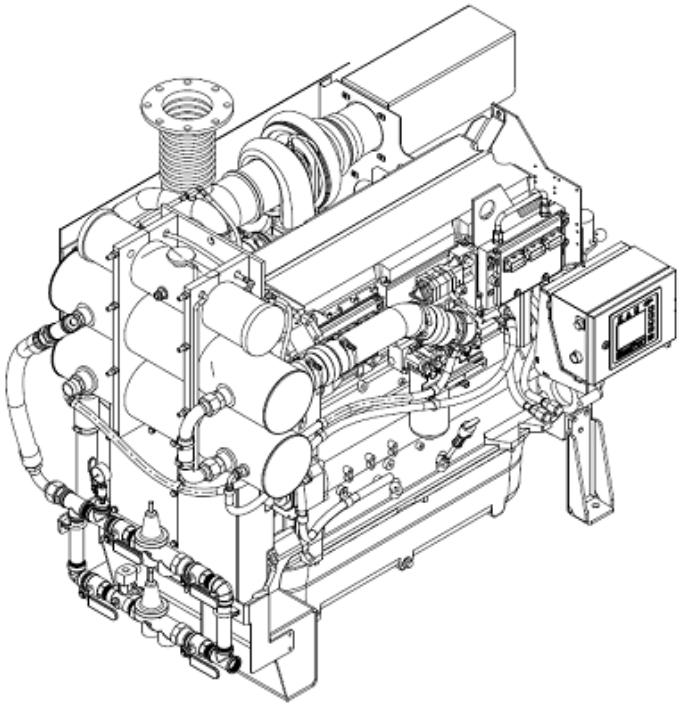
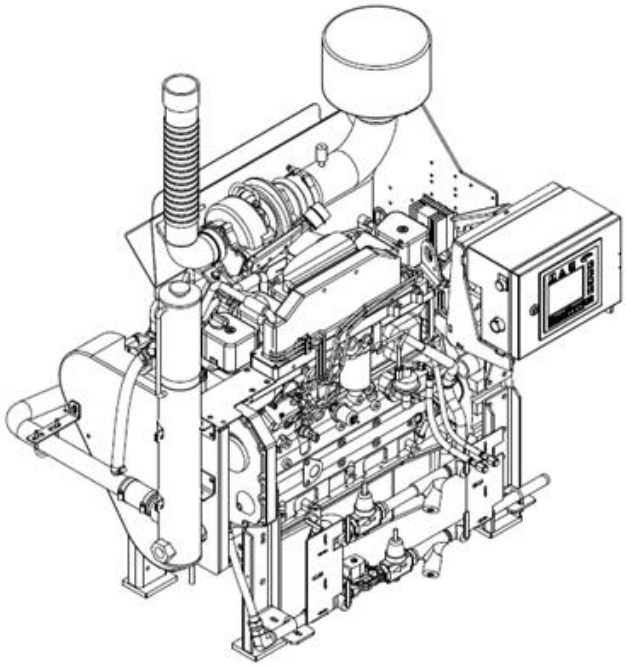
Cummins Fire Pump

USER'S GUIDE

Fire Pump Drive Engines





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English Version

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 purchased from Cummins Fire Power.

Warranty Information

LIMITED WARRANTY

EXCLUSIVE EXPRESS LIMITED WARRANTY: Cummins Fire Power (CFP), division of Cummins NPower, LLC 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 CFP, six (6) months from CFP shipment date), the diesel fire pump drivers, manufactured and sold by CFP, 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 nontransferable 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 CFP;
- Additional components added to a diesel fire pump driver package subsequent to shipment of the engine;
- Starting batteries;
- Coolant heaters (12 months coverage).

DISCLAIMER OF WARRANTIES: Except for the Exclusive Warranty provided above, which is in lieu of all other express and implied warranties, CFP 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 CFP 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 CFP's reasonable discretion, to repair, replacement or other appropriate adjustment of a nonconforming diesel fire pump driver determined, upon CFP's inspection, to have been properly installed, maintained and operated in accordance with the Operations and Maintenance Manual furnished by CFP. IN ANY EVENT, **CFP 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 1 - Safety

1.1 Introduction

Cummin's Fire Power Manuals and Engine Manuals should be considered part of the equipment. Keep the manuals with the equipment. If the equipment is traded or sold, give the manuals to the new owner.

All personnel responsible for operation and maintenance of the equipment should read and thoroughly understand this manual.

1.2 Advisory and Cautionary Statements

Advisory and Cautionary Statements are used throughout this manual to call attention to special information, correct operating procedures, and safety precautions.

NOTE: *A general advisory statement relating to equipment operation and maintenance procedures.*

IMPORTANT: *A specific advisory statement intended to prevent damage to the equipment or associated components.*

Cautionary Statements consist of two levels:

WARNING

Indicates the presence of a hazard which CAN cause severe personal injury.

CAUTION

Indicates the presence of a hazard which CAN cause personal injury or cause equipment damage.

1.3 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. When they apply, special safety precautions are included with operating procedures.

Warning: Before manual operation, perform a walk around inspection and alert all area personnel that the equipment will be starting.

Warning: Do not operate faulty or damaged equipment. Ensure that all hoses, pipe connections, clamps, and guards are in place and securely fastened. Electrical components should be kept in good working condition and repaired immediately by qualified personnel.

Warning: After performing maintenance, remove all tools and foreign materials, reinstall and securely fasten ALL guards, covers, and protective devices.

Warning: Exposed in-running belt nips can cause severe personal injury or dismemberment. Ensure that guards are in place and securely fastened before operation.

Warning: Rotating drive shafts can lacerate, dismember, or cause strangulation. Keep hands, body parts, long hair, or loose-fitting clothing clear at all times.

Warning: Never attempt to manually clean a machine while it is operating or in standby mode.

Warning: Never open ports on tanks or piping while the engine is operating. Contact with pressurized agents can cause severe personal injury.

Warning: Relieve all pressure in the air, oil, and cooling systems before any lines, fittings, or related items are removed or disconnected.

Caution: Engine fuel is flammable when in contact with electrical spark or flame sources. Remove all sources of spark or flame from the work area.

Caution: Always use the same fastener part number (or equivalent) when replacing fasteners.

Caution: Some state and federal agencies in the USA have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Dispose of waste oil in accordance with applicable requirements.

Section 2 - Description and Figures

2.1 Introduction

This manual contains information for the correct operation and maintenance of a Cummins Fire Pump Engine. Refer to the general safety instructions in Section 1 - Safety.

This manual covers installation, operation, and maintenance of specific engine models. Most illustrations are representations that are common between models. Where differences occur, refer to the standard Fire Pump Manual, Section 8 - Component Parts and Assemblies, for detailed information and emissions ratings.

Cummins Fire Power, Cummins NPower, and Cummins Inc. reserve the right to make changes at any time without obligation.

2.2 Fire Pump Engines

Cummins complete line of fire pump engines have been approved by Factory Mutual Approvals and listed by Underwriter's Laboratories, Inc. and Underwriter's Laboratories of Canada.

No deviations to supplied equipment from Cummins Fire Power are permitted without prior written approval.

2.3 Engine Control Panel

The engine control panel is mounted on the left side of the engine at the flywheel end.

The engine control panel contains controls for starting, monitoring engine performance, and controlling fire pump engine operation.

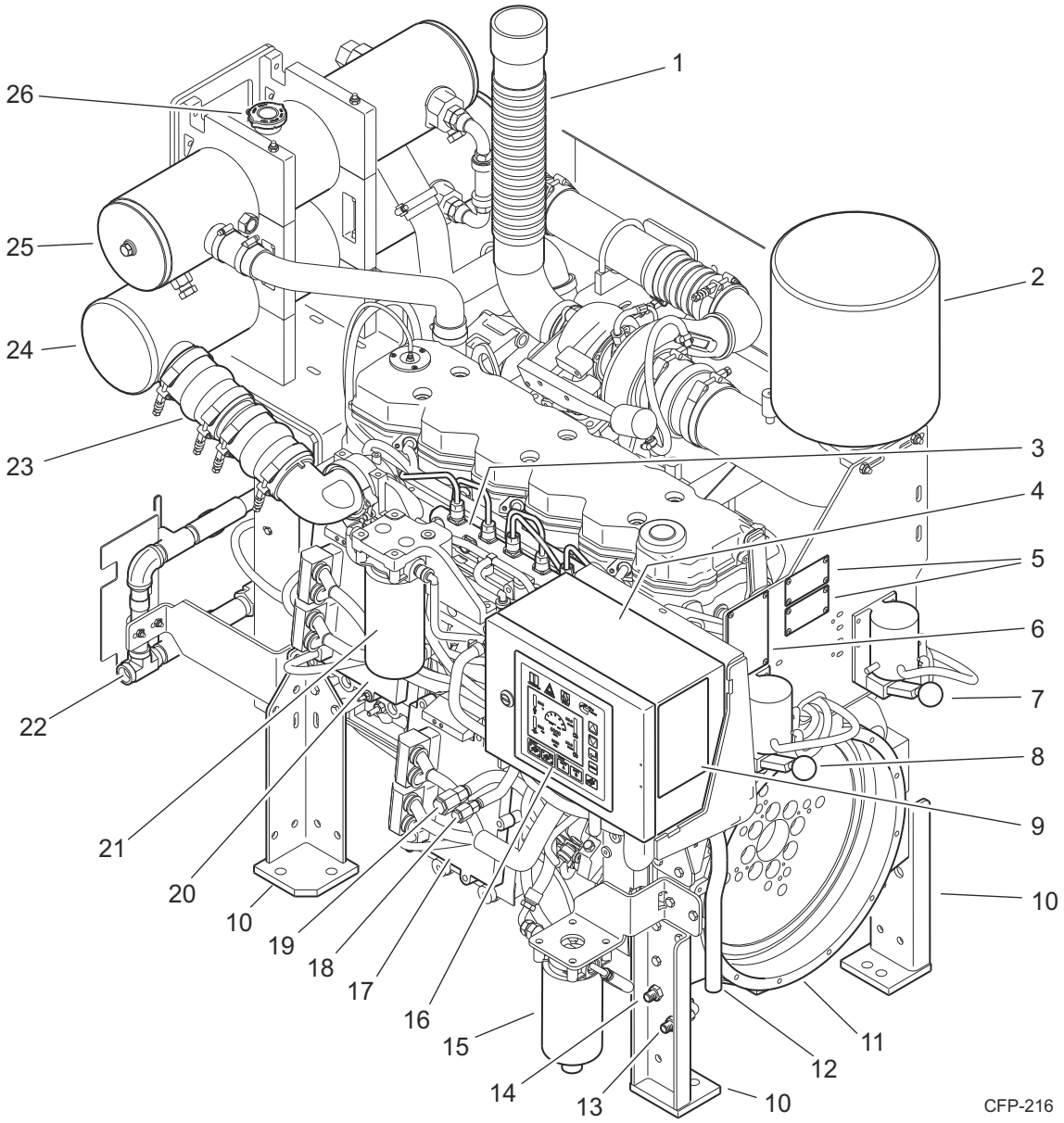
Refer to Section 4 - Controls for additional information.

2.3.1 Overspeed Function Feature

Each engine is equipped with an electronic overspeed control which activates the fuel pump solenoid valve or ECM ignition to shut off the engine when the RPM exceeds a preset limit. The overspeed control senses engine speed during the start cycle and stops the starting motor cranking cycle.

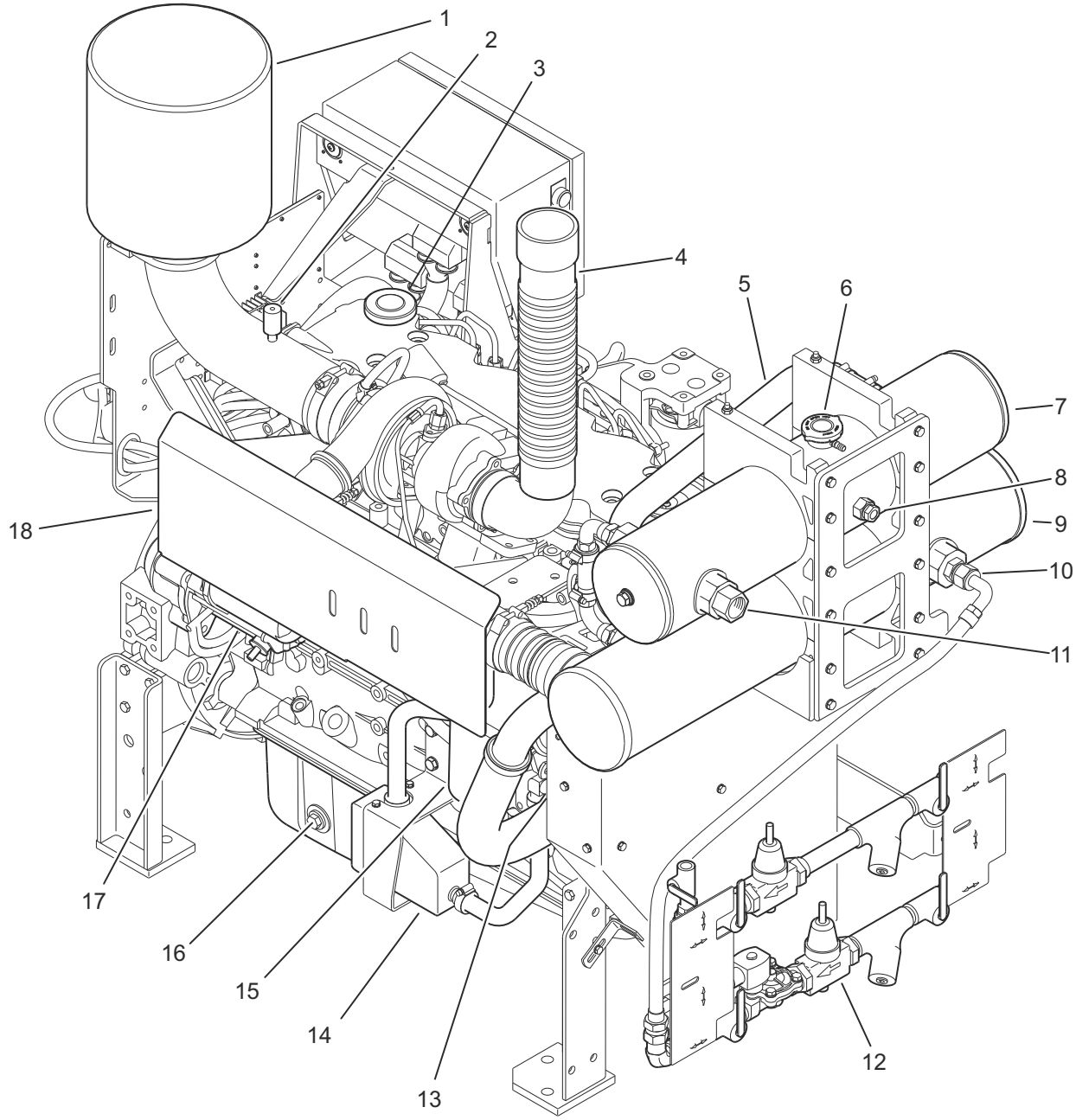
2.3.2 Operating Speed

All Cummins fire pump engines are shipped from the factory adjusted to the requested operating speed (RPM). Final operating speed adjustment must be made during the in-service inspection to obtain the required operating speed specified by the pump manufacturer.



1. Exhaust Flex Connection
2. Air Cleaner Assembly
3. Fuel System
4. Terminal Box (inside EDCP)
5. Engine Speed Setting Plates
6. Engine Serial Number Plate
7. Battery Starter Contactor B
8. Battery Starter Contactor A
9. Manual Start Instruction Decal
10. Engine Supports
11. Flywheel Housing
12. Crankcase Ventilation Hose
13. Fuel Return Outlet (optional location)
14. Fuel Inlet (optional location)
15. Fuel Pre-Filter/Water Separator
16. Engine Digital Control Panel
17. Electronic Control Module (ECM) B
18. Fuel Return Outlet
19. Fuel Inlet
20. Electronic Control Module (ECM) A
21. Primary Fuel Filter
22. Raw Water Inlet (optional manifold)
23. Charge Air Cooler Outlet Air Hose
24. Charge Air Cooler (CAC) Heat Exchanger (model specific)
25. Coolant Heat Exchanger/Expansion Tank
26. Coolant Pressure/Fill Cap

Figure 2-1 Engine Components - Control Panel Side (typical)



1. Air Cleaner Assembly
2. Air Cleaner Service Indicator
3. Engine Oil Fill Port
4. Exhaust Flex Connection
5. Upper Coolant Hose
6. Coolant Pressure/Fill Cap
7. Coolant Heat Exchanger/Expansion Tank (model specific)
8. Coolant Level Sight Glass
9. Charge Air Cooler (CAC) Heat Exchanger
10. Raw Water Inlet (standard)
11. Raw Water Outlet
12. Raw Water Cooling Loop Manifold (optional)
13. Alternator (located behind pulley guard)
14. Engine Coolant Heater
15. Engine Oil Filter
16. Engine Oil Pan/Drain
17. Starter Motor
18. Manifold Heat Shield

Figure 2-2 Engine Components - Turbocharger Side (typical)

2.4 Fire Pump Controller

The fire pump controller is not supplied by Cummins Fire Power or Cummins Inc. The fire pump controller starts the engine automatically when a remote fire demand signal is initiated and automatically shuts down the engine when the fire demand signal is discontinued.

The engine may be started locally in the manual mode and shut down using the engine digital control panel stop button.

2.5 Air Intake System

The air intake system supplies combustion air to the fire pump engine cylinders. The air filter prevents particulate matter from entering the air intake. Combustion air drawn into the system by the turbocharger is directed through the Charge Air Cooler (CAC) heat exchanger for cooling before entering the intake manifold where the charge air is mixed with fuel. Refer to Figure 2-4.

2.6 Cooling System

Water entering the cooling system through the raw water inlet, first circulates through the charge air cooler heat exchanger, cooling the compressed air from the turbocharger outlet ducting. The cooled combustion air exits the CAC outlet duct to the engine air intake manifold. Refer to Figure 2-5.

NOTE: *The raw water supply must be immediately available when the engine is started.*

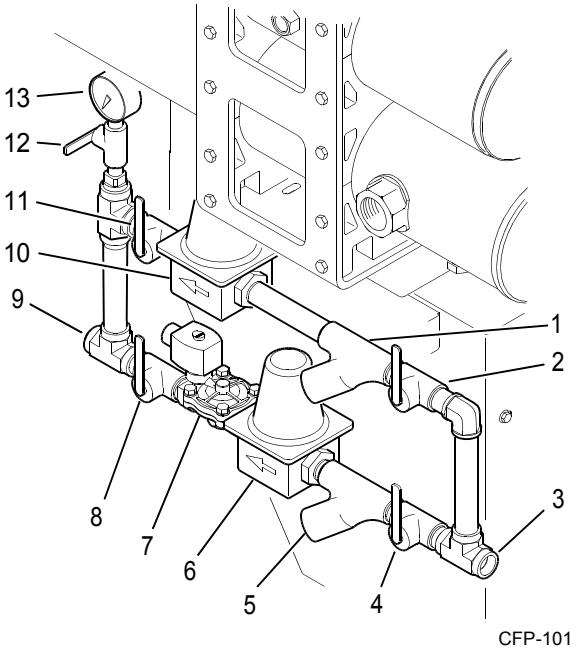
The raw water from the CAC heat exchanger then passes through the engine coolant heat exchanger. The raw water exits the coolant heat exchanger through a discharge connection.

IMPORTANT: *If the raw water manifold assembly is supplied by the customer, they must provide raw water supply piping and components equivalent to components supplied by Cummins Fire Power. Refer to National Fire Protection Association NFPA 20 for installation requirements.*

The engine coolant system contains a mixture of at least 50 % antifreeze and 50 % water. The coolant level should be maintained so it is visible in the coolant level sight gauge.

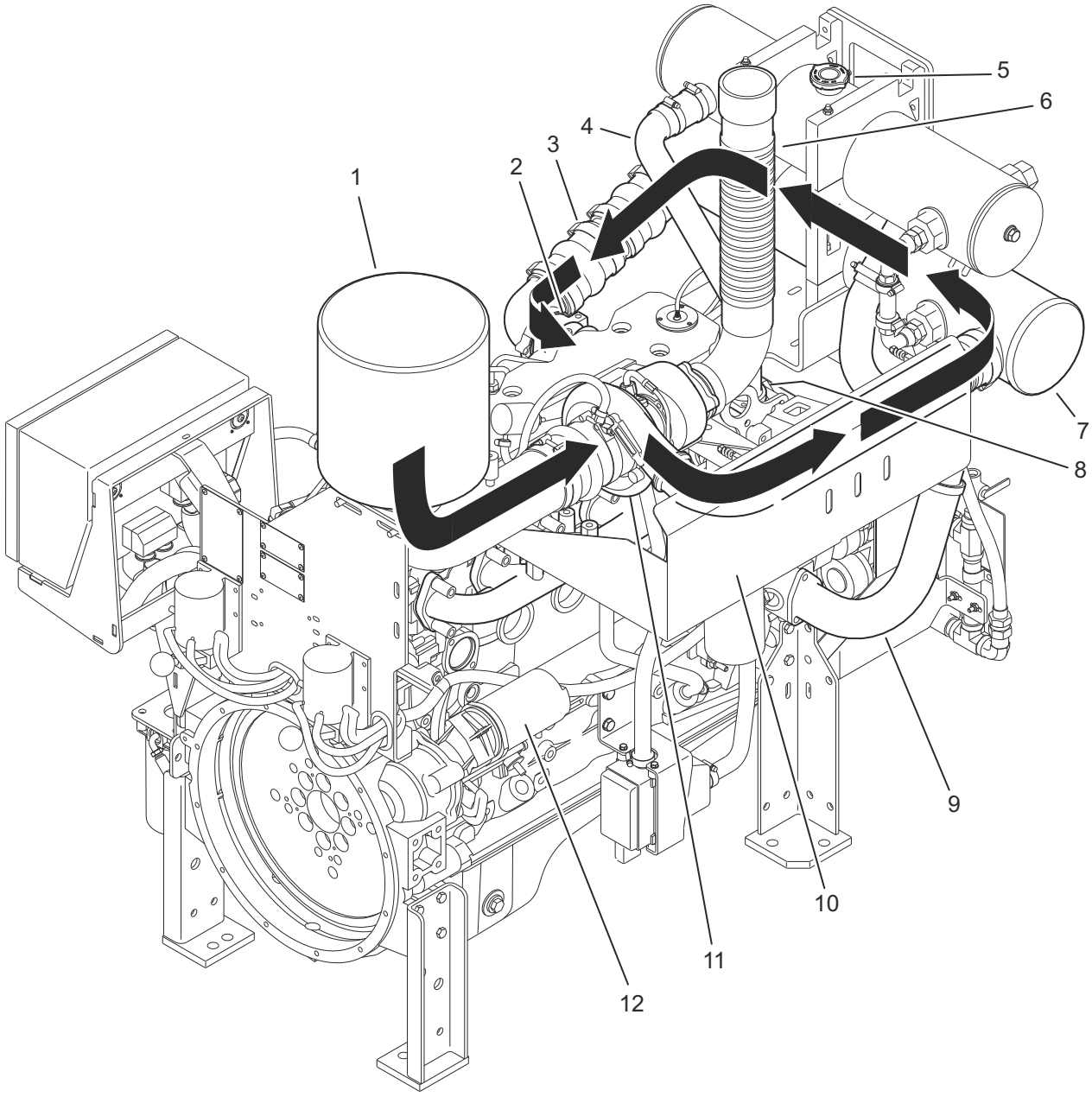
⚠ CAUTION

Continuous operation with low coolant temperature (below 70° C [158° F]) or high coolant temperature (above 107° C [225° F]) can damage the engine. Verify raw water pressure and flow.



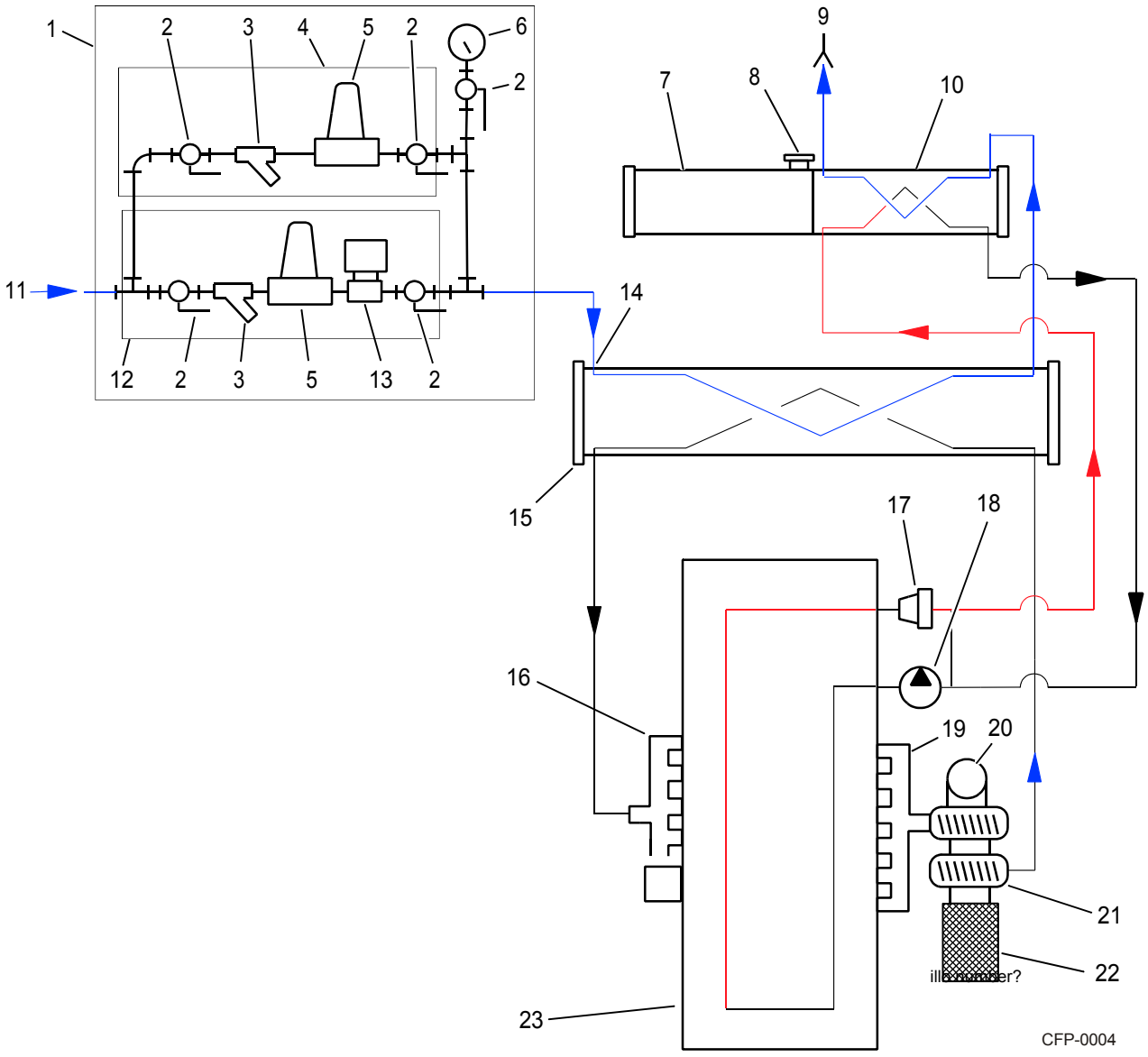
1. Bypass Water Strainer
2. Bypass Water Inlet Valve
3. Raw Water Inlet
4. Normal Water Inlet Valve
5. Normal Water Strainer
6. Normal Water Pressure Regulator
7. Normal Water Solenoid Valve
8. Normal Water Outlet Valve
9. Outlet To Heat Exchanger
10. Bypass Water Pressure Regulator
11. Bypass Water Outlet Valve
12. Pressure Gauge Isolation Valve
13. Water Supply Pressure Gauge

Figure 2-3 Raw Water Manifold (typical)



1. Air Cleaner Assembly (intake)
2. Combustion Air Intake Manifold
3. Charge Air Cooler Outlet Hose/Pipe - Turbo-charged Air Connection
4. Upper Coolant Hose
5. Coolant Pressure/Fill Cap
6. Exhaust Flex Connection
7. Charge Air Cooler (CAC) Heat Exchanger (model specific)
8. Thermostat Housing
9. Lower Coolant Hose
10. Manifold Heat Shield
11. Turbocharger
12. Starter

Figure 2-4 Engine Air Intake and Charge Air Cooling Flow Diagram (typical)



1. Raw Water Manifold (optional)
2. Manual Shut-off Valve
3. Raw Water Strainer
4. Raw Water - Bypass Loop
5. Raw Water Pressure Regulator
6. Raw Water Pressure Gauge
7. Coolant Expansion Tank
8. Coolant Pressure/Fill Cap
9. Raw Water Return Connection
10. Coolant Heat Exchanger
11. Raw Water Supply Connection (optional)
12. Raw Water - Normal Loop
13. Raw Water Solenoid Valve
14. Raw Water Supply Connection (standard)
15. Charge Air Cooler (CAC)/Heat Exchanger (model specific)
16. Combustion Air Intake Manifold
17. Thermostat
18. Coolant Pump
19. Exhaust Mannifold
20. Exhaust Connection
21. Turbocharger
22. Air Filter
23. Engine Block

Figure 2-5 Engine Cooling System Flow Diagram (typical)

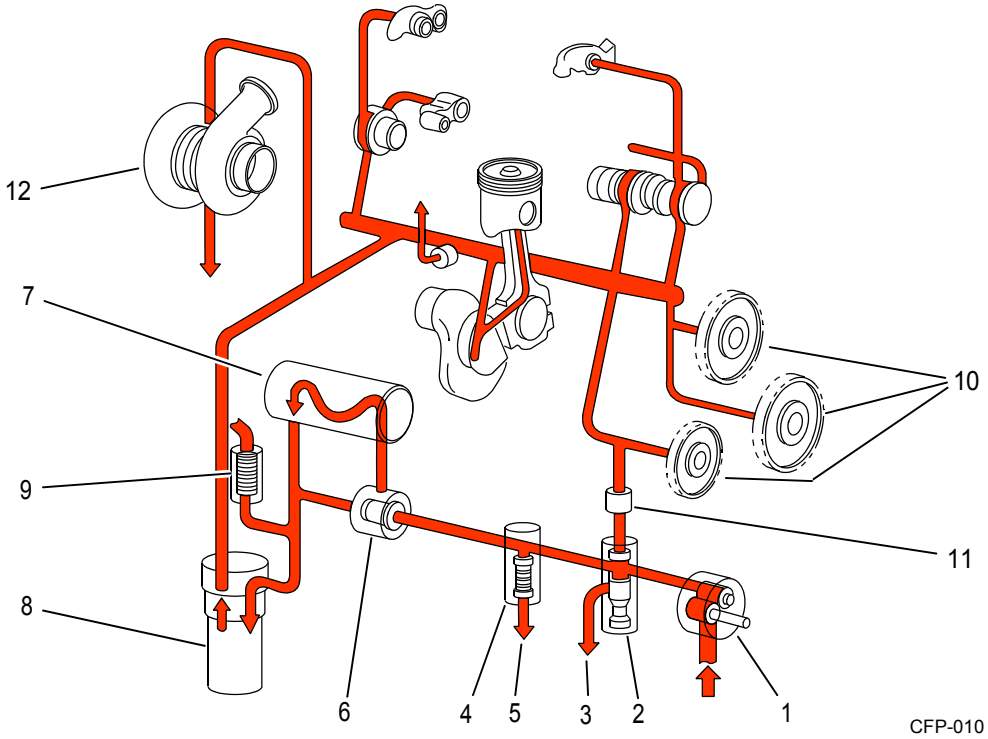
2.7 Fuel Supply and Drain Location

The fuel supply and return connections are centrally located on the fuel pump side of the engine. Refer to Figure 2-1. Refer to the Engine Data Sheets in Section 8 of the standard Fire Pump Manual for allowable fuel tank supply locations.

2.8 Engine Oil System

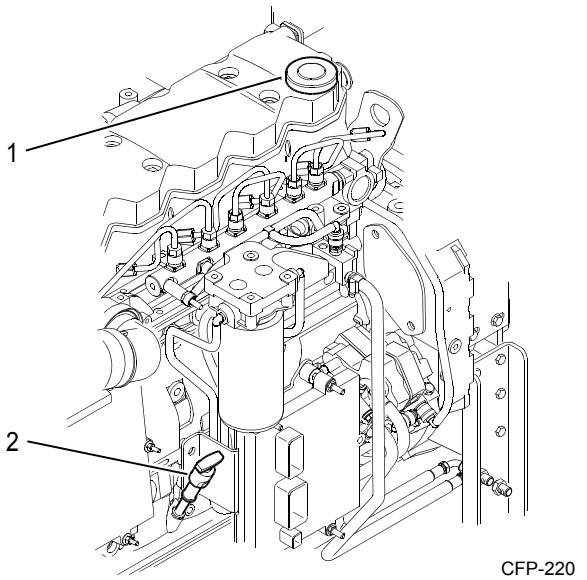
The engine oil system lubricates moving internal engine parts (pistons, piston arms, valves, cam shafts, drive shafts, and bearings). The oil pump circulates oil from the oil pan, through the oil filter, and into engine areas where friction may develop. Typically, engine oil has been added during manufacture and testing procedures, however, shipping restrictions can affect whether the oil is maintained in the engine or drained for shipment.

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



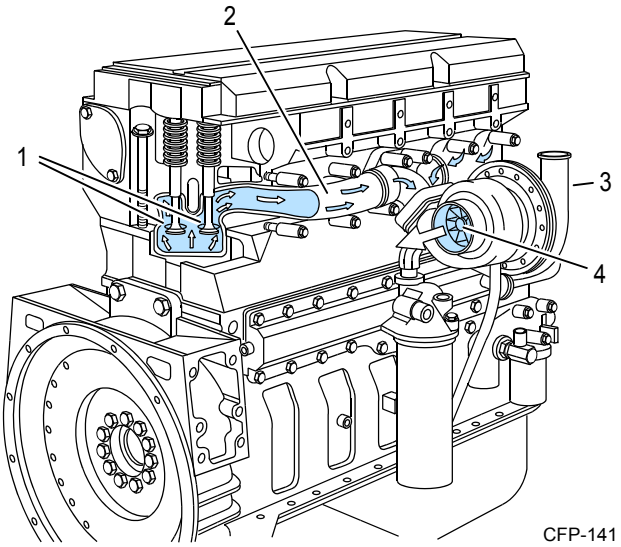
1. Oil Pump
2. Pressure Regulator Valve
3. Oil Return to Pan
4. High Pressure Relief Valve
5. Oil Return to Pan
6. Oil Thermostat
7. Oil Cooler
8. Combination Oil Filter
9. Filter Bypass Gears
10. Idler Gears
11. Viscosity Sensor
12. Turbocharger

Figure 2-6 Engine Lubricating Oil System Flow Diagram (typical)



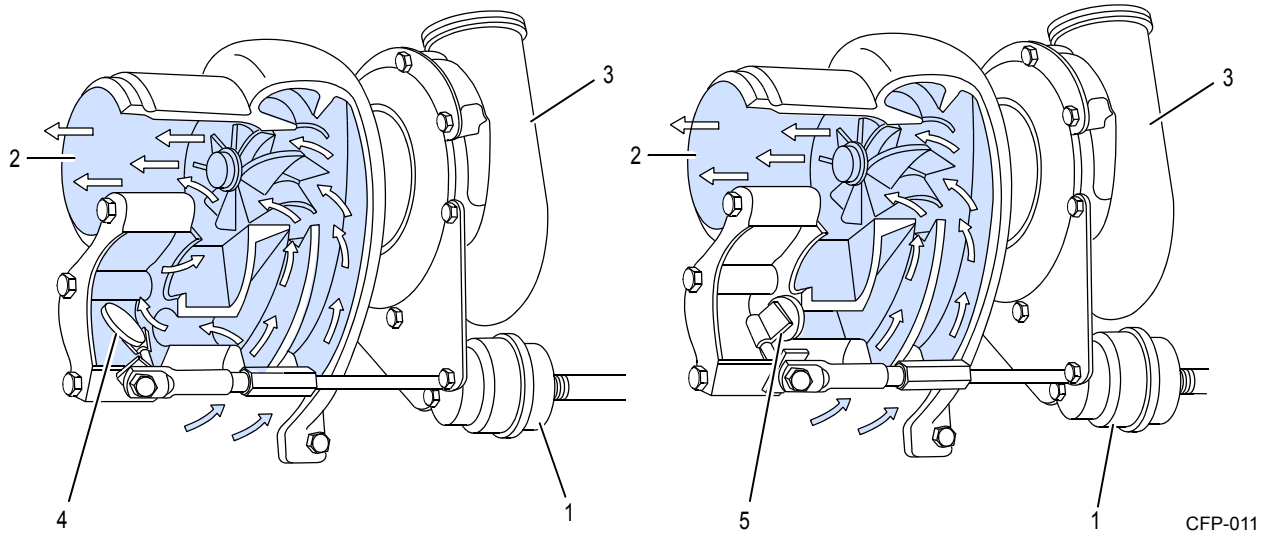
1. Engine Oil Fill Port
2. Engine Oil Level Dipstick

Figure 2-7 Oil Level Dipstick and Fill Port (typ.)



1. Exhaust Valve Ports
2. Engine Exhaust Manifold
3. Combustion Air to Charge Air Cooler
4. Turbocharger Turbine

Figure 2-8 Exhaust System Flow Diagram (typ.)



1. Wastegate Actuator Cylinder
2. Exhaust Flow to Flex Pipe
3. Combustion Air to Charge Air Cooler
4. Wastegate OPEN
5. Wastegate CLOSED

Figure 2-9 Turbocharger Exhaust Flow Diagram (typical)

Section 3 - Installation

3.1 Equipment Installation

The equipment should be installed by trained technicians familiar with local codes and regulations.

Refer to National Fire Protection Association NFPA 20 for installation and applicable local code requirements and NFPA 25 for inspection, testing, and maintenance requirements.

3.1.1 Drive Shaft Installation

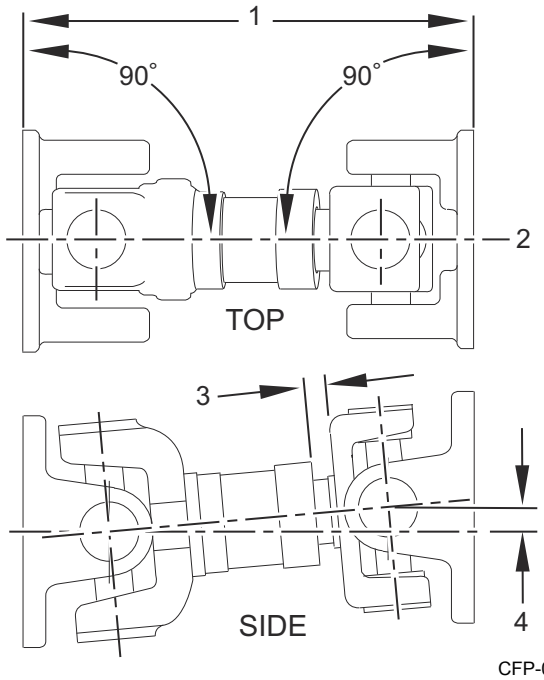
Refer to the general fire pump and engine layout drawings for installation dimensions supplied with this manual.

If the engine is assembled with the drive line, pump, and mounting base, use the lifting points provided on the mounting base or lift the entire skid using an approved fork lift.

CAUTION

Ensure that the lifting device or forklift is capable of safely lifting the weight of the engine or the combined weight of the assembled pump base, drive line, and pump.

1. Ensure that the engine and pump are correctly aligned.
   a. Ensure engine position is centered on frame side to side within ± .76 mm (.03 in), by measuring outside of frame side to engine support leg mounting pad. (Compare the two front engine supports and two back engine supports).
   b. Align engine center line to pump center line within ± .76 mm (.03 in). Refer to Figure 3-1.
   c. The pump center line to the engine crankshaft center line (in vertical plane) is to be 2° ± 1°.
   d. Drive shaft mounting flanges must be parallel.
2. Lubricate grease fittings on the drive shaft universal joint. Refer to Figure 3-2.
3. Check that the pump is properly installed per the pump manufacturer's specifications.



1. Planes Must Be Parallel
2. Align Both Mounting Center lines to ± .76 mm (.03 in)
3. Distance to Equal Half of Total Travel
4. 2° ± 1°

Figure 3-1 Drive Shaft Alignment

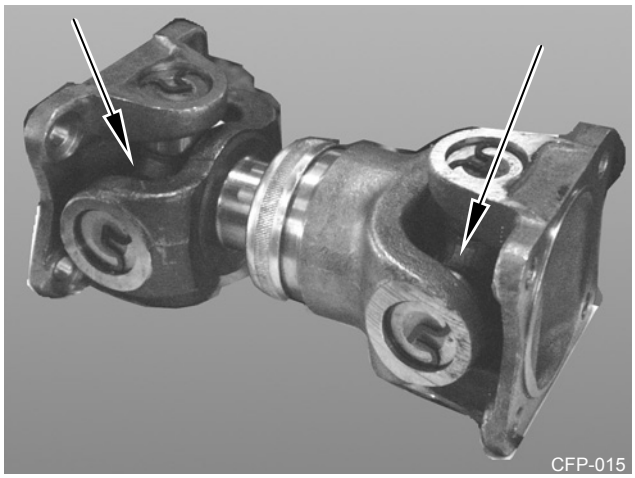


Figure 3-2 Drive Shaft Universal Joint Grease Fittings

3.2 Fuel System Installation

1. Install a properly rated fuel tank per NFPA 20 guidelines.

2. Install properly sized fuel and return lines per the model specific Engine Data Sheet in Section 8 of the standard Fire Pump Manual.

NOTE: *DO NOT use copper or galvanized pipe for the fuel return or supply lines.*

3.2.1 Fuel Recommendations

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

CAUTION

Use ONLY no. 2 diesel (ASTM no. 2D) fuel. Any adjustment to compensate for reduced performance with a fuel system using alternate fuel is not warrantable.

3.3 Raw Water Supply Installation

Raw water circulated through the system cools the engine. Refer to Figure 2-3 and Figure 2-5.

IMPORTANT: *The raw water supply must be immediately available when the engine is started. Ensure that the supply line valves are in the OPEN position.*

CAUTION

Raw water supplied shall not exceed 414 kPa (60 psi).

3.3.1 Install Raw Water Piping

NOTE: *The velocity of the raw water should be as great as possible without exceeding the maximum allowable pressure shown in the model specific Engine Data Sheet in Section 8 of the standard Fire Pump Manual.*

1. Provide a raw water discharge line at the outlet of the engine coolant heat exchanger and provide a raw water supply line to the engine assembly raw water inlet per the model specific Engine Data Sheet in Section 8 of the standard Fire Pump Manual.

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

2. Check both pressure regulator settings with water flowing through the heat exchanger. If supplied as an option from CFP, both water pressure regulators have been set at 207 kPa (30 psi) or slightly less water pressure, during manufacture and testing.

IMPORTANT: *The manual raw water valves for the automatic loop should remain OPEN at ALL times. The manual raw water valves for the bypass loop should be CLOSED during automatic (pump controller) operation.*

IMPORTANT: The minimum raw water flow rate and engine operating temperature are provided in the model specific Engine Data Sheet in Section 8 of the standard Fire Pump Manual.

3.4 Battery Requirements

One set of batteries must be supplied for the standard 12VDC operating voltage. Two redundant sets of batteries must be supplied for the optional 24 VDC operating voltage. Refer to National Fire Protection Association NFPA 20 and Section 1 - Safety of this manual for additional battery installation information.

The minimum recommended reserve capacity (SAE RC) and cold cranking ampere (SAE CCA) values and system requirements for a particular engine can

be found in the Engine Data Sheet in Section 8 of the standard Fire Pump Manual.

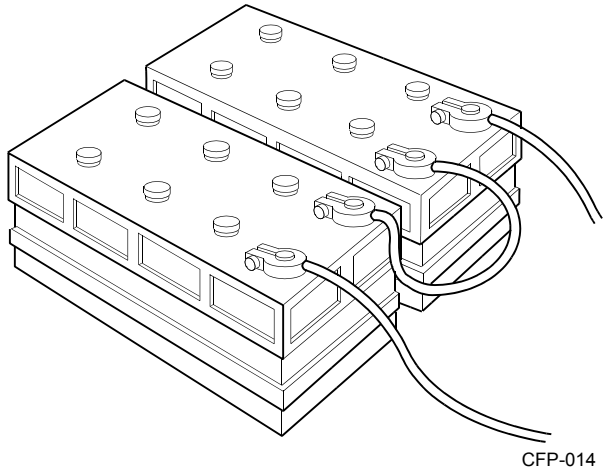


Figure 3-3 Series Battery Connection - 24 VDC (shown)

WARNING

Battery electrolyte (sulfuric acid) is highly caustic and can burn clothing and skin. Wear acid impervious neoprene gloves and safety goggles, or full face shield, when working with the batteries.

CAUTION

DO NOT connect battery charging cables to any electronic control system component. This can damage the electronic control system.

WARNING

Batteries can emit explosive gases during charging. Always ventilate the compartment before servicing the batteries. Remove sources of spark or open flame. To avoid arcing, remove the negative (-) battery cable first and attach the negative (-) battery cable last when reconnecting.

3.5 Signal and Control Installation

This section explains how to connect the controller wires to the terminal block.

1. Ensure that the fire control system is properly installed and configured per the manufacturer's instructions.
2. Complete the fire pump controller wiring (customer supplied) per the manufacturer's instructions.
3. Connect the following wires to the fire pump engine digital control panel per the engine electrical diagrams. Refer to Figure 3-4.
   a. TB-1: Connect the control power from the fire pump controller. This power source is necessary for fire pump operations while in the AUTO mode.
   b. TB-2: Connect the crank termination input signal for the fire pump controller. This 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.
   c. TB-3: Connect the remote overspeed alarm input to the fire pump controller. This signal is present when the overspeed control module has operated. If this event occurs, the fire pump engine will stop.
   d. TB-4: Connect the low oil pressure alarm input from the fire pump controller. This 0 VDC grounded signal is present when the oil pressure has dropped below the 83 ± 13 kPa (12 ± 2 psi) set point
   e. TB-5: Connect the high coolant temperature alarm input from the fire pump controller. This 0 VDC grounded signal is activated when the engine is running and the coolant temperature is at or above 93° C (200° F). The alarm will deactivate when the engine is running and the coolant temperature drops below 88° C (190° F).
   f. TB-6: Connect battery set A lead from the controller. The controller senses battery A charge state and charges the battery through this heavy gauge wire.
   g. TB-8: Connect battery set B lead from the controller. The controller senses battery B charge state and charges the battery through this heavy gauge wire.
   h. TB-9: Connect crank from battery A lead. During a cranking cycle, the controller energizes the coil of starter contactor A through terminal TB-9 to start the engine.

i. TB-10: Connect crank from battery B lead. During a cranking cycle, the controller energizes the coil of starter contactor B through terminal TB-10 to start the engine.

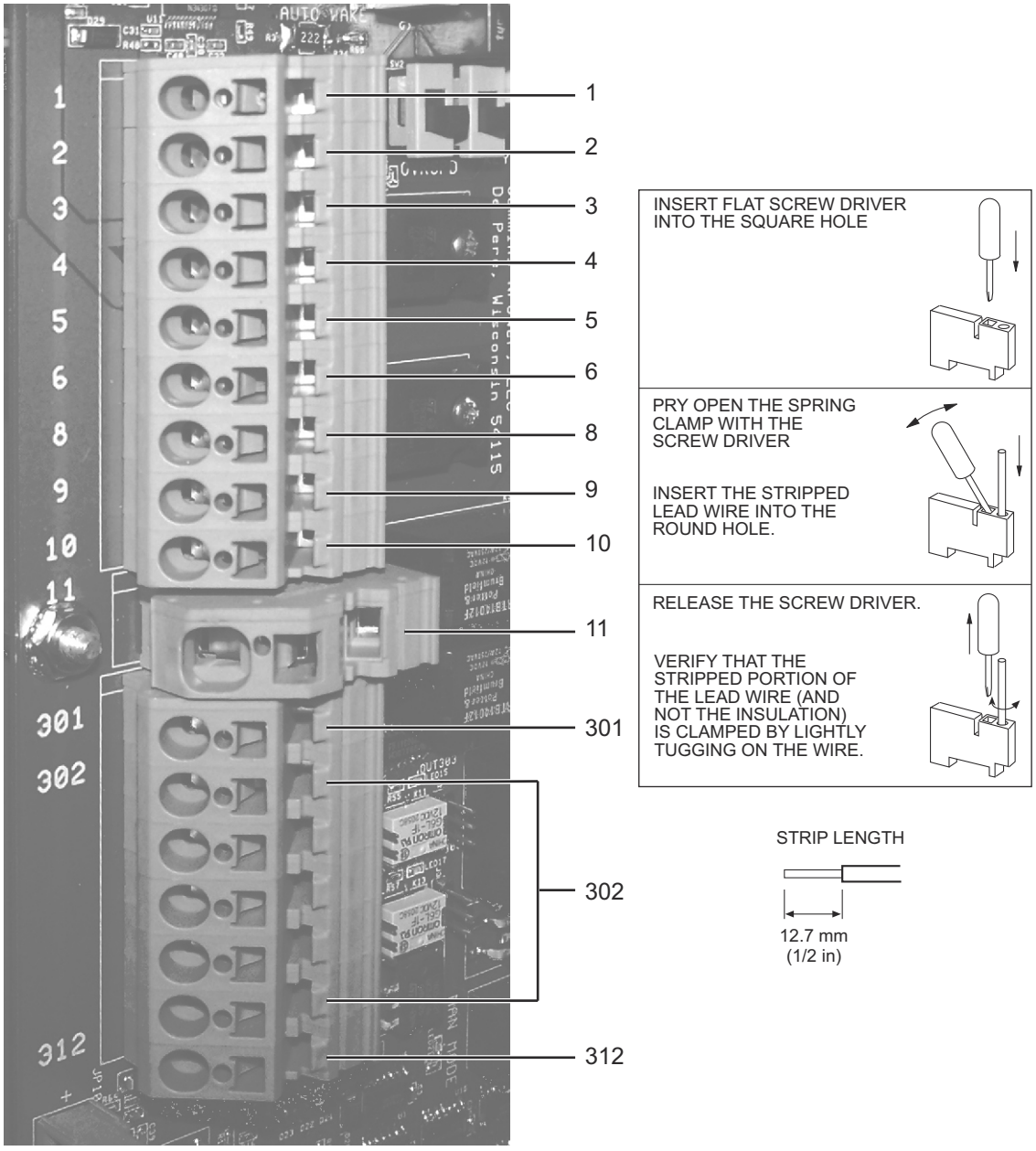


Figure 3-4 Termination Blocks and Wiring Decal

j. TB-11: Connect the battery ground lead from the controller. This heavy gauge wire provides a common ground between the engine and controller.

k. TB-301: Connect the operating on alternate ECM lead. This 0 VDC ground signal is present when the engine's ECM selector is set to ECM-B. For mechanical engine models, this terminal is not active.

l. TB-302: Connect the ECM/fuel fault signal wire. This 0 VDC ground signal is present when the engine signals a trouble fault. For

mechanical engine models, this terminal is not active.

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

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

6. Check that both voltmeters on the engine digital control panel indicate the approximate battery voltage.

7. Both batteries can be used for starting the engine in the event one of the batteries is low.

3.6 Coolant System Preparation

The fire pump engine cooling system was initially filled during manufacture and testing.

NOTE: *Additional coolant flow diagrams can be found in the engine manual.*

WARNING

Do not remove the pressure/fill cap from a hot engine. Heated coolant spray or steam can cause personal injury.

1. Inspect the engine coolant hoses and hose clamps. Ensure that all coolant hoses and clamps are properly installed and tight.

2. Ensure that the engine coolant level is visible at the center of each expansion tank sight gauge. Add coolant as required. DO NOT OVERFILL!

3. Ensure that water is present in the engine coolant heater before energizing heater.

3.7 Lubricating Oil System Preparation

The fire pump engine was initially lubricated during manufacture and testing.

CAUTION

Ensure that all cooling and lubrication systems have been filled to the proper level before operation.

3.8 Pre-Start Inspections

Perform a visual inspection as follows:

1. Check that there is no apparent damage and that all components are installed.

2. Check that the drive belt is properly installed.

3. Check that all hoses and tubes are properly installed.

4. Check that all electrical connections are properly installed.

5. Check that the fire pump is properly installed per the pump manufacturer's instructions, is correctly aligned, and is free to rotate.

6. After completing preliminary set-up procedures, perform the engine start test procedures as outlined in detail in Section 5 - Operation.

WARNING

Before operating the equipment, complete all safety checks, remove all tools and foreign objects from the equipment, and ensure that all guards are in place and securely fastened. Alert area personnel that the equipment will be starting. Unintentional equipment start-up or contact with exposed or moving components can cause personal injury or equipment damage.

3.9 Engine Monitoring

When the engine starts, it is important to monitor the displays.

CAUTION

If the oil pressure is not displayed on the gauge, or it is not within the rated range, or if the low oil pressure lamp is illuminated for 15 seconds, STOP THE ENGINE immediately! Continued operation without proper lubrication will cause engine damage.

1. 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.

2. The minimum raw water flow rate is provided in the model specific Engine Data Sheets in Section 8 of the standard Fire Pump Manual.

3. The maximum allowable pressure shall not exceed 414 kPa (60 psi).

CAUTION

If the water temperature display is not reading properly, or if the water temperature lamp is illuminated for 15 seconds, STOP THE ENGINE.

4. Ensure that engine operating temperature stabilizes within the applicable range as identified in the model specific Engine Data Sheet in Section 8 of the standard Fire Pump Manual.
5. Operate the engine for 8 to 10 minutes.
6. Inspect for leaks, unusual noises, or other indications of incorrect operation.
7. Shut off the engine by pressing and holding the RESET/STOP button.
8. Check that the raw water flow stops automatically shortly after the engine stops.
9. Correct any problems found during the inspection before proceeding.
10. Check the engine oil level.
11. Check the coolant level.
12. Check the raw water strainers. Clean the strainers as required per the instructions in Section 6 - Maintenance of the standard Fire Pump Manual.
13. Perform engine speed control and safety system tests per the instructions in Section 5 - Operation.

Section 4 - Controls

4.1 Engine Digital Control Panel

The Engine Digital Control Panel (EDCP) contains controls for starting, monitoring engine performance, and controlling fire pump engine operation. Refer to Figure 4-1. In manual mode, the panel remains active as long as battery power is available. In auto mode, the panel is active when battery power is present on TB-1, otherwise it goes into standby mode after 30 minutes of no battery voltage on TB-1.

4.1.1 Warning Lamp

Illuminates (yellow) in the event that the ECM has sensed a non-mission disabling fault.

4.1.2 Fault Indicator Lamp

Indicates Fuel Injection Fault (FIF) and illuminates (red) in the event that the ECM has detected a fuel injection fault or primary sensor fault.

The engine digital control panel also sends a ground signal to terminal buss #302 which sends a signal to set off an alarm on the fire pump system controller to indicate a FIF fault.

4.1.3 Scroll Buttons

Used to scroll up or down when in the menus.

4.1.4 Enter Button

Used when making changes in the menu screen.

4.1.5 Menu Button

Opens the menu option on the display.

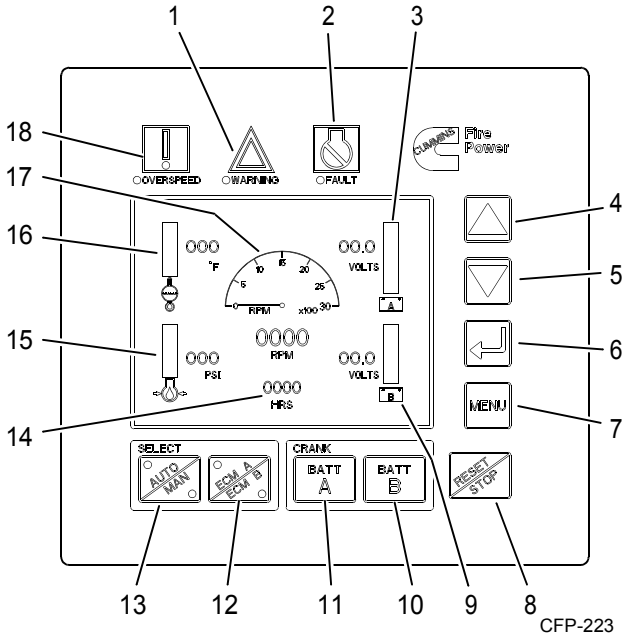
4.1.6 Overspeed RESET/STOP Switch

Used to shut off the engine at the engine digital control panel.

Pressing the overspeed RESET switch after correcting an engine overspeed shutdown resets the overspeed control module, allowing subsequent restarts of the fire pump engine.

4.1.7 Battery A and B Voltmeters

The battery voltmeters display the charge status (VDC) of the relative battery connections.



1. Warning Lamp
2. Fault Lamp
3. Battery “A” Voltmeter
4. Scroll UP Button
5. Scroll DOWN Button
6. ENTER Button
7. MENU Button
8. Overspeed RESET/STOP Switch
9. Battery “B” Voltmeter
10. Crank Battery B Momentary Start Button
11. Crank Battery A Momentary Start Button
12. ECM A/B Selector Switch & Indicator Lamps
13. AUTO/MAN Mode Switch & Indicator Lamps
14. Hour Meter
15. Engine Oil Pressure
16. Coolant Temperature
17. Tachometer
18. Overspeed Warning Lamp

Figure 4-1 Engine Digital Control Panel (EDCP)

4.1.8 Tachometer and Hour Meter

The tachometer displays the engine speed in Revolutions Per Minute (RPM) whenever the engine is operating. The hour meter maintains a running total of the hours of operation (run time).

4.1.9 ECM A/B Indicator Lamps - Applicable on Electronic Engines

The ECM indicator lamps (yellow) will illuminate, indicating the ECM is being used to control the engine. If the ECM switch is in the ECM A (normal) position, ECM A is controlling the engine. Refer to Figure 4-1.

If the ECM switch is in the ECM B (alternate) position, ECM B is controlling the engine. When the alternate (B) ECM is selected, the EDCP will send a ground signal to terminal buss #301, which will send a signal to set off an alarm on the fire pump system controller to indicate that the engine is operating on the alternate ECM.

4.1.10 Crank Battery A or B Buttons

The CRANK BATT A or CRANK BATT B buttons initiate an immediate engine start (momentary start) using the selected A or B crank battery.

Crank A or B will energize battery contactor A or B, depending on which one is selected.

Both A and B buttons can be energized at the same time in the event both batteries are weak.

4.1.11 AUTO/MANUAL Mode

The AUTO/MANUAL mode determines whether the engine starts and is controlled by the operator (MANUAL) or by an automatic signal from the fire pump system controller (AUTO). The lamp (yellow) is illuminated on which mode is selected.

The MANUAL mode is typically used for engine setup, testing, and emergency and maintenance procedures.

The AUTO mode is used to start the engine under the control of the fire pump control system. In the auto mode, the fire pump engine stops upon loss of signal power from the fire pump controller.

4.1.12 Coolant Temperature Gauge

The coolant temperature gauge displays the engine coolant temperature.

4.1.13 Engine Oil Pressure Gauge

The engine oil pressure gauge displays the engine oil pressure. The gauge is independent of the low oil pressure alarm.

4.1.14 Engine Overspeed Warning Lamp

The overspeed control module monitors engine speed. If the engine RPM's exceed 115% rated speed, the engine overspeed warning lamp is illuminated (yellow).

The Engine Digital Control Panel (EDCP) will send a power signal to terminal buss #3 which will send a signal to set off an alarm on the fire pump system controller, indicating that an overspeed condition has occurred.

The EDCP will automatically switch to MANUAL mode and will shut the engine down. After the overspeed has been reset by using the RESET/STOP switch on the EDCP, the engine operation will revert to the original AUTO mode position.

NOTE: *The engine will not be allowed to restart automatically from the fire pump system controller until the EDCP is reset.*

4.1.15 ECM Fault Code Lamps - Applicable on Electronic Engines

The amber engine warning lamp and the red engine shutdown lamp alert the operator of engine malfunctions that is categorized as follows:

1. An illuminated amber lamp indicates an engine malfunction that requires timely operator attention.

2. An illuminated red lamp indicates an engine malfunction that requires immediate and decisive operator response.

3. A 3-4 digit diagnostic fault code will display on the EDCP which can then be used to help describe the engine malfunction.

4.1.16 Engine Stop Button

The engine stop button is located on the left side of the EDCP enclosure and is used to stop the operation of the engine in either manual or auto mode. The button must be pressed and held until the engine has stopped.

4.1.17 Engine Communications Port

This plug-in is located on the left side of the EDCP enclosure and is used for the communications connection port for Cummins Insite.

NOTE: *Insite is a Cummins Inc. computer software tool used to monitor or report engine performance criteria.*

4.1.18 Contractor Access Port

The contractor access knock-out is located on the lower side of the EDCP enclosure. This is the only 25.4 cm (1 in) knock-out provided for the installing contractor to connect the fire pump system controller to the EDCP.

IMPORTANT: *If this port is not used for the installation, all warranty on the fire pump engine will be void.*

4.1.19 Engine ECM Power Supply

This plug-in is located on the lower side of the EDCP enclosure. The power supply port supplies unswitched battery power to both ECM A and ECM B on electronic engines.

4.1.20 Engine Harness Connection

This plug-in is located on the lower side of the EDCP enclosure. The engine harness connection connects the panel to the power source, start contactors, magnetic pick-up, alternator, and other engine related functions controlled by the EDCP.

4.2 Electronic Control Module (ECM) - Applicable on Electronic Engines

The engine control system is an electronically operated fuel controls system. The ECM performs diagnostic tests on most of its circuits and will activate a fault code if a problem is detected.

4.3 Engine Protection System - Applicable on Electronic Engines

The engine ECM identifies any 3-4 digit engine fault codes and illuminates the appropriate amber warning lamp or red shutdown lamp on the operator engine digital control panel.

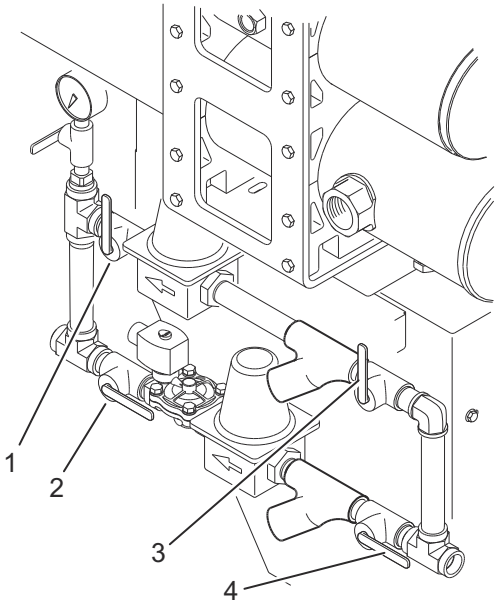
⚠ CAUTION

Normally, Cummins engines with ECMs have derate and shutdown protection calibrated into the ECM. However, the ECM on this Cummins engine has no derate or shutdown protection. The engine will run to destruction. Therefore preventive maintenance is essential.

4.4 Raw Water Flow Control Valves

1. The fire pump system controller opens the raw water normal loop solenoid valve in either manual or automatic mode. In the OPEN position, water can flow through the heat exchangers. Refer to Figure 4-2. Manual raw water valves for the automatic loop should remain OPEN at ALL times.

2. Manual raw water valves for the bypass loop should be CLOSED during automatic (fire pump system controller) operation.



1. Bypass Raw Water Manual Outlet Valve
2. Normal Raw Water Manual Outlet Valve
3. Bypass Raw Water Manual Inlet Valve
4. Normal Raw Water Manual Inlet Valve

Figure 4-2 Normal Open Raw Water Manual Valves (typical)

Section 5 - Operation

5.1 Start-up Procedures

This section provides the operator with the information required to prepare the fire pump engine for normal operation, in a safe manner. This Operator's Manual is provided for your specific equipment and should be considered a part of that equipment. All personnel responsible for the operation and maintenance of the equipment should read and thoroughly understand this manual.

WARNING

Before preparing the equipment for normal production, complete all safety checks, remove all tools and foreign objects from the equipment, ensure all guards are in place and securely fastened, and alert area personnel that the equipment will be starting.

5.2 Remote Starting Procedure

To start the engine from the fire pump controller panel:

1. Press the AUTO/MANUAL mode switch on the engine digital control panel to place the engine in the AUTO mode position. Refer to Figure 4-1.
2. Start the engine by initiating an engine crank signal from the fire pump controller.

CAUTION

If the crank termination signal is absent, the engine starter motor will continue to operate. Shut the engine off immediately at the fire pump controller panel to avoid damage to the starter.

3. The engine continues to operate as long as the RUN signal is present. When the RUN signal is terminated by the fire pump control panel, the engine stops.
4. The engine may be stopped locally by pressing the engine stop button on the side of the engine digital control panel.

5.3 Local Starting Procedure

To start the engine locally from the engine digital control panel:

1. Press the AUTO/MANUAL mode switch on the engine digital control panel to the MANUAL mode position to place the engine in manual mode.
2. Press either the CRANK BATT A or CRANK BATT B button to start the engine.

5.4 Emergency Starting Procedure

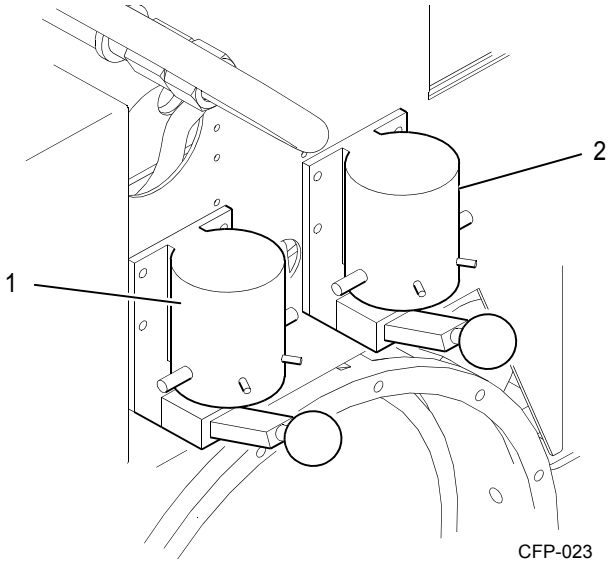
The engine starts automatically in the event of a fire emergency. However, if it fails to start automatically, the engine can be started locally from the engine digital control panel:

1. If necessary, open both manual bypass valves in the raw water supply manifold (if equipped). Refer to Figure 4-2.
2. Press the AUTO/MANUAL mode switch on the engine digital control panel to MANUAL mode position to place the engine in manual mode. Refer to Figure 4-1.
3. Press downward on the desired battery contactor lever for up to 15 seconds or until the engine starts. Repeat up to three times if necessary. Refer to Figure 5-1.
4. Release the contactor lever immediately after the engine starts.

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 up to six attempts.

5. The engine may be stopped locally by pressing and holding the stop button on the left hand side of the engine digital control panel enclosure.



1. Battery A Starter Contactor
2. Battery B Starter Contactor

Figure 5-1 Manual Starter Contactors (typical)

5.5 Engine Digital Control Panel Screens and Adjustments

The following menu screens are available for operator input and monitoring of engine parameters on the engine digital control panel menu screens.

5.5.1 Main Menu

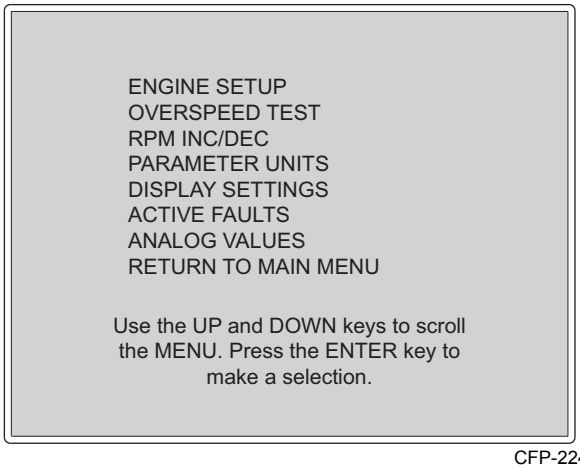


Figure 5-2 Main Menu Screen

This screen is the main menu screen for all functions.

5.5.2 Engine Set-up Screen

This screen is for Cummins Fire Power internal use.

5.5.3 Overspeed Test Screen

The engine overspeed set point was set during manufacturing and test procedures. It may, however, be necessary to adjust the overspeed set point based on the actual fire pump application.

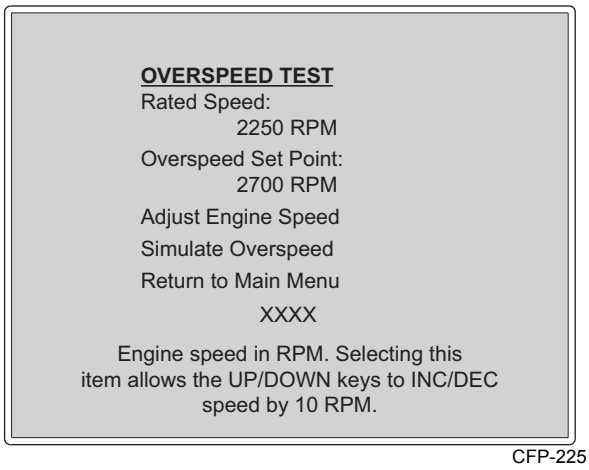


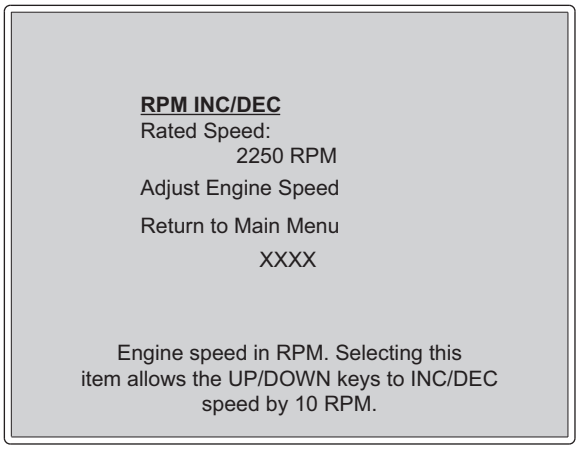
Figure 5-3 Overspeed Test Screen

The overspeed test screen will allow for two options to demonstrate overspeed:

1. Increment the engine speed up to reach overspeed set point for the specific engine model. Example above identifies 2250 RPM.
2. Used to simulate overspeed for engine speed models above 2250 RPM or for instances when over-pressurizing of sprinkler systems can cause damage.

NOTE: *If Option 1 is selected, the engine speed will have to be manually reset back to pump rated speed after overspeed test is completed. Use the RESET/STOP button to reset engine back to the original values.*

5.5.4 RPM INC/DEC Screen



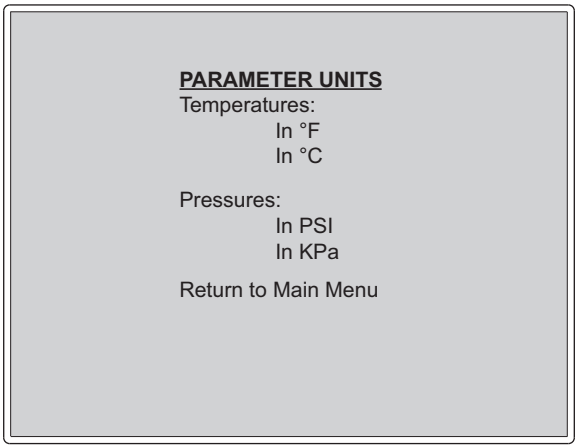
CFP-226

Figure 5-4 RPM INC/DEC Screen

This screen allows the operator to make adjustments by incrementing or decrementing the engine operating speed for on-site adjustments. The engine operating speed was factory set during manufacturing and test procedures.

If the speed does not match the engine RPM shown on the factory setting plate, scribe the actual RPM on the field setting plate.

5.5.5 Parameter Units Screen

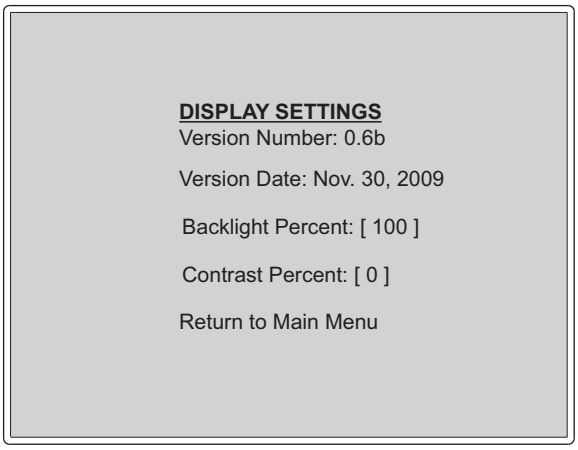


CFP-227

Figure 5-5 Parameter Units Screen

This screen will allow the operator to select Imperial or Metric units.

5.5.6 Display Settings Screen

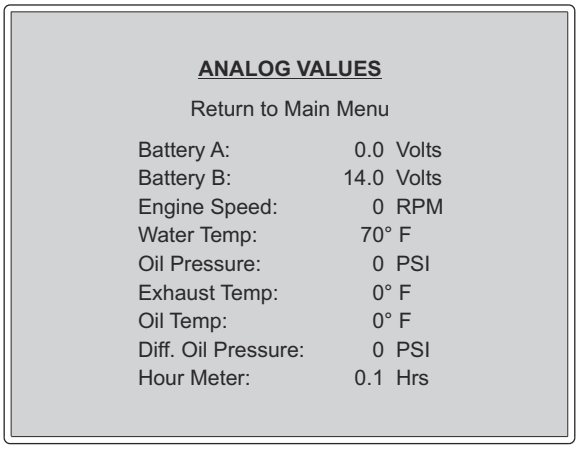


CFP-228

Figure 5-6 Display Settings Screen

This screen will enable adjustments to the backlight and contrast for optimal viewing in varying lighting environments. The version number of the EDCP software will be indicated on this screen.

5.5.7 Analog Values Screen



CFP-00012

This screen will provide analog output values for battery voltages, engine speed, water temperature, oil pressure and temperature, exhaust temperature, differential oil pressure, and hours of operation.

NOTE: *Metric or Imperial values can be changed using the Parametric Units screen.*

NOTE: *For exhaust temperature values less than 93° C (200° F), or not monitored, the value will be displayed as 0°. For oil temperature values less than 24° C (75° F), or not monitored, the value will be displayed as 0°.*

5.6 Active Fault Codes - Applicable on Electronic Engines

The Electronic Control Module (ECM) can display and record operation irregularities, which are displayed as fault codes on the engine digital control panel.

5.7 Field Acceptance Testing

The required tests are outlined in the NFPA 20 and NFPA 25 Standards and shall be performed to validate automatic and manual operational requirements for field acceptance testing.

Section 6 - Maintenance

6.1 Introduction

Before performing maintenance procedures, read and understand the Safety Section of this manual. Improper performance or lack of critical information could result in personal injury or equipment damage.

Cummins encourages our customers to perform maintenance and repairs whenever necessary. However, servicing complex components within the normal warranty period may void the Cummins warranty and any specified warranty extended by the manufacturer of OEM products.

Maintenance procedures should be performed by skilled technicians, who are familiar with the equipment, local regulations, and service procedures for fire pump engine and pump systems. Improper maintenance can damage the engine or fire pump, or cause severe personal injury.

6.2 Engine Operation Report

The engine must be maintained in top mechanical condition. The maintenance department needs weekly running reports. Check the following:

1. Low engine oil pressure.
2. Engine surge.
3. Erratic operation or frequent shutdowns.
4. Any warning lamps flashing or staying illuminated.
5. Abnormal coolant or oil temperature.
6. Unusual engine noise or vibration.
7. Excessive smoke.
8. Excessive use of coolant, fuel, or engine oil.
9. Any fluid leaks.
10. Loose, worn, or damaged parts.

6.3 Regular Maintenance

6.3.1 General Walk Around Inspection

The following areas should be inspected weekly to maintain safe and reliable operation.

1. Check fluid levels before starting the engine. Check oil pressure and coolant temperatures frequently.
2. Check the engine appearance for excessive heat, wiring short circuits, excessive end-play, vibrations, excessive wear, excessive abrasion, damaged electrical wiring, or loose electrical wiring.

6.3.2 Air Cleaner Filter and Piping

1. Visually inspect the air intake filter and piping for blockage, damage to piping, loose clamps, or punctures that can allow debris to enter the engine. If there is a blockage, the service indicator will be activated. Refer to Figure 2-1.

CAUTION

Never operate the engine without an air cleaner.

2. Replace damaged air filter or hoses, and tighten loose clamps, as necessary, to prevent the air system from leaking.

6.3.3 Cooling System

CAUTION

Never use a sealing additive to stop leaks in the cooling system.

1. Inspect the raw water piping, coolant heat exchanger tanks, charge air cooling system, engine coolant hoses, and hose clamps for loose fittings, leaks, holes, damage and corrosion.
2. Tighten the hose clamps as necessary.

3. Ensure that the coolant level is visible in the coolant level sight gauge. Add coolant as required.

6.3.4 Engine Oil System

Check the oil level at the engine dipstick and fill if needed.

NOTE: *Cummins recommends using Premium Blue S.A.E. 15W-40 Multi-viscosity Engine Oil or equivalent.*

6.3.5 Fuel System Inspections

WARNING

Engine fuel is highly flammable and represents an extreme hazard for fire or explosion when exposed to electrical sparks or open flame. Clean up spilled fuel immediately. Keep sources of electrical spark or open flame away from a fuel source.

1. Shut off the engine.

2. Inspect the fuel supply line, return line, filter, and fittings for cracks or abrasions.

3. Ensure the lines are not rubbing against anything that could damage the fuel system hoses. Repair any leaks or alter line routing to eliminate wear immediately.

NOTE: *See the model specific Engine Data Sheet in Section 8 of the standard Fire Pump Manual for recommended replacement components.*

6.3.6 Engine Exhaust System

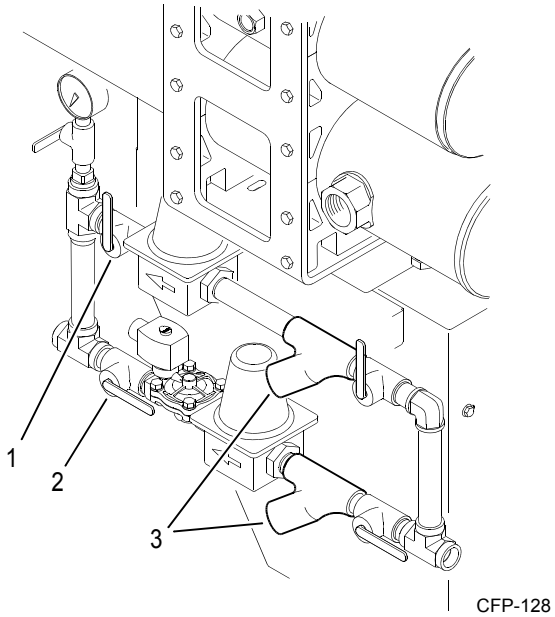
Check for leaks at all connections, welds, gaskets, and joints, and make sure that the exhaust pipes are not heating surrounding areas excessively. Repair any leaks immediately.

6.3.7 Electrical Supply and Controls

Check the terminals on the starting batteries for clean and tight connections. Inspect harness connections to be sure they are secure.

6.3.8 Clean Raw Water Strainers (optional raw water manifold)

1. The (2) raw water strainers (one on the normal line and one on the bypass line) should be cleaned weekly to remove sediment. Refer to Figure 6-1.



1. Bypass Water Line
2. Normal Water Line
3. Raw Water Strainers

Figure 6-1 Raw Water Strainers (optional raw water manifold)

To clean the normal line strainer, ensure that the normal line valves are closed and the bypass line valves are open.

To clean the bypass line strainer, ensure that the bypass line valves are closed and the normal line valves are open.

1. For each raw water strainer, remove the plug. Inspect and remove any debris. Reinstall the strainer plugs.

2. When finished, open the normal line valves and close the bypass line valves for normal operation.

6.3.9 Engine Coolant Heater

NOTE: *Perform this inspection procedure 24 hours after shutting off the engine.*

Check to be sure heater is operational.

6.3.10 Drive Shaft Lubrication

It is recommended that proper lubrication to drive shafts be performed annually.

1. Remove the drive shaft guards.

2. Wipe the grease fittings and grease gun nozzle with a clean cloth to avoid contamination.

3. Add grease to the drive shaft universal joint grease fittings. Refer to Figure 3-2.

NOTE: *Use NLGI #2 lithium complex grease or equivalent.*

4. Wipe excess grease from the fittings.

WARNING

Before equipment operation, ALL guards, covers and protective devices MUST BE in place and securely fastened.

6.4 Regular Engine Preventative Maintenance

All checks or inspections listed under daily or previous maintenance intervals must also be performed regularly. Refer to model specific Cummins Engine Operation and Maintenance Manual.

6.5 Replacement Parts

Replacement parts for the Cummins Inc. equipment are manufactured to the same quality standards and specifications as the original equipment. Unapproved substitution may result in poor performance, reduced service life, lost production, or unsafe operation.

When ordering parts, please be prepared to provide the following information:

1. Model and serial number.

2. Part description by name or number.

3. Quantity required.

4. Purchase order number.

6.6 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.

6.7 Emergency Repairs 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.

Refer also to the Cummins Inc. web site at www.cummins.com.

6.8 Recommended Spares Inventory

To minimize downtime and increase productivity, Cummins Inc. recommends maintaining a stock of spare parts critical to uninterrupted engine operation. Shipping costs can be lower using ground transportation rather than overnight or next day air freight. For this reason Cummins Inc. can provide a list of recommended spare parts. Contact the Cummins Authorized Repair Location for additional information.

Section 7 - Troubleshooting

7.1 Troubleshooting

The following information is intended as a guide to troubleshooting. Many problems can be resolved using preventative maintenance, adjustment, or minor repair.

For engine related issues, refer to the model specific Engine Operation and Maintenance Manual or contact the Cummins Customer Assistance Center at 1-800-DIESELS (1-800-343-7357).

WARNING

The status checks should be performed ONLY by a qualified technician. Before equipment operation, ALL guards, covers, and protective devices MUST BE in place and securely fastened.

WARNING

Never climb or stand on the equipment frame, guards, or enclosures.

Table of Contents

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.1 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.*	Battery cables or connections are loose, broken, or corroded (excessive resistance). Alternator not functioning. Battery isolator input has faulted.	Check the battery cables and connections. Ensure that all connections are free of corrosion and that no cables are broken. Replace the alternator. Contact a Cummins Authorized Repair Facility. Test continuity from the alternator to the battery isolator input. Repair any open circuit. Test continuity through the battery isolator. If an internal open circuit exists, replace battery isolator.
7.1.2 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.*	Battery has failed. Battery cables or connections are loose, broken, or corroded (excessive resistance). Battery isolator has failed.	Check battery charge. Check the battery cables and connections. Ensure connections are clean and that no cables are broken. Replace the battery isolator.
7.1.3 Coolant Temperature Above Normal **NOTE:** *The thermostat's normal operating temperature range is 82°-95° C (180°-203° F).*	Incorrect raw water flow. Raw water pressure regulator is improperly adjusted. **NOTE:** *Pressure should not exceed 414 kPa (60 psi).* Raw water solenoid has failed. (Applicable to horizontal pump installations only.) Raw water piping or heat exchanger is plugged.	Measure the raw water flow and adjust per data sheet values found in the standard Fire Pump Manual. Check the raw water pressure indication. If the pressure is inadequate, adjust the regulator. Replace the solenoid. Check the raw water piping for blockage. Clean the piping if necessary. Remove any blockage. Check for flow through the heat exchanger. Replace the heat exchanger as necessary.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.3 Coolant Temperature Above Normal (continued)	Coolant level is low.	Refill to proper level per instructions.
	Cooling system hose is collapsed, restricted, or leaking.	Inspect and replace the hoses and pressure/fill cap as necessary.
	Coolant thermostat is malfunctioning.	Remove and replace the defective thermostat.
	Coolant pump is malfunctioning.	Contact a Cummins Authorized Repair Facility.
	Contaminated coolant.	Contact a Cummins Authorized Repair Facility.
	Coolant mixture of antifreeze and water is not correct.	Verify the concentration of antifreeze in the coolant. Correct the concentration as necessary.
	Coolant temperature switch is malfunctioning.	Repair or replace the switch.
	Coolant thermostat has failed.	Test operation of the thermostat. Replace the thermostat per instructions in Section 6 - Maintenance as necessary.
7.1.4 Coolant Temperature Below Normal when Engine is not Running	The standard 120 VAC or optional 240 VAC power supply to the coolant heater is not connected.	Connect the power supply. Correct any electrical faults in the supply circuit.
	The heater's overload thermostat has operated.	Ensure that there is coolant in the heater. Allow time for the automatic overload reset to occur.
	Coolant is not free to circulate through the heater.	Ensure coolant hoses are clear. Repair or replace as necessary.
	The coolant heater has failed.	Replace the coolant heater.
	Coolant temperature switch is malfunctioning.	Repair or replace the switch.
7.1.5 Raw Water Solenoid Valve Fails to Operate (Applicable to Horizontal Pump Installations Only) **NOTE:** *Apply 12 VDC to standard operating systems or 24 VDC to optional operating systems.*	Solenoid valve fails to operate.	Clean the raw water strainer more frequently.
		Check electical continuity and insulation from ground to the solenoid. Repair any open or short circuits in the wiring.
		Apply temporary voltage to the solenoid. If the solenoid fails to operate, replace the solenoid valve. Contact a Cummins Authorized Repair Facility.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.6 Manual Start Failure from Contactor Lever - Does not Crank on A or B **NOTE:** *The fire pump engine will not crank locally when either contactor lever is actuated.*	Crank battery A and B contactor failed to make contact.	Replace the faulty contactor as necessary.
	Both batteries dead or not connected.	Charge, check wiring, or replace batteries.
	Starter motor has failed.	Replace the starter motor.
	Engine is seized.	Bar the engine over to break the seizure. Contact a Cummins Authorized Repair Facility.
7.1.7 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.*	The battery cable connections are loose, broken, or corroded, creating excessive resistance.	Check the battery cables and connections. Ensure that connections are clean and tight.
	The battery is not properly charged or has failed.	Recharge the battery. If the battery does not take the charge, replace it.
	Engine oil level is too high.	Check the oil level. Drain any excess oil.
	Starter motor is malfunctioning.	Replace the starter motor. Contact a Cummins Authorized Repair Facility.
7.1.8 Engine will not Shut Off Locally	Power source has not been removed by the fire pump controller.	Depress and hold stop on left side of engine digital control panel.
	Engine running on fumes drawn into the air intake.	Identify and isolate the source of the combustible fumes.

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Fire Pump Applications

Installation & Maintenance Manual

Universal Joint Driveshafts

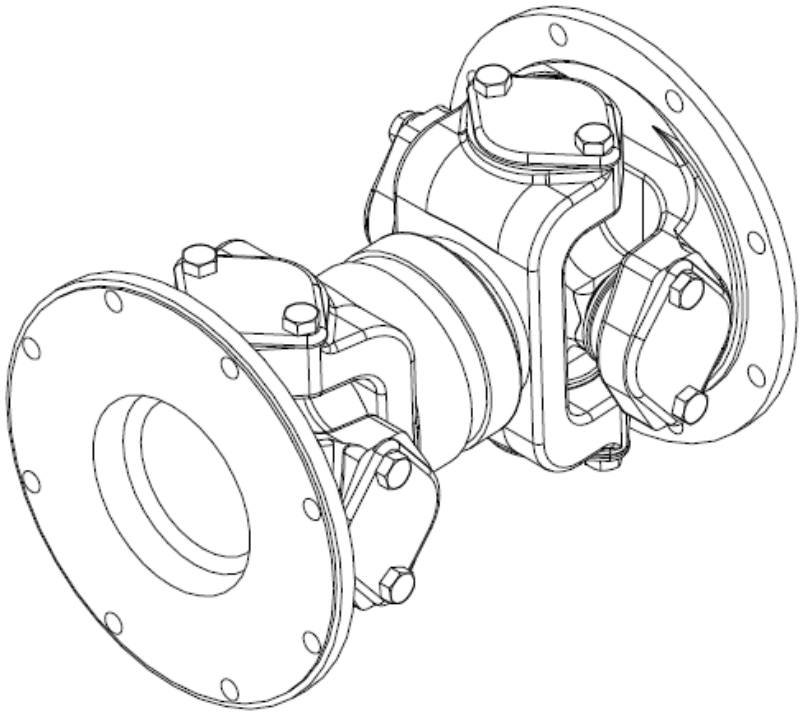

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Table of Contents

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)

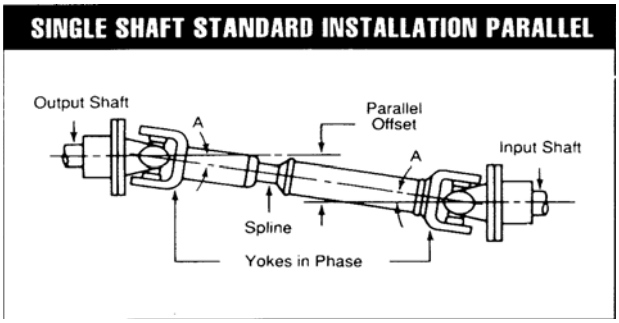


Figure 1

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.

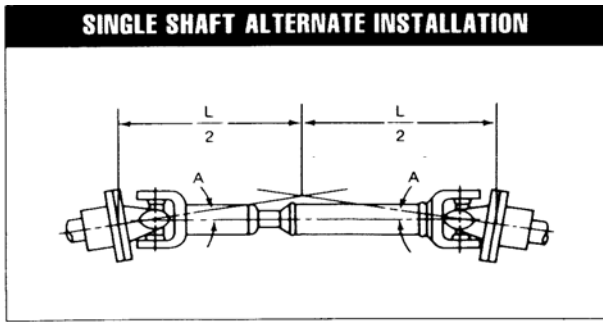


Figure 2

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.

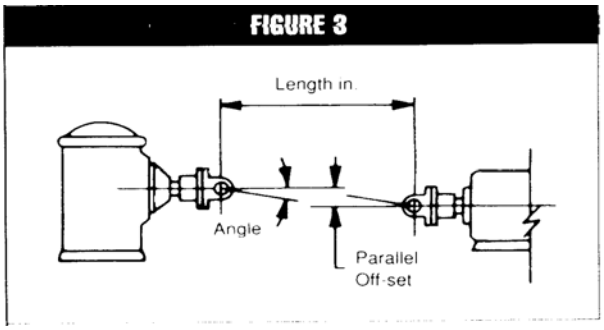


Figure 3

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.

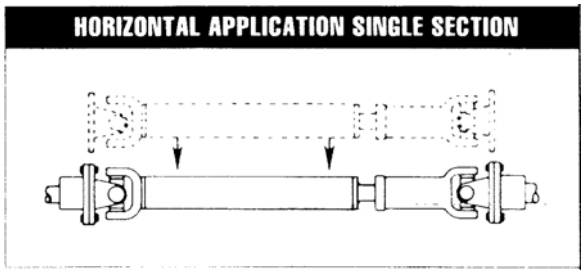


Figure 4

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.

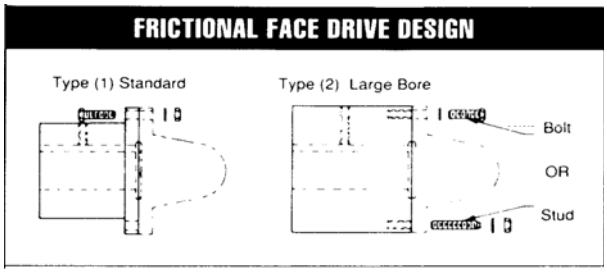


Figure 5

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).

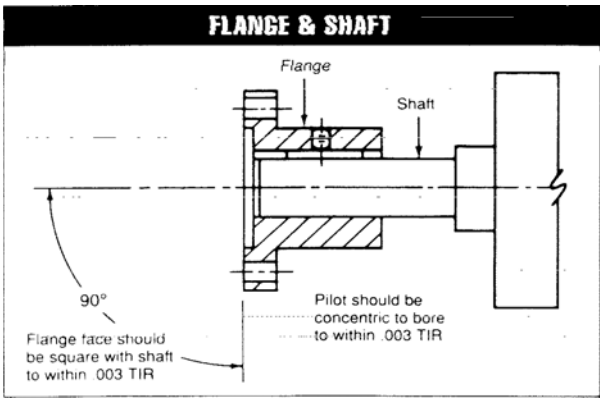


Figure 6

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.

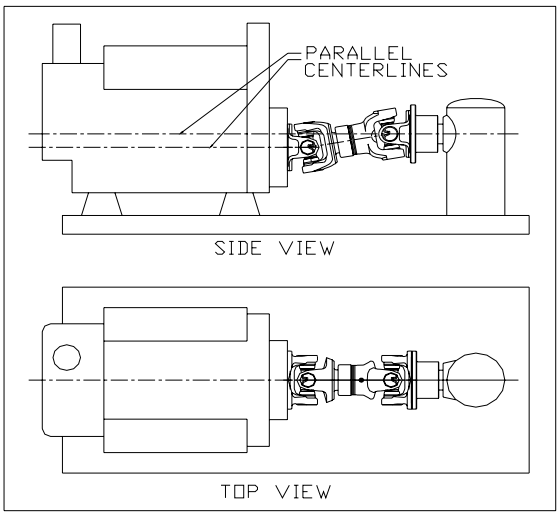


Figure 7

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.

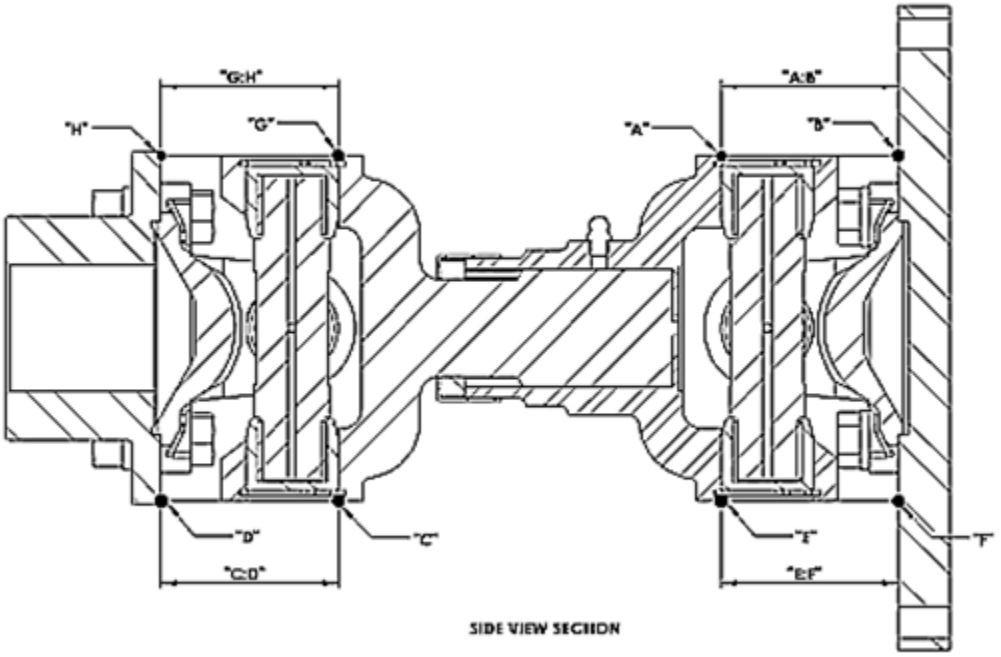
Fax: 1-920-337-9746

Please provide Engine serial number or the Driveshaft serial no. and tag information.

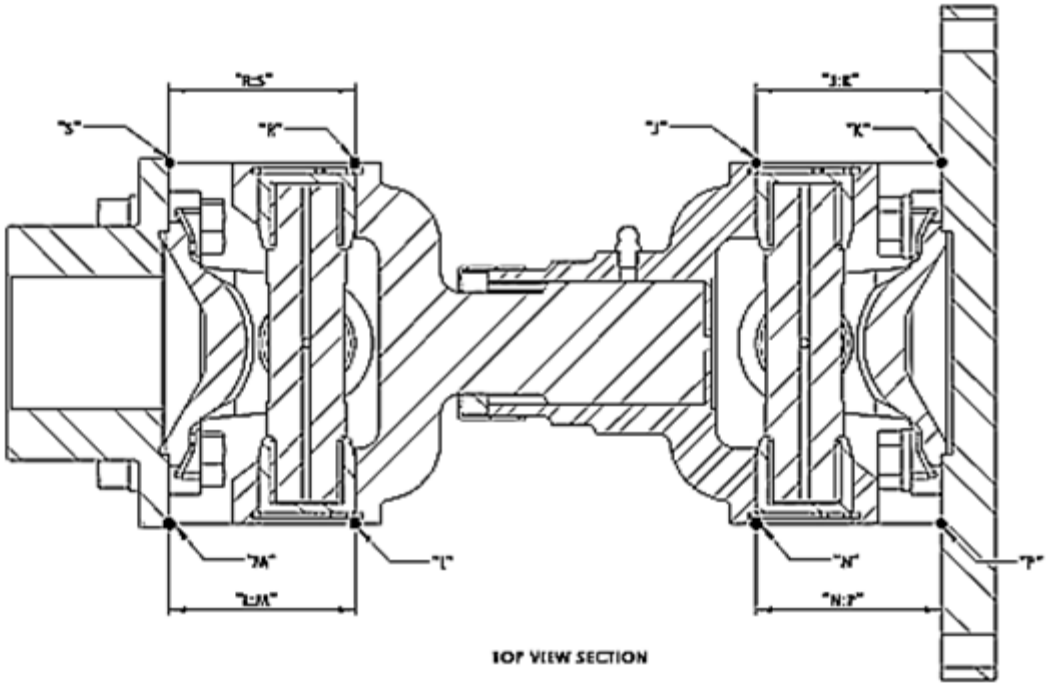
Visit us on the web at:
www.cumminsfirepower.com

Series 1410 – 1550 (13418 – 13419)
Series U3101 – U3172 (13424 – 13430)

Vertical Offset Sectional View
Figure 8a

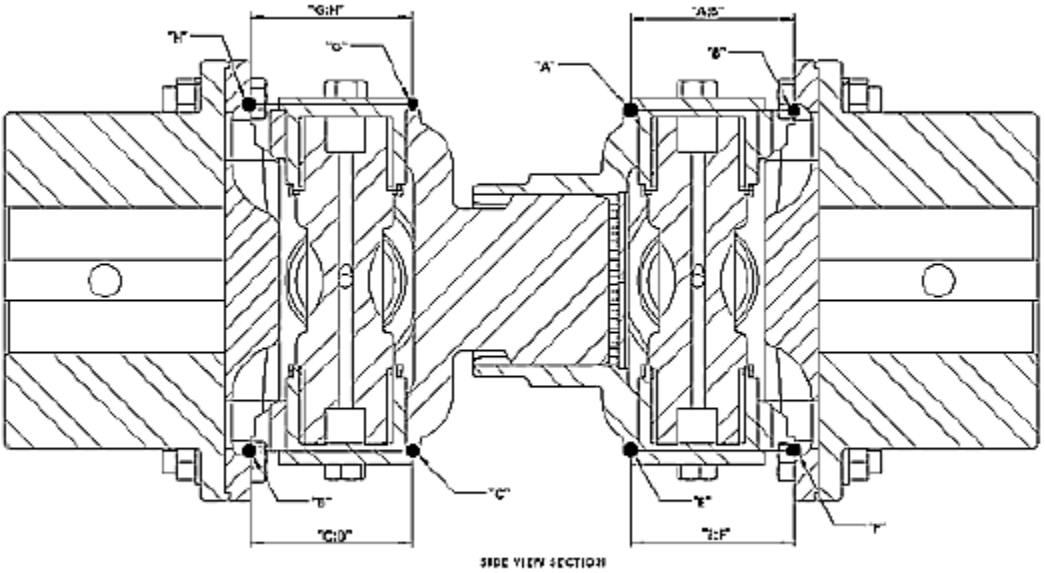


Horizontal Offset Sectional View
Figure 8b

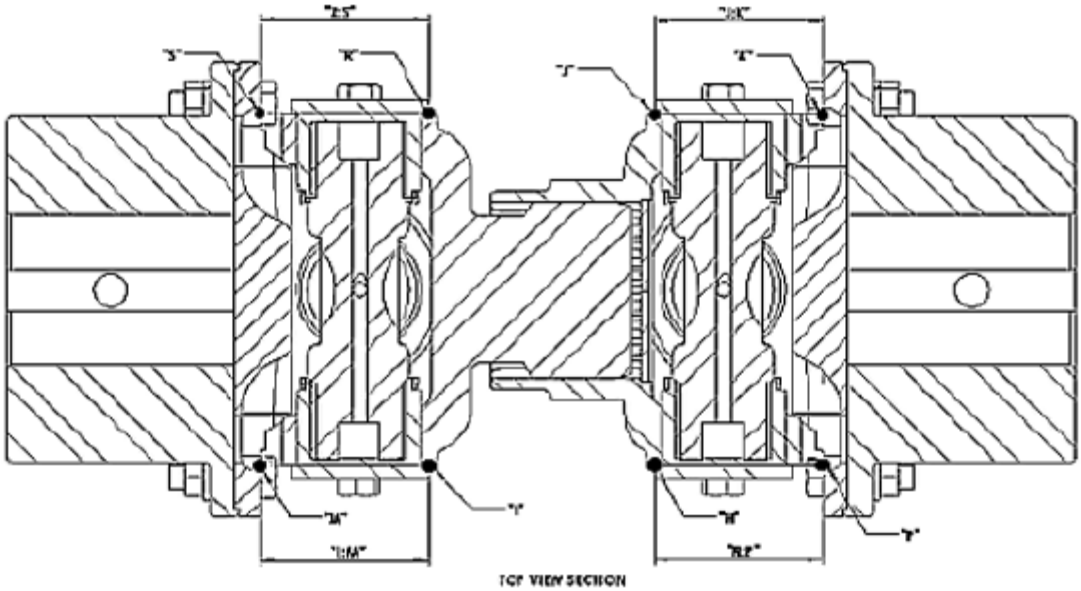


Series 1610 – Series 1880 (13420-13423) Only

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.

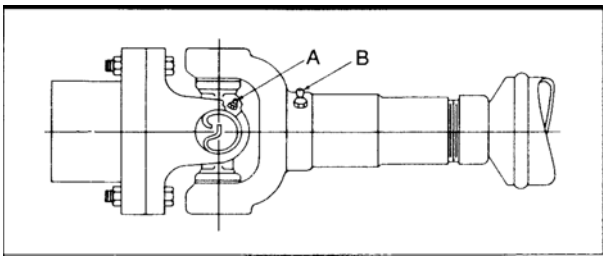


Figure 9

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	8	75 lb x ft
1480	1/2 – 20		110 lb x ft
1550	1/2 – 20		110 lb x ft
1610	3/8 – 24		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	10.9	25 lb x ft
U3126	M12 - 1.75		90 lb x ft
U3127	M12 - 1.75		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

$$\text{Rated Torque} = \frac{\text{Max Torque}}{5252}$$

$$\text{Rated HP} = \frac{\text{Rated Torque} \times \text{RPM}}{\text{Service Factor (SF)}}$$

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)

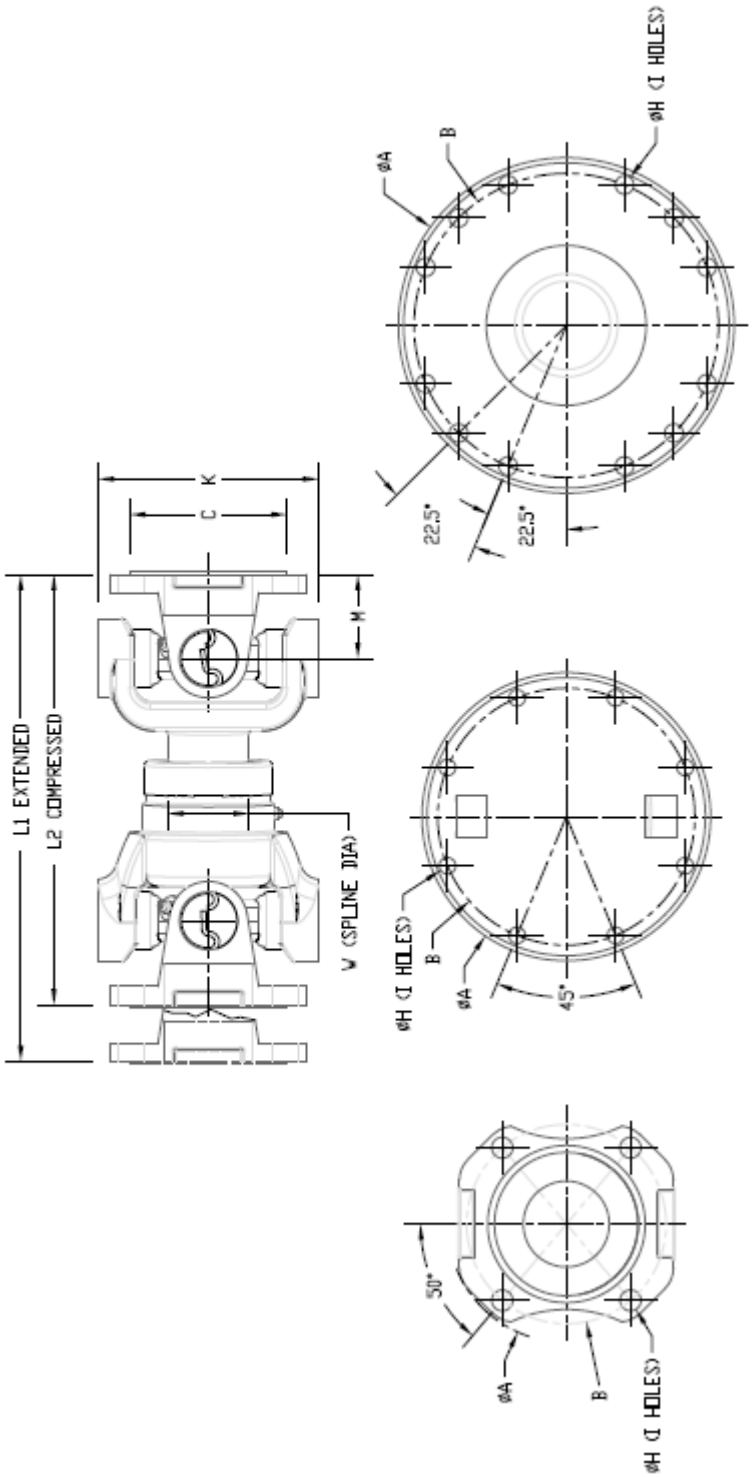
5.2 Selection of Flexible connecting driveshaft shall be based on rating of the driver and not the pump.

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.