

# Fire Pump Drive Engines CFP60E Series

## **Operation and Maintenance Manual**



Doc. A057W499 September 2018



This manual contains proprietary information to equipment produced by Cummins Sales and Service and Cummins Inc. and is being supplied solely for the purpose of operating, maintaining, and servicing the fire pump drive engine purchased from Cummins Sales and Service in De Pere, Wisconsin.

Please visit us at power.cummins.com/fire-power to view the English version of this manual in color, as well as experience a wealth of information about Cummins fire pump drive engines.



This product has been manufactured under the controls established by a Bureau Veritas Certification approved management system that conforms with ISO 9001:2015.

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## Fire Pump Drive Engine

### Limited Warranty

#### **Description**

This limited warranty applies to all Cummins fire pump drive engines (hereinafter referred to as "Cummins" branded fire pump drive engines and associated accessories (hereinafter referred to as "Product")). This warranty covers any failures of the Product, under normal use and service, which result from a defect in material or factory workmanship.

#### Warranty Period:

The warranty start date for stationary Product is the date of initial start-up, demonstration or eighteen (18) months after factory ship date, whichever is sooner. Base Engine Warranty Duration (whichever occurs first): 2 years/2000 hours.

#### **Cummins Responsibilities:**

In the event of a failure of the Product during the warranty period due to defects in material or workmanship, Cummins will only be responsible for the following costs:

- All parts and labor required to repair the Product.
- Reasonable travel expenses to and from the Product site location.
- Maintenance items that are contaminated or damaged by a warrantable failure.

#### **Owner Responsibilities:**

The owner will be responsible for the following:

- Notifying a Cummins distributor or dealer within thirty (30) days of the discovery of failure.
- Installing, operating, commissioning and maintaining the Product in accordance with Cummins published policies and guidelines.
- · Providing evidence for date of commissioning.
- Providing sufficient access to and reasonable ability to remove the Product from the installation in the event of a warrantable failure.
- In addition, the owner will be responsible for:
- Incremental costs and expenses associated with Product removal and reinstallation resulting from difficult or non-standard installations.
- Costs associated with Fire Watch Protection during Product being repaired.
- Costs associated with labor overtime and premium shipping requested by the owner.
- All downtime expenses, fines, all applicable taxes, and other losses resulting from a warrantable failure.

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#### Limitations:

This limited warranty does not cover Product failures resulting from:

- Inappropriate use relative to designated power rating or application guidelines.
- Normal wear and tear, negligence, accidents or misuse.
- Improper and/or unauthorized installation.
- Lack of maintenance or unauthorized repair.
- Noncompliance with any Cummins published guideline or policy.
- Use of improper or contaminated fuels, coolants or lubricants.
- Improper storage before and after commissioning.
- Owner's delay in making Product available after notification of potential Product problem.
- Replacement parts and accessories not authorized by Cummins.
- Owner or operator abuse or neglect such as: operation without adequate coolant or lubricants; over-fueling; over-speeding; lack of maintenance to lubricating, cooling or air intake systems; late servicing and maintenance; improper storage, starting, warm-up, run-in or shutdown practices, or for progressive damage resulting from a defective warning device.
- Damage to parts, fixtures, housings, attachments and accessory items that are not part of the fire pump package.

This limited warranty does not apply to:

- Costs of maintenance, adjustments, installation, commissioning or start-up.
- Starting batteries and enclosures.
- Components added to the Product after shipment from Cummins.
- Block heaters are warranted for one (1) year from date in service

Please contact your local Cummins Sales and Service for clarification concerning these limitations.

#### **Extended Warranty**

Cummins Inc. offers several levels of Extended Warranty Coverage (**Base Engine Only**). Please contact your local Cummins Distributor for details.

#### **Cummins Right to Failed Components:**

Failed components claimed under warranty remain the property of Cummins. Cummins has the right to reclaim any failed component that has been replaced under warranty.

#### THE WARRANTIES SET FORTH HEREIN ARE THE SOLE WARRANTIES MADE BY CUMMINS INC. IN REGARD TO THE PRODUCT. CUMMINS INC. MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, OR OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT IS CUMMINS INC. LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

This limited warranty shall be enforced to the maximum extent permitted by applicable law. This limited warranty gives the owner specific rights that may vary from state to state or from jurisdiction to jurisdiction.

See the Cummins Inc. warranty bulletins for additional base engine warranty details: <u>US & Canada: 3381321</u> International: <u>3381322</u>.



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## Section 1 - Safety

### **1.1 Introduction**

Cummins 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 General Safety Precautions**

Read and understand all of the safety precautions and warnings before performing any repair. Special safety precautions are included in the procedures when they apply. This list contains the general safety precautions that **must** be followed to provide personal safety:

- Perform a walk around inspection and alert all area personnel that the equipment will be starting before manual operation.
- 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.
- After performing maintenance, remove all tools and foreign materials and reinstall and securely fasten ALL guards, covers, and protective devices.
- Exposed in-running belt nips can cause severe personal injury or dismemberment. Ensure that guards are in place and securely fastened before operation.
- Rotating drive shafts can lacerate, dismember, or cause strangulation. Keep hands, body parts,

long hair, or loose-fitting clothing clear at all times.

- Never attempt to manually clean a machine while it is operating or in standby mode.
- Never open ports on tanks or piping while the engine is operating. Contact with pressurized agents can cause severe personal injury.
- Relieve all pressure in the air, oil, and the cooling systems before any lines, fittings, or related items are removed or disconnected.
- Engine fuel is flammable when in contact with electrical spark or flame sources. Remove all sources of spark or flame from the work area.
- Always use the same fastener part number (or equivalent) when replacing fasteners.
- Some state and federal agencies in the United States have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Dispose of waste oil in accordance with applicable requirements.

# 1.3 Use of Advisory and Cautionary Statements

#### 1.3.1 Advisory Statements

**Advisory** statements used throughout this manual call attention to special information and correct operating procedures. These Advisory statements are delineated by the terms "NOTE" and "IMPORTANT" in uppercase letters:

**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.

#### **1.3.2 Cautionary Statements**

*Cautionary* statements highlight particular safety precautions pertaining to personal injury and/or damage to the equipment. Cautionary statements are always preceded by the following symbols:

## **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.



## **Section 2 - Description**

### 2.1 Introduction

This manual contains information for the correct operation and maintenance of a Cummins fire pump drive engine. Read and follow all safety instructions in Section 1 - Safety. Keep this manual with the equipment. If the equipment is traded or sold, give the manual to the new owner.

Cummins fire pump drive engines have been designed in accordance with National Fire Protection Association (NFPA) 20 guidelines. The CFP60E complies with the NFPA 20 installation standard except for the requirements regarding a redundant ECM.

No deviations are permitted without prior written approval. These engines are to be used only for fire protection applications. Figure 2-2 and Figure 2-3 provide visual descriptions of the engine components for this fire pump drive engine.

Cummins Inc. reserves the right to make changes at any time. If any differences are found between an

engine and the information in this manual, contact your 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 parts.



Injury may result and warranty is voided if fuel rate, revolutions per minute (RPM), or altitudes exceed published maximum values for this model and application.

### 2.2 Fire Pump Drive Engine Nameplate

Each fire pump drive engine is labeled with a nameplate that provides its unique information. A typical fire pump drive engine nameplate is shown in Figure 2-1.



Figure 2-1 Fire Pump Drive Engine Nameplate (Typical)

### 2.3 Fire Pump Controller

The fire pump controller starts the engine automatically when the Fire Pump Digital Panel (FPDP) is in automatic mode and a remote fire demand signal is received. The fire pump controller automatically shuts down the engine when the fire demand signal is discontinued. The fire pump controller is optionally supplied by Cummins or Cummins Sales and Service.

**NOTE:** With the fire pump controller in **manual** mode, starting and stopping the fire pump drive engine can be controlled by the FPDP, located on the fire pump drive engine itself.

## 

Upon turning the fire pump controller to OFF, the fire pump drive engine may continue to run at a reduced speed to cool the engine down. To stop the fire pump drive engine at this point - in the case of an emergency - press the Engine STOP button on the FPDP rather than on the pump controller.



- 1. Air Cleaner Service Indicator (4)
- 2. ESN and Engine Speed Setting Decals
- 3. Manual Start Instruction Decal
- 4. Fire Pump Digital Panel (FPDP)
- 5. Electronic Control Modules (ECMs)
- 6. Engine Base
- 7. Fuel Return Line
- 8. Engine Coolant Heater (2) (one on each side)
- 9. Oil Level Dipstick
- 10. Oil Fill Port
- 11. Crankcase Ventilation Hose (2)
- 12. Fuel Supply Line
- 13. Fuel Filter (3)

- 14. Oil Drain Valve
- 15. Coolant Filter (2)
- 16. Fuel Pump
- 17. Upper Jacket Water (JW) Coolant Hose
- 18. Cooling Water Manifold
- 19. Lower JW Coolant Hose
- 20. Low-temperature Aftercooler (LTA) Coolant Heat Exchanger
- 21. JW Coolant Heat Exchanger
- 22. Coolant Expansion Tank
- 23. Expansion Tank Level Sight Gauge
- 24. Coolant Pressure/Fill Cap
- 25. Exhaust Flex Connection (2)

#### Figure 2-2 Engine Components - Fire Pump Digital Panel (FPDP) Side



- Coolant Pump 6.
- 7. Oil Filter (3)

- Flywheel Housing 13. 14. Air Cleaner Assembly (4)
- Figure 2-3 Engine Components Turbocharger Side

### 2.4 Fire Pump Digital Panel (FPDP)

The FPDP control panel (shown in Figure 2-4) is mounted on the left-hand side (or right-hand side optional) of the flywheel end of the engine and contains controls for starting the engine, monitoring engine performance, and controlling fire pump drive engine operation. In **manual** mode, the FPDP and the Electronic Control Module (ECM) remain active as long as battery power is available. In **automatic** mode, starting and stopping of the engine is controlled by the fire pump controller.



- 1. Engine STOP Button
- 2. Customer Access Port
- 3. Diagnostics Connector
- 4. Engine ECM Power Supply

3

5. Tachometer

2

- 6. Battery "A" Voltmeter
- 7. Battery "B" Voltmeter
- 8. SCREENSoft Key
- 9. RESET/STOP Switch
- 10. IDLE Soft Key

- 11. Crank Battery B Momentary Start Switch
- 12. Crank Battery A Momentary Start Switch
- 13. ECM A/ECM B Selector Switch and Indicator Lamps
- 14. AUTO/MAN Mode Selector Switch and Indicator Lamps
- 15. MENU Soft Key
- 16. Hour Meter
- 17. Engine Oil Pressure Gauge
- 18. Coolant Temperature Gauge

#### Figure 2-4 FPDP Control Panel

#### 2.4.1 Engine STOP Button

The Engine STOP Button (1) is located on the left side of the FPDP enclosure and is used to stop the operation of the engine in either manual or automatic mode. The button must be pressed and held until the engine has shut down.

**NOTE:** Upon release of the Engine STOP Button, the fire pump drive engine will attempt to restart, If there is still a "pump on demand" signal present from the fire pump controller. The engine must also be stopped at the fire pump controller.

#### 2.4.2 Customer Access Port

The customer access knock-out (**2**) is located on the left side of the FPDP for ease of access. This is the only 1 in. (25.4 cm) knock-out provided for the pump controller interconnect.

**IMPORTANT:** If additional holes are placed in the FPDP, all warranty on the fire pump drive engine will be void.

#### 2.4.3 Diagnostics Connector

The Diagnostics Connector (**3**) is located on the bottom of the FPDP enclosure and is strictly used for Cummins service personnel.

#### 2.4.4 Engine ECM Power Supply

The Engine ECM Power Supply plug-in (4) is located on the lower side of the FPDP to provide unswitched battery power to both ECM A and ECM B.

#### 2.4.5 Tachometer

The Tachometer (5) displays the engine speed in revolutions per minute (RPM) whenever the engine is operating.

#### 2.4.6 Battery "A" and "B" Voltmeters

The Battery "A" (**6**) and Battery "B" (**7**) Voltmeters display the charge status - or Voltage Direct Current (VDC) - of the relative battery connections.

#### 2.4.7 SCREEN Soft Key

The SCREEN soft key (8) allows the user to switch to a detailed pop up list of additional analog values (when available): exhaust temperature; cooling loop temperature; cooling loop differential pressure; and J1939 values including: oil temperature; intake manifold temperature; and intake manifold pressure.

#### 2.4.8 RESET/STOP Switch

The RESET/STOP Switch (9) serves multiple purposes:

- To shut off the engine by removing the ECM keyswitch/Fuel Shutoff (FSO) valve until the engine speed decelerates to 0 RPM.
- To reset the fire pump drive engine after an overspeed fault has been activated, allowing subsequent restarts of the fire pump drive engine.

#### 2.4.9 IDLE Soft Key

The IDLE soft key (**10**) allows the user to run an electronic engine at a reduced speed while the FPDP is in manual mode (See Operation: FPDP Screens and Adjustments in Manual Mode - IDLE Soft Key). When the FPDP AUTO/MAN selector switch is in the MAN position (manual mode), the IDLE soft key will appear and display in red. When the engine idle command is active, the IDLE soft key will display in green.

**NOTE:** The IDLE soft key is only intended to be used for commissioning or service events.

## 2.4.10 Crank Battery A and B Momentary Start Switches

The CRANK BATT A (**12**) and CRANK BATT B (**11**) momentary start switches engage the starter when the FPDP is in MANUAL mode.

CRANK BATT A energizes battery contactor A and CRANK BATT B energizes battery contactor B. Both CRANK BATT A and CRANK BATT B buttons can be energized at the same time in the event both batteries are weak.

## 2.4.11 ECM A/ECM B Selector Switch and Indicator Lamps

The ECM A / ECM B selector switch and indicator lamps (13) illuminate in yellow, indicating which ECM is being used to control the engine.

If ECM A (normal position) is selected, ECM A is monitoring and controlling the engine.

If ECM B (alternate position) is selected, ECM B is monitoring and controlling the engine, and the FPDP will indicate that the engine is operating on the alternate ECM.

## 2.4.12 Automatic or Manual Mode of Operation Selector Switch and Indicator Lamps

The AUTO/MAN selector switch and indicator lamps (**14**) illuminate in yellow, indicating the operational state of the FPDP.

The MAN selector switch (for manual operation) is only to be selected for engine setup, testing, and emergency and maintenance procedures. When the FPDP is in manual mode, the ECM keyswitch/FSO and raw water solenoids are always activated, except under an overspeed condition.

The AUTO selector switch (for automatic operation) is the normal state of the FPDP, in which the fire pump controller starts and stops the engine. In automatic mode, the fire pump drive engine shuts down or enters engine cool down upon loss of a signal from the fire pump controller.

#### 2.4.13 MENU Soft Key

The MENU soft key (**15**) on the FPDP display allows the user to open the menu options. A complete list of FPDP screens and their functionality is outlined in the Operation Section of this manual.

#### 2.4.14 Hour Meter

The Hour Meter (**16**) maintains a running total of the hours of engine operation (run time).

#### 2.4.15 Engine Oil Pressure Gauge

Based on user parameter screen display selection, the Engine Oil Pressure Gauge (**17**) displays the engine oil pressure in pounds per square inch (PSI) or kPa. The Engine Oil Pressure Gauge displays by default in three different colors:

- green when the engine oil pressure is greater than 25 PSI (172 kPa);
- yellow when the engine oil pressure is between 17 PSI (117 kPa) and 25 PSI (172 kPa); and
- red when the engine oil pressure is below 16 PSI (110 kPa). NOTE: Engine oil pressure displayed in red will also be accompanied by a low oil pressure fault. Refer to TB-4.

#### 2.4.16 Coolant Temperature Gauge

Based on user parameter screen display selection, the Coolant Temperature Gauge (**18**) displays the engine coolant temperature in degrees Fahrenheit or degrees Celsius. The Coolant Temperature Gauge displays in three different colors:

- green when the coolant temperature is between 100-199 °F (38-93 °C);
- yellow when the coolant temperature is between 200-211 °F (93-100 °C) OR below 100 °F (38 °C). NOTE: when the coolant temperature is below 100 °F (38 °C), the yellow gauge will also be accompanied by a low coolant temperature fault. Refer to TB-312.; and
- red when the coolant temperature is greater than 212 °F (100 °C). NOTE: the red gauge will also be accompanied by a high coolant temperature fault. Refer to TB-5.

### 2.5 FPDP Informational Displays

#### 2.5.1 Fault Code Warning Displays

Fault codes diagnosed by the ECM are displayed in a yellow or red International Organization for Standardization (ISO) symbol and/or overlay box which lies atop the tachometer signal (the engine speed is still digitally displayed) to alert the operator to service the engine as soon as possible. Only the first seven active ECM faults will be displayed in the overlay.

**NOTE:** To remove the overlay box from atop the tachometer, press the SCREEN Soft Key.

#### 2.5.1.1 Yellow Warning Indicators

The yellow ISO symbol (shown in Figure 2-5) or the yellow ISO symbol AND a large yellow box covering the tachometer (shown in Figure 2-6) indicate an engine malfunction that requires timely operator attention.



#### Figure 2-5 Yellow Warning Indicator ISO Symbol Only



Figure 2-6 Yellow Warning Indicator ISO Symbol and Overlay Box

When applicable, the FPDP may display the Yellow Warning Indicator for any one of the following operational issues:

- The ECM has sensed a non-mission disabling fault. A three- or four-digit diagnostic fault code will display on the FPDP which can then be used to help diagnose the engine malfunction. Refer to the Fault Code Chart in the Fault Codes Section or contact your local Cummins Distributor.
- Communications have been lost with the ECM. The FPDP communicates with electronically-controlled engines via J1939. As shown in Figure 2-7, if communications are lost, "J1939 Lost" will appear on the top left of the screen. The warning lamp will also illuminate and the text "NWF" (which stands for "Network Failure") will replace all digital J1939 values, except the tachometer, which will revert to using a mechanical speed sensor for engine speed detection.



Figure 2-7 Loss of J1939 Communications

• Communications have been lost with the Digital Panel Expansion Module (DPEM). As shown in Figure 2-8, "DPEM Lost" will appear on the FPDP User Interface Screen if communications between the FPDP and DPEM are compromised.



#### Figure 2-8 DPEM Lost Fault Screen

• A DPEM alarm has been activated.

#### 2.5.1.2 Red Warning Indicators

The red ISO symbol (shown in Figure 2-9) or the red ISO symbol AND a large red box covering the tachometer (shown in Figure 2-10) indicate an engine malfunction that requires immediate and decisive operator response. The FPDP will display the Red Warning Indicator when the ECM has sensed a fuel system or ECM-specific diagnostic fault. Refer to the Fault Code Chart in the Fault Codes Section or contact your local Cummins Distributor.



Figure 2-9 Red Warning Indicator ISO Symbol Only



#### Figure 2-10 Red Warning Indicator ISO Symbol and Overlay Box

#### 2.5.2 Overspeed Warning Indicator

As shown in Figure 2-11, "ENGINE OVERSPEED" flashing in red at the top of the FPDP screen indicates that the engine has exceeded its rated RPM and that possible damage to the sprinkler system may occur. This malfunction requires immediate and decisive operator response. A three- or four-digit diagnostic fault code will display on the FPDP which can then be used to help diagnose the engine malfunction. Refer to the Fault Code Chart in the Fault Codes Section or contact your local Cummins Distributor.





#### 2.5.3 DPEM Fault Screens

When an analog input parameter crosses the alarm setpoint or a switched input is active, the FPDP may display the DPEM fault one of two ways: • From the FPDP - As shown in Figure 2-12, the warning symbol will illuminate and the overlay will activate in yellow with the text of the active fault.



#### Figure 2-12 DPEM Fault Screen (Sample)

 From the DPEM/remote location - The terminal block interface inside of the DPEM has been created for connection to monitor alarms remotely. There is an LED next to each terminal block that will also illuminate if the relay is commanded closed.

Each set of four relays has a common dry contact associated for integration flexibility:

- Terminal Blocks 13-16 (R1-R4) are dedicated to switched inputs, with TB-17 being the common contact
- Terminal Blocks 18-21 (R5-R8) are dedicated to temperature inputs, with TB-22 being the common contact
- Terminal Blocks 23-26 (R9-R12) are dedicated to pressure inputs, with TB-27 being the common contact
- Terminal Blocks 28-31 (R13-R16) are dedicated to additional pressure inputs or J1939 setpoints, with TB-32 being the common contact

As shown in Figure 2-13, "DPEM Lost" will appear on the FPDP screen if communications between the FPDP and DPEM are compromised.



Figure 2-13 DPEM Lost Fault Screen (Sample)

### 2.6 Electronic Control Module (ECM)

The engine Operation and Maintenance manual provides detailed information about the ECM(s).

A second ECM is installed on electronic engines to satisfy the NFPA 20 requirement for a redundant means of electronic fuel injection. Switching of the sensor inputs and outputs to the respective ECM is controlled through the FPDP either manually (by means of the ECM A/B Selector Switch on the panel) or through an automated process called Autoswitching (refer to the Operation section of this manual for more information on Autoswitching).

**NOTE:** Cummins electronically-controlled "engines" normally enable ECMs with derate and shutdown protection. Fire pump drive engines have the derates and shutdowns and disabled. Fire pump drive engines will run to destruction, making preventive maintenance even more essential for a fire pump drive engine.

# 2.7 Digital Panel Expansion Module (DPEM) (Optional)

The Digital Panel Expansion Module (DPEM) is an optional electronic device that works in conjunction with the FPDP to provide options for monitoring and alarming custom inputs. As shown in Figure 2-14, the DPEM is housed in a 316 stainless steel enclosure and contains a series of terminal blocks for customer connection to specified alarm points. One DPEM can be configured for any or all of the following:

- · Four switched inputs;
- Three temperature inputs;

- One exhaust temperature input;
- Six pressure inputs; and/or
- J1939 parameters (when applicable).



#### Figure 2-14 Digital Programming Expansion Module (DPEM)

### 2.8 Fuel Supply and Drain

As shown in Figure 2-2, the fuel supply and return connections are centrally located on the FPDP side. Refer to the Engine Data Sheet for the maximum allowable fuel tank supply locations above the fuel pump.

# 2.9 Modular Common Rail (MCRS) Fuel System

The CFP60E comes with a gear type fuel pump driven by the engine.

As shown in Figure 2-15, the fire pump drive engine is equipped with an electronic fuel system that delivers precise fuel quantities with precise injection timing at high injection pressures. The system consists of high-pressure unit injectors and the fuel supply system uses various system monitoring sensors. The system is controlled by ECMs for fueling and timing based on temperature, altitude, pressure, and throttle position.

With the MCRS fuel system, fuel priming is required for conditions such as: initial start-up, running out of fuel, and maintenance of the fuel system components (e.g., filter change).



### 2.10 Air Intake System

The air intake system supplies combustion air to the fire pump drive engine cylinders. The air filters prevent particulate matter from entering the air intake. Figure 2-16 shows how the combustion air is drawn into the system. The turbocharger directs the air through the LTA heat exchanger for cooling before entering the cylinders.



- 1. Intake air inlet to turbochargers
- 2. Turbocharged air to aftercooler

- 3. Turbocharged air travels through aftercoolers
- 4. Aftercooled air to intake ports

#### Figure 2-16 Engine Air Intake and Charge Air Cooling Flow Diagram (typical)

### 2.11 Cooling Water System

Figure 2-17 illustrates a typical cooling water manifold and Figure 2-18 shows the path of water through the engine cooling system. Water entering the cooling system through the cooling water inlet first circulates through the LTA heat exchanger, cooling the compressed air from the turbocharger outlet ducting. The cooled combustion air exits the LTA outlet duct to the engine air intake manifold.

#### NOTE: The cooling water supply must be immediately available when the engine is started.

The cooling water from the LTA heat exchanger then passes through the engine coolant heat exchanger. The cooling water exits the coolant heat exchanger through a discharge connection. This heat exchanger has parallel flow to both the LTA cooler and JW cooler.



- 1. Water Supply Pressure Gauge 2
- **Temperature Sensor** 3.
- Outlet to Heat Exchanger 4.
- Pressure Gauge Isolation Valve 5.
- Normal Water Solenoid Valve, where 6. required
- 7. Normal Water Pressure Regulator

- Post Strainer Pressure Sensor
- 9. **Bypass Water Strainer**
- Normal Water Strainer 10.
- **Bypass Water Inlet Valve** 11.
- Normal Water Inlet Valve 12.
- Pre Strainer Pressure Sensor 13.
- **Cooling Water Inlet** 14.

#### Figure 2-17 Cooling Water Manifold (typical)

**IMPORTANT:** Do not operate without a pressure cap.

**NOTE:** When filling with coolant, allow air to bubble out after the initial fill and then add coolant to the maximum level again. Monitor the coolant level after running the engine to ensure that all of the air is out of the system and replace with coolant.



### 2.12 Engine Oil System

Figure 2-19 illustrates how the engine oil system lubricates moving internal engine parts (pistons, connecting rods, valves, cam shafts, shafts, and bearings). The oil pump circulates oil from the oil pan, through the oil filter, and into engine areas where friction may develop. Refer to the Cummins engine Operation and Maintenance Manual for additional information.

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



- Oil Return to Pan
- High Pressure Relief Valve 7.
- 8. **Oil Thermostat**

- **Piston Cooling** 14.
- 15. Rocker
- Camshaft 16.

#### Figure 2-19 Engine Lubricating Oil System Flow Diagram (Typical)

### 2.13 Exhaust System

Figure 2-20 shows how the exhaust system removes engine exhaust from the cylinders after the combus-

tion process. The exhaust discharges from the exhaust manifold, passes through (drives) the turbocharger, and exits through the exhaust connection.



- 1. Exhaust Manifold
- 2. Turbocharger exhaust inlet

- 3. Turbocharger exhaust outlet
- 4. Exhaust flange outlet (left side NOT shown)

#### Figure 2-20 Exhaust System Flow Diagram (typical)



## Section 3 - Installation

### 3.1 Introduction

This section provides instructions for the initial installation, adjustment, and testing of the Cummins fire pump drive engine. Appropriate portions of this section should be used when returning the engine to operation after overhaul or major maintenance.

### 3.2 Receiving and Handling

Cummins fire pump drive engines are pre-assembled and tested before shipment. Parts not shipped attached to the engine are sometimes shipped individually. The equipment was thoroughly inspected and prepared for shipping before it was turned over to the carrier. Upon receipt of the fire pump drive engine from the shipper:

- 1. Inspect the equipment for damage that may have occurred in shipping; and
- 2. Check each item carefully against the shipping manifest or bill of lading.

#### 3.3 Site Preparation

The site should be clean and relatively level. Clear the proposed equipment area of overhanging obstructions and obstacles protruding from the floor.

## 

Avoid installation in a dusty or dirty environment. Provide adequate physical protection from other physical damage as may be present in the specific location.

### 3.4 Drive Shaft Installation

Drive shaft installation should be done by trained technicians familiar with local, state, and federal 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.

Follow these steps to install the drive shaft:

## 

Ensure that the lifting device is capable of safely lifting the weight of the engine or the combined weight of the assembled pump base, drive line, and pump. Do not use the engine lifting points for assembly!

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



- 1. Planes must be parallel
- 2. Align both mounting center lines to  $\pm$  .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

**NOTE:** Cummins recommends using a good quality semi-synthetic, molybdenum-fortified National Lubricating Grease Institute (NLGI) #2 lithium complex grease.

**NOTE:** Some lubrication loss may occur during transport and storage. It is recommended that the drive shaft be re-lubricated upon installation.

### 3.5 Fuel Supply Installation

**NOTE:** It is the responsibility of the customer to provide and install a properly-rated fuel tank per NFPA 20 guidelines.

To properly install a fuel supply, follow these instructions:

1. Install an elevated no. 2 diesel fuel tank or other fuel supply arrangement which is compatible with American Society of Testing and Materials (ASTM) no. 2 diesel fuel specifications.

**NOTE:** The fuel supply line at the fuel tank must be higher than the fuel intake port on the engine fuel filter. Ensure that the fuel system is installed in a safe and effective manner.

- 2. Size the fuel tank for the maximum expected fullload engine operation period with the initial fuel level at the minimum level for refueling.
- 3. Install a fuel return line and route this line to the bottom of the fuel tank in order to minimize the return head.
- 4. Install a fuel supply line to the fire pump drive engine.

**NOTE:** For fuel line specifications, refer to the Engine Data Sheet.

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

The fire pump drive engine fuel system has been primed during manufacturing and test procedures. The engine is equipped with an engine driven (gear) fuel pump.

An optional fuel pre-filter and a fuel filter/water separator is integrated into the fuel delivery system of the fire pump drive engine. To ensure that the filter/separator is free of water, open the fuel filter/water separator drain at the bottom of the filter and drain the fuel into a container until no water is present. Dispose of the contaminated fuel in accordance with local environmental regulations.

## 

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.

## 

Do not mix gasoline, alcohol, gasohol, ethanol, or methanol with diesel fuel. This mixture will cause severe engine damage or explosion.

## 

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

## 3.6 Cooling Water Supply Installation

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

**NOTE:** The flow rate of the cooling water should be as great as possible without exceeding the maximum allowable pressure shown in the Engine Data Sheet.

To install the cooling water supply:

1. Provide a cooling water discharge line at the outlet of the engine coolant heat exchanger and provide a cooling water supply line to the cooling water inlet per the Engine Data Sheet.

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

 Check the pressure regulator setting on the cooling loop with water flowing through the heat exchanger. The cooling loop is supplied by Cummins; both water pressure regulators have been set at 276 kPa (40 psi) (or slightly less) water pressure during manufacture and testing. **IMPORTANT:** The manual water valves for the automatic loop should remain OPEN at ALL times. The manual valves for the bypass loop should be CLOSED during automatic (pump controller) operation. When running, the engine should stabilize between temperatures identified on the Engine Data Sheet. The flow rate may need to be adjusted to maintain the desired engine temperature.

**NOTE:** Excessively cold (4 °C to 23 °C [40 °F to 75 °F]) cooling water flow can cause condensation inside the charge air cooler.

**IMPORTANT:** Continuous operation with low coolant temperature (below 70 °C [158 °F]) or high coolant temperature (above 107 °C [225 °F]) can damage the engine.

- 3. Adjust the cooling water based on the water *flow* rather than the water *pressure*. The flow is dependent on the cooling water temperature. Refer to the Engine Data Sheet.
- 4. To measure the water flow, use an appropriatesized container to measure the amount of water and the elapsed time of the water to flow from the discharge pipe and then formulate the calculations:

Flow rate = container size/ time to fill container.

#### Example:

Time to fill a 20 gallon container = 15 seconds.

20 gallons divided by 15 seconds = 1.33 gallons per second.

Multiply by 60 seconds = 80 gallons per minute (gpm) (FLOW RATE)

5. Adjust both pressure regulators to a pressure that will provide a flow rate at or above the specifications listed in the Engine Data Sheet.

## 

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

## Installation

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

**NOTE:** Maximum engine coolant temperature should not exceed the temperature listed on the Engine Data Sheet. The coolant expansion pressure/fill cap must meet the minimum pressure of 10 kPa (15 psi).

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.

### 3.7 Battery Installation

The minimum recommended Society of Automotive Engineers (SAE) reserve capacity (RC) and SAE cold cranking ampere (CCA) values for a particular engine can be found on the Engine Data Sheet. RC and CCA definitions can be found in SAE Standard J537. Refer to NFPA 20 and FM 1333 standards for additional battery installation information.

## 

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

**IMPORTANT:** Batteries must meet the requirement listed in the electrical system specifications. Batteries may be supplied by Cummins as an option, or may be supplied by the customer.

To properly install the batteries:

1. As shown in Figure 3-3 or Figure 3-4, install the Battery Cable Kit or equivalent customer-supplied wiring. Install battery sets in a well-ventilated or otherwise protected location.

## 

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



#### Figure 3-3 Series Battery Connection 12 VDC

- 2. Provide adequate room for servicing or replacing the batteries. Provide protection from extremes of temperature and weather.
- Locate the batteries near the engine or increase the size of the conductors as required by applicable codes. Ensure that the batteries are configured properly for 12 - or 24 - VDC standard operations.
- 4. Check the battery cables and connections.

**NOTE:** Coat the terminals with petroleum jelly to prevent corrosion. Install the cables and tighten the battery connections.



Figure 3-4 Series Battery Connection 24 VDC

### 3.8 Signal and Control Installation

The fire pump controller wires must be connected to the terminal blocks (TBs) on the FPDP Interface Terminal Strip and on the Battery Charger Interface. To complete the signal and control installation:

- 1. Ensure that the fire pump controller 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. Ensure electrical continuity and adequate insulation resistance for the installed wiring. Refer to the Operation - Engine Setup Screen section to conduct a Terminal Block Test from the FPDP.

#### 3.8.1 FPDP Interface Terminal Strip

As shown in Figure 3-5, the TBs between the fire pump controller and the fire pump driver are standard UL and FM controller terminals and follow a direct one-to-one correspondence (some TBs are optional):

 TB-1 [Run Solenoid Circuit]: This B+ signal is necessary for fire pump operations while in the FPDP is in AUTO mode. The Electronic Control Module (ECM) keyswitch/Fuel Shutoff (FSO) and raw water solenoid are activated when voltage is present at TB-1. When TB-1 is removed while the engine is running, the FPDP will command electronic engines to idle for up to three minutes.

- TB-2 [Crank Termination Switch]: This B+ signal is provided by the FPDP to inform the pump controller that the engine is running. Crank Termination indicates that the engine has started and that the crank command from the fire pump controller should stop immediately.
- TB-3 [Overspeed Switch]: This B+ signal is provided by the FPDP when the engine speed has exceeded 115% of the rated engine speed. When overspeed occurs, the ECM keyswitch or FSO outputs and the raw water cooling loop solenoid are immediately deactivated in an attempt to stop the fire pump drive engine. The FPDP will not allow the engine to be restarted until after the overspeed alarm has been reset.
- TB-4 [Low Lubricant Pressure Switch]: A ground path is provided by the FPDP when the oil pressure has dropped below the 16 psi (110 kPa) setpoint when the engine is running. A ground path is also provided to indicate low oil pressure when the engine is NOT running.
- TB-5 [High Engine Temperature Signal]: A ground path is present when the engine is running and the coolant temperature is at or above 212 °F (100 °C).
- TB-9 [Main Battery Contactor One Coil or Battery Relay One Coil]: This B+ signal is driven from the fire pump controller to contactor A when desiring to crank the engine from Battery A. Current in this circuit shall not exceed 10A continuous.

## Installation

- TB-10 [Main Battery Contactor Two Coil or Battery Relay Two Coil]: This B+ signal is driven from the fire pump controller to contactor B when desiring to crank the engine from Battery B. Current in this circuit shall not exceed 10A continuous.
- TB-301 [ECM Switch]: A ground path is provided by the FPDP when the engine is operating on ECM B.
- TB-302 [Fuel Injection Malfunction (FIM)]: A ground path is provided by the FPDP when either of the ECMs triggers a fault code which can affect the performance of the Fuel Injection System. See the Troubleshooting section for possible fault causes and solutions.
- TB-303 [ECM Warning]: A ground path is provided by the FPDP when a single ECM has been diagnosed as failed.
- TB-304 [ECM Failure]: A ground path is provided by the FPDP when both ECMs have been diagnosed as failed.
- TB-305 [Custom Output 1]: A ground path is provided by the FPDP when the custom alarm is configured and activated.

**NOTE:** If an Air Shutoff Valve is purchased, TB-305 is reserved for valve position feedback.

- **Type K Thermocouple Input** *optional*: The screws to the Type K thermal couple input may be loosened for installation of an exhaust temperature.
- TB-306 [Custom Output 2]: A ground path is provided by the FPDP when the custom alarm is configured and activated.
- TB-307 [Custom Output 3]: A ground path is provided by the FPDP when the custom alarm is configured and activated.
- TB-310 [Raw Water High Inlet Temperature] not applicable on radiator-cooled models - A ground path is provided by the FPDP when high raw water temperature is sensed.



Thermocouple Input

#### Figure 3-5 FPDP Interface Terminal Strip

- TB-311 [Clogged Raw Water Coolant Loop Strainer] - not applicable on radiator-cooled models - A ground path is provided by the FPDP when the raw water supply restriction is sensed.
- TB-312 [Low Engine Temperature Signal]: A ground path is provided by the FPDP when the engine coolant falls below 100 °F (37.8 °C).

#### 3.8.2 Battery Charger Interface

As shown in Figure 3-6, the Battery Charger Interface provides power to the fire pump controller, as well as provides charging current to the fire pump drive engine batteries. The Battery Charger Interface includes:

- TB-6 [Battery A Positive]: The fire pump controller senses Battery A charge state and charges Battery A through TB-6.
- TB-8 [Battery B Positive]: The fire pump controller senses Battery B charge state and charges Battery B through TB-8.
- TB-11 [Battery A and Battery B Negative]: The fire pump controller uses TB-11 as a ground reference for incoming power, as well as to charge the fire pump drive engine batteries.

**NOTE:** This is not intended to create a fully isolated battery negative or ground system. Current in each terminal block shall not exceed 30 amperes continuous.

To complete the battery signal connections:

- 1. Provide the initial charge on the redundant batteries per the battery charger's instructions.
- 2. Check that both voltmeters on the FPDP indicate the approximate battery voltage.

**NOTE:** Both sets of batteries can be used for starting the engine in the event that one set is low.



#### Figure 3-6 Battery Charger Interface

### 3.9 Coolant System Preparation

The fire pump drive engine cooling and lubrication system was initially filled during manufacture and testing. To properly prepare the coolant system:

## 

Ensure that all coolant systems have been filled to the proper level before operation by checking the coolant level sight gauge on the surge tank.

- 1. Inspect the engine coolant hoses and hose clamps and ensure that all coolant hoses and clamps are properly installed and water tight.
- Ensure that the engine coolant heater maintains an engine coolant temperature of 49 °C (120 °F) or above.
- 3. Ensure that coolant is present in the engine coolant heater before plugging the heater element into a dedicated circuit. Add coolant, if necessary.
- 4. Inspect the heat exchanger weekly for external damage and contamination.

**NOTE:** Contamination of the heat exchanger will affect the ability of the cooling system to transfer heat and properly cool the engine and intake manifold.

5. Add coolant, if necessary:

**NOTE:** Supplemental engine coolant should be a mixture of 50% ethylene glycol antifreeze and 50% water to avoid engine damage. For additional information, refer to the antifreeze information found in the Maintenance section.

- If the engine *IS equipped with a sight level* gauge, ensure that the engine coolant level is visible at the center of the sight level gauge. Add coolant as required. DO NOT OVERFILL!
- If the engine *IS NOT equipped with a sight level* gauge, fill the cooling system with coolant to the bottom of the fill neck. Do not fill above the bottom of the fill neck.
- 6. Re-install the pressure/fill cap.

## 

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

## 3.10 Lubricating Oil System Preparation

The fire pump drive engine and turbocharger were initially lubricated during manufacture and testing. To prepare the lubricating oil system for operation:

- 1. Check the oil level using the dip stick before operating the fire pump drive engine.
- 2. Fill the oil fill port to the "H" mark on the dipstick with lubricating oil.

**NOTE:** 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 used during normal operation.

## 

Some regulatory and shipping restrictions may require that all lubricants, fuels, and coolants be drained for transport. Ensure that all cooling and lubrication systems have been filled to the proper level before operation.

**NOTE:** Using multi-viscosity lubricating oil can improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures. Cummins recommends Premium Blue® 15W-40 oil for most climates.

## 

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

### 3.11 Pre-Start Inspections

Prior to starting the fire pump drive engine for the first time, perform a visual inspection:

- 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 drive engine is properly installed per the pump manufacturer's instructions, is correctly aligned, and is free to rotate.
- 6. Lubricate the grease fittings on the axillary drive shaft.

**NOTE:** Use the same type of oil as used in normal operation. Cummins recommends Premium Blue<sup>®</sup> 15W-40 oil for most climates.

### A 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.

### 3.12 Engine Monitoring

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

1. Immediately check that water flow is established through the coolant heat exchanger. The water flow should be established immediately, but some delay may occur before the flow exits the heat exchanger drain connection. **NOTE:** Ensure that cooling water is flowing and the water pressure shown on the local pressure gauge is no more than 414 kPa (60 psi). The minimum cooling water flow rate is identified in the Engine Data Sheet.

- 2. Ensure that the engine operating temperature stabilizes between applicable ranges as identified in the Engine Data Sheet.
- 3. Operate the engine for eight to ten minutes.
- 4. Inspect the engine for leaks, unusual noises, or other indications of incorrect operation.
- 5. While running the engine, look for the following signals during operation and field testing:
- Low engine lubricant pressure

### CAUTION

If the oil pressure is not displayed on the gauge or if the low oil pressure message is displayed within fifteen seconds, STOP THE ENGINE IMME-DIATELY! Continued operation without proper lubrication will cause engine damage.

- High engine coolant temperature
- Low engine temperature
- High raw water temperature
- 6. Shut off the engine by pressing and holding the overspeed **RESET/STOP** switch.
- 7. Shortly after the engine stops, check that the water flow stops automatically.
- 8. Correct any problems found during the inspection before proceeding.
- 9. Check the engine lubricating oil level at the dip stick. Add oil, if necessary.
- 10. Check the coolant expansion tank level. Add coolant, if necessary.

### Installation

- 11. Check the cooling water strainers. Clean the strainers according to the maintenance schedule in Section 5 Maintenance.
- 12. Perform engine speed control and safety system tests per the instructions in Section 4 Operation.

### 3.13 Field Acceptance Testing

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

- 1. Place the FPDP in MANUAL mode.
- 2. Start the fire pump drive engine and run a fixed speed test.

**NOTE:** The maximum engine speed should only be altered by a Cummins technician.



### Section 4 - Operation

### 4.1 Introduction

This section outlines general operating information for starting and stopping the fire pump drive engine, as well as instructions for navigating the menu screens of the Fire Pump Digital Panel (FPDP). This manual is provided for your 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.

### **A** WARNING

Before preparing the equipment for normal service, 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.

### 4.2 Starting and Stopping Procedures

By default, the fire pump drive engine will turn on automatically when low system water pressure is sensed by the pump controller. The engine will continue to operate as long as TB-1 is active. When the TB-1 signal is terminated by the fire pump controller, the engine will stop or enter a cool down procedure by lowering the engine speed.

For testing purposes, the fire pump drive engine can be turned on and off locally using the buttons on the FPDP (see the FPDP Description section). If the engine fails to start automatically in the event of a fire emergency, follow the Emergency Starting/Stopping Procedure outlined in Section 4.2.2.

### 4.2.1 Local Starting/Stopping Procedure

To start the engine locally from the FPDP:

- 1. Press the AUTO/MAN selector switch on the FPDP to place the engine in MANUAL mode.
- 2. Press the CRANK BATT A and/or CRANK BATT B button to crank the engine.

The engine may be stopped locally by pressing the RESET/STOP switch on the FPDP or by holding down the red Engine STOP button on the left side of the FPDP.

**NOTE:** Upon release of the Engine STOP Button, the fire pump drive engine will attempt to restart, If there is still a "pump on demand" signal present from the fire pump controller. The engine must also be stopped at the fire pump controller.

### 4.2.2 Emergency Starting Procedure

The engine will start automatically in the event of a fire emergency. However, if it fails to start automatically, the engine can be started locally. The following procedure outlines an emergency manual mode electrical start:

- 3. Press the AUTO/MAN selector switch on the FPDP to place the engine in MANUAL mode.
- As shown in Figure 4-1, open the FPDP panel door and slide the key switch override to the "RIGHT" position. Verify that LED 49 - KEY FB (key feedback) switch is lit.



Figure 4-1 FPDP Override Switch

### CAUTION

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

5. As shown in Figure 4-2, press downward on either the Battery A or Battery B contactor lever to start the engine. If crank contactor lever A does not engage the starter, repeat using crank contactor lever B. If the battery charge is low, press downward on both battery contactor levers at the same time. Release the contactor lever immediately after the engine starts.

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

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

**IMPORTANT:** Engine oil pressure must be indicated on the gauge within fifteen seconds after starting.



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

#### Figure 4-2 Manual Starter Contactors

The engine may be stopped locally by pressing the RESET/STOP button on the FPDP or by holding down the red ENGINE STOP button on the left side of the FPDP.

**IMPORTANT:** Upon release of the Engine **STOP** Button, the fire pump drive engine will attempt to restart, if there is still a "pump on demand" signal present from the FPDP. The engine must also be stopped at the fire pump controller.

### 4.3 Fire Pump Digital Panel (FPDP) Screens and Adjustments in Automatic Mode

The FPDP consists of an LCD touchpad that displays the fire pump drive engine tachometer, coolant temperature, oil pressure, Battery A voltage, Battery B voltage and hour meter, as well as includes three soft keys:

- SCREEN Soft Key
- MENU Soft Key
- IDLE Soft Key (electronic engines in MAN mode, only)

**NOTE:** When the key switch is not on, the coolant temperature defaults to "0 °F" (or "0 °C") and the oil pressure defaults to "0 PSI" (or "0 kPa").

The FPDP LCD will go into SLEEP MODE after fifteen minutes of inactivity by the user. The FPDP LCD will resume normal display features when the user presses a hard button or touches the LCD screen.

### 4.3.1 The SCREEN Soft Key

The SCREEN Soft Key, on the bottom right of the LCD, deactivates and activates an overlay box which lies atop the tachometer signal (the engine speed is still digitally displayed). The overlay is used to:

- Automatically Warn the operator of ECM and/or DPEM faults, when applicable (see Section 4.3.2.6 FAULT CODES Screen); and/or
- Operator-selected Display additional analog values not required by NFPA 20.

The overlay background color will display in gray, unless there is an active fault present. Fault overlays will display in the color of the most severe fault. To deactivate the Fault overlay, press the SCREEN Soft Key to make the overlay disappear from the LCD.



#### Figure 4-3 FPDP User Interface Screen (Electronic Engine)

**NOTE:** Electronic engines display tachometer, engine temperature and oil pressure values from J1939. Mechanical engines display parameters via sensors added by Cummins.

As shown below, the Analog Values overlay background color displays in gray.



Figure 4-4 Analog Values Overlay (Electronic Engine)

Additional values that may be displayed include:

- Exhaust temperature (when a pyrometer is installed and terminated to the Power Board).
- Cooling loop raw water temperature and strainer status on FM-approved and UL-listed fire pump drivers. The Analog Values Overlay can assist in troubleshooting the cooling loop by identifying issues with the pressure sensors.
- J1939 parameters.

**NOTE:** The Oil Temperature value (from J1939) will only be shown on CFP11E and CFP15E.

**NOTE:** The Intake Manifold Pressure (from J1939) will be showing 0 PSI at no load.

**NOTE:** A thermocouple must be purchased and installed from Cummins in order for exhaust temperature values to display. If a thermocouple is not connected to the Power Board or the thermocouple input temperature is less than 200 °F, the Exhaust Temperature will display 0 °F.

To deactivate the Analog Values overlay, press the SCREEN Soft Key to make the overlay disappear from the LCD.

### 4.3.2 The MENU Soft Key - Settings Menu

If the operator presses the MENU Soft Key from the FPDP User Interface Screen, the Settings Menu Screen appears as shown below.



### Figure 4-5 Settings Menu Screen (Electronic Engine)

The Settings Menu provides options for further operator input and monitoring of fire pump drive engine parameters. Press the corresponding soft key to access a sub-menu.

#### 4.3.2.1 ENGINE SETUP Screen

The fire pump drive engine was preconfigured with custom options (if applicable) at the factory prior to shipping to the customer. The System Options screen provides a view of the custom configuration that has been set up for your fire pump drive engine. The Cummins Service Department must be notified if any of these parameters are adjusted in the field.

- 1. Starting at the User Interface Screen (Main Menu), press the MENU Soft Key.
- 2. As shown in Figure 4-6, press the soft number keys to enter password "806" in the Engine Setup Login screen.

Engine Setup Login		
	ХХХ	
	1 2 3 4 5 6 7 8 9 0	
RETURN		SUBMIT

### Figure 4-6 Engine Setup Login Screen (Typical)

3. Press SUBMIT to access the Engine Setup screen.



### Figure 4-7 Engine Setup Screen (Electronic Engine)

### **Engine Setup Screen - SYSTEM OPTIONS**

The System Options sub-menu displays the custom configurations of the fire pump drive engine. When

active, the soft buttons turn green in color and display "ON". Conversely, the soft button will turn red in color and display "OFF", if the feature is disabled. To change a numeric data field, tap the data field to access the popup keyboard and enter different data.



#### Figure 4-8 System Options Screen (Electronic Engine)

The custom options of the System Options sub-menu include:

**DPEM** – When active, the FPDP initiates communications with the Digital Panel Expansion Module (DPEM).

**OVERSPEED SHUTDOWN** – When active, the FPDP shuts the engine fueling off when the engine speed reaches or exceeds 115% of the configured rated speed.

**COOLING LOOP** – When active, the FPDP will monitor and diagnose the cooling loop parameters.

**IMPORTANT:** The COOLING LOOP System Option shall be enabled for FM-approved fire pump drive engines.

**COOLING LOOP SENSOR**– The FPDP is configured for two different sensors, a three-terminal 0-5V sensor labeled "Cummins" and a single post-resistive sensor labeled "Datcon". When active, the applicable soft key will display in green.

**IMPORTANT:** The COOLING LOOP SENSOR System Option must match the cooling loop sensor installed on the engine for proper decoding and alarming of cooling loop parameters. Ensure that the toggle switch on the FPDP Interface Terminal Strip also matches the cooling loop sensor System Option. **LOOP ALARM TEMP (F)**– When active, the display shows the alarm setpoint for the raw water temperature entering the cooling loop. When the cooling loop is disabled, the alarm will show "XXX".

**LOOP ALARM PRES (PSI)**– When active, the display shows the alarm setpoint for diagnosing a clogged raw water strainer in the cooling loop. When the cooling loop is disabled, the alarm will show "XXX".

# **ENGINE COOLDOWN (SEC) (on electronic engines only)** - When active, the operator shall denote a specific amount of seconds to idle the fire pump drive engine. When the engine cool down is disabled, the seconds shall be set to "0" (see 4.5 Engine/Turbocharger Cool Down).

Press either RETURN or SUBMIT to return to the Engine Setup menu.

### Engine Setup Screen - TERMINAL BLOCK TEST

The TERMINAL BLOCKS sub-menu provides a convenient means of checking the signal integrity between the fire pump controller and the terminal block interface inside the FPDP.

As shown in Figure 4-9, any of the signals on the terminal block interface can be manually activated by pressing the respective red soft key. When the button turns green, the signal is active.



### Figure 4-9 Terminal Block Test Screen (Sample)

To perform a Terminal Block Test:

1. Starting at the User Interface Screen (Main Menu), press the MENU soft key;

- Press the ENGINE SETUP soft key from the Settings menu;
- 3. As shown in Figure 4-6, press the soft number keys to enter password "806" in the Engine Setup Login screen.
- 4. Press the TERMINAL BLOCKS soft key from the Engine Setup menu;
- 5. Press the soft key corresponding to the terminal block requiring verification;

**NOTE:** If the selected terminal block soft key turns green, but the pump controller alarm does not activate, troubleshoot the terminal block connection for a *B*+ or ground signal (see the Section FPDP Signal and Control Connections or contact your local Cummins Sales and Service representative).

**NOTE:** For electronic engines, the Fuel Inj. Malf. (fuel injection malfunction) can only momentarily be set.

6. To exit the Terminal Block Test menu, press the RETURN soft key to return to the Engine Setup menu.

**NOTE:** Oil pressure and coolant temperature alarms will not latch upon backing out of the menu, but instead will be driven directly from datalink values.

#### Engine Setup Screen -VSPLC TRANSDUCER CAL

**NOTE:** The VSPLC TRANSDUCER CAL screen **only** applies to VSPLC fire pump drive engines. The settings in this menu are meaningless unless VSPLC is enabled.

To account for a system pressure differential, the operator may enter a pressure offset. This same pressure offset is used throughout the entire incoming pressure range. To access the VSPLC Transducer Configuration screen:

- 1. Starting at the User Interface Screen, press the MENU soft key.
- 2. Press the ENGINE SETUP soft key from the Settings menu.

- As shown in Figure 4-6, press the soft number keys to enter password "806" in the Engine Setup Login screen.
- 4. Press the VSPLC TRANSDUCER CAL soft key from the Engine Setup menu.
- 5. As shown in Figure 4-10, press the VSPLC Offset (PSI) data field to activate the popup keyboard and enter the desired pressure offset.

**NOTE:** The software limits the pressure offset to +/-10 PSI with a resolution of 0.1 PSI.

VSPLC Transducer Configuration		
VSPLC Offset (PSI):	- 01.0	
RETURN	SUBMIT	

### Figure 4-10 VSPLC Transducer Configuration

- 6. Press SUBMIT.
- 7. Press RETURN to return to the Engine Setup menu.

#### 4.3.2.2 OVERSPEED TEST Screen

The Overspeed Test Screen allows the operator to simulate an overspeed shutdown for all engine models:

- 1. Starting at the User Interface Screen (Main Menu), press the MENU soft key.
- 2. Press the OVERSPEED TEST soft key from the Settings Menu.
- If necessary, press Adjust Engine Speed (shown in Figure 4-11) and then use the INC and DEC buttons to increase or decrease the engine speed by increments of ten RPM.



### Figure 4-11 Overspeed Test - Adjust Engine Speed

4. Press the RUN soft button.



Figure 4-12 Overspeed Timer

5. When the timer expires (shown in Figure 4-12), "ENGINE OVERSPEED" written in red will flash at the top of the FPDP screen (shown in Figure 4-13).



### Figure 4-13 Overspeed Test Timer Expired (Sample)

6. The fire pump drive engine will enter MANUAL mode until reset.

7. Press the RESET/STOP Switch on the FPDP to reset the fire pump drive engine.

### 4.3.2.3 IMPERIAL/SI VALUES Screen

The Imperial/SI Values Screen, shown in Figure 4-14, allows the operator to select Imperial or *Système Internationale* (SI) (also known as metric) units of measurement. The default units of measure are Imperial units of degrees in Fahrenheit and pounds per square inch (PSI), but the user may elect degrees in Celsius or kilo Pascal (kPa).

	Imperial/SI Values		
	Temperatures		
	Degrees F	Degrees C	
1	Pressures		
	PSI	kPa	
RETURN			SUBMIT

### Figure 4-14 Parameter Units Screen (Typical)

To change the displayed units of measurement:

- 1. Starting at the User Interface Screen (Main Menu), press the MENU soft key.
- 2. Press the IMPERIAL/SI VALUES soft key from the Settings Menu.
- 3. Press the soft key for the desired unit of measure.
- 4. Press the SUBMIT soft key.
- 5. To exit the Imperial/SI Values menu, press the RETURN soft key.

### 4.3.2.4 ANALOG VALUES Screen

To view the information about the fire pump drive engine in digital format:

- 1. Starting at the User Interface Screen (Main Menu), press the MENU soft key.
- 2. Press the ANALOG VALUES soft key from the Settings Menu.

3. To exit the Analog Values screen (shown in Figure 4-15), press the RETURN soft key.

**NOTE:** The display choice of Imperial or SI values is made using the Imperial/SI Values Screen.

#### Analog Values Battery A: 23.8V Cooling Loop Temp: 70F Battery B: 23.7V Engine Speed: 1760 RPM

Diff Press Pre: 170 PSI Diff Press Post: 158 PSI

#### RETURN

#### Figure 4-15 Analog Values Screen (Sample)

#### 4.3.2.5 AUTOSWITCH Screen

Water Temp: 187 F Oil Pressure: 44 PSI Exhaust Temp: 0 F

Hour Meter: 1.99 hrs Var Speed Pressure: 0 PSI

The National Fire Protection Association (NFPA) 20 Standard, as well as Underwriters Laboratories (UL) and Factory Mutual (FM) Standards, requires redundancy for fire safety systems. If the fuel system is electronically-controlled, switching of ECMs must be controlled automatically. Cummins refers to this process as "ECM Autoswitching." When the FPDP switches ECMs automatically, the fault code responsible for the last switch can be found on the Autoswitch Screen. The FPDP will activate the ECM keyswitch for fifteen seconds every thirty minutes to validate communications with the ECM.

**IMPORTANT:** In order to maintain NFPA 20 compliance, autoswitching must be enabled.

As shown in Figure 4-16, the Autoswitch Settings screen allows the operator to disable or enable this autoswitch capability.

Autoswitch Settings		
Autoswitch Enable ON		
Last Autoswitch Fault: xxx		
RETURN	SUBMIT	

### Figure 4-16 Autoswitch Settings Screen (Typical)

To change the autoswitch setting:

- 1. Starting at the User Interface Screen (Main Menu), press the MENUsoft key.
- 2. Press the AUTOSWITCH soft key from the Settings Menu.
- 3. Press the ON/OFF soft key the soft key displayed (in green) indicates which mode has been selected.
- 4. Press the SUBMIT soft key.
- 5. To exit the Autoswitch Settings screen, press the RETURN soft key.

#### 4.3.2.6 FAULT CODES Screen

As shown in the Description Section, fault codes diagnosed by the ECM are displayed in a yellow or red overlay box which lies atop the tachometer signal (the engine speed is still digitally displayed) to alert the operator to service the engine as soon as possible. Only the first seven active ECM faults will be displayed in the overlay.

As shown in Figure 4-17, the Fault Codes Screen displays the full list of active faults. To view the information about the fire pump drive engine active faults:

- 1. Starting at the User Interface Screen (Main Menu), press the MENU soft key.
- 2. Press the FAULT CODES soft key from the Settings Menu.
- 3. To exit the FAULT CODES menu, press the RETURN soft key.

For more information about fault codes and their meanings, see the Fault Code Section of this manual or contact your local Cummins Distributor.



#### Figure 4-17 Fault Codes Screen (Sample)

#### 4.3.2.7 RPM ADJUSTMENT Screen

As shown in Figure 4-18, the RPM AdjustmentScreen allows the operator to make on-site adjustments to **FIXED SPEED** fire pump drive engines. Each press of the INC soft key or the DEC soft key will increase or decrease the engine speed setpoint by 10 RPM (not to exceed +/-50 RPM) for electronic engines.



### Figure 4-18 RPM Adjustment Screen (Typical)

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, follow these steps to adjust the speed setting:

- 1. Starting at the User Interface Screen (Main Menu), press the ECM A Selector Switch.
- 2. Press the MENUsoft key.
- Press the RPM ADJUSTMENT soft key from the Settings Menu.

- 4. Press either the INC soft key or the DEC soft key to change the ECM RPM setpoint.
- 5. Press the RETURN soft key.
- 6. Press the RESET/STOP Switch on the FPDP and wait for thirty seconds.
- 7. Repeat Steps 1 through 5 for ECM B.

**NOTE:** The speed setpoint adjustments must be made on each ECM to experience the same system level of performance on the alternate ECM.

**IMPORTANT:** Never switch from ECM A to ECM B while the engine is running.

#### 4.3.2.8 DPEM (Optional)

As shown in Figure 4-19, the DPEM Screen displays the function name, status, alarm setpoint, and relay associated with the alarm (if applicable) of any custom inputs that are configured on the fire pump drive engine. When an analog input parameter crosses the alarm setpoint or a switched input is active, all information associated with that parameter will turn red in color. To access the DPEM Screen:

- 1. Starting at the User Interface Screen (Main Menu), press the MENU soft key.
- 2. Press the DPEM soft key from the Settings Menu.
- 3. To exit the DPEM Screen, press the RETURN soft key.



### Figure 4-19 DPEM Screen (Sample)

If communications between the FPDP and DPEM are compromised, the DPEM screen may be accessed by pressing the DPEM soft key that appears on the User Interface Screen (Main Menu) (shown below).





### 4.4 FPDP Screens and Adjustments in Manual Mode - IDLE Soft Key

**NOTE:** The IDLE soft key shown in Figure 4-21 displays in red while the engine idle command is inactive. The IDLE soft key will display in green when the engine idle command is active.



Figure 4-21 IDLE Soft Key (Typical)

With the FPDP in manual mode and using the IDLE soft key, the FPDP can now command electronic engines to idle. The operator can choose to idle the fire pump drive engine to warm up the engine for weekly testing and/or to evaluate water leaks during commissioning. To manually place the fire pump drive engine in idle:

- 1. Select MAN on the AUTO/MAN Mode Switch on the FPDP to place the fire pump drive engine in manual mode.
- 2. Press the IDLE soft key on the screen.

**NOTE:** Engaging the IDLE soft key will turn the IDLE soft key display from red to green, engaging the engine idle command.

- 3. Press the BATT A or the BATT B Momentary Start Switch to start the engine.
- 4. To disengage manual engine idle, press the IDLE soft key on the screen. The IDLE soft key will return to red in color.

The engine will ramp to rated speed. The engine will also ramp to rated speed (for fixed speed applications) or enter a closed loop VSPLC mode, if enabled, when TB-1 becomes active while the engine is idling.

### 4.5 Engine/Turbocharger Cool Down

The FPDP has the ability to idle an electronic engine for up to three minutes when a shutdown has been commanded from the fire pump controller. The cool down feature promotes engine turbocharger longevity. During engine cool down, the FPDP will display "Engine Cooldown Active" (shown in Figure 4-22).



### Figure 4-22 Engine/Turbocharger Cool Down (Typical)

During engine cool down, the fire pump drive engine may shutdown automatically - prior to the timer expiring - to protect the engine. The operator also has the option to shut down the engine manually from the fire pump controller or the FPDP during cool down, if necessary. **IMPORTANT:** All fire pump drive engines are shipped from the factory with the cool down feature disabled. This feature must be manually enabled by the customer. Prior to enabling the cool down feature, ensure all operators are trained on the operation of this engine cool down feature.

#### 4.5.1 Automatic Shutdown - Cool Down Timer

The fire pump drive engine will automatically shutdown when the Engine Cooldown timer expires.

**4.5.2 Automatic Shutdown - Engine Protection** The FPDP will automatically shut the engine off and during engine cool down if:

- Low oil pressure is sensed;
- High coolant temperature is sensed; and/or
- Communications with the ECM are lost.

### 4.5.3 Manual Shutdown - From the Fire Pump Controller

During cool down, the fire pump drive engine can be shut down manually from the fire pump controller by:

- 1. Turning the fire pump controller switch to OFF (deactivating TB-1). NOTE: *The FPDP will keep the fire pump drive engine running to idle*; AND
- 2. Turning the fire pump controller from OFF to MAN (manual) and back to OFF (reactivating and deactivating TB-1). The fire pump drive engine will shut down.

### 4.5.4 Manual Shutdown - From the FPDP

The engine can also be shutdown manually by pressing the RESET/STOP Switch on the FPDP two times in succession. This page is intentionally left blank.



### Section 5 - Maintenance

### **5.1 Introduction**

Before performing maintenance procedures, read and understand Section 1 - Safety 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 Original Equipment Manufacturer (OEM) products. See the warranty information at the beginning of this manual.

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

The National Fire Protection Association (NFPA) 25 Standard outlines the maintenance tests to be performed to validate automatic and manual operational requirements for field acceptance testing.

Cummins recommends that the engine be maintained according to the Cummins Operation and Maintenance manual for that engine family.

**NOTE:** If your engine is equipped with a component or accessory not manufactured by Cummins, refer to the component manufacturer's vendor supplied literature for specific maintenance recommendations.

### 5.2 Engine Operation Reports

The engine must always be maintained in top mechanical condition. Proper maintenance of the fire pump drive engine requires documenting regular running reports to include the following:

- Low engine oil pressure.
- Engine surge.
- Erratic operation or frequent shutdowns.
- Any warning lamps flashing or staying illuminated.
- Abnormal coolant or oil temperature.
- Unusual engine noise or vibration.
- Excessive smoke.
- Excessive use of coolant, fuel, or engine oil.
- Any fluid leaks.
- · Loose, worn, or damaged parts.

The weekly running report also helps to make provisions for more extensive maintenance, as the reports indicate the necessity.

The Fault Codes displayed on the Fire Pump Digital Panel assist in recording operation irregularities. See Section 6 - Troubleshooting of the model-specific English manual for a listing of Fault Codes.

### **Maintenance Record Form**

Table 5-1.

Engine Serial Number:		Engine Model: Equipment Name/Number:			
Owner's Name:					
Date	Hours or Time Interval	Actual Hours	Check Performance	Performed By	Comments
	3				
	<b>1</b>				
_					
19					

NOTE: All maintenance and inspections intervals are accumulative. When performing annual maintenance, also perform maintenance listed under daily, weekly, monthly, and three month intervals.

### 5.3 Weekly Maintenance

When the engine is running, be alert for mechanical problems that could create unsafe or hazardous conditions.

#### 5.3.1 General

Each week, a general walk-around inspection should include the following areas:

- 1. Check fluid levels before starting the engine. Check oil pressure and coolant temperatures frequently. Most engine problems give an early warning.
- 2. Look and listen for changes in engine performance, sound, or appearance that will indicate that service or repair is needed. Be alert for misfires, vibration, excessive exhaust smoke, loss of power, or increases in oil or fuel consumption.
- 3. 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.
- 4. Check the engine for odors of diesel fuel, burning rubber, electrical system failure, exhaust fumes, or smoke.

### 

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.

#### 5.3.2 Air Cleaner Filter and Piping

On a weekly basis, perform the following inspections:

1. Visually inspect the air intake filter and piping daily 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 2-2.

**NOTE:** Turbocharged engines must be operated at rated revolutions per minute (*RPM*) and full load to check maximum intake air restriction.

**NOTE:** Cummins recommends using an air cleaner filter element as listed on the Engine Data Sheet.

### 

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. Dirt or foreign objects could cause engine damage.

- a. If the red indicator flag is at the raised position in the window, clean or replace the air filter per the manufacturer's recommendation as required. Do not remove the felt washer from the indicator. The felt washer absorbs moisture.
- b. After the air cleaner has been serviced, push the flag in to reset the service indicator.

**IMPORTANT:** See the Engine Data Sheet for maximum intake air restriction.

- 2. 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.
- 3. Replace any damaged air filter or hoses and tighten loose clamps, as necessary, to prevent the air system from leaking. Torque the hose clamps to the recommended torque value. Refer to the Torque Tables.

### 5.3.3 Cooling System

### CAUTION

Do not remove a coolant pressure/fill cap from a hot engine. Shut down the engine and wait until the coolant temperature is below 50 °C (120 °F) before removing the pressure cap. Heated coolant spray or steam can cause severe personal injury.

### Maintenance

On a weekly basis, perform the following inspections on the cooling system:

- Inspect the cooling water piping, coolant heat exchanger tanks, charge air cooling system (if applicable), engine coolant hoses, and hose clamps for loose fittings, leaks, damage, and corrosion.
  - a. Tighten the hose clamps, as necessary.
  - b. Check for cracks, holes, or other damage. Repair or replace as necessary.

### 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.

- 2. With the coolant expansion tank at ambient temperature, press down, unscrew, and remove the pressure cap as shown in Figure 2-1.
  - a. Ensure that the coolant level is visible by checking the coolant level sight gauge.
  - b. Add coolant, as required. DO NOT OVER-FILL!

**NOTE:** Supplemental engine coolant should be a mixture of 50% ethylene glycol antifreeze and 50% water to avoid engine damage.

- 3. Check the antifreeze concentration at least six times a year or whenever coolant is added to the cooling system by using a refractometer.
- 4. Drain a small amount of coolant from the return line petcock and inspect the coolant for excessive rust or particulate matter. Change the coolant more frequently if particles are present.

### 

Do not mix coolant brands or chemical solutions, as this could damage the cooling system. Keep a record of the coolant concentration and manufacturer with the engine maintenance records.

5. Check for soft, overly-pliant hoses, oxidation, and loose hose clamps. Torque the hose clamps to the recommended torque value. Refer to the Torque Tables. Replace damaged hoses and clamps as required.

 Check the coolant heat exchanger tanks for leaks, damage, and dirt buildup. Clean and repair as required.

### 5.3.4 Engine Oil System

### A WARNING

Perform the specific checks in this section only after the engine is fully stopped. Unless tests require engine operation, disconnect the battery leads from the batteries (negative terminal first). Contact with exposed or moving components can cause severe personal injury.

Inspect the engine oil system on a weekly basis following these steps:

- 1. For accurate dipstick readings, shut off the engine and wait approximately ten minutes to allow the oil in the upper portions of the engine to drain back into the crankcase.
- 2. As shown in Figure 5-1, check the oil level at the engine dipstick.



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- 1. Oil Fill Port (on valve cover)
- 2. Oil Level Dipstick
- 3. Engine Oil Filter

### Figure 5-1 Oil Level Dipstick

• If the oil level is greater than the high mark (H), drain the excess oil and recheck the level.

 If the oil level is consistently below normal after a fill, check for leaks, loose or damaged gaskets, or oil in the coolant system. If the oil level is below the low mark (L), add the equivalent type oil.

**NOTE:** Cummins recommends using Premium Blue<sup>®</sup> 15W-40 Multi-viscosity Lubricating Oil or equivalent.

5.3.5 Fuel System

### 

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.

To inspect the fuel system:

- 1. Shut off the engine.
- 2. Inspect the fuel supply line, return line, filter and fittings for cracks or abrasions.
  - a. 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.
  - b. Relieve fuel line pressure by carefully loosening the fuel inlet line.

**NOTE:** Refer to the Engine Data Sheet for Cummins recommended replacement components.

### 5.3.6 Engine Exhaust System

With the engine operating, inspect the entire exhaust system: exhaust manifold, exhaust flex pipe, muffler, and piping.

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

### 5.3.7 Electrical Supply and Controls

Check the terminals on the starting batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Inspect the FPDP harness connections to be sure they are secure.

### 5.3.8 Crankcase Ventilation Hose

Inspect the crankcase ventilation hose for wear, damage, sludge, blockage, or dirt buildup (refer to Figure 2-1). Clean the ventilation hose, if obstructed or blocked. Replace a worn or damaged hose.

**5.3.9 Heat Exchanger - Cooling Water Strainers** As shown in Figure 5-2, the (two) cooling water strainers should be cleaned weekly to remove sediment.

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.

For each cooling water strainer:

- 1. Remove the plug.
- 2. Inspect and remove any debris.
- 3. Install the strainer plugs.
- 4. When finished, open the normal line valves and close the bypass line valves for normal operation.



- 1. Bypass Water Line Strainer
- 2. Normal Water Line Strainer

Figure 5-2 Cooling Water Strainer (typical)

### 5.3.10 Batteries

### CAUTION

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

### 

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

For proper weekly maintenance of the batteries:

- 1. Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.
- 2. Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell. A fully-charged battery will have a specific gravity of 1.260. Replace the battery, if the specific gravity reading is below 1.215.
- 3. Check the battery wiring and cable connections for loose, corroded, worn, or damaged cables. Check both connectors at the alternator, battery connections, and engine grounding lug (near the starter motor).
  - a. If the battery cables are corroded, remove the battery cable clamps, starting with the negative (-) battery cable.
  - b. Use a fine emery cloth or a wire brush to clean the cable clamps and battery cables. The metal should be shiny.
  - c. Wash the battery terminals with a solution of baking soda and water (2 oz (1/4 cup) baking soda to 0.94 liter (1 qt) of water).
  - d. Be careful to prevent the solution from entering the battery cells, and flush the batteries with clean water when done.
  - e. After cleaning the connections, coat the terminals with a light application of petroleum jelly.
  - f. Reinstall and tighten the cable clamps.

### 

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

- 4. Check the electrolyte level in the batteries monthly. If low, fill the battery cells to the bottom of the filler neck with distilled water.
- 5. Check for continuity between terminals using a digital multimeter or other test equipment. Also check the insulation resistance to ground. Correct any electrical faults.
- 6. Reinstall the battery cables; attach the negative (-) battery cable last.

#### 5.3.11 Engine Test Run

Start the engine at least once a week for a minimum of thirty minutes with as much load as possible. Periods of no-load operation should be held to a minimum, because unburned fuel tends to accumulate in the exhaust system. Refer to the operating instructions in Section 4 - Operation.

Check that the engine starts and operates at the recommended fire pump drive engine speed specification and inspect the following:

- 1. Check that the engine oil pressure is indicated on the gauge within fifteen seconds after starting.
- 2. Check that the engine has attained a normal running temperature after running the engine for a minimum of thirty minutes.
- 3. Observe that the engine is operating at the proper operating speed. (If the engine is not operating at the proper speed, see Section 5.3.12 Engine Operation Checks.)
- 4. Check for unusual engine noise. Listen for any unusual engine noise which can indicate that service is required.
- 5. Ensure that the oil pressure is greater than 69 kPa (10 psi).
- Check that the coolant temperature is between 70 °C (158 °F) and 107 °C (225 °F).

- Check that both battery voltmeters indicate 12 VDC for standard or 24 VDC for optional operating systems.
- 8. Check that the air filter service indicator has not popped-up, indicating an air filter blockage. Replace the air filter as required.

End the test run by pressing and holding the overspeed RESET/STOP switch until the engine stops.

### 5.3.12 Engine Operation Checks

The following service inspections ensure that the engine starts and operates properly under normal conditions.

### 

Before equipment operation, ALL guards, covers, and protective devices MUST BE in place and securely fastened. Serious personal injury could result from contact with exposed or moving components.

#### 5.3.12.1 Crank Termination Setpoint

The speed switch crank termination setpoint is factory-set at 600 RPM and should not be changed from this value.

### 5.3.12.2 Engine Speed Adjustment

The electronic engine operating speed was factory set during manufacturing and test procedures. If the speed unintentionally does not match the engine RPM shown on the factory setting plate, refer to Section 4 - Operation: RPM Adjustment Screen.

#### 5.3.13 Engine Coolant Heater

**NOTE:** Perform this inspection procedure twenty-four 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 (38 °C (100 °F)) in the water jacket areas (see Figure 2-2).

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

### 5.4 Annual Maintenance

All checks or inspections listed under previous maintenance intervals must also be performed at the time of the annual maintenance, in addition to those listed *only* under the annual maintenance interval.

#### **5.4.1 Electrical Components**

### 

**AVOID** SERVICING complex components such as: printed circuit boards, programmable controllers, and ECMs not specifically authorized by Cummins. Contact a Cummins Authorized Repair Location before performing any extensive maintenance.

### 

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

The electrical components of the fire pump drive engine must be thoroughly inspected on an annual basis. Remove the battery terminal cables, starting with the negative (-) cable first and check the following:

- Inspect the electrical wiring harness, electrical terminal connections, and electrical plug-ins for secure, clean electrical contacts, worn or damaged insulation, burnt wires, broken wires, and loose connections (see Figure 2-2).
- Clean and tighten any loose electrical connections.
- Repair or replace worn, damaged, burnt, or poorly insulated wiring immediately.

**IMPORTANT:** Refer to the vendor-supplied literature for recommended maintenance procedures.

- 2. Inspect the function of all gauges, voltmeters, switches, and warning lamps on the FPDP. Replace the FPDP if any are not functioning properly.
- 3. Reinstall the battery cables; attach the negative (-) battery cable last.

#### 5.4.2 Turbocharger Mounting Nuts

As shown in Figure 5-3, check the turbocharger mounting nuts and torque the mounting nuts to the recommended torque value. Refer to the Torque Tables.

### Maintenance



- 1. Exhaust Flex Connection
- 2. Turbocharger
- 3. Air Cleaner/Filter
- 4. Service Indicator
- 5. Air Cleaner Piping

Figure 5-3 Turbocharger (typical)

#### 5.4.3 Engine Supports

### CAUTION

Loose engine mount bolts or damaged brackets can cause engine misalignment or excessive vibration. These conditions can cause engine or pump damage.

Refer to Figure 2-2 for the location of the engine supports and inspect all engine supports for cracks or loose hardware. Check the torque on the engine support mounting capscrews. Torque the engine mounting cap screws to the support bracket. Refer to the Torque Tables for recommended torque values.

#### 5.4.4 Fuel Pumps and Filters

As shown in Figure 5-4, inspect the fuel injection pump mounting nuts (including the support bracket) for loose or damaged hardware. Inspect the fuel line hoses and fuel filters for wear, damage, loose fittings, and leaks. Repair or replace damaged hoses and filters as required.



Figure 5-4 Fuel Pumps (typical)

### 

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.

### **A** WARNING

Do not open the fuel filter/water separator drain valve or dismantle the fuel lines on the high-pressure fuel system with the engine running. High pressure fuel spray from an operating engine can cause serious personal injury or fire hazard.

To change the fuel filters:

- 1. Shut off the engine.
- 2. Close any fuel valves (if equipped) to prevent fuel from draining or siphoning.
- 3. Clean the area around the fuel filter or fuel/water separator heads.

**NOTE:** Refer to the Engine Data Sheet for filter replacement recommendations.

4. Remove the spent filter canisters using a filter wrench.

- 5. Clean the filter mounting head surfaces of sludge buildup and foreign particles. Ensure mating gasket surfaces are clean.
- 6. Lubricate the gasket seals with clean SAE 15W-40 lubricating oil.
- 7. Center the filter ring on the threaded mounting nipple. Screw the filter canister onto the mounting flange until the gasket is snug against the mounting flange, then tighten an additional 1/4 turn.
- 8. Open the fuel supply valves (if equipped).

### 

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

- 9. Press either the CRANK BATT A or CRANK BATT B button to start the engine to allow the fuel to flow through the system.
- 10. Depress the contactor switch for up to fifteen seconds or until the engine starts. Repeat up to three times, if necessary.

### CAUTION

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

**IMPORTANT:** 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.

**NOTE:** Engines used in fire pumps or standby service are expected to immediately accelerate from crank to full load.

### 5.4.5 Engine Oil and Filter

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. Change the oil at least once annually.

**NOTE:** 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.

**IMPORTANT:** If the engine oil is drained from the oil pan to make an engine repair, new oil must be used.

### **A** WARNING

To reduce the possibility of personal injury, avoid direct contact of hot oil with your skin. Some state and federal agencies have determined that used engine oil can be carcinogenic. Prolonged, repeated contact can cause skin disorders or other bodily injury. Wash thoroughly after contact. Avoid inhalation of vapors and ingestion of used engine oil. Dispose of the oil in accordance with local environmental regulations.

To change the oil and filter to remove the contaminants suspended in the oil:

- 1. Operate the engine until the coolant temperature reaches 70 °C (158 °F). Shut the engine off.
- Place an appropriate container under the oil pan drain plug. Refer to the Engine Data Sheet for oil pan capacity.
- 3. Remove the oil drain plug and drain the oil immediately to make sure all the oil and suspended contaminants are removed from the engine.
- 4. Remove the oil filter (see Figure 5-5) following these steps:
  - Clean the area around the engine oil filter canister. Use a filter wrench to remove the filter.
  - Remove and discard the O-ring seal if it has remained attached to the mounting flange. Clean the filter mounting flange with a clean lint-free cloth.
  - c. Apply a light film of 15W-40 lubricating oil to the replacement filter gasket before installing the filter.
- Fill the oil filter with a high-quality 15W-40 multiviscosity lubricating oil, such as Premium Blue<sup>®</sup>, or its equivalent.



- 1. Oil Fill Port (on valve cover)
- 2. Oil Level Dipstick
- 3. Engine Oil Filter

Figure 5-5 Oil Filter and Oil Level Dipstick (Typical)

6. Center the filter ring on the threaded mounting nipple. Screw the filter canister onto the mounting flange until the gasket is snug against the mounting flange. Then tighten an additional 1/4 turn.

### 

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

**NOTE:** Cummins recommends using oil filter replacement parts as outlined in the Engine Data Sheet.

- 7. Check and clean the oil pan drain plug threads and sealing surface. Install the oil pan drain plug. Torque the plug according to the Torque Tables.
- 8. Fill the engine to the proper level with clean, high quality 15W-40 oil at the fill port.

### 

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

- 9. Restart the engine and let it run for approximately one to two minutes.
- 10. Stop the engine.
- 11. Wait approximately fifteen minutes to let the oil drain from the upper parts of the engine.
- 12. Check the oil level again. Add oil as necessary to bring the oil level to the H (high) mark on the dipstick.

### 5.4.6 Drive Shaft

It is recommended that proper lubrication to drive shafts be completed on a regular schedule according to these steps:

- 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 (see Figure 3-2).
- 4. Wipe excess grease from the grease fittings.

**NOTE:** Cummins recommends using a good quality semi-synthetic, molybdenum-fortified NLGI #2 lithium complex grease which protects from -47 to 204 °C (-54 to 400 °F).

### 5.4.7 Coolant Pump/Alternator Belt

On some engine models, the pump and alternator belt drives both the pump and alternator.

To inspect the coolant pump and the alternator belt:

- 1. Press the AUTO/MAN button on the FPDP to place the fire pump drive engine in MANUAL operation.
- 2. Disconnect both batteries at their terminals. Remove the negative (-) cable first.
- Remove the belt guard capscrews and the belt guard. Set aside for re-installation (see Figure 5-6).



- 1. Belt Guard
- 2. Alternator Pulley
- 3. Drive Belt
- 4. Idler Pulley
- 5. Coolant Pump Pulley
- 6. Balancer Pulley
- 7. Belt Tensioner

### Figure 5-6 Coolant Pump/Alternator Belt (typical)

4. Visually inspect the belt for frayed, worn, missing pieces, or cracked belt surfaces. Check the belt for intersecting cracks.

### 

Belt damage can be caused by: incorrect tension, incorrect size or length, pulley misalignment, incorrect installation, severe operating environment, and/or oil or grease on the belt or pulley.

**NOTE:** Transverse cracks (across the belt width) are acceptable. Longitudinal cracks (direction of belt length) that intersect with transverse cracks are not acceptable. Replace the belt if it is cracked, frayed, or damaged.

5. If the belt condition is acceptable, check the belt tension. There are two ways to check the belt condition:

**NOTE:** Belts with glazed or shiny surfaces indicate belt slippage. Correctly installed and tensioned belts will show even pulley and belt wear.

### 

**Disconnect the batteries (negative cable first)** before performing service on the fire pump drive engine or on any of its controls.

- Use the Cummins belt tension gauge (Part Number 3822524) to measure the drive belt tension in the center span of the belt between the idler and alternator pulleys. Ensure that the belt tension is set to the specifications outlined in the Engine Operation manual.
- Use the deflection method and measure the belt tension in the center span of the belt between the alternator and idler pulleys. If the belt deflection is more than one belt thickness per foot of pulley center-to-center distance, adjust the belt tension.
- 6. Reinstall the battery cables; attach the negative (-) battery cable last.

### 5.4.8 Raw Water Zinc Anode

The zinc anode (see Figure 5-7) acts as a raw water filter and must be checked for erosion and replaced, when necessary. If the anode has eroded more than fifty percent, it must be replaced.





### Maintenance

#### 5.4.9 Heat Exchanger Pressure Test

If internal leakage in the heat exchanger is suspected, a heat exchanger pressure test may be performed prior to removal from the engine.

**NOTE:** Use Teflon<sup>™</sup> tape or other pipe sealant when installing the test setup in order to prevent leaks.

**NOTE:** The size of fittings required on the water outlets and inlets are listed on the Engine Data Sheet.

To test the heat exchanger pressure:

- 1. Install an adapter at the cooling water outlet of the heat exchanger.
- 2. Install a pressure test setup with 689 kPa (100 psi) pressure gauge at the cooling water inlet to the heat exchanger.
- 3. Apply air pressure at 414 kPa (60 psi).
  - a. Isolate the pressure source and monitor the pressure gauge for five minutes.
  - b. There should be no change in pressure for the duration of the test.
- 4. After testing, release the pressure. Remove the tubing adapters, plug, and test equipment.
- 5. If leakage is detected, the heat exchanger must be replaced.

#### 5.4.10 Turbocharger

As shown in Figure 5-3, follow these steps to thoroughly inspect the turbocharger:

1. Visually inspect the air intake filter and piping according to the steps outlined in Section 5.3.2.

**NOTE:** Turbocharged engines must be operated at rated revolutions per minute (*RPM*) and full load to check maximum intake air restriction.

**NOTE:** Cummins recommends using an air cleaner filter element as listed on the Engine Data Sheet.

### CAUTION

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. Dirt or foreign objects could cause engine damage.

- 2. Remove the air intake and exhaust piping from the turbocharger.
- Inspect the turbocharger turbine wheel for cracks in the housing or turbine blades, missing blades, mechanical binding, eccentric motion, or excessive end-play.
- 4. Replace the turbocharger if damage, excessive end-play, binding, wear, or eccentric motion is found. Contact a Cummins Authorized Repair Location for replacement.

**IMPORTANT:** The turbocharger must be removed for replacement or rebuild if the clearance is beyond the limits, the housing is cracked, or the turbine wheel is damaged.

5. Reinstall the air intake filter and exhaust piping. Tighten the clamps. Torque the loosened clamps to the recommended torque value. Refer to the Torque Tables.

### 5.5 Every Two Years

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.

#### 5.5.1 Coolant Pump

Inspect the coolant pump for eccentric motion, mechanical binding, excessive end play, seal damage, and excessive grease or coolant leakage around the pump shaft.

Replace with a new or rebuilt pre-lubricated unit, as necessary. Contact a Cummins Authorized Repair Location for replacement.

#### 5.5.2 Cooling System - Heat Exchanger

Figure 5-8 illustrates the heat exchanger cooling system. The cooling system must be clean to work properly. If the system shows excessive mineral buildup, particulate matter, scale, oxidation, or oil contamination, drain and flush the cooling system. If the coolant is excessively dirty or is mixed with oil, contact a Cummins Authorized Repair Facility.



- 1. Lower Coolant Tube
- 2. Coolant Drain Petcock
- 3. Coolant Filter
- 4. Coolant Filter Shut-off Valve
- 5. Engine Coolant Heater

Figure 5-8 Engine Coolant Drain -Heat Exchanger

### 

Do not remove the pressure/fill cap from a hot engine. Shut down the engine and wait until the coolant temperature is below 50 °C (120 °F) before removing the pressure cap. Heated coolant spray or steam can cause severe personal injury.

- 1. Disconnect both batteries at their terminals. Remove the negative (-) cable first.
- 2. Press down, unscrew, and remove the coolant expansion tank pressure/fill cap. The cap must be removed to allow air to vent the cooling system during the draining process.
- 3. Disconnect the engine coolant heater power supply before draining the cooling system.
- Place a container that will hold at least 57 liters (15 gallons) of liquid under the coolant drain valve.

- 5. Ensure that the coolant filter shut-off valves are OPEN.
- 6. Open the drain petcock on the lower coolant tube, allowing the coolant to drain into the waste container.
- 7. When the system is empty, move the container under the engine coolant heater.
- 8. Disconnect either end of the engine heater coolant hose and drain the engine heater.

### 

Coolant is toxic. Avoid prolonged and repeated skin contact with used antifreeze - wash thoroughly after contact. Prolonged, repeated contact can cause skin disorders. Dispose of waste antifreeze in accordance with local environmental regulations.

9. Flush with clean fresh water or heavy-duty heat exchanger cleaner. Follow the manufacturer's directions on the product container.

**NOTE:** Some cooling system cleaners or commercial solvents require a soapy water rinse after use. Follow the directions on the cleaning solution or solvent.

### 

Over-concentration of antifreeze or use of highsilicate antifreeze can damage the engine. Do not use more than 50% antifreeze in the mixture unless additional freeze protection is required. Antifreeze at 68% concentration provides the maximum freeze protection, and must never be exceeded under any condition. Antifreeze protection decreases above 68%.

- 10. When the flushing water has fully drained, use a filter wrench to remove the water coolant filter from the filter housing.
  - a. Clean the filter housing gasket mount of dirt buildup, oxidation, or particulate matter with a clean cloth.
  - b. Coat the replacement filter gasket with a light coating of *15W-40* lubrication oil.
- 11. Center the filter ring on the threaded mounting nipple. Screw the filter canister onto the mount-

ing flange until the gasket is snug against the mounting flange, then tighten an additional 1/4 turn. If using a soapy water solution, flush again with clear water. Allow time for the water to fully drain.

### 

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

**NOTE:** Recommendations on filter replacements and fill rates can be found on the Engine Data Sheet.

12. Reconnect the engine heater coolant hose and close the drain petcock on the lower coolant tube.

**NOTE:** During filling, air must be vented from the engine coolant passages. The air vents through the coolant filler port. The fill rate can be found in the *Engine Data Sheet*.

 Fill the coolant tanks with the proper antifreeze. Use a mixture of 50% water and 50% ethyleneglycol base or propylene-glycol antifreeze (or pre-mixed solution) to protect the engine to -37 °C (-34 °F) year-around.



Use soft or distilled 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.

### 

Never use a sealing additive to stop leaks in the cooling system. This can result in cooling system blockage or restricted coolant flow, causing the engine to overheat.

NOTE: Cummins recommends using Fleetguard<sup>®</sup> ES COMPLEAT<sup>™</sup> Ethylene-Glycol (EG) or Fleetguard<sup>®</sup> Propylene-Glycol (PG) Plus<sup>™</sup> Antifreeze/Coolants. Both products are available in concentrated or premixed formulations. Use a 50% concentration level (40% to 60% range) of ethylene-glycol or propyleneglycol and Supplemental Coolant Additive (SCA) required for wet-sleeved engines in most climates. Contact your local Cummins Authorized Repair Location for additional information.

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% = -54° C (-65° F)
68% = -71° C (-96° F)	68% = -63° C (-82° F)

### 

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

- 14. Check the condition of the pressure/fill cap.
  - a. If the pressure/fill cap seal is worn, damaged, missing, or the pressure spring is damaged or shows signs of sticking, replace the filler cap.
  - b. Re-install the expansion tank fill cap.
- 15. Re-install the heater wiring.
- 16. Reinstall the battery cables; attach the negative (-) battery cable last.
- 17. Operate the engine until it reaches a temperature of 82 °C (180 °F), and check for coolant leaks.
- 18. Ensure that the coolant level is just below the fill neck and that the coolant heater is reconnected.

### 5.6 Every Four Years

All maintenance checks and inspections listed in previous maintenance intervals must also be performed at this time.

Cummins recommends performing maintenance on valve lash settings.

### CAUTION

*Disconnect both batteries (negative cable first) before performing service on the fire pump drive*  engine or on any of its controls. Wear safety glasses when disconnecting batteries!

### 

Valve lash maintenance should be performed by a skilled technician. Improper maintenance can damage the engine or cause severe personal injury. Contact your local Cummins Authorized Repair Location before performing any extensive maintenance.

### 5.6.1 Coolant Thermostat Removal/Installation

The thermostat regulates the temperature of the engine coolant circulating through the engine cooling system. Refer to the engine manual for complete instructions.

### 

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.

- 1. As shown in Figure 5-9, remove the upper coolant hose clamps and upper coolant hose at the thermostat housing.
- 2. Remove the (2) thermostat housing flange cap screws and the thermostat flange.
- 3. Remove the thermostat and gasket from the housing.
- 4. Clean the housing flange faces of dirt buildup, oxidation, and sludge.
- 5. If still in good condition, re-install the thermostat in the housing.

**IMPORTANT:** Inspect the seal on the thermostat housing flange surface and - if damaged or cracked - apply a new seal.



- 1. Hose Clamps
- 2. Upper Coolant Hose
- 3. Thermostat Housing

#### Figure 5-9 Thermostat Housing (typical)

**NOTE:** Recommendations on thermostat replacement components can be found on the Engine Data Sheet.

6. Replace the thermostat flange and cap screws.

#### **5.6.2 Coolant Pump/Alternator Belt Replacement** Replace the coolant pump/alternator belt if it is cracked, frayed, or has pieces of material missing.

- 1. Remove the belt guard.
- 2. Use a 3/8" drive ratchet or breaker bar to rotate the tensioner arm away from the belt and remove the belt.
- Check the belt tensioner cap screw torque. For recommended torque values, refer to the Torque Tables.
- 4. Check the tensioner arm, pulley, and stops for cracks. If any cracks are noticed, the tensioner must be replaced.
- Verify that the tensioner arm stop is not in contact with the spring casing stop. If either stop is touching, the tensioner must be replaced.
- 6. Inspect the tensioner for evidence of the tensioner arm contacting the tensioner cap.

### Maintenance

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

- 7. Check the tensioner bearing.
  - a. Rotate the belt tensioner pulley. The pulley should spin freely with no mechanical binding, eccentric motion, or excessive end-play.
  - b. If the arm rotates with mechanical binding, eccentric movement, or excessive end play, replace the tensioner.
- 8. Inspect the clearance between the tensioner spring case and the tensioner arm for uneven bearing wear.

If the clearance exceeds 3 mm (0.12 in) at any point, the tensioner must be replaced as a complete assembly. Contact a Cummins Authorized Repair Location for replacement.

**NOTE:** Experience has shown 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.

- 9. After checking the torque, use a 3/8" drive ratchet or breaker bar to rotate the tensioner slowly away from the area of belt contact.
- 10. Install the replacement drive belt.

### 

To prevent pulley or belt damage, do not roll a belt over the pulley or pry it on with a tool. Move the tensioner arm away from the belt area before installing the drive belt.

- 11. 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.
- 12. Reinstall the belt guard.

### 

Unaligned belts, either too far forward or backward, can cause belt wear, belt roll-off failures or increase uneven tensioner bushing wear.



### Section 6 - Troubleshooting

### 6.1 Introduction

The following information is intended as a guide for some common non-technical equipment problems. The first part of this section includes troubleshooting charts that cross-reference the problem, the possible cause, and the solution. The second section includes complete Fault Code charts outlining a numerical listing of fault codes and their descriptions.

Many problems can be resolved using corrective maintenance, adjustment, or minor repair. Refer to the vendor supplied literature, electrical schematics, and mechanical prints for additional information.

For engine-related issues, refer to the engine Operation and Maintenance Manual or contact the Cummins Customer Assistance Center at 1-800-CUMMINS<sup>TM</sup> (1-800-286-6467).

### CAUTION

AVOID SERVICING complex components such as: printed circuit boards, programmable controllers, and ECMs not specifically authorized by Cummins. Contact the Cummins Customer Service Department toll free at 1-800-343-7357 before performing any extensive maintenance.

**CAUTION** Never climb or stand on the equipment frame, guards, or enclosures. Contact with exposed or moving components can cause personal injury or equipment damage.

### 

The status checks should be performed ONLY by a qualified technician. Contact with exposed electrical components could cause extreme personal injury or death.

### Troubleshooting

### 6.2 Engine Will Not Start



### 6.3 Engine Cranks But Will Not Start



### Engine Cranks But Will Not Start (cont.)



### 6.4 Engine Starts But Continues to Crank

## STOP THE ENGINE AT THE FIRE PUMP CONTROLLER (PLACE THE CONTROLLER IN THE OFF POSITION) AND TROUBLESHOOT FROM THE FIRE PUMP DRIVE ENGINE:

### PRIOR TO MAKING A SERVICE CALL, PERFORM A VISUAL INSPECTION:



### 6.5 Engine Will Not Stop


#### 6.6 Low Battery Voltage

## PROBLEM: LOW BATTERY VOLTAGE

SYMPTOM: The Fire Pump Digital Panel (FPDP) will mometarily "blink" upon starting or the fire pump drive engine is slow to crank. There is a high probability that the engine will not start.



## 6.7 Fault Code Charts - CFP11E, CFP15E/EVS, CFP23E/EVS, CFP30E/EVS, CFP60E

The following tables specify the fault codes and their meanings for the CFP11E, CFP15E/EVS, CFP23E/EVS, and CFP30E model fire pump drive engines:

	CDN	ENAL				
	SPIN	FIVII		CUIVIIVIINS DESCRIPTION	FIIVI FAULI	
	620	12		Engine Control Module - Critical internal failure		SWIICH
111	029	12	RED			^
112	635	7	RED	Engine Timing Actuator is not responding to ECM		
				commands		
113	635	3	YELLOW	Engine Timing Actuator Circuit - shorted high		
114	635	4	YELLOW	Engine Timing Actuator Circuit - shorted low		
115	190	2	RED	Engine Speed/Position Sensor Circuit - lost both	X	
				of two signals from the magnetic pickup sensor		
116	156	3	RED	Fuel Timing Pressure Sensor Circuit - shorted	Х	
				high		
117	156	4	RED	Fuel Timing Pressure Sensor Circuit - shorted low	Х	
110	125	2	VELLOW	Fuel Pump Delivery Pressure Sensor Circuit -	v	
110	135	5	YELLOW	Fuel Pump Delivery Pressure Sensor Circuit -	Λ	
110	125	1	VELLOW	Shorted nigh	v	
119	135	4	YELLOW	Fuel Pump Delivery Pressure Sensor Circuit -	Λ	
101	100	10	VELLOW	Shorted IOW	v	
121	190	10	YELLOW	Engine Speed/Position Sensor Circuit - lost one of	^	
100	102	2		two signals from the magnetic pickup sensor		
122	102	3	YELLOW	Intake Manifold Pressure Sensor #1 Circuit -		
100	102	Δ		shorted high		
123	102	4	YELLOW			
124	102	16		shorted Iow		
124	102	10	YELLOW	High Intake Manifold Pressure Left Barik		
125	102	18		Low Intake Manifold Pressure Left Bank		
126	1129	16	YELLOW	High Intake Manifold Pressure Right Bank		
127	1129	18		Low Intake Manifold Pressure Left Bank		
128	1129	3		Right Bank Intake Manifold Pressure Sensor		
120	1125	5		Circuit Sailed High		
129	1129	4		Right Bank Intake Manifold Pressure Sensor		
125	1125	-,		Circuit Failed Low		
131	91	3	RED	Accelerator Pedal Position Sensor Circuit -		
101	51	Ŭ	neo	charted high		
132	91	4	RED	Accelerator Pedal Position Sensor Circuit -		
102	51			charted low		
133	974	3	RED	Remote Accelerator Pedal Position Sensor Circuit		
100	57.	<u> </u>		- chorted high		
133	29	3	RFD	Remote Accelerator Pedal Position Sensor Circuit		
100	25	Ĵ		- shorted high		
134	974	4	RFD	Remote Accelerator Pedal Position Sensor Circuit		
101	57.			- shorted low		
134	29	4	RED	Remote Accelerator Pedal Position Sensor Circuit		
134	25	-		- shorted low		
135	100	3	YELLOW	Engine Oil Pressure Sensor Circuit - shorted high		
	_00					

Table 6-1. CFP11E, CFP15E, CFP23E, CFP30E, CFP60E FAULT CODES

136	1208	3		Pre Filter Oil Pressure Sensor Circuit Failed High	
137	1208	4		Pre Filter Oil Pressure Sensor Circuit Failed Low	
141	100	4	YELLOW	Engine Oil Pressure Sensor Circuit - shorted low	
143	100	18	YELLOW	Engine Oil Pressure Low - Warning	
143	100	1	RED	Engine Oil Pressure Low - Warning	
144	110	3	YELLOW	Engine Coolant Temperature Sensor Circuit - shorted high	
145	110	4	YELLOW	Engine Coolant Temperature Sensor Circuit - shorted low	
147	91	8	RED	Accelerator Pedal Position Sensor Circuit - low frequency	
148	91	8	RED	Accelerator Pedal Position Sensor Circuit - high frequency	
151	110	0	RED	Engine Coolant Temperature High - Critical	
153	105	3	YELLOW	Intake Manifold Temperature Sensor #1 Circuit - shorted high	
154	105	4	YELLOW	Intake Manifold Temperature Sensor #1 Circuit - shorted low	
155	105	0	RED	Intake Manifold Temperature #1 High - Critical	
166	733	3	YELLOW	Rack Position Sensor #1 Circuit - shorted high	
172	638	6	RED	Rack Actuator Position #1 Circuit - grounded circuit	
173	638	7	YELLOW	Rack Actuator - mechanically stuck open	
184	609	2	YELLOW	Engine Control Module Identification Input State Frror	Х
185	639	2	YELLOW	Engine Control Module Network Communication	Х
187	620	4	YELLOW	Sensor Supply Voltage #2 Circuit - shorted low	
211	1484	31		Additional OEM/Vehicle Diagnostic Codes have	
212	175	3	YELLOW	Engine Oil Temperature Sensor Circuit - shorted	
213	175	4	YELLOW	Engine Oil Temperature Sensor Circuit - shorted	
214	175	0	RED	Engine Oil Temperature High - Critical	
221	108	3	YELLOW	Ambient Air Pressure Sensor circuit - shorted high	
222	108	4	YELLOW	Ambient Air Pressure Sensor circuit - shorted low	
223	1265	4	YELLOW	Engine Oil Burn Valve Solenoid Circuit - shorted	
225	1266	4	YELLOW	Engine Oil Replacement Valve Solenoid Circuit -	
227	620	3	YELLOW	Sensor Supply Voltage #2 Circuit - shorted high	

231	109	3	YELLOW	Engine Coolant Pressure Sensor Circuit - shorted high		
232	109	4	YELLOW	Engine Coolant Pressure Sensor Circuit - shorted		
233	109	1	RED	Engine Coolant Pressure Low - Warning	1	
233	109	18	YELLOW	Engine Coolant Pressure Low - Warning	_	
234	190	0	RED	Engine Speed High - Critical	X	
235	111	1	RED	Engine Coolant Level Low - Critical		
237	644	2	YELLOW	External Speed Input (Multiple Unit		
				Sychronization) - data incorrect		
241	84	2	YELLOW	Vehicle Speed Sensor Circuit - data incorrect	X	
242	84	10	YELLOW	Vehicle Speed Sensor Circuit - tampering has been detected	X	
245	647	4	YELLOW	Fan Clutch Circuit - shorted low		
254	632	4	RED	Fuel Shutoff Valve Circuit - shorted low	Х	
255	632	3	YELLOW	Fuel Shutoff Valve Circuit - shorted high	Х	
259	632	7	RED	Fuel Shutoff Valve - Stuck Open	Х	
261	174	0	RED	Fuel Temperature High - Warning	Х	
263	174	3	YELLOW	Fuel Temperature Sensor Circuit - shorted high	Х	
265	174	4	YELLOW	Fuel Temperature Sensor Circuit - shorted low	Х	
284	1043	4	YELLOW	Engine Speed / Position Sensor #1 (Crankshaft)	X	
				Supply Voltage Circuit - shorted low		
285	639	9	YELLOW	SAE J1939 Multiplexing PGN Timeout Error		
286	639	13	YELLOW	SAE J1939 Multiplexing Configuration Error		
287	91	19	RED	SAE J1939 Multiplexing Accelerator Pedal Sensor		
				System Error		
288	974	19	RED	SAE J1939 Multiplexing Remote Throttle Data		
292	1083	14	RED	Auxiliary Temperature Sensor Input #1 Engine		
				Protection - Critical		
293	1083	3	YELLOW	Auxiliary Temperature Sensor Input #1 Circuit -		
				shorted high		
294	1083	4	YELLOW	Auxiliary Temperature Sensor Input #1 Circuit -		
295	108	2	YELLOW	Ambient Air Pressure Sensor Circuit - data		
				incorrect		
296	1084	14	RED	Auxiliary Pressure Sensor Input #2 Engine		
	1071			Protection - Critical		
297	1084	3	YELLOW	Auxiliary Pressure Sensor Input #2 Circuit -		
209	1004	Λ		Shorteu Iligii Auvilianu Procesura Concor Ianut #2 Circuit		
298	1084	4	YELLOW	Auxiliary Pressure Sensor Input #2 Circuit - shorted low		
L						

299	1384	31		Engine Shutdown Commanded by J1939		
311	651	6	YELLOW	Injector Solenoid Valve Cylinder #1 Circuit -	Х	
212	655	6		grounded circuit	V	
512	055	0	TELLOW	arounded sizevit	^	
212	652	6		grounded circuit	Y	
515	055	0	TLLLOW	grounded circuit	A	
21/	656	6		grounded circuit	Y	
514	030	0	TELLOW	mjector solenoid valve cynnder #0 circuit -	^	
215	652	6		grounded circuit	v	
313	0.52	0	TLLLOW	mjector Solehold valve Cylinder #2 Circuit -	Λ	
216	021	2		grounded circuit	V	
310	931	3	YELLOW	Fuel Supply Pullip Actuator Circuit - Shorted High	X	
318	931	7	YELLOW	Fuel Supply Pump Actuator - mechanically stuck	Х	
319	251	2		Real Time Clock - Power Interrupt		
321	654	6	YELLOW	Injector Solenoid Valve Cylinder #4 Circuit -	Х	
				grounded circuit		
322	651	5	YELLOW	Injector Solenoid Valve Cylinder #1 Circuit - open	Х	
				circuit		
323	655	5	YELLOW	Injector Solenoid Valve Cylinder #5 Circuit - open	Х	
				circuit		
324	653	5	YELLOW	Injector Solenoid Valve Cylinder #3 Circuit - open	Х	
				circuit		
325	656	5	YELLOW	Injector Solenoid Valve Cylinder #6 Circuit - open	Х	
				circuit		
331	652	5	YELLOW	Injector Solenoid Valve Cylinder #2 Circuit - open	Х	
				circuit		
332	654	5	YELLOW	Injector Solenoid Valve Cylinder #4 Circuit - open	Х	
				circuit		
341	630	2	YELLOW	Engine Control Module - data lost		Х
3/12	630	13	RED	Engine Control Module - Out of Calibration		X
542	030	15	NLD			^
343	629	12	YELLOW	Engine Control Module - Warning Internal		Х
				Hardware Failure		
346	630	12	YELLOW	Engine Control Module - Warning Software error		
349	191	16	YELLOW	Transmission Output Shaft (Tailshaft) Speed High		
				- Warning		
349	191	0	YELLOW	Transmission Output Shaft (Tailshaft) Speed High		
				- Warning		
352	1079	4	YELLOW	Sensor Supply Voltage #1 Circuit - shorted low		
378	633	5	YELLOW	Fueling Actuator #1 Circuit - Open Circuit	Х	
379	633	6	YELLOW	Fueling Actuator #1 Circuit - Grounded Circuit	Х	
384	626	11	YELLOW	Start Assist Device Control Circuit Error (Ether		
				Injection)		
386	1079	3	YELLOW	Sensor Supply Voltage #1 Circuit - shorted high		
	<u>                                     </u>	<u> </u>				

387	1043	3	YELLOW	Accelerator Pedal Position Sensor Supply Voltage		
394	635	5	YELLOW	Timing Actuator #1 Circuit - Open Circuit		
395	635	6	YELLOW	Timing Actuator #1 Circuit - grounded circuit		
396	1244	5	YELLOW	Fueling Actuator #2 Circuit - open circuit	х	
397	1244	6	YELLOW	Fueling Actuator #2 Circuit - grounded circuit	х	
398	1245	5	YELLOW	Timing Actuator #2 Circuit - open circuit		
399	1245	6	YELLOW	Timing Actuator #2 Circuit - Grounded Circuit		
414	608	9	YELLOW	Data Communication error over the J1587 data link circuit		
415	100	1	RED	Engine Oil Pressure Low - Critical		
418	97	15		Water in Fuel Indicator High - Maintenance		
419	1319	2	YELLOW	Intake Manifold Boost Pressure Imbalance		
422	111	2	YELLOW	Engine Coolant Level Sensor Circuit - data incorrect		
423	156	2	YELLOW	Fuel Timing Pressure or Timing Actuator stuck	Х	
426	639	2	2	SAE J1939 datalink - cannot transmit		Х
427	639	9		SAE J1939 not fast enough		Х
428	97	3	YELLOW	Water in Fuel Sensor Circuit - shorted high		
429	97	4	YELLOW	Water in Fuel Sensor Circuit - shorted low		
431	558	2	YELLOW	Accelerator Pedal Idle Validation Circuit - data incorrect		
431	91	2	YELLOW	Accelerator Pedal Idle Validation Circuit - data		
432	558	13	RED	Accelerator Pedal Idle Validation Circuit - Our of		
432	91	13	RED	Accelerator Pedal Idle Validation Circuit - Our of		
433	102	2	YELLOW	Intake Manifold Pressure Sensor Circuit - data		
434	627	2	YELLOW	Power Lost without Ignition Off		
435	100	2	YELLOW	Engine Oil Pressure Sensor Circuit - data incorrect		
441	168	18	YELLOW	Battery #1 Voltage Low - Warning		
441	168	1		Battery #1 Voltage Low - Warning		
442	168	16	YELLOW	Battery #1 Voltage High- Warning		
443	1043	4	YELLOW	Accelerator Pedal Position Sensor Supply Voltage		
449	94	16	YELLOW	Circuit - shorted low Fuel Pressure High - Warning	Х	

451	157	3	YELLOW	Injector Metering Rail #1 Pressure Sensor Circuit - Shorted High	Х
452	157	4	YELLOW	Injector Metering Rail #1 Pressure Sensor Circuit - Shorted Low	Х
455	633	3	RED	Fuel Control Valve Circuit - shorted high	X
466	1188	4	YELLOW	Turbocharger #1 Wastegate Control Circuit - shorted low	
467	635	2	YELLOW	Timing Rail Actuator Circuit - data incorrect	
468	633	2	YELLOW	Fuel Rail Actuator Circuit - data incorrect	Х
479	1318	9		Exhaust Port Temperature Bank Imbalance	
482	94	18	YELLOW	Fuel Pressure Low - Warning	X
483	1349	3	YELLOW	Injector Metering Rail #2 Pressure Sensor Circuit - Shorted High	x
484	1349	4	YELLOW	Injector Metering Rail #2 Pressure Sensor Circuit - Shorted Low	X
485	1349	16	YELLOW	Injector Metering Rail #2 Pressure High - Warning	X
486	1349	18	YELLOW	Injector Metering Rail #2 Pressure Low - Warning	Х
487	626	1	$\nabla_{i}$	Start Assist Device - Canister Empty (Ether Injection)	
489	191	18	YELLOW	Transmission Output Shaft (Tailshaft) Speed Low - Warning	
489	191	1	YELLOW	Transmission Output Shaft (Tailshaft) Speed Low - Warning	
496	1043	11	YELLOW	Engine Speed/Position Sensor #2 (Camshaft) Supply Voltage	X
497	1377	2	YELLOW	Multiple Unit Sychronization Switch Circuit - data incorrect	
514	633	7	RED	Fuel Control Valve - mechanically stuck	X
524	113	2	YELLOW	OEM Alternate Droop Switch Validation - data incorrect	
527	702	3	YELLOW	Auxiliary Input/Output #2 Circuit - shorted high	
528	93	2	YELLOW	OEM Alternate torque validation switch - data incorrect	
529	703	3	YELLOW	Auxiliary Input/Output #3 Circuit - shorted high	
546	94	3	YELLOW	Fuel Delivery Pressure Sensor Circuit - shorted high	X
547	94	4	YELLOW	Fuel Delivery Pressure Sensor Circuit - shorted	X
551	558	4	YELLOW	Accelerator Pedal Idle Validation Circuit - shorted	
551	91	4	RED	Accelerator Pedal Idle Validation Circuit - shorted Iow	
553	157	16	YELLOW	Injector Metering Rail #1 Pressure High - Warning Level	X

554	157	2	YELLOW	Fuel Pressure Sensor Error	Х	
555	1264	16	YELLOW	Engine Blowby - Warning Level		
555	1264	0	RED	Engine Blowby - Warning Level		
581	1381	3	YELLOW	Fuel Supply Pump Inlet Pressure Sensor Circuit - shorted high	Х	
582	1381	4	YELLOW	Fuel Supply Pump Inlet Pressure Sensor Circuit - shorted low	х	
583	1381	18	YELLOW	Fuel Supply Pump Inlet Pressure Low - warning level	Х	
595	103	16	YELLOW	Turbocharger #1 Speed High - warning level		
596	167	16	YELLOW	Electrical Charging System Voltage High - warning level		
597	167	18	YELLOW	Electrical Charging System Voltage Low - warning level		
598	167	1	RED	Electrical Charging System Voltage Low - critical level		
611	1383	31		Engine Hot Shutdown		
612	99	1	RED	High Lubricating Oil Filter Restrication		
617	1172	0		High Turbo Compressor Inlet Temperature LB		
621	1137	18	YELLOW	Low #1 LB Cylinder Power		
622	1138	18	YELLOW	Low #2 LB Cylinder Power		
623	1139	18	YELLOW	Low #3 LB Cylinder Power		
624	1140	18	YELLOW	Low #4 LB Cylinder Power		
625	1141	18	YELLOW	Low #5 LB Cylinder Power		
626	1142	18	YELLOW	Low #6 LB Cylinder Power		
631	1329	1	YELLOW	Low #1 RB Cylindar Power		
632	1329	1	YELLOW	Low #2 RB Cylinder Power		
633	1329	1	YELLOW	Low #3 RB Cylinder Power		
634	1329	1	YELLOW	Low #4 RB Cylinder Power		
635	1329	1	YELLOW	Low #5 RB Cylinder Power		
636	1329	1	YELLOW	Low #6 RB Cylinder Power		
641	1137	0	RED	High #1 LB Cylinder Exhaust Temperature		
642	1138	0	RED	High #2 LB Cylinder Exhaust Temperature		
643	1139	0	RED	High #3 LB Cylinder Exhaust Temperature		
644	1140	0	RED	High #4 LB Cylinder Exhaust Temperature		
645	1141	0	RED	High #5 LB Cylinder Exhaust Temperature		
646	1142	0	RED	High #6 LB Cylinder Exhaust Temperature		

649	1378	0		Change Lubricating Oil and Filter		
651	1143	0	RED	High #1 RB Cylinder Exhaust Temperature		
	11/15	0	RED			
(52)	1145	0	NED .	Uteb #2 DD Collington External Terror contents	_	
652	1144	0	RED	High #2 RB Cylinder Exhaust Temperature		
	1146	0	RED			
653	1145	0	RED	High #3 RB Cylinder Exhaust Temperature		
	1147	0	RED			
654	1146	0	RED	High #4 RB Cylinder Exhaust Temperature		
	1148	0	RED			
655	1147	0	RED	High #5 RB Cylinder Exhaust Temperature		
	1149	0	RED			
656	1148	0	RED	High #6 BB Cylinder Exhaust Temperature		
	1140	0	PED			
	1149	0	KED			
661	1323	0	YELLOW	High #1 LB Cylinder Power		
662	1324	0	YELLOW	High #2 LB Cylinder Power		
663	1325	0	YELLOW	High #3 LB Cylinder Power		
664	1326	0	YELLOW	High #4 LB Cylinder Power		
665	1327	0	YELLOW	High #5 LB Cylinder Power		
666	1328	0	YELLOW	High #6 LB Cylinder Power		
671	1137	4		Cylinder #1 LB Exhaust Temperature Sensor		
				Failed Low		
672	1138	4		Cylinder #2 LB Exhaust Temperature Sensor		
673	1139	4		Falled Low Cylinder #3 LB Exhaust Temperature Sensor		
				Failed Low		
674	1140	4		Cylinder #4 LB Exhaust Temperature Sensor		
675	1141	4		Failed Low Cylinder #5 LB Exhaust Temperature Sensor		
				Failed Low		
676	1142	4		Cylinder #6 LB Exhaust Temperature Sensor		
691	1172	3		Failed Low		
051	11/2	5		High		
692	1172	4		LBF Turbo Comp Inlet Temperature Sensor Failed		
711	1220	0	VELLOW	Low		
/11	1323	0				
712	1330	0	YELLOW	Hign #2 RB Cylinder Power		
713	1331	0	YELLOW	High #3 RB Cylinder Power		

714	1332	0	YELLOW	High #4 RB Cylinder Power		
715	1333	0	YELLOW	High #5 RB Cylinder Power		
716	1334	0	YELLOW	High #6 RB Cylinder Power		
719	1264	3	YELLOW	Crankcase Blowby Pressure Sensor Circuit - shorted high		
721	1143	4		Cylinder #1 RB Exhaust Temperature Sensor Failed Low	I.	
	1145	4				
722	1144	4		Cylinder #2 RB Exhaust Temperature Sensor Failed Low		
	1146	4				
723	1145	4		Cylinder #3 RB Exhaust Temperature Sensor Failed Low		
	1147	4	- N			
724	1146	4		Cylinder #4 RB Exhaust Temperature Sensor Failed Low		
	1148	4				
725	1147	4		Cylinder #5 RB Exhaust Temperature Sensor Failed Low		
	1149	4				
726	1148	4		Cylinder #6 RB Exhaust Temperature Sensor Failed Low		
100	1149	4				
729	1264	4	YELLOW	Crankcase Blowby Pressure Sensor Circuit - shorted low		
753	723	2		Engine Speed/Position #2 - Cam sync error	X	
758	1349	7	YELLOW	Injector Metering Rail #2 Pressure Malfunction	Х	
951	166	2		Cylinder Power Imbalance between cylinders		
2155	611	4		Post-Filter Oil Pressure Sensor Circuit - shorted low		

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# **Section 7 - Component Parts and Assemblies**

## 7.1 Ordering 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.

Cummins Inc. relies on the best and most cost effective shipping methods, unless specific instructions or requirements are requested by the customer. When ordering parts, please be prepared to provide the following information.

- Model and serial number.
- · Part description by name or number.
- Quantity required.
- Purchase order number.

**NOTE:** A purchase order number is desirable, even if the part(s) are supplied on a Returned Goods Authorization (RGA) issue number. A purchase order number helps Cummins and its customer track the parts and necessary credits.

#### 7.2 Repairs and Technical Service

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.

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 cannot 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 cummins.com.

#### 7.3 Recommended Spare Parts 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 a Cummins Authorized Repair Location for additional information.

### 7.4 Engine Data Sheet and Torque Values

The following pages outline applicable reference material for the CFP60E fire pump drive engine. Table 7-1. represents the engine data for the CFP60E and all its ratings at the time of this printing. For a complete, up-to-date, Model Specification Sheet, refer to power.cummins.com/fire-power outlines the recommended cap screw markings and torque values for fire pump drive engines.

## **Air Induction System**

#### Table 7-1. CFP60E Engine Data

Maximum Temperature Rise Between Ambient Air and Engine Air Inlet	20 °F (11.1 °C)
Maximum Inlet Restriction with Dirty Filter	25 in. H <sub>2</sub> O (635 mm H <sub>2</sub> O)
Recommended Air Cleaner Primary Element - (Standard)	(4) Cummins Filtration AF25593
Recommended Air Cleaner Primary Element - (Heavy Duty)	(4) Cummins Filtration AF899
Recommended Air Cleaner Secondary Element - (Heavy Duty)	(4) Cummins Filtration AF880

#### **Lubrication System**

Oil Pressure Range at Rated	60-70 PSI (414-483 kPa)
Oil Capacity of Pan (High - Low)	69-61 qt. (261-231 L)
Total System Capacity	74 gal. (280 L)
Recommended Lube Oil Filter	(4) Cummins Filtration LF9050

## **Cooling System\***

Raw Water Working Pressure Range at Heat Exchanger	40 PSI (276 kPa) MAX
Recommended Minimum Water Supply Pipe Size to Heat Exchanger	2.5 in. (63.5 mm)
Recommended Minimum Water Discharge Pipe Size From Heat Exchanger	3.00 in. (76.2 mm)
Coolant Water Capacity (Engine Only)	42 gal. (159 L)
Standard Thermostat - Type	Modulating
Standard Thermostat - Range	180-200 °F (82-93 °C)
Normal Operating Temperature	180-212 °F (82-100 °C)
Minimum Raw Water Flow:	
- with Water Temperatures to 60 °F (16 °C)	135 GPM (8.52 L/sec)
- with Water Temperatures to 80 °F (27 °C)	220 GPM (13.88 L/sec)
- with Water Temperatures to 100 °F (38 °C)	425 GPM (26.81 L/sec)
Recommended Cooling Water Filter	(2) Cummins Filtration WF2075

\* A jacket water heater is mandatory on this engine. The recommended heater wattage for the two heaters is 4000 down to 40 °F (4 °C)



#### **Exhaust System**

Maximum Allowable Back Pressure by Complete Exhaust System Exhaust Pipe Size Normally Acceptable 27.2 in. H<sub>2</sub>O (7 kPa) 9.1 in. (231 mm)

Noise Emissions - The noise emission values are estimated sound pressure levels at 3.3 ft. (1 m).

Тор	129 dBa
Right Side	129 dBa
Left Side	129 dBa
Front	129 dBa
Exhaust	129 dBa

#### **Fuel Supply/Drain System**

Operating Speed in RPM	15	00	18	00			
CFP60E F-10 Fuel Rate - Gal/hr (L/hr)	91.8	(348)	110.5	(418)			
CFP60E F-20 Fuel Rate - Gal/hr (L/hr)	96.8	(366)	118.3	(448)			
CFP60E F-30 Fuel Rate - Gal/hr (L/hr)	101.9	(386)	126.1	(447)			
CFP60E F-40 Fuel Rate - Gal/hr (L/hr)	106.9	(405)	133.9	(507)			
Fuel Type		No. 2 diesel only					
Minimum Supply Line Size		1 1/*	16 in. (26	.99 mm)			
Minimum Drain Line Size		1 1/16 in. (26.99 mm)					
Maximum Fuel Line Length Between Supply Tank & Fuel	Pump	40 ft. (12 m)					
Maximum Fuel Inlet Pressure		5 PSI (34 kPa)					
Recommended Fuel Filter - Primary		(3) Cummins Filtration FF5782NN					
Recommended Fuel Filter - Secondary		(2) Cummins Filtration FS19763					
Maximum Restriction @ Lift Pump-Inlet - With Clean Filter		5 in. Hg (127 mm Hg)					
Maximum Restriction @ Lift Pump-Inlet - With Dirty Filter		9 in. Hg (229 mm Hg)					
Maximum Return Line Restriction - Without Check Valves		10 in. Hg (254 mm Hg)					
Minimum Fuel Tank Vent Capability		TBD					
Maximum Fuel Temperature @ Lift Pump Inlet		160 °F (71 °C)					

### **Starting and Electrical System**

Min. Recommended Battery Capacity - Cold Soak at 0 °F (-18 °C) or Above	24V
Engine Only - Cold Cranking Amperes	1800 CCA*
Engine Only - Reserve Capacity	640 minutes*
*Record on FM requirement for a minimum of 000 CCA and 420 Records Canacity Minutes	

\*Based on FM requirement for a minimum of 900 CCA and 430 Reserve Capacity Minutes

Battery Cable Size - Minimum of 2/0 AWG and Maximum Cable Length Not to Exceed 6 ft. (1.5 m)	24V
Maximum Resistance of Starting Circuit	0.002 Ohms
Typical Cranking Speed	150 RPM
Alternator (Standard), Internally Regulated	55 amps

## **Operating Conditions**

Operating Speed in RPM	15	00	1800		
CFP60E F-10					
Output - BHP (kW)	1820	(1357)	2191	(1633)	
Ventilation Air Required - CFM (litre/sec)	4636	(2188)	6658	(3142)	
Exhaust Gas Flow - CFM (litre/sec)	11465	(5411)	15074	(7114)	
Exhaust Gas Temperature - °F (°C)	912	(489)	795	(424)	
Heat Rejection to Jacket Coolant - BTU/min. (kW)	29237	(514)	34370	(604)	
Heat Rejection to Aftercooler Coolant - BTU/min. (kW)	23058	(405)	38946	(685)	
Heat Rejection to Ambient - BTU/min. (kW)	9090	(160)	11385	(201)	
CFP60E F-20					
Output - BHP (kW)	1920	(1431)	2346	(1749)	
Ventilation Air Required - CFM (litre/sec)	4636	(2188)	6658	(3142)	
Exhaust Gas Flow - CFM (litre/sec)	11465	(5411)	15074	(7114)	
Exhaust Gas Temperature - °F (°C)	912	(489)	795	(424)	
Heat Rejection to Jacket Coolant - BTU/min. (kW)	29237	(514)	34370	(604)	
Heat Rejection to Aftercooler Coolant - BTU/min. (kW)	23058	(405)	38946	(685)	
Heat Rejection to Ambient - BTU/min. (kW)	9090	(160)	11385	(201)	
CFP60E F-30					
Output - BHP (kW)	2020	(1506)	2501	(1864)	
Ventilation Air Required - CFM (litre/sec)	4636	(2188)	6658	(3142)	
Exhaust Gas Flow - CFM (litre/sec)	11465	(5411)	15074	(7114)	
Exhaust Gas Temperature - °F (°C)	912	(489)	795	(424)	
Heat Rejection to Jacket Coolant - BTU/min. (kW)	29237	(514)	34370	(604)	
Heat Rejection to Aftercooler Coolant - BTU/min. (kW)	23058	(405)	38946	(685)	
Heat Rejection to Ambient - BTU/min. (kW)	9090	(160)	11385	(201)	
CFP60E F-40				1	
Output - BHP (kW)	2120	(1580)	2656	(1980)	
Ventilation Air Required - CFM (litre/sec)	4636	(2188)	6658	(3142)	
Exhaust Gas Flow - CFM (litre/sec)	11465	(5411)	15074	(7114)	
Exhaust Gas Temperature - °F (°C)	912	(489)	795	(424)	
Heat Rejection to Jacket Coolant - BTU/min. (kW)	29237	(514)	34370	(604)	
Heat Rejection to Aftercooler Coolant - BTU/min. (kW)	23058	(405)	38946	(685)	
Heat Rejection to Ambient - BTU/min. (kW)	9090	(160)	11385	(201)	

#### Table 7-2. Cap Screw Markings and Torque Tables

#### **Cap Screw Markings and Torque Values**



Always use a cap screw of the same measurement and strength as the cap screw being replaced. Using the wrong cap screws can result in engine damage.

Always use the torque values listed in the following tables when specific torque values are not available.

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 Cap Screw 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 Cap Screw Head Markings

Metric cap screws and nuts are identified by the grade number stamped on the head of the cap screw or on the surface of the nuts.



#### **US Customary Cap Screw 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 Cap Screw Head Markings

U.S. Customary cap screws are identified by radial lines stamped on the head of the cap screw.

SAE Grade 5 w/ three lines	SAE Grade 8

Metric Cap Screw Torque Values (lubricated threads)													
Class:	Class: 8.8					10.9				12.9			
Diameter	r Cast Iron Alumi		inum	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		—					

U.S. Customary Cap Screw Torque Values (lubricated threads)

Grade:		SAE G	irade 5		SAE Grade 8					
Cap Screw Body Size	Cast Iron		Alur	ninum	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		

### 7.5 CFP60E Assembly Drawings

Please refer to our website at power.cummins.com/fire-power for the most up-to-date information.

Drawing No.	Description
A059H023	General Arrangement, Installation, Fire Pump, CFP60E
A042H691	Assembly, Fire Pump, CFP60E F10-F40
A057W670	Options, Engine, CFP60E
A058N619	Assembly, Heat Exchanger CFP60E
ON ENGINE	Assembly, Air Intake CFP60E
A058N547	Assembly, Air Intake, Heavy Duty CFP60E
A059G846	Assembly, Guarding CFP60E
A030Z457	Assembly, Coolant Heater CFP60E
A059G923	Assembly, Sensors and Harnessing CFP60E
21249	Assembly, Control Panel Mounting
Assembly, All Compone	nts Top-level:
A042H780	Assembly, Panel, Digital Electronic CFP60E
A042B041	Battery Contactors 24V CFP60E
A059G800	Kit, Fuel Lines CFP60E
A058P091	Misc. Piping, Cooling Loop, Raw Water CFP60E
A058N589	Assembly, Raw Water Cooling Loop, 2.5" Vertical CFP60E
A058N590	Assembly, Raw Water Cooling Loop, 2.5" Horizontal CFP60E
A059G906	Misc. Piping, Cooling Loop, Sea Water CFP60E
A058N591	Assembly, Sea Water Cooling Loop, 2.5" Vertical CFP60E
A058N592	Assembly, Sea Water Cooling Loop, 2.5" Horizontal CFP60E
A059G925	Schematic, Overall CFP60E, GEN II FPDP

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D	BILL OF MATERIAL ITEM QTY DESCRIPTION I I ASSEMBLY, ENGINE, FIRE PUMP; G-DRIVE, TIER 2, 2922HP, 1800 R 2 I MANUAL, CFP60E; 3 276 PREMIUM BLUE I5W40; (QUART)	PART NUMBER           PM         201704260152           A057W499           V705290	
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		BILL OF MATE	ERIAL		ÂB						i	REV REL NO REVISIO
	ITEM OTY	DESCRIPTION		PART NUMBER								- 2017-539 RELEASE
	1 12	WASHER, PLAIN; 1.56" OD, 0.39" ID, 0.09" TH	łK	0181								DELETE:
	2 2	HOSE, STELICONE; 5" I.D. X 6" LG		0063-05								A058G83
	4 3	FTG, STR OKTITCE, TO BEAD & T4 NFT		12181-M14-4			- B					B 2018-456 A059J01
	5 2	FTG, STR; -12 BARB X -12 NPT		12548-12-12			(53)					QTY 6 W
	6 3	FTG, STR; -16 BARB X -16 NPT		12548-16-16				~		$\frown$		· · · · · · · · · · · · · · · · · · ·
D	7 5	FTG, STR; -6 BARB X -4 NPT		12548-6-4		COOLANT FILL DECAL — (	(7)			(15)		
-	8 18	CLAMP, T-BOLT; 3.28-3.59		13164-0350		9526-09	$\prec$ $Y$	S		$\searrow$		
	9 4	CLAMP, T-BOLT; 5.28-5.59		13164-0550		HIGH PRESSURE DECAL		$\mathcal{A}$				
	10 9	CLAMP, WORM; .3987		14990-06		IS402I-BA	$\wedge$ $\circ$			$\frown$		
	12 2	CLAMP, PIPE, 2-1/2", PLASTIC		14556 10				• X/		(8)		
	13 1	TAG; ENGINE WEIGHT		16825		HOT DECAL	× e			$\searrow$		
	14 1	ELB, 90 DEG; -16 BEAD X -16 NPT		16899-16-16		131024 00	<_ ' ∥ `			(1)		
	15 2	HOSE, SILICONE, 90 DEG; 3.00 ID PUROSIL 90-	- 300 - MK	21105				f f		42		$\sim$
	16 2	PLUG. PIPE; -12 NPT		26961-12		44				$\bigcirc$		( 7
	18 1	HOSE FUEL LINE 5/161D: 96"1		26961-4						(19)		
	19 6	MOUNT, ISOLATOR, 2-PIECE; TECH PRODUCTUCT	TS 60011	60011						$\leq$		
	20 4	CLAMP, U-BOLT, GUILLOTINE; 3.00"		89545K		1.				(1)		
	21 6	CLAMP, U BOLT; 5" GUILLOTINE		89549K		(51) $(51)$				$\sim$	$\frown$	$\binom{28}{28}$ + K/
	22 2	HOSE, SILICONE; 3.000IN IDx5.00IN LONG		A042F067						$\mathcal{L}$	(1)	
	23 4	HOSE, SILICONE; 3.000IN IDx6.00IN LONG		A042F067							(32)	
	25 1	HOSE, 3/4" SILICONE: 5.25" LONG		A042F073			1			L.		
	26 I	HOSE, I" SILICONE; 64" LONG		A042F074						(17)		
	27 1	HOSE, I" SILICONE; 51" LONG		A042F074						41		
	28 I	HOSE, 3/8" SILICONE; 18" LONG		A042H252					-	- 27	$\sim$	
С	29 1	HOSE, 3/8" SILICONE; 30" LONG		A042H252						(2)	(48)	
	30 1	HOSE, 378" SILICONE; 30" LONG		AU42H252		-				(54) ®	$\smile$	
	32 1	HOSE, 3/8" SILICONE; 30" LONG		A042H252		(45)					e e e e e e e e e e e e e e e e e e e	
	33 I	CONNECTION, HEAT EXCHANGER; CFP30E		A057V859							$\frown$	
	34 3	CONNECTION, HEAT EXCHANGER; CFP30E		A057V860							(22)	
	35 I	BRACKET, HEAT EXCHANGER; MOUNTING, CFP60E		A058N750					<b>*</b>		$\sim$	
	36 1	STAND, FUEL FILTER		A058N770		$\frown$					(4)	
	38 1	BRACKET, JW TUBE, CFP60E		A058N789		(13)					$\sim$	
	39 1	BRACKET, LOWER LTA TUBE; CFP60E		A058N790				Nor Ry	10		B (3)	
	40 I	BRACKET, RAW WATER PIPING; CFP60E		A058N791		(24)						
	41 1	BRACKET		A058N797							(37)	T
	42 1	BRACKET		A058N798							$\sim$	
	43 2	SUPPORT, FRONT		A058P081							(33)	
	44 1	BRACKET		A058P239							$\sim$	
	46 1	TUBE, LOWER JW; CFP60E		A058P282							(14)	
	47 1	TUBE, JW; CFP60E		A058P283								
	48 I	TUBE, UPPER JW; CFP60E		A058P284		(43)						
	49 1	TUBE, LOWER LTA; CFP60E		A058P285		$\bigcirc$						
Б	51 1	HEAT EXCHANGER: CEPGOE		AU596856		$\sim$	/ /					
D	52 1	NIPPLE, 3/4" NPT X 6.75" LONG; BLACK IRON	N	A059J017		(38)					(a)	
	53 I	TANK, SURGE; CFP60E		A060R034		$\bigcirc$	(21)					
	54 I	BRACKET, FILTER; FUEL		A060R772			$\bigcirc$		Sel la		(40)	
	55 1	NIPPLE, BLK, 3/4x1-1/2		LTL-CPN34					/		(39)	
	- 00 - 2	ILE, DLAGN FIFE; 3/4 NFI		LIL-3134							(20)	
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												CONFIDENTIAL AND PROPRIETARY AND SHALL N IN HARD COPT OR ELECTRONIC FORM, REPRODU USED FOR ANY PURPOSE WITHOUT BUILTER COM
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		BILL OF MATERIAL	
ITEM	QTY	DESCRIPTION	PART NUMBER
	4	CLAMP, T-BOLT; 6.00-6.31	3   6 4 - 0 6 2 5
2	4	CLAMP, T-BOLT; 7.28-7.59	3   6 4 - 0 7 5 0
3	4	CLAMP, T-BOLT; 8.25-8.56	3   6 4 - 0 8 5 0
4	4	HOSE, REDUCING HUMP; 10.00 TO 8.00	23814
5	4	PLUG. PIPE; -2 NPT	26961-2
6	4	CLAMP, T-BOLT; 10.25" - 10.75"	3316666-5
7	4	ELBOW, REDUCING 90 DEGREE, 7.00 X 5.50; REF 89832K	3316592S
8	4	INTAKE BONNET, IO"; FLEETGUARD 3940356S OR EQUIV	3940356S
9	8	CLAMP, 21" AIR FILTER	39409265
10	1	SPACER; -	A042H157
	1	BRACKET, LEFT REAR AIR FILTER	A058N569
12	1	BRACKET, RIGHT REAR AIR FILTER	A058N577
13	2	ANGLE, BRACE	A058N582
4		ANGLE, BRACE	A058N583
15	2	BRACKET, ANGLE	A058N586
16		BRACKET, AIR FILTER	A058N587
17	2	MOUNT, AIR FILTER; CFP60E	A058P073
18	2	TUBE, LONG INTAKE; CFP60E	A058P297
19	2	TUBE, SHORT INTAKE; CFP60E	A059G798
20	4	AIR FILTER	AHI9473

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Z         J           REL NO         REVISION         DWN         CKD         APVD         DATE           2017-539         RELEASED TO PRODUCTION         HE392         NE627         29SEP17           2018-261         DELETE:         23819, 13164-0600         HE392         MS707         03MAY18	
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DO NOT SCALE PRINT       CMI DATA CLASSIFICATION Currentes Confidential Currentes Confidential       Currentes Confidential         ES       SCALE . 150       DWN HE392       Item NAME         Minim       CKD       APVD NE627       Item NAME         Intermines description       APVD NE627       Item NAME         Intermines description       FOR INTERPENTITION OF DATE 295EP2017       MUST CONFORM       Item NUMBER TO CES 10903         Intermines NRC       FOR INTERPENTION OF DIMENSING AND TOTERS IN SEC ASME YIAS. 2009       MUST CONFORM       Item NUMBER TO CES 10903       CAD SHEET A 0 58N 547	A



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2	01	1-539	RELEA	SED TO PRODUCTION	0.5.4		HE 392		NE 627	15JANI8	
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0.381mm		$\underline{\Psi}$		DATE 15JAN18		CFP60E					
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			BILL OF MATERIAL		
	ITEM	QTY	DESCRIPTION	PART NUMBER	Â
		2	STRAP, GROUNDING, 4 AWG, 12"; 1/2" STUD, WC90397-1	9757	
	2	1	STRAP, GROUNDING, 4 AWG, 30"; WC90397-5	2     4	
h	3	1	SENSOR, ENGINE SPEED;	4327239	
J	4	2	SENSOR, PRESSURE;	4921499	
	5	1	CABLES, STARTER KIT; FIRE PUMP	A 0 4 2 B 0 4 9	
	6	1	HARNESS, WIRING; PWR/INTERFACE, CFP60E, FPDP GEN 2	A 0 5 9 G 9 2 7	
	7	1	HARNESS, WIRING; ECM CFP60E, FPDP GEN 2	A059G928	
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REV	REL NO	REVISION
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А	2018-261	ADD: 21141 AND 9757

DIMENSIONS ARE IN: INCHES		CMI DATA CLASSIFICATION	
[] ARE IN: .	DO NOT SCALE PRINT	Cummins Confidential	
DIMENSION TOLERANCES	SCALE .500	DWN OZ7IO	- unit
X.X: ±0.0901N OR 2.3mm		CKD KP937	
X.XX: ±0.0301N OR 0.76mm X XXX: ±0.0151N OR 0.381mm		APVD KP937	
ANGULAR TOLERANCE: ± 1°		DATE 02FEB18	
THIS DOCUMENT (AND THE INFORMATION SHO CONFIDENTIAL AND PROPRIETARY AND SHALL IN HARD COPY OR ELECTRONIC FORM, REPRO USED FOR ANY PURPOSE WITHOUT WRITTEN C	WN THEREON) IS NOT BE DISCLOSED TO OTHERS DUCED BY ANY MEANS, OR ONSENT OF CUMMINS INC.	FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME YI4.5-2009	MUST C TO CES
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mins	ITEM NAME	Cummi	ns Inc			
Innin <sup>5</sup> ®	ITEM NAME ASSEMBLY	<b>Cummi</b> , SNS	<mark>ns Inc</mark> SRS &	H A R I	NESS	
unin <sup>s</sup> ®	ITEM NAME ASSEMBLY CFP60E	<b>Cummi</b> , SNS	<b>ns Inc</b> SRS &	Н А П I	NESS	
CONFORM ES 10903	ITEM NAME ASSEMBLY CFP60E BITEM NUMBE A0	Cummi , SNS <sup>R</sup> 59G9	ns Inc SRS & 23	нап нап с,	NESS AD SHEET OF I	

		BILL OF MATERIAL	
ITEM	QTY	DESCRIPTION	PART NUMBER
		MOUNT, OPERATOR STATION, CFP CONTROL PANEL	22318
2	2	ISOLATOR, PLATE MOUNT, 3 LB (YELLOW MARK)	15400
3	2	ISOLATOR, PLATE MOUNT, 6 LB (RED MARK)	15412
4	12	RIVET, ALUMINUM, STEEL SHANK, 0.156 DIA, 0.25-0.38 GRIP	54 4
5	2	FENDER WASHER, 0.281 X 1.25	15421
6	4	SCREW, SELF LOCKING, 0.25-20 X I.00, PH OR BH	15422





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	the document, or upon demand, ret all material copied therefrom. C	urn the document OPYRIGHT Cummins	t, all copies the s Fire Power LLC	reof, and	AS
	UNLESS OTHERWISE SPECIF	IED ALL DIMI	ENSION TOLER	ANCES ARE	CF
	ANGULAR DIMENSIONS $\pm$ 1°	MACHINED SURFACES	IMPERIAL UNITS	METRIC UNITS	DW
	THIRD ANGLE PROJECTION		MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2	ΙN
		125/	FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4	SC
ΤE		$\sim$	FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8	ES

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

numin <sup>s</sup> Fire Pow	) /er	CUMMINS FIRE POWER CORPORATE OFFICE 1600 BUERKLE ROAD WHITE BEAR LAKE, MM WWW.CUMMINSFIREPOWE	LLC I R.COM	CUSTOM DESIGN AND UPFIT CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN
SEMBLY, CON <sup>-</sup> P POWER UNI <sup>-</sup>	FROL PAI	NEL MOUNTING		
G UNITS:	DRAWN B	BY: S DUBICK		DATE: 26-SEP-12
/LB/S	PRO-E	ENGINEER		INIT ECO: 2012-392
ALE: 0.333		SHEET	DR	AWING NO:
T WEIGHT: 16	. 439	I OF I	2	1249

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	BILL OF MATERIAL
	ITEM QTY DESCRIPTION PART NUMBER
	I I ASSEMBLY, DIGITAL CONTROL PANEL, ELECTRONIC CFP ENGINES A042G185
(3)	2 I DECAL, MANUAL START/STOP, ELECTRONIC (AUTOCAD CONTROLLED) A042K209
	3 I DECAL, NO DRILLING A059H894
	A         I         DECAL, INFORMATION, FPDP COOLDOWN         A060R473
	B
	This document contains confidential and trade secret information, is the property of Cummins Fire Power LLC and is given to the receiver in confidence. The receiver by receiving and receiving and receiving and receiving and receiving and receiving the document accepts the
	document in confidence and agrees that, except as authorized in a triling by Comment in Will (1) not use the document or any copy thereof or the there in the there in the confidential or trade secret information therein, (2) not copy the document (3) not disclose to others either the document or the confidential or trade secret information there in the confidential or trade secret information there in the document.
	secret information therein, and (4) upon completion of the need to retain the downent, and upon demond, return the downent, all capies thereof, and all material capied therefrom. COPYRIGHT Cummins Fire Power LLC CONTROL ASSEMBLY
D 2018-392 ADD A060R473 HE392 I9JULI	8 UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE FPDP ELECTRONIC CARBON STEEL
C         ZUIS-Z8Z         AUD         AUS9H894         HE39Z         14MAY1           B         2017-245         DELETE         A042A311         ADD         A042K209         PBS         21APR20	o ANGULAR DIMENSIONS ± I SURFACES UNITS DWG UNITS DWG UNITS: DRG
A 2017-057 UPDATED PER A042G185 PBS 01FEB20	17 I 25 row TOLEBAKES TOW TOLEBAKES SCALE: 0.500 SHEET DRAWING NO:
REV ECO DESCRIPTION OF REVISION REV BY DATE	THE



AA	TAGS	SUB	QTY	CATALOG	MFG	DESCRIPTION		
	1	1	1	CSD302010SS	HOFFMAN	ENCLOSUE, 30 X 20 X 10, STAINLESS STEEL 4X		
	2 1 1 8		8838	NPOWR	BATTERY ISOLATOR, FIRE PUMP			
	3	1	1	17292	NPOWR	INSTRUCTIONS, EMERGENSY START		
	4	1	4	17293	NPOWR	CONTACTOR, MANUAL OVERIDE, FIREPUMP		
	5	5 1 2		17294	NPOWR	ANGLE, CONACTOR PULL		
	6	1	30"	F1.5X1.5LG6	PANDUIT	WIREWAY,1.5W X 1.5H		
	7	1	30"	C1.5XLG6	PANDUIT	COVER, WIREWAY, 1.5		
	8	1	5"	0801733	PHOENIX	DIN RAIL, NS 35/7.5		
	9 2 1			120656	PHOENIX	END CAPS, DIN RAIL		
	10	2	1	3022276	PHOENIX	CLAMP END CLI FIX 35-5		
	11	6	1	3036178	PHOENIX	TERMINAL, SPRING CASE, 14-2 AWG, 125A, 2POS		
	12	6	1	0819217	PHOENIX	MARKER, UC-TM 16		
	13	3	1	3005963	PHOENIX	BRIDGE, PLUG-IN, FBS 2-16		
	14	6	1	CGB297	CROUSE-HINDS	CONNECTOR,CORD,3/4"NPT,.75875 CABLE OD		
	15	2	1	CGB3814	CROUSE-HINDS	CONNECTOR,CORD,3/8"NPT,.12525 CABLE OD		
			1	HD34-24-18-PN	DEUTSCH	CONNECTOR, RECEPTACLE, 18 POSITION		
			1	112263-90	DEUTSCH	NUT, PANEL		
			1	112264	DEUTSCH	LOCKWASHER,PANEL		
			1	HD30-24BT-BK	DEUTSCH	BOOT, BLACK		
	C1	1	1	16-04477	DEUTSCH	GASKET		
			1	0460-204-08141	DEUTSCH	CONTACT, SIZE 8, NICKEL, PIN		
			2	0460-204-12141	DEUTSCH	CONTACT, SIZE 12, NICKEL, PIN		
			9	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN		
			6	114017	DEUTSCH	PLUG,SEALING		
		9	1	31203	WAYTEK	TERMINAL, RING, #10 STUD, 16-14 AWG		
		0	1	218N1V02	VTE	CAP,LUG AND RING TERMINAL, 200 SERIES		
		1	1	31204	WAYTEK	TERMINAL,RING,1/4" STUD,16-14 AWG		
		1	1	218N1V02	VTE	CAP,LUG AND RING TERMINAL, 200 SERIES		
		2	1	32205	WAYTEK	TERMINAL,RING,3/8" STUD,12-10 AWG		
		2	1	218N1V02	VTE	CAP,LUG AND RING TERMINAL, 200 SERIES		
		7	1	34001	WAYTEK	TERMINAL,RING,1/4" STUD,6 AWG		
		2	1	218N2V02	VTE	CAP,LUG AND RING TERMINAL, 200 SERIES		
		2	1	34003	WAYTEK	TERMINAL,RING,3/8" STUD,6 AWG		
		4	1	218N2V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES		
		8	1	33004	WAYTEK	TERMINAL,RING,3/8" STUD,8 AWG		
		1	1	33002	WAYTEK	TERMINAL,RING,1/4" STUD,8 AWG		
		1	1	218N2V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES		
		4	1	6440F	QUICKCABLE	LUG, MAGNA, 4/0, 3/8" HOLE		



i Fire Pov	<b>) ver</b>		CUMMINS FIRE POWER LLC CORPORATE OFFICE 1600 BUERKLE ROAD WHITE BEAR LAKE, MN WWW.CUMMINSFIREPOWER.COM			CUSTOM DESIGN AND UPFIT CENTER 875 LAWRENCE DRIVE DEPERE, WISCONSIN		
TACTORS, MANUAL START PUMP,RIGHT								
INITS:	DRAWN	N BY:	RMJ		DATE: 07APR2014			
LB/S AUTO CA			CAD	INT EC			2014-242	
NTS SUFET 10F2 DRAWING NO. A042D041								
EIGHT: 100			I TOFZ   DRAWING NO. A			AU4Z	DU41	



FRO	M	то					FROM		FROM TO		CTANAD	NOTES
TOR	POSITION	CONNECTOR	POSITION	WIRE COLOR	WIRE SIZE	WIRE ITPE	TERMINAL	SEAL	TERMINAL	SEAL	STAMP	NUTES
	1	BATT ISOL	А	RED	8	GXL	0460-204-08141		33002		ALT B+	
	6	CR1B	30	RED	12	GXL	0460-204-12141		32205		BATT 1+	
	7	CR2B	30	RED	12	GXL	0460-204-12141		32205		BATT 2+	
	2	BATT ISOL	E	RED	16	GXL	0460-202-16141		31204		EXCITE	
	3	CR2B	85	BLK	16	GXL	0460-202-16141		31203		CRANK 2B GND	
	4	CR2B	86	RED	16	GXL	0460-202-16141		31203		CRANK 2B	
	5	CR2A	85	BLK	16	GXL	0460-202-16141		31203		CRANK 2A GND	
	9	CR2A	86	RED	16	GXL	0460-202-16141		31203		CRANK 2A	
	10	CR1B	85	BLK	16	GXL	0460-202-16141		31203		CRANK 1B GND	
	11	CR1B	86	RED	16	GXL	0460-202-16141		31203		CRANK 1B	
	12	CR1A	85	BLK	16	GXL	0460-202-16141		31203		CRANK 1A GND	
	13	CR1A	86	RED	16	GXL	0460-202-16141		31203		CRANK 1A	
SOL	1	CR1A	30	RED	6	GXL	34001		34003		BATT 1+	
SOL	2	CR2A	30	RED	6	GXL	34001		34003		BATT 2+	
	6	CR1A	30	RED	8	GXL	-		33004		BATT 1A+	
	6	CR1B	30	RED	8	GXL			33004		BATT 1B+	
	8	CR2A	30	RED	8	GXL	-		33004		BATT 2A+	
	8	CR2B	30	RED	8	GXL	-		33004		BATT 2B+	
7	30	CR2B	30	RED	8	GXL	33004		33004			
1	30	CR1B	30	RED	8	GXL	33004		33004			
						202109						
4	87	CR1A	87	RED	4/0	QUICK	6440F		6440F		CONTACTOR 1A-2A	
						CABLE						
						202109						
в	87	CR1B	87	RED	4/0	QUICK	6440F		6440F		CONTACTOR 1B-2B	
						CABLE						

Culture Fire Pow	<b>) ver</b>	CUMMINS Corpora 1600 BU White Be WWW.CUMM	CUMMINS FIRE POWER LLC     CUSTOM DESIGN AND       CORPORATE OFFICE     UPFIT CENTER       1600 BUERKLE ROAD     875 LAWRENCE DRIVE       WHITE BEAR LAKE, MN     DEPERE, WISCONSIN       WWW.CUMMINSFIREPOWER.COM     WWW.CUMMINSFIREPOWER.COM			
CONTACTORS FIRE PUMP, F	S, MAN RIGHT	IUAL S	START			
DWG UNITS:	DRAWN E	BY: RMJ	Y: RMJ		DATE: 07APR2014	
INCH/LB/S	AUTO	CAD		INT ECO:	2014-242	
SCALE: NTS		T 20F2		NO: A042B041		
EST WEIGHT: 100			DRAWING N			

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		BILL OF MATERIAL	
ITEM	QTY	DESCRIPTION	PART NUMBER
I		ELB, 90 DEG; -12 JIC X -12 NPT	2270- 2- 2
2	2	FUEL LINE, I2" EXTENSION; #I2 FEM JIC X #I2 22IFR X 3/4" NPT	4400-0 3
3	3	CLAMP, LOOM; I.00 ID	26963-16
4		ADAPTER, REDUCING PIPE	4964 78
5		BRACKET, HOSE	A042G917
6		HOSE, FUEL TRANSFER	A059G802
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	5	4	3	REV R - 20	EL NO REVISI 17-539 RELEAS	<b>2</b> ON ED TO PRODUCTION	DWN CKD A HE392 N	IPVD DATE E627 03JANI8
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				[] ARE IN: . DIMENSION TOLERANCES X.X: ±0.090IN OR 2.3mm X.XX: ±0.030IN OR 0.76mm X.XX: ±0.015IN OR 0.381mm ANGULAR TOLERANCE: ±1° THIS DOCUMENT (AND THE INFORMATION SHO COMFUNENTIAL AND THE INFORMATION SHO	SCALE . 500	Cummins Confidential DWN HE392 CKD APVD NE627 DATE 03JANI8 FOR INTERPRETATION OF MUST CONCOMM	Cummins Inc. ITEM NAME ASSEMBLY, FUEL LIN CFP60E SWE ITEM NUMBER	E S CAD SHEET
	5	4	<b>२</b>	CONFIDENTIAL AND PROPRIETARY AND SHALL IN HARD COPY OR ELECTRONIC FORM, REPRC USED FOR ANY PURPOSE WITHOUT WRITTEN C	NUI DE UISCLUSED IO OTHERS DUCED BY ANY MEANS, OR ONSENT OF CUMMINS INC.	DIMENSIONING AND TOLERANCING, MUST CONTORM SEE ASME Y14.5-2009	D A059G800	I OF I

	8	7	6
D	BILL OF MATERIAL           ITEM QTY         DESCRIPTION           1         2         CLAMP, T-BOLT; 3.28-3.59           2         4         CLAMP, PIPE, 2-1/2", PLASTIC           3         2         NIPPLE, 2-1/2" NPT PIPE; 2.50" LONG           4         1         NIPPLE, 2-1/2" NPT PIPE; 3.50" LONG           5         1         NIPPLE, 2-1/2" NPT PIPE; 11.00" LONG           6         1         NIPPLE, 2-1/2" NPT PIPE; 21.75" LONG           7         1         HOSE, SILICONE; 3.000IN IDx18.00IN LONG	PART NUMBER           13164-0350           16438           26970_0250           26970_0350           26970_1100           26970_2175           A042F067	
	8       1       FLANGE, 3.00 NPT         9       1       BUSHING, REDUCER; 3 TO 2-1/2 NPT         10       6       ELBOW, 2-1/2" NPT, 90 DEGREE; McMASTER-CARR: 44605K110         11       2       FTG, STR 40NPT X 3.00 BARB; -         12       2       MOUNT, COOLING LOOP; CFP60E         13       2       FLANGE         14       2       CONNECTION, HEAT EXCHANGER; CFP60E	A042F345         A042F348         A042G833         A042J475         A058N621         A058N622         A058N738	
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ES 3mm 76mm	SCALE .2	50	CKD	E 3 9 2	Cumu	ITEM NAME ASSEMBLY,	MISCE	ELLAN	eous f	PIPING	
381mm			DATE FOR	I 4 DEC I 7 INTERPRETATION OF	MUST CONFORM	CFP60E, R	AW WAT er	ER	<u> </u>	AD SHFFT	
NU SHALL M, REPRO RITTEN C	NUT BE DISCLOSI DUCED BY ANY ME ONSENT OF CUMMII	ED TO OTHERS ANS, OR NS INC.	DIMENSI SE	ONING AND TOLERANCING, E ASME YI4.5-2009	TO CES 10903		<u>058P0</u>	9		OFI	
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	ITEM QTY DESCRIPTION	PART NUMBER	
	I         2         CLAMP, T-BOLT; 3.28-3.59           2         C         ELBOW         MADINE CDADE         2.1721         NDT	13164-0350	
	3 I BUSHING, MARINE GRADE; 2-1/2" NPI	15758-40	
	4 2 ADAPTER, NAVAL BRONZE, NPT X BARB; 2-1/2" NPT X 3" BARB	5766-40-48	
	5 4 CLAMP, PIPE, 2-1/2", PLASTIC	16438	
П	7     I     HOSE, SILICONE; 3.000IN IDx18.00IN LONG	A042F067	
D	8 2 NIPPLE, 2-1/2 CLOSE; SEA WATER COMPATIBLE	A042G350	
	9 I NIPPLE, 2-1/2" X 21-3/4"; SEA WATER 10 2 CONNECTION HEAT EXCHANGER: SEA WATER CEP30E	A042G815 A057W046	
	II     2     MOUNT, COOLING LOOP; CFP60E	A 0 5 8 N 6 2 I	
	12 2 FLANGE	A058N622	
	13     1     NITTEL, 2 1/2 X 3.30 , SEA WATER COMPATIBLE       14     1     NIPPLE, 2-1/2" X 11.00"; SEA WATER COMPATIBLE	A059G908	
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		CKD APVD_NE627	R	ASSEMBLY,	MISCELLAN	EOUS PIPING	
TION SHO	WN THEREON) IS NOT BE DISCLOSED TO OTHERS	DATE 26JANI8 FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING	MUST_CONFORM	CFP60E, S Size item numb	EA WAIER	CAD SHEET	
м, КЕРКС <u>RITTEN C</u>	DUCED DI ANT MEANS, OR ONSENT OF CUMMINS INC.	SEE ASME Y14.5-2009	10 CES 10903	<u> U  A</u>	<u>u59G906</u>	1   OF   1	
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IF AIR SHUT-OFF (ASO) IS SELECTED, THE UL/FM LISTING IS REMOVED AS THIS OPTION IS I

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_	[] ARE IN DIMENS X.X: X YY	N: . ION TOLERANCES ±0.090IN OR 2.3mm ±0.030IN OR 0.76mm	S SCALE 1.00	Cummins Confidential DWN KP937 CKD HV937 AD//D + 1/277	<b>Cummins</b> <b>Cummins</b> <b>S</b>	em name CHEMATIO	CS, OVE	IRALL, (	• CPF60E	
-	X.XXX: ANGUL THIS DOCUMEI PROPRIETARY ELECTRONIC F	±0.0151N OR 0.381mm AR TOLERANCE: ±1* IT (AND THE INFORMATION SH AND SHALL NOT BE DISCLOSE ORM, REPRODUCED BY ANY M	OWN THEREON) IS CONFIDENTIAL AND D TO OTHERS IN HARD COPY OR EANS, OR USED FOR ANY PURPOSE	APVD HV937 DATE 1 FEB 2018 FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING,	MUST CONFORM SIZE TO CES 10903	PDP GEN	I II BER 059000	5	ACAD SHEET	
	WITHOUT WRIT	TEN CONSENT OF CUMMINS IN	C.	SEE ASME Y14.5-2009		A	009692	J	∠ UF 3	



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DIMENSIONS ARE IN: INCHES [ ] ARE IN: .	DO NOT SCALE PRINT	CMI DATA CLASSIFICATION Cummins Confidential		Cummins Inc.					
DIMENSION TOLERANCES	SCALE 1.00	DWN KP937	a wanter	ITEM NAME					
X.X: ±0.090IN OR 2.3mm		CKD HV937		SCHEMATICS, OVERALL, CPF60E FPDP gen II					
X.XXX: ±0.015IN OR 0.381mm ANGULAR TOLERANCE: ±1*	$  \Psi \Box$	APVD HV937 DATE 1 FEB 2018							
THIS DOCUMENT (AND THE INFORMATION SHOW PROPRIETARY AND SHALL NOT BE DISCLOSED ELECTRONIC FORM, REPRODUCED BY ANY MEAI WITHOUT WRITTEN CONSENT OF CUMMINS INC.	N THEREON) IS CONFIDENTIAL AND TO OTHERS IN HARD COPY OR NS, OR USED FOR ANY PURPOSE	FOR INTERPRETATION OF DIMENSIONING AND TOLERANCING, SEE ASME Y14.5-2009	MUST CONFORM TO CES 10903	Difference billing bil	D SHEET OF 3				
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