This manual contains proprietary information to equipment produced by Cummins Fire Power or Cummins Inc. and is being supplied solely for the purpose of operating, maintaining, and servicing the fire pump engine purchased from Cummins Fire Power.

Warranty Information

LIMITED WARRANTY

EXCLUSIVE EXPRESS LIMITED WARRANTY: Cummins Fire Power (CFP), division of Cummins NPower, LLC expressly warrants to the original end consumer only that, for a period not to exceed the earlier of two (2) years or 2000 hours of use from the start-up date (or, if the original end consumer fails to register as purchaser with CFP, six (6) months from CFP shipment date), the diesel fire pump drivers, manufactured and sold by CFP, shall be free from defects in material and workmanship when used and serviced in accordance with the Operations and Maintenance Manual for the applicable Cummins Fire Pump engine model (the "Exclusive Warranty"). The Exclusive Warranty is nontransferable and shall immediately terminate and be of no further force or effect upon the sale, lease, assignment, transfer or other disposition by an original end consumer of a Cummins Fire Pump engine that contains a diesel fire pump driver covered by this Exclusive Warranty. Nothing contained herein shall be construed to extend the Exclusive Warranty, and the Exclusive Warranty shall not be extended to:

- Maintenance, adjustment, installation or start-up costs;
- Diesel fire pump driver failure due to normal wear, accident, misuse, abuse, neglect, improper installation or a defect attributable to a Cummins Fire Pump engine;
- Alterations or modifications not authorized in writing by CFP;
- Additional components added to a diesel fire pump driver package subsequent to shipment of the engine;
- Starting batteries;
- Coolant heaters (12 months coverage).

DISCLAIMER OF WARRANTIES: Except for the Exclusive Warranty provided above, which is in lieu of all other express and implied warranties, CFP EXPRESSLY DISCLAIMS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION AND EXCLUSION OF REMEDIES: All claims under this Exclusive Warranty shall be deemed waived by the original end consumer if not submitted to CFP or an authorized distributor within thirty (30) days of initial discovery that a diesel fire pump driver is not conforming to the Express Warranty. The original end consumer's remedy under this Exclusive Warranty is limited, in CFP's reasonable discretion, to repair, replacement or other appropriate adjustment of a nonconforming diesel fire pump driver determined, upon CFP's inspection, to have been properly installed, maintained and operated in accordance with the Operations and Maintenance Manual furnished by CFP. IN ANY EVENT, **CFP SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

The Cummins Industrial Warranty covers the base engine for a period of time not to exceed the earlier of two (2) years or 2000 hours of operation from the date of delivery and start-up of the engine. Reference bulletin numbers 3381321 US/Canada & 3381322 Outside US/Canada. Cummins Fire Power components are warranted for a period of time not to exceed the earlier of two (2) years or 2000 hours of operation from the start-up date of the fire pump system, and the coverage includes travel time and mileage for the first year of the Limited Warranty, and repair or replacement of parts and reasonable cost of labor. The Cummins Fire Power Limited Warranty does not cover failures or damage due to abuse or neglect and including, but not limited to: shipping damage, improper storage, improper installation, unauthorized modification or lack of maintenance. Cummins Fire Power is not responsible for incidental or consequential damages.

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Section 1 - Safety

1.1 Introduction

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

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

1.2 Advisory and Cautionary Statements

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

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

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

Cautionary Statements consist of two levels:

WARNING

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

CAUTION

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

1.3 Safety Precautions

Warning: Read and understand all of the safety precautions and warnings before performing any repair. This manual contains the general safety precautions that must be followed to provide personal safety. When they apply, special safety precautions are included with operating procedures.

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

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

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

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

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

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

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

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

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

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

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

Section 2 - Description

2.1 Introduction

This manual contains information for the correct operation and maintenance of a Cummins Fire Pump Engine. Read and follow all safety instructions. Refer to the General 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 Power, Cummins NPower, and Cummins Inc. reserve the right to make changes at any time without obligation. If any differences are found between an engine and the information in this manual, contact the local Cummins Authorized Repair Location.

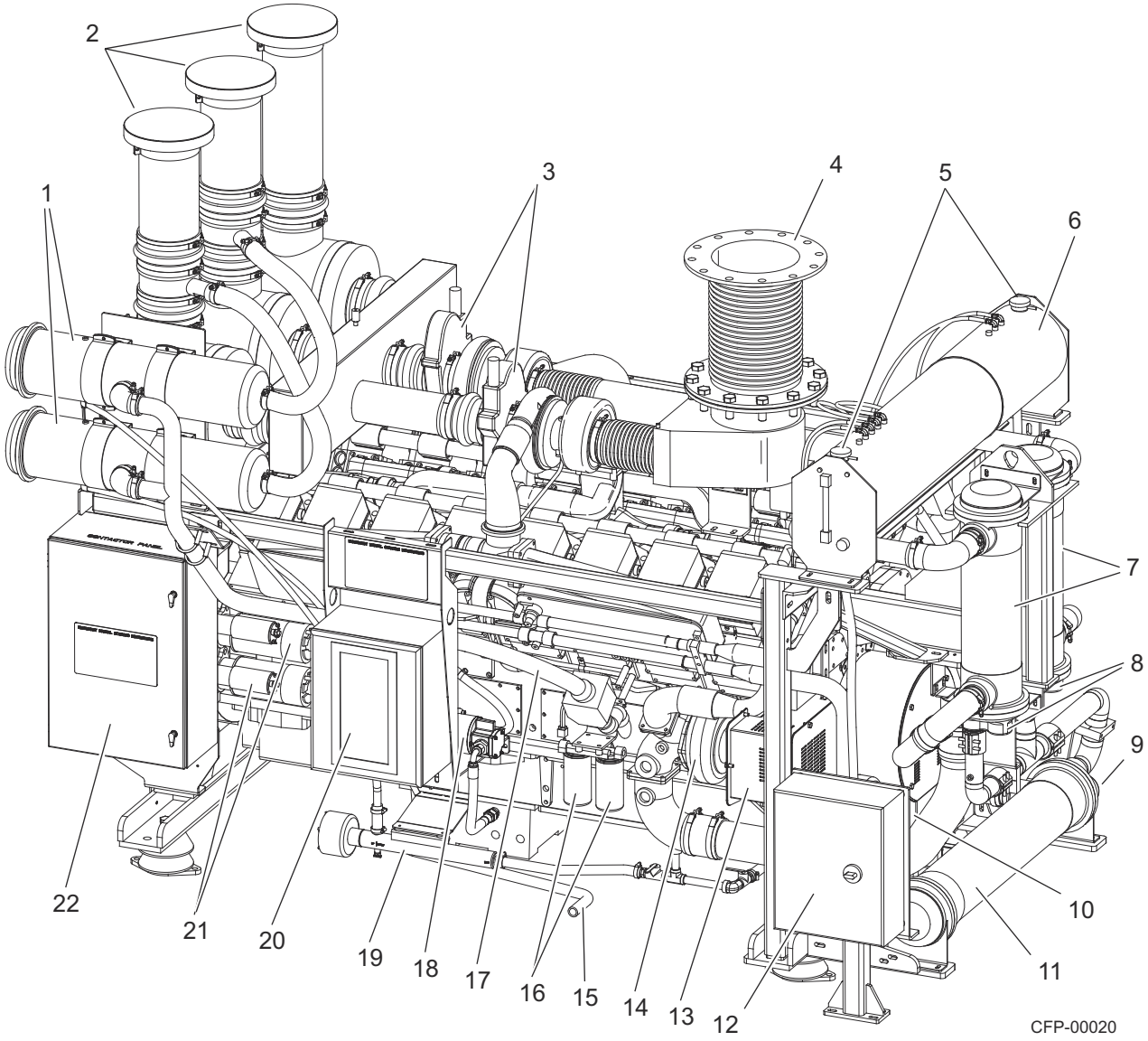
The latest technology and the highest quality components were used to produce this engine. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts.

2.2 Fire Pump Engines

Cummins complete line of fire pump engines have been designed and tested in accordance to NFPA 20 guidelines.

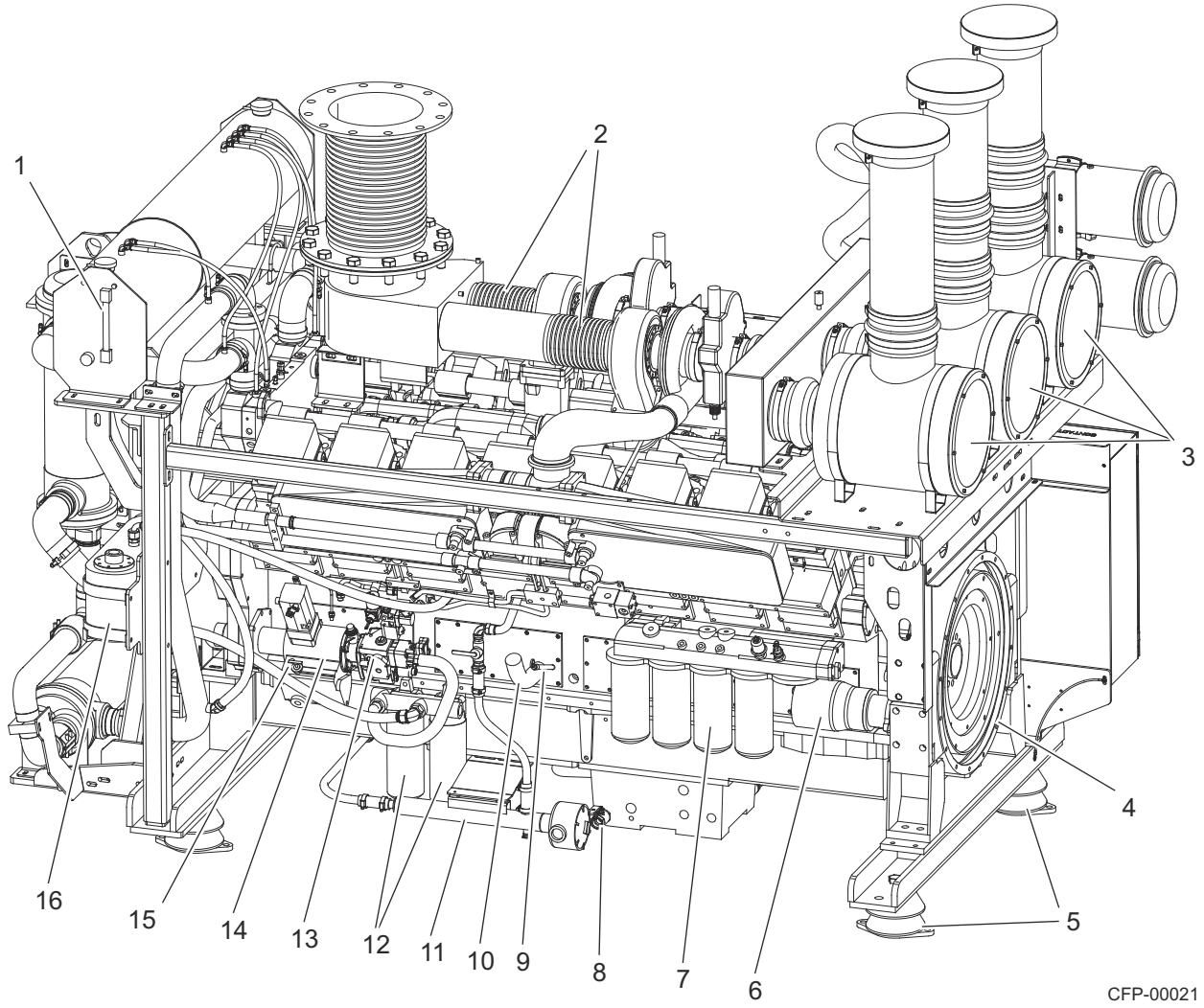
No deviations are permitted without prior written approval. These engines are to be used only for fire protection applications. Refer to Figure 2-1 and Figure 2-2.

NOTE: *Refer to the model specific Engine Data Sheet in Section 8 for emission levels.*



1. Crankcase Breather Filters (optional)
2. Air Cleaner Inlets (3) (optional)
3. Air Intake Shut-Downs (optional)
4. Exhaust Flex Connection
5. Coolant Pressure/Fill Cap (2)
6. Coolant Expansion Tank
7. Coolant Heat Exchanger (JW) (2)
8. Raw Water Discharge
9. Raw Water Inlet
10. Low Temperature Aftercooler (LTA)
11. Coolant Heat Exchanger (LTA)
12. Pre-Lube Panel (optional)
13. Alternator (with guard)
14. Coolant Pump
15. Oil Drain Hose
16. Coolant Filter (2)
17. Crankcase Ventilation Hose
18. Pre-Lube Pump (optional)
19. Engine Coolant Heater (2)
20. Control Panel
21. Starter (2)
22. Contactor Box

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



1. Expansion Tank Level Sight Gauge (2)
2. Exhaust Connection
3. Air Cleaner Assembly (3)
4. Flywheel Housing
5. Isolator Mounts
6. Hydralic Starter (optional)
7. Oil Filter (4)
8. Oil Drain Plug (2)
9. Oil Level Dipstick
10. Oil Fill Tube
11. Engine Coolant Heater (2)
12. Fuel Filter (2)
13. Woodward Governor (with actuator)
14. Fuel Pump
15. Governor Oil Level Dipstick
16. Fuel Tank (optional)

Figure 2-2 Engine Components - Raw Water Manifold Side (typical)

2.3 Operator Control Panel

The operator control panel contains controls for starting, monitoring engine performance, and controlling fire pump engine operation. Refer to Section 4 - Controls for additional information.

2.3.1 Overspeed Switch

Each engine is equipped with an overspeed module which activates the fuel pump solenoid valve to shut off the engine when the RPM exceeds a preset limit. The overspeed switch senses engine speed during the start cycle and stops the starter motor cranking cycle. Refer to Figure 2-3.

2.3.2 Operating Speed

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

required operating speed specified by the pump manufacturer.

CFP-040a

1. RESET Button
2. TEST Button
3. CRANK Termination or Run Signal Indicator Lamp (factory use only)
4. Overspeed Indicator Lamp
5. Pre-wired Terminals
6. Crank Termination Potentiometer Cover
7. Overspeed Potentiometer Cover

Figure 2-3 Engine Overspeed Control Module

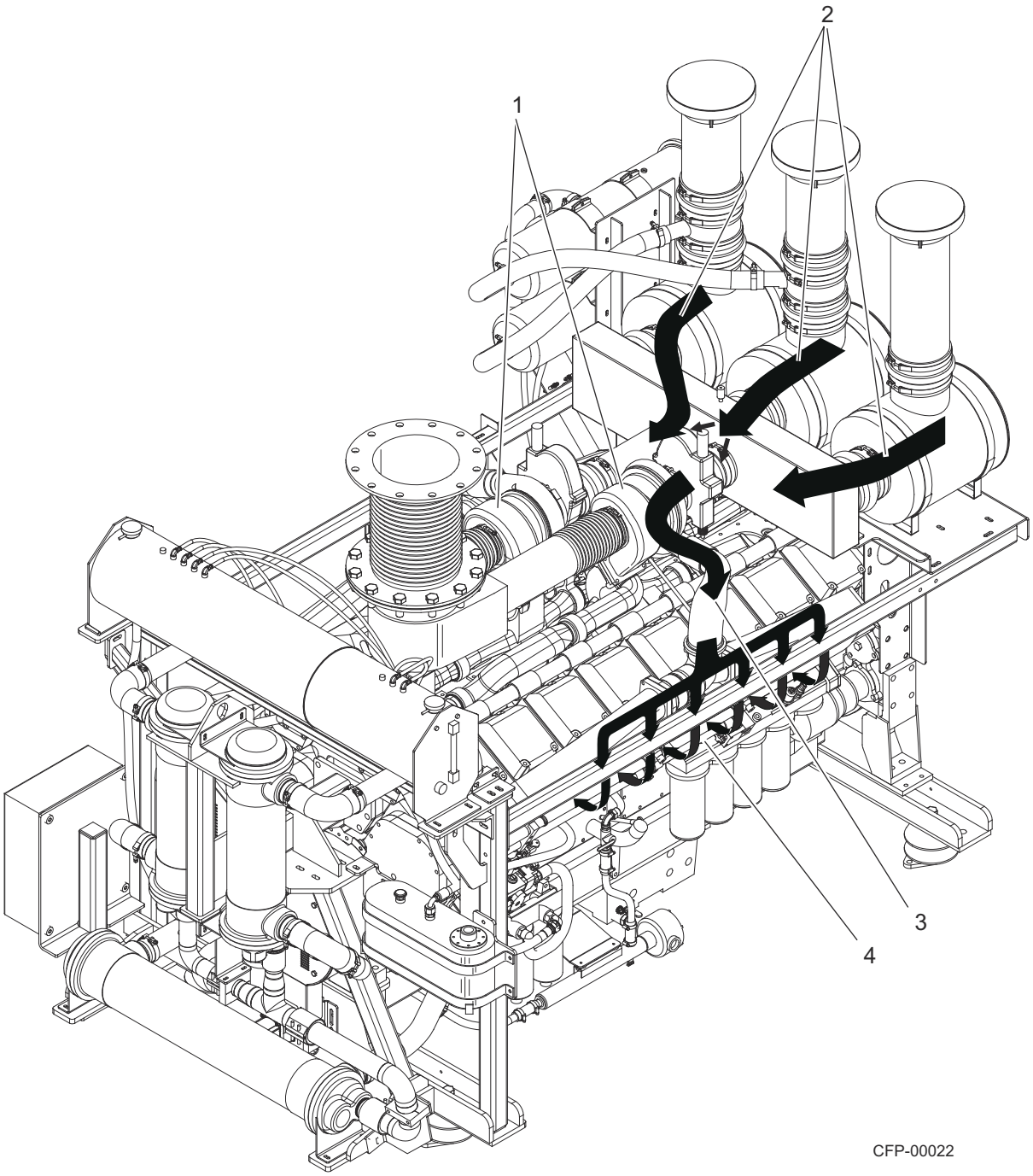
2.4 Fire Pump Controller

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

The engine may be started locally in the manual mode and shut down using the operator control panel RESET/STOP switch.

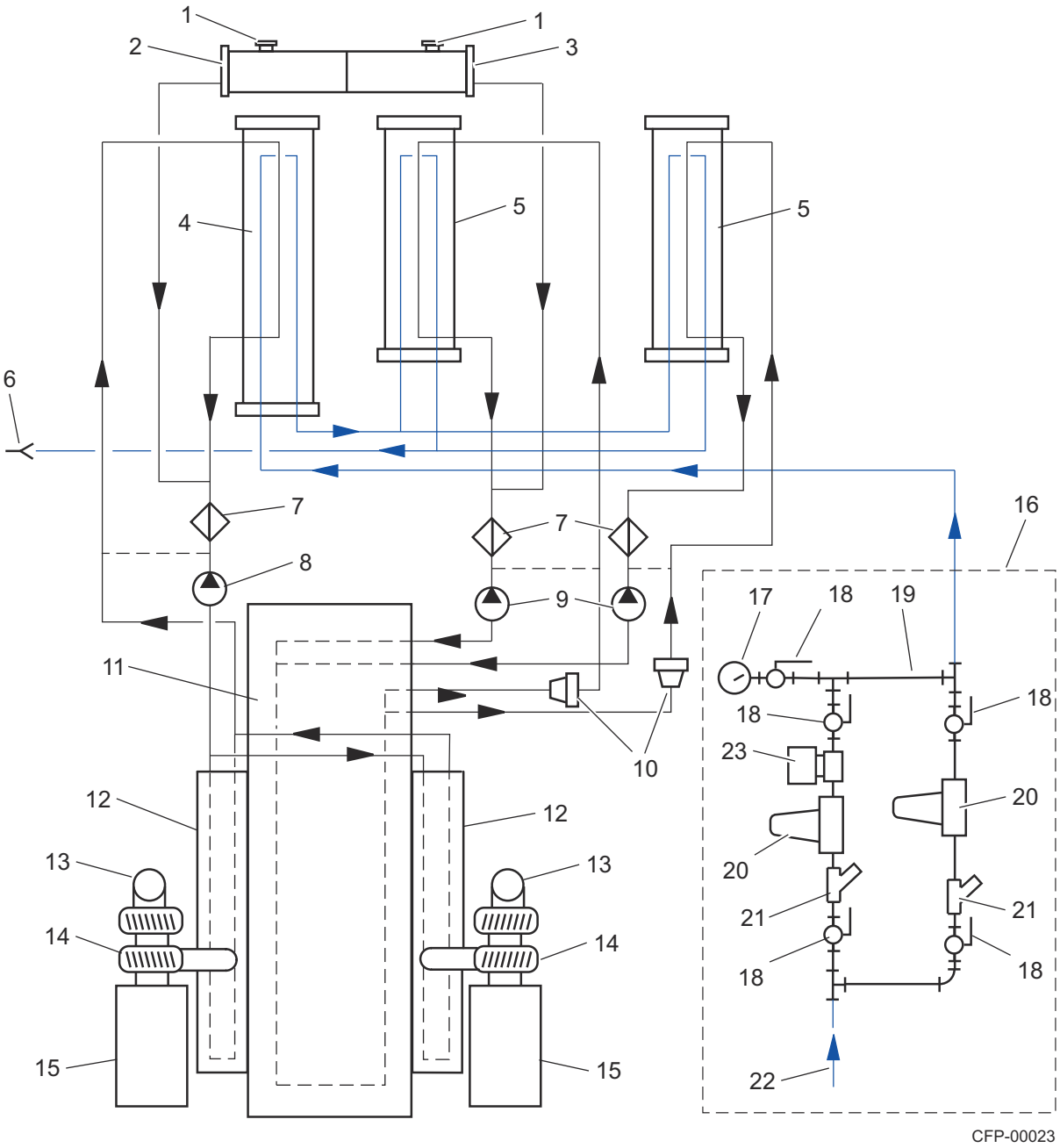
2.5 Air Intake System

The air intake system supplies combustion air to the fire pump engine cylinders. The air filters prevent particulate matter from entering the air intake. Combustion air drawn into the system is compressed by the turbochargers. The compressed combustion air is directed through Low Temperature Aftercooler (LTA) heat exchangers for cooling before it enters the combustion chambers (cylinders). Refer to Figure 2-4.



1. Turbocharger (2)
2. Filtered Intake Air from Air Cleaner (3)
3. Turbocharger Outlet (2)
4. Low Temperature Aftercooler (LTA) Heat Exchanger (2)

Figure 2-4 Engine Air Intake and Low Temperature Aftercooler Flow Diagram (typical)



1. Coolant Pressure/Fill Cap (2)
2. Coolant Expansion Tank (LTA)
3. Coolant Expansion Tank (engine)
4. Coolant Heat Exchanger (LTA)
5. Coolant Heat Exchanger (JW) (2)
6. Raw Water Discharge Connection
7. Coolant Filter (2)
8. Coolant Pump (LTA)
9. Coolant Pump (engine)
10. Thermostat (3)
11. Engine Block
12. Low Temperature Aftercooler (LTA)
13. Exhaust Connection
14. Turbocharger
15. Air Filter
16. Raw Water Piping (optional)
17. Raw Water Pressure Gauge
18. Manual Shut-off Valve
19. Bypass Piping
20. Raw Water Pressure Regulator
21. Raw Water Strainer
22. Raw Water Inlet Connection
23. Raw Water Solenoid Valve

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

2.6 Raw Water Cooling System (Customer Supplied)

The fire pump raw water supply provides cooling water for the Low Temperature Aftercooler (LTA) heat exchanger and the engine coolant heat exchanger.

The Low Temperature Aftercooler (LTA) heat exchanger helps the engine meet emission levels while improving engine performance and efficiency. The system produces a low charge air temperature requirement of 60° C (140° F) when operating in a 25° C (77° F) ambient temperature environment.

Raw water entering the cooling system through the raw water inlet circulates through the heat exchanger for the Low Temperature Aftercooler (LTA) system, cooling the compressed air from the turbocharger before it enters the combustion chamber. Refer to Figure 2-5 and Figure 2-6.

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

The raw water from the LTA heat exchanger then enters the engine heat exchanger for the engine cooling system. The raw water exits the heat exchanger (engine) through the flange drain line. Refer to Figure 2-5.

IMPORTANT: *If the piping will be supplied by the customer, provide raw water supply piping and components equivalent to components supplied by Cummins Fire Power and as shown in the Assembly Diagram for Raw Water Piping. Refer to National Fire Protection Association NFPA 20 for US installation requirements. When choosing components for the raw water supply and bypass, ensure that the internal cross sectional area of the component is at least as large as the recommended pipe size.*

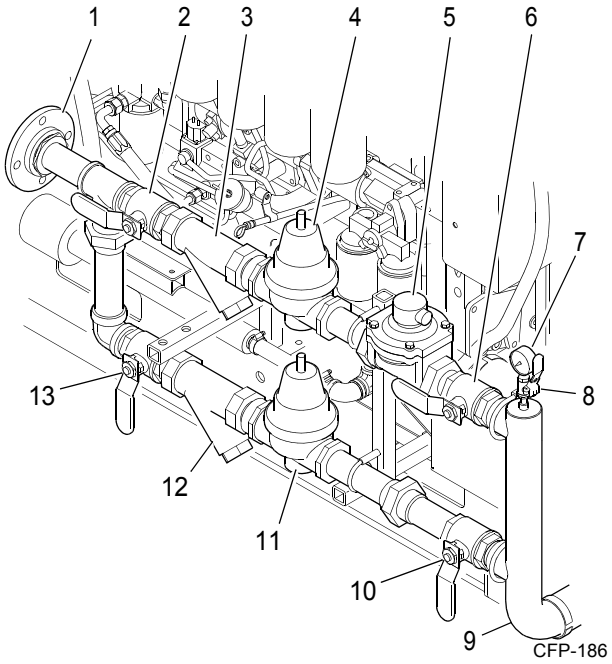
When the raw water piping is installed, adjust both pressure regulator set points before operating the pump.

1. The lower line is the bypass line. The bypass line outlet valve should be closed.

2. The upper line with the solenoid valve is the normal inlet line. The pressure gauge isolation valve must be open. The normal raw water inlet line valve should be open.

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

The engine coolant system contains a mixture of at least 50% antifreeze and 50% water. The coolant level should be maintained in or just below the coolant expansion tank level sight gauge.

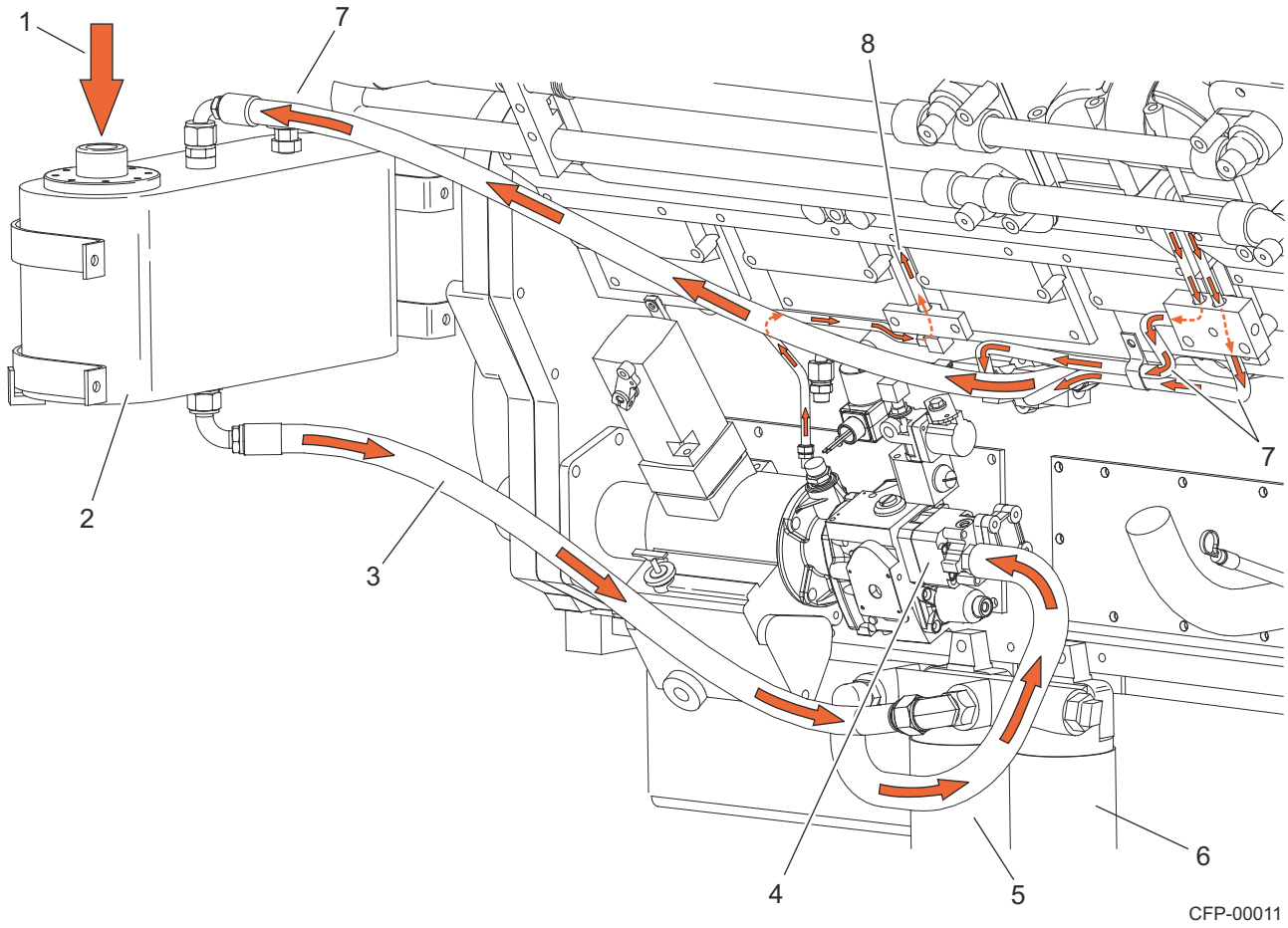


1. Raw Water Inlet Flange
2. Normal Water Inlet Valve (shown open)
3. Normal Water Strainer
4. Normal Water Pressure Regulator
5. Normal Water Solenoid Valve
6. Normal Water Outlet Valve (shown open)
7. Water Supply Pressure Gauge
8. Pressure Gauge Isolation Valve
9. Pipe to Heat Exchanger
10. Bypass Water Outlet Valve (shown closed)
11. Bypass Water Pressure Regulator
12. Bypass Strainer
13. Bypass Water Inlet Valve (shown closed)

Figure 2-6 Raw Water Cooling Loop Manifold (typical)

CAUTION

Continuous operation with low coolant temperature (below 71° C [160° F]) or high coolant temperature (above 100° C [212° F]) can damage the engine. Verify raw water coolant pressure and flow.



1. Fuel Inlet
2. Fuel/Day Tank (optional)
3. Fuel Supply Line
4. Fuel Injection Pump
5. Primary Filter
6. Fuel Filter
7. Fuel Return Line
8. To Injectors

Figure 2-7 Fuel System Flow Diagram (typical)

2.7 Fuel Supply and Return

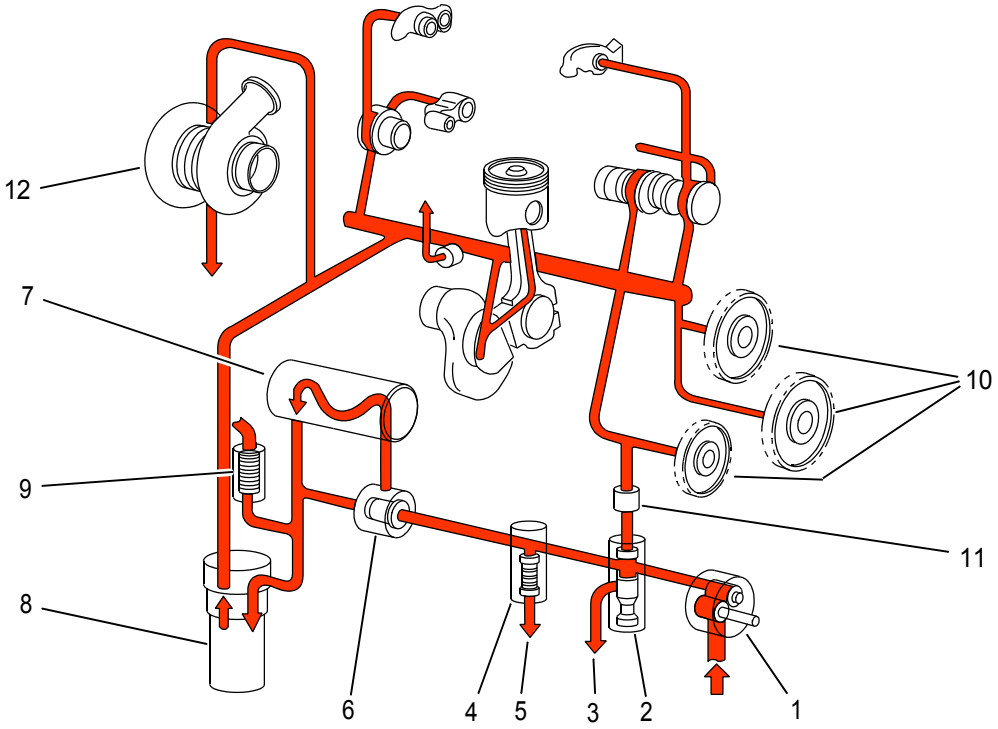
The fuel supply and return connections are located at the front of the unit below the belt guard assembly. The fuel supply travels through the fuel supply line to a fuel pre-filter and then on to the primary fuel filter/water separator. After passing through the filters, the fuel supply is available for the fuel injection pump and is circulated through the fuel manifold into the fuel injectors. Unused fuel is returned by the fuel injection pump through the fuel return line. Refer to Figure 2-7.

2.8 High Pressure Injector Fuel System

The fire pump engine is equipped with a fuel system that delivers precise fuel quantities with precise injection timing at high injection pressures. The system consists of twelve (12) high-pressure unit injectors and an Integrated Fuel System Module (IFSM). The IFSM provides individual cylinder control fuel metering and injection timing, and controls the fuel supply pump and regulator pressure using various system monitoring sensors.

With the HPI fuel system, fuel priming is required for conditions such as: initial start-up, running out of fuel, and maintenance of fuel system components (i.e., filter change). A 24 VDC fuel lift pump is standard.

NOTE: *The system will prime a totally dry fuel system in 120 seconds or less. Applications with a remote fuel tank require a fuel lift pump (supplied). Lift pump run time is limited to two minutes.*



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

Figure 2-8 Engine Lubricating Oil System Flow Diagram (typical)

2.9 Engine Oil System

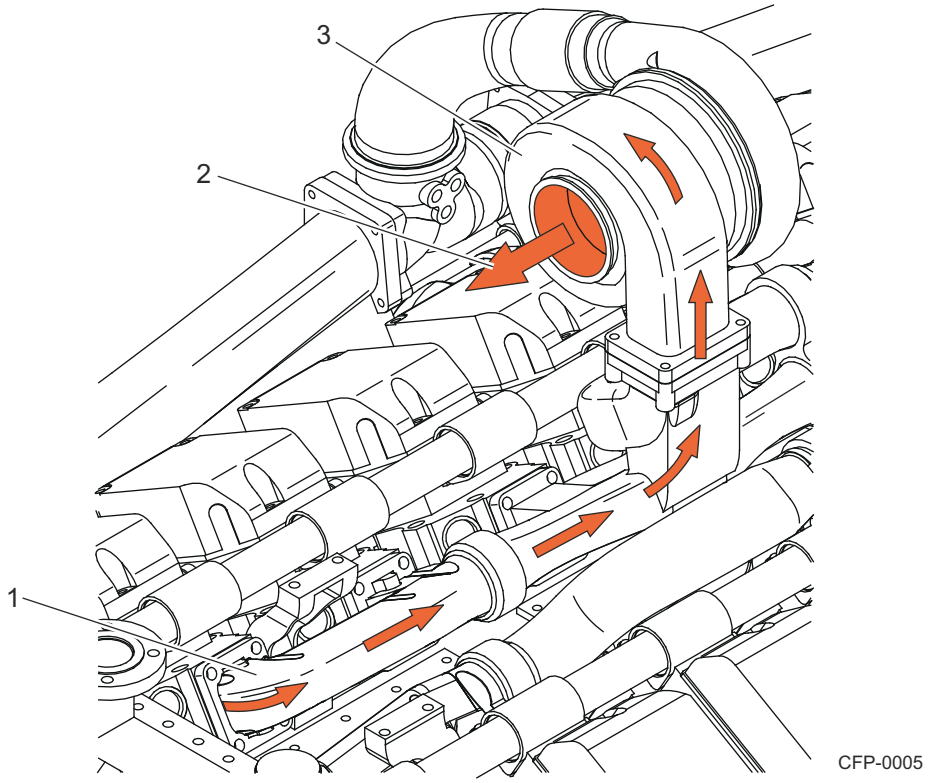
The engine oil system lubricates moving internal engine parts (pistons, piston arms, valves, cam shafts, drive shafts, and bearings). The oil pump circulates oil from the oil pan, through the oil filter, and into engine areas where friction may develop. Refer to Figure 2-8.

Typically engine oil has been added during manufacture and testing procedures, however, shipping restrictions can affect whether the oil is maintained in the engine or drained for shipment.

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

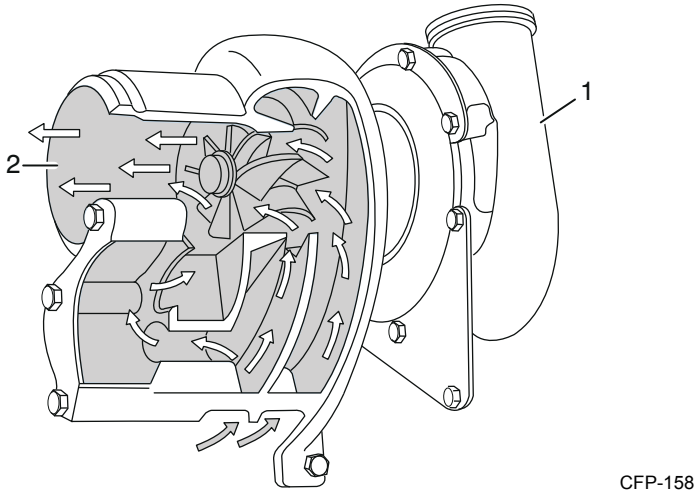
2.10 Exhaust System

The exhaust system removes engine exhaust from the cylinders after the combustion process. The exhaust discharges from the exhaust manifold, passes through (drives) the turbocharger, and exits through the exhaust connection. Refer to Figure 2-9 and Figure 2-10.



1. Exhaust Manifold
2. To Exhaust Connection
3. Turbocharger Turbine Housing

Figure 2-9 Exhaust System Flow Diagram (typical)



1. Combustion Air to Low Temperature Aftercooler (LTA)
2. Exhaust Flow to Flex Pipe

Figure 2-10 Turbocharger Exhaust Flow Diagram (typical)

Section 3 - Installation

3.1 Receiving and Handling Information

Cummins Fire Power Pump 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.

1. Carefully remove the components from the shipping container. Remove crating, shipping tape, braces, and tie-downs.

2. Inspect the equipment for damage that may have occurred in shipping.

3. Check each item carefully against the shipping manifest or bill of lading.

3.2 Site Preparation

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

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

Raw water piping should be installed by trained technicians familiar with local, state, and federal codes and regulations, per the equipment layouts supplied by Cummins Fire Power or Cummins Inc.

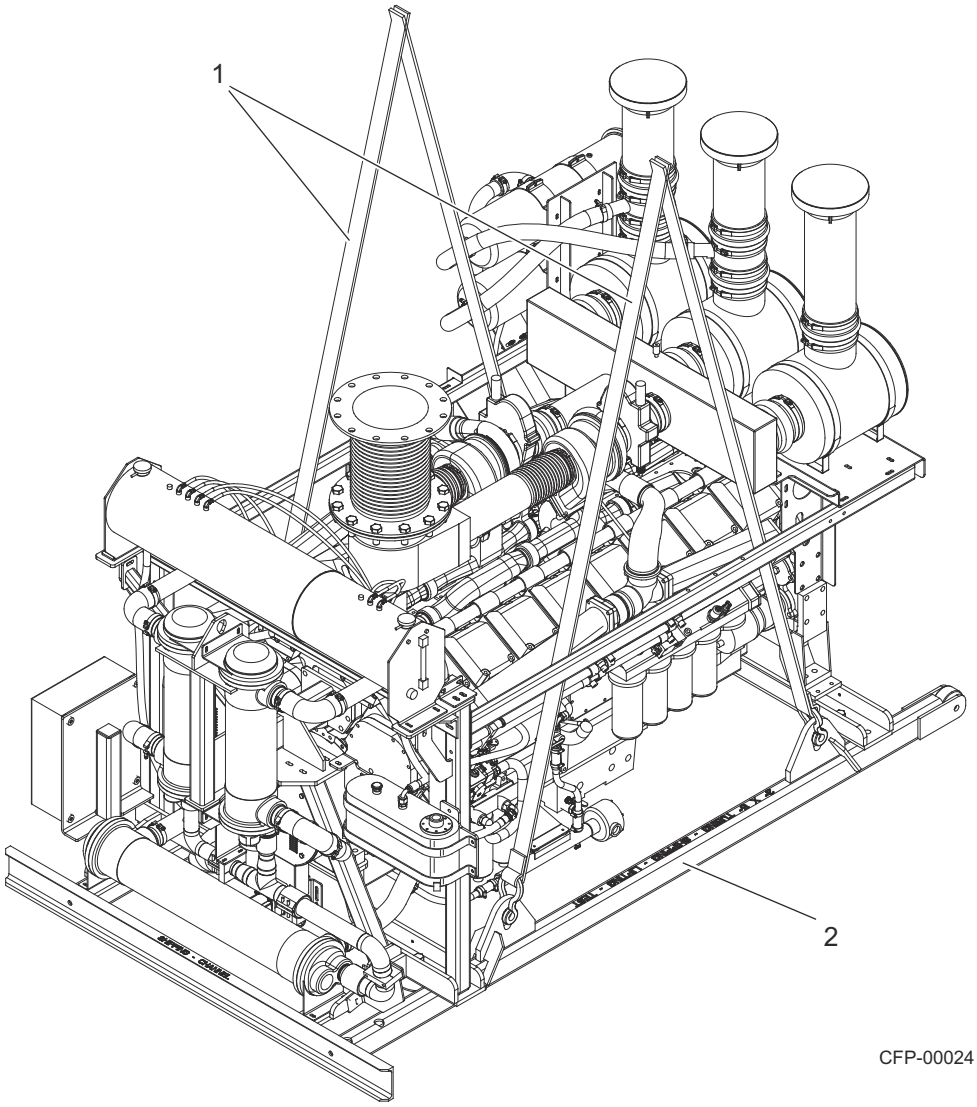
Refer to the general fire pump and engine layout drawings for installation dimensions supplied with this manual.

CAUTION

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

Refer to National Fire Protection Association NFPA 20 and NFPA 25 for US installation and applicable local code requirements.

1. Lay out a designated center line on the site floor. Find the center line of the engine drive shaft. Lay out a center line on the cross frame members.



1. Lifting straps (customer supplied)
2. Shipping/Lifting Frame

Figure 3-1 Engine Lifting Straps

2. If the engine is lifted separately, attach lifting straps (customer supplied) to the shipping/lifting frame to position the engine. Refer to Figure 3-1.

   If the engine is assembled with the drive line, pump, and mounting base, use the lifting points provided on the mounting base or lift the entire skid using an approved fork lift. Refer to the lay-out drawings supplied with this manual for lifting points.

CAUTION

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. Refer to the bill of lading for combined shipping weights.

3. Position the engine as required for the interface with the fire pump, water piping, fuel piping, exhaust, and air system connections.

3.2.1 Drive Shaft Installation

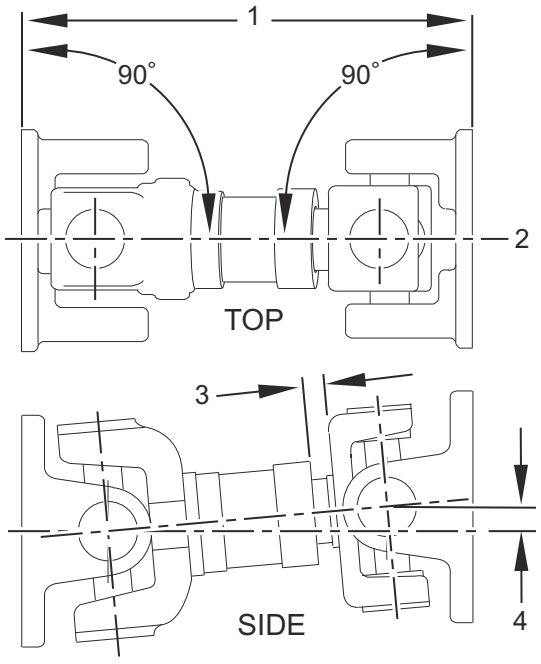
1. Position the engine center line to align the engine drive shaft with the fire pump drive. Ensure that the engine and pump are correctly aligned.

   a. Ensure engine position is centered on frame side to side within ± .76 mm (.03 in) by measuring outside of frame side to engine support leg mounting pad. (Compare the two front engine supports and two back engine supports).

   b. Align engine center line to pump center line within ± .76 mm (.03 in). Refer to Figure 3-2.

   c. The pump center line to the engine crankshaft center line (in vertical plane) is to be 2° ± 1°.

   d. Drive shaft mounting flanges must be parallel.



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

Figure 3-2 Drive Shaft Alignment

2. Check that the fire pump is properly installed per the pump manufacturer's specifications.

3. Connect the exhaust piping to a safe location, away from building air intake sources (air conditioners, windows, fresh air intake pipes, etc.).

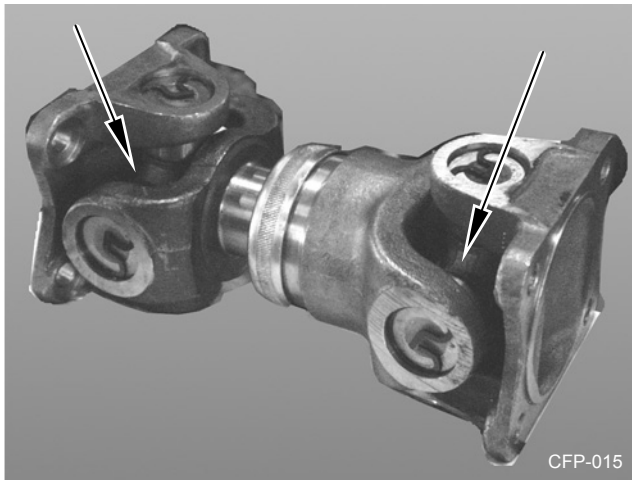


Figure 3-3 Drive Shaft Universal Joint Grease Fittings

4. Check that the alternator drive belt is properly installed.

5. Check that all hoses and tubes are properly installed and all clamps secure.

6. Lubricate the grease fittings on the drive shaft universal joint. Refer to Figure 3-3.

   a. Wipe the grease fittings and grease gun nozzle with a clean cloth.

   b. Add grease to the drive shaft universal joint grease fittings.

   c. Wipe excess grease from the grease fittings.

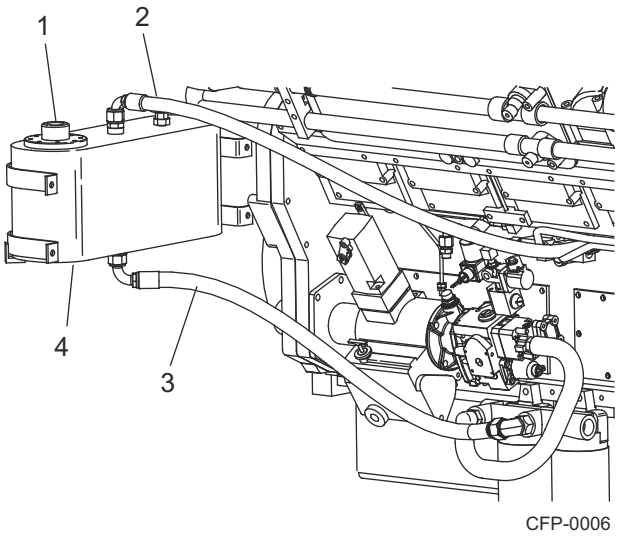
NOTE: *Cummins Fire Power or Cummins Inc. recommends using a good quality semi-synthetic, molybdenum-fortified NLGI #2 lithium complex grease.*

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

3.3 Fuel Supply Installation

1. Install an elevated no. 2 diesel fuel tank or other fuel supply arrangement which is compatible with 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.*



1. Fuel Inlet
2. Fuel Return Line
3. Fuel Supply Line
4. Fuel Float Tank (optional)

Figure 3-4 Fuel Supply and Return

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

3. Install a fuel return line. 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 engine.

NOTE: *For fuel line specifications, refer to the model specific Engine Data Sheet in Section 8.*

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

3.3.1 Fuel System Preparation

The fire pump 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 engine. Refer to Figure 2-7.

1. Ensure that the filter/separator is free of water by opening the fuel filter/water separator drain at the bottom of the filter.

2. Drain the fuel into a container until no water is present. Dispose of the contaminated fuel in accordance with local environmental regulations.

CAUTION

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

3.3.2 Fuel Recommendations

WARNING

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

CAUTION

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

3.4 Raw Water Supply Installation

Raw water supplied from the fire pump water source prior to the pump discharge flange is forced through the cooling system to the various heat exchangers. Raw water is circulated through the system to cool the Low Temperature Aftercooler (LTA) heat exchanger and the engine coolant heat exchanger. Refer to Figure 2-5 and Figure 2-6.

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

CAUTION

When the raw water piping is installed, adjust both pressure regulator set points before operat-

ing the pump. Damage to the heat exchanger may occur from improperly regulated raw water supply pressure.

3.4.1 Install Raw Water Piping

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

1. Provide a 7.62 cm (3 in) ANSI flange raw water drain line at the outlet of the engine coolant heat exchanger. (Raw water piping must be provided by the customer.) Refer to Figure 2-6.

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

2. Provide a raw water supply line to the connection at the raw water cooling loop manifold.

NOTE: *The water supply set points have been set by the manufacturer during engine assembly and testing.*

3. Check the pressure regulator setting with water flowing through the heat exchanger. Both raw water pressure regulators have been set at 207 kPa (30 psi) or slightly less during manufacture and testing. The raw water should be adjusted based on water flow rather than water pressure. The flow is dependent on the raw water temperature.

4. Use an appropriate sized container to measure and time the flow from discharge pipe.

   Flow rate = time to fill container/container.

   Example: Time to fill 19 liter (5 gal) container = 15 seconds.

   Divide 15 by 5 = 3 (seconds per liter [gal]).

   Divide 60 seconds by 3 = 76 liters (20 gal) per minute.

5. Adjust both pressure regulators to a pressure that will provide the flow rate at or above the specifications.

IMPORTANT: *The manual raw 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.*

NOTE: *When running, the engine should stabilize between temperatures listed on the model specific Engine Data Sheet. Do not exceed 413 kPa (60 psi).*

NOTE: *Excessively cold (4° C to 23° C [40° F to 75° F]) raw water flow can cause condensation inside the heat exchangers.*

IMPORTANT: *Continuous operation with low coolant temperature (below 70° C [158° F]) or high coolant temperature (above 100° C [212° F]) can damage the engine.*

3.5 Battery Selection

The minimum recommended reserve capacity (SAE RC) and cold cranking ampere (SAE CCA) values for a particular engine can be found on the Engine Data Sheet in Section 8. RC and CCA definitions can be found in SAE Standard J537. All battery information is for lead/acid batteries.

3.5.1 Battery Requirements

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

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

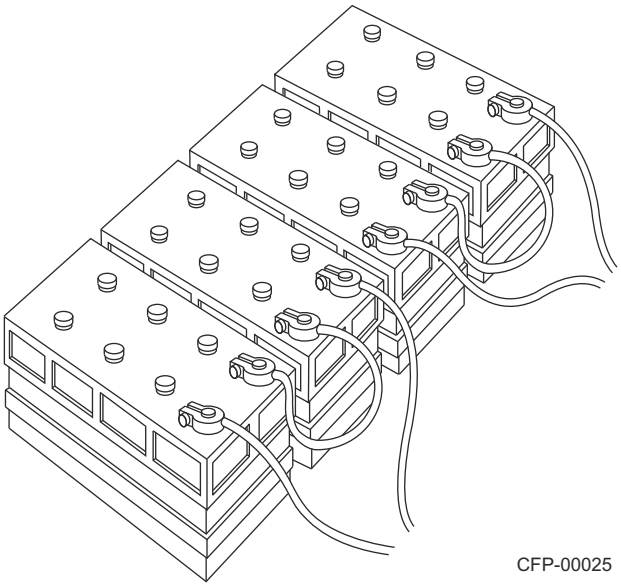


Figure 3-5 Series Battery Connection - 24 VDC

WARNING

Battery electrolyte (sulfuric acid) is highly caustic and can burn clothing and skin. Wear acid impervious neoprene gloves and safety goggles, or full face shield, when working with the batteries. Always disconnect the negative (-) battery cable first and attach the negative (-) battery cable last.

CAUTION

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

3.5.2 Battery Installation

Install the Loose Wire Kit per instructions. If purchased, install the optional Battery Cable Kit or equivalent customer supplied wiring. Install battery sets in a well ventilated or otherwise protected location.

NOTE: *There are two possible heavy-duty battery connections: Battery terminal and clamp, or threaded battery terminal and nut.*

1. Provide adequate room for servicing or replacing the batteries. Provide protection from extremes of temperature and weather.
2. 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 24 VDC standard operations. Refer to Figure 3-5.
3. Check the battery cables and connections.

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

3.5.3 Auxiliary Battery Starting

If a battery charging system is not provided, the engine can be started using charged batteries.

WARNING

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

3.6 Signal and Control Installation

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

CAUTION

If the batteries have been installed prior to the control wiring, disconnect the negative (-) cable first and then disconnect the positive (+) battery lead. Install the cables with the positive (+) cable first and the negative (-) cable last before testing.

NOTE: *Install signal and control wiring at the Terminal Board (TB). Refer to the terminal wiring schematic decal on the inside of the instrument enclosure.*

1. Ensure that the fire control system is properly installed and configured per the manufacturer's instructions. Refer to the wiring schematic drawings provided with the pump manual.

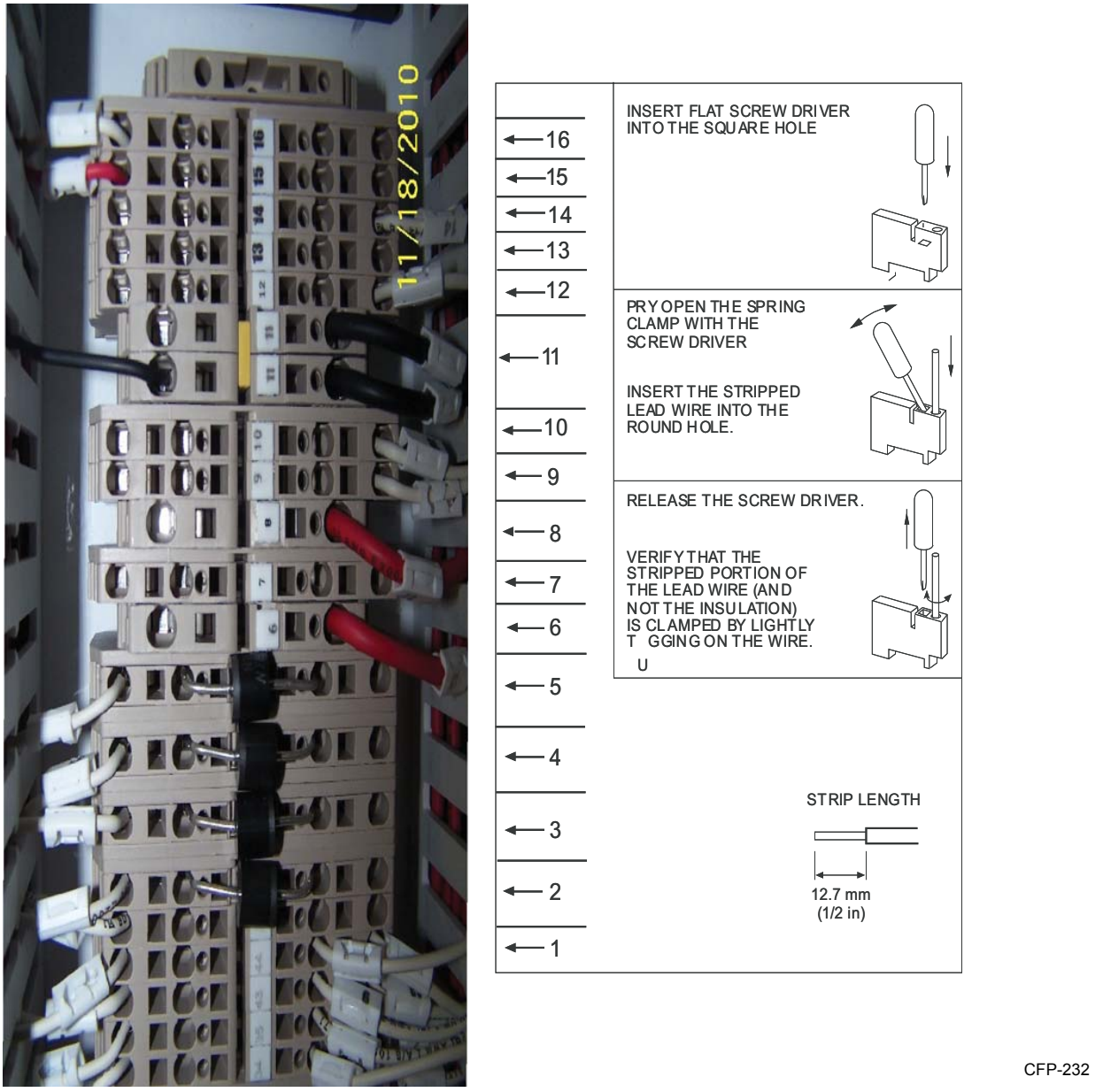


Figure 3-6 Termination Blocks and Wiring Decal

2. Complete the fire pump controller wiring (customer supplied) per the manufacturer's instructions.

3. Connect the following wires to the fire pump engine instrument panel per the engine electrical diagrams. Refer to Figure 3-6.

   a. TB-1: For optional raw water solenoid.

   b. TB-2: Connect the crank termination input signal for the fire pump controller. This signal is present when the engine is running. This signal indicates that the engine has started and that the crank command from the fire pump controller should stop immediately.

   c. TB-3: Connect the remote overspeed alarm input to the fire pump controller. This signal is present when the overspeed switch has operated. If this event occurs, the fire pump engine will stop.

d. TB-4: Connect the low oil pressure alarm input from the fire pump controller. This 0 VDC grounded signal is present when the oil pressure has dropped below the 83 ± 13 kPa (12 ± 2 psi) set point.

e. TB-5: Connect the high coolant temperature alarm input from the fire pump controller. This 0 VDC grounded signal is activated when the engine is running and the coolant temperature is at or above 93° C (200° F). The alarm will deactivate when the engine is running and the coolant temperature drops below 88° C (190° F).

f. TB-6: Connect battery set A lead from the controller. The controller senses battery A charge state and charges the battery through this heavy gauge wire.

g. TB-8: Connect battery set B lead from the controller. The controller senses battery B charge state and charges the battery through this heavy gauge wire.

h. TB-9: Connect crank from battery A lead. During a cranking cycle, the controller energizes the coil of starter contactor A through terminal TB-9 to start the engine.

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

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

k. TB-12: Connect the energize to close fuel shut off circuit from the controller.

l. TB-14: Connect the high oil temperature alarm input from the fire pump controller. This 0 VDC grounded signal is present when the oil pressure has risen to 129° C (265° F).

m. TB-15: Connect the air intake flaps closed input from controller. This 0 VDC grounded signal is present when the flaps are closed.

n. TB-16: Connect the engine run signal to the prelube control box.

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

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

6. Check that both voltmeters on the operator's control panel indicate the approximate battery voltage.

3.7 Coolant System Preparation

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

A separate coolant heat exchanger and coolant pump is used for the Low Temperature Aftercooler (LTA) system, and separate coolant heat exchanger and coolant pump is used for the engine cooling system.

NOTE: *Additional coolant flow diagrams can be found in the Engine Manual.*

CAUTION

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

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

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

    a. If engine coolant temperature is below 50° C (122° F), remove the expansion tank pressure/fill caps.

NOTE: *Supplemental engine coolant should be a mixture of 50% ethylene glycol anti-freeze and 50% water to avoid engine damage. For additional information, refer to the anti-freeze information found in Section 6 - Maintenance.*

    b. Check and correct any cooling system leaks.

    c. Install the pressure/fill caps on the coolant expansion tank.

3. Ensure the engine coolant filter shut-off valves are open.

4. The engine coolant heaters must maintain an engine coolant temperature of 49° C (120° F) or above. Refer to Figure 2-1 and Figure 2-2.

5. Ensure that coolant is present in the engine heater before plugging in the heater element.

3.8 Low Temperature Aftercooler (LTA) System

The Low Temperature Aftercooler (LTA) system reduces the temperature of the compressed combustion air from the turbocharger before entering the combustion chamber. Refer to Figure 2-4.

1. Inspect the low temperature aftercooler piping and hoses for loose/missing hose clamps, hose punctures, leaking manifold seals, or corrosion. Torque the hose clamps to the recommended value. Refer to the Torque Table in Section 8.

2. After the engine starts, a whistling noise may indicate an air leak from the turbocharger to discharge connection, loose hose clamps, damaged manifold seals, missing hose clamps, or hose punctures.

3. Inspect for damage. Tighten loose clamps. Torque hose clamp screws to the recommended value. Refer to the Torque Table in Section 8.

3.9 Lubricating Oil System Preparation

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

⚠ CAUTION

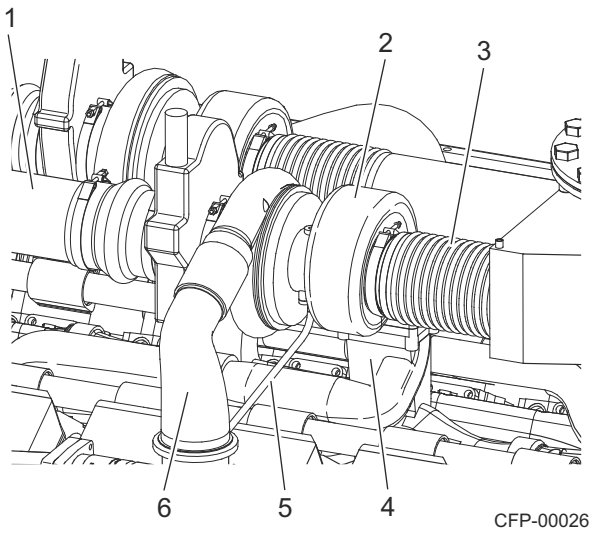
Some regulatory and shipping restrictions may require that all lubricants, fuels, and coolants be drained for transport. Ensure that all cooling and lubrication systems have been filled to the proper level before operation.

1. Check the oil level using the crankcase dip stick before operating. Refer to Figure 2-2.

2. Fill the crankcase at 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 in normal 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 Inc. recommends Premium Blue® 15W-40 oil for most climates.*



1. Turbocharger Air Intake
2. Turbocharger
3. Exhaust Connection
4. Exhaust Manifold
5. Turbocharger Oil Line
6. Low Temperature Aftercooler (LTA) Tubing

Figure 3-7 Turbocharger Oil Line Location (typical)

3. The turbocharger has been lubricated during manufacture and testing. Refer to Figure 3-7.

   a. Remove the turbocharger air intake tubing.

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

   c. Lubricate the bearings using clean engine lubricating oil for the turbocharger oil supply line fitting.

   d. Reconnect the turbocharger oil inlet line.

   e. Install the air intake filter assembly.

3.10 Pre-Start Inspections

Perform a visual inspection as follows:

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

2. Check that the drive belt is properly installed.

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

4. Check that all electrical connections are properly installed.

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

6. Lubricate grease fittings on the auxiliary drive shaft.

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

7. Ensure that the engine exhaust pipe exhausts to atmosphere away from other building air intake piping.

⚠ 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.

3.11 Engine Monitoring

When the engine starts it is important to monitor the oil and cooling water pressure gauges to ensure safe operation.

⚠ CAUTION

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

1. Immediately check that raw water flow is established through the coolant heat exchanger. Raw water flow should be established immediately but some delay may occur before the flow exits the heat exchanger drain connection.

NOTE: *Ensure that raw water is flowing through the heat exchanger and the water presssure shown on the local pressure gauge is no more than 414 kPa (60 psi). The minimum raw water flow rate is identified in the model specific Engine Data Sheet in Section 8.*

⚠ CAUTION

If the raw water flow is not evident at the discharge outlet or cone within 15 seconds, STOP THE ENGINE immediately! Continued operation without proper raw water flow will cause engine damage.

2. Ensure that engine operating temperature stabilizes between applicable ranges as identified on the model specific Engine Data Sheet in Section 8.

NOTE: *If temperature does not stabilize, stop the engine and refer to Coolant Temperature Above Normal or Coolant Temperature Below Normal (Engine Running) in Section 7 - Troubleshooting.*

3. Operate the engine for 8 to 10 minutes.

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

5. Shut off the engine by pressing and holding the overspeed RESET/STOP switch.

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

7. Correct any problems found during the inspection before proceeding.

8. Check the engine lubricating oil level at the crankcase dip stick. Top off if necessary.

9. Check the cooland expansion tank level. Top off if necessary.

10. Check the raw water strainers. Clean the strainers as required.

11. Perform engine speed control and safety system tests per the instructions in Section 5 - Operation.

Section 4 - Controls

4.1 Operator Control Panel

The operator control panel is mounted on the flywheel end of the engine.

The operator control panel contains instruments and controls for starting, monitoring engine performance, and controlling fire pump engine operation. Refer to Figure 4-1.

4.1.1 Coolant Temperature Gauge

The coolant temperature gauge displays the temperature of the coolant circulating through the fire pump engine. The gauge works in unison with the high coolant temperature alarm sensor to the fire pump controller at terminal TB-5. This 0 VDC grounded signal is present when the engine is running and the coolant temperature has risen above the 93° C (200° F) set point.

When the engine starts, immediately check that raw water flow is established through the fuel/coolant heat exchanger. Raw water flow should be established immediately but some delay may occur before the flow exits the heat exchanger drain connection. Stop the engine if the coolant temperature alarm is illuminated for more than 15 seconds.

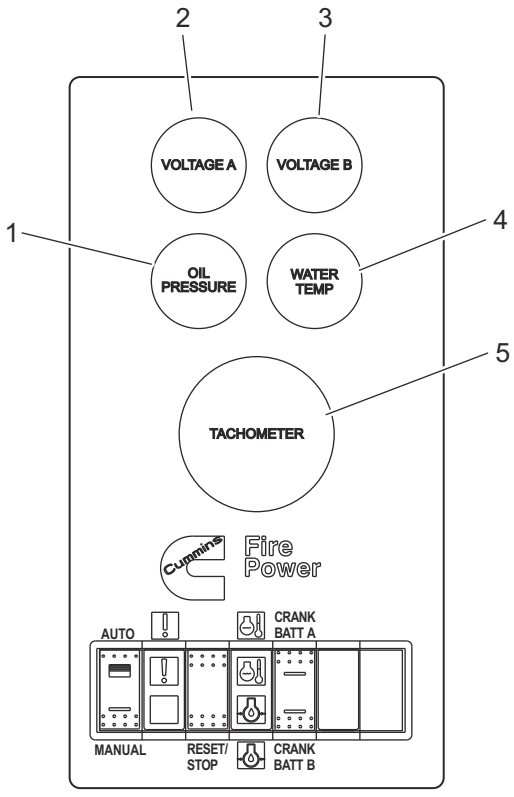
CAUTION

If the coolant temperature exceeds the high coolant temperature set point, the high coolant temperature warning lamp is illuminated. The engine will continue to operate, but immediate attention is necessary in order to prevent extensive damage to the engine or catastrophic engine failure.

4.1.2 Lubrication Oil Pressure Gauge

The lubrication oil pressure gauge displays the lubricating oil pressure. The gauge works in unison with the low oil pressure alarm input from sensor TB-5. The 0 VDC grounded signal is terminated when the oil pressure has dropped below the 83 kPa (12 psi) set point.

When the engine starts, immediately check that oil pressure is displayed. It should be on-scale within a few seconds. If oil pressure is not present or if the low oil pressure lamp does not go out, stop the engine and troubleshoot per the instructions in Section 7 - Troubleshooting.



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1. Battery “A” Voltmeter
2. Battery “B” Voltmeter
3. Engine Oil Pressure Gauge
4. Coolant Temperature Gauge
5. Tachometer and Hour Meter

Figure 4-1 Operator Control Panel - Instruments

CAUTION

If the engine oil pressure drops below the minimum oil pressure set point, the low oil pressure warning lamp is illuminated. The engine will continue to operate, but immediate attention is

necessary in order to prevent extensive damage to the engine or catastrophic engine failure.

4.1.3 Tachometer and Hour Meter

The tachometer displays the engine speed in revolutions per minute (RPM) whenever the engine is operating. The hour meter maintains a running total of the hours of operation (run time). The tachometer works in unison with the engine overspeed alarm input from sensor TB-3. This 24 VDC signal is present when the overspeed switch has operated.

CAUTION

If an engine overspeed condition occurs, the fire pump engine will stop to avoid fire system overpressurization. The fault must be corrected and the local RESET button must be pressed in order to restart the engine.

NOTE: *The run speed and engine overspeed set point are displayed on the factory setting tag on the flywheel end of the unit.*

NOTE: *Engines should operate within a few RPM of the rated speed, whether the engine is fully loaded or unloaded. If it becomes necessary to adjust the engine's actual speed to match the rated value, refer to 6.4.7.3 Overspeed Set Point Adjustment in Section 6 - Maintenance.*

4.1.4 Battery A and B Voltmeters

The battery voltmeters display the charge status (VDC) of the relative battery connections. Permanently installed redundant battery charging systems with connections at TB-6 and TB-8 (+) and TB-11 (-) should also be used for remote battery voltage indications at the fire pump control system or elsewhere.

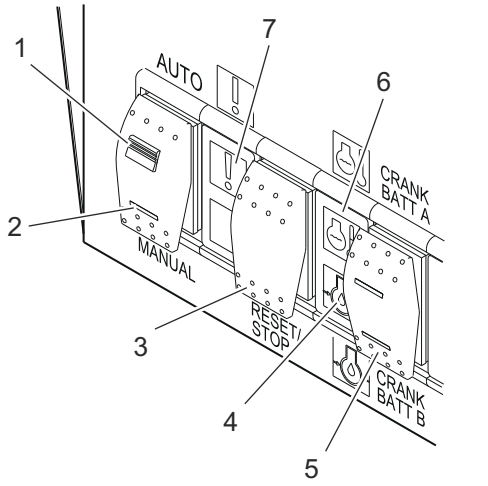
NOTE: *The two voltmeters may differ slightly due to calibration differences between the meters. Normal differences in battery condition may also cause indication differences. These are normal differences and require no action.*

4.1.5 AUTO/MANUAL Mode Switch

The AUTO/MANUAL mode switch determines whether the engine starts and is controlled by the operator (MANUAL) or by an automatic signal from the fire pump controller (AUTO). Refer to Figure 4-2.

The MANUAL mode is typically used for engine setup, testing, and maintenance procedures. The AUTO mode is used to start the engine under the control of the fire pump control system (in the absence of a live operator).

In the AUTO mode, the fire pump engine stops upon loss of signal power from the fire pump controller.



1. AUTO/MANUAL Mode Switch Locking Button
2. AUTO/MANUAL Mode Switch
3. Overspeed RESET/STOP Switch
4. Low Oil Pressure Warning Lamp
5. Crank Battery A/B Momentary Start Switch
6. High Coolant Temperature Warning Lamp
7. Overspeed Warning Lamp

Figure 4-2 Operator Control Panel - Controls

4.1.6 Overspeed Warning Lamp

The overspeed warning lamp is illuminated whenever the engine RPM rate exceeds the factory set engine overspeed set points. The lamp is not lit when the engine is operating within the normal engine RPM range. Refer to Figure 4-2.

NOTE: *The run speed and engine overspeed set point are displayed on the factory setting tag on the flywheel end of the unit.*

4.1.7 Engine Overspeed Warning Lamp

The overspeed sensor monitors engine speed during the start cycle and engine operation. The remote overspeed alarm input from the engine controller is connected to terminal TB-3. The speed switch is factory programmed to enable at 115% rated engine speed. If the engine RPM's exceed 115% rated

speed, the engine overspeed warning lamp is illuminated and the engine will shut down.

NOTE: *The overspeed switch has been set at the factory during assembly and testing. It should not require additional programming unless the pump operating speed is changed.*

CAUTION

If the overspeed sensor is tripped, the fire pump engine will stop to avoid catastrophic failure. The fault must be corrected and the local RESET button must be pressed in order to restart the engine.

4.1.8 Overspeed RESET/STOP Switch

Pressing the overspeed RESET switch after correcting an engine overspeed shutdown resets the operator controls, allowing subsequent restart of the fire pump engine.

Once running, the engine may be stopped locally by pressing and holding the overspeed RESET/STOP switch until the engine stops.

4.1.9 High Coolant Temperature Warning Lamp

The high coolant temperature lamp is lit whenever the engine is running and the coolant temperature has risen above the 100° C (212° F) set point.

IMPORTANT: *If the high coolant temperature lamp does not go out, stop the engine and troubleshoot per the instructions in Section 7 - Troubleshooting.*

CAUTION

If the coolant temperature exceeds the high coolant temperature set point, the high coolant temperature warning lamp is illuminated. The engine will continue to operate, but immediate attention is necessary in order to prevent extensive damage to the engine or catastrophic engine failure.

4.1.10 Low Oil Pressure Warning Lamp

The low oil pressure warning lamp is switch deactivated at a falling pressure of 83 kPa (12 psi), and activates at a rising pressure of 110 kPa (16 psi) set point. (When the engine is not running, the low oil pressure lamp will be illuminated). When a low oil pressure condition exists, the low oil pressure lamp on the engine control panel will illuminate.

IMPORTANT: *If oil pressure is not present or if the low oil pressure lamp does not go out, stop the engine and troubleshoot per the instructions in Section 7 - Troubleshooting.*

CAUTION

If the engine oil pressure drops below the minimum oil pressure set point, the low oil pressure warning lamp is illuminated. The engine will continue to operate, but immediate attention is necessary in order to prevent extensive damage to the engine or catastrophic engine failure.

4.1.11 Crank Battery A/B Switch

The fire pump engine requires (2) sets of 12 VDC lead/acid core batteries, with each pair wired in series to produce 24 VDC. The batteries can be supplied by Cummins Inc. or by the customer.

The CRANK BATT A and CRANK BATT B momentary start switches initiate an immediate engine start using the selected A or B crank battery.

4.2 Overspeed Switch

The overspeed switch senses engine speed during normal operation and during the start cycle. The switch deactivates the fuel pump solenoid valve and shuts off the engine whenever the speed exceeds the overspeed set point. Refer to Figure 4-3.

NOTE: *The overspeed switch is set during manufacture and test procedures and typically does not require setup at installation.*

1. RESET Button
2. TEST Button
3. CRANK Termination or Run Signal Indicator Lamp (factory use only)
4. Overspeed Indicator Lamp
5. Pre-wired Terminals
6. Crank Termination Potentiometer Cover
7. Overspeed Potentiometer Cover

Figure 4-3 Engine Overspeed Control Module

1. Use the adjustment and test procedure in Section 6 - Maintenance to change the set point.

2. Repeat the adjustments and checks until the desired set point is demonstrated. When the overspeed set point is set, check that the engine operates normally while not in the test mode.

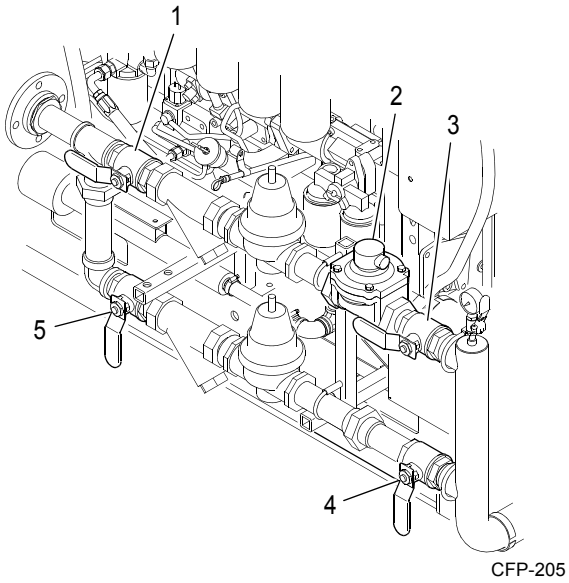
NOTE: *The overspeed set point must be set at between 115 and 120% of the engine's rated speed.*

The speed switch located on the engine's local control panel has a TEST button which lowers the currently adjusted overspeed by 20%.

Thus, an overspeed set point of 2112 RPM would be reduced to (2112 * 0.8) = 1689 RPM when the test button is pressed.

4.3 Raw Water Flow Control Valves

The engine controller opens the raw water normal loop solenoid valve in either manual or automatic mode. In the OPEN position, raw water can flow through the heat exchangers. Refer to Figure 4-4.



1. Normal Water Inlet Valve (shown open)
2. Normal Water Solenoid Valve
3. Normal Water Outlet Valve (shown open)
4. Bypass Water Outlet Valve (shown closed)
5. Bypass Water Inlet Valve (shown closed)

Figure 4-4 Raw Water Flow Control Valves

The manual valves control whether the automatic or bypass lines are supplying water.

1. Manual valves for the automatic loop should remain OPEN at ALL times.

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

Section 5 - Operation

5.1 Start-up Procedures

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

⚠ WARNING

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

5.2 General Operating Information

Cummins Fire Pump Engines are tested before being shipped from the factory. The engine operating speed must be set per the pump RPM requirements.

NOTE: *The engine speed set points are displayed on the factory setting plate, located on the power takeoff end of the engine.*

5.3 Remote Starting Procedure

If the AUTO/MANUAL mode switch is in the AUTO mode position, the pump engine starts automatically upon receipt of the start command from the customer installed pump controller panel. The AUTO mode position is the default switch position.

NOTE: *The AUTO/MANUAL mode switch locking button must be disengaged to place the switch in the MANUAL mode.*

The remote start command consists of a crank signal from the pump controller. When the pump has started, the crank termination signal is sent to the pump controller to indicate that the engine is running and to discontinue the crank signal.

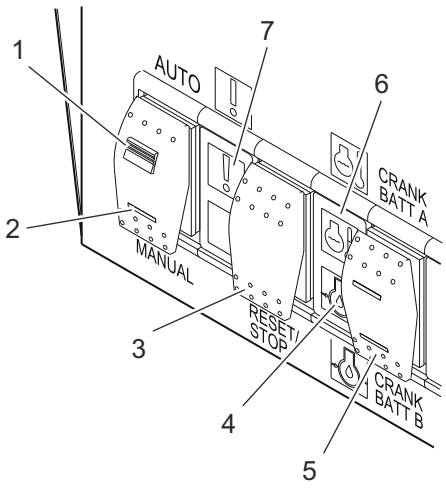
NOTE: *How the crank and crank termination signals are displayed depends upon the fire pump controller manufacturer. This indication should be checked in the event that an automatic start is initiated. If the signal is not present, the engine can be started locally using the Local Starting Procedure in this section.*

To start the engine from the fire pump controller panel:

1. Place the AUTO/MANUAL mode switch on the operator's control panel in the AUTO mode position. Refer to Figure 5-1.

2. Start the engine by initiating an engine crank signal from the fire pump controller.

   a. When the engine starts, a crank termination signal is sent to the fire pump control panel, indicating that the engine is running.



CFP-00028

1. AUTO/MANUAL Mode Switch Locking Button
2. AUTO/MANUAL Mode Switch
3. Overspeed RESET/STOP Switch
4. Low Oil Pressure Warning Lamp
5. Crank Battery A/B Momentary Start Switch
6. High Coolant Temperature Warning Lamp
7. Overspeed Warning Lamp

Figure 5-1 Operator Control Panel Switches

CAUTION

If the crank termination signal is absent, the engine starter motor will continue to operate. Shut the engine off immediately to avoid damaging the starter motor or the starter motor gears.

b. If the crank termination signal is not present, the engine can be started locally using the Local Starting Procedure in this section.

3. The engine continues to operate as long as the RUN signal is present. When the RUN signal is terminated by the fire pump controller, the engine stops immediately.

4. The engine may be stopped locally by pressing and holding the STOP/RESET rocker switch until the engine stops.

5.4 Local Starting Procedure

The fire pump engine can be started locally from the operator control panel for testing and maintenance. To start the engine from the operator control panel:

1. Disengage the AUTO/MANUAL mode switch locking button.

2. Place the AUTO/MANUAL mode switch in the MANUAL position. Refer to Figure 5-1.

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

4. Press either the CRANK BATT A or CRANK BATT B switch to start the engine.

   a. Depress the selector switch for up to 15 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 15 seconds. Wait 15 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 accelerate from crank to full load within a short period of time.*

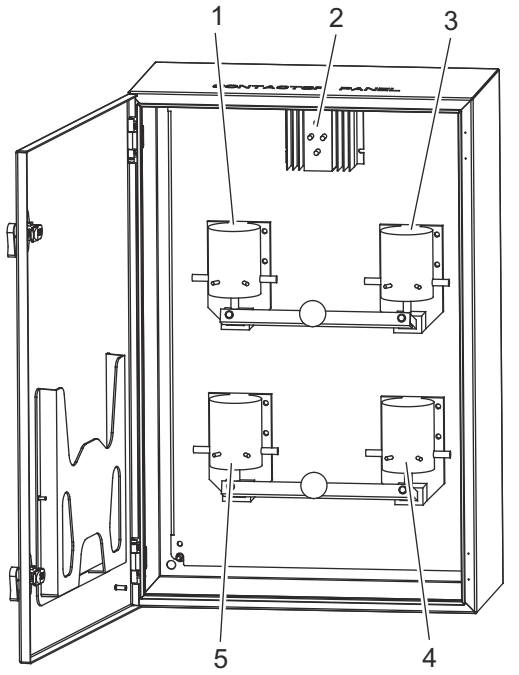
   b. Engine oil pressure must be indicated on the gauge within 15 seconds after starting.

5. Stop the engine locally by pressing and holding STOP/RESET rocker switch until the engine stops.

5.5 Emergency Starting Procedure

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

1. Open both manual bypass valves in the raw water supply loop.



1. Battery Starter Contactor A1
2. Battery Isolator
3. Battery Starter Contactor A2
4. Battery Starter Contactor B2
5. Battery Starter Contactor B1

Figure 5-2 Manual Starter Contactors

2. Disengage the AUTO/MANUAL mode switch locking button.

3. Place the AUTO/MANUAL mode switch on the operator's control panel in the MANUAL position. Refer to Figure 5-1.

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

5. Press downward on either battery A or battery B contactor lever to start the engine. Refer to Figure 5-2.

   a. If crank contactor lever A does not engage the starter, repeat using crank contactor lever B.

   b. Release the contactor lever immediately after the engine starts.

CAUTION

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

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

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

7. The engine may be stopped locally by pressing the STOP/RESET rocker switch.

5.6 Engine Operating Speed

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

If the speed does not match the engine RPM shown on the factory settings plate, refer to Section 6 - Maintenance for adjustment procedures.

5.7 Overspeed Set Point

The engine overspeed set point was set during manufacturing and test procedures. It may, however, be necessary to adjust the overspeed set point based on the actual fire pump application. Refer to Section 6 - Maintenance for adjustment procedures.

5.8 Crank Termination Set Point

The crank termination signal informs the pump controller that the engine has started and discontinues the pump controller crank signal. The crank termination signal was factory set at the manufacturer. Refer to Section 6 - Maintenance for set point adjustment and testing procedures.

5.9 Field Acceptance Testing

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

Section 6 - Maintenance

6.1 Introduction

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

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

Cummins recommends that the engine be maintained according to the maintenance schedule in this section.

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

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

6.2 Engine Operation Report

The engine must be maintained in top mechanical condition if the operator is to get optimum satisfaction from its use. The maintenance department needs daily running reports from the operator to make necessary adjustments in the time allocated.

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

Report to the maintenance department any of the following conditions:

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

Maintenance Chart

NOTE: *All maintenance and inspection intervals are accumulative. When performing annual maintenance, also perform maintenance listed under daily, weekly, monthly, and 3 month intervals.*

Maintenance Record Form

Engine Serial Number:	Engine Model:
Owner's Name:	Equipment Name/Number:

Date	Hours or Time Interval	Actual Hours	Check Performance	Performed By	Comments

6.3 Weekly Maintenance

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

6.3.1 General Walk Around Inspection

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

1. Check fluid levels, oil pressure, and coolant temperatures frequently. Most engine problems give an early warning.

   a. 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.

   b. Check the engine appearance for excessive heat, wiring short circuits, excessive endplay, vibrations, excessive wear, excessive abrasion, damaged electrical wiring, or loose electrical wiring.

   c. Check the engine for odors of diesel fuel, burning rubber, electrical system failure, exhaust fumes, or smoke.

WARNING

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

6.3.2 Air Cleaner Filter and Piping

The frequency of cleaning or replacing the air cleaner filter element is determined by the conditions in which the engine operates.

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.

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

NOTE: *Cummins recommends using an air cleaner filter element, as listed on the model specific Engine Data Sheet in Section 8.*

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.

NOTE: *Follow the manufacturer's instructions when cleaning or replacing the air cleaner element. Do not remove the felt washer from the indicator. The felt washer absorbs moisture.*

2. The air cleaner service indicator is acutated when excessive air restriction has occurred at the air cleaner. Refer to Figure 2-2.

   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: *Maximum intake air restriction is 762 mm H_2O (25.0 in H_2O) for turbocharged engines.*

3. 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.

4. Replace damaged air filters or pipes, and tighten loose clamps, as necessary, to prevent the air system from leaking. Torque hose clamps to the recommended torque value. Refer to the Torque Table in Section 8. Follow the manufacturer's instructions when cleaning or replacing the air cleaner element. Do not remove the felt washer from the indicator. The felt washer absorbs moisture.

6.3.3 Cooling System

CAUTION

Do not remove a pressure 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.

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.

1. Inspect the raw water piping, heat exchangers, Low Temperature Aftercooler (LTA) system, engine coolant hoses and hose clamps for loose fittings, leaks, holes, damage, and corrosion.

   a. Tighten the hose clamps as necessary.

   b. Check for cracks, holes, or other damage. Repair or replace as necessary.

2. With the coolant expansion tank at ambient temperature, press down, unscrew, and remove the pressure/fill caps. Refer to Figure 2-1.

   a. Ensure that the coolant level is visible at the center of the coolant level sight gauge.

   b. Add coolant as required. DO NOT OVERFILL!

NOTE: *Supplemental engine coolant should be a mixture of 50% ethylene glycol antifreeze and 50% water to avoid engine damage. Refer to the antifreeze information in Section 6.5.2 Drain and Flush Cooling System.*

3. 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.

CAUTION

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.

4. Check for soft, overly pliant hoses, oxidation, and loose hose clamps. Torque hose clamps to the recommended torque value. Refer to the Torque Table in Section 8. Replace damaged hoses and clamps as required.

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

6.3.4 Engine Oil System

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.

CAUTION

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

1. For accurate dipstick readings, shut off the engine and wait approximately 10 minutes to allow the oil in the upper portions of the engine to drain back into the crankcase.

2. Check the oil level at the engine dipstick. Refer to Figure 2-2.

   a. If the oil level is greater than the high mark (H), drain excess oil and recheck the level. Sample oil for contaminants such as fuel, coolant, etc.

   b. If the oil levels are consistently below normal after a fill, check for leaks, loose or damaged gaskets, or oil in the coolant system. Troubleshoot per Engine Oil Consumption Excessive in Section 7 - Troubleshooting.

3. If the oil level is below the low mark (L), add the equivalent type oil.

   Keep the oil level as near as possible to the “full” mark on the dipstick by adding the same quality and brand of oil.

NOTE: *Cummins recommends using Premium Blue S.A.E. 15W-40 Multi-viscosity Lubricating Oil or equivalent. Refer to the oil change interval and the*

procedures in Section 6.4.5 Engine Oil and Oil Filter Change.

6.3.5 Fuel System Inspections

WARNING

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

1. Shut off the engine.

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

   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 supply line.

3. Drain each fuel filter/water separator.

NOTE: *A water separator can be integrated into the fuel delivery system of the fire pump engine. A fuel filter/water separator may be installed directly on the unit in the primary fuel filter location, or a separate filter/separator may be installed in the fuel delivery system near the fire pump engine assembly.*

   a. Open the drain valve: Turn the valve counterclockwise approximately 3-1/2 turns until the valve drops down 25.4 mm (1 in) and draining occurs. Drain the fuel filter/water separator until clear fuel is visible.

   b. Close the drain valve: Lift the valve and turn it clockwise until it is hand-tight. Do not overtighten the valve. Over-tightening can damage the threads.

   c. Dispose of the contaminated fuel in accordance with local environmental regulations.

NOTE: *Refer to the model specific Engine Data Sheet in Section 8 for Cummins recommended replacement components.*

6.3.6 Engine Exhaust System

With the engine operating, inspect the entire exhaust system, including the 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.

6.3.7 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.

6.3.8 Crankcase Ventilation Hose

1. Inspect the crankcase ventilation hose for wear or damage, sludge, blockage, or dirt buildup. Refer to Figure 2-1.

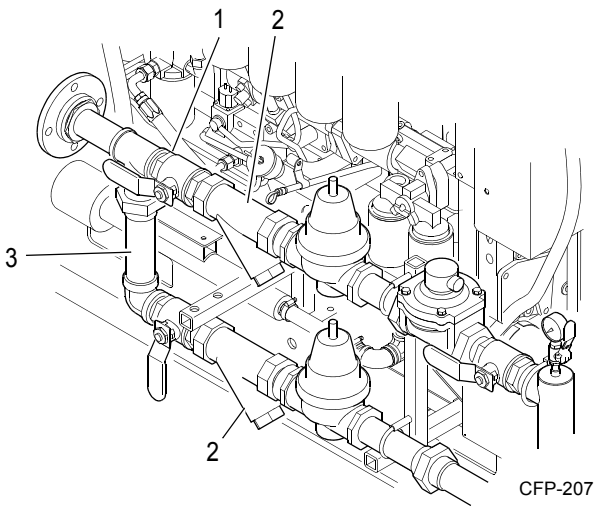
2. Clean the ventilation hose if obstructed or blocked. Replace if worn or damaged, as required.

6.3.9 Clean Raw Water Strainers

Each raw water strainer (one in the normal raw water line and one in the bypass raw water line) should be cleaned weekly to remove sediment. Refer to Figure 6-1.

1. Close the normal and bypass raw water line valves.

2. For each raw water strainer, remove the plug.



1. Normal Water Line
2. Raw Water Strainers

3. Bypass Water Line

Figure 6-1 Raw Water Strainers

3. Inspect and remove any debris.
4. Install the strainer plugs.
5. Open the normal raw water line valves.

6.3.10 Check Battery Condition

Weak or undercharged starting batteries are the most common cause of standby power system failures. Even when kept fully charged and maintained, lead-acid starting batteries are subject to deterioration over time and must be periodically replaced when they no longer hold a proper charge.

Only a regular schedule of inspection and testing under load can prevent engine starting problems. Use a manual battery load tester to verify the condition of each starting battery. Inspect the condition of the batteries, the electrical cables, and the engine ground lug.

CAUTION

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

CAUTION

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

1. Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive. Refer to Figure 3-5.
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. Charge the battery if the specific gravity reading is below 1.215.
3. Check battery wiring and cable connections for loose, corroded, worn, or damaged cables. Include both connectors at the alternator, battery connections, and engine grounding lug (near starter motor).
   a. If the battery cables are corroded, remove the battery cable clamps, starting with the negative (-) battery cable.
   b. Use fine emery cloth or a wire brush to clean the cable clamps and battery cables. The metal should be shiny.
   c. After cleaning the connections, coat the terminals with a light application of petroleum jelly.
   d. Reinstall the positive (+) battery cable first followed by the negative (-) battery cable. Tighten the cable clamps.

WARNING

Battery electrolyte (sulfuric acid) is highly caustic and can burn clothing, the 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.

6.3.11 Engine Test Run

1. Start the engine at least once a week for a minimum of 30 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.
2. Refer to the instructions in Section 5 - Operation.
3. Check that the engine starts and operates at the recommended fire pump speed specification.
4. Engine oil pressure must be indicated on the gauge within 15 seconds after starting.
5. Run the engine no less than 30 minutes to attain normal running temperature. Observe that the engine is operating at proper operating speed.

6. Check unusual engine noise. Listen for any unusual engine noise which can indicate that service is required.

7. Ensure oil pressure is greater than 69 kPa (10 psi).

8. Check coolant temperature is between 70° C (160° F) and 100° C (212° F).

9. Check that both battery voltmeters indicate 24 VDC.

10. Check that the inlet air restriction indicator has not popped-up; indicating an air filter blockage. Replace the air cleaner filter as required.

11. Shut off the engine by pressing and holding the RESET/STOP switch until the engine stops.

12. When finished, set the AUTO/MANUAL mode switch to AUTO.

6.3.12 Engine Coolant Heater

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

The engine coolant heaters must maintain an engine coolant temperature of 49° C (120° F) or above. The engine block must be warm to the touch in the water jacket areas. Refer to Figure 2-2.

If the heaters do not appear to be working correctly, see Section 7 - Troubleshooting.

6.3.13 Check Antifreeze

Antifreeze is essential in any climate. It broadens the operating temperature range by lowering the coolant freezing point and raising its boiling point. The corrosion inhibitors also protect the cooling system components from corrosion and provide longer component life.

CAUTION

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

1. Check the antifreeze concentration using a refractometer (such as Fleetguard® Part No. CC2800).

   a. At least twice per year.

   b. At every subsequent oil drain interval, if the concentration is above 3 units.

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

6.4 Annual Maintenance

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

6.4.1 Electrical Components

CAUTION

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

CAUTION

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

1. Remove the battery terminal cables, starting with the (-) negative cable first.

2. Inspect the electrical wiring harness, terminal panels, and electrical plug-ins for secure, clean electrical contacts, worn or damaged insulation, burnt wires, broken wires, and loose connections.

   a. Clean and tighten any loose electrical connections.

   b. Replace worn, damaged, burnt, or poorly insulated wiring immediately.

   c. Refer to the OEM vendor supplied literature for recommended maintenance procedures.

IMPORTANT: *Solid state or sealed electrical components have no user serviceable parts. Contact your*

local Cummins Authorized Repair Location for additional information.

d. Repair or replace damaged components. Refer to Section 8 - Component Parts and Assemblies or contact a Cummins Authorized Repair Location.

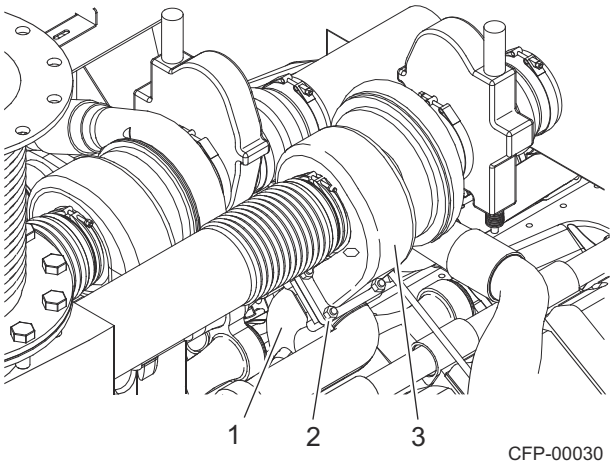
3. Inspect electrical terminal connectors on the instrument panel for burnt, loose, damaged, or broken contacts.

4. Inspect the function of all gauges, voltmeters, switches, warning lamps, and circuit breakers. Replace panel components, breakers, and warning lamps as required.

6.4.2 Turbocharger Mounting Nuts

Check the turbocharger mounting bolts for each turbocharger. Refer to Figure 6-2.

Torque the mounting nuts to the recommended torque value. Refer to the Torque Table in Section 8.



1. Exhaust Manifold (2)
2. Turbocharger Mounting Nuts (4 ea.)
3. Turbocharger (2)

Figure 6-2 Turbocharger

6.4.3 Engine Mounting Bolts

CAUTION

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

1. Inspect all engine supports for cracks or loose bolts. Refer to Figure 2-2.

2. Check the torque on the engine mounting bolts. Torque the support bracket to engine mounting cap screws to the recommended torque value. Refer to the Torque Table in Section 8.

6.4.4 Inspect Fuel Pump

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

2. Inspect the fuel lines and hoses for wear damage, loose fittings, and leaks. Repair or replace damaged lines and hoses as required per engine manual.

6.4.5 Engine Oil and Oil Filter Change

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. Refer to engine manual.

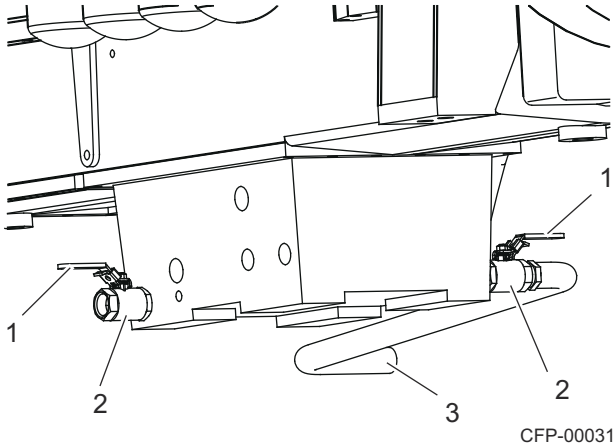
NOTE: *For composite oil pans, always use a new sealing washer on the oil drain plug. Hold the external locking nut in place while tightening the oil drain plug.*

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

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.

IMPORTANT: *If the engine oil is drained from the oil pan to make an engine repair, new oil must be used. Do not use oil that has been drained from the oil pan.*



1. Oil Pan Drain Valve (2)
2. Oil Pan Drain Plug (2)
3. Oil Pan Drain Hose

Figure 6-3 Oil Pan Drain Plugs

NOTE: *Cummins does not recommend exceeding 600 hours on oil change intervals.*

2. Operate the engine until the coolant temperature reaches 71° C (160° F). Shut the engine off.

3. Place an appropriate container under the oil pan drain plug. For improved access, the unit has a drain plug located on each side. Refer to Figure 6-3.

4. Open the oil pan drain valve and drain the oil completely, making sure that all suspended contaminants are removed from the engine.

5. Remove the oil filters. Refer to Figure 2-2.

   a. Clean the area around the oil filter canisters.

   b. Use a filter wrench to remove the filters.

   c. Remove and discard the O-ring seal if it has remained attached to the mounting flange. Clean the filter mounting flanges with a clean lint-free cloth.

   d. Apply a light film of 15W-40 lubricating oil to each replacement filter gasket before installing the filters.

6. Fill the oil filter with a high-quality 15W-40 multi-viscosity lubricating oil, such as Premium Blue®, or its equivalent.

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

CAUTION

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

NOTE: *Cummins recommends using fuel filter replacement parts as outlined in the model specific Engine Data Sheet in Section 8.*

8. Check and clean the oil pan drain plug threads and sealing surface. Install the oil pan drain plug. Torque the plug to the recommended torque value per the Engine Manual.

9. Add a high-quality 15W-40 multi-viscosity lubricating oil, such as Cummins Premium Blue®, or its equivalent.

10. Fill the engine to the proper level with clean oil at the fill port.

NOTE: *The standard pan capacity is listed on the Engine Data Sheet. Total system capacity assumes standard pan plus filter.*

CAUTION

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

11. Stop the engine.

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

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

6.4.5.1 Change Fuel Filters

WARNING

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

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 and operating engine can cause serious personal injury or fire hazard.

NOTE: *Refer to the Engine Manual for additional information.*

1. Shut off the engine.
2. Close any fuel valves (if equipped) to prevent fuel from draining or siphoning.
3. Clean the area around each fuel filter head.
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 seal of each filter canister with clean S.A.E. 15W-40 lubricating oil.
7. Center the filter on the threaded mounting stud. Screw the filter canisters onto the mounting stud until the gasket is snug against the mounting flange, then tighten each an additional 1/4 turn.

CAUTION

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

8. Open the fuel supply valves (if equipped).
9. Press either the CRANK BATT A or CRANK BATT B switch to start the engine.
10. Depress the selector switch for up to 15 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 15 seconds. Wait 15 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 ramp accelerate from crank to full load.*

6.4.6 Output Shaft Lubrication

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

1. Remove the output shaft guards.
2. Wipe the grease fittings and grease gun nozzle with a clean cloth to avoid contamination.
3. Add grease to the drive shaft universal joint grease fittings. Refer to Figure 3-3.

NOTE: *Cummins Inc 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).*

4. Wipe excess grease from the grease fittings.

WARNING

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.

6.4.7 Engine Operation Checks

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

6.4.7.1 Crank Termination Set Point

The speed switch crank termination set point is factory set at 650 RPM and should not be changed from this value. Refer to Figure 6-4.

If the crank termination set point must be set, proceed as follows:

1. Open the engine control panel and remove the crank termination potentiometer cover.

   There will be 2 potentiometers visible. The crank termination potentiometer is the upper one.

2. This is a 30-turn potentiometer. The crank termination potentiometer must be set to 14 turns clockwise.

3. To ensure that the potentiometer is set at 0 turns: Rotate the potentiometer 30 turns counterclockwise. The potentiometer will not be damaged by turning it past its zero-point.

4. After setting the crank termination potentiometer at 0 turns, turn the potentiometer 14 turns clockwise.

5. Replace the cover. The crank termination potentiometer is now set at approximately 650 RPM.

6.4.7.2 Engine Speed Calibration

For engine speed calibration information, see Woodward govenor set up instructions.

1. RESET Button
2. TEST Button
3. CRANK Termination or Run Signal Indicator Lamp (factory use only)
4. Overspeed Indicator Lamp
5. Pre-wired Terminals
6. Crank Termination Potentiometer Cover
7. Overspeed Potentiometer Cover

Figure 6-4 Engine Overspeed Control Module

1. Remove the cap screw from the operator's control face plate, allowing the face plate to gently drop down supported by the hinge.

2. Start the engine using the local start method.

3. Observe that the engine starts and accelerates to the speed set point listed on the factory settings plate.

4. Monitor engine speed on the tachometer. Record the observed engine speed.

   If the speed does not ramp up to the setting shown on the factory settings plate, the engine operating speed set point must be calibrated.

5. Move the INC/DEC speed switch to the required INC (increase) or DEC (decrease) pole position. Refer to Figure 6-4.

6. Stop the engine.

7. Start the engine.

8. Observe that the engine starts and accelerates to the rated speed set point.

9. Close the panel and tighten the enclosure cap screw to secure the panel face.

6.4.7.3 Overspeed Set Point Adjustment

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

1. Open the engine instrument panel and remove the overspeed potentiometer cover.

2. Place the engine in the MANUAL position by switching the MANUAL/AUTO mode switch to the MANUAL position.

NOTE: *The test button reduces the actual overspeed set point by a value of 20%.*

3. Start the engine and adjust the engine speed to the system design pump speed. Refer to Section 6.4.7.2 Engine Speed Calibration for additional information.

4. Press and hold the test button. If the engine remains running, slowly turn the overspeed

potentiometer counterclockwise until the engine stops. Remember to keep the test button depressed during this adjustment procedure. The speed switch is now set for the correct overspeed RPM.

NOTE: *Turning the potentiometer clockwise raises the set speed and counterclockwise lowers the set speed.*

5. Press the RESET button on the speed switch or front panel so the engine can be restarted.

IMPORTANT: *The final pump speed is typically set while the pump is flowing 150%.*

Alternate Overspeed Set Point Adjustment Procedure (without the test button)

1. Remove the drive shaft or stub shaft coupling to prevent overspeeding the pump. Refer to appropriate driveline drawings in Section 8 - Component Parts and Assemblies.

2. Open the engine instrument panel and remove the overspeed potentiometer cover. Refer to Figure 6-4.

3. Place the engine in MANUAL position by switching the MANUAL/AUTO switch to the MANUAL position.

4. Calculate the actual overspeed setting.

   a. Determine required pump speed (example: 1760 RPM).

   b. Calculate actual overspeed setting (example: 1760 X 120% = 2112 RPM).

5. Start the engine and adjust the engine speed to the calculated overspeed. (2112 RPM in the example above). Refer to Section 6.4.7.2 Engine Speed Calibration for additional information.

6. If the engine remains running, slowly turn the overspeed potentiometer counterclockwise until the engine stops. The speed switch is now set for the correct overspeed RPM.

NOTE: *Turning the potentiometer clockwise raises the set speed and counterclockwise lowers the set speed.*

7. Press the RESET button on the speed switch or front panel so the engine can be restarted.

8. Readjust the engine speed to the proper pump speed (1760 RPM in the example above).

9. Reconnect the pump drive shaft or stub shaft coupling. Refer to appropriate driveline drawings in Section 8 - Component Parts and Assemblies.

IMPORTANT: *The final pump speed is typically set while the pump is flowing 150%.*

6.4.8 Alternator Belt Inspection

CAUTION

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

1. Place the AUTO/MANUAL mode switch in the MANUAL position.

2. Disconnect both batteries at their terminals Remove (-) negative cable first. Install the (-) negative cable last.

3. Remove the belt guard bolts and the belt guard.

4. Visually inspect the alternator belt for frayed, worn, missing pieces, or cracked belt surfaces. Check the belt for intersecting cracks. Refer to and Figure 6-5.

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 alternator belt if it is cracked, frayed, or has pieces of material missing.*

5. If the belt condition is acceptable, check the belt tension.

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

6.4.9 Alternator Belt Tension

Use the following procedure to properly tension the alternator drive belt.

CAUTION

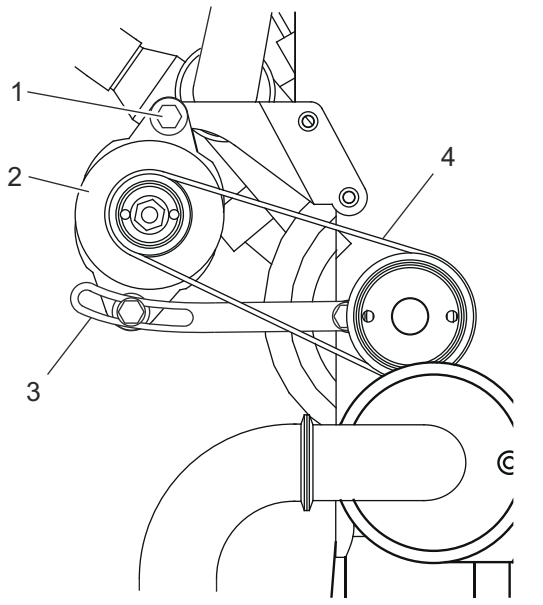
Disconnect both batteries (negative cable first) before performing service on the fire pump engine or on any of its controls.

1. Check the alternator drive belt tension. Refer to Figure 6-5.

2. Determine the belt tension using Cummins belt tensioner gauge, Part No. 3822524, to measure drive belt tension. Belt tension should be set and checked per engine operation manual.

NOTE: *The belt must not touch the bottom of the pulley grooves nor protrude more than 3 mm (3/32 in) above the top of the groove.*

3. A threaded adjustment rod attached to the top of the alternator controls the alternator belt tension. To adjust the alternator drive belt, loosen the alternator mounting bolts slightly.



CFP-00032

1. Alternator Mounting Bolt (2)
2. Alternator
3. Adjuster
4. Alternator Drive Belt

Figure 6-5 Alternator Drive Belt

4. Turn the adjuster in or out to obtain correct belt tension.

5. Tighten the alternator mounting bolts.

6. Re-check drive belt tension.

7. Reinstall the belt guard.

6.4.10 Heat Exchanger Pressure Test

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

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

1. Install an adapter at the raw water outlet of the heat exchanger.

2. Install a pressure test setup with 689 kPa (100 psi) pressure gauge at the raw water inlet to the heat exchanger.

3. Apply air pressure at 414 kPa (60 psi) maximum.

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

6.4.11 Turbocharger Inspection

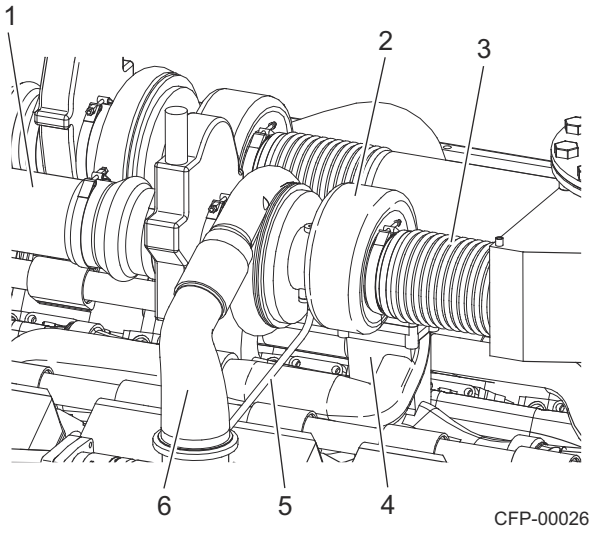
1. Visually inspect the air filter and piping for dirt buildup, blockage, wear points, soft hoses, loose clamps, or punctures. Refer to Figure 6-6.

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

2. Check that the air filter pop-up service indicator has not indicated a filter blockage. Clean or replace blocked filters.

3. Check for corrosion under the clamps and hoses of the intake system piping. Corrosion can allow foreign particles and dirt to enter the intake system.

   Disassemble and clean, as required.



1. Turbocharger Air Intake
2. Turbocharger
3. Exhaust Connection
4. Exhaust Manifold
5. Turbocharger Oil Line
6. Low Temperature Aftercooler (LTA) Tubing

Figure 6-6 Turbocharger Connections (typical)

4. Remove the air intake and the exhaust piping.

5. Remove the exhaust pipe from the turbocharger.

6. Inspect the turbocharger turbine wheel for cracks in the housing or turbine blades, missing blades, mechanical binding, eccentric motion, or excessive end-play.

   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.*

7. Reinstall the air intake filter and the exhaust piping. Tighten the clamps. Torque loosened clamps to the recommended torque value. Refer to the Torque Table in Section 8.

6.5 Every 2 Years or 2000 Hours

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.

6.5.1 Coolant Pump Inspection

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

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

6.5.2 Drain and Flush Cooling System

Each 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.

WARNING

Do not remove the pressure 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.

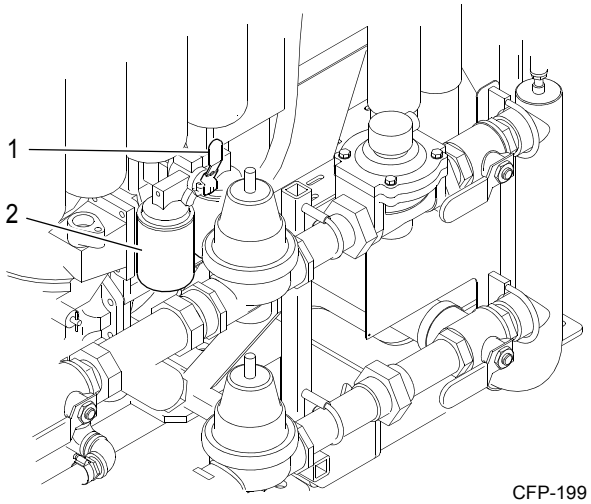
1. Press down, unscrew, and remove the pressure/fill cap from either the Low Temperature Aftercooler (LTA) or engine cooling side of the coolant expansion tank. The cap must be removed to allow air to vent the cooling system during the draining process.

2. Disconnect the engine heater power supply before draining the cooling system.

3. Place a container that will hold at least 57 liters (15 gal) of liquid under the heat exchanger or the system to be drained.

4. Ensure that the coolant filter shut-off valves are OPEN. Refer to Figure 6-7.

5. Remove the pipe plug in the plumbing under the heat exchanger to be drained.



1. Coolant Filter Shut-off Valve
2. Coolant Filter

Figure 6-7 Coolant Filters

6. 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.*

7. When the flushing water has fully drained, use a filter wrench to remove the coolant filters from the filter housing.

   a. Clean the filter housing gasket mounts of dirt buildup, oxidation, or particulate matter with a clean cloth.

   b. Coat the replacement filter gaskets with a light coating of 15W-40 lubrication oil.

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

CAUTION

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

8. If using a soapy water solution, flush again with clear water. Allow the water to fully drain.

9. Install the pipe plug in the plumbing under the heat exchanger.

CAUTION

Handling and disposing of used antifreeze can be subject ot federal, state, and local laws and regulations.

NOTE: *During filling, air must be vented from the engine coolant passages. The air vents through the coolant filler port.*

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

CAUTION

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.

NOTE: *Cummins Inc. recommends using Fleetguard® ES COMPLEAT™ Ethylene-Glycol (EG) or Fleetguard® Propylene-Glycol (PG) Plus™ Antifreeze/Coolants. Both products are available in concentrated or pre-mixed formulations. Use a 50% concentration level (40% to 60% range) of ethylene-glycol or propylene-glycol 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)

CAUTION

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.

CAUTION

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

11. Check the condition of the fill/pressure cap.

    a. If the fill/pressure cap seal is worn, damaged, missing, or the pressure spring is damaged or shows signs of sticking, replace the filler cap.

    b. Install the expansion tank fill/pressure cap.

12. Repeat steps 1 - 11 for the remaining cooling system.

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

14. Ensure that the coolant level is just below the fill neck.

6.6 Every 4 Years or 5000 Hours

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

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.

6.6.1 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.

CAUTION

Always use the correct thermostat, and never operate the engine without a thermostat installed. The engine can overheat if operated without a

thermostat because the path of least resistance for the coolant is through the bypass to the pump inlet.

1. Use the pipe plug in the plumbing under the engine coolant heat exchanger or loosen the coolant hose at either engine coolant heater and drain the coolant level to just below the thermostat housing.
2. Remove power from the coolant heaters.
3. Remove the hose clamps and remove the upper coolant hose from the thermostat housing.
4. Remove the (2) thermostat housing flange cap screws and the thermostat flange.
5. Remove the thermostat, seal, and gasket from the housing.
6. Clean the housing flange faces of dirt buildup, oxidation, and sludge.

NOTE: *Use only a Cummins approved thermostat and thermostat seal.*

7. Install a new thermostat seal and gasket on the thermostat housing flange surface.
8. Replace the thermostat flange and cap screws.

6.6.2 Alternator Belt Replacement

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

CAUTION

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

1. Remove the belt guard.
2. To replace the alternator drive belt, loosen the alternator mounting bolts slightly.
3. Turn the adjuster in to obtain enough slack in the belt to slip it over one of the pulleys.
4. Remove the old belt and install the replacement drive belt.

CAUTION

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.

5. Turn the adjuster out to obtain proper belt tension. Refer to 6.4.9 Alternator Belt Tension.
6. Tighten the alternator mounting bolts.
7. Re-check drive belt tension.
8. Replace the belt guard and tighten the cap screws to the proper torque value. Torque the cap screws to the recommended torque value. Refer to the Torque Table in Section 8.

6.6.3 Heat Exchangers

The heat exchangers should be removed and cleaned internally at least once every four years.

1. Place the AUTO/MANUAL mode switch in the MANUAL position.
2. Disconnect both batteries at their terminals. Remove (-) negative cable first. Install the (-) negative cable last.

CAUTION

Both batteries must be disconnected before performing service on the fire pump engine or on any of its controls. Wear safety glasses when disconnecting batteries!

3. Shut off the normal and bypass raw water shut-off valves on the raw water manifold.
4. Disconnect raw water inlet and outlet fittings from the heat exchangers. Refer to Figure 2-2.
5. Drain the coolant from the heat exchanger. Refer to 6.5.2 Drain and Flush Cooling System.
6. Provide support for the heat exchanger in order to avoid dropping it.
7. Remove the heat exchanger mounting bracket bolts from the mounting bracket and remove the heat exchanger from the mounting brackets.

WARNING

Cleaning chemicals may be caustic and cause skin irritation. Follow the instructions on cleaning containers. Wear protective clothing, eye wear, and rubber gloves when working with cleaning solutions. Dispose of solvents and cleaning solutions properly.

CAUTION

Do not use caustic cleaners to clean the heat exchanger. Damage to the heat exchanger will result. Follow the directions provided by the cleaning solution manufacturer.

8. Flush the heat exchanger internally with cleaning solution in the opposite direction of normal flow.

9. Shake the heat exchanger and lightly tap on the tank ends with a rubber mallet to dislodge trapped debris. Continue flushing until all debris or oil is removed.

CAUTION

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

10. After the heat exchanger has been thoroughly cleaned of all oil and debris with solvent, wash the heat exchanger internally with hot, soapy water to remove the remaining solvent.

11. Rinse thoroughly with clean water.

12. Blow compressed air into the heat exchanger in the opposite direction of normal flow until the heat exchanger is dry internally.

13. If internal water leakage is suspect, perform a pressure test on the heat exchanger. Refer to 6.4.10 Heat Exchanger Pressure Test.

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

15. Position the heat exchanger and clamps on the engine's mounting bracket and hand tighten the mounting bolts.

16. Repeat steps 5 - 15 on the remaining heat exchanger.

17. Align the heat exchangers with the required hose connections and tighten the hose clamp fasteners. Refer to Figure 2-1.

18. Reinstall all water supply and drain fittings. Use Teflon™ pipe tape to prevent leaks. Torque the hose clamp screws to the recommended torque value. Refer to the Torque Table in Section 8.

19. When all heat exchanger hose clamps and cooling water lines are secure, tighten the mounting bracket bolts.

20. Open the cooling loop normal raw water supply shut-off valves and check for leaks.

21. After completing all service work, start the engine and check for air leaks, loose clamps, and blowby.

Section 7 - Troubleshooting

7.1 Troubleshooting

The following information is intended as a guide to troubleshooting some common non-technical equipment problems. 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 Operation and Maintenance Manual or contact the Cummins Customer Assistance Center at 1-800-DIESELS (1-800-343-7357).

It is beyond the scope of this manual to cover all of the various problems that may affect engine performance.

WARNING

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

WARNING

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.

CAUTION

AVOID SERVICING complex components such as: printed circuit boards, programmable controllers, and ECM's not specifically authorized by Cummins Inc. Contact a Cummins Authorized Repair Location 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.

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Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.1 Alternator Overcharging with the Engine Running **NOTE:** *If the batteries are overcharged while the engine is not running, troubleshoot the customer supplied battery charging system.*	Batteries have failed.	Check the condition of the batteries. Replace any defective batteries.
	Voltage regulator malfunction.	Test the alternator electrically. Contact a Cummins Authorized Repair Facility. Replace alternator as necessary.
7.1.2 Neither Battery is Charging with the Engine Running **NOTE:** *If one or both batteries do not charge with the engine stopped, troubleshoot the customer supplied battery charging system.* **NOTE:** *If only one battery is maintaining charge, go to Only One Battery is Charging with the Engine Running.*	Battery cables or connections are loose, broken, or corroded (excessive resistance).	Check the battery cables and connections. Ensure that all connections are free of corrosion and that no cables are broken.
	Alternator rotor is not rotating.	Test the alternator mechanically. If the alternator shaft does not spin freely because of a bad bearing, replace the alternator. If the alternator does not turn because of a bad drive belt, replace the drive belt. Refer to Section 6 - Maintenance. If the alternator does not charge because of poor drive belt tension, adjust belt tension. Refer to Section 6 - Maintenance. If the alternator pulley spins freely on the shaft because of a broken key, replace the alternator. Contact a Cummins Authorized Repair Facility.
	Battery isolator input has faulted.	Test continuity from the alternator to the battery isolator input. Repair any open circuit. Test continuity through the battery isolator. If an internal open circuit exists, replace battery isolator.
	Alternator excitation is lost.	Test the alternator electrically. Replace the alternator diode as necessary. Locate and repair the open circuit or short to ground in the alternator excitation wiring as necessary.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.2 Neither Battery is Charging with the Engine Running (continued)	Alternator internal voltage regulator is malfunctioning.	Test the alternator electrically. If required, replace the alternator. Contact a Cummins Authorized Repair Facility.
7.1.3 Only One Battery is Charging with the Engine Running **NOTE:** *If one or both batteries do not charge with the engine stopped, troubleshoot the customer supplied battery charging system.* **NOTE:** *If neither battery is maintaining charge, go to Neither Battery is Charging with the Engine Running.*	Battery has failed. Battery cables or connections are loose, broken, or corroded (excessive resistance). Battery isolator has failed.	Check battery charge. Check the battery cables and connections. Ensure connections are clean and that no cables are broken. Replace the battery isolator.
7.1.4 Voltage Indications Differ **NOTE:** *The two voltmeters may differ slightly due to calibration differences between the meters. Normal differences in battery condition may also cause differences in indication. These are normal differences and require no action.*	Voltmeter is providing false indication. One battery is discharged or failing. Open circuit or short to ground in indicator wiring. Voltmeter has failed.	Check wiring for corrosion. Ensure good electrical contact. Check battery condition. Replace failing battery elements. Charge discharged batteries by running the engine or with an external battery charger. If the battery does not charge with the engine running, go to Only One Battery is Charging with the Engine Running. Check for apparent wire damage or shorts to grounds. Replace the failed fuse. Locate and repair the electrical fault. Remove wiring at the voltmeter and apply test voltage. Replace the faulted voltmeter as necessary.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.5 Coolant Contamination	Coolant is rusty or contaminated.	Drain and flush the cooling system per the instructions in Section 6 - Maintenance. Replace the coolant filter per the instructions in Section 6 - Maintenance. Refill with correct mixture of antifreeze and water per the instructions in Section 6 - Maintenance.
	Heat exchanger is leaking raw water into the coolant. Coolant volume increases and pressure is relieved when the unit is operating. Antifreeze concentration decreases.	Drain and flush the cooling system per the instructions in Section 6 - Maintenance. Perform a pressure test of the raw water side of the heat exchanger. If the heat exchanger leaks, it should be replaced. Check and adjust raw water pressure regulator set points. Refill with correct mixture of antifreeze and water per the instructions in Section 6 - Maintenance.
7.1.6 Excessive Coolant Loss	Adequate coolant was not added following previous maintenance activities.	Check the coolant level. Add coolant as required and check engine operation. If coolant loss persists, check for other problems.
	Coolant leak is present.	Inspect the engine for coolant leaking from drain cocks or vents. Close the leaking drain or vent. Add coolant as required and check engine operation.
	Cooling system hose is leaking.	Check the condition of the hoses. Replace and/or tighten loose hose clamps. Replace any damaged hoses as necessary. Add coolant as required and check engine operation.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.6 Excessive Coolant Loss (continued)	Pressure cap is malfunctioning or has low-pressure rating.	Check that the pressure/fill cap does not relieve coolant under normal operating conditions. Replace a leaking pressure cap. Add coolant as required and check engine operation.
	Manifold coolant leak.	Inspect the engine for coolant leaking from the manifold, expansion and pipe plugs, fittings, oil cooler, coolant pump seal, cylinder block, and other components that have coolant flow. Repair leaking components. Add coolant as required and check engine operation.
7.1.7 Coolant Temperature Above Normal **NOTE:** *The thermostat's normal operating temperature range is 82-95° C (180-203° F) The high coolant temperature lamp is on the operator control panel. The lamp only illuminates if the engine is running. If the lamp is illuminated or if temperature is otherwise excessive, the engine should be stopped as soon as practical and the problem corrected.*	Raw water flow valves are improperly aligned.	Check that the raw water valves are aligned for normal flow through the solenoid valve (preferred) or bypass flow around the solenoid valve (alternative). Align flow valves if required.
	Raw water pressure regulator is improperly adjusted. **NOTE:** *Pressure should not exceed 414 kPa (60 psi).*	Check the raw water pressure gauge. If pressure is indicated but is low, adjust the regulator. If pressure is not indicated or is excessively low, go to Raw Water Solenoid Valve Fails to Operate. If pressure is excessively low when aligned for bypass flow, open the normal valves.
		Check the raw water strainer for blockage per the instructions in Section 6 - Maintenance. Clean the strainer if necessary.
		Check the raw water piping for blockage. Clean the piping if necessary.
	Raw water solenoid has failed. (Applicable to horizontal pump installations only.)	Replace the solenoid.
	Raw water piping or heat exchanger is plugged.	Remove any blockage. Check for flow through the heat exchanger. Replace the heat exchanger as necessary.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.7 Coolant Temperature Above Normal (continued)	Coolant level is low.	Refill to proper coolant level per instructions.
	Cooling system hose is collapsed, restricted, or leaking.	Inspect the hoses. Replace any damaged hoses as necessary.
	Coolant thermostat is malfunctioning.	Remove and test the coolant thermostat per the instructions in Section 6 - Maintenance. Replace the defective thermostat.
	Coolant pump is malfunctioning.	Contact a Cummins Authorized Repair Facility.
	Engine oil is contaminated with coolant or fuel.	Check the appearance of the engine oil. If the color and texture is abnormal, refer to the Engine Oil is Contaminated in this section.
	Coolant mixture of antifreeze and water is not correct.	Verify the concentration of antifreeze in the coolant. Add antifreeze or water to correct the concentration.
	Engine oil level is above or below specification.	Check the oil level per the instructions in Section 6 - Maintenance.
	Coolant temperature sender is malfunctioning.	Replace the temperature sender as necessary.
	Coolant temperature gauge is malfunctioning.	Replace the temperature gauge as necessary.
	Coolant temperature switch is malfunctioning.	Remove the temperature switch. Test the temperature switch. Repair or replace the switch, if necessary.
7.1.8 Coolant Temperature Below Normal when Engine is not Running	The standard 120 VAC or optional 240 VAC power supply to the coolant heater is not connected.	Connect the power supply. Correct any electrical faults in the supply circuit.
	The heater's overload thermostat has operated.	Ensure that there is coolant in the heater. Allow time for the automatic overload reset to occur.
	Coolant temperature sender is malfunctioning.	Replace the temperature sender.
	Coolant temperature gauge is malfunctioning.	Replace the temperature gauge.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.8 Coolant Temperature Below Normal when Engine is not Running (continued)	Coolant is not free to circulate through the heater.	Ensure that the coolant hoses are clear. Repair or replace hoses as necessary.
	The coolant heater has failed.	Replace the coolant heater.
	Coolant thermostat has failed.	Test operation of the thermostat. Replace the thermostat per instructions in Section 6 - Maintenance as necessary.
7.1.9 Raw Water Drain Steaming **NOTE:** *The raw water drain from the coolant heat exchanger may steam if raw water flow is inadequate when the engine is running. It may also steam shortly after the engine is stopped. If coolant is leaking into the raw water drain piping, the steaming may last for some time while the engine cools. Antifreeze may also be observed in the raw water drain.*	Raw water flow did not start when the engine started.	Check engine coolant temperature. Go to, Coolant Temperature Above Normal in this section.
	Engine coolant is leaking into the raw water piping in the coolant heat exchanger.	Remove the coolant heat exchanger and perform a pressure test. Refer to Section 6 - Maintenance. If pressure is not maintained, replace the heat exchanger.
	Raw water flow not adequate.	Compare actual flow rate against required flow rate - adjust regulators to required flow.
7.1.10 Raw Water Solenoid Valve Fails to Operate (Applicable to Horizontal Pump Installations Only) **NOTE:** *The raw water solenoid may fail to open or to close. The normally closed valve may fail to open when the engine starts. This fault will prevent raw water flow through the normal valves. Bypass flow should be aligned in this event. The valve may also fail to close because of mechanical blockage. In this event, the raw water flow from the heat exchanger does not stop when it should. Depending upon the fire protection system piping, the open solenoid valve may drain all water from the fire protection system piping that is higher than the engine's piping.*	Solenoid valve fails to operate.	Clean the raw water strainer more frequently. Check electrical continuity and insulation from ground to the solenoid. Repair any open or short circuits in the wiring. Apply temporary voltage to the solenoid. If the solenoid fails to operate, replace the solenoid valve. Contact a Cummins Authorized Repair Facility.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.11 Auto Start Failure - Does not Crank on Battery A or B	The electrical connection from the fire protection system controller to terminal board has failed.	Test continuity and insulation from ground between the fire protection system controller and the operator control panel. Locate and repair any electrical fault in the field wiring or in the fire protection system controller panel.
	The electrical connection from terminal board to solenoid has failed.	Test continuity and insulation from ground between the terminal board and the solenoid. Locate and repair any electrical fault.
	Solenoid has failed.	Check de-energized continuity at the solenoid. Replace the solenoid if the circuit is open. Contact a Cummins Authorized Repair Facility.
	The fire protection system controller fails to produce either redundant start signal to the fire pump.	Locate and correct the common mode fault in the fire protection system controller.
7.1.12 Auto Start Failure - Cranks but does not Start **NOTE:** *The fire pump engine will crank automatically when either contactor A or contactor B is selected at the fire protection system controller. However, the engine does not start. The engine will start locally. If local starting problems are identified, go to the applicable Manual Start Failure troubleshooting table.*	The overspeed switch has activated. The overspeed lamp is illuminated on the operator control panel.	Press the RESET switch on the operator control panel. Replace the switch or repair other electrical faults as necessary. When done, close the circuit breaker at the operator control panel.
	The overspeed switch has failed. **NOTE:** *Check system basics* *- Battery voltage level* *- Fuel supply* *- Crank speed* *Reference base engine T/R manual.*	Check power and grounding to the overspeed switch. Repair any electrical faults. Test and adjust the overspeed setting. Refer to Overspeed Set Point Adjustment in Section 6 - Maintenance. Replace switch as necessary.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.13 Auto Start Failure - Engine Starts but Crank Termination does not Occur	The overspeed switch is not correctly adjusted or has failed.	With the engine running, verify speed sensor input to the overspeed switch. Adjust the overspeed switch crank termination set point. Replace the overspeed switch as necessary.
	The speed sensor has failed. The tachometer indicates zero RPM.	Locate and repair any electrical fault in the speed sensor circuitry. Replace the speed sensor as necessary.
	An electrical fault is present between operator control panel and the fire protection system controller.	Test continuity and insulation from ground between the fire protection system controller and the operator control panel. Locate and repair any electrical fault in the field wiring.
7.1.14 Manual Start Failure from Contactor Lever - Does not Crank on A or B **NOTE:** *The fire pump engine will not crank locally when either contactor lever is actuated.*	Crank battery A and B contactors failed to make contact.	Replace the faulty contactor as necessary.
	Both batteries dead or not connected.	Charge or replace batteries.
	Starter motor has failed.	Replace the starter motor.
	Engine is seized.	Contact a Cummins Authorized Repair Facility.
7.1.15 Manual Start Failure from Control Panel - Does not Crank on A or B **NOTE:** *The fire pump engine will not crank locally from the control panel when either CRANK BATT A or CRANK BATT B is selected, however, it does start when a contactor lever is actuated.*	The AUTO/MANUAL mode switch contact fails to close.	Test the electrical operation of the AUTO/MANUAL mode switch. Replace the faulty switch as necessary.
	An electrical fault exists in the signal power circuit or the ground to the solenoids.	Test continuity and insulation from ground between the AUTO/MANUAL mode switch and the solenoids. Check the solenoid connection to ground. Locate and repair any electrical fault.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.15 Manual Start Failure from Control Panel - Does not Crank on A or B (continued)	An electrical fault exists in the signal power circuit or the ground to the overspeed switch's crank circuit.	Test continuity and insulation from ground between breaker and the overspeed switch's crank circuit. Check the crank circuit output to the crank battery switches. Locate and repair any electrical fault.
	Overspeed switch crank circuit fails to reset with engine shutdown.	Test and adjust the crank setting as necessary. Refer to Overspeed Set Point Adjustment in Section 6 - Maintenance. Replace the overspeed switch as necessary.
7.1.16 Engine Cranks Normally but will not Start (No Exhaust Smoke)	No fuel in supply tank.	Check and replenish fuel supply. Check fittings, hose connections, and hose conditions.
	Air is in the fuel system.	Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel tank stand pipe, and fuel filters as necessary. Vent air from the system.
	Fuel drain line is restricted.	Check the fuel drain lines for restriction. Clear or replace the fuel lines, check valves, or tank vents as necessary.
	Fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filter in Section 6 - Maintenance.
	Fuel grade is not correct for the application or fuel quality is poor.	Operate the engine from a separate tank of high-quality no. 2 diesel fuel.
	Fuel injection pump is malfunctioning. Pump timing incorrect.	Contact a Cummins Authorized Repair Facility.
	Fuel pump overflow valve is malfunctioning.	Check the overflow valve. Replace if necessary.
	Fuel suction line is restricted.	Check the fuel suction line for restriction.
	Fuel connections on the fuel pump are loose.	Tighten all the fuel fittings and connections between the fuel tanks and fuel pump.
	Fuel suction stand pipe in the fuel tank is broken.	Check and repair the stand pipe, if necessary.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.16 Engine Cranks Normally but will not Start (No Exhaust Smoke) (continued)	Fuel supply is not adequate.	Locate and correct the restriction in the customer supplied fuel lines to the engine.
	Fuel tank air breather is blocked.	Clean the fuel tank breather.
	Fuel pump is malfunctioning.	Check the fuel pump for correct operation. Check the pump output pressure. Replace the fuel pump if necessary.
	Injection pump drive shaft or drive shaft key is damaged.	Repair or replace the injection pump.
	Fuel injectors are plugged.	Replace the fuel injectors.
	Moisture is in the wiring harness connectors.	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.
	Starter motor rotation is not correct or not turning engine.	Check the direction of crankshaft rotation. Replace the starter motor as necessary. Contact a Cummins Authorized Repair Facility.
7.1.17 Engine Cranks Slowly but does not Start **NOTE:** *Typical engine cranking speed is 120 RPM. Engine cranking speed can be checked with a hand-held tachometer, stroboscope, or electronic service tool.*	The battery cable connections are loose, broken, or corroded, creating excessive resistance.	Check the battery cables and connections. Ensure that connections are clean and tight.
	The battery is not properly charged or has failed.	Recharge the battery. If the battery does not take the charge, replace it.
	Engine oil level is too high.	Check the oil level per instructions in Section 6 - Maintenance. Drain any excess oil.
	Engine oil is the wrong grade or type.	Check the grade and type of oil. If the wrong type or grade of oil is present, drain and replace it. Refer to Engine Oil and Oil Filter Change in Section 6 - Maintenance.
	Starter motor is malfunctioning.	Replace the starter motor. Contact a Cummins Authorized Repair Facility.
7.1.18 Engine Stops During Operation	Normal automatic mode shutdown occurs when the fire protection system controller removes the signal power feed to the local control panel.	No action required. This is a desirable outcome.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.18 Engine Stops During Operation (continued)	In AUTO mode, the signal power feed is lost from the fire protection system controller to the operator control panel.	Locate and correct the electrical fault in the fire protection system controller or the field wiring to the operator control panel.
	An overspeed trip has occurred. The overspeed trip lamp is illuminated on the operator control panel.	Remote indications may also be present. Overspeed switch failure has occurred. The trip indications may not be present. Go to Engine Overspeed Trip in this section.
	Fuel tank level is low.	Fill the fuel tank. Fill and bleed the fuel lines to the engine.
	Clogged fuel tank air breather hole.	Clean the fuel tank breather.
	Fuel piping to engine is clogged.	Clean and repair engine fuel piping.
	The fuel filter is clogged.	Replace the fuel filter. Refer to Change Fuel Filters in Section 6 - Maintenance.
	Air is trapped in the low pressure fuel lines at the engine.	Bleed the fuel lines.
	Fuel pump has failed.	Check the fuel pump for correct operation. Check the pump output pressure. Replace the fuel pump if necessary. Contact a Cummins Authorized Repair Facility.
7.1.19 Engine will not Reach Rated Speed (RPM)	Tachometer is not calibrated. Compare the tachometer reading with a hand held tachometer or an electronic service tool reading.	If out of calibration, calibrate the tachometer as necessary at the CAL adjustment on the back of the gauge. Refer to the vendor supplied literature for additional information. If the tachometer is malfunctioning, replace the tachometer. Contact a Cummins Authorized Repair Facility.
	Fuel filter requires replacement.	Refer to Change Fuel Filters per the instructions in Section 6 - Maintenance.
	Fuel grade not correct for the application, or fuel quality is poor.	Operate the engine with a good quality no. 2 diesel fuel.
	Fuel suction line is restricted.	Check the fuel suction line for restriction.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.19 Engine will not Reach Rated Speed (RPM) (continued)	Low Temperature Aftercooler (LTA) heat exchanger is restricted.	Inspect each Low Temperature Aftercooler (LTA) heat exchanger for internal and external restrictions. Replace the restricted cooler if necessary.
	Fuel supply is not adequate.	Locate and correct any restriction in the fuel lines to the engine.
	Stop circuit malfunction in the fire pump controller or field wiring.	In AUTO mode operation, the fire pump engine stops upon loss of signal power from the fire pump controller. Check stop circuit in fire pump controller.
7.1.20 Engine will not Shut Off Remotely	Stop circuit malfunction in the fire pump controller or field wiring.	Check for short to voltage on the signal wiring from the fire pump controller to the engine control panel. Correct any faults. Check operation of the switch contacts of the AUTO/MANUAL mode switch at the operator control panel. Replace the switch if the switch contacts fail to operate properly.
	Engine running on fumes drawn into the air intake.	Identify and isolate the source of the combustible fumes. Contact a Cummins Authorized Repair Facility.
7.1.21 Engine will not Shut Off Locally	Power source has not been removed by the fire pump controller.	In MANUAL mode operation, the fire pump engine stops when the AUTO/MANUAL mode switch is returned to the AUTO mode.
		Check for inadvertent voltage on the wiring to terminal board at the operator control panel.
	Engine running on fumes drawn into the air intake.	Identify and isolate the source of the combustible fumes.
7.1.22 Fuel Consumption is Excessive	Fuel is leaking.	Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Repair any leaks.
	Poor-quality fuel is being used.	Assure good-quality no. 2 diesel fuel is being used.
	Defective or clogged injection nozzle.	Replace the defective or clogged injection nozzle.
	Incorrect injection timing.	Adjust injection timing.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.22 Fuel Consumption is Excessive (continued)	Injection pump is adjusted incorrectly, causing excessive injection.	Adjust or replace the injection pump.
	Air intake or exhaust leaks.	Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Repair any leaks.
	Air intake system restriction is above specification.	Check the air intake system for restriction. Refer to Air Cleaner Filter and Piping in Section 6 - Maintenance. Replace the air filter as necessary.
7.1.23 Fuel or Engine Oil Leaking from Exhaust Manifold	Intake air restriction is high.	Check the air intake system for restriction. Refer to Air Cleaner Filter and Piping in Section 6 - Maintenance. Replace the air filter if required.
	Turbocharger drain line is restricted.	Contact a Cummins Authorized Repair Facility.
	Turbocharger oil seal is leaking.	Contact a Cummins Authorized Repair Facility.
7.1.24 Engine Oil is Contaminated	Bulk oil supply is contaminated.	Check the oil supply. Replace it as necessary. Drain the oil and replace with non-contaminated oil. Also, replace the oil filter. Refer to Engine Oil and Oil Filter Change in Section 6 - Maintenance.
	Fuel is present in the engine oil.	Contact a Cummins Authorized Repair Facility.
	Coolant is present in the engine oil.	Contact a Cummins Authorized Repair Facility.
	Metal is present in the engine oil.	Contact a Cummins Authorized Repair Facility.
7.1.25 Engine Oil Consumption is Excessive	Verify the oil consumption rate.	Check the amount of oil added versus the operating hours.
	Engine crankcase overfilled.	Remove excess oil and recalibrate dipstick.
	External engine leak is present.	Inspect the engine and its components for seal, gasket, tappet cover, oil cooler, or drain cock leaks. Repair or correct any leaks.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.25 Engine Oil Consumption is Excessive (continued)	Crankcase ventilation system is plugged.	Check and clean the crankcase ventilation hose per the instructions in Section 6 - Maintenance.
	Turbocharger oil seal is leaking.	Contact a Cummins Authorized Repair Facility.
	Engine oil does not meet specifications for operating conditions.	Change the oil and filters per the instructions in Section 6 - Maintenance.
	Engine oil drain interval is excessive.	Verify the correct engine oil drain interval. Refer to Engine Oil and Oil Filter Change in Section 6 - Maintenance.
	Piston, cylinder liner, or piston rings are worn or damaged.	Contact a Cummins Authorized Repair Facility.
	Piston rings are not seated correctly (after an engine rebuild or piston installation).	Contact a Cummins Authorized Repair Facility.
7.1.26 Lubrication Oil in the Coolant	Bulk coolant supply is contaminated.	Check the coolant expansion tank per the instructions in Section 6 - Maintenance. Drain the coolant and replace with non-contaminated coolant. Replace the coolant filter. Refer to Drain and Flush Cooling System in Section 6 - Maintenance.
	Cylinder head gasket is damaged or leaking.	Contact a Cummins Authorized Repair Facility.
	Cylinder head is cracked or porous.	Contact a Cummins Authorized Repair Facility.
	Cylinder block is cracked or porous.	Contact a Cummins Authorized Repair Facility.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.27 Engine Overspeed Trip **NOTE:** *An engine overspeed trip occurs when the engine's speed exceeds the value specified on the factory setting tag described in Section 2 - Description. The trip isolates the fuel supply to the engine and it stops immediately. The trip is indicated on the local control panel. Additionally, a trip output is supplied to the fire protection system controller for remote display.*	Engine operated at too great a speed due to catastrophic load failure such as pipe break, pump mechanical failure, or loss of suction.	Correct the cause of the load failure. Contact a Cummins Authorized Repair Facility.
	Engine operated at too great a speed due to configuration error.	Check rated speed setting as specified on the factory setting tag. Refer to Overspeed Set Point Adjustment in Section 6 - Maintenance.
	Overspeed switch is set at too low a set point.	Check overspeed speed setting as specified on the factory setting tag. Refer to Overspeed Set Point Adjustment in Section 6 - Maintenance.
	Speed switch wiring failure has occurred.	Check continuity and insulation from ground for the signal power wiring and ground wiring to the speed switch. Replace defective components and repair electrical faults.
	Speed switch failure has occurred.	If the speed switch fails to operate as per Overspeed Set Point Adjustment in Section 6 - Maintenance, replace the speed switch. Contact a Cummins Authorized Repair Facility.
7.1.28 Tachometer does not Indicate Engine Speed	An electrical fault exists in the tachometer power and grounding circuits.	Check continuity and insulation from ground for the power wiring and ground wiring to the tachometer. Replace defective components and repair electrical faults. Contact a Cummins Authorized Repair Facility.

Troubleshooting Chart (Continued)

PROBLEM	POSSIBLE CAUSE	SOLUTION
7.1.28 Tachometer does not Indicate Engine Speed (continued)	An electrical fault exists in the speed sensor input circuit.	This fault may also cause a failure in the crank termination signal to the fire protection system controller. Check continuity and insulation from ground for the speed sensor circuit. Replace defective components and repair electrical faults. Contact a Cummins Authorized Repair Facility.
	The speed sensor has failed.	With the engine running, check the signal from the speed sensor with an oscilloscope or pulse counter. Replace the speed sensor if it has failed. Contact a Cummins Authorized Repair Facility.
	The tachometer has failed.	Check the operation of the tachometer with a pulse generator. Replace the tachometer if it has failed. Contact a Cummins Authorized Repair Facility.

Section 8 - Component Parts and Assemblies

8.1 Part Ordering Information

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.

PART REQUESTS REQUIRE:

1. Model and serial number.
2. Part description by name or number.
3. Quantity required.
4. 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 NPower Inc. and its customer track the parts and necessary credits.*

8.2 Routine Service and Parts

Personnel at Cummins Authorized Repair Locations can assist you with the correct operation and service of your engine. Cummins has a worldwide service network of more than 5,000 Distributors and Dealers who have been trained to provide sound advice, expert service, and complete parts support.

Check the telephone directory yellow pages or refer to the directory in this section for the nearest Cummins Authorized Repair Location.

8.3 Emergency Repairs and Technical Service

The Cummins Customer Assistance Center provides a 24-hour, toll free telephone number to aid in technical and emergency service when a Cummins Authorized Repair Location can not be reached or is unable to resolve an issue with a Cummins product.

If assistance is required, call Toll-Free: 1-800-DIESELS (1-800-343-7357). Includes all 50 states, Bermuda, Puerto Rico, Virgin Islands, and the Bahamas.

Outside of North America contact your Regional Office. Telephone numbers and addresses are listed in the International Directory.

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

8.4 Recommended Spares Inventory

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

Engine Data Sheet

Cummins Fire Power	**Engine Data Sheet**	**Drawing No. 16460**	Basic Engine Model
	Cummins Fire Power	**Rev. 0**	**CFP50-F10, F20, F30, F40**
	De Pere, WI 54115		Curve Number: **FR - 6295**
	http://www.cumminsfirepower.com		CPL Code: **2533**
Configuration Number: **D283002DX02**			Engine Family: **G Drive**
Installation Drawing: **17001 or 17002 REF**			Revision Date: **June 2010**

General Engine Data

Type	4 Cycle; Vee; 16 Cylinder	
Aspiration	Turbocharged, 2P2L, Aftercooled	
Bore & Stroke - in. (mm)	6.25 x 6.25	(159 x 159)
Displacement - in.^{3} (litre)	3067	(50.3)
Compression Ratio	16.0:1	
Valves per Cylinder - Intake	2	
- Exhaust	2	
Dry Weight - lb (kg)	15958	(7181)
Wet Weight - lb (kg)	16623	(7480)
Maximum Allowable Bending Moment @ Rear Face of Block - lb.-ft. (N-m)	2000	(2712)

Air Induction System

Max. Temperature Rise Between Ambient Air and Engine Air Inlet - °F (°C)	30	(16.7)
Maximum Inlet Restriction with Dirty Filter - in. H_2O (mm H_2O)	25	(635)
Recommended Air Cleaner Element - (Standard)	Cummins Filtration (Fleetguard)	(2) AF25278

Lubrication System

Oil Pressure Range at Rated - PSI (kPa)	50-70	(345-483)
Oil Capacity of Pan (High - Low) - U.S. Gal. (litre)	40-32	(151-121)
Total System Capacity - U.S. Gal. (litre)	47	(177.9)
Recommended Lube Oil Filter	Cummins Filtration (Fleetguard)	(5) LF9325

Cooling System

Raw Water Working Pressure Range at Heat Exchanger - PSI (kPa)	60	(413) MAX
Recommended Min. Water Supply Pipe Size to Heat Exchanger - in. (mm)	2.50	(63.50)
Recommended Min. Water Discharge. Pipe Size From Heat Exchanger - in. (mm)	3.00	(76.20)
Coolant Water Capacity (Engine Side) - U.S. Gal. (litre)	76.5	(289.6)
Standard Thermostat - Type	Modulating	
- Range - deg F (deg C)	180-200	(82.2-93.3)
Normal Operating Temperature - °F (°C)	180-212	(82-100)
Minimum Raw Water Flow		
with Water Temperatures to 50 °F (10 °C) - U.S. GPM (litre/s)	70	(4.42)
with Water Temperatures to 75 °F (24 °C) - U.S. GPM (litre/s)	85	(5.36)
with Water Temperatures to 90 °F (32 °C) - U.S. GPM (litre/s)	100	(6.31)
Recommended Cooling Water Filter	Cummins Filtration (Fleetguard)	(2) WF2076

A jacket water heater is mandatory on this engine. The recommended heater wattage is (2) 4000 down to 40F (4C).

Exhaust System

Max. Back Pressure Imposed by Complete Exhaust System in in. H_2O (kPa)	27.2	(6.8)
Exhaust Pipe Size Normally Acceptable - in. (mm)	12.0	(305)

Noise Emissions

Top	100 dBa
Right Side	98 dBa
Left Side	98 dBa
Front	98 dBa
Exhaust	130 dBa

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

Engine Data Sheet (Continued)

Fuel Supply / Drain System	**1760**	**1800**
CFP50-F40 Nominal Fuel Consumption - Gal./hr. (L/hr)	93.2 (352.9)	94.9 (359.4)
CFP50-F30 Nominal Fuel Consumption - Gal./hr. (L/hr)	86.7 (328.2)	88.3 (334.2)
CFP50-F20 Nominal Fuel Consumption - Gal./hr. (L/hr)	81.6 (309.1)	83.1 (314.7)
CFP50-F10 Nominal Fuel Consumption - Gal./hr. (L/hr)	75.7 (286.4)	77.0 (291.5)
Fuel Type	Number 2 Diesel Only	
Minimum Supply Line Size - in. (mm)	1.50	(38.10)
Minimum Drain Line Size - in. (mm)	1.00	(25.40)
Maximum Fuel Line Length Between Supply Tank & Fuel Pump - ft. (m)	40	(12)
Maximum Fuel Height above C/L Crankshaft - in. (mm)	84	(2134)
Recommended Fuel Filter - Primary ..... Cummins Filtration (Fleetguard)	(2) FS1006	
- Secondary	None	
Maximum Restriction @ Lift Pump-Inlet - With Clean Filter - in. Hg (mm Hg)	4.0	(102)
Maximum Restriction @ Lift Pump-Inlet - With Dirty Filter - in. Hg (mm Hg)	8.0	(203)
Maximum Return Line Restriction - Without Check Valves - in. Hg (mm Hg)	6.5	(165)
Minimum Fuel Tank Vent Capability - ft^3/hr (m^3/hr)	15	(0.45)
Maximum Fuel Temperature @ Lift Pump Inlet - °F (°C)	160	(71)

Starting and Electrical System	**12V**	**24V**
Min. Recommended Battery. Capacity - Cold Soak at 0°F (-18°C) or Above		
Engine Only - Cold Cranking Amperes - (CCA)	12 volt	1800
Engine Only - Reserve Capacity - Minutes	option is	460
Battery Cable Size (Maximum Cable Length Not to Exceed 5 ft. [1.5 m] AWG)	not	2/0
Maximum Resistance of Starting Circuit - Ohms	offered	0.002
Typical Cranking Speed - RPM		120
Alternator (Standard), Internally Regulated - Ampere		35
Wiring for Automatic Starting (Negative Ground)	Standard	
Reference Wiring Diagram	10423	

Performance Data

All data is based on the engine operating with fuel system, water pump, lubricating oil pump, air cleaner, and alternator not included are compressor, fan, optional equipment, and driven components. Data is based on operation at SAE standard J1394 conditions of 300 ft. (91.4 m) altitude, 29.61 in. (752 mm) Hg dry barometer, and 77°F (25 °C) intake air temperature, using No.2 diesel or a fuel corresponding to ASTM-D2.

Altitude Above Which Output Should be Limited - ft. (m)	300	(91.4)
Correction Factor per 1000 ft. (305 m) above Altitude Limit	3%	
Temperature Above Which Output Should be Limited - °F (°C)	77	(25)
Correction Factor per 10 °F (11 °C) Above Temperature Limit	1%	(2%)

Exhaust Emissions (EPA/CARB Tier T2)	**g/kW-hr**	**g/BHP-hr**
Hydrocarbons (HC/OMHCE)	1.30	0.97
Oxides of Nitrogen (NOx)	9.20	6.86
Non-Methane Hydrocarbons + NOx (NMHC+NOx)		
Carbon Monoxide (CO)	11.40	8.50
Particulate	0.54	0.40

Engine Data Sheet (Continued)

Ratings for CFP50-F10, F20, F30, F40

Engine Speed - RPM	**1760**	**1800**
CFP50-F40 Output - BHP (kW)	**1982 (1,478)**	**2018 (1,505)**
Ventilation Air Required for Combustion - CFM (litre/sec)	4100 (1,935)	4400 (2,077)
Exhaust Gas Flow - CFM (litre/sec)	9600 (4,531)	10650 (5,027)
Exhaust Gas Temperature - °F (°C)	920 (493)	960 (516)
Engine Heat Rejection to Coolant- BTU/min. (kW)	59500 (1,046)	60100 (1,056)
Engine Heat Rejection to Ambient - BTU/min. (kW)	10950 (192)	11220 (197)
CFP50-F30 Output - BHP (kW)	**1843 (1,374)**	**1877 (1,400)**
Ventilation Air Required for Combustion - CFM (litre/sec)	3814 (1,800)	4093 (1,932)
Exhaust Gas Flow - CFM (litre/sec)	8929 (4,215)	9906 (4,676)
Exhaust Gas Temperature - °F (°C)	856 (458)	893 (478)
Engine Heat Rejection to Coolant- BTU/min. (kW)	55343 (973)	55901 (982)
Engine Heat Rejection to Ambient - BTU/min. (kW)	10185 (179)	10436 (183)
CFP50-F20 Output - BHP (kW)	**1705 (1,271)**	**1736 (1,295)**
Ventilation Air Required for Combustion - CFM (litre/sec)	3484 (1,644)	3739 (1,765)
Exhaust Gas Flow - CFM (litre/sec)	8158 (3,850)	9050 (4,272)
Exhaust Gas Temperature - °F (°C)	782 (417)	816 (435)
Engine Heat Rejection to Coolant- BTU/min. (kW)	50561 (889)	51071 (897)
Engine Heat Rejection to Ambient - BTU/min. (kW)	9305 (164)	9534 (168)
CFP50-F10 Output - BHP (kW)	**1566 (1,168)**	**1594 (1,189)**
Ventilation Air Required for Combustion - CFM (litre/sec)	3099 (1,463)	3325 (1,570)
Exhaust Gas Flow - CFM (litre/sec)	7255 (3,425)	8049 (3,799)
Exhaust Gas Temperature - °F (°C)	695 (368)	726 (385)
Engine Heat Rejection to Coolant- BTU/min. (kW)	44968 (790)	45421 (798)
Engine Heat Rejection to Ambient - BTU/min. (kW)	8276 (145)	8480 (149)

All Data is Subject to Change Without Notice.

Director of Engineering: Jim Vanden Boogard June 2010

Cummins Fire Power, De Pere, WI 54115 U.S.A.

Torque Table

Cap Screw Markings and Torque Values

CAUTION

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.

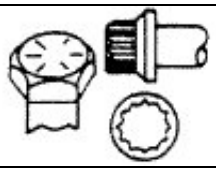
Commercial Steel Class	**8.8**	**10.9**	**12.9**
Caps Screw Head Markings			

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**
	

Torque Table (Continued)

Metric Cap Screw Torque Values (lubricated threads)

Class:	8.8				10.9				12.9			
Diameter	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	13	10	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	23	17	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	65	50	30	25	70	50	30	25
12	80	60	55	40	115	85	55	40	125	95	55	40
14	125	90	90	65	180	133	90	65	195	145	90	65
16	195	140	140	100	280	200	140	100	290	210	140	100
18	280	200	180	135	390	285	180	135	400	290	180	135
20	400	290	—	—	550	400	—	—	—	—	—	—

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

Grade:	SAE Grade 5				SAE Grade 8			
Cap Screw Body Size	Cast Iron		Aluminum		Cast Iron		Aluminum	
	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
1/4-20	9	7	8	6	15	11	8	6
1/4-28	12	9	9	7	18	13	9	7
5/16-18	20	15	16	12	30	22	16	12
5/16-24	23	17	19	14	33	24	19	14
3/8-16	40	30	25	20	55	40	25	20
3/8-24	40	30	35	25	60	45	35	25
7/16-14	60	45	45	35	90	65	45	35
7/16-20	65	50	55	40	95	70	55	40
1/2-13	95	70	75	55	130	95	75	55
1/2-20	100	75	80	60	150	110	80	60
9/16-12	135	100	110	80	190	140	110	80
9/16-18	150	110	115	85	210	155	115	85
5/8-11	180	135	150	110	255	190	150	110
5/8-18	210	155	160	120	290	215	160	120
3/4-10	325	240	255	190	460	340	255	190
3/4-16	365	270	285	210	515	380	285	210
7/8-9	490	360	380	280	745	550	380	280
7/8-14	530	390	420	310	825	610	420	310
1-8	720	530	570	420	1100	820	570	420
1-14	800	590	650	480	1200	890	650	480

Section 8.5 - Assembly Drawings

Description	Drawing No.	Sheet No	Revision Level
Assembly, Power Unit Fire Pump, CFP50, RH	17001	1-2	A
Assembly, Power Unit Fire Pump, CFP50, LH	17002	1-2	A
Options, Engine, Fire Pump, CFP50, RH	16923		A
Options, Engine, Fire Pump, CFP50, LH	16922		A
Assembly, Coolant Heater, CFP50, RH & LH	16399		A
Assembly, Sensors, CFP50, RH & LH	16432		-
Assembly, Expansion Tank & Vents, CFP50, RH & LH	17063		-
Assebmly, Cooling Package, Shell & Tube, CFP50, RH	17057		-
Assebmly, Cooling Package, Shell & Tube, CFP50, LH	17132		-
Assembly, Sea Water Piping, CFP50, RH	17083		-
Assembly, Sea Water Piping, CFP50, LH	17134		-
Assembly, Air Cleaners, CFP50 RH & LH	17072		-
Assembly, Operator Station, CFP50, RH & LH	17087		-
Assembly, Hydraulic Recharge Pump, CFP50, RH & LH	17091		-
Assembly, Front Guards, CFP50, RH & LH	17098		-
Kit, Earth Bonding Wires, CFP50, RH & LH	17107		-
Assembly, Prelube Starters, CFP50, RH	17112		-
Assembly, Prelube Starters, CFP50, LH	17114		-
Assembly, Contactors Manual Start, CFP50, RH & LH	17290	1-2	-
Assembly, Fuel Valve, Power to Close, CFP50, RH & LH	17359		-
Assembly, Breather Vent Filter, CFP50, RH & LH	17438		-
Assembly, Data Tag, CFP50, RH & LH	17803		-
Kit, Panel, Gauge, CFP50, RH & LH	17449	1-3	A
Kit, Panel, Periodic Lube System, CFP50, RH & LH	17441	1-2	-
Kit, Contactors, Manual Start, CFP50, RH & LH	17290	1-2	-
Kit, Harness, CFP50, RH	17555	1-3	-
Kit, Harness, CFP50, LH	17645	1-3	-

The most current revisions to these drawings and related documents are accessible at: http://www.cumminsfirepower.com/products.html.

Section 8.5 - Assembly Drawings

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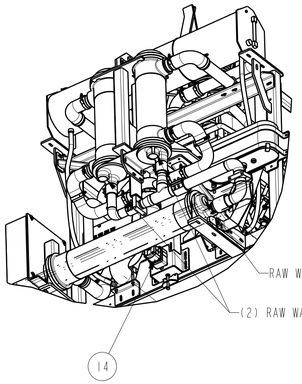
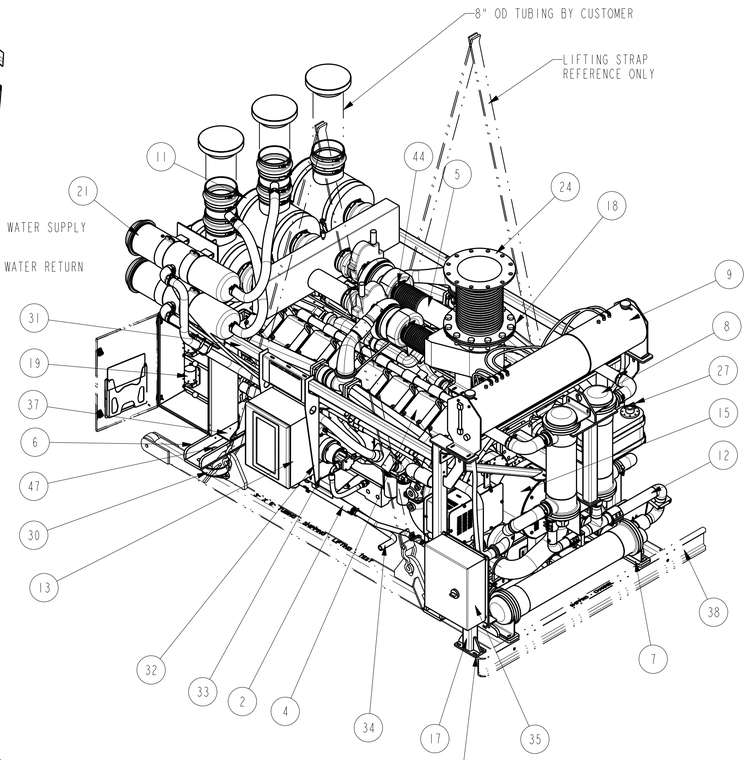
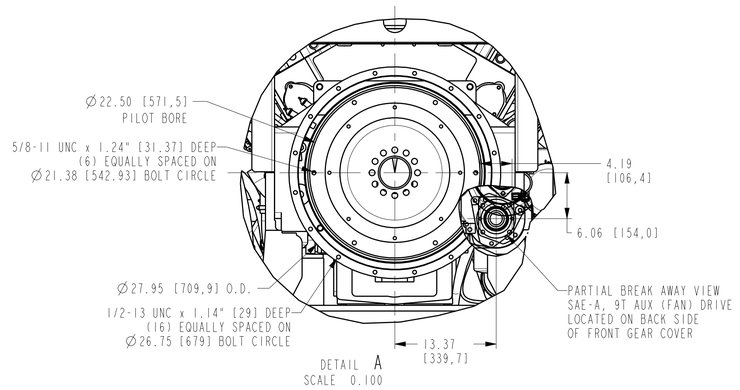
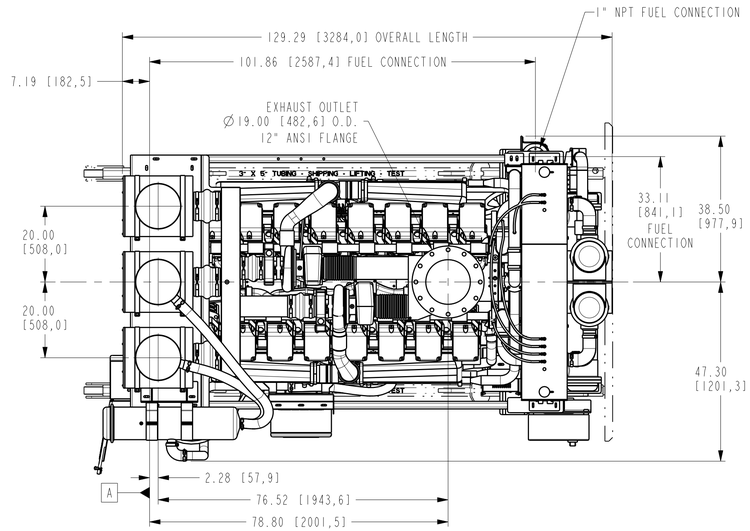




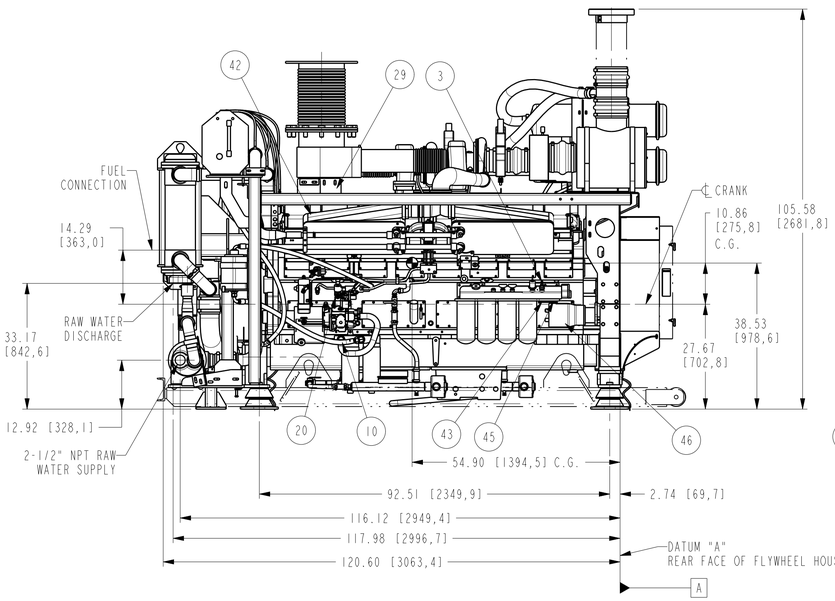
NOTES:
1. NO EXPOSED METAL - FINISH PER ES 042
2. STAINLESS STEEL CABLE TIES REQUIRED
   GRAINGER 2CMT2 (0.31 X 14.3) 2CMR7 (0.18 X 7.9) OR EQUAL
3. HYDRAULIC STARTER INSTALLED - NOT TESTED
4. PRE-LUBE SYSTEM WIRED AND TESTED PRIOR TO SHIPMENT
4. RECHAGRE PUMP BELT FITTED AND REMOVED PRIOR TO TEST

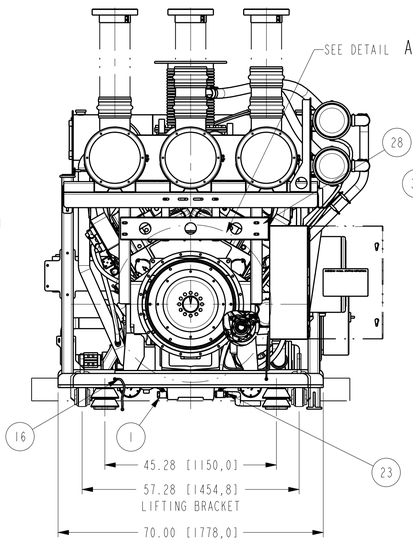


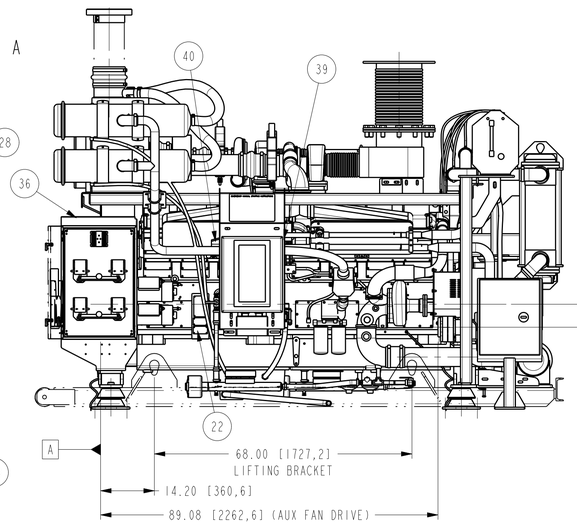


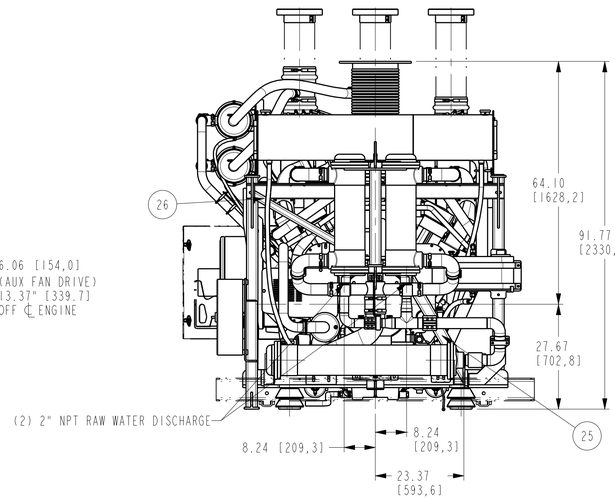
BILL OF MATERIAL

	ITEM	QTY	DESCRIPTION	PART NUMBER
	1	2	VALVE,BL -16 LK HDL, BRASS,NPTFxNPTF	16145-16
	2	1	ASSEMBLY,COOLANT HEATER, CFP50	16399
	3	1	ASSEMBLY, SENSORS, CFP50	16432
	4	1	ENGINE, KTA50-G9, STARTERS RIGHT BANK	16923
	5	1	EXHAUST WYE PIPE, STAINLESS STEEL, CFP50	17044
	6	1	WELDMENT, REAR MOUNT, CFP50	17055
	7	1	WELDMENT, FRONT MOUNT, CFP50	17056
	8	1	ASSEMBLY, COOLING PACKAGE, SHELL & TUBE, CFP50	17057
	9	1	ASSEMBLY, EXPANSION TANK & VENTS, CFP50	17063
	10	1	KIT, FUEL LINE, CFP50	17068
	11	1	ASSEMBLY, AIR CLEANERS, CFP50	17072
	12	1	ASSEMBLY, SEA WATER PIPING, CFP50	17083
	13	1	ASSEMBLY, OPERATORS STATION, CFP50	17087
	14	1	ASSEMBLY, HYDRAULIC RECHARGE PUMP, CFP50	17091
	15	1	ASSEMBLY, FRONT GUARDS, CFP50	17098
	16	1	KIT, EARTH BONDING WIRES, CFP50	17107
	17	1	PRELUBE, STARTERS RIGHT BANK	17112
	18	1	KIT, GASKET & BOLT, 12" SS ANSI	17185
	19	1	CONTACTORS, MANUAL START, CFP50	17290
A	20	1	ASSEMBLY, FUEL VALVE, POWER TO CLOSE, CFP50	17359
	21	1	ASSEMBLY, BREATHER VENT FILTER, CFP50	17438
A	22	1	ASSEMBLY, DATA TAG, CFP50	17803
	23	1	FTG, STR, -1.0 BEADx-1.0 NPT	12545-16-16
	24	1	FLEX PIPE, 12" SS ANSI FLANGE, CFP50	17045
	25	1	BRACKET, FRONT MOUNT STABILIZER, CFP50	17066
	26	1	BRACKET, EXPANSION TANK STABILIZER, CFP50	17067
	27	1	BRACKET, FUEL BREAK TANK, CFP50	17069
	28	1	CHANNEL, PANEL MOUINTING, CFP50	17076
	29	2	BRACKET, FORMED	17080
	30	2	ISOLATOR, REAR, CFP50	17081
	31	2	BRACKET, OPERATOR PANEL, CFP50	17088
	32	1	BRACKET, OPERATOR PANEL MOUNTING, CFP50	17089
	33	1	STAND OFF, OPERATOR PANEL, CFP50	17090
	34	1	HOSE, 80242GL, 1.00" ID X 48" LG	17096
	35	2	ISOLATOR, FRONT, CFP50	17105
	36	1	BRACKET, CONTACTOR PANEL	17121
	37	1	BRACKET, CONTACTOR PANEL	17122
	38	1	CHANNEL, SHIPPING, C6 X 10.5#	17170
	39	1	BRACE, OPERATORS STATION, RH, CFP50	17231
	40	1	BRACE, OPERATORS STATION, RH, CFP50	17232
A	41	2	SCREW, SHCS, 3/4-10 X 2.25	206028
A	42	2	BRACKET, CAST IRON	3051793
A	43	1	PLATE, COVER, CUMMINS OIL FILTER	3626803
A	44	2	V-BAND, 6"	3626944
A	45	1	GASKET, COVER, CUMMINS OIL FILTER	3626965
	46	1	STARTER, HYDRAULIC, CFP50	BY OTHERS
	47	4	BOLT, SS, M24	M24-BOLT,50









REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE
A	2010-462	ADDED GATA TAG. ITEMS RELOCATED FROM ENGINE ASSEMBLY	DAN	11-OCT-10

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE
ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS
THIRD ANGLE PROJECTION

MOVING TOLERANCES	MOVING TOLERANCES	FIXED TOLERANCES
.xx ± 0.030	.x ± 0.03	.xx ± 0.030
.xxx ± 0.005	.xx ± 0.005	.xxx ± 0.005
FIXED TOLERANCES	FIXED TOLERANCES	MOVING TOLERANCES
.x ± 0.060	.x ± 0.06	.x ± 0.060
.xx ± 0.030	.xx ± 0.03	.xx ± 0.030
.xxx ± 0.010	.xxx ± 0.010	.xxx ± 0.010

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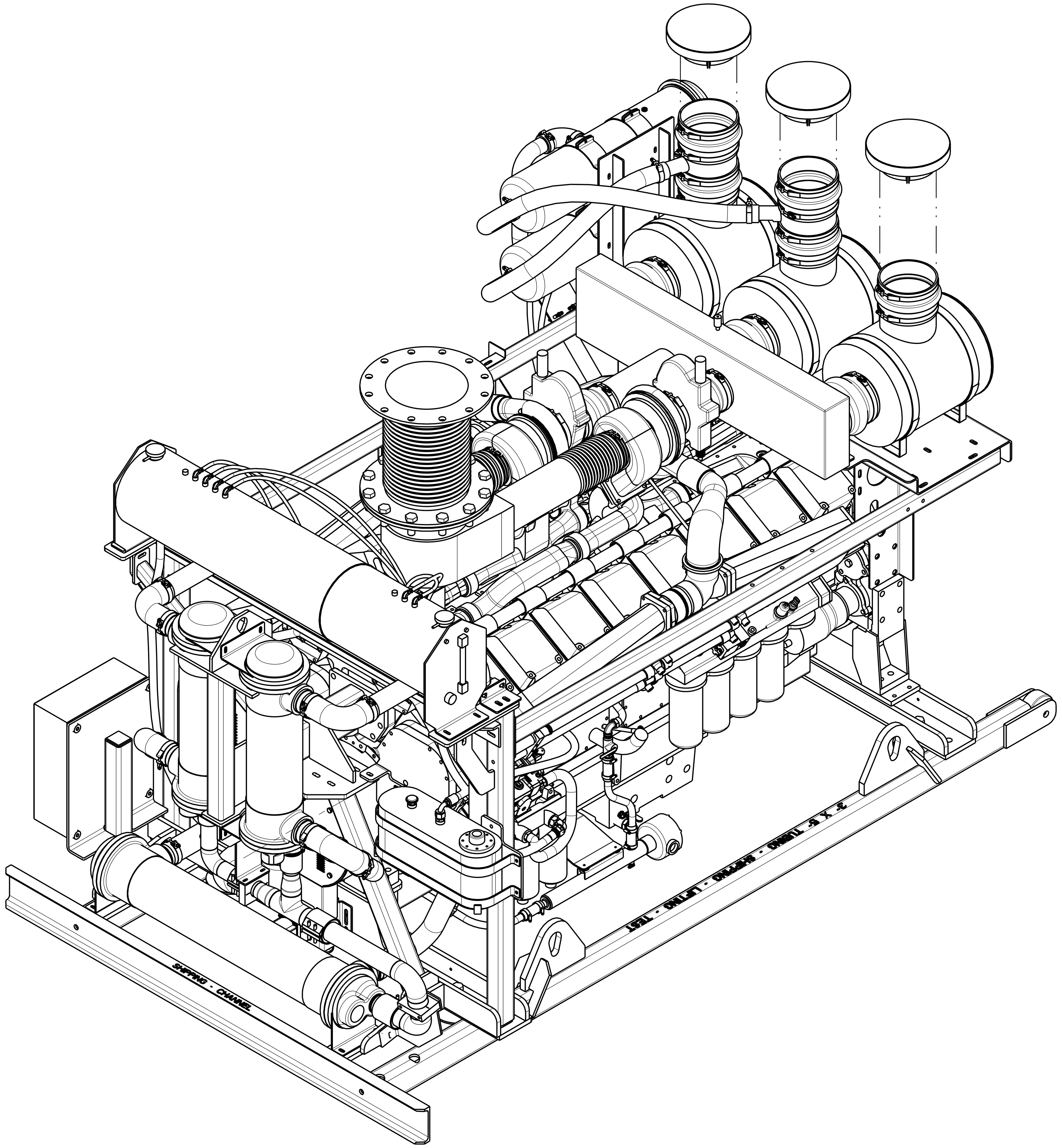
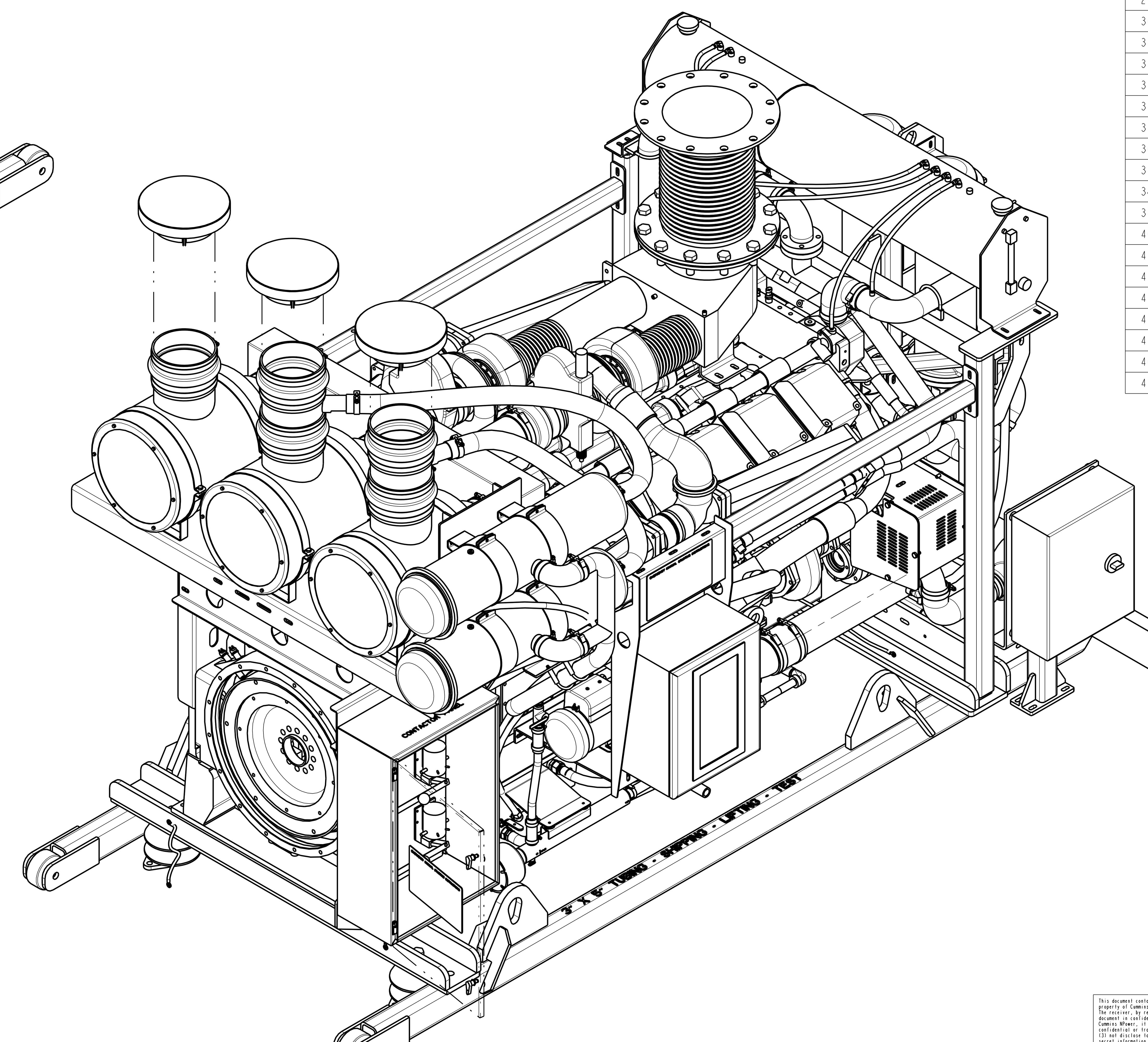
CUSTOM DESIGN
AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, CFP50, CHIRAG OIL
STARTERS RIGHT BANK

DRAWN BY: DAN | DATE: 19-MAY-10
DWG UNITS: IN/LB/S | PRO-ENGINEER | INIT ECO: 2010-250
SCALE: 0.050 | SHEET 1 OF 2 | EST WEIGHT: 15682.845
DRAWING NO. 17001





BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	VALVE,BL -16 LK HDL, BRASS,NPTFxNPTF	16145-16
2	1	ASSEMBLY,COOLANT HEATER, CFP50	16399
3	1	ASSEMBLY, SENSORS, CFP50	16432
4	1	ENGINE, KTA50-G9, STARTERS RIGHT BANK	16923
5	1	EXHAUST WYE PIPE, STAINLESS STEEL, CFP50	17044
6	1	WELDMENT, REAR MOUNT, CFP50	17055
7	1	WELDMENT, FRONT MOUNT, CFP50	17056
8	1	ASSEMBLY, COOLING PACKAGE, SHELL & TUBE, CFP50	17057
9	1	ASSEMBLY, EXPANSION TANK & VENTS, CFP50	17063
10	1	KIT, FUEL LINE, CFP50	17068
11	1	ASSEMBLY, AIR CLEANERS, CFP50	17072
12	1	ASSEMBLY, SEA WATER PIPING, CFP50	17083
13	1	ASSEMBLY, OPERATORS STATION, CFP50	17087
14	1	ASSEMBLY, HYDRAULIC RECHARGE PUMP, CFP50	17091
15	1	ASSEMBLY, FRONT GUARDS, CFP50	17098
16	1	KIT, EARTH BONDING WIRES, CFP50	17107
17	1	PRELUBE, STARTERS RIGHT BANK	17112
18	1	KIT, GASKET & BOLT, 12" SS ANSI	17185
19	1	CONTACTORS, MANUAL START, CFP50	17290
20	1	ASSEMBLY, FUEL VALVE, POWER TO CLOSE, CFP50	17359
21	1	ASSEMBLY, BREATHER VENT FILTER, CFP50	17438
22	1	ASSEMBLY, DATA TAG, CFP50	17803
23	1	FTG, STR, -1.0 BEADx-1.0 NPT	12545-16-16
24	1	FLEX PIPE, 12" SS ANSI FLANGE, CFP50	17045
25	1	BRACKET, FRONT MOUNT STABILIZER, CFP50	17066
26	1	BRACKET, EXPANSION TANK STABILIZER, CFP50	17067
27	1	BRACKET, FUEL BREAK TANK, CFP50	17069
28	1	CHANNEL, PANEL MOUNTING, CFP50	17076
29	2	BRACKET, FORMED	17080
30	2	ISOLATOR, REAR, CFP50	17081
31	2	BRACKET, OPERATOR PANEL, CFP50	17088
32	1	BRACKET, OPERATOR PANEL MOUNTING, CFP50	17089
33	1	STAND OFF, OPERATOR PANEL, CFP50	17090
34	1	HOSE, 80242GL, 1.00" ID X 48" LG	17096
35	2	ISOLATOR, FRONT, CFP50	17105
36	1	BRACKET, CONTACTOR PANEL	17121
37	1	BRACKET, CONTACTOR PANEL	17122
38	1	CHANNEL, SHIPPING, C6 X 10.5#	17170
39	1	BRACE, OPERATORS STATION, RH, CFP50	17231
40	1	BRACE, OPERATORS STATION, RH, CFP50	17232
41	2	SCREW, SHCS, 3/4-10 X 2.25	206028
42	2	BRACKET, CAST IRON	3051793
43	1	PLATE, COVER, CUMMINS OIL FILTER	3626803
44	2	V-BAND, 6"	3626944
45	1	GASKET, COVER, CUMMINS OIL FILTER	3626965
46	1	STARTER, HYDRAULIC, CFP50	BY OTHERS
47	4	BOLT, SS, M24	M24-BOLT.50

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AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

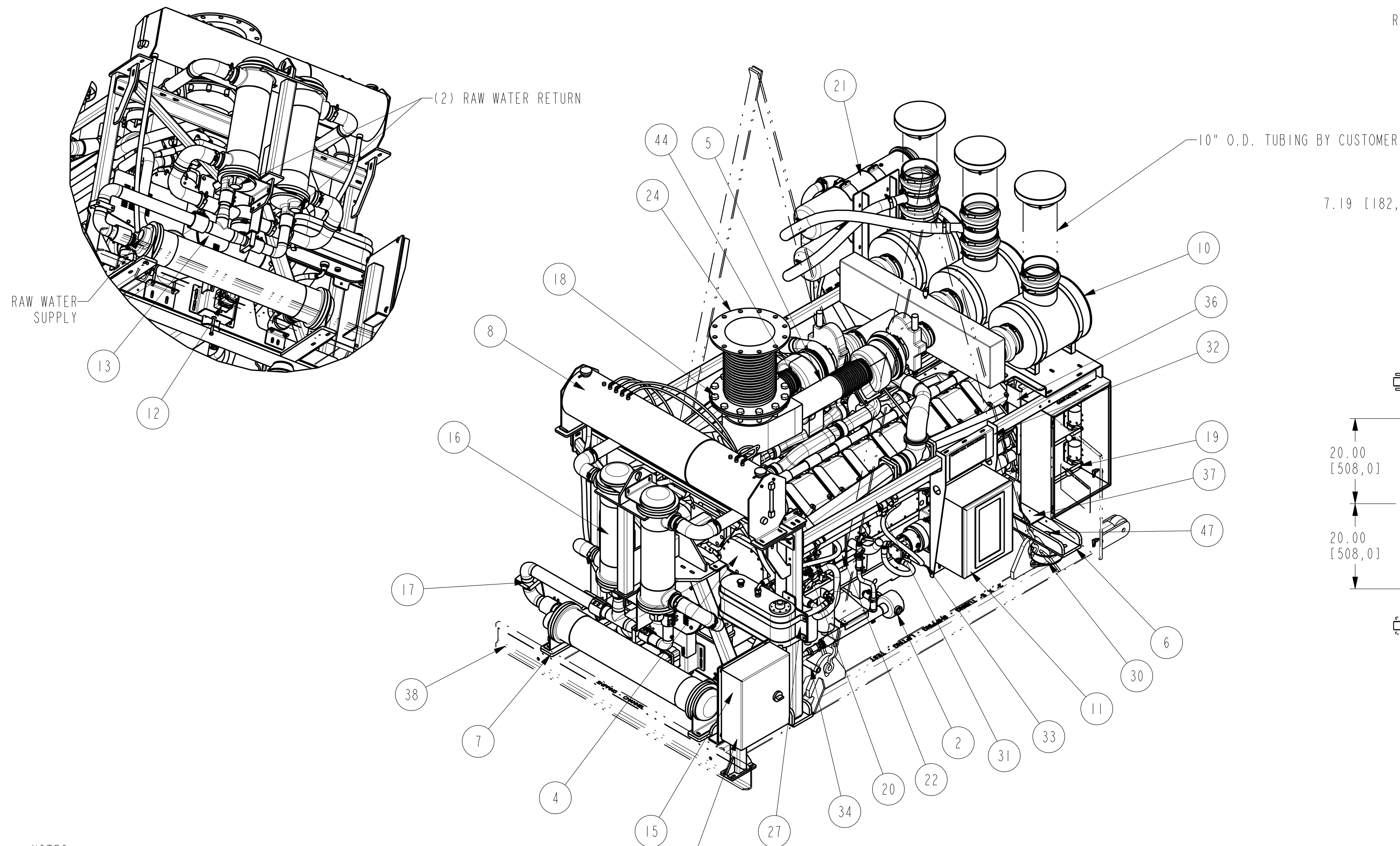
ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

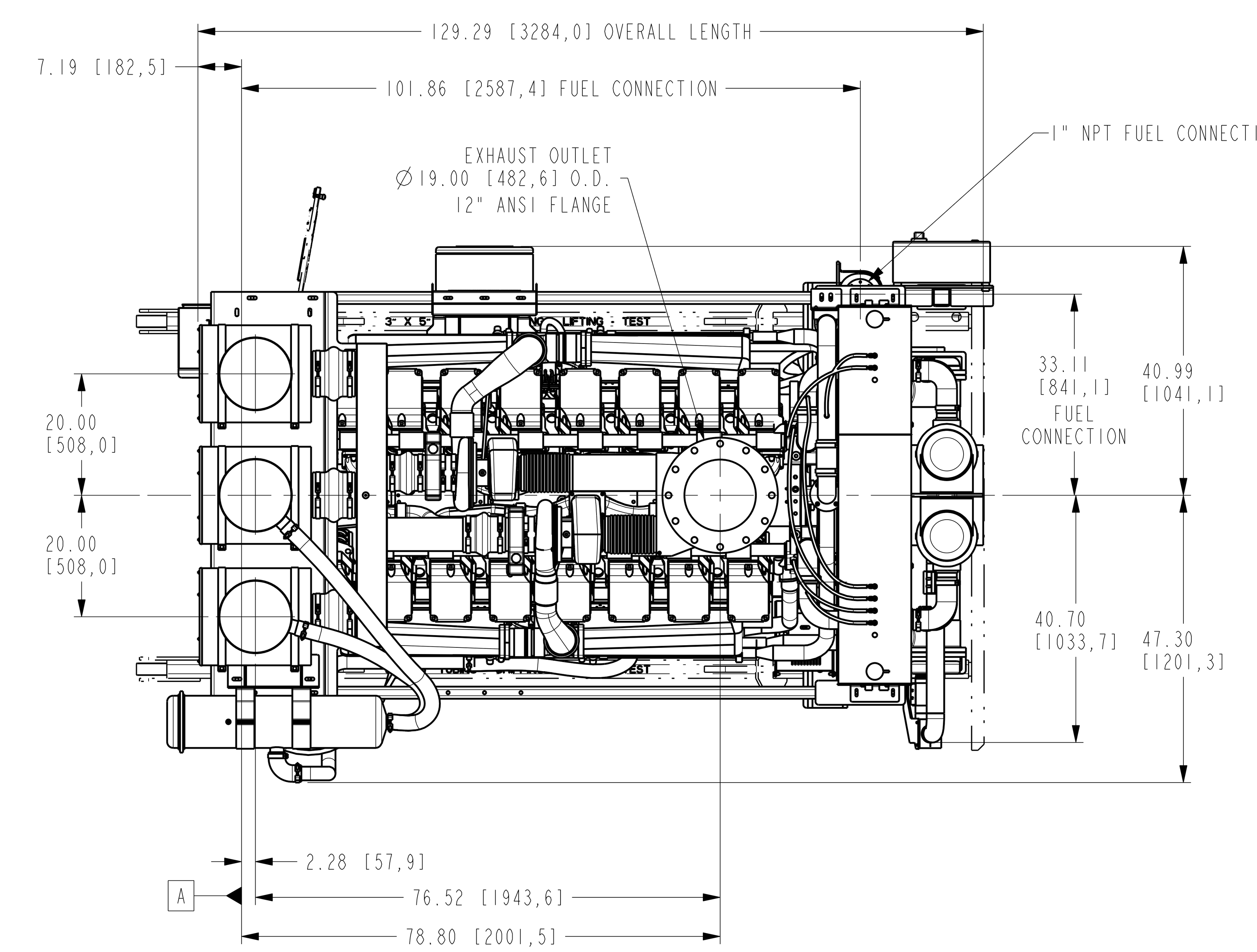
ASSEMBLY, CFP50, CHIRAG OIL
STARTERS RIGHT BANK

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 19-MAY-10
	PRO-ENGINEER	INIT ECO: 2010-250
SCALE: 0.090	SHEET 2 OF 2	DRAWING NO: 17001
EST WEIGHT: 15682.845		

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

REFERENCE 17001 FOR FLYWHEEL AND AUX DRIVE DETAILS





	ITEM	QTY	DESCRIPTION	PART NUMBER
	1	2	VALVE,BL -16 LK HDL, BRASS,NPTFxNPTF	16145-16
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	3	1	ASSEMBLY, SENSORS, CFP50	16432
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	5	1	EXHAUST WYE PIPE, STAINLESS STEEL, CFP50	17044
	6	1	WELDMENT, REAR MOUNT, CFP50	17055
	7	1	WELDMENT, FRONT MOUNT, CFP50	17056
	8	1	ASSEMBLY, EXPANSION TANK & VENTS, CFP50	17063
	9	1	KIT, FUEL LINE, CFP50	17068
	10	1	ASSEMBLY, AIR CLEANERS, CFP50	17072
	11	1	ASSEMBLY, OPERATORS STATION, CFP50	17087
	12	1	ASSEMBLY, HYDRAULIC RECHARGE PUMP, CFP50	17091
	13	1	ASSEMBLY, FRONT GUARDS, CFP50	17098
	14	1	KIT, EARTH BONDING WIRES, CFP50	17107
	15	1	ASSEMBLY, PRELUBE	17114
	16	1	ASSEMBLY, COOLING PACKAGE, LH, SHELL & TUBE, CFP50	17132
	17	1	ASSEMBLY, SEA WATER PIPING, CFP50	17134
	18	1	KIT, GASKET & BOLT, 12" SS ANSI	17185
	19	1	CONTACTORS, MANUAL START, CFP50	17290
A	20	1	ASSEMBLY, FUEL VALVE, POWER TO CLOSE, CFP50	17359
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	23	1	FTG, STR, -1.0 BEADx-1.0 NPT	12545-16-16
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	27	1	BRACKET, FUEL BREAK TANK, CFP50	17069
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	29	2	BRACKET, FORMED	17080
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	35	2	ISOLATOR, FRONT, CFP50	17105
	36	1	BRACKET, CONTACTOR PANEL	17121
	37	1	BRACKET, CONTACTOR PANEL	17123
	38	1	CHANNEL, SHIPPING, C6 X 10.5#	17170
	39	1	BRACE, OPERATORS STATION, RH, CFP50	17231
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A	41	2	SCREW, SHCS, 3/4-10 X 2.25	206028
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	46	1	STARTER, HYDRAULIC, CFP50	BY OTHERS
	47	4	BOLT, SS, M24	M24-BOLT.50

BILL OF MATERIAL

NOTES:
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2. STAINLESS STEEL CABLE TIES REQUIRED
   GRAINGER 2CMT2 (0.31 X 14.3) 2CMR7 (0.18 X 7.9) OR EQUAL
3. HYDRAULIC STARTER INSTALLED - NOT TESTED
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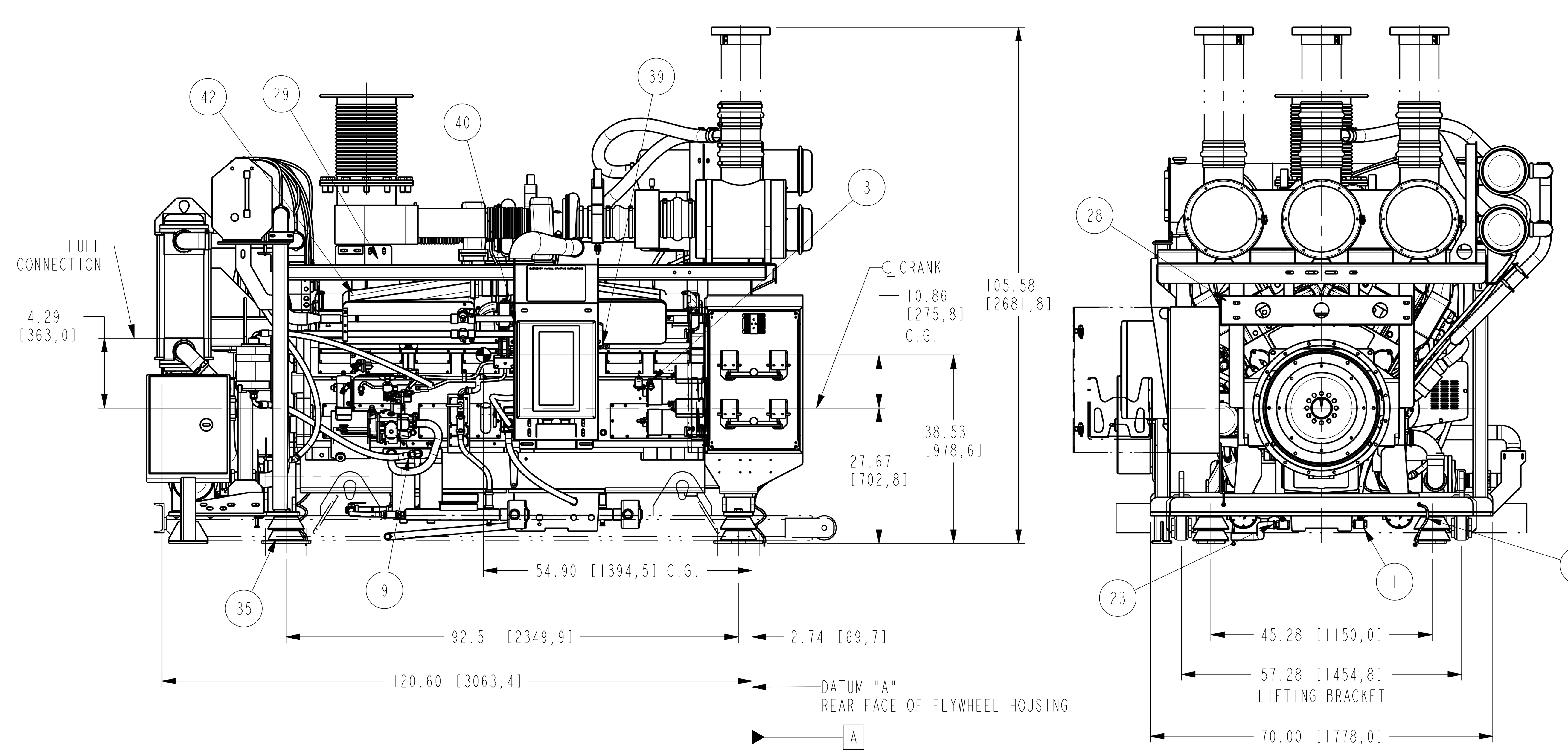

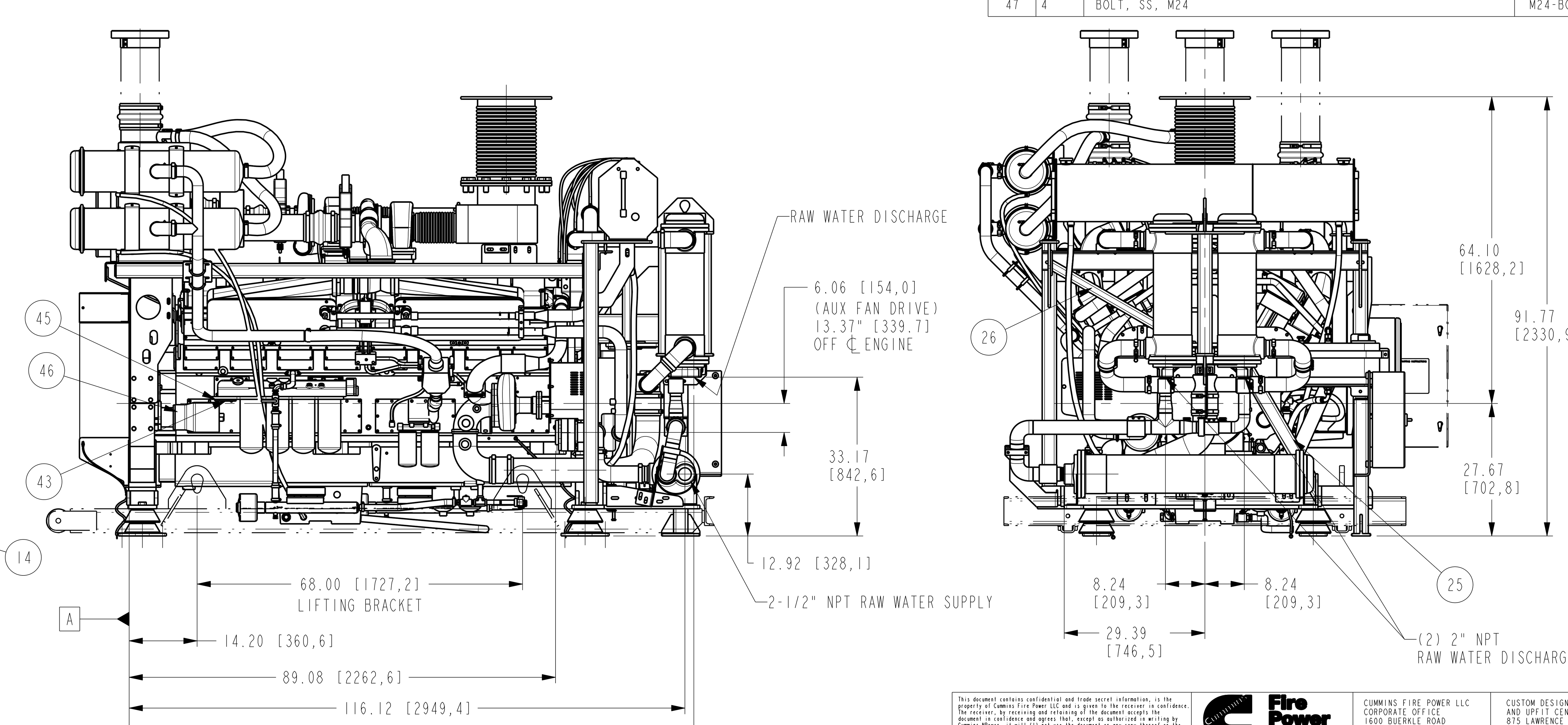

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CUSTOM DESIGN
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875 LAWRENCE DRIVE
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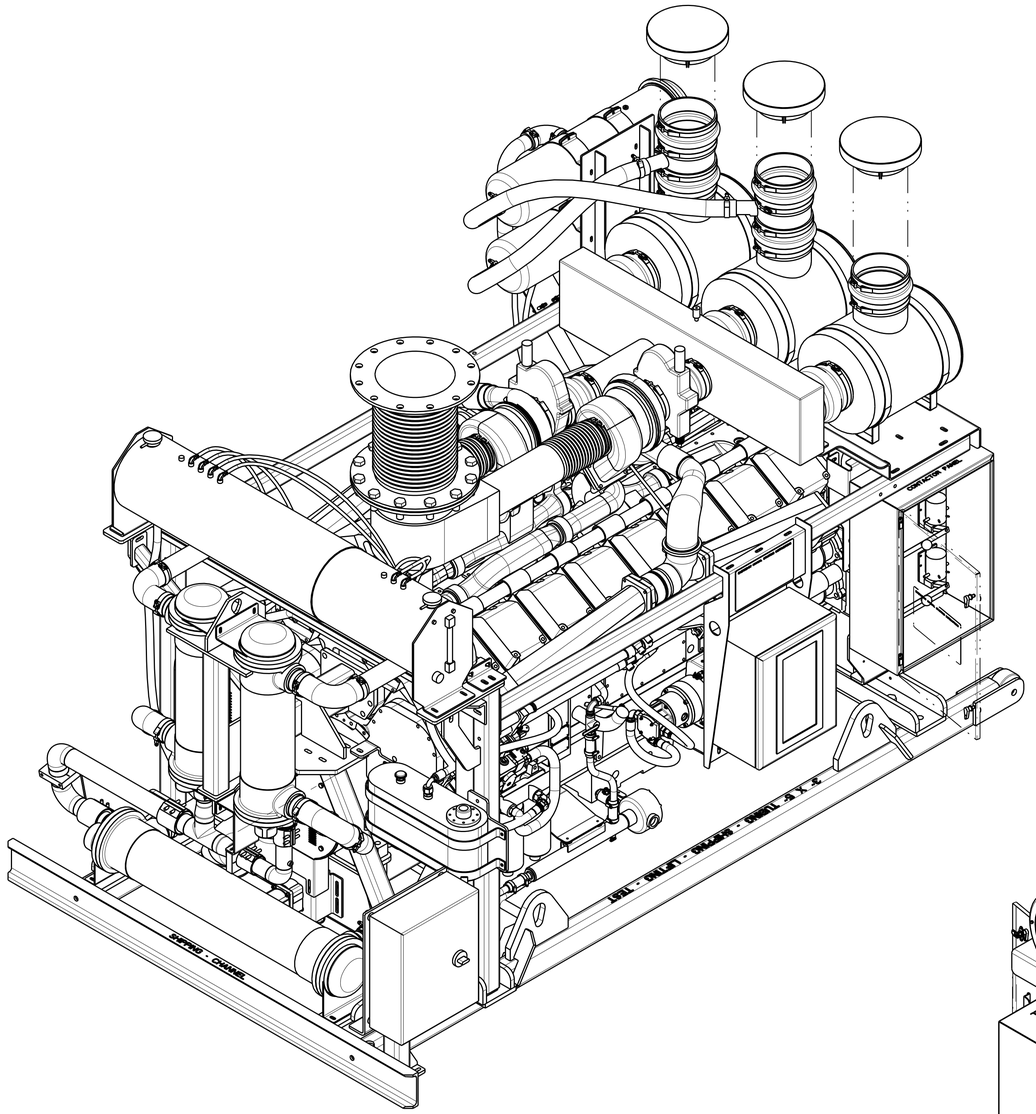
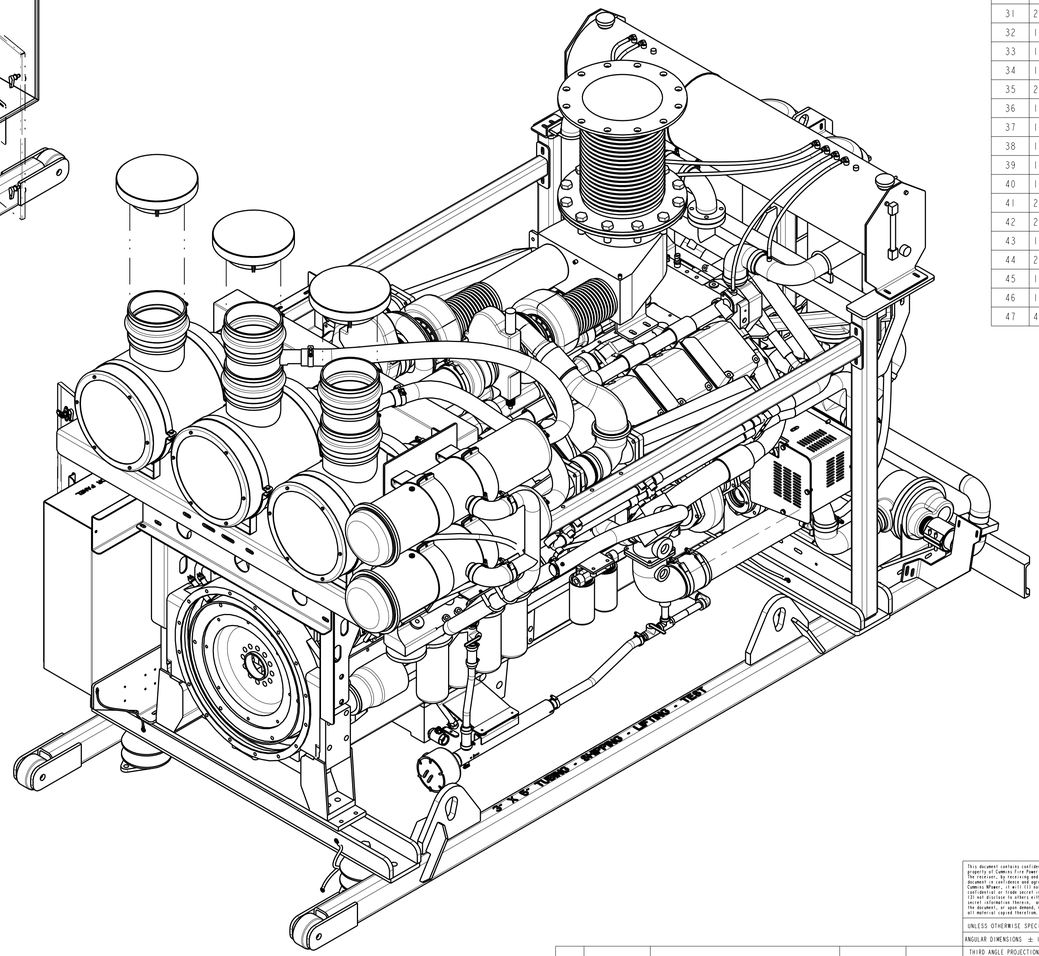
ASSEMBLY, CFP50, CHIRAG OIL
STARTERS LEFT BANK

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE
ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS
THIRD ANGLE PROJECTION

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 20-MAY-10
	PRO-ENGINEER	INIT ECO: 2010-250
SCALE: 0.050	SHEET 1 OF 2	DRAWING NO: 17002
EST WEIGHT: 15691.366		

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE
A	2010-462	ADDED DATA TAG. ITEMS RELOCATED FROM ENGINE ASSEMBLY.	DAN	11-OCT-10





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17	1	ASSEMBLY, SEA WATER PIPING, CFP50	17134
18	1	KIT, GASKET & BOLT, 12" SS ANSI	17185
19	1	CONTACTORS, MANUAL START, CFP50	17290
20	1	ASSEMBLY, FUEL VALVE, POWER TO CLOSE, CFP50	17359
21	1	ASSEMBLY, BREATHER VENT FILTER, CFP50	17438
22	1	ASSEMBLY, DATA TAG, CFP50	17803
23	1	FTG, STR, -1.0 BEADx-1.0 NPT	12545-16-16
24	1	FLEX PIPE, 12" SS ANSI FLANGE, CFP50	17045
25	1	BRACKET, FRONT MOUNT STABILIZER, CFP50	17066
26	1	BRACKET, EXPANSION TANK STABILIZER, CFP50	17067
27	1	BRACKET, FUEL BREAK TANK, CFP50	17069
28	1	CHANNEL, PANEL MOUINTING, CFP50	17076
29	2	BRACKET, FORMED	17080
30	2	ISOLATOR, REAR, CFP50	17081
31	2	BRACKET, OPERATOR PANEL, CFP50	17088
32	1	BRACKET, OPERATOR PANEL MOUNTING, CFP50	17089
33	1	STAND OFF, OPERATOR PANEL, CFP50	17090
34	1	HOSE, 80242GL, 1.00" ID X 48" LG	17096
35	2	ISOLATOR, FRONT, CFP50	17105
36	1	BRACKET, CONTACTOR PANEL	17121
37	1	BRACKET, CONTACTOR PANEL	17123
38	1	CHANNEL, SHIPPING, C6 X 10.5#	17170
39	1	BRACE, OPERATORS STATION, RH, CFP50	17231
40	1	BRACE, OPERATORS STATION, RH, CFP50	17232
41	2	SCREW, SHCS, 3/4-10 X 2.25	206028
42	2	BRACKET, CAST IRON	3051793
43	1	PLATE, COVER, CUMMINS OIL FILTER	3626803
44	2	V-BAND, 6"	3626944
45	1	GASKET, COVER, CUMMINS OIL FILTER	3626965
46	1	STARTER, HYDRAULIC, CFP50	BY OTHERS
47	4	BOLT, SS, M24	M24-BOLT_50

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

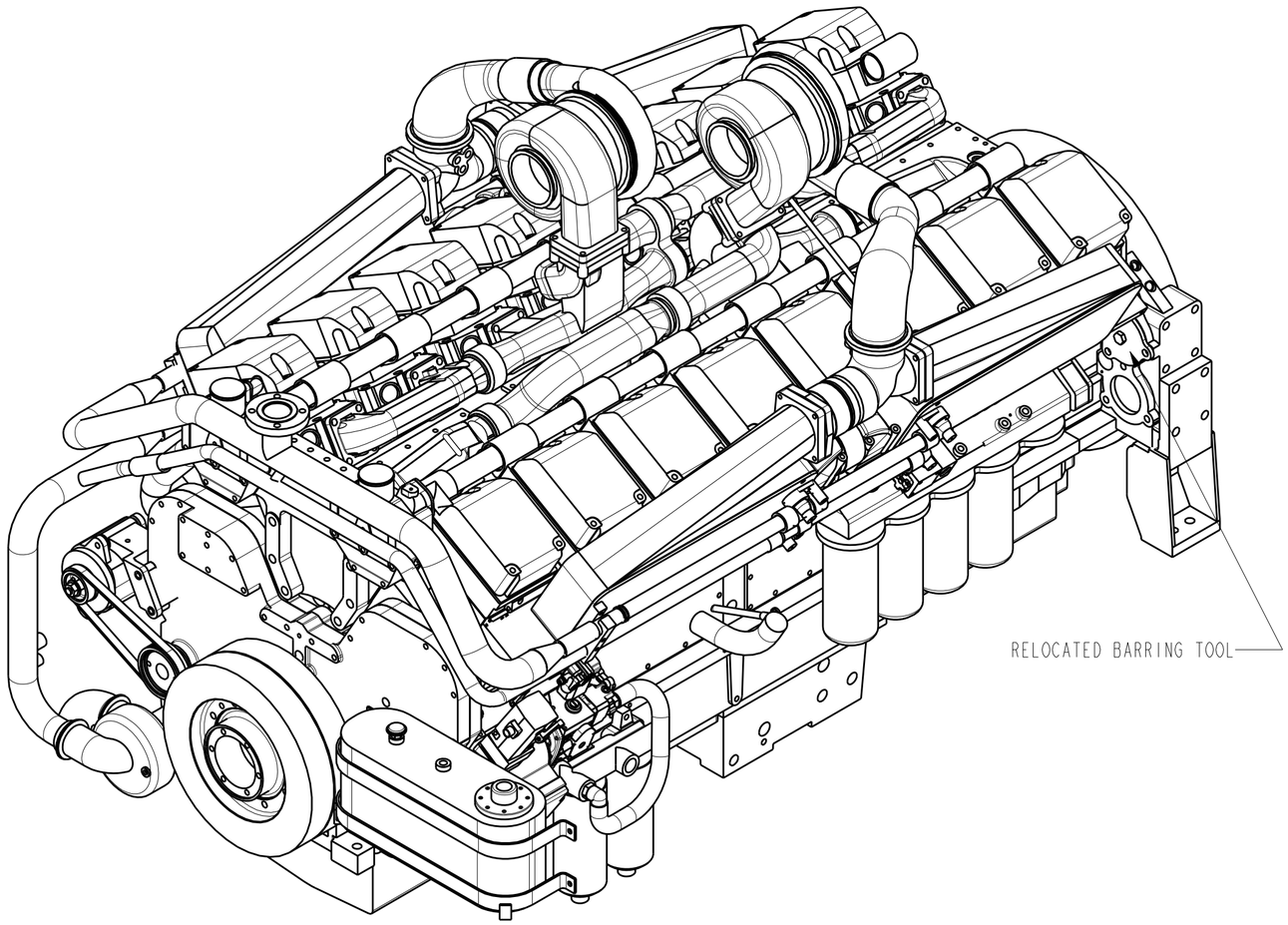
REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

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

ASSEMBLY, CFP50, CHIRAG OIL
STARTERS LEFT BANK

DWG UNITS: IN/LB/S
DRAWN BY: DAN
DATE: 20-MAY-10
PRO-ENGINEER
INIT ECO: 2010-250
SCALE: 0.090
EST WEIGHT: 15691.366
SHEET 2 OF 2
DRAWING NO: 17002



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL PUMP, WOODWARD GOVERNOR	FP6085
2	1	FUEL FLOAT TANK	FS8023
3	1	SAE-A, 9T REAR, SAE-B, 13T FRONT OF GER COVER	HD6038
4	1	REAR ENGINE SUPPORT	RE6002
5	1	DIPSTICK, LEFT REAR BANK	LG6003
6	1	ACCESSORY DRIVE PULLEY	AD6005
7	1	DATA PLATE	AP6129
8	1	BASE ENGINE	BP6126
9	1	DAMPER	DA6084
10	1	DUTY CYCLE	DC8003
11	1	ALTERNATOR MOUNTING	EE6017
12	1	ALTERNATOR, 24V, 35A, DELCO 20SI	EE8080
13	1	ENGINE MOUNT	EM6001
14	1	NO MAG SWITCH	ES0000
15	1	FAN DRIVE, NONE	FA6014
16	1	FUEL FILTERS (2) MICRON	FF6063
17	1	FLYWHEEL HOUISING, SAE-0	FH6024
18	1	FUEL RATING, 2220 HP, 1800 RPM	FR6295
19	1	FUEL CHECK VALVE, INTEGRAL	FS6013
20	1	NO POSITIVE HEADF FUEL SUPPLY SYSTEM REQUIRED	FS6022
21	1	FUEL SHUT OFF VALVE, 24V	FV6020
22	1	FLYWHEEL, SAE-0, 14" & 18" O/C CLUTCH	FW6009
23	1	HEAT EXCHANGER PLUMBING	HX6126
24	1	INTAKE MANIFOLD	IM6053
25	1	STANDARD ENGINE TEST REPORT	LE6001
26	1	LUBE FILTERS (5), LEFT BANK	LF6026
27	1	LITERATURE, O&M AND PARTS MANUAL	LT6029
28	1	OIL FILL, LEFT BANK	OB6164
29	1	NO BYPASS OIL FILTER	OF6031
30	1	OIL PAN, REAR CENTER SUMP, 40 GALLON	OP6024
31	1	PERFORMANCE PARTS	PP2533
32	1	PULLEY, ALTERNATOR DRIVE	PU6003
33	1	NO GUARDS	SG NONE
34	1	WOOD SHIPPING SKID	SK6026
35	1	PAINT, CUMMINS RED	SS6013
36	1	STARTERS, 24V, RIGHT BANK	ST6026
37	1	SECOND LOOP WATER PUMP	SW6016
38	1	WATER FILTERS, (2), RIGHT BANK	WF6023
39	1	WATER INLET	WI6020
40	1	WATER TRANSFER TUBES, DRY EXHAUST	WM6005
41	1	WATER OUTLET, 3" VERTICAL	WO6009
42	1	EXHAUST MANIFOLDS	XM6021
43	1	EXHAUST MANIFOLDS, NONE	XS0000

NOTES:
1. MATERIAL: KTA50-G9 CONFIG# D283022DX02
2. FINISH: FACTORY FINISH CUMMINS RED
3. NO EXPOSED METAL - FINISH PER ES 042

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE
A	2010-462	UPDATED PER SPEC. MOVED COMPONENTS TO UPPER LEVEL ASSEMBLY.	DAN	11-OCT-10

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

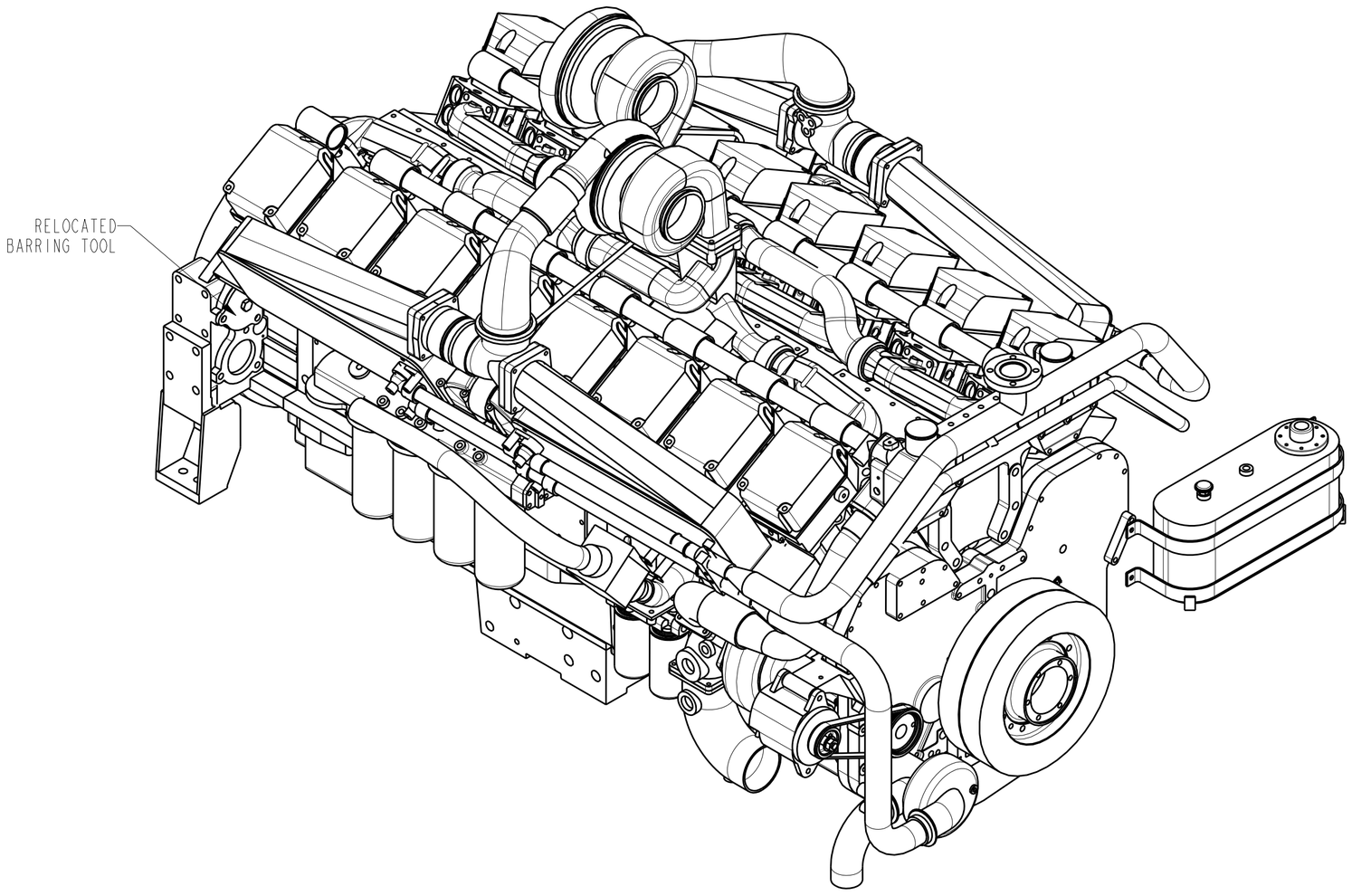
MACHINE TOLERANCES .XX ± 0.010 .XXX ± 0.005
FORM TOLERANCES .XX ± 0.015 .XXX ± 0.015
PAD TOLERANCES .XX ± 0.060 .XXX ± 0.030
MACHINE TOLERANCES .X ± 0.2 .XX ± 0.2
FORM TOLERANCES .X ± 0.4 .XX ± 0.4
PAD TOLERANCES .X ± 1.5 .XX ± 0.8

Cummins Fire Power
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

ENGINE, KTA50-G9, STARTERS RIGHT BANK

DWG UNITS: IN/LB/S | DRAWN BY: DAN | DATE: 17-MAY-10
PRO-ENGINEER | INIT ECO:
SCALE: 0.100 | SHEET 1 OF 1 | DRAWING NO: 16923
EST WEIGHT: 12366.573



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	FUEL PUMP, WOODWARD GOVERNOR	FP6085
2	1	FUEL FLOAT TANK	FS8023
3	1	SAE-A, 9T REAR, SAE-B, 13T FRONT OF GER COVER	HD6038
4	1	REAR ENGINE SUPPORT	RE6002
5	1	DIPSTICK, LEFT REAR BANK	LG6003
6	1	ACCESSORY DRIVE PULLEY	AD6005
7	1	DATA PLATE	AP6129
8	1	BASE ENGINE	BP6126
9	1	DAMPER	DA6084
10	1	ALTERNATOR MOUNTING	EE6017
11	1	ALTERNATOR, 24V, 35A, DELCO 20SI	EE8080
12	1	ENGINE MOUNT	EM6001
13	1	NO MAG SWITCH	ES0000
14	1	FAN DRIVE, NONE	FA6014
15	1	FUEL FILTERS (2) MICRON	FF6063
16	1	FLYWHEEL HOUISING, SAE-0	FH6024
17	1	FUEL RATING, 2220 HP, 1800 RPM	FR6295
18	1	FUEL CHECK VALVE, INTEGRAL	FS6013
19	1	NO POSITIVE HEADF FUEL SUPPLY SYSTEM REQUIRED	FS6022
20	1	FUEL SHUT OFF VALVE, 24V	FV6020
21	1	FLYWHEEL, SAE-0, 14" & 18" O/C CLUTCH	FW6009
22	1	HEAT EXCHANGER PLUMBING	HX6126
23	1	INTAKE MANIFOLD	IM6053
24	1	STANDARD ENGINE TEST REPORT	LE6001
25	1	LUBE FITERS, (5), RIGHT BANK	LF6027
26	1	LITERATURE, O&M AND PARTS MANUAL	LT6029
27	1	NO BYPASS OIL FILTER	OF6031
28	1	OIL PAN, REAR CENTER SUMP, 40 GALLON	OP6024
29	1	PERFORMANCE PARTS	PP2533
30	1	PULLEY, ALTERNATOR DRIVE	PU6003
31	1	NO GUARDS	SG NONE
32	1	WOOD SHIPPING SKID	SK6026
33	1	PAINT, CUMMINS RED	SS6013
34	1	STARTERS, 24V, LEFT BANK	ST6027
35	1	SECOND LOOP WATER PUMP	SW6016
36	1	WATER FILTERS, (2), RIGHT BANK	WF6023
37	1	WATER INLET	WI6020
38	1	WATER TRANSFER TUBES, DRY EXHAUST	WM6005
39	1	WATER OUTLET, 3" VERTICAL	WO6009
40	1	EXHAUST MANIFOLDS	XM6021
41	1	EXHAUST MANIFOLDS, NONE	XS0000

NOTES:
1. MATERIAL: KTA50-G9 CONFIG# D283022DX02
2. FINISH: FACTORY FINISH CUMMINS RED
3. NO EXPOSED METAL - FINISH PER ES 042

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE
A	2010-462	UPDATED PER SPEC. MOVEED COMPONENTS TO UPPER LEVEL ASSEMBLY	DAN	11-OCT-10

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX ± 0.005 .XXX ± 0.005
FORM TOLERANCES .XX ± 0.030 .XXX ± 0.015
FAB TOLERANCES .XX ± 0.060 .XXX ± 0.030

MACHINE TOLERANCES .X ± 0.2
FORM TOLERANCES .X ± 0.8 .XX ± 0.4
FAB TOLERANCES .X ± 2.0 .XX ± 2.0

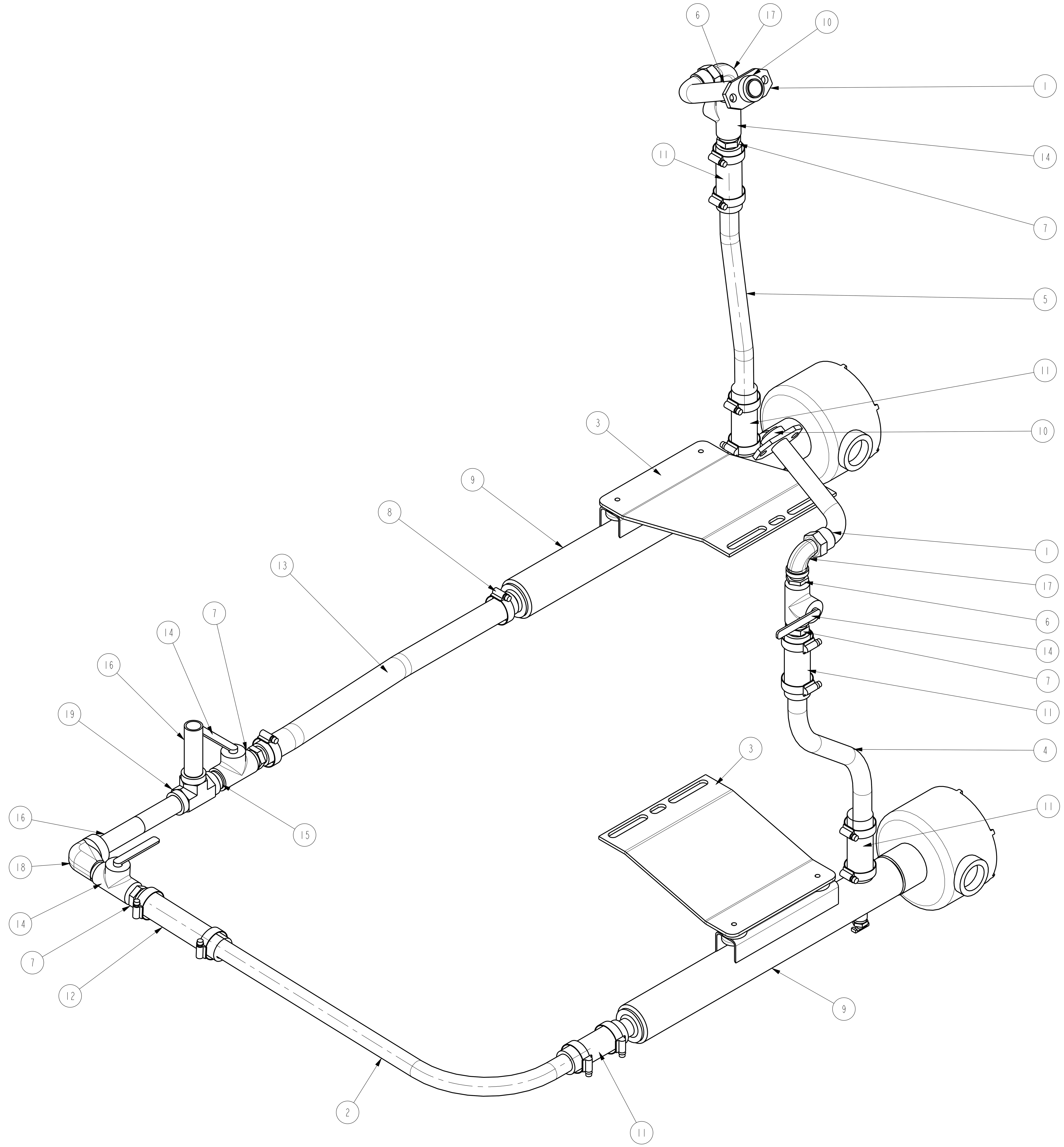
Cummins Fire Power

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

ENGINE, KTA50-G9, STARTERS LEFT BANK

DWG UNITS: IN/LB/S | DRAWN BY: DAN | DATE: 20-MAY-10
PRO-ENGINEER | INIT ECO: 2010-250
SCALE: 0.100 | SHEET 1 OF 1 | DRAWING NO: 16922
EST WEIGHT: 12409.199



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	2	TUBE,WATER HEATER, CUMMINS POWER GENERATION	0130_5607
2	1	TUBE,CROSSOVER,HEATER, GTA 38/50	7884
3	2	BRACKET, COOLANT HEATER, MULTI-UNIT	8143
4	1	TUBE,BLOCK HEATER,LH, GTA 38/50	10113
5	1	TUBE,BLOCK HEATER,RH, GTA 38/50	10114
6	2	NIPPLE, PIPE HEX, -12 NPT X -8 NPT	12529-12-8
7	4	FTG, STR, -1.0 BEADx-.75 NPT	12545-16-12
8	14	CLAMP, WORM, 1 1/4" NOM., 1 5/8" HOSE OD	14990-20
9	2	COOLANT HEATER, EXPLOSION PROOF, 4000 WATT, 120/240 VOLT	17306
10	2	SEAL, RECTANGULAR RING	3177556
11	5	HOSE, SILICONE, HI-TEMP, 1", P/N 78100GL X LENGTH	78100GL-4INCH
12	1	HOSE, SILICONE, HI-TEMP, 1", P/N 78100GL X LENGTH	78100GL-6INCH
13	1	HOSE,SILICONE,HI-TEMP, 1.00" ID X 20.00"	78100GL_009
14	4	VALVE, BALL, 3/4" NPT	FA60406
15	1	NIPPLE, BLK, 3/4x1-1/2	LTL-CPN34
16	3	NIPPLE, 3/4 X 3, BLK	LTL-CPN343
17	2	STREET ELBOW,BLK,1/2" NPT	LTL-SE1290
18	1	ELBOW, STREET, 90 DEG 3/4NPT, PER SAE NO. 130239	LTL-SE3490
19	1	TEE, BLK, 3/4" NPT	LTL-ST34

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE
A	2010-250	UPDATED PER FIRST BUILD & HEATERS	DAN	24-JUN-10

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

Fire Power

CUMMINS FIRE POWER LLC
CORPORATE OFFICE
1600 BUERKLE ROAD
WHITE BEAR LAKE, MN
WWW.CUMMINSFIREPOWER.COM

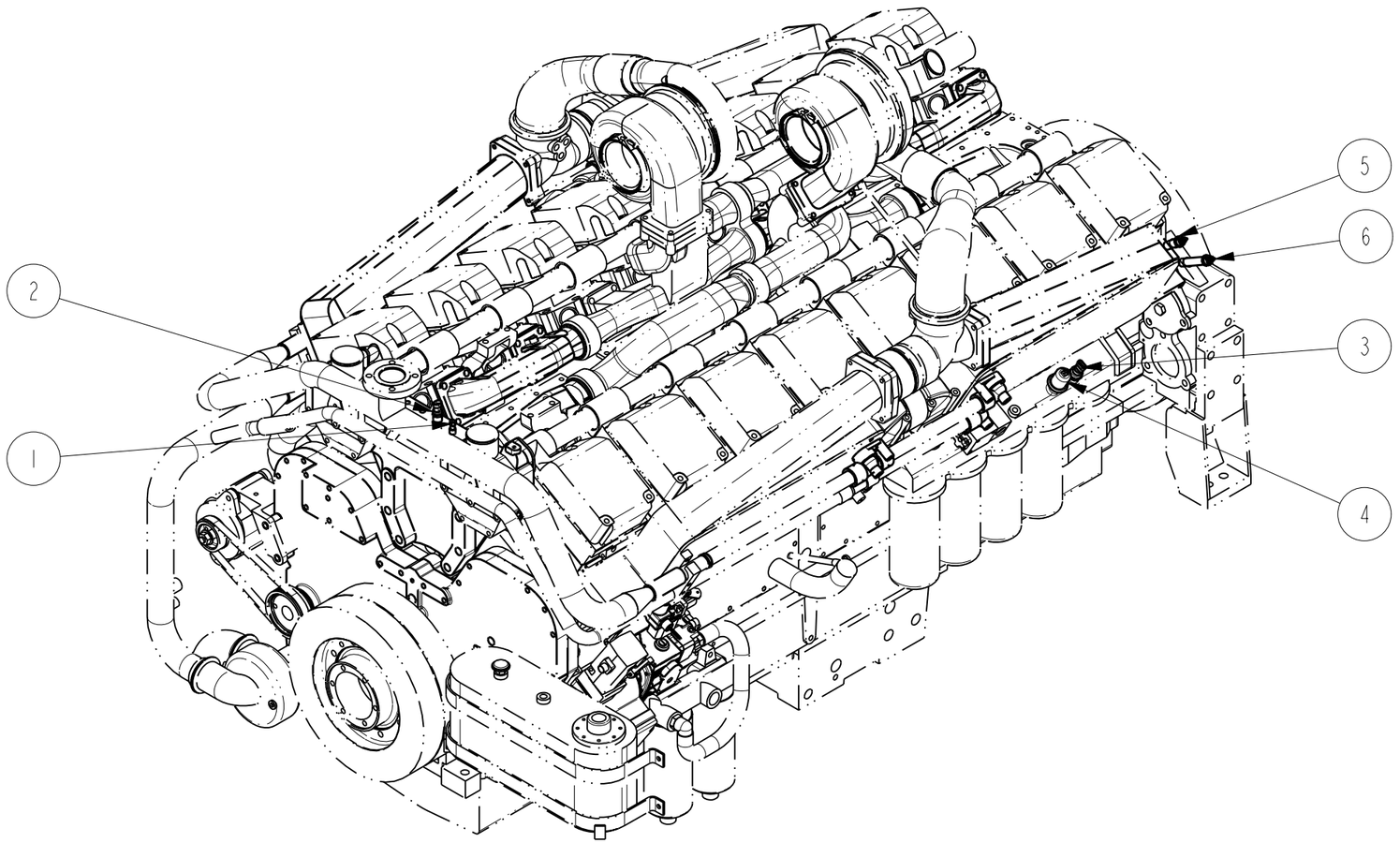
CUSTOM DESIGN
AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY,COOLANT HEATER
CFP50

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 19-JAN-10
	PRO-ENGINEER	INIT ECO:
SCALE: 0.313	SHEET 1 OF 1	DRAWING NO: 16399
EST WEIGHT: 55.727		

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	SENDER, WATER TEMPERATURE, DATCON #02025-00	n/a
2	1	SWITCH, WATER TEMP, 200F SETTING, #3408632	8860
3	1	SWITCH, OIL PRESSURE, 16 PSI, #3408607	8861
4	1	SENDER, OIL PRESURE, DATCON #02504-00	8863
5	1	SENSOR, MAG PICK UP	3034572
6	1	SENSOR, MAG PICK UP	3039525



UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

Fire Power

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

ASSEMBLY, SENSORS
CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

PRO-ENGINEER

DATE: 12-MAY-10

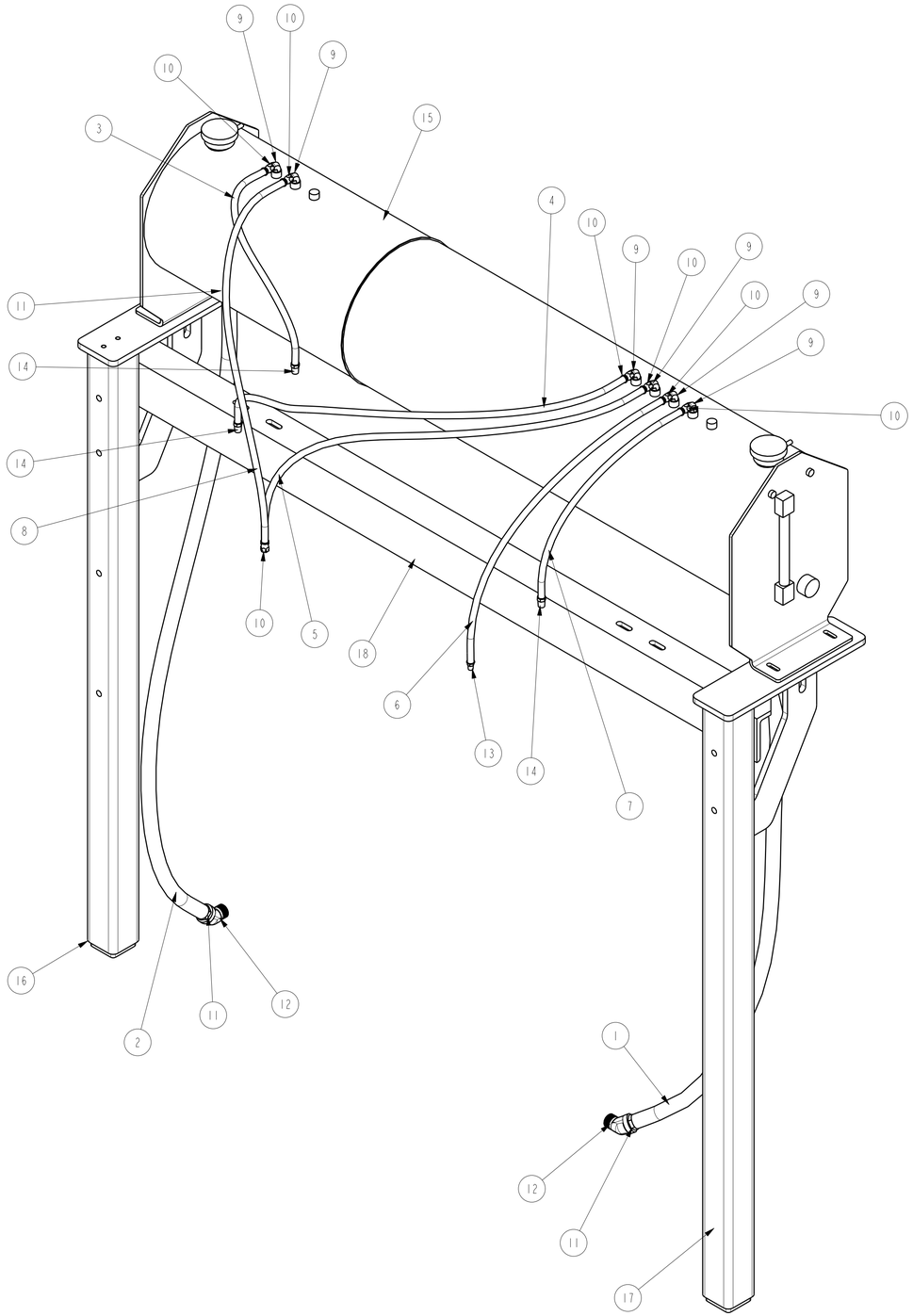
INIT ECO: 2010-250

SCALE: 0.075

EST WEIGHT: 0.929

SHEET 1 OF 1

DRAWING NO: 16432



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, HEATER, DAYCO G.L., 80242GL, 3/4" I.D. x 54"	14194-017
2	1	HOSE, HEATER, DAYCO G.L., 80242GL, 3/4" I.D. x 54"	14194-018
3	1	HOSE, VENT LINE, PARKER 801, 1/4" ID X 18" LG	15130-013
4	1	HOSE, VENT LINE, PARKER 801, 1/4" ID X 46" LG	15130-014
5	1	HOSE, VENT LINE, PARKER 801, 1/4" ID X 42" LG	15130-015
6	1	HOSE, VENT LINE, PARKER 801, 1/4" ID X 30" LG	15130-016
7	1	HOSE, VENT LINE, PARKER 801, 1/4" ID X 18" LG	15130-017
8	1	HOSE, VENT LINE, PARKER 801, 1/4" ID X 18" LG	15130-018
9	6	ELB, 90 DEG, -4 JIC X -4 NPT	12270-4-4
10	7	HOSE END, STR, -4 FLR X -4 HS	12543-4-4
11	4	FTG, STR, -.75 BEADx-.75 NPT	12545-12-12
12	2	ELBOW, 45", 3/4"NOM, MNPTxFNPT, 150LB BLACK IRON	14204-12
13	2	HOSE END, STR, -2 NPT X -4 HS	14590-2-4
14	3	HOSE END, STR, -4 NPT X -4 HS	14590-4-4
15	1	TANK, SURGE, DUAL CHAMBER - 20 GAL - 10 GAL	16390
16	1	BRACKET, EXPANSION TANK, LH, CFP50	17064
17	1	BRACKET, EXPANSION TANK, RH, CFP50	17065
18	1	ANGLE, TUBE SUPPORT	17106

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

IMPERIAL TOLERANCES
.XX = ±.030
.XXX = ±.010
FRACTIONS = ±1/64
ANGLES = ±1°

METRIC TOLERANCES
.X = ±1.0
.XX = ±0.25
ANGLES = ±1°

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

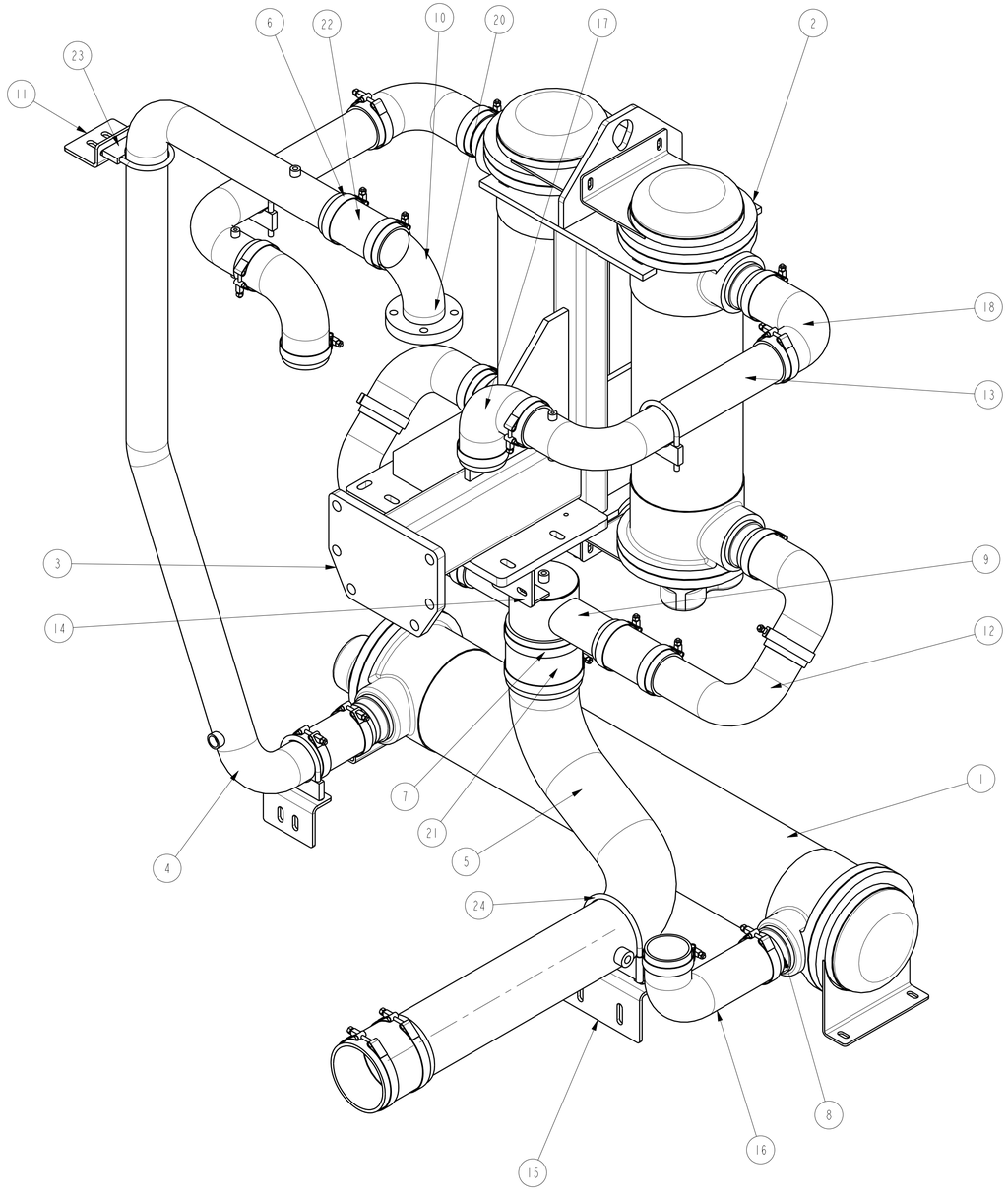
CUMMINS FIRE POWER LLC
CORPORATE OFFICE
1600 DUERKLE ROAD
WHITE BEAR LAKE, MN
WWW.CUMMINSFIREPOWER.COM

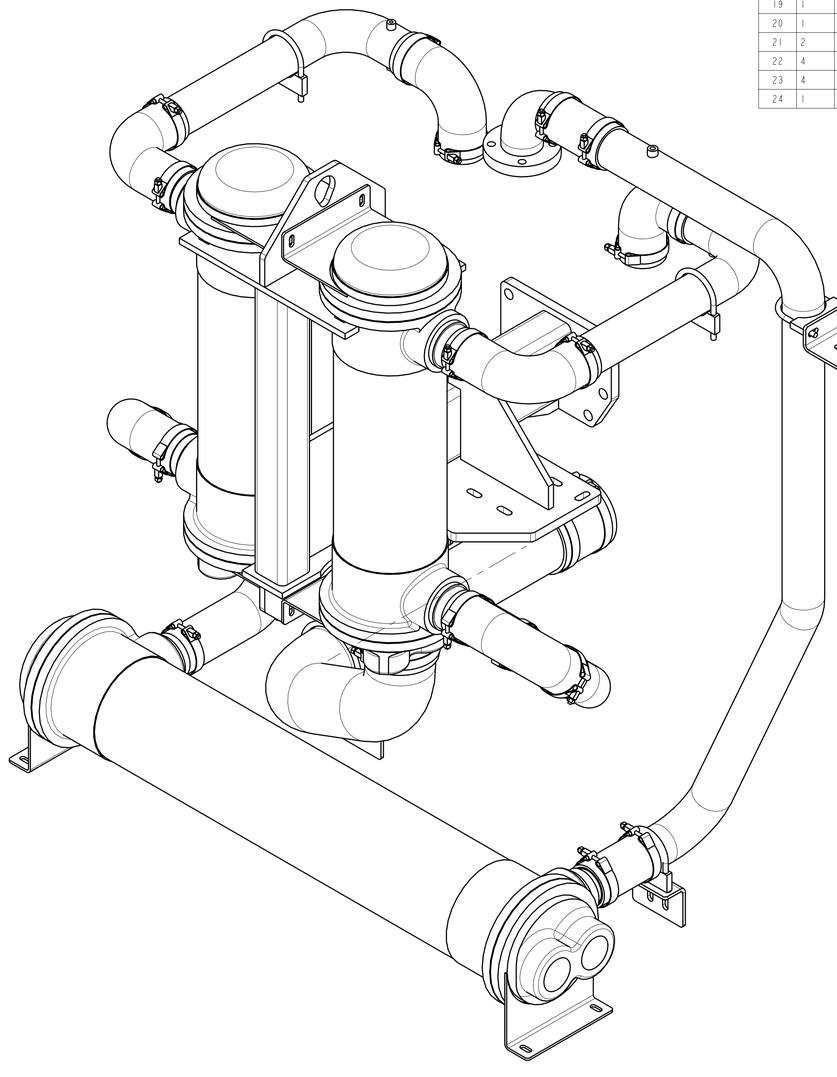
CUSTOM DESIGN
AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, EXPANSION TANK & VENTS
CFP50

DWG UNITS: IN/LB/S
DRAWN BY: DAN
PRO-ENGINEER
DATE: 17-MAY-10
INIT ECO: 2010-250

SCALE: 0.188
EST WEIGHT: 2004.947
SHEET 1 OF 1
DRAWING NO: 17063





BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HEAT EXCHANGER, SHELL AND TUBE, 2-PASS, 8" DIA. W/ 2-1/2" NPT WATER CONNECTION	16229
2	2	HEAT EXCHANGER, SHELL AND TUBE, 4-PASS, 8" DIA. W/ 2" NPT WATER CONNECTION	16230
3	1	BRACKET, HEAT EXCHANGER MOUNTING, CFP50	17058
4	1	TUBE, LTA DISCHARGE, CFP50	17061
5	1	TUBE, JW SUCTION, CFP50	17062
6	22	CLAMP, T-BOLT, 3.28-3.59	13164-0350
7	4	CLAMP, T-BOLT, 5.28-5.59	13164-0550
8	6	FITTING, BARBED HOSE, 3" NPT-3" HOSE	13779
9	1	TUBE, JW SUCTION SPLITTER, CFP50	16409
10	1	FLANGE ADAPTER, 3" ELBOW, LTA CIRCUIT DIACHARGE, CFP50	16410
11	2	BRACKET, TUBE BRACE, FITS 3" U-BOLT	16503
12	2	TUBE, RADIATOR, 3" DIA. 90 DEGREE, 10" X 8"	17059
13	2	TUBE, RADIATOR, 3" DIA. 90 DEGREE, 8" X 20"	17060
14	1	BRACKET, JW TUBE BRACE	17115
15	1	BRACKET, TUBE BRACE, FITS 3" U-BOLT	17169
16	1	ELBOW, 3" ID, 90 DEGREE	21042
17	2	ELBOW, 3" ID, 90 DEGREE	21042
18	4	ELBOW, 3" ID, 90 DEGREE	21042
19	1	SPRING, , NOT SHOWN	21042_SPRING
20	1	GASKET, WATER HEADER	3633419
21	2	HOSE, 5" x 6" LONG	24480G-5
22	4	HOSE, 3" x 6" LONG	77300GL-6
23	4	U-BOLT CLAMP, 3.0"	U-300
24	1	CLAMP, U-BOLT, GUILLOTINE, 5.00", PLATED	U-500

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES
.xx ± 0.03
.xxx ± 0.010
.xxxx ± 0.0050

MACHINE TOLERANCES
.x ± 0.2
.xx ± 0.25
.xxx ± 0.010

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

ASSEMBLY, COOLING PACKAGE
SHELL & TUBE, CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

DATE: 17-MAY-10

PRO-ENGINEER

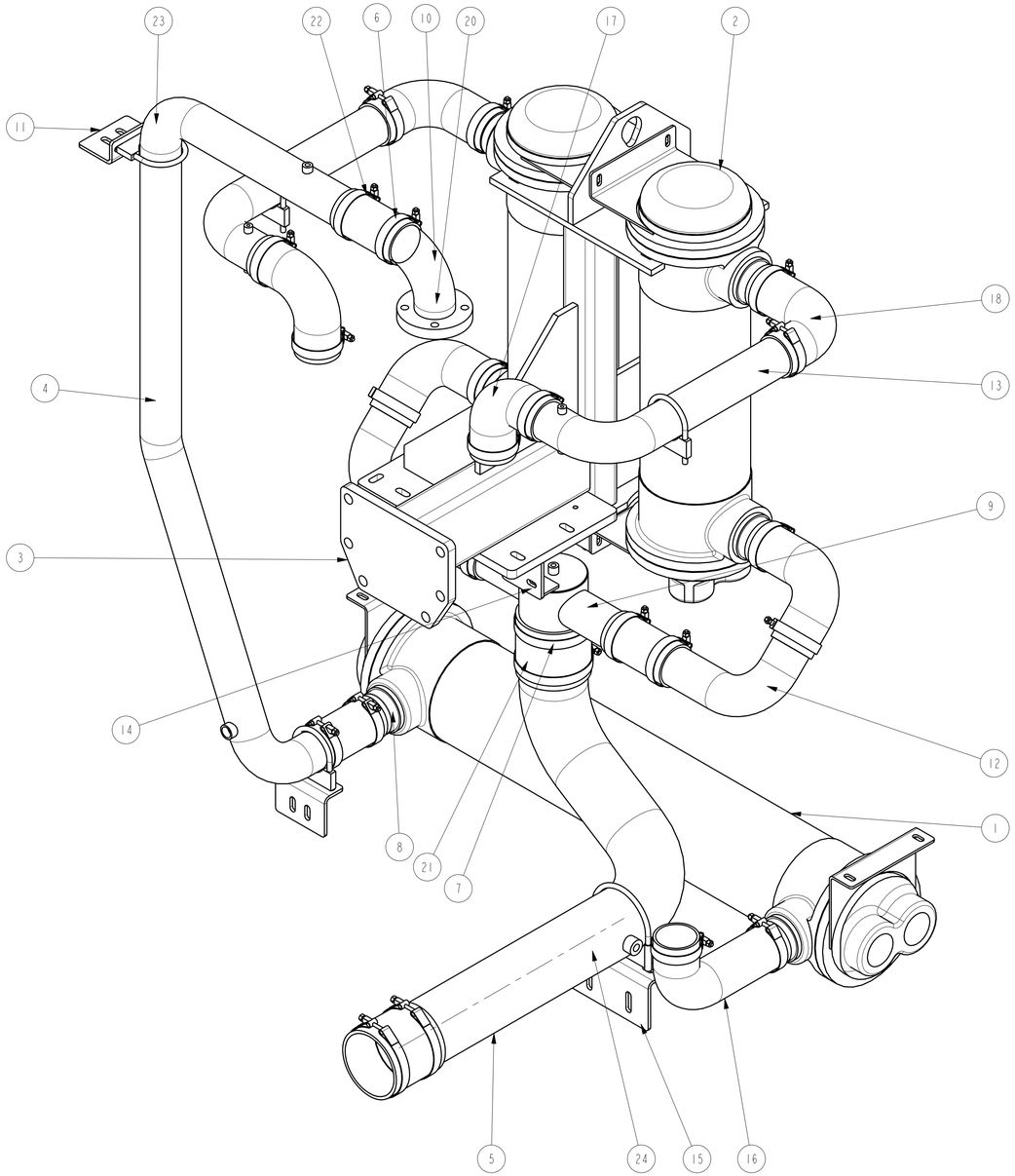
INIT ECO: 2010-250

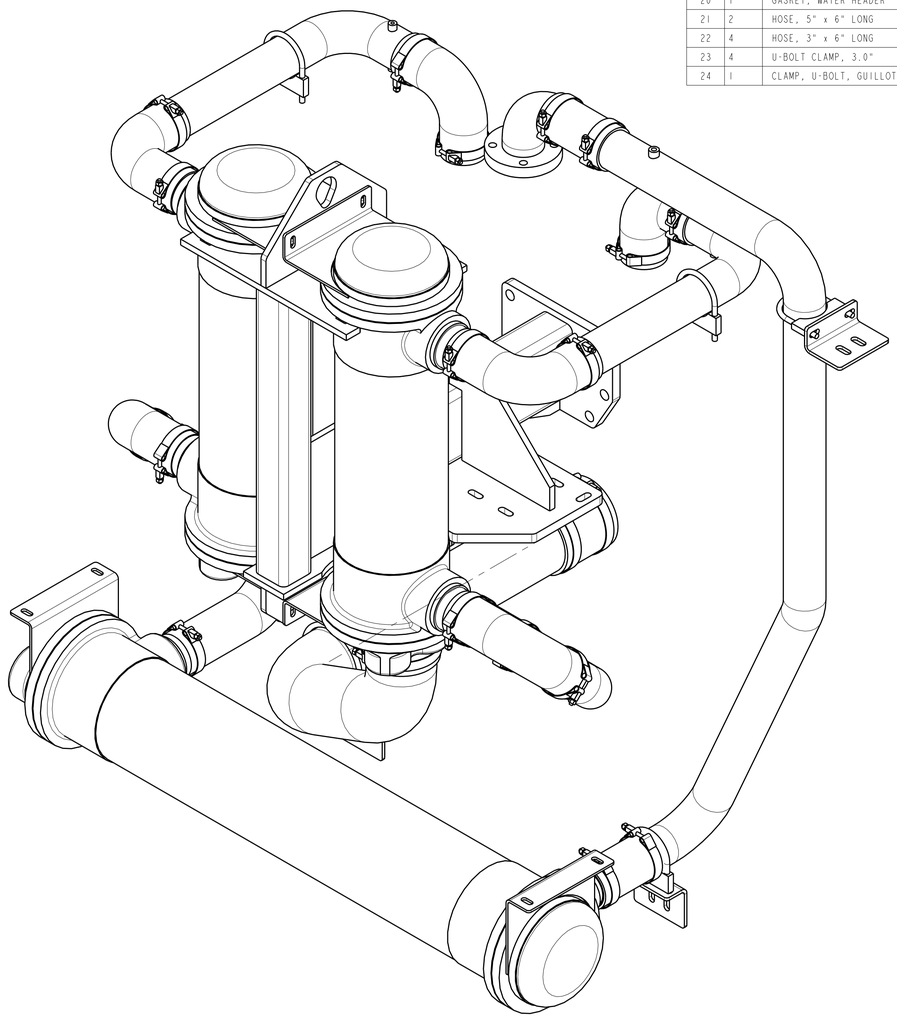
SCALE: 0.188

EST WEIGHT: 927.284

SHEET 1 OF 1

DRAWING NO: 17057





BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HEAT EXCHANGER, SHELL AND TUBE, 2-PASS, 8" DIA. W/ 2-1/2" NPT WATER CONNECTION	16229
2	2	HEAT EXCHANGER, SHELL AND TUBE, 4-PASS, 8" DIA. W/ 2" NPT WATER CONNECTION	16230
3	1	BRACKET, HEAT EXCHANGER MOUNTING, CFP50	17058
4	1	TUBE, LTA DISCHARGE, CFP50	17061
5	1	TUBE, JW SUCTION, CFP50	17062
6	22	CLAMP, T-BOLT, 3.28-3.59	13164-0350
7	4	CLAMP, T-BOLT, 5.28-5.59	13164-0550
8	6	FITTING, BARBED HOSE, 3" NPT-3" HOSE	13779
9	1	TUBE, JW SUCTION SPLITTER, CFP50	16409
10	1	FLANGE ADAPTER, 3" ELBOW, LTA CIRCUIT DIACHARGE, CFP50	16410
11	2	BRACKET, TUBE BRACE, FITS 3" U-BOLT	16503
12	2	TUBE, RADIATOR, 3" DIA. 90 DEGREE, 10" X 8"	17059
13	2	TUBE, RADIATOR, 3" DIA. 90 DEGREE, 8" X 20"	17060
14	1	BRACKET, JW TUBE BRACE	17115
15	1	BRACKET, TUBE BRACE, FITS 3" U-BOLT	17169
16	1	ELBOW, 3" ID, 90 DEGREE	21042
17	2	ELBOW, 3" ID, 90 DEGREE	21042
18	4	ELBOW, 3" ID, 90 DEGREE	21042
19	1	SPRING, , NOT SHOWN	21042_SPRING
20	1	GASKET, WATER HEADER	3633419
21	2	HOSE, 5" x 6" LONG	24480G-5
22	4	HOSE, 3" x 6" LONG	77300GL-6
23	4	U-BOLT CLAMP, 3.0"	U-300
24	1	CLAMP, U-BOLT, GUILLOTINE, 5.00", PLATED	U-500

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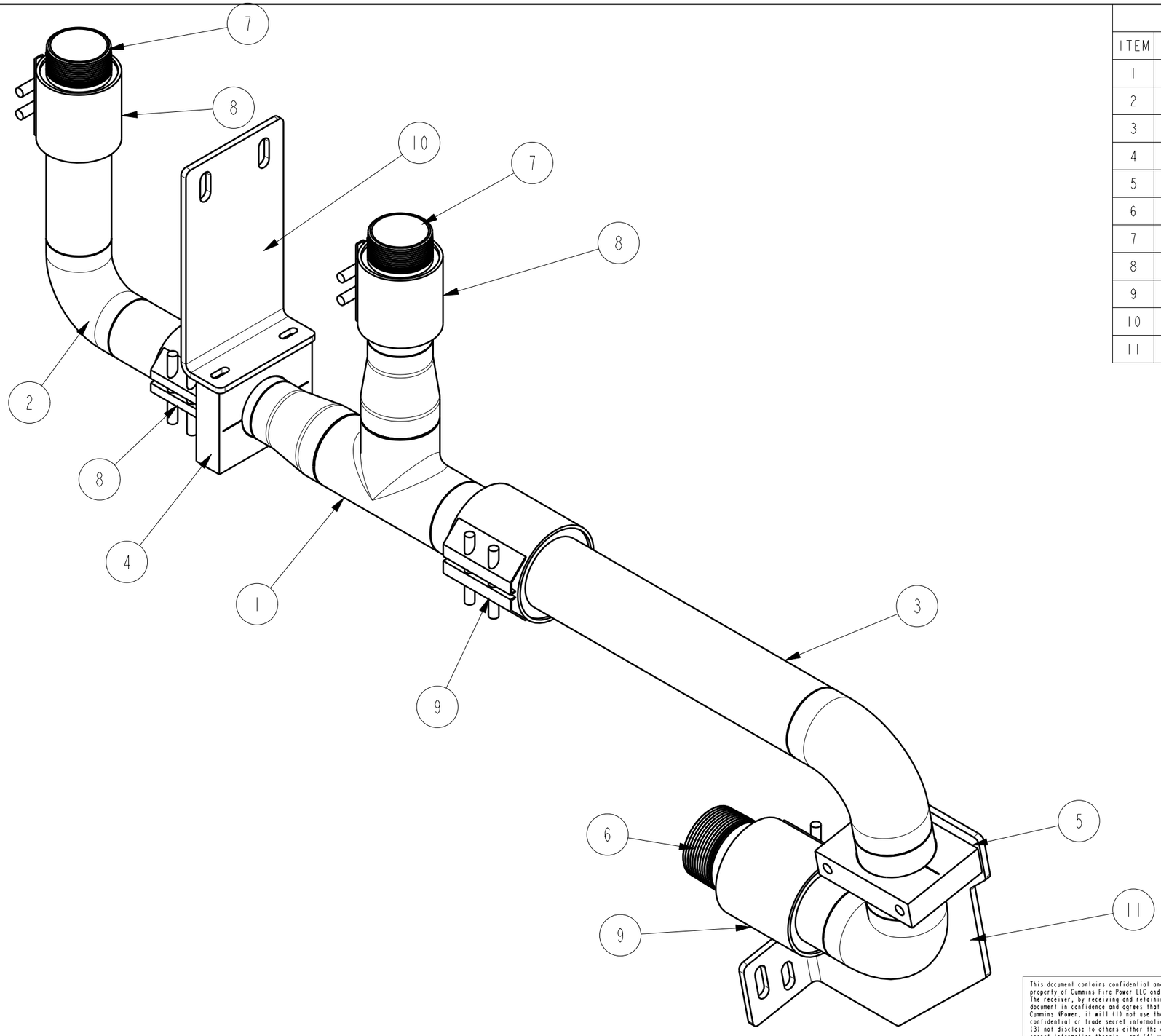
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, COOLING PACKAGE, LH
SHELL & TUBE, CFP50

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE
ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS
THIRD ANGLE PROJECTION

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

DWG UNITS: IN/LB/S
DRAWN BY: DAN
DATE: 17-MAY-10
PRO-ENGINEER
INIT ECO: 2010-250
SCALE: 0.188
EST WEIGHT: 933.228
SHEET 1 OF 1
DRAWING NO: 17132



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	PIPE WELDMENT, COPPER NICKEL, CFP50	17084
2	1	WELDMENT, 2" PIPE, 90 DEGREE, SEA WATER COMPATABLE	17085
3	1	WELDMENT, 2-1/2" PIPE, 180 DEGREE, SEA WATER COMPATABLE	17086
4	1	CLAMP,PIPE,2",PLASTIC	15360
5	1	CLAMP, PIPE, 2-1/2", PLASTIC	16438
6	1	HALF NIPPLE, 2-1/2" X 4", COPPER NICKEL	16481
7	2	HALF NIPPLE, 2" X 2-1/2", COPPER NICKEL	16483
8	3	COUPLING, CLAMP TYPE, 2" NPT	16484_32
9	2	COUPLING, CLAMP TYPE, 2-1/2" NPT	16484_40
10	1	BRACKET, SEA WATER PIPING, CFP50	17343
11	1	BRACKET, SEA WATER PIPING, CFP50	17351

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, SEA WATER PIPING CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

DATE: 17-MAY-10

PRO-ENGINEER

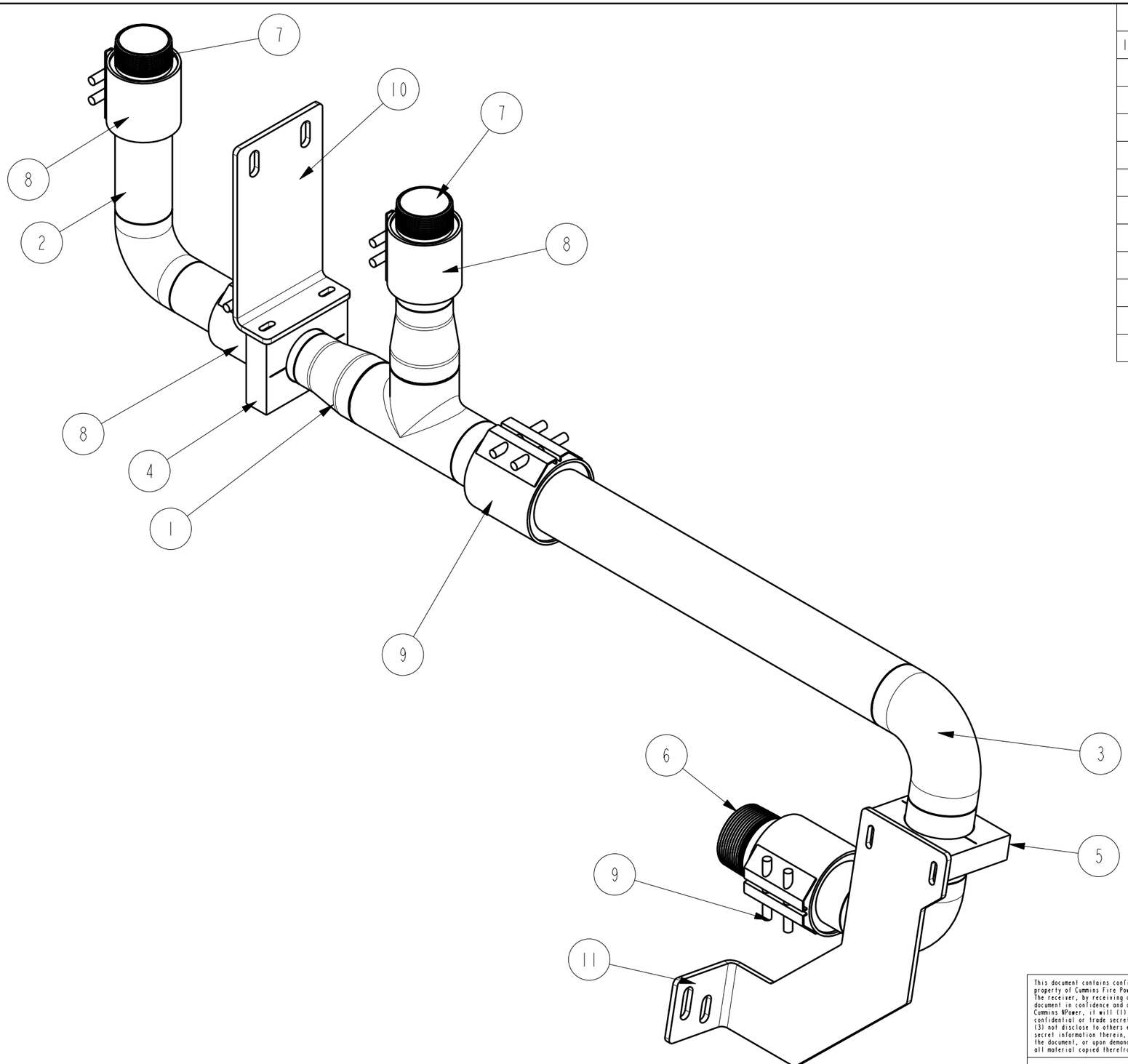
INIT ECO: 2010-250

SCALE: 0.250

EST WEIGHT: 37.518

SHEET 1 OF 1

DRAWING NO: 17083



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	PIPE WELDMENT, COPPER NICKEL, CFP50	17084
2	1	WELDMENT, 2" PIPE, 90 DEGREE, SEA WATER COMPATABLE	17085
3	1	WELDMENT, 2-1/2" PIPE, 180 DEGREE, SEA WATER COMPATABLE	17133
4	1	CLAMP,PIPE,2",PLASTIC	15360
5	1	CLAMP, PIPE, 2-1/2", PLASTIC	16438
6	1	HALF NIPPLE, 2-1/2" X 4", COPPER NICKEL	16481
7	2	HALF NIPPLE, 2" X 2-1/2", COPPER NICKEL	16483
8	3	COUPLING, CLAMP TYPE, 2" NPT	16484_32
9	2	COUPLING, CLAMP TYPE, 2-1/2" NPT	16484_40
10	1	BRACKET, SEA WATER PIPING, CFP50	17343
11	1	BRACKET, SEA WATER PIPING, CFP50	17351

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015	FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

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ASSEMBLY, SEA WATER PIPING CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

PRO-ENGINEER

DATE: 17-MAY-10

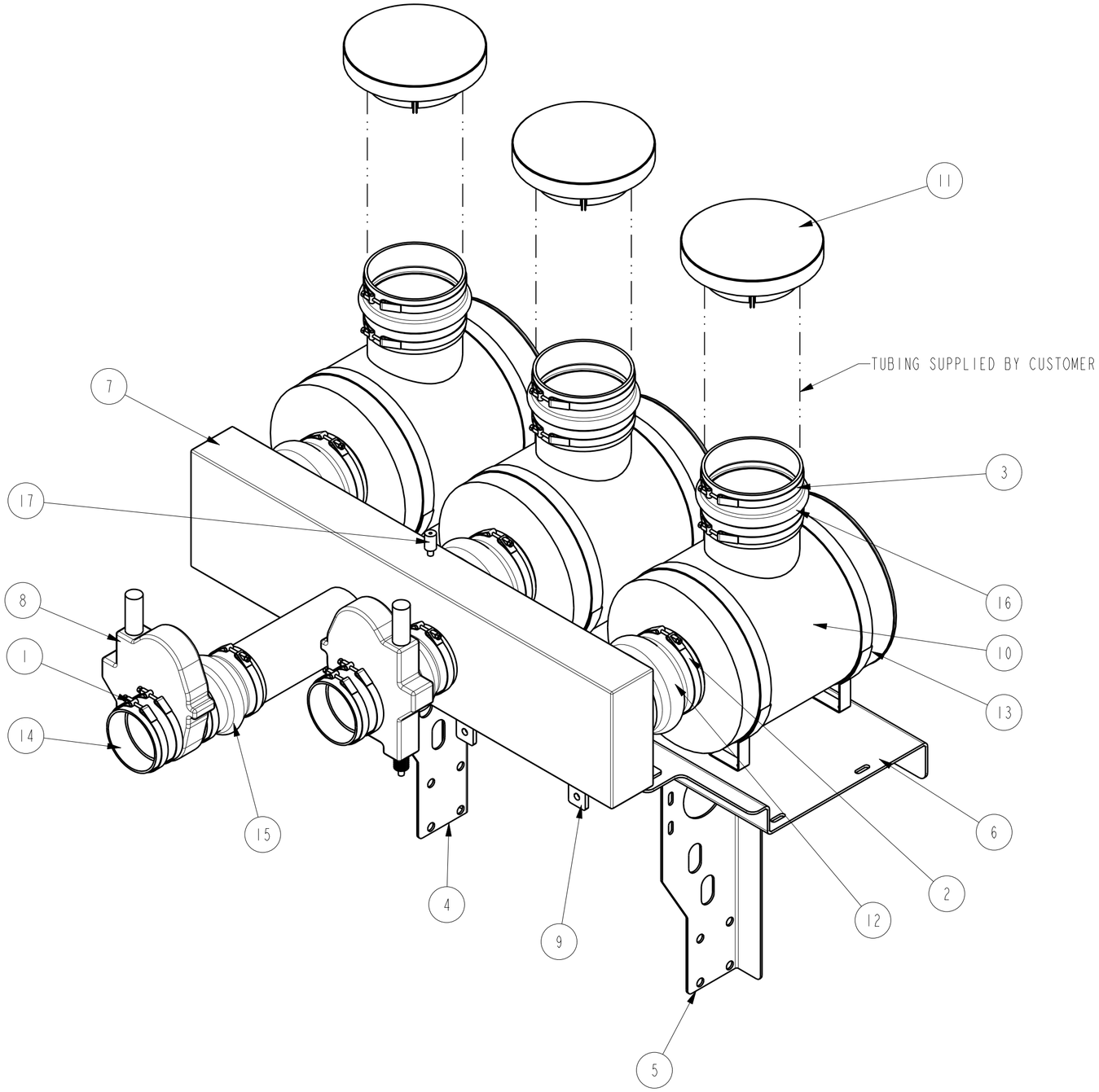
INIT ECO: 2010-250

SCALE: 0.219

EST WEIGHT: 39.015

SHEET 1 OF 1

DRAWING NO: 17134



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	8	CLAMP, T-BOLT, 5.78-6.09	13164-0600
2	6	CLAMP, T-BOLT, 7.28-7.59	13164-0750
3	6	CLAMP, T-BOLT, 8.25-8.56	13164-0850
4	1	BRACKET, AIR CLEANER SUPPORT, RH, CFP50	17073
5	1	BRACKET, AIR CLEANER SUPPORT, LH, CFP50	17074
6	1	BRACKET, AIR CLEANER MOUNTING, CFP50	17075
7	1	PLENUM, AIR INTAKE, CFP50	17077
8	2	INTAKE SHUT DOWN, 5.50" DIA CONNECTION	17078
9	2	BRACE, AIR CLEANER BRACKET, CFP50	17166
10	3	AIR CLEANER, METAL, MARINE GRADE, 7" CONNECTION, 8" INLET	17269
11	3	BONNET, AIR INTAKE, 8" I.D. INLET, 316 STAINLESS STEEL, PAINTED	17270
12	3	HUMP HOSE, 7.0"DIA, -	3316613S
13	6	MOUNTING BAND, 16" DIAMETER	3918236S
14	2	HOSE, 5.50" x 3" LONG	75550GL-3
15	2	HUMP-HOSE, 5.5" ID	89838K
16	3	HUMP HOSE, 8", NELSON 8"	89841K
17	1	RESTRICTION INDIACOR, 1/8" NPT	RAX00-2352

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS

THIRD ANGLE PROJECTION

MACHINE TOLERANCES .XX ± 0.010 .XXX ± 0.005
FORM TOLERANCES .XX ± 0.030 .XXX ± 0.015
FAB TOLERANCES .XX ± 0.060 .XXX ± 0.030

MACHINE TOLERANCES .X ± 0.2 .XX ± 0.2
FORM TOLERANCES .X ± 0.8 .XX ± 0.4
FAB TOLERANCES .X ± 1.5 .XX ± 0.8

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DEPERE, WISCONSIN

ASSEMBLY, AIR CLEANERS
CFP50

DWG UNITS: IN/LB/S | DRAWN BY: DAN | DATE: 17-MAY-10

PRO-ENGINEER | INIT ECO: 2010-250

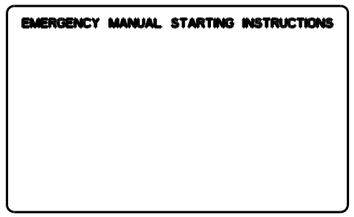
SCALE: 0.125 | SHEET 1 OF 1 | DRAWING NO: 17072

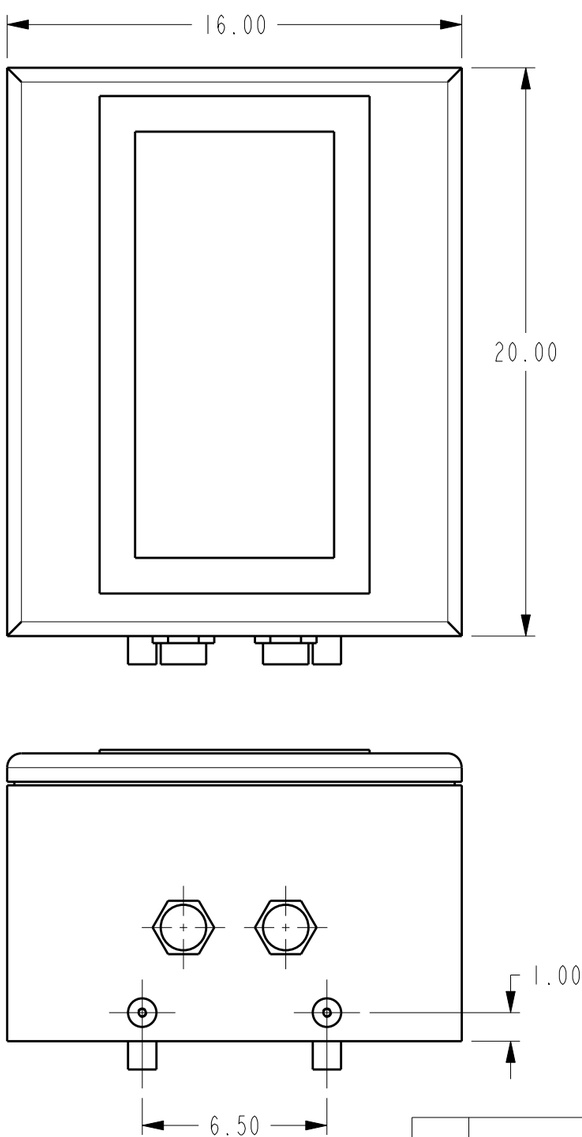
EST WEIGHT: 460.808

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	6	ISOLATOR, PLATE MOUNT, 5/16-18 x 1LG x 1 DIA, NEOPRENE	16201
2	1	INSTRUCTIONS, EMERGENCY START	17292

NEW CONTROL PANEL P/N TBD





REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005 FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015 FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2 FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4 FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

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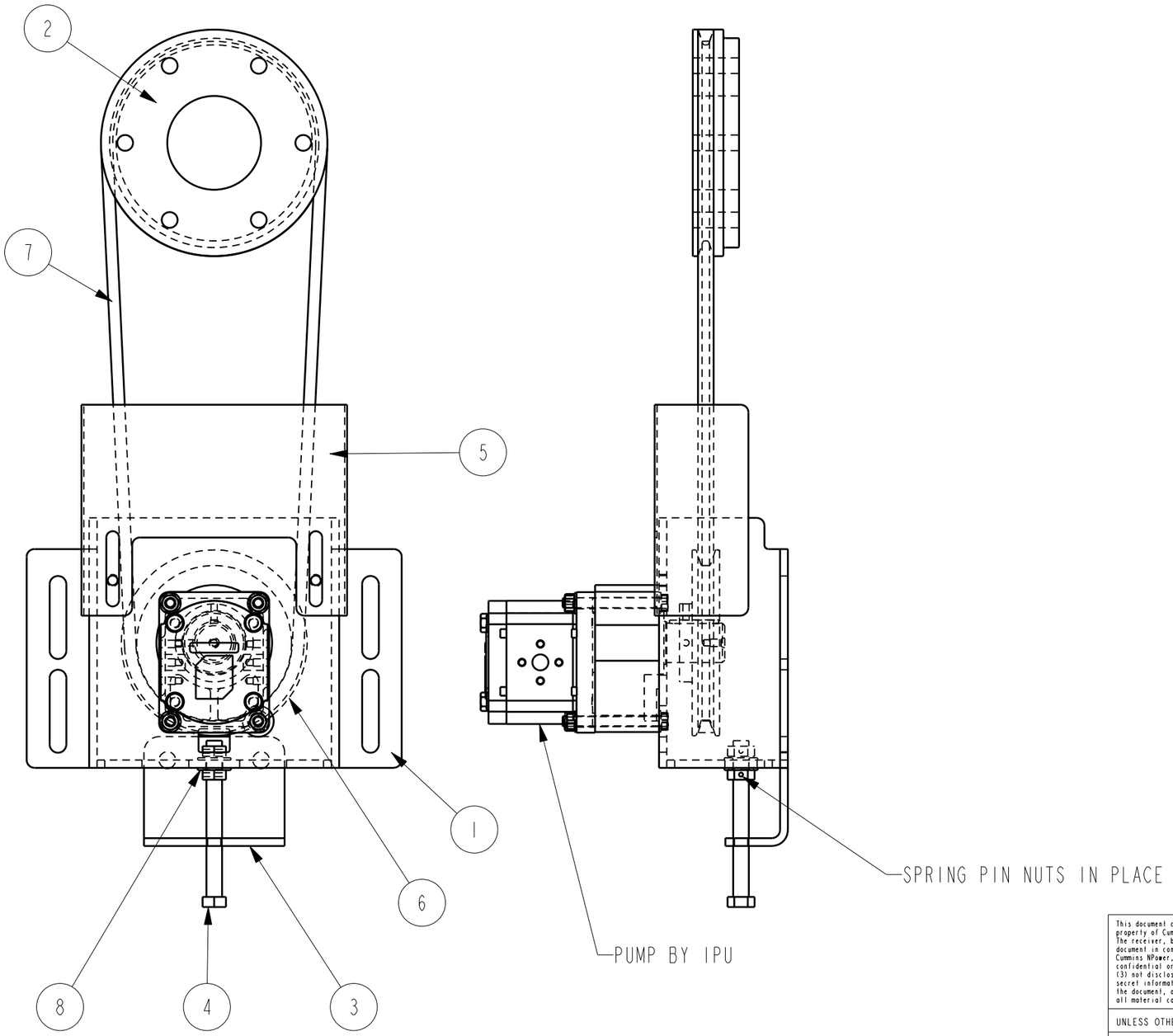
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

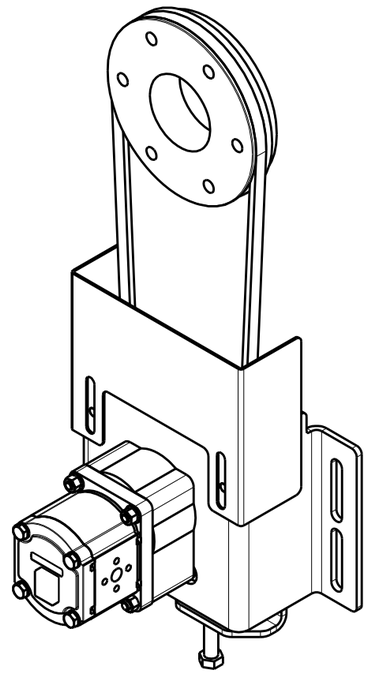
ASSEMBLY, OPERATORS STATION
CFP50

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 19-JUL-10
PRO-ENGINEER		INIT ECO: 2010-250
SCALE: 0.188	SHEET 1 OF 1	DRAWING NO: 17087
EST WEIGHT: 142.702		

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	BRACKET, RECHARGE PUMP, CFP50	17092
2	1	PULLEY, ACCESSORY DRIVE,, "A" SECTION V-BELT	17093
3	1	BRACKET, JACKING, RE-CHARGE PUMP, CFP50	17094
4	1	BOLT, JACKING, RECHARGE PUMP, CFP50	17095
5	1	GUARD, RECHARGE PUMP PULLEY, CFP50	17097
6	1	PULLEY, "A" GROOVE, 5.95" O.D., 32mm BORE	17754
7	1	V-BELT, "A" SECTION, 51.2" DEVELOPED LENGTH	556421
8	2	WASH,FLT,0.531D X 1.060D X .074THK, -	WASHER_1-2





SCALE 0.188

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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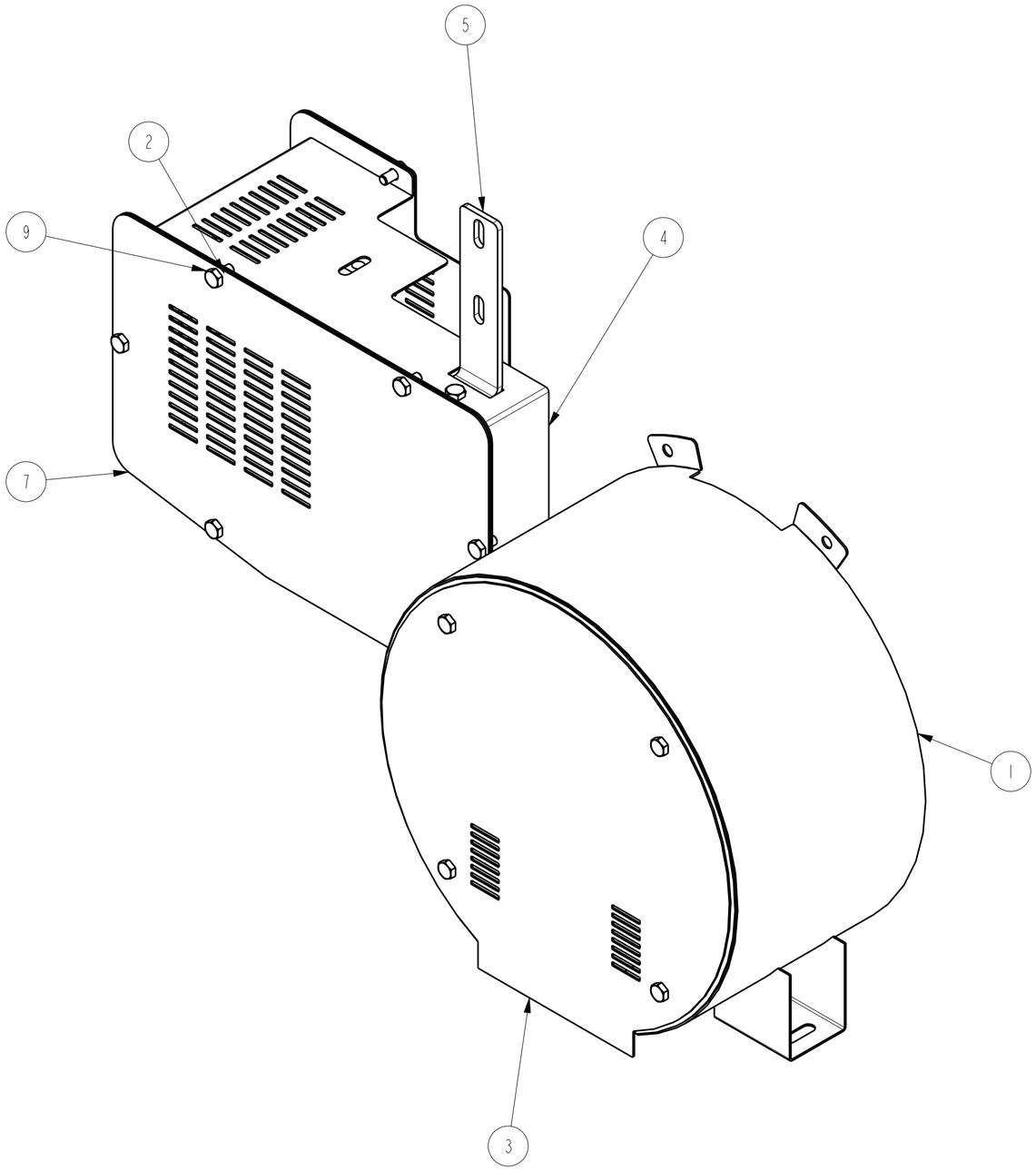
DEPERE, WISCONSIN

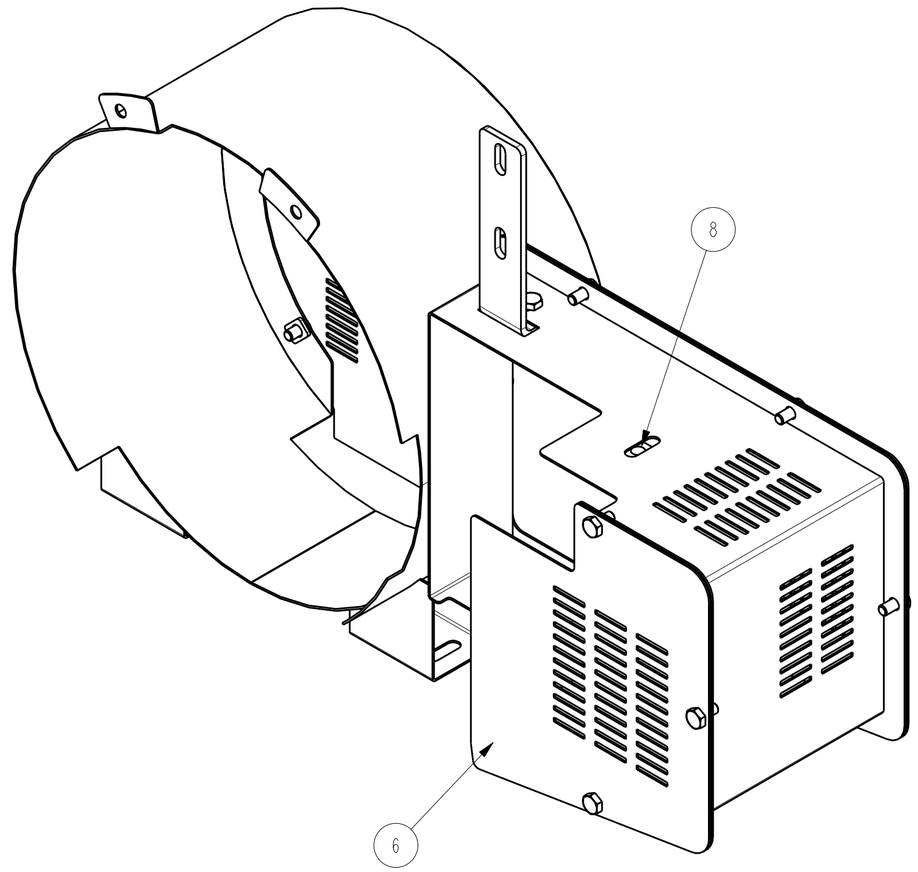
ASSEMBLY, HYDRAULIC RECHARGE PUMP
CFP50

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 17-MAY-10
	PRO-ENGINEER	INIT ECO: 2010-389
SCALE: 0.250	SHEET 1 OF 1	DRAWING NO: 17091
EST WEIGHT: 34.148		

BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	GUARD, DAMPENER, CFP50	17099
2	13	RETAINING WASHER, PUSHNUT, M10 BOLT	16662-13
3	1	COVER, DAMPENER, CFP50	17100
4	1	GUARD BODY, ALTERNATOR, CFP50	17101
5	1	BRACKET, ALTERNATOR GUARD, CFP50	17102
6	1	COVER, ALTERNATOR, CFP50	17103
7	1	COVER, ALTERNATOR GUARD, CFP50	17104
8	1	SPACER, ALTERNATOR GUARD, CFP50	17186
9	14	SCREW, CAP, HEX HEAD, M10-1.5 x 20	HHCS_M10-20





UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

	IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES	.XX ± 0.010 .XXX ± 0.005	.X ± 0.2 .XX ± 0.1
FORM TOLERANCES	.XX ± 0.015 .XXX ± 0.075	.X ± 0.4 .XX ± 0.2
FAO TOLERANCES	.XX ± 0.030 .XXX ± 0.090	.X ± 0.8 .XX ± 0.2

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

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DEPERE, WISCONSIN

ASSEMBLY, FRONT GUARDS
CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

PRO-ENGINEER

DATE: 17-MAY-10

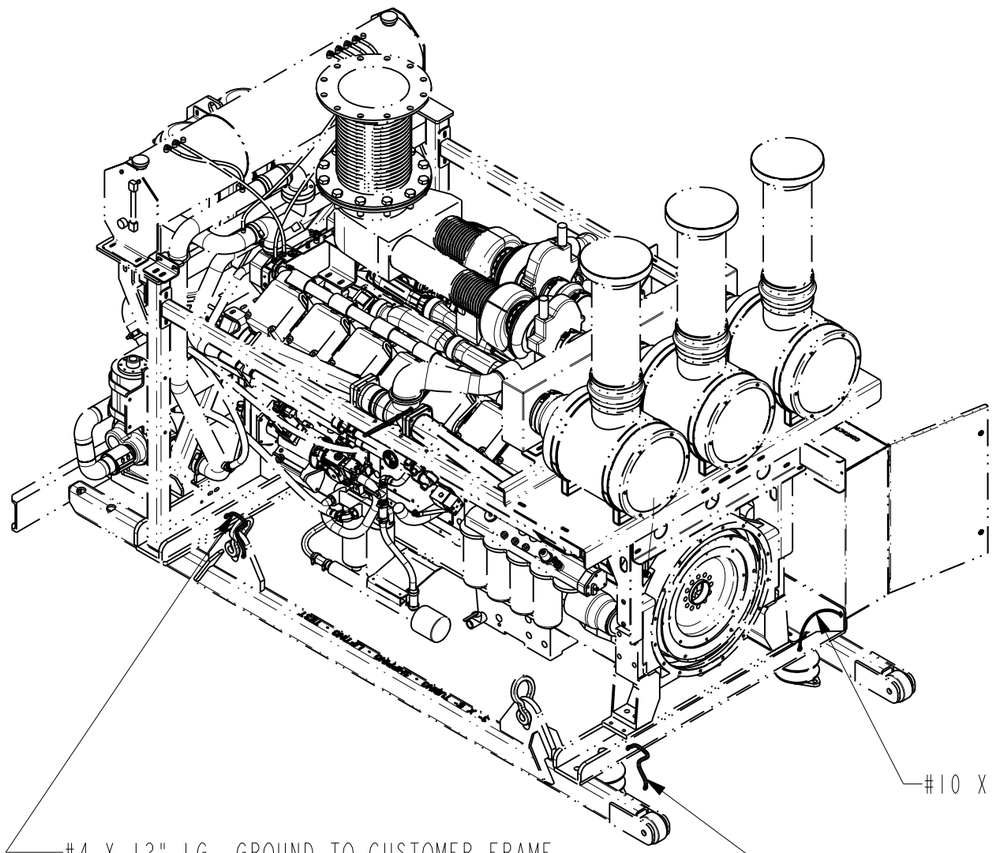
INIT ECO: -

SCALE: 0.250

EST WEIGHT: 35.954

SHEET 1 OF 1

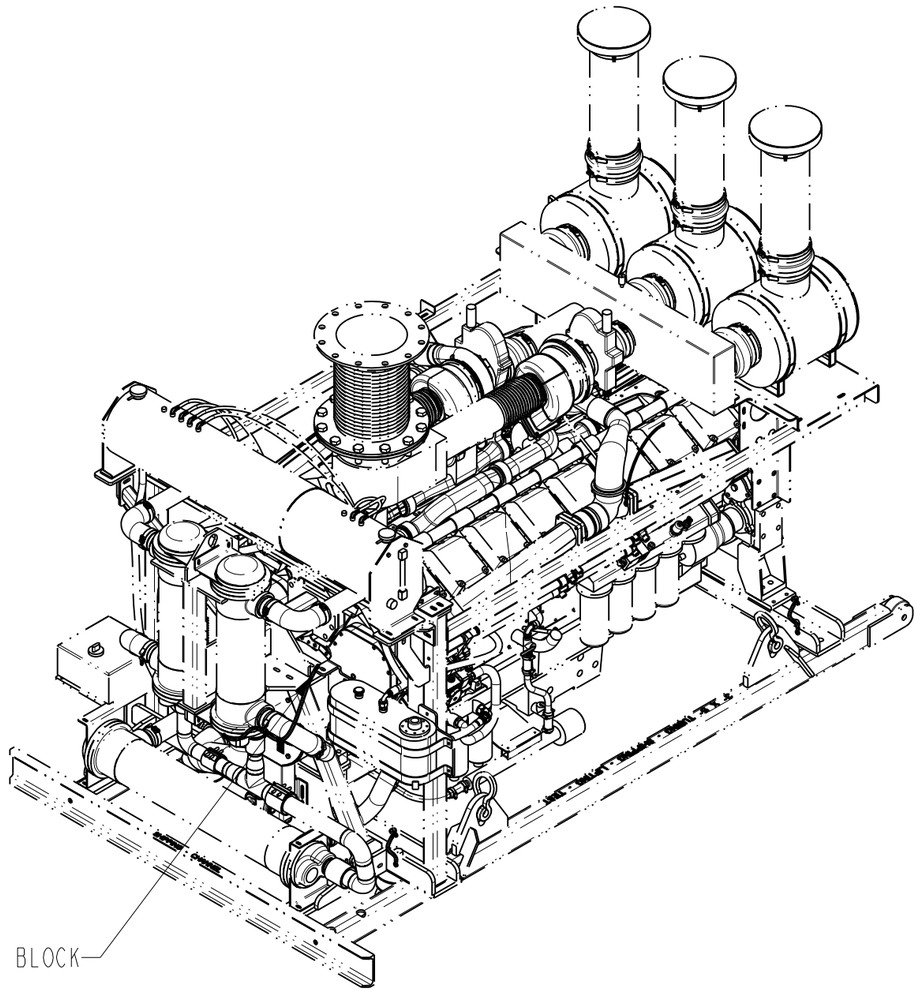
DRAWING NO: 17098



#10 X 18" GROUND CONTACTOR PANEL

#4 X 12" LG. GROUND TO CUSTOMER FRAME

#4 X 12" LG. GROUND TO CUSTOMER FRAME



#10 GROUND WIRES ON EACH HEAT EXCHANGER BACK TO BLOCK REQUIRED (NOT SHOWN)

#10 X 18" LG. GROUND HEAT EXCHANGER MOUNTING TO ENGINE BLOCK

ALL GROUNDING WIRES MADE FROM STOCK MATERIALS AT ASSEMBLY

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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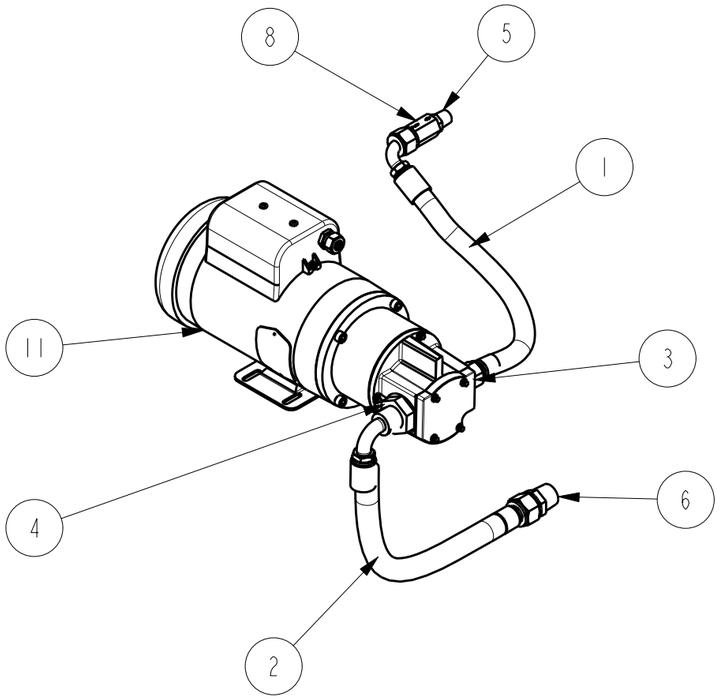
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

KIT, EARTH BONDING WIRES
CFP50

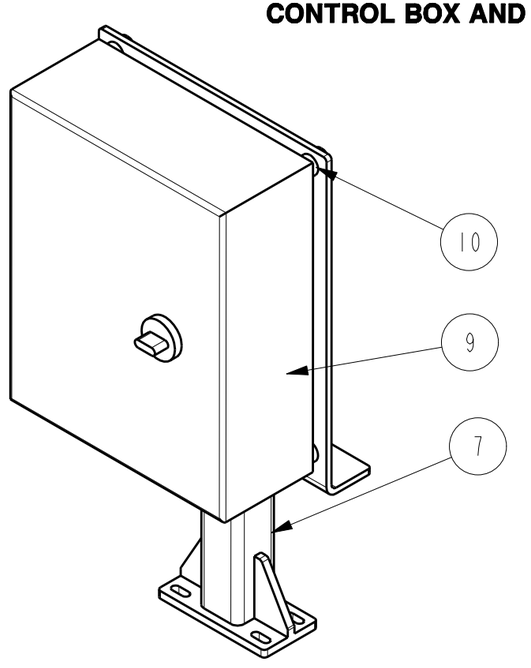
DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 17-MAY-10
	PRO-ENGINEER	INIT ECO: 2010-250
SCALE: 0.100	SHEET 1 OF 1	DRAWING NO: 17107
EST WEIGHT: 6.321		



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	HOSE, PRESSURE, PRELUBE, CFP50	17251
2	1	HOSE, SUCTION, PRELUBE, CFP50	17252
3	1	FTG, STR, -12 JIC X -16 ORB	12235-12-16
4	1	FTG, STR, -16 JIC X -20 ORB	12235-16-20
5	1	FTG, STR, -10 JIC X -8 NPT	12238-10-8
6	1	FTG, STR, -16 JIC X -16 NPT	12238-16-16
7	1	PEDISTALL, PRELUBE MODULE, CFP50 - NPT DEFINED	17113
8	1	VALVE, CHECK, MALE JIC X FEMALE JIC, #10 JIC	17167-10
9	1	CONTROL, PRELUBE	SEE ELECTRICAL
10	4	MOUNT, ISOLATOR, 2-PIECE, TECH PRODUCTUCTS 60012	60012
11	1	PUMP W/ MOTOR	RPM# 100536-1

CONTROL BOX AND STAND TO SHIP LOOSE



REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005 FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015 FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2 FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4 FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

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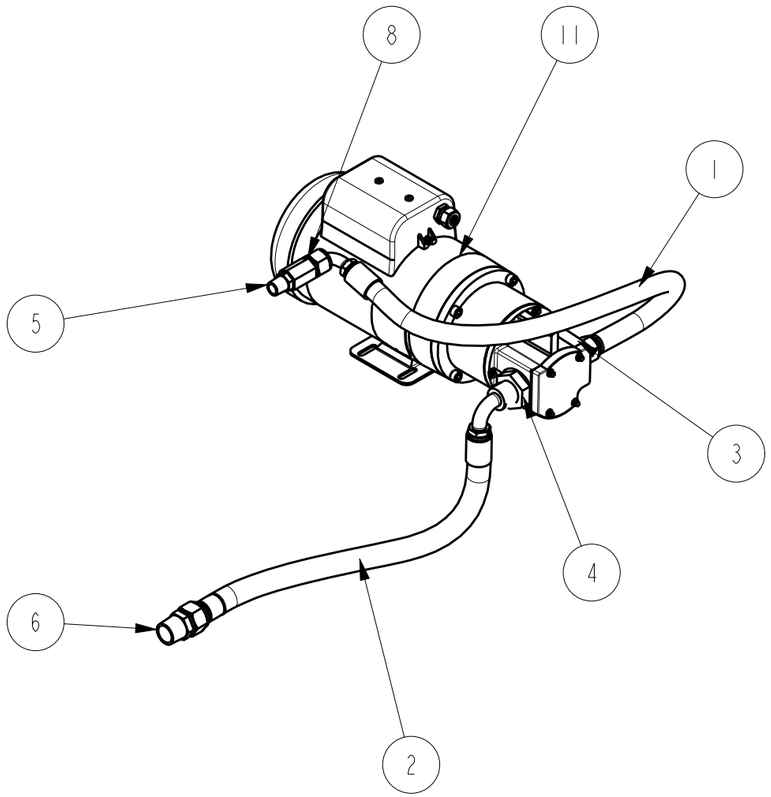
DEPERE, WISCONSIN

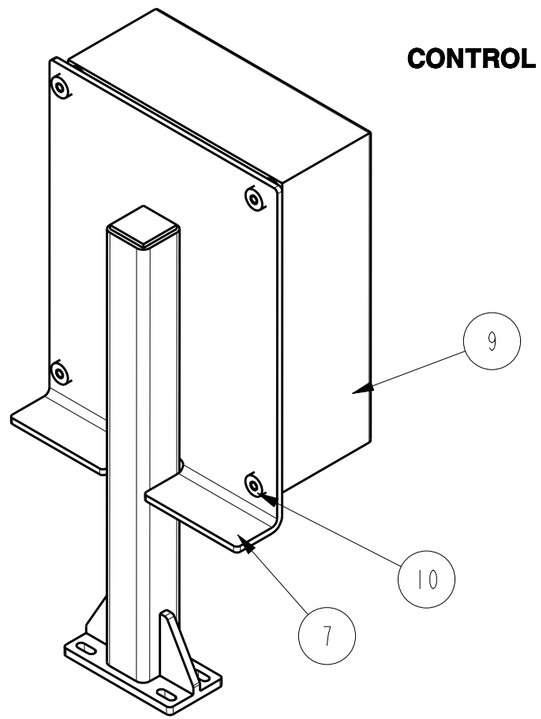
PRELUBE, STARTERS RIGHT BANK

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 10-JUN-10
	PRO-ENGINEER	INIT ECO: 2010-250
SCALE: 0.125	SHEET 1 OF 1	DRAWING NO: 17112
EST WEIGHT: 144.490		



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ASSEMBLY, HOSE, PRELUBE, CFP50 PRESSURE	17253
2	1	ASSEMBLY, HOSE, PRELUBE, CFP50 SUPPLY	17254
3	1	FTG, STR, -12 JIC X -16 ORB	12235-12-16
4	1	FTG, STR, -16 JIC X -20 ORB	12235-16-20
5	1	FTG, STR, -10 JIC X -8 NPT	12238-10-8
6	1	FTG, STR, -16 JIC X -16 NPT	12238-16-16
7	1	PEDISTALL, PRELUBE MODULE, CFP50 - NPT DEFINED	17113
8	1	VALVE, CHECK, MALE JIC X FEMALE JIC, #10 JIC	17167-10
9	1	CONTROL, PRELUBE	SEE ELECTRICAL
10	4	MOUNT, ISOLATOR, 2-PIECE, TECH PRODUCTUCTS 60012	60012
11	1	PUMP W/ MOTOR	RPM# 100536-1



CONTROL BOX AND STAND TO SHIP LOOSE

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

IMPERIAL UNITS

MACHINE TOLERANCES
.XX : ± 0.010
.XXX : ± 0.005

FORM TOLERANCES
.XX : ± 0.030
.XXX : ± 0.015

FAB TOLERANCES
.XX : ± 0.060
.XXX : ± 0.030

METRIC UNITS

MACHINE TOLERANCES
.X : ± 0.4
.XX : ± 0.2

FORM TOLERANCES
.X : ± 0.8
.XX : ± 0.4

FAB TOLERANCES
.X : ± 1.5
.XX : ± 0.8

THIRD ANGLE PROJECTION

Fire Power

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

ASSEMBLY, PRELUBE

DWG UNITS: IN/LB/S

DRAWN BY: DAN

DATE: 17-MAY-10

PRO-ENGINEER

INIT ECO: 2010-250

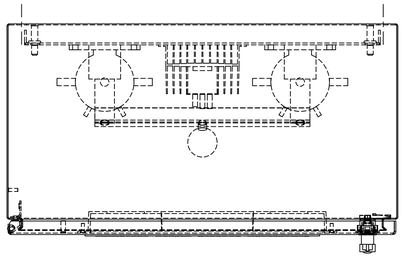
SCALE: 0.125

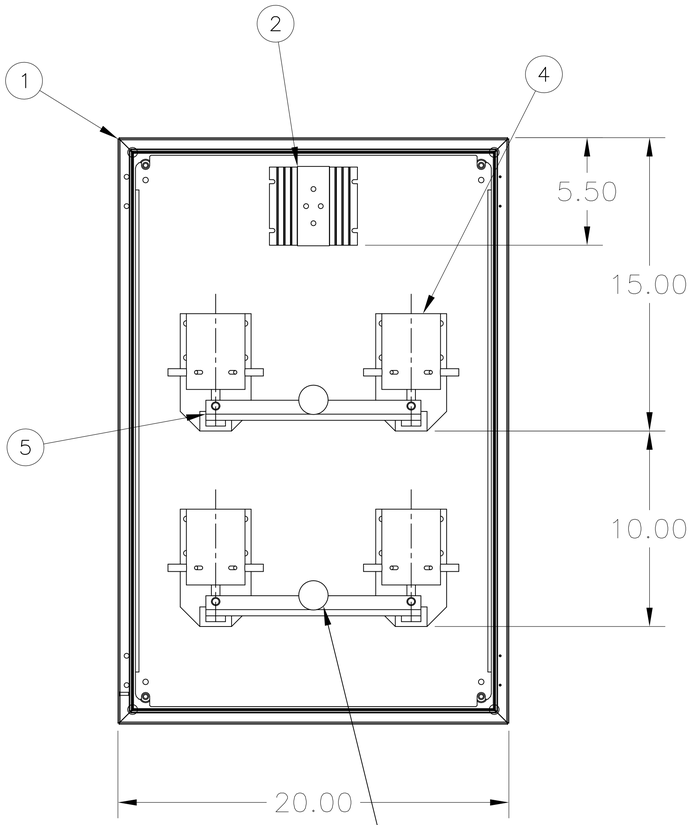
EST WEIGHT: 145.728

SHEET 1 OF 1

DRAWING NO: 17114

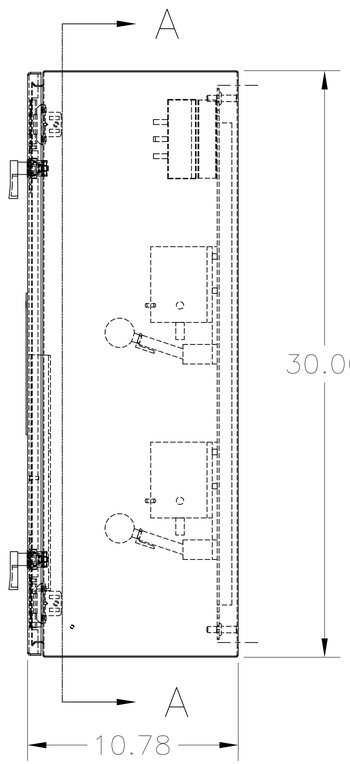
BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ENCLOSURE, 20 X 30 X 10, STAINLESS STEEL	17291
2	1	BATTERY ISOLATOR, FIRE PUMP	8838
3	1	INSTRUCTIONS, EMERGENCY START	17292
4	4	CONTACTOR, MANUAL OVERIDE, FIREPUMP	17293
5	2	ANGLE, CONTACTOR PULL	17294
6	1	SCHEMATIC, FIREPUMP CONTACTOR BOX, SEE PAGE #2	17507

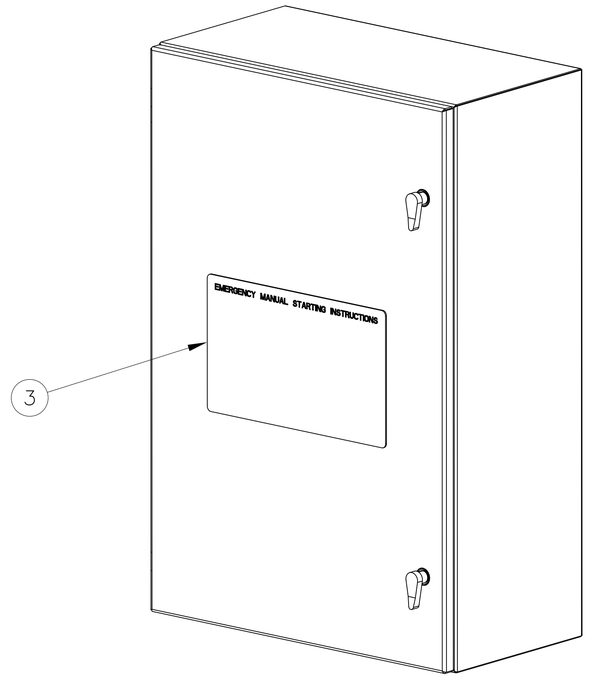




SECTION
A–A

(2) RELOCATE KNOB
TO ANGLE





UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

Fire Power

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

CONTACTORS, MANUAL START
CFP50

DWG UNITS: INCH/LB/S

DRAWN BY: DAN

AUTO CAD

DATE: 22JUL2010

REF DRWG:

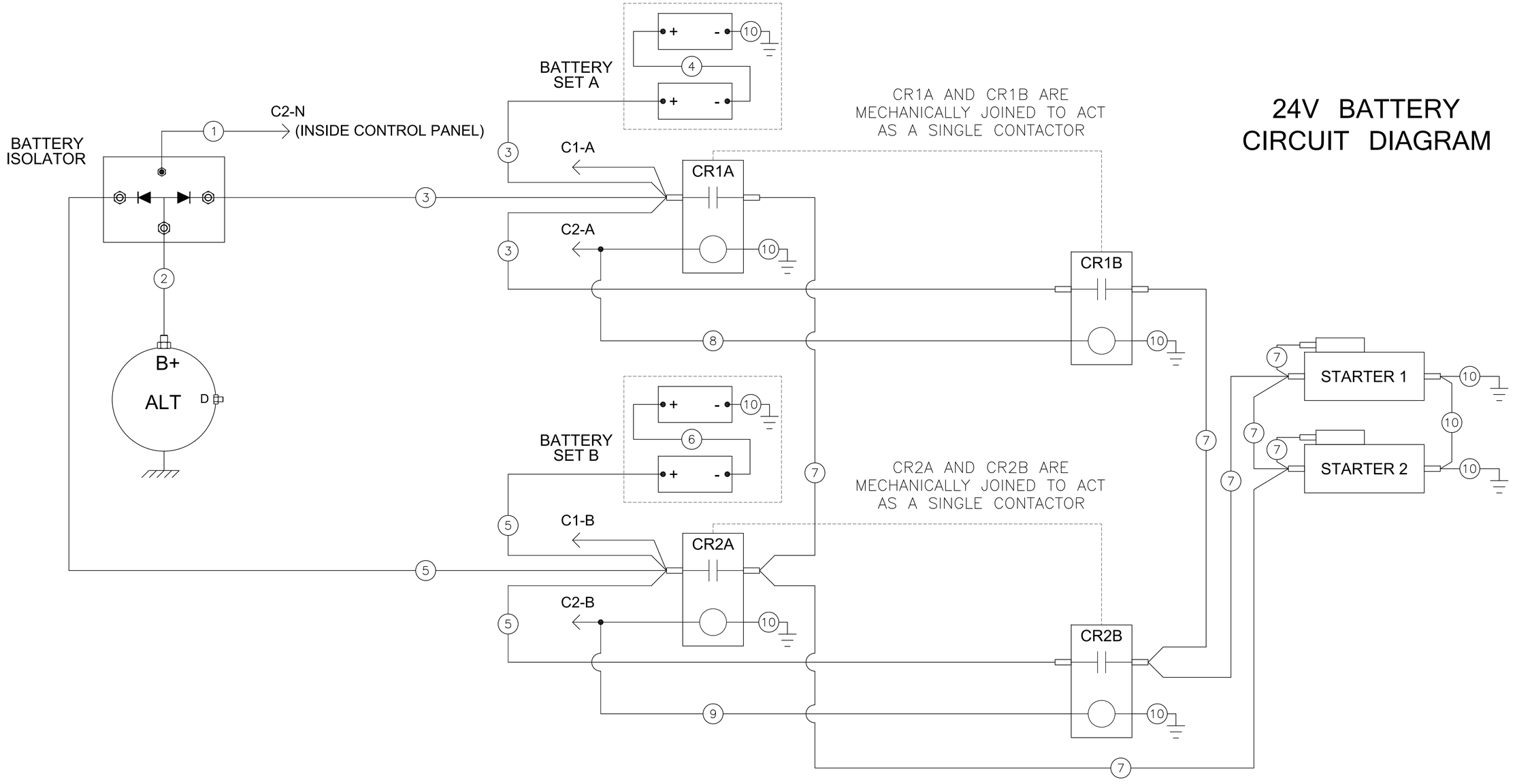
SCALE:

EST WEIGHT:

SHEET 1OF2

DRAWING NO: 17290

24V BATTERY CIRCUIT DIAGRAM



NOTES:
1. ALL WIRES MUST BE LSZH
2. WIRES MUST BE LABELED ON BOTH ENDS USING WEIDMULLER 1813130000 LABELS

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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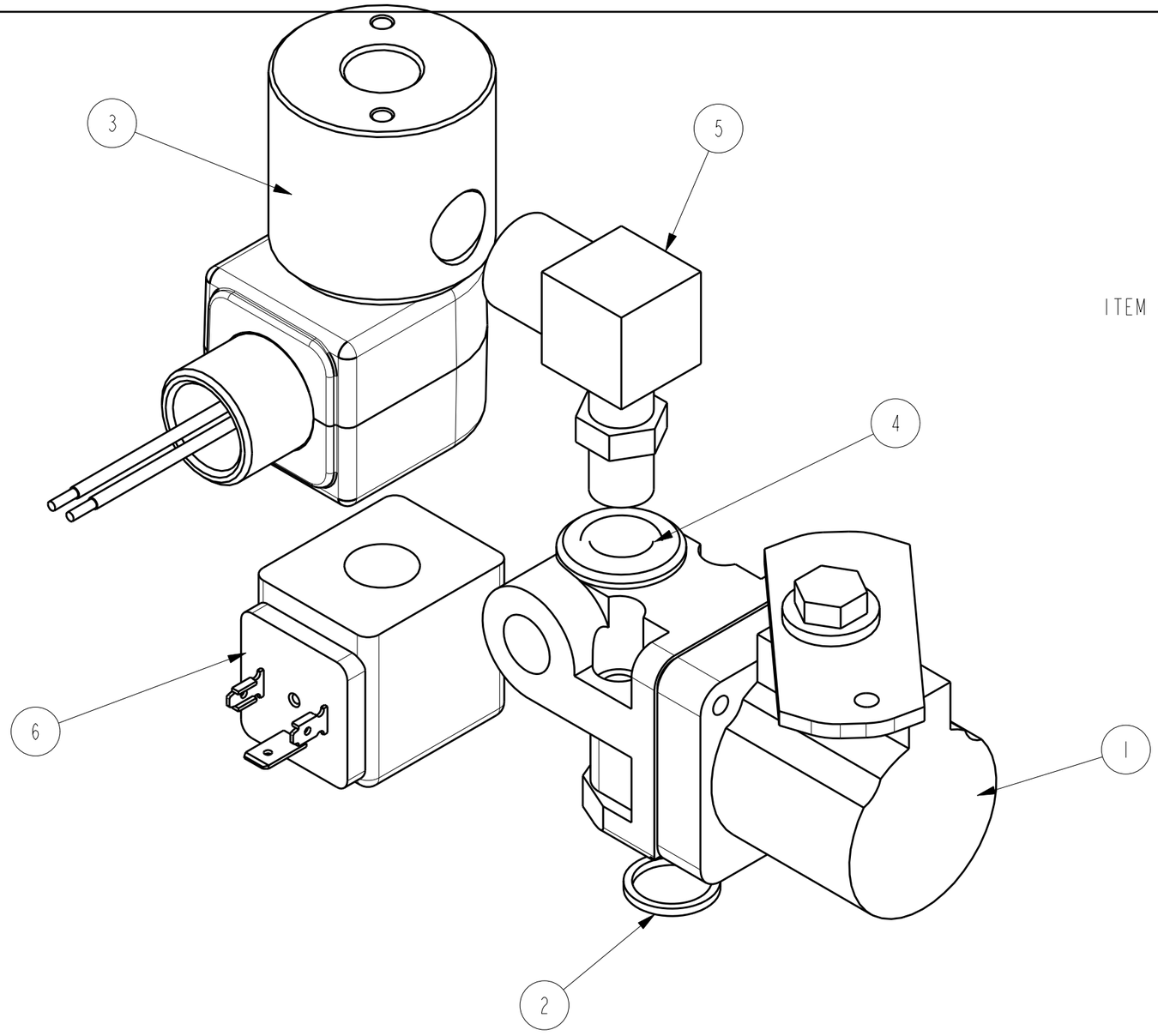
CUSTOM DESIGN AND
UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

CONTACTORS, MANUAL START
CFP50

DWG UNITS: INCH/LB/S	DRAWN BY: PBS	DATE: 22JUL2010
	AUTO CAD	REF DRWG:
SCALE:	SHEET 2OF2	DRAWING NO: 17290
EST WEIGHT:		



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	VALVE, FUEL SHUT OFF, NORMALLY OPEN, CFP50	3417159
2	1	SEAL, RECTANGULAR RING	154087
3	1	VALVE, FUEL SHUT OFF, 24 VDC	3025987
4	1	SEAL, O-RING	3627695
5	1	ELBOW, FUEL PLUMBING	3631691
6	1	COIL, NORMALLY OPEN, 24 VDC	481865C2

ITEM #6 REPLACEMENT SOLENOID (PARKER NO. 481865) MAY NOT BE NEEDED

STARTING POINT ONLY - UPDATE PER FIRST BUILD

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015	FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

Fire Power

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CORPORATE OFFICE
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WHITE BEAR LAKE, MN
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CUSTOM DESIGN
AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, FUEL VALVE, POWER TO CLOSE CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

PRO-ENGINEER

DATE: 01-JUL-10

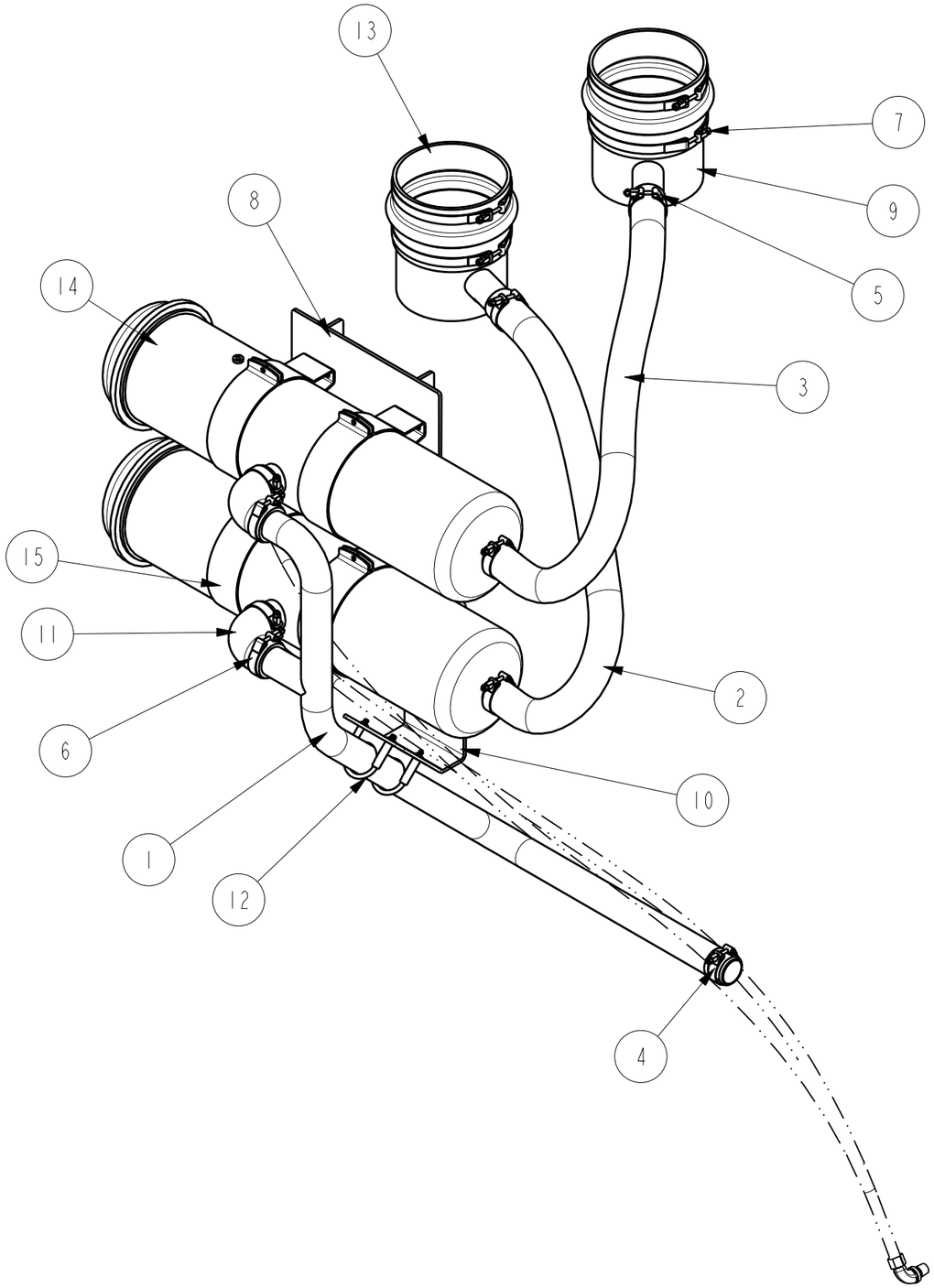
INIT ECO: 2010-250

SCALE: 1.000

EST WEIGHT: 0.000

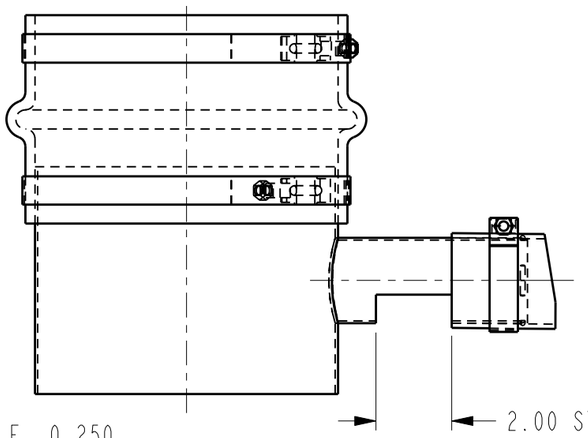
SHEET 1 OF 1

DRAWING NO: 17359



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	TUBE, BREATHER VENT FILTER, CFP50	17443
2	1	FLEX HOSE, 2.25" I.D., BREATHER VENT	17447
3	1	FLEX HOSE, 2.25" I.D., BREATHER VENT	17447
4	1	CLAMP, T-BOLT, 2.06-2.37	13164-0225
5	4	CLAMP, T-BOLT, 2.31-2.62	13164-0250
6	4	CLAMP, T-BOLT, 2.56-2.87	13164-0275
7	4	CLAMP, T-BOLT, 8.25-8.56	13164-0850
8	1	BRACKET, BREATHER VENT FILTER, CFP50	17439
9	2	CONNECTION, BREATHER RECIRCULATION TUBE, CFP50	17446
10	1	BRACKET, TUBE HOLDER, FIREPUMP, CFP50	17448
11	2	ELBOW, MOLDED, 2.25" I.D.	21194-002
12	2	CLAMP,U-BOLT,GUILLOTINE, 2.25"	89542K
13	2	HUMP HOSE, 8", NELSON 8"	89841K
14	2	ECOVENT, CRANK CASE BREATHER	93192A
15	4	MOUNTING BAND, 8.62 I.D.	Q53017



SCALE 0.250

2.00 STARTING POINT ADJUST TO READ "0.0 TO 0.3" INCHES OF WATER ON U-TUBE MANOMETER WHILE ENGINE IS RUNNING

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015	FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

Fire Power

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WHITE BEAR LAKE, MN
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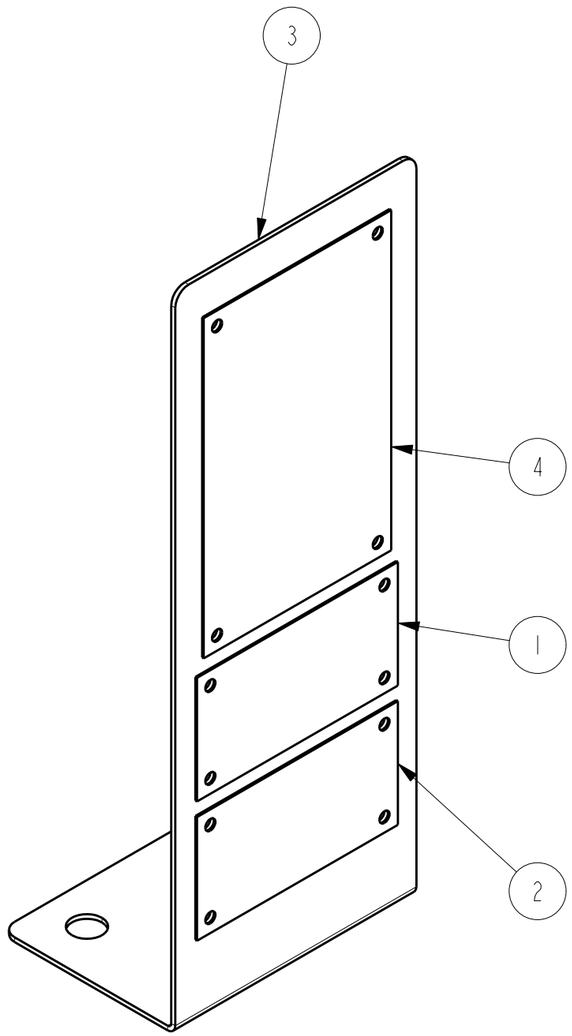
CUSTOM DESIGN
AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, BREATHER VENT FILTER
CFP50

DWG UNITS: IN/LB/S	DRAWN BY: DAN	DATE: 15-JUL-10
	PRO-ENGINEER	INIT ECO: 2010-250
SCALE: 0.100	SHEET 1 OF 1	DRAWING NO: 17438
EST WEIGHT: 82.542		



BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	DATA TAG, FACTORY SETTINGS	17800
2	1	DATA TAG, FIELD SETTINGS	17801
3	1	BRACKET, DATA TAG MOUNTING, CFP50	17802
4	1	DATA TAG, FIREPUMP	SEE WO

REV	ECO	DESCRIPTION OF REVISION	REV BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX : ± 0.010 .XXX : ± 0.005	MACHINE TOLERANCES .X : ± 0.4 .XX : ± 0.2
FORM TOLERANCES .XX : ± 0.030 .XXX : ± 0.015	FORM TOLERANCES .X : ± 0.8 .XX : ± 0.4
FAB TOLERANCES .XX : ± 0.060 .XXX : ± 0.030	FAB TOLERANCES .X : ± 1.5 .XX : ± 0.8

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CUSTOM DESIGN
AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

ASSEMBLY, DATA TAG
CFP50

DWG UNITS: IN/LB/S

DRAWN BY: DAN

PRO-ENGINEER

DATE: 27-SEP-10

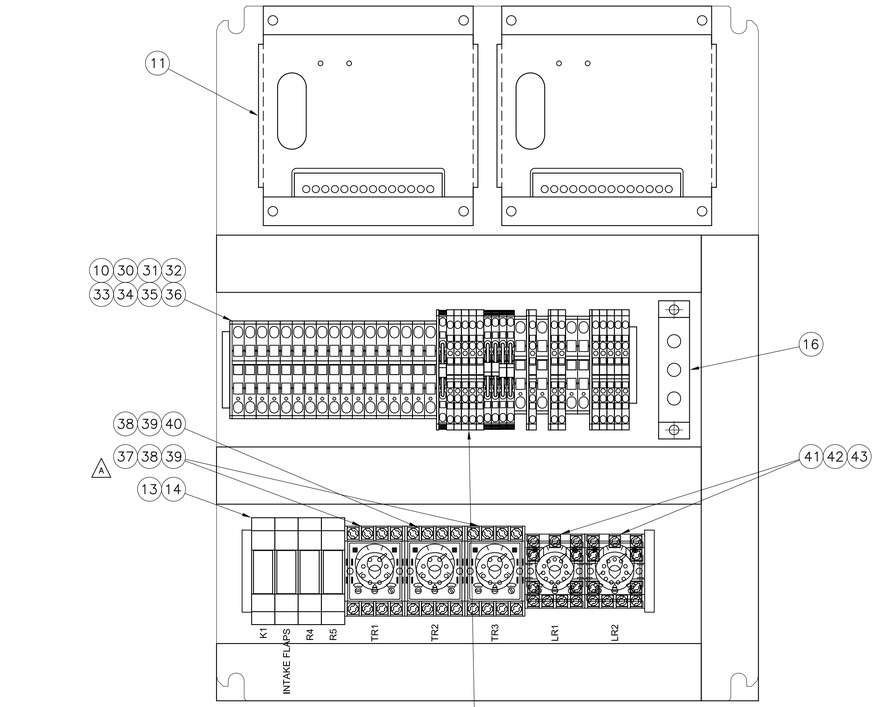
INIT ECO: 2010-438

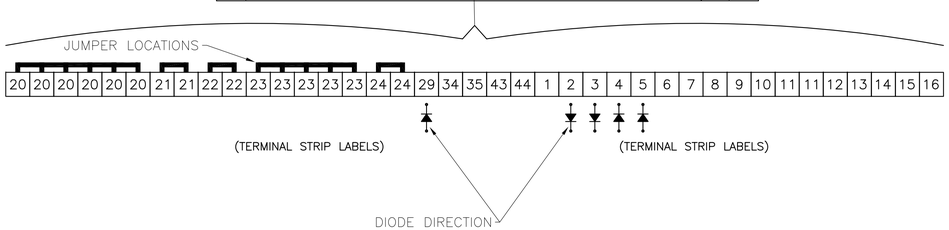
SCALE: 0.500

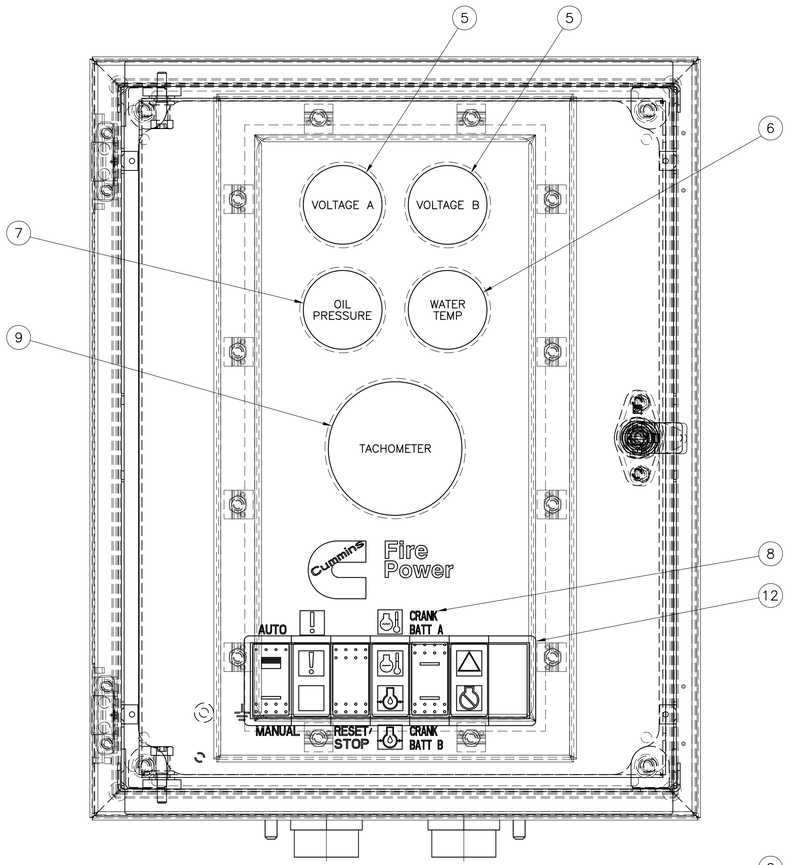
EST WEIGHT: 1.706

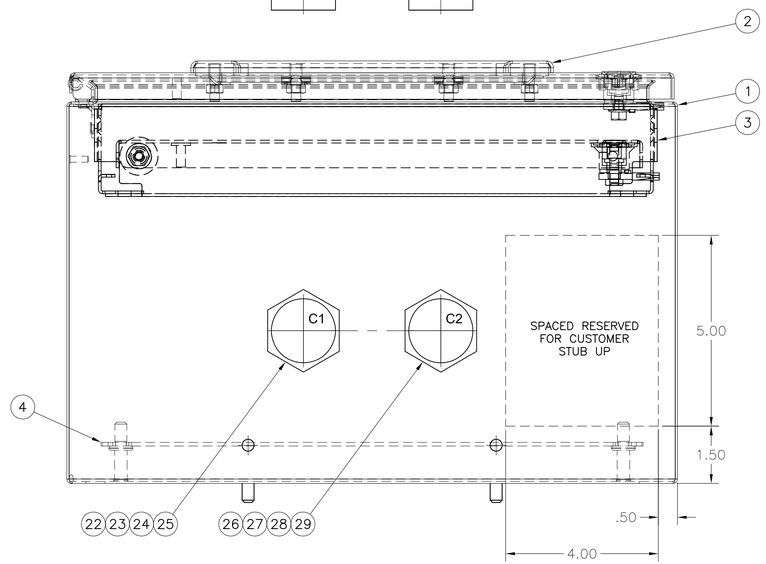
SHEET 1 OF 1

DRAWING NO: 17803









ITEM	QTY	DESCRIPTION	MATERIAL
1	1	ENCLOSURE, 316SS (HOFFMAN)	CSD201610SS6
2	1	KIT, WINDOW (HOFFMAN)	APWK715NFSS
3	1	PANEL, SWING-OUT	CSP2016
4	1	PANEL, BACK	CP2016
5	2	GAUGE, 24V VOLTAGE	
6	1	GAUGE, 24V WATER TEMPERATURE	
7	1	GAUGE, 24V OIL PRESSURE	
8	1	DECAL, ELECTRICAL PANEL	17450
9	1	TACHOMETER	
10	1	PARTITION, END PLATE (WEIDMULLER)	1632090000
11	2	MODULE, OVERSPEED, FIREPUMP	
12	1	ASSEMBLY, SWITCH GANG 24VDC, FIREPUMP	17451
13	4	SOCKET, SPDT RELAY (IDEC/NEWARK)	SJ1S-05B/33K1091
14	4	RELAY, SPDT (IDEC/NEWARK)	RJ1S-CD-D24/01N5247
15	–	–	–
16	1	MODULE, DIODE, INSTRUMENT PANEL	
17	AR	WIRE, 10 AWG BLK (MOUSER ELECTRONICS)	602-6719-100-02
18	AR	WIRE, 16 AWG BLK (MOUSER ELECTRONICS)	602-6716-100-02
19	AR	WIRE, 10 AWG RED (MOUSER ELECTRONICS)	602-6719-100-03
20	AR	WIRE, 16 AWG RED (MOUSER ELECTRONICS)	602-6716-100-03
21	AR	WIRE, 16 AWG WHT (MOUSER ELECTRONICS)	602-6716-100-01
22	1	CONNECTOR	HD34-18-8PN
23	1	LOCK WASHER	114021
24	1	NUT	114020-90
25	7	CONTACT, SOLID PIN, SIZE 12 (DEUTSCH)	0460-204-12141
26	1	CONNECTOR	HD34-24-23PN
27	1	LOCK WASHER	112264
28	1	NUT	112263-90
29	16	CONTACT, SOLID PIN, SIZE 16 (DEUTSCH)	0460-202-16141
30	5	TERMINAL (WEIDMULLER)	1608600000
31	21	TERMINAL (WEIDMULLER)	1632050000
32	13	TERMINAL (WEIDMULLER)	1608570000
33	2	CONNECTION, 2 POLE CROSS (WEIDMULLER)	1608950000
34	2	CONNECTION, 10 POLE CROSS (WEIDMULLER)	1609030000
35	5	PARTITION, END PLATE (WEIDMULLER)	1608800000
36	4	BRACKET, END (WEIDMULLER)	9540000000
37	2	RELAY (IDEC/NEWARK)	GT3A-2AD24/96F3882
38	3	BASE (IDEC/NEWARK)	SR2P-06/13M2991
39	3	HOLD DOWN CLIP (IDEC/NEWARK)	SFA-202/16F5300
40	1	RELAY (IDEC/NEWARK)	RTE-P1AD24/83H4149
41	2	RELAY (IDEC/NEWARK)	RR2KP-UDC24V/91F5566
42	2	BASE (IDEC/NEWARK)	SR3P-05/13M2996
43	2	HOLD DOWN SPRING (IDEC)	SR3P-06F3

NOTES:
1. SEE SHEET 2 FOR CUT-OUT DETAILS.

REV	ENF	DESCRIPTION OF REVISION	BY	DATE
A	2010-526	ADDED TR3, CIRCUITS 45 AND 46 AND D6.	PBS	18NOV2010

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE:
ANGULAR DIMENSIONS ± 1°
THIRD ANGLE PROJECTION
IMPERIAL UNITS: two place decimals ± 0.02; three place decimals ± 0.005; four place decimals ± 0.0025
METRIC UNITS: two place decimals ± 0.5; three place decimals ± 0.13; four place decimals ± 0.06

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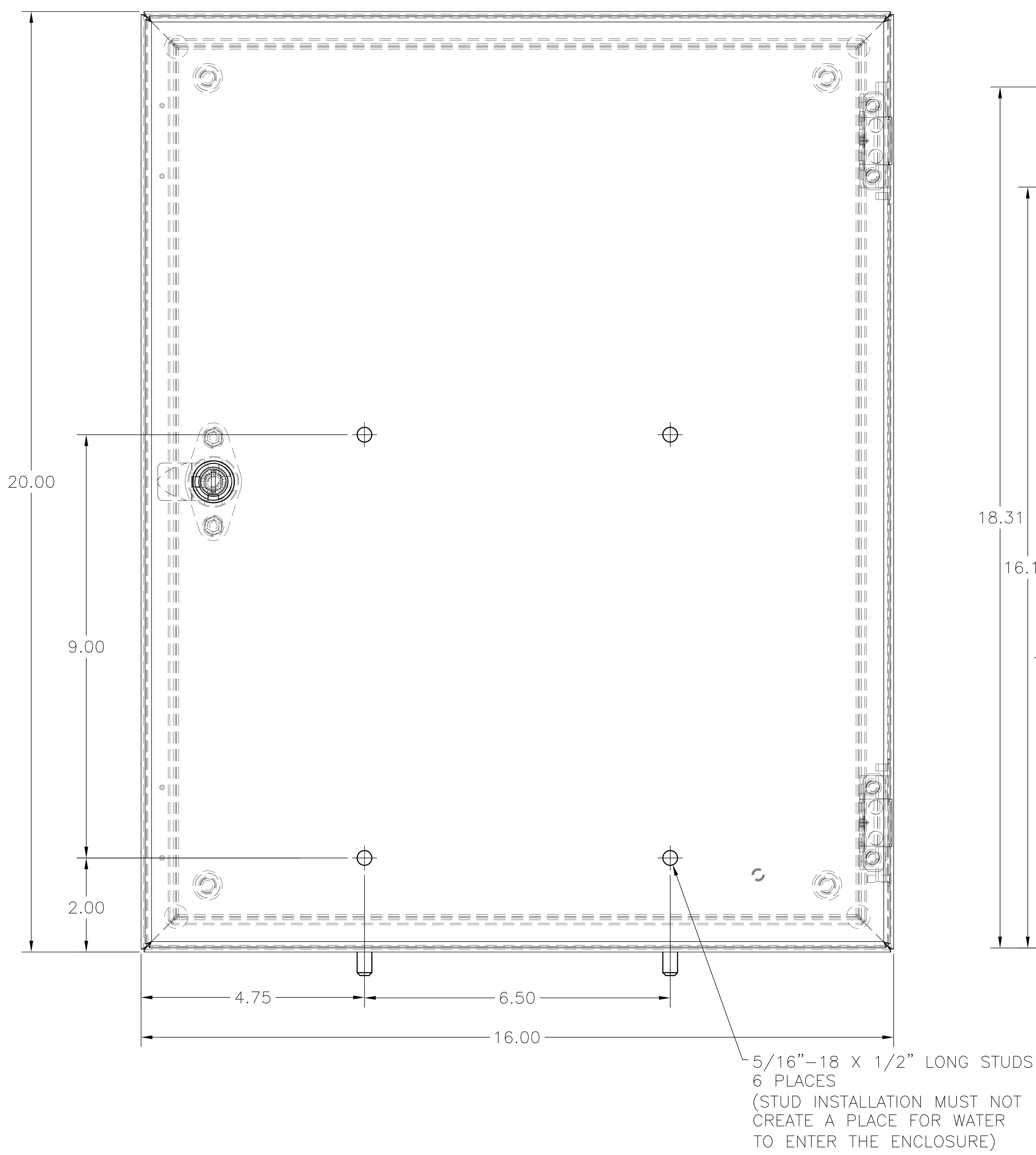
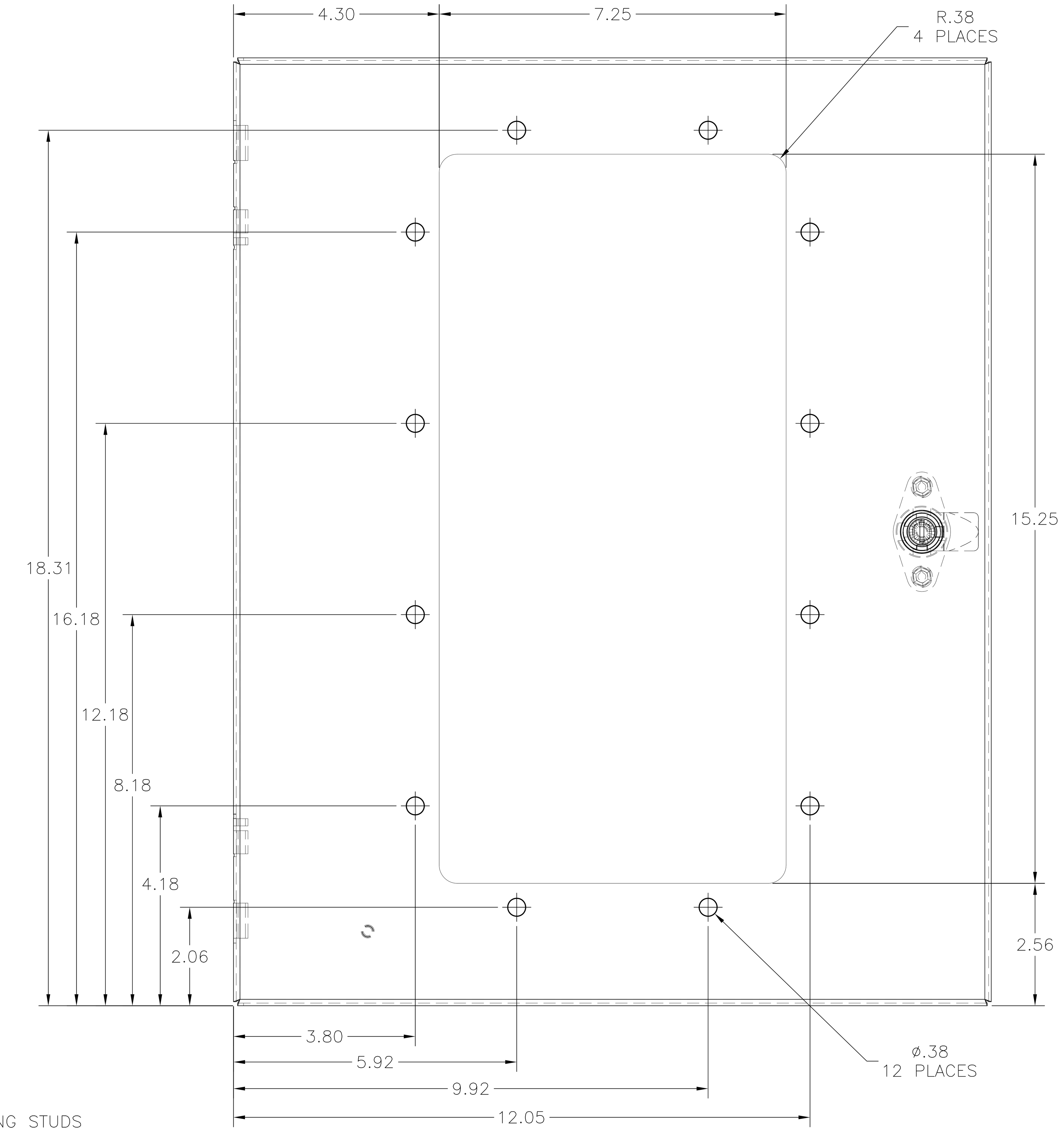
CUSTOM DESIGN AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

PANEL, GAUGE
CFP50

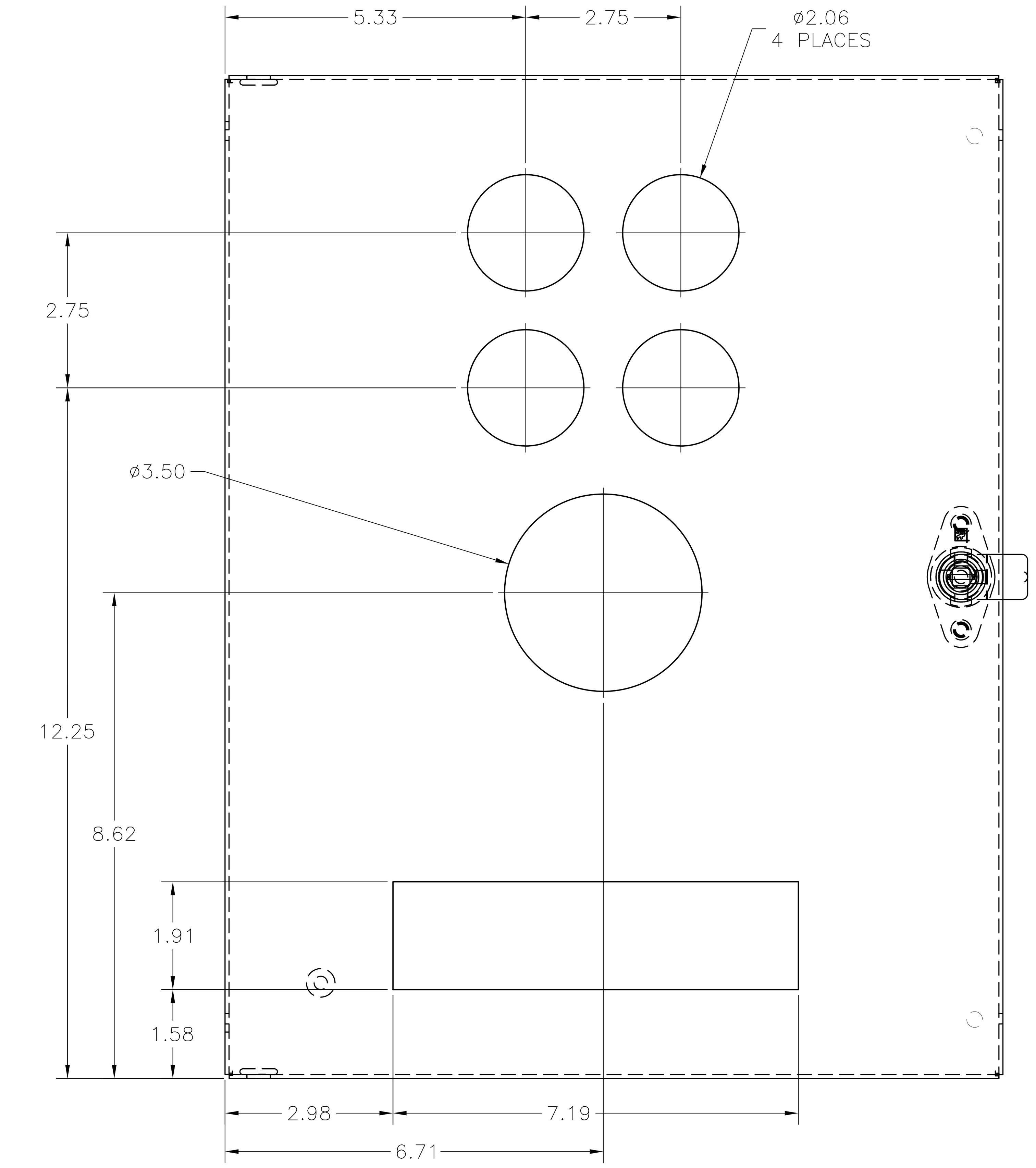
DWG UNITS: INCH/LB/S
DRAWN BY: PBS
DATE: 19JUL2010
AUTO CAD
REF DRWG:
SCALE:
EST WEIGHT:
SHEET 1OF3
DRAWING NO: 17449



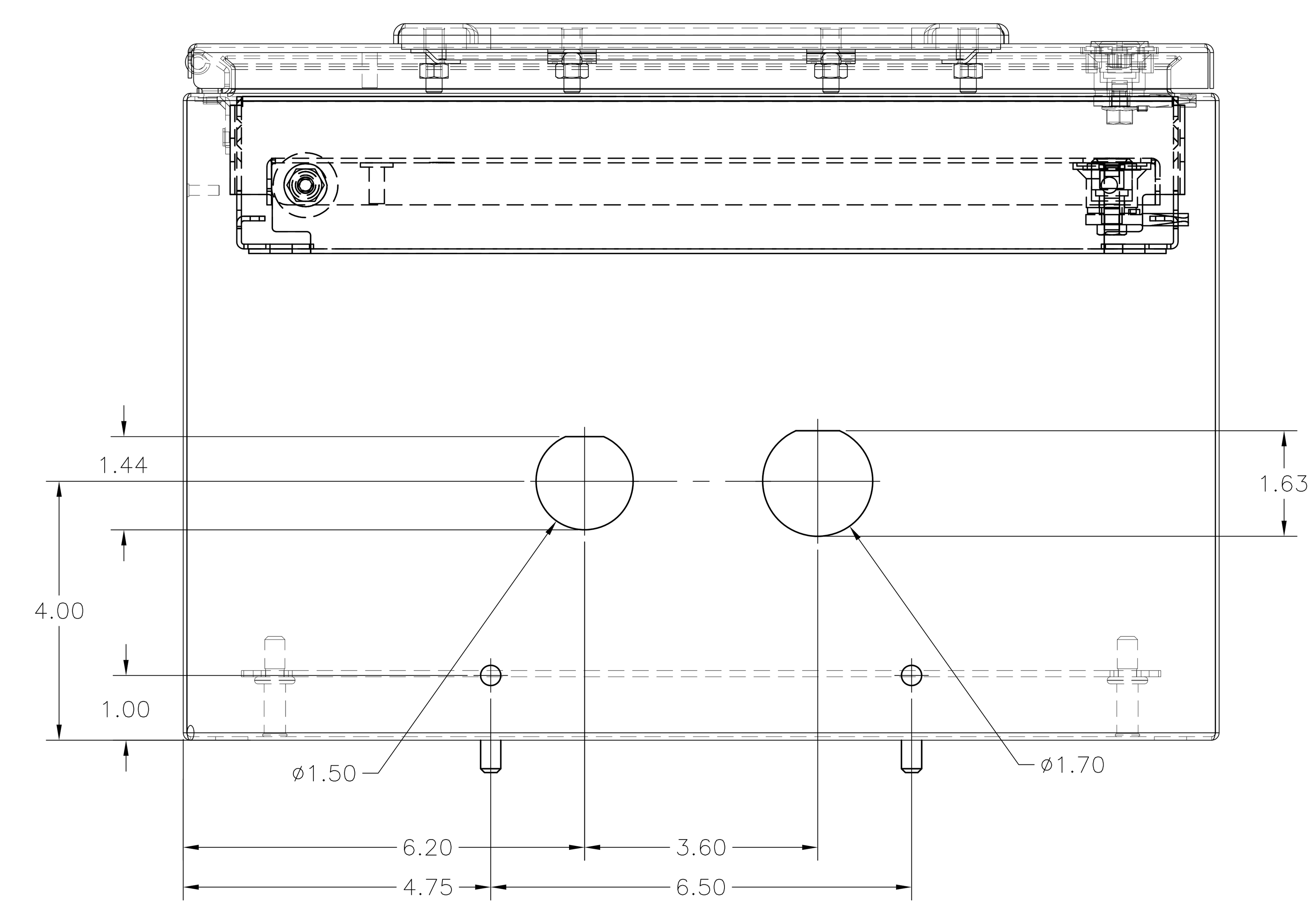
BACK VIEW SHOWING MOUNTING STUD LOCATIONS



DOOR CUT-OUT TO ACCOMMODATE WINDOW KIT



SWING PANEL CUT-OUT FOR GAUGES AND SWITCHES



BOTTOM VIEW SHOWING STUD LOCATION AND CUT-OUTS

REV	ENF	DESCRIPTION OF REVISION	BY	DATE
A	2010-526	SEE SHEET 1 FOR LATEST REVISION DETAILS.	PBS	18NOV2010

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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WHITE BEAR LAKE, MN
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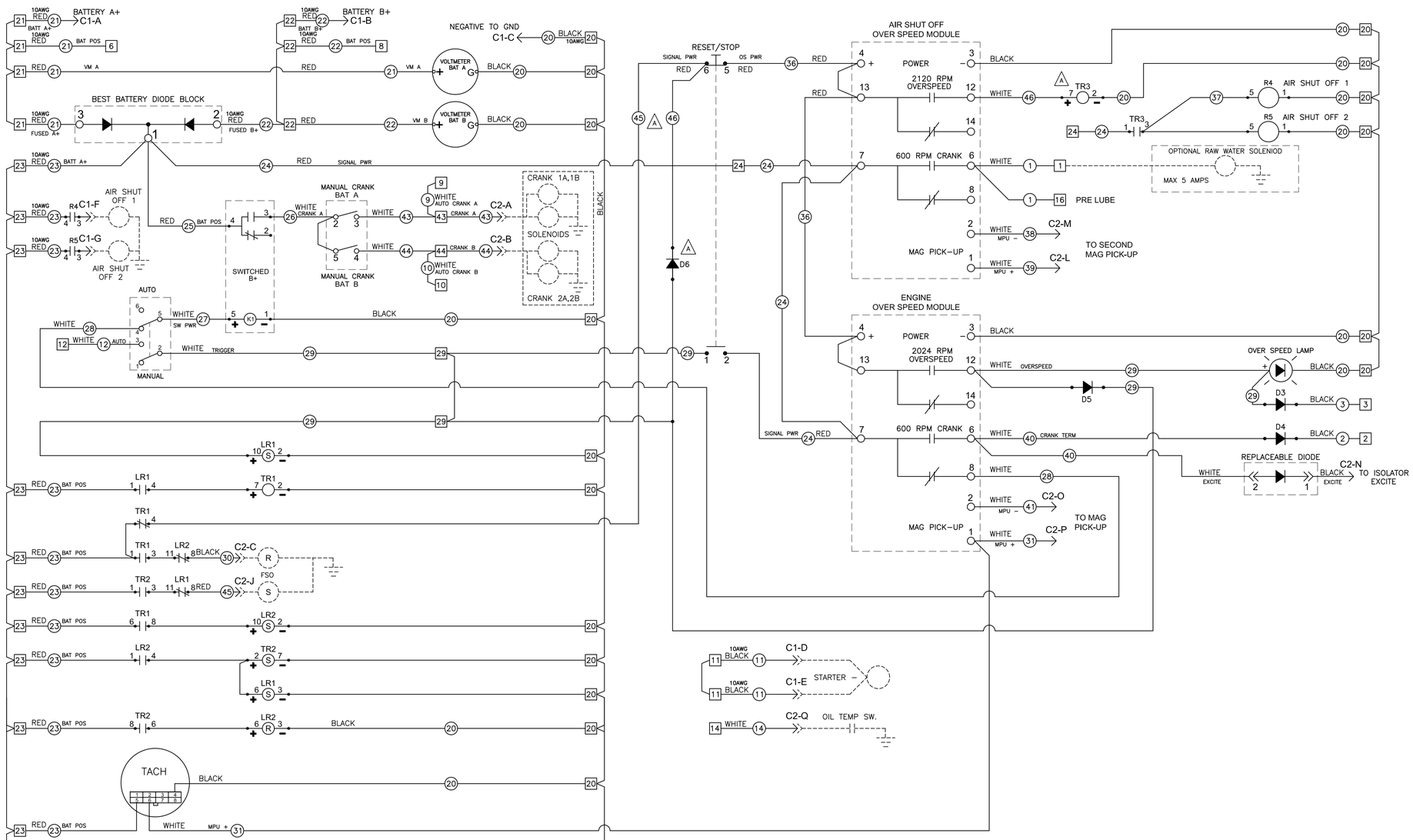
CUSTOM DESIGN AND
UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

PANEL, GAUGE
CFP50

DWG UNITS: INCH/LB/S	DRAWN BY: PBS	DATE: 19JUL2010
	AUTO CAD	REF DRWG:
SCALE:	SHEET 2OF3	DRAWING NO: 17449
EST WEIGHT:		

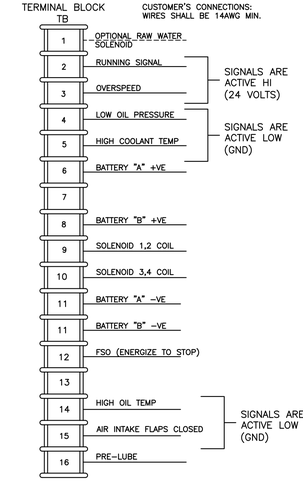


NOTES:
1. ALL WIRES MUST BE LSZH
2. WIRES MUST BE LABELED ON BOTH ENDS USING WEIDMULLER 1813130000 LABELS
3. WIRE IS 16 AWG UNLESS OTHERWISE NOTED
4. D1 – D5: 6 Amp/400 Vpiv
5. TR1=SET MODE TO A (ON DELAY)
   SET TIME TO 25 SECONDS
6. TR2=SET MODE TO A (ON DELAY)
   SET TIME TO 5 SECONDS
7. TR3=SET MODE TO A (ON DELAY)
   SET TIME TO 4 SECONDS

LEGEND:

[14] = TERMINAL BLOCK

(14) = CIRCUIT NUMBER

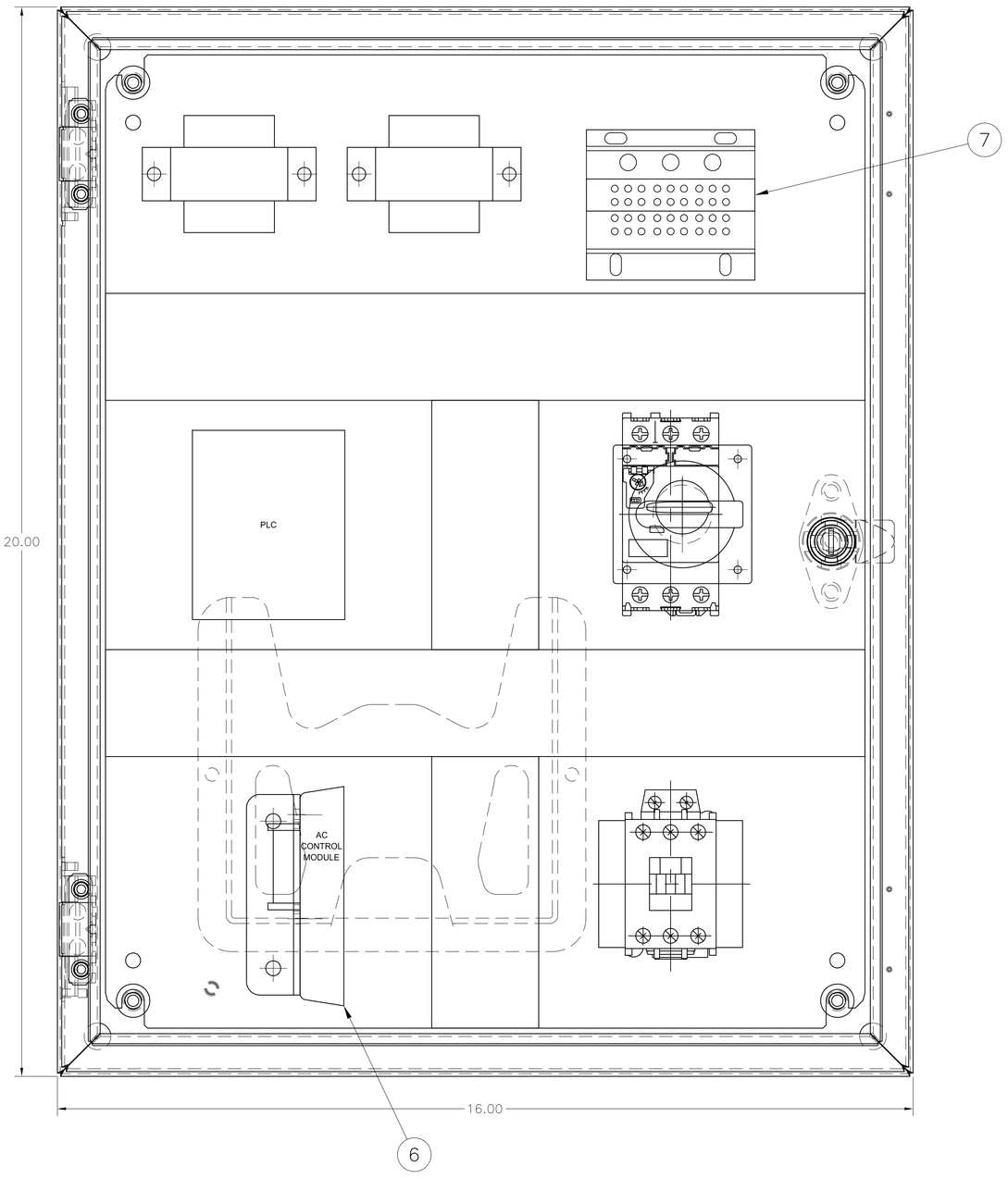


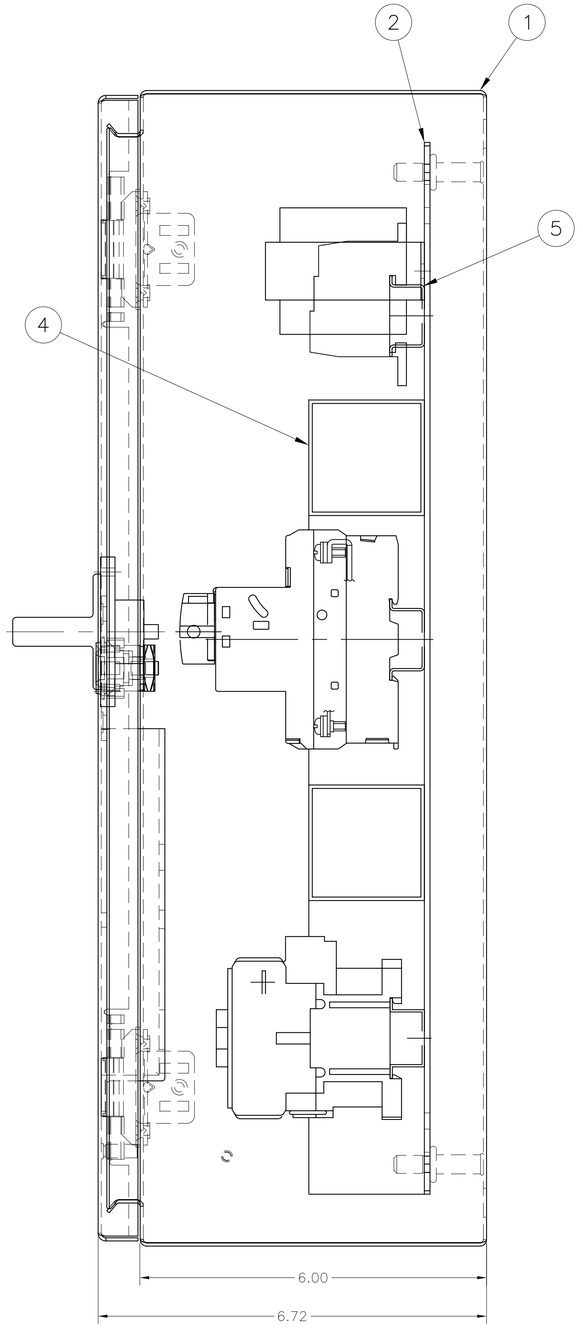
REV	DESCRIPTION OF REVISION	BY	DATE
A	2010–526 SEE SHEET 1 FOR LATEST REVISION DETAILS.	PBS	18NOV2010
ENF			

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE
ANGULAR DIMENSIONS ± 1° | IMPERIAL UNITS | METRIC UNITS
THIRD ANGLE PROJECTION

Fire Power	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
PANEL, GAUGE	
CFP50	
DWG UNITS: INCH/LB/S	DRAWN BY: PBS
AUTO CAD	DATE: 19JUL2010
SCALE:	REF DRWG:
EST WEIGHT:	SHEET 3OF3
DRAWING NO: 17449	

ITEM	QTY	DESCRIPTION	MATERIAL
1	1	ENCLOSURE, 316SS (HOFFMAN)	CSD20166SS6
2	1	PANEL, BACK	CP2016
3	1	PRE-LUBE, CFP50 PERIODIC	17691
4	38"	WIRE WAY, 2" x 2"	
5	8"	RAIL, DIN	
6	1	BRACKET, AC CONTROL MODULE	
7	1	BLOCK, DISTRIBUTION	12022
8	AR	WIRE, 10 AWG BLK (MOUSER ELECTRONICS)	602-6719-100-02
9	AR	WIRE, 16 AWG BLK (MOUSER ELECTRONICS)	602-6716-100-02
10	AR	WIRE, 16 AWG RED (MOUSER ELECTRONICS)	602-6716-100-03
11	AR	WIRE, 16 AWG WHT (MOUSER ELECTRONICS)	602-6716-100-01
12	1	BRACKET, PRE-LUBE CONTROLLER MOUNTING	17760





UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	.xx ± 0.030 .xxx ± 0.010 .xxxx ± 0.005	.x ± 1 .xx ± 0.25 .xxx ± 0.127

Fire Power

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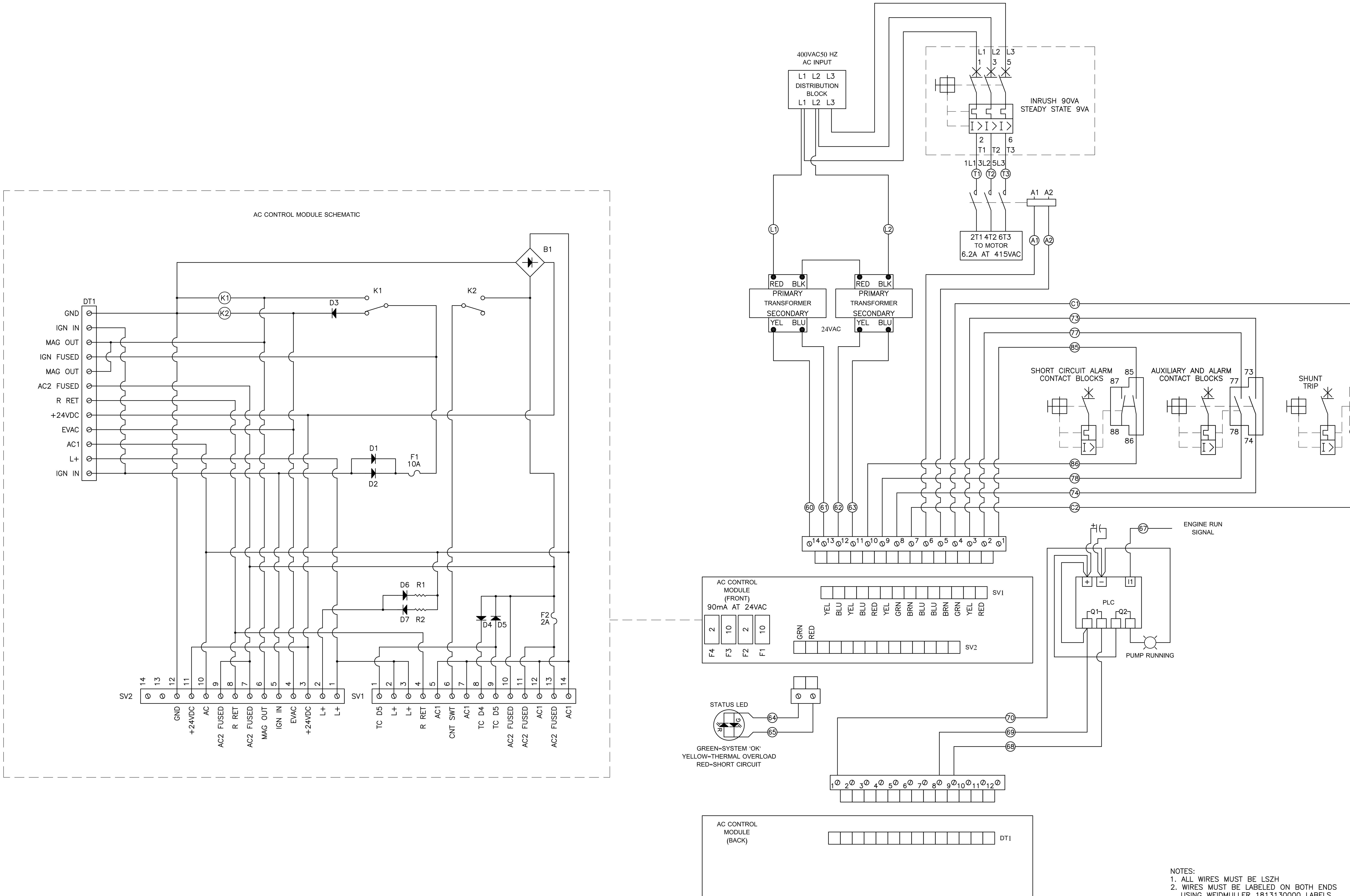
WWW.CUMMINSFIREPOWER.COM

CUSTOM DESIGN AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

PANEL, PERIODIC LUBE SYSTEM CFP50

DWG UNITS: INCH/LB/S	DRAWN BY: PBS	DATE: 15JUL2010
	AUTO CAD	REF DRWG:
SCALE: 3/4		
EST WEIGHT:	SHEET 1OF2	DRAWING NO: 17441

REV	ENF	DESCRIPTION OF REVISION	BY	DATE



NOTES:
1. ALL WIRES MUST BE LSZH
2. WIRES MUST BE LABELED ON BOTH ENDS USING WEIDMULLER 1813130000 LABELS

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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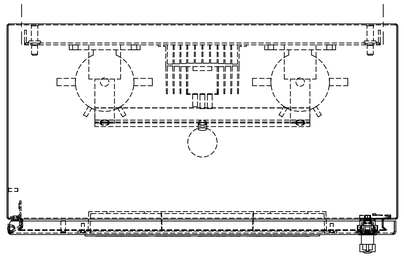
DEPERE, WISCONSIN

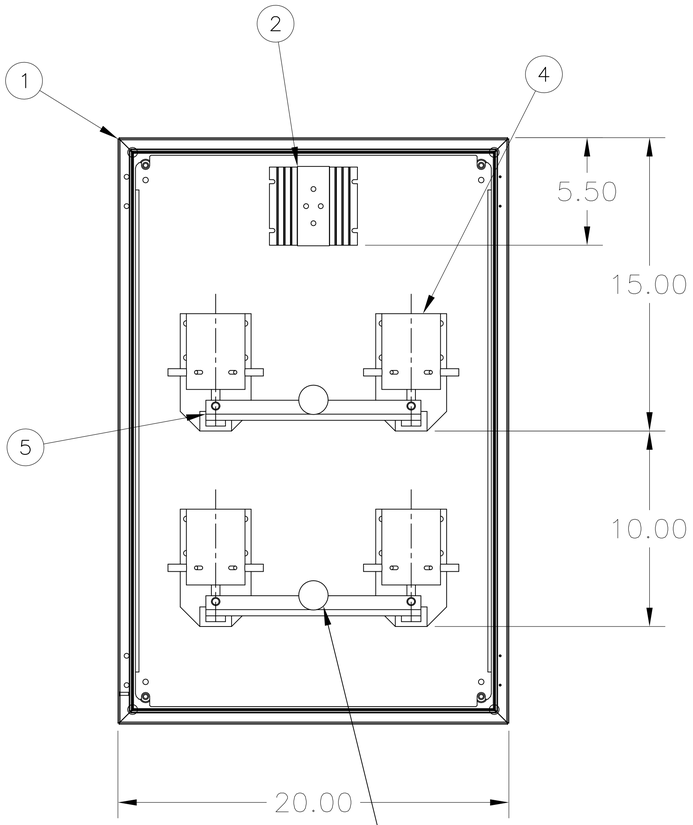
PANEL, PERIODIC LUBE SYSTEM
CFP50

DWG UNITS: INCH/LB/S	DRAWN BY: PBS	DATE: 15JUL2010
	AUTO CAD	REF DRWG:
SCALE: N/A	SHEET 2OF2	DRAWING NO: 17441
EST WEIGHT:		

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

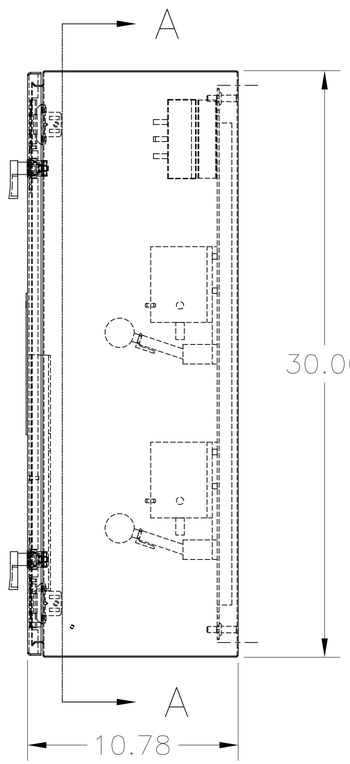
BILL OF MATERIAL			
ITEM	QTY	DESCRIPTION	PART NUMBER
1	1	ENCLOSURE, 20 X 30 X 10, STAINLESS STEEL	17291
2	1	BATTERY ISOLATOR, FIRE PUMP	8838
3	1	INSTRUCTIONS, EMERGENCY START	17292
4	4	CONTACTOR, MANUAL OVERIDE, FIREPUMP	17293
5	2	ANGLE, CONTACTOR PULL	17294
6	1	SCHEMATIC, FIREPUMP CONTACTOR BOX, SEE PAGE #2	17507

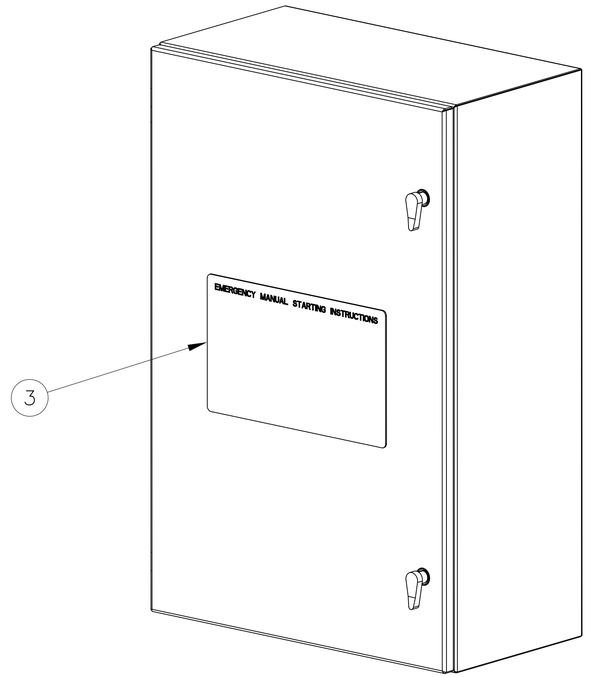




SECTION
A–A

(2) RELOCATE KNOB
TO ANGLE





UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

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CUSTOM DESIGN AND
UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

CONTACTORS, MANUAL START
CFP50

DWG UNITS: INCH/LB/S

DRAWN BY: DAN

AUTO CAD

DATE: 22JUL2010

REF DRWG:

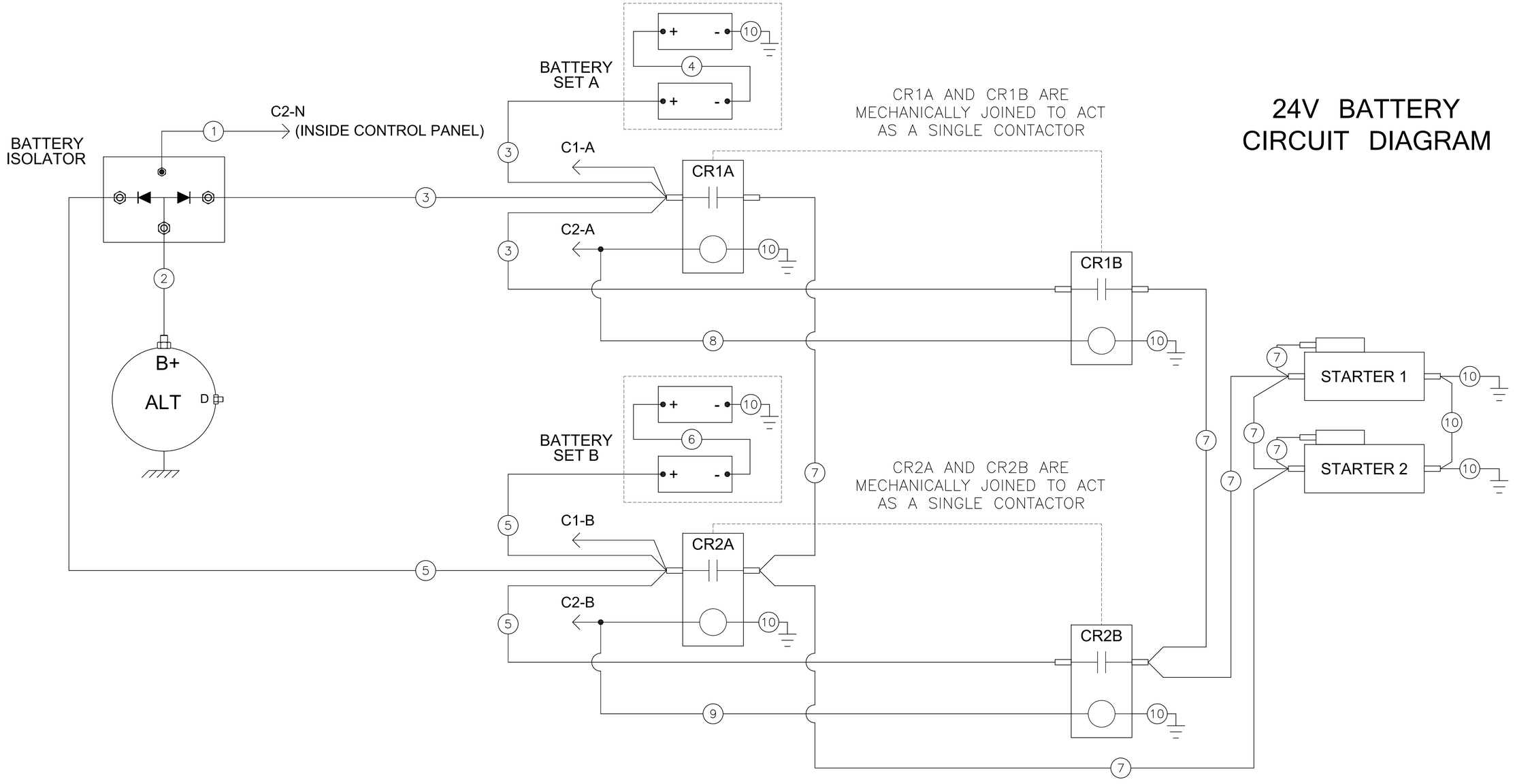
SCALE:

EST WEIGHT:

SHEET 1OF2

DRAWING NO: 17290

24V BATTERY CIRCUIT DIAGRAM



NOTES:
1. ALL WIRES MUST BE LSZH
2. WIRES MUST BE LABELED ON BOTH ENDS USING WEIDMULLER 1813130000 LABELS

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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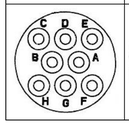
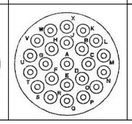
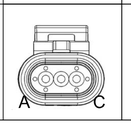
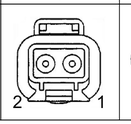
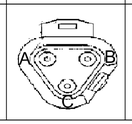
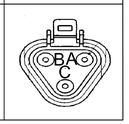
DEPERE, WISCONSIN

CONTACTORS, MANUAL START
CFP50

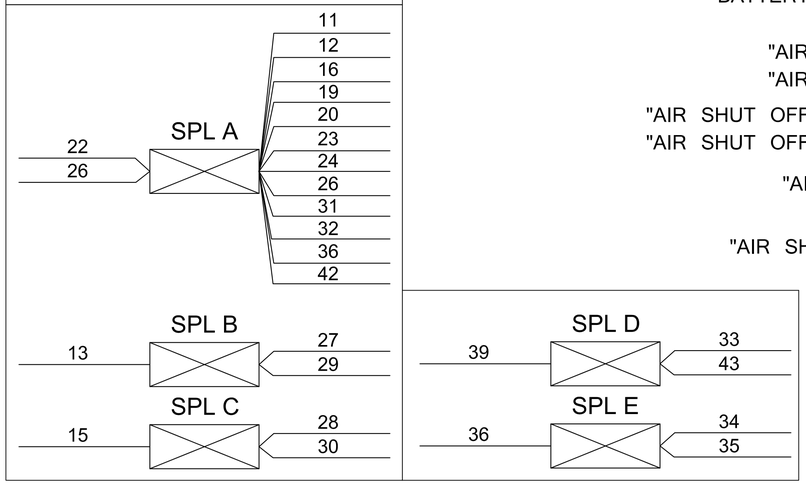
DWG UNITS: INCH/LB/S	DRAWN BY: PBS	DATE: 22JUL2010
	AUTO CAD	REF DRWG:
SCALE:	SHEET 2OF2	DRAWING NO: 17290
EST WEIGHT:		

CONNECTOR WIRE INSERTION VIEW

C1	C2	C3,C4,C7	C5,C6	C8	C9
					

NOTES:
1. LOOM WITH BLACK NYLON BRAID W/ RED TRACERS, 28 MIL MINIMUM.
2. PROMINENTLY LABEL ALL CONNECTORS AS NDICATED IN " ".
3. ALL SPLICES TO BE FITTED WITH GLUED HEAT SHRINK.
4. ALL DIMENSIONS SHOWN ARE MEASURED FROM THE REAR OF THE CONNECTOR (WIRE ENTRY VIEW).
5. RUN BRAID OVER THE BOOT AT LEAST 1" ON ALL CONNECTORS WITH BOOTS TO PREVENT THE BRAID FROM SLIPPING BACK. MAKE SURE BOOT DOES NOT PULL AWAY FROM CONNECTOR WHEN BRAIDING.
6. USE A 3" LONG GLUED HEAT SHRINK ON ALL RING TERMINALS AND RUN THE BRAID HALF WAY UP THE HEAT SHRINK.
7. PUT CONNECTOR C9 AND THE TERMINALS, WEDGELOCK, AND BOOT IN A BAG AND TIE WRAP TO THE HARNESS BY CONNECTOR C8.

SPLICE DETAIL



TAGS	QTY	SUB	CATALOG	MFG	DESCRIPTION
C1	1	1	HD36-18-8SN	DEUTSCH	CONNECTOR, PLUG, 8 POSITION
		7	0462-203-12141	DEUTSCH	CONTACT, SIZE 12, NICKEL, SOCKET
		1	HD30-18BT-BK	DEUTSCH	BOOT, BLACK
		1	114017	DEUTSCH	PLUG, SEALING
C2	1	1	HD36-24-23SN	DEUTSCH	CONNECTOR, PLUG, 23 POSITION
		15	0462-201-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, SOCKET
		1	HD30-24BT-BK	DEUTSCH	BOOT, BLACK
		8	114017	DEUTSCH	PLUG, SEALING
C3	1	1	12162280	DELPHI	CONNECTOR, 3-WAY ASSEMBLY
		3	12124075	DELPHI	TERMINAL
		1	3656059	ELL-TRON	BOOT
C4,C7	2	1	12162280	DELPHI	CONNECTOR, 3-WAY ASSEMBLY
		2	12124075	DELPHI	TERMINAL
		1	12034413	DELPHI	PLUG, CABLE CAVITY, BLACK
		1	3656059	ELL-TRON	BOOT
C5,C6	2	1	DT04-2P	DEUTSCH	CONNECTOR, RECEPTACLE, 2-WAY DT SERIES
		1	W2P	DEUTSCH	WEDGELOCK, GREEN, DT SERIES
		2	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN
		1	DT2P-BT	DEUTSCH	BOOT, 2 POS., GREY
C8	1	1	DT04-3P	DEUTSCH	CONNECTOR, RECEPTACLE, 3-WAY DT SERIES
		1	W3P	DEUTSCH	WEDGELOCK, 3 POSITION, DT SERIES
		3	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN
		1	DT3P-BT	DEUTSCH	BOOT, 3 POSITION, GREY
C9	1	1	DT06-3S	DEUTSCH	CONNECTOR, PLUG, 3-WAY DT SERIES
		1	W3S	DEUTSCH	WEDGELOCK, 3 POSITION, DT SERIES
		3	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN
		1	DT3P-BT	DEUTSCH	BOOT, 3 POSITION, GREY
W2,W9,W10,W11,W13,W14,W16,W17,W25,W26	13	1			TERMINAL, RING, #10 STUD, 16-14 AWG
		1	218N1V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES
W1,W5,W22,W24,W30,W31,W32	7	1			TERMINAL, RING, 1/4" STUD, 16-14 AWG
		1	218N1V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES
W3,W6,W43,W44	4	1			TERMINAL, RING, 1/4" STUD, 6 AWG
		1	218N2V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES
W18,W19,W28,W29	5	1			TERMINAL, RING, #10 STUD, 16-14 AWG
W38,W39	2	1			TERMINAL, RING, 3/8" STUD, 6 AWG
W4	1	1			TERMINAL, RING, 1/4" STUD, 6 AWG
W27	1	1			TERMINAL, RING, 3/8" STUD, 4 AWG
W8,W12	2	1			TERMINAL, RING, 1/2" STUD, 10 AWG
	AR	AR	602-6716-100-02	MOUSER	WIRE, 16 AWG BLK
	AR	AR	602-6716-100-03	MOUSER	WIRE, 16 AWG RED
	AR	AR	602-6719-100-03	MOUSER	WIRE, 16 AWG RED
	AR	AR	602-6719-100-02	MOUSER	WIRE, 10 AWG BLK
	AR	AR	602-6719-100-03	MOUSER	WIRE, 10 AWG RED

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

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ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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CUSTOM DESIGN AND UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

HARNESS, CFP50 RIGHT HAND

DWG UNITS: INCH/LB/S	DRAWN BY: PBS	DATE: 10AUG2010
	AUTO CAD	REF DRWG:
SCALE:	SHEET 1OF3	DRAWING NO: 17555
EST WEIGHT:		

CIRCUIT DATA													
	FROM		TO					FROM		TO			
CIRCUIT #	CONNECTOR	POSITION	CONNECTOR	POSITION	WIRE COLOR	WIRE SIZE	WIRE TYPE	TERMINAL	SEAL	TERM 2	SEAL	STAMP	NOTES
1	C2	O	W16	-	BLK	16	LSZH	0462-201-16141	-		-	MPU -	TWIST
2	C2	P	W17	-	RED	16	LSZH	0462-201-16141	-		-	MPU +	
3	C2	C	C8	A	BLK	16	LSZH	0462-201-16141	-	0460-202-16141	-	FSO CLOSE	
4	C2	E	W9	-	BLK	16	LSZH	0462-201-16141	-		-	OPG	
5	C2	D	W2	-	BLK	16	LSZH	0462-201-16141	-		-	WTG	
6	C2	G	C3	C	BLK	16	LSZH	0462-201-16141	-	12124075	-	LOPL	
7	C2	F	C4	B	BLK	16	LSZH	0462-201-16141	-	12124075	-	HWTL	
8	C1	D	W8	-	BLK	10	LSZH	0462-203-12141	-		-	GND	
9	C2	N	W22	-	RED	16	LSZH	0462-201-16141	-		-	EXCITE	
10	C1	E	W12	-	BLK	10	LSZH	0462-203-12141	-		-	GND	
11	C1	C	SPL A	>	BLK	10	LSZH	0462-203-12141	-	-	-	GND	
12	C8	B	SPL A	>	BLK	16	LSZH	0460-202-16141	-	-	-	FSO GND	
13	C2	A	SPL B	<	RED	14	LSZH	0462-201-16141	-	-	-	CRANK BATT A+	
14	C1	F	W24	-	RED	16	LSZH	0462-203-12141	-		-	ASO 1 B+	
15	C2	B	SPL C	<	RED	14	LSZH	0462-201-16141	-	-	-	BATT B+	
16	W30	-	SPL A	>	BLK	16	LSZH	-	-		-	ASO 1 GND	
17	C1	G	W31	-	RED	16	LSZH	0462-203-12141	-		-	ASO 2 B+	
18	C4	A	C3	B	BLK	16	LSZH	12124075	-	12124075	-	OPS TO WTS	
19	W32	-	SPL A	>	BLK	16	LSZH	-	-		-	ASO 2 GND	
20	C3	A	SPL A	>	BLK	16	LSZH	12124075	-	-	-	OPS GND	
21	W38	-	W43	-	RED	6	GXL		-		-	BATT B+	
22	W27	-	SPL A	<	BLK	4	GXL		-	-	-	GND	
23	W18	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 1A GND	
24	W19	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 1B GND	
25	W6	-	W3	-	RED	6	GXL		-		-	ALT B+	
26	W4	-	SPL A	<	BLK	6	GXL		-	-	-	ALT GND	
27	W25	-	SPL B	>	RED	16	LSZH		-	-	-	CRANK 1B B+	
28	W26	-	SPL C	>	RED	16	LSZH		-	-	-	CRANK 2B B+	
29	W10	-	SPL B	>	RED	16	LSZH		-	-	-	CRANK 1A B+	
30	W11	-	SPL C	>	RED	16	LSZH		-	-	-	CRANK 2A B+	
31	W28	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 2A GND	
32	W29	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 2B GND	
33	C6	1	SPL D	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW2 SIG	
34	C5	2	SPL E	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW1 GND	
35	C6	2	SPL E	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW2 GND	
36	SPL E	-	SPL A	<	BLK	16	LSZH		-	-	-	GND	
37	C2	L	W13	-	BLK	16	LSZH	0462-201-16141	-		-	MPU 2 -	TWIST
38	C2	M	W14	-	RED	16	LSZH	0462-201-16141	-		-	MPU 2 +	
39	C2	H	SPL D	<	BLK	16	LSZH	0462-201-16141	-	-	-	ASO SW SIG	
40	C2	Q	C7	A	BLK	16	LSZH	0462-201-16141	-	12124075	-	HOT SW SIG	
41	W39	-	W44	-	RED	6	GXL		-		-	BATT A+	
42	C7	B	SPL A	>	BLK	16	LSZH	12124075	-	-	-	HOT SW GND	
43	C5	1	SPL D	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW1 SIG	
44	C1	A	W1	-	RED	10	LSZH	0462-203-12141	-		-	BATTERY A+	
45	C1	B	W5	-	RED	10	LSZH	0462-203-12141	-		-	BATTERY B+	
46	C2	J	C8	C	RED	16	LSZH	0462-201-16141	-	0460-202-16141	-	FSO OPEN	

UNLESS OTHERWISE SPECIFIED ALL DIMENSION TOLERANCES ARE

ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS
MACHINE TOLERANCES
.XX = ± 0.010
.XXX = ± 0.005
FORM TOLERANCES
.XX = ± 0.030
.XXX = ± 0.015
FAB TOLERANCES
.XX = ± 0.060
.XXX = ± 0.030

METRIC UNITS
MACHINE TOLERANCES
.X = ± 0.4
.XX = ± 0.2
FORM TOLERANCES
.X = ± 0.8
.XX = ± 0.4
FAB TOLERANCES
.X = ± 1.5
.XX = ± 0.8

REV	ENF	DESCRIPTION OF REVISION	BY	DATE

Cummins Fire Power

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CUSTOM DESIGN AND
UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

HARNESS, CFP50 RIGHT HAND

DWG UNITS: INCH/LB/S

DRAWN BY: PBS

AUTO CAD

DATE: 10AUG2010

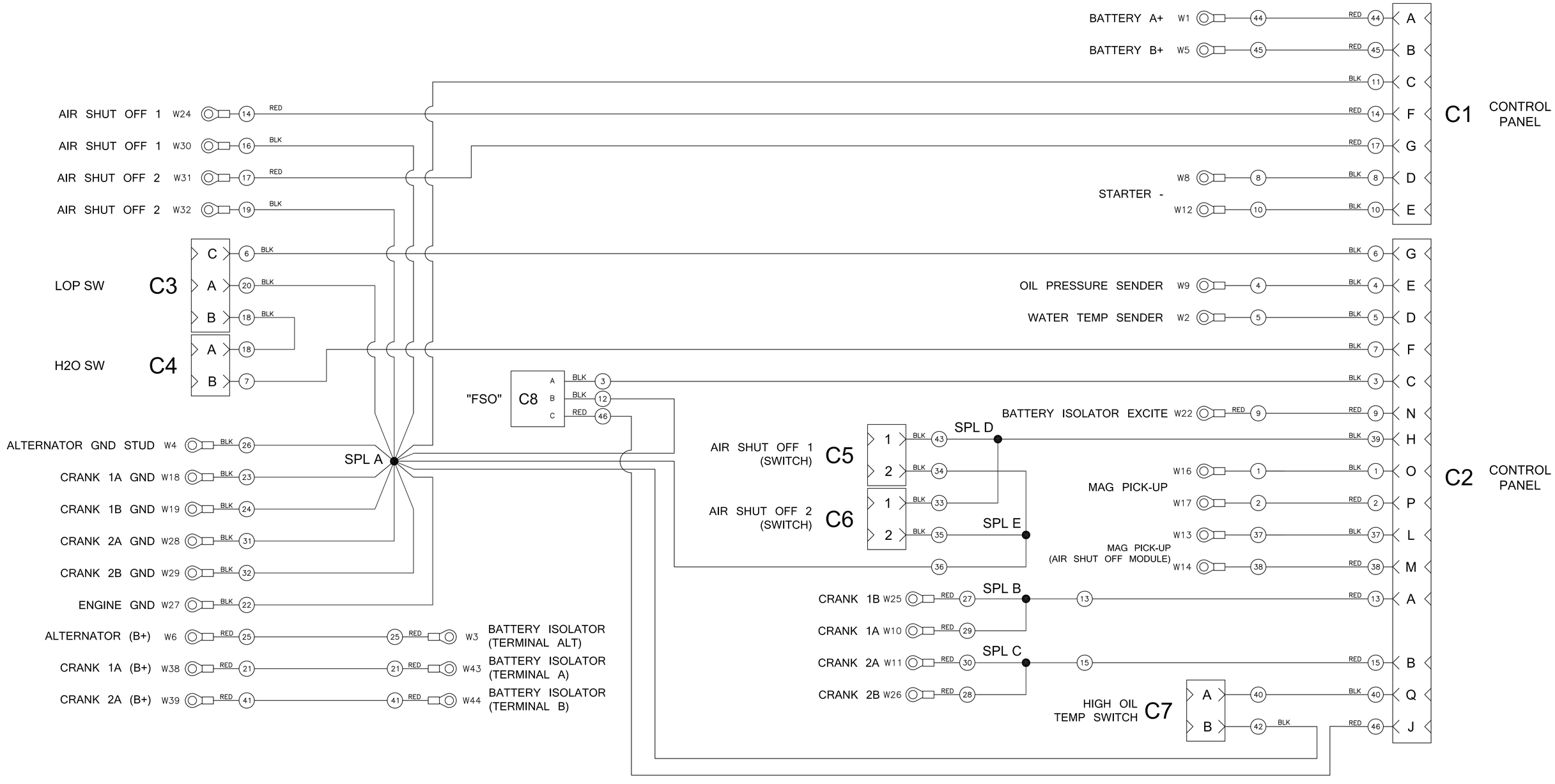
REF DRWG:

SCALE:

EST WEIGHT:

SHEET 2OF3

DRAWING NO: 17555



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ANGULAR DIMENSIONS ± 1°

THIRD ANGLE PROJECTION

IMPERIAL UNITS	METRIC UNITS
MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2
FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015	FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4
FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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CUSTOM DESIGN AND
UPFIT CENTER
875 LAWRENCE DRIVE
DEPERE, WISCONSIN

HARNESS, CFP50 RIGHT HAND

DWG UNITS: INCH/LB/S

DRAWN BY: PBS

AUTO CAD

DATE: 10AUG2010

REF DRWG:

SCALE:

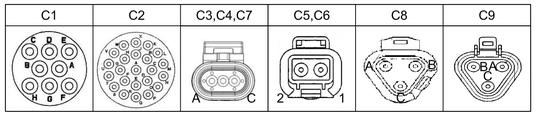
EST WEIGHT:

SHEET 3OF3

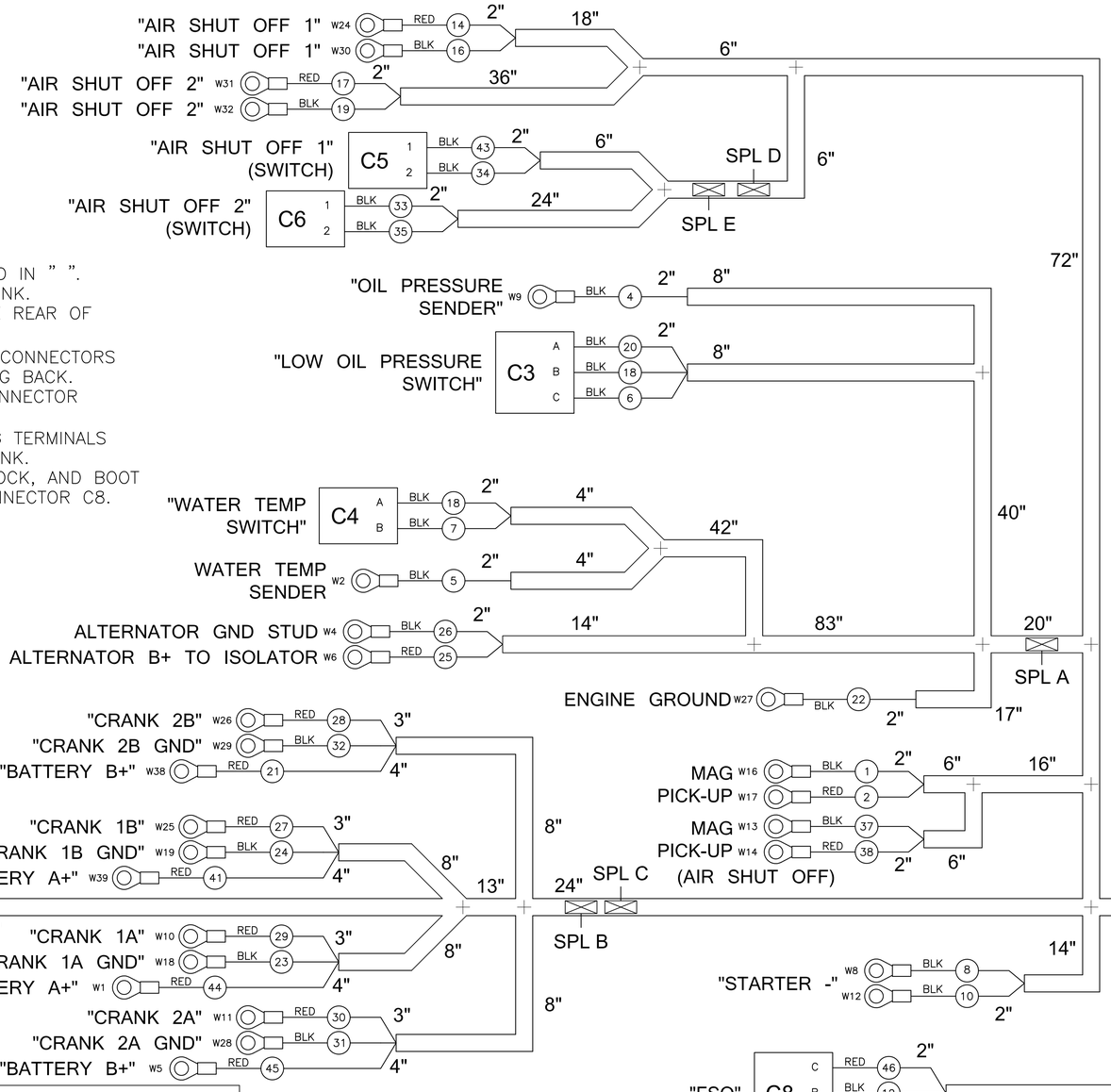
DRAWING NO: 17555

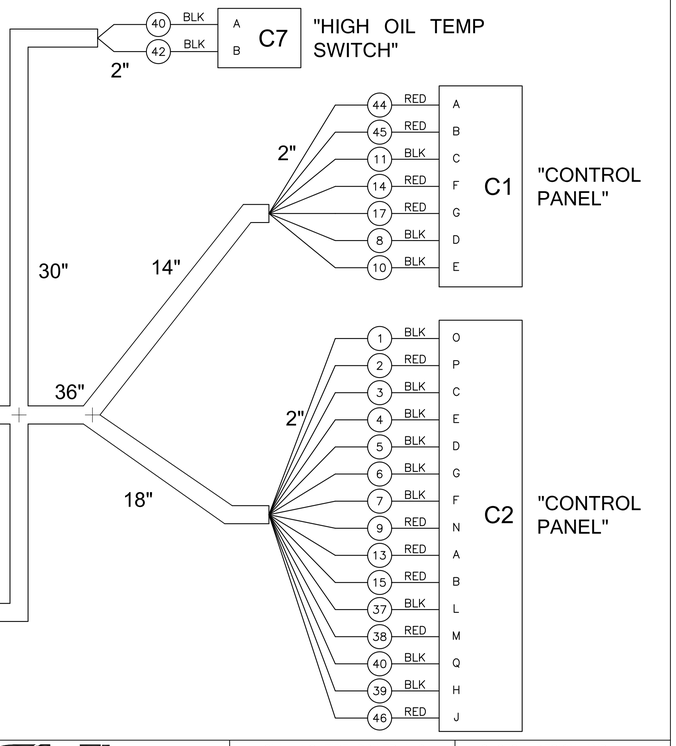
REV	ENF	DESCRIPTION OF REVISION	BY	DATE

CONNECTOR WIRE INSERTION VIEW



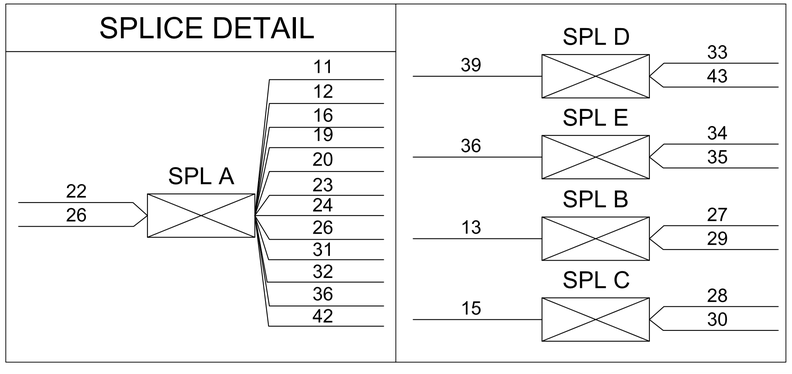
NOTES:
1. LOOM WITH BLACK NYLON BRAID W/RED TRACERS, 28 MIL MINIMUM.
2. PROMINENTLY LABEL ALL CONNECTORS AS NDICATED IN " ".
3. ALL SPLICES TO BE FITTED WITH GLUED HEAT SHRINK.
4. ALL DIMENSIONS SHOWN ARE MEASURED FROM THE REAR OF THE CONNECTOR (WIRE ENTRY VIEW).
5. RUN BRAID OVER THE BOOT AT LEAST 1" ON ALL CONNECTORS WITH BOOTS TO PREVENT THE BRAID FROM SLIPPING BACK. MAKE SURE BOOT DOES NOT PULL AWAY FROM CONNECTOR WHEN BRAIDING.
6. USE A 3" LONG GLUED HEAT SHRINK ON ALL RING TERMINALS AND RUN THE BRAID HALF WAY UP THE HEAT SHRINK.
7. PUT CONNECTOR C9 AND THE TERMINALS, WEDGELOCK, AND BOOT IN A BAG AND TIE WRAP TO THE HARNESS BY CONNECTOR C8.





TAGS	QTY	SUB	CATALOG	MFG	DESCRIPTION
C1	1	1	HD36-18-8SN	DEUTSCH	CONNECTOR, PLUG, 8 POSITION
		7	0462-203-12141	DEUTSCH	CONTACT, SIZE 12, NICKEL, SOCKET
		1	HD30-18BT-BK	DEUTSCH	BOOT, BLACK
		1	114017	DEUTSCH	PLUG, SEALING
C2	1	1	HD36-24-23SN	DEUTSCH	CONNECTOR, PLUG, 23 POSITION
		15	0462-201-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, SOCKET
		1	HD30-24BT-BK	DEUTSCH	BOOT, BLACK
		8	114017	DEUTSCH	PLUG, SEALING
C3	1	1	12162280	DELPHI	CONNECTOR, 3-WAY ASSEMBLY
		3	12124075	DELPHI	TERMINAL
		1	3656059	ELL-TRON	BOOT
C4,C7	2	1	12162280	DELPHI	CONNECTOR, 3-WAY ASSEMBLY
		2	12124075	DELPHI	TERMINAL
		1	12034413	DELPHI	PLUG, CABLE CAVITY, BLACK
		1	3656059	ELL-TRON	BOOT
C5,C6	2	1	DT04-2P	DEUTSCH	CONNECTOR, RECEPTACLE, 2-WAY DT SERIES
		1	W2P	DEUTSCH	WEDGELOCK, GREEN, DT SERIES
		2	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN
		1	DT2P-BT	DEUTSCH	BOOT, 2 POS., GREY
C8	1	1	DT04-3P	DEUTSCH	CONNECTOR, RECEPTACLE, 3-WAY DT SERIES
		1	W3P	DEUTSCH	WEDGELOCK, 3 POSITION, DT SERIES
		3	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN
		1	DT3P-BT	DEUTSCH	BOOT, 3 POSITION, GREY
C9	1	1	DT06-3S	DEUTSCH	CONNECTOR, PLUG, 3-WAY DT SERIES
		1	W3S	DEUTSCH	WEDGELOCK, 3 POSITION, DT SERIES
		3	0460-202-16141	DEUTSCH	CONTACT, SIZE 16, NICKEL, PIN
		1	DT3P-BT	DEUTSCH	BOOT, 3 POSITION, GREY
W2,W9,W10,W11,W13,W14,W16,W17,W25,W26	13	1			TERMINAL, RING, #10 STUD, 16-14 AWG
		1	218N1V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES
W1,W5,W22,W24,W30,W31,W32	7	1			TERMINAL, RING, 1/4" STUD, 16-14 AWG
		1	218N1V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES
W3,W6,W43,W44	4	1			TERMINAL, RING, 1/4" STUD, 6 AWG
		1	218N2V02	VTE	CAP, LUG AND RING TERMINAL, 200 SERIES
W18,W19,W28,W29	5	1			TERMINAL, RING, #10 STUD, 16-14 AWG
W38,W39	2	1			TERMINAL, RING, 3/8" STUD, 6 AWG
W4	1	1			TERMINAL, RING, 1/4" STUD, 6 AWG
W27	1	1			TERMINAL, RING, 3/8" STUD, 4 AWG
W8,W12	2	1			TERMINAL, RING, 1/2" STUD, 10 AWG
	AR	AR	602-6716-100-02	MOUSER	WIRE, 16 AWG BLK
	AR	AR	602-6716-100-03	MOUSER	WIRE, 16 AWG RED
	AR	AR	602-6719-100-03	MOUSER	WIRE, 16 AWG RED
	AR	AR	602-6719-100-02	MOUSER	WIRE, 10 AWG BLK
	AR	AR	602-6719-100-03	MOUSER	WIRE, 10 AWG RED

SPLICE DETAIL



REV	ENF	DESCRIPTION OF REVISION	BY	DATE

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ANGULAR DIMENSIONS ± 1°	IMPERIAL UNITS	METRIC UNITS
THIRD ANGLE PROJECTION	MACHINE TOLERANCES .XX = ± 0.010 .XXX = ± 0.005 FORM TOLERANCES .XX = ± 0.030 .XXX = ± 0.015 FAB TOLERANCES .XX = ± 0.060 .XXX = ± 0.030	MACHINE TOLERANCES .X = ± 0.4 .XX = ± 0.2 FORM TOLERANCES .X = ± 0.8 .XX = ± 0.4 FAB TOLERANCES .X = ± 1.5 .XX = ± 0.8

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EST WEIGHT:		

CIRCUIT DATA													
	FROM		TO					FROM		TO			
CIRCUIT #	CONNECTOR	POSITION	CONNECTOR	POSITION	WIRE COLOR	WIRE SIZE	WIRE TYPE	TERMINAL	SEAL	TERM 2	SEAL	STAMP	NOTES
1	C2	O	W16	-	BLK	16	LSZH	0462-201-16141	-		-	MPU -	TWIST
2	C2	P	W17	-	RED	16	LSZH	0462-201-16141	-		-	MPU +	
3	C2	C	C8	A	BLK	16	LSZH	0462-201-16141	-	0460-202-16141	-	FSO CLOSE	
4	C2	E	W9	-	BLK	16	LSZH	0462-201-16141	-		-	OPG	
5	C2	D	W2	-	BLK	16	LSZH	0462-201-16141	-		-	WTG	
6	C2	G	C3	C	BLK	16	LSZH	0462-201-16141	-	12124075	-	LOPL	
7	C2	F	C4	B	BLK	16	LSZH	0462-201-16141	-	12124075	-	HWTL	
8	C1	D	W8	-	BLK	10	LSZH	0462-203-12141	-		-	GND	
9	C2	N	W22	-	RED	16	LSZH	0462-201-16141	-		-	EXCITE	
10	C1	E	W12	-	BLK	10	LSZH	0462-203-12141	-		-	GND	
11	C1	C	SPL A	>	BLK	10	LSZH	0462-203-12141	-	-	-	GND	
12	C8	B	SPL A	>	BLK	16	LSZH	0460-202-16141	-	-	-	FSO GND	
13	C2	A	SPL B	<	RED	14	LSZH	0462-201-16141	-	-	-	CRANK BATT A+	
14	C1	F	W24	-	RED	16	LSZH	0462-203-12141	-		-	ASO 1 B+	
15	C2	B	SPL C	<	RED	14	LSZH	0462-201-16141	-	-	-	BATT B+	
16	W30	-	SPL A	>	BLK	16	LSZH	-	-		-	ASO 1 GND	
17	C1	G	W31	-	RED	16	LSZH	0462-203-12141	-		-	ASO 2 B+	
18	C4	A	C3	B	BLK	16	LSZH	12124075	-	12124075	-	OPS TO WTS	
19	W32	-	SPL A	>	BLK	16	LSZH	-	-		-	ASO 2 GND	
20	C3	A	SPL A	>	BLK	16	LSZH	12124075	-	-	-	OPS GND	
21	W38	-	W43	-	RED	6	GXL		-		-	BATT B+	
22	W27	-	SPL A	<	BLK	4	GXL		-	-	-	GND	
23	W18	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 1A GND	
24	W19	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 1B GND	
25	W6	-	W3	-	RED	6	GXL		-		-	ALT B+	
26	W4	-	SPL A	<	BLK	6	GXL		-	-	-	ALT GND	
27	W25	-	SPL B	>	RED	16	LSZH		-	-	-	CRANK 1B B+	
28	W26	-	SPL C	>	RED	16	LSZH		-	-	-	CRANK 2B B+	
29	W10	-	SPL B	>	RED	16	LSZH		-	-	-	CRANK 1A B+	
30	W11	-	SPL C	>	RED	16	LSZH		-	-	-	CRANK 2A B+	
31	W28	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 2A GND	
32	W29	-	SPL A	>	BLK	16	LSZH		-	-	-	CRANK 2B GND	
33	C6	1	SPL D	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW2 SIG	
34	C5	2	SPL E	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW1 GND	
35	C6	2	SPL E	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW2 GND	
36	SPL E	-	SPL A	<	BLK	16	LSZH		-	-	-	GND	
37	C2	L	W13	-	BLK	16	LSZH	0462-201-16141	-		-	MPU 2 -	TWIST
38	C2	M	W14	-	RED	16	LSZH	0462-201-16141	-		-	MPU 2 +	
39	C2	H	SPL D	<	BLK	16	LSZH	0462-201-16141	-	-	-	ASO SW SIG	
40	C2	Q	C7	A	BLK	16	LSZH	0462-201-16141	-	12124075	-	HOT SW SIG	
41	W39	-	W44	-	RED	6	GXL		-		-	BATT A+	
42	C7	B	SPL A	>	BLK	16	LSZH	12124075	-	-	-	HOT SW GND	
43	C5	1	SPL D	>	BLK	16	LSZH	0460-202-16141	-	-	-	ASO SW1 SIG	
44	C1	A	W1	-	RED	10	LSZH	0462-203-12141	-		-	BATTERY A+	
45	C1	B	W5	-	RED	10	LSZH	0462-203-12141	-		-	BATTERY B+	
46	C2	J	C8	C	RED	16	LSZH	0462-201-16141	-	0460-202-16141	-	FSO OPEN	

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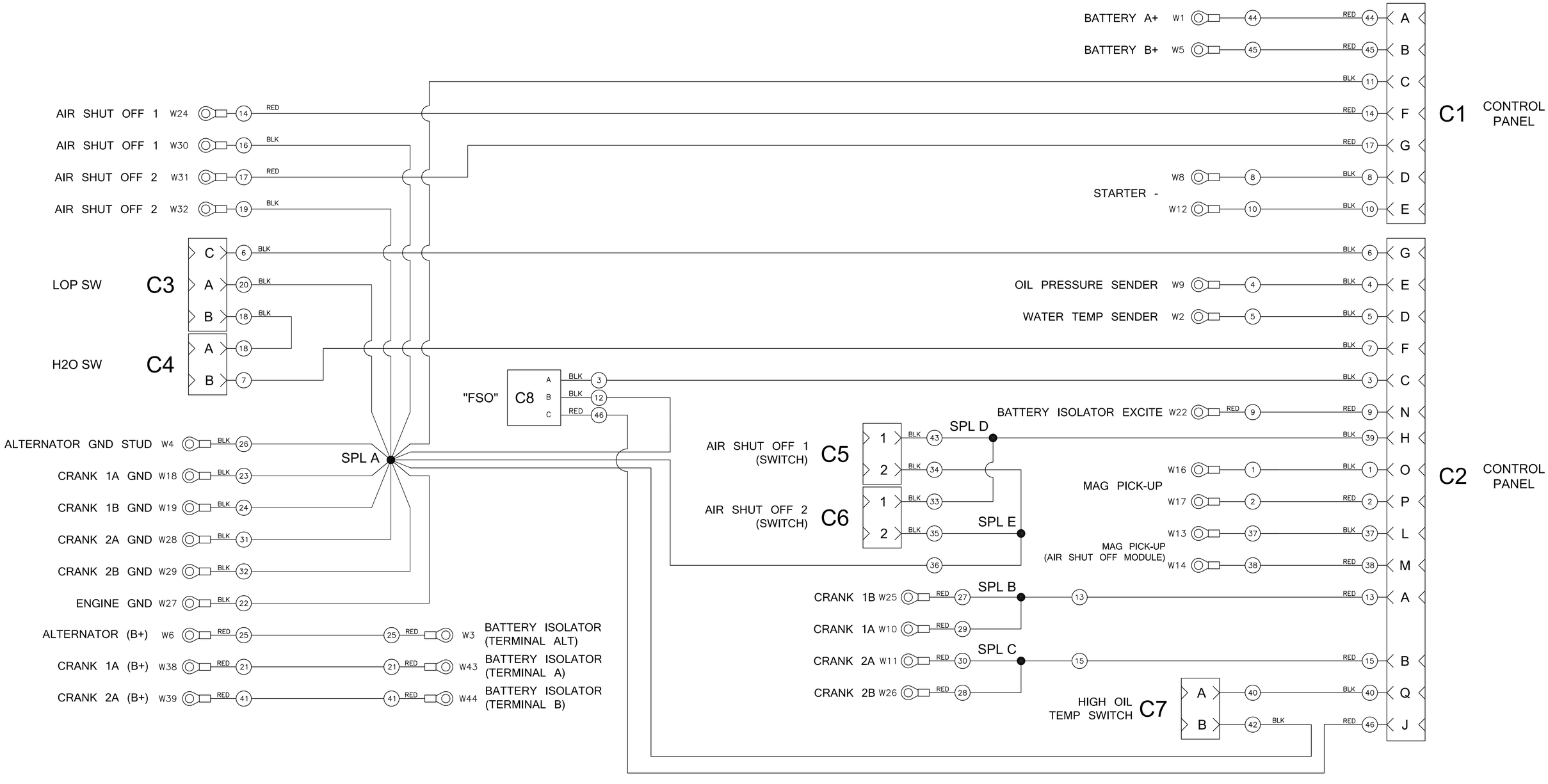

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