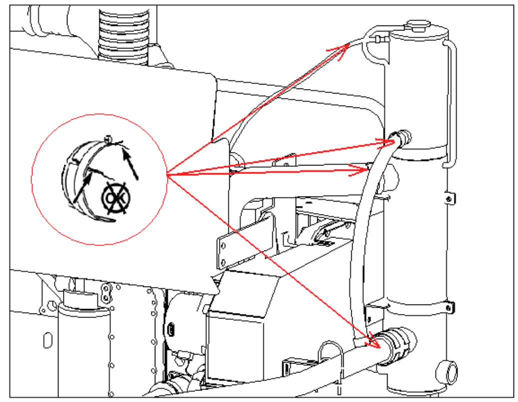
Push up on the drain valve until fluid drains out of the drain tube.



Procedure 6 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.

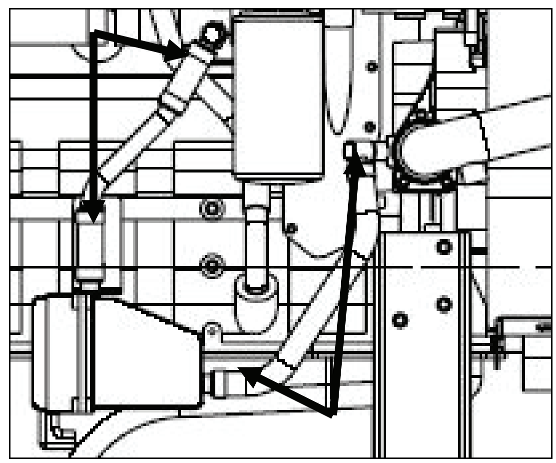
Replace damaged tubes, clamps, or pipes, and tighten loose clamps, as necessary, to prevent the coolant system from leaking. Refer to Adjustment, Repair and Replacement in Section 7 for replacement procedures.



Procedure 7 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 weekly checks:

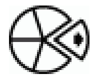
Procedure 8 — Bleed Fuel Tanks

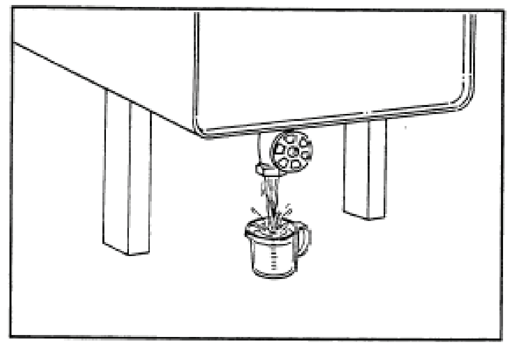
Loosen the fuel tank drain plug or open the drain valve.

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.





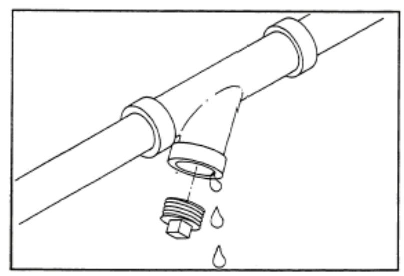
Procedure 9 — Clean Raw Water Strainers

For each raw water strainer, remove the plug.

Inspect and remove any debris.

Install the strainer plugs.

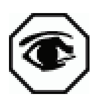
Unless otherwise directed, ensure that the bypass line valves are closed and the normal line valves are open.

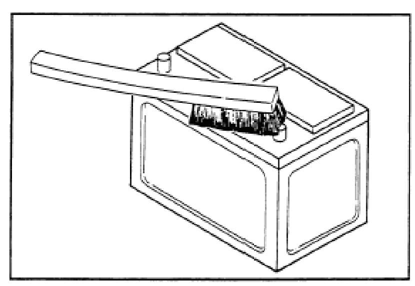


Procedure 10 — Check Battery Condition

Inspect the condition of the batteries.

Refer to Section 7 for inspection and maintenance procedures.



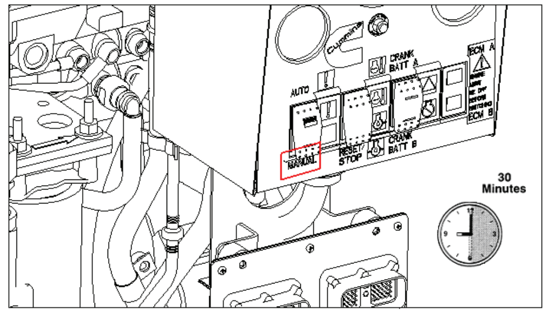


Procedure 11 **Test Run Engine**

Start Test Run

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

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

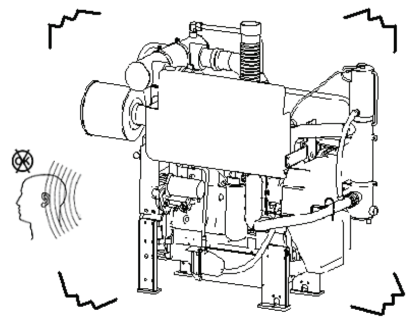


Check Unusual Engine Noise

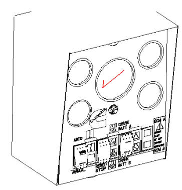
Run the engine no less than 30 minutes to attain normal running temperature.

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

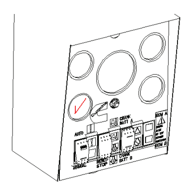
Check running indications.



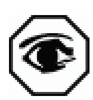
Observe that the engine is operating at test speed as follows:

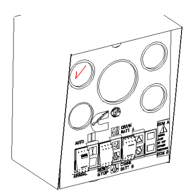


Check oil pressure greater than 10 PSI.

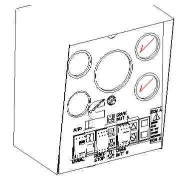


Check coolant temperature between 140°F and 212°F.

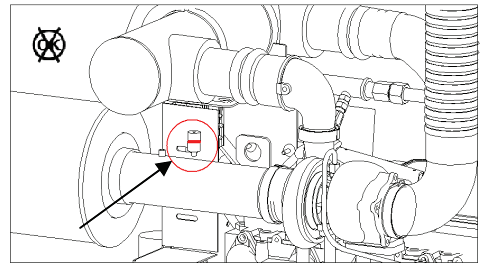




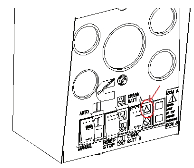
Check that both battery voltmeters indicate 12 VDC standard (24 VDC optional) depending upon the application.



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

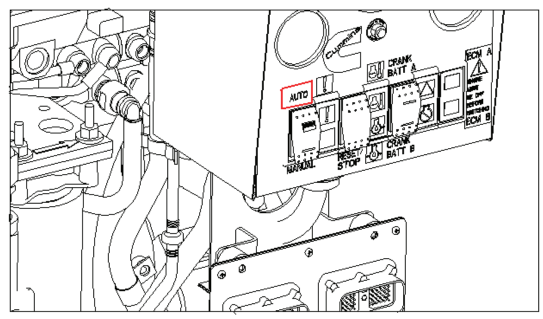


Check that the Fuel Injection Failure (F.I.F.) light is not turned on.



End Test Run

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



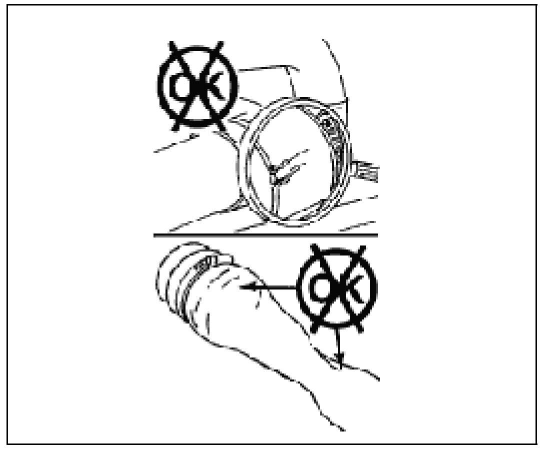
Every Three Months or 250 Hours

General Information

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

Procedure 12 — 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.

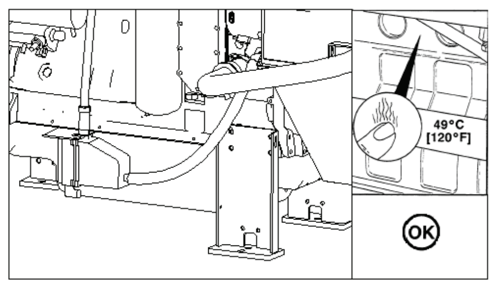


Procedure 13 — Check Engine Coolant Heater

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.

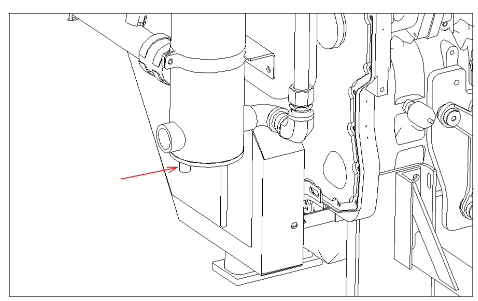
If the heater does not appear to be working correctly, contact a Cummins Authorized Repair Location.



Procedure 14 — Inspect Heat Exchanger Zinc Plug

Remove the zinc plug.

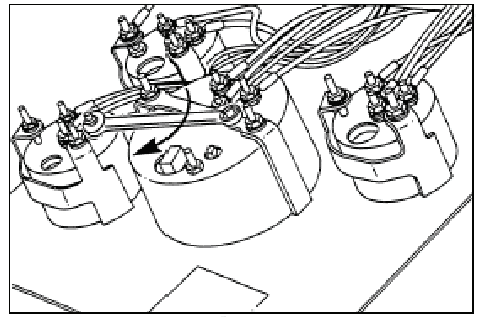
Inspect the plug. If it has eroded over 50 percent, replace the plug (Cummins Fire Power Part No. 9750) and brass fitting (Cummins Fire Power Part No. 9751).



Procedure 15 — Inspect Electrical Components

Clean and tighten any loose electrical connections.

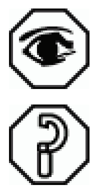
Follow the manufacturer's recommended procedures for servicing the electrical components and batteries.

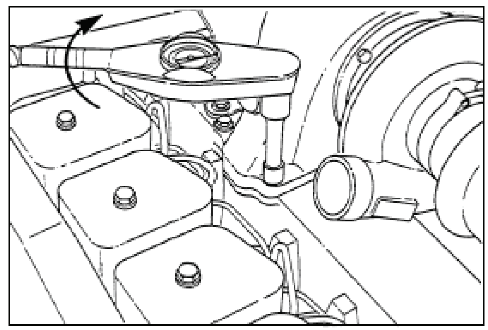


Procedure 16 — Check Turbocharger Mounting Nuts

Check the turbocharger mounting nuts. Tighten the mounting nuts.

Torque Value: 65 N•m (50 ft-lb)





Procedure 17 — Check Engine Mounting Bolts

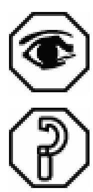
CAUTION

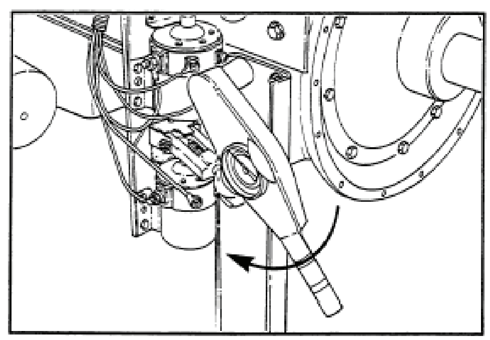
Damaged engine mounts and brackets can cause engine misalignment. Driveline component damage can result in vibration complaints.

Inspect all rubber-cushioned mounts for cracks or damage.

Inspect all mounting brackets for cracks or damaged bolt holes.

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





Procedure 18 Check Cooling System Condition

WARNING

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

Supplemental Coolant Additive(SCA)

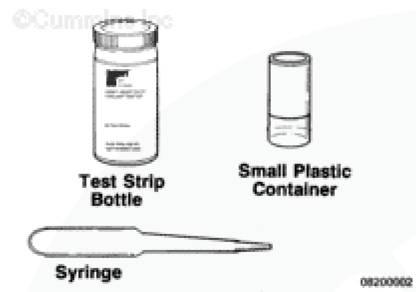
Check the SCA concentration level:

~At least twice a year

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

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

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



Antifreeze

CAUTION

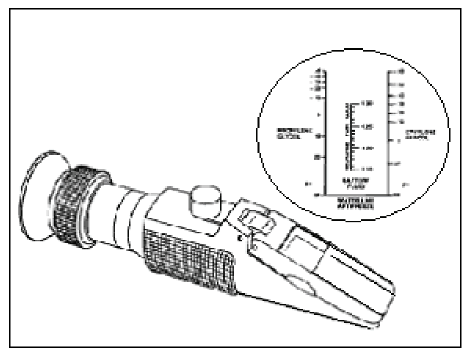
Over concentration of antifreeze or use of high-silicate antifreeze can damage the engine.

Check the antifreeze concentration.

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

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

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



Procedure 19 Check Air Cleaner Service Indicator

CAUTION

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

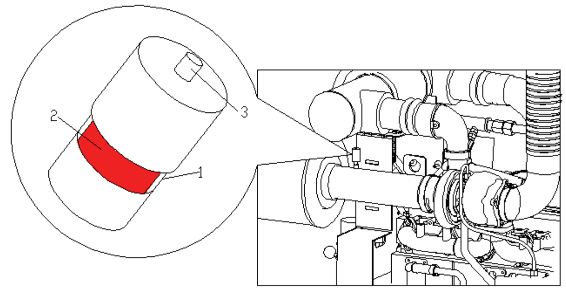
Maximum intake air restriction is 762 mm H2O [30.0 in H2O] for turbocharged engines.

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

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

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

Check the air cleaner service indicator, if equipped.



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

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

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

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

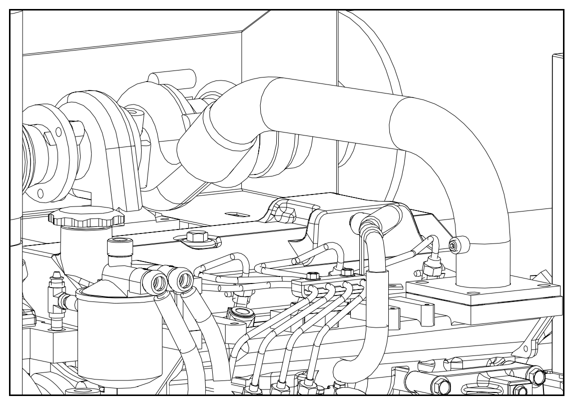
Procedure 20 Inspect Air Intake System Piping

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.

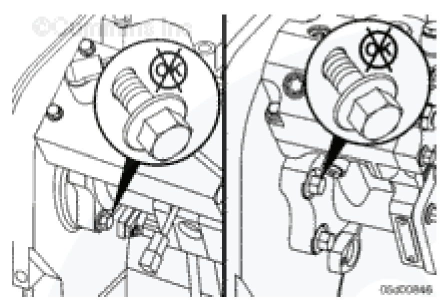
Check for corrosion of the intake system piping under the clamps and hoses. Corrosion can allow corrosive products and dirt to enter the intake system.

Disassemble and clean as required.



Procedure 21 Check Fuel Pump

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



Procedure 22 **Change Lubricating Oil and Filters**

WARNING

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

WARNING

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

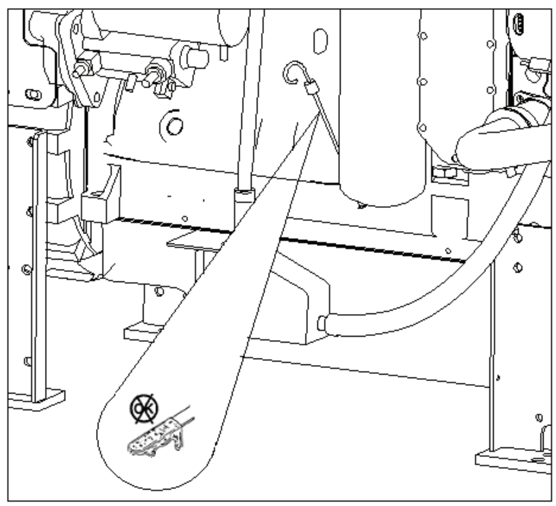
WARNING

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

CAUTION

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

Lubricating Oil and Filter Change Interval



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

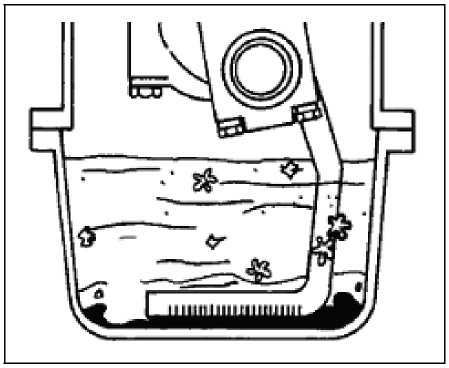
The oil change interval for turbocharged engines is every 3 months or 250 hours. Change the oil and the filters to remove the contaminants suspended in the oil.

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

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

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

Drain

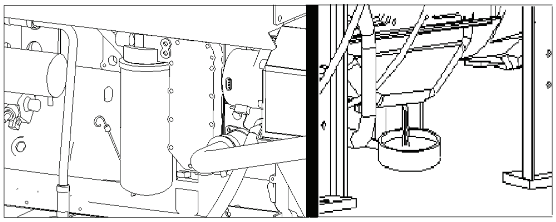


CAUTION

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

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

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

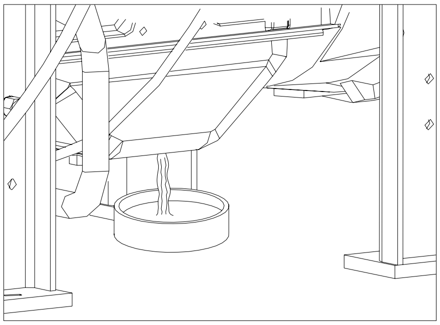


Change the oil and filters to remove the contaminants suspended in the oil.

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

CAUTION

Hot oil can cause personal injury.



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

Shut the engine off.

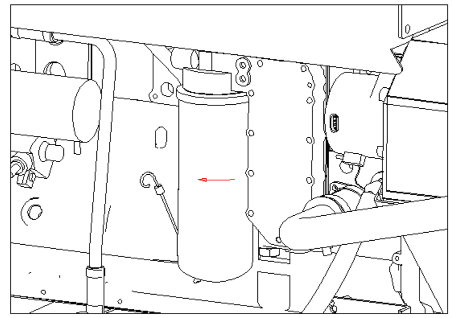
NOTE: Use a container that can hold at least 20 liters [21.1 qt] of oil.

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

Remove the oil drain plug.

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

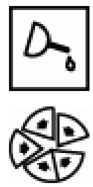
Remove

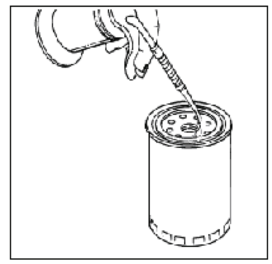


Clean the area around the lubricating oil filter head. Using an oil filter wrench, remove the filter. Clean the gasket surface of the filter head with a clean lint-free cloth.

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

Install





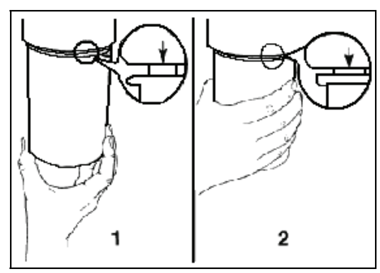
CAUTION

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

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

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

Fill the filter with clean 15W-40 oil.

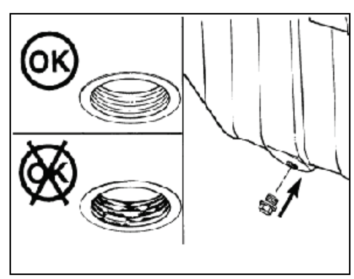


CAUTION

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

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

Install the filter as specified by the filter manufacturer.



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

Install the oil drain plug.

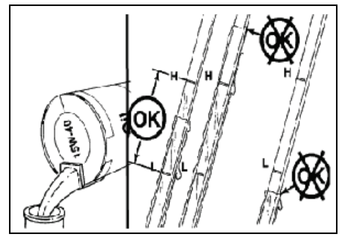
Torque Value: 50 N•m [37 ft-lb]

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

Fill the engine with clean oil to the proper level.

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

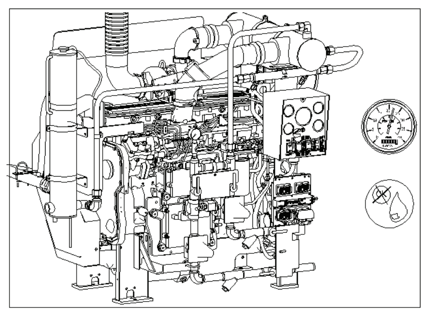
NOTE: When filling the oil pan, use the fill tube on the side of the engine rather than on top of the rocker lever cover.



WARNING

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

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

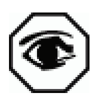


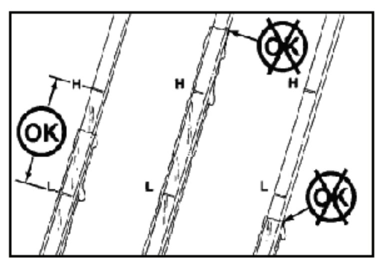
Stop the engine.

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

Check the oil level again.

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





Procedure 23 **Change Fuel Filter (Spin-on Type)**

WARNING

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

CAUTION

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

CAUTION

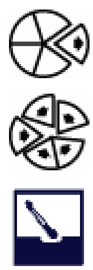
Mechanical overtightening can distort the threads as well as damage the filter element seal or filter canister.

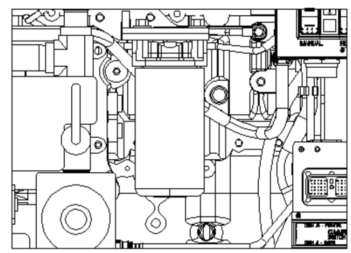
Remove

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

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

Replace the o-ring.

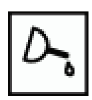


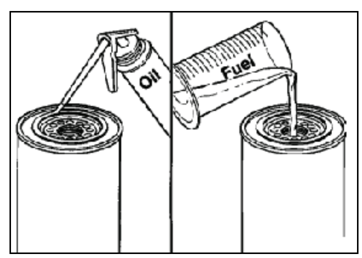


Install

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

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

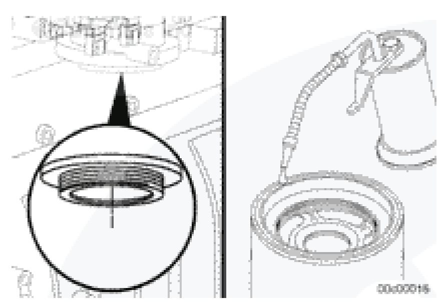




It will be necessary to fill the 10-micron water stripping (suction side) fuel filter with fuel.

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

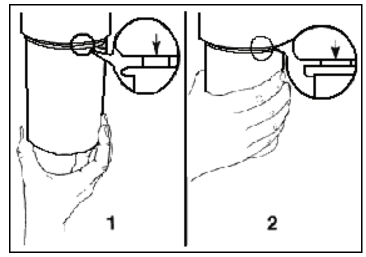
Be sure the center seal ring is installed onto the filter spud.



CAUTION

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

Install the filter as specified by the filter manufacturer.

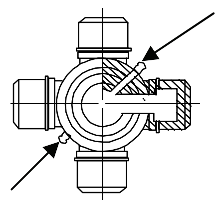


Finishing Steps

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

Procedure 24 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 25 Drain and Flush Cooling System

The cooling system must be clean to work correctly.

Drain the system and flush with clean water.

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

Drain

CAUTION

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

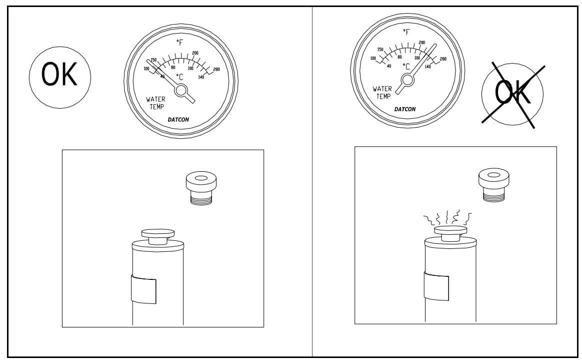
CAUTION

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

Avoid excessive contact - wash thoroughly after contact.

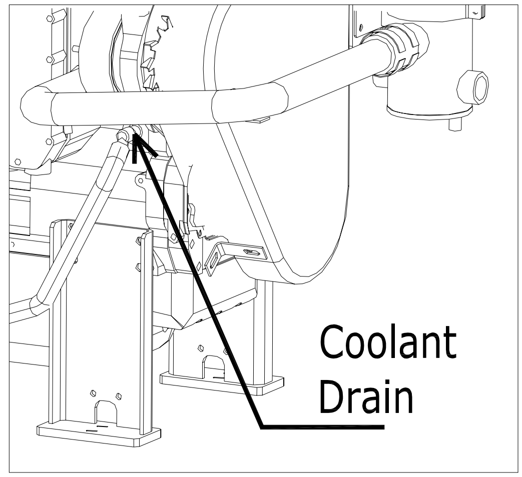
Keep out of reach of children.

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



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

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

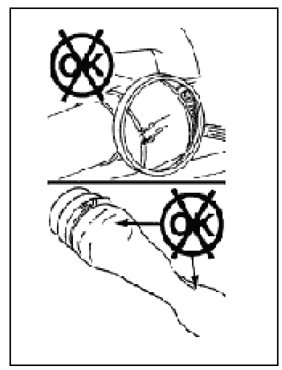


Check for damaged hoses and loose or damaged hose clamps.

Replace as required.

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

Clean and repair as required.

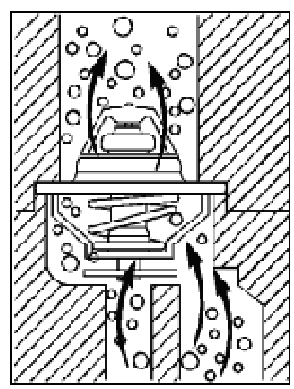


Flush

CAUTION

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

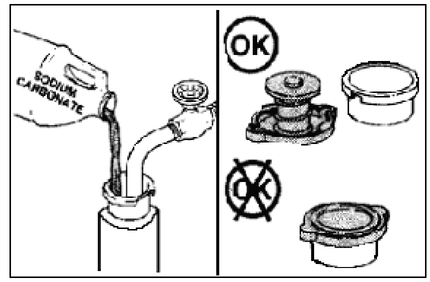
NOTE: Adequate venting is provided for a fill rate of 10 liters/minute [2.6 gal/min].



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

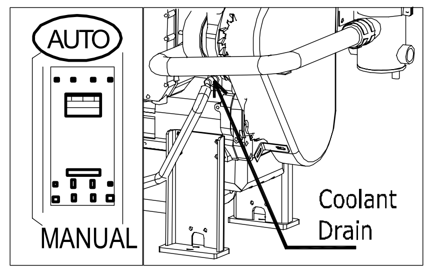
Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent).

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



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

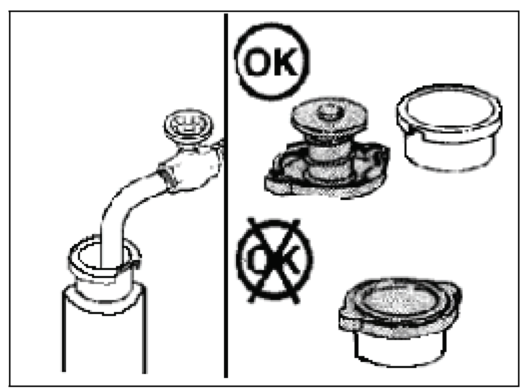
Shut the engine off, and drain the cooling system.



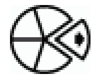
Fill the cooling system with clean water.

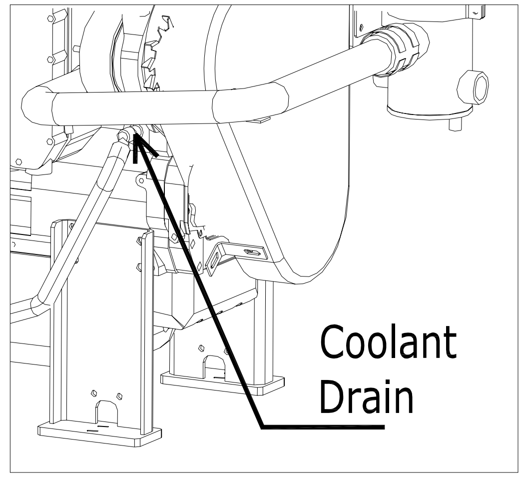
NOTE: Be sure to vent the engine and aftercooler for complete filling.

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



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



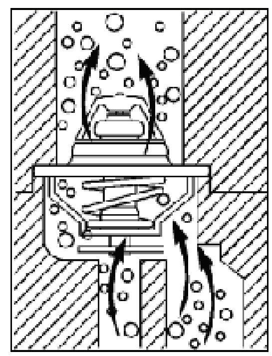


Shut the engine off.

Drain the cooling system.

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

Fill



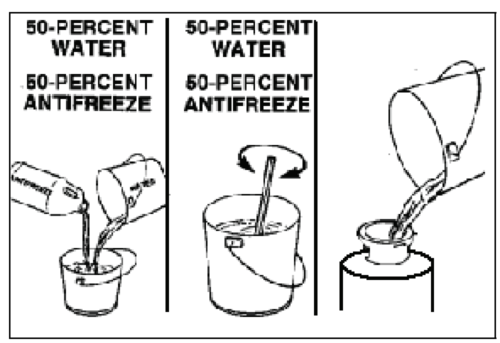
CAUTION

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

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

CAUTION

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

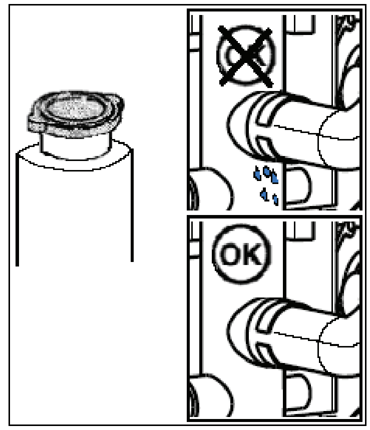


Use a mixture of 50-percent water and 50-percent ethylene glycol antifreeze to fill the cooling system.

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

WARNING

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



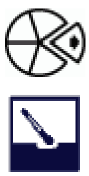
Install the pressure cap (Cummins Fire Power Part No 11407.).

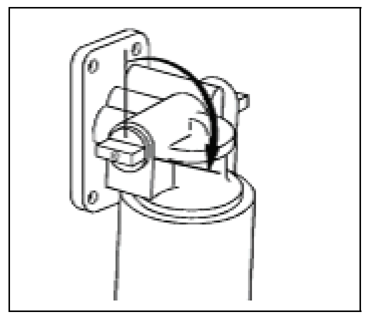
Operate the engine until it reaches a temperature of 82°C [180°F], and check for coolant leaks.

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

Procedure 26 Change Coolant Filter

Remove



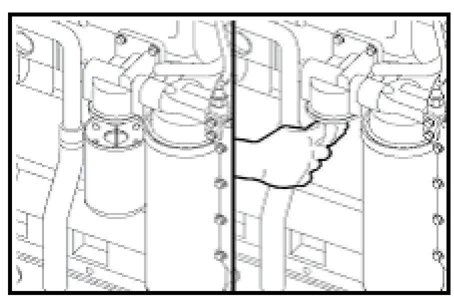


WARNING

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.

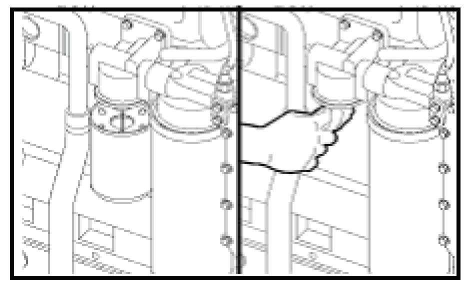
CAUTION

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

Remove and discard the coolant filter.

Clean

Clean the gasket surface.



Install

CAUTION

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

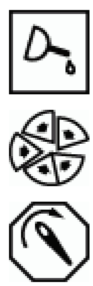
CAUTION

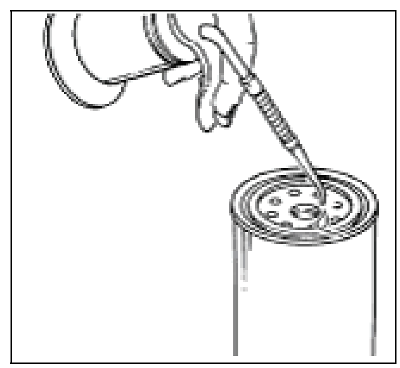
Mechanical over-tightening can distort the threads or damage the filter head.

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

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

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

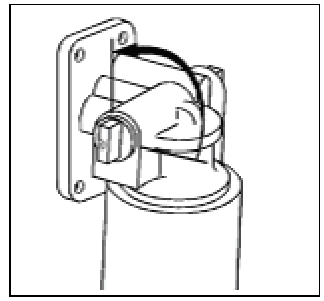




CAUTION

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

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



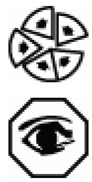
Test Run

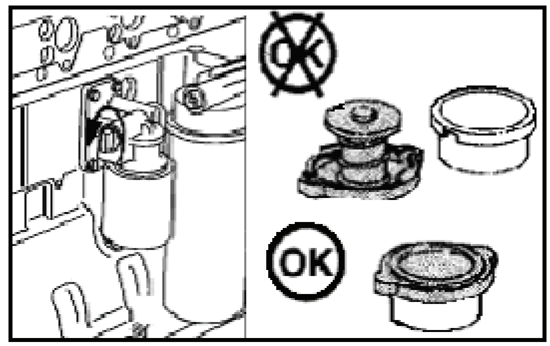
Install the coolant system pressure cap (Cummins Fire Power Part No. 11407).

Operate the engine.

Check for coolant leaks.

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





Procedure 27 **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.

Low Pressure Fuel Line(s)

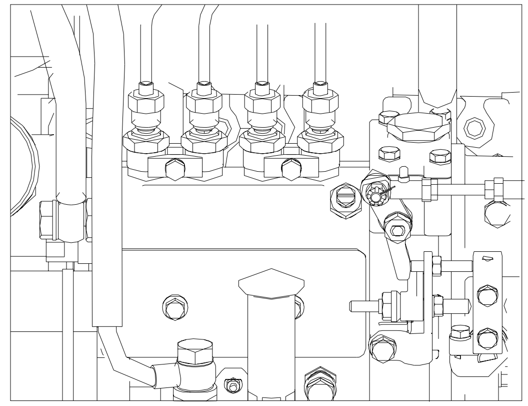
Open the vent screw.

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.

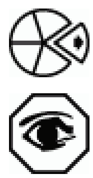


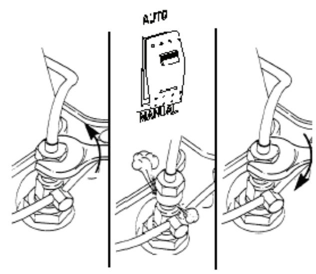
High Pressure Fuel Line(s)

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.

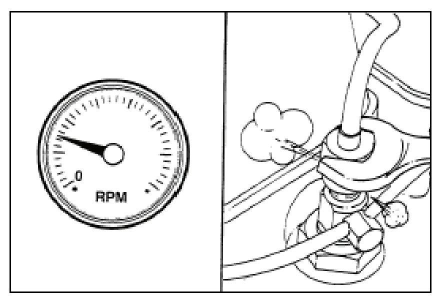




WARNING

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

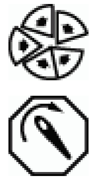
With the engine at idle, vent one line at the time until the engine runs smoothly.

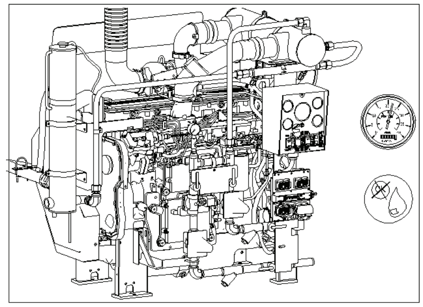


Retighten Line Fittings

Tighten the line fittings and check for leaks.

Torque Value: 22 N•m [16 ft-lb]



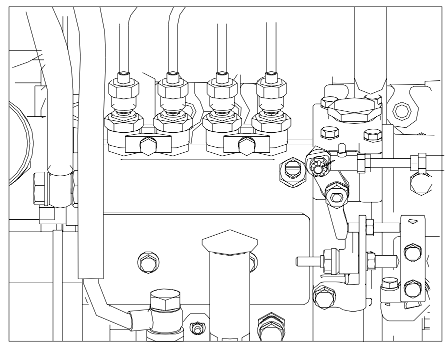


Procedure 28 — Vent Injection Pump

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

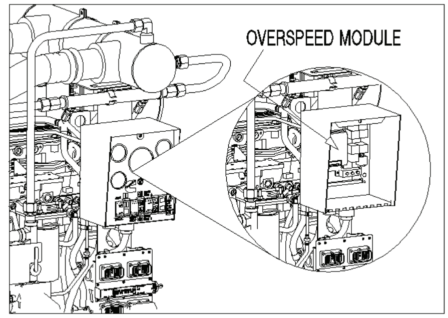
General Information

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 29 Check Overspeed Switch Operation

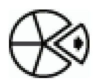
Check the overspeed switch for operation.

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

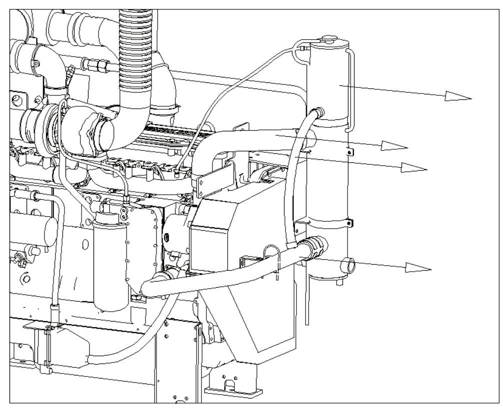


Procedure 30 Check Drive Belt, Tensioner Bearing and Belt Tension

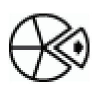
Inspect

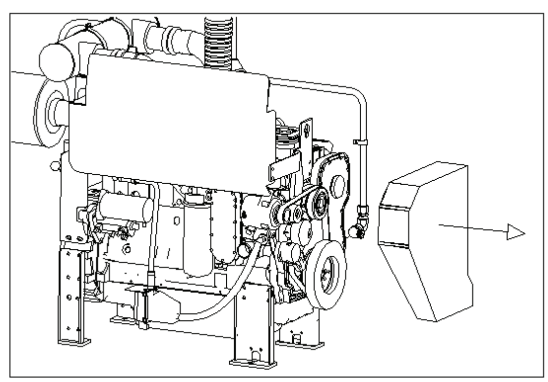


Remove heat exchanger, piping and hoses.

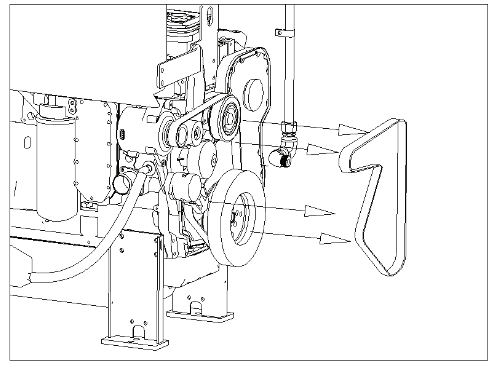


Remove the belt guard.





Remove the drive belt.

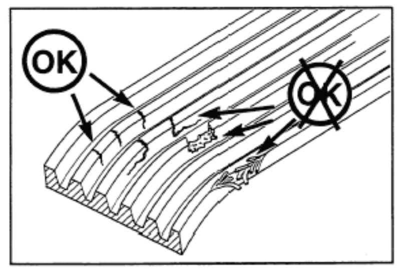


Poly-Vee Belt

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

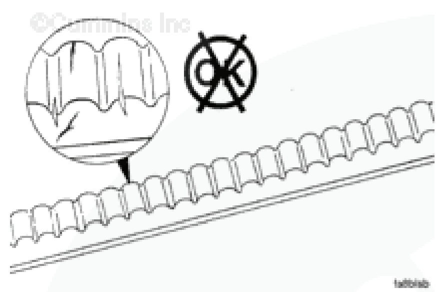
Incorrect installation

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

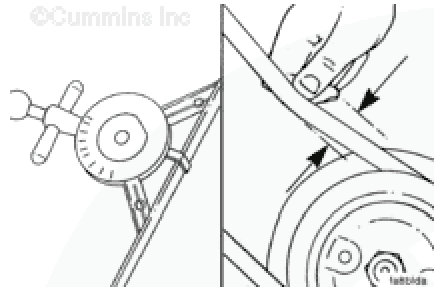
Oil or grease on the belts

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

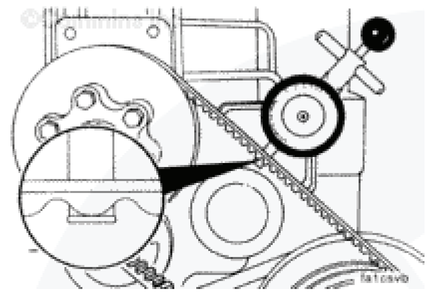
Refer to the Belt Tension Chart in Section V for the correct gauge and tension value for the belt width used.

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.

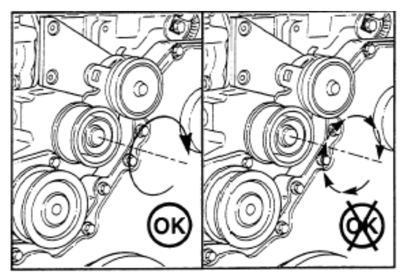


For cogged belts, make sure that the belt tension gauge is positioned so that the center tensioning leg is placed directly over the high point (hump) of a cog. Other positioning will result in incorrect measurement.



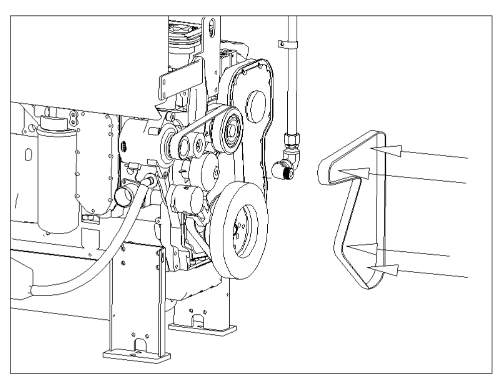
Check the tensioner bearing.

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

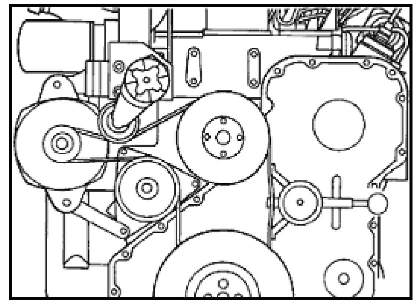


Replace tensioner or bearing if defective.

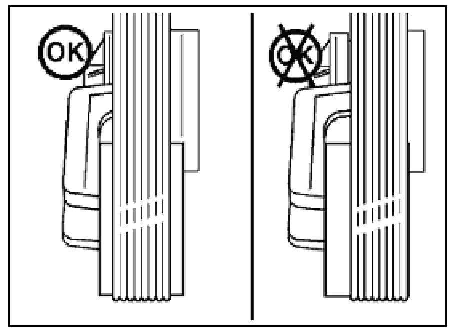
Install the drive belt.



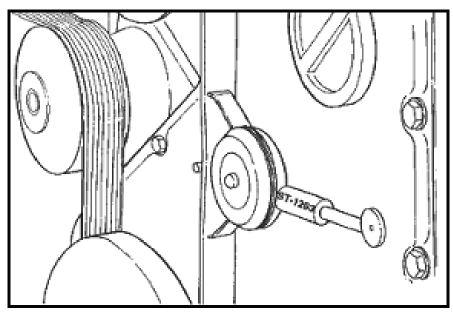
Torque Value: Tension Limit: 360 to 490 N•m [266 to 361 ft-lb]



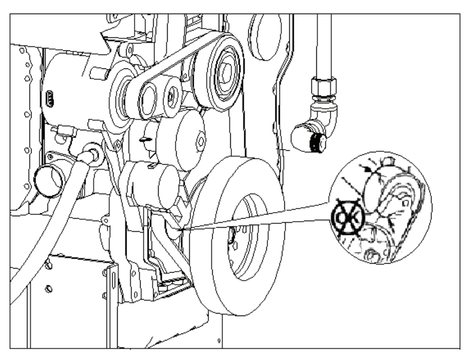
Check the location of the drive belt on the belt tensioner pulley. The belt should be centered on, or centered close to the middle of, the pulley. Unaligned belts, either too far forward or backward, can cause belt wear, belt roll-off failures, or increase uneven tensioner bushing wear.



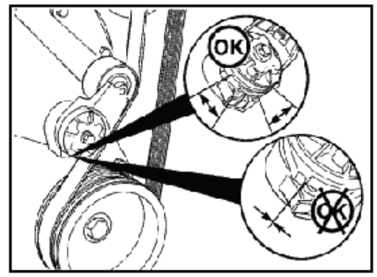
Use the Cummins belt tensioner gauge, Part No. 3822524, to measure the tension in the drive belt. This needs to be in the range of 360 to 490 N•m [266 to 361 ft-lb].



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.

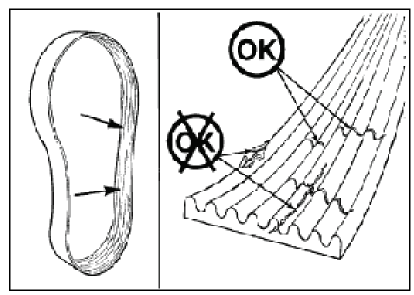


Remove the drive belt, and check the torque of the tensioner capscrew. After checking the torque, use a breaker bar with a 3/8-inch ratchet to rotate the tensioner slowly away from the area of belt contact. If the arm rotates with any roughness or hesitancy, replace the tensioner.

Torque Value: 43 N•m [32 ft-lb]

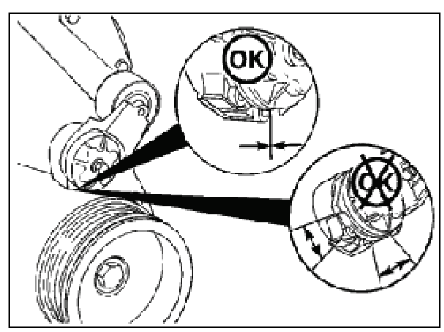
Check the belt for damage. Transverse (across the belt width) cracks are acceptable. Longitudinal (direction of the belt length) cracks that intersect with transverse cracks are not acceptable.

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.

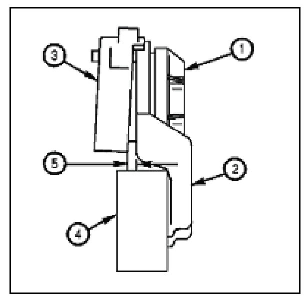
Tensioner cap

Tensioner arm

Spring case

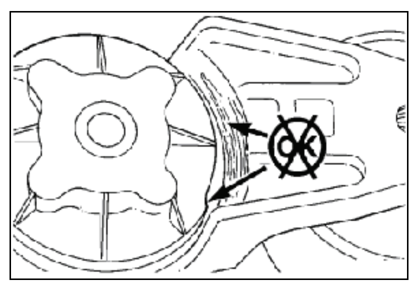
Tensioner pulley

Clearance gap



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

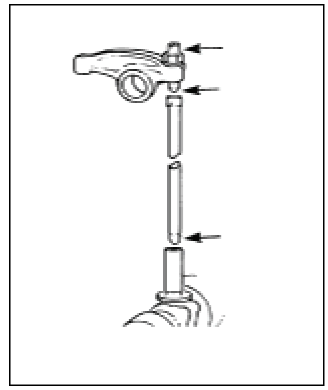
If there is evidence of the two areas making contact, the pivot tube bushing has failed and the tensioner must be replaced.



Procedure 31 **Adjust Valve Lash Clearance**

Adjust

Remove the cylinder head cover.



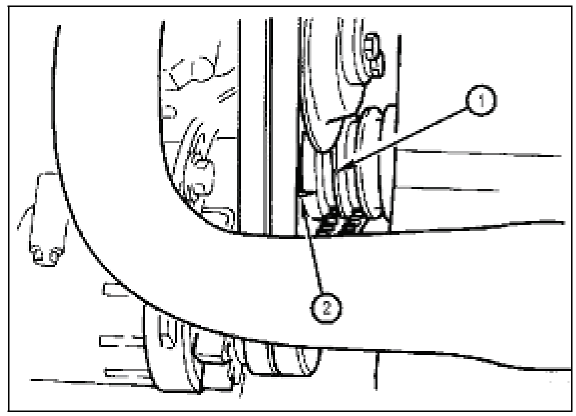
WARNING

Do not use the fan to rotate the engine.

Rotate the crankshaft in the normal direction using the crankshaft pulley mounting capscrews or the alternator pulley mounting nut.

While watching the movement of the intake valve of the No. 4 cylinder, bring the No.1 cylinder into compression top dead center position.

Align the TOP engraved mark on the crankshaft pulley (1) with pointer (2).

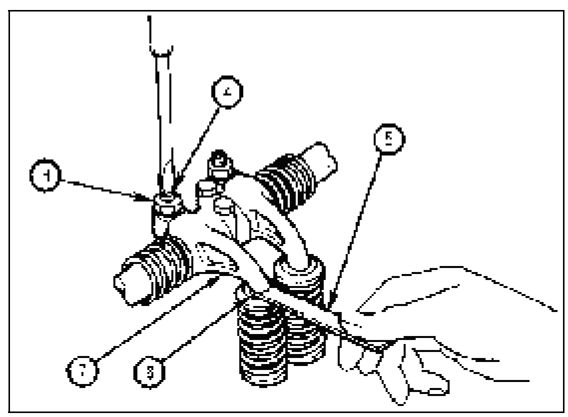


NOTE: The engraved mark on the crankshaft pulley will read “1.4 TOP.” The No. 4 intake valve will start to open when the No. 1 cylinder comes near compression top dead center.

Loosen the locknut (3) on the adjustment screw (4).

Insert the feeler gauge (5) between the valve stem (6) and the rocker arm (7).

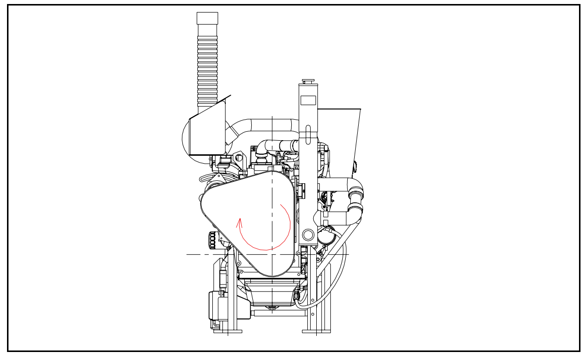
Adjust the clearance with the adjustment screw until slight drag is felt on the feeler gauge.



Valve Clearance (Engine Hot or Cold)

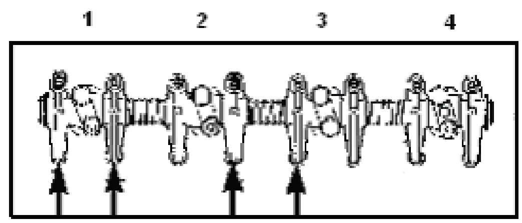
- **Intake Valve: 0.35 mm [0.014 in]**
- **Exhaust Valve: 0.50 mm [0.020 in]**

NOTE: Adjust intake and exhaust clearances in the following firing order by rotating the crankshaft 180 degrees in the normal direction: 1-2-4-3.



Adjust the valve clearances for intake valves No. 1 and No. 3.

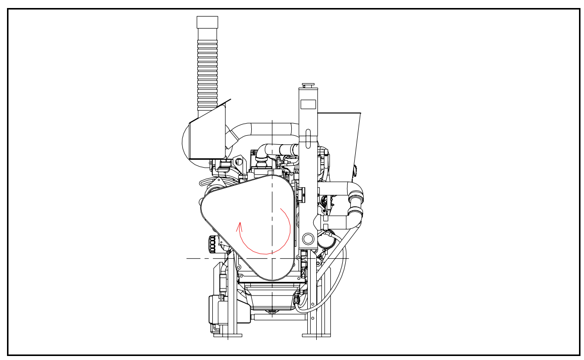
Adjust the valve clearances for exhaust valves No. 1 and No. 2.



Rotate the crankshaft in the normal direction one revolution.

Adjust the valve clearances for intake valves No. 2 and No. 4.

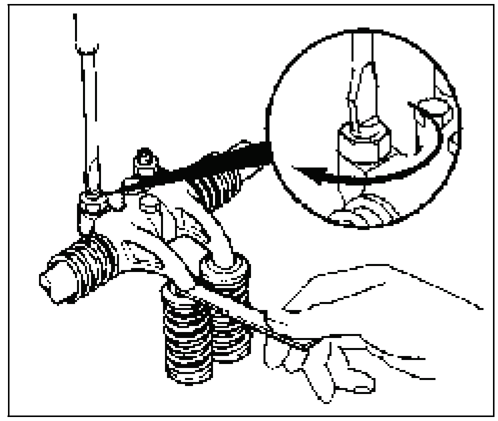
Adjust the valve clearances for exhaust valves No. 3 and No. 4.



Tighten the locknut to secure the adjustment screw.

Locknut Torque Value

- **Minimum 39 N•m [29 ft-lb]**
- **Maximum 49 N•m [36 ft-lb]**

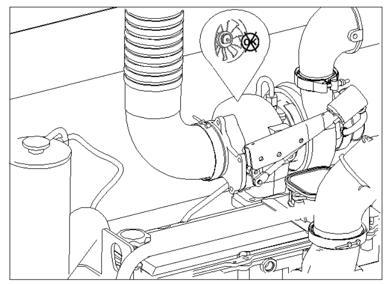


Procedure 32 Inspect Turbocharger

Remove the air intake and the exhaust piping.

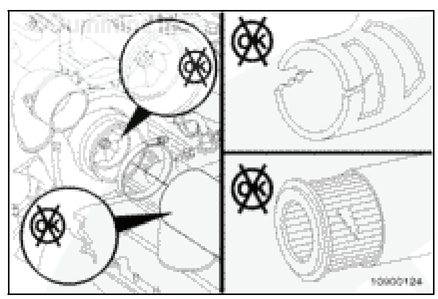
Look for damaged or cracked compressor or turbine blades.

Check to see that the turbocharger shaft spins freely.



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

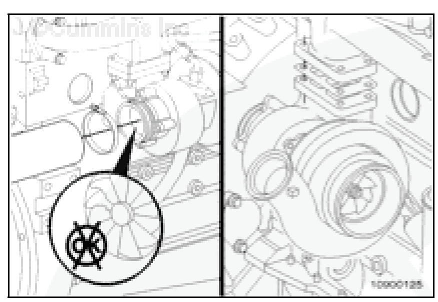
Repair any damage before operating the engine.



Remove the exhaust pipe from the turbocharger.

Inspect the turbine wheel for damage.

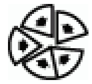
Replace the turbocharger if damage is found. Contact a Cummins Authorized Repair Location for replacement.

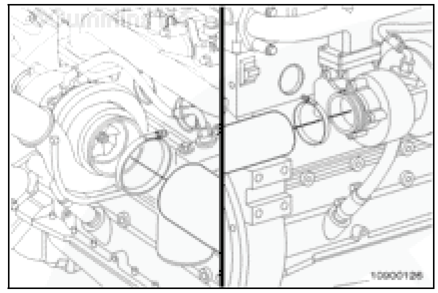


NOTE: If visual inspections or dimensional checks indicate a problem, contact a Cummins Authorized Location for Assistance.

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

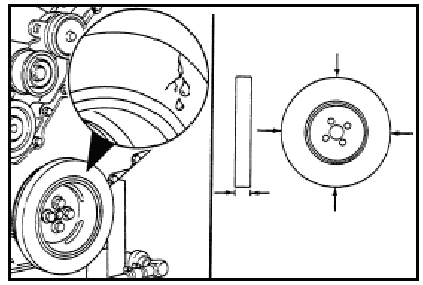
All checks or inspections listed under daily or previous maintenance intervals must also be performed at this time, in addition to those listed under this maintenance interval.

Procedure 33 Inspect Vibration Damper

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.

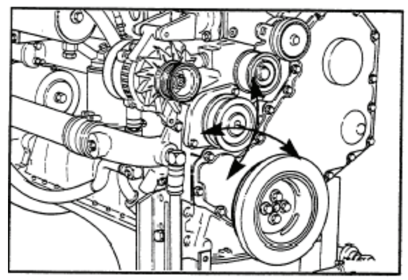


Procedure 34 Inspect Water Pump

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.



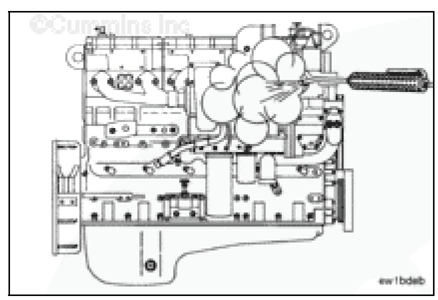
Procedure 35 Engine Steam Cleaning

WARNING

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

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

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



Every Four Years or 5000 Hours

General Information

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

Procedure 36 — Inspect Overhead Set

Preparatory Steps

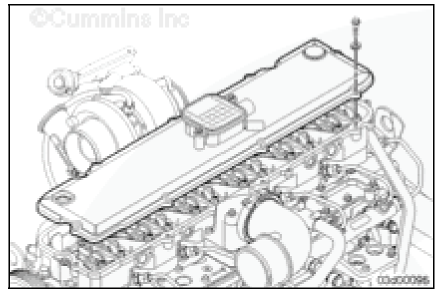
Remove the crankcase breather tube, rocker lever cover mounted breather only.

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

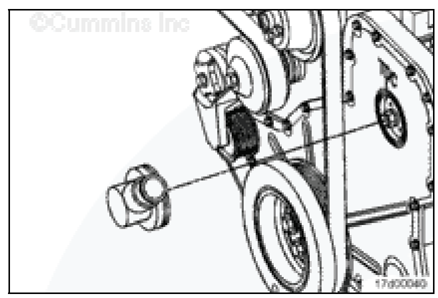
Remove the capscrews.

Remove the rocker lever cover and gasket.

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



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

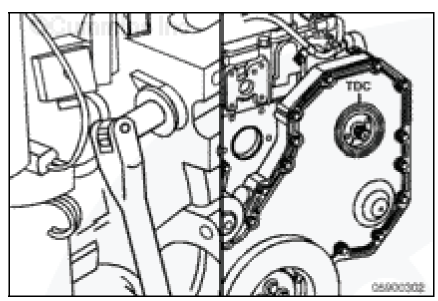


Adjust

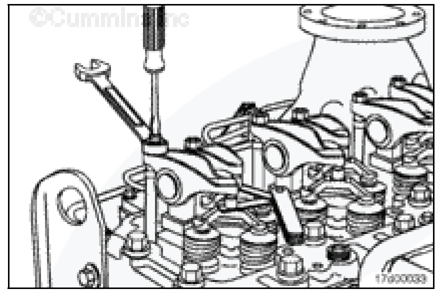
CAUTION

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

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



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	0.35	NOM	0.014
Exhaust	0.5	NOM	0.020

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.

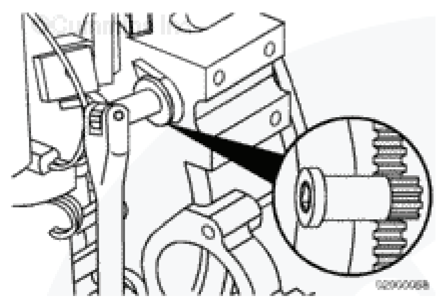
Tighten the locknut and measure again.

Torque Value: 24 N•m [18 ft-lb]

Finishing Steps

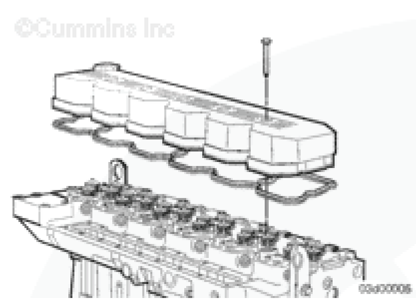
Center Bolted Rocket Lever Cover

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.



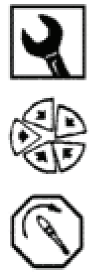
Place the gasket on the cylinder head. Be sure the gasket is properly aligned around the cylinder head capscrews.

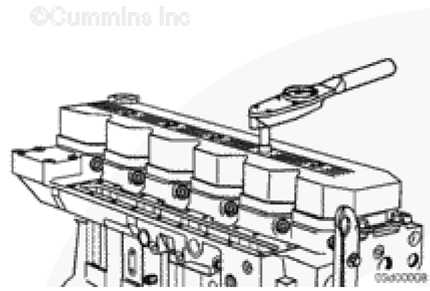
Install the rocker lever cover and capscrews.



Tighten the capscrews.

Torque Value: 12 N•m [106 in-lb]





Perimeter Bolted Rocker Lever Cover

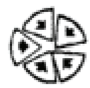
NOTE: If the gasket has been removed from the rocker lever cover, a new gasket must be used.

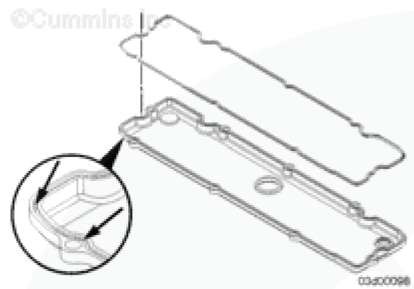
The following installation procedure must be used when installing the press-in gasket.

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

Press the gasket around the capscrew mounting holes.

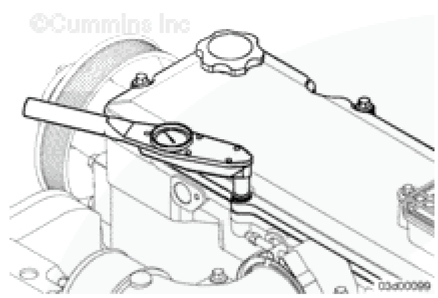
Press the remaining gasket into the rocker lever cover.





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

Section Contents

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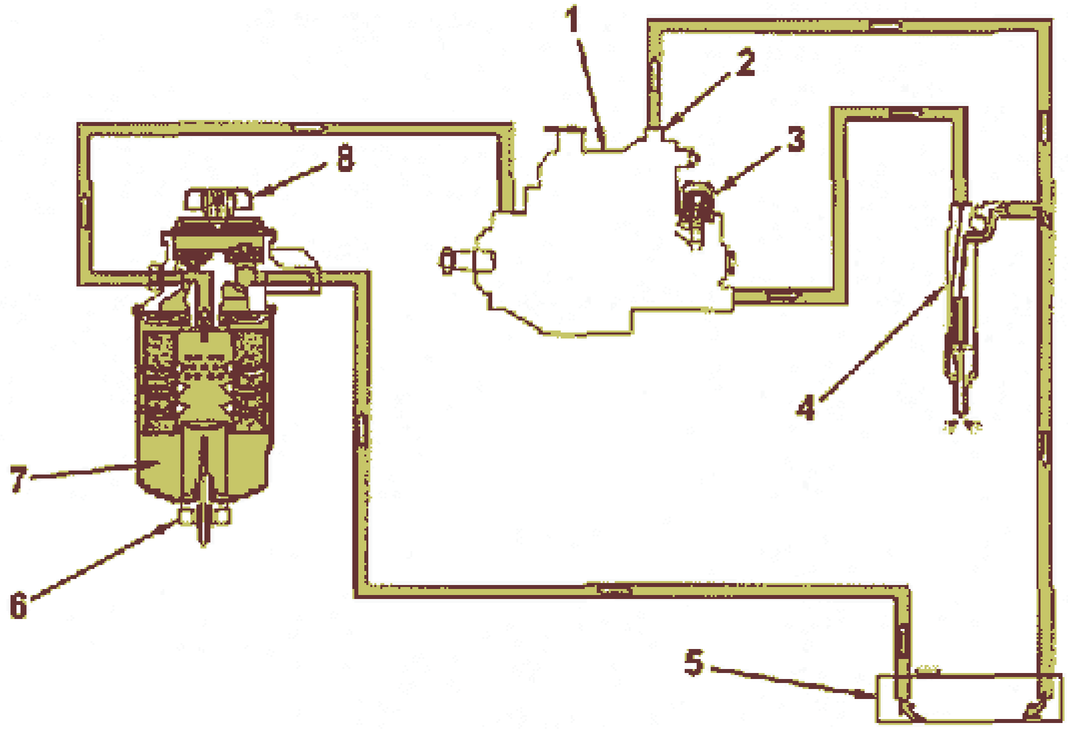
General Information

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

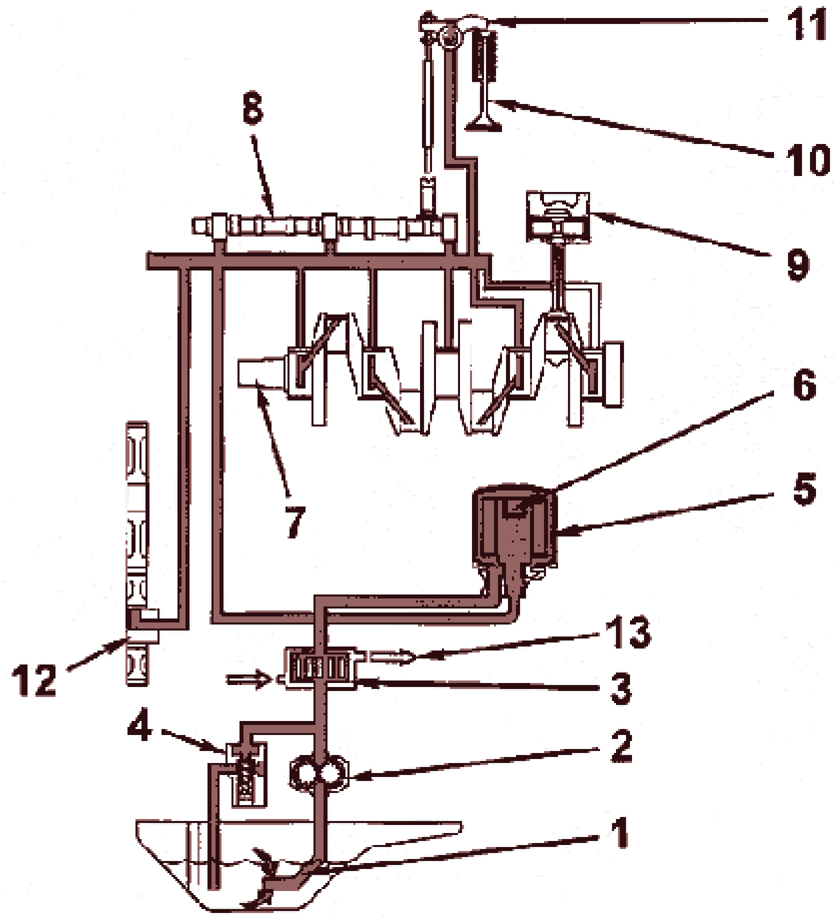
Knowledge of the engine systems can help in troubleshooting, service, and general maintenance of the engine.

Flow Diagram, Fuel System



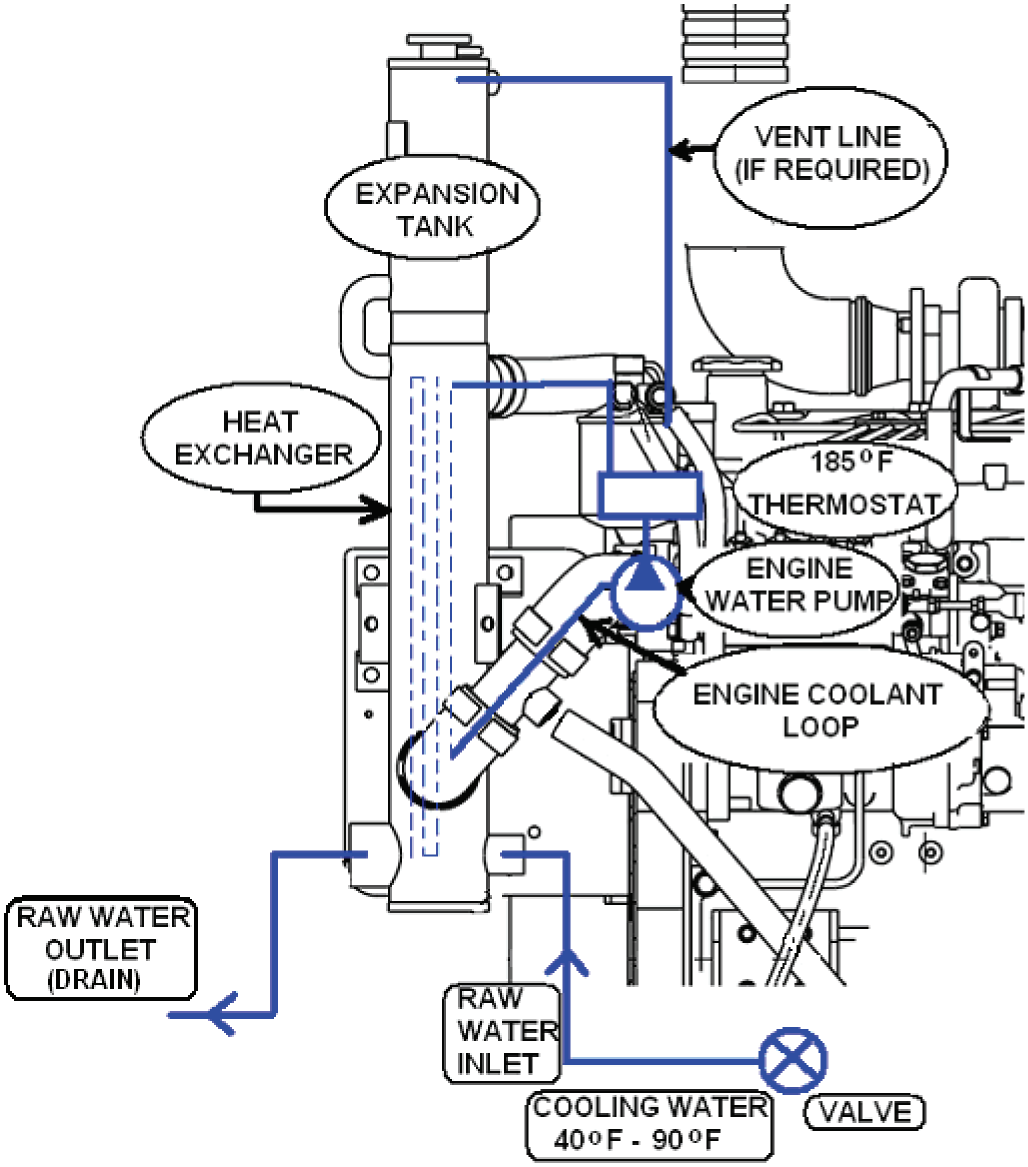
1.	Fuel Injection Pump	5.	Fuel Tank
2.	Overflow Valve	6.	Water in Fuel Sensor (WIF)
3.	Fuel Shut-off Solenoid	7.	Fuel Filter
4.	Fuel Injection Nozzle	8.	Hand Priming Pump

Flow Diagram, Lubricating Oil System



1.	Oil Strainer	8.	Camshaft
2.	Oil Pump	9.	Piston
3.	Oil Cooler (Optional)	10.	Intake and Exhaust Valve
4.	Regulator Valve	11.	Rocker Arm
5.	Oil Filter	12.	Timing Gear
6.	Safety Valve	13.	Cooling Water
7.	Crankshaft		

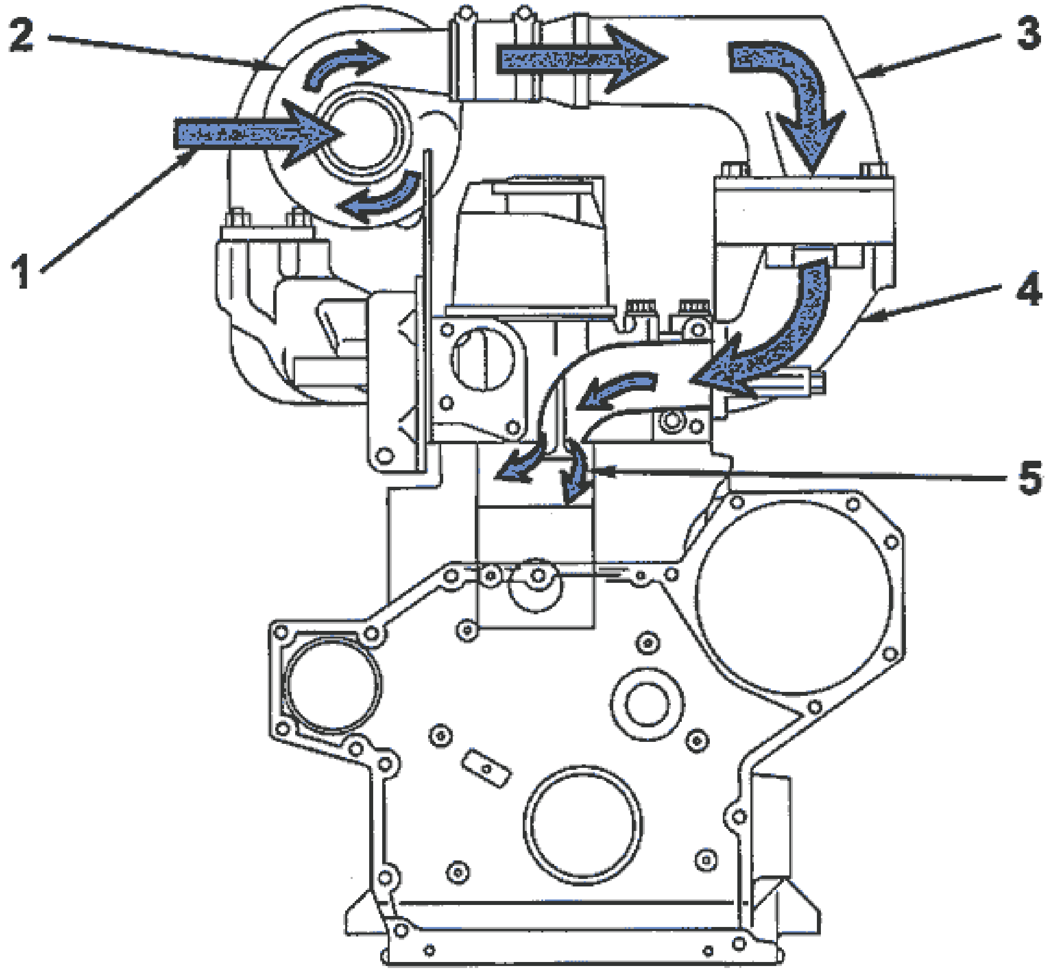
Flow Diagram, Cooling System



The engine is cooled by a heat exchanger system. Engine coolant is circulated around the outside of the heat exchanger tube bundle and is cooled by raw water flowing through the bundle tubes.

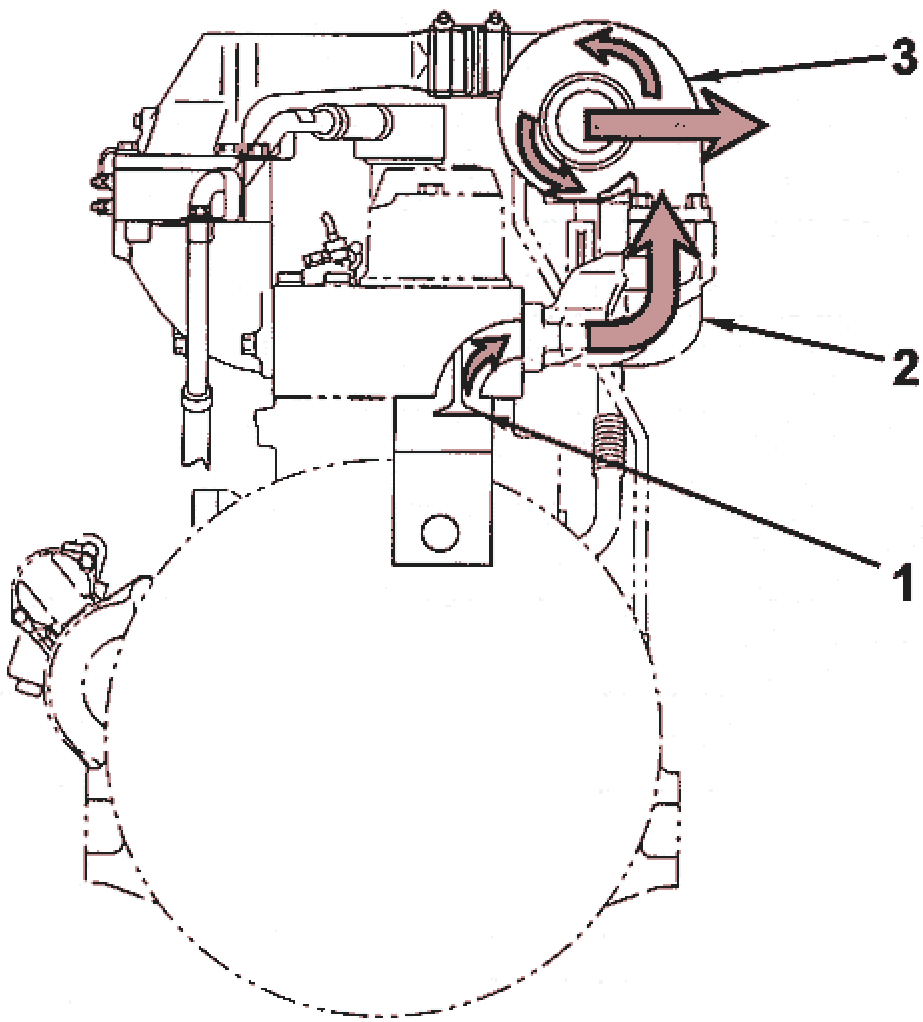
Coolant flow returns from the aftercooler to the head between cylinders one and two. This provides the oil cooler and aftercooler with the coolest possible coolant.

Flow Diagram, Air Intake System



1. Filtered Air
2. Turbocharger Compressor
3. Air Crossover Tube
4. Intake Manifold
5. Intake Valve Port

Flow Diagram, Exhaust System

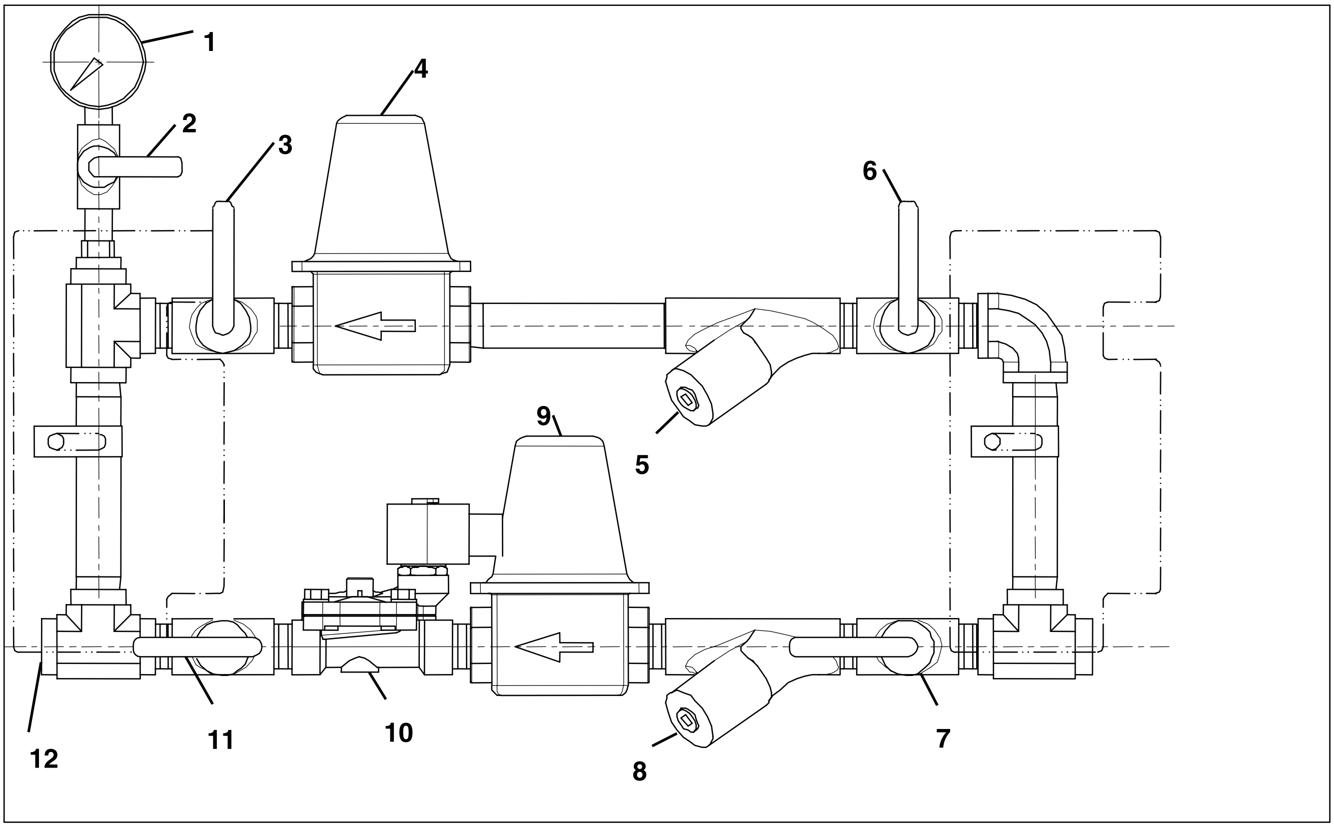


1. Exhaust Valve Port
2. Exhaust Manifold
3. Turbocharger Turbine

Assembly Diagram, Raw Water Piping

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

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



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

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Section 7 – Adjustment, Repair and Replacement

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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 manual.

Base engine components are addressed in Cummins Manual No. 3666418, Troubleshooting and Repair Manual, B3.3 Series Engines

Refer to Service Literature Section 8 for additional information about this manual.

Requirements

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

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

Ensure that the area is prepared for the intended service.

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

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

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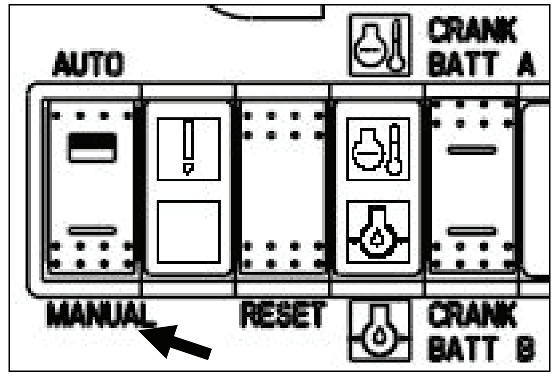
Belt Guard Removal/Installation

Prepare

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

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

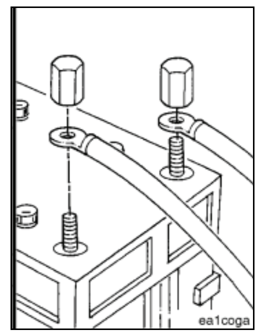


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.

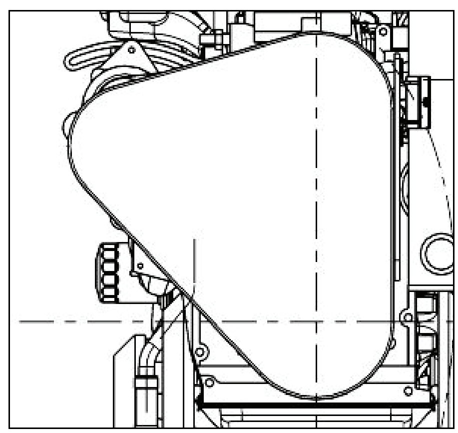
Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Remove

Remove the bolts and the belt guard.



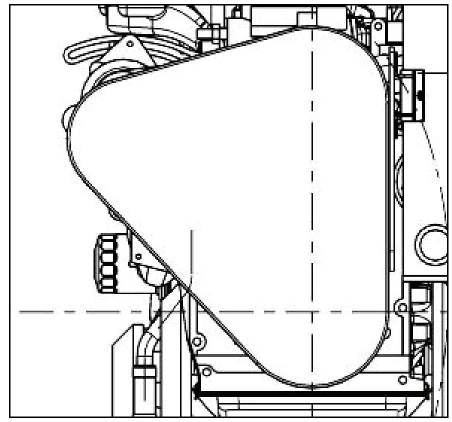
Belt Guard Removal/Installation (Cont)

Install

NOTE: Install only Cummins approved replacement belt guard (Cummins Fire Power Part No. 8805 for CFP33-F25, F35 or No. 9537 for CFP33-F10, F20, F30) or equivalent.

When other work is completed, install the belt guard. Refer to Belt Guard Removal / Installation in this section.

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

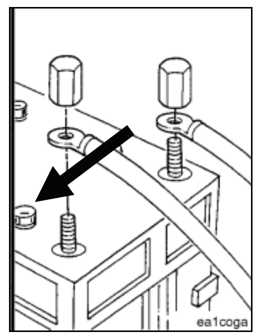


Follow-Up

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.



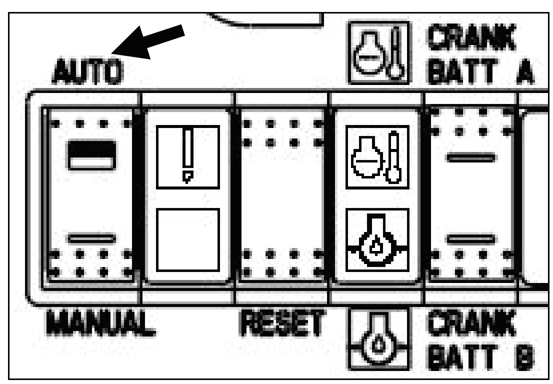
Start the engine. Refer to Normal Local Starting Procedure in Section 3.

Ensure that repairs are completed satisfactorily.

Stop the engine.

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

Return the fire protection system to operating status.



Belt Removal/Installation/Adjustment

Prepare

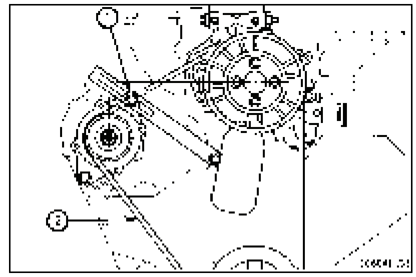
Do the preparatory steps and remove the Belt Guard. Refer to Belt Guard Removal / Installation in this section.

Remove

Loosen the mounting capscrew of the adjustment plate (1).

Loosen the alternator mounting capscrew and nut.

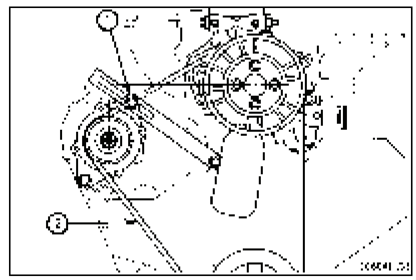
Move the alternator toward the cylinder block and remove the belt (2).



Install

NOTE: Install only Cummins approved replacement v-ribbed belts (Cummins Part No. C0412021745) or equivalent.

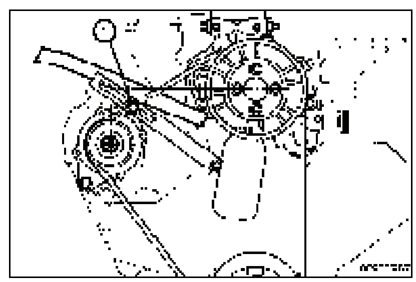
As required, position the fan belt (2) into the fan pulley groove, and loosely tighten the adjustment capscrew (1).



WARNING

Be careful not to injure your fingers or damage the alternator when adjusting the belt tension.

Insert a bar or pipe between the alternator and the cylinder block. Raise the alternator to adjust the fan tension.



NOTE: The belt must deflect 7 mm to 10 mm [0.28 in to 0.39 in] when pushed with finger-pressure of 6 kg [13 lb] at a point midway between the fan pulley and the crankshaft pulley.

Tighten the adjustment capscrew (1).

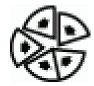
Torque Value:

- **Mounting Capscrew: 31 N•m [23 ft-lb]**
- **Adjustment Capscrew: 31 N•m [23 ft-lb]**

Belt Removal/Installation/Adjustment (Cont)

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.

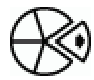


Check that the drive belt operates without unusual noises.

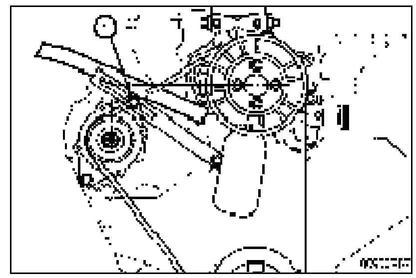
Adjust Alternator Drive Belt Tension

Prepare

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



Adjust



WARNING

Be careful not to injure your fingers or damage the alternator when adjusting the belt tension.

Loosen the adjustment capscrew (1).

Insert a bar or pipe between the alternator and the cylinder block. Raise the alternator to adjust the fan tension.

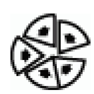
NOTE: The belt must deflect 7 mm to 10 mm [0.28 in to 0.39 in] when pushed with finger-pressure of 6 kg [13 lb] at a point midway between the fan pulley and the crankshaft pulley.

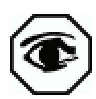
When tension is correct, tighten the adjustment capscrew (1).

Torque Value:

- **Mounting Capscrew: 31 N•m [23 ft-lb]**
- **Adjustment Capscrew: 31 N•m [23 ft-lb]**

Follow-Up





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

Check that the drive belt operates without unusual noises.

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Coolant Heat Exchanger Removal/Installation

Prepare

WARNING

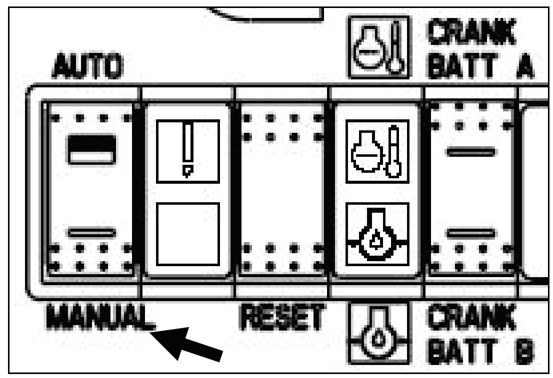
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

Do not remove the pressure cap (Cummins Fire Power Part No. 11407) 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.



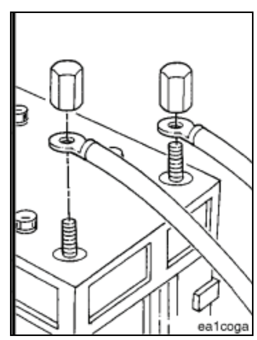
Disconnect or isolate the coolant heater power supply.

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.

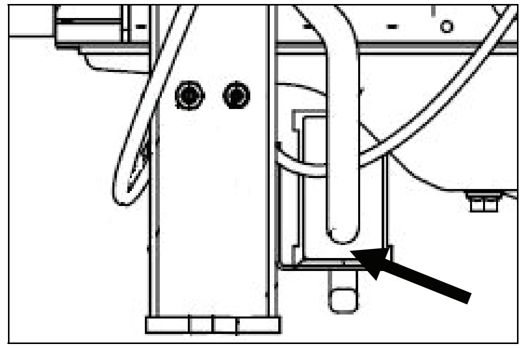


Coolant Heat Exchanger Removal/Installation (Cont)

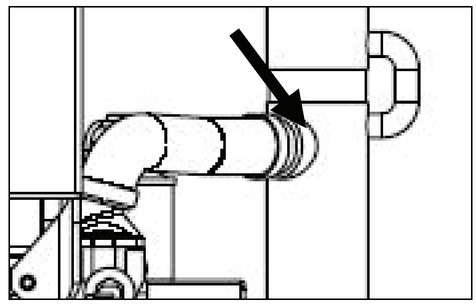
Ensure that the engine and engine coolant is cool in order to avoid burns.

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

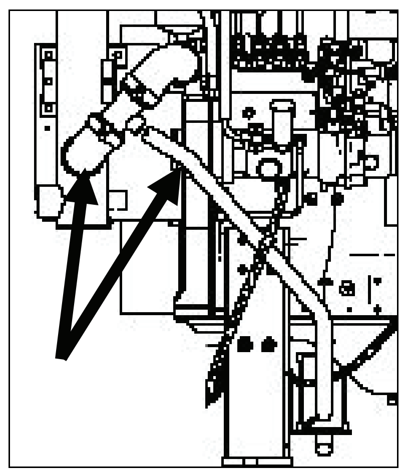
Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 5.



Remove the Upper Engine Coolant Hose from the heat exchanger.

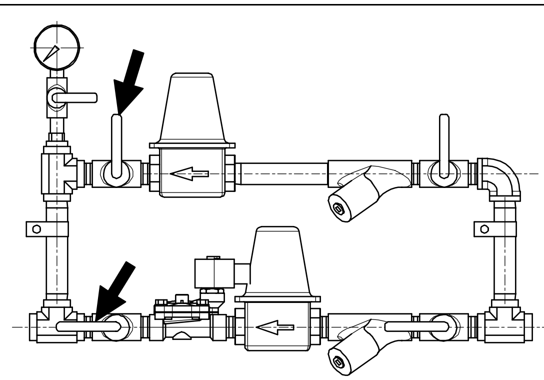


Remove the Lower Coolant Heater Hose and the Lower Engine Coolant Hose from the heat exchanger.



Close the Raw Water Manifold Bypass Line Outlet Isolation Valve.

Close the Raw Water Manifold Normal Line Outlet Isolation Valve.

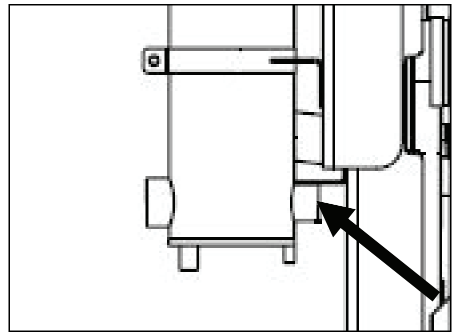


Coolant Heat Exchanger Removal/Installation (Cont)

NOTE: If using piping supplied by Cummins Fire Power, refer to Drawing 9636 in Section 13 for raw water supply piping details.

Remove the ¾" NPT raw water inlet piping from the valve manifold to the heat exchanger.

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



Pressure Test

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

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

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

Install a pressure test setup with 700 kPa [100 psi] pressure gauge at the 3/4" NPT raw water inlet to the heat exchanger.

NOTE: There should be no detectable decrease in the pressure reading for the duration of the test.

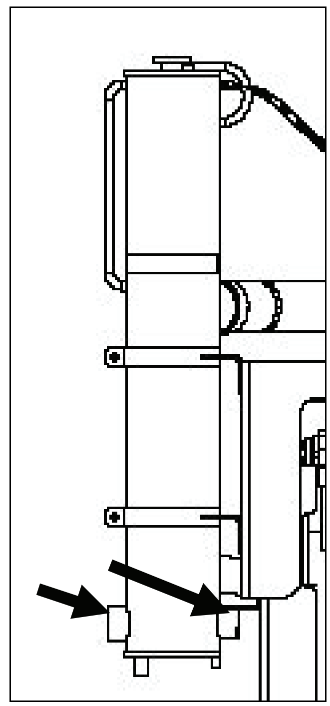
Apply air pressure at 621 kPa [90 psig].

Isolate the pressure source and monitor the pressure gauge for 5 minutes.

After testing, release the pressure.

Remove the pipe plug and the test setup.

If leakage is detected, the heat exchanger must be replaced.



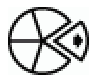
Coolant Heat Exchanger Removal/Installation (Cont)

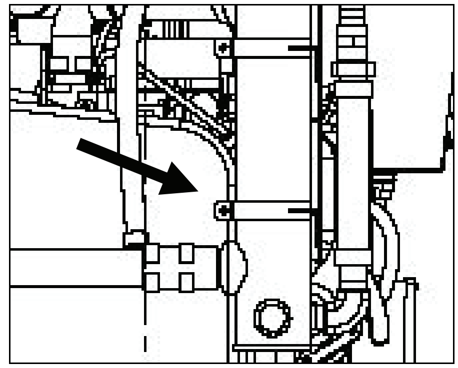
Remove

Provide temporary support for the coolant heat exchanger in order to avoid dropping it.

Remove the four back sets of nuts, washers, and bolts at the heat exchanger mounting clamps.

Remove the heat exchanger and clamps from the engine.

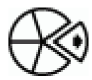


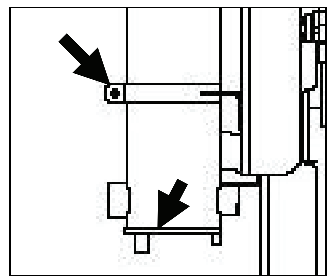


Disassemble

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

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



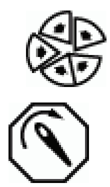


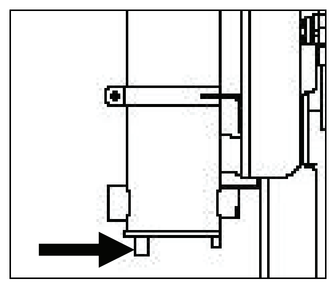
Assemble

NOTE: Use teflon or other pipe sealant when installing threaded pipe fittings.

If missing, install the zinc plug (Cummins Fire Power Part No. 9750) and brass fitting (Cummins Fire Power Part No. 9751) in the bottom of the heat exchanger.

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

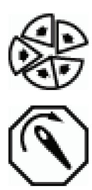


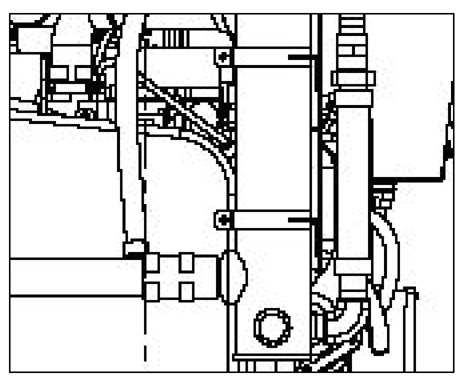


If missing, install the pipe fittings removed from the original heat exchanger. Refer to Drawing 8769 in Section 13 for component information.

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 8769 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.

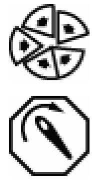
Position the heat exchanger and clamps on the engine's mounting bracket and start the four bolts.

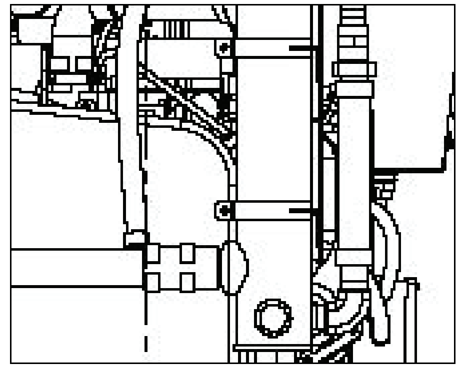
Start the nut and washers on the four bolts.

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.

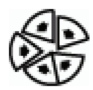
Torque Values: As per capscrew markings and torque values in Section 10

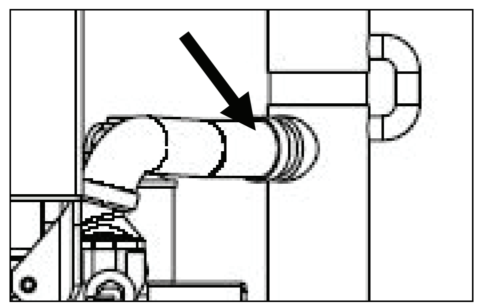




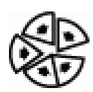
Follow-Up

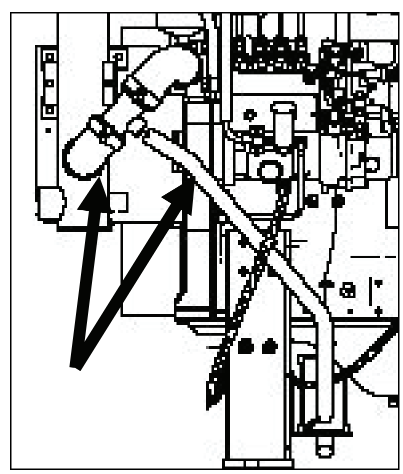
Install the Upper Engine Coolant Hose from the heat exchanger.





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



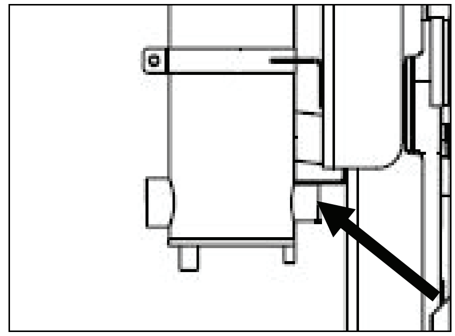


Coolant Heat Exchanger Removal/Installation (Cont)

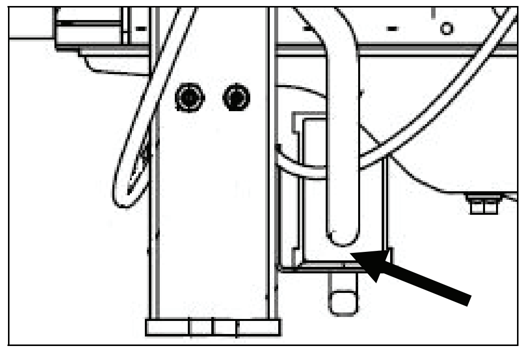
NOTE: If using piping supplied by Cummins Fire Power, refer to Drawing 9636 in Section 13 for raw water supply piping details.

Install the ¾" NPT raw water inlet piping from the valve manifold to the heat exchanger.

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

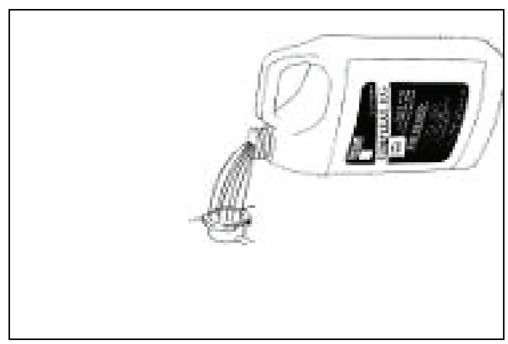


Close the coolant drain valve.



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

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

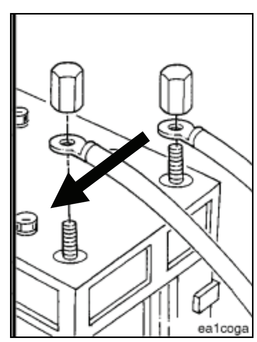


Reconnect the coolant heater power supply.

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.

CAUTION

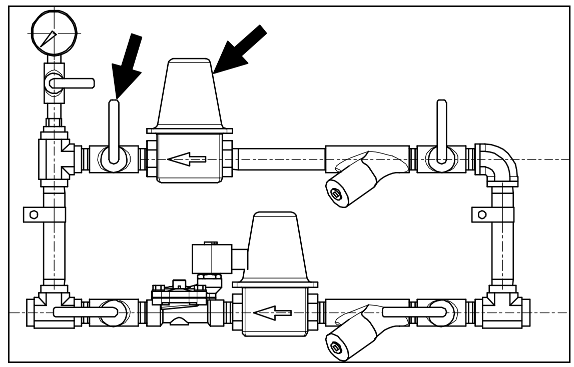
When establishing raw water flow, ensure that the raw water pressure does not exceed 414 kPa (60 psig) at the heat exchanger. Adjust the pressure regulators as required.

Slowly open the Raw Water Manifold Bypass Line Outlet Isolation Valve.

Observe raw water flow through the heat exchanger.

Adjust the bypass pressure regulator if required.

Close the Raw Water Manifold Bypass Line Outlet Isolation Valve.



CAUTION

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

Slowly open the Raw Water Manifold Normal Line Outlet Isolation Valve.

Observe raw water flow through the heat exchanger.

Adjust the normal pressure regulator if required.

Coolant Heat Exchanger Removal/Installation (Cont)

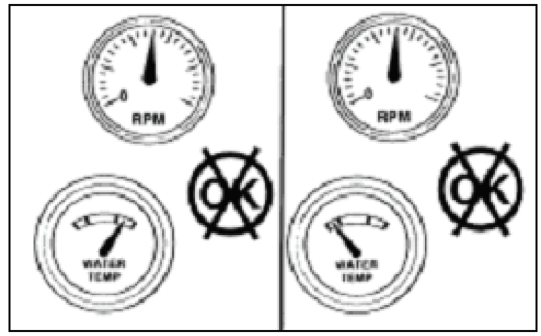
NOTE: If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Troubleshooting Section 12.

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.

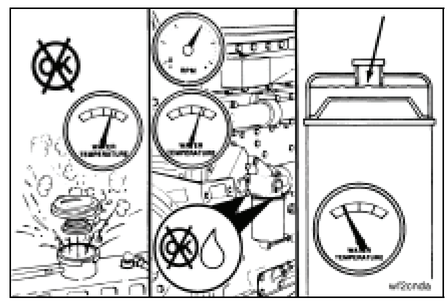
Ensure that repairs are completed satisfactorily.



WARNING

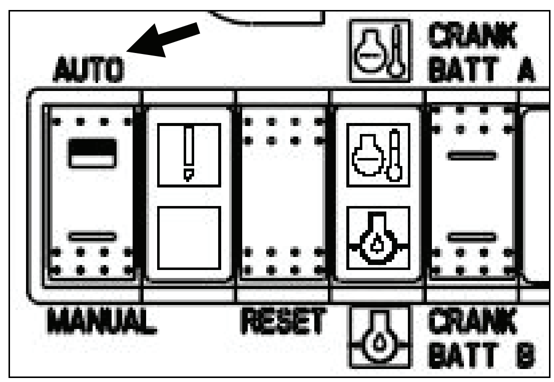
Do not remove the pressure cap (Cummins Fire Power Part No. 11407) from a hot engine. Wait until the coolant temperature is below 50°C [120°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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

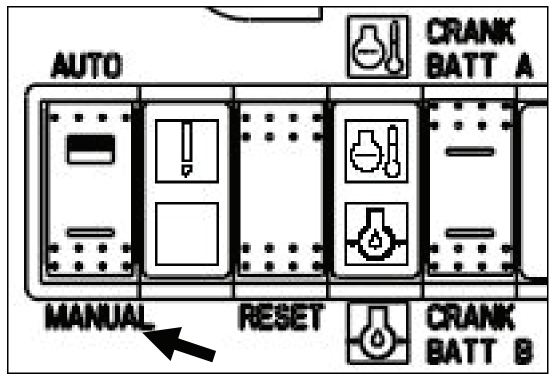
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

Do not remove the pressure cap (Cummins Fire Power Part No. 11407) 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.



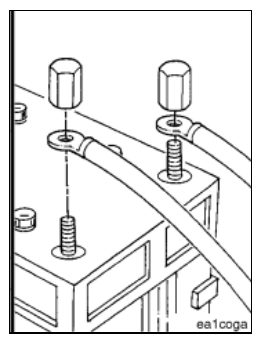
Disconnect or isolate the coolant heater power supply.

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.

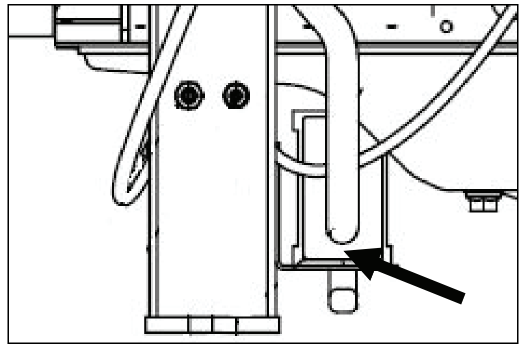


Coolant Heater Removal/Installation (Cont)

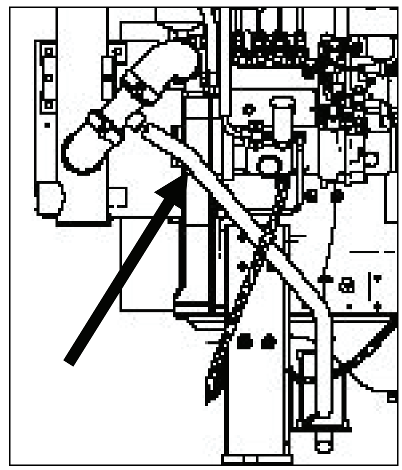
Ensure that the engine and engine coolant is cool in order to avoid burns.

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

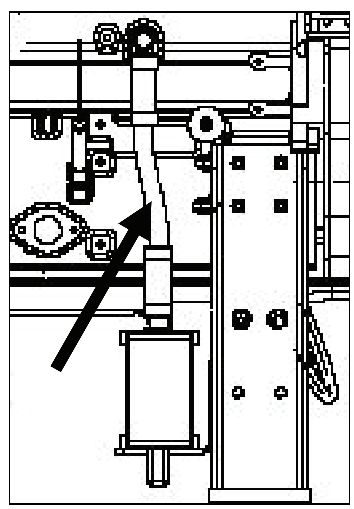
Drain the engine coolant system. Refer to Drain and Flush Coolant System in Section 5.



Remove the Lower Coolant Heater Hose from the coolant heater.



Remove the Upper Coolant Heater Hose from the coolant heater.

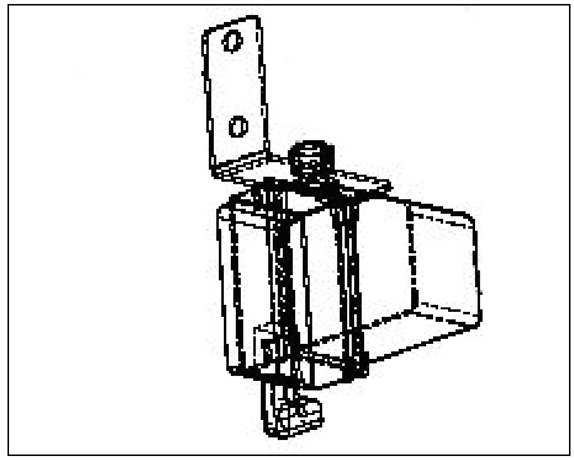


Coolant Heater Removal/Installation (Cont)

Remove

Remove the two capscrews, washers, bracket, and coolant heater. Refer to Drawing 8813 in Section 13 for component information.

If required, remove the nuts, bolts, washers and mounting bracket from the coolant heater.

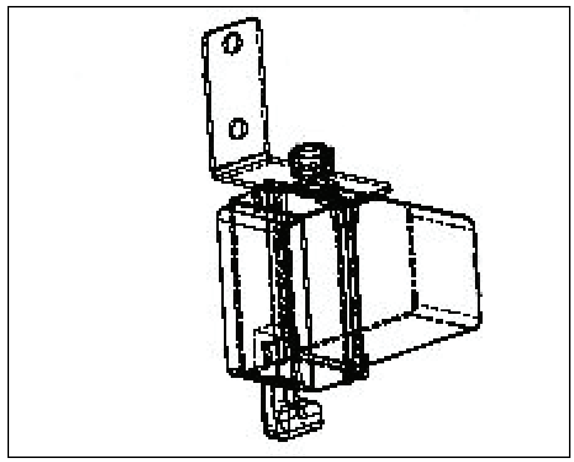


Install

If missing, install the nuts, bolts, washers and mounting bracket on the coolant heater. Refer to Drawing 8813 in Section 13 for component information.

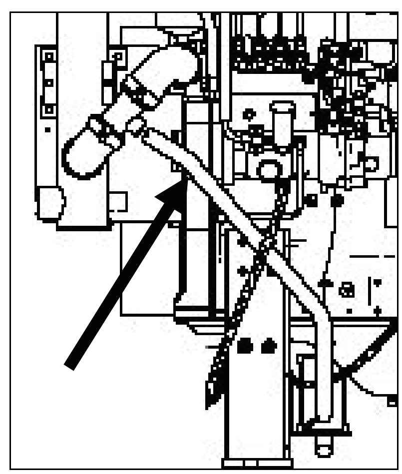
Position the coolant heater and mounting bracket and start the two bolts with washers.

Torque the two bolts on the mounting bracket as per Capscrew Markings and Torque Values in Section 10.

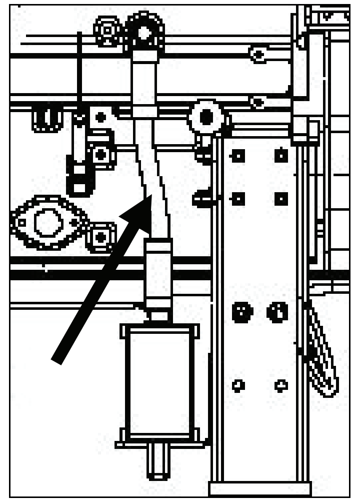
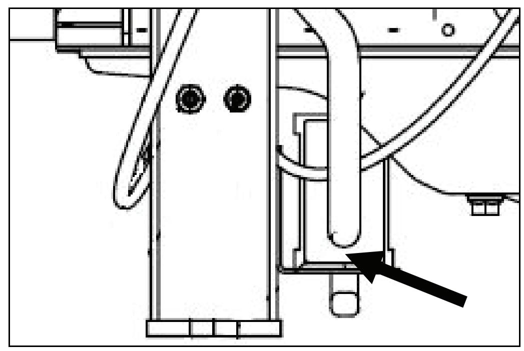
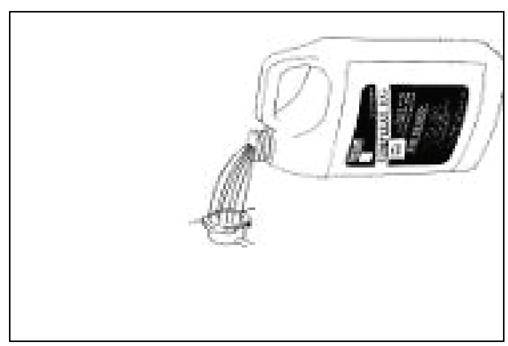


Follow-Up

Install the Lower Coolant Heater Hose at the coolant heater.



Coolant Heater Removal/Installation (Cont)

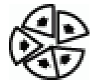
Install the Upper Coolant Heater Hose at the coolant heater.	
Close the coolant drain valve.	
Refill engine coolant. Refer to Drain and Flush Coolant System in Section 5. Install the coolant system pressure cap (Cummins Fire Power Part No. 11407).	

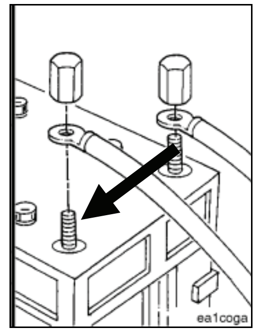
Coolant Heater Removal/Installation (Cont)

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.



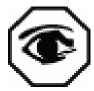


NOTE: Start the engine and do a quick check for leaks. If any coolant leaks are observed, stop the engine, repair the leak, check coolant level, then restart the engine.

Start the engine. Refer to <u>Normal Local Starting Procedure</u> in Section 3.

Check for and repair any coolant leaks.

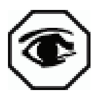
Stop the engine.

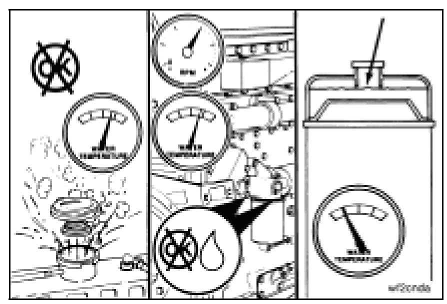


WARNING

Do not remove the pressure cap (Cummins Fire Power Part No. 11407) 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 <u>Check Coolant Level</u> in Section 5. Add coolant if necessary.

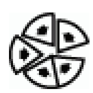




Reconnect the coolant heater power supply.

Observe that the coolant temperature cools down but stabilizes.

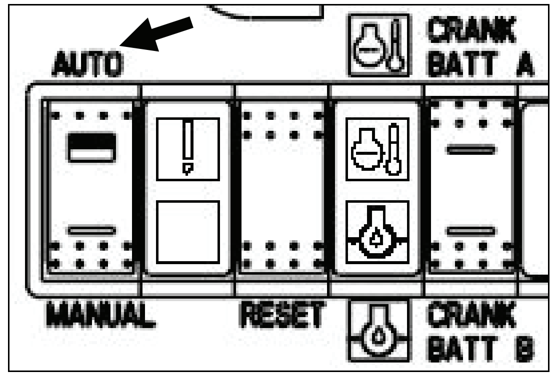
Check that the engine block remains warm to the touch.



Coolant Heater Removal/Installation (Cont)

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

Return the fire protection system to operating status.



Coolant Hose Removal/Installation

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.

Coolant Hose Removal/Installation (Cont)

Prepare

WARNING

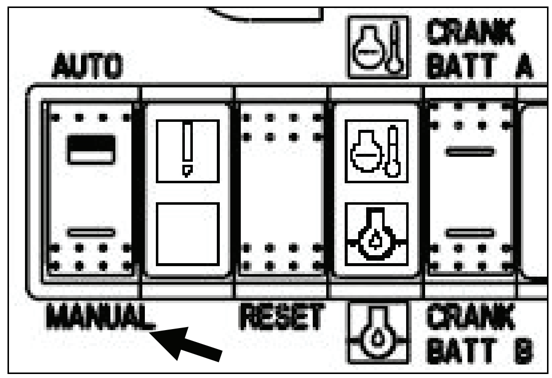
Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

WARNING

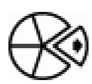
Do not remove the pressure cap (Cummins Fire Power Part No. 11407) from a hot engine. Wait until the coolant temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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.

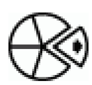


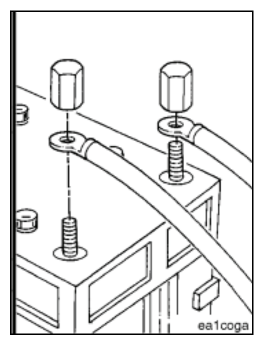
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.

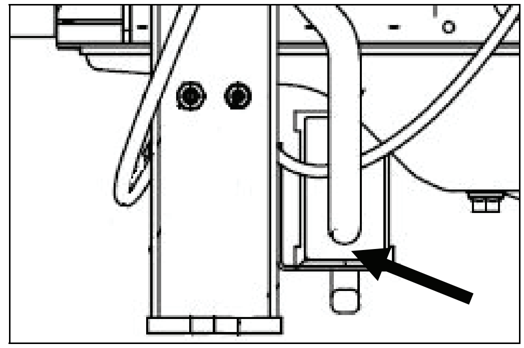




Ensure that the engine and engine coolant is cool in order to avoid burns.

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.



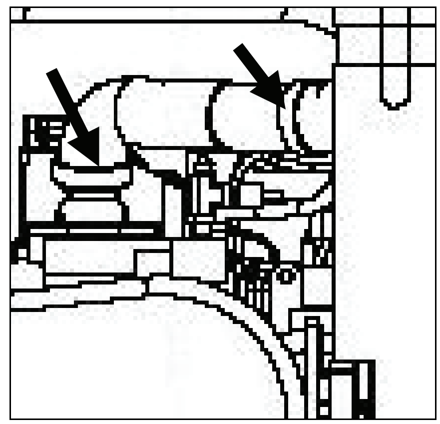
Remove the Upper Engine Coolant Hose

NOTE: Refer to Assembly Drawing 8769 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 Hose

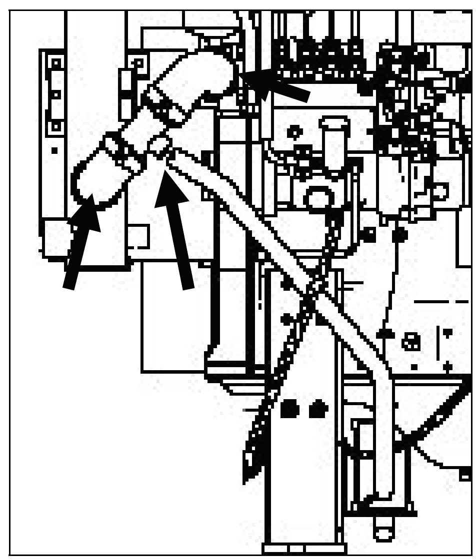
NOTE: Refer to Assembly Drawing 8769 in Section 13 for detailed construction.

Remove the Lower Coolant Heater Hose.

Loosen the hose clamp at the heat exchanger.

Loosen the 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

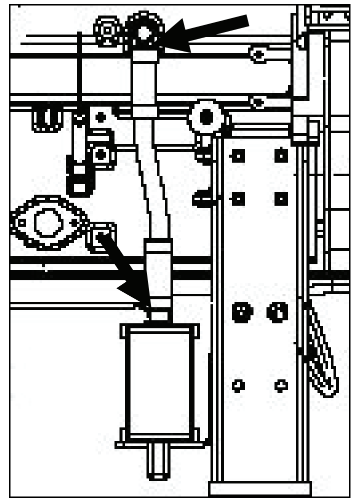
NOTE: Refer to Assembly Drawing 8813 in Section 13 for detailed construction.

Loosen the hose clamp at the coolant heater.

Loosen the hose clamp at the engine.

Pull the hose and tubing assembly from the connections.

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



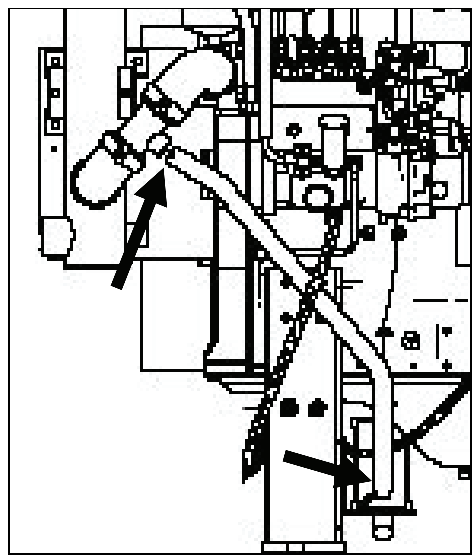
Remove the Lower Coolant Heater Hose

NOTE: Refer to Assembly Drawing 8813 in Section 13 for detailed construction.

Loosen the hose clamp at the Lower Engine Coolant Hose.

Loosen the hose clamp at the water inlet and at the coolant heater.

Pull the hose from the connections.



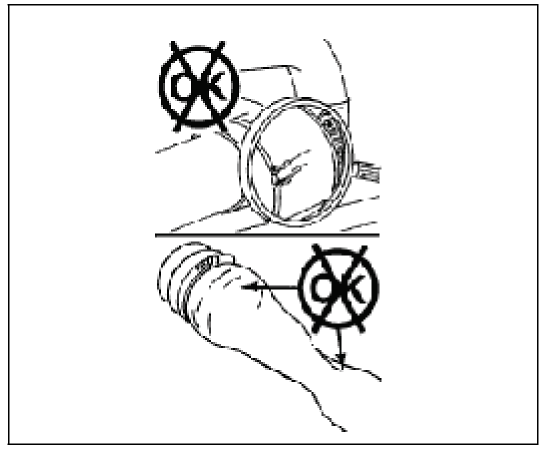
Coolant Hose Removal/Installation (Cont)

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

CAUTION

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

NOTE: Refer to Assembly Drawing 8769 in Section 13 for detailed construction.

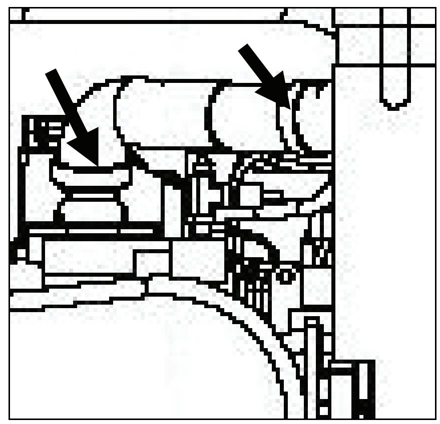
Remove any debris or hose residue from the fittings.

Position the hose clamps on the hose.

Push the hose onto the heat exchanger and engine.

Tighten the hose clamp at the heat exchanger.

Tighten the hose clamp at the engine.



Coolant Hose Removal/Installation (Cont)

Install the Lower Engine Coolant Hose

CAUTION

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

NOTE: Refer to Assembly Drawing 8769 in Section 13 for detailed construction.

Remove any debris or hose residue from the fittings.

Position the hose clamps on the hose.

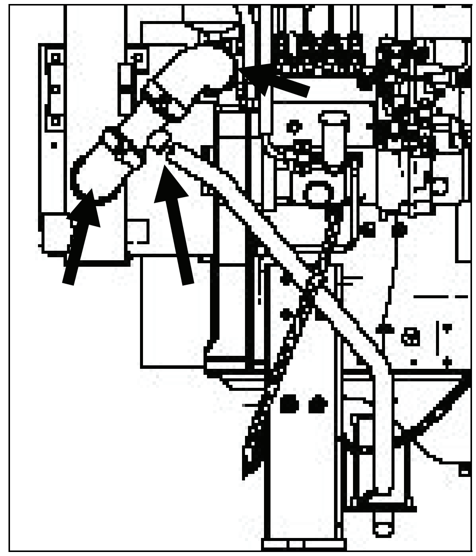
Position the hose at the heat exchanger and engine.

Tighten the lower engine coolant hose clamp at the engine.

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

Install the Lower Coolant Heater Hose.

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



Install the Upper Coolant Heater Hose

CAUTION

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

NOTE: Refer to Assembly Drawing 8813 in Section 13 for detailed construction.

Remove any debris or hose residue from the fittings.

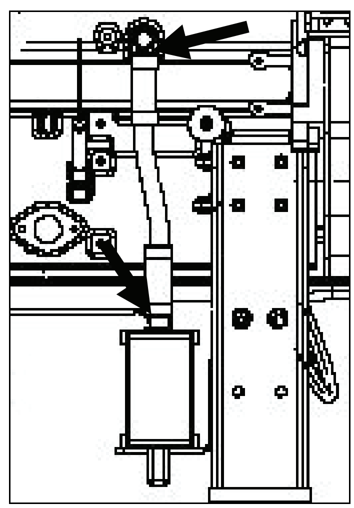
As required, assemble the tube, hose extensions, and clamps.

Insert the hose extension on the engine connection.

Insert the hose extension on the heater 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

CAUTION

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

NOTE: Refer to Assembly Drawing 8813 in Section 13 for detailed construction.

Remove any debris or hose residue from the fittings.

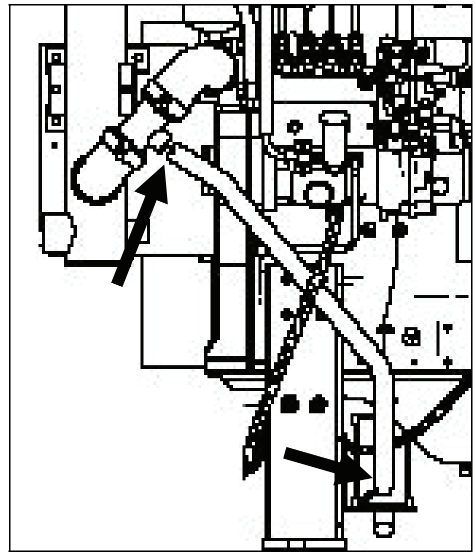
Position the hose clamps on the hose.

Position the hose and hose clamps on the tee fitting on the Lower Engine Coolant Hose.

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

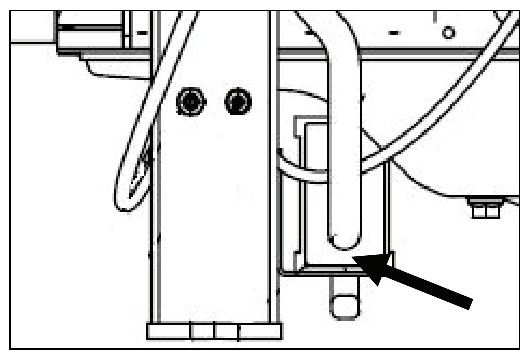
Position and tighten the hose clamps.

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



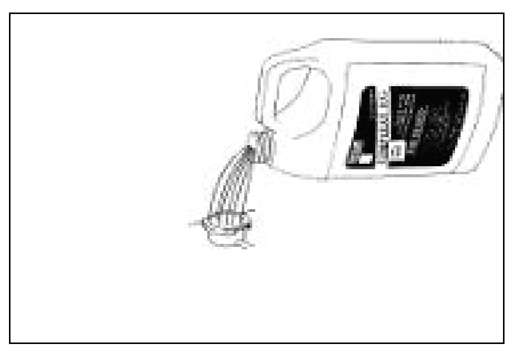
Follow-Up

Close the coolant drain valve.



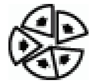
Refill engine coolant. Refer to Drain and Flush Coolant System in Section 5.

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



Coolant Hose Removal/Installation (Cont)

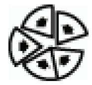
Reconnect the coolant heater power supply.

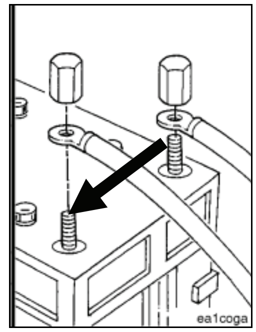


For safety reasons, both batteries must be re-connected before putting the engine and fire protection system controller back in service.

Wear safety glasses when reconnecting batteries!

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





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

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

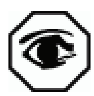
Check for and repair any coolant leaks.

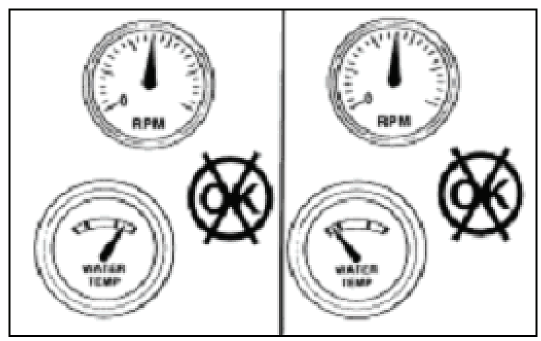
Check that engine operating temperature stabilizes between about 82 and 93 °C [180 and 200 °F].

Check that no coolant hoses are collapsed.

When temperature has stabilized, stop the engine.

Ensure that repairs are completed satisfactorily.

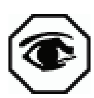


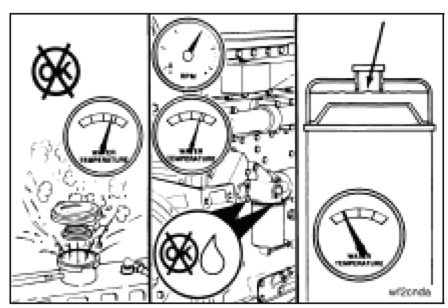


WARNING

Do not remove the pressure cap (Cummins Fire Power Part No. 11407) 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.

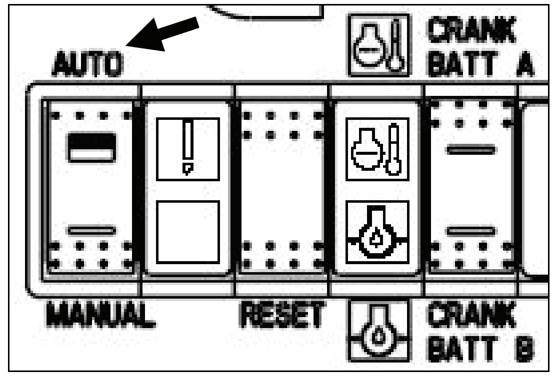




Coolant Hose Removal/Installation (Cont)

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.

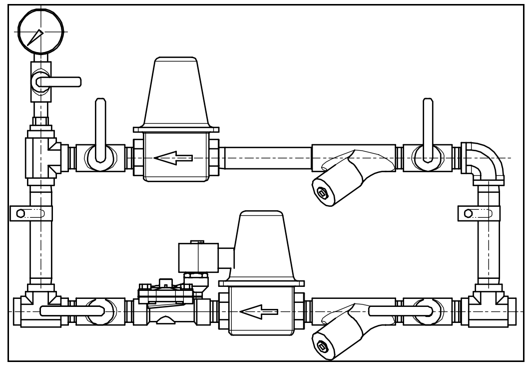
NOTE: This section applies to both the normal and bypass lines.

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.

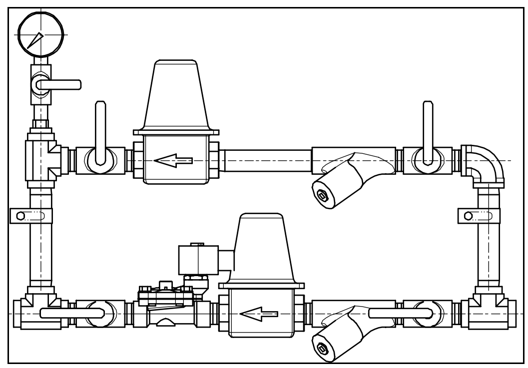


Prepare (Normal Line)

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.



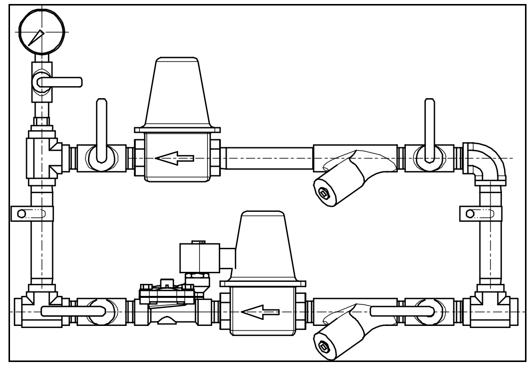
Raw Water Pressure Regulator Removal/Installation (Cont)

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.

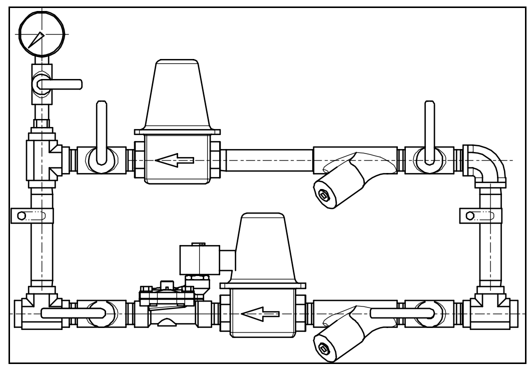


Remove (Normal Line)

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)

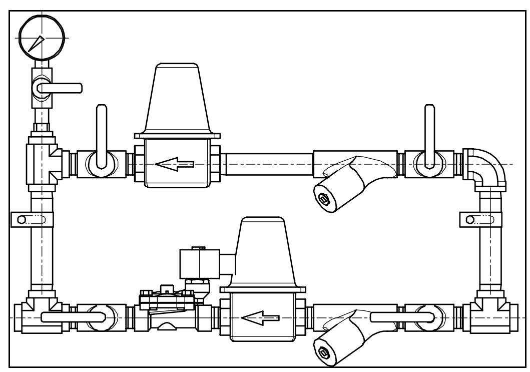
When the pressure regulator is repaired or replaced, prepare it for installation.

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)

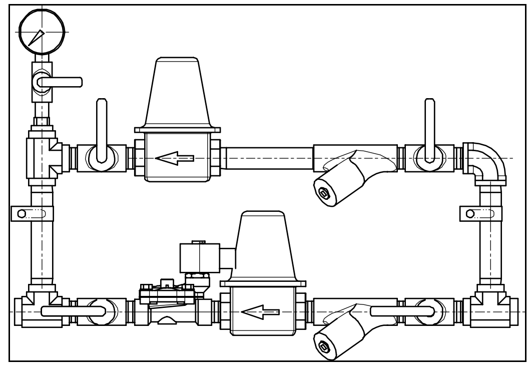
When the pressure regulator is repaired or replaced, prepare it for installation.

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.

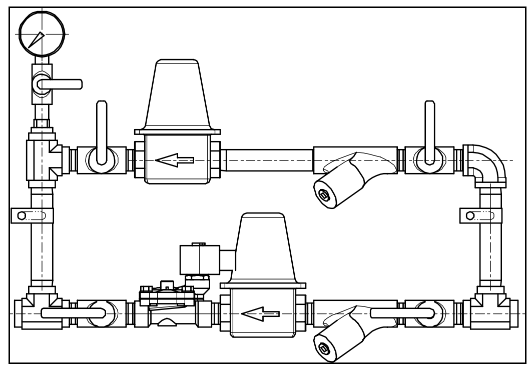


Follow-Up (Bypass Line)

Check the pressure regulator setpoint (refer to Section 3).

If required, open the Raw Water Manifold Bypass Line Inlet Isolation Valve.

If required, open the Raw Water Manifold Bypass Line Outlet Isolation Valve.



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

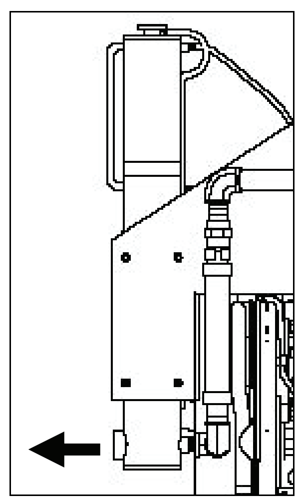
When flow is verified, close the bypass line outlet valve.

Ensure that the normal line inlet and outlet valves are both open.

Ensure that the pressure gauge isolation valve is open.

Ensure that repairs are completed satisfactorily.

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



Raw Water Pressure Regulator Removal/Installation (Cont)

Follow-Up (Normal Line)

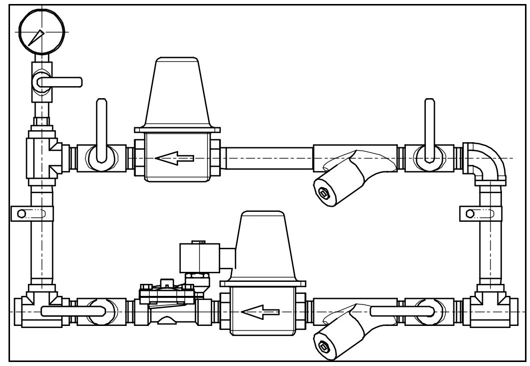
Check the pressure regulator setpoint (refer to Section 3).

If required, open the Raw Water Manifold Normal Line Inlet Isolation Valve.

If required, open the Raw Water Manifold Normal Line Outlet Isolation Valve.

As required, close the bypass line outlet valve.

Ensure that the pressure gauge isolation valve is open.



Start the engine to operate the raw water solenoid valve. Refer to instructions in Section 3.

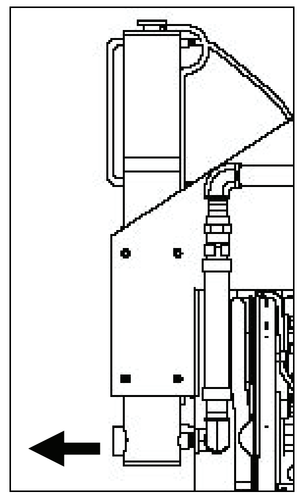
Verify that raw water flow is established through the heat exchanger.

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.

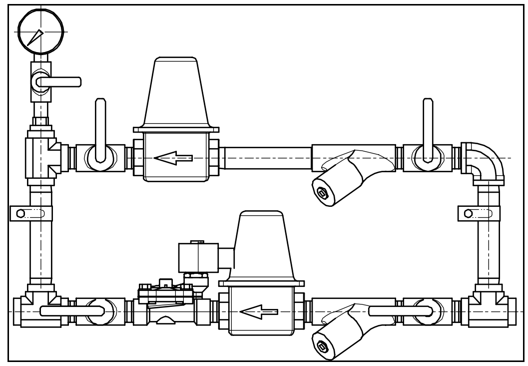


Raw Water Solenoid Valve Removal/Installation

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.



WARNING

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

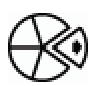
Disconnect the positive battery cables from both batteries.

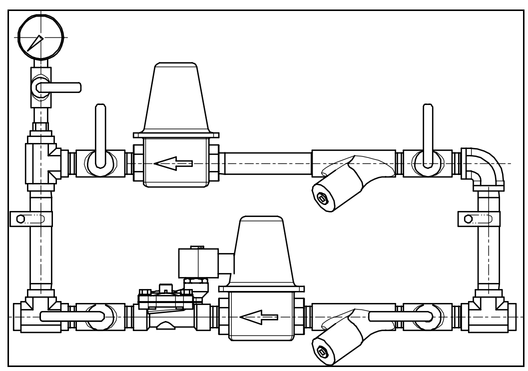
Disconnect any customer supplied battery chargers.

Close the Raw Water Manifold Normal Line Inlet Isolation Valve.

Close the Raw Water Manifold Normal Line Outlet Isolation Valve.

Remove





NOTE: Minimize the loss of wire when cutting the splices.

NOTE: Tag each end of the wire before making the cut.

Cut the butt-splices at the connection between the two solenoid valve pigtail wires and the fire pump electrical harness.

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

Unscrew the solenoid valve from the outlet isolation valve or inlet nipple.

Remove the solenoid valve.

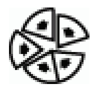
If appropriate for replacement, remove the pipe fittings from the solenoid valve.

Raw Water Solenoid Valve Removal/Installation (Cont)

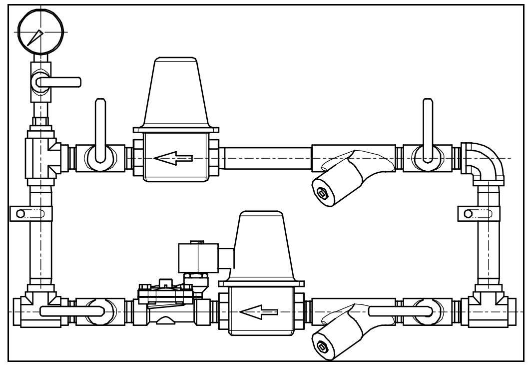
Install

NOTE: Install only Cummins approved replacement solenoid valves [Cummins Fire Power Part No. 8210G003-12VDC (12 VDC) or 8210G3-24VDC (24 VDC)].

NOTE: Use thread sealant when making threaded plumbing connections.



If removed, install the inlet and outlet fittings on the solenoid valve.



Position the solenoid valve and start threading it into the outlet valve or onto the outlet valve nipple.

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

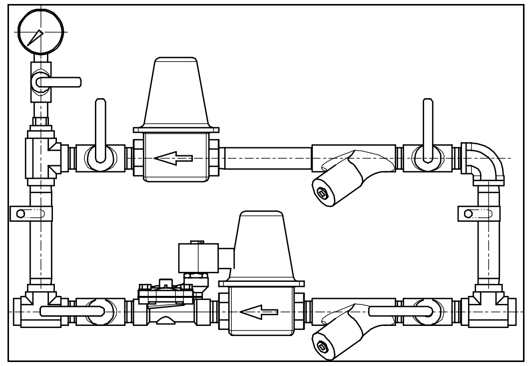
Align and tighten the union connection.

NOTE: Use termination techniques that meet all local requirements. Cummins recommends crimped and insulated butt splices.

NOTE: The solenoid valve's green pigtail lead is not used. The other two leads are not polarity dependent.

Splice the two solenoid pigtail leads to the fire pump harness solenoid leads.

Raw Water Solenoid Valve Removal/Installation (Cont)



Follow-Up

WARNING

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

Connect the positive battery cables at both batteries.

Open the Raw Water Manifold Normal Line Inlet Isolation Valve.

Open the Raw Water Manifold Normal Line Outlet Isolation Valve.

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

Operate the engine. Refer to Operating Instructions TBD 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.

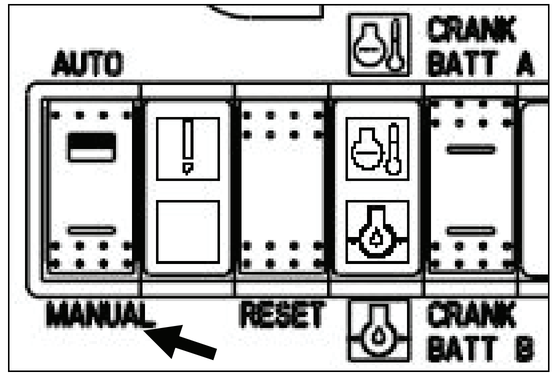
If raw water flow does not stop shortly after the engine stops, refer to Troubleshooting Section 12.

Water Temperature 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.

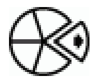


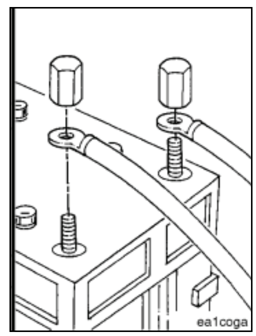
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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

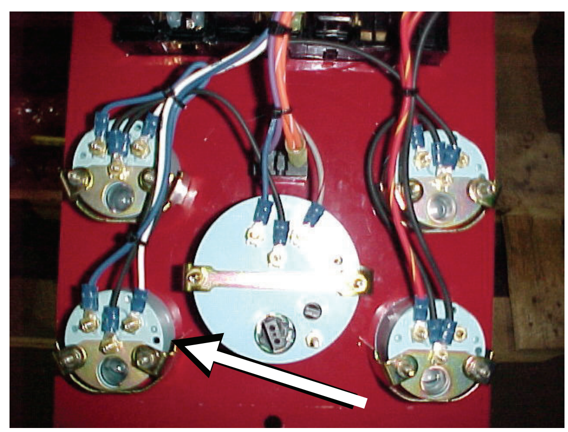
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for electrical schematic details.

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.



Water Temperature Gauge Removal/Installation (Cont)

Install

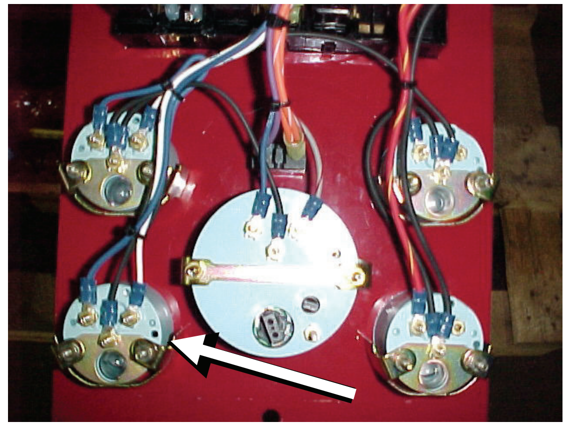
Orient the gauge in the cutout in the electrical panel.

Position the mounting bracket on the gauge.

Install the mounting nuts.

Reconnect the electrical wires on the studs in the same positions as they were originally installed.

Tighten the nuts on the studs.

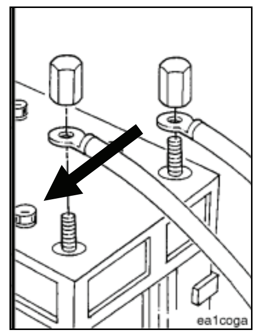


Follow-up

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

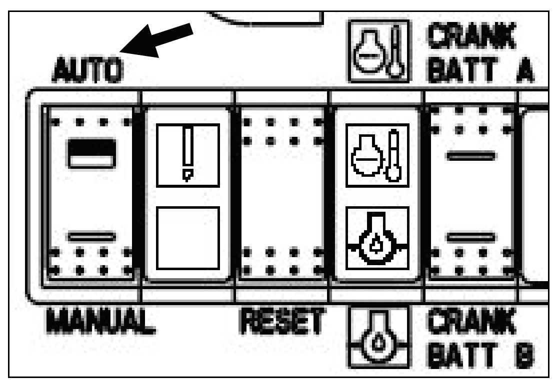
Wear safety glasses when reconnecting batteries!

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



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

Return the fire protection system to operating status.



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

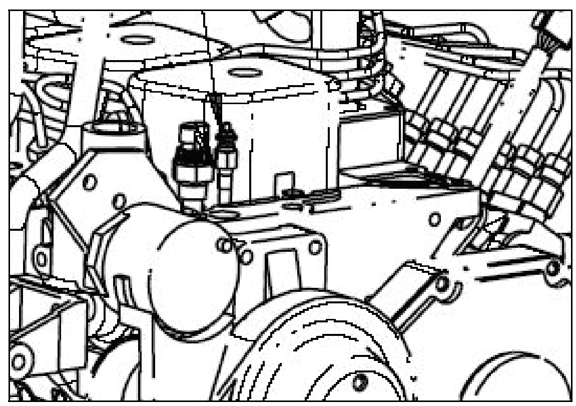
Do not remove the pressure cap (Cummins Fire Power Part No. 11407) from a hot engine. Wait until the temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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

Remove

Disconnect the temperature sensor wiring.

Remove the temperature sensor.



Install

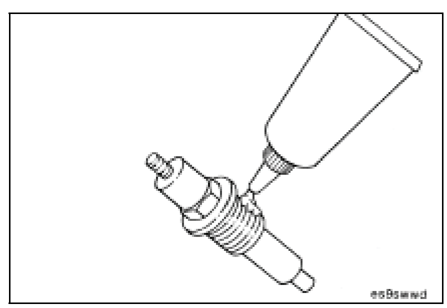
NOTE: Apply liquid teflon sealant to the threads when installing the temperature sensor.

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.

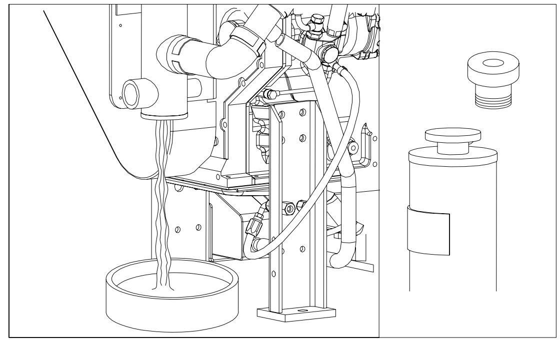
Operate the engine. Refer to Operating Instructions in Section 3.

Check for leaks. Repair any leaks.

Check that engine operating temperature stabilizes between 83 and 91°C [181 and 196°F]. If temperature does not stabilize, stop the engine and refer to Troubleshooting 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

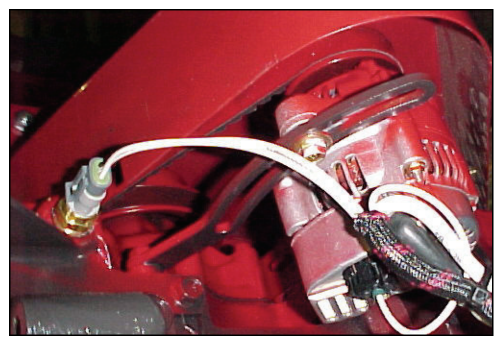
Do not remove the pressure cap (Cummins Fire Power Part No. 11407) from a hot engine. Wait until the temperature is below 50°C [122°F] before removing the pressure cap (Cummins Fire Power Part No. 11407). Heated coolant spray or steam can cause personal injury.

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

Remove

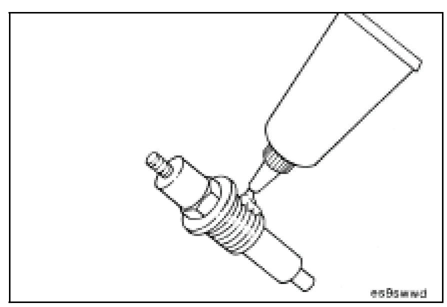
Disconnect the temperature switch wiring.

Remove the temperature switch.



Install

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



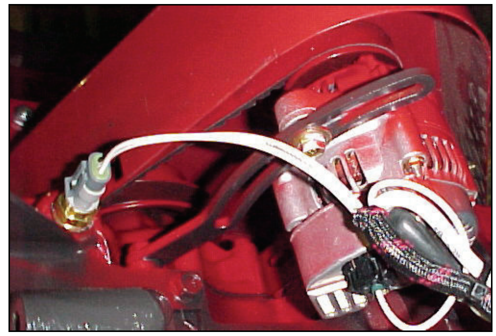
Coolant Temperature Switch Removal/Installation (Cont)

Install the temperature switch.

Torque Value:

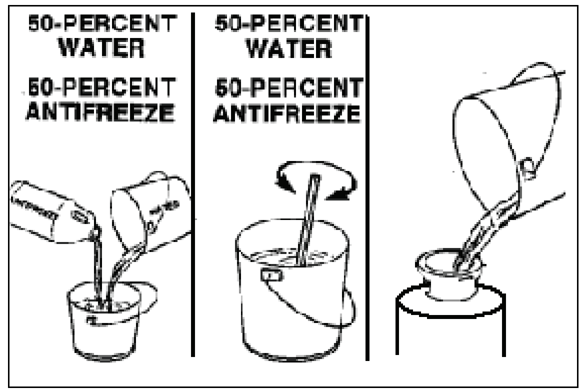
- **(Cast Iron) 50 N•m [37 ft-lb]**
- **(Aluminum) 30 N•m [22 ft-lb]**

Reconnect the wiring connector.



Follow-Up

Fill coolant to proper level. Refer to Drain and Flush Cooling System in Section 5.



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

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

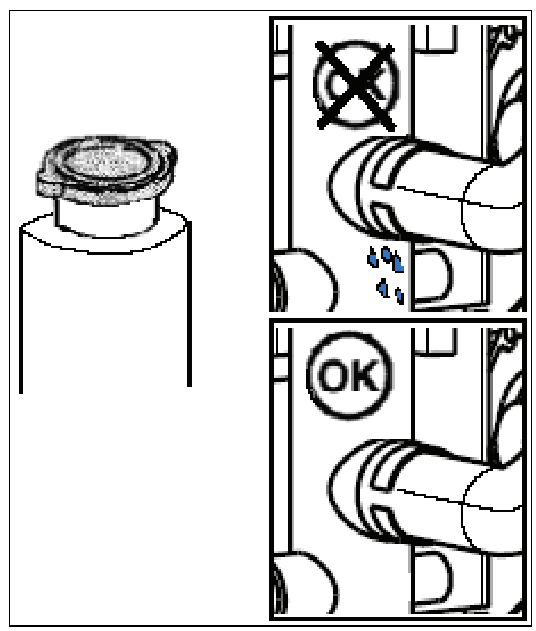
Check for leaks. Repair any leaks.

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 82 and 94°C [180 and 201°F].

Stop the engine.

Check coolant level. Refer to instructions in section 5.



Coolant Thermostat Removal/Installation

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 (Cummins Fire Power Part No. 11407) 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

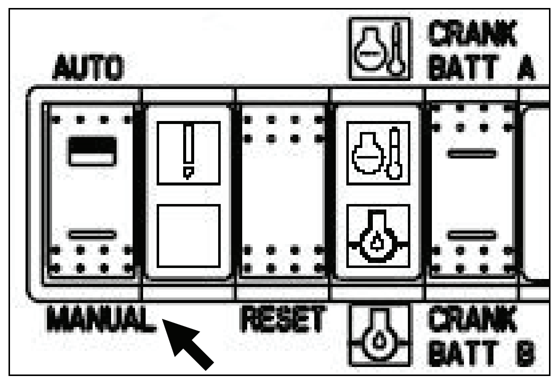
Always use the correct thermostat, and never operate the engine without a thermostat installed. The engine can overheat if operated without a thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet. An incorrect thermostat can cause the engine to overheat or run too cold.

Prepare

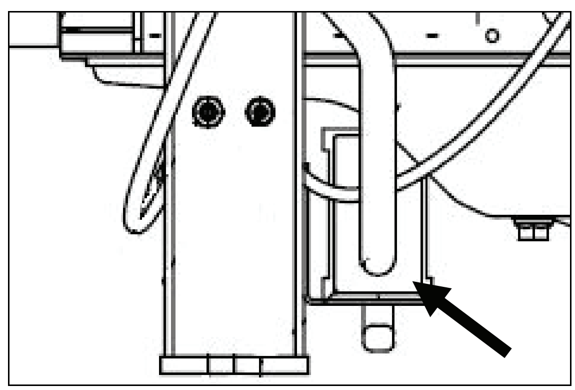
Place the fire protection system in a safe mode for engine service.

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

Disconnect the battery cables at the battery source.

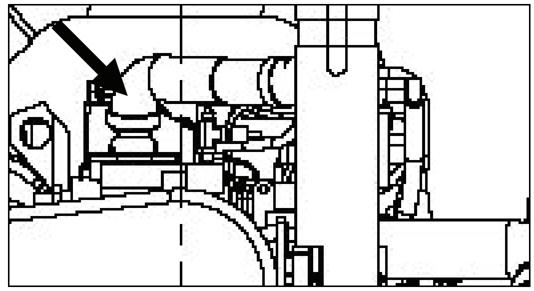


Drain the coolant. Refer to Drain and Flush Cooling System in Section 5.



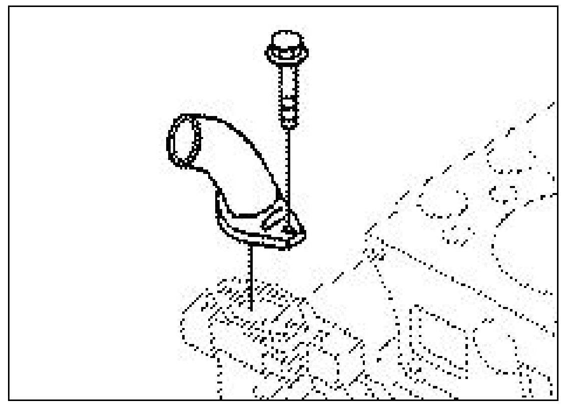
Coolant Thermostat Removal/Installation (Cont)

Disconnect the coolant hose. Refer to Remove Upper Engine Coolant Hose in this section.



Remove

Remove the two mounting capscrews and the water outlet connection.



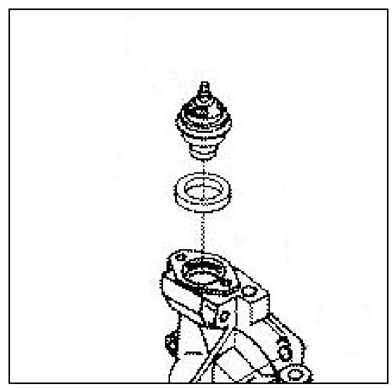
Remove the thermostat and seal.

Use a clean rag to plug the water outlet until the thermostat is installed.

Inspect the thermostat for obvious damage such as obstructions caused by debris, broken springs, or stuck or missing vent pins.

Make sure the thermostat is clean and free from corrosion.

Replace any defective or excessively corroded thermostat.



Coolant Thermostat Removal/Installation (Cont)

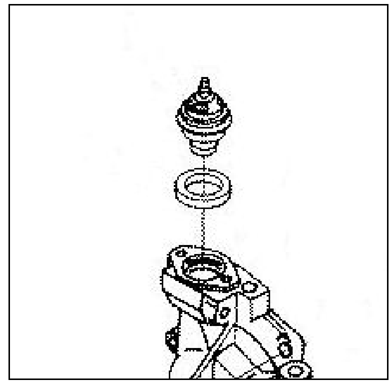
Install

CAUTION

Always use the correct thermostat, and never operate the engine without a thermostat installed. The engine can overheat if operated without a thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet. An incorrect thermostat can cause the engine to overheat or run too cold.

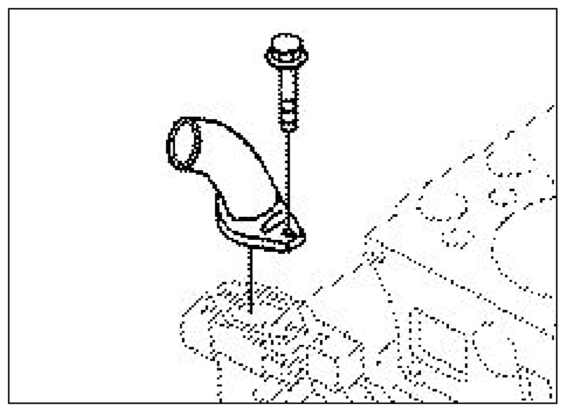
If used, remove the rag from the hole in the water pump.

Install the thermostat (Cummins Part No. C6004216120) and new thermostat seal (Cummins Part No. C6140116331) into the water pump.

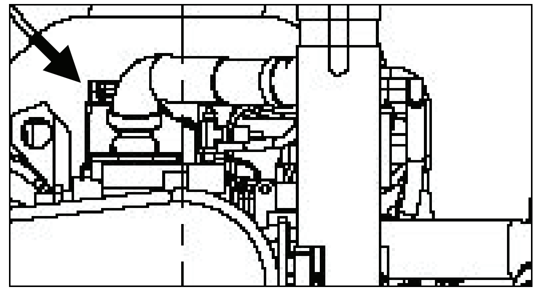
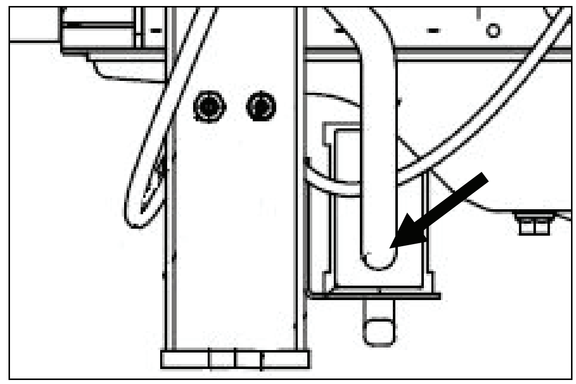
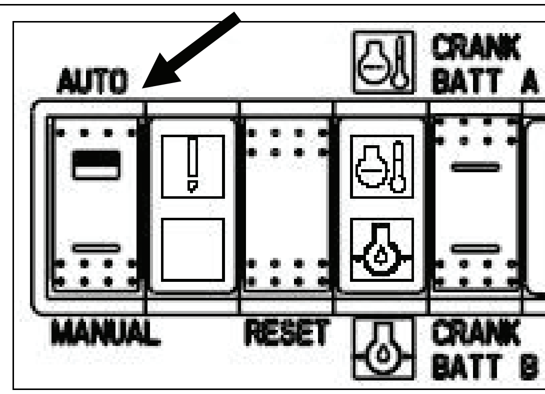


Install the water outlet connection and the two mounting capscrews.

Torque Value: 19 N•m [14 ft-lb]



Coolant Thermostat Removal/Installation (Cont)

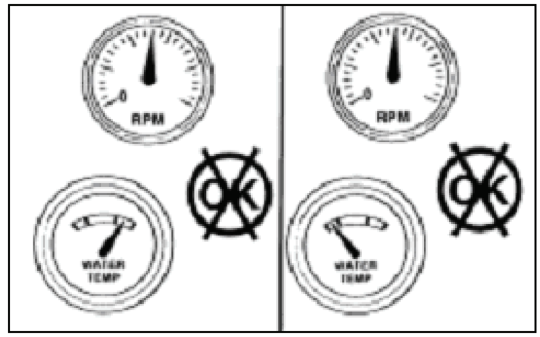
Follow-Up Connect the coolant hose. Refer to Install Upper Engine Coolant Hose in this section.		
Check that the lower coolant heater hose is installed. Refer to Install Lower Coolant Heater Hose in this section. Fill the cooling system. Refer to Drain and Flush Cooling System in Section 5.		
Start the 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. Check for leaks. Repair any leaks. Allow the engine to approach operating temperature.		
Check that engine operating temperature stabilizes between about 82 and 95°C [180 and 203°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 Test in Section 3. Ensure that repairs are completed satisfactorily. Place the AUTO/MANUAL Switch at the local panel in the AUTO position.		

Coolant Thermostat Tests

Coolant Thermostat Leak Test

CAUTION

The engine thermostat must operate properly in order for the engine to operate in the most efficient heat range. Overheating or overcooling will shorten engine life.



WARNING

Do not remove the pressure cap (Cummins Fire Power Part No. 11407) 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.

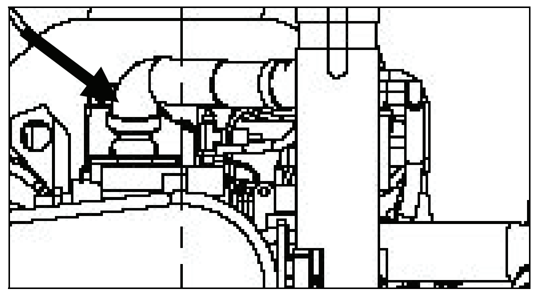
Allow the engine to cool well below 83°C [181°F].

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

NOTE: If coolant starts to leak at the hose clamp, then drain the engine until the leakage stops. Refer to <u>Drain and Flush Cooling System</u> in Section 5.

Loosen the hose clamp on the Upper Engine Coolant Hose.

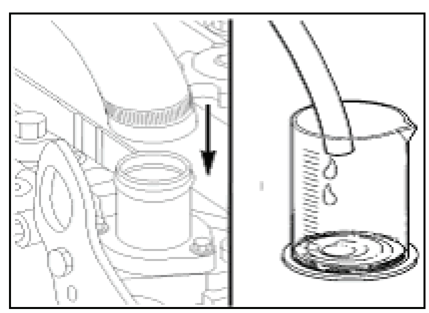
Remove the hose from the water outlet connection.



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

Install and tighten a hose clamp on the water outlet.

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



Coolant Thermostat Tests (Cont)

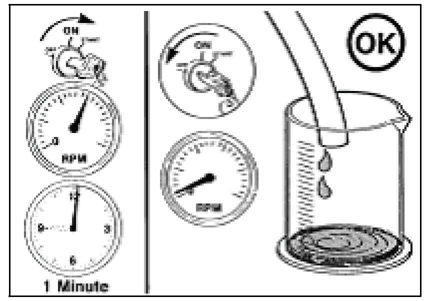
Start the engine. Refer to Local Starting Procedure for Test in Section 3.

Operate the engine at rated rpm for 1 minute.

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

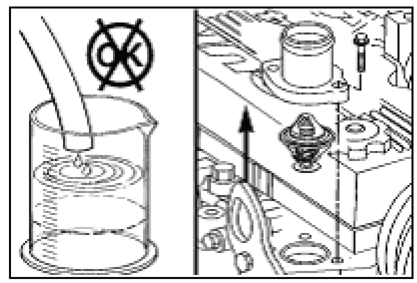
NOTE: The amount of coolant collected must not be more than 100 cc [3.3 fl oz].

Measure the amount of coolant collected in the container.



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.

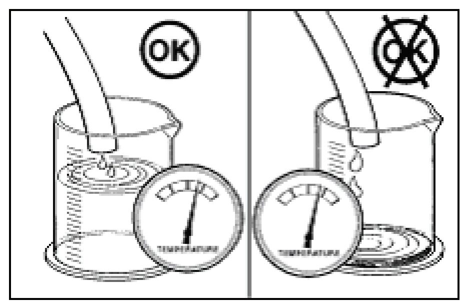
NOTE: Monitor water temperature on the water temperature gauge on the engine control panel.

Allow the engine to approach operating temperature.

Thermostat Initial Opening Temperature

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

When the coolant starts to flow or if temperature exceeds the maximum, stop the engine. Refer to Local Starting Procedure for Test in Section 3.



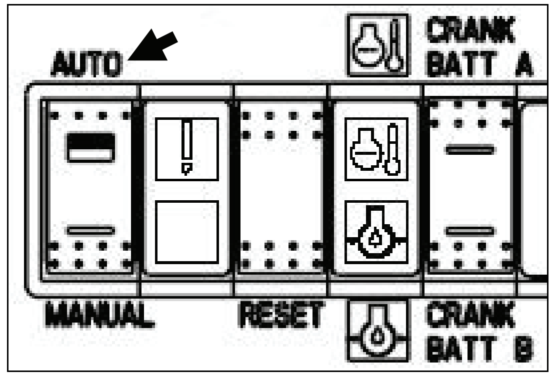
Coolant Thermostat Tests (Cont)

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.

Install the heat exchanger hose and tighten hose clamp.

Refill any lost coolant. Refer to Check Coolant Level in Section 5.

When work is completed, place the AUTO/MANUAL Switch at the local panel in the AUTO position.



Coolant Water Pump Removal/Installation

Prepare

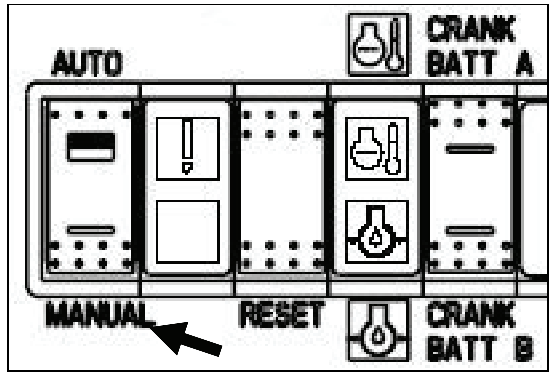
WARNING

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

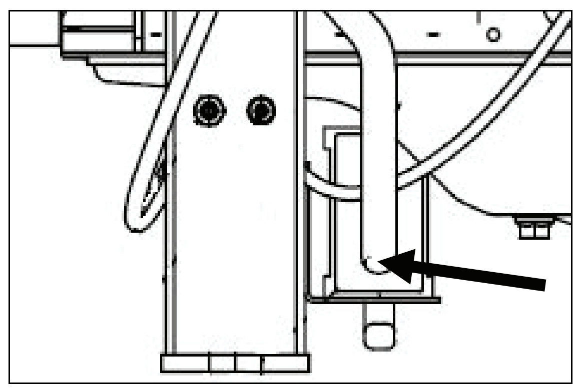
WARNING

Do not remove the pressure cap (Cummins Fire Power Part No. 11407) 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.

Press the MANUAL position on the AUTO/MANUAL rocker switch on the fire pump engine control panel.

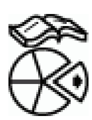


Drain engine coolant as required for the intended service. Refer to Drain and Flush Coolant System in Section 5.

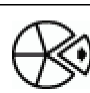


If installed, remove the Belt Guard. Refer to Belt Guard Removal/Installation in this section.

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



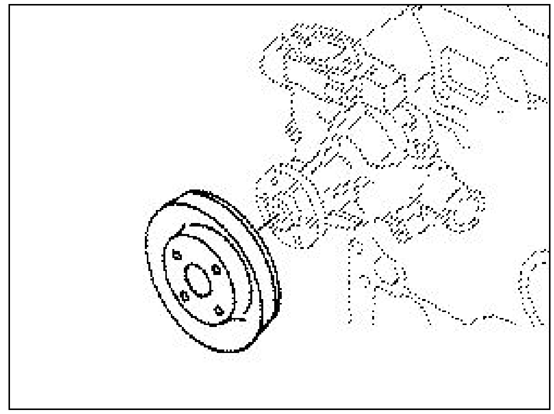
If installed, remove the Upper Engine Coolant Hose. Refer to Remove Upper Engine Coolant Hose in this section.



Coolant Water Pump Removal/Installation (Cont)

Remove

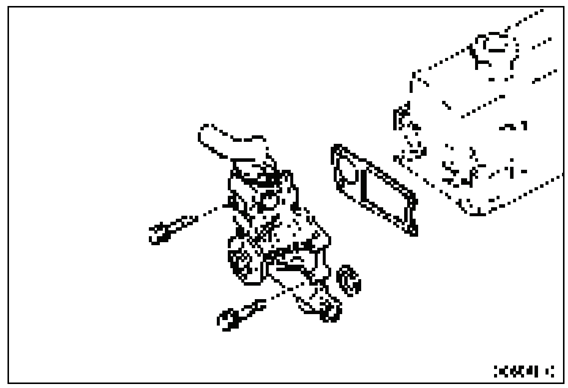
Remove the four capscrews and the fan pulley mounting.



Water Pump

Remove the mounting capscrews, water pump, gasket, and o-ring.

Discard the gasket and o-ring.



Install

Replace any disassembled seals or gaskets with new components.

Install the water pump.

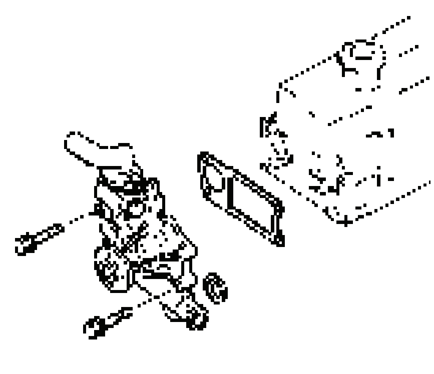
Refer to Water Pump Service Parts

Water Pump

Install the o-ring, gasket, water pump, and mounting capscrews.

Tighten the capscrews.

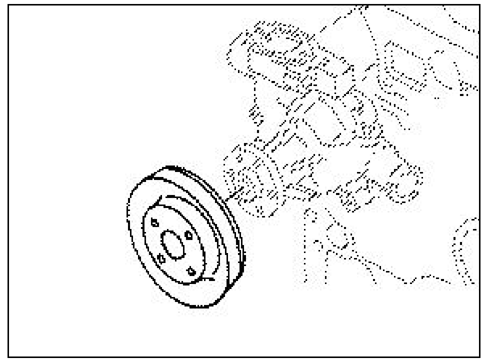
Torque Value: 19 N•m [14 ft-lb]



Coolant Water Pump Removal/Installation (Cont)

Install the four capscrews and the fan pulley mounting.

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



Follow-Up

Install the Upper Engine Coolant Hose. Refer to Install Upper Engine Coolant Hose 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.

Ensure that the lower coolant heater hose is reinstalled. Refer to Install Lower Coolant Heater Hose in this section.

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

If removed, install the heat exchanger pressure cap (Cummins Fire Power Part No. 11407).

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

Check for leaks. Repair any leaks.

Check that the alternator is charging.

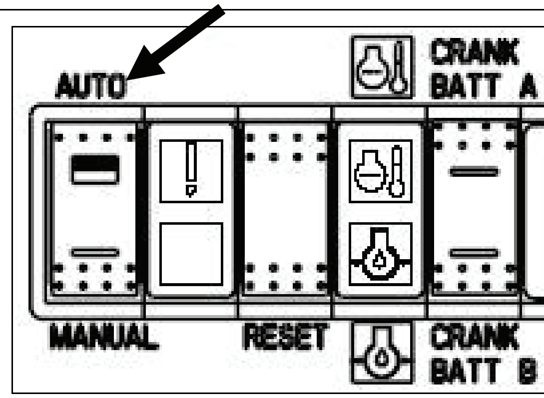
Coolant Water Pump Removal/Installation (Cont)

Check that engine operating temperature stabilizes between 82 and 95°C [180 and 203°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 Test in Section 3.

Ensure that repairs are completed satisfactorily.

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



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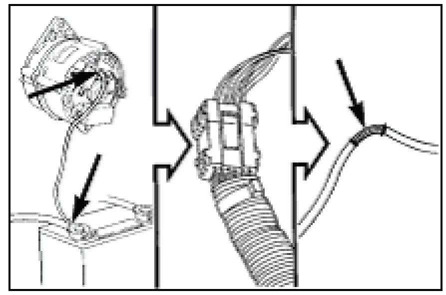
Alternator Checks and Testing

Alternator Wiring Integrity Check



NOTE: Refer to Drawing 10423 Sheet 1, Drawing 10423 Sheet 2, and Drawing 9766 in Section 13 for schematic details.

WARNING

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

WARNING

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

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

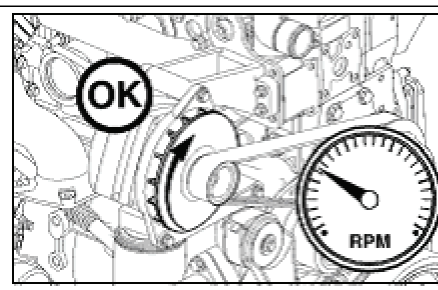
Check all connections for tightness and cleanliness. Include both the slip connectors at the alternator and connections at the battery.

NOTE: Continuity should be in the single digit Ohms or less. Resistance to ground should be in the mega-Ohm range. Refer to any applicable customer criteria.

Using a digital multimeter or other test equipment, check for continuity between terminals. Check also the insulation resistance to ground.

Correct any electrical faults.

Alternator Mechanical Check



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

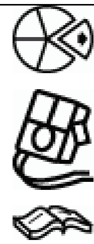
Visually check the drive belt and alternator pulley to be sure the alternator is rotating.

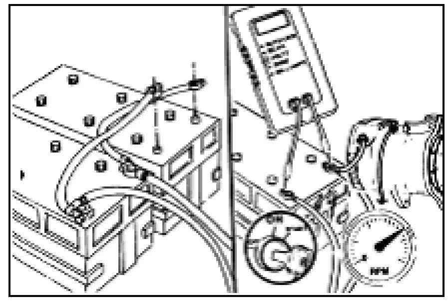
Note any unusual noises such as from belt whine or alternator mechanical fault.

Stop the engine.

Correct any mechanical failures.

Alternator Checks and Testing (Cont)





Alternator Voltage Output Test

CAUTION

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

CAUTION

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

NOTE: Conduct this testing at normal shop temperature.

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

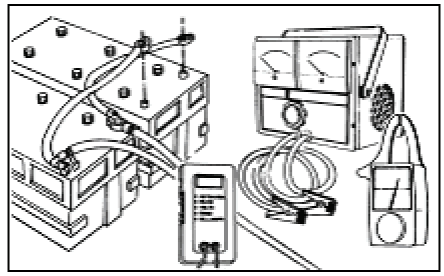
Start the engine and operate at rated speed. Refer to Normal Local Starting Procedure in Section 3.

Measure the alternator voltage output to the batteries with digital multimeter, Cummins Part Number 3377161.

Stop the engine.

Replace the alternator if the voltage exceeds specification. Refer to Alternator Removal/Installation in this section.

Alternator Checks and Testing (Cont)



Alternator Amperage Output Test

NOTE: Conduct this testing at normal shop temperature.

NOTE: Refer to Electrical Specifications in Section 10 for the minimum required alternator output. Use the value listed for the system voltage.

Connect a carbon pile load in parallel across the battery terminals. Refer to Jumpering the Batteries in Section 3 for how to make a parallel connection.

Connect a clamp-on (induction) ammeter across the alternator output cable.

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

Adjust the carbon pile for maximum indication.

Note the amperage indicated on the ammeter.

Stop the engine.

Remove the test equipment.

Replace the alternator if the output is not 90% or more of the specification value. Refer to Alternator Removal/Installation in this section.

Alternator Removal/Installation

Prepare

Remove the belt guard. Refer to Belt Guard Removal/Installation in this section.

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

NOTE: Refer to Drawing 8885 Sheet 1 in Section 13 for wiring harness information.

NOTE: Ensure that the connectors are clearly tagged for the correct reconnection.

Disconnect the engine wiring harness connectors from the alternator.

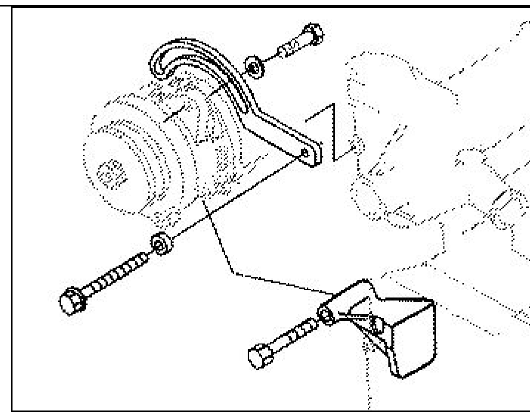
Remove

Remove the adjusting capscrew and washer.

Remove the capscrew, adjustment plate, and spacer.

Remove the remaining capscrew and alternator.

NOTE: If the alternator bracket must also be removed, go to Alternator Bracket Removal/Installation in this section.



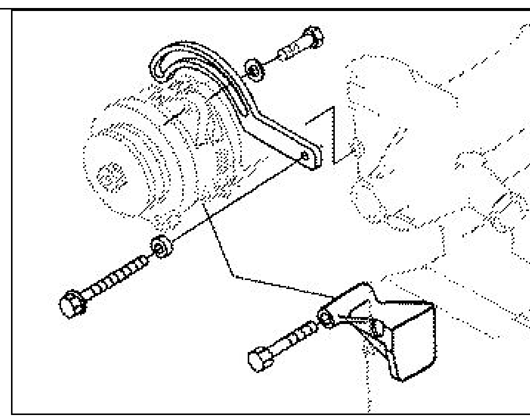
Install

Ensure that the alternator bracket is installed. Refer to Alternator Bracket Removal/Installation in this section.

Install the alternator and capscrew.

Install the spacer, mounting capscrew, and adjustment plate.

Loosely install the washer and adjustment capscrew.

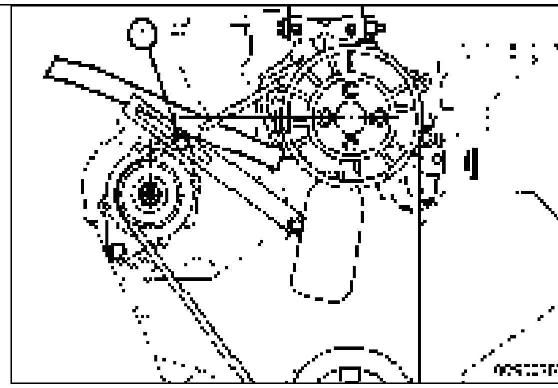


Alternator Removal/Installation (Cont)

WARNING

Be careful not to injure your fingers or damage the alternator when adjusting the belt tension.

NOTE: The belt must deflect 7 mm to 10 mm [0.28 in to 0.39 in] when pushed with finger-pressure of 6 kg [13 lb] at a point midway between the fan pulley and the crankshaft pulley.



Insert a bar or pipe between the alternator and the cylinder block.

Raise the alternator to adjust the fan tension.

Tighten the adjustment capscrew (1).

Torque Value: 31 N•m [23 ft-lb]

Tighten the mounting capscrew.

Torque Value: 31 N•m [23 ft-lb]

Follow-Up

NOTE: Refer to Drawing 8885 Sheet 1 in Section 13 for wiring harness information.

Connect the engine wiring harness connectors to the alternator.

Install the belt guard. Refer to Belt Guard Removal/Installation in this section.

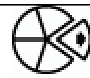
Alternator Bracket Removal/Installation

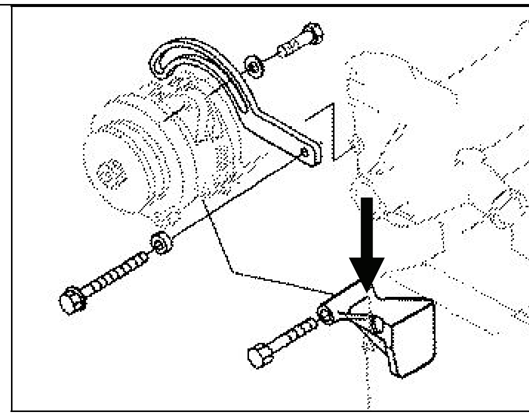
Prepare

Remove the alternator. Refer to Alternator Removal/Installation in this section.

Remove

Remove the alternator mounting bracket and capscrew.



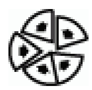


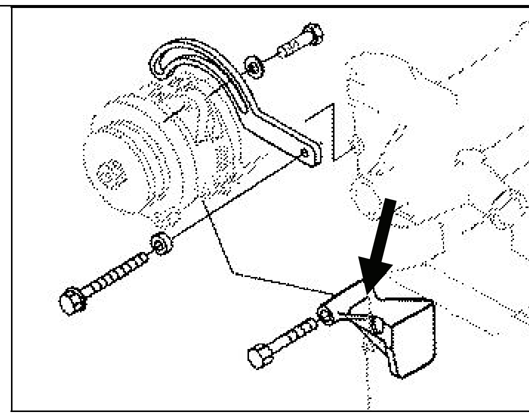
Install

Install the capscrew and alternator mounting bracket.

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

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





Follow-Up

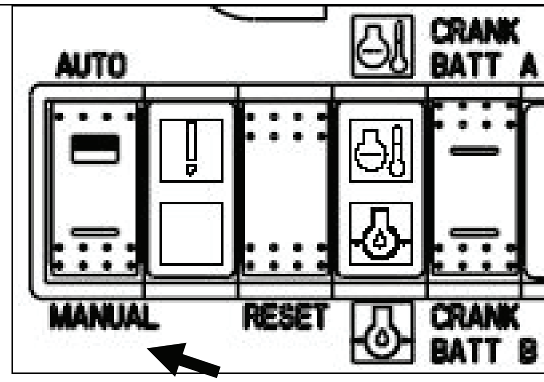
Install the alternator. Refer to Alternator Removal/Installation in this section.

Battery Isolator Removal/Installation

Prepare

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

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



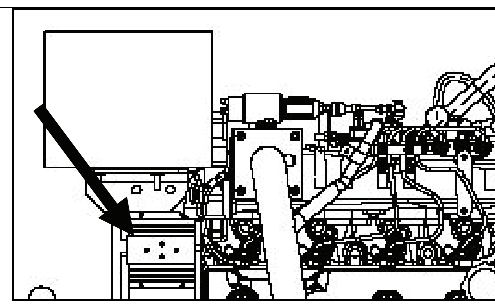
NOTE: Refer to Battery Removal/Installation in this section for detailed instructions for disconnecting the battery cable clamps.

Disconnect the negative battery cable from Battery A.

Disconnect the negative battery cable from Battery B.

Remove

NOTE: Ensure that all battery isolator wires are clearly tagged for reconnection. Also note the orientation of the existing isolator.



Battery Isolator Removal/Installation (Cont)

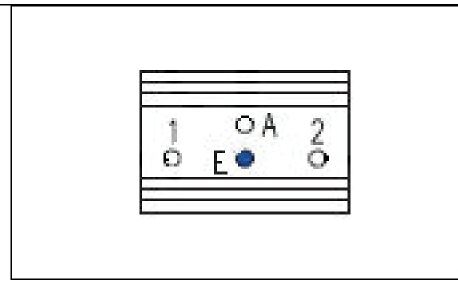
Disconnect the battery cable from terminal 1.

Disconnect the battery cable from terminal 2.

Disconnect the alternator cable from terminal A.

Disconnect the alternator excitation cable from terminal E.

Remove the four mounting nuts and the battery isolator.

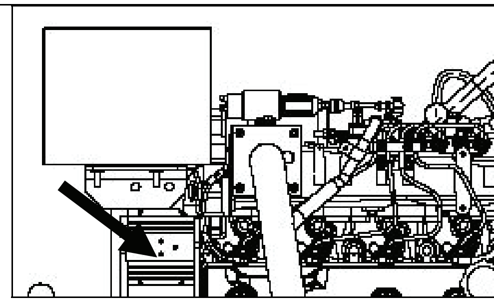


Install

Align and position the battery isolator on the four mounting studs.

Install the four mounting nuts.

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



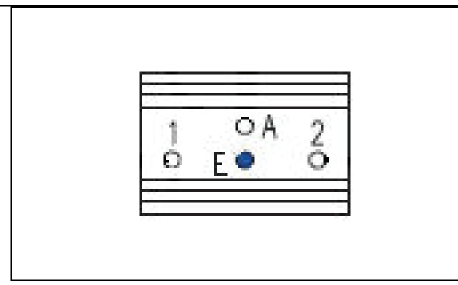
Connect the battery cable at terminal 1.

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.

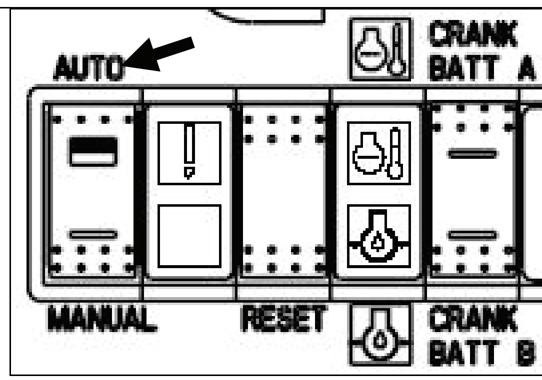
Terminal E indicates battery voltage.

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.

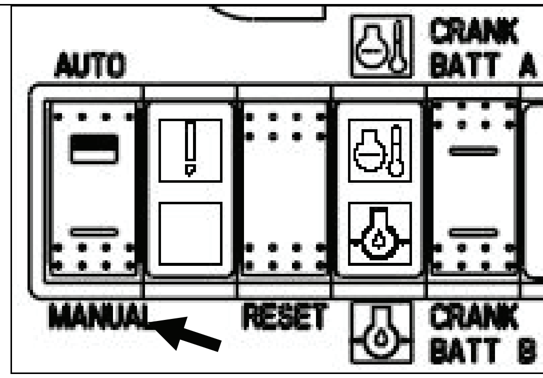


Engine Harness Removal/Installation

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 8885 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 8885 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.

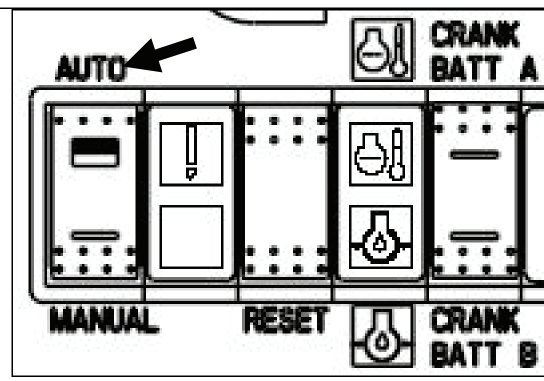
Observe that the engine starts with no unusual noises or vibrations.

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.

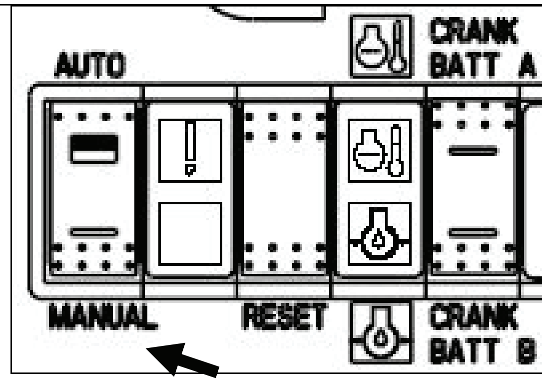


Voltmeter Removal/Installation

Prepare

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

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

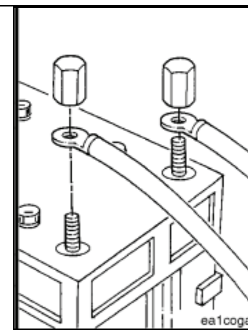


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.



Remove

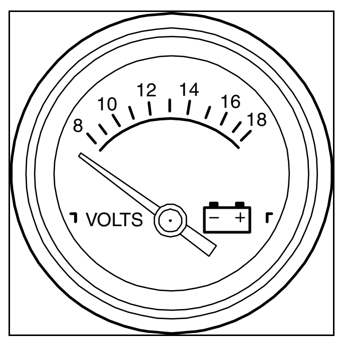
NOTE: Refer to Drawing 10423 Sheet 1 in Section 18 for electrical schematic details.

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

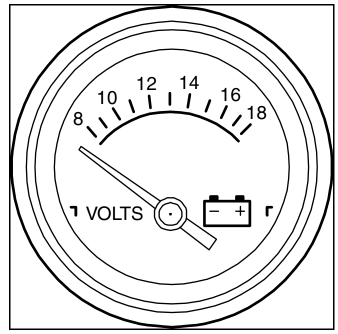
Orient the voltmeter in the cutout in the electrical panel.

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.

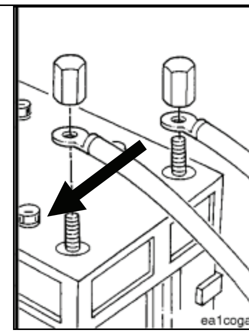


Follow-up

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

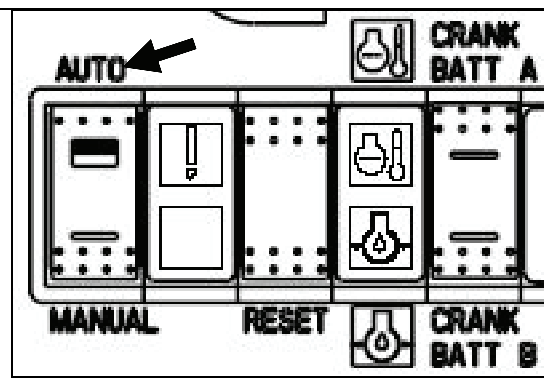
Wear safety glasses when reconnecting batteries!

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.



Battery Testing

WARNING

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

WARNING

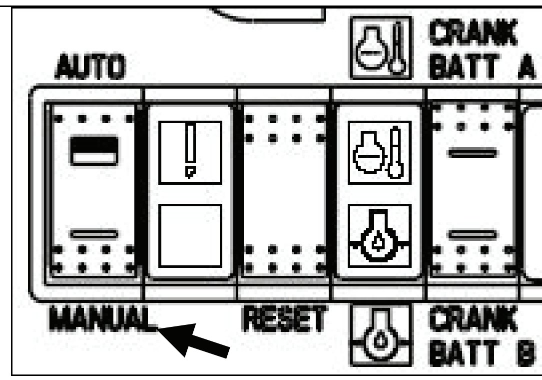
Acid is extremely dangerous and can damage the machinery and can also cause serious burns. Always provide a strong tank of soda water as a neutralizing agent when servicing the batteries. Wear goggles and protective clothing to avoid serious burns.

NOTE: This section is for conventional batteries only. Maintenance-free batteries may be supplied by the customer. These are sealed and do not require the addition of water. Also, specific gravity cannot be checked. If the batteries are not supplied by Cummins Fire Power, follow the battery manufacturer's recommendations for testing and servicing their batteries.

Prepare

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

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

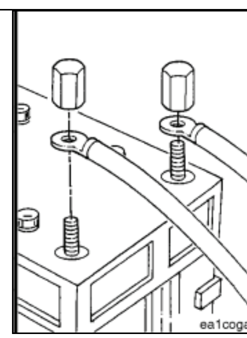


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



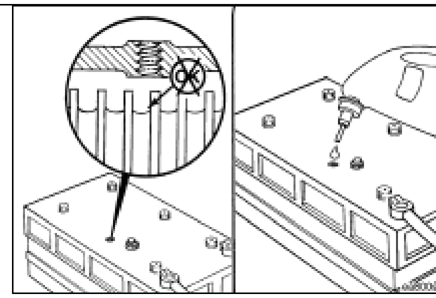
Battery Testing (Cont)

Check Electrolyte Level

Remove all cell covers for both sets of batteries.

Check the electrolyte level in each cell of each battery.

NOTE: Cummins recommends the use of a self-leveling filler. If a syringe type filler is used, use care to prevent overflow or splashing of acid from the cell.



CAUTION

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

CAUTION

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

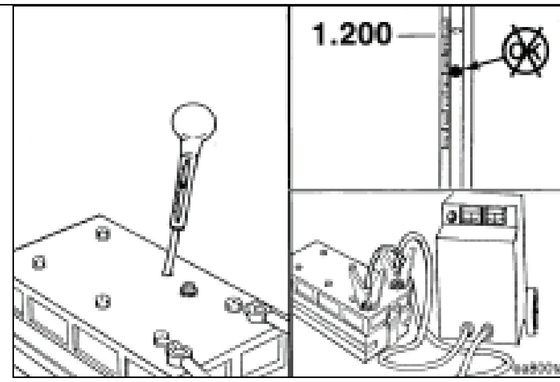
As required, fill each battery cell with distilled water.

Install all cell covers for both sets of batteries.

If water was added, recharge the battery prior to checking specific gravity.

Battery Testing (Cont)

Check Specific Gravity



NOTE: If water has been added to a dry cell, recharge the battery to mix the added water with the existing battery electrolyte. This will prevent incorrect readings.

NOTE: The battery must be more than about ¼ charged before the hydrometer readings can be accurate. Accurate readings may require several hours of charging for a fully discharged battery.

Use a hydrometer to measure the specific gravity of each cell.

State of Charge and Specific Gravity*

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

* At 26.7°C [80°F]

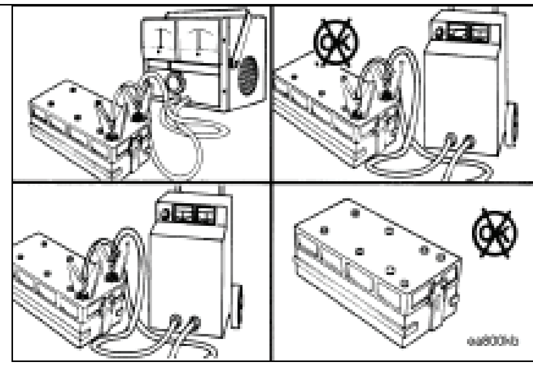
Check the battery fluid column in the refractometer to determine the state of charge of each battery cell.

NOTE: Evaluate the state of charge in respect to the local requirements. A cold location will require a greater specific gravity than a hot climate for the necessary cranking amperes.

If charge is low, charge the batteries. Refer to <u>Battery and Electrical Installation</u> in Section 3.

Battery Testing (Cont)

Check Battery Output



⚠CAUTION⚠

Do not connect battery charging cables to any electronic control system part. This can damage the electronic control system parts.

NOTE: Use the inductive charging-cranking systems analyzer, Cummins Part Number 3377193, to test the output amperage of either maintenance-free or conventional vent cap batteries. Follow the instructions provided with the test equipment.

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

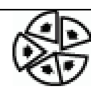
Test both sets of batteries.

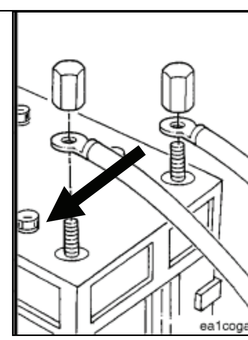
NOTE: For customer supplied batteries, refer to the manufacturer's literature for charging instructions.

If the output amperage is low, charge the battery. Refer to Battery and Electrical Installation in Section 3.

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

Follow-up





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

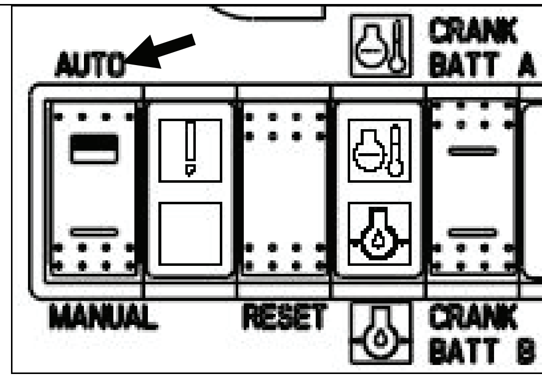
Wear safety glasses when reconnecting batteries!

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

Battery Testing (Cont)

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

Return the fire protection system to operating status.



Battery Removal/Installation

WARNING

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

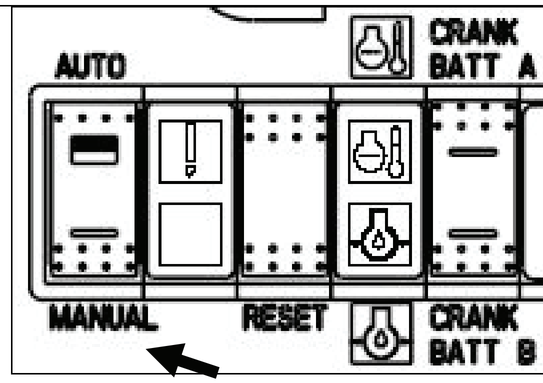
WARNING

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

Prepare

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

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

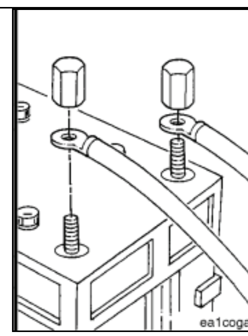


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.



Clear and ventilate the battery storage area.

Collect the necessary tools and safety equipment.

Battery Removal/Installation (Cont)

Remove

NOTE: Use the correct battery tools. Use end wrenches to loosen the battery clamps. Use a battery cable puller to remove tight cable clamps from the battery terminal. Use a battery carrier to lift and carry the battery.

Remove any battery support hardware.

WARNING

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

Loosen the battery cable clamps.

Remove the negative battery cable first.

Remove the positive battery cable first.

WARNING

Do not tip the battery and spill the acid.

Using a battery carrier, lift and remove the battery.

If disposing of the battery, dispose of it in accordance with all applicable environmental regulations.

Clean

NOTE: Use the correct battery tools. Use a terminal cleaning brush for the battery terminal. Use a putty knife and wire brush to remove dirt and corrosion from the battery body and any support.

Clean the battery posts to remove all corrosion and to expose the metal.

Remove any other corrosion or debris from the battery body or battery support.

Battery Removal/Installation (Cont)

Install

NOTE: Use the correct battery tools. Use a battery cable clamp spreader to install tight cable clamps on the battery terminal. Use end wrenches to tighten the battery clamps.

WARNING

Do not tip the battery and spill the acid.

Using a battery carrier, carry and position the battery.

WARNING

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

Spread the positive cable clamp and position the clamp on the post.

Tighten the positive cable clamp.

Spread the negative cable clamp and position the clamp on the post.

Tighten the negative cable clamp.

Install any battery support hardware.

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

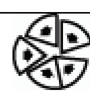
Follow-Up

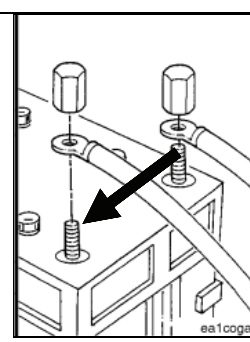
If new batteries are installed, charge the batteries. Refer to Battery and Electrical Installation in Section 3.

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

Wear safety glasses when reconnecting batteries!

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

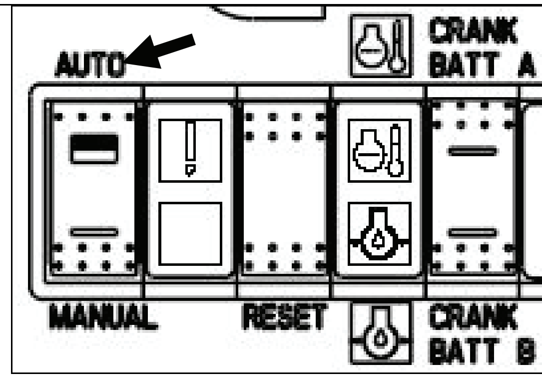




Battery Removal/Installation (Cont)

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

Return the fire protection system to operating status.



Check Battery Cables and Connections

WARNING

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

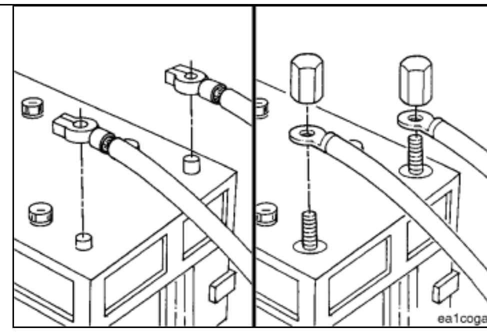
WARNING

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

NOTE: There are two possible heavy-duty battery connections:

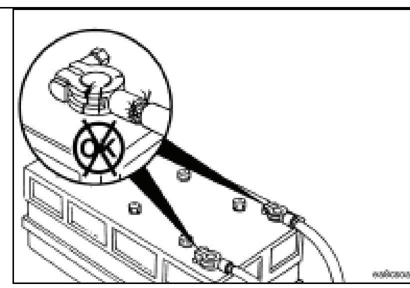
Battery terminal and clamp

Threaded battery terminal and nut



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

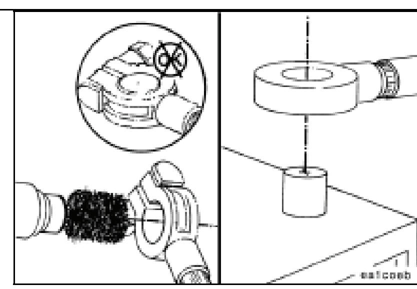
Replace broken terminals, connectors, or cables.



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

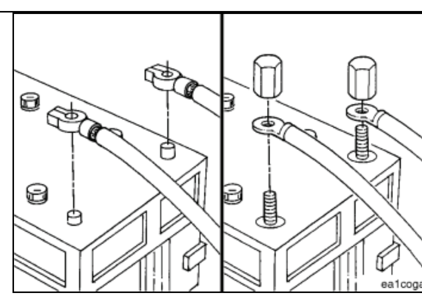
Alternatively, if a brush won't do the job, use an acid neutralizing solution to remove the corrosion.

Brush or wipe all residue or debris from the terminals.



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

Install the cables and tighten the battery connections.

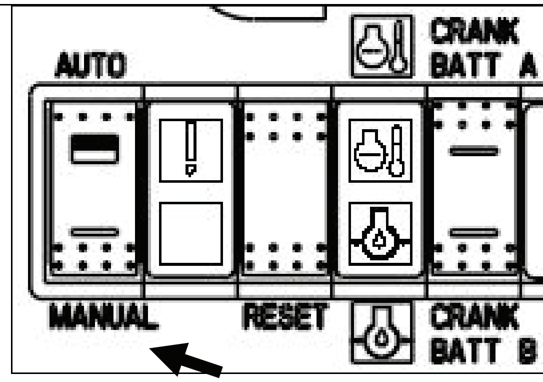


Starter Motor Assembly Removal/Installation

Prepare

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

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

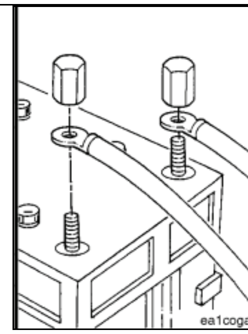


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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

Wear safety glasses when disconnecting batteries!

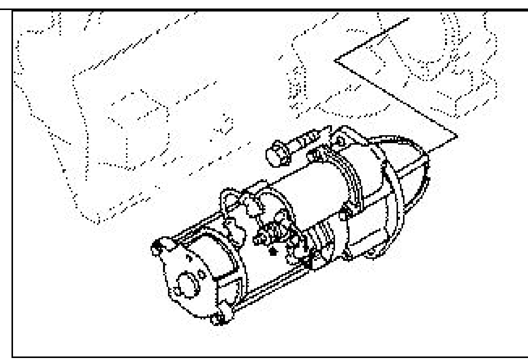
Next, disconnect both batteries at their terminals.



Remove

Remove the three capscrews and starter motor.

Inspect the starter motor gears. If gear damage is present, check also the ring gear.



Starter Motor Removal/Installation (Cont)

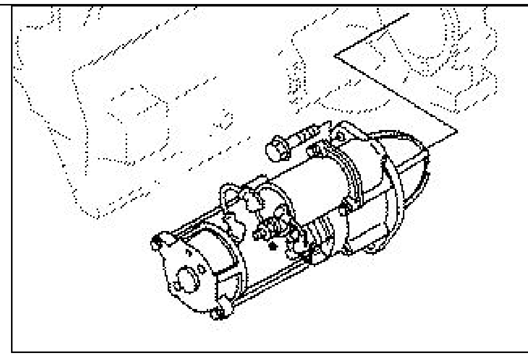
Install

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

Align and install the starter motor.

Install and tighten the three mounting capscrews.

Torque Value: 43 N•m [32 ft-lb]

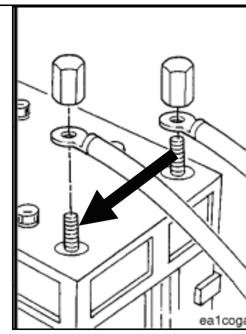


Follow-up

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.



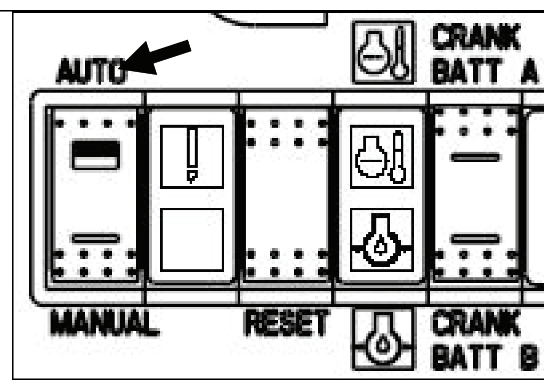
Start the engine. Refer to Normal Local Starting Procedure in Section 3.

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.



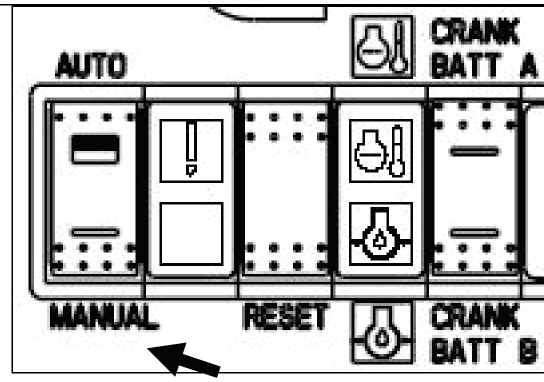
Crank Solenoid Assembly Removal/Installation

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.

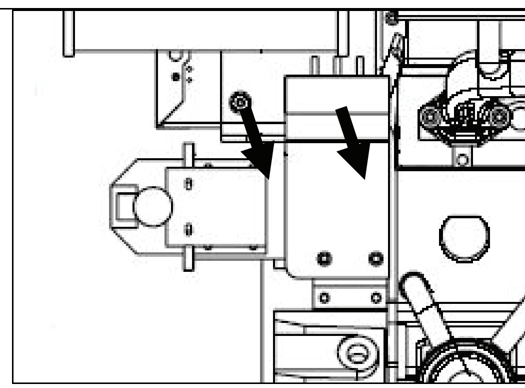
NOTE: Observe the location of flat and lock washers for ease of reconnection.

NOTE: Save the nuts, bolts, flat washers, and lock washers for reuse.

Disconnect all electrical connectors from the solenoid's four terminal studs.

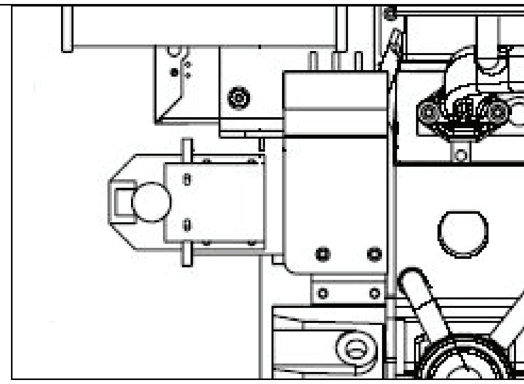
Loosen the four sets of mounting nuts, bolts, and washers.

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.

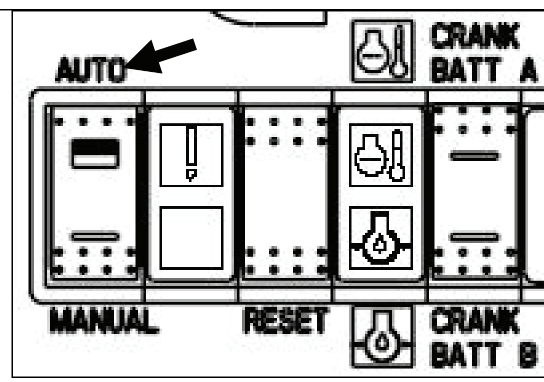
Start the engine manually from the crank solenoid lever handle. Refer to Normal Local Starting Procedure in Section 3.

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.

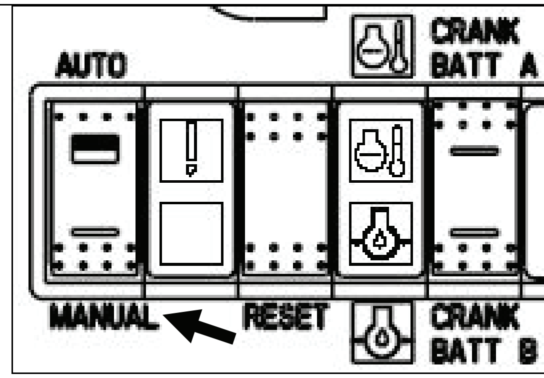


Control Panel Fuse Replacement

Prepare

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

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

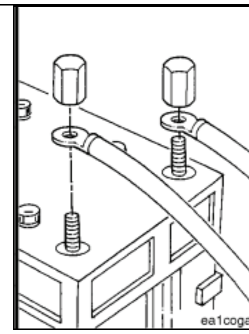


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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!

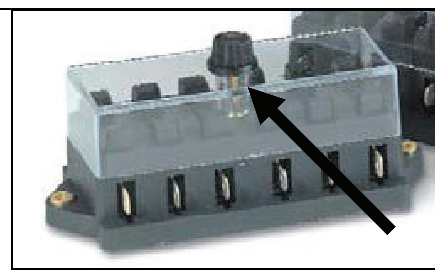
Next, disconnect both batteries at their terminals.



Remove

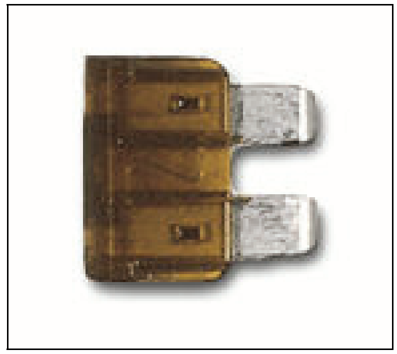
Open the fire pump engine’s local control panel.

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.

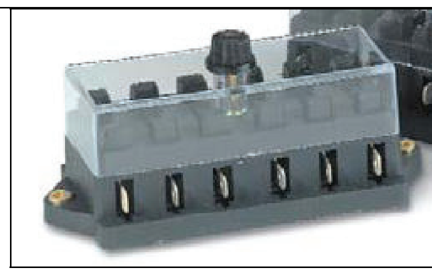
Pull the fuse from the fuse block.

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.

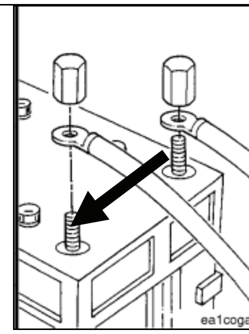
Control Panel Fuse Replacement (Cont)

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.



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 <u>Normal Local Starting Procedure</u> in Section 3.

Observe that the engine starts with no unusual indications.

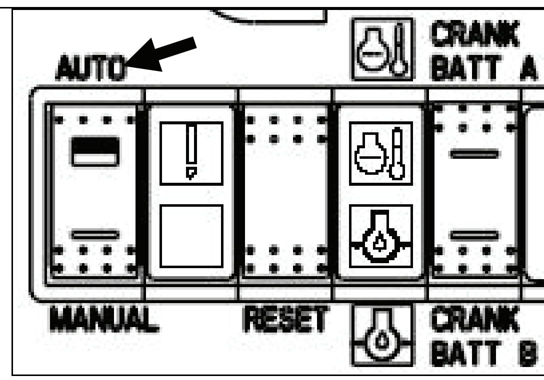
Observe that engine speed is indicated.

Observe that raw water flow has started.

Stop the engine.

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

Return the fire protection system to operating status.



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Exhaust Manifold Removal/Installation

Prepare

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

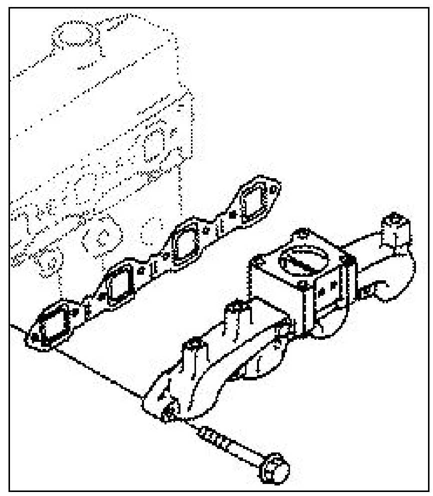
Remove the heat shield. Refer to Exhaust Shield Removal/Installation in this section.

Remove the exhaust outlet piping from the turbocharger. Refer to Turbocharger Exhaust Piping Removal/Installation in this section.

Remove the turbocharger. Refer to Turbocharger in Engine Disassembly in Troubleshooting and Repair Manual B3.3 Series Engines, Bulletin Number 3666418-00.

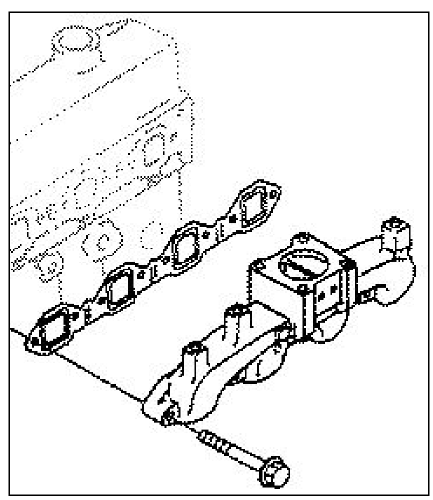
Remove

Refer to Exhaust Manifold in Engine Disassembly in Troubleshooting and Repair Manual B3.3 Series Engines, Bulletin Number 3666418-00.



Install

Refer to Exhaust Manifold in Engine Assembly in Troubleshooting and Repair Manual B3.3 Series Engines, Bulletin Number 3666418-00.



Exhaust Manifold Removal/Installation (Cont)

Follow-Up

Install the turbocharger. Refer to Turbocharger in Engine Assembly in Troubleshooting and Repair Manual B3.3 Series Engines, Bulletin Number 3666418-00.

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 heat shield. Refer to Exhaust Shield Removal/Installation in this section.

Install the air intake piping at the turbocharger. 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.

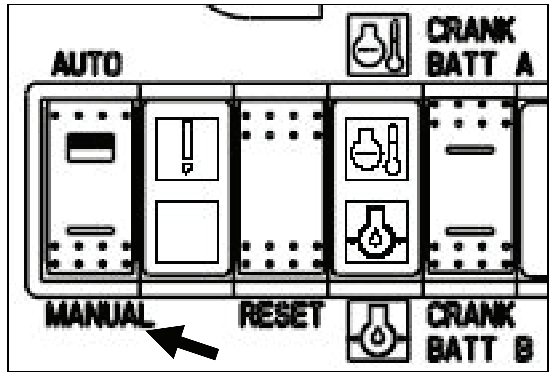
If the backpressure exceeds specification, modify the exhaust piping accordingly.

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.

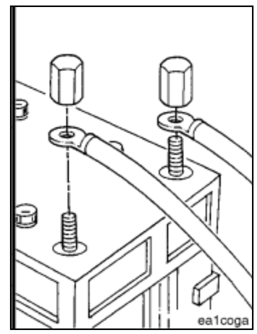


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

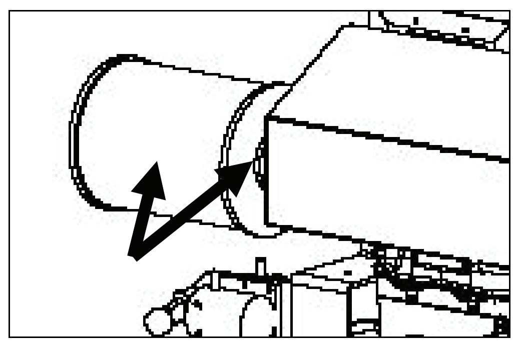
For safety reasons, both batteries must be disconnected before performing service on the Firepump Engine or on any of its controls. Before disconnecting the batteries, place the Firepump Controller in its appropriate service position in order to avoid a “Battery Failure” alarm.

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.

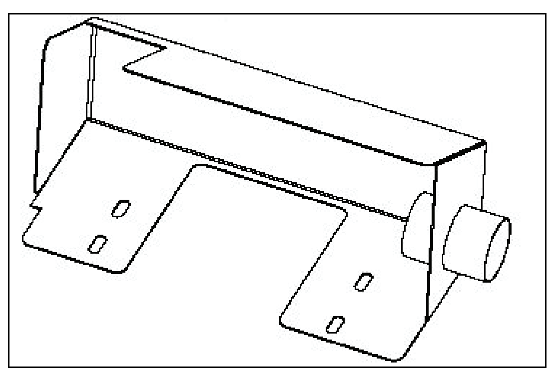


Remove the air filter and air inlet pipe from the turbocharger. Refer to instructions in this section.



Remove

Remove the exhaust shield and fasteners. Refer to Drawing 8795 in Section 13.

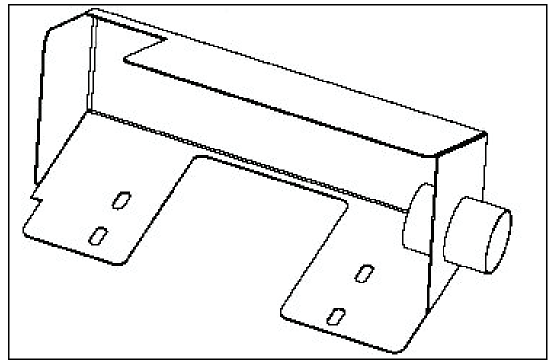


Exhaust Shield Removal/Installation (Cont)

Install

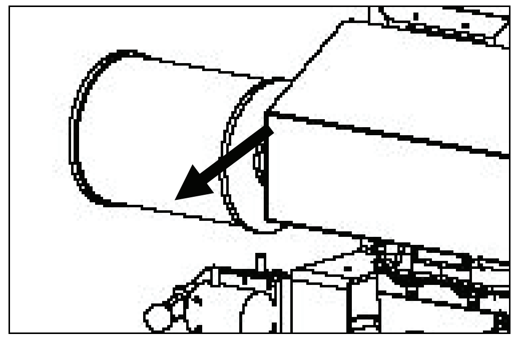
Install the exhaust shield and fasteners. Refer to Drawing 8795 in Section 13.

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



Follow-Up

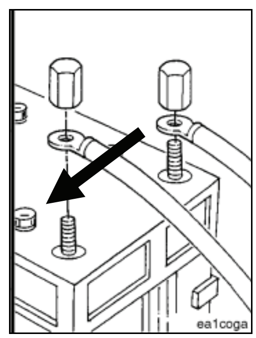
Install the air filter and air inlet pipe at the turbocharger. Refer to instruction in this section.



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!

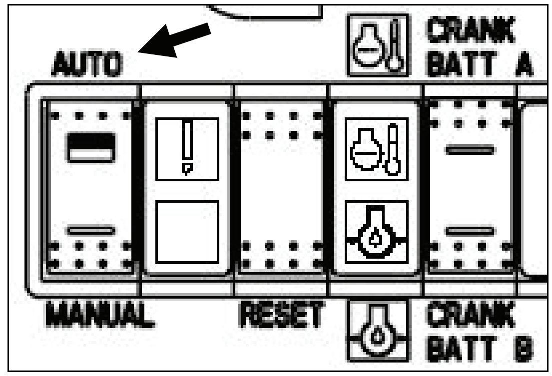
Reconnect the batteries at their terminals after all service work has been completed.



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.

Exhaust Shield Removal/Installation (Cont)

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



Air in Fuel

General Information

WARNING

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

WARNING

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

The low-pressure fuel system for a Cummins engine consists of the fuel tank, lines between tank and engine, transfer pump and lines, and fuel filter and lines. Air or bubbles at the injection pump can cause no or erratic engine operation and/or subsequent malfunction of the fuel injection pump. Air can be introduced by leaks in the fuel system prior to the transfer pump since fuel pressure is a vacuum. Bubbles can result from any number of restrictions in the system:

Plugged fuel filter

Crimped fuel line

Stopped-up tank module

Inoperative transfer pump

If sufficient fuel reaches the injection pump from the low-pressure system, then solutions to engine operational problems are elsewhere. The following steps will aid in evaluating low-pressure fuel system performance in absence of fault codes.

NOTE: For cold-start/performance problems, perform the following steps:

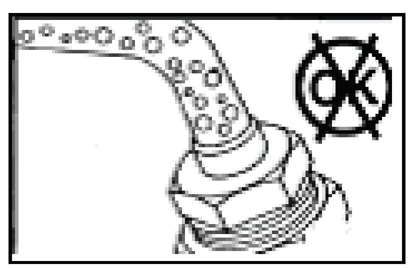
Leave engine outside in cold environment for at least 12 hours.

Perform outlined test.

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

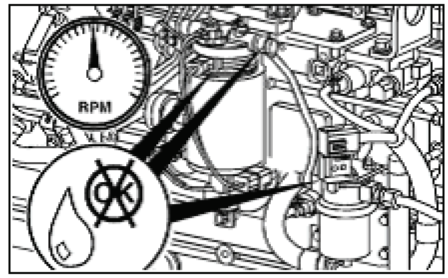
Test

NOTE: 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)

NOTE: 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.

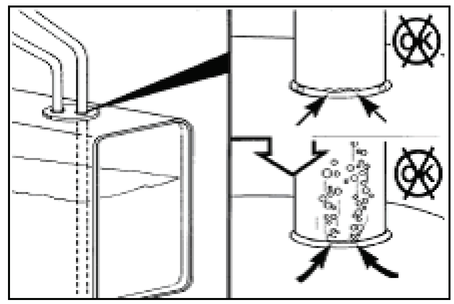


If air continues to bubble out of the system for several minutes, then an air leak is present.

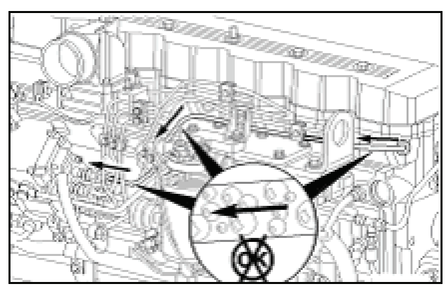
NOTE: An often overlooked source from which air can enter the fuel system is between the inlet of the fuel transfer pump and the suction tube in the tank. Fuel tanks that have the outlet fitting at the top will have a suction tube that extends to the bottom of the tank. Cracks or pin holes in the weld 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.



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



Air in Fuel (Cont)

NOTE: A stuck-open injector can also blow combustion gas back into the pump and cause air to be present in the overflow.

If the engine seems to be misfiring or running rough, break all the injector supply lines loose at the pump end.

Crank the engine, and observe the lines.

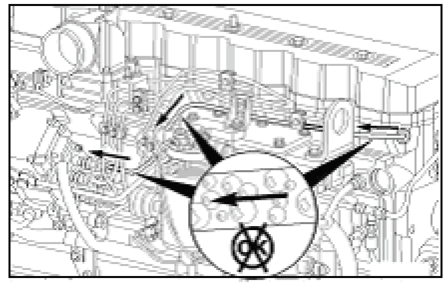
If combustion gas seems to be blowing back through the line, the injector is stuck open.

Remove the injector.

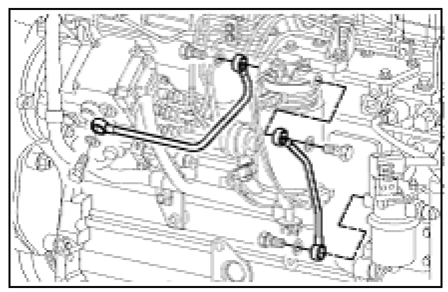
Take the engine to an Authorized Cummins Repair Facility/Dealer Location for testing.

Torque Value: 24 N•m [212 in-lb]

NOTE: Use two wrenches when loosening the lines at the fuel pump: One to hold the delivery valve and one to loosen the fuel line.

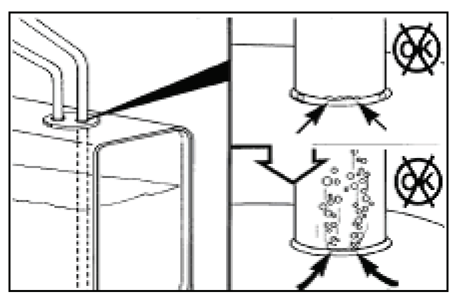


Disconnect the fuel line from the outlet of the fuel filter.



If bubbles are present, check for air leaks in the fuel supply circuit.

Measure the amount of fuel in the container. If more than 1.33 liters [45 fl oz] are collected and the fuel is bubble-free, then it is unlikely the low-pressure fuel system is the cause of engine operational problems.

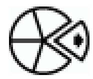


Fuel Filter Adapter Removal/Installation

Prepare

Clean debris

Remove fuel filter.




Remove

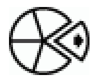
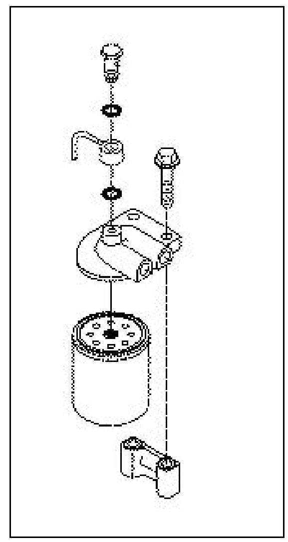
Disconnect the fuel drain hose to the drain manifold.

Tag the inlet and outlet fuel hoses for ease of reconnection.

Disconnect the fuel inlet hose.

Disconnect the fuel outlet hose.

Remove the two mounting capscrews, the filter head, and the mounting spacer.

Install

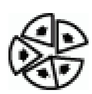
Install the two mounting capscrews, the filter head, and the mounting spacer.

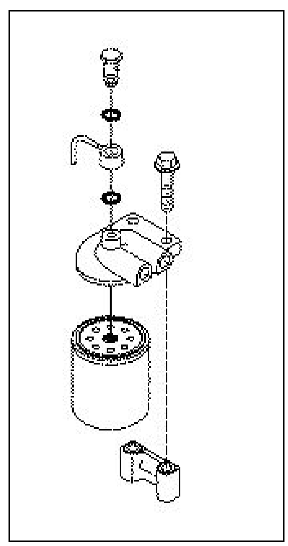
Tighten the capscrews. Refer to Capscrew Markings and Torque Values in Section 10.

Connect the fuel drain hose.

Connect the fuel inlet hose.

Connect the fuel outlet hose.





Follow-Up

Checking and Adjusting Fuel Injection Timing

There are two methods for checking and adjusting the fuel injection timing of an injection pump.

The “MATCH MARK ALIGNMENT” method, which is used when the injection pump is installed on the original engine and the pump is not being repaired.

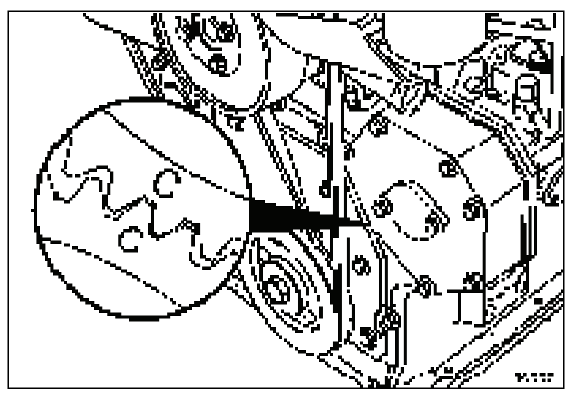
The “MEASURING DEVICE” method, which is used when a repaired or replaced injection pump is installed on the engine.

Checking and Adjusting with the Match Mark Alignment Method

NOTE: Set the No. 1 cylinder at compression top dead center (TDC) by aligning the pointer on the gear cover with the TDC line on the crankshaft pulley. Confirm that the mark “C” can be seen on the idler gear. If the mark “C” can not be seen, rotate the crankshaft one complete revolution and confirm that “C” can be seen.

NOTE: Align the match mark “C” on the injection pump gear with the match mark “C” on the idler gear during installation for correct alignment. Align the stamped line “a” on the injection pump with the stamped line “b” on the timing gear case during installation for correct alignment.

Install the injection pump.

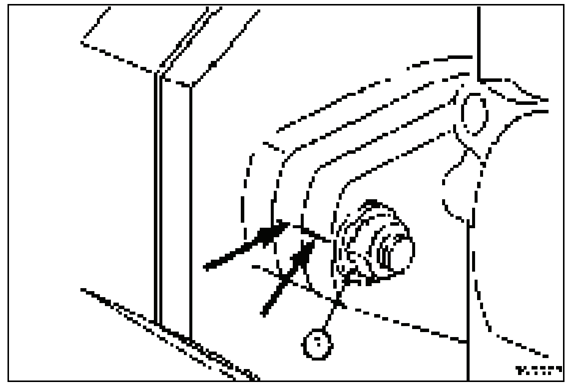


Checking and Adjusting Fuel Injection Timing (Cont)

If the stamp lines are out of alignment, loosen nut (7). Align the stamp lines by rotating the coupling.

Tighten the nut.

Torque Value: 31 N•m [23 ft-lb]

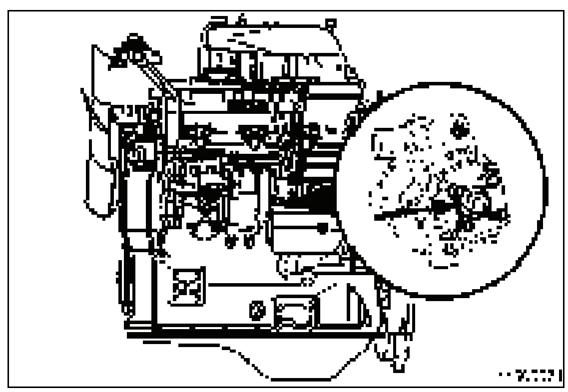


Checking and Adjusting with the Measuring Device Method

NOTE: Set the No. 1 cylinder at compression top dead center (TDC) by aligning the pointer on the gear cover with the TDC line on the crankshaft pulley.

Remove the distributor head bolt and copper washer from the injection pump.

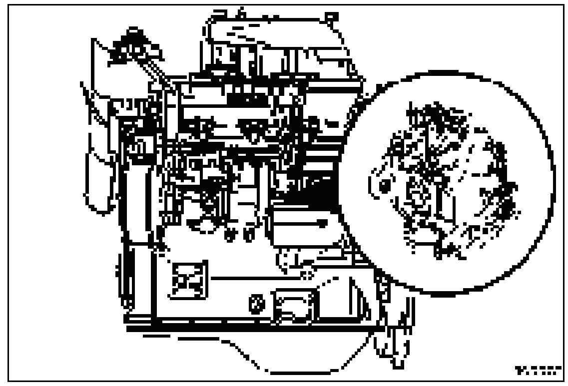
Discard the copper washer.



Checking and Adjusting Fuel Injection Timing (Cont)

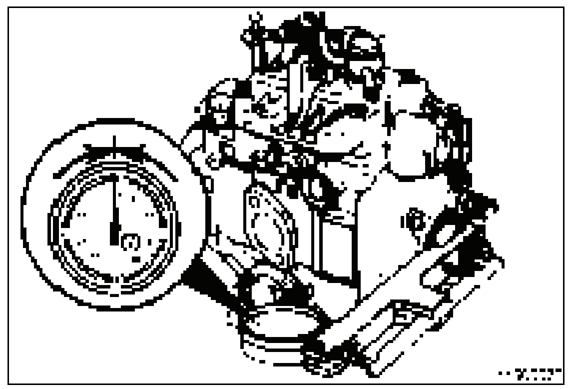
Install the dial gauge, Part No. 3377259, into the distributor head.

NOTE: Check that the stylus end of the dial gauge contacts the plunger head.

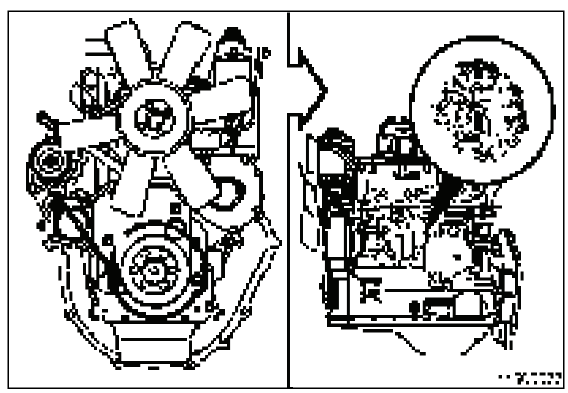


Rotate the crankshaft opposite normal engine rotation (counterclockwise) slightly, until the dial gauge does not move any longer.

Set the dial gauge pointer to 0.



Rotate the crankshaft in the normal direction until the dial gauge reads 1.0 ± 0.3 mm [0.04 ± 0.01 in].



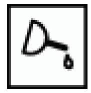
Checking and Adjusting Fuel Injection Timing (Cont)

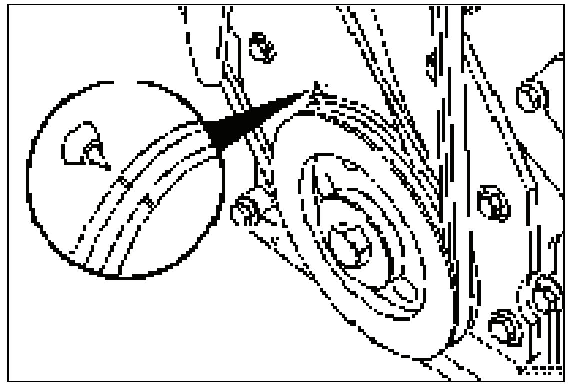
Look at the pointer on the crankshaft. It should point to the timing mark in degrees as stamped on the dataplate. The timing marks on the crank pulley range from 6 to 14 degrees in two degree increments.

NOTE: Check the values on the data plate. Values may change as new ratings are developed.

NOTE: The gauge reading ±0.03 mm [0.001 in] is equivalent to ±0.5 degrees fuel injection timing.

NOTE: The crankshaft must be rotated in the normal direction (clockwise looking from the front of the engine) without stopping.

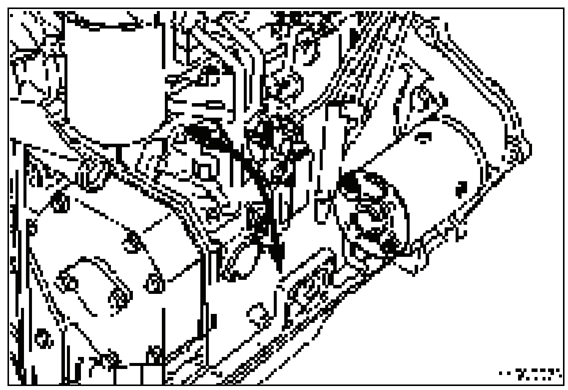




If the dial readings are not within the standard value, loosen nut. Adjust the fuel injection timing to within standard value by rotating the injection pump body.

Tighten the nut.

Torque Value: 31 N•m [23 ft-lb]

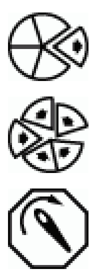


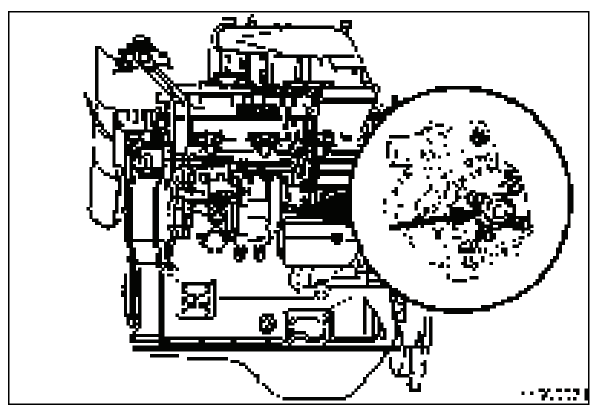
Remove the dial gauge.

Install the distributor head bolt and new copper washer into the injection pump.

Tighten the bolt.

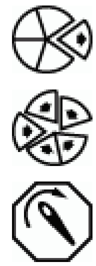
Torque Value: 17 N•m [13 ft-lb]

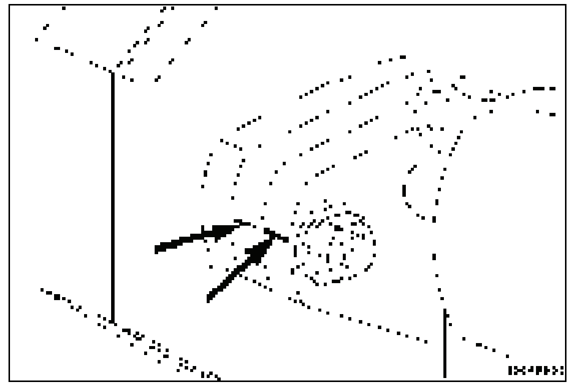




Checking and Adjusting Fuel Injection Timing (Cont)

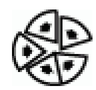
Stamp a match mark on the injection pump and the timing gear case.

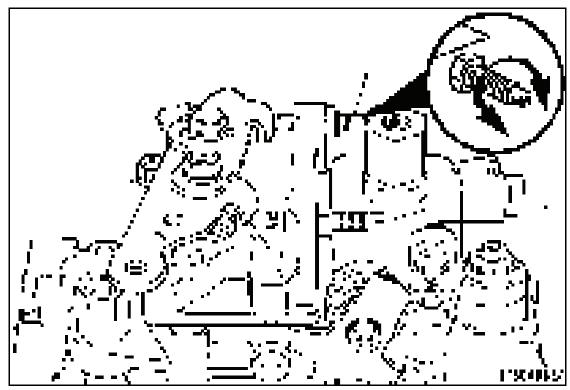




Adjusting the Idle

Move the governor control lever to the desired idling speed by using the idling adjustment screw.





Inline Fuel Injection Pump Removal/Installation

Prepare

Clean debris.

Remove injector supply lines.

Remove low pressure supply line.

Remove control linkage.

Remove fuel shutoff solenoid.

Remove oil line.

Remove high-pressure line, supply line, and return line. Remove the AFC air line, oil line(s), fuel shutoff solenoid, and control linkage.

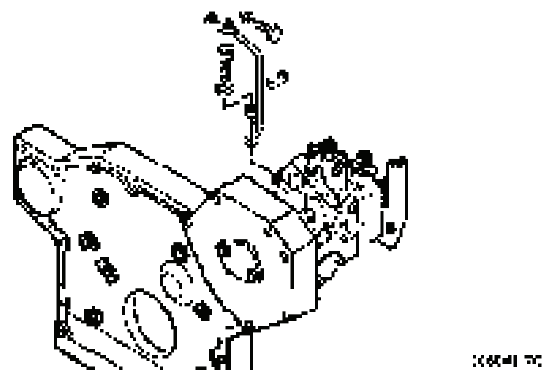
Remove

CAUTION

Do not allow dirt or dust to enter the oil and fuel inlet and outlet ports. Severe engine damage will occur if contaminants are allowed to enter the engine.

Remove the fuel supply tube from the fuel injection pump.

Remove the mounting capscrew from the bracket and fuel injection pump.

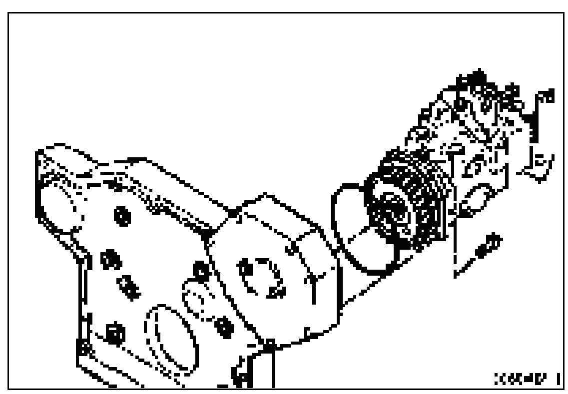


NOTE: The fuel injector pump, adapter plate, and gear are removed as an assembly. The gear can then be removed from the pump if necessary.

Remove the mounting capscrews of the fuel injector pump adapter plate.

Remove the fuel injector pump assembly, adapter plate, and o-ring from the gear housing.

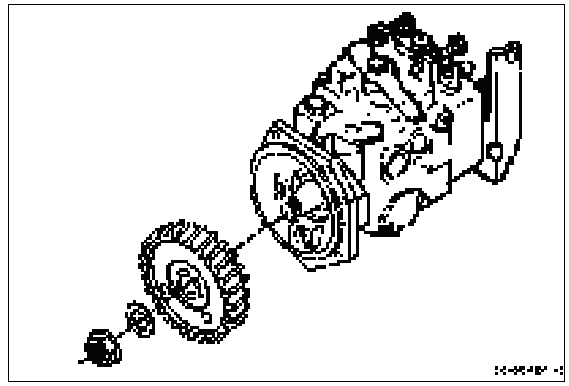
Discard the o-ring.



Inline Fuel Injection Pump Removal/Installation (Cont)

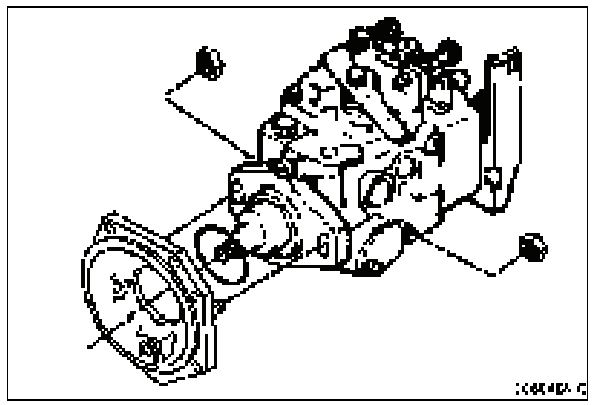
Remove the nut and washer from the fuel injection pump.

Remove the fuel injection pump gear from the fuel injection pump.



Remove the two mounting nuts, fuel injection pump, and o-ring from the adapter plate.

Discard the o-ring.



Install

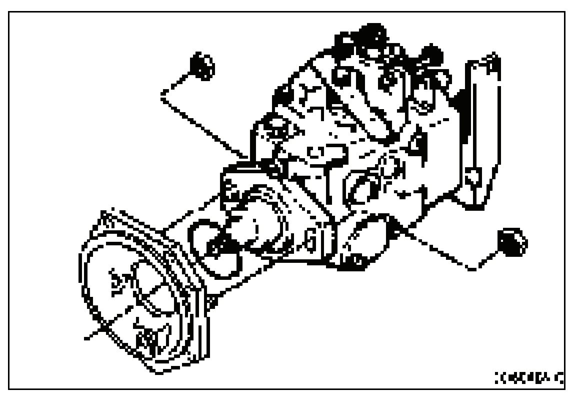
CAUTION

Do not allow dirt or dust to enter the oil and fuel inlet and outlet ports. Severe engine damage will occur if contaminants are allowed to enter the engine.

Install new o-ring, fuel injection pump, and two mounting nuts on the adapter plate.

Tighten the nuts.

Torque Value: 31 N•m [23 ft-lb]

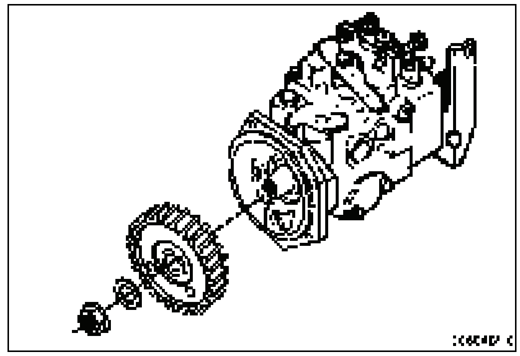


Inline Fuel Injection Pump Removal/Installation (Cont)

Install the fuel injection pump gear, washer, and nut on the fuel injection pump.

Tighten the nut.

Torque Value: 70 N•m [52 ft-lb]

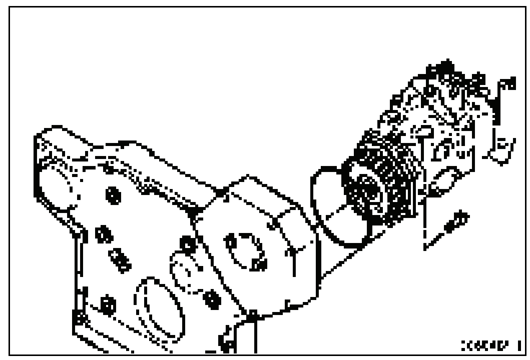


NOTE: Align the fuel injection pump gear match mark “C” with the idler gear match mark “C”.

Install new o-ring, adapter plate, fuel injection pump assembly, and mounting capscrews to the gear housing.

Tighten the mounting capscrews.

Torque Value: 19 N•m [14 ft-lb]



Install the mounting capscrew on the fuel injection pump support bracket.

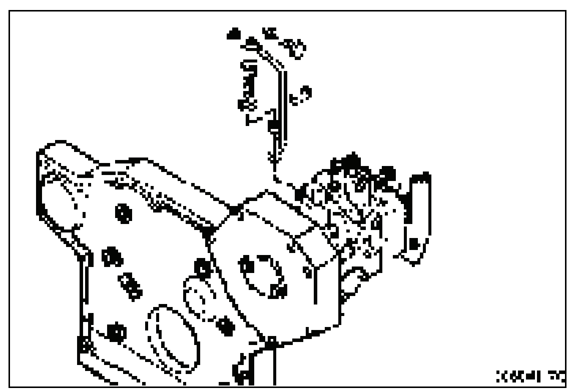
Tighten the capscrew.

Torque Value: 19 N•m [14 ft-lb]

NOTE: The fuel supply tube has a 12-mm and 14-mm banjo fitting. The 12-mm banjo fitting connects to the fuel injection pump. The 14-mm banjo fitting connects to the fuel filter head, which is installed later in the assembly process.

Install the fuel supply tube to the fuel injection pump.

Torque Value: 20 N•m [15 ft-lb]



Follow-Up

Fuel Injectors Removal/Installation

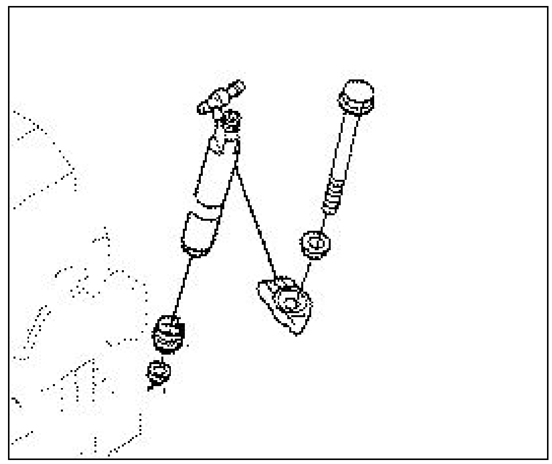
Prepare

Clean around the injectors.

Disconnect the high-pressure fuel lines. Refer to High Pressure Injector Supply Lines Removal/Installation in this section.

Disconnect the fuel drain manifold. Refer to Fuel Drain Manifold Removal/Installation in this section.

Remove



CAUTION

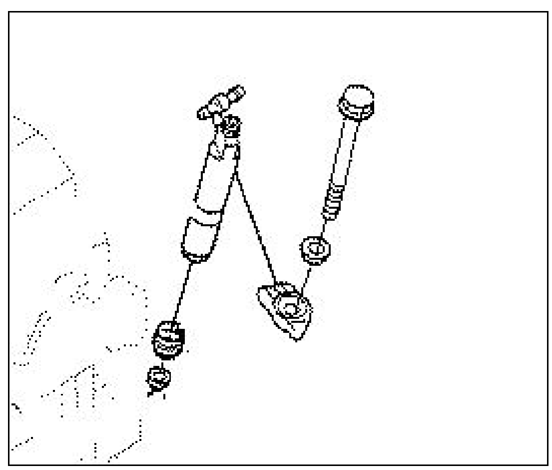
Be careful not to damage the tip of the injector when removing.

Remove the mounting capscrew, washer, and injector.

NOTE: When removing the injector, clean around the injector, and insert a blind plug to prevent dust or dirt from entering the engine.

NOTE: Mark the injectors with tags showing the cylinder number, and keep it in a safe place. If there is no abnormality in the injector, install it in the same position during assembly.

Install



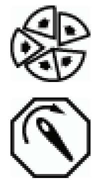
NOTE: Install new injector gasket (Cummins Part No. C6204113880) or replacement injector kit (Cummins Option No. II3002.01).

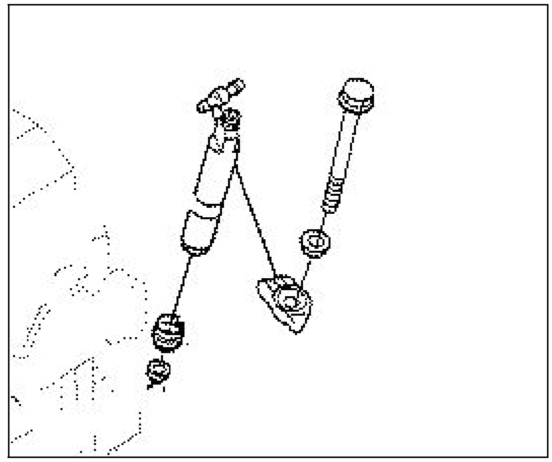
Coat the injectors with anti-seize compound, Part No. 3824879, before installation.

Fuel Injectors Removal/Installation (Cont)

CAUTION

Be careful not to damage the tip of the injector when installing.





NOTE: When installing the injector, clean around the injector, and do not allow dust or dirt to enter the engine.

NOTE: If there is no abnormality in the injector, install it in the same position during assembly.

Install the injector, washer, and mounting capscrew.

Tighten the capscrew.

Torque Value: 44 N•m [33 ft-lb]

Follow-Up

Reconnect the high-pressure fuel lines. Refer to High Pressure Injector Supply Lines Removal/Installation in this section.

Reconnect the fuel drain manifold. Refer to Fuel Drain Manifold Removal/Installation in this section.

Operate the engine.

Check for leaks.

Check function.

Stop the engine.

RTN

Fuel Drain Manifold Removal/Installation

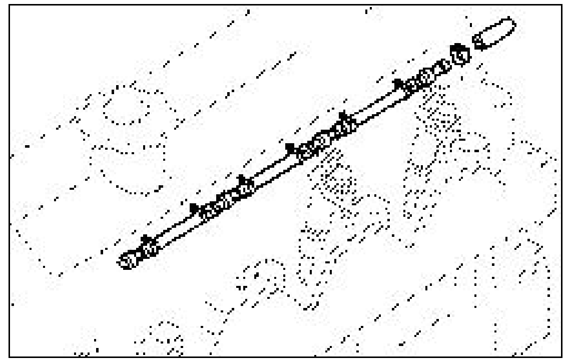
Prepare

Remove

Disconnect the hose connection at the fuel pump.

Remove the braided drain hose from the end of the drain rail shown to the engine mount fuel drain connection.

Remove the three fuel drain tube sections and clips from the injectors

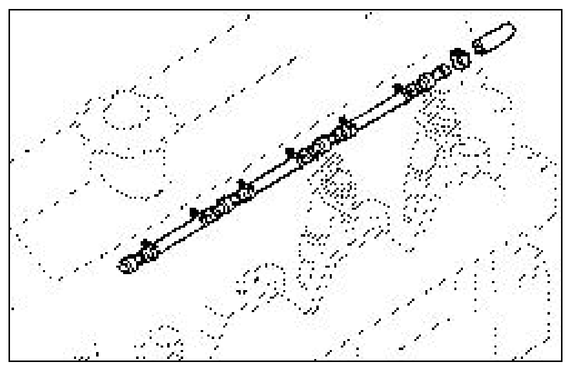


Install

Install the three fuel drain tube sections and clips to the injectors.

Install the braided drain hose from the end of the drain rail shown to the engine mount fuel drain connection.

Connect the hose connection at the fuel pump.



Follow-Up

Low Pressure Fuel Supply Lines Removal/Installation

Prepare

Low Pressure Fuel Line

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

Diaphragm Style Lift Pump

Disconnect the fuel line from the lift pump and filter head. Use two wrenches to disconnect the line from the lift pump.

Piston Style Lift Pump

Disconnect the fuel line from the lift pump and filter head. Use two wrenches to disconnect the line from the lift pump.

Install

Diaphragm Style Lift Pump

Install the fuel line to the lift pump and filter head. Use two wrenches to tighten the connection to the lift pump.

Torque Value: 24 N•m [18 ft-lb]

NOTE: Do not overtighten the connection. Fuel leaks can result from over-tightening.

Low Pressure Fuel Supply Lines Removal/Installation (Cont)

Piston Style Lift Pump

Install the fuel line to the lift pump and filter head. Use two wrenches to tighten the connection to the lift pump.

Torque Value: 24 N•m [18 ft-lb]

Injection Pump Supply Line Replacement

Remove the bleed screw banjo fitting.

Remove the supply line (Bosch® injection pump).

NOTE: Replace the seals (1) in the fittings if the line is disassembled.

Remove the supply line (Lucas CAV injection pump). The Lucas CAV pump has two fittings for the supply line.

Replace fitting sealing washers (1), and ferrules (2) each time they are removed.

Torque Value: 32 N•m [24 ft-lb]

NOTE: Replace the seals in the fittings if the line is disassembled.

Engines rated at 2500 rpm and above require additional fuel line support. Install as illustrated.

Torque Value: 24 N•m [18 ft-lb]

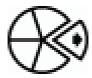
Follow-Up

High Pressure Injector Supply Lines Removal/Installation

Prepare

Clean all debris from around the fittings.

Remove

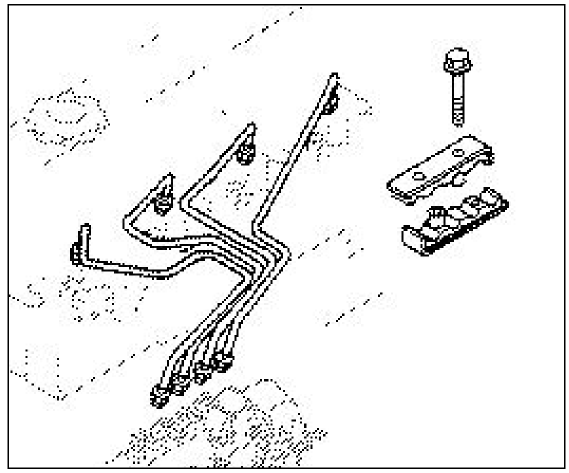


Remove the two capscrews and clamp.

Loosen the tubing nuts at the fuel injection pump.

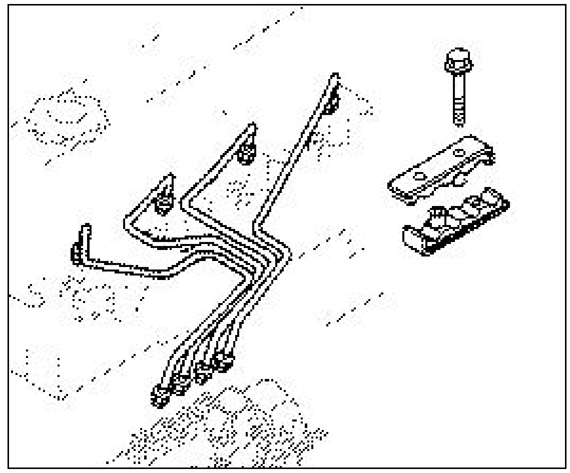
Loosen the tubing connections at the fuel injectors.

Remove the high pressure fuel injection tubes.



High Pressure Injector Supply Lines Removal/Installation (Cont)

Install



NOTE: Before installing the fuel injection tubing, blow compressed air through it to clean it.

CAUTION

To prevent damage to the fuel lines, they must be connected to the injectors and fuel injection pump in a free state without forcing the connecting nuts. The fuel lines are correctly sized for each application. Bending the lines is not acceptable and can cause fuel leaks.

Position the fuel injection tubing, and loosely install the sleeve nuts on the fuel injection pump and the injectors.

CAUTION

Install the support clamp in the original position and, to prevent damage from high-frequency vibration, make sure the lines have not been bent or do not contact each other or another component.

Install the two capscrews and clamp.

Tighten the capscrews. Refer to Capscrew Markings and Torque Values in Section 10.

Tighten the eight tube fittings.

Torque Value: 20 N•m [15 ft-lb]

Follow-Up

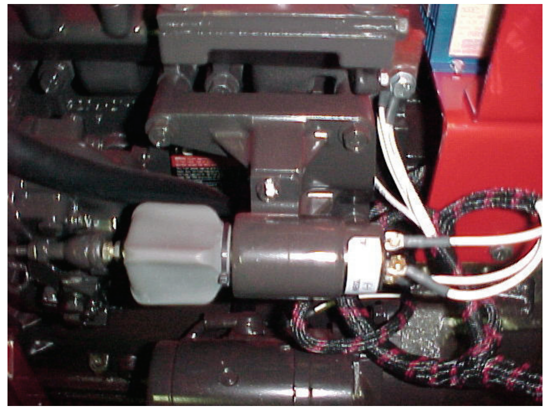
Fuel Shutoff Valve (FSOV) Removal/Installation

Prepare

Remove

Remove the electrical wiring.

Remove the fuel drain line.

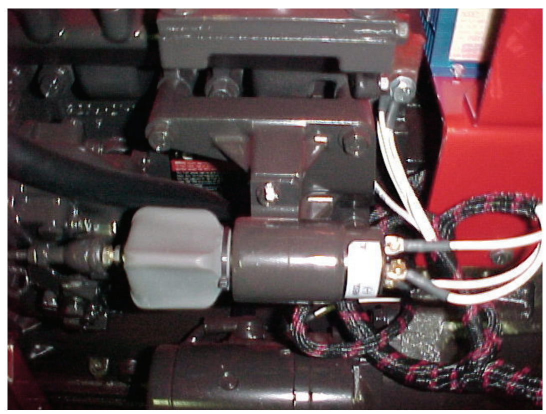


Install

Install the fuel drain line.

Torque Value: 14 N•m [124 in-lb]

Install the electrical wiring.



Follow-Up

Air Leaks, Air Intake and Exhaust Systems

Prepare

Initial Check

CAUTION

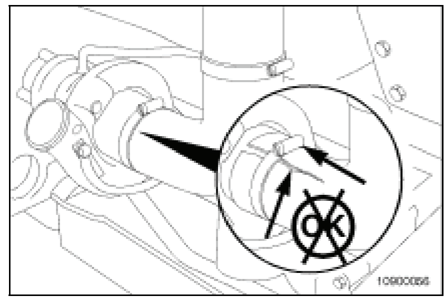
Engine intake air must be filtered to prevent dirt and debris from entering the engine. If intake air piping is damaged or loose, unfiltered air will enter the engine and cause premature wear.

Inspect the intake air piping for cracked hoses, damage, or loose clamps.

Replace damaged pipes, and tighten loose clamps, as necessary, to make sure the air intake system does not leak.

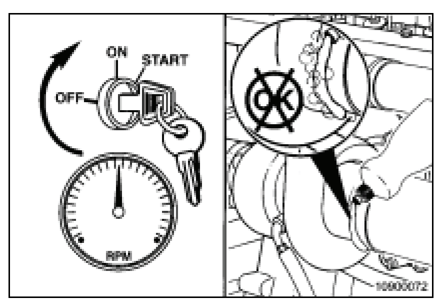
Torque Value: 8 N•m [71 in-lb]

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



Operate the engine at high idle, and use a solution of soapy water to spot intake air leaks.

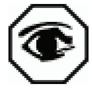
If an air leak exists, the soap bubbles will be drawn in with the air.

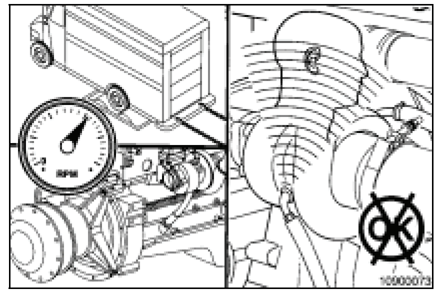


Air Leaks, Air Intake and Exhaust Systems (Cont)

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

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



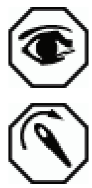


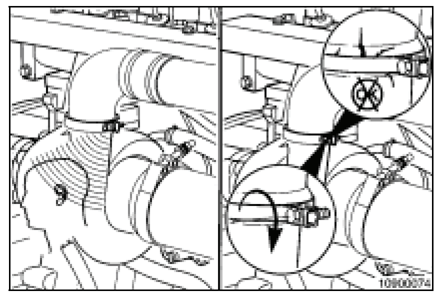
The noise can be caused by an air leak from the:

Turbocharger-to-discharge elbow connection.

Inspect for damage. Tighten loose clamps.

Torque Value: 8 N•m [71 in-lb]



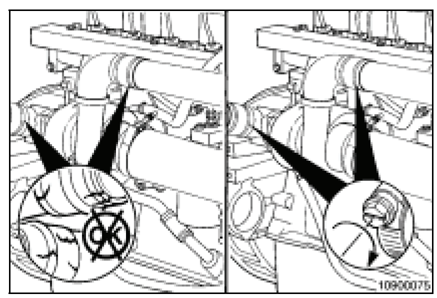


Any charge air cooler tubing or connecting hoses.

Inspect the hose and tubing for damage.

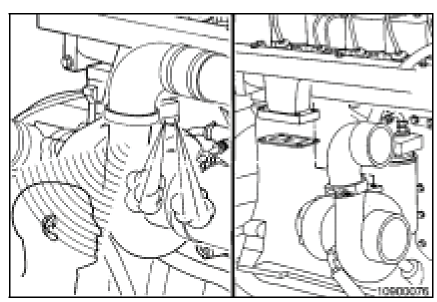
Tighten the hose clamps.

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



Turbocharger-to-exhaust-manifold mounting gasket.

Replace the gasket. Refer to Procedure 010-033.

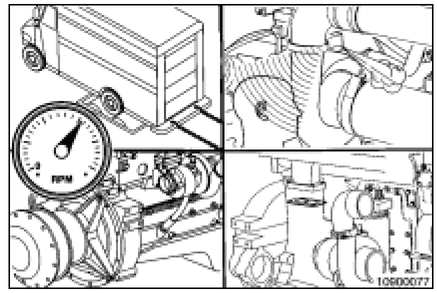


Air Leaks, Air Intake and Exhaust Systems (Cont)

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

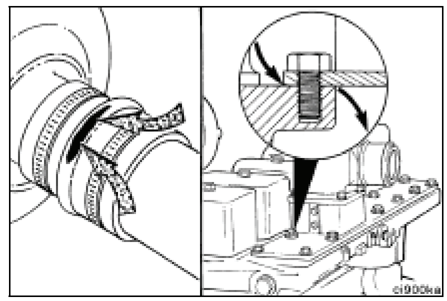
Listen again for leaks.

Replace the turbocharger if the air piping is not damaged and the noise can still be heard. Refer to Procedure 010-033.



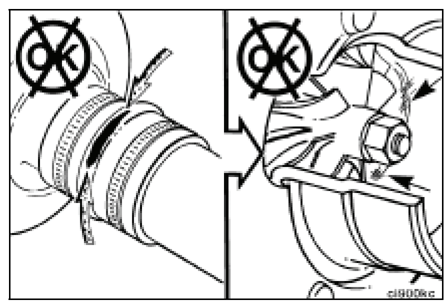
Loose connections or cracks in the suction side of the intake pipe and after the air filter can allow debris to be ingested by the engine, causing rapid wear in the cylinders.

Leaks at the intake manifold, unsealed bolt holes, or manifold cover gasket can also allow dust and dirt to be ingested into naturally aspirated engines.



Debris drawn into the air suction side can damage the compressor blades, causing an imbalance resulting in bearing failure.

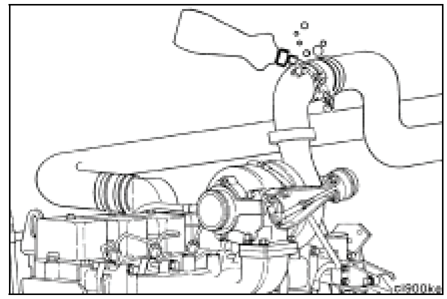
To verify a bearing failure or damaged compressor, remove the intake and exhaust piping, and check for contact. The rotor assembly must rotate freely and should not be damaged. Measurement of axial and radial clearance is described in this section.



Excessive smoke and low power from a turbocharged engine can be caused by pressurized air leaking from loose connections or cracks in the crossover tube or intake manifold. This can also cause a noise problem.

Air Leaks, Air Intake and Exhaust Systems (Cont)

In addition to the inspection for cracks and loose fittings, liquid soap can be applied to the charge air cooler, connections, and the manifold cover sealing surfaces to find the leaks. The leaks will create bubbles that are easier to detect. Measurement of manifold pressure is described in this section.



Follow-Up

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Intake Air Cleaner Element Removal/Installation

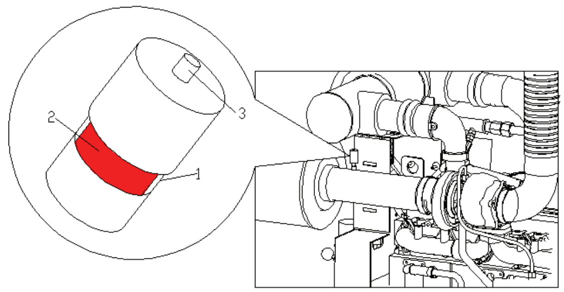
CAUTION

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

Check Air Restriction Indicator. Replace the air cleaner element when the restriction reaches the maximum allowable limit, or clean according to the manufacturer's recommendations. See Air Cleaner Restriction Removal/Installation 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 H_2O [30.0 in H_2O] for turbocharged engines.



Loosen air cleaner clamp.

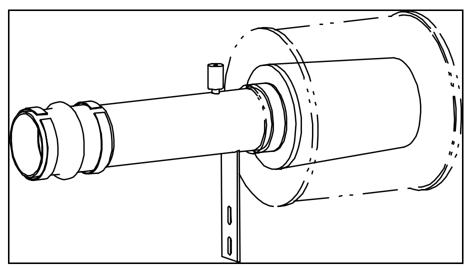
Remove the air cleaner element.

Clean and Inspect for Reuse

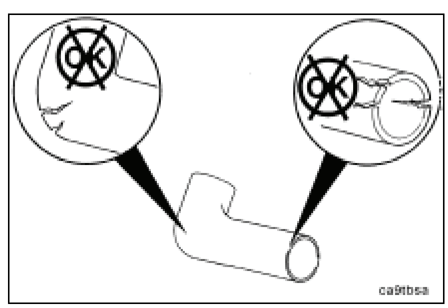
Inspect the air cleaner for cuts, cracks, holes, or excessive debris.

Clean or replace if necessary.

See Air Intake System Specifications in Section 10 for correct Cummins Fire Power replacement part number.



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



Intake Air Cleaner Element Removal/Installation (Cont)

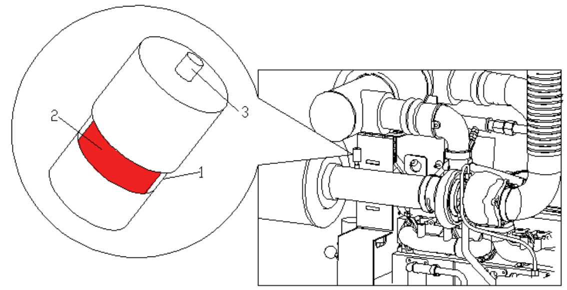
Re run engine at rated RPM at full load to check maximum intake restriction.

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

Follow-Up

Air Intake Restriction Indicator Removal/Installation

A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument is mounted on the air cleaner outlet tube.



Refer to Air Filter Assembly Drawing in Section 13.

Change the filter element when the red indicator flag (2) is at the raised position in the window (1). See Air Cleaner Element Removal/Installation this section.

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

After the air cleaner has been serviced, push the button (3) to reset the service indicator. If the indicator does not retract to the service position with new air cleaner element installed, the service indicator needs to be replaced.

Remove service indicator from Air Cleaner Element piping. Apply Teflon sealant to the threads on the indicator. Install new indicator on Intake pipe.

Follow-Up

Run engine to determine if new indicator is functioning.

Air Crossover Pipe Removal/Installation

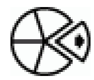
Prepare

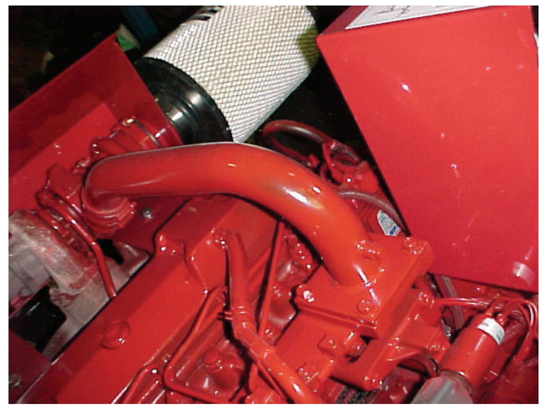
Remove

Loosen the hose clamp connection at the turbocharger air outlet.

Remove the four capscrews at the intake manifold connection.

Remove the crossover tube.





Install

NOTE: Install new air intake connection gasket.

NOTE: Install new hose and clamps.

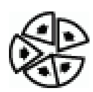
Install one hose clamp and the molded hose on the end of the tube. Do not tighten the hose clamp at this time.

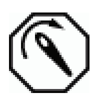
Align the crossover tube at the intake manifold and start the four capscrews.

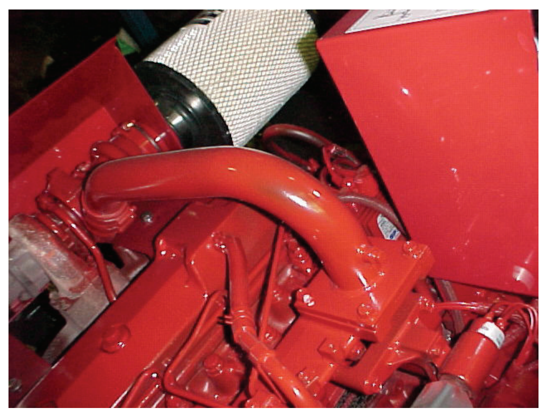
Position the other hose clamp and the molded hose on the turbocharger air outlet.

Align the hose and clamps on the tube and turbocharger. Then, tighten the hose clamps.

Tighten the four capscrews at the manifold. Refer to Capscrew Markings and Torque Values in Section 10.







Follow-Up

Air Intake Manifold Removal/Installation

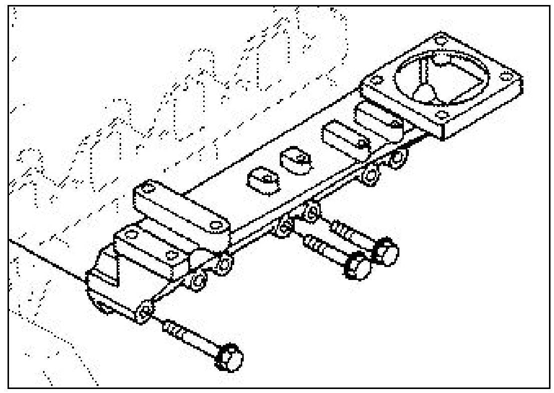
Prepare

Remove the air crossover tube. Refer to Air Crossover Pipe Removal/Installation in this section.

Remove

Remove the six long capscrews, two short capscrews, and the manifold.

Clean the air intake manifold and engine block surfaces to remove the previous sealant.



Install

NOTE: Apply a 1-mm [0.039-in] bead of gasket sealant, per Cummins specifications, to the mounting surface of the intake manifold.

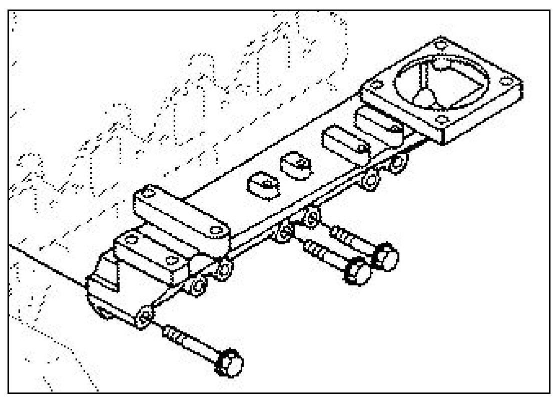
Apply sealant to the manifold.

Align the manifold and start the six long and two short capscrews.

NOTE: Tighten the capscrews in two passes alternating position to tighten the manifold equally at all points.

Tighten the capscrews.

Torque Value: 40 N•m [30 ft-lb]



Air Intake Manifold Removal/Installation (Cont)

Follow-Up

Install the air crossover tube. Refer to Air Crossover Pipe Removal/Installation in this section.

Turbocharger Removal/Installation

Prepare

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

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

Remove the customer installed exhaust piping. Refer to instructions in this section.

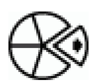
Remove the turbocharger exhaust outlet tube. Refer to instructions in this section.

Disconnect or remove the air crossover tube. Refer to instructions in this section.

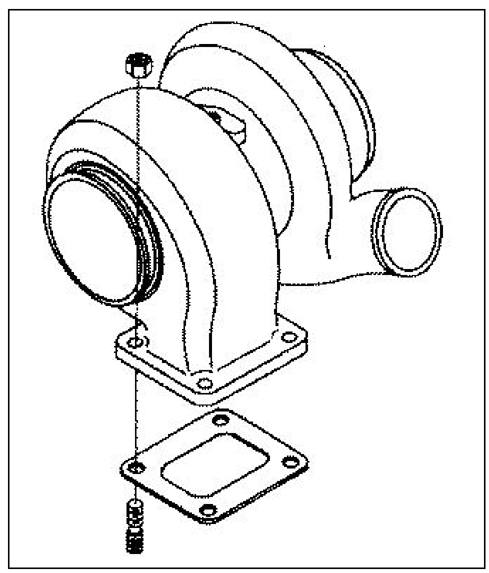
Remove the turbocharger lubricating oil supply line. Refer to instructions in this section.

Disconnect the lubricating oil drain tube. Refer to instructions in this section.

Remove



Remove the exhaust clamp, turbocharger mounting nuts, turbocharger and gasket.



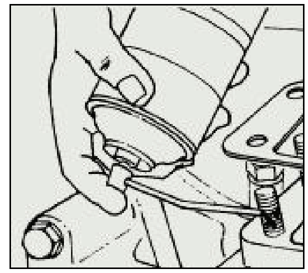
Turbocharger Removal/Installation (Cont)

Install

Install a new gasket.

Apply anti-seize compound, Part No. 3824759, to the mounting studs.

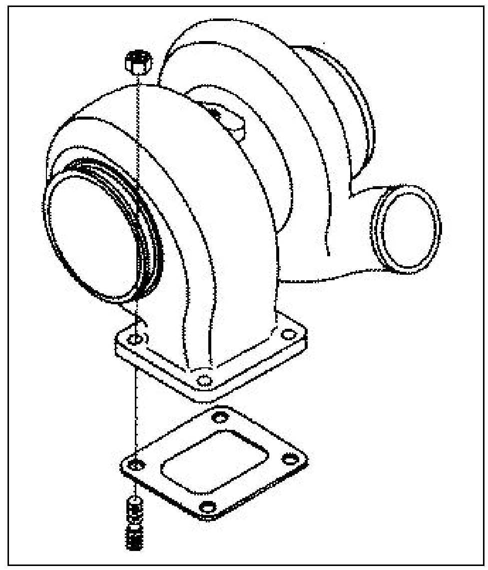
NOTE: Use only lead free anti-seize compound compatible with oxygen sensors.



Install the turbocharger and mounting nuts.

Tighten the nuts.

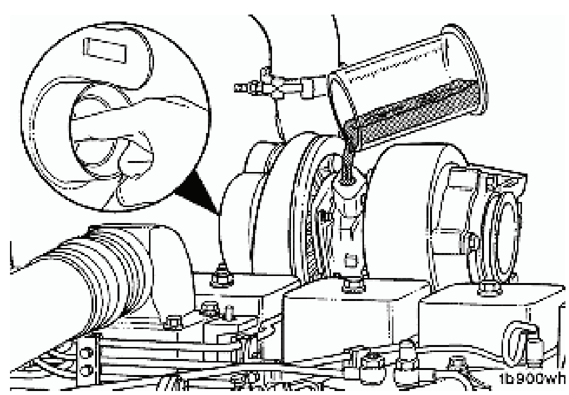
Torque Value: 31 N•m [23 ft-lb]



Connect the lubricating oil drain tube. Refer to instructions in this section.

NOTE: New turbochargers must be pre-lubricated before start-up.

Pour 50 to 60 cc [2 to 3 ounces] of clean engine oil into the oil supply fitting. Rotate the turbine wheel to allow the oil to enter the bearing housing.



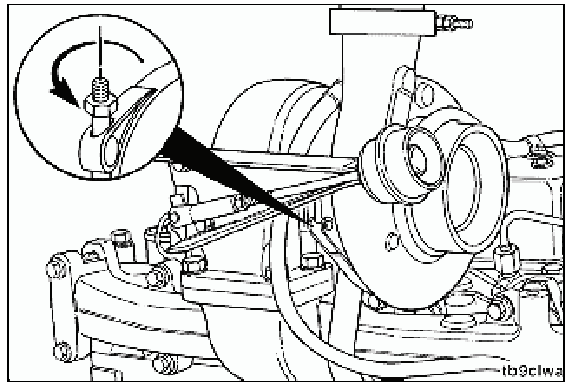
Turbocharger Removal/Installation (Cont)

Align the Housing

NOTE: New turbochargers may require alignment.

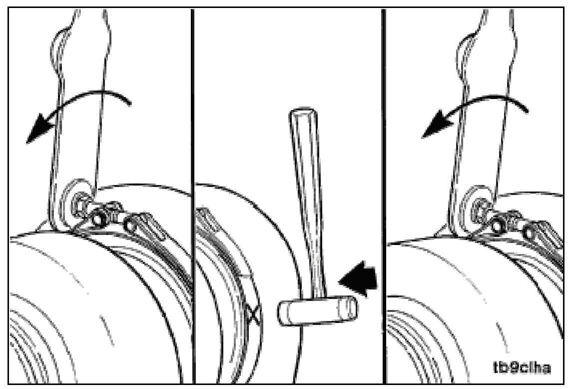
If required, loosen the compressor housing v-band clamp and position the housing to align with the turbocharger air outlet tube.

If required, loosen the snap ring and align the compressor housing with the turbocharger air outlet connection.



Tighten the band clamp. Tap around the clamp with a plastic hammer and tighten again.

Torque Value: 8.5 N•m [75 in-lb]



Follow-Up

Install the turbocharger lubricating oil supply line. Refer to instructions in this section.Install the turbocharger exhaust outlet tube. Refer to instructions in this section.

Install the air crossover tube. Refer to instructions in this section.

Install the customer installed exhaust piping. Refer to instructions in this section.

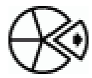
Install the exhaust heat shield. Refer to instructions in this section.

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

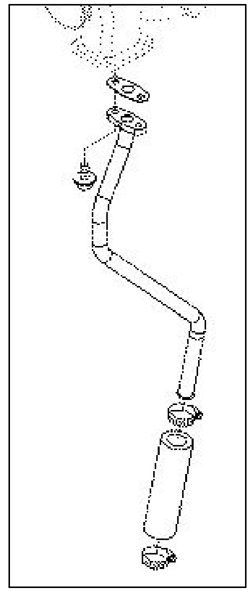
Turbocharger Oil Drain Line Removal/Installation

Prepare

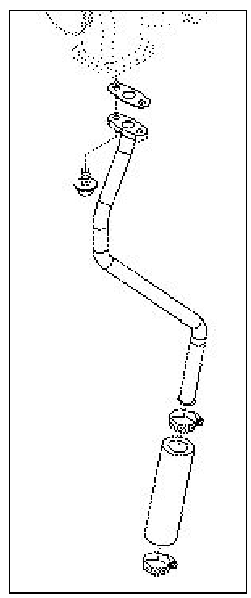
Remove



Disconnect the lubricating oil drain tube from the bottom of the turbocharger.



Install

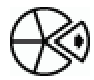


Follow-Up

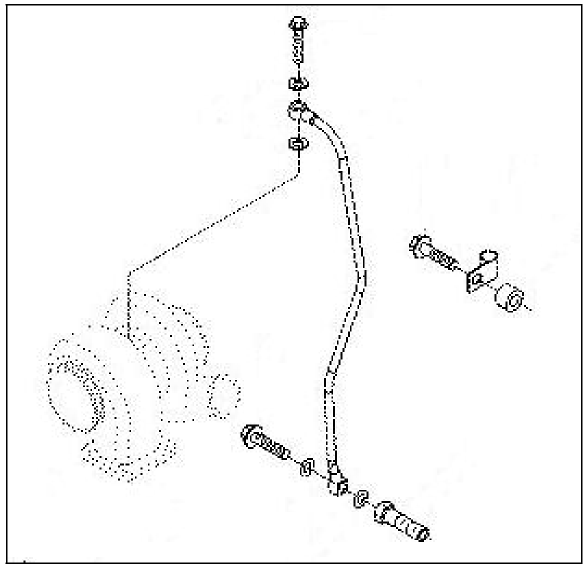
Turbocharger Oil Supply Line Removal/Installation

Prepare

Remove



Remove the turbocharger lubricating oil supply line and hose clamp from the turbocharger and cylinder block.



Install

NOTE: If the turbocharger is new, add oil as per Turbocharger Removal/Installation in this section.

Position the oil drain line in the clamp and start the capscrew.

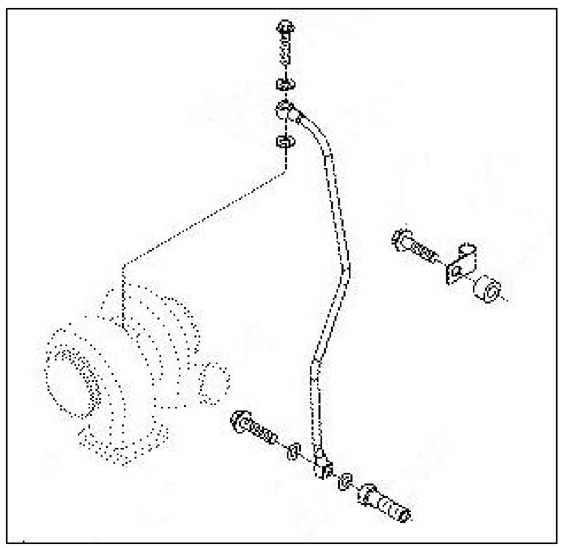
Connect the oil supply line at the cylinder block.

Torque Value: 10 N•m [7 ft-lb]

Connect the oil supply line at the Turbocharger.

Torque Value: 10 N•m [7 ft-lb]

Tighten the capscrew at the clamp. Refer to Capscrew Markings and Torque Values in Section 10.



Follow-Up

Turbocharger Exhaust Piping Removal/Installation

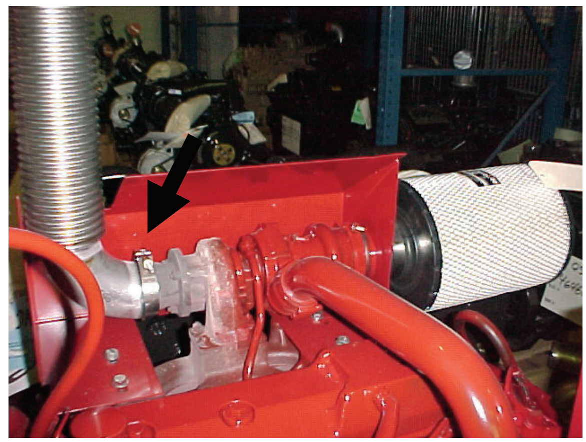
Prepare

Remove the turbocharger exhaust shield.

Remove the customer-supplied exhaust piping.

Remove

Loosen the v-band clamp and remove the 90° elbow.



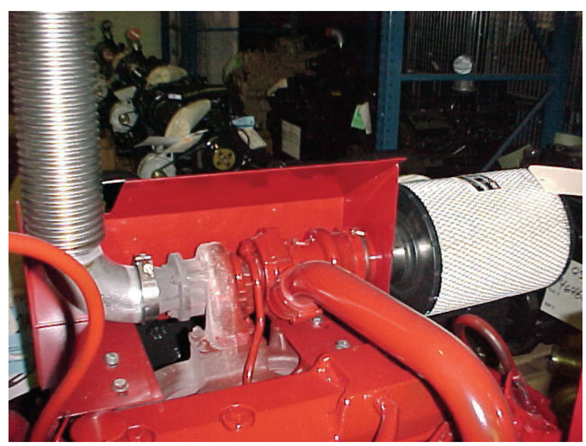
Install

Ensure that the turbocharger exhaust connector is uninstalled. Refer to Turbocharger Exhaust Connector Removal/Installation in this section.

Align the 90° elbow on the turbocharger exhaust connector and tighten the v-band clamp (Cummins Part No. 3905216).

Torque Values: Refer to Capscrew Markings and Torque Values in Section 10.

Install the customer-supplied exhaust piping.



Follow-Up

Install the customer-supplied exhaust piping.

Turbocharger Exhaust Connector Removal/Installation

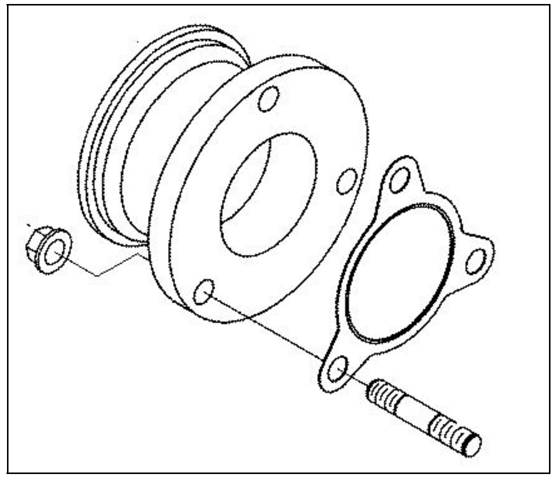
Prepare

Remove the Turbocharger Exhaust Piping. Refer to Turbocharger Exhaust Piping Removal/Installation in this section.

Remove

Remove the three nuts, the exhaust connector, and the connector gasket.

If required, clean the gasket surfaces on the turbocharger and on the exhaust connector.



Install

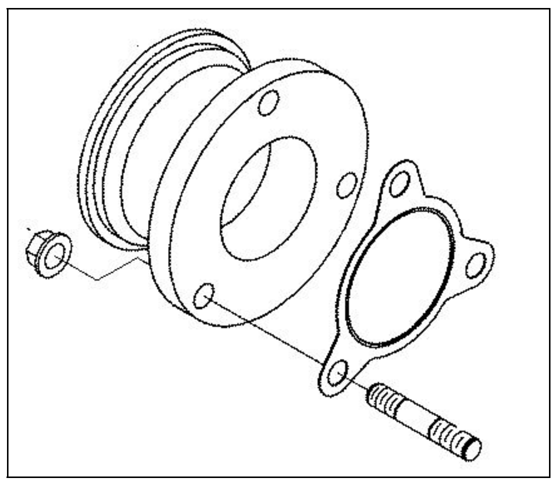
NOTE: If required, install three new exhaust connector studs in the turbocharger.

NOTE: Install new connector gasket.

Install the three studs, gasket, connector, and three nuts.

Tighten the nuts.

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



Follow-Up

Install the Turbocharger Exhaust Piping. Refer to Turbocharger Exhaust Piping Removal/Installation in this section.

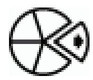
Lubricating Oil Cooler Removal/Installation

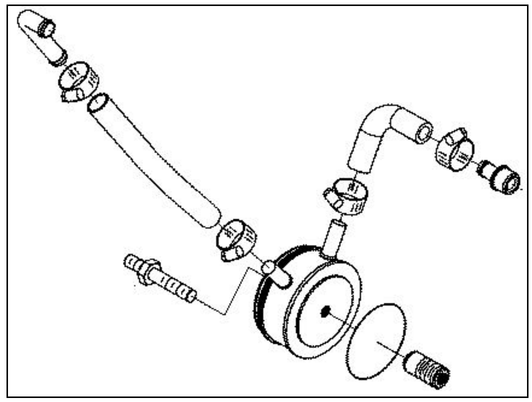
Prepare

Drain the lubricating oil and remove the lubricating oil filter. Refer to Change Lubricating Oil and Filters in Section 5.

Drain the coolant. Refer to instruction in this section.

Remove



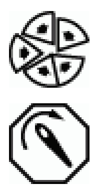


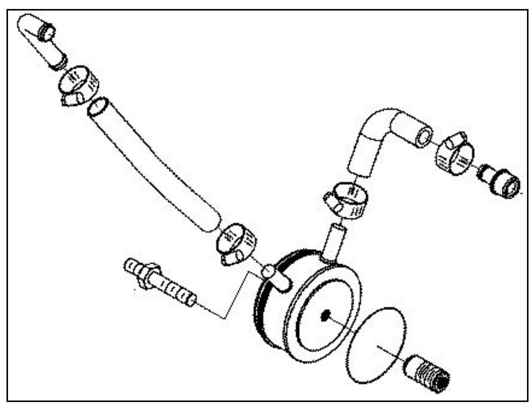
Loosen the hose clamps and remove the cooling water hoses from the oil cooler.

Remove the oil cooler from the engine.

If required, remove the oil filter hose nipple.

Install





Install the oil cooler on the engine.

If required, install the oil filter hose nipple.

Install the cooling water inlet and outlet hoses.

Tighten the hose clamps.

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

Follow-Up

Refill the coolant. Refer to instructions in this section.Install the oil filter and add lubricating oil. Refer to Change Lubricating Oil and Filters in Section 5.

Lubricating Oil Filter Removal/Installation

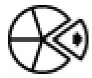
Prepare

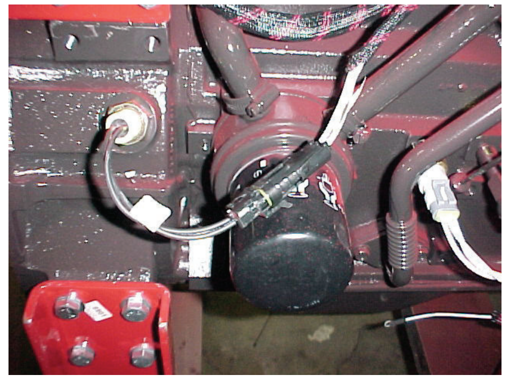
Drain lubricating oil. Refer to Change Lubricating Oil and Filters in Section 5.

Remove

Unscrew and remove the lubricating oil filter.

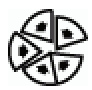
NOTE: Dispose of old filters in accordance with applicable environmental regulations.





Install

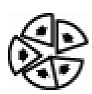
NOTE: Install replacement oil filters.

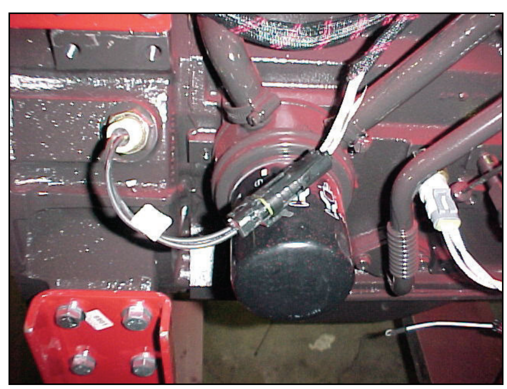


NOTE: Ensure that the lube oil cooler is installed. Refer to Lube Oil Cooler Removal/Installation in this section.

NOTE: Follow the manufacturer's instructions.

Install the lubricating oil filter.





Lubricating Oil Filter Removal/Installation (Cont)

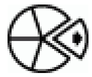
Follow-Up

Add lubricating oil. Refer to Change Lubricating Oil and Filters in Section 5.

Lubricating Oil Pan Removal/Installation

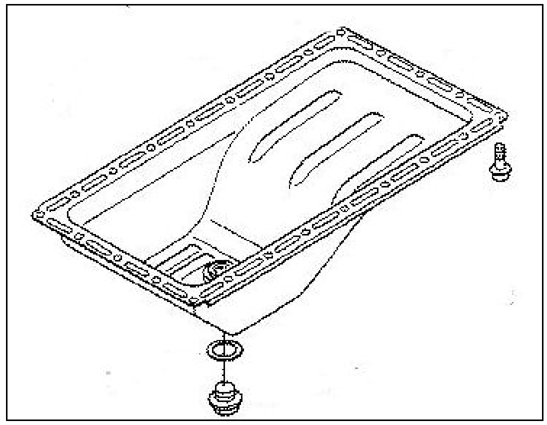
Prepare

Remove



Remove the 24 capscrews, lubricating oil pan, and gasket.

Discard the gasket.



Clean

If sludge is present in the oil pan, remove any sludge.

NOTE: Troubleshoot sludge problems.

Refer to Troubleshooting in Section 12.

Lubricating Oil Pan Removal/Installation (Cont)

Install

NOTE: Apply a 1-mm [0.039-in] bead of gasket sealant, per Cummins specifications, to the mounting surface of the lubricating oil pan.

Install a new gasket, lubricating oil pan, and 24 capscrews.

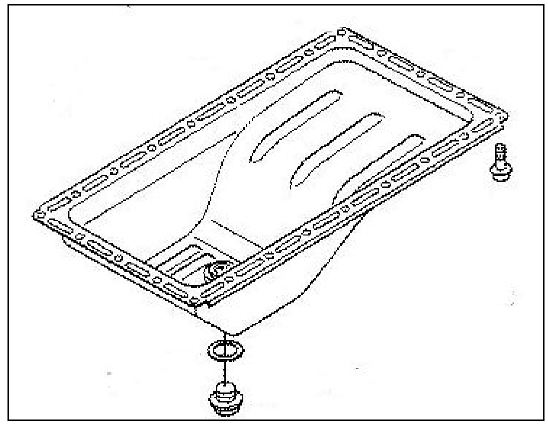
NOTE: Tighten the capscrews alternating from side to side and from end to end.

Tighten the 24 capscrews.

Torque Value: 32 N•m [24 ft-lb]

If the oil drain plug was removed, install the drain plug.

Torque Value: 51 N•m [38 ft-lb]



Follow-Up

Lubricating Oil Suction Tube Removal/Installation

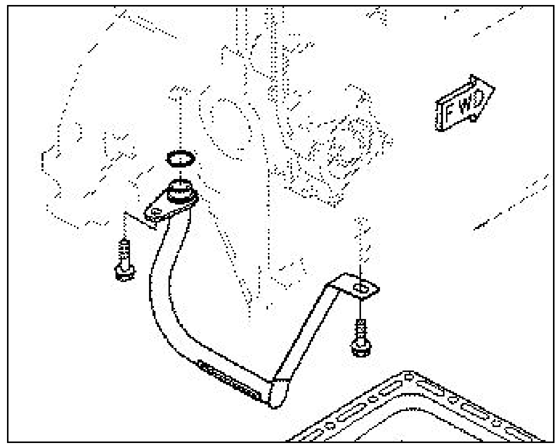
Prepare

Remove the lubricating oil pan. Refer to Lubricating Oil Pan Removal/Installation in this section.

Remove

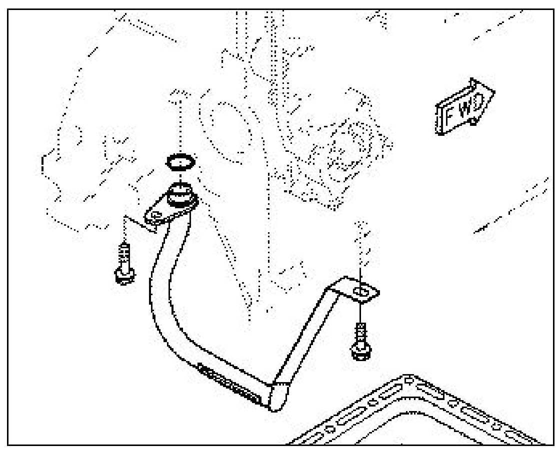
Remove the two mounting capscrews, lubricating oil suction tube, and o-ring.

Discard the o-ring.



Clean

If sludge is present in the oil pan, remove any sludge from the oil suction tube.



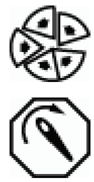
Lubricating Oil Suction Tube Removal/Installation (Cont)

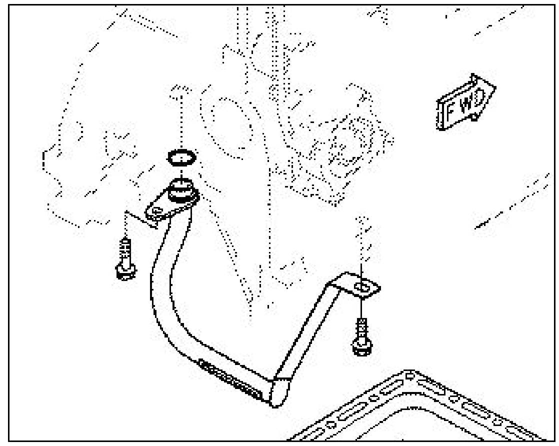
Install

Install a new o-ring, oil suction tube, and two capscrews.

Tighten the capscrews.

Torque Value: 19 N•m [14 ft-lb]





Follow-Up

Install the lubricating oil pan. Refer to <u>Lubricating Oil Pan Removal/Installation</u> in this section.

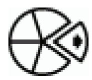
Oil Pressure Sender Removal/Installation

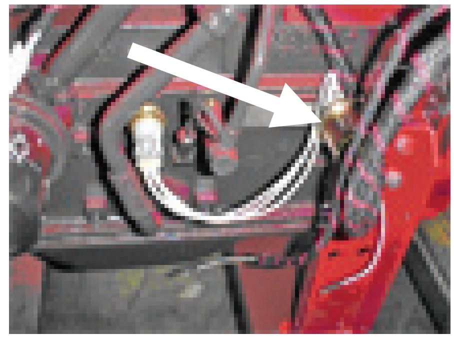
Prepare

Remove

Disconnect the oil pressure sensor wiring.

Remove the sender.





Install

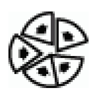
NOTE: Apply liquid teflon sealant to the threads when installing the temperature sensor.

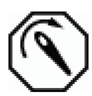
Install the temperature sensor.

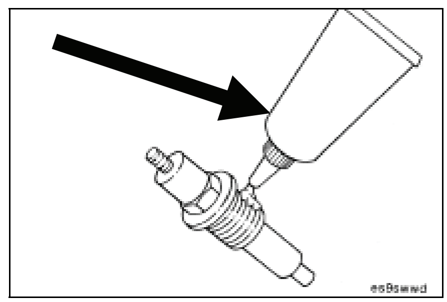
Torque Value:

- **(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 <u>Operating Instructions</u> in Section 3.

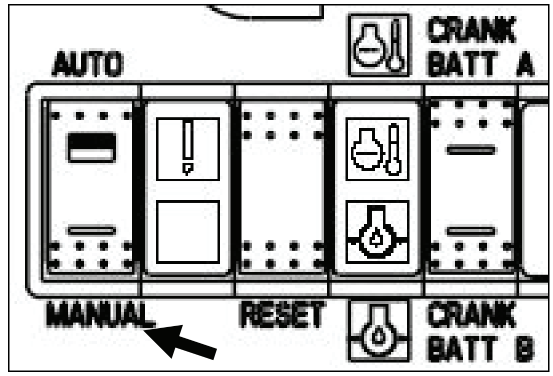
Check for leaks. Repair any leaks.

Oil Pressure Gauge Removal/Installation

Prepare

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

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

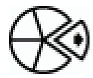


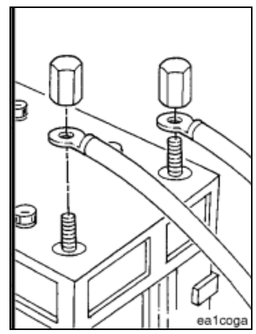
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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

Wear safety glasses when disconnecting batteries!

Next, disconnect both batteries at their terminals.





Remove

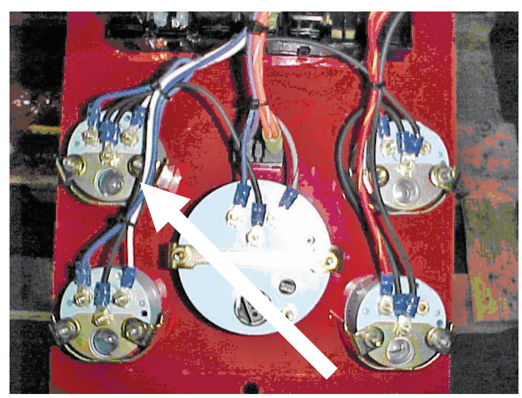
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for electrical schematic details.

Open the local control panel.

NOTE: Ensure that the wires are clearly tagged for reconnection.

Loosen the nuts on the stud and remove the wires.

Remove the nuts on the mounting bracket and remove the gauge from the panel.



Oil Pressure Gauge Removal/Installation (Cont)

Install

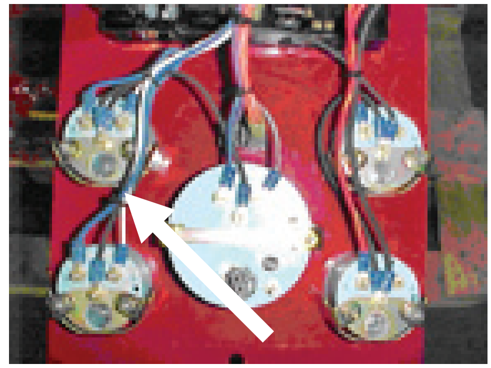
Orient the gauge in the cutout in the electrical panel.

Position the mounting bracket on the gauge.

Install the mounting nuts.

Reconnect the electrical wires on the studs in the same positions as they were originally installed.

Tighten the nuts on the studs.

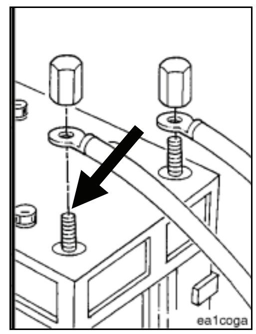


Follow-up

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

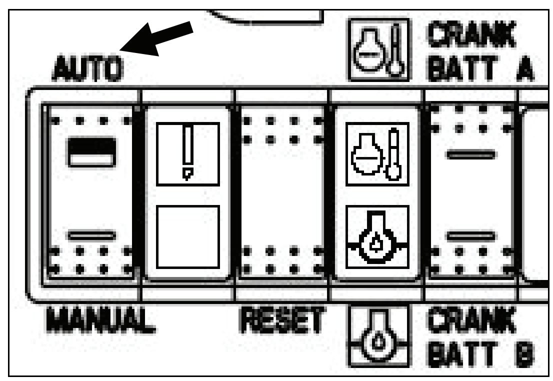
Wear safety glasses when reconnecting batteries!

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



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

Return the fire protection system to operating status.



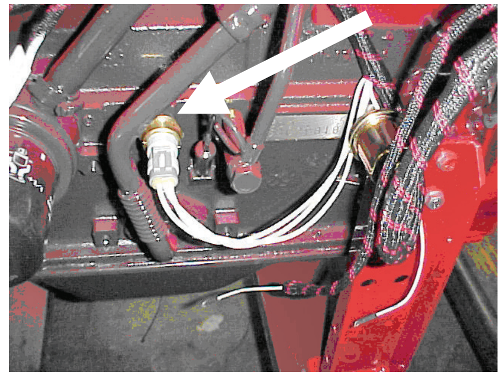
Oil Pressure Switch Removal/Installation

Prepare

Remove

Disconnect the oil pressure switch wiring.

Remove the oil pressure switch.



Install

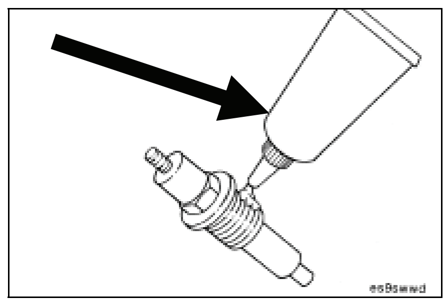
NOTE: Apply liquid teflon sealant to the threads when installing the temperature switch.

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 <u>Operating Instructions</u> in Section 3.

Check for leaks. Repair any leaks.

Lubricating Oil Pump Removal/Installation

Prepare

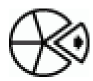
Drain oil

Belt guard

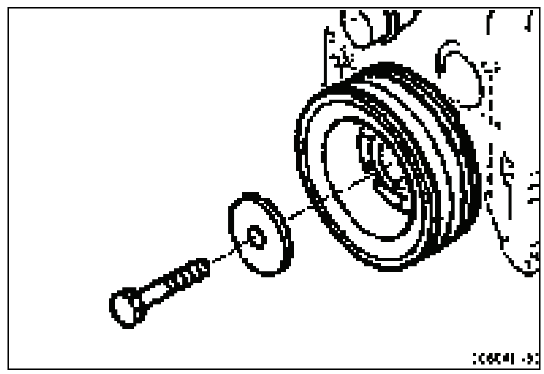
Alternator belt

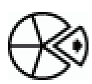
Remove

Crankshaft Pulley



Remove the capscrew and mounting plate.



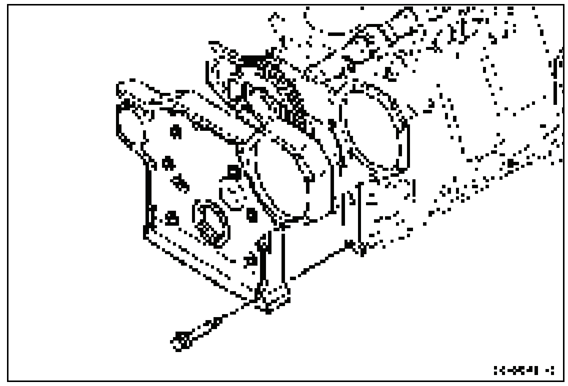


Remove the crankshaft pulley using flange puller, Part No. 3397890.

Lubricating Oil Pump Removal/Installation (Cont)

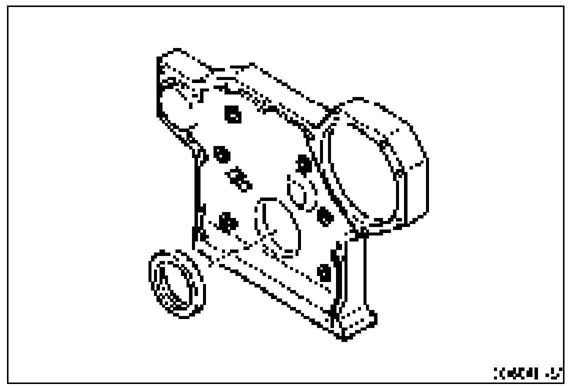
Gear Housing Cover

Remove the 17 capscrews and the gear housing cover.



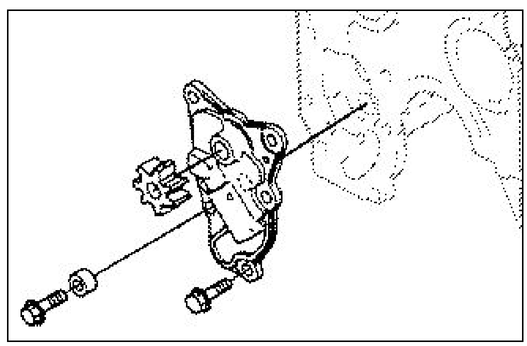
NOTE: A noise damper is installed on some engines. The noise damper must be removed prior to removing the front oil seal.

Remove the front oil seal from the gear housing cover.



Lubricating Oil Pump

Remove the five capscrews and the lubricating oil pump.



Install

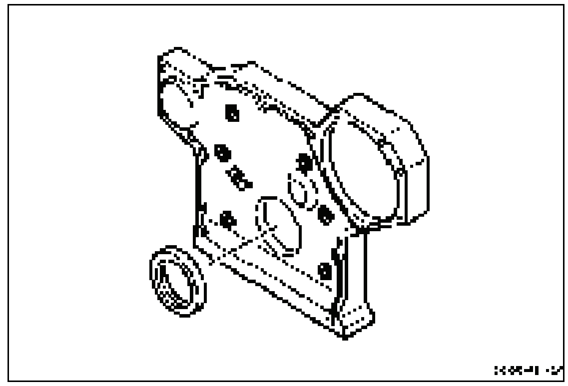
Lubricating Oil Pump Removal/Installation (Cont)

Gear Housing Cover

NOTE: A noise damper is installed on some engines. The noise damper must be installed prior to installing the front oil seal.

Install the front oil seal using tool, Part No. 3824498.

Fill 40 to 60 percent of the space in the seal lip with grease.



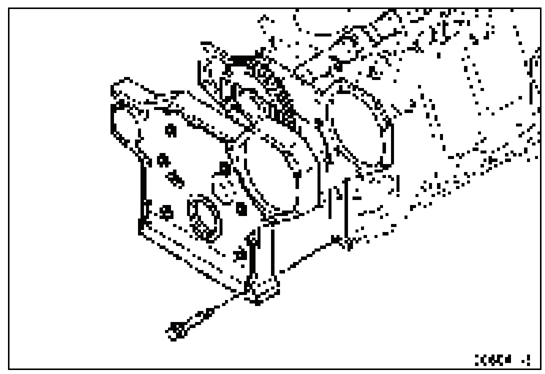
CAUTION

Do not apply excessive force to the seal lip surface when aligning and installing the gear housing cover. Damage to the engine will occur if the seal is damaged.

NOTE: Apply gasket sealant, Part No. 3823494, to the gear housing cover mounting surface.

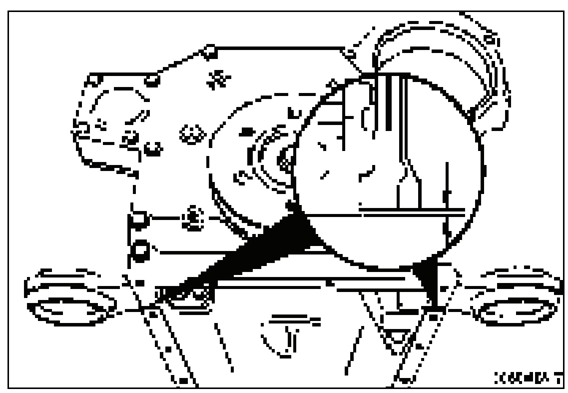
Install the gear housing cover and 17 capscrews. Tighten the capscrews.

Torque Value: 19 N•m [14 ft-lb]



Measure the distance in height between the cylinder block and the gear housing cover.

Maximum Height Difference: 0.15 mm [0.0059 in]



Lubricating Oil Pump Removal/Installation (Cont)

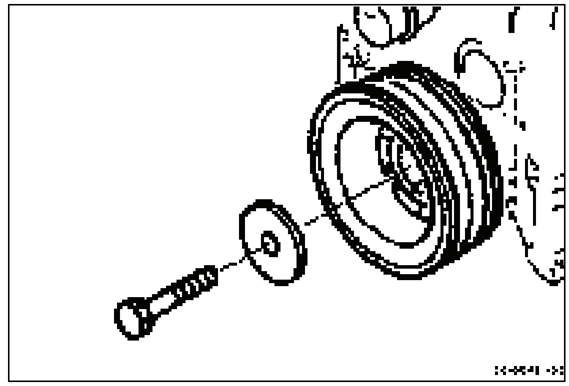
Crankshaft Pulley

Align the crankshaft pulley with the crankshaft key.

Install the crankshaft pulley, mounting plate, and capscrew.

Tighten the capscrew.

Torque Value: 93 N•m [69 ft-lb]



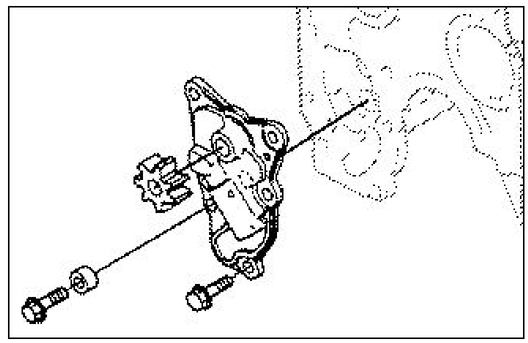
Oil Pump

NOTE: Install the mounting spacer for the one capscrew as shown.

Install the lubricating oil pump and five capscrews.

Tighten the capscrews.

Torque Value: 19 N•m [14 ft-lb]



Measure the end play of the lubricating oil pump drive gear.

Lubricating Oil Pump Drive Gear End Play

Minimum: 0.020 mm [0.0008 in]

Maximum: 0.070 mm [0.0028 in]

Follow-Up

Alternator belt

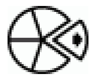
Belt guard

Add oil

Lubricating Oil Dip Stick/Tube Removal/Installation

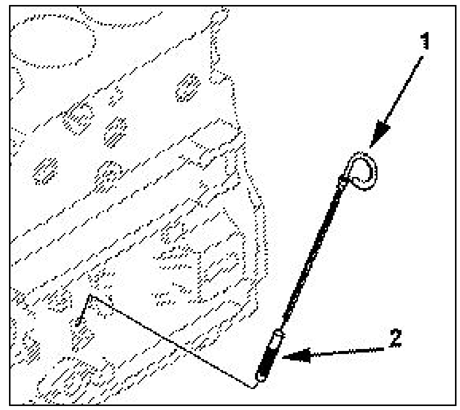
Prepare

Remove

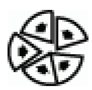


Remove the dipstick (1).

Remove the oil gauge tube (2).



Install



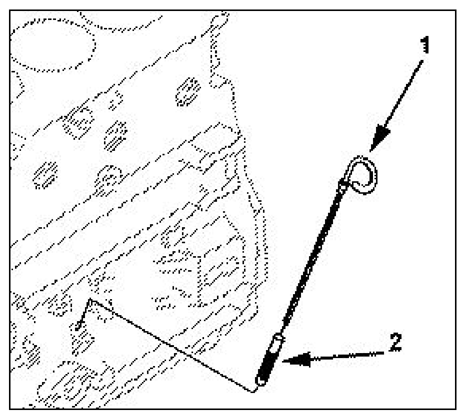
CAUTION

Excessive sealant can run back into the engine and cause damage to other components.

NOTE: Apply Loctite™ sealant, Cummins Part No. 3375068, or equivalent, to the outside of the dipstick tube.

Install the dipstick guide (2) (Cummins Part No. C6204215410).

Install the dipstick (1) (Cummins Part No. C6204215310).



Follow-Up

Lubricating Oil Filler Removal/Installation

Prepare

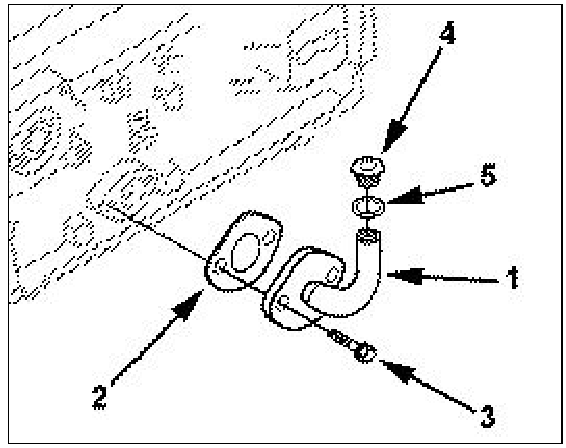
Engine stopped.

Remove

Remove the filler cap (4) and gasket (5).

Remove the two mounting capscrews (3), the filler tube (1), and cover plate gasket (2).

If necessary, clean the cover plate gasket surface.



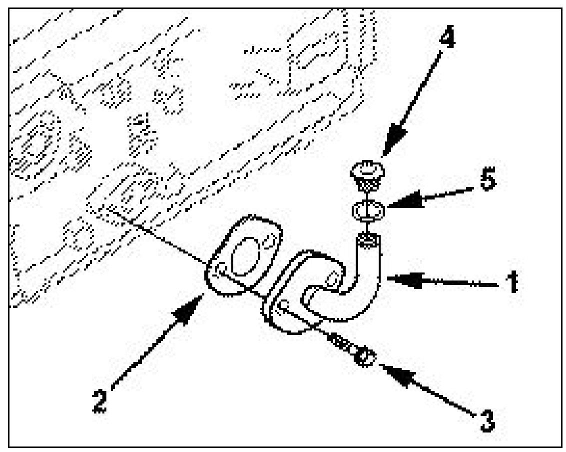
Install

Install new cover plate gasket (2) (Cummins Part No. C6204216811), filler tube (1) (Cummins Part No. C62052176110) and two capscrews (3).

Tighten the capscrews. Torque as per Capscrew Markings and Torque Values in Section 10.

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

Install the filler cap (4) (Cummins Part No. C6136217120) and gasket (5) (Cummins Part No. C6136217180).



Follow-Up

Run engine, check for leaks

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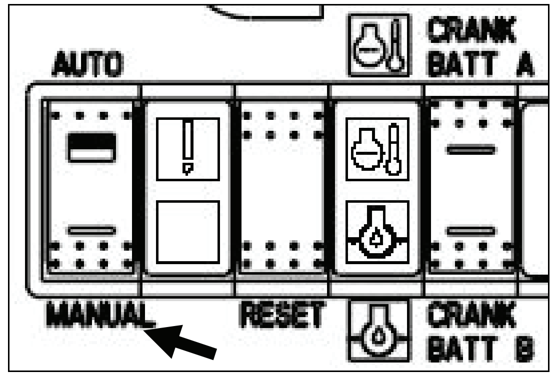
Speed Sensor Removal/Installation

Prepare

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

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

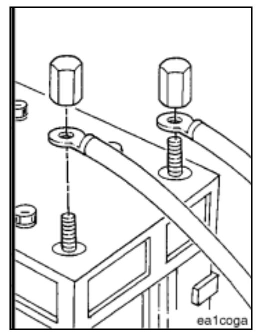


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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!

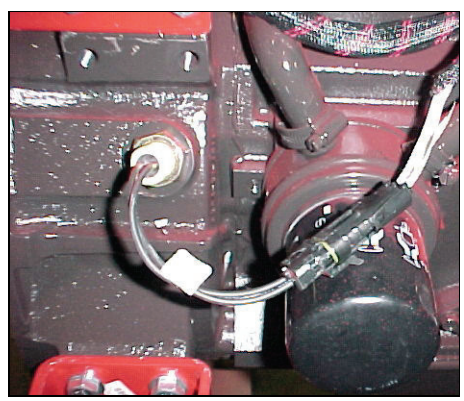
Next, disconnect both batteries at their terminals.



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.

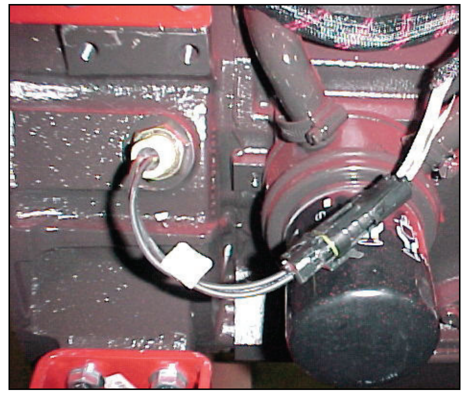


Speed Sensor Removal/Installation (Cont)

Install

When installing a new Mag Pick-Up, first check that the threads in the bell-housing are clean. Any burrs may prevent proper installation.

Install the Mag Pick-Up by threading it into the bell-housing until its tip is bottomed out against the flywheel. Then back out the Mag Pick-Up ½ turn. Reconnect the 2-wire cable. Reconnect the batteries.

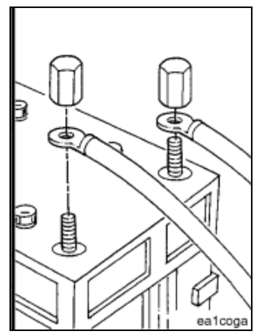


Follow-up

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

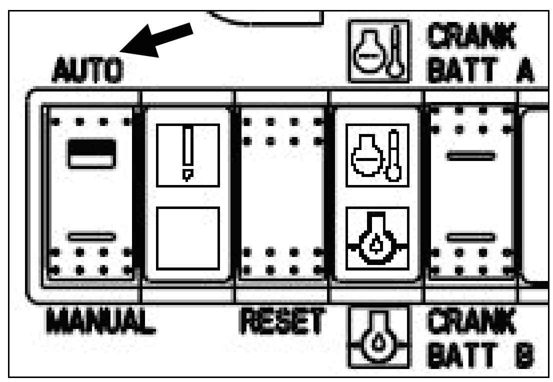
Wear safety glasses when reconnecting batteries!

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



Place the AUTO/MANUAL rocker switch in the AUTO position on the fire pump panel.

Return the fire protection system controller back to operating status.

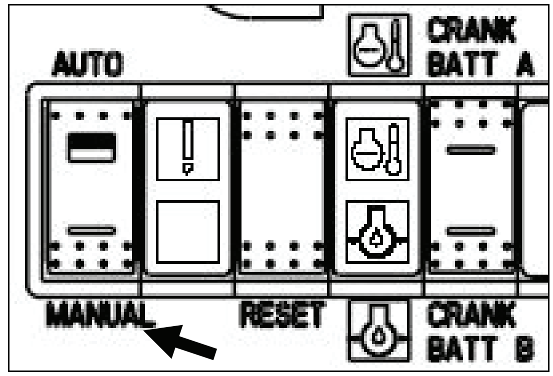


Tachometer Removal/Installation

Prepare

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

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

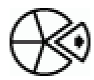


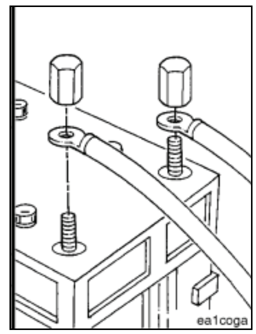
REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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.





Remove

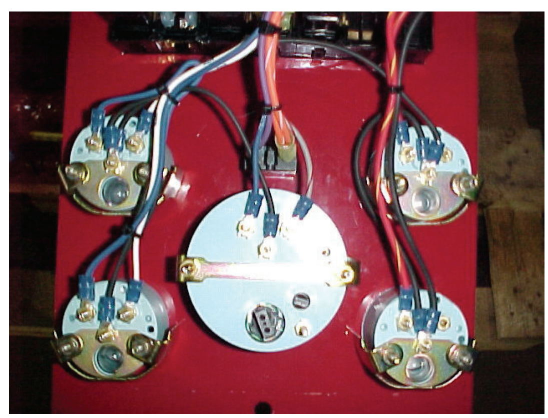
NOTE: Refer to Drawing 10423 Sheet 1 in Section 13 for electrical schematic details.

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.



Tachometer Removal/Installation (Cont)

Install

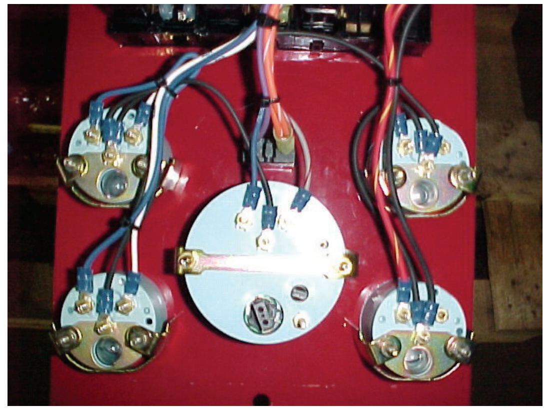
Orient the gauge in the cutout in the electrical panel.

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.

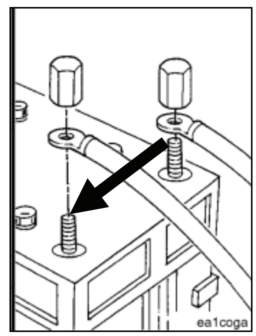


Follow-up

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

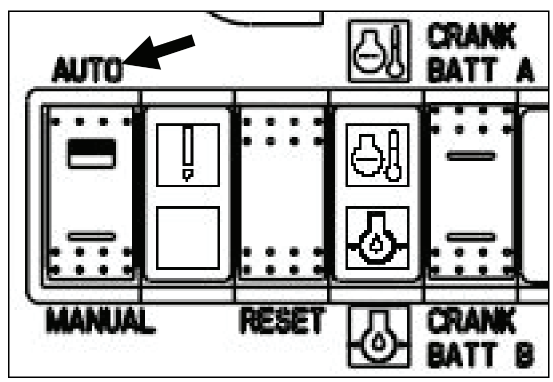
Wear safety glasses when reconnecting batteries!

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.

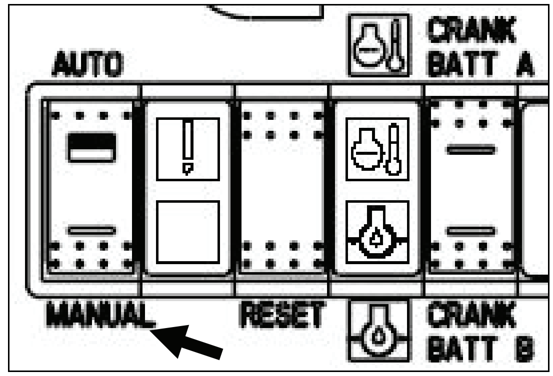


Overspeed Switch Removal/Installation

Prepare

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

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

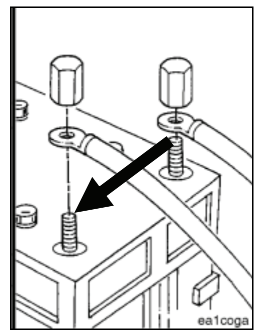


REMOVE BATTERY POWER BEFORE SERVICING ENGINE OR CONTROLS.

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!

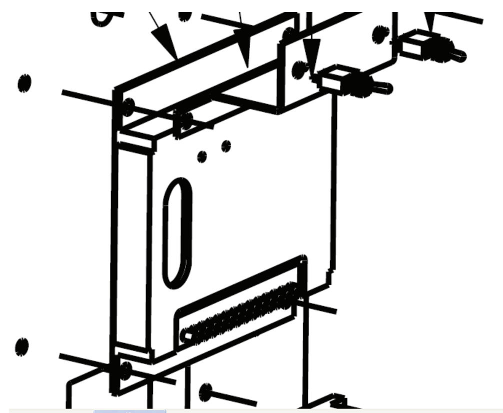
Next, disconnect both batteries at their terminals.



Remove

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.

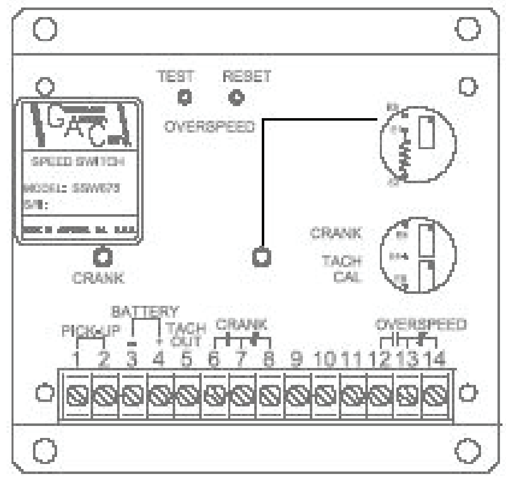
Once all of the wires are removed, the Speed Switch can be removed from the Engine Control Panel by removing the four screws that are securing it to the panel. Each screw is nutted to the back of the Control Panel. In order to access the four retaining nuts, the Control Panel may have to be loosened from the engine frame to allow clearance for a wrench.



Overspeed Switch Removal/Installation (Cont)

Install

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.

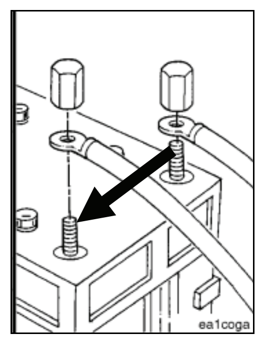


Follow-up

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

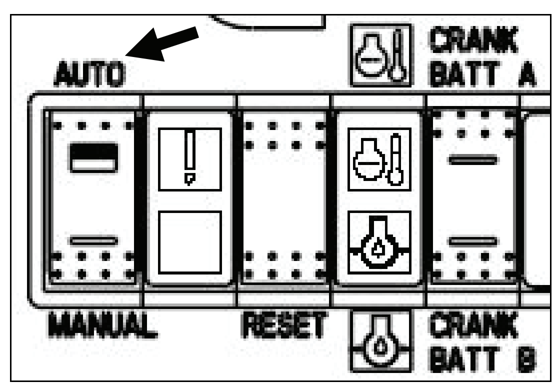
Wear safety glasses when reconnecting batteries!

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



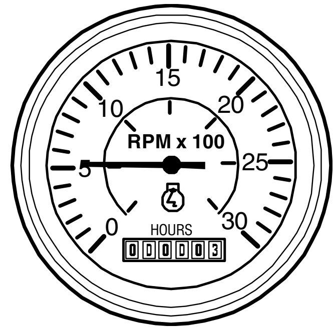
Place the AUTO/MANUAL rocker switch in the AUTO position.

Return the fire protection system controller back to operating status.

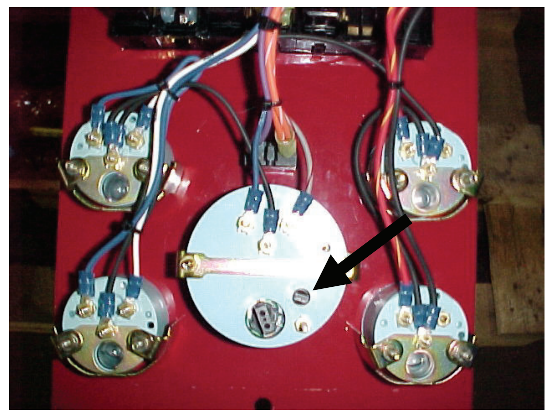


Tachometer Calibration

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.



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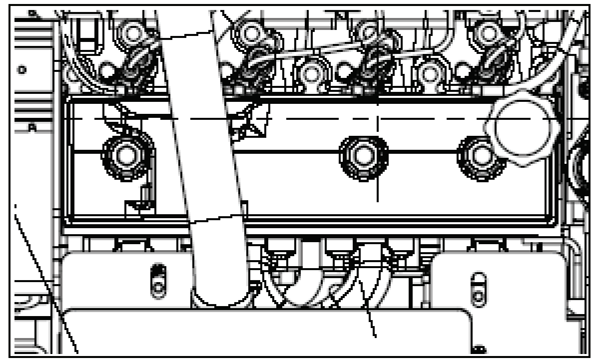
Adjust Valve Lash Clearance

Prepare

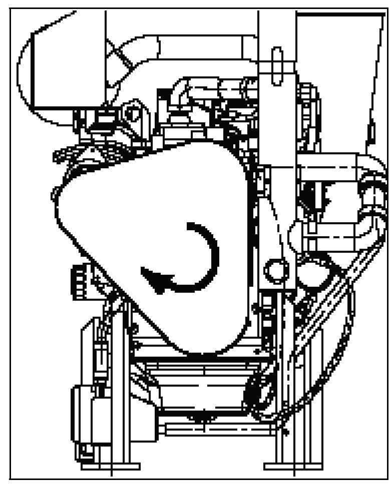
Remove the belt guard. Refer to Belt Guard Removal/Installation in this section.

Remove the cylinder head cover.

Remove and discard the old valve cover gasket.



NOTE: Adjust intake and exhaust clearances in the following firing order by rotating the crankshaft 180 degrees in the normal direction: 1-2-4-3.



Adjust Valve Lash Clearance (Cont)

Align to Adjust

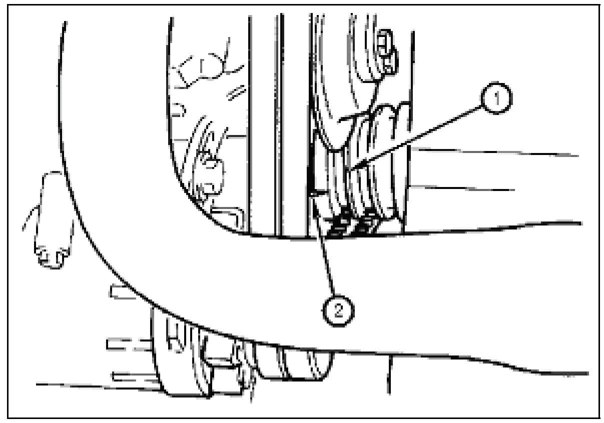
NOTE: Use either the crankshaft pulley mounting capscrews or the alternator pulley mounting nut to move the crankshaft while watching the movement of the intake valve of No. 4 cylinder, bring the No.1 cylinder into compression top dead center position.

NOTE: The No. 4 intake valve will start to open when the No. 1 cylinder comes near compression top dead center.

NOTE: The engraved mark on the crankshaft pulley will read "1.4 TOP."

Rotate the crankshaft in the normal direction (Clockwise from the front of the engine).

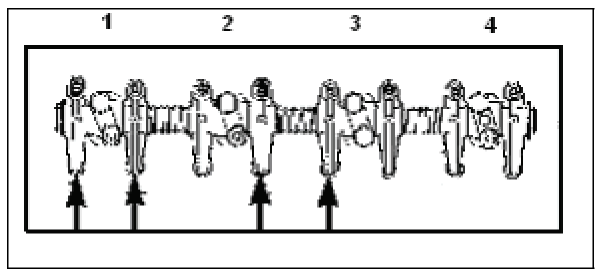
Align the TOP engraved mark on the crankshaft pulley (1) with pointer (2).



NOTE: Adjust the valve clearances for the following in this position:

Intake valves No. 1 and No. 3

Exhaust valves No. 1 and No. 2



Adjust

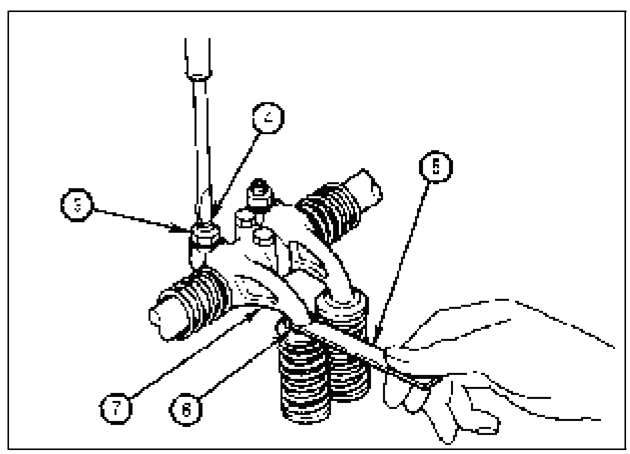
Loosen the lock nut (3) on the adjustment screw (4).

Insert the feeler gauge (5) between the valve stem (6) and the rocker arm (7).

Adjust the clearance with the adjustment screw until slight drag is felt on the feeler gauge.

Valve Clearance (Engine Hot or Cold)

- **Intake Valve 0.35 mm [0.014 in]**
- **Exhaust Valve 0.50 mm [0.020 in]**



Adjust Valve Lash Clearance (Cont)

Tighten the locknut to secure the adjustment screw.

Locknut Torque Value

- **MIN 39.2 N•m 28.9 ft-lb**
- **MAX 49 N•m 36.1 ft-lb**

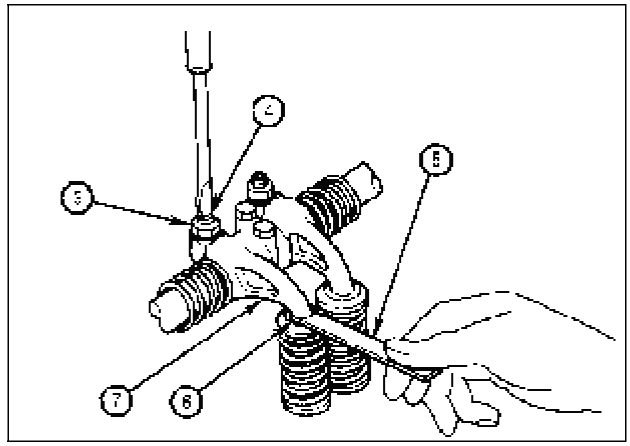
Repeat

Rotate the crankshaft in the normal direction one revolution.

In this position, adjust the valve clearances for the following as described above:

Intake valves No. 2 and No. 4

Exhaust valves No. 3 and No. 4



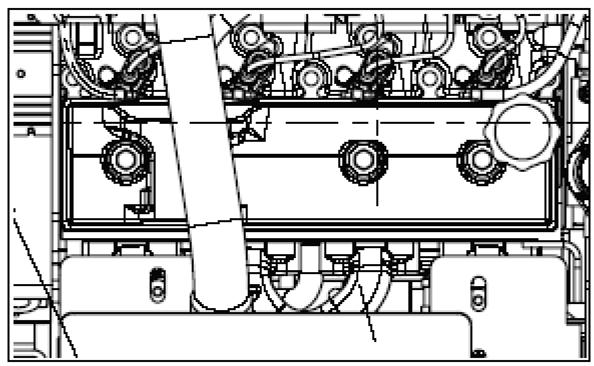
Follow-Up

Install new valve cover gasket (Cummins Part No. C6204118810).

Install the cylinder head cover.

Torque Value: 24 N•m (18 ft-lb]

Install the belt guard. Refer to Belt Guard Removal/Installation in this section.



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Section 8 – Service Literature

Section Contents

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Additional Service Literature

General Information

The following publications can be purchased at your selected Service Literature Ordering Location:

Bulletin	Title of Publication
3379000	Air for Your Engine
3379001	Fuel for Cummins Engines Bulletin
3379009	Operation - Cold Weather Bulletin
3666132	Coolant Requirements and Maintenance Bulletin
3666418	Troubleshooting and Repair Manual, B3.3 Series Engines
3810326	4B Series Standard Repair Times
3810340	Cummins Engine Oil Recommendations Bulletin

Service Literature Ordering Location

Contact Information

Region	Ordering Location
United States and Canada	Cummins Distributors at 1-800-DIESELS (1-800-343-7357) **OR** Credit Cards at 1-800-646-5609 **OR** Order online at www.powerstore.cummins.com
U.K., Europe, Mid-East, Africa, and Eastern European Countries	Cummins Engine Co., Ltd. Royal Oak Way South Daventry Northants, NN11 5NU, England
South and Central America (excluding Brazil and Mexico)	Cummins Americas, Inc. 16085 N.W. 52nd Avenue Hialeah, FL 33104
Brazil and Mexico	Cummins Inc. International Parts Order Dept., MC 40931 Box 3005 Columbus, IN 47202-3005
Far East (excluding Australia and New Zealand)	Cummins Diesel Sales Corp. Literature Center 8 Tanjong Penjuru Jurong Industrial Estate Singapore
Australia and New Zealand	Cummins Diesel Australia Maroondah Highway, P.O.B. 139 Ringwood 3134 Victoria, Australia

Section 9 – Service Assistance

Section Contents

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Routine Service and Parts

Personnel at Cummins Authorized Repair Locations can assist you with the correct operation and service of your engine. Cummins has a worldwide service network of more than 5,000 Distributors and Dealers who have been trained to provide sound advice, expert service, and complete parts support. Check the telephone directory yellow pages or refer to the directory in this section for the nearest Cummins Authorized Repair Location.

Emergency and Technical Service

The Cummins Customer Assistance Center provides a 24-hour, toll free telephone number to aid in technical and emergency service when a Cummins Authorized Repair Location can not be reached or is unable to resolve an issue with a Cummins product.

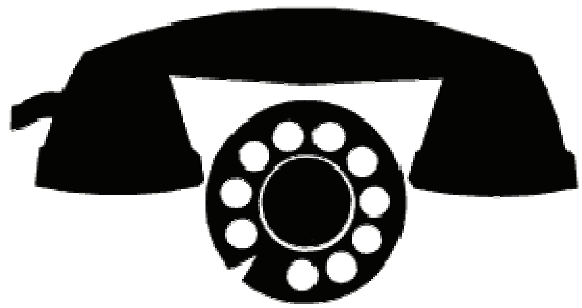
If assistance is required, call Toll-Free:

1-800-DIESELS (1-800-343-7357)

Includes all 50 states, Bermuda, Puerto Rico, Virgin Islands, and the Bahamas.

Outside of North America contact your Regional Office. Telephone numbers and addresses are listed in the International Directory.

See also www.cummins.com



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Problem Solving

Normally, any problem that arises with the sale, service, or repair of your engine can be handled by a Cummins Authorized Repair Location in your area. Refer to the telephone directory yellow pages for the one nearest you. If the problem has not been handled satisfactorily, follow the steps outlined below:

If the disagreement is with a Dealer, talk to the Cummins Distributor with whom he has his service agreement.

If the disagreement is with a Distributor, call the nearest Cummins Division or Regional Office; however, most problems are solved below the Division or Regional office level. Telephone numbers and addresses are listed in this section.

Before calling, write down the following information:

- Engine model and serial number
- Type and make of equipment
- Total kilometers [miles] or hours of operation
- Warranty start date
- Nature of problem
- Summary of the current problem arranged in the order of occurrence
- Name and location of the Cummins Distributor or Dealer

If a problem can not be resolved satisfactorily through your Cummins Authorized Repair Location or Division Office, write to:

Cummins Customer Assistance Center - 41403,

Cummins Engine Company, Inc.,

Box 3005, Columbus, IN 47202-3005

Section 10 – Maintenance Specifications

Section Contents

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General Engine Data

NOTE: The following engine and system specification data is extracted from the curves and data sheets that were current when this document was prepared.

Refer to the applicable performance curve drawing and the data sheet drawing 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).

Model	Performance Curve Drawing	Data Sheet Drawing
CFP33-F10	9728	9729
CFP33-F20	9728	9729
CFP33-F25	9730	9731
CFP33-F30	9728	9729
CFP33-F35	9730	9731

Model	Cummins Engine Co. Base Engine	Cummins Base Engine Fuel Rating
CFP33-F10	4BT3.3G2	FR30005
CFP33-F20	4BT3.3G2	FR30005
CFP33-F25	B3.3C85T	FR30203
CFP33-F30	4BT3.3G2	FR30005
CFP33-F35	B3.3C85T	FR30203

Type	4 Cycle; In-Line; 4 Cylinder
Firing Order	1-2-4-3
Rotation, Viewed from the Front of the Engine	Clockwise
Compression Ratio:	17:1
Valves per cylinder: Inlet/Exhaust	1 / 1
Installation Drawing	8700 (see Section 13)
Configuration Number	D782002GX03
Fuel System	Zexel A Direct Injection
Aspiration	Turbocharged

	Metric	US
Bore	95 mm	3.74 in
Stroke	115 mm	4.53 in.
Displacement	3.3 liter	199 in.^{3}
Intake Valve Clearance	0.35 mm	0.014 in
Exhaust Valve Clearance	0.50 mm	0.020 in
Dry Weight	272 kg	599 lb
Wet Weight	327 kg	722 lb

Fuel System Specifications

Fuel	Type Number 2 Diesel Only
Recommended fuel filter	Komatsu ff30006
Recommended fuel filter	Komatsu/Denso FF30001 & FF30005

	Metric	US
Minimum supply line size	6.4 mm D.	0.25 in. D.
Minimum drain line size	3.2 mm D.	0.125 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	76 mm Hg	3 in. Hg
Maximum restriction @ lift pump-inlet - with dirty filter	203 mm Hg	8 in. Hg
Maximum return line restriction - without check valves	381 mm Hg	15 in. Hg
Minimum fuel tank vent capability	0.34 m^3/hr	12 ft^3/hr
Maximum fuel temperature @ lift pump inlet	70 ^oC	158 ^oF

Lubricating Oil System Specifications

Recommended lube oil filter	Fleetguard OF30004

	Metric	US
Oil pressure range at rated	276-414 kPa	40-60 PSI
Oil capacity of pan (high - low)	7.0-5.5 liter	1.9-1.45 U.S. Gal
Total system capacity	8 liter	2.1 U.S. Gal.

Cooling System Specifications

	Metric	US
Maximum raw water working pressure range at heat exchanger	414 kPa	60 PSI
Recommended minimum water supply pipe size to heat exchanger	19.1 mm D.	0.75 in. D.
Recommended minimum water discharge pipe size from heat exchanger	25.4 mm D.	1.0 in. D.
Coolant water capacity (engine side)	4.5 liter	1.2 U.S. Gal.
Modulating thermostat range	82-95^{o}C	180-203 ^oF
Minimum raw water flow with water temperatures to 90 ^oF (32 ^oC)	0.76 liter/s	12 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 RU3570 (Optional) Donaldson B085001

	Metric	US
Maximum temperature rise between ambient air and engine air inlet	8^oC	18^oF
Maximum inlet restriction with dirty filter	762 mm H_2O	30 in. H_2O

Exhaust System Specifications

	Metric	US
Maximum exhaust back pressure imposed by complete exhaust system	10.2 kPa	40.8 in. H_2O
Exhaust pipe size normally acceptable	76 mm D.	3 in. D.

Electrical System Specifications

Start Circuit

The start circuit consists of a single starter motor and redundant starter control relays as well as using redundant power sources either 12 V or 24 V comprised of 12 V wet type storage batteries (optional at shipment).

The battery, starter and starter solenoid positive terminals are booted with a non-conducting cover or otherwise insulated from unintended grounding. Battery cable leads from the batteries to the designated connection points in the starting circuit are minimum 6.53 mm D. (No. 2 AWG), neoprene or rubber insulated with a 1.5 mm (0.060 in.) minimum insulation thickness rated 80°C (176 ^oF) 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	30H or 31

	12V	24V
Minimum recommended battery cold cranking amperes (CCA)(1)	620 Amps	310 Amps
Minimum recommended battery reserve capacity	400 Minutes	800 Minutes
Maximum resistance of starting circuit	0.002 Ohms	0.004 Ohms
Typical cranking speed	120 RPM	120 RPM
Alternator (standard), internally regulated	65 Amps	35 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^oC (0^oF) or above

Cummins/Fleetguard® Liquid Filter Specifications

General Information

Fleetguard®/Nelson is a subsidiary of Cummins Inc. Fleetguard®/Nelson filters are developed through joint testing at Cummins and Fleetguard®/Nelson. Fleetguard®/Nelson filters are standard on new Cummins engines. Cummins Inc. recommends their use.

Fleetguard®/Nelson products meet all Cummins Source Approval Test standards to provide the quality filtration necessary to achieve the engine's design life. If other brands are substituted, the purchaser should insist on products that the supplier has tested to meet Cummins high-quality standards.

Cummins can not be responsible for problems caused by non-genuine filters that do not meet Cummins performance or durability requirements.

Fuel Recommendations and Specifications

Fuel Recommendations

WARNING

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

CAUTION

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

Use only number 2 diesel (ASTM no. 2D) fuel.

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

Additional information for fuel recommendations and specifications can be found in Fuel for Cummins Engines, Bulletin No. 3379001. See Section 8, Service Literature, for ordering information.

Lubricating Oil Recommendations and Specifications

Oil Performance Recommendations

Using quality engine lubricating oils, along with appropriate oil drain and filter change intervals, is a critical factor in maintaining engine performance and durability. Refer to Service Literature in Section 8 for reference to related Cummins service bulletins.

Cummins Engine Company, Inc. recommends the use of a high-quality SAE 15W-40 heavy-duty engine oil (such as Cummins Premium Blue®), which meets the American Petroleum Institute (API) performance classification CH4/SG.

A sulfated ash limit of 1.0 mass percent is suggested for optimum valve and piston deposit and oil consumption control. The sulfated ash must not exceed 1.85 mass percent.

New Engine Break-In Oils

Do not use special “break-in” lubricating oils for new or rebuilt Cummins engines. Use the same type of oil during the “break-in” as that which is used in normal operation.

Recommended Oil Change Intervals

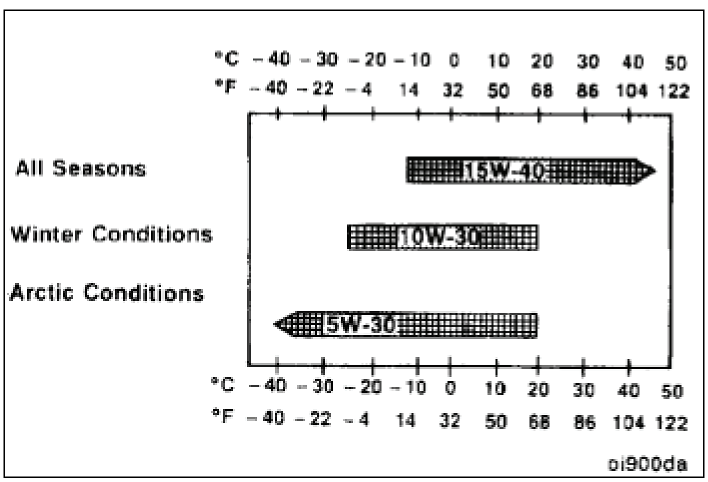
The oil change interval for turbocharged engines is every 6 months or 250 hours.

Oil Viscosity Recommendations

The use of multiviscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures.

While 15W-40 oil is recommended for most climates, refer to the accompanying table for oil viscosity recommendations for extreme climates.

NOTE: Limited use of low-viscosity oils, such as 10W-30, can be used for easier starting and providing sufficient oil flow at ambient temperatures below -35°C [23°F]. However, continuous use of low viscosity oils can decrease engine life because of wear. Refer to the accompanying chart.



Coolant Recommendations and Specifications

Heavy-duty diesel engines require a balanced coolant mixture of water and antifreeze.

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 <u>Service Literature</u> in Section 8 for reference to related Cummins service bulletins.

Concentration

Antifreeze must be used in any climate for both freeze and boiling point protection. Cummins recommends a 50-percent concentration level (40-percent to 60-percent range) of ethylene glycol or propylene glycol in most climates. Antifreeze at 68-percent concentration provides the maximum freeze protection and must never be exceeded under any condition. Antifreeze protection decreases above 68 percent.

Ethylene Glycol	Propylene Glycol
40% = -23°C [-10°F]	**40% = -21°C [-6°F]**
50% = -37°C [-34°F]	**50% = -33°C [-27°F]**
60% = -54°C [-65°F]	**60% = -49°C [-56°F]**
68% = -71°C [-90°F]	**68% = -63°C [-82°F]**

Concentration Testing

Antifreeze concentration must be checked using a refractometer (such as Fleetguard® Part No. CC2800). “Floating ball” types of density testers or hydrometers are not accurate enough for use with heavy-duty diesel cooling systems.

Engine Component Torque Values

Torque Table

Component	Wrench Size	N•m	ft-lb or in-lb
After cooler Mounting	10 mm	24	18 ft-lb
After cooler Water Hose Clamp	8 mm	5	44 in-lb
Alternator Link (Delco 10-15 SI)	13 mm	24	18 ft-lb
Alternator Link (Delco 20-27 SI)	3/4 in	43	32 ft-lb
Alternator Mtg. Bolt 10-15 SI	15 mm	43	32 ft-lb
Alternator Mtg. 27 SI	18 mm	77	57 ft-lb
Alternator Support (Upper)	10 mm	24	18 ft-lb
Belt Tensioner Flat Bracket	Allen 5 mm	24	18 ft-lb
Belt Tensioner Mounting	15 mm	43	32 ft-lb
Crankshaft Damper and Pulley	15 mm	137	101 ft-lb
Crossover Clamp	5/16 in	5	44 in-lb
Tee Bolt Type Clamp	11 mm	8	71 in-lb
Exhaust Outlet Pipe, V Band Clamp	7/16 in	8	71 in-lb
Fuel Filter	75 to 85 mm	Install as specified by filter manufacturer	
Fuel Filter Adapter Nut	24 mm	32	24 ft-lb
Lubricating Oil Filter	75 to 85 mm	3/4 Turn after Contact	
Lubricating Oil Cooler Assembly	10 mm	24	18 ft-lb
Lubricating Oil Pan Drain Plug (steel)	17 mm	80	59 ft-lb
Lubricating Oil Pan Drain Plug (aluminum)	17 mm	55	41 ft-lb
Lubricating Oil Pan Heater Plug	27 mm	80	59 ft-lb
Lubricating Oil Pressure Regulator Plug	19 mm	80	59 ft-lb
Starter Mounting	10 mm	43	32 ft-lb
Thermostat Housing	10 mm	24	18 ft-lb
Water Inlet Connection	15 mm	43	32 ft-lb
Water Pump Mounting	13 mm	24	18 ft-lb
Rocker Lever Cover	15 mm	24	18 ft-lb
Water-in-Fuel Sensor	19 mm	Hand-Tighten	
Top-Load Filter Lid	10 mm	Hand-Tighten	

Sealants

General Information

Use either the sealants listed below or sealants containing equivalent properties.

Description	Sealing Method
Pipe Plugs	Precoated teflon or pipe sealer.
Cup Plugs	Loctite 277 or 11,264.
O-Rings	No sealant required.
Rear Camshaft Expansion Plug	Precoated or Loctite 59,241 liquid teflon.
Turbocharger Drain in Block	Loctite 277 or 11,264.
Oil Pan at T-Joint	Silicone Sealant (P/N 3823494)
Front Cover	Silicone Sealant (P/N 3823494)

Capscrew Markings and Torque Values

General Information

CAUTION

Always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

Always use the torque values listed in the following tables when specific torque values are not available.

Do not use the torque values in place of those specified in other sections of this manual.

The torque values in the table are based on the use of lubricated threads.

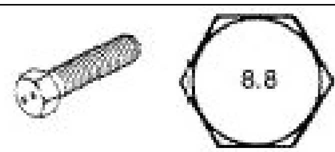
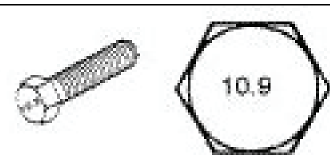
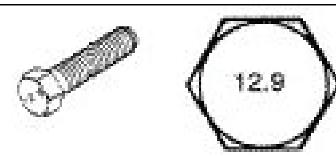
When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

Metric Capscrew Identification

Sample:	M8-1.25 x 25		
Value:	M8	1.25	X 25
Meaning:	Major thread diameter in millimeters	Distance between threads in millimeters	Length in millimeters

Metric Capscrew Head Markings

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts.

Commercial Steel Class	**8.8**	**10.9**	**12.9**
Capscrew Head Markings			

Metric Capscrew Torque Values

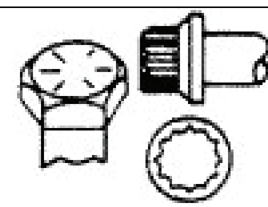
Class:	**8.8**				**10.9**				**12.9**			
Diameter	**Cast Iron**		**Aluminum**		**Cast Iron**		**Aluminum**		**Cast Iron**		**Aluminum**	
mm	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	25
12	80	60	55	40	115	85	55	40	125	95	55	40
14	125	90	90	65	180	133	90	65	195	145	90	65
16	195	140	140	100	280	200	140	100	290	210	140	100
18	280	200	180	135	390	285	180	135	400	290	180	135
20	400	290	—	—	550	400	—	—	—	—	—	—

US Customary Capscrew Identification

Sample:	5/16 x 18 x 1-1/2		
Value:	5/16	18	1-1/2
Meaning:	Major thread diameter in inches	Number of threads per inch	Length in inches

U.S. Customary Capscrew Head Markings

U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

SAE Grade 5 **w/ three lines**	**SAE Grade 8**
	

U.S. Customary Capscrew Torque Values

Grade	**SAE Grade 5**				**SAE Grade 8**			
Capscrew Body Size	**Cast Iron**		**Aluminum**		**Cast Iron**		**Aluminum**	
	N•m	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**	**N•m**	**ft-lb**
1/4-20	9	7	8	6	15	11	8	6
1/4-28	12	9	9	7	18	13	9	7
5/16-18	20	15	16	12	30	22	16	12
5/16-24	23	17	19	14	33	24	19	14
3/8-16	40	30	25	20	55	40	25	20
3/8-24	40	30	35	25	60	45	35	25
7/16-14	60	45	45	35	90	65	45	35
7/16-20	65	50	55	40	95	70	55	40
1/2-13	95	70	75	55	130	95	75	55
1/2-20	100	75	80	60	150	110	80	60
9/16-12	135	100	110	80	190	140	110	80
9/16-18	150	110	115	85	210	155	115	85
5/8-11	180	135	150	110	255	190	150	110
5/8-18	210	155	160	120	290	215	160	120
3/4-10	325	240	255	190	460	340	255	190
3/4-16	365	270	285	210	515	380	285	210
7/8-9	490	360	380	280	745	550	380	280
7/8-14	530	390	420	310	825	610	420	310
1-8	720	530	570	420	1100	820	570	420
1-14	800	590	650	480	1200	890	650	480

Section 11 – Warranty Information

EXCLUSIVE EXPRESS LIMITED WARRANTY: Cummins NPower, LLC ("CNP"), expressly warrants to the original end consumer only that, for a period not to exceed the earlier of two (2) years or 2000 hours of use from the start-up date (or, if the original end consumer fails to register as purchaser with CNP, six (6) months from CNP shipment date), the diesel fire pump drivers, manufactured and sold by CNP, shall be free from defects in material and workmanship when used and serviced in accordance with the Operations and Maintenance manual for the applicable Cummins Fire Pump engine model (the "Exclusive Warranty"). The Exclusive Warranty is non-transferable and shall immediately terminate and be of no further force or effect upon the sale, lease, assignment, transfer or other disposition by an original end consumer of a Cummins Fire Pump engine that contains a diesel fire pump driver covered by this Exclusive Warranty. Nothing contained herein shall be construed to extend the Exclusive Warranty, and the Exclusive Warranty shall not be extended, to:

- Maintenance, adjustment, installation or start-up costs;
- Diesel fire pump driver failure due to normal wear, accident, misuse, abuse, neglect, improper installation or a defect attributable to a Cummins Fire Pump engine;
- Alterations or modifications not authorized in writing by CNP;
- Additional components added to a diesel fire pump driver package subsequent to shipment of the engine; or
- Starting batteries and heaters.

DISCLAIMER OF WARRANTIES: Except for the Exclusive Warranty provided above, which is in lieu of all other express and implied warranties, CNP EXPRESSLY DISCLAIMS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION AND EXCLUSION OF REMEDIES: All claims under this Exclusive Warranty shall be deemed waived by the original end consumer if not submitted to CNP or an authorized distributor within thirty (30) days of initial discovery that a diesel fire pump driver is not conforming to the Express Warranty. The original end consumer's remedy under this Exclusive Warranty is limited, in CNP's reasonable discretion, to repair, replacement or other appropriate adjustment of a non-conforming diesel fire pump driver determined, upon CNP's inspection, to have been properly installed, maintained and operated in accordance with the Operations and Maintenance manual furnished by CNP. IN ANY EVENT, CNP SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

The Cummins Industrial Warranty covers the base engine for a period of time not to exceed the earlier of two (2) years or 2000 hours of operation from the date of delivery and start-up of the engine. Reference bulletin numbers 3381321 US/Canada & 3381322 Outside US/Canada. Cummins Fire Power components are warranted for a period of time not to exceed the earlier of two (2) years or 2000 hours of operation from the start-up date of the fire pump system, and the coverage includes travel time and mileage for the first year of the Limited Warranty, and repair or replacement of parts and reasonable cost of labor. The Cummins Fire Power Limited Warranty does not cover failures or damage due to abuse or neglect and including, but not limited to: shipping damage, improper storage, improper installation, unauthorized modification or lack of maintenance. **Cummins Fire Power is not responsible for incidental or consequential damages.**

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Section 12 – Troubleshooting

Section Contents

Section Contents (Cont)

Troubleshooting Procedures and Techniques

General information

This guide describes some typical engine operating problems, their causes, and some acceptable corrections to those problems.

WARNING

Performing troubleshooting procedures NOT outlined in this in Section can result in equipment damage or personal injury or death.

Troubleshooting must be performed by trained, experienced technicians.

Consult a Cummins Authorized Repair Location for diagnosis and repair beyond that which is contained in this manual, and for symptoms not listed in this in section.

Before beginning any troubleshooting, refer to the General Safety Instructions in Section 1 of this manual.

Follow the suggestions below for troubleshooting:

Study the complaint thoroughly before acting.

Refer to the Engine Identification diagrams in Section 2, the System Diagrams in Section 6, and the Assembly Drawings in Section 13.

Do the easiest and most logical things first.

Find and correct the cause of the complaint.

Troubleshooting Symptoms Charts

WARNING

Troubleshooting presents the risk of equipment damage, personal injury or death Troubleshooting must be performed by trained, experienced technicians.

Use the charts on the following pages of this section to aid in diagnosing specific engine symptoms.

Read each row of blocks from top to bottom.

Follow through the chart to identify the corrective action.

Alternator Overcharging with the Engine Running

NOTE: If the batteries are overcharged while the engine is not running, troubleshoot the customer supplied battery charging system.

Cause	Correction
Batteries have failed.	Check the condition of the batteries. Replace any defective batteries.
OK	
The internal voltage regulator in the alternator is malfunctioning.	Test the alternator electrically. Refer to Alternator Checks and Testing in Section 7. If required, replace the alternator. Refer to Alternator Removal/Installation 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.	Test the alternator mechanically. Refer to Alternator Checks and Testing in Section 7. If the alternator shaft does not spin freely because of a bad bearing, replace the alternator (refer to Alternator Removal/Installation in Section 7). If the alternator does not turn because of a bad drive belt, replace the drive belt (refer to Belt Removal/Installation in Section 7). If the alternator does not charge because of poor drive belt tension, adjust belt tension (refer to Adjust Alternator Drive Belt Tension in Section 7). If the alternator pulley spins freely on the shaft because of a broken key, replace the alternator (refer to Alternator Removal/Installation in Section 7).
OK	
Battery Isolator input has faulted.	Test continuity from the alternator to the battery isolator input (refer to Drawing 10423 Sheet 2 in Section 13). Repair any open circuit. Test continuity through the battery isolator. If an internal open circuit is detected, replace the battery isolator (refer to Battery Isolator Removal/Installation in Section 7).
OK	

Neither Battery is Charging with the Engine Running (Cont)

Cause	Correction
Alternator excitation is lost.	Test the alternator electrically. Refer to Alternator Checks and Testing in Section 7. If required, replace the replaceable diode. Refer to Drawing 10423 Sheet 1 in Section 13. If required, locate and repair the open circuit or short to ground in the alternator excitation wiring.
OK	
Alternator internal voltage regulator is malfunctioning.	Test the alternator electrically. Refer to Alternator Checks and Testing in Section 7. If required, replace the alternator. Refer to Alternator Removal/Installation Section 7.
OK	
Battery temperature is above specification.	Position the batteries away from heat sources.
OK	
Contact an Authorized Cummins Repair Facility.	

Only One Battery is Charging with the Engine Running

NOTE: If one or both batteries do not charge with the engine stopped, troubleshoot the customer supplied battery charging system.

NOTE: If neither battery is maintaining charge, go to Neither Battery is Charging with the Engine Running.

Cause	Correction
Battery has failed.	Test battery condition. Refer to Battery Testing in Section 7. If the battery has failed, replace the failed battery units. Refer to Battery Removal/Installation in Section 7.
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. Refer to Battery Isolator Removal/Installation in Section 7. Test the internal diodes for open circuit or short to ground. Refer to the Schematic, Electrical Wiring, 10423 Sheet 2 Section 13. If required, obtain a replacement battery isolator (Cummins Part No. 8838). Install the battery isolator. Refer to Battery Isolator Removal/Installation 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.	Check battery condition. Replace failing battery elements. Check wiring for corrosion. Ensure good electrical contact. Charge discharged batteries by running the engine or with an external battery charger. If the battery does not charge with the engine running, go to Only One Battery is Charging with the Engine Running.
OK	
Fuse 1 or Fuse 2 is open. (Refer to Drawing 10423 Sheet 1 in Section 13).	Check for apparent wire damage or shorts to grounds. Replace the failed fuse. Refer to Fuse Replacement in Section 7. If the fuse operates again, locate and correct the overload or repair the short circuit.
OK	
Open circuit or short to ground in indicator wiring.	Locate and repair the electrical fault. (Refer to Drawing 10423 Sheet 1 in Section 13).
OK	
Voltmeter has failed.	Remove wiring at the voltmeter and apply test voltage. If necessary, replace the faulted voltmeter. Refer to Voltmeter Removal/Installation in Section 7.
OK	
Contact an Authorized Cummins Repair Facility.	

Coolant Contamination

Cause	Correction
Coolant is rusty and has debris.	Drain and flush the cooling system. Refer to Drain and Flush Cooling System in Section 5. If the drained coolant has excessive rust or debris, change the coolant more frequently or contact a Cummins Authorized Repair Facility. Otherwise, refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5.
OK	
Lubricating oil cooler is leaking oil into the coolant. Coolant begins to have the texture and color of chocolate pudding.	Drain and flush the cooling system. Refer to Drain and Flush Cooling System in Section 5. Check the lubricating oil cooler for coolant leaks and cracks. Refer to Lubricating Oil Cooler Removal/Installation in Section 7. Replace the oil cooler gasket or other parts. Refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5. If the problem persists, the cylinder block may be cracked or porous. Refer to a Cummins Authorized Repair Facility.
OK	

Coolant Contamination (Cont)

Cause	Correction
Coolant Heat Exchanger is leaking raw water into the coolant. Coolant volume increases and pressure is relieved when the unit is operating. Antifreeze concentration decreases.	Drain and flush the cooling system. Refer to Drain and Flush Cooling System in Section 5. Remove Coolant Heat Exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. Perform a pressure test of the raw water side of the heat exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. If the heat exchanger leaks, it should be replaced. Install a known good Coolant Heat Exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7. Check and adjust raw water pressure regulator setpoints. Refer to Raw Water Piping, Lineup, and Configuration in Section 3. Check and, if required, replace the Zinc Plug. Refer to Inspect Heat Exchanger Zinc Plug in Section 5. Refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5.
OK	
Coolant is inadvertently contaminated with unknown liquids.	Drain and flush the cooling system. Refill with correct mixture of antifreeze and water. Refer to Drain and Flush Cooling System in Section 5.
OK	
Contact an Authorized Cummins Repair Facility.	

Excessive Coolant Loss

Cause	Correction
Adequate coolant was not added following previous maintenance activities.	Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant as required and check engine operation. If coolant loss persists, check for other problems.
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 Check Hose Condition in Section 5. Replace and/or tighten loose hose clamps. Replace any damaged hoses. Refer to Coolant Hose Removal/Installation in Section 7. Add coolant as required and check engine operation.
OK	
Pressure cap (Cummins Fire Power Part No. 11407) 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. 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)

Cause	Correction
Engine is overheating.	Refer to the Coolant Temperature Above Normal 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 ^{o}C [180-203 ^{o}F]. The High Water Temperature lamp on the local control panel (see Instrument Panel in Section 2) illuminates at 93 (92-94)^{o}C [200 (198-202)^{o}F]. The lamp will only illuminate if the engine is running. If the lamp is illuminated or if temperature is otherwise excessive, the engine should be stopped as soon as practical and the problem corrected.

Cause	Correction
Raw water flow is improperly aligned.	Check that the raw water manifold is aligned for normal flow through the solenoid valve (preferred) or bypass flow around the solenoid valve (alternative). (Refer to Drawing 8682 in Section 13). Align flow if required.
OK ⬇	
Raw water pressure regulator is improperly adjusted.	**NOTE**: Pressure should be about 414 kPa [60 psig] or slightly less. Check the raw water pressure indication. If pressure is indicated but is low, adjust the regulator (Refer to Check Raw Water Pressure Regulator Setpoints in Section 3.) If pressure is not indicated or is excessively low, go to Raw water solenoid has failed in this table.
OK ⬇	
Raw water solenoid has failed.	If pressure is excessively low when aligned for normal flow, open the bypass valves. Then, when practical, troubleshoot the raw water solenoid valve. Refer to Raw Water Solenoid Valve Fails to Operate in this section. If the solenoid valve operates, replace the pressure regulator. (Refer to Raw Water Pressure Regulator Removal/Installation in Section 7.) If pressure is excessively low when aligned for bypass flow, open the normal valves. Then, when practical, replace the pressure regulator. (Refer to Raw Water Pressure Regulator Removal/Installation in Section 7.)
OK ⬇	

Coolant Temperature Above Normal (Cont)

Cause	Correction
Raw water piping or heat exchanger is plugged.	Check the raw water strainer for blockage. Refer to Drawing 8682 in Section 13. Clean the strainer if necessary. Check the Cummins supplied raw water piping for blockage. Refer to Drawing 8682 and Drawing 9636 in Section 13. Clean the piping if necessary. Check the customer supplied raw water piping for blockage. Remove any blockage. Check for flow through the heat exchanger. If necessary, replace the heat exchanger. Refer to Coolant Heat Exchanger Removal/Installation in Section 7.
OK	
Coolant level is below specification.	Check the coolant level. Refer to Check Coolant Level in Section 5. Add coolant as required. If coolant level was excessively low, go to Excessive Coolant Loss in this section.
OK	
Cooling system hose is collapsed or restricted.	Inspect the hoses. Refer to Check Hose Condition in Section 5. Replace any damaged hoses. Refer to Coolant Hose Removal/Installation in Section 7.
OK	
Coolant thermostat is malfunctioning.	Remove and test the coolant thermostat. Refer to Coolant Thermostat Removal/Installation in Section 7. Replace the thermostat if it is defective.
OK	
Coolant water pump is malfunctioning.	Remove and inspect the water pump. Refer to Coolant Water Pump Removal/Installation in Section 7. Replace the thermostat if it is defective.
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 Lubricating Oil Contaminated symptom tree.
OK	
Cooling system hose is collapsed, restricted, or leaking.	Inspect the hoses. Refer to Check Hose Condition in Section 5. Replace any damaged hoses. Refer to Coolant Hose Removal/Installation in Section 7.
OK	
Coolant mixture of antifreeze and water is not correct.	Verify the concentration of antifreeze in the coolant. Refer to Check Cooling System Condition in Section 5. Add antifreeze or water to correct the concentration. Refer to Coolant Recommendations and Specifications in Section 10.
OK	
Lubricating oil level is above or below specification.	Check the oil level. Refer to Check Engine Oil Level in Section 5. Add or drain oil, if necessary.
OK	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to Coolant Temperature Sender Removal/Installation in Section 7.
OK	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to Coolant Temperature Gauge Removal/Installation in Section 7.
OK	

Coolant Temperature Above Normal (Cont)

Cause	Correction
Coolant temperature switch is malfunctioning.	Remove the temperature switch. Refer to Coolant Temperature Switch Removal/Installation in Section 7. Test the temperature switch. Repair or replace the switch, if necessary.
OK	
Refer to a Cummins Authorized Repair Facility.	

Coolant Temperature Below Normal (Engine Off)

Cause	Correction
The 120 VAC power supply to the coolant heater is not connected.	Connect the power supply. Correct any electrical faults in the supply circuit.
OK ⬇	
The heater's overload thermostat has operated.	Ensure that there is coolant in the heater. Allow time for the automatic overload reset to occur.
OK ⬇	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to Coolant Temperature Sender Removal/Installation in Section 7.
OK ⬇	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to Coolant Temperature Gauge Removal/Installation in Section 7.
OK ⬇	
Coolant is not free to circulate through the heater.	Ensure that the coolant hoses are clear. Refer to Coolant Hose Removal/Installation in Section 7.
OK ⬇	
The coolant heater has failed electrically.	Replace the coolant heater. Refer to Coolant Heater Removal/Installation in Section 7.
OK ⬇	
Contact a Cummins Authorized Repair Facility.	

Coolant Temperature Below Normal (Engine Running)

Cause	Correction
Coolant thermostat has failed open.	Test operation of the thermostat. Refer to Coolant Thermostat Tests in Section 7. If necessary, replace the thermostat. Refer to Coolant Thermostat Removal/Installation in Section 7.
OK ⬇	
Coolant temperature sender is malfunctioning.	Replace the temperature sender. Refer to Coolant Temperature Sender Removal/Installation in Section 7.
OK ⬇	
Coolant temperature gauge is malfunctioning.	Replace the temperature gauge. Refer to Coolant Temperature Gauge Removal/Installation in Section 7.
OK ⬇	
Contact an Authorized Cummins Repair Facility.	

Raw Water Drain Steaming

NOTE: The raw water drain from the Coolant Heat Exchanger may steam if raw water flow is inadequate when the engine is running. It may also steam shortly after the engine is stopped. If coolant is leaking into the raw water drain piping, the steaming may last for some time while the engine cools. Antifreeze may also be observed in the raw water drain.

Cause	Correction
Raw water flow did not start when the engine started.	Check engine coolant temperature. Go to Coolant Temperature Above Normal in this section.
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 Coolant Heat Exchanger Removal/Installation 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 Raw Water Solenoid Valve Removal/Installation in Section 7. Clean the raw water strainer more frequently. Increase the frequency of operational testing.
OK ↓	
Solenoid valve fails to energize.	Check electrical continuity and insulation from ground to the solenoid. Repair any open or short circuits in the wiring.
OK ↓	
Solenoid fails to open mechanically.	**NOTE**: Apply the correct operating voltage, either 12 VDC or 24 VDC depending upon the model. Apply temporary voltage to the solenoid. If the solenoid fails to operate, replace it. Refer to Raw Water Solenoid Valve Removal/Installation in Section 7.
OK ↓	
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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 as actuated. The overspeed lamp is illuminated on the local control panel.	Press the RESET switch on the local control panel.
OK	
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.
OK	
Circuit Breaker CB is open in the local control panel.	Check whether Circuit Breaker CB at the local control panel is open. Refer to Drawing 10423 Sheet 1 in Section 13. If open, reset the circuit breaker. Locate and correct any electrical faults in the control panel. Press the RESET switch on the local control panel.
OK	
The AUTO/MANUAL Rocker Switch fails to select AUTO mode.	When practical, open Circuit Breaker CB at the local control panel and test switch operation electrically. Refer to Drawing 10423 Sheet 1 in Section 13. If required, replace the switch or repair other electrical faults. When done, close Circuit Breaker CB at the local control panel and reset rocker switch to AUTO mode.
OK	

Auto Start Failure – Cranks but does not Start (Cont)

The overspeed switch has failed.	Check power and grounding to the overspeed switch. Refer to Drawing 10423 Sheet 1 in Section 13. Repair any electrical faults. If required, test and adjust the overspeed setting. Refer to Overspeed Setpoint Adjustment and Testing in Section 3. Replace the overspeed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
OK	
Contact an Authorized Cummins Repair Facility.	

Auto Start Failure – Engine Starts but Crank Terminate does not Occur

Cause	Correction
The overspeed switch not correctly adjusted or has failed.	When practical, with the engine running, verify speed sensor input to the overspeed switch. Refer to Drawing 10423 Sheet 1 in Section 13. If signal is not present, go to The speed sensor has failed. The tachometer also indicates zero speed in this table. Adjust the overspeed switch crank terminate setpoint. Refer to Section 3. If required, replace the overspeed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
OK	
Fuse 3 has opened. The raw water solenoid valve also fails to open.	Open the raw water bypass valves. When practical, replace Fuse F3. Locate and repair any local electrical fault. Refer to Drawing 10423 Sheet 1 in Section 13.
OK	
The speed sensor has failed. The tachometer also indicates zero speed.	When practical, locate and repair any electrical fault in the speed sensor circuitry. Refer to Drawing 10423 Sheet 1 in Section 13. If necessary, replace the speed sensor. Refer to Speed Sensor Removal/Installation in Section 7.
OK	
An electrical fault is present in the Fire Protection System.	When practical, test continuity and insulation from ground in the fire protection system and the engine control panel. Locate and repair any electrical fault in the fire protection system panel.
OK	
An electrical fault is present between Control Panel TB 2 and the Fire Protection System.	When practical, test continuity and insulation from ground between the fire protection system and the engine control panel. Locate and repair any electrical fault in the field wiring.
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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 in Section 13.
OK ↓	
Solenoid A's switch contact does not close.	Remove and test Solenoid A lever and switch operation. Refer to Crank Solenoid Assembly Removal/Installation in Section 7. If required, replace Solenoid A.
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 Drawing 10423 Sheet 1 in Section 13.
OK	
Solenoid B's switch contact does not close.	Remove and test Solenoid B lever and switch operation. Refer to Crank Solenoid Assembly Removal/Installation in Section 7. If required, replace Solenoid B.
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 Starter Motor Removal/Installation 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 in Section 13.
OK	
Solenoid A fails to operate.	When practical, test the electrical operation of the Solenoid A. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the solenoid if faulted.
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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 in Section 13.
OK ↓	
Solenoid B fails to operate.	When practical, test the electrical operation of the Solenoid B. Refer to Drawing 10423 Sheet 1 in Section 13. Replace the solenoid if faulted.
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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 in Section 13.
OK ↓	
Overspeed switch crank circuit fails to reset with engine shutdown.	If required, test and adjust the crank setting. Refer to Overspeed Setpoint Adjustment and Testing in Section 3. If required, replace the overspeed switch. Refer to Overspeed Switch Removal/Installation in Section 7.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke)

Cause	Correction
No fuel in supply tank.	Check and replenish fuel supply. Check fittings and hose connections and hose conditions.
OK ↓	
Air is in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK ↓	
Manual fuel shutoff lever is binding.	Check to be sure manual shutoff lever is not binding at the injection pump.
OK ↓	
Fuel drain line is restricted.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK ↓	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 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 ↓	
Fuel injection pump is malfunctioning.	Perform the fuel injection pump test.
OK ↓	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke) (Cont)

Cause	Correction
Fuel injection pump timing is not correct.	Check and adjust the fuel pump timing. Refer to Fuel Adjust Fuel Pump 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 Shutoff Valve (FSOV) fails to open.	If the fuel shutoff valve is not functioning, manually override it. Refer to Emergency Starting With Failed Fuel Shut-Off Solenoid in Section 3. When practical, check the wiring for electrical faults. Refer to Drawing 10423 Sheet 2 in Section 13. If the wiring is OK, replace the Fuel Shutoff Valve. Refer to Fuel Shutoff Valve (FSOV) Removal/ Installation in Section 7.
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 ↓	

Engine Cranks Normally But Will Not Start (No Exhaust Smoke) (Cont)

Cause	Correction
Fuel suction standpipe in the fuel tank is broken.	Check and repair the standpipe, if necessary.
OK	
Fuel supply is not adequate.	Check the flow through the filter to locate the source of the restriction.
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	
Injection pump driveshaft or driveshaft key is damaged.	Repair or replace the injection pump. Refer to Fuel Injection 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. Refer to instructions in Section 7.
OK	
Starting motor rotation is not correct.	Check the direction of crankshaft rotation. Refer to instructions in Section 7. Replace the starting motor if necessary. Refer to Starter Motor Assembly Removal/Installation 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 Starter Motor Assembly Removal/Installation in Section 7.
	
Contact an Authorized Cummins Repair Facility.	

Engine Cranks Slowly But Does Not Start

NOTE: Typical engine cranking speed is 120 RPM. Engine cranking speed can be checked with a hand-held tachometer, stroboscope, or electronic service tool.

Cause	Correction
The batteries are cold.	Ensure that the batteries are protected from extreme temperatures.
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 Check Engine Oil Level 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 Lubricating Oil Recommendations and Specifications in Section 10. If the wrong type or grade of oil is present, drain and replace it. Refer to Change Lubricating Oil and Filters in Section 7.
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)

Cause	Correction
Starting motor is malfunctioning.	Replace the starting motor. Refer to Starter Motor Assembly Removal/Installation 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
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 Change Fuel Filter in Section 7.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Fuel injection pump is malfunctioning.	Perform the fuel injection pump test.
OK	
Fuel injection pump timing is not correct.	Check and adjust the fuel pump timing. Refer to Fuel Adjust Fuel Pump in Section 7.
OK	
Fuel pre-filter is clogged.	Clean the customer-supplied fuel pre-filter.
OK	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK	

Engine Difficult to Start or Will Not Start - Exhaust Smoke Present (Cont)

Cause	Correction
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. Refer to instructions in Section 7.
OK ↓	
Intake air flow is restricted.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 5. Replace the air filter if required.
OK ↓	

Engine Difficult to Start or Will Not Start - Exhaust Smoke Present (Cont)

Cause	Correction
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
Fuel drain line is restricted.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
OK ↓	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK ↓	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK ↓	
Fuel injection pump is malfunctioning.	Perform the fuel injection pump test.
OK ↓	
Fuel injection pump timing is not correct.	Check and adjust the fuel pump timing. Refer to Fuel Adjust Fuel Pump in Section 7.
OK ↓	
Fuel pre-filter is clogged.	Clean the customer-supplied fuel pre-filter.
OK ↓	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK ↓	
Fuel suction line is restricted.	Check the fuel suction line for restriction.
OK ↓	

Engine Acceleration or Response Poor (Cont)

Cause	Correction
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. Refer to instructions in Section 7.
OK	
Intake air flow is restricted.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 7. Replace the air filter if required.
OK	
Exhaust air flow is restricted.	Check the exhaust air piping for restriction. Remove any restriction.
OK	

Engine Acceleration or Response Poor (Cont)

Cause	Correction
Exhaust air is leaking.	Check the exhaust piping for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. If required, replace the turbocharger. Refer to Turbocharger Removal/Installation in Section 7.
OK ⬇	
Refer to a Cummins Authorized Repair Facility.	

Engine Noise Excessive - Mechanical

Cause	Correction
Lubricating oil is thin or diluted.	Check the oil level. Refer to Check Lubricating Oil Level in Section 7. If the oil level is above the high mark, go to Oil Level Rises in this section.
OK	
Lubricating oil pressure is below specification.	**NOTE**: Oil pressure should range between 69 and 345 kPa [10 to 50 PSI] with the engine running. Check the oil pressure on the local control panel. If the pressure is low, refer to the Lubricating Oil Pressure Low symptom tree in this section.
OK	
Vibration damper is damaged.	Inspect the vibration damper. Refer to Inspect Vibration Damper in Section 5. If the vibration damper is damaged, refer to a Cummins Authorized Repair Facility.
OK	
Engine mounts are worn or damaged.	Inspect the engine mounts. If the engine mounts are worn or damaged, refer to a Cummins Authorized Repair Facility.
OK	
Coolant temperature is above specification.	Check the coolant temperature indication on the local control panel. If the high coolant temperature light is illuminated, refer to the Coolant Temperature Above Normal symptom tree in this section.
OK	

Engine Noise Excessive – Mechanical (Cont)

Cause	Correction
Drive belt is squeaking due to insufficient tension or high loading.	Check and adjust belt tension. Refer to Adjust Alternator Drive Belt Tension in Section 7.
OK ↓	
Intake air flow is restricted.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 5. 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 Turbocharger Removal/Installation in Section 7.
OK ↓	
Contact a Cummins Authorized Repair Facility.	

Engine Noise Excessive — Combustion Knocks

Cause	Correction
Engine is overloaded.	Check for added mechanical loading from damaged or defective pump, changes in suction head, or changes in discharge piping restriction.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine using the correct fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Air in present in the fuel supply to the engine.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
The fuel injection pump’s timing is not correct.	Check and adjust the fuel injection pump timing. Refer to Adjust Fuel Pump in Section 7.
OK	
The fuel injection pump is failing.	Replace the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7.
OK	
Coolant temperature is below specification.	Refer to the Coolant Temperature Below Normal (Engine Running) symptom tree in this section.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Runs Rough at Idle

NOTE: Operation at idle speed is for maintenance only.

Cause	Correction
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
OK ↓	
Idle speed is set too low.	Adjust the idle speed. Refer to instructions in Section 7.
OK ↓	
Air is present in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK ↓	
Fuel filter is becoming plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 5.
OK ↓	
Fuel supply to the engine is inadequate.	Locate and correct the restriction in fuel flow to the engine.
OK ↓	
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK ↓	
Engine mounts are worn or damaged.	Check the engine mounts. If damaged, refer to a Cummins Authorized Repair Facility.
OK ↓	

Engine Runs Rough at Idle (Cont)

Cause	Correction
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine on the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
OK	
Fuel injection pump timing is incorrect.	Check and adjust the injection pump timing. Refer to Adjust Fuel Pump in Section 7.
OK	
Injector is malfunctioning.	Inspect the injectors. Replace the injectors as necessary. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Fuel injection pump is malfunctioning.	Remove the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Check the calibration of the fuel injection pump. Refer to instructions in Section 7. Replace the pump if necessary.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Runs Rough or Misfires Under Load

Cause	Correction
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal (Engine Running) symptom tree.
OK	
Air is present in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
Fuel filter is becoming plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 7.
OK	
Fuel supply to the engine is inadequate.	Locate and correct the restriction in fuel flow to the engine.
OK	
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	
Engine mounts are worn or damaged.	Check the engine mounts. If damaged, refer to a Cummins Authorized Repair Facility.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine on the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	

Engine Runs Rough or Misfires Under Load (Cont)

Cause	Correction
Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary. Refer to instruction in Section 7.
OK ↓	
Fuel injection pump timing is incorrect.	Check and adjust the injection pump timing. Refer to Adjust Fuel Pump in Section 7.
OK ↓	
Injector is malfunctioning.	Inspect the injectors. Replace the injectors as necessary. Refer to Fuel Injectors Removal/Installation in Section 7.
OK ↓	
Fuel injection pump is malfunctioning.	Remove the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Check the calibration of the fuel injection pump. Refer to instructions in Section 7. 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
Fuel level is low in the tank.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
OK	
Engine idle speed is set too low.	Adjust the idle speed. Refer to instructions in Section 7.
OK	
Air is in the fuel supply to the engine.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK	
The fuel filter is plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 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	
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine with the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK	

Engine Speed Surges at Idle (Cont)

Cause	Correction
The fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Calibrate the fuel pump. Refer to instructions in Section 7. If required, replace the fuel injection pump.
OK	
A fuel supply line restriction exists between the fuel injection pump and the injectors.	Check the fuel supply line or passage for sharp bends or restriction. Remove any restrictions.
OK	
A fuel injector is malfunctioning.	Replace the malfunctioning injector. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Moisture is present in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Speed Surges Under Load

Cause	Correction
Pump suction head or pump discharge head changes.	Some variation in speed response to load changes is normal. Excessive speed changes may occur upon sudden failures in either suction or discharge piping systems.
OK ↓	
Fuel level is low in the tank.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
OK ↓	
Air is in the fuel supply to the engine.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank standpipe and fuel filters as necessary. Vent air from the system. Refer to Air in Fuel in Section 7.
OK ↓	
The fuel filter is plugged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 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 ↓	
The fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK ↓	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine with the required fuel. Refer to Fuel Recommendations and Specifications in Section 10.
OK ↓	

Engine Speed Surges Under Load (Cont)

Cause	Correction
The fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Calibrate the fuel pump. Refer to instructions in Section 7. If required, replace the fuel injection pump.
OK	
A fuel supply line restriction exists between the fuel injection pump and the injectors.	Check the fuel supply line or passage for sharp bends or restriction. Remove any restrictions.
OK	
A fuel injector is malfunctioning.	Replace the malfunctioning injector. Refer to Fuel Injectors Removal/Installation in Section 7.
OK	
Moisture is present in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
OK	
Contact a Cummins Authorized Repair Facility.	

Engine Vibration Excessive at Rated Speed

Cause	Correction
Engine runs rough or is misfiring.	Refer to the Engine Runs Rough or Misfires Under Load symptom tree in this section.
OK	
Fuel injection pump is adjusted incorrectly.	Adjust or replace the injection pump. Refer to Adjust Fuel Pump and/or Fuel Injection Pump Removal/ Installation in Section 7.
OK	
Engine mounts are worn or damaged.	Inspect the engine mounts. Refer to Check Engine Mounting Bolts in Section 5. Replace the engine mounts as needed. Refer to a Cummins Authorized Repair Facility.
OK	
Vibration damper is malfunctioning.	Inspect the vibration damper. Refer to Inspect Vibration Damper in Section 5. Replace, if necessary. Refer to a Cummins Authorized Repair Facility.
OK	
Alternator bearing is worn or damaged.	Check if the alternator is vibrating excessively. Replace the alternator if necessary. Refer to Alternator Removal/Installation in Section 7.
OK	
Water pump bearing is worn or damaged.	Check if the water pump is vibrating excessively. Replace the pump if necessary. Refer to Water Pump Removal/Installation in Section 7.
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 is required. This is a desirable outcome.
OK	
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.
OK	
Signal power is lost by the operation of the circuit breaker the engine control panel.	Press the circuit breaker reset button on the engine control panel. Locate and correct the electrical fault in engine control panel. Refer to Drawing 10423 Sheet 1 in Section 13.
OK	
An overspeed trip has occurred. The overspeed trip light is illuminated on the local control panel. Remote indications may also be present. Alternatively, a related overspeed switch failure has occurred. The trip indications may not be present.	Go to Engine Overspeed Trip in this section.
OK	
The fuel shutoff valve (FSOV) has failed.	Check the wiring continuity and insulation from ground for the Fuel Shutoff Switch. Refer to Drawing 10423 Sheet 1 and Drawing 10423 Sheet 2 in Section 13. Correct any electrical faults. If required, replace the FSOV. Refer to Fuel Shutoff Valve (FSOV) 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	

Engine Stops During Operation (Cont)

Cause	Correction
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 Change Fuel Filter in Section 5.
OK	
Air is trapped in the low pressure fuel lines at the engine.	Bleed the fuel lines. Refer to Air in Fuel in Section 7.
OK	
Fuel lift pump has failed.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	
Fuel injection pump has failed.	Replace the fuel injection pump. Refer to Fuel Injection Pump Removal/Installation in Section 7.
OK	
Contact an Authorized Cummins Repair Facility.	

Engine Will Not Reach Rated Speed (RPM)

Cause	Correction
Load is excessive for engine horsepower rating.	Reduce the engine load.
OK	
Throttle adjustment is not correct.	Check the throttle adjustment. Refer to Section 3.
OK	
Fuel shutoff lever (mechanical) partially engaged.	Make sure fuel shutoff lever is in the RUN position. Refer to Section 3. Replace if necessary. 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 Tachometer Calibration in Section 7.
Tachometer is malfunctioning.	Replace the tachometer. Refer to Tachometer Removal/Installation in Section 7.
OK	
Engine power output is low.	Refer to the Engine Acceleration or Response Poor 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 Fuel Recommendations and Specifications in Section 10.
OK	
Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 5.
OK	

Engine Will Not Reach Rated Speed (RPM) (Cont)

Cause	Correction
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	
Exhaust back pressure too high.	**NOTE**: The maximum allowable exhaust back pressure is specified in Exhaust System Specifications in Section 10. Measure the exhaust back pressure. Correct the problem is it is above specification.
OK	
Fuel lift pump is malfunctioning.	Check the fuel lift pump for correct operation. Check the pump output pressure. Replace the fuel lift pump if necessary. Refer to Fuel Lift Pump Removal/ Installation in Section 7.
OK	

Engine Will Not Reach Rated Speed (RPM) (Cont)

Fuel injection pump is malfunctioning.	Remove the fuel pump. Refer to Fuel Injection Pump Removal/Installation in Section 7. Calibrate the fuel pump. If required, replace the fuel injection pump.
OK	
Contact an Authorized Cummins Repair Facility.	

Engine Will Not Shut Off Remotely

Cause	Correction
Stop circuit malfunction in the fire pump controller of field wiring.	**NOTE**: In the AUTO mode, the fire pump engine stops upon loss of signal power from the fire pump controller. Check the engine stop circuit in the fire pump controller. Correct any faults. Check for short to voltage on the signal wiring from the fire pump controller to the engine control panel. Correct any faults. Check operation of the switch contacts of the AUTO/MANUAL switch at the engine control panel. Replace the switch if the switch contacts fail to operate properly.
OK	
Fuel Shutoff Valve (FSOV) fails to close.	Press the RESET switch on the engine control panel. Alternatively, operate the manual override. **NOTE**: If the RESET switch did not close the valve, an electrical fault to voltage may be present. Refer to Drawing 10423 Sheet 1 and Drawing 10423 Sheet 2 in Section 13. If required, replace the fuel shutoff valve. Refer to Fuel Shutoff Valve (FSOV) Removal/Installation in Section 7.
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
Fuel Shutoff Valve (FSOV) fails to close.	Press the RESET switch on the engine control panel. Alternatively, operate the manual override. **NOTE**: If the RESET switch did not close the valve, an electrical fault to voltage may be present. Refer to Drawing 10423 Sheet 1 and Drawing 10423 Sheet 2 in Section 13. If required, replace the fuel shutoff valve. Refer to Fuel Shutoff Valve (FSOV) Removal/Installation in Section 7.
OK ↓	
Engine is running on fumes drawn into the air intake.	Identify and isolate the source of the combustible fumes.
OK ↓	
Refer to a Cummins Authorized Repair Facility.	

Excessive White Exhaust Smoke

Cause	Correction
Engine is operating at low ambient temperature.	Refer to Cold Weather Operation, Bulletin Number 3387266, and the Operation and Maintenance manual, Bulletin Number 3666417 for cold weather operating aids and guidelines.
OK ↓	
Air in the fuel system.	Check for air in the fuel system by installing a clear hose on the suction side of the fuel pump. Verify fuel drain is below the fuel level in the tank as air will enter the suction and drain lines if fuel drain is not below fuel level. Injectors can also be a source of combustion gases leaking back into the fuel system.
OK ↓	
Fuel grade is not correct for the application or the fuel quality is poor.	Operate the engine from a tank of good fuel (40 Cetane min. above 32°F, 45 Cetane min. below 32°F). Refer to Fuel recommendations and Specifications in the Operation and Maintenance manual, Bulletin Number 3666417.
OK ↓	
Fuel filter is plugged.	Measure the fuel inlet restriction to the filter head (3 in. Hg max.). Measure the fuel pressure drop across the fuel filter (1.5 in. Hg. max). Max. restriction to fuel pump is 4.5 in. Hg.
OK ↓	
Air intake system restriction is above specification.	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary.
OK ↓	
Air intake or exhaust leaks.	Visually inspect the air intake and exhaust systems for air leaks by looking for cracks, listening for high pitch whining or sucking noises, or use a soapy solution in the suspect areas.
OK ↓	

Excessive White Exhaust Smoke (Cont)

Cause	Correction
Fuel drain line restriction is above specification.	Check the fuel drain lines for restriction (7.5 in. Hg max). Clear or replace the fuel lines or tank vents as necessary.
OK	
Fuel pump static injection timing is not correct.	Verify the static injection timing with the value listed on the engine data tag. Refer to the Troubleshooting and Repair manual, Bulletin Number 3666418 for procedure. Turbocharged engines = 8°BTDC +/- 1°
OK	
Overhead adjustments are not correct.	Adjust the overhead settings. Refer to the Troubleshooting and Repair manual, Bulletin Number 3666418.
OK	
Injectors are not correct.	Remove the injectors and compare the identification number on the injector with the injector cross-reference table 1.
OK	
Injector is malfunctioning.	Test the injector opening pressures (min 167 bar for used injectors). Replace injectors as necessary. Refer to the Troubleshooting and Repair manual, Bulletin Number 3666418.
OK	
Fuel injection pump is malfunctioning.	Replace the fuel pump. Refer to the Troubleshooting and Repair manual, Bulletin Number 3666418.
OK	
Raw fuel in the intake manifold (external source).	Check the intake manifold for fuel. Locate the fuel sources and repair as necessary.
OK	

Excessive White Exhaust Smoke (Cont)

Cause	Correction
Coolant is leaking into the combustion chamber.	Check for head gasket leaks, cylinder head or block cracks.
OK	
Front gear train is not aligned properly.	Align the match marks of the idler gear, crankshaft gear, camshaft gear and fuel pump gears. Refer to the Troubleshooting and Repair Manual, Bulletin Number 3666418.
OK	
Internal engine damage.	Analyze the oil and inspect the filter to locate the area of probable damage.
OK	
Contact an Authorized Cummins Repair Facility.	

Excessive Black Exhaust Smoke

Cause	Correction
Engine is being lugged down.	Increase pump suction head or decrease pump discharge head.
OK	
Clogged air cleaner element.	Clean or replace the air cleaner element.
OK	
Muffler is crushed or clogged.	Replace the muffler. Refer to the OEM's service manual.
OK	
Air leakage between the turbocharger and head.	Tighten the clamp between turbocharger and head. Repair leaks between turbocharger and head.
OK	
Exhaust leak between turbocharger and exhaust manifold.	Inspect and change gaskets.
OK	
Turbocharger does not rotate freely.	Replace the turbocharger.
OK	
Defective or clogged injection nozzle.	Replace the defective or clogged injection nozzle.
OK	
Injection pump is adjusted incorrectly causing excessive injection.	Adjust or replace the injection pump.
OK	

Excessive Black Exhaust Smoke (Cont)

Cause	Correction
Incorrect injection timing.	Adjust injection timing.
OK	
Overhead adjustments are not correct.	Measure and adjust the overhead settings.
OK	
Contact an Authorized Cummins Repair Facility.	

Fuel Consumption Is Excessive

Cause	Correction
Fuel is leaking.	Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Repair any leaks.
OK ↓	
Poor-quality fuel is being used.	Assure good-quality No. 2 diesel fuel is being used. Refer to Fuel Recommendations and Specifications in Section 10.
OK ↓	
Intake or exhaust restriction.	Refer to troubleshooting logic for Exhaust Smoke Excessive Under Load in this section.
OK ↓	
Defective or clogged injection nozzle.	Replace the defective or clogged injection nozzle. Refer to instructions in Section 7.
OK ↓	
Incorrect injection timing.	Adjust injection timing. Refer to instructions in Section 7.
OK ↓	
Injection pump is adjusted incorrectly causing excessive injection.	Adjust or replace the injection pump. Refer to instructions in Section 7.
OK ↓	
Hour meter is not calibrated.	Check the hour meter. Calibrate or replace the hour meter if necessary.
OK ↓	

Fuel Consumption Is Excessive (Cont)

Cause	Correction
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. Refer to instructions in Section 7.
OK	
Air intake system restriction is above specification.	Check the air intake system for restriction. Refer to Check Air Cleaner Service Indicator in Section 5. Replace the air filter as necessary.
OK	
Lubricating oil level above specification.	Check the oil level. Refer to Check Engine Oil Level in Section 5. Drain excess oil and correct the deficiency in maintenance processes.
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 Check Air Cleaner Service Indicator in Section 5. Replace the air filter if required.
OK	
Turbocharger drain line is restricted.	Remove the turbocharger drain line and check for restriction. Refer to instructions in Section 7. 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 Turbocharger Leaks Engine Oil or Fuel 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 it is necessary. Refer to Lubricating Oil Recommendations and Specifications in Section 10. Drain the oil and replace with non-contaminated oil. Also, replace the oil filter. Refer to Change Lubricating Oil and Filters in Section 7.
OK	
Fuel is present in the lubricating oil.	Refer to the Fuel in Lubricating Oil symptom tree.
OK	
Coolant is present in the lubricating oil.	Refer to the Coolant in Lubricating Oil 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.
OK	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Consumption Excessive

Cause	Correction
Lubricating oil leak (external).	Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace the gaskets if necessary.
OK ↓	
Intake system is contaminated with dust.	Remove and clean intake manifold.
OK ↓	
Dipstick is not calibrated correctly.	Verify the dipstick is correctly marked.
OK ↓	
Breather or breather hose is clogged.	Clean the breather and breather hose.
OK ↓	
Turbocharger compressor or turbine oil seal is leaking.	Replace the compressor or turbine seal.
OK ↓	
Rear crankshaft seal or seal surface is damaged.	Repair or replace seal and surface.
OK ↓	
Valve stem, guide, or seal is damaged.	Repair or replace the damaged component.
OK ↓	
Worn or broken piston ring or cylinder.	Replace the worn or broken piston ring or cylinder.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Pressure High

Cause	Correction
Engine is cold.	Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to the Coolant Temperature Below Normal (Engine Running) symptom tree in this section.
OK	
Lubricating oil viscosity not correct.	Drain the oil and replace the oil filter. Refer to Change Lubricating Oil and Filters in Section 7. Use the correct oil. Refer to Lubricating Oil Recommendations and Specifications in Section 10.
OK	
Lubricating oil filter is not correct.	Replace the oil filter. Refer to Change Lubricating Oil and Filters in Section 7. Use the correct oil filter. Refer to Lubricating Oil Recommendations and Specifications in Section 10.
OK	
The pressure gauge is malfunctioning.	Install a temporary pressure gauge at main oil rifle. Compare the indications with the engine running. If required, replace the pressure sender. Refer to Lubricating Oil Pressure Sensor, OEM (007-052) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02. If required, replace the pressure gauge. Refer to Oil Pressure Gauge Removal/ Installation in Section 7.
OK	
Pressure regulator valve has malfunctioned.	Check and replace valve. Refer to Lubricating Oil Pressure Regulator (Main Rifle) (007-029) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK	

Lubricating Oil Pressure High (Cont)

Lubricating oil pump installation not correct.	Verify that the correct lubricating oil pump and o-rings are installed. Refer to Lubricating Oil Pump (007-031) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK ↓	
Contact an Authorized Cummins Repair Facility.	

Lubricating Oil Pressure Low

Cause	Correction
Lubricating oil level is below specification.	Check the oil level. Verify the dipstick calibration and the oil pan capacity. Fill the system to the specified level.
OK	
Oil level or oil pressure sensor is damaged.	Replace the oil level or oil pressure sensor.
OK	
Lubricating oil filter is clogged.	Replace the filter.
OK	
Fuel or coolant is in the lubricating oil.	Refer to Oil Level Rises symptom tree.
OK	
Regulator or relief valve is not adjusted correctly.	Adjust the regulator or relief valve.
OK	
Lubricating oil pan strainer is clogged.	Clean the strainer.
OK	
Lubricating oil suction tube is damaged.	Repair or replace the suction tube.
OK	
Lubricating oil pump is damaged.	Replace the oil pump.
OK	
Main or rod bearing is worn or damaged.	Replace the bearing.
OK	
Contact an Authorized Cummins Repair Facility.	

Oil Level Rises

NOTE: Oil level may increase due to thermal expansion as the engine warms up and then decrease as the engine cools down. Slight variations due to temperature changes are normal.

Cause	Correction
Excessive oil has been added to the engine.	Drain the excess oil. Refer to Change Lubricating Oil and Filters in Section 7.
OK	
Fuel is leaking into the oil system.	Troubleshoot as per Lubricating Oil Contaminated in this section.
OK	
Coolant is leaking into the oil system.	Troubleshoot as per Lubricating Oil Contaminated 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. Replace it is necessary. Refer to Lubricating Oil Recommendations and Specifications in Section 10. Drain the oil and replace with non-contaminated oil. Also, replace the oil filter. Refer to Change Lubricating Oil and Filters in Section 7.
OK	
Coolant temperature is below specification.	Refer to the Coolant Temperature Below Normal (Engine Running) symptom tree in this section.
OK	
Crankcase ventilation system is plugged.	Check and clean the crankcase breather and vent tube. Refer to Crankcase Breather Tube (003-018) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
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 does not meet specifications for operating conditions.	Check the grade and type of oil. Refer to Lubricating Oil Recommendations and Specifications in Section 10. If the wrong type or grade of oil is present, drain and replace it. Refer to Change Lubricating Oil and Filters in Section 7.
OK	
Lubricating oil drain interval is excessive.	Verify the correct lubricating oil drain interval. Refer to Change Lubricating Oil and Filters in Section 7.
OK	

Lubricating Oil Sludge in the Crankcase Excessive (Cont)

Lubricating oil is contaminated with coolant or fuel.	Go to the Lubricating Oil Contaminated symptom tree in this section.
OK ↓	
Crankcase pressure is excessive.	Check for excessive blowby. Refer to the Crankcase Gases (Blowby) Excessive symptom tree in this section.
OK ↓	
Closed crankcase ventilation hoses are leaking or damaged.	Inspect the closed crankcase ventilation system hoses and connections for leaks, obstruction, or damage. Refer to Closed Crankcase Ventilation Hoses (003-024) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK ↓	
Close crankcase ventilation valve is leaking or malfunctioning.	Inspect the closed crankcase ventilation valve for obstruction or damage. Refer to Closed Crankcase Ventilation Valve (003-023) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK ↓	
Refer to a Cummins Authorized Repair Facility.	

Turbocharger Leaks Engine Oil or Fuel

Cause	Correction
Engine is operating for extended periods under light or no-load conditions (slobbering).	Operate the engine at idle speed for maintenance activities only.
OK	
Lubricating oil or fuel is entering the turbocharger.	Check the turbocharger for oil or fuel in the piping. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK	
Turbocharger drain line is restricted.	Remove the turbocharger drain line and check for restriction. Clean or replace the drain line. Refer to Turbocharger Oil Drain Line (010-045) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK	
Turbocharger oil supply line is loose or leaking.	Check and tighten oil supply line fitting(s), if necessary. Refer to Turbocharger Oil Supply Line (010-046) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK	
Contact an Authorized Cummins Repair Facility.	

Crankcase Gases (Blowby) - Excessive

NOTE: Crankcase gases or blowby may be measured. Refer to Crankcase Blowby, Measure (014-010) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.

Cause	Correction
Cylinder head valve guides are excessively worn.	Check the valve guides for wear. Replace the cylinder head if necessary. Refer to Cylinder Head (002-004) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK	
Pistons or piston rings are worn, damaged, or not correct.	Check the pistons for correct part numbers. Refer to Control Parts List (CPL), Bulletin 3379133 or 4021327. Check the pistons and rings for wear and damage. Refer to Piston (001-043) and Piston Rings (001-047) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
OK	
Turbocharger oil seal is leaking.	Check the turbocharger compressor and turbine seals. Refer to Turbocharger (010-033) in Troubleshooting and Repair Manual B3.9, B4.5, and B5.9 Series Engines, Bulletin Number 3666087-02.
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 Factory Setting Tag described in Section 2. Refer to Rated Speed Setpoint Adjustment and Testing in Section 3.
OK	
Overspeed switch is set at too low a setpoint.	Check overspeed speed setting as specified on the Factory Setting Tag described in Section 2. Refer to Overspeed Setpoint Adjustment and Testing 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 Drawing 10423 Sheet 1 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 Overspeed Setpoint Adjustment and Testing in Section 3, replace the speed switch. Refer to Overspeed Switch Removal/Installation 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 Drawing 10423 Sheet 1 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 is it has failed. Refer to Speed Sensor Removal/Installation in Section 7.
OK ⬇	
The tachometer has failed.	Check the operation of the tachometer with a pulse generator. Replace the tachometer is it has failed. Refer to Tachometer Removal/Installation in Section 7.
OK ⬇	
Contact an Authorized Cummins Repair Facility.	

Section 13 – Assembly Drawings [(1)]

Description	Drawing No.	Sheet No	Revision
Drawing, Installation, FirePump, CFP33-F10/20/30 (B3.3-G2)	8700		F
Drawing, Installation, FirePump, CFP33-F25/35 (B3.3-C85T)	8701		F
Assembly, Raw Water Cooling, ¾" Generic	8682		D
Options, Engine, FirePump, G-Drive, CFP33-F10/20/30 (B3.3-G2)	8720		B
Options, Engine, FirePump, Industrial, CFP33-F25/35 (B3.3-C85T)	8721		A
Assembly, Air Cleaner, CFP33-F10/20/30	8766		D
Assembly, Air Cleaner, CFP33-F25/35	11142		B
Assembly, Air Filter Cover Implementation Date of April, 2009	13439		
Assembly, Heat Exchanger, CFP33	8769		C
Assembly, Support, Engine, CFP33	8798		D
Leg, Engine Support, Front, CFP33	8799		C
Leg, Engine Support, Rear, CFP33	8801		F
Assembly, Coolant Heater, CFP33	8813		D
Assembly, Sensor Package, CFP33-F10/20/30	9570-01		
Assembly, Sensor Package, CFP33-F25/35	9570		B
Assembly, Fuel Supply and Return Lines, CFP33-F10/20/30	9571		A
Assembly, Fuel Supply and Return Lines, CFP33-F25/35	9571-01		
Misc. Piping, Cooling Loop, Raw Water, CFP33	9636		B
Hose, Water, CFP33	11148		A
Assembly, Fuel Solenoid Override, CFP33-F10/20/30	10111		A
Fuel Line, Flex Extension, ¼" NPT,	10235		
Fuel Line, Flex Extension, 1/8" NPT,	10242		A
Assembly, Operators Station, CFP33 Effective Date to 01-09	8765		F
Assembly, Operators Station, CFP33 New Effective Date 01-09	11138		B
Assembly, Panel, Instrument, 12VDC Effective Date to 08-08	10452		E
Assembly, Panel, Instrument, 12VDC New Effective Date 09-08	13236		
Assembly, Panel, Instrument, 24VDC Effective Date to 08-08	10453		E
Assembly, Panel, Instrument, 24VDC New Effective Date 09-08	13237		
Heat Shield, CFP33 New Effective Date 01-09	11143		
Exhaust, 3" Bellows w/ Elbow	8550		C
Guard, Pulley, CFP33-F10/20/30	9537		D
Guard, Pulley, CFP33-F25/35	8805		C
Assembly, Drive Shaft & Guard	10163		A
Assembly, Stub Shaft & Guard	9676		A
Kit, Loose Wires; 3.3 liter Fire Pumps	9766		D
General Layout, FirePump, CFP33	CFP33_GEN		G
Schematic, Control Panel, Alternate Beginning 9/06	10423	1-6	E
Wiring Harness, B3.3	8885	1-2	F

(1): Also see Engine Identification in Section 2 the System Diagrams in Section 6. The most current revisions to these drawings and related documents are accessible at http://www.cumminsfirepower.com/products.html.

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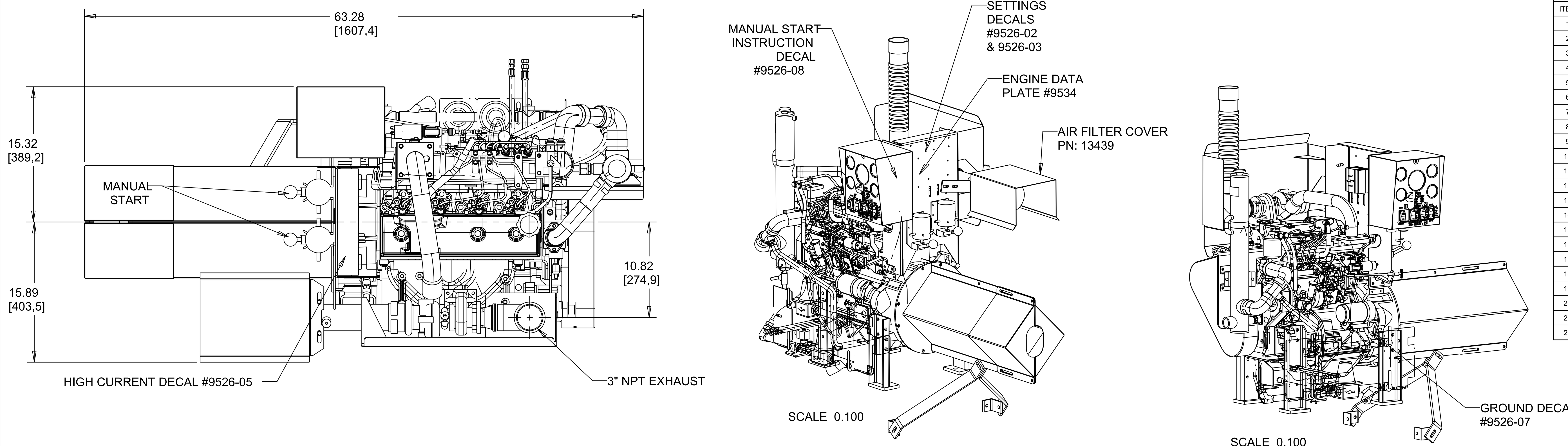

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, RAW WATER COOLING, 3/4" NPT, FIREPUMP	8682
2	1	ENGINE, B3.3	8720
3	1	ASSEMBLY, AIR CLEANER, CFP33-F10/20/30, FIREPUMP, 8700	8766
4	1	ASSEMBLY, HEAT EXCHANGER, FIREPUMP, B3.3	8769
5	1	ASSEMBLY, SUPPORT, ENGINE, FIREPUMP, B3.3	8798
6	1	ASSEMBLY, COOLANT HEATING, B3.3	8813
7	1	HARNESS, ENGINE, B3.3, NOT SHOWN, FIREPUMP	8885
8	1	ASSEMBLY, SENSOR PACKAGE, B3.3, FIREPUMP	9570
9	1	ASSEMBLY, FUEL PLUMBING, B3.3, FIREPUMP	9571
10	1	MISC PIPING, RAW WATER, CFP33, FIREPUMP	9636
11	1	ASSEMBLY, THROTTLE SOLENOID OVERIDE, FIREPUMP	10111
12	1	FUEL LINE, #6, 1/4" NPT x 12" LG	10235
13	1	FUEL LINE, #4, 1/8" NPT x 12" LG	10242
14	1	ASSEMBLY, OPERATORS STATION, CFP33, FIREPUMP	11138
15	1	SHIELD, TURBO, CFP33, FIREPUMP	11143
16	1	ASSY TELESCOPING GUARD 24" DS, SAE # 4 CFP 3.3 L	11812
17	1	ASSEMBLY, AIR FILTER COVER, -	13439
18	1	FLEX, EXHAUST, 3" FLANGE, FIREPUMP	8550
19	1	FLANGE, COMPANION, -	8606_OLD
20	1	GUARD, PULLEY, B3_3, G2, FIREPUMP	9537
21	1	ADAPTER, U-JOINT, HAYES #127727-01	9673
22	1	CLAMP, U-BOLT, GUILLOTINE, 3.00"	89545K

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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, POWER MODULE, CFP33-F10/20/30
TITLE 2: FIREPUMP, B3.3-G2

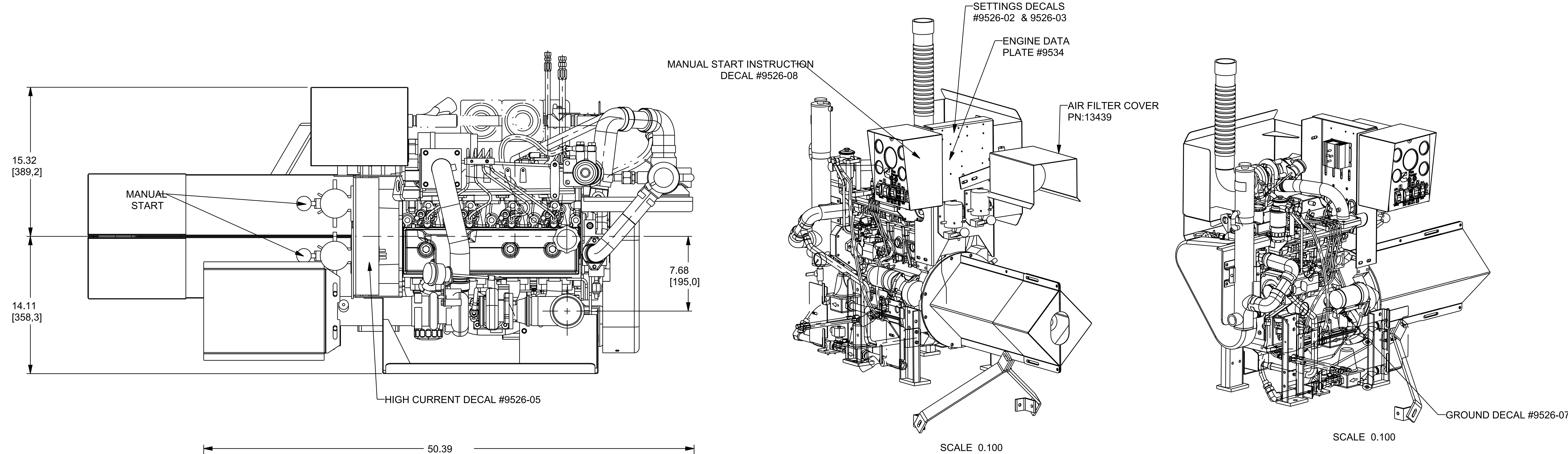
UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS 1±° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

REV	DESCRIPTION OF REVISION	REV BY	DATE
F	ADDED PN:13439 & 89545K ENF PN:2008-275	MAC	10-14-2008
E	REV PER OP STATION & SHIELD	DAVE N	28NOV06
D1	GRAPHICS UPDATE	DAVE N	12JUL05

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 25-FEB-2004
	APPD BY:			DATE:
EST WEIGHT: 889.000	SCALE: 0.150	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8700 REV: F



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, RAW WATER COOLING, 3/4" NPT, FIREPUMP	8682
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4	1	ASSEMBLY, SUPPORT, ENGINE, FIREPUMP, B3.3	8798
5	1	ASSEMBLY, COOLANT HEATING, B3.3	8813
6	1	HARNESS, ENGINE, B3.3, NOT SHOWN, FIREPUMP	8885
7	1	ASSEMBLY, SENSOR PACKAGE, B3.3, FIREPUMP	9570
8	1	ASSEMBLY, FUEL PLUMBING, CFP33-F25/35, FIREPUMP	9571-01
9	1	MISC PIPING, RAW WATER, CFP33, FIREPUMP	9636
10	1	FUEL LINE, #6, 1/4" NPT x 12" LG	10235
11	1	FUEL LINE, #4, 1/8" NPT x 12" LG	10242
12	1	ASSEMBLY, OPERATORS STATION, CFP33, FIREPUMP	11138
13	1	ASSEMBLY, AIR CLEANER, CFP33-F15/25, FIREPUMP, 8701	11142
14	1	SHIELD, TURBO, CFP33, FIREPUMP	11143
15	1	ASSY TELESCOPING GUARD 24" DS, SAE # 4 CFP 3.3 L	11812
16	1	ASSEMBLY, AIR FILTER COVER, -	13439
17	1	FLEX, EXHAUST, 3" FLANGE, FIREPUMP	8550
18	1	FLANGE, COMPANION, -	8606_OLD
19	1	GUARD, PULLEY, B3_3, CONSTRUCTION ENGINE, FIREPUMP	8805
20	1	ADAPTER, U-JOINT, HAYES #127727-01	9673
21	1	CLAMP, U-BOLT, GUILLOTINE, 3.00"	89545K

REV	DESCRIPTION OF REVISION	REV BY	DATE
F	ADDED PN: 13439 & 89545K ENF PN:2008-275	MAC	10-14-2008
E	REV PER OP STATION & SHIELD	DAVE N	26SEP06

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TITLE 2: FIREPUMP, B3.3-C85

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

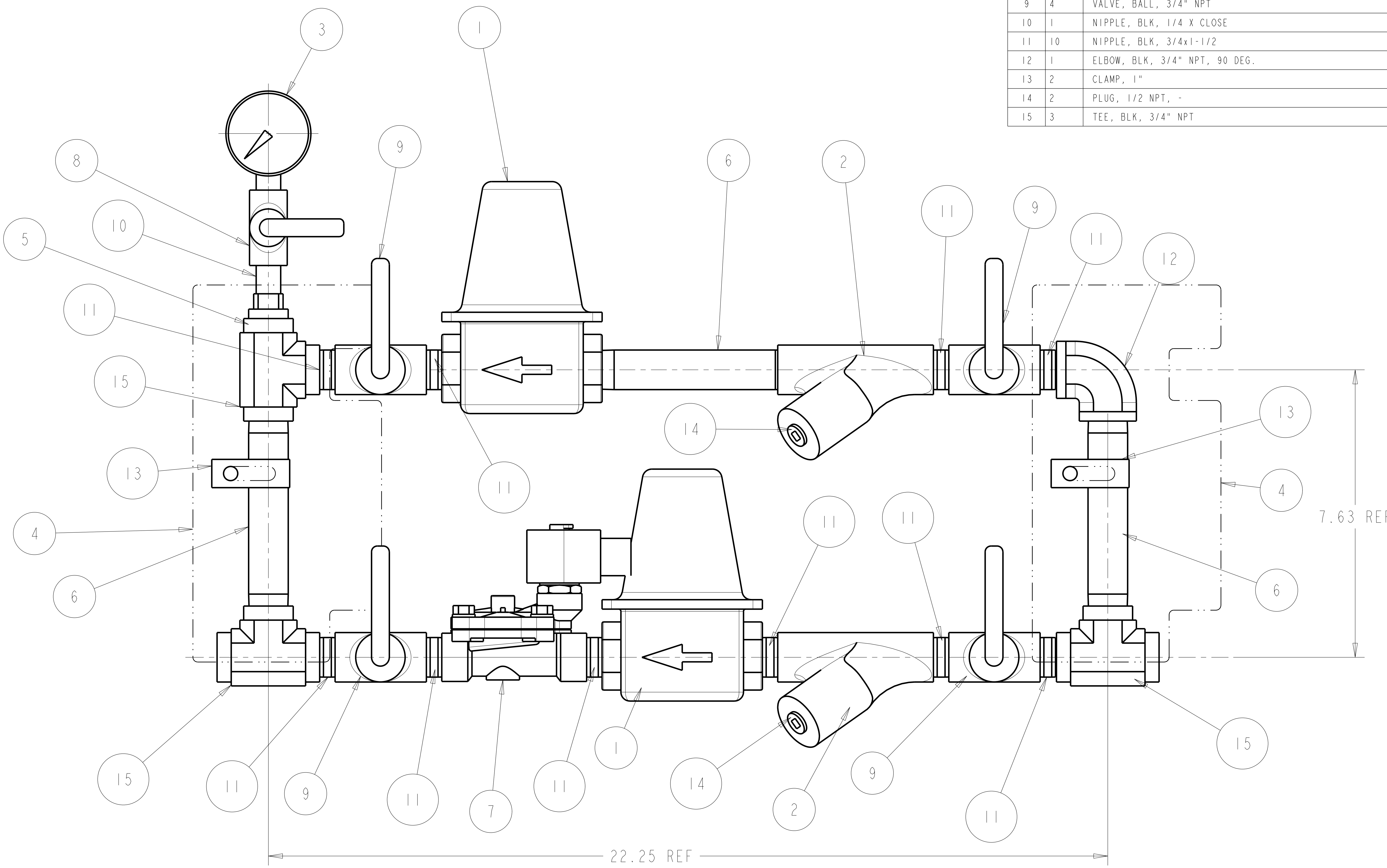
DWG UNITS: IN/LB/S
DRAWN BY: S.DANFORTH
DATE: 25-FEB-2004
APPD BY:
DATE:
EST WEIGHT: 889.000
SCALE: 0.160
DO NOT SCALE
SHEET 1OF1
DRAWING NO: 8701
REV: F

8682-01 FOR VERTICLE TURBINE PUMP:
REMOVE VALVE ITEM #7 AND REPLACE WITH
ITEM #6 - 6" LONG NIPPLE

8682-02 FOR 24 VOLT OPERATION:
REMOVE VALVE ITEM #7 AND REPLACE WITH
ASCO #8210G3-24vdc

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	REGULATOR, 3/4" NPT, 400 PSI MAX, 25 TO 75 PSI OUT	8890
2	2	STRAINER, 3/4" NPT W/ PLUG	8891
3	1	GUAGE, PRESSURE, 1/4" NPT, 0-100 PSI RANGE	8892
4	2	TAG, COOLANT LOOP LABEL, VERTICAL MTG	10965
5	1	BUSHING, REDUCING, 3/4" NPT X 1/4" NPT	71494
6	3	NIPPLE, BLK, 3/4x6	71550
7	1	VALVE, ELEC ACT, BRASS, 3/4" NPT, 12vdc, 150 PSI MAX	8210G3-12VDC
8	1	VALVE, BALL, 1/4" NPT	FA60204-1
9	4	VALVE, BALL, 3/4" NPT	FA60406
10	1	NIPPLE, BLK, 1/4 X CLOSE	LTL-CPN14
11	10	NIPPLE, BLK, 3/4x1-1/2	LTL-CPN34
12	1	ELBOW, BLK, 3/4" NPT, 90 DEG.	LTL-E3490
13	2	CLAMP, 1"	LTL-SCPV16627
14	2	PLUG, 1/2 NPT, -	LTL-SCSP12
15	3	TEE, BLK, 3/4" NPT	LTL-ST34



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TITLE 1: ASSEMBLY, RAW WATER COOLING, 3/4" NPT
TITLE 2: FIREPUMP

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

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 12JUN2004	
	APPD BY:			DATE:	
EST WEIGHT: 42238.628	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8682	REV: D

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER PART NUMBERS	DAVE N	19SEP06

PN8720
SO94474
ModelB3.3-G2
ConfigD782002GX03

Option	Desc
GDRV	187B3.3-G2
A AF30201	ADAPTER,FRONT DR
AP30004	APPROVAL,AGENCY
BC30034	ENGINE,BASE
DF30000	DRIVE,FRO GER TR
EE30003	ALTERNATOR
FA30007	DRIVE,FAN
FF30008	FILTER,FUEL
FH30009	HOUSING,FLYWHEEL
FR30005	RATING,FUEL
FV30002	VALVE,FUEL SHUTO
A FW30001	FLYWHEEL
LC30002	COOLER,ENGINE OIL
LG30001	GAUGE,OIL LEVEL
OB30000	ARRANGEMENT,OIL
OF30002	FILTER,LUBRICATI
OP30002	PAN,OIL
SD30001	PLUMBING,SENSOR
SS30001	PAINT
ST30001	MOTOR,STARTING
A TB30002	TURBOCHARGER
WO30001	CONNECTION,WATER
XS30003	CONNECTION,EXHAU

BUILT BEFORE JANUARY 1, 2007

PN8720
SO94474
ModelB3.3-G2
ConfigD782002GX03

Option	Desc
GDRV	187B3.3-G2
AF30201	ADAPTER,FRONT DR
B AP30005	APPROVAL,AGENCY
B BC30106	ENGINE,BASE
DF30000	DRIVE,FRO GER TR
EE30003	ALTERNATOR
B FA37001	DRIVE,FAN
FF30008	FILTER,FUEL
FH30009	HOUSING,FLYWHEEL
FR30005	RATING,FUEL
FV30002	VALVE,FUEL SHUTO
FW30001	FLYWHEEL
B IM30001	MANIFOLD, AIR INTAKE
LC30002	COOLER,ENGINE OIL
LG30001	GAUGE,OIL LEVEL
B LP30002	PUMP, LUBRICATION OIL
B OB30002	ARRANGEMENT,OIL FILL
OF30002	FILTER,LUBRICATI
OP30002	PAN,OIL
B SD30005	SWITCH, OIL PRESSURE
B SD30006	GUAGE, COOLANT TEMPERATURE
SS30001	PAINT
B ST30201	MOTOR,STARTING
TB30002	TURBOCHARGER
B TU30002	TURBOCHARGER
WO30001	CONNECTION,WATER
B XM30003	MANIFOLD, EXHAUST
XS30003	CONNECTION,EXHAU

BUILT AFTER JANUARY 1, 2007

REV	DESCRIPTION OF REVISION	BY	DATE
B	UPDATED PER ENGINE SPEC AND DWG BORDER	DAVE N	08JAN2007
A	UPDATED PER ENGINE SPEC	DAVE N	16OCT2004

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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: NTS	DRAWN BY: DAVE N	DATE: 23SEP2004
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION: ASSEMBLY, ENGINE, 4BT3.3-G2

REFERENCE: CFP33-F10/20/30

DRAWING NUMBER: 8720B

PN 8721
SO 94475
Model B3.3-C
Config D782001CX03

Rev	Option	Desc
	CONS 436	B3.3-C
A	AF30203	ADAPTER,FRONT DR
	AP30201	APPROVAL,AGENCY
	BC30261	ENGINE,BASE
	DF30001	DRIVE,FRO GER TR
A	EE30008	ALTERNATOR
A	FA30005	DRIVE,FAN
	FF30001	FILTER,FUEL
	FH30001	HOUSING,FLYWHEEL
	FR30203	RATING,FUEL
	FV30003	VALVE,FUEL SHUTO
	FW30001	FLYWHEEL
	LC30001	COOLER,ENGINE OI
	LG30004	GAUGE,OIL LEVEL
	LT30001	LITERATURE
	OB30000	ARRANGEMENT,OIL
	OF30001	FILTER,LUBRICATI
	OP30002	PAN,OIL
	SD30001	PLUMBING,SENSOR
	SS30001	PAINT
A	ST30201	STARTER
A	TB30004	TURBOCHARGER
A	TU30005	TURBOCHARGER
	WO30001	CONNECTION,WATER
	XS30001	CONNECTION,EXHAU

REV	DESCRIPTION OF REVISION	BY	DATE
A	REDRAWN PER ENGINE SPEC	DAVE N	16OCT2004

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DEPERE, WISCONSIN

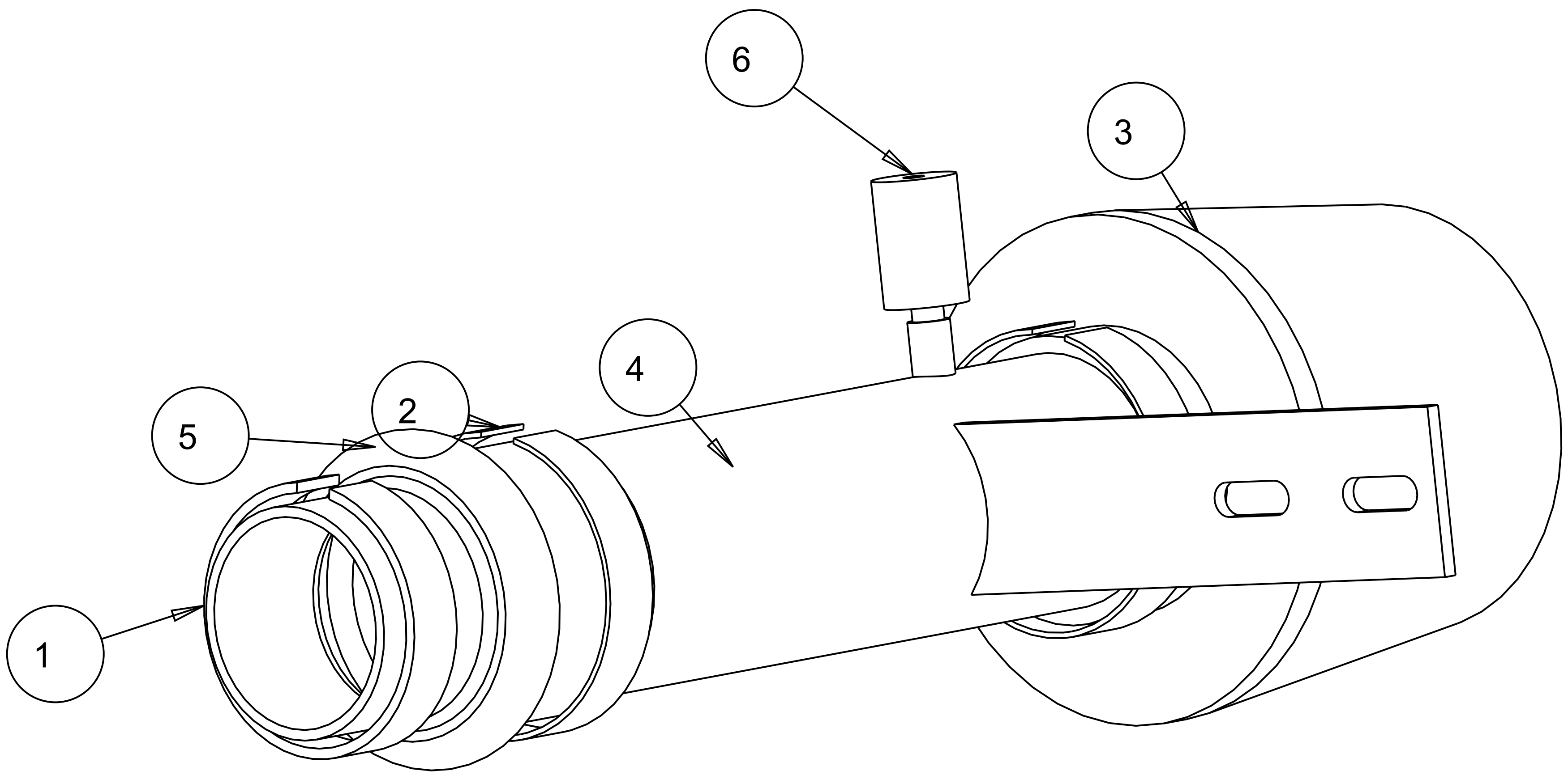
UNLESS OTHERWISE NOTED
–
ALL DIMENSIONS ARE IN INCHES
–
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
–
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

DWG SCALE: NTS	DRAWN BY: DAVE N	DATE: 23SEP2004
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
ASSEMBLY, ENGINE, B3.3C85T

REFERENCE: CFP–F25/35
DRAWING NUMBER: 8721A

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	CLAMP, 2.5" NOMINAL, AC250	8754
2	2	CLAMP, 3" NOMINAL, AC300	8816
3	1	AIR FILTER, 3" DIA. INLET, CFP33, 39 FIREPUMP	9604
4	1	TUBE, AIR CLEANER EXTENSION, 3" DIA, FIREPUMP	11141
5	1	COUPLING, RUBBER, 2-1/2" TO 3", DONALDSON #P10280	P102820
6	1	RESTRICTION INDICATOR, 30" H20, 1/8" NPT	X002354



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TITLE 1: ASSEMBLY, AIR CLEANER, CFP33-F10/20/30
TITLE 2: FIREPUMP, 8700

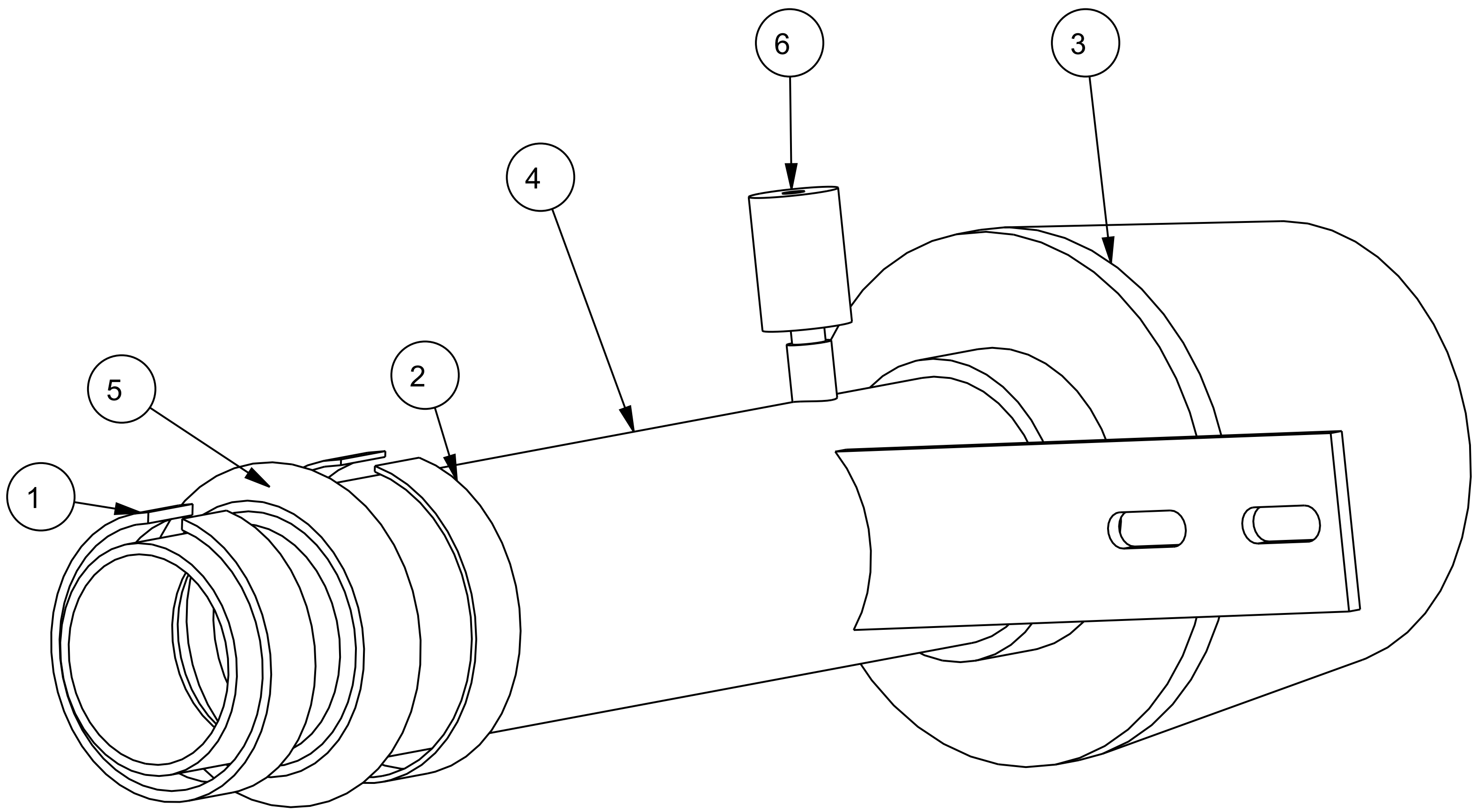
UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

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

D	OMIT PN:8756 ENF PN:2008-275	MAC	10-14-2008
C	REV PER TUBE, IND, AIR CLEANER	DAVE N	01SEP06
B	REV PER BRACKETS	DAVE N	20AUG04
REV	DESCRIPTION OF REVISION	REV BY	DATE

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 26MAY2004	
	APPD BY:			DATE:	
EST WEIGHT: 14.621	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8766	REV: D

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	CLAMP, 2.5" NOMINAL, AC250	8754
2	1	CLAMP, 3" NOMINAL, AC300	8816
3	1	AIR FILTER, 3" DIA. INLET, CFP33, 39 FIREPUMP	9604
4	1	TUBE, AIR CLEANER EXTENSION, 3" DIA, FIREPUMP	11141
5	1	COUPLING, RUBBER, 2.36" TO 3"	3H236
6	1	RESTRICTION INDICATOR, 30" H20, 1/8" NPT	X002354



REV	DESCRIPTION OF REVISION	REV BY	DATE
B	OMIT PN: 8756 ENF PN: 2008-275	MAC	10-14-2008
A	REV PER RESTRICTION INDICATOR	DAVE N	05SEP06

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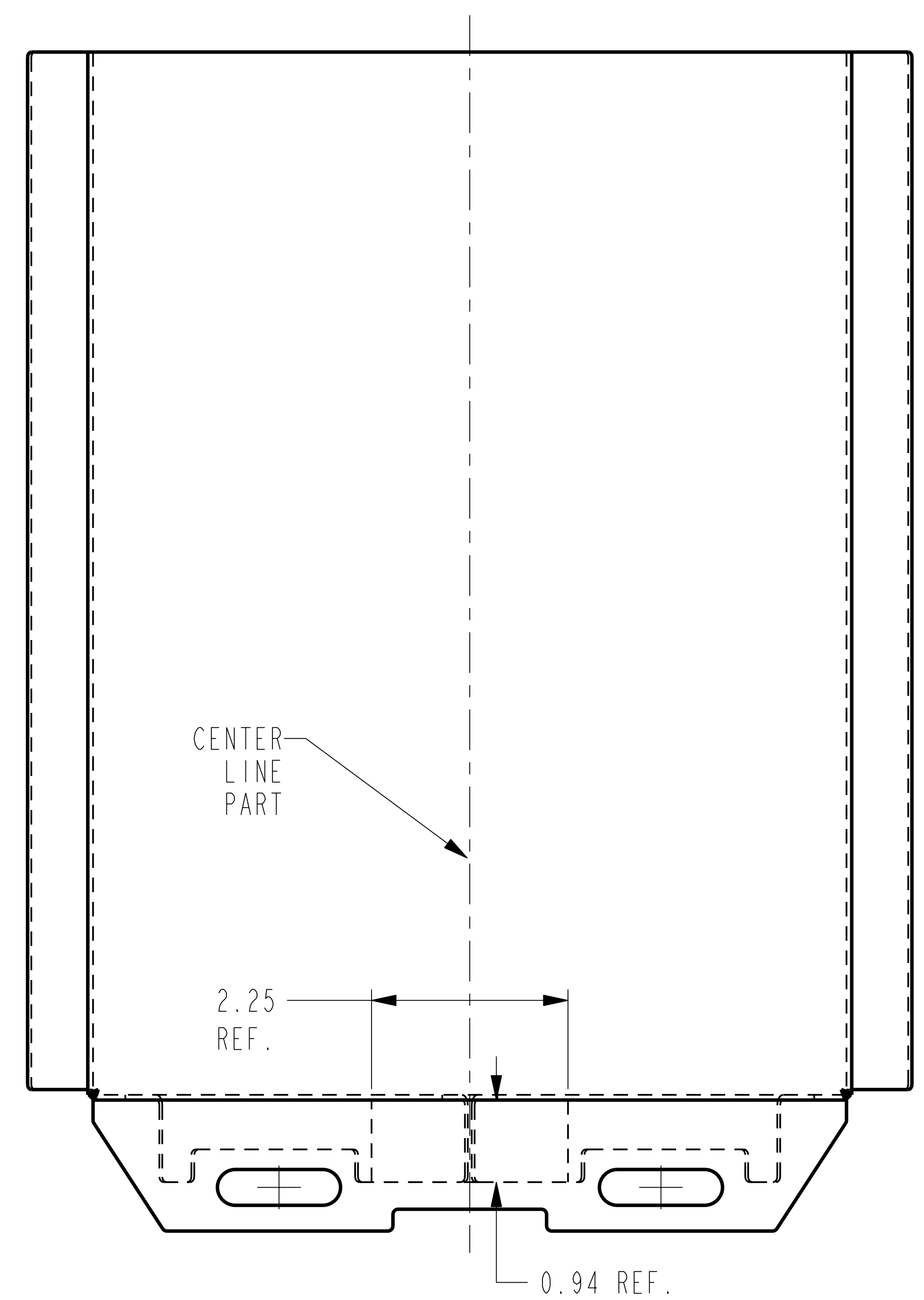
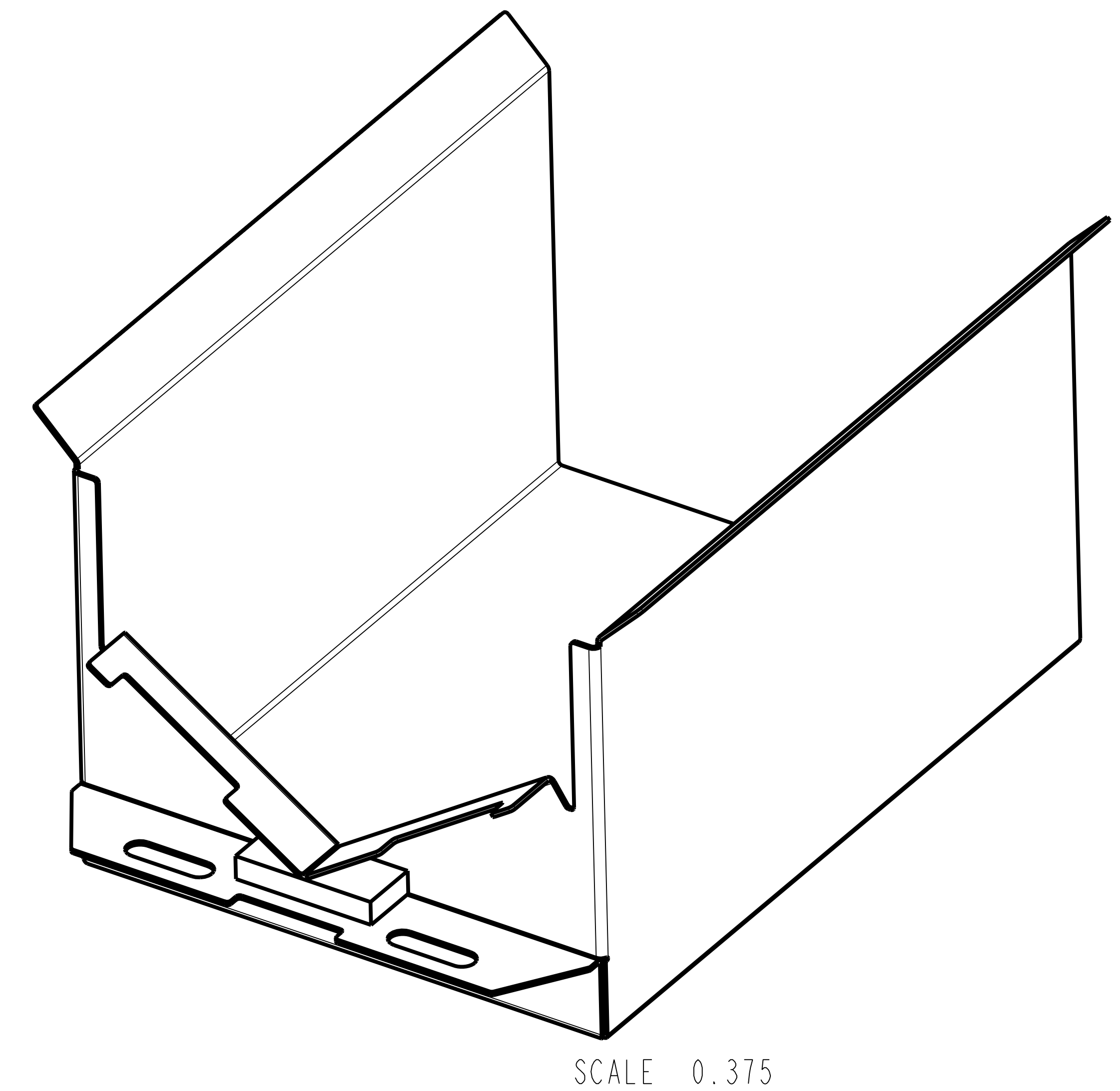
TITLE 1: ASSEMBLY, AIR CLEANER, CFP33-F15/25
TITLE 2: FIREPUMP, 8701

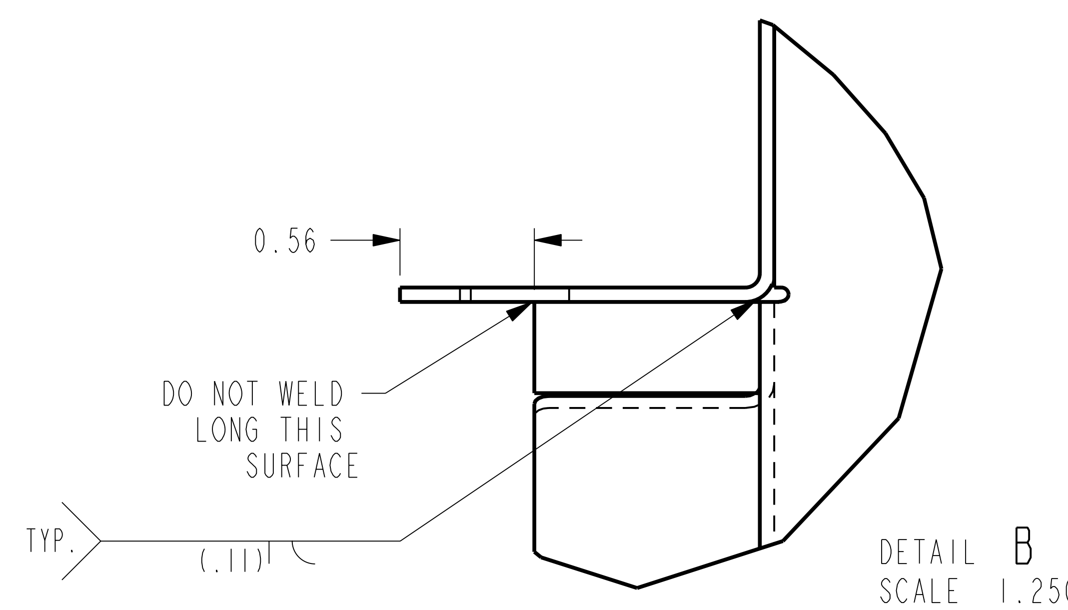
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 01SEP2006	
	APPD BY:			DATE:	
EST WEIGHT: 14.542	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 11142	REV: B

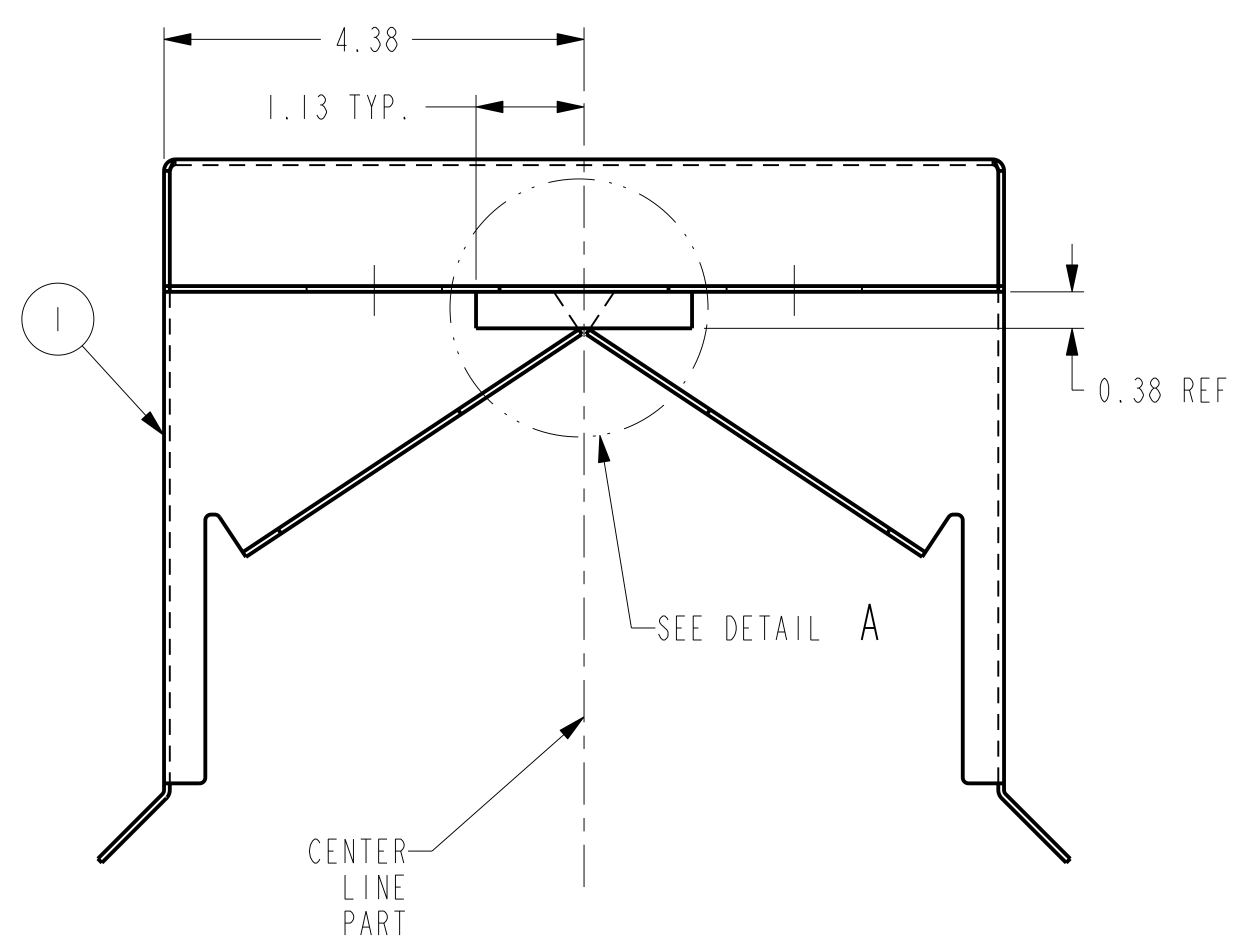
BILL OF MATERIAL

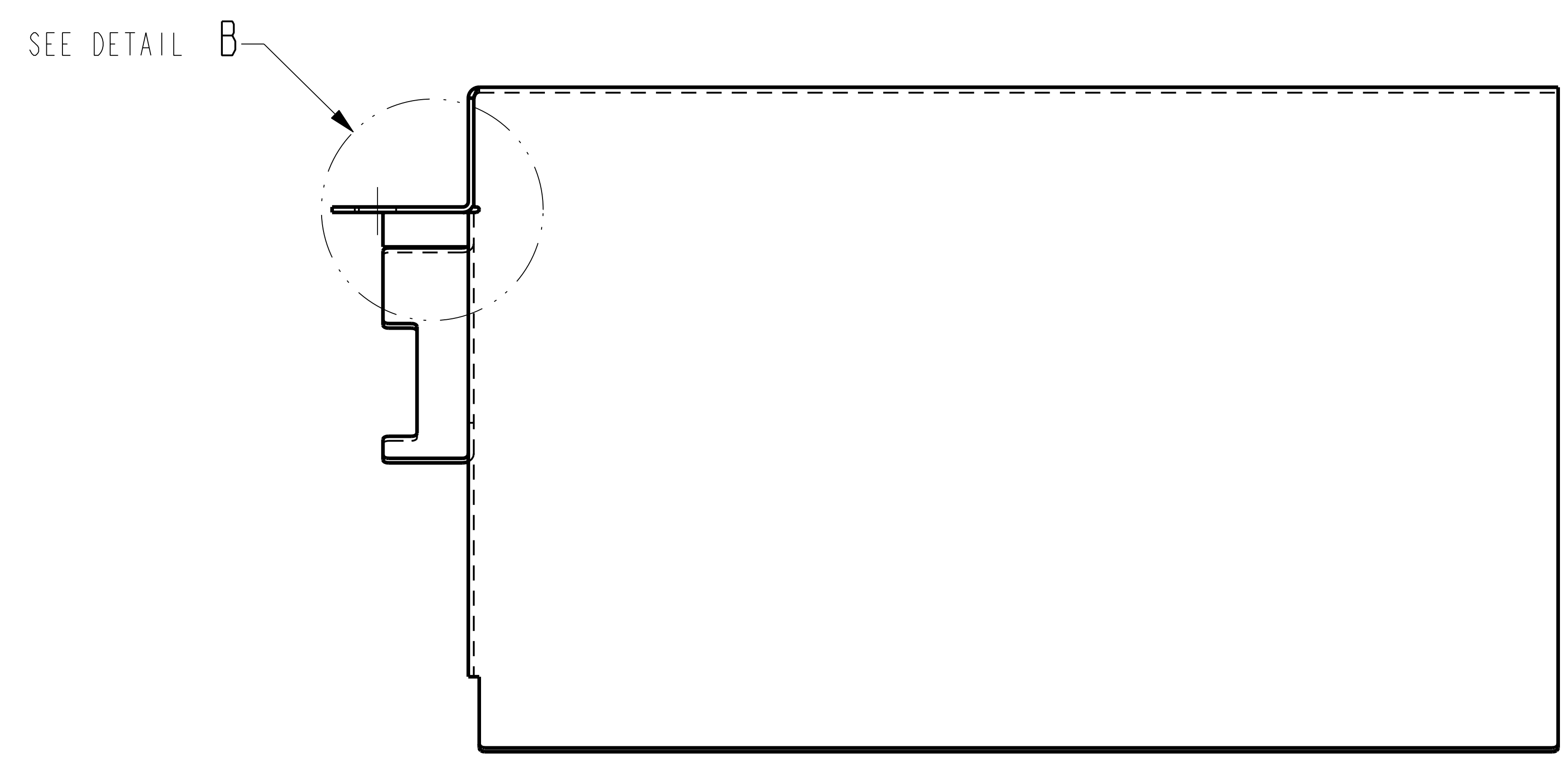
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	BRACKET, AIR FILTER COVER, -	13440
2	1	PLATE, SUPT, AIR FILTER COVER, -	13441

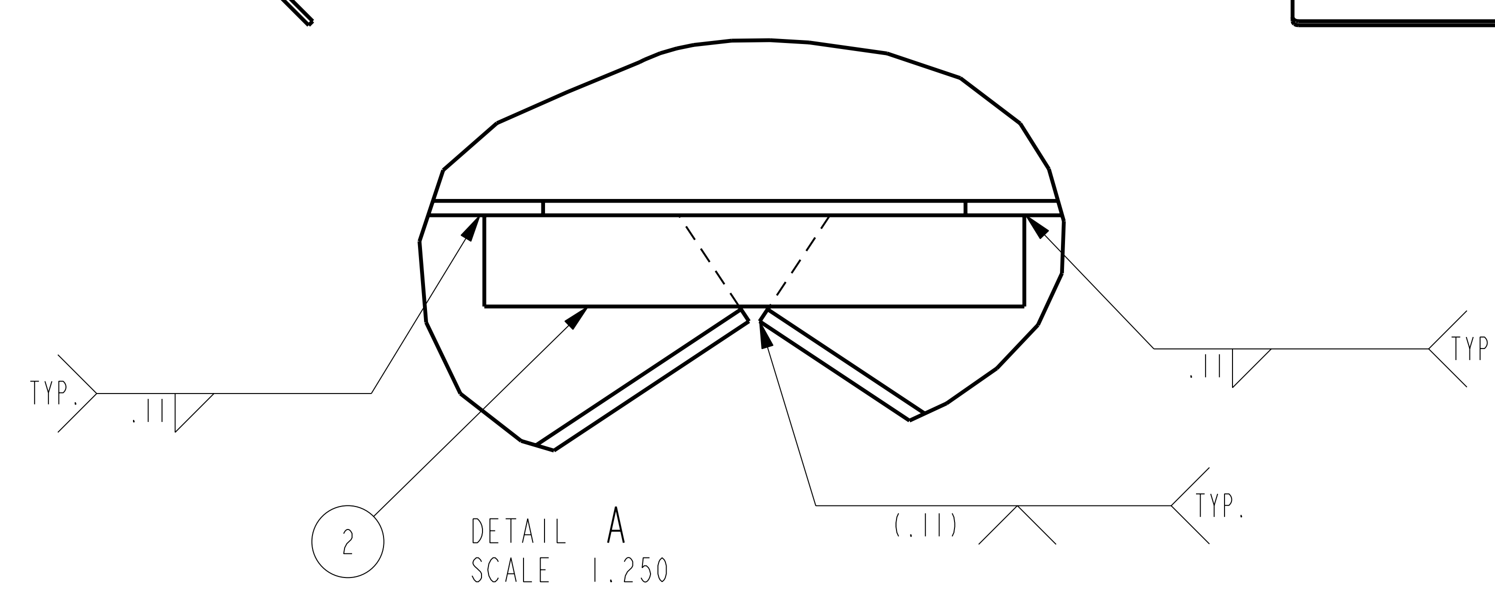












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1.) PRIME AND PAINT CASE RED

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TITLE 1: ASSEMBLY, AIR FILTER COVER
TITLE 2: -

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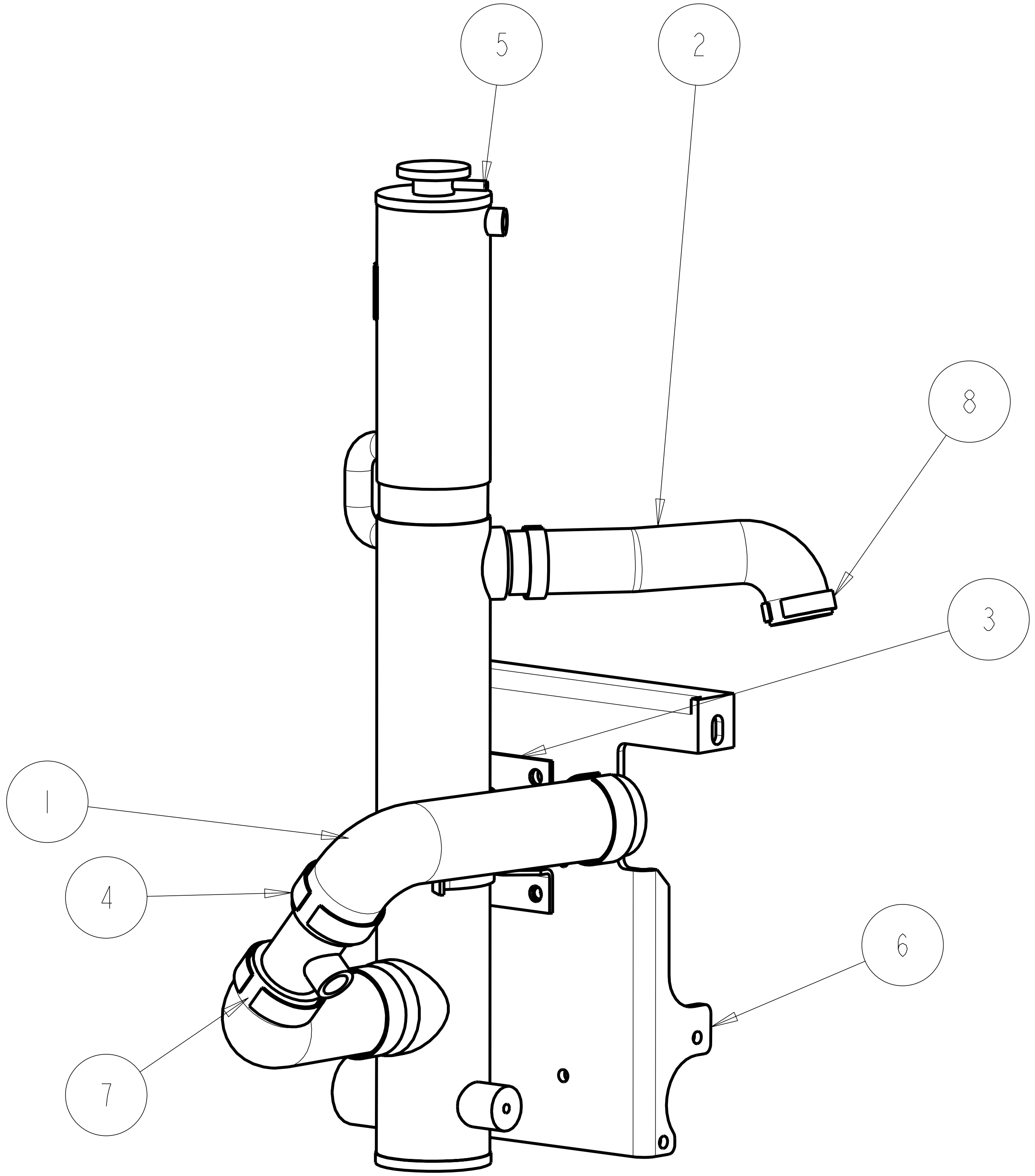
ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

DWG UNITS: IN/LB/S	DRAWN BY: MAC			DATE: 08-21-2008	
	APPD BY: -			DATE: -	
EST WEIGHT: 42238.628	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 13439	REV: P0



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, WATER INLET, LOWER, FIREPUMP, B3.3	8806
2	1	HOSE, COOLING, UPPER, FIREPUMP, B3.3	8807
3	1	CLAMP, MOUNTING, HEAT EXCHANGER, 3", FIREPUMP, B3.3	8660
4	4	CLAMP, 2-1/8" NOMINAL, #92232	8661
5	1	HEAT EXCHANGER, 3" DIAMETER, FIREPUMP, B3_3	8759
6	1	BRACKET, MOUNTING, HEAT EXCHANGER, FIREPUMP, B3.3	8768
7	1	TUBE, 1.75" O.D. W/ 3/4" PORT, FIREPUMP	9538
8	2	CLAMP, 1.75" NOMINAL	9539

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ANGULAR DIMENSIONS ± 1°

TITLE 1: ASSEMBLY, HEAT EXCHANGER
TITLE 2: FIREPUMP, B3.3

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

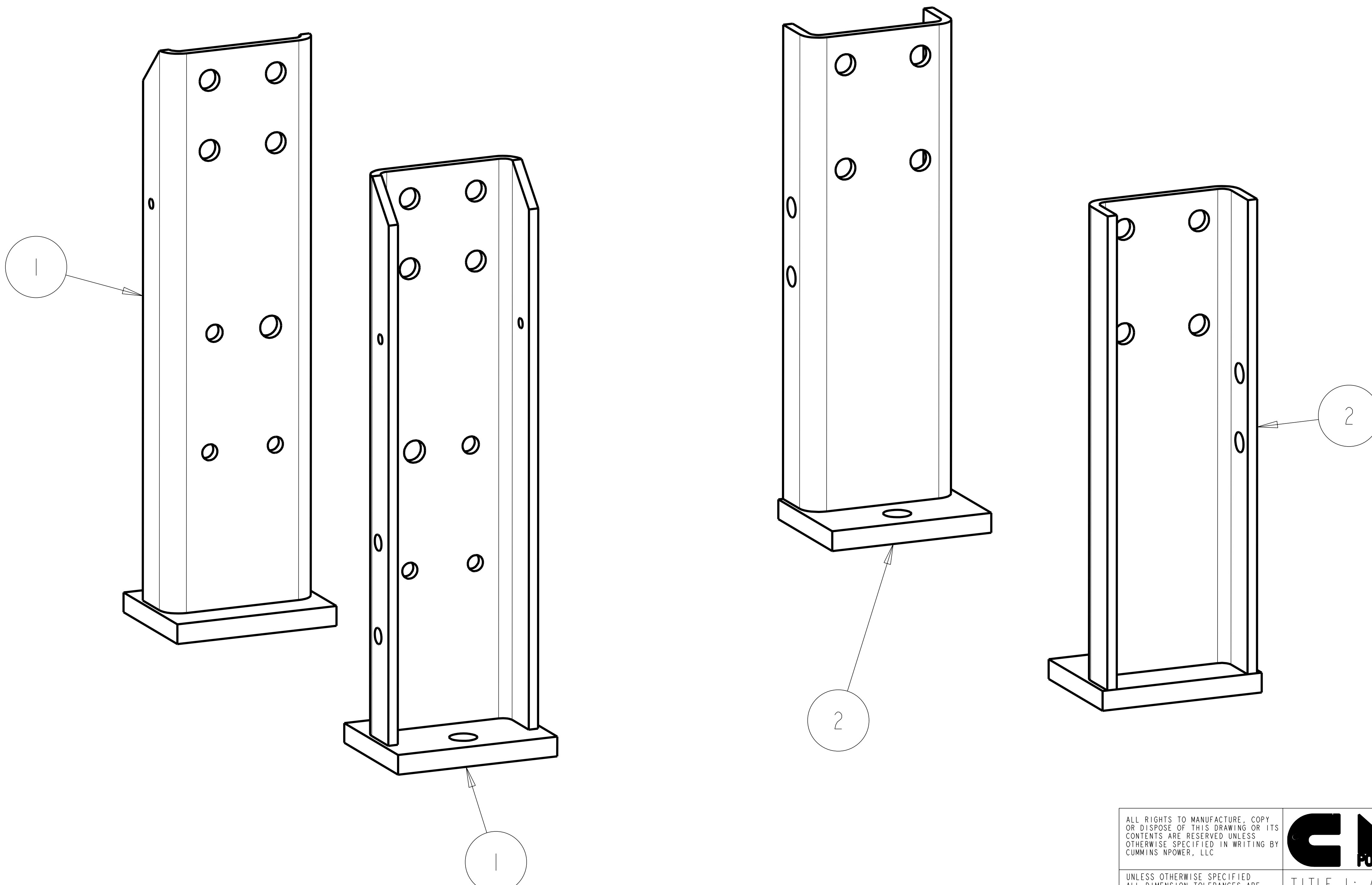
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 08APR2004
	APPD BY:		DATE:
EST WEIGHT: 123.267	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1

DRAWING NO:	REV:
8769	C

REV	DESCRIPTION OF REVISION	REV BY	DATE
C1	GRAPHICS REVISION	DAVE N	31MAY05
C	REV PER HEAT EXCHANGER	DAVE N	17JUL04
A/B	MISC REVISIONS	DAVE N	JUN04

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	LEG, ENGINE SUPPORT, FRONT, FIREPUMP, B3_3	8799
2	2	LEG, SUPPORT, ENGINE, REAR, FIREPUMP, B3_3	8801



REV	DESCRIPTION OF REVISION	REV BY	DATE
D	REV PER SUB COMPONENTS	DAVE N	02MAR05
C	REV PER SUB COMPONENTS	DAVE N	17OCT04
A/B	MISC REVISIONS	DAVE N	AUG04

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ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

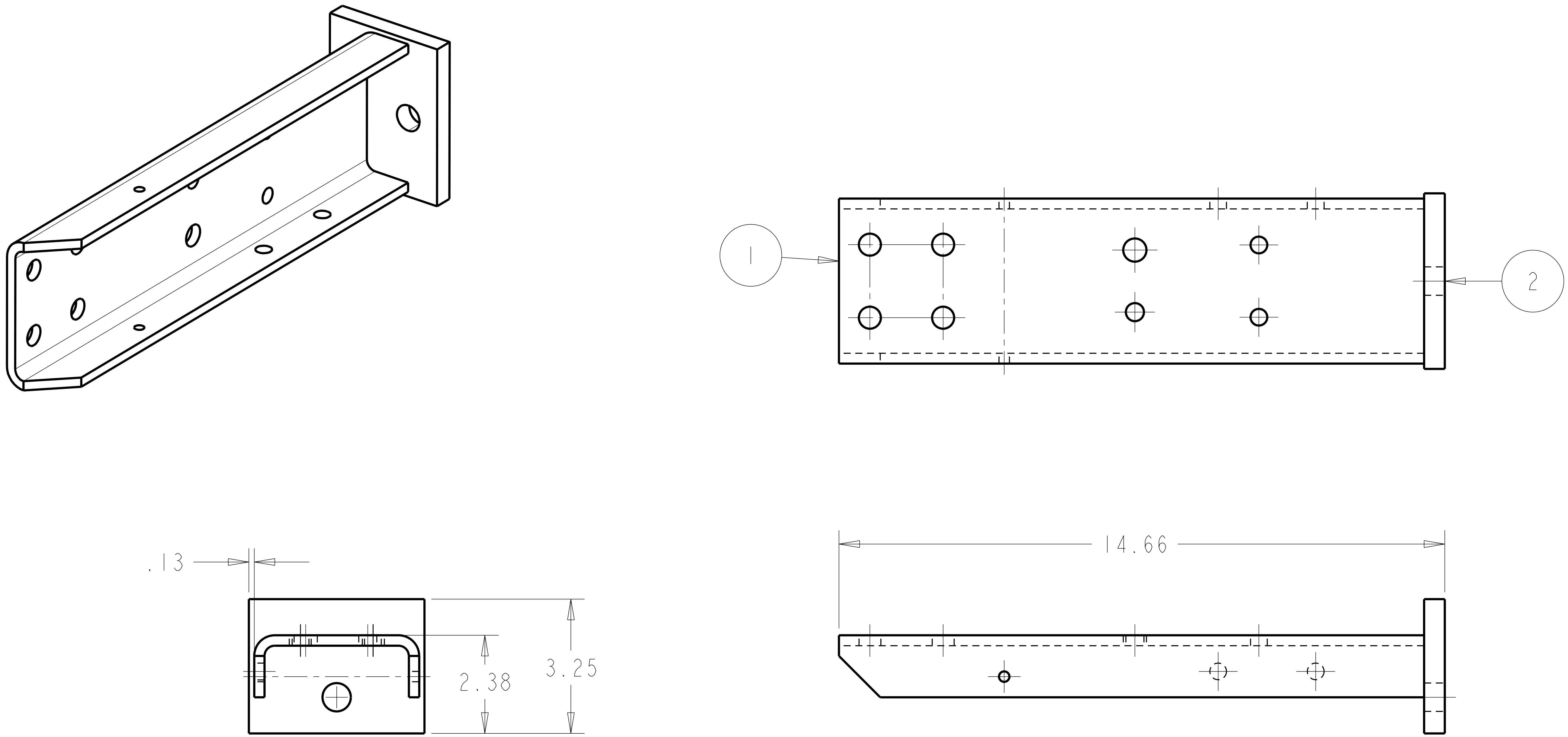
IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

TITLE 1: ASSEMBLY, SUPPORT, ENGINE
TITLE 2: FIREPUMP, B3.3

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 26MAY2004
	APPD BY:			DATE:
EST WEIGHT: 42238.628	SCALE: 0.375	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8798	REV: D

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	CHANNEL, SUPPORT, ENGINE, FIREPUMP, B3_3	8800
2	1	PLATE, ENGINE SUPPORT, FIREPUMP, B3_3	8804



NOTES:
1) REMOVE ALL BURS AND SHARP EDGES
2) PRIME AND PAINT FIRE ENGINE RED
3) CENTER CHANNEL ON PLATE

REV	DESCRIPTION OF REVISION	REV BY	DATE
C	REV PER SUB COMPONENTS	DAVE N	02MAR05
A/B	MISC REVISIONS	DAVE N	SEP04

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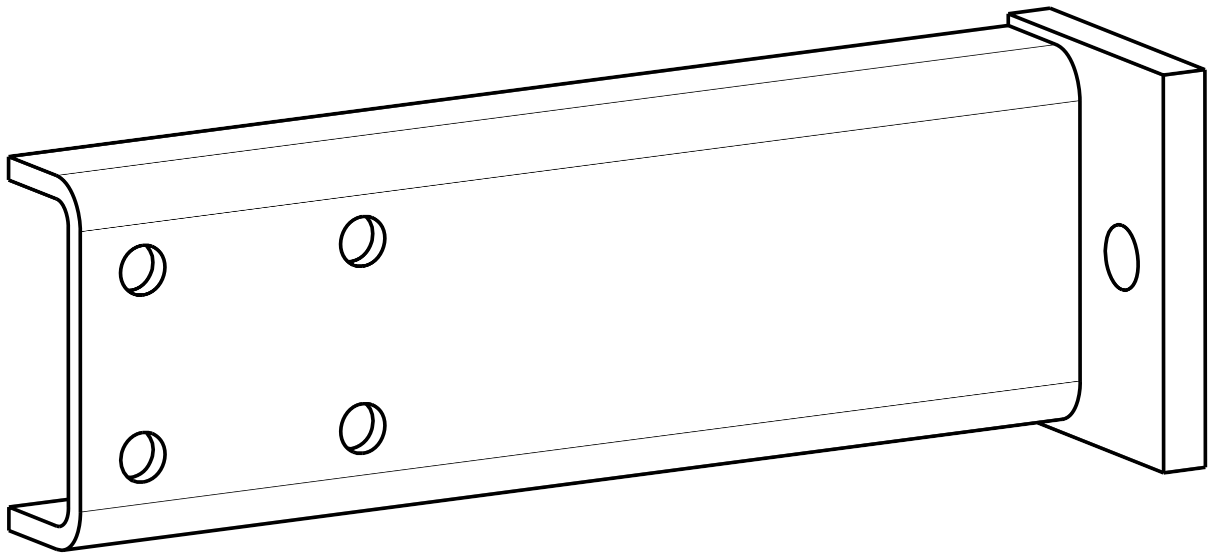
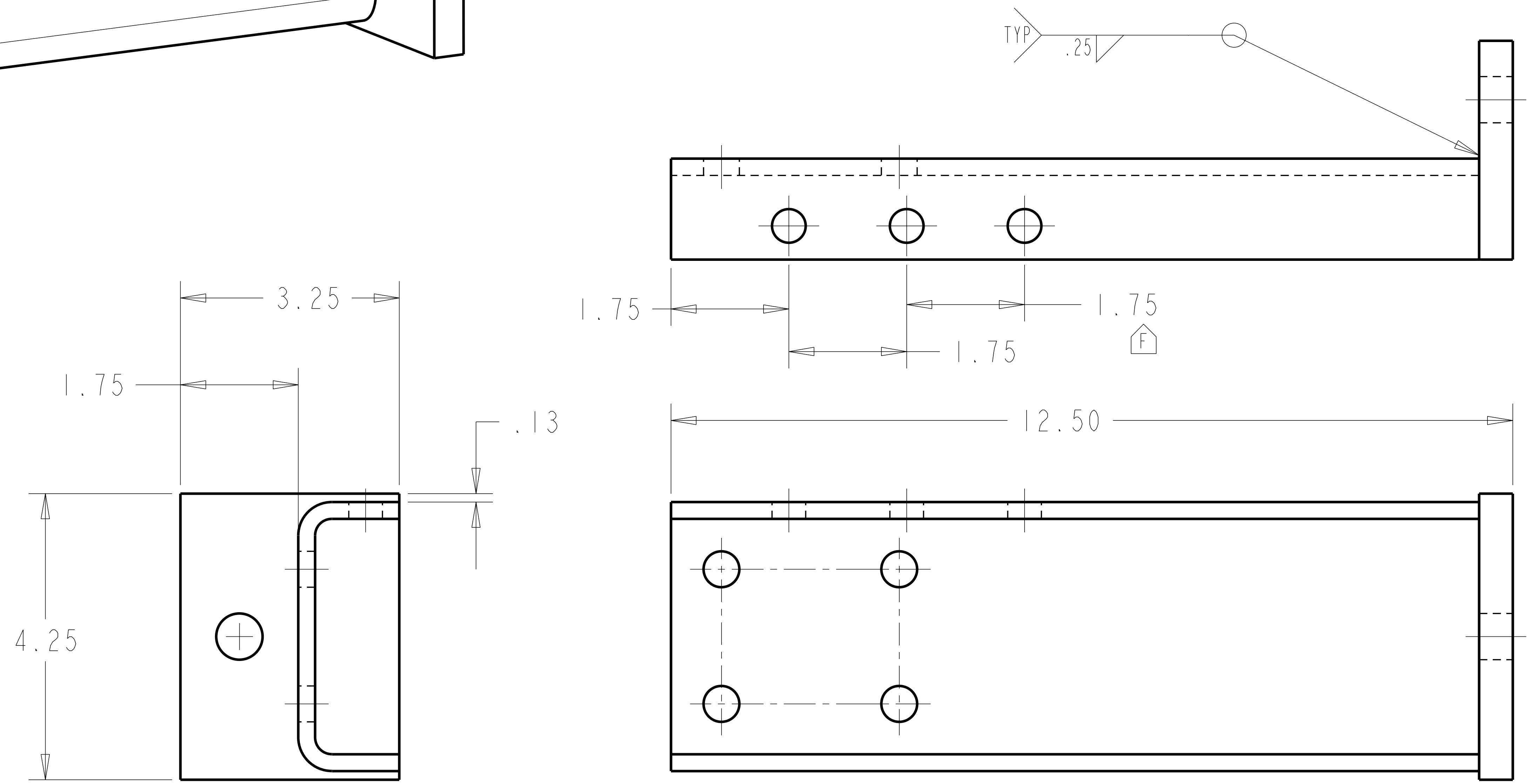
ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

TITLE 1: LEG, ENGINE SUPPORT, FRONT
TITLE 2: FIREPUMP, B3_3

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 08APR2004	
	APPD BY:			DATE:	
EST WEIGHT: 7.956	SCALE: 0.375	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8799	REV: C





BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	CHANNEL, SUPPORT, ENGINE, FIREPUMP, B3_3	8802
2	1	PLATE, ENGINE SUPPORT, FIREPUMP, B3_3	8804

NOTES:
1) REMOVE ALL BURS AND SHARP EDGES
2) PRIME AND PAINT CASE RED
3) CENTER CHANNEL ON PLATE

REV	DESCRIPTION OF REVISION	REV BY	DATE
F1	ADDED WELD SYMBOL	DAVE N	09NOV06
F	REV PER SUB CONPONENTS.ADDED HOLE	DAVE N	03OCT05

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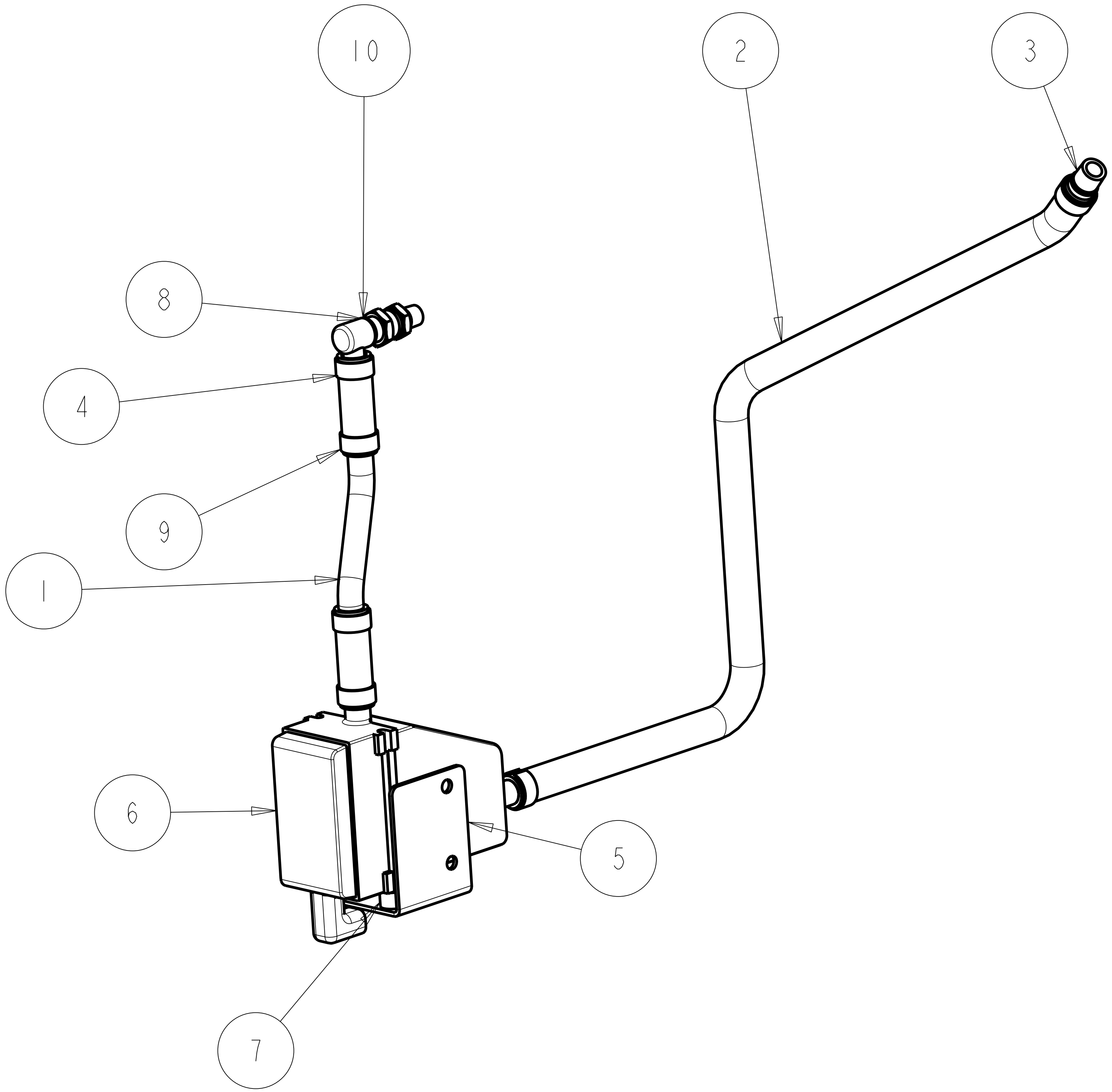
TITLE 1: LEG, SUPPORT, ENGINE, REAR
TITLE 2: FIREPUMP, B3_3

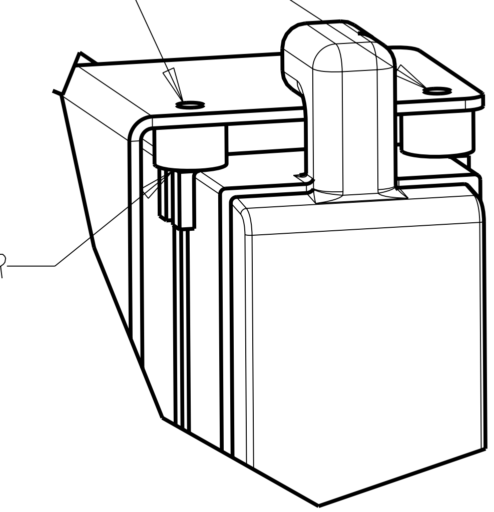
DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 08APR2004
	APPD BY:			DATE:
EST WEIGHT: 7.058	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8801 — REV: F

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	TUBE, COOLANT HEATER	8817
2	1	HOSE, COOLANT HEATER, 3/4" I.D. X 30" LG	8818
3	1	ADAPTER, 3/4" NPT X 3/4" OD HOSE	8288
4	2	COUPLING, HOSE, 3/4" I.D. #80242GL X 3" LG, FIREPUMP	8562
5	1	BRACKET, MOUNTING, COOLANT HEATER, OFFSET, FIREPUMP	9523
6	1	CIRCULATION HEATER, P&T #3315032, 1500W , 120V , 176° F	9598
D 7	2	ISOLATOR, STUD MOUNT, 1/4-20, TECH PRODUCTS #51201	13102
8	1	ADAPTER, 3/8 NPTM X 1/2 NPTF	222P-8-6
9	6	CLAMP, 1" NOMINAL #92216	CLAMP_100
10	1	ADAPTER, 1/2" NPT X 3/4" 90 DEG BARB	R-269HB-12-8



ATTACH HEATER TO BRACKET USING
LOCTITE #425 BLUE ON FASTENERS
HAND TIGHT + 1/4 TURN.



INSTALL ISOLATORS (2) ON HEATER
WITH LOCTITE #425 BLUE, HAND TIGHT.

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	ADDED ISOLATOR	S DUBICK	18JUL08
C	HEATER WAS 3305060	DAVE N	19NOV04
B	REV AS BUILT	DAVE N	JUL04
A	MISC REVSIONS	DAVE N	JUN04

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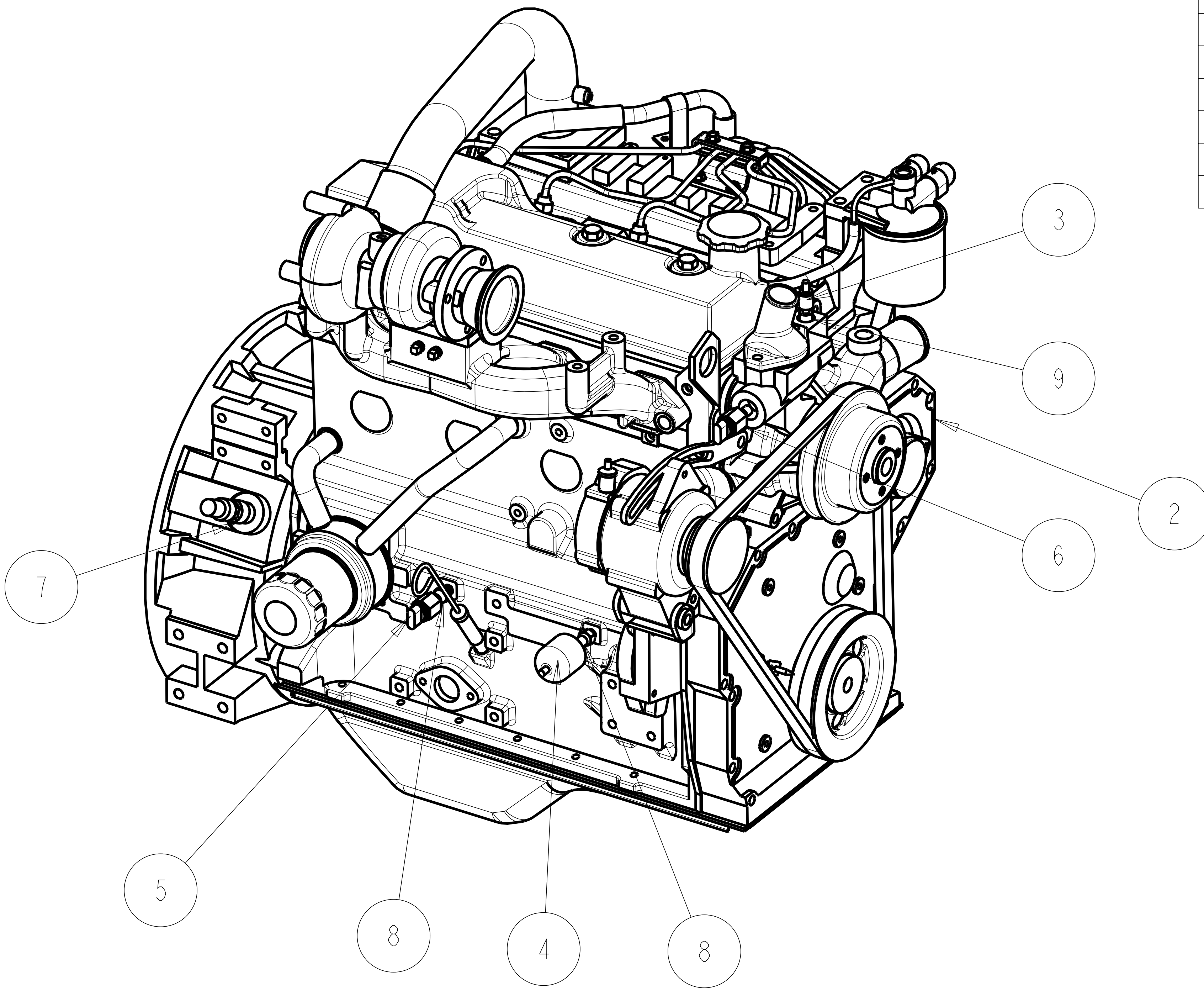
TITLE 1: ASSEMBLY, COOLANT HEATING, B3.3
TITLE 2:

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 29JUN2004	
	APPD BY:			DATE:	
EST WEIGHT: 3.999	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8813	REV: D



BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	RECTIFIER, SILICON (NOT SHOWN)	357-0030
2	1	ASSEMBLY, ENGINE, B3.3-G2	8720
3	1	SENDER, WATER TEMPERATURE, DATCON #02022-00	8862
4	1	SENDER, OIL PRESURE, DATCON #02504-00	8863
5	1	SWITCH, OIL PRESSURE, (8040333)	3408607
6	1	SWITCH, WATER TEMPERATURE, (8037302)	3408632
7	1	SENSOR, MAG PICK UP, 22mm	5MT2005
8	2	NIPPLE	C6151211230
9	1	BUSHING, 3/8" NPT X 1/8" NPT	LTL-SRB3818

REV	DESCRIPTION OF REVISION	REV BY	DATE

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ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

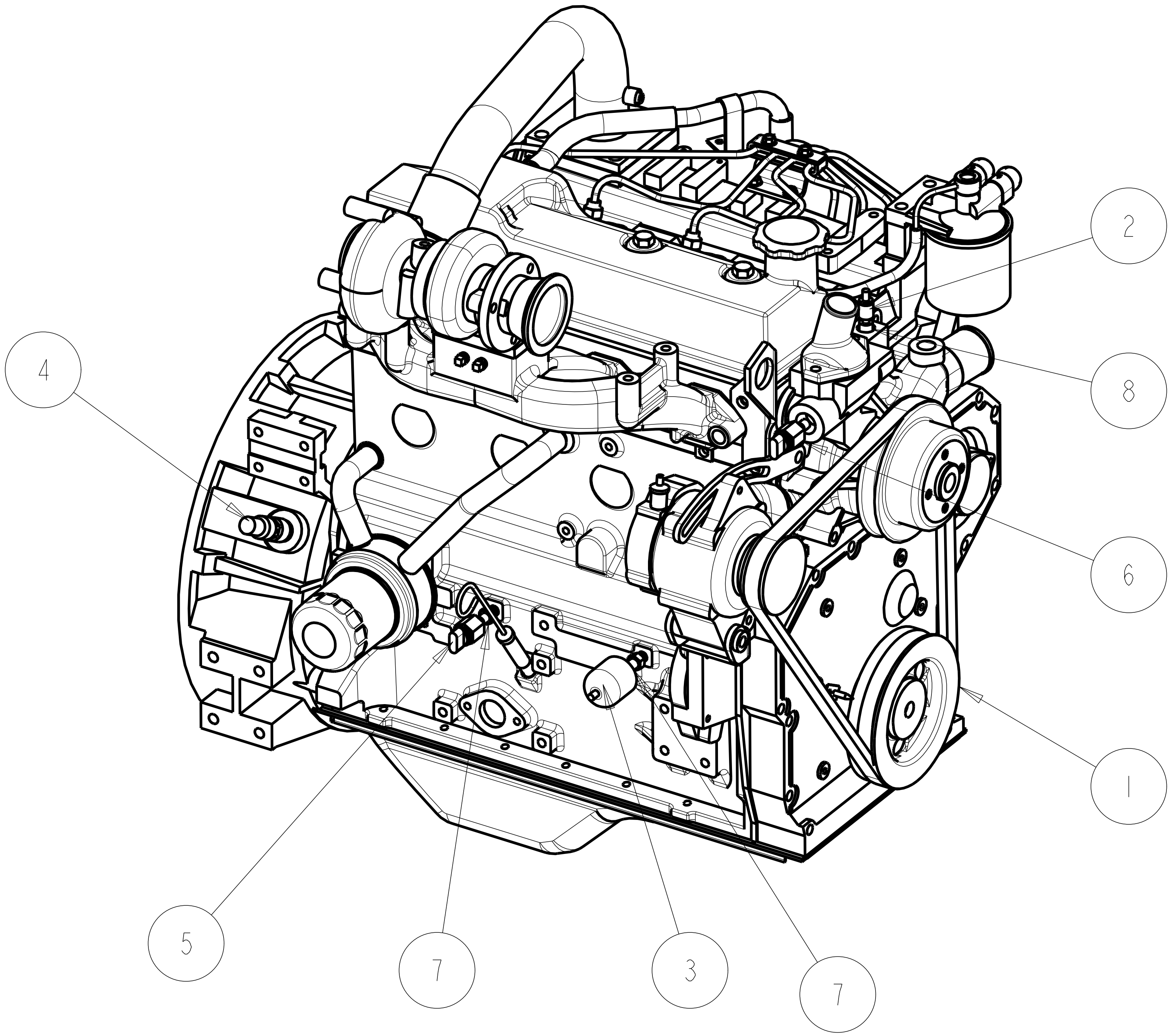
IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

TITLE 1: ASSEMBLY, SENSOR PACKAGE, B3.3-G2
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 21MAR2006	
	APPD BY: -		DATE: -	
EST WEIGHT: 42238.628	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9570-01	REV:

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, ENGINE, B3.3-C85T	8721
2	1	SENDER, WATER TEMPERATURE, DATCON #02022-00	8862
3	1	SENDER, OIL PRESURE, DATCON #02504-00	8863
4	1	SENSOR, MAG PICK UP, 22mm	110239
5	1	SWITCH, OIL PRESSURE, (8040333)	3408607
6	1	SWITCH, WATER TEMPERATURE, (8037302)	3408632
7	2	NIPPLE	C6151211230
8	1	BUSHING, 3/8" NPT X 1/8" NPT	LTL-SRB3818



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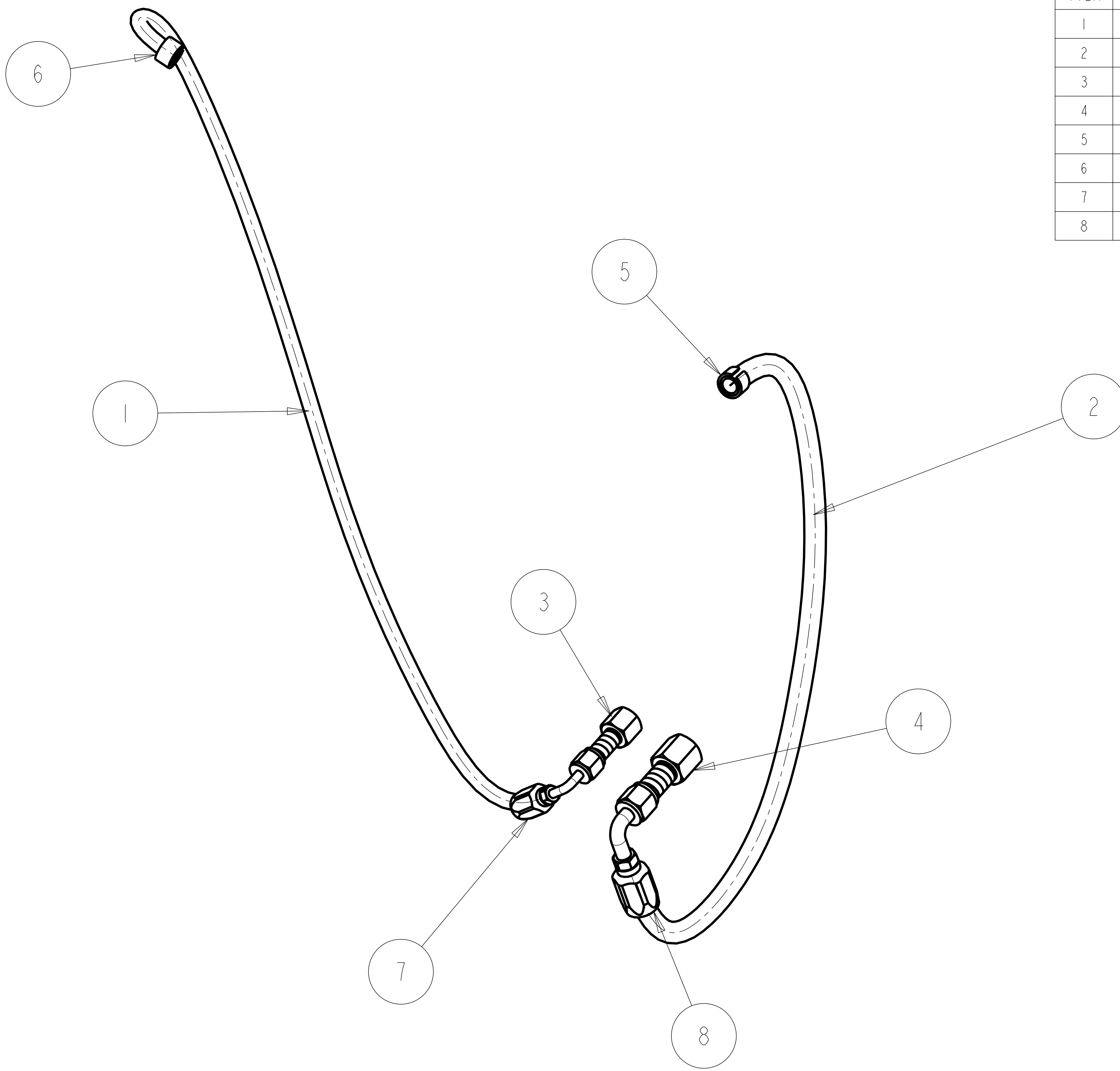
TITLE 1: ASSEMBLY, SENSOR PACKAGE, B3.3
TITLE 2: FIREPUMP

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

REV	DESCRIPTION OF REVISION	REV BY	DATE
C	ADDED ENGINE	DAVE N	21MAR06
B	REV PER PART NUMBERS	DAVE N	20JAN06
A	REV PER INSTALL	DAVE N	01SEP04

DWG UNITS: IN/LB/S | DRAWN BY: DAVE N | DATE: 19AUG2004
APPD BY: - | DATE: -
EST WEIGHT: 42238.628 | SCALE: 0.200 | DO NOT SCALE | SHEET 1OF1 | DRAWING NO: 9570 | REV: B



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, RETURN, #261-4 X 38" LG	9571_RETURN
2	1	FUEL LINE, SUPPLY, #261-6 X 24" LG	9571_SUPPLY
3	1	BULKHEAD, #4 X 1/8" NPT	4_WGTX-S
4	1	BULKHEAD, #6 X 1/4" NPT	6_WGTX-S
5	1	CLAMP, 5/8" NOMINAL, #CL-6	8663
6	1	CLAMP, 1/2" NOMINAL, #CL-1	10690
7	1	ELBOW, HOSE, FEMALE JIC 37 DEG. SWIVEL 90 DEG. ELBOW	23920-4-4
8	1	ELBOW, HOSE, FEMALE JIC 37 DEG. SWIVEL 90 DEG. ELBOW	23920-6-6

REV	DESCRIPTION OF REVISION	REV BY	DATE
A1	CORRECTED CLAMP	DAVE N	19JAN06
A	REV PER INSTALL	DAVE N	01SEP04

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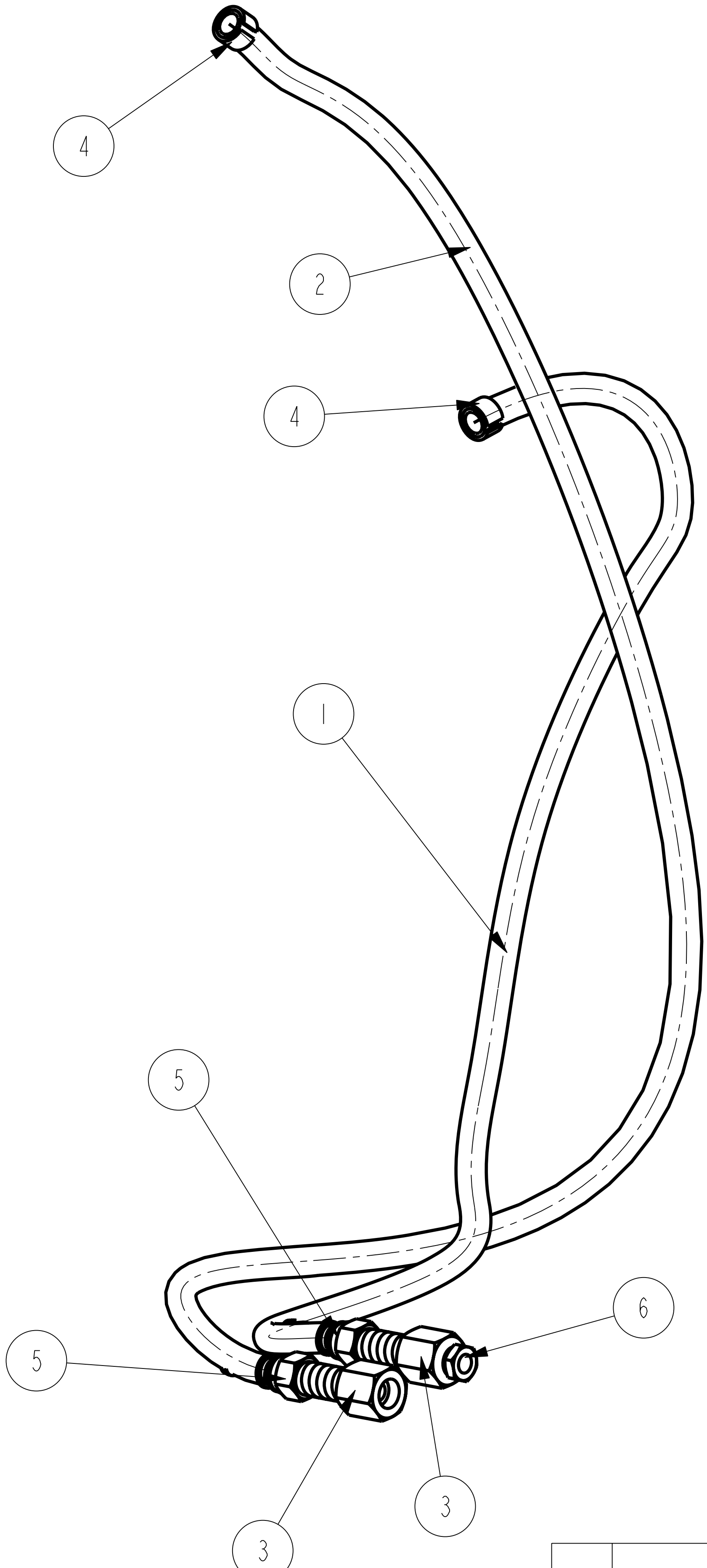
TITLE 1: ASSEMBLY, FUEL PLUMBING, B3.3
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S
DRAWN BY: DAVE N
DATE: 19AUG2004
APPD BY: -
DATE: -
EST WEIGHT: 42238.628
SCALE: 0.375
DO NOT SCALE
SHEET 1OF1
DRAWING NO: 9571
REV: A



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, RETURN, #801-6 X 38" LG	9571-01_RETURN
2	1	FUEL LINE, SUPPLY, #801-6 X 38" LG	9571-01_SUPPLY
3	2	BULKHEAD, #6 X 1/4" NPT	6_WGTX-S
4	2	CLAMP, 5/8" NOMINAL, #CL-6	8663
5	2	ADAPTER, 37 DEG FLAIR X #6 HOSE BARB	30682-6-6B
6	1	BUSHING, BRASS, 1/4" NPT X 1/8" NPT	209P-4-2

REF. SCALES

REV	DESCRIPTION OF REVISION	REV BY	DATE
A	ITEM #1 WAS 24" LONG	JDT	02MAY07

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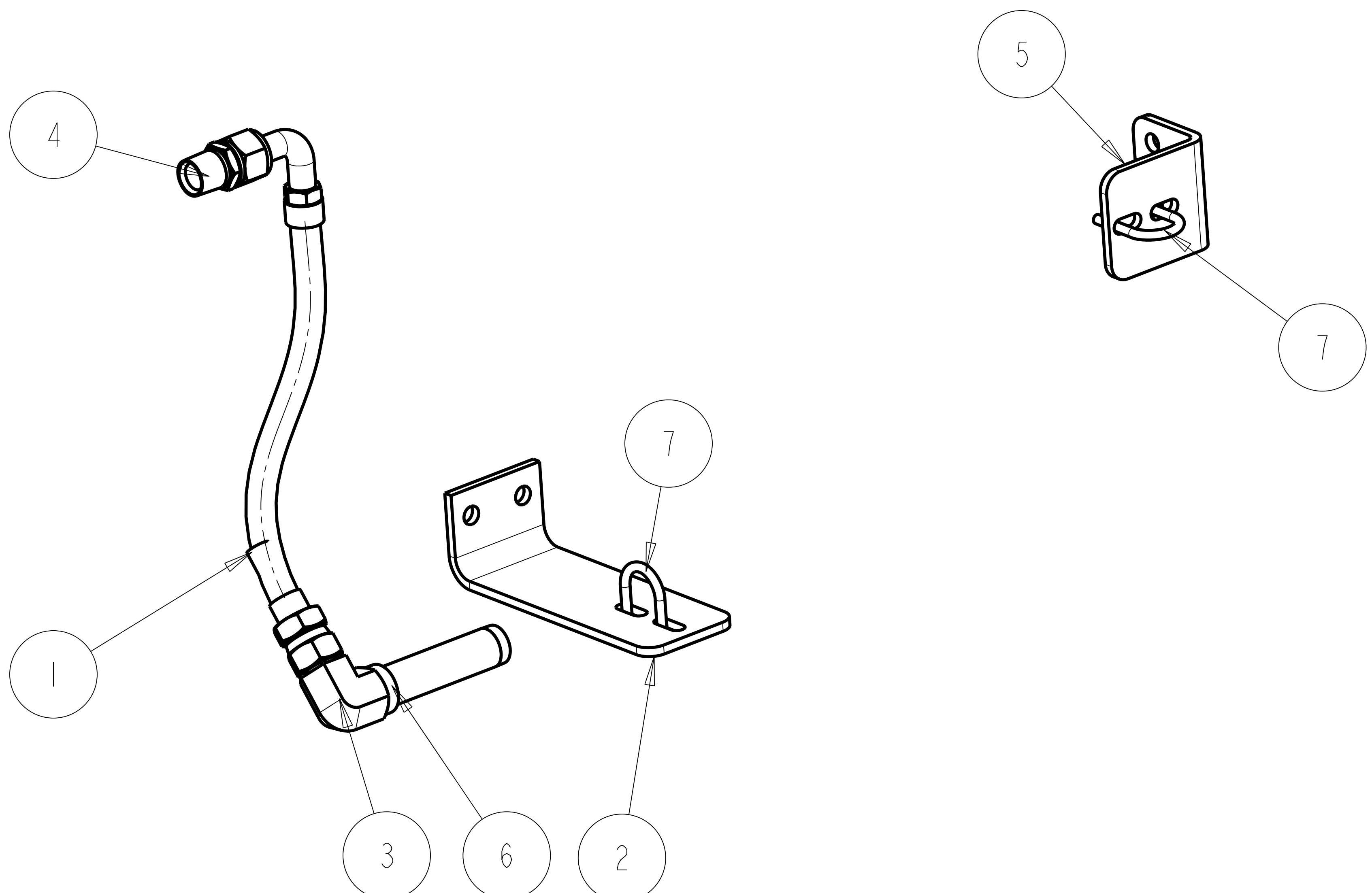
TITLE 1: ASSEMBLY, FUEL PLUMBING, CFP33-F25/35
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 26SEP2006
	APPD BY: -			DATE: -
EST WEIGHT: 0.658	SCALE: 0.375	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9571-01 REV: A

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, WATER, 12 JIC BOTH ENDS, FIREPUMP	11148-01
2	1	BRACKET, RAW WATER COOLING, 8" LG, FIREPUMP	8814
C 3	1	ELBOW, 3/4" NPT X JIC STEEL	11590
C 4	1	ADAPTER, 3/4" NPT X JIC STEEL	11591
C 5	1	BRKT,RAW WATER,CFP33, FIREPUMP	11595
6	1	NIPPLE, BLK, 3/4x6	71550
7	2	U-BOLT, FITS 1" PIPE	UBOLT



REV	DESCRIPTION OF REVISION	REV BY	DATE
C	P/N 11590 WAS 12_DTX-S & P/N 11591 WAS 12_FTX-S; P/N 11595 WAS 8814	JDT	16MAY07
B	REV PER ENGINE CONNECTION	DAVE N	07SEP06

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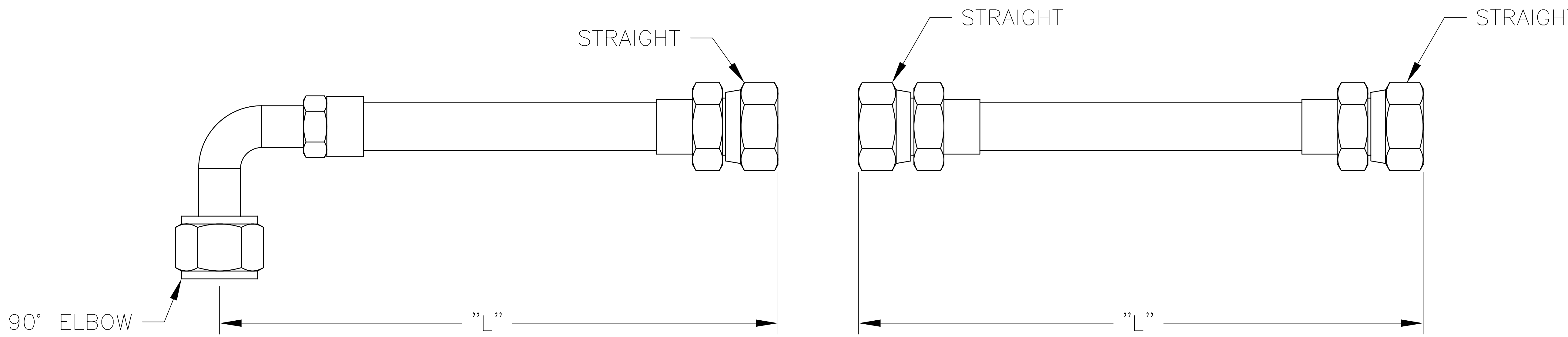
TITLE 1: MISC PIPING, RAW WATER, CFP33
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N		DATE: 14OCT2004	
	APPD BY: -		DATE: -	
EST WEIGHT: 98.929	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9636	REV: C

ITEM	QTY	DESCRIPTION	END FITTING	END FITTING	LENGTH "L"
01	A/R	CFP33 COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	15"
02					
03	A/R	CFP39 COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	12"
04	A/R	CFP59 COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	12.5"
05	A/R	CFP6E CAC WATER CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	25"
06	A/R	CFP6E COOLING LOOP CONNECTION	90° SWIVEL	STRAIGHT SWIVEL	50"
07					
08					



NOTES

1) FLEXIBLE HOSE RATING:
   - –250 PSI BURST
   - –WATER/SEA WATER @ TEMP 32°–120°
   - –ENVIORMENT MAY CONTAIN OIL, FUEL, OR ENGINE COOLANT
   - –ENVIORMENT TEMPERATURE UP TO 200°
2) END FITTINGS INSTALLED ON HOSE
3) EACH PIECE INDIVIDUALLY LABELED

REV	DESCRIPTION OF REVISION	BY	DATE

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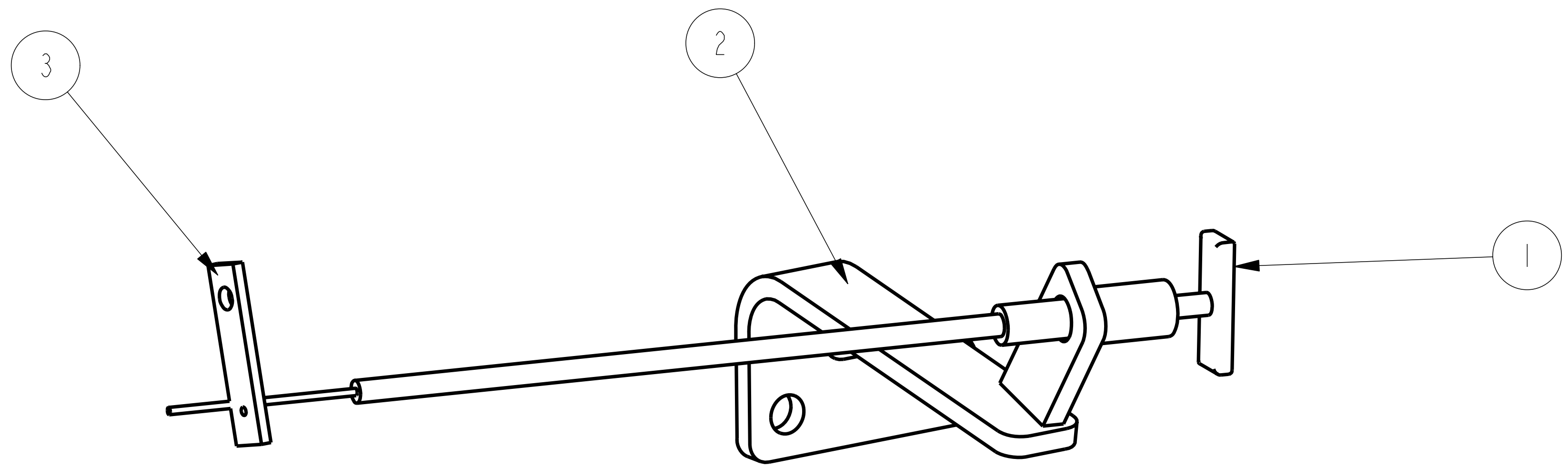
HOSE, WATER, #12 37° JIC ENDS

DWG UNITS: IN\LB\S	DRAWN BY: DAVE N			DATE: 20DEC2006	
	APPD BY:			DATE:	
EST WEIGHT:	SCALE: NTS	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 11148	REV:

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	THROTTLE CABLE, TURN LOCKING, R09D3-5X06	10125
2	1	BRACKET, FUEL SOLENOID OVERIDE, CFP33, FIREPUMP	11132
3	1	CLIP, THROTTLE SOLENOID OVERIDE, B3.3, FIREPUMP	10124



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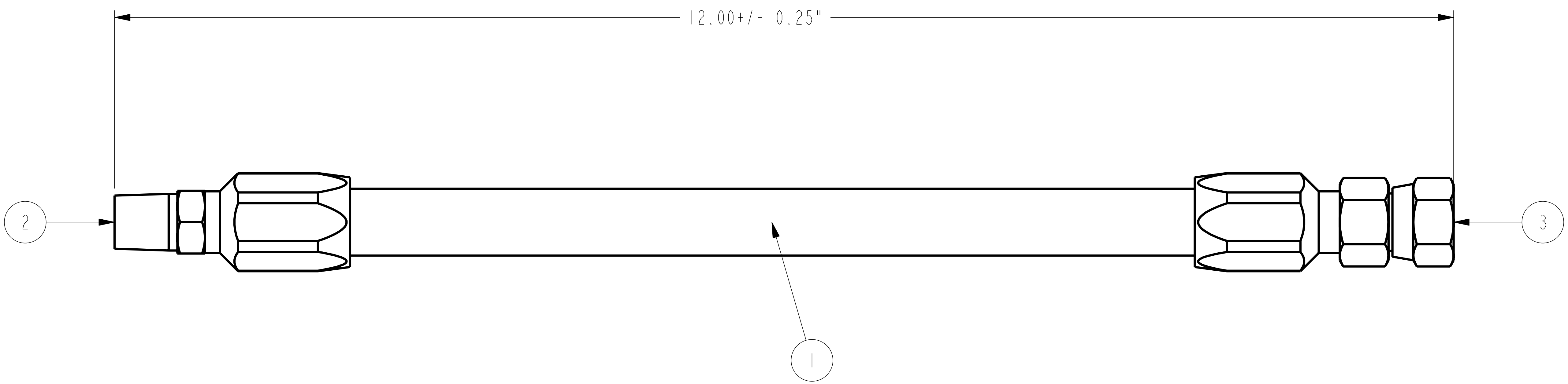
TITLE 1: ASSEMBLY, THROTTLE SOLENOID OVERIDE
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 24MAY2005	
	APPD BY: -			DATE: -	
EST WEIGHT: 1.140	SCALE: 0.500	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10111	REV: A

REV	DESCRIPTION OF REVISION	REV BY	DATE
A	REV PER MTG BRACKET	DAVE N	01SEP06

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, #6-261 x 9.375" LG, -	10235_LINE
2	1	HOSE END, 20 SERIES, 1/4" NPT X #6 HOSE	20120-4-6
3	1	ADAPTER, HOSE, FEMALE JIC 45 DEG SWIVEL	20820-6-6



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ANGULAR DIMENSIONS ± 1°

TITLE 1: FUEL LINE, #6, 45 DEG FLARE X 1/4" NPT
TITLE 2: 12" LONG FLEX EXTENSION

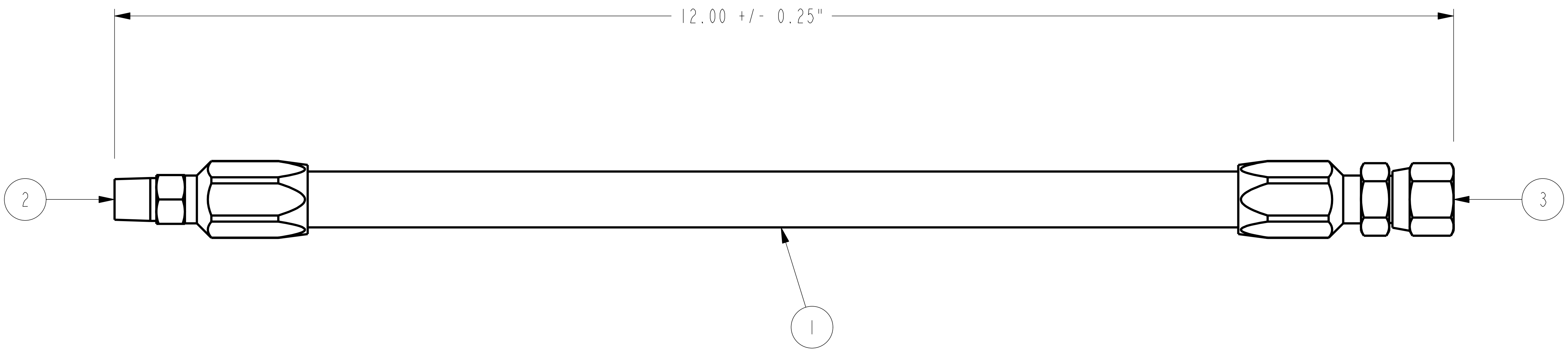
IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 22JUL2005	
	APPD BY: -			DATE: -	
EST WEIGHT: 42238.628	SCALE: 1.000	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10235	REV:

REV	DESCRIPTION OF REVISION	REV BY	DATE
A			

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL LINE, #4-261 x 9.375" LG, -	10242_LINE
2	1	HOSE END, 20 SERIES, 1/8" NPT X #4 HOSE	20120-2-4
3	1	ADAPTER, #4 HOSE, #4 FEMALE JIC 45 DEG SWIVEL	20820-4-4



REV	DESCRIPTION OF REVISION	REV BY	DATE
A	CORRECTED TUBING SIZE	DAVE N	27JUL05

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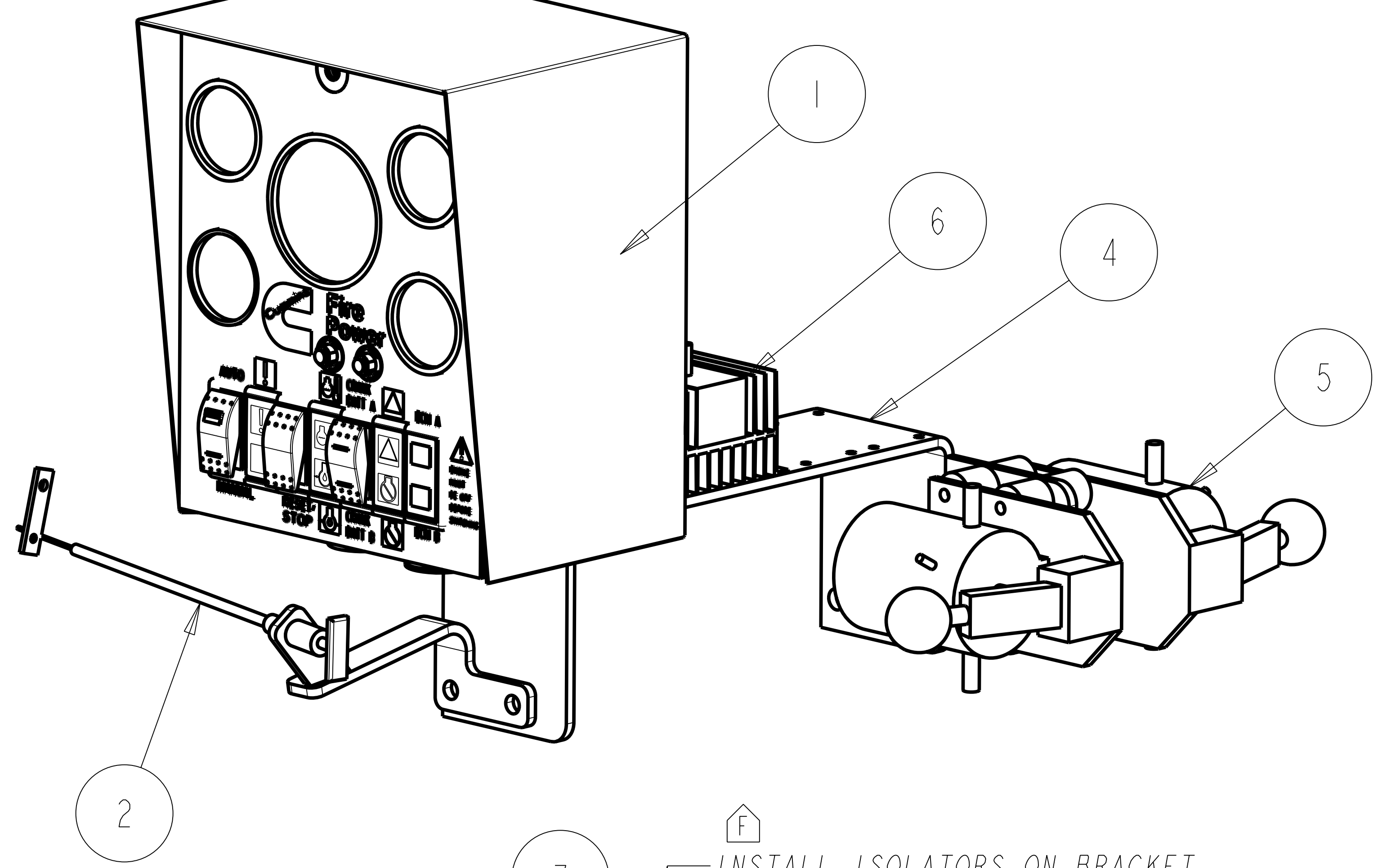
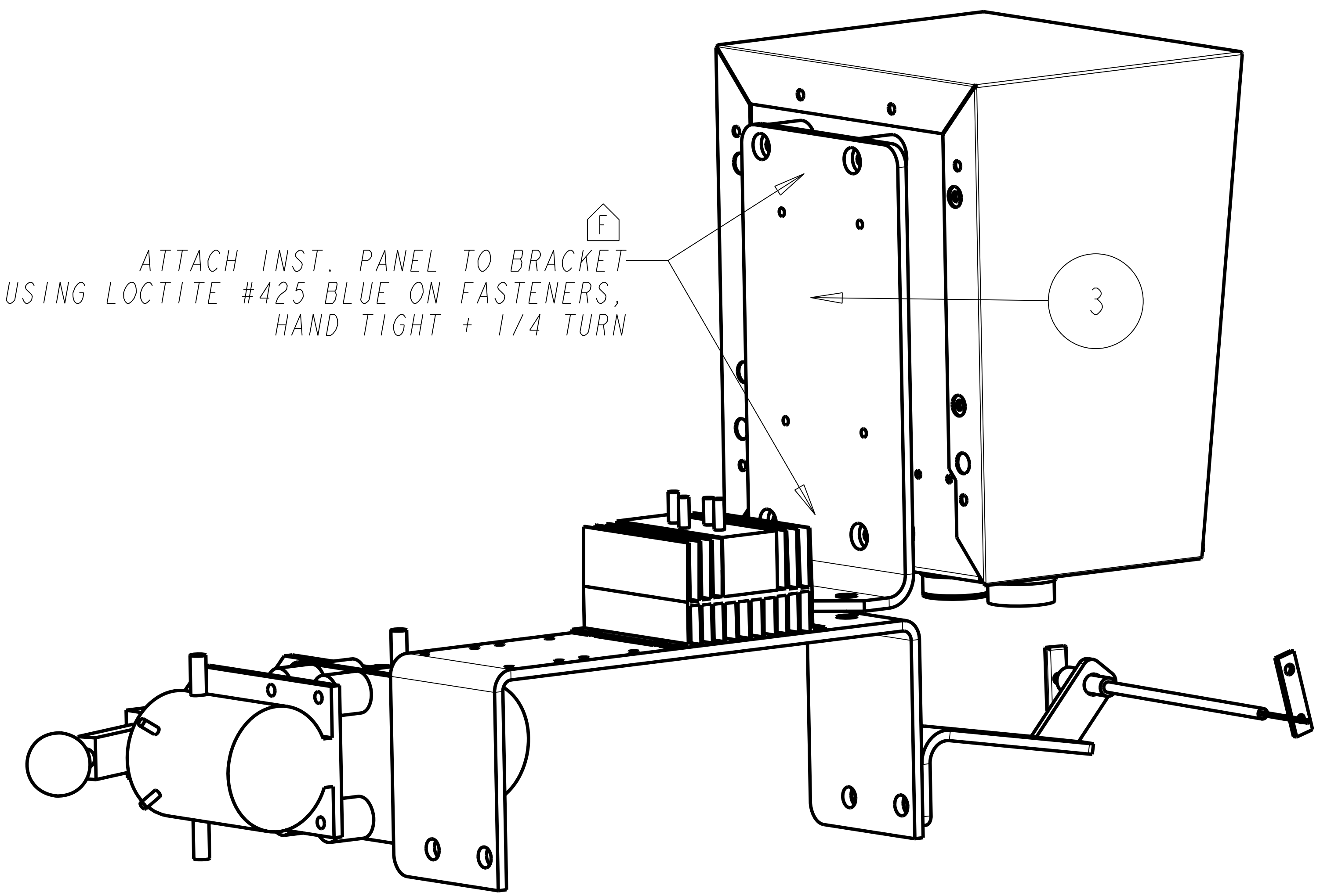
TITLE 1: FUEL LINE, #4, 45 DEG FLARE X 1/8" NPT
TITLE 2: 12" LONG FLEX EXTENSION

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 25JUL2005	
	APPD BY: -			DATE: -	
EST WEIGHT: 42238.628	SCALE: 1.000	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10242	REV: A

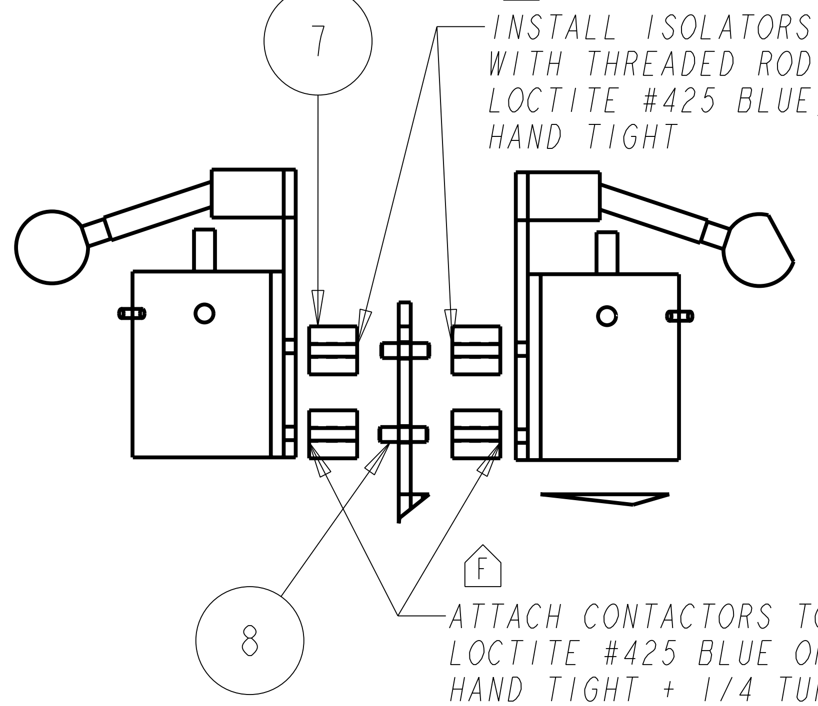
BILL OF MATERIAL

	ITEM	QTY	DESCRIPTION	PART NUMBER
D	1	1	ASSEMBLY, INSTRUMENT PANEL 12V, ISOLATED, FIREPUMP	13236
	2	1	ASSEMBLY, THROTTLE SOLENOID OVERIDE, FIREPUMP	10111
	3	1	BRACKET, MOUNTING, GUAGE PANEL, B3.3, FIREPUMP	8763
	4	1	BRACKET, SUPPORT, GUAGE PANEL, FIREPUMP, "B" ENGINE	8764
	5	2	CONTACTOR, MANUAL OVERIDE, FIREPUMP	8824
	6	1	BATTERY ISOLATOR, FIRE PUMP	8838
E	7	8	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011
F	8	4	ROD, THREADED, 5/16-1/ x 1	13291





F
ATTACH INST. PANEL TO BRACKET
USING LOCTITE #425 BLUE ON FASTENERS,
HAND TIGHT + 1/4 TURN



F
INSTALL ISOLATORS ON BRACKET
WITH THREADED ROD USING
LOCTITE #425 BLUE,
HAND TIGHT

F
ATTACH CONTACTORS TO ISOLATORS USING
LOCTITE #425 BLUE ON FASTENERS,
HAND TIGHT + 1/4 TURN

REF. SCALES

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REV	DESCRIPTION OF REVISION	REV BY	DATE
F	MODIFIED ISOLATOR MTG SPEC., INST PANEL	S DUBICK	18JUL08
E	CHANGED ISOLATOR	S DUBICK	28MAY08
D	INST. PANEL, REPLACED 8508 WITH 10452	P RICK S	05FEB07
C	ADDED MANUAL THROTTLE ASSY	DAVE N	06JUL06

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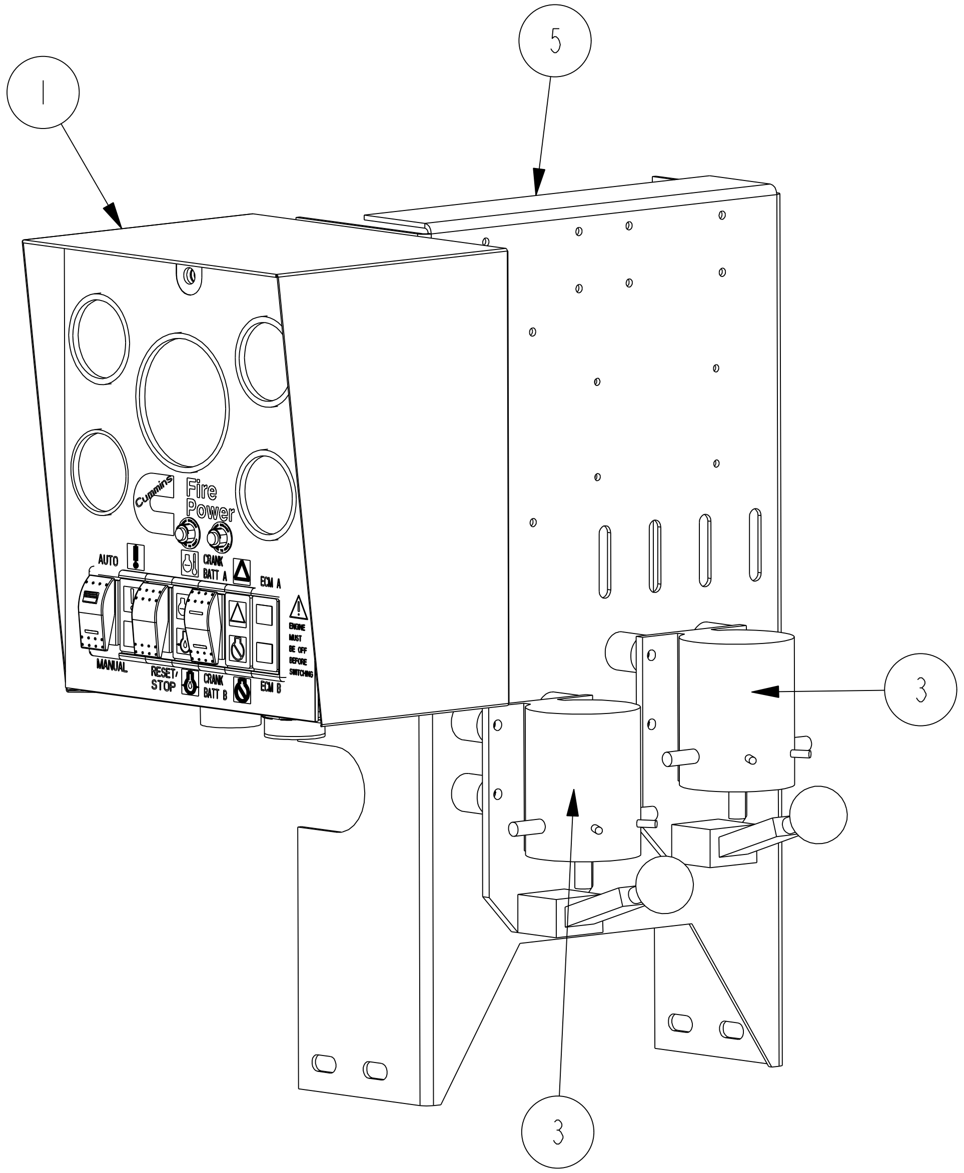
WHITE BEAR LAKE, MN
WWW.NPOWER.CUMMINS.COM

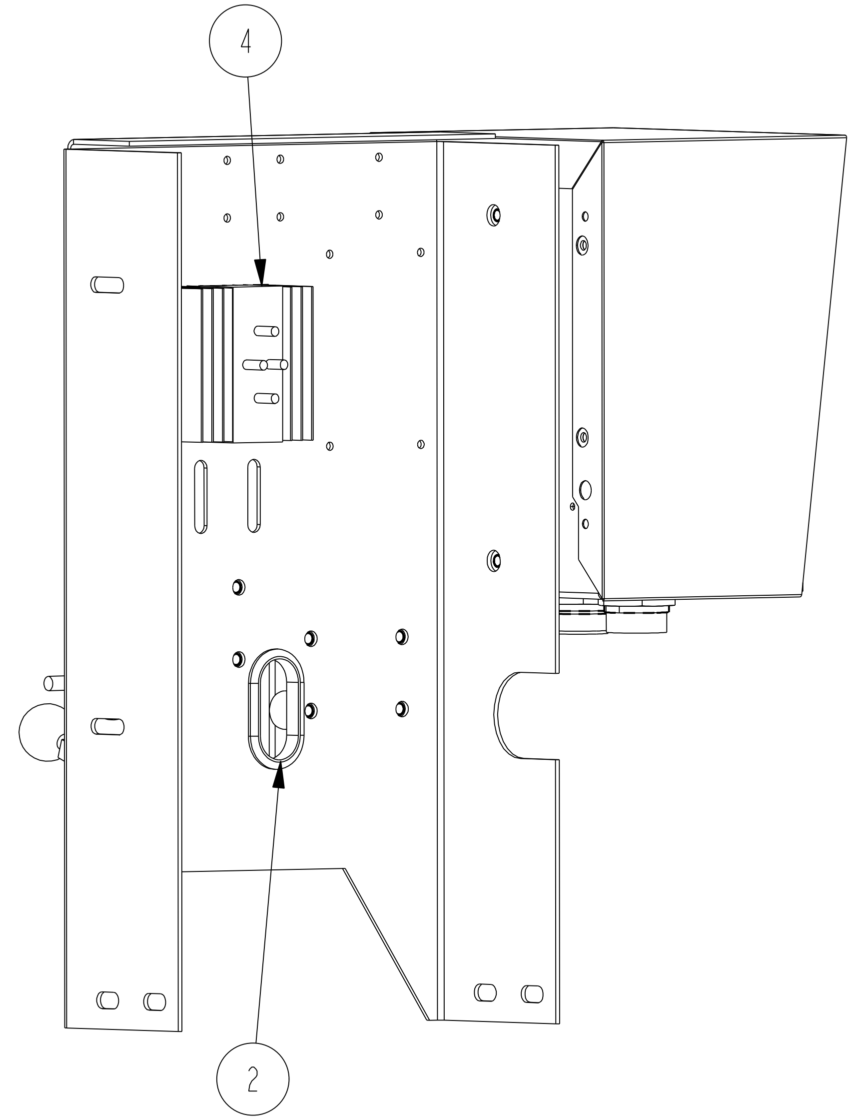
NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

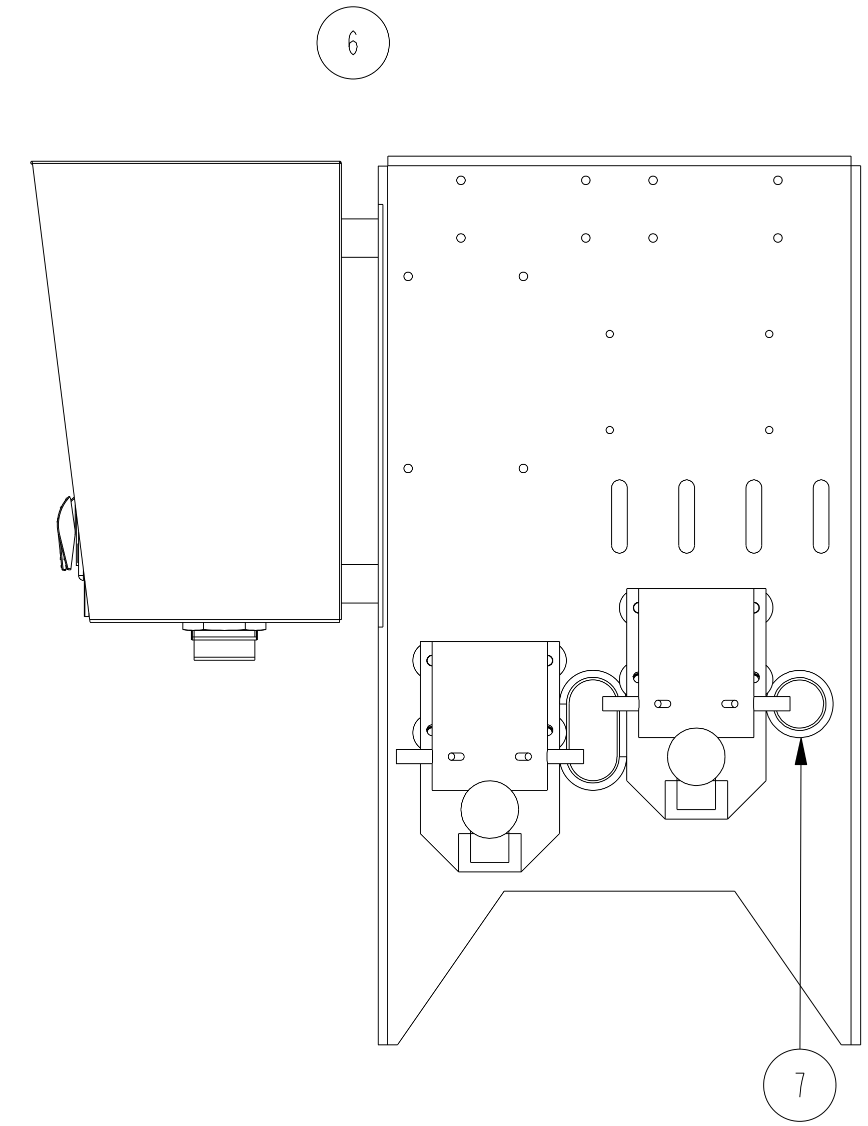
TITLE 1: ASSEMBLY, INSTRUMENT PANEL
TITLE 2: FIREPUMP, B3.3

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 15MAY2004	
	APPD BY:			DATE:	
EST WEIGHT: 47.062	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8765	REV: F

BILL OF MATERIAL				
ITEM	QTY	DESCRIPTION	PART NUMBER	
1	1	ASSEMBLY, INSTRUMENT PANEL 12V, ISOLATED, FIREPUMP	13236	B
2	1	GROMMETT	508-1057	
3	2	CONTACTOR, MANUAL OVERIDE, FIREPUMP	8824	
4	1	BATTERY ISOLATOR, FIRE PUMP	8838	
5	1	BRACKET, OPERATORS STATION, CFP33, FIREPUMP	11139	
6	8	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011	B
7	1	GROMMETT, 1.50 DIA HOLE	19447	







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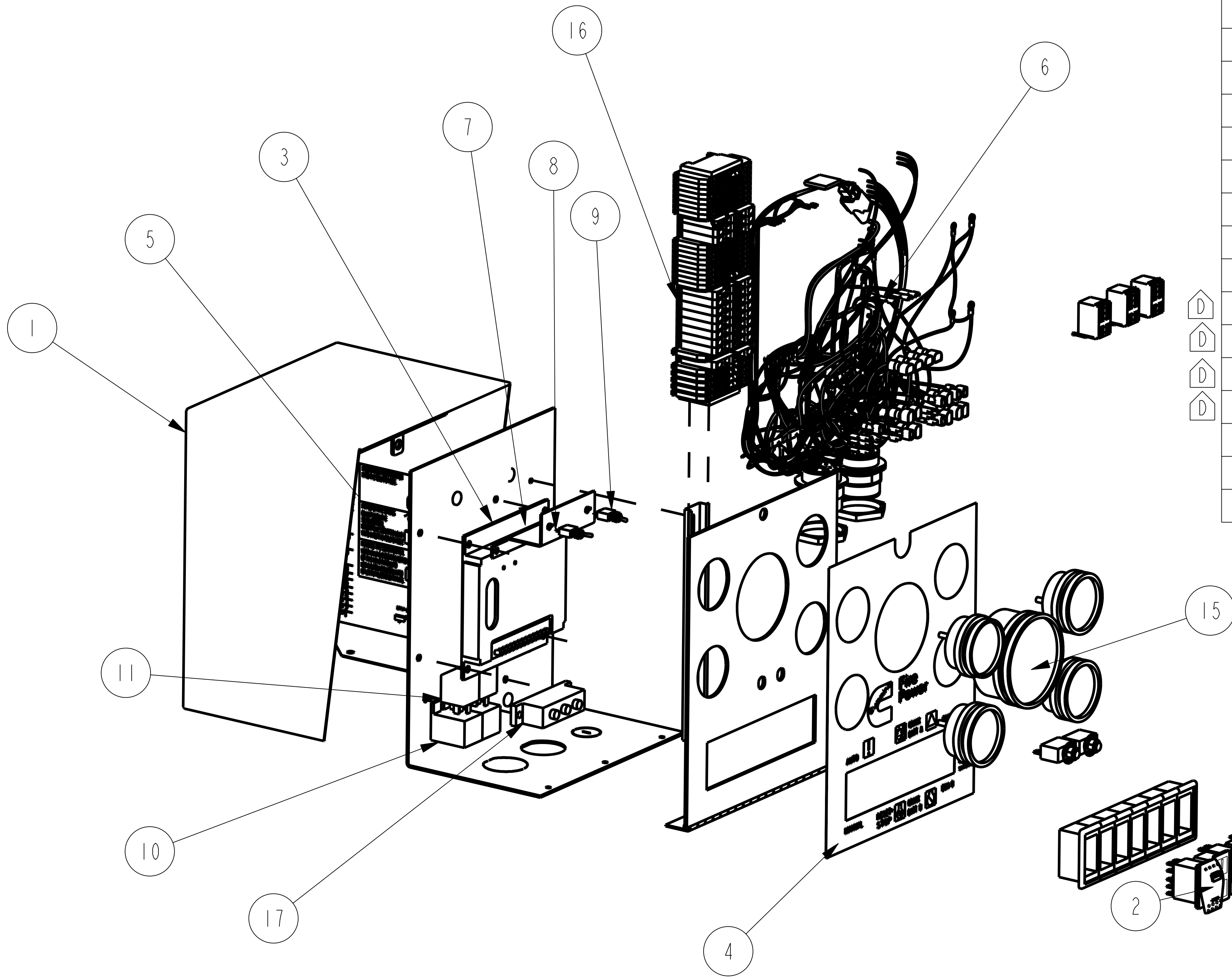
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, OPERATORS STATION, CFP33
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 01SEP2006
	APPD BY:			DATE:
EST WEIGHT: 56.779	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 11138 / REV: B

REV	DESCRIPTION OF REVISION	REV BY	DATE
B	REV PER ISOLATOR AND PANEL	S DUBICK	28MAY08
A	REMOVED OVERIDE	DAVE N	18SEP06



BILL OF MATERIAL

	ITEM	QTY	DESCRIPTION	PART NUMBER
E	1	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
	2	1	ASSEMBLY, SWITCH GANG, FIREPUMP	11084
	3	1	MODULE, OVERSPEED, FIREPUMP	8836
	4	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
	5	1	DECAL, INSTRUCTION, GAUGE PANEL	11136
	6	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
	7	1	BRACKET, TOGGLE SWITCH MOUNTING, FIREPUMP GAUGE PANEL - E-ENG	8887
	8	1	SWITCH, TOGGLE, MINIATURE, MOMENTARY (ON)-OFF-(ON)	8889
	9	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
	10	2	RELAY HOLDER, FIREPUMP	9528
	11	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
D	12	1	GUAGE, OIL PRESSURE, 0-80 PSI, 12VDC, FIREPUMP	11194
D	13	1	GUAGE, WATER TEMPERATURE, 12VDC, FIREPUMP	11197
D	14	2	GUAGE, VOLTMETER 8-18VDC, FIREPUMP	11200
D	15	1	GUAGE, TACHOMETER/HOUR METER, FIREPUMP	11202
	16	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
	17	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
	19	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203

NOTES:
GAUGE PANEL EXPLOSION DEPICTED FOR SERVICE PART IDENTIFICATION. WHERE APPLICABLE, SUB-ASSEMBLY DRAWINGS MAY BE REQUIRED FOR COMPONENT DETAIL(S). WIRING HARNESS IS NOT FIELD SERVICEABLE WITHOUT TRP ISSUED BY CUMMINS FIREPOWER IF APPLICABLE.

REF. SCALES

REV	DESCRIPTION OF REVISION	REV BY	DATE
E	MODIFIED 10454	S DUBICK	28MAY08
D	CORRECTED GAUGE P/N'S	S.DANFORTH	02JAN07
C	REDRAWN AND RELEASED	ANTONIO G.	25SEP06
B	REVISED TERMINAL STRIP	S.DANFORTH	
A	PROTOTYPE RELEASE	S.DANFORTH	10JUL2006

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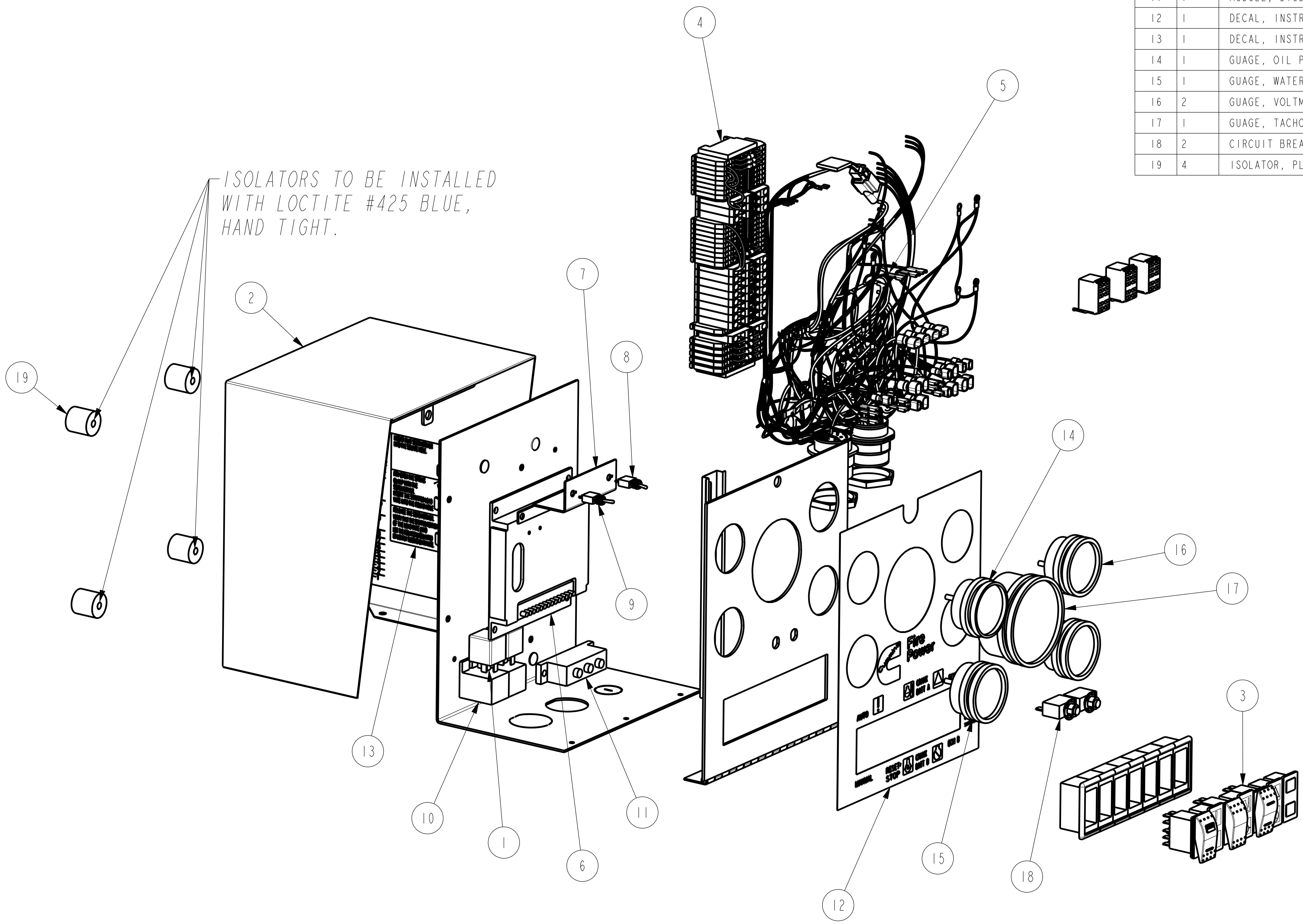
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 12V
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH			DATE: 10JUL2006	
	APPD BY:			DATE:	
EST WEIGHT: 21.524	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10452	REV: E

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
2	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
3	1	ASSEMBLY, SWITCH GANG, FIREPUMP	11084
4	1	ASSEMBLY, TERMINALS, GAUGE PANEL, FIREPUMP	11137
5	1	ASSEMBLY, HARNESS, INSTRUMENT PANEL, FIREPUMP	11185
6	1	MODULE, OVERSPEED, FIREPUMP	8836
7	1	BRACKET, TOGGLE SWITCH MOUNTING, FIREPUMP GAUGE PANEL - E-ENG	8887
8	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
9	1	SWITCH, TOGGLE, MINIATURE, MOMENTARY (ON)-OFF-(ON)	8889
10	2	RELAY HOLDER, FIREPUMP	9528
11	1	MODULE, DIODE, INSTRUMENT PANEL, FIREPUMP	9529
12	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
13	1	DECAL, INSTRUCTION, GAUGE PANEL	11136
14	1	GUAGE, OIL PRESSURE, 0-80 PSI, 12VDC, FIREPUMP	11194
15	1	GUAGE, WATER TEMPERATURE, 12VDC, FIREPUMP	11197
16	2	GUAGE, VOLTMETER 8-18VDC, FIREPUMP	11200
17	1	GUAGE, TACHOMETER/HOUR METER, FIREPUMP	11202
18	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203
19	4	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011



NOTES:

* GAUGE PANEL EXPLOSION DEPICTED FOR SERVICE PART ID.
* WHERE APPLICABLE, SUB-ASSEMBLY DRAWINGS MAY BE REQUIRED FOR COMPONENT DETAILS.
* WIRING HARNESS IS NOT FIELD SERVICEABLE WITHOUT TRP ISSUED BY CUMMINS FIREPOWER IF APPLICABLE.

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DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 12V, ISOLATED
TITLE 2: FIREPUMP

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

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DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH			DATE: 10JUL2006	
	APPD BY:			DATE:	
EST WEIGHT: 21.524	SCALE: 0.300	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 13236	REV: _

REV	DESCRIPTION OF REVISION	REV BY	DATE

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
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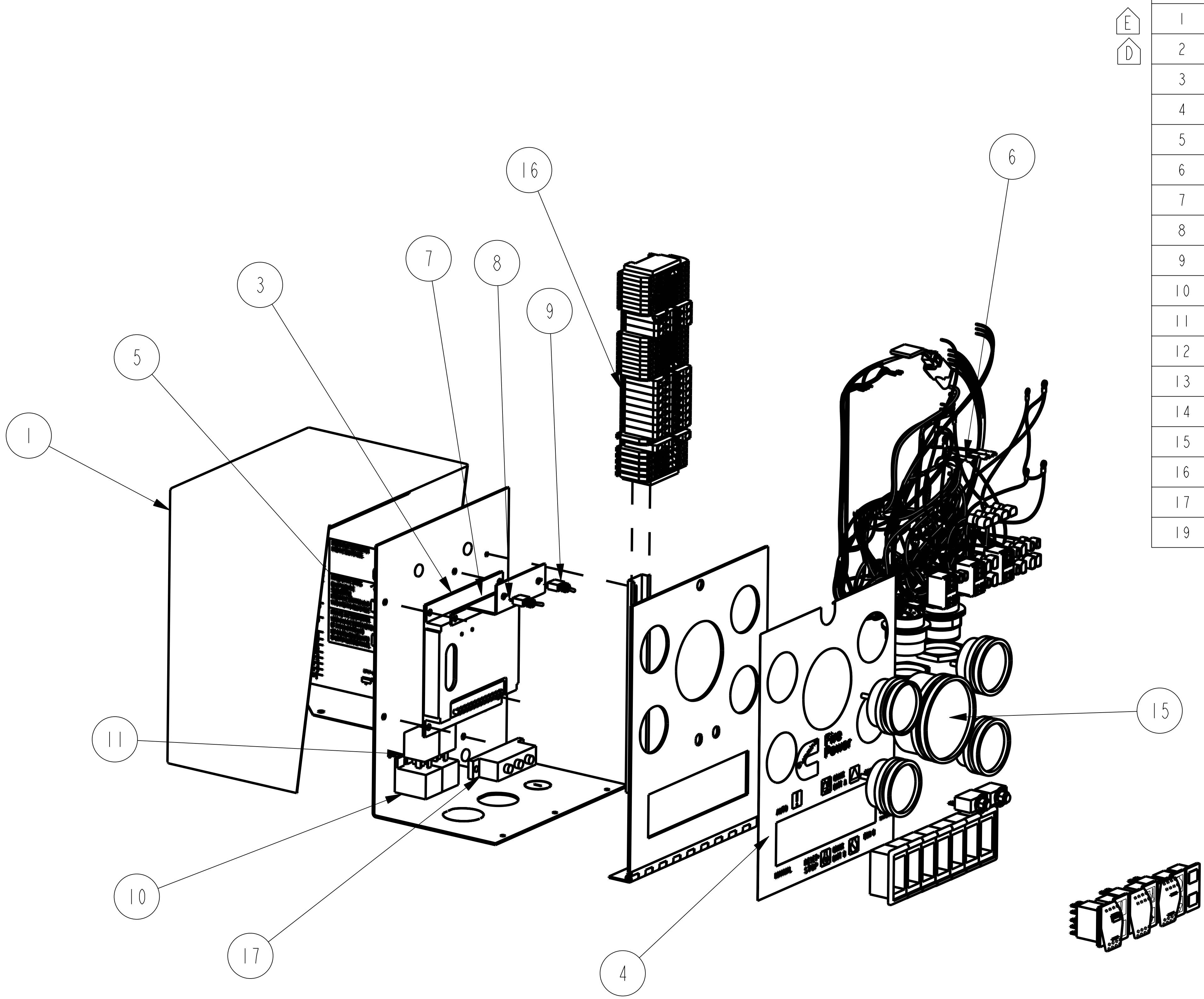
9	1	SWITCH, TOGGLE, MINIATURE, SUSTAINED ON-OFF-ON	8888
10	2	RELAY HOLDER, FIREPUMP	9528
11	2	RELAY, INSTRUMENT PANEL, 40 AMP, 12vdc	8857
12	1	GUAGE, OIL PRESSURE, 0-80 PSI, 24VDC, FIREPUMP	11195
13	1	GUAGE, WATER TEMPERATURE, 24VDC, FIREPUMP	11198
14	2	GUAGE, VOLTMETER 16-32VDC, FIREPUMP	11201
15	1	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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REF. SCALES

REV	DESCRIPTION OF REVISION	REV BY	DATE
E	MODIFIED 10454	S DUBICK	28MAY08
D	11085 WAS 11084	S.DANFORTH	02JAN07
C	REDRAWN AND RELEASED	ANTONIO G.	25SEP06
B	REVISED TERMINAL STRIP	S.DANFORTH	
A	PROTOTYPE RELEASE	S.DANFORTH	10JUL2006

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DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 24V
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S.DANFORTH			DATE: 10JUL2006	
	APPD BY:			DATE:	
EST WEIGHT: 20.096	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 10453	REV: E

BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ENCLOSURE, FIREPUMP INSTRUMENT	10454
2	1	ASSEMBLY, SWITCH GANG 24VDC, FIREPUMP	11085
3	1	MODULE, OVERSPEED, FIREPUMP	8836
4	1	DECAL, INSTRUMENT PANEL, FIREPUMP	10731
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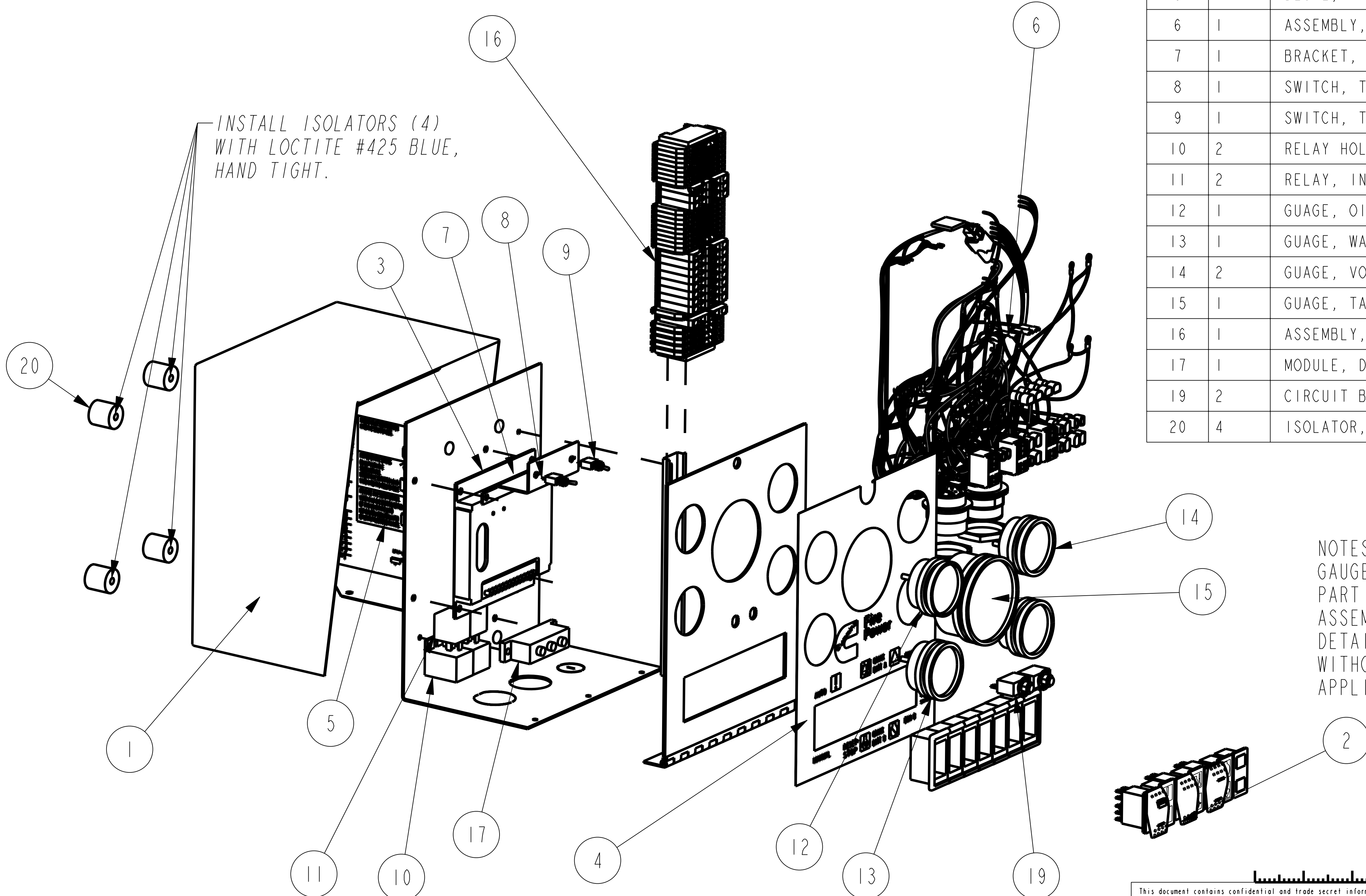
19	2	CIRCUIT BREAKER, INSTRUMENT PANEL, FIREPUMP	11203
20	4	ISOLATOR, PLATE MOUNT, 5/16-18x1x1 NEOPRENE, TECH PRODUCTS #51272	13011



NOTES:
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REF. SCALES

REV	DESCRIPTION OF REVISION	REV BY	DATE

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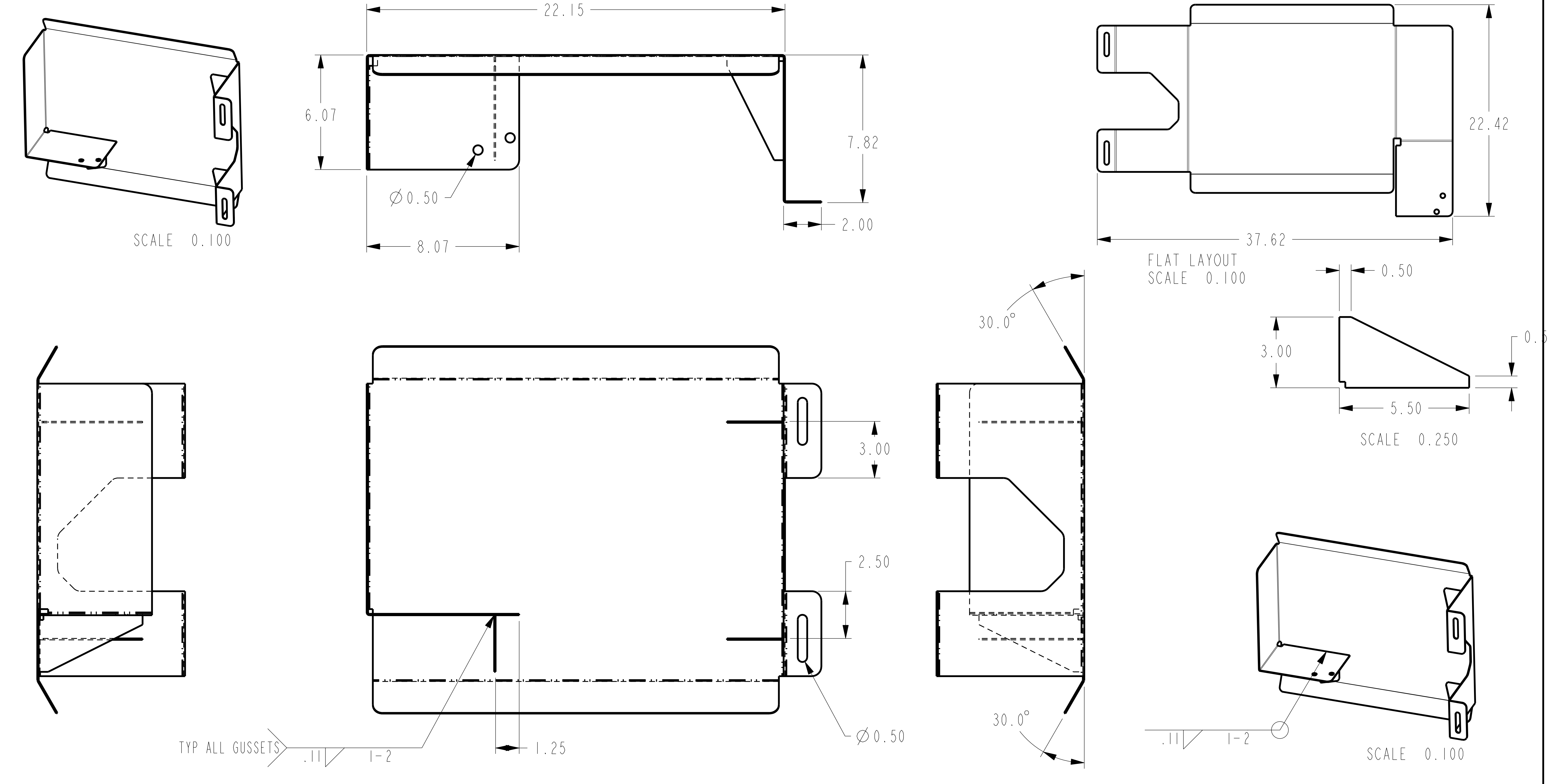
DEPERE, WISCONSIN

TITLE 1: ASSEMBLY, INSTRUMENT PANEL 24V, ISOLATED
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: S DUBICK			DATE: 08/06/08	
	APPD BY:			DATE:	
EST WEIGHT: 20.096	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 13237	REV: -



NOTES:
1) MATERIAL: 14 GA. HRS
2) ALL BENDS AT MINIMUM BEND RADIUS
3) REMOVE ALL BURS AND SHARP EDGES
4) PRIME AND PAINT CASE RED
5) DETAILS PROVIDED IN ELECTRONIC FILE

REV	DESCRIPTION OF REVISION	REV BY	DATE
A			

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NPOWER SYSTEMS
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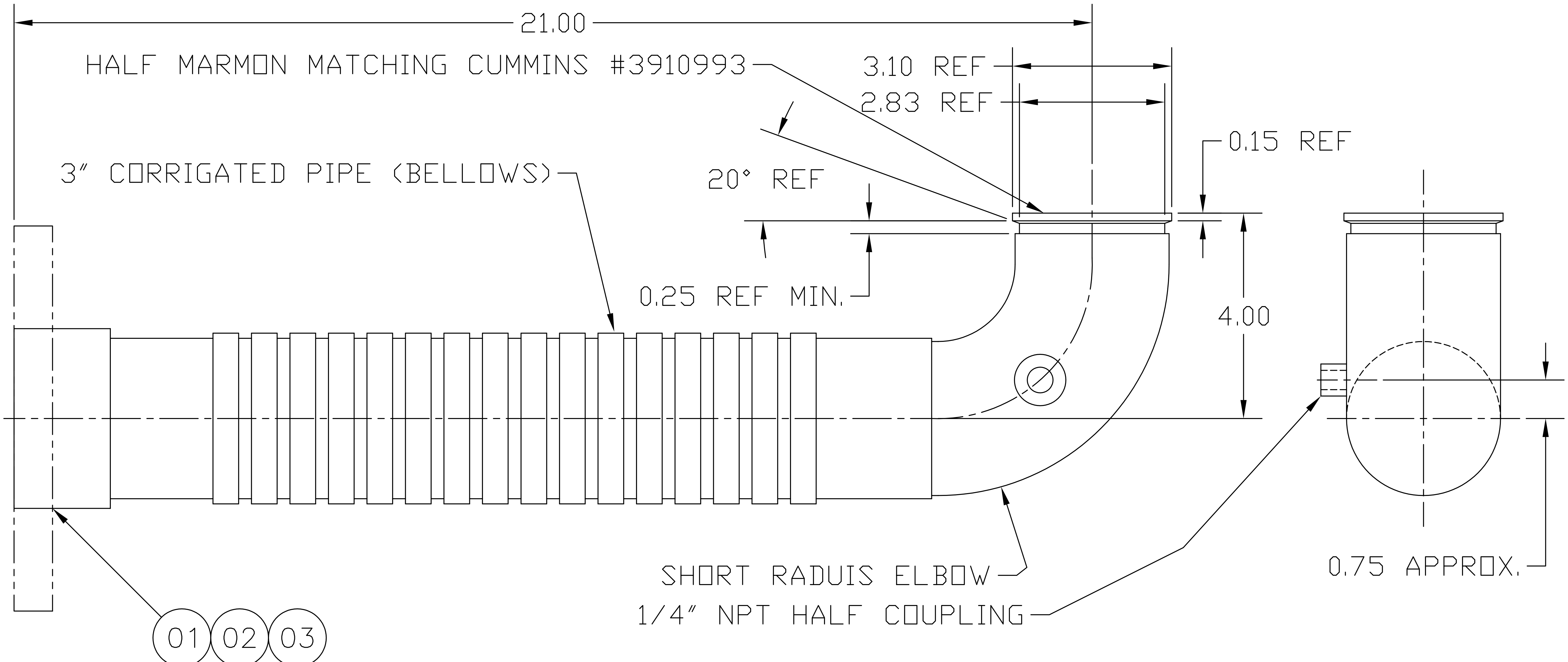
DEPERE, WISCONSIN

TITLE 1: SHIELD, TURBO, CFP33
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 01SEP2006	
	APPD BY: -			DATE: -	
EST WEIGHT: 42238.628	SCALE: 0.200	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 11143	REV:

ITEM	QTY	DESCRIPTION	MATERIAL
01	A/R	3" MALE NPT	
02	A/R	3" I.D. CUFF	
03	A/R	3" 125# ANSI FLANGE	



REV	DESCRIPTION OF REVISION	BY	DATE
C1	REV PER TITLE BLOCK	DAVE N	21JUN2005
C	ADDED HALF COUPLING	DAVE N	21JAN2005
B	REWORKED BOM TO TABULATE END OPTIONS	DAVE N	18NOV2004
A	ITEM 2 WAS FLEX	CMC	18MAY2004

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UNLESS OTHERWISE NOTED
ALL DIMENSIONS ARE IN INCHES
APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

Cummins Fire Power

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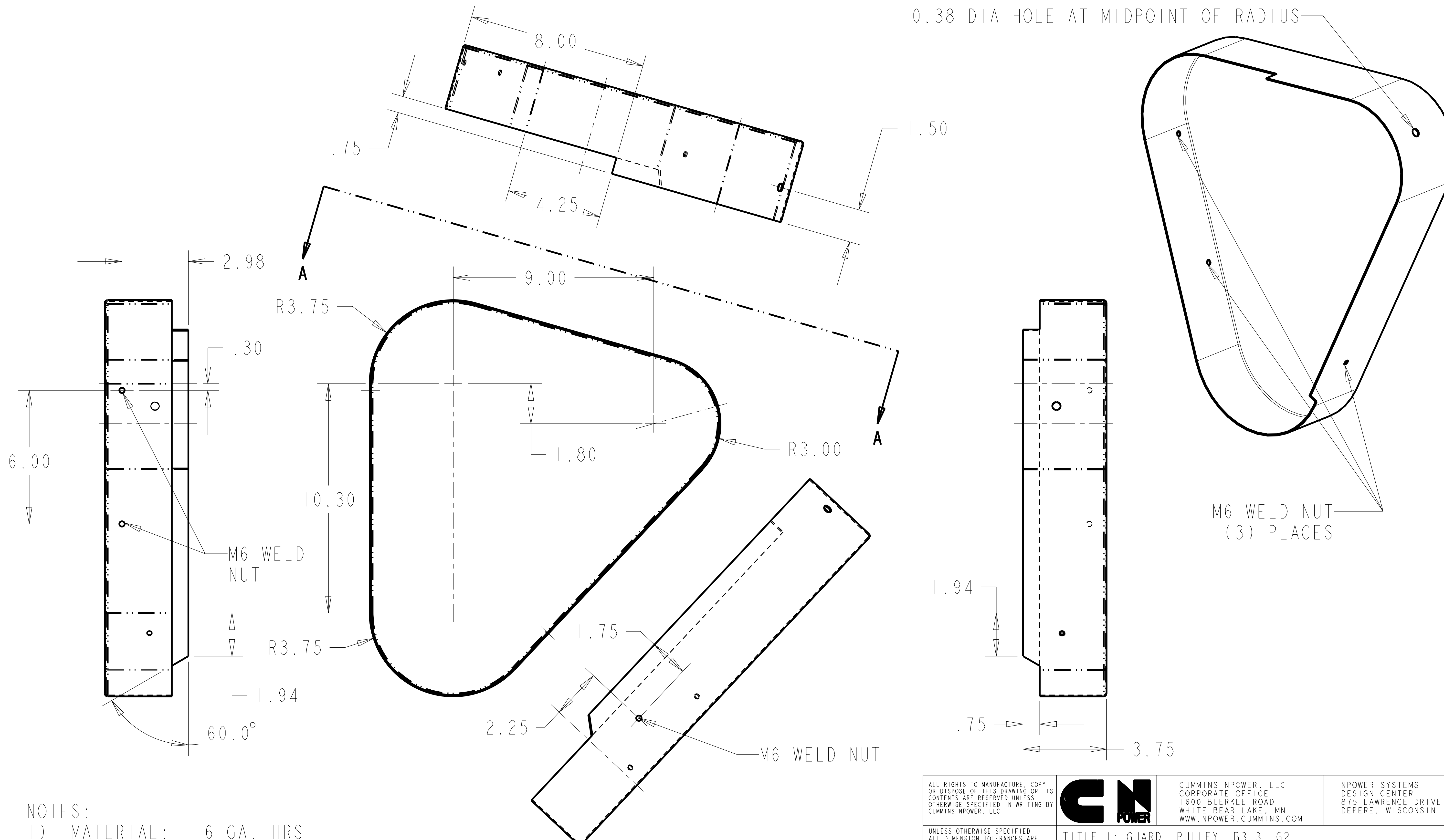
DWG SCALE: 1/2	DRAWN BY: DAVE N	DATE: 09MAR2004
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
EXHAUST, 90°, HALF MARMON TABULATED

REFERENCE:
FIREPUMP, 3" TURBO OUTLET

DRAWING NUMBER:
8550C



NOTES:
1) MATERIAL: 16 GA. HRS
2) ALL BENDS AT MINIMUM BEND RADIUS
3) REMOVE ALL BURS AND SHARP EDGES
4) PRIME AND PAINT CASE RED

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UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

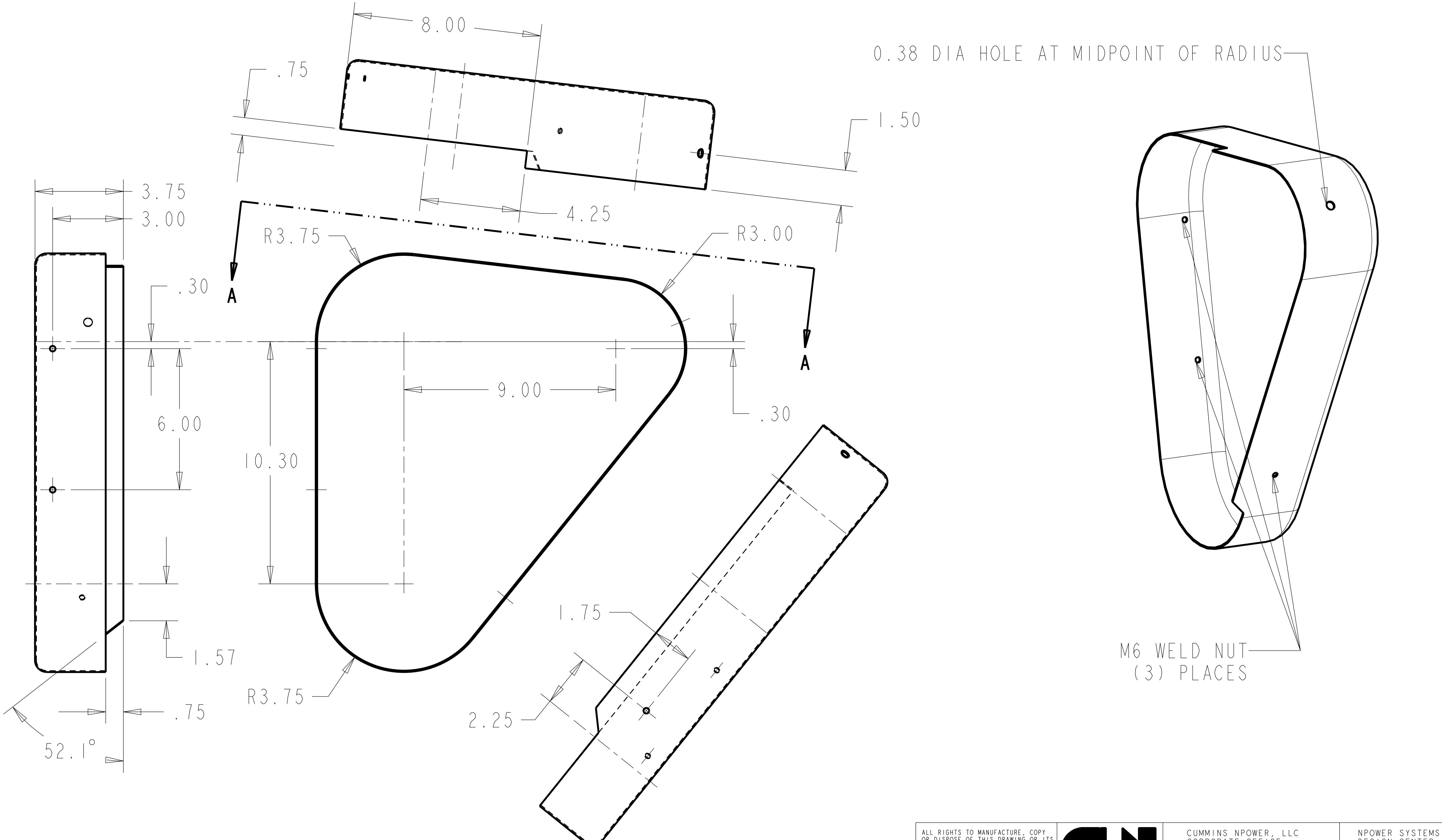
ANGULAR DIMENSIONS ± 1°

TITLE 1: GUARD, PULLEY, B3_3, G2
TITLE 2: FIREPUMP

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .X = ± 0.06 .XX = ± 0.010 .XXX = ± 0.001 - WELD TOLERANCES .X = ± 0.25 .XX = ± 0.12 .XXX = ± 0.06	MACHINE TOLERANCES X = ± 1.5 X.X = ± 0.5 X.XX = ± 0.05 - WELDED TOLERANCES X = ± 5 X.X = ± 3 X.XX = ± 1.50

REV	DESCRIPTION OF REVISION	REV BY	DATE
D	ADDED MOUNTING HOLES	DAVE N	18NOV05
C	ADDED LENGTH TO CUT-OUT	DAVE N	02MAR05

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 16JUL2004	
	APPD BY:			DATE:	
EST WEIGHT: 7.661	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9537	REV: D



NOTES:
1) MATERIAL: 16 GA. HRS
2) ALL BENDS AT MINIMUM BEND RADIUS
3) REMOVE ALL BURS AND SHARP EDGES
4) PRIME AND PAINT CASE RED

REV	DESCRIPTION OF REVISION	REV BY	DATE
C	ADDED MTG HOLES	DAVE N	18NOV05
B	ADDED MTG HOLE. REV CUTOUTS	DAVE N	05MAR05

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ANGULAR DIMENSIONS ± 1°

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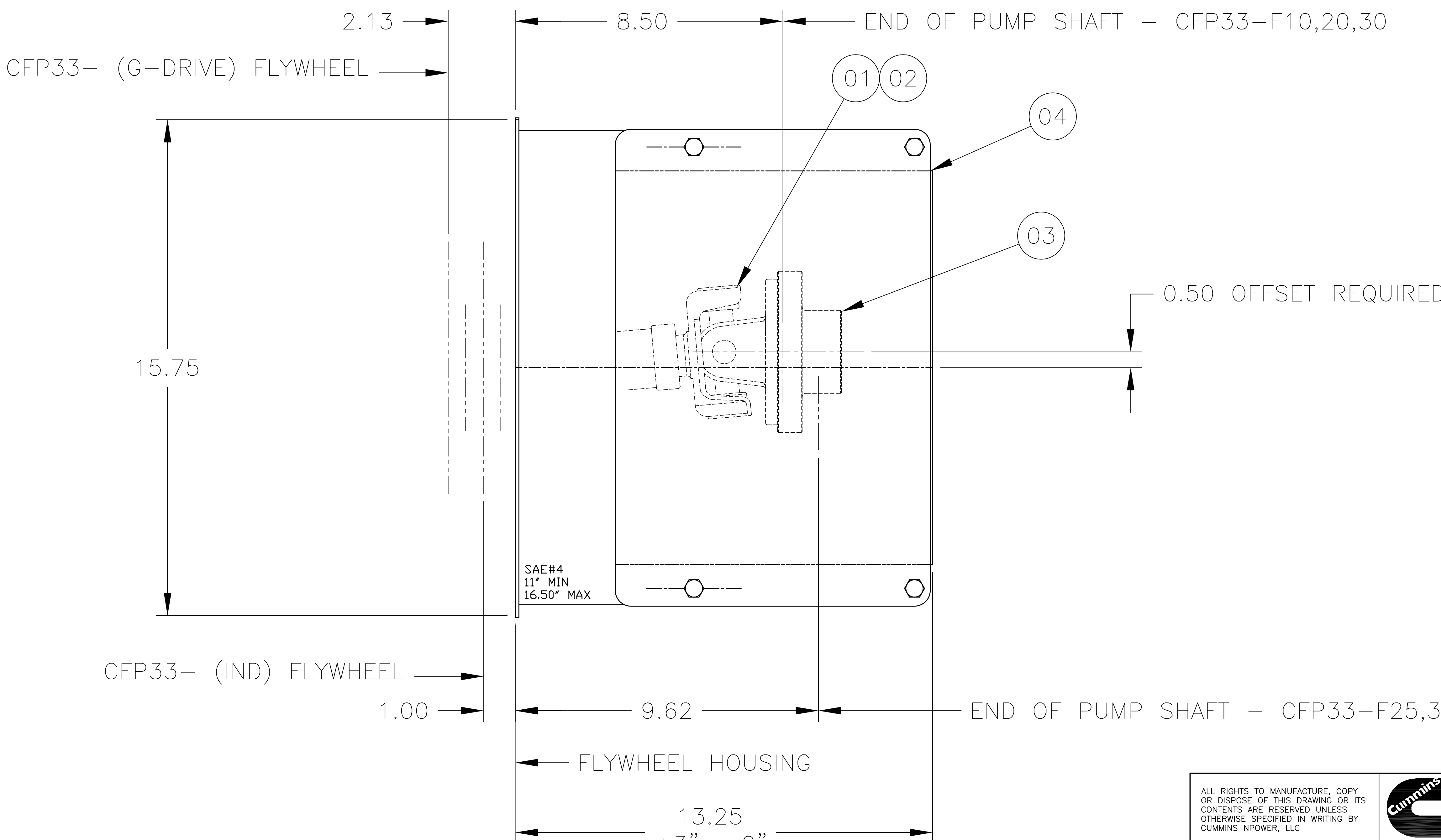
TITLE 1: GUARD, PULLEY, B3_3, CONSTRUCTION ENGINE
TITLE 2: FIREPUMP

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 20FEB2004
	APPD BY:			DATE:
EST WEIGHT: 7.661	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 8805 · REV: C

ITEM	QTY	DESCRIPTION	MATERIAL
01	1	U-JOINT ADAPT, SAE#4, HAYES #127727-01	9673
02	1	DRIVE SHAFT, 1410	8617
03	1	COMPANION FLANGE, SEE WO FOR BORE	8606-__
04	1	ASSEMBLY, TELESOPING GUARD, CFP33	9488



REV	DESCRIPTION OF REVISION	BY	DATE
A	REV PER FLYWHEEL LOCATION	DAVE N	16NOV2005

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-
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:

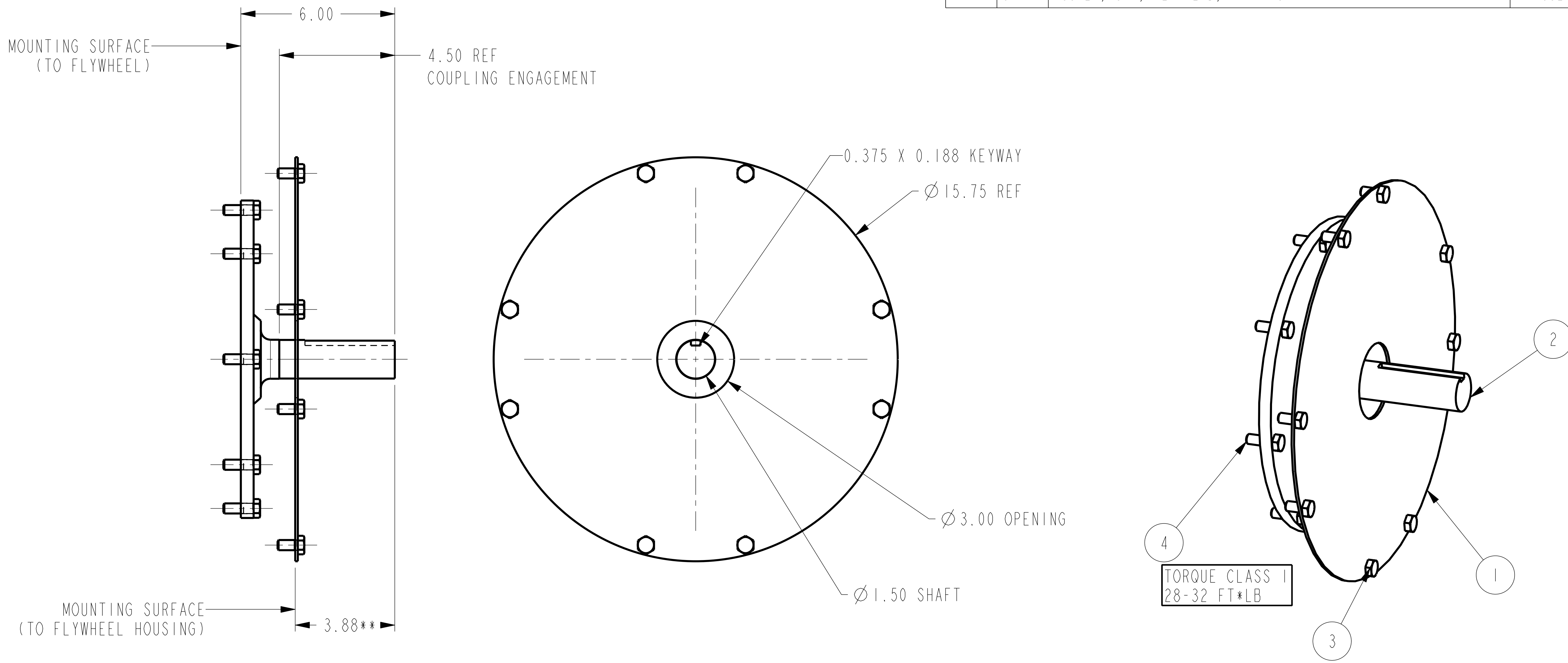
DESCRIPTION
ASSEMBLY, DRIVE SHAFT W/ GUARD

REFERENCE:
CFP33, 1410 DRIVE SHAFT

DRAWING NUMBER:
10163A

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	PLATE, STUB SHAFT GUARD, SAE #4, FIREPUMP	9551
2	1	STUB SHAFT, 1.50" DIA. HAYES #126976, FIREPUMP	9675
3	8	SCREW, CAP, HEX HEAD, M10 x 20	HHCS_M10_20
4	8	SCREW, CAP, HEX HEAD, M10 x 30	HHCS_M10_30



**NOTE: FOR CFP-F25 & F35 SUBTRACT 1.13"

REV	DESCRIPTION OF REVISION	REV BY	DATE
A1	CORRECTED TORQUE	DAVE N	20JUN05
A	CREATED DRAWING	DAVE N	01JUN05

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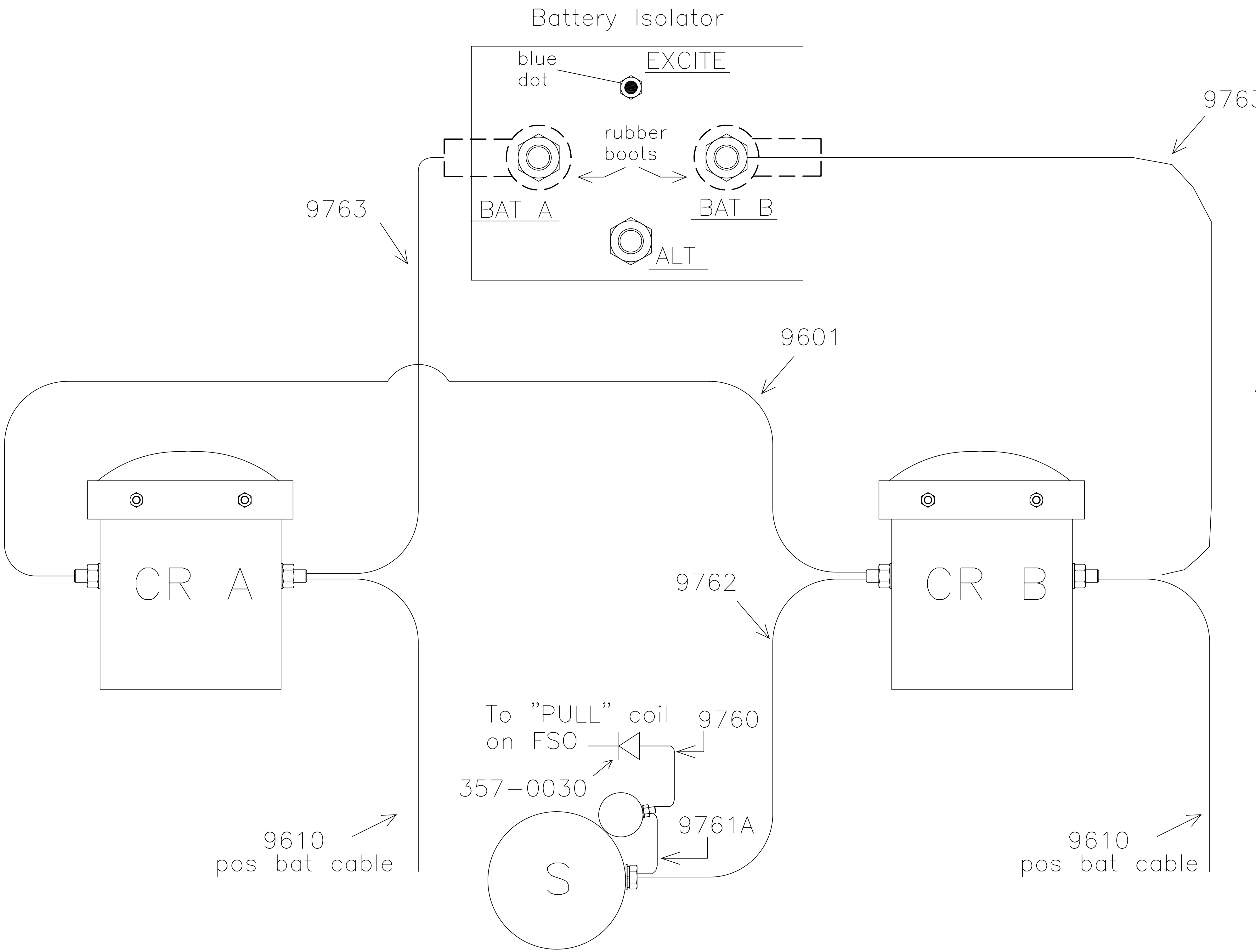
TITLE 1: ASSEMBLY, STUB SHAFT, 1.50" DIA.
TITLE 2: FIREPUMP, CFP33

DWG UNITS: IN/LB/S	DRAWN BY: DAVE N			DATE: 01JUN2005
	APPD BY: -			DATE: -
EST WEIGHT: 42238.628	SCALE: 0.250	DO NOT SCALE	SHEET 1OF1	DRAWING NO: 9676	REV: A



P/N	DESCRIPTION	QTY
9601A	Cable, Battery Contactor Jumper	1
9760	Wire, Diode to Starter Solenoid	1
9761A	Wire, Starter Solenoid Jumper	1
9762A	Cable, Contactor to Starter	1
D 9763B	Cable, Isolator to Battery	2
9609	Battery Cable Kit (optional)	1

(neg bat cable: 9611)
(not shown)

REV	DESCRIPTION OF REVISION	BY	DATE
D	CHANGED P/N 9763 TO REV B	RJS	6 NOV 06
C	CHANGED P/N 9761 TO REV A	RJS	25 JULY 06
B	P/N 9601 CHG'S TO REV A	RJS	11 NOV 05
A2	MOVED THE CR A-TOCR B JUMPER	RJS	2 JULY 05
A1	ADDED REV'S TO P/N'S	RJS	17 JUNE 05
A	ADDED WIRING DIAGRAM	RJS	5 JAN 05

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APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

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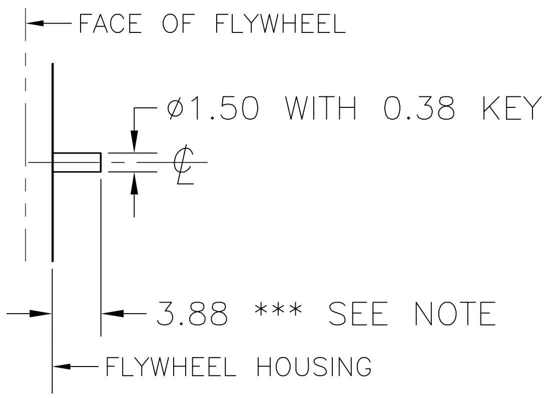
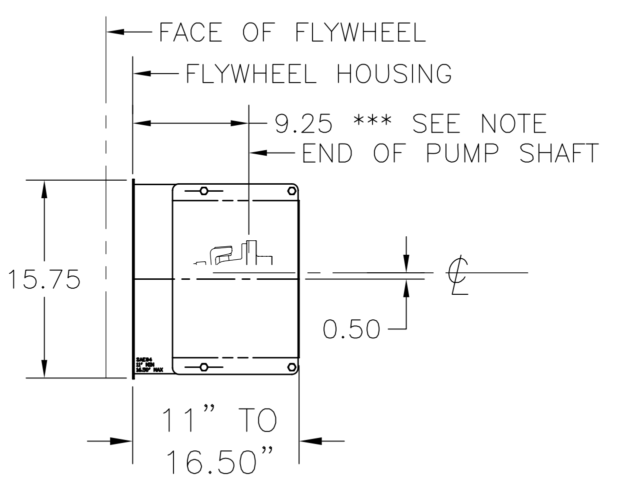
DWG SCALE:	DRAWN BY: RJS	DATE: 6 DEC 2004
PLOT SCALE:	APPD BY:	DATE:
DESCRIPTION: KIT, LOOSE WIRES		
REFERENCE: 3.3 liter fire pumps		DRAWING NUMBER: 9766_D

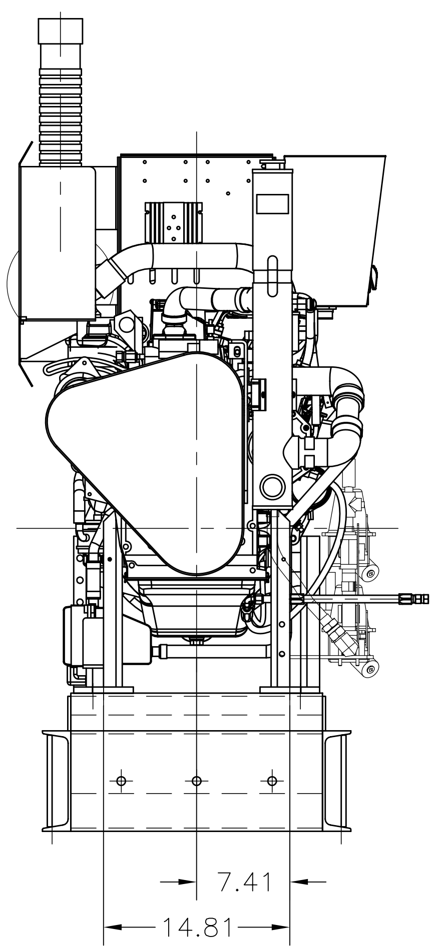
SAE #4	FLYWHEEL HOUSING
1/4" NPT	FUEL SUPPLY
1/8" NPT	FUEL RETURN
3/4" NPT	RAW WATER SUPPLY
1" NPT	RAW WATER RETURN
115v. PLUG	COOLANT HEATER
3" DIA.	EXHAUST CONNECTION

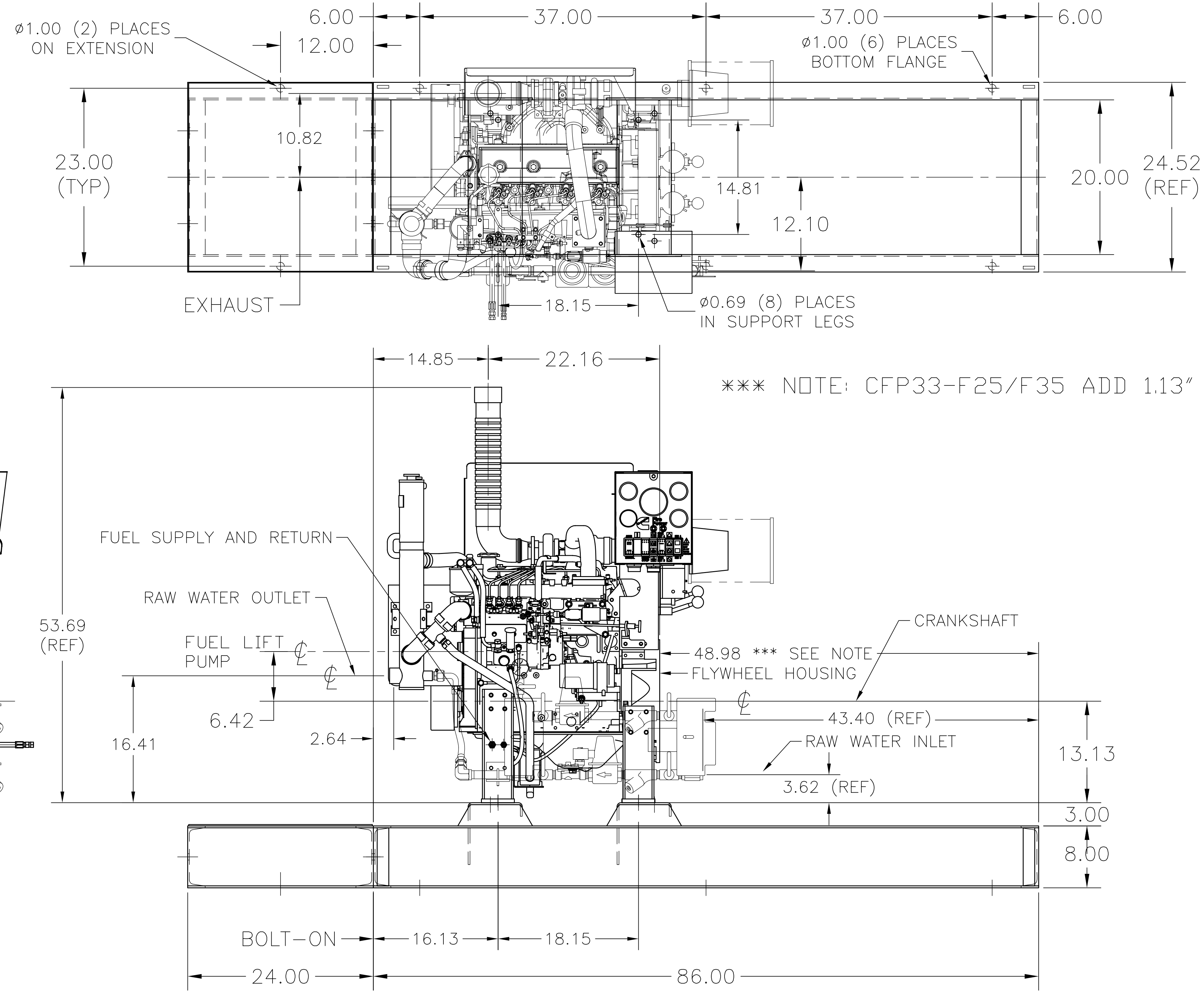


STUB SHAFT & GUARD



1410 DRIVE SHAFT & GUARD





NOTES

1) DETAILS REMOVED FOR CLARITY
2) OPTIONAL COMPONENTS SHOWN
3) SUBJECT TO CHANGE WITHOUT NOTICE
4) LEG EXTENSIONS MAY BE REQUIRED TO INTERFACE PUMP
5) SEE ASSEMBLY DRAWING AND DATA SHEET FOR ADDITIONAL INFORMATION
6) DRIVESHAFT MUST NOT RUN AT 0° ANGLE

REV	DESCRIPTION OF REVISION	BY	DATE
G	GRAPHICS REV	DAVE N	09JAN2007
F	REV PER STUB SHAFT.	DAVE N	28JUN2005

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.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
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.XXX = ± 0.06

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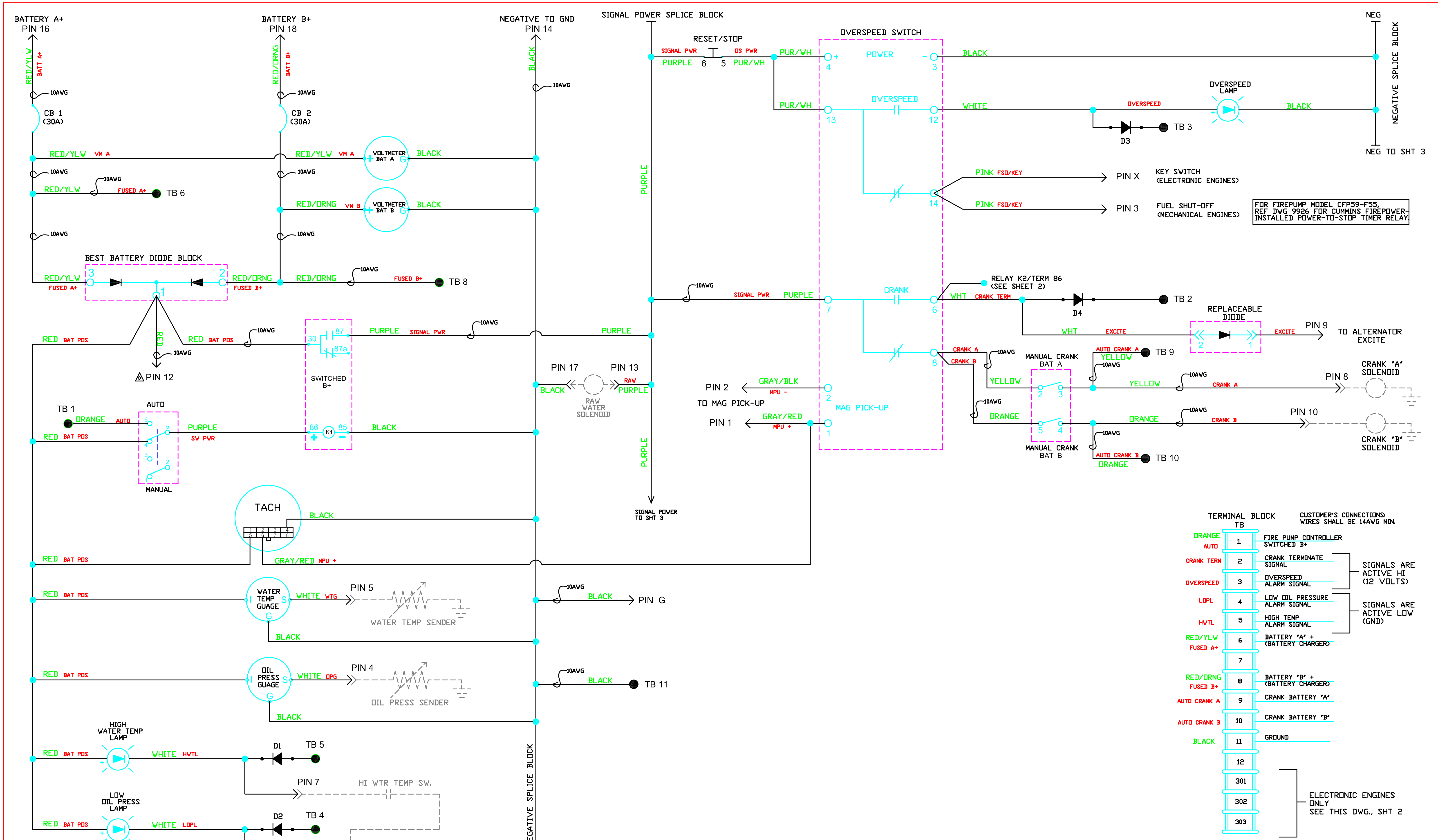
DWG SCALE: 1/16	DRAWN BY: CNP	DATE: NOV2004
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
GENERAL LAYOUT, FIREPUMP, CFP3.3

REFERENCE:

DRAWING NUMBER:
CFP33_GEN



A NOTES: WIRE IS 14 AWG UNLESS OTHERWISE NOTED
RED TEXT = WIRE TAG
GREEN TEXT = WIRE COLOR
WIRE COLOR IS WHITE UNLESS OTHERWISE NOTED
D1 - D4: 6 Amp/400 Vpiv

REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	PIN 12 WAS PIN B	RJS	19 SEPT 06
C	REMOVED 5 AMP CIRCUIT BREAKER	RJS	27 JUNE 06
B	ADDED CONNECTION TO TERM 6 OF SPEED SWITCH	RJS	17 DEC 05
A	CHANGED WIRE GAUGES; CHG'D TB 1 LABELS	RJS	27OCT05

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APPLY WELDED TOLERANCES
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.XXX = ± 0.06

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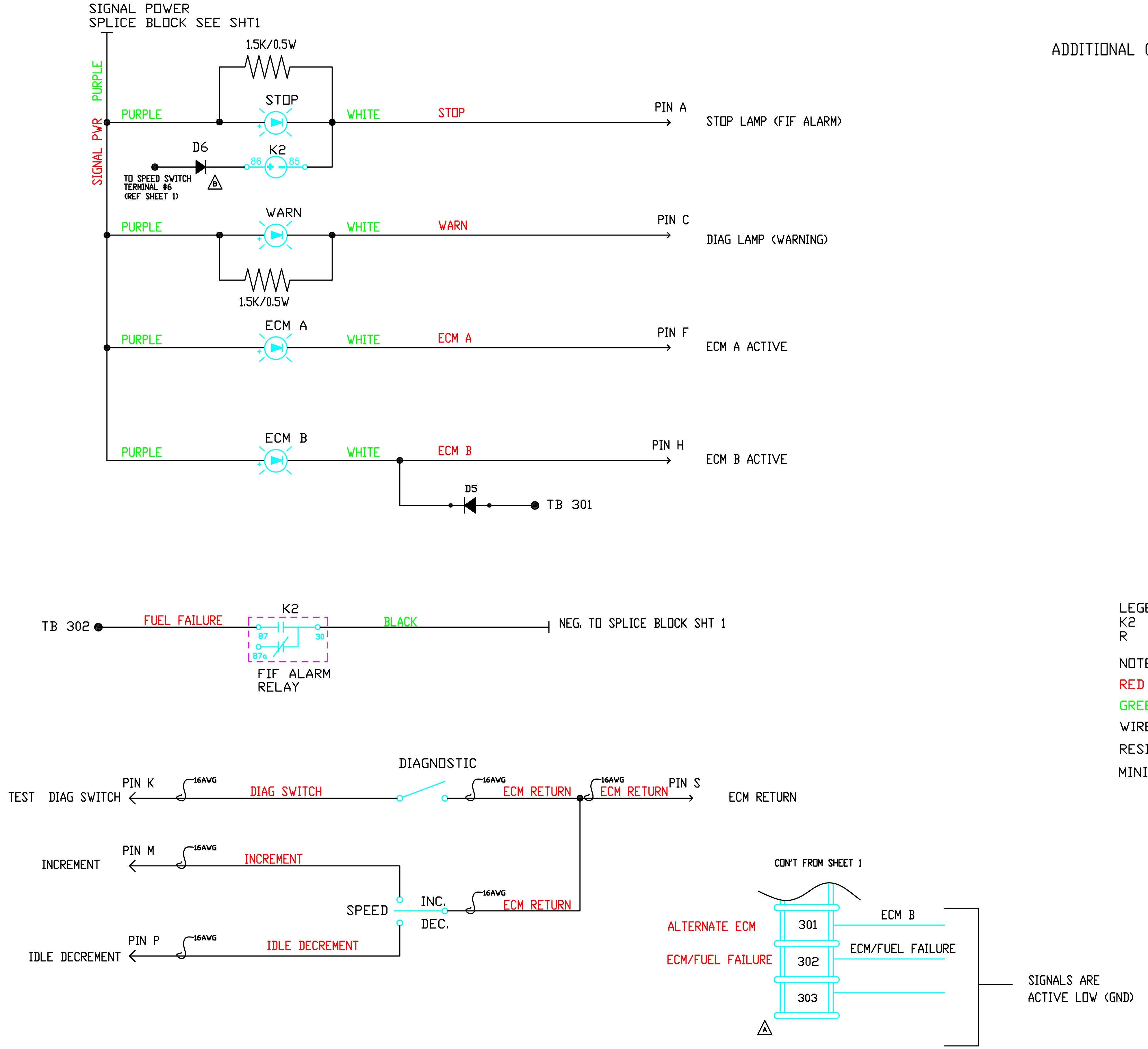
DWG SCALE: N/A | DRAWN BY: RJS | DATE: 06_OCT_2005
PLOT SCALE: N/A | APPD BY: — | DATE: —
DESCRIPTION: SCHEMATIC,_CONTROL_PANEL
REFERENCE: FIREPUMP
DRAWING NUMBER: 10423E_SHT1

ADDITIONAL CIRCUITS FOR ELECTRONIC ENGINES



LEGEND:
K2 ECM/FUEL FAIL RELAY
R RESISTOR

NOTES: WIRE IS 14AWG UNLESS OTHERWISE NOTED
RED TEXT = WIRE TAG
GREEN TEXT = WIRE COLOR
WIRE COLOR IS WHITE UNLESS OTHERWISE NOTED
RESISTOR VALUE = 1.5Kohms, 1/2W
MINIMUM DIODE RATING: 6A/400V

REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

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.XXX = ± 0.06

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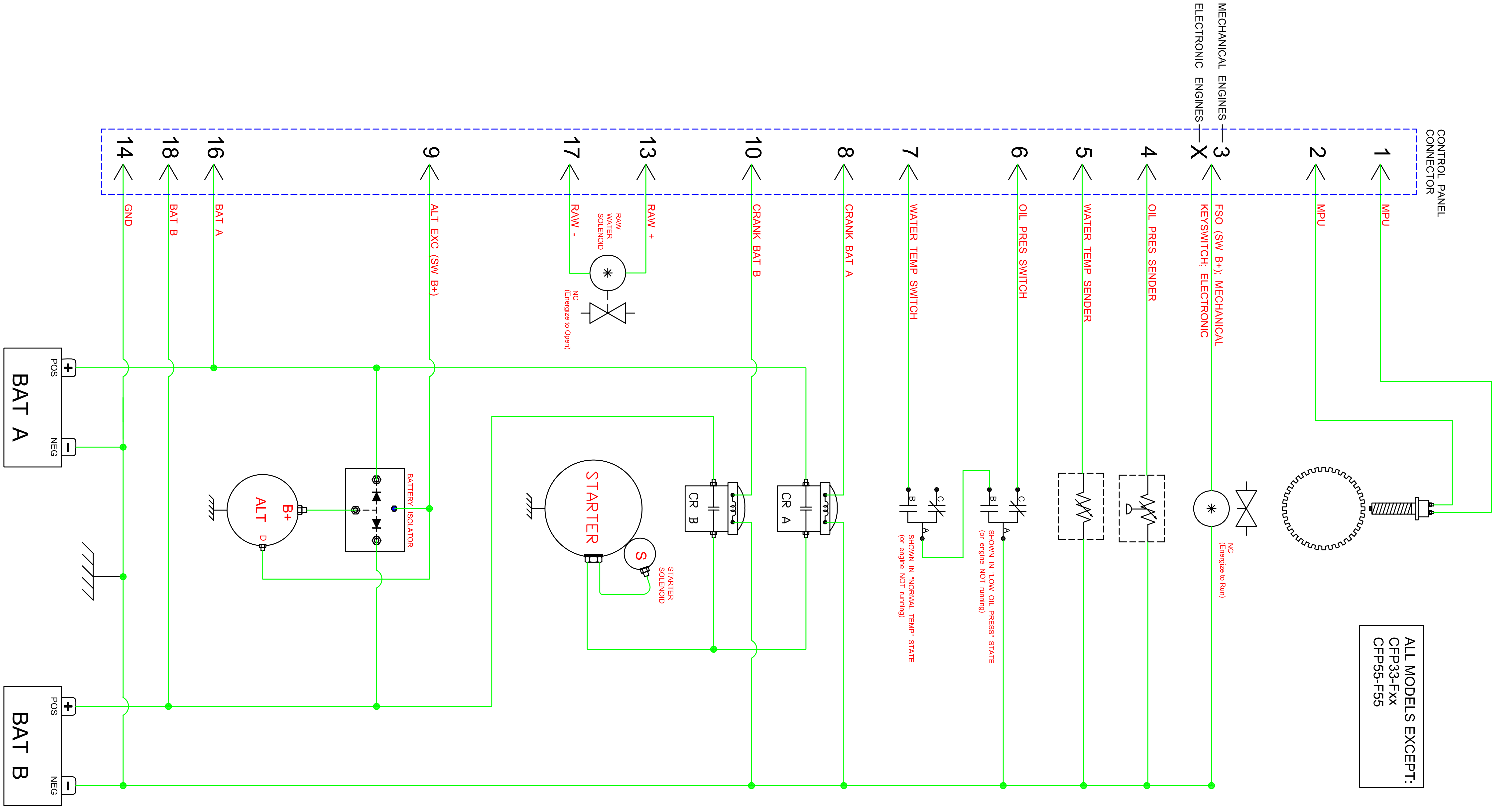
DWG SCALE: N/A
DRAWN BY: RJS
DATE: 06_OCT_2005
PLOT SCALE: N/A
APPD BY: —
DATE: —
DESCRIPTION
SCHEMATIC;_CONTROL_PANEL
REFERENCE:
FIREPUMP
DRAWING NUMBER:
10423E_SHT2



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REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

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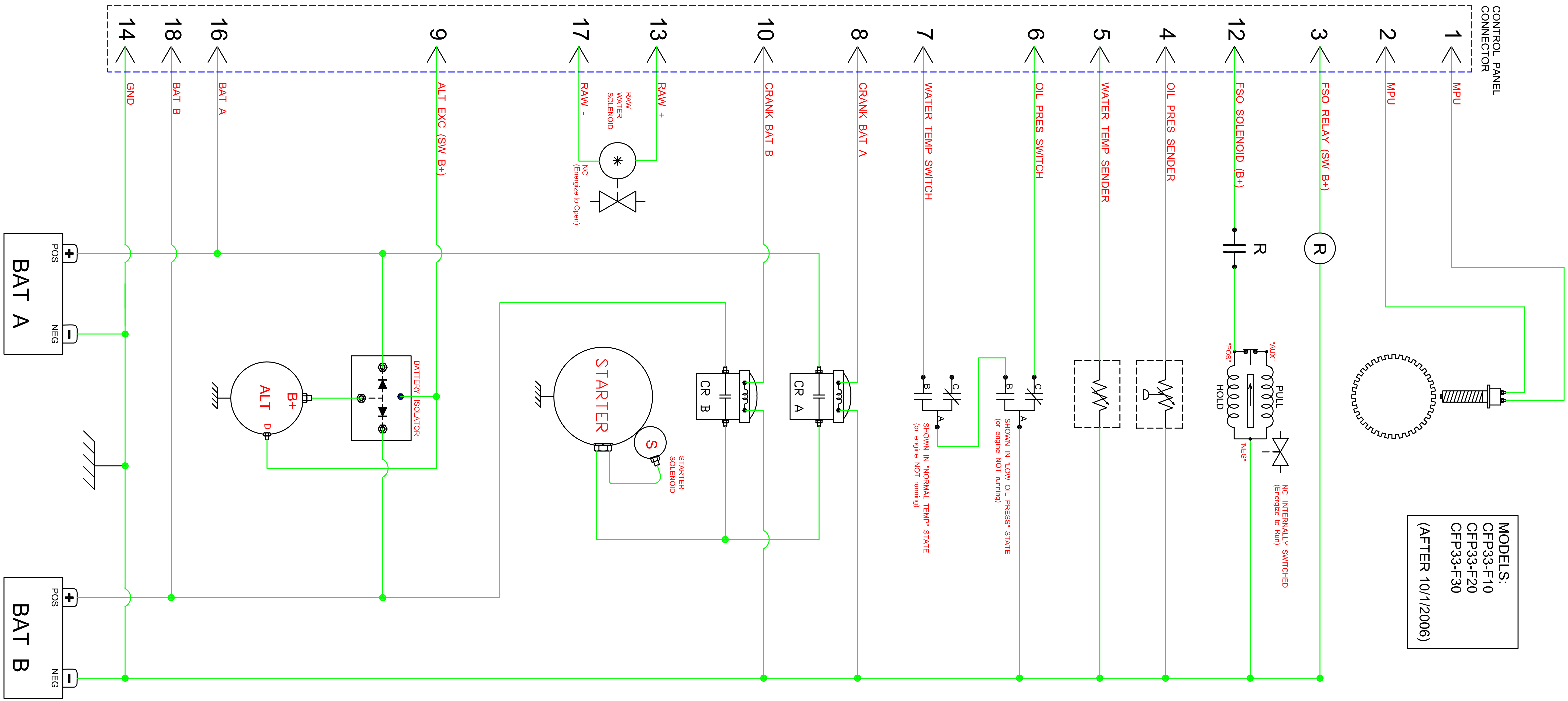
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
PLOT SCALE: N/A	APPD BY: —	DATE: —

DESCRIPTION: ENGINE_SCHEMATIC

REFERENCE: FIREPUMP

DRAWING NUMBER: 10423E_SHT3



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REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

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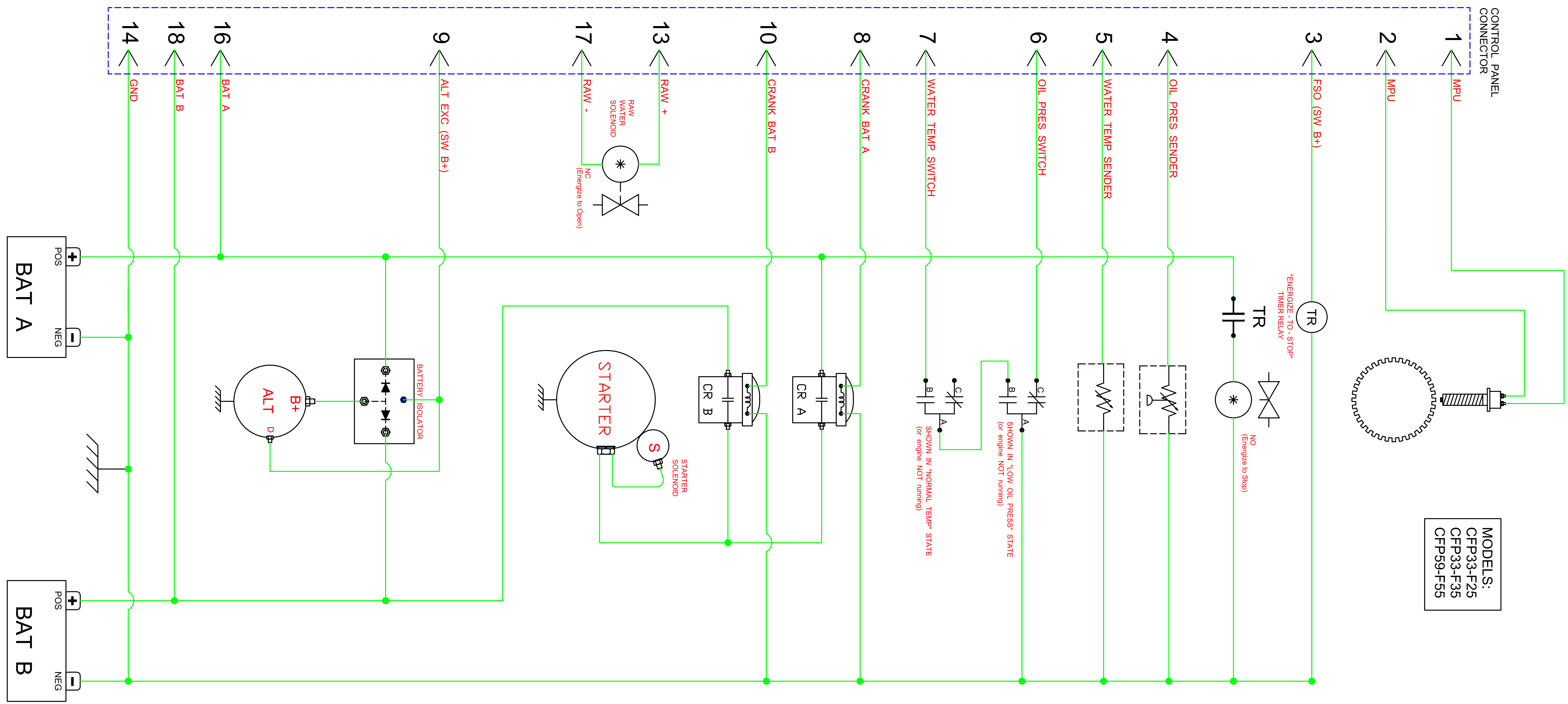
.XX = ± 0.12
.XXX = ± 0.06

DWG SCALE: N/A
PLOT SCALE: N/A
DRAWN BY: RJS
APPD BY: –
DATE: 06_OCT_2005
DATE: –

DESCRIPTION: ENGINE_SCHEMATIC

REFERENCE: FIREPUMP

DRAWING NUMBER: 10423E_SHT4



REV	DESCRIPTION OF REVISION	BY	DATE
E	ADDED SHEETS 3, 4, 5, & 6	RJS	20 MAR 07
D	SEE SHT 1 FOR REV CHANGE	RJS	19 SEPT 06
C	REDREW	RJS	3 JULY 06
B	CHG'D WIRING OF K2	RJS	17 DEC 05
A	REF PAGE 1 REV NOTES	RJS	27 OCT 05

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.XXX = ± 0.06

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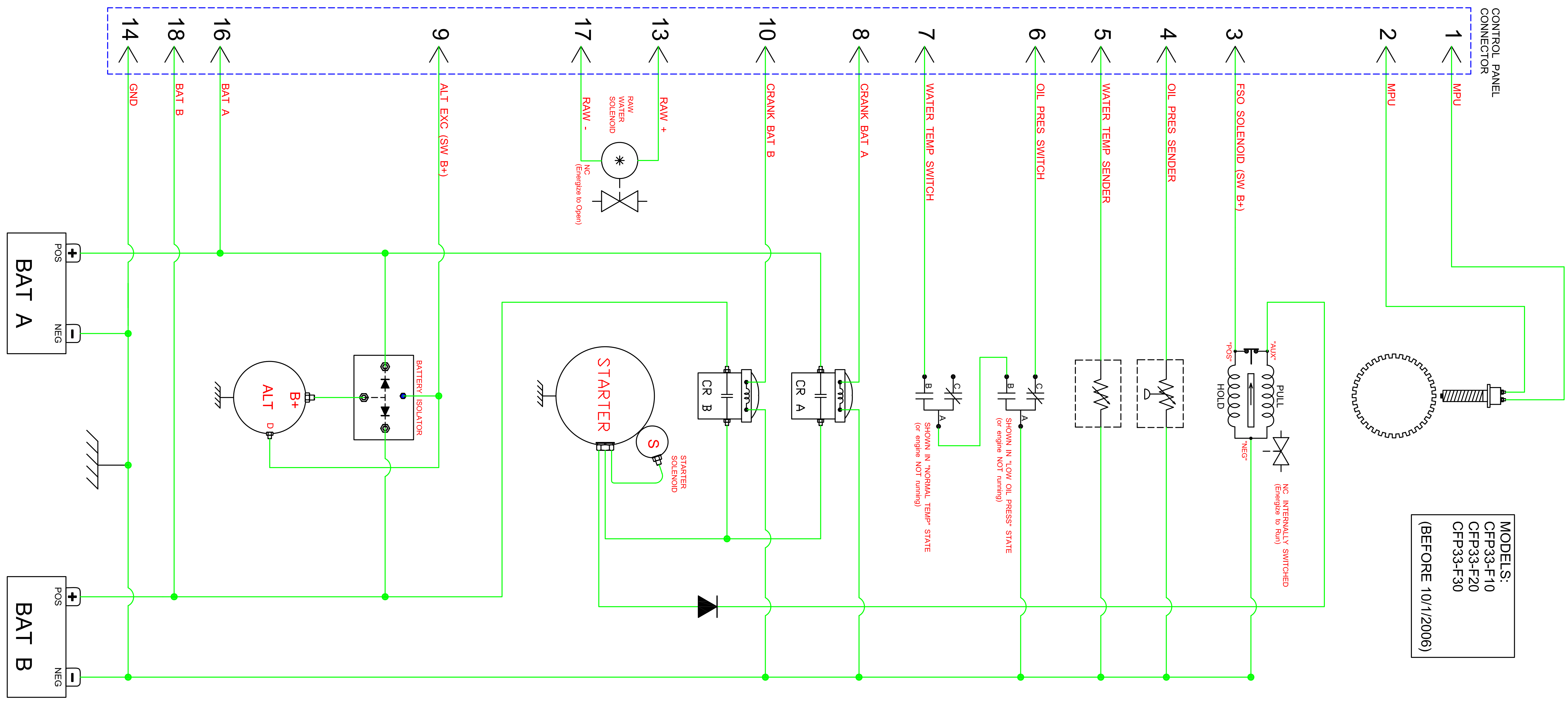
DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
PLOT SCALE: N/A	APPD BY: –	DATE: –
DESCRIPTION: ENGINE_SCHEMATIC		
REFERENCE: FIREPUMP		DRAWING NUMBER: 10423E_SHT5



REV	DESCRIPTION OF REVISION	BY	DATE

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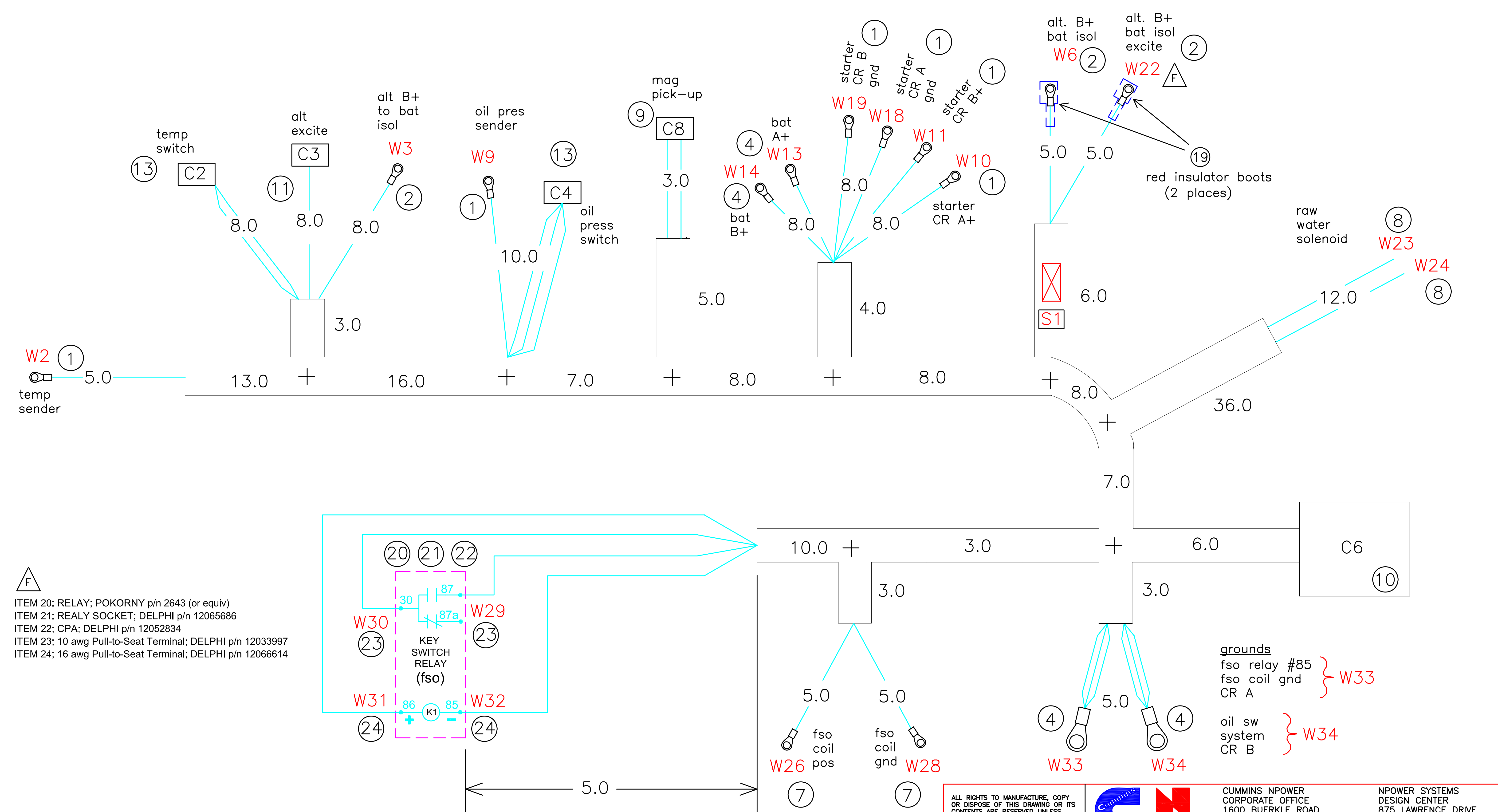
DWG SCALE: N/A	DRAWN BY: RJS	DATE: 06_OCT_2005
PLOT SCALE: N/A	APPD BY: —	DATE: —

DESCRIPTION
ENGINE_SCHEMATIC

REFERENCE:
FIREPUMP

DRAWING NUMBER:
10423_SHT6



ITEM 20: RELAY; POKORNY p/n 2643 (or equiv)
ITEM 21: REALY SOCKET; DELPHI p/n 12065686
ITEM 22; CPA; DELPHI p/n 12052834
ITEM 23; 10 awg Pull-to-Seat Terminal; DELPHI p/n 12033997
ITEM 24; 16 awg Pull-to-Seat Terminal; DELPHI p/n 12066614

THIS HARNESS TO BE OVER-BRAIDED WITH BLACK & RED NYLON

ALL DIMENSIONS IN INCHES (NOT DRAWN TO SCALE)

REV	DESCRIPTION OF REVISION	BY	DATE
F	ADDED RELAY SOCKET; REMOVED ALT EXCITE FUSE	RJS	16 OCT 06
E	ADDED KEY SWITCH RELAY; COMBINED GROUNDS	RJS	13 SEPT 06

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NPOWER SYSTEMS
DESIGN CENTER
875 LAWRENCE DRIVE
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APPLY MACHINE TOLERANCES
.X = ± 0.06
.XX = ± 0.010
.XXX = ± 0.001
APPLY WELDED TOLERANCES
.X = ± 0.25
.XX = ± 0.12
.XXX = ± 0.06

DWG SCALE:	DRAWN BY: S.DANFORTH	DATE: 15APR04
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
WIRING HARNESS SCHEMATIC

REFERENCE:
3.3 liter FIRE PUMPS

DRAWING NUMBER:
8885SHT1_F

CIRCUIT DATA

CIRCUIT NO.	FROM DESIG-NATOR	FROM CAVITY POS./ TERMINAL	TO DESIG-NATOR	TO CAVITY POS./ TERMINAL	WIRE COLOR	WIRE SIZE (AWG)	INSUL TYPE	STAMP
	C2	A	C4	B	WHT	16	GXL	OPS TO WTS
	C3	B	S1		WHT	16	SXL	EXCITE
	C4	A	W34	3/8" RING	WHT	16	GXL	OPS GND
	S1	-	W22	1/4" RING	WHT	16	SXL	BATT EXCITE
	C6	1	C8	A	WHT	16	SXL	MPU +
	C6	2	C8	B	WHT	16	SXL	MPU -
	C6	3	W31	1/4" TAB	WHT	16	SXL	FSO RELAY 86
	C6	4	W9	#10 RING	WHT	16	SXL	OPG
	C6	5	W2	#10 RING	WHT	16	SXL	WTG
	C6	6	C4	C	WHT	16	GXL	LOPL
	C6	7	C2	B	WHT	16	GXL	HWTL
	C6	8	W10	#10 RING	WHT	10	SXL	CRANK A
	C6	9	S1	-	WHT	16	SXL	EXCITE
	C6	10	W11	#10 RING	WHT	10	SXL	CRANK B
	C6	12	W30	1/4" TAB	WHT	10	SXL	FSO RELAY 30
	C6	13	W23	heatshrink	WHT	14	SXL	RW SOL +
	C6	14	W34	3/8" RING	WHT	10	GXL	SYS GND
	C6	16	W13	3/8" RING	WHT	10	GXL	BATT A+
	C6	17	W24	heatshrink	WHT	14	SXL	RW SOL-
	C6	18	W14	3/8" RING	WHT	10	GXL	BATT B+
	W18	#10	W33	3/8" RING	WHT	14	SXL	CRNK A GND
	W19	#10	W34	3/8" RING	WHT	14	SXL	CRNK B GND
	W3	1/4" RNG	W6	1/4" RING	WHT	6	GXL	ALT B+
	W28	#8 RING	W33	3/8" RING	WHT	10	SXL	FSO GND
	W26	#8 RING	W29	1/4" TAB	WHT	10	SXL	FSO POS
	W32	1/4" TAB	W33	3/8" RING	WHT	16	SXL	FSO RELAY 85

REF NO.	SUPPLIER	SUPPLIER PART NO.	QTY	DESCRIPTION
1			6	#10 RING TERMINAL
2			3	1/4" RING TERMINAL
4			4	3/8" RING TERMINAL
6			4	1/4" INSUL FEMALE TAB
7			2	#8 INSUL RING TERMINAL
8			2	HEAT SHRINK
9	PACKARD	12010973	1	2-PLACE SHROUD W/ PINS
10	DEUTSCH	HDP26-24-19SN	1	MAIN CONNECTOR
11	SUMITOMO	6189-0442	1	HOUSING
	SUMITOMO	8100-0461	1	TERMINAL
	SUMITOMO	7165-0395	1	RUBBER SEAL
	SUMITOMO	7160-9465	2	PLUGS
13	PACKARD	12162280	2	WTS/OPS CONN. W/ SOCKETS & SEAL
19	STELLA-MARIS	400N9V02	2	RED INSULATOR BOOT
20	POKORNY	2643 (or equiv)	1	12VDC RELAY
21	DELPHI	12065686	1	RELAY SOCKET
22	DELPHI	12052834	1	CPA
23	DELPHI	12033997	2	10awg pull-to-seat TERMINAL
24	DELPHI	12066614	2	16awg pull-to-seat TERMINAL

REV	DESCRIPTION OF REVISION	BY	DATE
F	ADDED ITEMS 21,22,23,24 REMV'D ITEMS 16,17,18	RJS	16 OCT 06
E	ADDED KEY SWITCH RELAY; CHG'D CIRCUITS	RJS	13 SEPT 06

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DEPERE, WISCONSIN

DWG SCALE:	DRAWN BY: RJS	DATE: 1 DEC 2004
PLOT SCALE:	APPD BY:	DATE:

DESCRIPTION
WIRING HARNESS SCHEMATIC

REFERENCE:
3.3 liter FIRE PUMPS

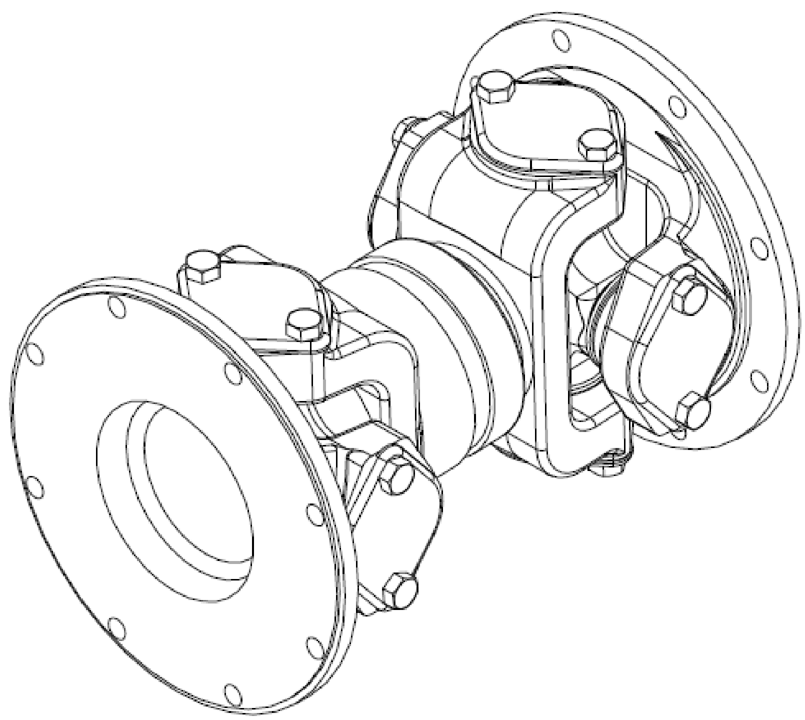
DRAWING NUMBER:
8885SHT2_F

Fire Pump

Applications

Installation & Maintenance Manual

Universal Joint Driveshafts



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Cummins Fire Power

Table of Contents

This Manual contains proprietary information to equipment produced by Cummins Fire Power or Cummins Inc. and is being supplied solely for the purpose of operating, maintaining and servicing the fire pump engine driveshaft application purchased from Cummins Fire Power.

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Section 1 - General

1.1 Introduction

This manual provides information for the installation and maintenance of universal joint driveshafts intended for use with diesel engine drivers. Following proper installation and maintenance procedures produces the optimum results in shaft performance and safety.

Cummins Fire Power Manuals should be considered part of the equipment. It is recommended to keep the manuals with the equipment. If the equipment is sold or traded, please transfer manuals to the new owner.

All personnel responsible for operation and maintenance of the equipment should read and thoroughly understand this manual.

Driveshafts shall be installed in accordance with the Standard for Installation of Stationary Pumps for Fire Protection, NFPA 20.

It is recommended that a torsional analysis be conducted on the actual drive system arrangement.

1.2 Safety Precautions

Warning: Read and understand all of the safety precautions and warnings before performing any repair. This manual contains the general safety precautions that must be followed to provide personal safety.

Warning: Rotating shafts can be dangerous. Keep hands, body parts, long hair, or loose fitting clothing clear at all times.

Warning: Rotating shafts can be dangerous. Follow all safety and lockout precautions during installation, maintenance and operation.

Warning: Perform a walk around inspection and alert all area personnel that the equipment will be starting before operation.

Caution: Consult applicable local and national safety codes for proper guarding of rotating members. Observe all safety rules when installing or servicing couplings and driveshafts.

Warning: After performing maintenance, remove all tools and foreign materials, reinstall and securely fasten ALL guards, covers and protective devices.

1.3 Warranty

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 modifications or lack of maintenance. Cummins Fire Power is not responsible for incidental or consequential damages.

1.4 Basic Guidelines to Universal Joint Driveshafts

Even though driveshafts have the unique capability of accepting both axial and offset movements, the following precautions must be taken:

1.4.1 They must work in pairs. A universal joint, working at an angle, will vibrate if it is not cancelled by another joint. The second joint (opposite side of the shaft) must be working at the same angle and in the same plane. (See Figures 1 & 2)

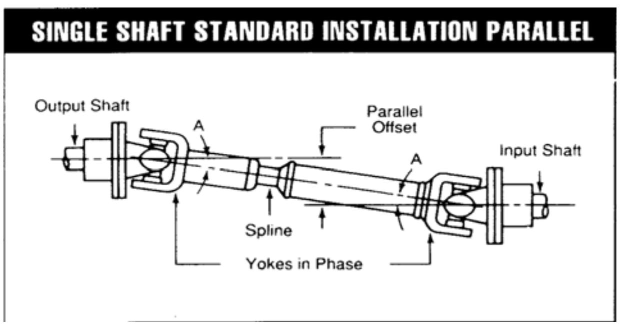


Figure 1

1.4.2 Joint angles must be equal within ½ degree. Joints, working in pairs will vibrate if they are not working at the same angle within ½ degree. (See Figure 2).

1.4.3 Yokes must be in phase (Figures 1 & 2). Joints, working in pairs, will vibrate if their yoke ears are not in the same plane.

1.4.4 Standard installation (Figure 1) requires that the input and output shafts be parallel.

1.4.5 In the alternate installation (Figure 2) the centerlines of the output and input shafts must intersect at the center of the driveshaft. Consult factory for installation using this method.

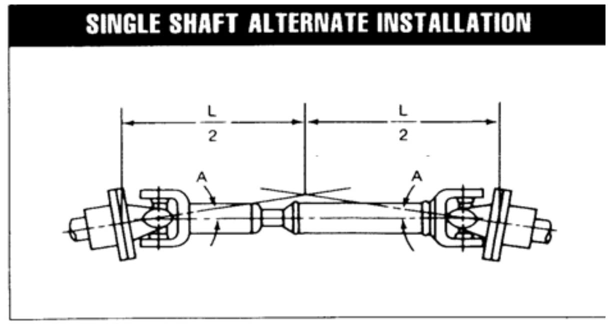


Figure 2

1.4.6 The universal joint operating angle shall be within 1-3 degrees.

1.4.7 To determine the correct amount of working angle; a) Measure the length in inches from centerline of yoke bore(s) to centerline of opposing yoke bore(s). b) Measure parallel offset between centerline of drive and driven shafts.

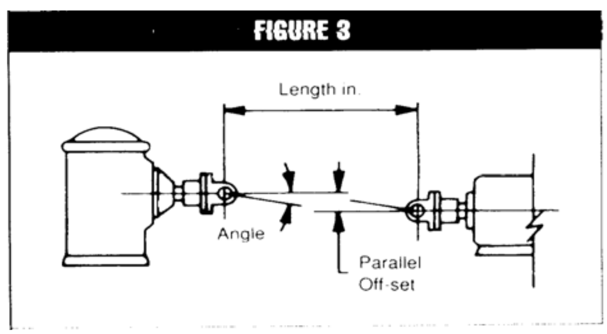


Figure 3

The actual offset shall measure 0.42 +/- 0.20 inches per 12 inches of shaft length. Following this offset relationship will yield an operating angle of 1-3 degrees.

Section 2 - Installation

2.1 Driveshaft Installation

2.1.1 Clean flange faces removing all paints or contaminants from the surface. Examine mating surfaces for any damage or nicks in the machine finish. Failure to properly clean the mating surfaces can result in premature driveshaft connection failure.

2.1.2 Inspect companion flanges for proper installation (see Section 2.2).

2.1.3 Compress driveshaft and place into position between mating flanges (see Figure 4). Large universal joint shaft assemblies are very heavy, use proper lifting equipment during installation. Carefully align pilot bore boss into/onto companion flange mating diameter. Align bolt holes on driveshaft flange with holes on companion flange. Secure flange to driveshaft with proper hardware. Extend shaft at slip section until pilot bore boss aligns with companion flange pilot bore boss. Align holes and secure flange.

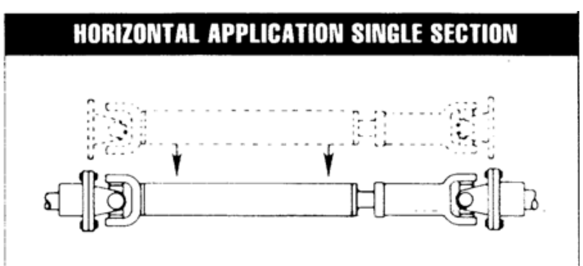


Figure 4

2.1.4 Torque fasteners to proper specification (see Table B).

2.1.5 Lubricate all joints, splines (where applicable) before startup. Lubricate until lubricant appears at all four bearing cap seals.

2.1.6 Verify offset and shaft operating angles.

2.1.7 Install proper shaft guarding prior to start up.

2.2 Companion Flange installation

There are two types of mating flanges available for connecting the drive and driven unit shaft ends to the driveshaft. Type (1) SF standard flange accepts through bolting. Type (2) SLF large bore flange are drilled and threaded to accept fasteners or stud kit (see Figure 5). Stock bore companion flanges SF or SLF are bored with a plus 0.001” minus 0.000” tolerance and shall be a slip fit over mating shaft.

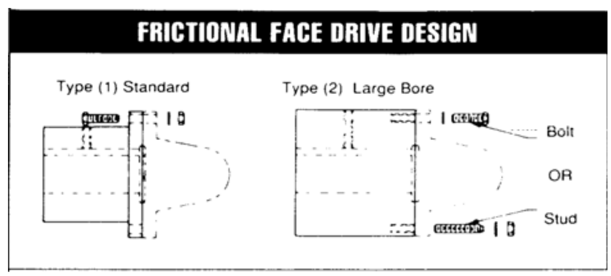


Figure 5

2.2.1 Align flange keyway with shaft key and gently tap flange onto shaft with soft face mallet. Take extreme care not to damage flange face or flange. If flange does not install easily, remove and retry. *Note*: The drive/driven shaft shall not extend out beyond the flange face or pilot bore/boss.

2.2.2 Tighten setscrew(s) to recommended torque (see Table C).

2.2.3 Check concentricity of companion flange face and pilot. Maximum allowable TIR is 0.003” on face and pilot (see Figure 6).

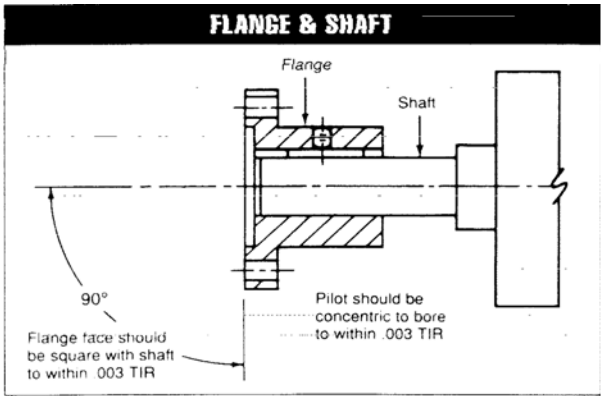


Figure 6

2.2.4 Thoroughly clean and inspect flange mounting face removing any oils, dirt, or contaminants.

2.3 Shaft Alignment

The procedure below is based on a fire pump installation where the engine crankshaft centerline is on the same centerline as the pump when examined from the top view and parallel in the side view (see Figure 7). If installation requires another configuration, please consult factory customer service for assistance. For all measurements vernier caliper or dial indicator will be needed.

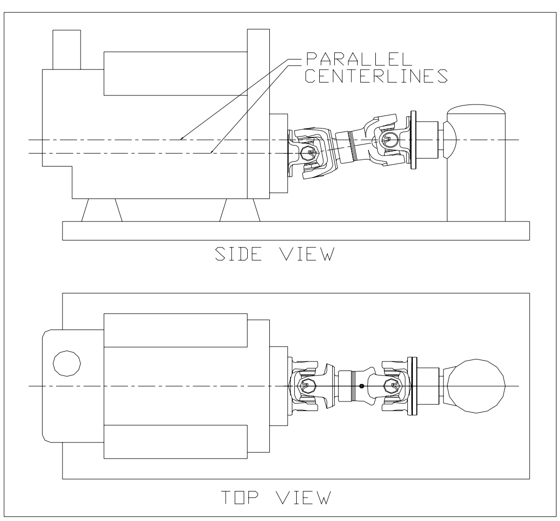


Figure 7

2.4 Vertical Offset

2.4.1 Position (rotate) shaft so that the inboard shaft yokes are vertical as shown (Figure 8a & 8c).

2.4.2 Measure distance from point A to B as shown (Figure 8a or 8c).

2.4.3 Measure distance from point C to D as shown in (Figure 8a or 8c).

2.4.4 On Table A locate row of shaft Part Number being aligned.

2.4.5 Raise or lower drive or driven unit until measurements AB & CD are within the Vertical Offset Tolerance range as note in Table A.

2.4.6 When finished, measurements AB and CD must also have equal values within tolerance ranges identified in Table A.

2.5 Horizontal Offset

Because the centerlines of the crankshaft and pump unit are designed to be on the same centerline, the horizontal offset alignment check is to confirm near zero misalignment.

2.5.1 Position (rotate) the shaft so that the inboard yokes are horizontal (Figure 8b or 8d).

2.5.2 Measure distance from point J to K as shown (Figure 8b or 8d).

2.5.3 Measure distance from point L to M as shown (Figure 8b or 8d).

2.5.4 See Table A and identify the proper row with applicable values of the shaft that is being installed.

2.5.5 Measured values at the four positions referenced (JK, LM, NP, RS) may not vary more than the published tolerance in the column listed as Horizontal Offset Tolerance as noted in Table A.

Table A

Shaft Series	Listed Shaft PN	Vertical Offset Measurement AB & CD (inches)	Vertical Offset Tolerance (+ or -) (inches)	Horizontal Offset Tolerance (+ or -) JK, LM, NP & RS (inches)	Weight in lbs per PN series
1410	13417	2.36	0.04	0.012	13.5
1480	13418	2.27	0.04	0.012	19.5
1550	13419	2.78	0.05	0.017	29.5
1610	13420	3	0.05	0.018	44
1710	13421	3.17	0.05	0.022	54
1810	13422	3.77	0.06	0.027	78
1880	13423	4.08	0.07	0.032	142
U3101	13424	2.45	0.03	0.009	11
U3127	13427	3.64	0.04	0.013	27
U3126	13426	3.67	0.04	0.013	40
U3144	13428	4.46	0.04	0.016	45
U3158	13429	4.66	0.05	0.02	57
U3172	13430	4.87	0.05	0.023	74

**Measurement taken from yoke side of flange face to far side of universal bearing plate as shown in the referenced Figures 8a-8d which are to be used for measuring instruction.

For parts and service inquiries, please contact:

Cummins Fire Power, LLC
875 Lawrence Drive
De Pere, WI 54115
Phone: 1-800-236-9750 in the US.

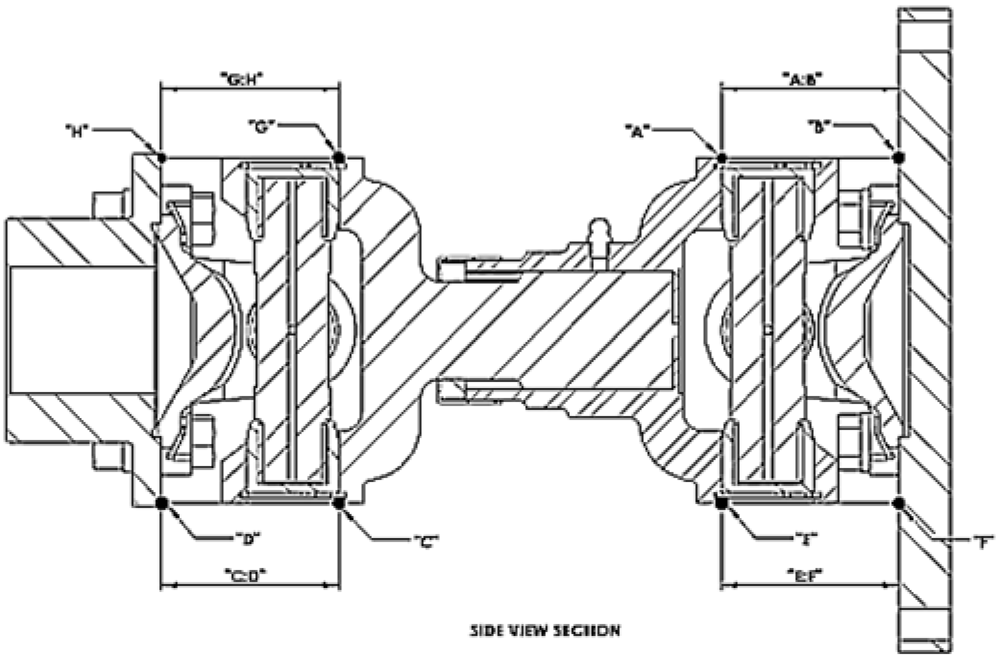
Fax: 1-920-337-9746

Please provide Engine serial number or the Driveshaft serial no. and tag information.

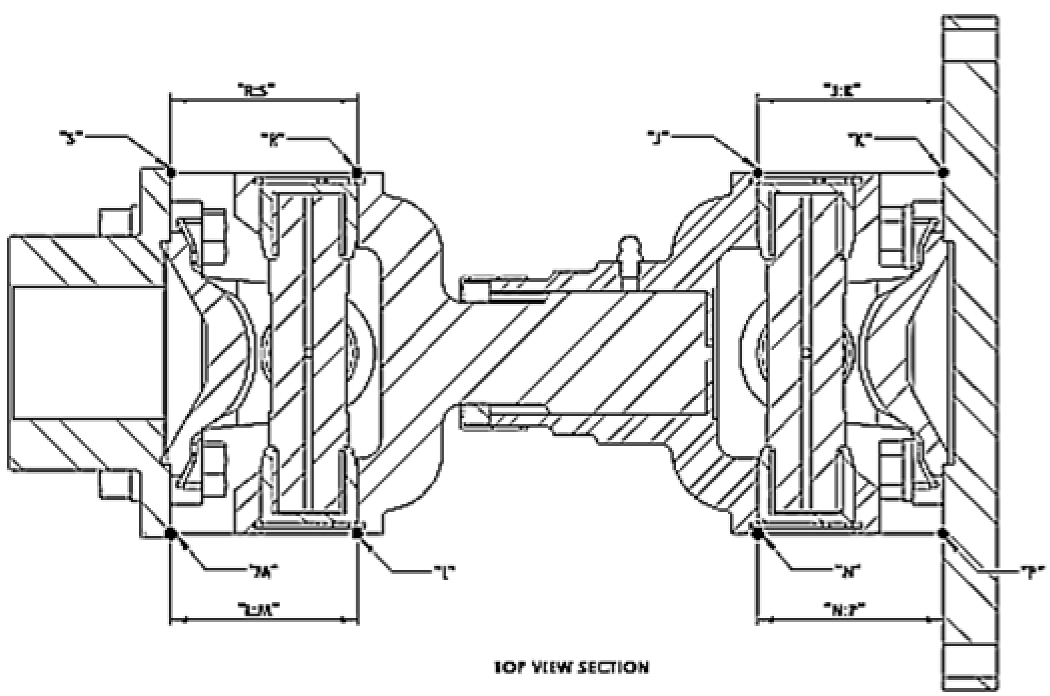
Visit us on the web at: www.cumminsfirepower.com

Series 1410 – 1550 (13418 – 13419)
Series U3101 – U3172 (13424 – 13430)

Vertical Offset Sectional View
Figure 8a

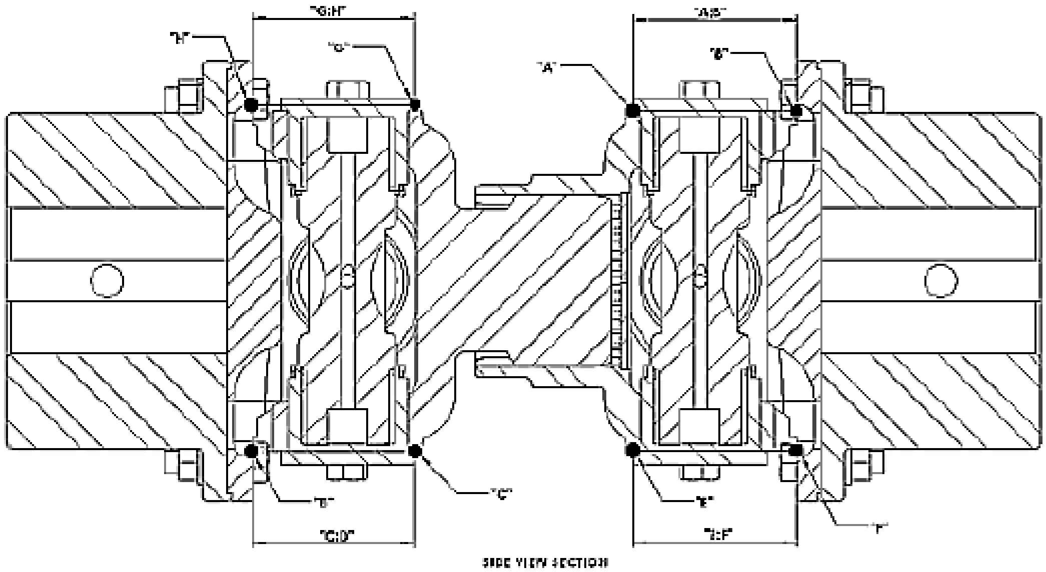


Horizontal Offset Sectional View
Figure 8b

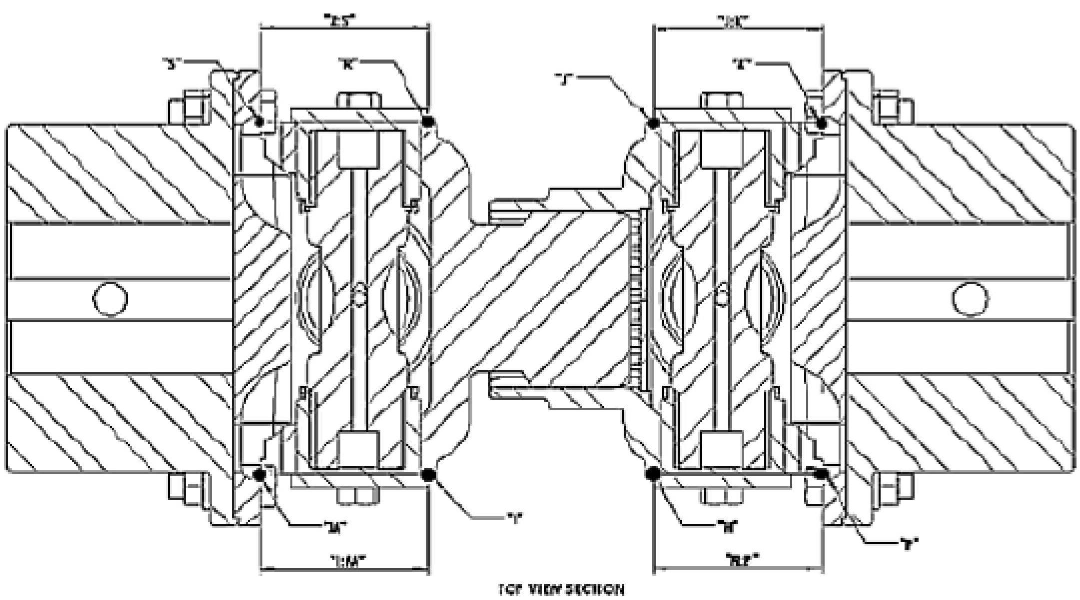


Series 1610 – Series 1880 (13420-13423) Only

Vertical Offset Sectional View
Figure 8c



Horizontal Offset Sectional View
Figure 8d



Section 3 - Lubrication

3.0 Lubrication

The majority of premature universal joint and slip spline failures are due to improper lubrication. Proper lubrication practice flushes contaminants from the bearings promoting maximum functional life. A high quality NLGI Grade 2 EP lithium grease is recommended for both universal joint and slip splines. *Note:* Do not use lubricants with molybdenum disulfide additives in universal joint bearings.

Lubrication intervals vary depending on the application, installation environment, and operating conditions. Continuously operating assemblies should be lubricated every 200 operating hours. Limited usage joints should be lubricated every 6 months in protected environmental conditions, every 60 days in harsh environments.

3.1 Lubrication Procedure

3.1.1 Using the proper NLGI Grade 2 lubricant, purge all four bearing seals of the universal joint. Pressure fill universal joint through fitting "A" in Figure 9. This flushes contaminants from each bearing assembly and assures all four are filled completely.

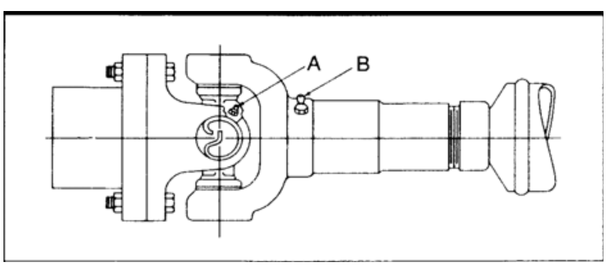


Figure 9

Note: If any seal fails to purge, move the driveshaft from side to side and then re-apply pressure to the fitting.

3.1.2 Lubricate slip splines through fitting "B" on the shaft assembly. Only shafts stamped Series 1410-1880 (13418 – 13423) require spline lubrication using the following procedure. Cover the vent hole and pressure fill the spline shaft until grease purges the shaft seal.

Note: On applications where spline shafts traverse in cold conditions, care must be taken to purge excess grease from the cavity immediately after lubricating. Failure to do so can cause excess axial pressure on components resulting in damage to the driveshaft or mating parts.

Note: Shafts stamped Series U3101-U3172 (13424-13430) are Rilsan coated and are maintenance free for the spline section only.

Table B

Flange Fastener Torque Values

Shaft Series	Thread Size	Grade (Class)	Dry Torque Value
1410	7/16 – 20		75 lb x ft
1480	1/2 – 20		110 lb x ft
1550	1/2 – 20		110 lb x ft
1610	3/8 – 24	8	45 lb x ft
1710	3/8 – 24		45 lb x ft
1810	7/16 – 20		75 lb x ft
1880	5/8 – 18		230 lb x ft
U3101	M8 - 1.25		25 lb x ft
U3126	M12 - 1.75		90 lb x ft
U3127	M12 - 1.75	10.9	90 lb x ft
U3144	M14 - 2.0		140 lb x ft
U3158	M14 - 2.0		140 lb x ft
U3172	M16 - 2.0		215 lb x ft

Table C

Setscrew Tightening Torques

Key Width	Thread Size	Torque Value
Below .313	1/4 - 28	6 lb x ft
.313 to .500	3/8 - 16	20 lb x ft
.501 to .750	1/2 - 13	50 lb x ft
Over .751	3/4 10	170 lb x ft

Section 4 – General Inspection

4.0. Inspection Guidelines

NOTE: Shaft assemblies must be inspected annually to maintain peak performance and safety.

4.1 Check companion flanges for attachment to mating shaft. Verify that setscrews remain secure.

4.2 Check fastener connection between companion flange and driveshaft. Torque to the specified values as detailed in Table B.

4.3 Check universal joints for excessive endplay. The allowable amount is 0.006 inches. See Figure 10 for inspection diagram. Use dial indicator if any looseness is perceived.

4.4 Check slip spline for radial movement. Side to side movement in spline section shall not be more than 0.007 inches in any direction.

Figure 10

4.5 Inspect overall length of shaft as referenced in Section 7 to determine that it is within the required tolerance.

4.6 Visually inspect for any damage to shaft seal, universal joint seals, spline end plug, universal joint retaining rings or spun bearing caps.

4.7 If any of the defects in Sections 4.3 to 4.5 are found, the shaft shall be removed from service, replaced, and returned to the factory for repair.

Warning: Rotating shafts can be dangerous. Follow all safety and lockout precautions during installation, maintenance, and operation. Proper guarding required. Consult local safety regulations for compliance.

Section 5 – Application Calculations

$$\text{Rated Torque} = \frac{\text{Max Torque}}{5252}$$

$$\text{Rated HP} = \frac{\text{Rated Torque x RPM}}{\text{Service Factor (SF)}}$$

For Centrifugal Fire Pump Application

5.1 A service factor is applied to the calculated end-use application torque. The calculated end-use application torques, as adjusted by the service factor, shall not exceed the torque rating of the flexible coupling or connecting shaft at the applicable speed.

Service Factor (SF) = 1.5 (6 Cylinders or More-diesel engine)

Service Factor (SF) = 2.0 (5 Cylinders or Less-diesel engine)

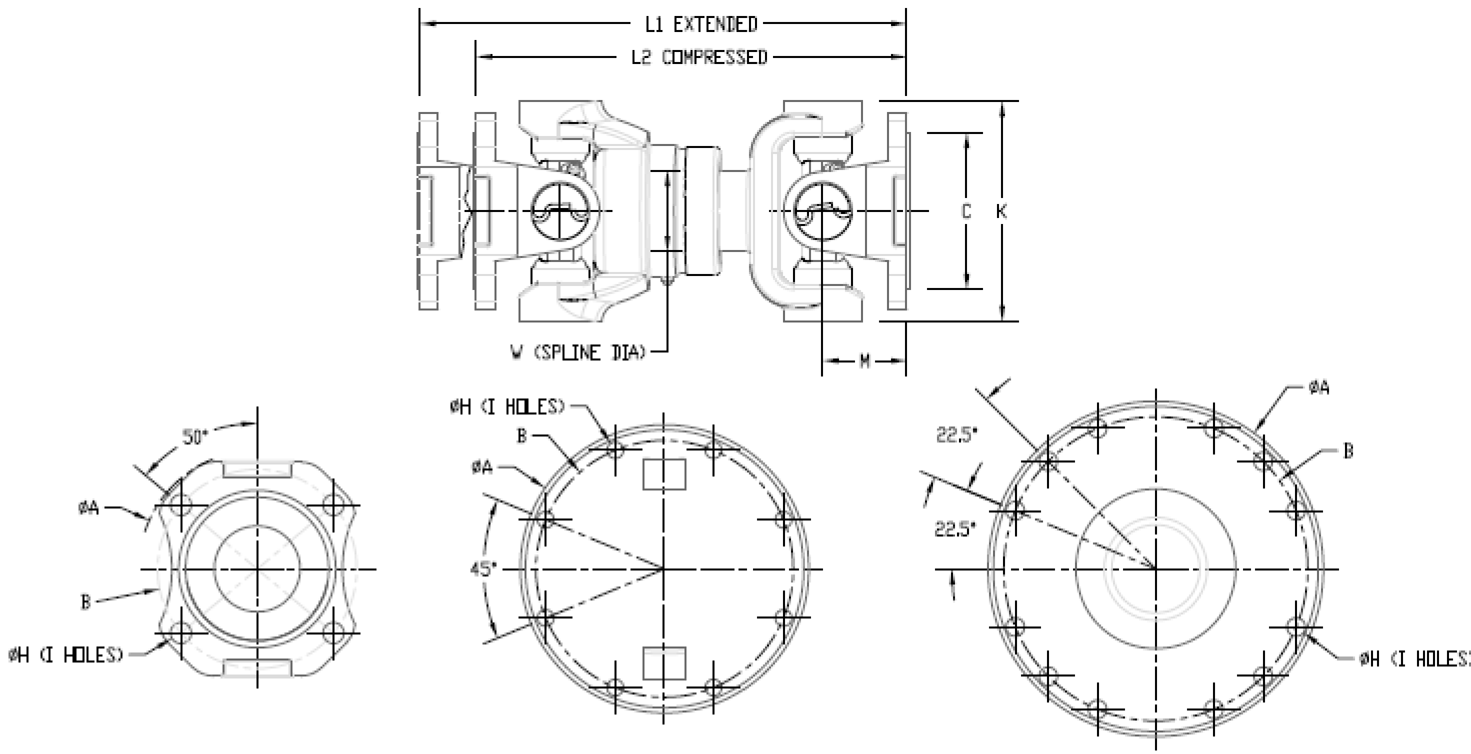
5.2 Selection of Flexible connecting driveshaft shall be based on rating of the driver and not the pump.

Section 6 - Application Charts

Shaft Series	Shaft PN	Rated Speed RPM		1470	1760	1800	1900	2100	2250	2300	2350	2600	2800	3000
1410	13417	Rated Torque	ft/lb	379	359	-	-	341	-	-	330	320	-	-
			N-m	43	41	-	-	39	-	-	37	36	-	-
1480	13418	Rated Torque	ft/lb	499	473	-	462	448	-	-	434	420	-	-
			N-m	56	53	-	52	51	-	-	49	47	-	-
1550	13419	Rated Torque	ft/lb	625	592	-	579	562	-	-	543	526	515	505
			N-m	71	67	-	65	63	-	-	61	59	58	57
1610	13420	Rated Torque	ft/lb	950	950	-	950	946	-	-	915	887	868	850
			N-m	107	107	-	107	107	-	-	103	100	98	96
1710	13421	Rated Torque	ft/lb	1200	1200	-	1200	1200	1200	1200	-	-	-	-
			N-m	136	136	-	136	136	136	136	-	-	-	-
1810	13422	Rated Torque	ft/lb	1525	1525	-	1525	1525	-	-	-	-	-	-
			N-m	172	172	-	172	172	-	-	-	-	-	-
1880	13423	Rated Torque	ft/lb	2158	2046	2034	-	-	-	-	-	-	-	-
			N-m	244	231	230	-	-	-	-	-	-	-	-
U3101	13424	Rated Torque	ft/lb	433	410	-	-	389	-	-	376	365	-	-
			N-m	49	46	-	-	44	-	-	42	41	-	-
U3126	13426	Rated Torque	ft/lb	950	950	-	950	950	-	-	950	950	950	944
			N-m	107	107	-	107	107	-	-	107	107	107	107
U3127	13427	Rated Torque	ft/lb	549	549	-	549	549	-	-	549	549	-	-
			N-m	62	62	-	62	62	-	-	62	62	-	-
U3144	13428	Rated Torque	ft/lb	1200	1200	-	1200	1200	-	1187	-	-	-	-
			N-m	136	136	-	136	136	-	134	-	-	-	-
U3158	13429	Rated Torque	ft/lb	1525	1493	-	1459	1416	-	-	-	-	-	-
			N-m	172	169	-	165	160	-	-	-	-	-	-
U3172	13430	Rated Torque	ft/lb	2200	2177	2163	-	-	-	-	-	-	-	-
			N-m	249	246	244	-	-	-	-	-	-	-	-

Note: All rated torque values have been tested with a Diesel Engine Driver. Torque Ratings within the stated speed ranges are determined by use of linear interpolation between torques and have been developed at minimum and maximum speeds. Driveshafts are designed for minimum B-10 Life of 5000 Hours.

Section 7- Dimensional Attributes



DIMENSION DATA (INCHES)										
MODEL P/N	L1	L2	A	B	C	H	I	K	M	W
13417	10.25	9.50	4.83	3.75	2.75	0.44	4	4.44	1.69	1.50
13418	9.50	8.50	5.63	4.75	3.75	0.50	4	4.44	1.50	2.25
13419	10.75	9.75	5.65	4.75	3.75	0.50	4	5.25	2.00	2.50
13420	9.88	9.13	6.87	6.12	6.63	0.39	8	5.31	1.94	2.67
13421	11.38	10.63	8.00	7.25	7.75	0.41	8	6.09	2.00	3.25
13422	14.56	13.44	7.99	7.25	7.75	0.44	12	7.56	2.59	3.25
13423	14.63	13.63	9.74	8.25	7.00	0.63	8	8.09	2.50	4.17
13424	10.63	9.84	3.94	3.31	2.24	0.32	6	3.56	1.81	1.65
13427	14.59	13.41	5.91	5.12	3.54	0.47	8	4.63	2.87	1.89
13426	19.30	17.72	5.91	5.12	3.54	0.47	8	4.53	2.76	2.17
13428	17.72	16.14	7.09	6.12	4.33	0.56	8	5.19	3.54	2.17
13429	17.13	15.75	7.09	6.12	4.33	0.56	8	5.85	3.62	2.44
13430	19.69	18.11	7.99	7.25	7.75	0.44	12	6.32	3.94	2.95

Section 8 – Troubleshooting

Cause:	Solution:
8.1 Flange Loose on Shaft	
1. Set screw over keyway not tightened	1. Remove and inspect set screw. Replace if damaged. Reassemble with new or original and torque set screw.
2. Weight limitations exceeded for bored flanges or shaft diameter undersized.	2. Add additional set screw or replace flange with interference fit bore.
8.2 Vibration	
1. Companion flange or fastener loose.	1. Remove and inspect set screw. Replace if damaged. Reassemble with new or original and torque set screw.
2. Driveshaft mounting fasteners loose.	2. Remove and inspect fasteners, drive shaft and flange face for burs, paint and debris. Clean or de-bur face. Replace damaged fasteners. Reassemble and torque to specifications.
3. Flange faces not seated.	3. Remove driveshaft fasters. Inspect components for burs, paint and debris. Clean or de-bur face. Reassemble and torque to specification.
4. Flange face or pilot run-out exceeding .005” TIR.	4. Inspect for run-out. Consult factory if out of specification.
5. Excessive radial movement at the slip yoke or binding movement.	5. Lack of adequate lubrication or overload condition. Consult factory.
6. Dry or brinelled (needle bearing indentations).	6. Replace defective joints. Review and recheck the working angle of shaft.
7. Driveshaft yokes out of phase.	7. Disassemble and realign yoke.
8. Exceeding maximum joint acceleration.	8. Reduce angle and/or reduce speed. Secure fastener and inspect for vibrations.
9. Driven shaft or driver run-out.	9. Consult with equipment manufacturer.
10. Driver or driven shafts/companion flange not parallel within 1 degree.	10. Align and adjust. Shimming structure may be necessary.
11. Driver or driven components out of balance.	11. Consult with equipment manufacturer.
12. Operating at or near driver or driven equipment natural frequency.	12. Consult with equipment manufacturer.
13. Operation near critical or half cycle speed resonance.	13. Consult with equipment manufacturer. Resizing of driveshaft may be required.
14. Operation speed within a torsional vibration mode.	14. Perform torsional vibration analysis. Consult manufacturer for assistance if needed.
15. System resonance or vibration.	15. Perform torsional vibration analysis. Consult manufacturer for assistance if needed.
16. Pump noise.	16. Consult with pump manufacturer.