Operation and Maintenance Instructions Manual

C18 MODEL ENGINES

With NSR or Brazed Heat-Exchanger

FOR CONSTANT SPEED FIRE PUMP APPLICATIONS

DOCUMENT ID:
C137833
Rev L
03/24

CLARKE®

Clarke UK, Ltd.
Unit 1, Grange Works
Lomond Road
Coatbridge
ML5 2NN
United Kingdom
TEL: +44(0)1236 429946
FAX: +44(0)1236 427274

Clarke Fire Protection Products Inc.
100 Progress Place

Cincinnati, OH
45246
USA
TEL: +1.513.771.2200 Ext. 427
FAX: +1.513.771.5375

1. Introduction

1.1. Scope of Supply

The following paragraphs summarize the "Scope of Supply" of the Engine:

- The CLARKE Engine supplied has been designed for the sole purpose of driving a stationary Emergency Fire Pump. It must not be used for any other purpose.
- Shall not be subjected to Horsepower requirements greater than the certified nameplate rating (for UL/cUL/FM/LPCB only).
- Engines must be sized to cover fully the maximum power absorbed by any particular driven equipment together with a safety factor on no less than 10%. (For Non-listed only).
- De-rates for elevation and temperature need to be considered for maximum pump power.
- Fuel delivery settings are factory set with-in the injection pump and must not be tampered with or adjusted. Minor RPM adjustments to meet pump requirements are permissible.
- The engine shall be installed and maintained in accordance with the guidelines stated in this manual.
- Periodic running checks to ensure functionality should be kept to a maximum of ½ hour per week.

1.2. Identification / Nameplate

Throughout this manual, the terms "Engine" and "Machine" are used. The term "Engine" refers solely to the diesel engine driver as supplied by CLARKE. The term "Machine" refers to any piece of equipment with which the engine might interface.

This manual provides all the information necessary to operate your newly acquired engine safely and efficiently and perform routine servicing correctly. Please read it carefully.

Model Numbering & Identification

There are two identification plates attached to each engine. Clarke Identification Plate: Engine Model, Serial Number, Rating and Date of Manufacture are shown on this identification plate. The C18 Series identification plate is mounted on the back of the left rear engine mounting foot. (See Figure #1-1)

Caterpillar Identification Label: The second identification tag contains the Caterpillar Feature Code and Serial Number. On the C18 Series, the Caterpillar identification tag is located on the left-hand side of the engine forward of the air intake.

Clarke Identification Plates
USA Listed/Approved

Figure 1-1

The Clarke model numbers reflects the base engine type, number of cylinders, cooling system, approval listing, manufacturing location, emissions code and a power rating code.

Example: C18H0-UFAC28

- C = Caterpillar base engine
- 18 = base engine displacement (18.1 liter)
- H = Heat Exchanger cooled (R = Radiator)
- 0 = Non-Hazardous Location
- UF = Underwriters Laboratories Listed/ Factory Mutual Approved, (NL = Non-Listed)
- A = Manufacture Location (United States)
- C = Tier 2, D = Tier 3, A = Non-Emissionized
- 28 = Power Rating Code

1.3. Safety, Caution and Warnings

ATTENTION: This engine has components and fluids that reach very high operating temperatures and is provided with moving pulleys and belts. Approach with caution. It is the responsibility of the builder of the machine using a Clarke engine to optimize the application in terms of maximum end user safety.

1.3.1. Basic Rules

The following recommendations are given to reduce the risk to persons and property when an engine is in service or out of service.

1.3.1.1. Engines must not be used for applications other than those declared under "Scope of Supply".

1.3.1.2. Incorrect handling, modifications and use of non-original parts may affect safety. When lifting the engine, take care to use suitable equipment to be applied to the points specially provided as shown on the appropriate Engine Installation Drawing. Engine weights are shown in Figure #1-2

Engine Model	Weight lbs (kg)
All C18H0 models	4100 (1860)

Figure1-2

Figure #1-3 shows the typical lifting arrangement of a bare engine. Note the lifting points on the engine are for lifting the ENGINE only. Caution, when lifting, lift point should always be over the equipment Center of Gravity.

Figure #1-4 shows the typical lifting arrangement of a base mounted engine and pump set when the base (or module) is furnished with lifting holes.

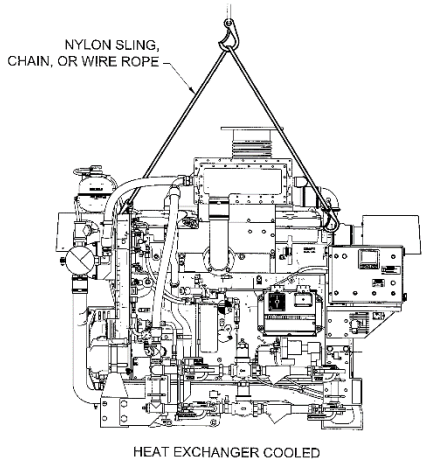


Figure 1-3

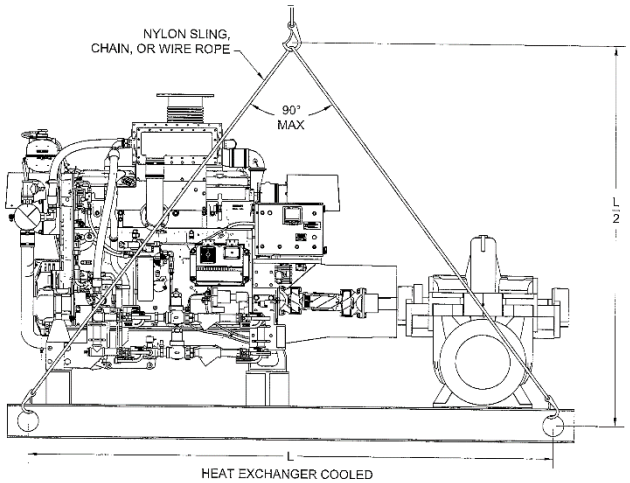


Figure 1-4

When Clarke furnishes the base (or module) for the engine and pump set, the combined weight of the engine and base (or module) will be indicated on the unit. Caution, when lifting, lift point should always be over the equipment Center of Gravity.

1.3.2. Hearing Protection. The engine produces a noise level exceeding 70 dB(a). When performing the weekly functional test, it is recommended that hearing protection be worn by operating personnel.

1.3.3. Declaration of Incorporation
CLARKE UK provides the machine manufacturer with a "Declaration of Incorporation" for the Engine, when required, a copy of which is enclosed in the manual. This document clearly states the machine manufacturers' duties and responsibilities with respect to health and safety. Refer to section 17

1.3.4. What to do in an Emergency
Any user of the Engine who follows the instructions set out in this manual and complies with the instructions on the labels affixed to the engine are working in safe conditions. If operating mistakes cause accidents call for help immediately from the EMERGENCY SERVICES. In the event of an emergency, and while awaiting the arrival of the EMERGENCY SERVICES, the following general advice is given for the provision of first aid.

1.3.4.1. FIRE. Put out the fire using extinguishers recommended by the manufacturer of the machine or the installation.

1.3.4.2. BURNS. Put out the flames on the clothing of the burns victim by means of: drenching with water, use of powder extinguisher, making sure not to direct the jets onto the face, blankets or rolling the victim on the ground
Do not pull off strips of clothing that are sticking to the skin. In the case of scalding with liquids, remove the soaked clothing quickly but carefully. Cover the burn with a special anti-burn packet or with a sterile bandage.

1.3.4.3. CARBON MONOXIDE POISONING (CO). Carbon monoxide contained in engine exhaust gases is odorless and dangerous because it is poisonous and with air, it forms an explosive mixture. Carbon monoxide is very dangerous in enclosed premises because it can reach a critical concentration in a short time. When attending a person suffering from CO poisoning in enclosed premises, ventilate the premises immediately to reduce the gas concentration. When accessing the premises, the person providing the aid must hold his breath, not light flames, turn on lights or activate electric bells or telephones so as to avoid explosions. Take the victim to a ventilated area or into the open air, placing him on his side if he is unconscious.

1.3.4.4. CAUSTIC BURNS. Caustic burns to the skin are caused by acid escaping from the batteries. Remove the clothes, wash with running water, being careful not to affect injury-free areas. Caustic burns to the eyes are caused by battery acid, lubricating oil and diesel fuel. Wash the eye with running water for at least 20 minutes, keeping the eyelids open so that the water runs over the eyeball and moving the eye in all directions.

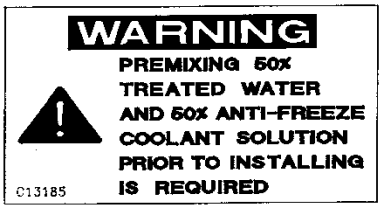
1.3.4.5. ELECTROCUTION. Electrocution can be caused by the engine's electrical system (12/24 VDC) or the electrical coolant pre-heating system (115/230 Volt AC) if supplied. In the first case, the low voltage does not involve high current flows through the human body; however, if there is a short circuit, caused by a metal tool, sparks and burns may occur. In the second case, the high voltage causes strong currents, which can be dangerous. If this happens, break the current by operating the switch before touching the injured person. If this is not possible, bear in mind that any other attempt is highly dangerous also for the person assisting; therefore, any attempt to help the victim must be carried out without fail using means that are insulating.

1.3.4.6. WOUNDS AND FRACTURES. The wide range of possible injuries and the specific nature of the help needed means that the medical services must be called. If the person is bleeding, compress the wound externally until help arrives. In the case of fracture do not move the part of the body affected by the fracture. When moving an injured person permission from that person must be received until you can help him. Unless the injury is life threatening, move the injured person with extreme care and then only if strictly necessary.

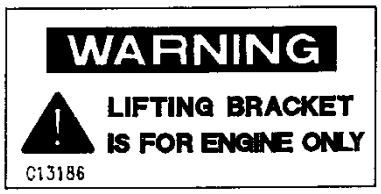
1.3.5. Warning Labels

Warning labels, in picture form, are applied to the engine. Their meanings are given below.
Important Note: Labels that show an exclamation mark indicate that there is a possibility of danger.

Heat Exchanger Maximum Working Pressure



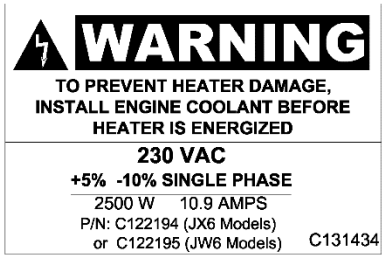
Coolant Mixture



Lifting Point

Automatic Start

Rotating Parts



Jacket Water Heater Voltage

Air Filter Installation

2. Installation

2.1. Typical Installation

A typical Fire Pump installation is shown in Figures #2-1 & 2-2.

1. Pump/Engine set
2. Main Pump Controller
3. Pump discharge
4. Air louver
5. Entrance door with air louver
6. Exhaust silencer
7. Exhaust system supports
8. Exhaust outlet pipe
9. Concrete base
10. Exhaust flexible connection joint/pipe
11. Air Discharge Duct from Radiator

NOTE: For radiator cooled engines, the total air supply path to the pump room, which includes any louvers or dampers, shall not restrict the flow of the air more than 0.2" (5.1mm) water column. Likewise, the air discharge path, which includes any louvers, dampers, or ducting, shall not restrict the flow of air more than 0.3" (7.6mm) water column.

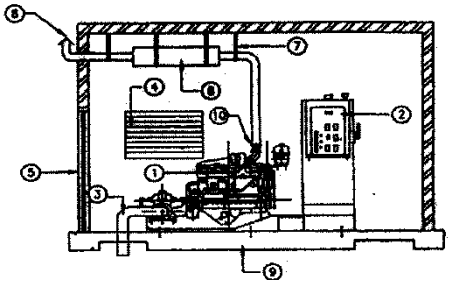


Figure #2-1
Typical Installation: Heat Exchanger

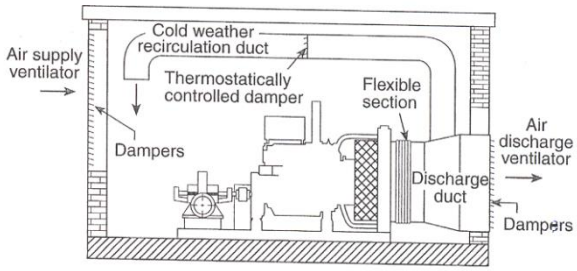


Figure #2-2
Typical Installation: Radiator

2.2. Engine Storage

2.2.1. Coolant System

Completely fill the cooling system before storage. (It is common for Clarke to ship the engine pre-filled with coolant.) Clarke Coolant (part # C054129).The only acceptable substitute is COOL-GARD II part number TY26575. Warranty is contingent on utilizing the indicated coolant.

2.2.2. Storage less than 1 year

Storing engines requires special attention. Clarke engines, as prepared for shipment, may be stored for a minimum of one year. During this period, they should be stored indoors in a dry environment. Protective coverings are recommended provided they are arranged to allow for air circulation. The stored engine should be inspected periodically for obvious conditions such as standing water, part theft, excess dirt buildup or any other condition that may be detrimental to the engine or components. Any such conditions found must be corrected immediately.

2.2.3. Extended Storage Maintenance Procedure

After a one-year storage period or if the engine is being taken out of service for more than 6 months, additional preservation service must be performed as follows:

2.2.3.1. Clean the engine of any dirt, rust, grease, and oil. Inspect the exterior. Paint areas that contain paint damage with a good quality paint.

2.2.3.2. Remove dirt from the air cleaners. Check all seals, gaskets, and the filter element for damage.

2.2.3.3. Apply lubricant to all points in this Operation and Maintenance Manual, "Maintenance Interval Schedule".

2.2.3.4. Drain the crankcase oil. Replace the crankcase oil and change the oil filters. For the proper procedure, refer to this Operation and Maintenance Manual.

2.2.3.5. If the engine is equipped with an air starting motor, fill the reservoir with the following mixture: 50 percent volatile corrosion inhibitor oil (VCI oil) and 50 percent engine oil.

2.2.3.6. Add VCI oil to the crankcase oil. The volume of VCI oil in the crankcase oil should be 3 to 4 percent.

Note: If the engine crankcase is full, drain enough engine oil so the mixture can be added.

2.2.3.7. Remove the air filter elements. Turn the engine at cranking speed with the throttle control in FUEL OFF position. Use a sprayer to add a mixture of 50 percent VCI oil and 50 percent engine oil into the air inlet or turbocharger inlet. Note: The mixture of VCI oil can be added to the inlet by removing the plug for checking turbocharger

boost pressure. The minimum application rate for the VCI oil mixture is 5.5 mL per L (3 oz per 1000 cu in) of engine displacement.

2.2.3.8. Use a sprayer to apply a mixture of 50 percent VCI oil and 50 percent crankcase oil into the exhaust openings. The minimum application rate for the oil mixture is 5.5 mL per L (3 oz per 1000 cu in) of engine displacement. Seal the exhaust pipe and seal any drain holes in the muffler.

2.2.3.9. Remove the fuel from the secondary fuel filter housing. Alternately, empty and reinstall the spin-on fuel filter element in order to remove any dirt and water. Drain any sleeve metering fuel pump. Clean the primary fuel filter. Fill with calibration fluid or kerosene. Install the primary fuel filter and operate the priming pump. This procedure will send clean oil to the secondary filter and the engine.

2.2.3.10. Remove the fuel nozzles or spark plugs. Apply 30 mL (1 oz) of the mixture of oils (50 percent VCI oil and 50 percent engine oil) into each cylinder. Use a bar or a turning tool in order to turn over the engine slowly. This procedure puts the oil on the cylinder walls. Install all fuel nozzles or spark plugs and tighten to the correct torque.

2.2.3.11. Spray a thin amount of a mixture of 50 percent VCI oil and 50 percent engine oil onto the following components: flywheel, ring gear teeth and starter pinion. Install the covers in order to prevent evaporation of the vapors from the VCI oil.

2.2.3.12. Apply a heavy amount of Cat Multipurpose Grease (MPGM) to all outside parts that move, such as rod threads, ball joints, linkage. Note: Install all covers. Ensure that tape has been installed over all openings, air inlets, exhaust openings, the flywheel housing, the crankcase breathers, the dipstick tubes. Ensure that all covers are airtight and weatherproof. Use a waterproof weather resistant tape such as Kendall No. 231 or an equivalent. Do not use duct tape. Duct tape will only seal for a short time.

2.2.3.13. Under most conditions, removing the batteries is the best procedure. As an alternative, place the batteries in storage. As needed, periodically charge the batteries while the batteries are in storage. If the batteries are not removed, wash the tops of the batteries until the tops are clean. Apply an electrical charge to the batteries in order to obtain a specific gravity of 1.225. Disconnect the battery terminals. Place a plastic cover over the batteries. Note: For additional information, refer to Special Instruction, SEHS7633, "Battery Test Procedure".

2.2.3.14. Loosen all belts.

2.2.3.15. Place a waterproof cover over the engine. Ensure that the engine cover is secure. The cover should be loose enough to allow air to circulate around the engine in order to prevent damage from condensation.

2.2.3.16. Attach a tag with the storage date to the engine.

2.2.3.17. Remove the waterproof cover at 2 month or 3 month intervals in order to check the engine for corrosion. If the engine has signs of corrosion, repeat the protection procedure.

2.2.4. Removal from Storage

2.2.4.1. Remove all outside protective covers.

2.2.4.2. Change the oil and filters.

2.2.4.3. Check the condition of the fan and alternator belts. Replace the belts, if necessary. Refer to this Operation and Maintenance Manual, "Belts - Inspect/Adjust/Replace" for the correct procedure.

2.2.4.4. Replace the fuel filter elements.

2.2.4.5. Remove the plastic covers from the air cleaner elements.

2.2.4.6. Use a bar or a turning tool in order to turn the engine in the normal direction of rotation. The procedure ensures that no hydraulic locks or resistance exist.

2.2.4.7. Before starting the engine, remove the valve cover or covers. Put a large amount of engine oil on the camshaft, cam followers, and valve mechanism in order to prevent damage to the mechanism.

2.2.4.8. Pressure-lubricate the engine before starting the engine. Pressure lubricating the engine ensures immediate lubrication and prevents damage to the engine during the first few minutes of engine operation. If the engine is not equipped with a prelube pump, contact your Cat dealer for information about lubrication of the engine before starting the engine.

2.2.4.9. Check the condition of all rubber hoses. Replace any worn hoses. Replace any damaged hoses.

2.2.4.10. Before start-up, test the cooling system for a 3 percent to a 6 percent concentration of coolant conditioner. Add liquid coolant conditioner or a coolant conditioner element, if equipped. Test the coolant mixture for proper nitrite level. If necessary, adjust the coolant mixture. Prime the engine with clean diesel fuel before starting.

2.2.4.11. Ensure that the cooling system is clean. Ensure that the system is full. Ensure that the system has the correct amount of supplemental cooling system conditioner.

2.2.4.12. On the first day of operation, check the entire engine several times for leaks and correct operation.

2.2.4.13. If the engine was removed from storage in which temperatures of less than -12°C (10°F) were encountered, refer to Service Manual, SEBU5898, "Cold Weather Recommendations Operation and Maintenance".

2.3. Installation Instructions

The correct installation of the engine is very important to achieving optimum performance and extended engine life. In this respect, the engine has certain installation requirements, which are critical to how it performs. These requirements are generally associated with the cooling, exhaust, induction air, and fuel systems. This section of the manual should be read in conjunction with the relevant Installation and Operation Data Sheets. If there is any doubt about an installation, contact should be made with Clarke Customer Support giving exact details of the problem. All installations should be clean, free of any debris and dry. Care should be taken to ensure that there is easy access to the engine for maintenance and repair. The safety of personnel who may be in the area of the engine when it is running is of paramount importance when designing the installation layout.

2.3.1. Secure pump set to foundation and complete installation in accordance with pump manufacturer's instructions. Perform engine to pump coupling alignment. Lubricate Falk coupling with supplied grease or driveshaft universal joints with NLGI grade #1 or #2 grease at the (3) zerk fittings. (Refer to section 2.4.3 for specific alignment instructions).

2.3.2. Install the heat exchanger discharge pipe (Engine with Heat Exchanger Cooling). The discharge pipe should be no smaller than the outlet connection on the heat exchanger. Discharge water piping should be installed in accordance with applicable codes. All plumbing connecting to the heat exchanger must be secured to minimize movement by the engine. Cooling loop water pressure to the heat exchanger must not exceed the limit that is stated on the heat exchanger supplied with the engine.

2.3.3. Install all engine cooling system draincocks and plugs.

Qty	Description	Location
1	⅛" Draincock	Coolant heater inlet tube
1	¼ " Draincock	Water Pump Inlet
1	Electrode plug	Bottom of heat exchanger

2.3.4. Engine is typically provided with premixed coolant installed. If engine is not provided with coolant or there is a need to top off, fill engine cooling system with Clarke Coolant 0C054129. The only acceptable substitute is COOL-GARD II TY26575. Refer to Figure #7-3 in section 7.3.3 for cooling system capacity. Refer to section 7.3.4 filling procedure.

2.3.5. Engine is shipped with oil installed. For make-up oil specifications refer to section 6 Lubrication System.

2.3.6. Connect fuel supply and return line to fuel supply tank plumbing. Reference the Fuel System section of the Installation and Operation Data in (See clarkefire.com), for piping size, maximum allowable fuel pump suction, and maximum allowable fuel head requirements. Fill supply tank with #2 diesel fuel (ASTM D-975) or EN 590 diesel fuel, bleed supply system of air and check for leaks.

CAUTION: Biodiesel fuel is not recommended for stand-by equipment that can have minimal fuel consumption (such as standby generators, fire protection, etc.). For standby applications, use only petroleum based diesel fuel with Caterpillar approved fuel conditioners/ additives. For fuel conditioners/additives, check with your local CAT dealer or Clarke. Fuel supply level must meet applicable code requirements. Do not use a copper based or galvanized material for any component of a diesel fuel system. The fuel will chemically react with the zinc resulting in clogged fuel filters and injector systems.

2.3.7. Remove protective covering on air cleaner element.

2.3.8. Connect jacket water heater (if supplied) to AC power source. Connect the supplied heater connection wire directly to a customer supplied electrical junction box. The electrical supply requirements are indicated on the connection box. Connect to the heater directly to the junction box at the end of the heater only. Supply wiring should never be routed through the engine gauge panel. Severe damage to critical engine control components could result. Energize heater only after step #4 is completed.

2.3.9. Connect exhaust system to flexible connection on the engine. The exhaust system plumbing must be supported by the building structure and not the engine. The exhaust flexible connection is provided only for the purpose of thermal expansion and vibration isolation, not for misalignment or directional change.

2.3.10. Make electrical DC connections between the engine gauge panel terminal strip (if supplied) and the controller per the controller manufacturer's instructions. Refer to the wiring diagram sticker located on the inside door of the engine gauge panel for proper connection of the water solenoid.

2.3.11. Fill batteries with electrolyte per battery manufacturer's instructions. Connect cables between engine and batteries only after electrolyte is installed. Refer to the wiring diagram inside the engine gauge panel door (if supplied), or appropriate wiring diagram, for correct positive and negative connections.

2.3.12. Connect negative cables directly to the ground stud. Connect each positive cable to the large outer post of the manual starting contactors. Connect negative cables directly to the engine block. Connect each positive cable to the large outer post of the manual starting contactors.
Note: Clarke Operation and Maintenance Instructions Manual is located inside the document bag hanging on the side of the engine.

2.3.13. IMPORTANT! In order to obtain prompt Warranty Service and to comply with Emissions regulations, this engine must be registered to the final installation name and address. To register this engine, go to www.clarkefire.com and select Warranty Registration.

2.4. Specific Flywheel Coupling Alignment Instructions

2.4.1. Listed Driveshafts. Refer to Listed Driveshaft Installation, Operation and Maintenance Manual C132355

2.4.2. Driveshaft Installation. To check the alignment of the pump shaft and engine crankshaft centerlines for proper Parallel Offset and Angular tolerance, the driveshaft must be installed between the flywheel drive disc and the flanged hub on the pump shaft. Before removing the driveshaft guard, disconnect the negative battery cable from both batteries. Before beginning the alignment, checks and making any necessary corrections, install the driveshaft and re-torque all driveshaft connection bolts to the values given in the following table:

MODELS	DRIVE SHAFT	BOLT SIZE /MATERIAL GRADE	TIGHTENING TORQUE ft-lbs (N-m)
C18H0-UFAD10, C18H0-UFAD18 C18H0-UFAD20, C18H0-UFAD28 C18H0-UFAD30, C18H0-UFAD38 C18H0-UFAD40, C18H0-UFAD48 C18H0-UFAD50, C18H0-UFAD70*	SC2160A	M16, Class 10.9 (Metric) (Hi-Tensile)	100-105 (135-142) (See Note #2)
C18H0-UFAD58, C18H0-UFAD68 C18H0-UFAD70**, C18H0-UFAA78 C18H0-UFAD78, C18H0-UFAC10 C18H0-UFAC18, C18H0-UFAC20 C18H0-UFAC28	2390A	M16, Class 10.9 (Metric) (Hi-Tensile)	210-220 (285-298) (See Note #2,3)

2.4.2.1. Note 1: It is recommended that a medium strength thread-locker (Loctite 243–blue) be used in the assembly and torqueing of all hardware. This may be purchased as part number C126758, 50ml bottle.

2.4.2.2. Note 2: Four of the hi-tensile bolts and/or nuts, that are used to connect the driveshaft to the drive disc and that connect the driveshaft to the pump companion flange, will require a "crow's foot" wrench attached to a standard torque wrench in order to apply the required tightening torque. A standard socket will not work due to close proximity of the bolts and/or nuts with the driveshaft yoke. The tightening torque values listed for these bolts and/or nuts have been corrected for using a "crow's foot" adapter which extends the standard torque wrench's length.

2.4.2.3. Note 3 – For the high torque required for these nuts it is recommended that a boxed end crows foot be used.

2.4.3. Driveshaft Alignment.

The following steps describe the proper way to check alignment. A small pocket scale or ruler with millimeter markings is recommended to make all measurements. (Clarke Pocket Scale part number C125781)

2.4.3.1. (Step A) To check the Horizontal Parallel Offset, the driveshaft must be in the proper orientation.

2.4.3.1.1. Rotate the shaft so the reference "AB" on the flywheel adapter disc or the circumference of the drive shaft flange (against the flywheel adapter disc) is in the 12 o'clock position shown on figure #2-3.

2.4.3.1.2. Measure from the face of the flywheel adapter disc to point E. (Point E is on the bearing bore as shown in Figure #2-3). This measurement must:

Measurement	Driveshaft
123.5 ± 1.5mm	SC2160A
142.5 ± 1.5mm	SC2390A

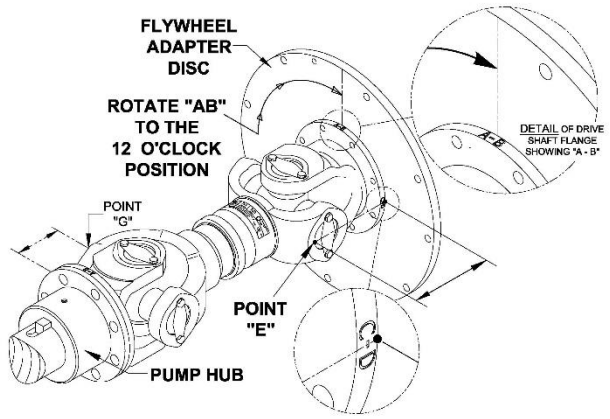


Figure 2-3

2.4.3.2. (Step B) With the driveshaft in the same orientation as the previous step (Step A), check the Horizontal Angular alignment of the shafts.

2.4.3.2.1. Measure from the mating surface of the companion hub to point G shown on figure #2-4. (Point G is the furthermost point on the bearing bore). This measurement must be equal to the measurement at point E + 0.5 mm.

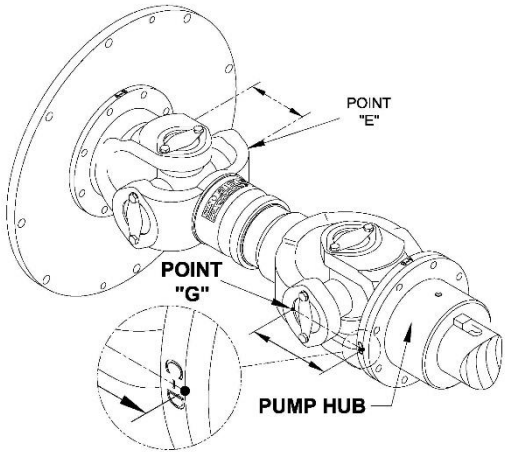


Figure 2-4

2.4.3.3. (Step C) To check the Vertical Parallel Offset, the driveshaft must be re-orientated.

2.4.3.3.1. Rotate the shaft 90° so the reference "CD" on the flywheel adapter disc or the circumference of the drive shaft flange (against the flywheel) is in the position shown on Figure 2-5.

2.4.3.3.2. Measure from the face of the flywheel adapter disc to point H. (Point H is the furthermost point on the bearing bore diameter). The measurement must be:

Measurement	Driveshaft
126.5 ± 1mm	SC2160A
145.5 ± 1.5mm	SC2390A

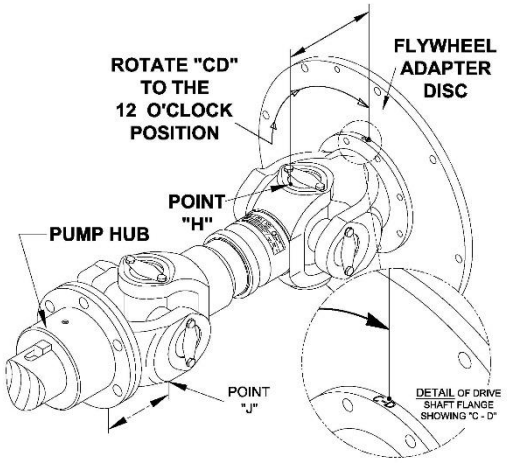


Figure 2-5

2.4.3.4. (Step D) With the driveshaft in the same orientation as the previous step (Step C), check the Vertical alignment of the shafts.

2.4.3.4.1. Measure from the mating surface of the pump companion hub of the drive shaft to point J as shown in figure 2-6. (Point J is the same as point G, with the driveshaft rotated 90°). This measurement must be equal to the measurement at point H ± 1.

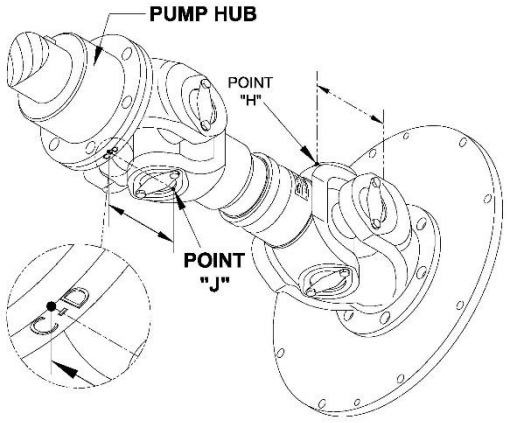


Figure 2-6

Note: Reinstall all guards and grease fittings before reconnecting the battery cables.

2.4.4. Driveshaft Maintenance

2.4.4.1. To service the driveshaft disconnect the negative battery cables, remove the top of guard and set aside.

2.4.4.2. Rotate engine shaft manually so the u-joint grease fittings are accessible.

2.4.4.3. Using a hand-held grease gun with N.L.G.I. grade 1 or 2 grease position on grease fitting. Pump with grease until grease is visible at all four cap seals.

2.4.4.4. Verify all driveshaft connecting bolts remain tight. Re-torque per 2.4.2 if necessary.

2.4.4.5. Reinstall top of guard and connect negative battery cables.

2.4.5. Other Coupling Types

Consult Factory or Clarke website at www.clarkefire.com for additional information.

3. Operation

Starting and Stopping the Engine

Before starting the engine for the first time, review section 7.3.5 to ensure there is an adequate Raw Water Supply to the Engine Heat Exchanger.

3.1. Starting from the Pump Controller

On UL/FM engines, use main pump controller for starting and stopping the engine. Should the main pump controller become inoperable, the engine can be manually started and stopped from the engine gauge panel.

3.2. Manual Start from the Engine Instrument Panel

IMPORTANT: Main pump controller selector should be in the OFF position when starting from engine gauge panel. Be sure to return selector on main pump controller and engine gauge panel to AUTOMATIC after completing manual run.

3.2.1. To manually start the engine with the instrument panel controls, position the mode selector switch to manual run (Figure 3-1 item 3).

3.2.2. Lift and hold the manual crank #1 switch (Figure 3-1 item 8) until the engine starts, or release after 15 seconds. If the engine fails to start, wait 15 seconds. Lift and hold the manual crank #2 switch (Figure 3-1 item 9) until the engine starts, or release after 15 seconds. Repeat.

NOTE: If the raw water is not flowing or the engine temperature is too high, open the cooling loop bypass manual valves. (applies to heat exchanger cooled engines only).

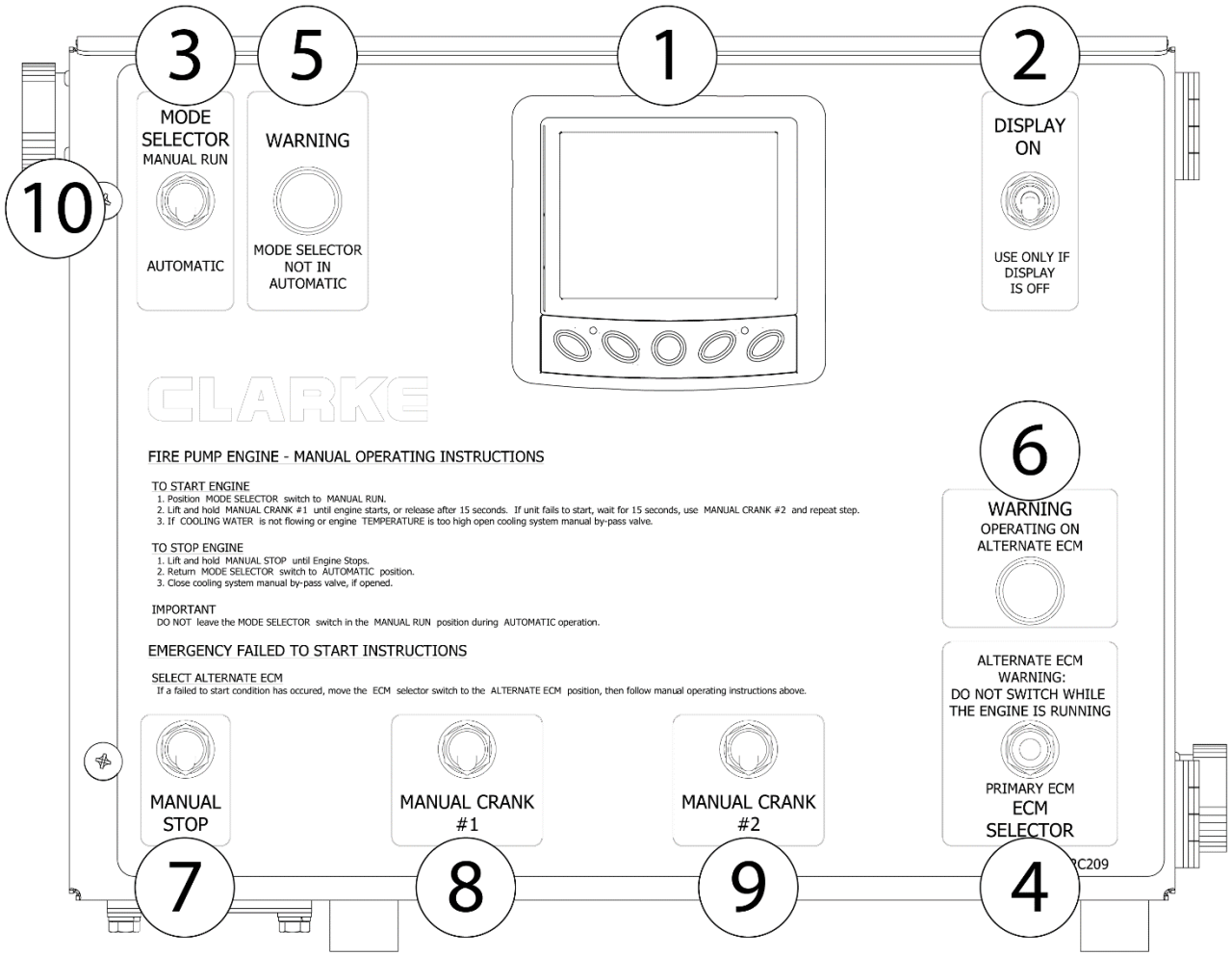


Figure 3-1

1 - PowerView Gauge
2 - Momentary Display On Switch
3 - Automatic/Manual Mode Selector Switch
4 - ECM Selector Switch
5 - Manual Mode Indicator Warning Light
6 - Alternate ECM Indicator Warning Light
7 - Manual Stop Switch
8 - Manual Crank Switch – Battery #1
9 - Manual Crank Switch – Battery #2
10 – Service Tool Connector

3.3. Soft Start.

During installation of the sprinkler system or initial commissioning, it may be desirable to start the engine at a reduced speed. Reducing the speed reduces the pressure of the pump discharge. This allows leak detection to be performed at reduced system pressure and reduces the likelihood of water hammer at start. The process is simple with a mechanical engine as it has a mechanical linkage that can be removed. No provision exists on most electronic engines.C18 models from Clarke are equipped with a "Soft Start" feature to allow operation at a reduced speed. To use the feature, the engine should be started manually from the engine gauge panel. To use the feature:

3.3.1. Switch the main fire pump controller to the OFF position.

3.3.2. Switch the MODE SELECTOR to MANUAL RUN. (Refer to Figure #8).

3.3.3. Open the engine gauge panel and locate the "Soft Start" switch. It is a momentary toggle switch located in the upper part of the panel interior. (See Figure #9B).

3.3.4. With your left hand, pull the toggle switch towards you and maintain that position. Then lift and hold the MANUAL CRANK #1 on the front of the engine gauge panel with your right hand. Release it when the engine starts.

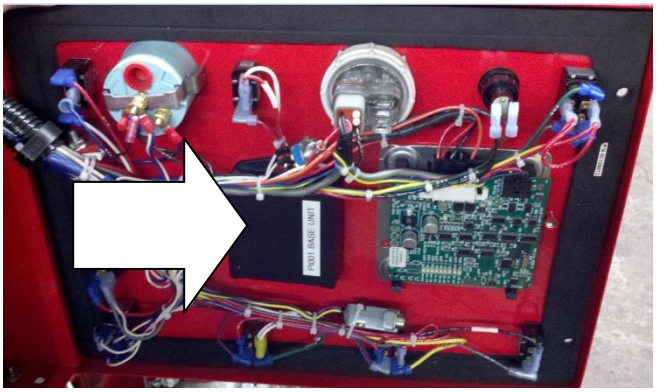
3.3.5. The engine will run at 1100 rpm until the "Soft Start" toggle is released. Once the toggle is released, the engine will increase speed at the rate of 10 rpms per second until it reaches rated speed. The "Soft Start" toggle can be activated again and the engine will immediately return to 1100 rpm.

3.4. To Stop the Engine

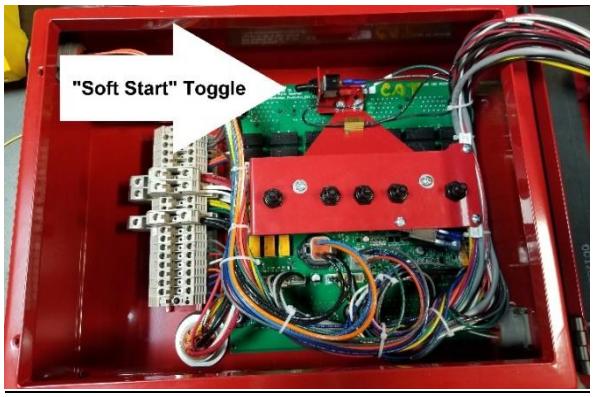
3.4.1. If engine is started from pump controller use pump controller to stop the engine.

3.4.2. If engine is started from engine instrument panel, lift and hold the Manual Stop Switch (Figure 3-1 item 7). Close cooling system manual by-pass valve if opened.

IMPORTANT: DO NOT leave the MODE SELECTOR switch in the MANUAL RUN position during AUTOMATIC operation. (The controller will be unable to stop the engine and DAMAGE MAY RESULT). Note: On C18 Engines you can also start the engine using the manual contactors.



Interior view of engine gauge panel door - BASE dual ECM auto-switching device and green LED
Figure #3-2



Interior view of engine gauge panel.
Figure #3-3

3.5. Describing Engine Instrument Panel

3.5.1. ECM Selector Switch and Primary/Alternate ECM

Clarke UL/FM Engines come equipped with dual ECMs and an ECM Selector Switch on engine gauge panel. (Item #6). Default position of ECM selector switch is to the Primary ECM. In the event of a failure of the Primary ECM, where-by the engine shuts down or will not start, it will become necessary to manually switch to the Alternate ECM position. When the ECM Selector Switch is positioned to the Alternate ECM position a warning light will illuminate at the engine gauge panel. Also, the main controller will display a warning light and an audible alarm. The engine should then be re-started manually. (See section 3.2.1). Contact a Clarke Authorized Service Dealer immediately when this situation occurs to troubleshoot. (See section 10.0). Information displayed on the PowerView diagnostic gauge will come from either the Primary or Alternate ECM depending upon the position of the ECM Selector Switch. If a fault code(s) is displayed and comes from the Primary ECM, and then the ECM selector switch is moved to the Alternate ECM position, it may be necessary to "crank" the engine for the Alternate ECM to pick-up the same fault code(s).

3.5.2. Dual ECM Automatic Switching

Engine models utilizing dual ECMs are equipped with a BASE unit (Board for Auto-Switching ECMs) that can detect failure on either primary or alternate ECM. The BASE monitors two separate heartbeat signals from each of the ECMs. If the BASE fails to detect BOTH of these signals, the BASE will recognize this as an ECM failure and initiate the automatic ECM switching process. If the BASE fails to detect only one of these signals, the automatic ECM switching process will not initiate however an indication will be made by a green status LED on the BASE.

3.5.2.1. Normal Operation: LED Flashes at 1/10 Hz or 1 time in 10 seconds
3.5.2.2. Primary heartbeat failure only: Led Flashes at ½ Hz or 5 times in 10 seconds.
3.5.2.3. Secondary heartbeat failure only: LED Flashes at 1 ½ Hz or 15 times in 10 seconds.
3.5.2.4. Double ECM failure: LED Flashes at 2 ½ Hz or 25 times in 10 seconds.

If the currently selected ECM experiences a failure detected by the BASE unit, an ECM warning alarm will be sent to the fire pump controller via interconnect terminal 303 and will automatically switch to the other functional ECM. If the automatic switching devices switches to alternate ECM, a visual indication light will illuminate on the engine control panel, and an alternate ECM alarm will be sent to the fire pump controller via interconnect terminal 301. Upon failure of the second ECM, the automatic switching device will alarm an ECM failure alarm to the fire pump controller via interconnect terminal 304. Additionally, the BASE status LED will flash at rate of 2 ½ Hz or 25 times in 10 seconds.

If an ECM failure occurs during engine operation, the automatic switching device will control engine shutdown and will prevent starter motor re-engagement while the engine is shutting down. After the engine safely comes to a stop the automatic switching device will switch to the other functional ECM and will then allow starter motor re-engagement control from the fire pump controller. The automatic ECM switching process will not initiate upon failure of any primary, alternate, or non-critical engine sensors as per UL/FM. After ECM repair, activate the ECM Failure reset switch to the down position for 3 seconds and release. This will de-activate the ECM Warning and Failure alarms to the fire pump controller at interconnect terminals 303 and 304. The hand operated ECM selector switch allows for manual selection of either primary or alternate ECM. In the event of failure of the BASE unit while the ECMs are functional, a Diagnostic Trouble Code of SPN 2145 FMI 9 will be displayed on the diagnostic gauge.

3.5.3. Programming ECM with Automatic Switching Device

This procedure will be performed by Clarke Certified Service Dealer or a Cat Dealer.
In the event of a failed or damaged ECM, programming will be required on the replacement unit. The diagnostic tool will be connected to the Service Tool Connector (#10 in Figure #8). In addition to the typical programming procedure used on Caterpillar engines, some extra steps are required.

3.5.3.1. To program the Primary ECM:
- 3.5.3.1.1. In manual operation mode, select the Primary ECM with the ECM SELECTOR (Item #4 on Figure #3-1).
- 3.5.3.1.2. Unplug the BASE dual ECM auto-switching device on the back side of the engine gauge panel door. (See Figure #3-4.)
- 3.5.3.1.3. This will prevent the BASE from switching to Alternate ECM during the software re-flashing process.
- 3.5.3.1.4. Complete the programming process as normal.
- 3.5.3.1.5. Plug the BASE back in.

3.5.3.2. To program the Alternate ECM:

3.5.3.2.1. Unplug the BASE dual ECM auto-switching device on the back side of the engine gauge panel door.

3.5.3.2.2. Insert the service tool, provided in the engine gauge panel, into the connector removed from the BASE. (See Figure #3-5)

3.5.3.2.3. This will force the panel into Alternate ECM mode.

3.5.3.2.4. Complete the programming process as normal.

3.5.3.2.5. Plug the BASE back in.

BASE connector
Figure 3-4

Service Tool
Figure 3-5

3.5.4. Using the PowerView Gauge

The PowerView gauge (reference Figure #3-6) allows the operator to view operating conditions and diagnostic trouble codes (DTC's). Press the menu key (C) to access the various engine functions in sequence. The displays can be selected as either customary English or metric units. The following menu of engine parameters can be displayed on the power view (refer to Figure #9E).

Engine rpm*	Coolant temperature*	Oil pressure*
Machine hours*	System voltage (battery #1)*	System voltage (battery #2)*
Percent engine load at the current rpm	Oil temperature	Intake manifold temperature
Fuel temperature	Engine torque	Fuel level
Active diagnostic codes	Stored diagnostic codes from the engine	Set the units for display
View the engine configuration parameters		

* These six parameters are fixed for the power-up display. (See Figure #3-7)

The PowerView gauge includes a liquid crystal display (LCD) screen. The display is programmed to show six NFPA required engine parameters simultaneously. The diagnostic gauge uses two arrow keys (A) and (B) for scrolling through the engine parameter list and viewing the menu list. An enter key (E) is used for selecting highlighted items. The (D) key is an escape option to leave a menu without making a change. The red (G) and amber (F) lights are used to signal active trouble codes received by the diagnostic gauge.

NOTE:

- Red indicator light (G) indicates a serious condition. Correct problem before restarting.
- Amber indicator light (F) indicates an abnormal condition. It is not necessary to shutdown engine immediately but problem should be corrected as soon as possible.

POWERVIEW BUTTON AND NOTIFICATION LIGHT LAYOUT

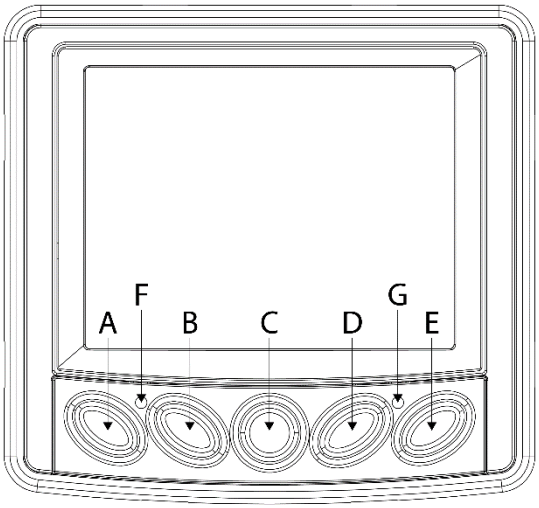


Figure 3-6

DEFAULT SIX-UP SCREEN

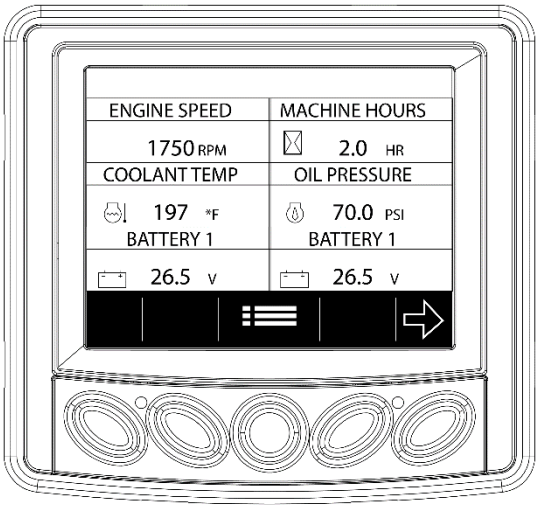


Figure 3-7

3.5.5. Main Menu Navigation

NOTE: The display gauge must be powered to navigate the diagnostic gauge screens. This is achieved by starting the engine or maintaining upward pressure on switch #2 from Figure #3-1. If engine start up is desired see: Starting the Engine. All the engine values illustrated in this example, on the diagnostic gauge, indicate the engine is running.

3.5.5.1. Starting at the default six-up engine display, press the "Menu" (C) key. (Figure 3-6)

3.5.5.2. The six items of the "Main Menu" will be displayed.

3.5.5.3. Pressing the "Arrow" (A&B) keys will scroll through the menu selections. (Figure 3-8)

MENU SCREEN

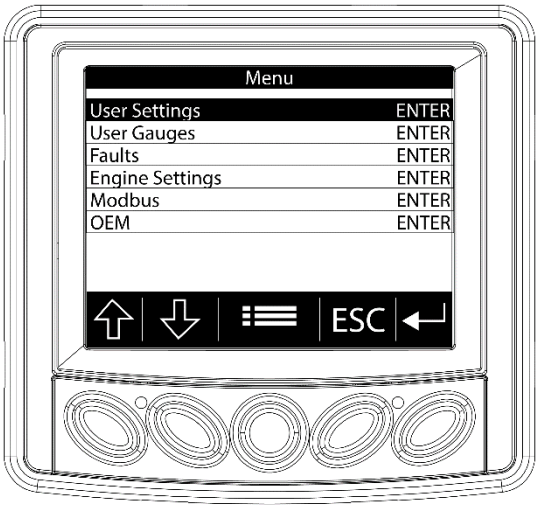


Figure 3-8

USER SETTINGS ADJUSTMENT SCREEN

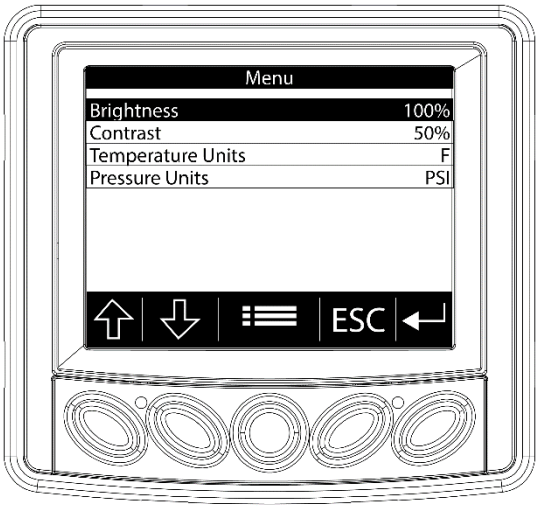


Figure 3-9

3.5.6. User Settings Adjustment

3.5.6.1. From the "Main Menu" screen you can select "User Settings" by highlighting the text and pushing the "Enter" (E) key.

3.5.6.2. The User Settings Screen will appear. This allows user adjustment of Brightness, Contrast, Temperature Units, and Pressure Units

3.5.6.3. Each of these parameters can be adjusted by highlighting the item with use of the "Arrow" (A&B) keys and then pressing the "Enter" (E) key to bring up the adjustment screen. See below for an example of adjusting the "Brightness".

3.5.6.4. The "Arrow" (A&B) keys become the add and subtract functions for brightness. Press the "Enter" (E) key to store the adjustment.
Press the "Menu" (C) key to return to the six-up display.

BRIGHTNESS ADJUSTMENT SCREEN

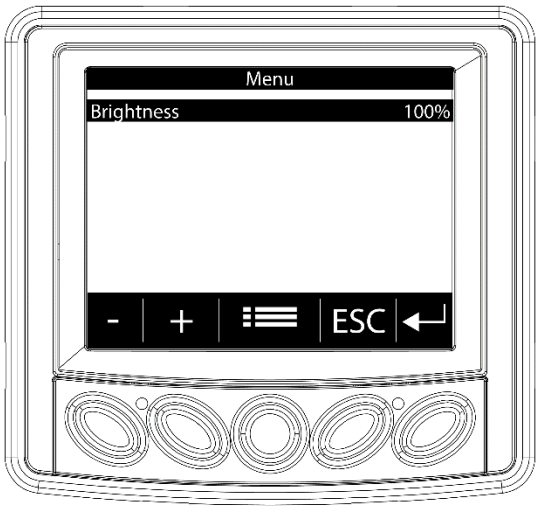


Figure 3-10

3.5.7. User Gauges Adjustment

3.5.7.1. Aside from the six-up default display, there is an "Auxiliary Parameters" screen that displays additional engine and system performance data.

3.5.7.2. Starting at the six-up display, press the "Arrow Right" (E) key.

3.5.7.3. The following "Fire Pump Parameters" screen will appear. This screen will not be populated with data unless the engine is a Clarke PLD (Pressure Limiting Driver).

3.5.7.4. Press the "Arrow Right" (E) key again to access the "Auxiliary Parameters" screen.
This screen displays six parameters that are customizable from a list of 11 user-selectable parameters. These values are obtained from the engine ECU via CAN bus protocol. Some of these parameters may not be able to be displayed. Compatibility depends on the specific Clarke engine model you own. To return to the six-up display from the "Auxiliary Parameters" screen, press the "Arrow Right" (E) key once or the "Menu" (C) key twice.

FIRE PUMP PARAMETERS SCREEN

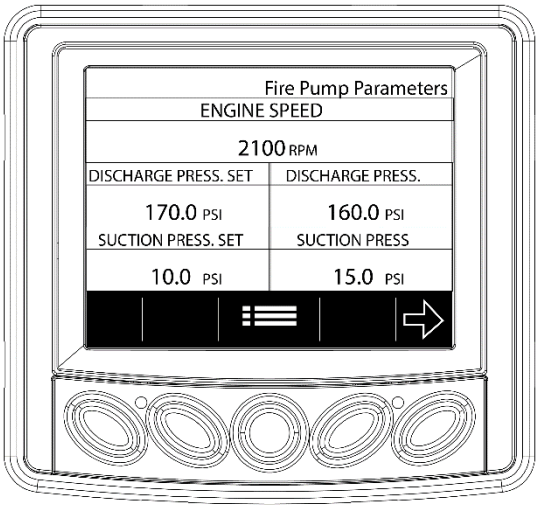


Figure 3-11

AUXILIARY PARAMETERS SCREEN

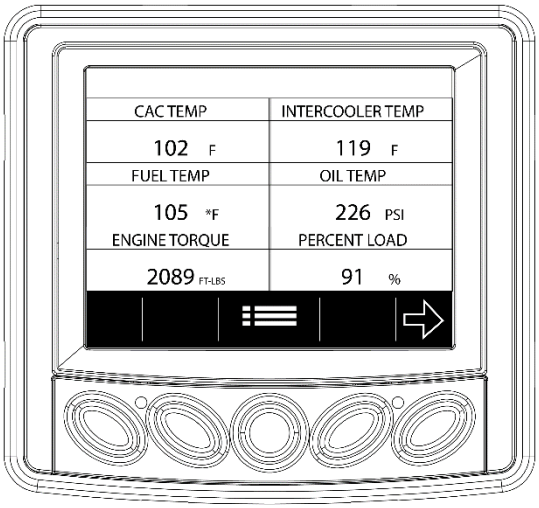


Figure 3-12

3.5.7.5. To program the parameters displayed on the "Auxiliary Parameters" screen, start from the six-up display

3.5.7.6. Press the "Menu" (C) key. The "Main Menu" will be displayed.

3.5.7.7. Press the "Down Arrow" (B) key to highlight "User Gauges".

3.5.7.8. Press the "Enter" (E) key to bring up the "User Gauges" screen.

3.5.7.9. On the "User Gauges" screen, use the "Arrow" (A&B) keys to highlight the gauge to replace. Press the "Enter" (E) key and the User Gauges Selection screen will appear.

USER GAUGES SCREEN

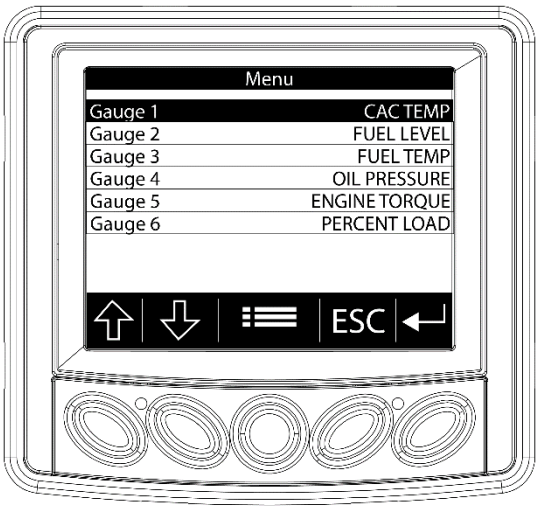


Figure 3-13

USER GAUGES SELECTION SCREEN

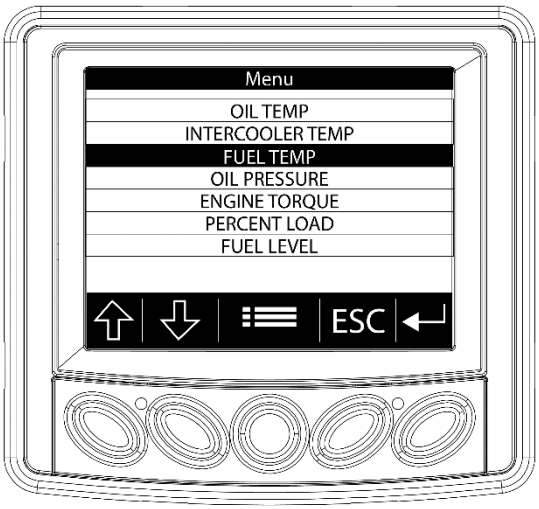


Figure 3-14

3.5.7.10. Continuing to press the "Arrow Down" (B) key will bring up another screen with four more parameters that can be added to the "Auxiliary Parameters" display.
Use the "Arrow" (A&B) keys to highlight the parameter to add to the "Auxiliary Parameters" display. Then press the "Enter" (E) key. This will confirm the selection and recall the "User Gauges" menu.

3.5.7.11. The following screen is a key depicting the locations of Gauge 1 - Gauge 6 on the "Auxiliary Parameters" display.

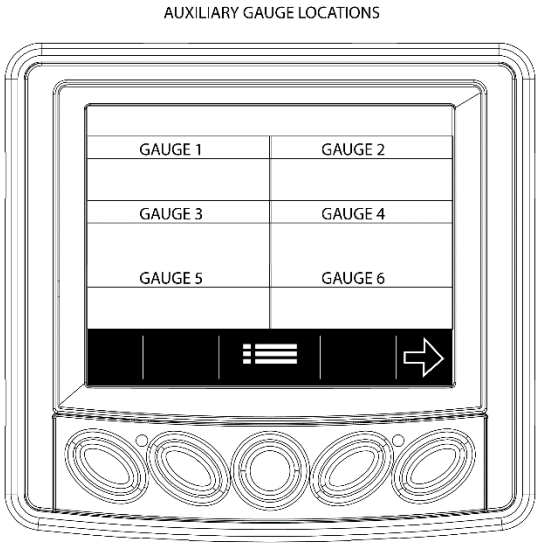


Figure 3-15

3.5.7.12. To return to the six-up display from the "Auxiliary Parameters" screen, press the "Arrow Right" (E) key once or the "Menu" (C) key twice.

3.5.8. Engine Settings Data

NOTE: The engine settings data is a read only function. All engine settings parameters are pre-set by Clarke. This menu is primarily used for trouble shooting activities.

3.5.8.1. Starting at the six-up display, press the "Menu" (C) key.

3.5.8.2. Use the "Arrow" (A&B) keys to scroll through the menu until "Engine Settings" is highlighted.

3.5.8.3. Press the "Enter" (E) key to view the Engine Settings Screen.

3.5.8.4. Pressing the "Enter" key on Engine Overspeed will display the Engine Overspeed Setpoint Screen. It displays the engine speed (RPM) required to trip the overspeed alarm during a verification of that alarm circuit and the engine speed (RPM) required to activate the overspeed alarm during normal operation.

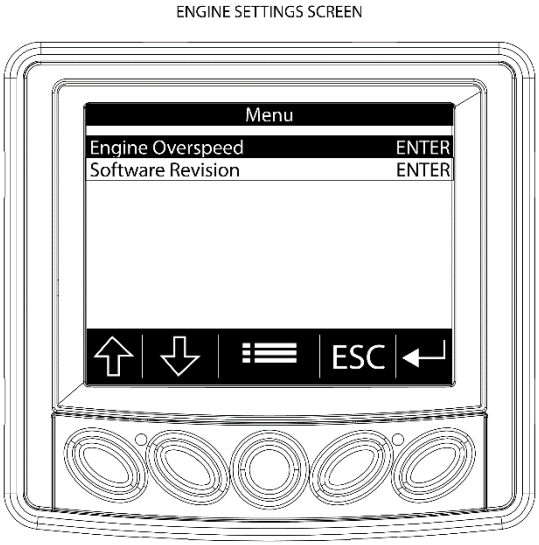


Figure 3-16

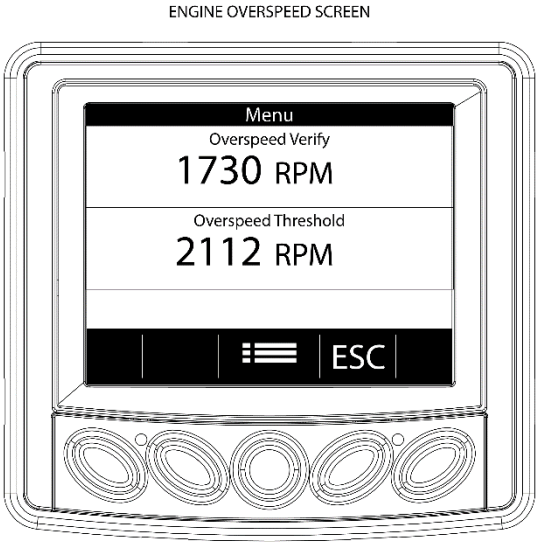


Figure 3-17

3.5.8.5. Pressing the “Escape” (D) key will return you to the “Engine Settings” menu.
3.5.8.6. Press the “Arrow” (B) key to highlight “Software Revision”. Press the” Enter” (E) key. The Software Revisions screen will appear. This information may be requested during an attempt to troubleshoot an issue.
3.5.8.7. Press the “Menu” (C) key to return to the main menu.

SOFTWARE VERSION SCREEN

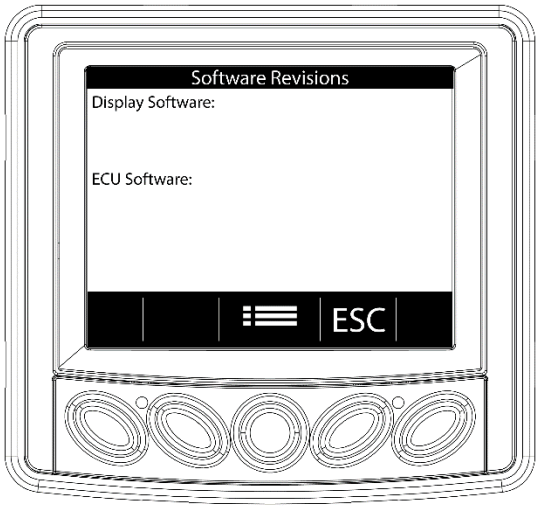


Figure 3-18

3.5.9. Accessing Stored Trouble codes
3.5.9.1. Starting at the six-up display, press the “Menu” key.
3.5.9.2. Use the “Arrow” (A&B) keys to scroll through the menu until “Faults” is highlighted.
3.5.9.3. Press the “Enter” (E) key once “Faults” is highlighted and the “Faults” menu will appear.
3.5.9.4. Press the “Arrow” (A&B) keys to highlight “Stored Faults” and press the “Enter” (E) key. The following screen will appear.
3.5.9.5. The top line of the “Stored Faults” screen informs the user of the number of stored fault codes. If there are two stored faults, beside the text “Diagnostic Message”, the text will read 1 of 2. SPN and FMI make up the code for the fault. See the Troubleshooting section of this manual for description of common codes. OC is the number of occurrences for the code displayed.
3.5.9.6. See Figure 3-21 for an example of a “Stored Faults” screen when there are stored faults. Press the “Arrow” (A&B) keys to scroll through all of the stored fault codes. Press the “Menu” (C) key once to return to the “Main Menu”. Press again to return to the six-up display.

FAULTS SCREEN

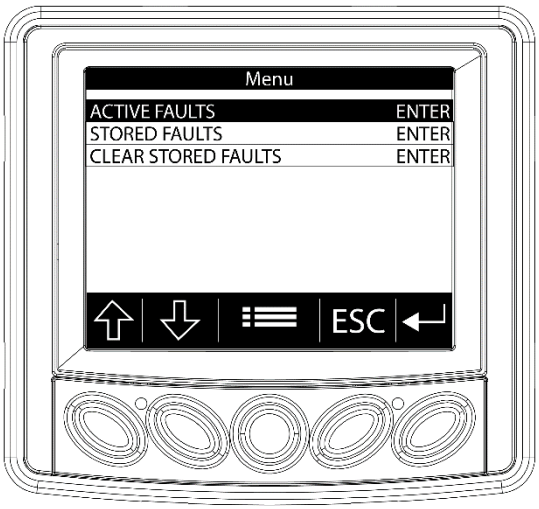


Figure 3-19

FAULT CODE SCREEN

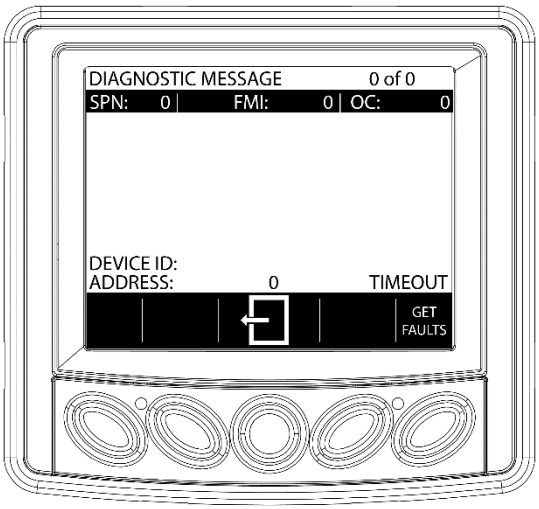


Figure 3-20

FAULT CODE SCREEN

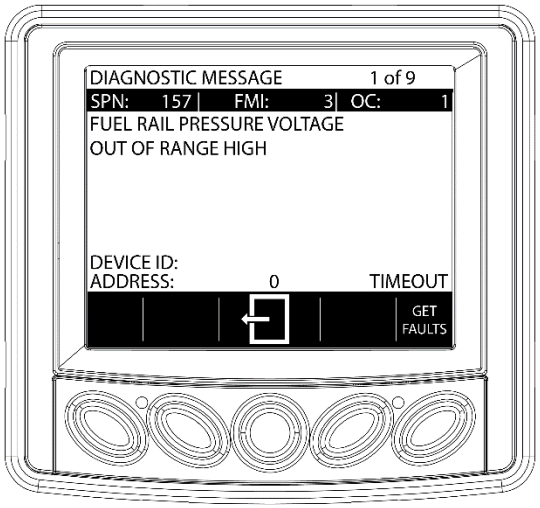


Figure 3-21

3.5.10. Accessing Active Trouble Codes

3.5.10.1. During normal operation, the default six-up display will be visible.

3.5.10.2. When the diagnostic gauge receives a trouble code from an engine control module, the six-up display will be replaced with the "Warning" message. The SPN and FMI number will be displayed along with a description of the problem. The yellow LED on the left will be illuminated as well.
IMPORTANT: Ignoring active trouble codes can result in severe engine damage.

3.5.10.3. If the arrows appear above keys A&B, there are more trouble codes that can be viewed by using the arrow keys to scroll to the next trouble code. It will also indicate multiple "Diagnostic Messages" at the top of the screen. Ex. (1 of 2 instead of 1 of 1.)

3.5.10.4. To acknowledge and hide the code and return to the six-up display, press the "Enter" Key.

3.5.10.5. The screen will return to the six-up display with a warning icon. The yellow LED will also remain illuminated. The warning icon and yellow LED will remain in place until the fault condition is corrected.

3.5.10.6. To view the active code(s) again, press the "Menu" (C) key to display the "Main Menu".

3.5.10.7. Press the "Down Arrow" (B) key two times to highlight the "Faults" option. Then press the "Enter" (E) key to access the "Faults Menu".

3.5.10.8. With "Active Faults" highlighted, press the "Enter" (E) key. The first "Active Fault" screen will appear.

3.5.11. Engine Shutdown Codes

Note: For Clarke Engine models, the only shutdown will be due to an overspeed condition.

FAULT CODE SCREEN

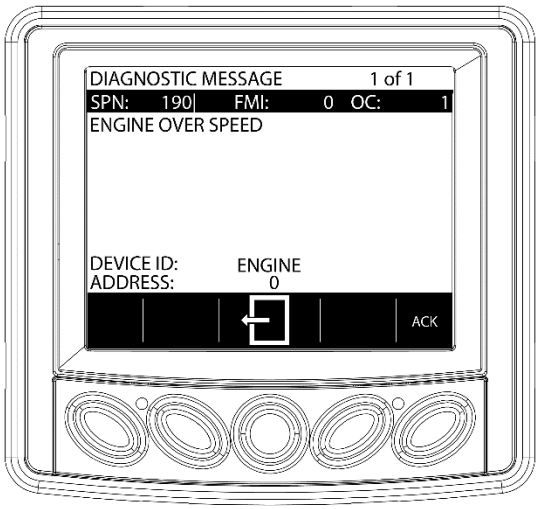


Figure 3-22

3.5.11.1. During normal operation, the six-up display will be viewed.
3.5.11.2. When the diagnostic gauge receives a severe trouble code from an ECM, the six-up display will be replaced with the "Shutdown" message, The SPN and FMI number will be displayed along with a description of the problem.
3.5.11.3. To acknowledge and hide the trouble code and return to the six-up display, press the "E" key.
3.5.11.4. The gauge will return to six-up display, but the display will contain the "Shutdown" icon. See section 3.5.10 for accessing "Active Faults" to display the shutdown code again.
3.5.11.5. The six-up display screen will contain the shutdown icon until the trouble code condition is corrected. For Clarke engines, the only shutdown condition is engine overspeed. See Section 8.3 for overspeed reset.
3.5.11.6. The engine will not restart and run until the overspeed reset procedure is performed.

3.6. Weekly Test

An experienced operator should always be present during the weekly test.
NOTE: This engine is designed to operate at rated load conditions. For testing purposes, the engine can be run at lower load (lower flow) conditions. Running times in any one period should not exceed 30 minutes maximum.

3.6.1. Before starting the engine make sure of the following:
3.6.1.1. The operator has free access to stop the engine in an emergency.
3.6.1.2. The plant room ventilation ducts are open and the engine has good access for air.
3.6.1.3. All the guards are in position and, if not, for whatever reason, any rotating parts will be free and clear without restriction.
3.6.1.4. Battery covers are in place and there is nothing on top of or touching the engine, which is not part of the original supply specification.
3.6.1.5. Heat Exchanger Cooling: The water supply for coolant is available again without restriction.
3.6.1.6. Radiator Cooling: The air supply for cooling is available again without restriction.

3.6.2. When engine is running make sure of the following are within the limits specified on the relevant Installation & Operation Data Sheet in the Technical Catalog.
3.6.2.1. Coolant temperature. If the coolant temperature is excessive, check cooling loop strainers, functioning thermostat and condition of heat exchanger tube bundle.
3.6.2.2. Oil pressure
3.6.2.3. Raw cooling water flow

4. Fuel System

4.1. Diesel Fuel Specification

4.1.1. All diesel fire pump drivers manufactured by Clarke are designed, tested and warranted for use only with No. 2-D Diesel Fuel conforming to ASTM International D-975 or European Standard EN 590.

4.1.2. Although the above referenced fuel specifications allow limited amounts of Biodiesel, 100% petroleum fuel is preferred and should be used whenever possible. Biodiesel in any amount greater than that allowed by the above referenced specifications should not be used. The use of fuels not referenced above, or Biodiesel in amounts greater than allowed in the above referenced specifications, may affect performance and reliability, and may result in a non-warrantable engine condition.

4.1.3. To insure engine reliability and performance, the fuel provided for Clarke fire pump drivers must be maintained in a quality condition. Refer to NFPA 25 2014, reprint provided below, for guidance to the minimum requirements for fuel maintenance for all Clarke fire pump engine installations.

4.1.4. The following is reprinted from the "NFPA 25 2014 Standard for the Inspection, Testing, and maintenance of Water-Based Fire Protection Systems," Copyright © 2013 National Fire Protection Association®. All Rights Reserved.

8.3.4 Diesel Fuel Testing and Maintenance

8.3.4.1 Diesel fuel shall be tested for degradation no less than annually.

8.3.4.1.1 Fuel degradation testing shall comply with ASTM D975-11b Standard Specification for Diesel Fuel Oils, or ASTM D6751 -11b Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels as approved by the engine manufacturer, using ASTM D 7462 -11 Standard Test Method for Oxidation Stability of Biodiesel (B100) and Blends of Biodiesel with Middle Distillate Petroleum Fuel (Accelerated Method).*

8.3.4.2 If diesel fuel is found to be deficient in the testing required in 8.3.4.1.1, the fuel shall be reconditioned or replaced, the supply tank shall be cleaned internally, and the engine fuel filter(s) shall be changed.*

8.3.4.2.1 After the restoration of the fuel and tank in 8.3.4.2, the fuel shall be retested each 6 months until experience indicates the fuel can be stored for a minimum of one year without degradation beyond that allowed in 8.3.4.1.1

8.3.4.3 When provided, active fuel maintenance systems shall be listed for fire pump service.

8.3.4.3.1 Maintenance of active fuel maintenance systems shall be in accordance with the manufacturer's recommendations.

8.3.4.3.2 Maintenance of active fuel maintenance systems shall be performed at a minimum annual frequency for any portion of the system that the manufacturer does not provide a recommended maintenance frequency.

8.3.4.3.3 Fuel additives shall be used and maintained in accordance with the active fuel maintenance system manufacturer's recommendations.

A.8.3.4.1.1 Commercial distillate fuel oils used in modern diesel engines are subject to various detrimental effects from storage. The origin of the crude oil, refinement processing techniques, time of year, and geographical consumption location all influence the determination of fuel blend formulas. Naturally occurring gums, waxes, soluble metallic soaps, water, dirt, blends and temperature all contribute to the degradation of the fuel as it is handled and stored. These effects begin at the time of fuel refinement and continue until consumption. Proper maintenance of stored distillate fuel is critical for engine operation, efficiency, and longevity.

Storage tanks should be kept water-free. Water contributes to steel tank corrosion and the development of microbiological growth where fuel and water interface. This and the metals of the system provide elements that react with fuel to form certain gels or organic acids, resulting in clogging of filters and system corrosion. Scheduled fuel maintenance helps to reduce fuel degradation. Fuel maintenance filtration can remove

contaminants and water and maintain fuel conditions to provide reliability and efficiency for standby fire pump engines. Fuel maintenance and testing should begin the day of installation and first fill.

A.8.3.4.2 Where environmental or fuel quality conditions result in degradation of the fuel while stored in the supply tank, from items such as water, micro-organisms and particulates, or destabilization, active fuel maintenance systems permanently installed on the fuel storage tanks have proven to be successful at maintaining fuel quality. An active fuel maintenance system will maintain the fuel quality in the tank, therefore preventing the fuel from going through possible cycles of degradation, risking engine reliability, and then requiring reconditioning.

4.2. Bleeding the Fuel System

CAUTION: Escaping fluid under pressure can penetrate the skin causing series injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles, which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand. If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Ref Figure 4-1

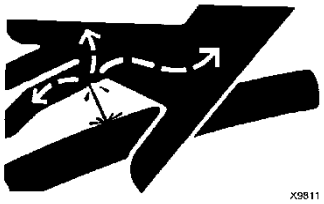


Figure 4-1

Whenever the fuel system has been opened up for service (lines disconnected, or filters removed), it will be necessary to bleed air from the system.

4.2.1. Priming the C18 Engine when secondary filter has been changed.

4.2.1.1. Open the air purge screw (2) three full turns. Do not remove screw. The air purge screw is located on the secondary filter base. See Figure #4-3.

4.2.1.2. Start the engine. The engine should start and run smoothly. Never crank the engine for more than 30 seconds continuously. Allow the starter motor to rest for 2 minutes after 30 seconds of cranking. You may use the hand priming pump (1), in lieu of starting the engine. The priming pump is located on the primary filter base on your Clarke C18 engine. See Figure #4-2.

4.2.1.3. While the engine is running, monitor the air purge screw (2). When a small drop of fuel appears at the threads, turn and tighten air purge screw. The tone of the engine may change as the screw is tightened, this is normal.

4.2.1.4. Clean residual fuel from all engine components.

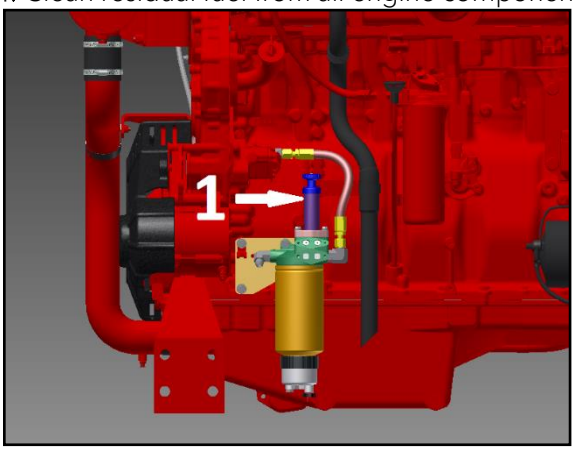


Figure 4-2

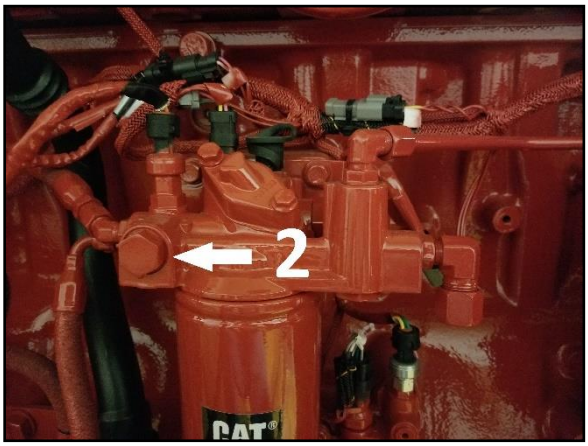


Figure 4-3

4.2.2. Priming the C18 Engine when the engine has been run out of fuel.
Note: Additional steps must be taken to prime the engine when the engine has ceased to run due to an exhausted fuel supply.

4.2.2.1. Fill the fuel tank with clean diesel fuel of the appropriate grade.
4.2.2.2. Open the air purge screw (2) three full turns. Do not remove screw.
4.2.2.3. Crank the engine for 30 seconds. Then allow the starter to rest for 2 minutes. Use a suitable container to catch fuel flow from the air purge screw bore. You may use the hand priming pump (1), in lieu of starting the engine. See Figure #4-2.
4.2.2.4. Crank the engine for 30 seconds. Allow the starter to cool for 2 minutes.
4.2.2.5. Repeat step 4 until the engine starts and runs.
4.2.2.6. Clean any residual fuel from all engine components.

4.3. Changing the Fuel Filters

Each engine has two fuel filters. For identity, the primary filter incorporates the transparent water separator. Both primary and secondary filters must be replaced at the same time.

4.3.1. Replacing Primary Fuel Filter / Water Separator
4.3.1.1. Close fuel shut-off valve at bottom of fuel tank, if equipped.
4.3.1.2. Thoroughly clean filter base (4) and surrounding area to keep from getting dirt and debris into fuel system. See Figure#4-4.
4.3.1.3. Remove element (1) from the mounting base while bowl (2) is still attached.
4.3.1.4. Dispose of the filter contents appropriately. Remove bowl (2) from element (1). The bowl is reusable, do not discard. Dispose of the used element.
4.3.1.5. Remove the o-ring from the gland of the bowl. Clean the bowl and the o-ring. Inspect the o-ring for damage or deterioration. Replace if necessary.
4.3.1.6. Lubricate the o-ring with clean diesel fuel.
4.3.1.7. Install bowl (2) on a new element. Tighten the bowl by hand. Do not use tools to tighten the bowl.
4.3.1.8. Lubricate the top seal of the element (1) with clean diesel fuel. Install the new element on the filter base. Tighten the element by hand.
4.3.1.9. Ensure the drain (3) is in the closed position.
4.3.1.10. Open the fuel shut-off valve at the bottom of the fuel tank, if equipped.
4.3.1.11. Start the engine and check for leaks. Run the engine for 1 minute. Stop the engine and check for leaks again.
4.3.1.12. The primary filter/water separator is under suction. A leak will allow air to enter the fuel. Aerated fuel can cause loss of power.

4.3.2. Replacing Secondary Fuel Element
4.3.2.1. Stop the engine. Close fuel shut-off valve at bottom of fuel tank, if equipped. Disconnect battery power.
4.3.2.2. It may be necessary to relieve residual fuel pressure from the fuel system before the fuel filter is removed. Wait 1 to 5 minutes until the fuel pressure is lowered. Use a suitable container to catch any fuel that may spill.
4.3.2.3. Remove and discard the used filter.
4.3.2.4. Apply clean diesel fuel to the new filter o-rings.
4.3.2.5. Install the new fuel filters. Spin the fuel filter onto the filter base until the o-ring makes contact. Use the rotation index marks on the filters as a guide for proper tightening. Tighten filters according to the instructions that are on the fuel filters. Do not overtighten the filters.
4.3.2.6. Open the fuel supply valve. The engine will need to be purged of air. Refer to Section 3.1.2.1 for fuel system priming instructions.

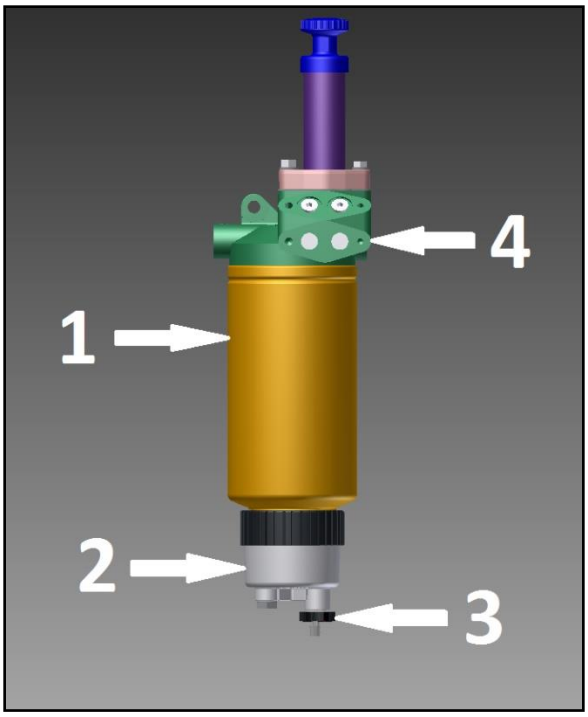


Figure 4-4

4.4. Fuel Tanks

Keep the fuel tank filled to reduce condensation to a minimum. Open drain at the bottom of the fuel tank once a week to drain off any possible water and/or sediment. Fill tank after each test run.
Note: Per NFPA 25 standards, the fuel tank level must never be less than 67% of its capacity.

Maximum Allowable Fuel Head above Fuel pump, Supply or Return.		
Engine Model	Feet	Meters
C18	15.0	4.57

5. Air/Exhaust System

5.1. Ambient Conditions

Clarke engines are tested in accordance with SAE J1349 (Clarke USA) or ISO 3046 (Clarke UK). In this capacity they may be derated to meet certain site conditions, failure to do so can seriously impede the performance of the engine and could lead to premature failure.

5.2. Ventilation

The engine must be provided with adequate ventilation to satisfy the requirements of the combustion system, radiator cooling systems where fitted, and allow adequate dissipation of radiated heat and crankcase emissions. For all this data refer to Installation & Operation Data in Technical Catalog, C133941(see Page 5). This data can be used for proper sizing of inlet and outlet louvers.

5.3. Standard Air Cleaner

The standard air cleaner is a reusable type. Should a situation occur where the air cleaner becomes plugged with dirt (starving the engine of air), loss of power and heavy black smoke will result; the air cleaner should be serviced immediately.

The maximum intake air restriction allowed, per engine model, can be seen in the following table.

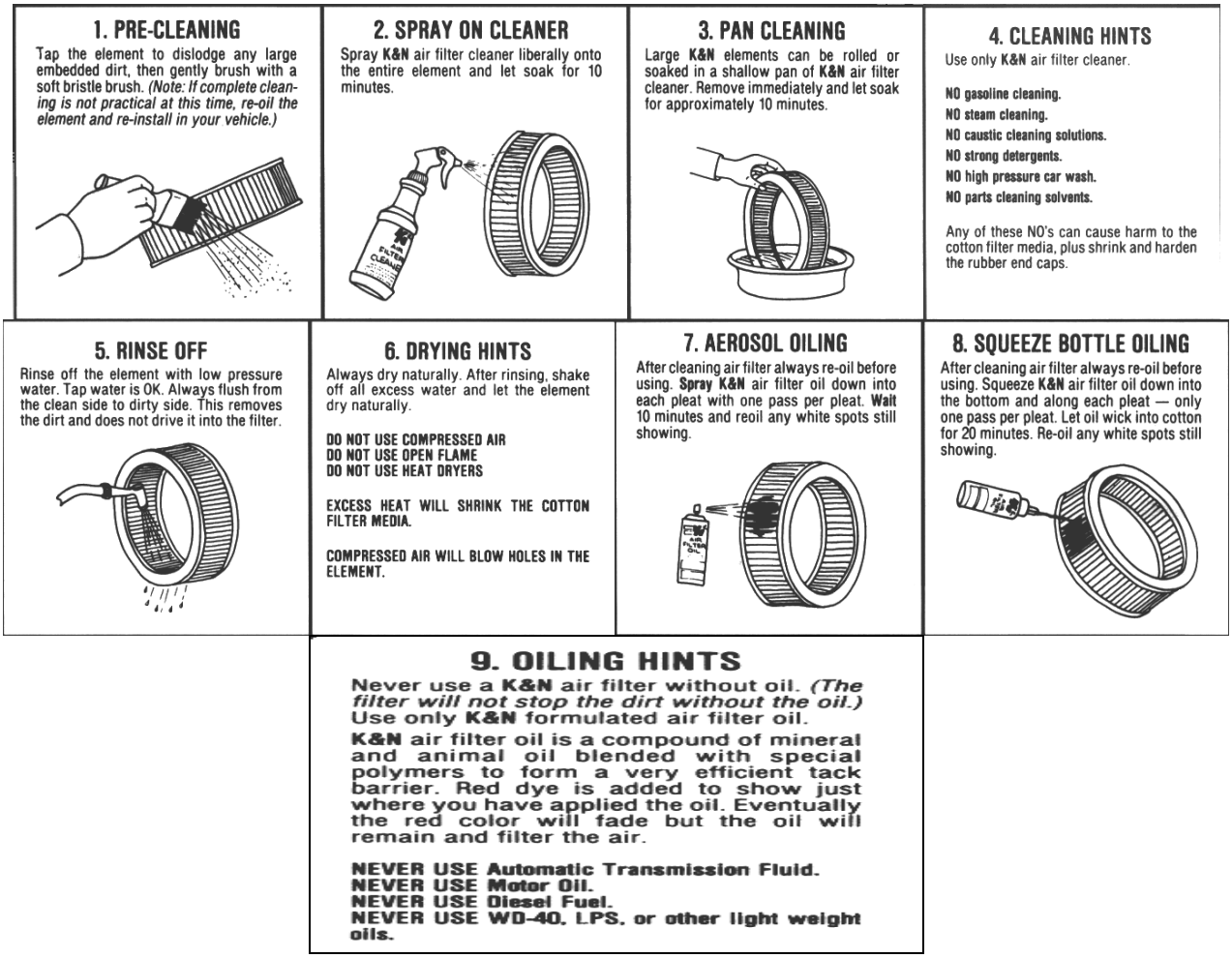
Base Engine	Air Filter Restriction (Inches of Water)
C18H0-UFAD50, C18H0-UFAD58, C18H0-UFAD68, C18H0-UFAD70, C18H0-UFAD78	25
C18H0-UFAD10, C18H0-UFAD18, C18H0-UFAD20, C18H0-UFAD28, C18H0-UFAD30, C18H0-UFAD38, C18H0-UFAD40, C18H0-UFAD48, C18H0-UFAD78, C18H0-UFAC10, C18H0-UFAC18, C18H0-UFAC20, C18H0-UFAC28	30

CAUTION: Do not attempt to remove the air cleaner while an engine is running nor run the engine while the air cleaner is off. Exposed components could cause severe injury to personnel and major internal engine damage could occur should any foreign matter be drawn into the engine.

The air cleaner manufacturer recommends the following:

1. The pre-oiled reusable elements are serviced with a special oil. The elements can be serviced or replaced.
2. Figure#15 shows the air filter service instructions.
3. When servicing the element is not practical, you can improve filter efficiency by re-spraying with oil.

NOTE: Do not attempt this while engine is running
NOTE: Do not over oil the reusable element



Note: Intake Air Shutoff Valve - Engine may include an intake air shutoff valve as an optional feature that is activated by an overspeed event and provides a positive shutoff of combustion air to the engine. The optional air intake shutoff valve has not been evaluated by UL as part of a UL Listed fire pump driver.

5.4. Crankcase Ventilation

Vapors that form within the engine are removed from the crankcase and gear train compartment by a continuous, pressurized ventilation system. A slight pressure is maintained within the engine crankcase compartment. Vapors are expelled through a vent pipe attached to the rocker cover. Ref. Figure #5-1. Contact Clarke for an optional breather kit if vapors accumulate in your pump room.

Figure 5-1

5.5. Exhaust System

5.5.1. Excessive back pressures to the engine exhaust can considerably reduce both engine performance and life. It is therefore important that exhaust systems should be the proper diameter and be as short as possible within the minimum amount of bends. Refer to Installation & Operating Data in Technical Catalog C133941 (see Page 5) for exhaust data. Also refer to table below for maximum exhaust restrictions.

Base Engine	Air Filter Restriction (Inches of Water)
C18H0-UFAD50, C18H0-UFAD58, C18H0-UFAD68, C18H0-UFAD70, C18H0-UFAD78	40
C18H0-UFAD10, C18H0-UFAD18, C18H0-UFAD20, C18H0-UFAD28, C18H0-UFAD30, C18H0-UFAD38, C18H0-UFAD40, C18H0-UFAD48, C18H0-UFAD78, C18H0-UFAC10, C18H0-UFAC18, C18H0-UFAC20, C18H0-UFAC28	40

5.5.2. Installation of Exhaust System should consist of the following:

5.5.2.1. Personnel protection from hot surfaces

5.5.2.2. Adequate supports to prevent strain on the engine exhaust outlet and minimize vibration.

5.5.2.3. Protection against entry of water and other foreign matter.

5.5.3. While the engine is running inspect exhaust pipe outlet outside of the pump room itself for environmental hazards such as excessive smoke conditions. The following could be used as a guide for general engine operating conditions.

5.5.3.1. Blue Smoke – Possible engine oil consumption.

5.5.3.2. White Smoke – Possibility of water in cylinders, water in fuel or internal engine problem.

6. Lubrication System

6.1. Checking Sump Oil

Check the sump oil level using the dipstick on the engine as shown in Figure #6-1.
This level must always be between the dipstick marks Min. and Max. with the engine not running. See Figure #6-2.

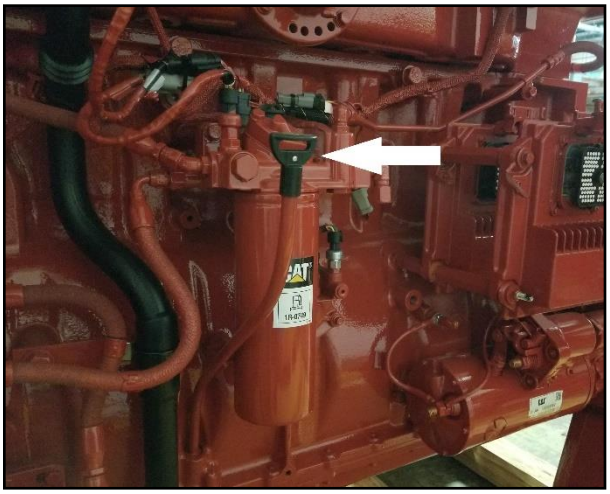


Figure 6-1

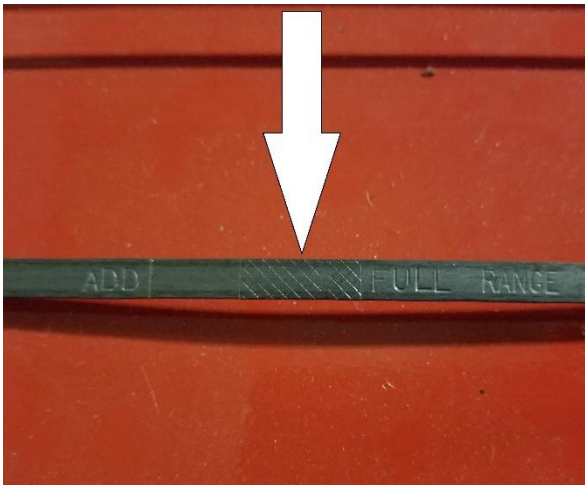


Figure 6-2

6.2. Changing Engine Oil

6.2.1. Operate the engine until it is warm.
6.2.2. Stop the engine. Remove the sump drain plug and drain the lubricating oil from the sump. Fit the drain plug tighten the plug to 34 Nm (25.1lbf-ft) /3.5 kgf-m.
6.2.3. Fill engine with oil at the oil filler neck on the valve cover. Check that the oil is at the 'FULL" mark on the dipstick with new and clean lubricating oil of an approved grade.
6.2.4. Dispose used oil properly.

6.3. Changing Oil Filter Cartridge

6.3.1. Put a tray under the filter to retain spilt lubricating oil.
6.3.2. Remove the filter with a strap wrench or similar tool. Then dispose of the filter properly.
6.3.3. Clean the filter head.
6.3.4. Add clean engine lubricating oil to the new filter. Allow the oil enough time to pass through the filter element.
6.3.5. Lubricate the top of the filter seal with clean engine lubricating oil.
6.3.6. Fit the new filter and tighten it by hand only. Do not use a strap wrench.
6.3.7. Ensure that there is lubricating oil in the sump. On turbocharged engines, ensure that the engine will not start and operate the starter motor until oil pressure is obtained.
6.3.8. Operate the engine and check for leakage from the filter. When the engine has cooled, check the oil level on the dipstick and put more oil into the sump, if necessary.
6.3.9. Return the unit back into service by returning the main pump controller selector to "automatic" position and the manual operating lever to AUTO-OFF position.

6.4. Oil Specification

Diesel Engine Oil
This engine is filled at Clarke with SAE 15W-40 oil meeting CAT ECF-3 specification.
Important: Do not add makeup oil until the oil level is BELOW the add mark on dipstick. Add Cat DEO 15W-40 or equivalent when makeup oil is required.

6.5. Oil Capacities (Including Filter)

Engine Model	Oil Capacity – Quarts (Liters)
C18 – All Models	48.0 (45.4)

7. Cooling System

7.1. Engine Operating Temperature

The C18 engines are provided with either a heat exchanger or radiator to maintain the engine coolant temperature within recommended operating guidelines.

7.1.1.1. Intended Engine Operating Temperature

The C18 models have an intended engine operating temperature of 190° F (88°C) to 205° F (96° C).

7.1.1.2. High Coolant Temperature Alarm

A high coolant temperature sensor monitors coolant temperature and will set an alarm at 217° F (103° C).

7.2. Heat Exchanger

C18 Engines were built with either a non-serviceable brazed heat exchanger or NSR heat exchanger.

7.2.1. Brazed heat exchanger (reference figure #7-1)

7.2.2. NSR heat exchanger (reference figure #7-2)

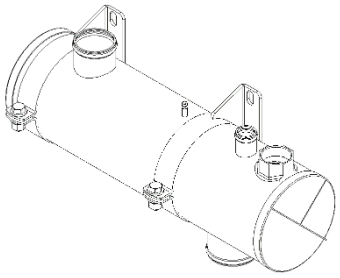


Figure 7-1
Brazed Heat exchanger

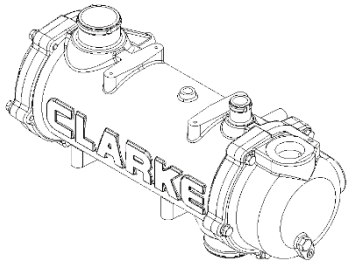


Figure 7-2
NSR Heat exchanger

7.3. Engine Coolant

Per recommendations from the engine manufacturers, it has become necessary that engine coolants be changed every 12 months using Clarke Coolant (part # C054129).
The only acceptable substitute is COOL-GARD II part number TY26575.
Warranty is contingent on utilizing the indicated coolant.

WARNING
A water and anti-freeze solution is required for pump installations. Premixing this solution prior to installing is required. This prevents possible pure anti-freeze chemical reactions to block heater elements which can burnout the element. Please see the I&O section (see Page 5) technical data section for proper cooling system capacities of each model.

7.3.1. Water

Water can produce a corrosive environment in the cooling system, and the mineral content may permit scale deposits to form on internal cooling surfaces. Therefore, inhibitors must be added to control corrosion, cavitation, and scale deposits.

Chlorides, sulfates, magnesium and calcium are among the materials which make up dissolved solids that may cause scale deposits, sludge deposits, corrosion or a combination of these. Chlorides and/or sulfates tend to accelerate corrosion, while hardness (percentage of magnesium and calcium salts broadly classified as carbonates) causes deposits of scale. Water within the limits specified in Figure #22 is satisfactory with an engine coolant when properly inhibited. Use of deionized or red distilled water is preferred.

Materials	Parts Per Million	Grains Per Gallon
Chloride (max.)	40	2.5
Sulfates (max.)	100	5.8
Total Dissolves Solids (max.)	340	20
Total Hardness (max.)	170	10

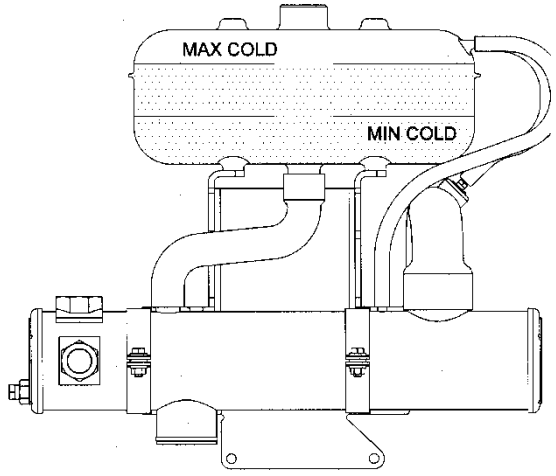
7.3.2. Coolant Capacities

Use Clarke Coolant (part # C054129). The only acceptable substitute is COOL-GARD II (part # TY26575).

Engine Model	Coolant Capacity – Quarts (Liters)
C18 – All Models	40 (37.9)

7.3.3. Procedure for Filling Engine

During filling of the cooling system, air pockets may form. The system must be purged of air prior to being put in service. This is best accomplished by filling with a pre-mix solution. Refer to Figure #7-3 for proper fill level.



HEAT EXCHANGER WITH SEPARATE
EXPANSION TANK WITHOUT DOWN TUBE

Figure #7-3

Caution: Do not overfill cooling system. A pressurized system needs space for heat expansion without overflowing.

7.3.3.1. Partial Fill

Install the pressure cap, start and run engine for approximately 5 minutes in order to purge the air from the engine cavities.

When verifying that the coolant is at a safe operating level, it is best to wait until the engine temperature drops to approximately 120°F (49°C), or lower, before removing the pressure cap.

Remove the pressure cap and refill to the proper fill level. To continue the deaeration process start and run engine until the temperature stabilizes at approximately 160°-200° (71°-93° C) or run engine for 25 minutes, whichever is longer. During this warming process, you may see coolant coming from the overflow tube attached at the pressure cap location. Allow engine to cool, then remove the pressure cap and refill to the proper fill level.

Caution: Do not remove pressure cap while coolant is at normal operating temperatures. Possible personal injury could result from the expulsion of hot coolant.

7.3.4. Providing Adequate Raw Water Supply to the Engine Heat Exchanger

7.3.4.1. Raw Water Supply

Most Clarke diesel engine fire pump drivers are heat exchanger cooled and some engines also have a charge air cooler (CAC) that uses raw water to cool the air before entering the intake manifold. If you have a radiator cooled Clarke engine, you can disregard this section. Heat exchanger cooled diesel engine drivers require a clean source of pressurized water from the discharge side of the fire pump in order to keep the engine from overheating by providing a specified minimum amount of raw water flow.

7.3.4.2. Cooling Loop

NOTE: Engine may include a cooling loop as an optional feature and has not been evaluated by UL as part of a UL Listed fire pump driver.

Clarke cooling loops are FM Approved to meet standard sizing conditions of 50% blocked wye strainers, 100degF (38degC) raw water inlet temperature, 80 psi inlet pressure, and 10 psi available at the engine outlet.

Figure #7-4 shows the standard NFPA 20 cooling loop piping arrangement. The cooling loop consists of an Automatic flow line with a 12v or 24v solenoid valve (HSC and ES pump applications only) that is energized to open anytime the engine is called upon to run from either the fire pump controller or from the engine instrument panel.

NOTE: VT type pump applications do not require a solenoid valve in the Automatic flow line.
NOTE: With the Mechanical Engine and Alarm Control Board, See section 3.5.5, the solenoid valve will open 15 seconds after engine shutdown and will stay open for 60 seconds. This allows for raw water to flow through the heat exchanger and reduce the heat soak rise caused in the engine.

The second flow line is called the Manual by-pass line and it can be opened at any time if for any reason the engine shows signs of overheating. Each line has two (quarter turn) shutoff values installed and the normal position of the shutoff valve is to remain open in the Automatic flow line and remain closed in the Manual by-pass flow line.

NOTE: Opening both lines to flow is never a problem should there be some concern of engine overheat, especially if there is an emergency situation. The Manual by-pass line can only be opened by an operator in the pump room.

The shutoff valves are all identified to show which are Normally Open (Automatic flow line) and which are Normally Closed (Manual by-pass flow line). The shutoff valves are also used to isolate water pressure in the event of maintenance to pressure regulators, strainers and solenoid valve. Shut off valves in the Automatic flow line are provided with lockable handles for cooling loops that have been tested to FM requirements.

In each flow line there is also a pressure regulator. Each pressure regulator protects the downstream piping from over-pressurization which includes the tube side of the engine shell & tube heat exchanger (and/or CAC) and to control raw water flow rate. The pressure regulators are set to limit downstream pressure to 60 psi (4 bar). There is a 0-60 psi (0-4 bar) pressure gauge installed at the cooling loop outlet, and prior to the engine heat exchanger (or CAC).

Wye strainers are used to remove debris from the raw water supply. One strainer is in the Automatic flow line and the other is in the Manual by-pass flow line.

Note: See section 9.1.11 regarding strainer maintenance.

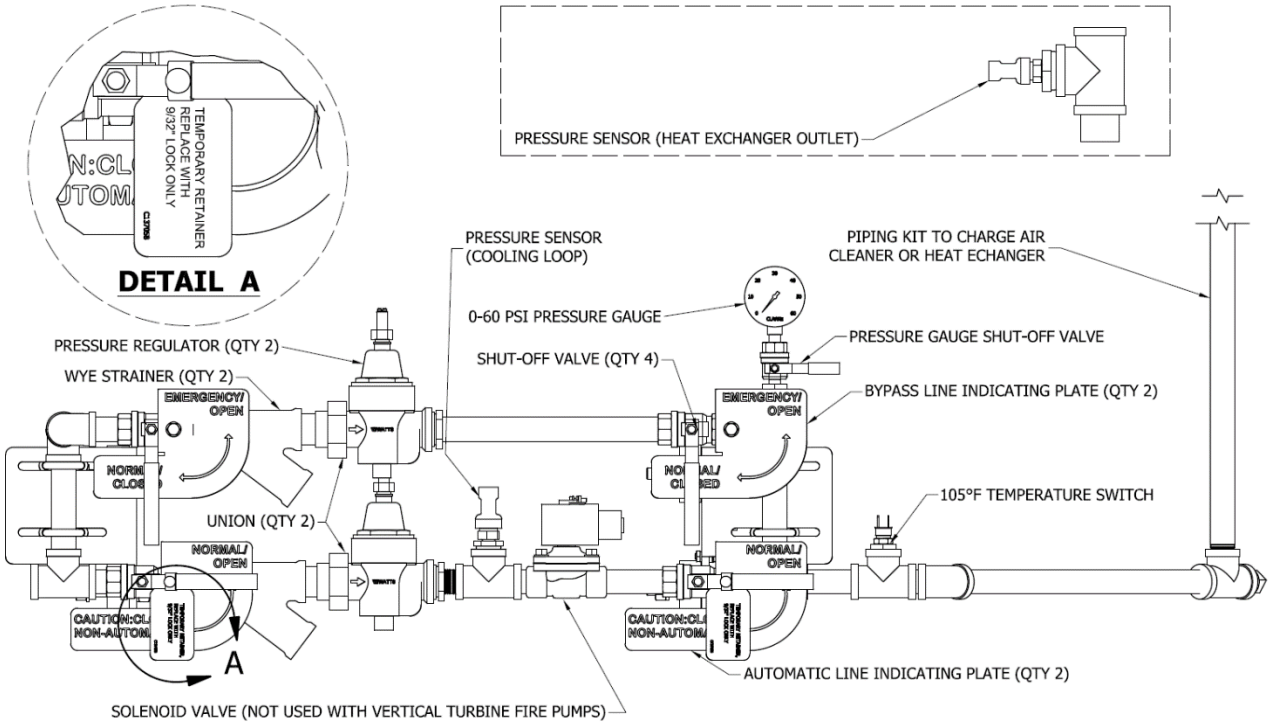


Figure 7-4

7.3.4.3. Setting Raw Water Flow Rate

The proper amount of raw water flow thru the engine is of the utmost importance, and the pressure gauge value does little to indicate if there is sufficient flow. When the engine is exercised weekly, the amount of raw water flow exiting the engine should always be checked to verify it does not appear to have diminished. During initial commissioning of the engine, it is important to correctly set the raw flow rate going thru the cooling loop. Each Clarke engine model has an Installation and Operation (I&O) Datasheet that provides basic operating conditions of the engine and most values are given based upon engine speed. You will find this datasheet in the documentation bag that

is shipped with the engine for your specific Clarke model. This datasheet must be available during commissioning in order to set the proper minimum raw water flow. With the fire pump flowing 150% of rated flow, and the Automatic flow line open; verify sufficient raw water flow rate is achieved and that the reading of the cooling loop pressure gauge does not exceed 60 psi (4 bar). You will need to capture the flow for a specific amount of time coming out of the heat exchanger and going to a floor drain in order to establish a reasonably accurate flow rate value. Using a container or bucket of known volume, record the time required to fill the container and compare to the gpm or L/min value provided on the I&O datasheet. THIS IS CRITICAL FOR PROPER ENGINE COOLING AT MAXIMUM PUMP LOAD!!

If proper cooling water flow rate is established then no fire pump controller alarm will be triggered to indicate clogged raw water strainer (low raw water flow).

After verifying raw water flow rate in the Automatic flowline, open the Manual by-pass line shut-off valves, and then close the Automatic flowline shut-off valves and repeat the above process in order to verify the flowrate going thru the Manual by-pass line. Note, with Automatic flowline closed the controller low raw water flow alarm may be present , this is normal. Once this is completed; close the Manual by-pass shut-off valves and open the Automatic flowline shut-off valves to restore conditions back to normal.

7.3.4.4. Raw Water Outlet

NOTE: NFPA 20 does allow for the heat exchanger outlet flow to be returned to a suction reservoir. This makes it very difficult to measure the flowrate. When discharging to a suction reservoir, NFPA provides additional requirements:

7.3.4.4.1. A visual flow indicator and temperature indicator are installed in the discharge (waste outlet) piping.

7.3.4.4.2. When waste outlet piping is longer than 15ft (4.6m) and / or the outlet discharges are more than 4ft (1.2M) higher than the heat exchanger, the pipe size increased by at least one size.

7.3.4.4.3. Verify that when the correct flow rate is achieved that the inlet pressure to the heat exchanger (or CAC) does not exceed 60psi (4bar)

If you have such an installation, it is recommended that you run the engine for a period of time at firepump 150% flow and confirm the visual flow indicator is showing water flow, the temperature rise is not excessive (usually no more than 40F (4.5C) over ambient raw water temperature) and the engine is showing no signs of overheating.

7.3.4.5. Raw Water Quality, Strainers and Deterioration of Heat Exchanger (or CAC)

Over time, as the heat exchanger (or CAC) begins to plug and foul, this pressure will rise and the flow will diminish which could mean that the heat exchanger (or CAC) may have to be serviced or replaced. (For NSR heat exchangers, reference section 9.6 for cleaning procedure.)

It can be not stressed enough how important it is to keep the wye strainers within the cooling loop clean: Most engine failures occur due to plugged cooling loop strainers! If the raw water supply has debris in it (leaves, stones, etc) as the strainer accumulates more debris (that will not pass thru it), the flowrate will continue to diminish which will eventually starve the engine of adequate cooling water flow which will lead to engine overheat and catastrophic engine failure. When this occurs you have no fire protection! Clarke recommends that after the initial engine commissioning and also prior to each weekly exercise of the engine / fire pump set, both strainers be removed and cleaned and then re-installed before starting the engine.

Clarke engines are equipped with an alarm that is meant to signal diminished raw water flow rate (terminal 311), possibly due to clogged raw water strainers in the cooling loop. Refer to Figure #7-5 for location of sensors. A circuit board located near the front of the cooling loop monitors differential pressure between the two sensors and will send an alarm to the controller if a low water flow condition exists.

Additionally, a raw water temperature switch will send an alarm (terminal 310) when temperature of the water exceeds 105°F (41° C). Refer to Figure #7-5 for location of switch. If either of these alarms are active, it indicates that the cooling system's capability may be compromised.

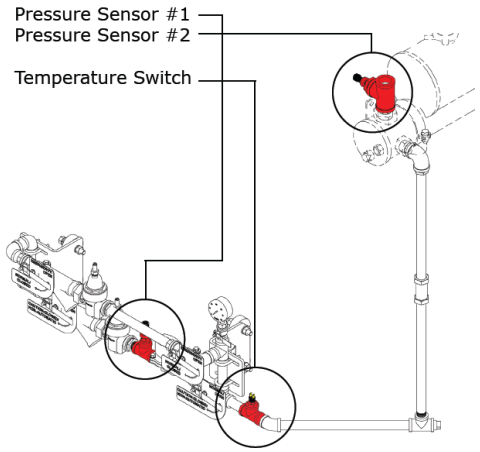


Figure 7-5

7.3.4.6. Backflow Preventers

NFPA20 allows for the use of backflow preventers in the Automatic and Manual flow line of the cooling loop as required by local code. For specific application information contact factory.

7.3.4.7. Raw Water Outlet Temperature

Certain local codes may not allow you to discharge the waste water outlet from the engine heat exchanger either due to its temperature or it now being considered hazardous waste. It is recommended you always check local codes regarding waste water discharge.

7.3.5. NSR Heat Exchanger Maintenance

The NSR heat exchanger tube bundle can be removed and cleaned to maintain proper cooling and flow requirements. The cleaning procedure should be performed on an as needed basis. Refer to section 9.6.

7.3.6. Flow Paths of Engine Cooling System

The engine coolant flows through the shell side of the heat exchanger (or radiator), engine coolant pump, oil cooler, turbo chargers, engine block and cylinder head, jacket water heater, thermostat, expansion tank, and coolant recovery tank (if equipped).

On heat exchanger equipped engines raw cooling water flows through the tube side of the charge air cooler, if equipped, and the tube side of the heat exchanger.

Refer to Figures #7-6 for heat exchanger cooled engines and #7-7 for radiator cooled engines for cooling system flow path diagram.

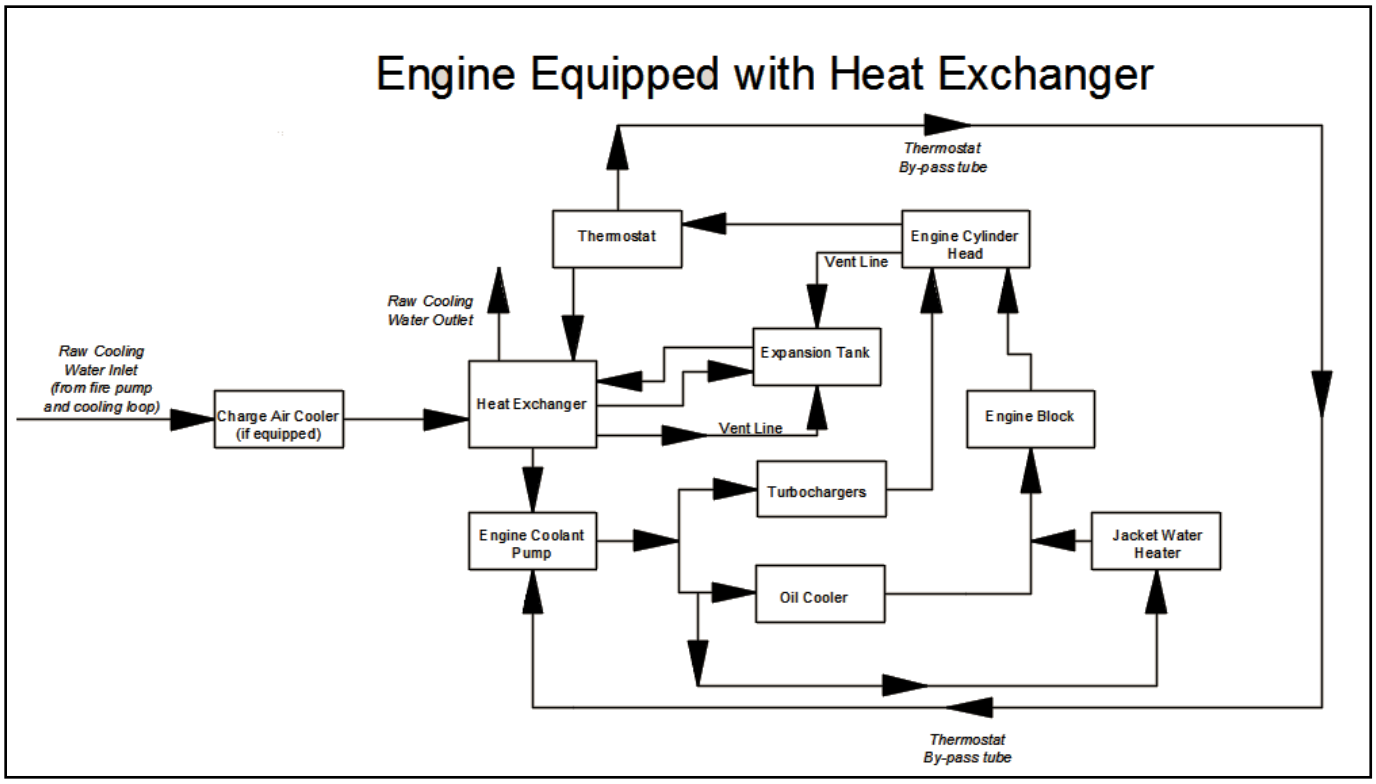


Figure 7-6 Heat Exchanger Cooled Engines

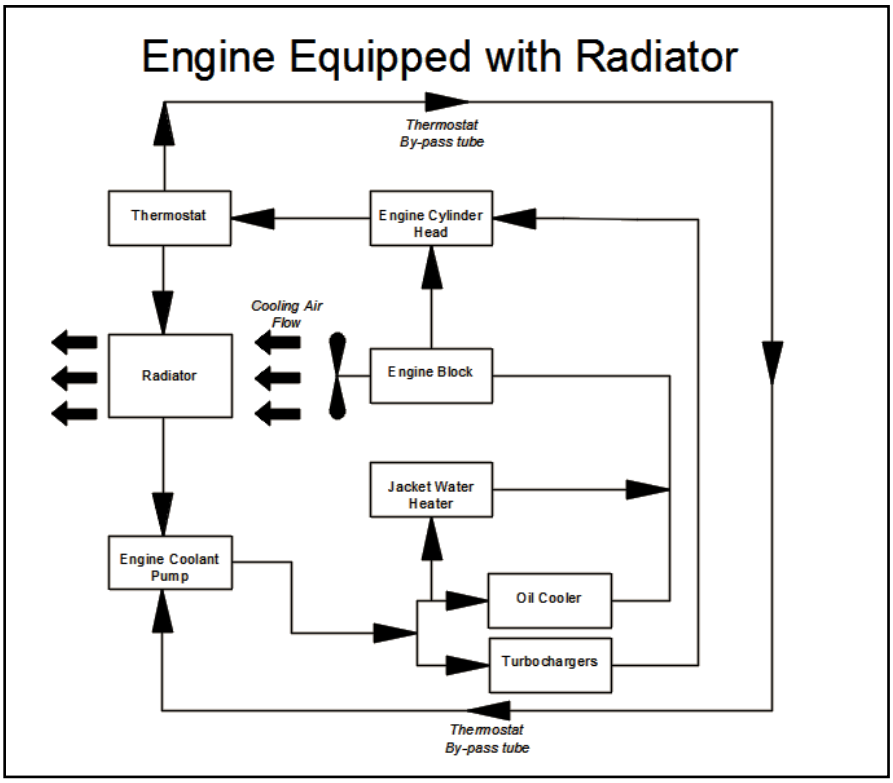


Figure 7-7 Radiator Cooled Engines

7.3.7. Important Service Notice

Any time an engine experiences a high coolant temperature alarm condition the primary cause of the overheat must be determined and the cause corrected to prevent a recurring overheat event.. Additionally, if an event of a restricted flow, collapsed hose, insufficient coolant level or failed pressure cap is experienced, further investigation of the cooling system is required.

- The coolant should be drained (after de-energizing the coolant heater
- Replace the engine thermostat(s)
- Remove the engine water pump and inspect the impeller and seal for damage, replace as necessary. Reassemble and refill coolant according to the Installation and Operations Instruction Manual.
- Run the engine to verify normal operating temperature.

7.3.7.1. Cavitation

Cavitation is a condition that occurs when bubbles form in the coolant flow in the low pressure areas of the cooling system and implode as they pass to the higher pressure areas of the system. This can result in damage to cooling system components, particularly the water pump impeller and cylinder liners. Cavitation in an engine can be caused by:

- Improper coolant
- Restricted coolant flow caused by collapsed hose or plugged system
- Coolant fill cap is loose or unable to retain the required pressure
- Insufficient fluid level
- Failure to de-aerate
- Overheat

8. Electrical System

8.1. Wiring Diagram

Document	Description
C072753	Instrument Panel (DC Voltage)
C072736	ECM Harness (DC Voltage)
C072753	C18 [all models] Engine Harness (DC Voltage)
C07651	Jacket Water Heater (AC Voltage)

8.2. Checking Drive Belt Tension and Adjustment

All drive belts must be adequately tightened to secure that both the engine water pump and battery charging alternator (when fitted) are operating efficiently. Refer to Figure #8-1.

8.2.1. To adjust Belt Tension:

8.2.1.1. Check belt tension: Give at arrow C must be approx. 0.5" (12.7mm)..

8.2.2. To increase tension of the alternator driving belts:

8.2.2.1. Loosen nut at D.

8.2.2.2. Loosen nut B on adjustment rod.

8.2.2.3. Tighten nut A to push the alternator to the right to tighten the belt. Do NOT overtighten the belt.

8.2.2.4. Tighten mounting nut B to lock adjustment in place.

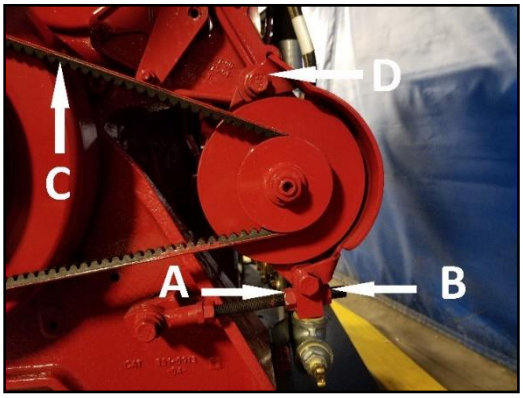


Figure 8-1

8.3. Overspeed

In the event of an engine overspeed, the ECM signals the main pump controller and also affects an engine shutdown. Should an overspeed condition occur, investigate the cause and make necessary corrections before placing engine back in service. The overspeed reset switch must be manually lifted for 30 seconds to reset. After reset, the Powerview Gauge will display "no data" for engine parameters. Cycle the ECM selector switch to Alternate ECM and back to Primary ECM before attempting to restart the engine.

8.3.1. Overspeed Verification

8.3.1.1. Hold the OVERSPEED VERIFICATION switch in the "up" position. This will provide the main pump controller with an overspeed signal and engine shutdown at 30 RPM's below the rated RPM.

8.3.1.2. Start the engine via the main pump controller; the speed switch will generate an overspeed signal and shutdown protecting both the engine and pump.

EXAMPLE
Rated Speed: 1760 RPM
Overspeed Shutdown: 2112 RPM (120% of 1760 RPM)
Verification Shutdown: 1730

If equipped with air inlet shutdown (AISOV), air inlet shutdown valves will close in conjunction with the activation of the overspeed alarm.

8.3.1.3. CAUTION: After verification of overspeed, lift the OVERSPEED RESET switch and reset the main pump controller to re-instate normal operation of the engine and speed switch. If equipped with AISOV, the valves will reset to the open position during the overspeed reset process. Cycle the ECM selector from the ECM in use to the other ECM and back again after lifting the OVERSPEED RESET.

The over speed shut down set point is factory set, programmed into the ECM, and not field adjustable. Caution: Do not attempt to overspeed the engine to verify overspeed shutdown.

8.4. Field Simulation of Pump Controller Alarms

8.4.1. Alarm 1: Overspeed Shutdown. Follow section 8.3

8.4.2. Alarm 2: Low Oil Pressure - With the engine running, lift the low oil pressure switch. (Note: There is no engine mounted Low Oil Pressure switch to jumper across).

8.4.3. Alarm 3: High Engine Coolant Temperature - With the engine running, lift high water temperature switch. It may take up to 5 minutes to activate the alarm. (Note: There is no engine mounted High Coolant Temperature switch to jumper across).

8.4.4. Alarm 4: Over crank (Fail to Start). Lift and hold the OVERSPEED RESET SWITCH, located on the internal verification switch plate, for 5 seconds prior to initiating the 6 crank cycles from the fire pump controller. Ensure the OVERSPEED RESET SWITCH is held for the entire 15 second duration of each of the 6 crank attempts. Each time, while the engine is resting for 15 seconds between cranking attempts, release the OVERSPEED RESET SWITCH for 3 seconds. Before the engine cranks again, activate the OVERSPEED RESET SWITCH and continue holding throughout the crank attempt, releasing between each attempt. NEVER shut off the fuel supply to the engine to prevent it from starting. Shutting off the fuel supply will cause an air lock condition in the fuel system and possibly cause fuel system component damage.

8.4.5. Alarm 5: Low Engine Coolant Temperature - With engine at rest, lift low coolant temperature switch for 25 seconds.

8.4.6. Alarm 6: ECM Warning - Lift the OVERSPEED RESET SWITCH for 2 minutes with engine not running to verify ECM Warning Alarm; note engine will automatically switch to alternate ECM.

8.4.7. Alarm 6: ECM Failure - After ECM Warning Alarm has been tested, continue lifting OVERSPEED RESET SWITCH for additional 2 minutes with engine not running to verify ECM Failure Alarm. After activation of both ECM Warning and Failure Alarms, activate the ECM Failure Reset Switch inside the engine control panel.

8.5. Battery Requirements

All Clarke engine models require 8D batteries, as sized per SAE J537 and NFPA20. The battery should meet the following criteria:
Cold Cranking Amps (CCA @ 0°F): 1400
Reserve Capacity (minutes): 430
Refer to Clarke drawing (see Page 5) for additional information on Clarke supplied batteries.

8.6. Engine Speed Adjustment

All governor and speed control functions are programmed into each ECM at the factory. During Start-Up Inspection, some minor speed adjustment may be required. To adjust the speed of the engine:

8.6.1. Start the engine by following the "To Start Engine" Procedure in this manual.

8.6.2. Let the engine warm-up. Open engine gauge panel.

8.6.3. While observing the tachometer, lift and hold the speed change enable switch. Toggle speed adjustment switch up or down to increase or reduce speed. (Refer to Figure # 8-2).

8.6.4. Stop engine by following "To Stop Engine" Procedure in this manual.

8.6.5. Switch to Alternate ECM and repeat steps A through D.

8.6.6. Stop engine by following "To Stop Engine" Procedure in this manual.

8.6.7. Switch back to Primary ECM.

8.6.8. Close panel door, replace door retaining screws.

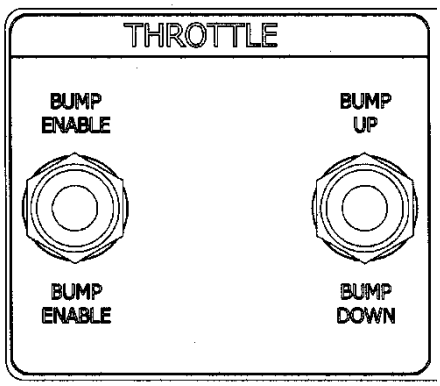


Figure 8-2

9. Maintenance Schedule

NOTE: The following Routine Maintenance schedule is based on an engine usage rate not exceeding 2 hours per month. For UL/FM engine models, also refer to NFPA25.
The **Maintenance Schedule Checklist** is an optional document to record Clarke Fire specific maintenance items. Based on NFPA 25 and Clarke Fire maintenance requirements, document **C137684** was created for customer and technician record keeping purposes. The PDF can be downloaded from ClarkeFire.com

9.1. Weekly Maintenance Items

9.1.1. **Check the Air Filte**r for rips, crushed elements or extreme dirt. A dirty filter can make it more difficult for the engine to draw in air and effect the power output.
9.1.2. **Check the Battery** electrolyte level and cable connections.
9.1.3. **Check the Coolant Hoses** for rips, splitting, collapses or bulges.
The heater system typically contains two to four hoses.
The heat exchanger assembly typically contains three to six hoses.
9.1.4. Check the Coolant Level.
9.1.5. **Check the Fuel Tank**. Inspect the outside of the container for signs of deterioration or leaks. This visual inspection is intended to be a routine walk-around and includes the tank's piped connections, supports and foundations.
9.1.6. **Check the Jacket Water Heater**. The heater should be warm to the touch. Confirm there is no discoloration to the outside of the heater assembly. Discoloration could indicate an overheating heater assembly.
9.1.7. **Check the Lubrication Oil Level**. The level must always be between the dipstick marks Min. and Max. with the engine not running.
9.1.8. **Remove water from the fuel filter** by opening the valve under the filter and let water and sediment flow until fuel comes out.
9.1.9. **Check the Not In Auto Warning Light.** Ensure the warning bulb is functional by changing the mode selector switch to the manual mode position.
9.1.10. **Check the Manual Valves** on the cooling loop. The bypass line manual valves should be normally closed, and the automatic line manual valves should be normally open.
9.1.11. **Check and Clean the Y-strainer screens.** With the engine off, close the manual valves to restrict flow to the cooling loop. Remove the endcaps on the y-strainer assembly and pull the screens. Clean the screens and ensure there is no containments or restrictions inside the y-strainer. Replace the screens, install the endcaps and return the manual valves to the normal position.
9.1.12. Run the engine.
Starting Method: From the Fire Pump Controller using test feature or actual pressure drop.
With the engine instrument panel in the automatic mode, start the engine from the pump controller using a test feature or pressure drop.
9.1.12.1. The engine is designed to operate at rated load conditions. For testing purposes, the engine can run at lower load (lower flow) conditions. Running times in any one period **should not exceed 30 minutes maximum**.
9.1.12.2. When the engine is running make sure that the **coolant temperature, oil pressure and raw water flow** are within limits specified on the relevant Installation & Operation Data Sheet.
9.1.13. **Check the Operating Gauges** on the engine instrument panel.
9.1.14. **Check the Cooling Loop Raw Water Solenoid** for operation while the engine is running.
9.1.15. Check the Heat Exchanger Discharge for free flow of water.
9.1.16. **Check the Exhaust System** for leaks, proper support and operational rain cap.
9.1.17. **General Inspection** for excessive noise, adequate ventilation, missing items, fluid leaks or anything broken.

9.2. 6 Month Maintenance Items

9.2.1. **Clean the Battery** posts and cable connectors. Use baking soda and water or battery cleaner to clean the terminals and battery surfaces. Use terminal spray or Vaseline on the terminals to minimize corrosion.
9.2.2. Check the Battery Charging Alternator for proper operation.
9.2.2.1. Disable the pump controller battery chargers.
9.2.2.2. Read the battery voltage with the engine off. (ex: 12 or 24 vdc)
9.2.2.3. Read the battery voltage with the engine running. (ex: 14-15 or 27-29 vdc)
9.2.2.4. Compare the readings to determine if the alternator is charging.
9.2.2.5. Enable the pump controller battery chargers
9.2.3. **Check the Belt** for proper tension, alignment, signs of fraying or cracks.

9.2.4. Check and Clean the Y-strainer screens.
9.2.5. Check the Driveshaft U-joints or Coupling. Visual inspection to ensure they are not loose and check the set screws. Disable the pump controller battery charger and disconnect negative battery cable before removing the driveshaft guard and inspecting the driveshaft. IMPORTANT: Return engine and pump controller to normal / automatic mode once check is complete.
9.2.6. Check the Fuel Lines for leaks, breaks, bends or inconsistencies.

9.3. 1 Year Maintenance Items

9.3.1. Clean or Replace the Air Filter.
9.3.2. Clean the Fuel Lift Pump Strainer. DP and DQ engines only. (Refer to section 3.1.6)
9.3.3. Check the Crank Case Vent System to make sure it is open and not kinked.
9.3.4. Lubricate the Driveshaft U-Joints and check alignment.
9.3.5. Replace the Fuel and Oil Filters with OEM or Clarke branded filters.
9.3.6. Check the Heat Exchanger Electrode. If the length is less than one inch, replace the electrode.
9.3.7. Test the Fuel for degradation. Testing shall comply with ASTM D975 or ASTM D 6751. If diesel fuel is found to be deficient the fuel shall be reconditioned or replaced.
9.3.8. Replace the Lubricating Oil.
9.3.9. Replace the Coolant. Clarke Coolant (part # C054129).The only acceptable substitute is COOL-GARD II part number TY26575. Warranty is contingent on utilizing the indicated coolant.
9.3.10. Check the Mounting Isolators and foundation nuts. (If applicable.)
9.3.11. Check the Wiring System connections, tighten if necessary.

9.4. 2 Year Maintenance Items

9.4.1. Replace the Air Filter.
9.4.2. Replace the Batteries.
9.4.3. Replace the Belts.
9.4.4. Replace the Coolant Hoses.
9.4.5. Replace the engine Thermostats.

9.5. 5 year Maintenance Items

9.5.1. Replace the Torsional Coupling (if applicable)

IMPORTANT: Set main pump controller to “OFF” while servicing engine. Before turning the main pump controller to the "OFF" position, check with the maintenance and security supervisors to verify that all the departments concerned will be alerted of the temporary interruption of their fire protection equipment for normal maintenance or testing. Also, alert the local fire department in the event that the main pump controller is connected by silent alarm to headquarters. When servicing is complete, return main pump controller selector to "Automatic" position and the mode selector on the engine to “Automatic” position. Advise the appropriate personnel the engine has been returned to the “Automatic”.

9.6. NSR Heat Exchanger Maintenance

The NSR heat exchanger tube bundle can be removed and cleaned to maintain proper cooling and flow requirements. The following cleaning procedure should be performed on an as needed basis.

9.6.1. Tool and Parts Requirement
The tools required to complete this maintenance procedure are the following:
9.6.1.1. O-Ring part number 0C12C979 qty 2
9.6.1.2. Lube part number 0C12E268 or equivalent all purpose, high viscosity lube compatible with rubber, heat resistant up to 204°C (400°F).
9.6.1.3. Cleaning Kit number: 0C12E280 (Includes: Handle 0C12E278, Rod 0C12E281, Brush 0C12E279 and De-scaler liquid 5 gal. 0C12E77).
9.6.1.4. Coolant Clarke Fire part number 0C054129 or Cool-Gard II part number TY26575.
9.6.2. Preparation
9.6.2.1. Lockout the engine
9.6.2.1.1. Place the pump controller mode selector in the OFF position, disable the pump controller battery chargers and remove the negative battery cable from each engine battery to prevent the engine from starting.
9.6.2.2. Drain the engine coolant
9.6.2.2.1. Drain the engine coolant into a proper container for disposal.
9.6.2.3. Turn off the raw water supply

9.6.2.3.1. Close the manual ball valves on the automatic and bypass side of the cooling loop to prevent raw water from flowing through the cooling system.

9.6.3. NSR Tube Bundle Removal

9.6.3.1. Remove the Crossover End Cap

9.6.3.1.1. Locate the Crossover End Cap (reference figure 9-1 item 1)

9.6.3.1.2. Remove the Crossover End Cap bolts (qty 5).

9.6.3.1.3. Remove the Crossover End Cap (reference figure 9-1 item 1)

9.6.3.1.4. Remove the rubber O-Ring and dispose.

9.6.3.2. Remove the IO (In/Out) End Cap

9.6.3.2.1. Locate the IO End Cap (reference figure 9-1 item 2)

9.6.3.2.2. Remove the IO End Cap bolts (qty 5).

9.6.3.2.3. Remove the IO End Cap (reference figure 9-1 item 2)

9.6.3.2.4. Remove the rubber O-Ring and dispose.

9.6.3.3. Remove the tube bundle

9.6.3.3.1. Identify the 12 o-clock mark on the tube bundle header plate from the IO side of the assembly and make note of its position.

9.6.3.3.2. Remove the tube bundle by sliding it out of the IO side of the assembly. (reference figure 9-1 item 3)

9.6.4. NSR Tube Bundle Cleaning

9.6.4.1. Clean the Tube Bundle

9.6.4.1.1. Submerge the tube in de-scaler for 30 minutes to 1 hour.

9.6.4.1.2. Inspect the inside of the tubes. If needed, use a cleaning rod and brush to clean the tubes.

9.6.4.1.3. Rinse tube bundle thoroughly with fresh water and let dry.

9.6.5. NSR Tube Bundle Installation

9.6.5.1. Install the Tube Bundle

9.6.5.1.1. Install the tube bundle from the IO side of the assembly. (reference figure 9-1 item 2)

9.6.5.1.2. Ensure the 12 o-clock marking is in the correct position, facing the IO side and not the crossover side.

9.6.5.1.3. Ensure the tube bundle is centered in the housing. Measure from the mating surface of the shell assembly to the header plate. This measurement should be equal to the value in table 1. Note: The header plate can float, ensure the header plate is flush with the cup.) Reference figure #9-1.

NSR Part Number	Description	Measurement
C053643	Standard Copper (Painted Endcaps)	5.5 mm
C053878	Copper Nickel (Bronze Endcaps)	6.0 mm

Table 1

9.6.5.2. Install the End Caps

IMPORTANT: Install the End Caps as described below, ensuring that the bundle does not shift from the centered position. If the bundle moves at any point during end cap installation, remove the end cap and repeat step 5.1.2 and 5.1.3 before attempting again.

9.6.5.2.1. Lubricate all surfaces of a new O-Ring (part number 0C12C979).

9.6.5.2.2. Install O-ring into Crossover side of the assembly. Ensure the O-ring is fully seated inside the groove.

9.6.5.2.3. Place the Crossover End Cap onto the shell assembly and finger tighten the 5 bolts in the assembly.

9.6.5.2.4. Lubricate all surfaces of a new O-Ring (part number 0C12C979).

9.6.5.2.5. Install O-ring into IO (In/Out) side of the assembly. Ensure the O-ring is fully seated inside the groove.

9.6.5.2.6. Place the IO End Cap onto the shell assembly and finger tighten the 5 bolts in the assembly

9.6.5.2.7. Hand tighten the 5 bolts on the Crossover End Cap assembly.

9.6.5.2.8. Hand tighten the 5 bolts on the IO End Cap assembly.

9.6.5.2.9. Properly torque the Crossover End Cap and IO End Cap Bolts to 31 FT-LBS in the sequence shown below in figure #9-2.

9.6.6. Return to Normal Operation

9.6.6.1. Refill the engine coolant

9.6.6.1.1. Refill the engine coolant using Clarke Fire part number 0C054129 or Cool-Gard II part number TY26575

9.6.6.2. Turn on the raw water supply

9.6.6.2.1. Return the manual ball valves on the automatic and bypass side of the cooling loop to the normal position. IMPORTANT: Ensure the manual ball valves are in the normal position. Restricting raw water flow to the cooling system will cause the engine to overheat.

9.6.6.3. Return the engine to normal operation

9.6.6.3.1. Install the negative battery cable on each engine battery, enable the pump controller battery chargers and return the pump controller to automatic mode.

9.6.6.4. Run the engine

9.6.6.4.1. During filling of the cooling system, air pockets may form. The system must be purged of air prior to being put in service. Caution: Do not overfill cooling system. A pressurized system needs space for heat expansion without overflowing. Install the pressure cap, start and run engine for approximately 5 minutes in order to purge the air from the engine cavities.

9.6.6.5. Leave the engine in automatic

Do a final inspection for leaks, coolant level and ensure engine mode selector is set in the automatic mode.

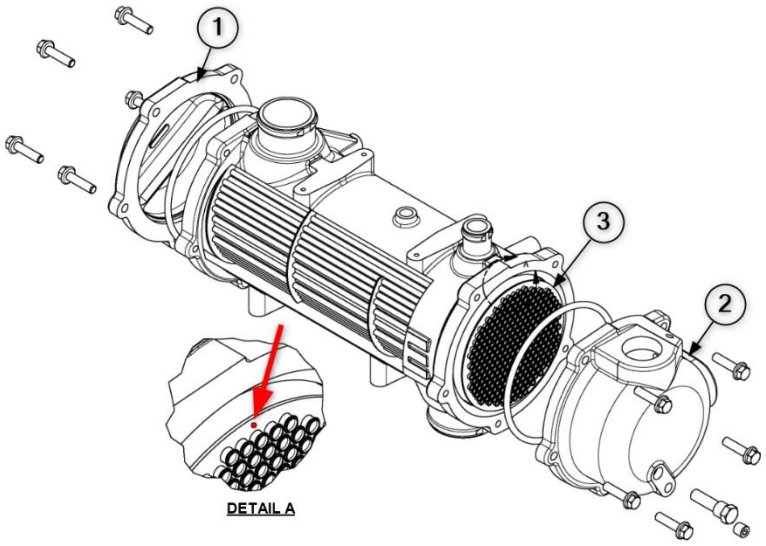


Figure 9-1

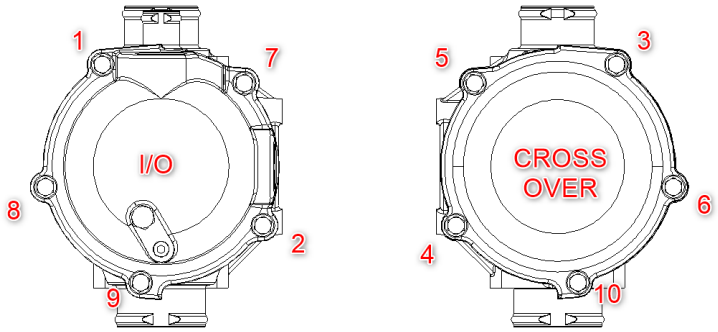


Figure 9-2

10. Troubleshooting

10.1. General Troubleshooting Information

Troubleshooting engine problems can be difficult.
The engine control unit (ECM) can detect problems internally and in the electronic control system. This includes determining if any of the sensor input voltages are too high or too low, if the camshaft and crankshaft position sensor inputs are valid, and if the unit injector solenoids are responding properly.
If the ECM detects a problem with the electronic control system a diagnostic trouble code (DTC) specific to the failed system will be stored in the ECM's memory.

10.2. Diagnostic Trouble Codes (DTC's)

There are two types of DTC's

- Active
- Inactive (stored)

10.2.1. Active DTCs indicate that the failure is occurring. These types of failures are sometimes called "hard" failures. They can be accessed on the diagnostic gauge (A) on the instrument panel.

10.2.2. Inactive DTCs indicate that a failure has occurred in the past but is not currently occurring. This type of "stored" DTC can be caused by an "intermittent" failure. These could be problems such as a bad connection or a wire intermittently shorting out.

If a sensor or wiring fails and a DTC is active for the sensor, the ECM will use a substitute "limp home" value in its calculation to continue engine operation.
Displaying of Diagnostic Trouble Codes (DTCs)
SPN/FMI CODES

Stored and active diagnostic trouble codes are output on the PowerView Gauge according to the J1939 standard as a two-part code as shown on the table on the following pages.
The first part is a Suspect Parameter Number (SPN) followed by a Failure Mode Identifier (FMI) code. To determine the exact failure, both (SPN and FMI) of the code are needed.

The SPN identifies the system or the component that has the failure; for example, SPN 000110 indicates a failure in the engine coolant temperature circuit.
The FMI identifies the type of failure that has occurred; for example, FMI03 indicates value above normal.
Combining the SPN 000110 with FMI 03 yields engine coolant temperature input voltage too high.
Always contact your Clarke service dealer for help in correcting diagnostic trouble codes which are displayed for your engine.
Inactive

10.2.3. Listing of Diagnostic Trouble Codes (DTCs)

The Diagnostic Trouble Codes (DTCs) are output on the diagnostic gauge according to J1939 standard as a two-part code. The first part is a two to four-digit Suspect Parameter Number (SPN) followed by a one or two-digit Failure Mode Identifier (FMI) code. Following is a list of SPN's, FMI's and a description of the diagnostic trouble codes that can occur in the various engine systems. Not all the codes will be present in all engine applications.

When trouble codes appear on the PowerView diagnostic gauge, see your engine dealer for repairs as soon as possible.

List of Diagnostic Trouble Codes

SPN	FMI	Description
28	3	Throttle #3 Input High
28	4	Throttle #3 Input Low
29	3	Throttle #2 Input High
29	4	Throttle #2 Input Low
91	3	Throttle #1 Input High
91	4	Throttle #1 Input Low
91	8	PWM Throttle Abnormal Pulse Width
91	9	Throttle Invalid
91	14	Throttle Voltage Out of Range
94	1	Fuel Supply Pressure Extremely Low
94	3	Fuel Supply Pressure Input Voltage High
94	4	Fuel Supply Pressure Input Voltage Low
94	16/31	Fuel Supply Pressure Moderately High
94	18	Fuel Supply Pressure Moderately Low
97	0	Water in Fuel – Continuously Detected
97	3	Water in Fuel Signal – Voltage High
97	4	Water in Fuel Signal – Voltage Low
97	16	Water in Fuel Detected
100	1	Engine Oil Pressure Extremely Low
100	3	Engine Oil Pressure Input Voltage High
100	4	Engine Oil Pressure Input Voltage Low
100	18	Engine Oil Pressure Moderately Low
102	3	Manifold Air Pressure Input Voltage High
102	4	Manifold Air Temperature Input Voltage Low
105	3	Manifold Air Temperature Input Voltage High
105	4	Manifold Air Temperature Input Voltage Low
105	16	Manifold Air Temperature Input Voltage High
110	0	Engine Coolant Temperature Extremely High
110	3	Engine Coolant Temperature Input Voltage High
110	4	Engine Coolant Temperature Input Voltage Low
110	16	Engine Coolant Temperature Moderately High
111	1	Engine Coolant Level Low
158	17	ECM Power Down Error
174	3	Fuel Temperature Input Voltage High
174	4	Fuel Temperature Input Voltage Low
611	3	Injector Shorted to Power Source
611	4	Injector Wiring Shorted to Ground
620	3	Sensor Supply Voltage High
620	4	Sensor Supply Voltage Low
627	1	Injector Supply Voltage Problem
629	12/13	ECM Error
636	2	Cam Position Input Noise
636	8	Cam Position Input Missing
636	10	Cam Position Input Pattern Error
637	2	Cam Position Input Noise
637	8	Cam Position Input Missing
637	7	Crank Position/Cam Position Out of Sync
637	10	Crank Position Input Pattern Error
651	5	Cylinder #1 EUI Circuit Open
651	6	Cylinder #1 EUI Circuit Shorted
652	5	Cylinder #2 EUI Circuit Open
652	6	Cylinder #2 EUI Circuit Shorted
653	6	Cylinder #3 EUI Circuit Open
653	5	Cylinder #3 EUI Circuit Shorted
654	6	Cylinder #4 EUI Circuit Open
654	5	Cylinder #4 EUI Circuit Shorted
655	6	Cylinder #5 EUI Circuit Open
655	5	Cylinder #5 EUI Circuit Shorted
656	5	Cylinder #6 EUI Circuit Open
656	6	Cylinder #6 EUI Circuit Shorted
970	2	Auxiliary Engine Shutdown Switch Signal Invalid
970	31	Auxiliary Engine Shutdown Switch Active
971	31	External Fuel De-Rate Switch Active
1109	31	Engine Shutdown Warning
1110	31	Engine Shutdown
1569	31	Fuel De-rate
2000	13	Security Violation
3133	4	PLD Transducer – under 13 psi

NOTE: The PowerView diagnostic gauge can have communication problems that result in Error Codes being shown on its LCD display window. The following Error Codes all indicate that there is a Diagnostic Gauge communication error with the ECM. Contact your servicing dealer for help in correcting these codes:

EE – Error	XXXXX – EP No Data
ACP – Err No Addr	XXXXX - BO No Data
ACP – Err BUS – EP	XXXXX - BR No Data

NOTE: Refer to wiring diagnostic earlier in this section as a guide to connections and wires.

11. Parts Information

11.1. Spare Parts

To ensure best operation and efficiency of all engine components, always use genuine Clarke spare parts.

Orders should specify:

- Engine Model Number - See Engine General
- Engine Serial Number - Specification

Part Number(s) Refer to Engine Maintenance Parts List in appendix section 18 or Parts Illustration (see Page 5).

Contact numbers for spare parts:

- www.clarkefire.com
- Phone USA: (513) 771-2200 Ext. 427 (calling within USA)
- Phone UK: (44) 1236 429946 (calling outside USA)
- Fax USA: (513) 771-5375 (calling within USA)
- Fax UK: (44) 1236 427274 (calling outside USA)
- E-Mail USA: parts@clarkefire.com
- E-Mail UK: dmurray@clarkefire.com

11.2. Engine Maintenance Parts List

Refer to Appendix "A" in section 18.

12. Owner Assistance

Consult Clarke Service Dealer or Factory. Service Dealers can be located by going to our website: www.clarkefire.com/home/service/service-providers/service-dealer-locator

13. Warranty

13.1. General Warranty Statement

The satisfactory performance of Clarke engines and the goodwill of owners / operators of Clarke engines are of primary concern to the Engine Manufacturer, the Engine Service Dealer and Clarke. All provide support of these products after final installation of the complete fire pump and sprinkler system.
Warranty responsibility involves both Clarke and the Caterpillar service organizations worldwide.

The Engine Manufacturer (Caterpillar) provides Warranty for the basic engine components and Clarke provides warranty on the accessories added to meet the NFPA-20 specifications and FM/UL certification requirements.

13.2. Clarke Warranty

All Clarke warranted components have warranty duration of 24 months beginning at the Start-up date of the fire pump system. The warranty coverage includes replacement of the part and reasonable cost of labor for installation. Components failed due to improper engine installation, transportation damage, or misuse is not covered under this warranty.
For additional warranty details, see the specific warranty statement "Caterpillar New Engine Warranty" in section 13.3. Contact Clarke directly if you have any questions or require additional information.

Clarke is not responsible for incidental or consequential costs, damage or expenses which the owner may incur as a result of a malfunction or failure covered by this warranty.

13.3. Caterpillar Warranty

Effective with sales to the first user on or after June 1, 2012

CATERPILLAR LIMITED WARRANTY

New and Remanufactured 3000 Family, C0.5 through C4.4, and ACERT™ Engines

Worldwide

Caterpillar Inc. or any of its subsidiaries ("Caterpillar") warrants new and remanufactured 3000 Family, C0.5 through C4.4, and ACERT industrial engines sold by it, to be free from defects in material and workmanship. ACERT industrial engines refer to the C6.6, C7, C7.1, C9, C9.3, C11, C13, C15, C18, C27, and C32 engine models.

This warranty does not apply to engines sold for use in marine, petroleum, electric power generation and on-highway vehicle applications, engines in machines manufactured by Caterpillar, or Cat® batteries. These products are covered by other Caterpillar warranties.

This warranty is subject to the following:

Warranty Period

The standard warranty period for new and remanufactured 3003, 3011, 3013, 3014, 3024, C0.5, C0.7, C1.1, C1.5, C1.6, C1.7, and C2.2 engines used in mobile agricultural, industrial and locomotive applications is 24 months or 2000 hours, whichever occurs first (with the first 12 months at unlimited hours) after the date of delivery to the first user.

The standard warranty period for new and remanufactured 3034, 3044, 3054, 3056, C3.4, C4.4, and C6.6 engines used in mobile agricultural, industrial, and locomotive applications is 24 months or 3000 hours, whichever occurs first (with the first 12 months at unlimited hours) after the date of delivery to the first user.

For new and remanufactured 3034, 3044, 3054, 3056, C0.5, C0.7, C1.1, C1.5, C1.6, C1.7, C2.2, C3.4, C4.4, and C6.6 engines:

- Low Usage: In cases where the engine use does not exceed 500 hours per year, the warranty period is extended for one additional year or until the engine use reaches a total of 1500 hours in the 3rd year of warranty, whichever occurs first, after the date of delivery to the first user.

The standard warranty period for new and remanufactured C7, C7.1, C9, C9.3, C11, C13, C15, C18, C27, and C32 engines (i) for use in mobile agricultural applications, 24 months after the date of delivery to the first user and (ii) for industrial, and locomotive applications 24 months or 3000 hours, whichever occurs first (with the first 12 months at unlimited hours), after the date of delivery to the first user.

The standard warranty period for rotating electrics (i) used on new and remanufactured 3000 Family, C0.5 through C4.4 and C6.6 engines is 12 months from the date of engine delivery to the first user, and (ii) used on new and remanufactured C7, C7.1, C9, C9.3, C11, C13, C15, C18, C27, C32 engines is 24 months or 3000 hours, whichever occurs first (with the first 12 months at unlimited hours) after the date of engine delivery to the first user.

For all other applications the warranty period is 12 months after date of delivery to the first user.

Extended Warranty

For all new and remanufactured 3000 Family, C0.5 through C4.4, and ACERT engines:

- **Major Components:** A major components extended warranty applies solely to the following components: cylinder block casting, cylinder head casting, crankshaft (excluding bearings), camshaft, and connecting rods. These parts are warranted against defects in material and workmanship for 36 months after the date of delivery to the first user. This warranty runs concurrently with the standard warranty period.

Caterpillar Responsibilities

If a defect in material or workmanship is found during the standard warranty period or the extended warranty period, as applicable, Caterpillar will, during normal working hours and at a place of business of a Cat dealer or other source approved by Caterpillar:

- Provide (at Caterpillar's choice) new, remanufactured, or Caterpillar approved repaired parts or assembled components needed to correct the defect.

Note: New, remanufactured, or Caterpillar approved repaired parts or assembled components provided under the terms of this warranty are warranted for the remainder of the warranty period applicable to the product in which installed as if such parts were original components of that product. Items replaced under this warranty become the property of Caterpillar.

- Replace lubricating oil, filters, coolant, and other service items made unusable by the defect.

Provide reasonable and customary labor needed to correct the defect.

For new and remanufactured 3003, 3011, 3013, 3014, 3024, C0.5, C0.7, C1.1, C1.5, C1.6, C1.7, and C2.2 engines:

- A maximum of 10 hours of labor to disconnect and reconnect the product to its attached equipment, mounting, and support system

For new and remanufactured 3034, 3044, 3054, 3056, C3.4, C4.4, and C6.6 engines:

- A maximum of 15 hours of labor to disconnect and reconnect the product to its attached equipment, mounting, and support system

For new and remanufactured 3000 Family and C0.5 through C7.1 engines:

- Provide travel labor, up to four hours round trip, if in the opinion of Caterpillar, the product cannot reasonably be transported to a place of business of a Cat dealer or other source approved by Caterpillar (travel labor in excess of four hours round trip, and any meals, mileage, lodging, etc. is the user's responsibility).

For new and remanufactured C9, C9.3, C11, C13, C15, C18, C27, and C32 engines:

- Provide reasonable travel expenses for authorized mechanics, including meals, mileage, and lodging when Caterpillar elects to make the repair on-site.

User Responsibilities

The user is responsible for:

- Providing proof of the delivery date to the first user.
- Labor costs, except as stated under "Caterpillar Responsibilities."
- Travel expenses not covered under "Caterpillar Responsibilities."
- All costs associated with transporting the product to and from the place of business of a Cat dealer or other source approved by Caterpillar.
- Premium or overtime labor costs.
- Parts shipping charges in excess of those that are usual and customary.
- Local taxes, if applicable.
- Costs to investigate complaints, unless the problem is caused by a defect in Caterpillar material or workmanship.
- Giving timely notice of a warrantable failure and promptly making the product available for repair.
- Performing all required maintenance (including use of proper fuel, oil, lubricants, and coolant) and items replaced due to normal wear and tear.
- Allowing Caterpillar access to all electronically stored data.

Limitations

Caterpillar is not responsible for:

- Failures resulting from any use or installation that Caterpillar judges improper.
- Failures resulting from attachments, acoessory items, and parts not sold or approved by Caterpillar.
- Failures resulting from abuse, neglect, and/or improper repair.
- Failures resulting from user's delay in making the product available after being notified of a potential product problem.
- Failures resulting from unauthorized repair or adjustment, and unauthorized fuel-setting changes.
- Damage to parts, fixtures, housings, attachments, and accessory items, which are not part of the engine.

(Continued on reverse side…)

SELF5670

This warranty covers every major component of the products. Claims under this warranty should be limited to a place of business of a Cat dealer or other source approved by Caterpillar. For further information concerning either the location to submit claims or Caterpillar as the issuer of this warranty, write Caterpillar Inc., 100 N.E. Adams St., Peoria, IL USA 61629.

Caterpillar's obligations under this Limited Warranty are subject to, and shall not apply in contravention of, the laws, rules, regulations, directives, ordinances, orders, or statutes of the United States, or of any other applicable jurisdiction, without recourse or liability with respect to Caterpillar.

A) For products operating outside of Australia, Fiji, Nauru, New Caledonia, New Zealand, Papua New Guinea, the Solomon Islands, and Tahiti, the following is applicable:

NEITHER THE FOREGOING EXPRESS WARRANTY NOR ANY OTHER WARRANTY BY CATERPILLAR, EXPRESS OR IMPLIED, IS APPLICABLE TO ANY ITEM CATERPILLAR SELLS THAT IS WARRANTED DIRECTLY TO THE USER BY ITS MANUFACTURER.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. REMEDIES UNDER THIS WARRANTY ARE LIMITED TO THE PROVISION OF MATERIAL AND SERVICES, AS SPECIFIED HEREIN.

CATERPILLAR IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

CATERPILLAR EXCLUDES ALL LIABILITY FOR OR ARISING FROM ANY NEGLIGENCE ON ITS PART OR ON THE PART OF ANY OF ITS EMPLOYEES, AGENTS, OR REPRESENTATIVES IN RESPECT OF THE MANUFACTURE OR SUPPLY OF GOODS OR THE PROVISION OF SERVICES RELATING TO THE GOODS.

IF OTHERWISE APPLICABLE, THE VIENNA CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS IS EXCLUDED IN ITS ENTIRETY.

For personal or family use engines operating in the USA, its territories and its possessions, some states do not allow limitations on how long an implied warranty may last nor allow the exclusion or limitation of incidental or consequential damages. Therefore, the previously expressed exclusion may not apply to you. This warranty gives you specific legal rights and you may also have other rights, which vary by jurisdiction. To find the location of the nearest Cat dealer or other authorized repair facility, call (800) 447-4986. If you have questions concerning this warranty or its application, call or write:

In USA and Canada: Caterpillar Inc., Engine Division, P. O. Box 610, Mossville, IL 61552-0610, Attention: Customer Service Manager, Telephone (800) 447-4986. Outside the USA and Canada: Contact your Cat dealer.

B) For products operating in Australia, Fiji, Nauru, New Caledonia, New Zealand, Papua New Guinea, the Solomon Islands, and Tahiti, the following is applicable:

THIS WARRANTY IS IN ADDITION TO WARRANTIES AND CONDITIONS IMPLIED BY STATUTE AND OTHER STATUTORY RIGHTS AND OBLIGATIONS THAT BY ANY APPLICABLE LAW CANNOT BE EXCLUDED, RESTRICTED, OR MODIFIED ("MANDATORY RIGHTS"). ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED (BY STATUTE OR OTHERWISE), ARE EXCLUDED. WITHOUT LIMITING THE FOREGOING PROVISIONS OF THIS PARAGRAPH, WHERE A PRODUCT IS SUPPLIED FOR BUSINESS PURPOSES, THE CONSUMER GUARANTEES UNDER THE CONSUMER GUARANTEES ACT 1993 (NZ) WILL NOT APPLY.

NEITHER THIS WARRANTY NOR ANY OTHER CONDITION OR WARRANTY BY CATERPILLAR, EXPRESS OR IMPLIED (SUBJECT ONLY TO THE MANDATORY RIGHTS), IS APPLICABLE TO ANY ITEM CATERPILLAR SELLS THAT IS WARRANTED DIRECTLY TO THE USER BY ITS MANUFACTURER.

IF THE MANDATORY RIGHTS MAKE CATERPILLAR LIABLE IN CONNECTION WITH SERVICES OR GOODS, THEN TO THE EXTENT PERMITTED UNDER THE MANDATORY RIGHTS, THAT LIABILITY SHALL BE LIMITED AT CATERPILLAR'S OPTION TO (a) IN THE CASE OF SERVICES, THE SUPPLY OF THE SERVICES AGAIN OR THE PAYMENT OF THE COST OF HAVING THE SERVICES SUPPLIED AGAIN AND (b) IN THE CASE OF GOODS, THE REPAIR OR REPLACEMENT OF THE GOODS, THE SUPPLY OF EQUIVALENT GOODS, THE PAYMENT OF THE COST OF SUCH REPAIR OR REPLACEMENT OR THE ACQUISITION OF EQUIVALENT GOODS.

CATERPILLAR EXCLUDES ALL LIABILITY FOR OR ARISING FROM ANY NEGLIGENCE ON ITS PART OR ON THE PART OF ANY OF ITS EMPLOYEES, AGENTS, OR REPRESENTATIVES IN RESPECT OF THE MANUFACTURE OR SUPPLY OF GOODS OR THE PROVISION OF SERVICES RELATING TO THE GOODS.

CATERPILLAR IS NOT LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES UNLESS IMPOSED UNDER MANDATORY RIGHTS.

IF OTHERWISE APPLICABLE, THE VIENNA CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS IS EXCLUDED IN ITS ENTIRETY.

C) For products supplied in Australia:

IF THE PRODUCTS TO WHICH THIS WARRANTY APPLIES ARE:

I. PRODUCTS OF A KIND ORDINARILY ACQUIRED FOR PERSONAL, DOMESTIC OR HOUSEHOLD USE OR CONSUMPTION; OR

II. PRODUCTS THAT COST AUD 40,000 OR LESS,

WHERE THOSE PRODUCTS WERE NOT ACQUIRED FOR THE PURPOSE OF RE-SUPPLY OR FOR THE PURPOSE OF USING THEM UP OR TRANSFORMING THEM IN THE COURSE OF PRODUCTION OR MANUFACTURE OR IN THE COURSE OF REPAIRING OTHER GOODS OR FIXTURES, THEN THIS SECTION C APPLIES.

THE FOLLOWING MANDATORY TEXT IS INCLUDED PURSUANT TO THE AUSTRALIAN CONSUMER LAW AND INCLUDES REFERENCES TO RIGHTS THE USER MAY HAVE AGAINST THE DIRECT SUPPLIER OF THE PRODUCTS: OUR GOODS COME WITH GUARANTEES THAT CANNOT BE EXCLUDED UNDER THE AUSTRALIAN CONSUMER LAW. YOU ARE ENTITLED TO A REPLACEMENT OR REFUND FOR A MAJOR FAILURE AND COMPENSATION FOR ANY OTHER REASONABLY FORESEEABLE LOSS OR DAMAGE. YOU ARE ALSO ENTITLED TO HAVE THE GOODS REPAIRED OR REPLACED IF THE GOODS FAIL TO BE OF ACCEPTABLE QUALITY AND THE FAILURE DOES NOT AMOUNT TO A MAJOR FAILURE. THE INCLUSION OF THIS TEXT DOES NOT CONSTITUTE ANY REPRESENTATION OR ACCEPTANCE BY CATERPILLAR OF LIABILITY TO THE USER OR ANY OTHER PERSON IN ADDITION TO THAT WHICH CATERPILLAR MAY HAVE UNDER THE AUSTRALIAN CONSUMER LAW.

TO THE EXTENT THE PRODUCTS FALL WITHIN THIS SECTION C BUT ARE NOT OF A KIND ORDINARILY ACQUIRED FOR PERSONAL, DOMESTIC OR HOUSEHOLD USE OR CONSUMPTION, CATERPILLAR LIMITS ITS LIABILITY TO THE EXTENT IT IS PERMITTED TO DO SO UNDER THE AUSTRALIAN CONSUMER LAW TO, AT ITS OPTION, THE REPAIR OR REPLACEMENT OF THE PRODUCTS, THE SUPPLY OF EQUIVALENT PRODUCTS, OR THE PAYMENT OF THE COST OF SUCH REPAIR OR REPLACEMENT OR THE ACQUISITION OF EQUIVALENT PRODUCTS.

THE WARRANTY SET OUT IN THIS DOCUMENT IS GIVEN BY CATERPILLAR INC. OR ANY OF ITS SUBSIDIARIES, 100 N. E. ADAMS ST, PEORIA, IL USA 61629, TELEPHONE 1 309 675 1000, THE USER IS RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH MAKING A CLAIM UNDER THE WARRANTY SET OUT IN THIS DOCUMENT, EXCEPT AS EXPRESSLY STATED OTHERWISE IN THIS DOCUMENT, AND THE USER IS REFERRED TO THE BALANCE OF THE DOCUMENT TERMS CONCERNING CLAIM PROCEDURES, CATERPILLAR RESPONSIBILITIES AND USER RESPONSIBILITIES.

TO THE EXTENT PERMISSIBLE BY LAW, THE TERMS SET OUT IN THE REMAINDER OF THIS WARRANTY DOCUMENT (INCLUDING SECTION B) CONTINUE TO APPLY TO PRODUCTS TO WHICH THIS SECTION C APPLIES.

SELF5670

14. Installation & Operation Data

(See www.clarkefire.com)

15. Wiring Diagrams

(See www.clarkefire.com)

16. Parts Illustration Drawing

(See www.clarkefire.com)

17. Declaration of Incorporation

CLARKE®

Clarke Fire Protection Products, Inc.
100 Progress Place
Cincinnati, Ohio 45246
United States of America
Tel: +1 (513) 475-3473
Fax: +1 (513) 771-0726

DECLARATION OF INCORPORATION

Product:

Description – Diesel Engines
Manufacturer – Clarke Fire Protection Products, USA
Model Number –
Serial Number –
Year of Manufacture -
Contract Number –
Customer Order Number –

Name and address of manufacturer:

Clarke Fire Protection Products, Inc.
100 Progress Place
Cincinnati, Ohio 45246
United States of America

Declaration

We hereby declare that the engine is intended to be incorporated into other machinery and must not be put into service until the relevant machinery, into which the engine is to be incorporated, has been declared in conformity with the essential health and safety requirements of the machinery Directive 2006/42/EC and consequently the conditions required for the CE Mark.

The object of the declaration described above is manufactured in accordance with the following directives:

Machinery Directive 2006/42/EC
Low Voltage Directive 2014/35/EU
EMC Directive 2014/30/EU

References to the relevant harmonized standards used:

EN ISO 12100:2010 - Safety of machinery. General principles for design. Risk assessment and risk reduction
EN 60204-1:2006+A1:2009 - Safety of machinery. Electrical equipment of machines. General requirements
EN 61000-6-2:2005 - Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments
EN 55011:2016+A1:2017 - Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement

A technical file for the product listed above has been compiled in accordance with part B of Annex Vii of the Machinery Directive 2006/42/EC and Annex III of Low Voltage Directive 2014/35/EU.

The engine has moving parts, areas of high temperatures and high temperature fluids under pressure. In addition, it has an electrical system, which may be under strong current.

The engine produces harmful gases, noise and vibration and it is necessary to take suitable precautionary measures when moving, installing and operating the engine to reduce risk associated with the characteristics stated above.

The engine must be installed in accordance with local laws and regulations. The engine must not be started and operated before the machinery into which it is to be incorporated and/or its overall installation has been made to comply with local laws and regulations. The engine must only be used in accordance with the scope of supply and the intended applications.

Signed Ken Wauligman Date: _____

Ken Wauligman – Engineering Manager

C13944, Rev.J 25Sept18

18. Appendix A

C18H MODELS PARTS MATRIX

Clarke Engine Models	C18H0-UFAC10 C18H0-UFAC18 C18H0-UFAC20 C18H0-UFAC28	C18H0-UFAD50 C18H0-UFAD58 C18H0-UFAD68 C18H0-UFAD70 C18H0-UFAD78	C18H0-UFAA78 C18H0-UFAD10 C18H0-UFAD18 C18H0-UFAD20 C18H0-UFAD28 C18H0-UFAD30 C18H0-UFAD38 C18H0-UFAD40 C18H0-UFAD48
Part Description	**Part Number (standard items only, optional items not shown)**		
Oil Filter	1R1808 (Qty.2)		
Fuel Filter (Primary)	3261641		
Fuel Filter (Secondary)	1R0749 (Qty.1 or 2)		
Air Filter	C03244		
Alternator (24V)	1693345		
Heat Exchanger	C051389 OR C053643 OR C053878		
Starter Motor (24V)	3383454		
Engine Control Module	4787932		
Turbocharger	3595394, 3595395		3595390, 3595391
Thermostat	2477133		
Fuel Injector	2768307	2915911	