Operation and Maintenance Instructions Manual

DP/DQ/DR/DS/DT MODEL ENGINES
FOR
FIRE PUMP APPLICATIONS

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C133292 rev J

CONTENTS

SUBJECT **PAGE**

Check factory availability for a manual in one of the following languages:

Spanish
French
German
Italian

NOTE

The information contained in this book is intended to assist operating personnel by providing information on the characteristics of the purchased equipment.

It does not relieve the user of their responsibility of using accepted practices in the installation, operation, and maintenance of the equipment.

NOTE: CLARKE FPPG Reserves the right to update the contents of this publication without notice.

1.0 INTRODUCTION

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).
- Derates 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 and technical catalog C133295.
- Periodic running checks to ensure functionality should be kept to a maximum of ½ hour per week.

1.1 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.

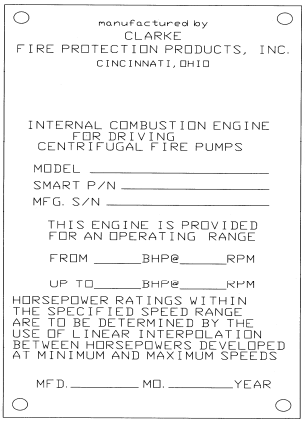
MODEL NUMBERING & IDENTIFICATION

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.

Note that there are five types of identification plates, dependent on whether the engine is a "Non-Listed" or "Listed/Approved" Model. These are typical examples. (See *Figure #1).*

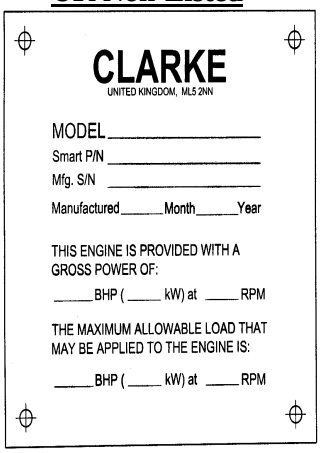
Clarke Identification Plates

USA Non Listed



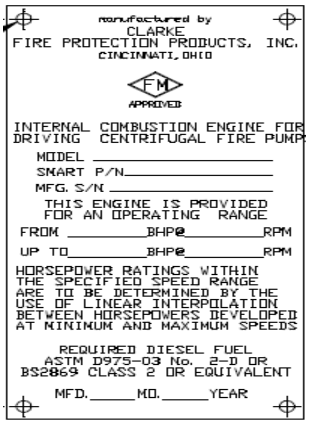
USA Listed/Approved

UK Non-Listed



UK Listed/Approved

USA Listed FM Approved



UK Listed – FM Approved

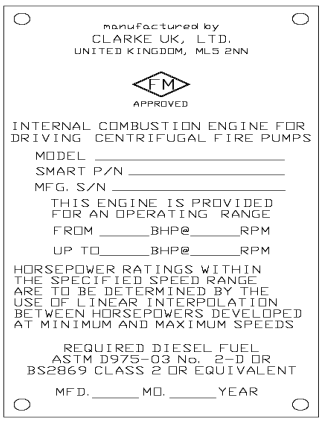


Figure 1

The Clarke 10 digit model numbers reflects the base engine type, number of cylinders, cooling system, approval listing, manufacturing location, emissions code and a power rating code.

Example: DT2H-UFAA90

- D = Doosan base engine prepared by CLARKE
- T = base engine series
- 2 = 12 cylinders
- H = Heat Exchanger cooled (R = Radiator)
- UF = Underwriters Laboratories Listed/ Factory Mutual Approved, (LP = LPCB Loss Prevention Council Board Approved, NL = Non-Listed, AP = APSAD
- A=Manufacturing Location (A= Cincinnati, K= Coatbridge)
- A= Non-Emissioned
- 90 = A power rating code

Doosan Identification Plate: The second identification plate contains the Doosan Model Number and Serial Number. On the DT Series, the Doosan Serial identification plate is located on the left-hand side of the engine near the front mount just above the oil pan rail.

1.2 SAFETY/CAUTION/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.

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

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 #2*

ENGINE MODEL	WEIGHT lbs (kg)
DP6H-UFAA50, DP6H-UFAA62, , DP6H-UFKA50, DP6H-UFKA62, DP6H-APKA60, DP6H-NLKA50, DP6H-NLKA62, DP6H-FMKA50, DP6H-UFAA88, DP6H-UFKA88, DP6H-FMKA88, DP6H-FMKA62, DP6R-NLKA49, DP6R-NLKA61	2250 (1020)
DQ6H-UFAA4G, DQ6H-UFAA48, DQ6H-UFAA50, DQ6H-UFAA60, DQ6H-UFAA88, DQ6H-UFAA98, DQ6H-UFKA4G, DQ6H-UFKA48, DQ6H-UFKA50, DQ6H-UFKA60, DQ6H-UFKA88, DQ6H-UFKA98 DQ6H-APKA60, DP6H-APKA90 DQ6H-NLKA48, DQ6H-NLKA4G DQ6H-NLKA50, DQ6H-NLKA60 DQ6H-NLKA88, DQ6H-NLKA98, DQ6H-UFAA40, DQ6H-UFAAX8, DQ6R-NLAA47, DQ6R-NLAA4F, DQ6R-NLAA49, DQ6R-NLAA59, DQ6R-NLAA87, DQ6R-NLAA97, DQ6H-NLKA40, DQ6H-NLKAX8, DQ6H-UFKA40, DQ6H-UFKAX8, DQ6H-FMKA48, DQ6H-FMKA4G, DQ6H-FMKA40, DQ6H-FMKA50, DQ6H-FMKA60, DQ6H-FMKA88, DQ6H-FMKA98, DQ6H-FMKAX8, DQ6R-NLKA47, DQ6R-NLKA4F, DQ6R-NLKA49, DQ6R-NLKA59, DQ6R-NLKA87, DQ6R-NLKA97	2500 (1134)
DR8H-UFAA40, DR8H-UFAA5G, DR8H-UFAA68, DR8H-UFAA62 DR8H-APKA60 DR8H-NLAA40, DR8H-NLAA5G, DR8H-NLAA62, DR8H-NLAA68, DR8H-UFAA98, DR8H-UFAA92	2700 (1225)
DS0H-UFAA68, DS0H-UFAA60, DS0H-UFAAN0 DS0H-APKA60 DS0H-NLAA60, DS0H-NLAA68, DS0H-NLAAN0, DS0H-NLAA70, DS0H-UFAA98, DS0H-UFAA92, DS0R-NLAAL1	3200 (1450)
DT2H-UFAA60, AA60, AA98, AA92 DT2H-FMAAX8, AAX2 DT2H-APKA90 DT2H-NLAA60, DT2H-NLAA98, DT2H-NLAA92, DT2H-UFAA48, DT2H-UFAA40, DT2H-UFAA50, DT2H-UFAA88, DT2H-UFAA68	4500 (2040)

Figure #2

Figure #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.*

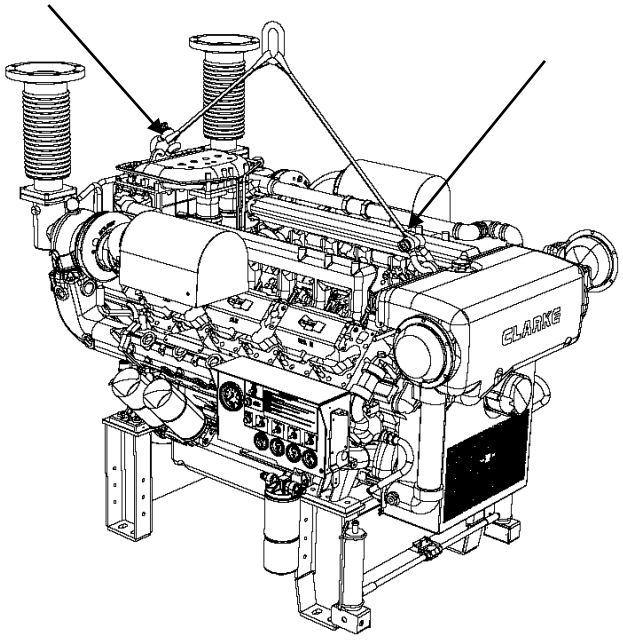


Figure #3

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

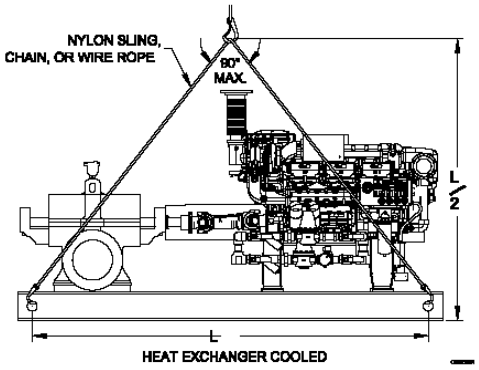


Figure #4

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.*

Note: 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.

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 *Figure #5.*

CLARKE

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DECLARATION OF INCORPORATION

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 98/37 EC and consequently the conditions required for the CE Mark.

We declare that the engine is manufactured in accordance with the following Standards and Directives:
Directive 98/37 EC, 89/336 EEC, 73/23 EEC, 2006/95/EC
Standards EN 292, Part 1 and Part 2, EN 60204-1

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

2) 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.

3) 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.

4) 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 _____ Date: _____
Ken Wauligman – Engineering Manager

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Figure #5

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
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.

FIRE

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

BURNS

1) 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
2) Do not pull off strips of clothing that are sticking to the skin.
3) In the case of scalding with liquids, remove the soaked clothing quickly but carefully.
4) Cover the burn with a special anti-burn packet or with a sterile bandage.

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.

CAUSTIC BURNS

1) 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
2) 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.

ELECTROCUTION

Electrocution can be caused by:

1) The engine's electrical system (12/24 VDC)
2) The electrical coolant pre-heating system 115/230 Volt AC (if supplied) AC current.

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.

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.

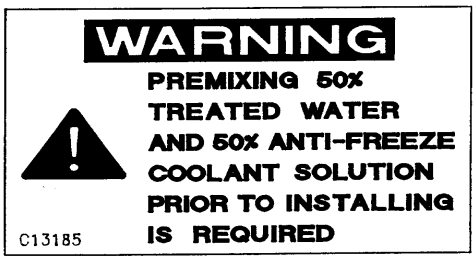
In the case of fracture do not move the part of the body affected by the fracture. When moving an injured person permission from that person must be received until you can help him. Unless the injury is life threatening, move the injured person with extreme care and then only if strictly necessary.

WARNING LABELS

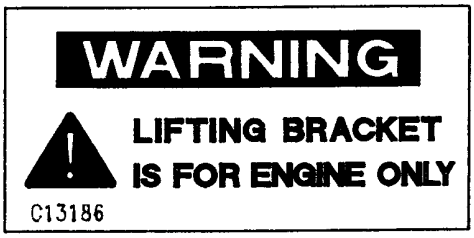
Warning labels, in picture form, are applied to the engine. Their meanings are given below.
Important Note: Labels that show an exclamation mark indicate that there is a possibility of danger.

Heat Exchanger Maximum Working Pressure

Coolant Mixture



Lifting Point



Automatic Start

Rotating Parts

Jacket Water Heater Voltage

Air Filter Installation

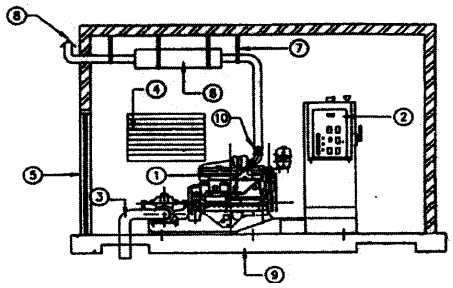
2.0 INSTALLATION/OPERATION

2.1 TYPICAL INSTALLATION

A typical Fire Pump installation is shown in *Figures #6 & 6A.*

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.



#6
Typical Installation
Heat Exchanger Cooled Engine

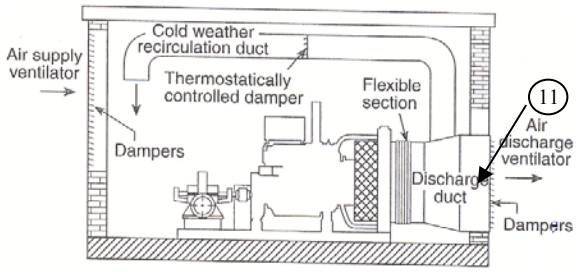


Figure #6A
Typical Installation
Radiator Cooled Engine

2.2 ENGINE STORAGE

2.2.1 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.

2.2.2 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:

1) Drain the engine oil and change the oil filter.
2) Refill the engine crankcase with MIL-L-21260 preservative oil.
3) Change the fuel filters.
4) Install the coolant plugs and install coolant in the normal mix percentage of 50% coolant, 50% water, premixed.
5) Remove the protection from the intake and exhaust openings.
6) Prepare a preservative fuel container as a fuel source using a fuel conditioner mixture of C02686 or C02687 with **ONLY** Diesel #2 fuel or "Red" diesel fuel (ASTM D-975) or BS2869 Class A2.
7) Disconnect the coupling or drive shaft from the pump.
8) Start and run the engine at a slow speed for 1-2 minutes being careful not to exceed the normal operating temperature.
9) Drain the oil and coolant.
10) Replace the protective plugs that were used for shipping and storage.
11) Attach to the engine a visible card, specifying "ENGINE WITHOUT OIL" DO NOT OPERATE".

IMPORTANT: THIS TREATMENT MUST BE REPEATED EVERY 6 MONTHS
****
PUTTING ENGINE INTO SERVICE AFTER ADDITIONAL PRESERVATION SERVICE:
To restore the normal operation running conditions of the engine, carry out the following:

1) Fill the engine sump with the normal recommended oil, to the required level.
2) Remove the protective plugs used for shipping and storage.
3) Refill cooling water to proper level.
4) Remove the card "ENGINE WITHOUT OIL, DO NOT OPERATE".
5) Follow all steps of the Installation Instructions when the engine will be put into service.

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.

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 for specific alignment instructions).
2) Engine with Heat Exchanger Cooling: Install the heat exchanger discharge pipe. 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.
3) Install all engine cooling system draincocks and plugs.

Qty	Description	Location
1	Plug	Water Pump Inlet
1 (DT2H only)	Plug	RH Exhaust Manifold - Front
1 (DT2H only)	Plug	LH Exhaust Manifold - Top
1	Plug	Water Pump Outlet Tube
1	¼" Draincock	Heater Inlet Tube

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 premixed 50% water / 50% coolant solution. Use only coolants meeting ASTM-D6210 specifications for heavy-duty diesel engines. Never use light-duty or automotive coolants in the engine that are stated as ASTM-D3306 only. Refer to *Figure #23* in section 3.4.3 for cooling system capacity. Refer to section 3.4.5 filling procedure.
5) Engine is shipped with oil **installed**. For make-up oil specifications refer to section 3.3 Lubrication System.
6) Connect fuel supply and return line to fuel supply tank plumbing. Reference the Fuel System section of the Installation and Operation Data in the Technical Catalog, for piping size, maximum allowable fuel pump suction, and maximum allowable fuel head requirements. Fill supply tank with **ONLY** #2 diesel fuel (ASTM D-975) or BS 2869 Class A2 "Red" diesel fuel, bleed supply system of air and check for leaks. **CAUTION:** Biodiesel fuel is not recommended or 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 Doosan approved conditioners/additives. For fuel conditioners/additives check with your local Doosan 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.
7) Remove protective covering on air cleaner element.
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.
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.
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.

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 in the Technical Catalog C133941, for correct positive and negative connections.
12) Connect negative cables directly to the ground stud. Connect each positive cable to the large outer post of the manual starting contactors.
13) Note: Clarke Operation and Maintenance Instructions Manual and Clarke parts illustration pages are located inside the engine gauge panel.
14) 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

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)
DP6H	SC81A or CDS50-SC	7/16, Grade 8 (Hi-Tensile)	50 (68)
DQ6H	SC81A or CDS50-SC	7/16, Grade 8 (Hi-Tensile)	50 (68)
DR8H	SC81A	7/16, Grade 8 (Hi-Tensile)	50 (68)
DS0H	SC2160A	M16, Class 10.9 (Metric) (Hi-Tensile)	210 (284)
DT2H-UFAA40 UFAA58 UFAA30 UFAA60	SC2160A	M16,Class 10.9 (Metric) (Hi-Tensile)	210 (284)
DT2H-UFAA98 UFAA92 FMAAX8 FMAAX2	SC2390	M16,Class 10.9 (Metric) (Hi-Tensile)	210 (284)

Note 1 – It is recommended that a medium strength threadlocker (i.e. Loctite – blue 24205) be used in the assembly and torquing of all hardware. This may be purchased as part number C126757.

Note 2 – 4 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.

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.

A) To check the Horizontal Parallel Offset, the driveshaft must be in the proper orientation.
   1. Rotate the shaft so the reference "AB" on the flywheel disc or the circumference of the

drive shaft flange (against the flywheel) is in the 12 o'clock position shown on *Figure# 7*.

2. Measure from the rear face of the flywheel drive disc or the drive shaft flange to point A. (Point A is on the bearing bore as shown in *Figure #7*, on the instrument panel side of the engine). This measurement must be:

Measurement	Driveshaft
109.0 ± 2mm	SC81A
108.0 ± 3mm	CDS50-SC
123.50 ± 1.5mm	SC2160A
142.5 ± .5mm	SC2390

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

1. Measure from the front face of the drive shaft flange on the pump end to point B. (Point B is the bearing bore on the exhaust side of the engine). This measurement must be equal to the measurement at point A ± 1 mm.

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

1. Rotate the shaft 90° so the reference "CD" on the flywheel drive disc or the circumference of the drive shaft flange (against the flywheel) is in the position shown on *Figure #8.*
2. Measure from the rear face of the flywheel drive disc or the drive shaft flange to point C. (Point C is the same as point A with the driveshaft rotated 90°). The measurement must be:

Measurement	Driveshaft
112.5 ± 1mm	SC81A
71 ± 1mm	CDS50-SC
126.5 ± 1mm	SC2160A
145.5 ± 1.5mm	SC2390

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

1. Measure the front face of the drive shaft flange on the pump end to point D. (Point D is the same as point B, with the driveshaft rotated 90). The measurement must be equal to the measurement at point C ± 1 mm.

Re-install all guards and grease fittings before reconnecting the battery cables.

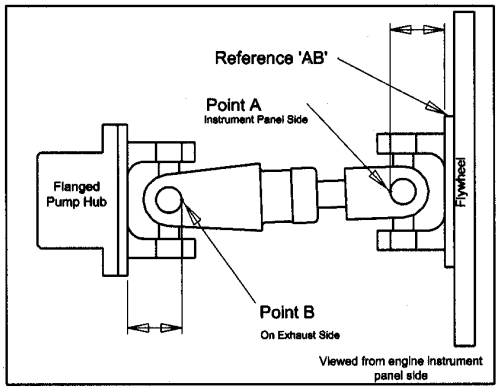


Figure #7

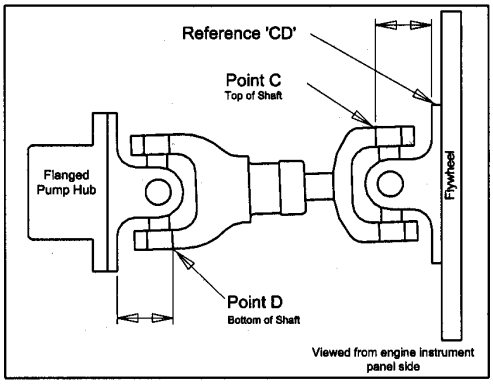


Figure #8

DRIVESHAFT MAINTENANCE

1. To service the driveshaft disconnect the negative battery cables, remove the top of guard and set aside.
2. Rotate engine shaft manually so the u-joint grease fittings are accessible.
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.
4. Verify all driveshaft connecting bolts remain tight. Re-torque per 2.4.1 if necessary.
5. Reinstall top of guard and connect negative battery cables.

2.4.3 Other Coupling Types

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

2.5 STARTING/STOPPING THE ENGINE

2.5.1 To Start Engine

Before starting the engine for the first time review section 3.4.6 to ensure there is an adequate Raw Water Supply to the Engine Heat Exchanger.

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. For manual starting and stopping of an engine with a gauge 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.

- Position **MAIN PUMP CONTROLLER TO "OFF" POSITION**. (Refer to *Figure #9*).
- Lift and hold **MANUAL CRANK #1**, until engine starts, or release after 15 seconds. If unit fails to start, wait for 15 seconds, use **MANUAL CRANK #2** and repeat step.
- If **COOLING WATER** is not flowing or engine **TEMPERATURE** is too **HIGH**, open cooling system manual by-pass valves (applies to heat exchanger cooled engines only).

Note: You can also crank engines using manual starting contactors.

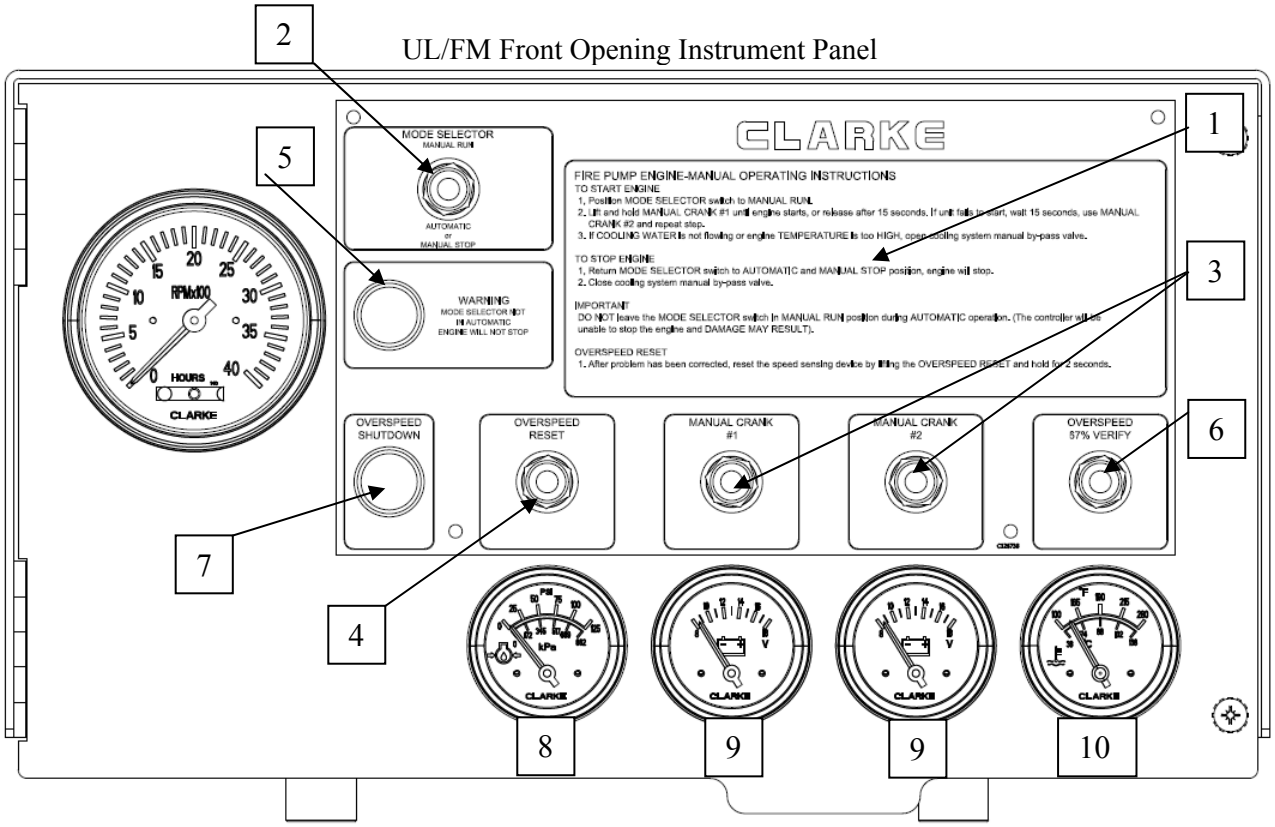
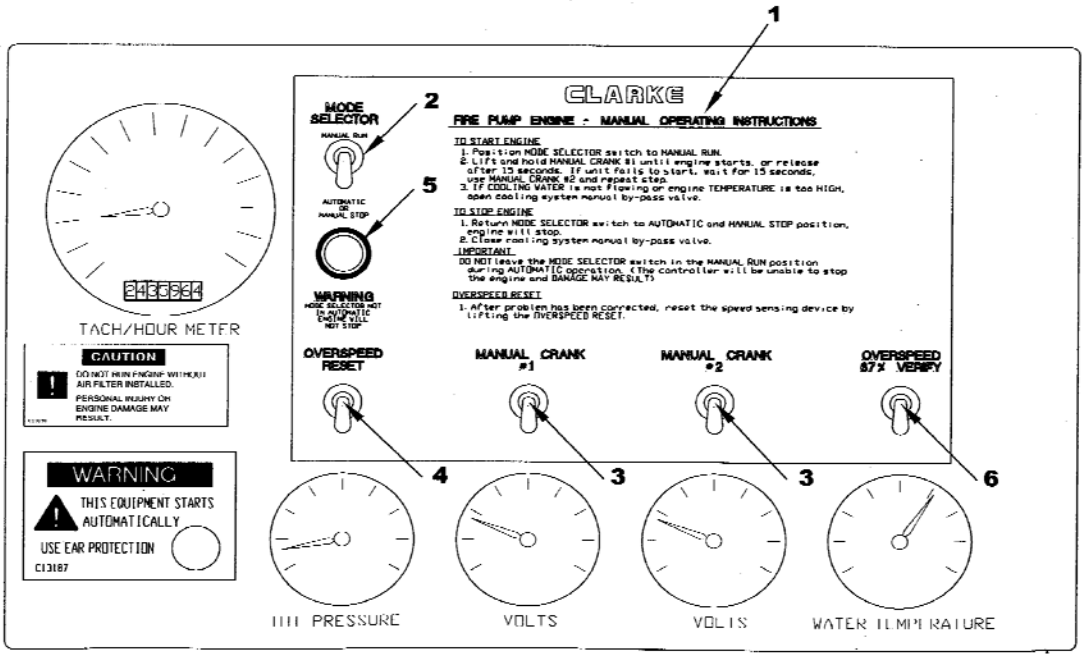


Figure #9

1 – Emergency Operating Instructions
2 – Automatic / Manual Mode Selector
3 – Manual Crank Controls
4 – Overspeed Reset
5 – Manual Mode Warning Light
6 – Overspeed Verification
7 – Overspeed Indication Light
8 – Oil Pressure Gauge
9 – Voltmeters Battery 1 & 2
10 – Coolant Temperature Gauge

Non-Listed Instrument Panel



1 – Emergency Operating Instructions
2 – Automatic-Manual Mode Selector
3 – Manual Crank Controls
4 – Overspeed Reset
5 – Warning Light
6 – Overspeed Verification

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.

2.5.2 To Stop Engine

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

If engine is started from engine gauge panel: Return **MODE SELECTOR** switch to **AUTOMATIC/MANUAL STOP** position, engine will stop. 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**).

2.5.3 Emergency Stop Instructions

If energized to stop solenoid fails, you will NOT be able to stop the engine from the instrument control panel or fire pump controller. Use the emergency stop lever to choke off fuel supply and shut the engine down.

DP6H & DQ6H engine models: The emergency stop lever is located on the right side (same side as instrument panel) of the engine on the fuel injection pump. To stop the engine, rotate the emergency stop lever clockwise until it stops (see *Figure #10A*). Continue to hold lever in "STOP" position until engine comes to a complete stop.

DR8H & DS0H engine models: The emergency stop lever is located near the front of the engine. To stop the engine rotate the emergency stop lever until it stops. Continue to hold lever in "STOP" position until engine comes to a complete stop.

DT2H engine models: If energized to stop solenoid fails, you will NOT be able to stop the engine from the instrument control panel or fire pump controller.

This solenoid is located on the left side (opposite side of instrument panel) of the engine towards the front. To stop the engine, rotate the emergency stop lever counter-clockwise until the solenoid plunger is completely depressed (see *Figure #1*0B). Continue to hold lever in "STOP" position until engine comes to a complete stop.

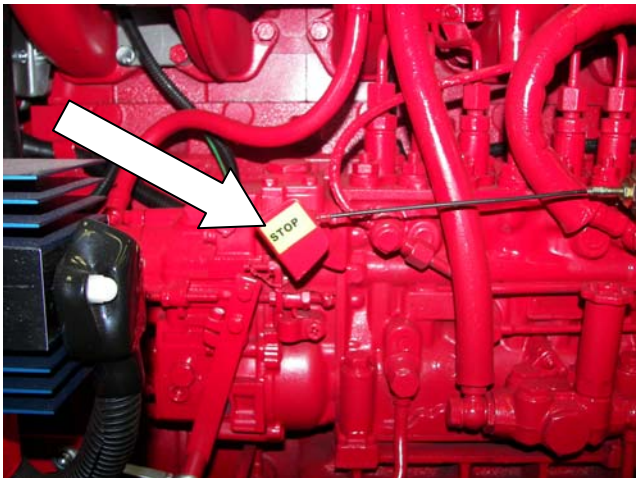


Figure #10A

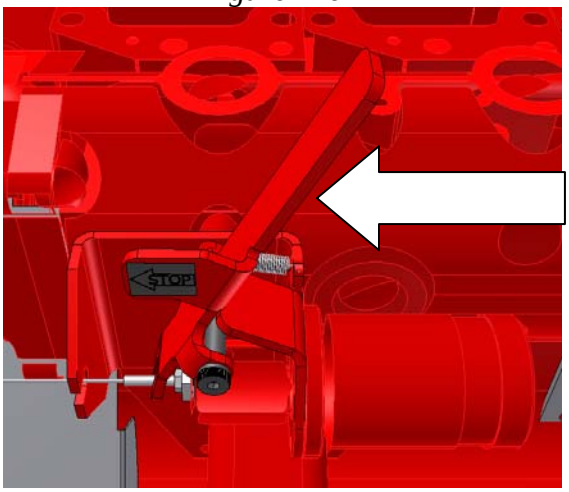


Figure #10B

2.6 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.

Before starting the engine make sure of the following:

1) The operator has free access to stop the engine in an emergency.
2) The plant room ventilation ducts are open and the engine has good access for air.
3) All the guards are in position and, if not, for whatever reason, any rotating parts will be free and clear without restriction.
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.

5a) Heat Exchanger Cooling: The water supply for coolant is available again without restriction.

5b) Radiator Cooling: The air supply for cooling is available again without restriction.

When engine is running make sure that the coolant temperature and oil pressure raw cooling water flow are within the limits specified on the relevant Installation & Operation Data Sheet in the Technical Catalog, C133295.

If the coolant temperature is excessive, check:

a) Cooling loop strainers
b) Proper functioning of thermostat
c) Condition of heat exchanger tube bundle

3.0 ENGINE SYSTEMS

3.1 FUEL SYSTEM

3.1.1 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 #11*

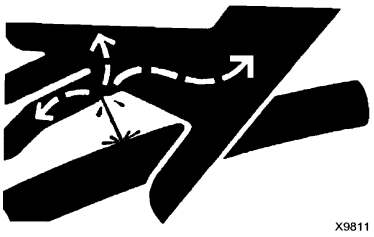


Figure #11

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.

DP6H, DQ6H, DR8H, DS0H, DT2H Engine Series:

1) Loosen the air bleed valve (A) by hand on fuel filter head. *Ref. Figure #12A and #12B.*

2) Operate supply pump primer lever (B) until fuel flow is free from air bubbles. On the DP6H, and DQ6H it will be necessary to rotate pump handle to release it and then to lock in place after fuel system is bled. Ref. *Figure* #13A and #13B.

3) Tighten bleeding valve securely; continue operating hand primer until pump action is not felt.

4) Start engine and check for leaks.

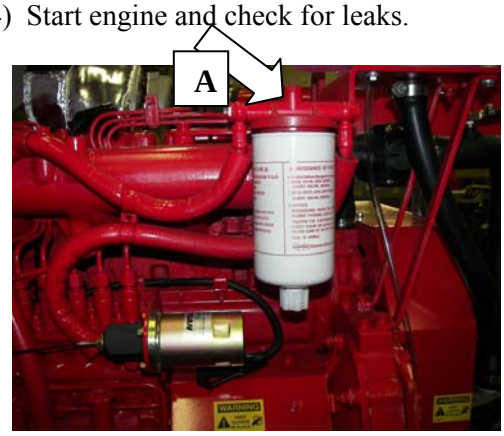


Figure #12A – DP6H, DQ6H, DR8H, & DS0H models

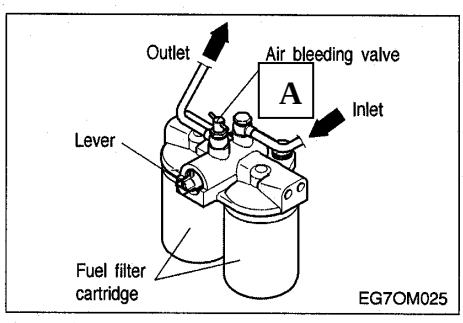


Figure #12B – DT2H-UFAA60,98,92,-FMAAX8,X2 models

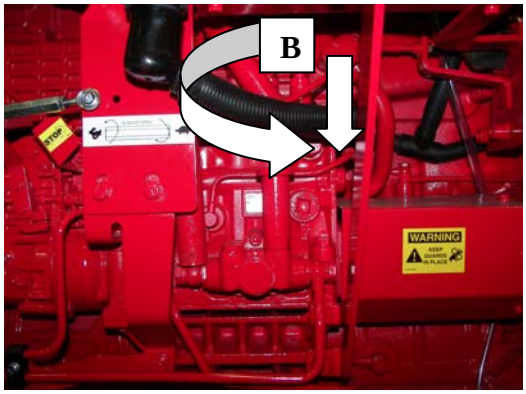


Figure #13A – DP6H & DQ6H models

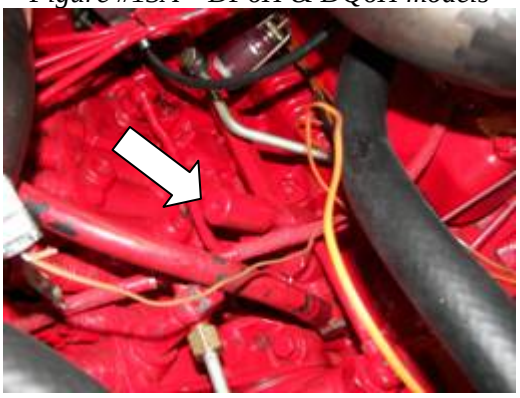


Figure #13B – DR8H models

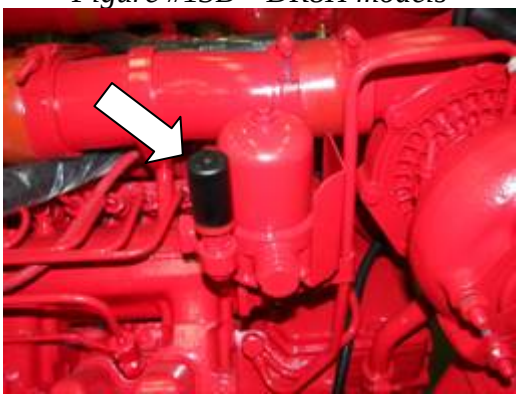


Figure #13C – DS0H models

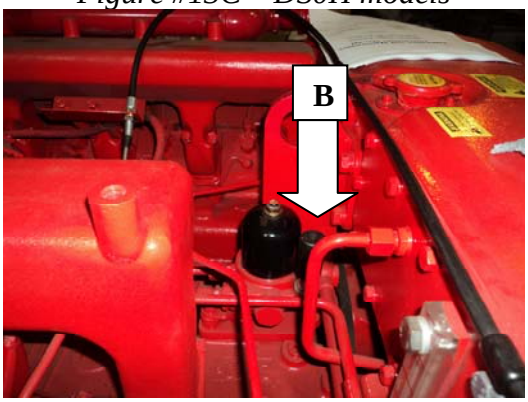


Figure #13D- DT2H models

3.1.2 Changing the Fuel Filter Cartridges

Changing the cartridges and bleed any air from the fuel system as per instructions given in section 3.1.1. Fuel filter changes should take place as per recommendations and only use approved filters. It may also be necessary to change filters out with the recommendations in the event of:

1) The engine has had an overhaul.
2) The quality of the fuel is questionable.
3) The engine has been subjected to temporary adverse conditions outwith it normal operating parameters.
4) The fuel tank condensation trap has not been drained in line with manufacturer's recommendations.

3.1.2.1 Fuel Filters

Note: DT2H-UFAA60,98,92,-FMAAX8,X2 engines are provided with parallel, duplex fuel filters. Each filter is to be replaced by utilizing the duplex valve to cut out that valve. Refer to Figure 14.

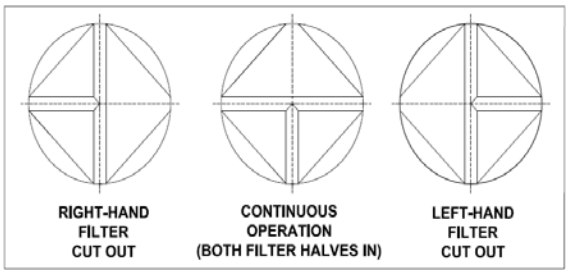


Figure 14 – DT2H-UFAA60,98,92,-FMAAX8,X2

- Loosen the fuel filter by turning it counterclockwise with the filter wrench. Discard the used filter in a designated place.
- Wipe the filter fitting face clean.
- Apply a light coat of engine oil to the O-ring and supply fuel to the new filters.
- Turn the new filter until the filter O-ring is fitted against the sealing face.
- And the turn the filter cartridge about ¾ ~ 1 turn more with hands or filter wrench.

CAUTION: DO NOT LEAVE SELECTOR LEVER IN ANY INTERMEDIATE POSITION BECAUSE THIS WOULD INTERFERE WITH THE FUEL SUPPLY. See *Figure #14.*

3.1.3 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.

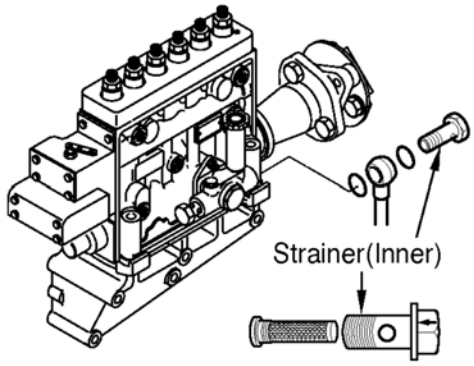
Note: Per NFPA 25 standards, the fuel tank level must never be less than 67% of its capacity.

3.1.4 Fuel Injection Pump Components

For Droop Spring and Run-Stop Solenoid (external to Injection Pump) part numbers consult factory.

3.1.5 Priming Pump Strainer Cleaning

Clean the priming pump strainer on an annual basis. The plastic strainer is incorporated in the priming pump inlet side "banjo" bolt. Clean any debris from the strainer with compressed air and rinse it with fuel.



3.2 AIR/EXHAUST SYSTEM

3.2.1 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.

3.2.2 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. This data can be used for proper sizing of inlet and outlet louvers.

3.2.3 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; if equipped air filter restriction indicator (ref. Fig. #17A); the air cleaner should be serviced immediately. See *Figure #39* for air cleaner part numbers by Clarke Engine Model.

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

AIR FILTER SERVICE INSTRUCTIONS

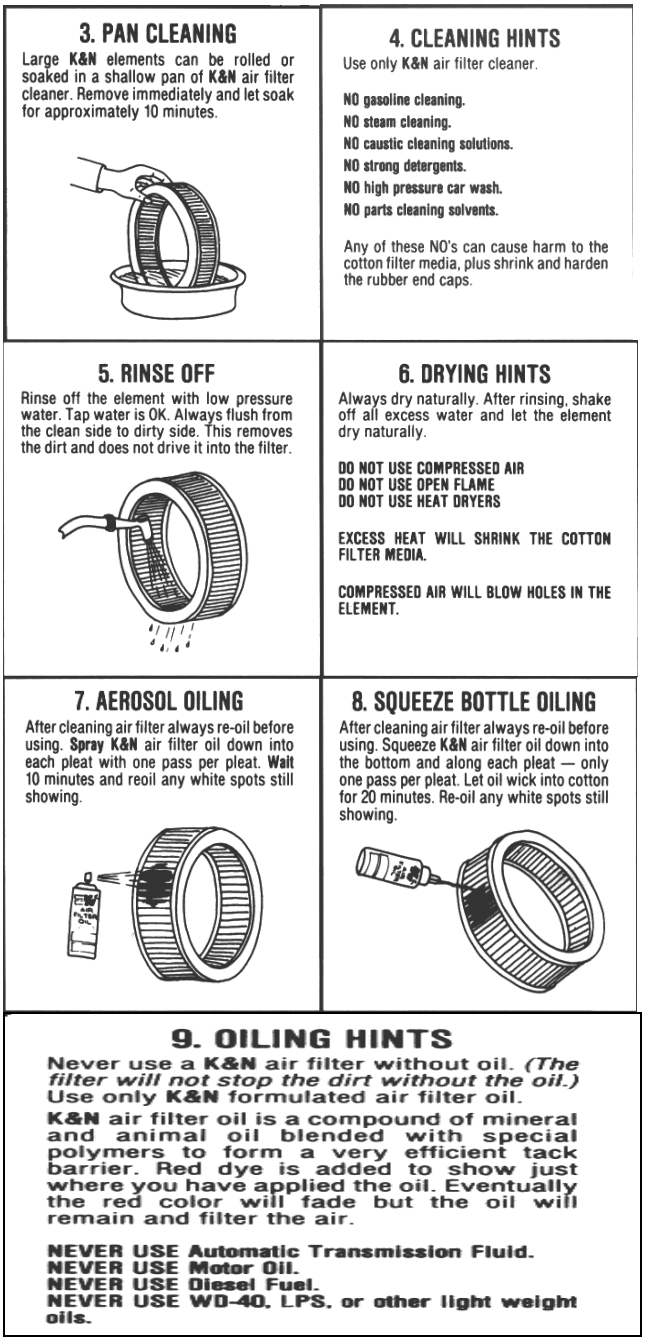


Figure #15

3.2.4 Crankcase Ventilation

3.2.4.1 DP6H, DQ6H – Open Crankcase Ventilation (Refer to *Figure #16*)

Vapors which may 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 expelled through a vent pipe attached to the rocker cover breather element. Ref. *Figure* #16.

Figure # 16

3.2.4.2 DR8H, DS0H, & DT2H – Crankcase Ventilation System

A crankcase ventilation system allows for the recirculation of vapors (expelled through a vent pipe attached to the rocker cover breather element) to the combustion air inlet. Refer to *Figures 17A, 17B, 17C, & 17D*

Figure #17A- DR8H / DS0H models

Figure #17B – DR8H / DS0H models

Figure #17C

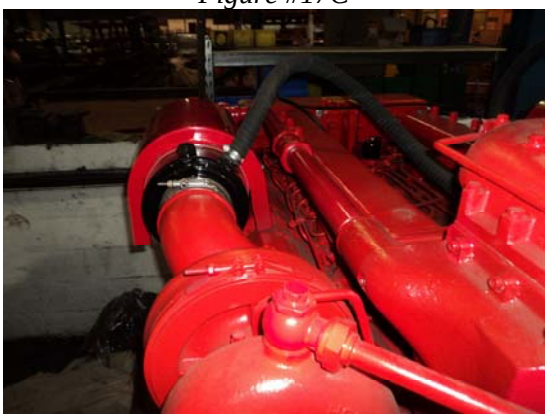


Figure #17D

Figure #17E

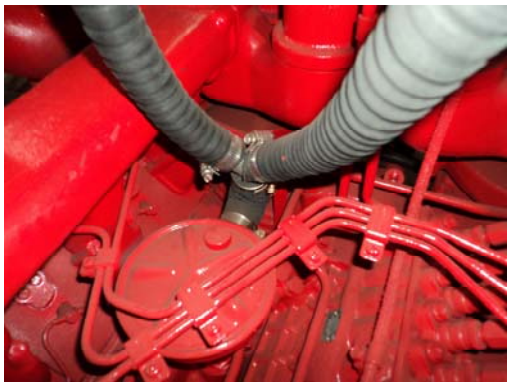


Figure #17F

Engine Model	Open Crankcase Ventilation	Crankcase Ventilation System
DP6H – all models	Standard	
DQ6H – all models	Standard	
DR8H – all models		Standard
DS0H – all models		Standard
DT2H – all models		Standard

3.2.5 Exhaust System

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 for exhaust data.

The installation of the exhaust system should consist of the following:

- Personnel protection from hot surfaces.
- Adequate supports to prevent strain on the engine exhaust outlet and minimize vibration.
- Protection against entry of water and other foreign matter.

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.

1) Blue Smoke – Possible engine oil consumption.
2) White Smoke – Possibility of water in cylinders, water in fuel or internal engine problem.

3.3 LUBRICATION SYSTEM

3.3.1 Checking Sump Oil

Check the sump oil level using the dipstick on the engine as shown in *Figures #18A and 18B.*

This level must always be between the dipstick marks Min. and Max. with the engine not running. On DT2H engines the dipstick should be reinserted for measurement very slowly so that the level on the dipstick is accurate.

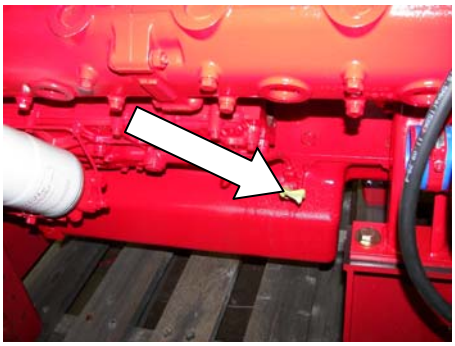


Figure #18A – DT2H, DR8H, DS0H

Figure #18B - DP6H, DQ6H

3.3.2 Changing Engine Oil

1) Operate the engine until it is warm.
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.
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. (see *Figure 19D)*

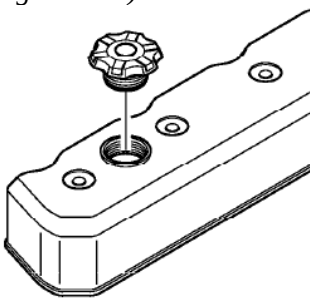


Figure #19D

4) 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.

5) Dispose used oil properly.

3.3.3 Changing Oil Filter Cartridge

1. Turn engine off.
2. Put a tray under the filter to retain spilt lubricating oil.

Note: DR8H, DS0H, and DT2H engines are provided with parallel, duplex oil filters. Each filter is to be replaced by utilizing the duplex valve to cut out that valve. Refer to Figure 14.

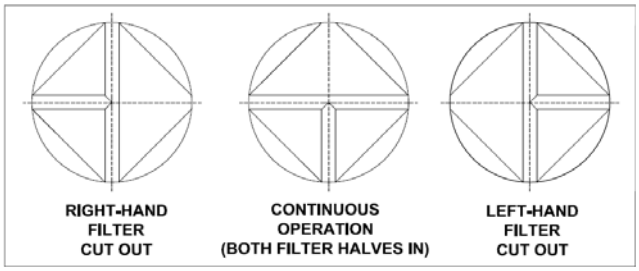


Figure 14 – DR8H, DS0H, and DT2H

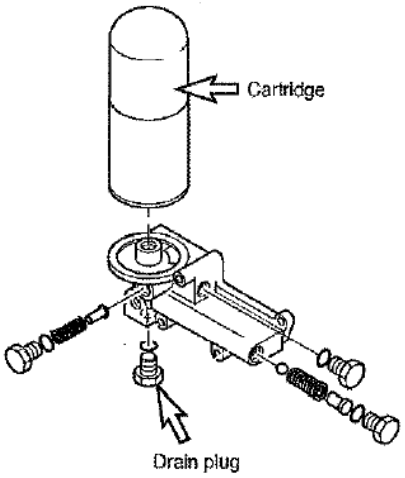


Figure 14 - DQ6H

Note: On DQ engines, drain oil from filter by loosening drain plug on filter heard.

3. Remove the filter with a strap wrench or similar tool. Then dispose of the filter properly (Ref *Figure #19A, #19B, and #19C*).
4. Clean the filter head.
5. Lubricate the top of the filter seal with clean engine lubricating oil.
6. Fit the new filter and tighten it until sealing face is against the 0-ring. Turn 3/4 – 1 turns further with the filter strap wrench.
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.
8. Refer to alarm 5 of section 3.5.5 for over crank/start disable instructions. 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.
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.

Figure #19A – DP6H models

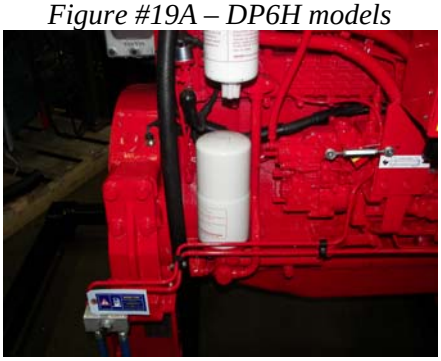


Figure #19B – DQ6H models

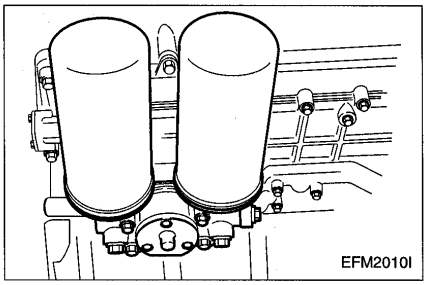


Figure #19C – DR8H, DS0H, DT2H

3.3.4 Oil Specification

This engine is factory-filled with oil.

Important: Do not add makeup oil until the oil level is BELOW the add mark on the dispstick.

Oil spec to be used for all engine models:

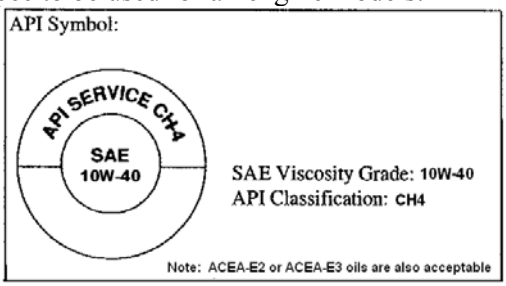


Figure #20

3.3.5 Oil Capacities (Including Filter)

ENGINE MODEL	OIL CAPACITY QUARTS (LITERS)
DP6 – All Models	15 (14)
DQ6 – All Models	23 (22)
DR8 – All Models	21 (20)
DS0– All Models	35 (33)
DT2 – All Models	45 (43)

Figure #21

3.4 COOLING SYSTEM

3.4.1 Intended Engine Operating Temperature

The DP, DQ, DR, DS & DT engines are provided with either a heat exchanger or radiator to maintain the engine coolant temperature within recommended operating guidelines.

The DP, DQ, DR, DS, & DT engines have an intended engine operating temperature of 160º F (71ºC) to 185º F (85º C). A high coolant temperature switch is provided to indicate a high coolant temperature alarm at 205º F (96º C).

3.4.2 Engine Coolant

The following information is provided as a guide for Clarke Engine users in the selection of a suitable coolant.

The water/ethylene glycol/inhibitor coolant mixture used in Clarke engines must meet the following basic requirements:

- Provide for adequate heat transfer.
- Provide protection from cavitation damage.
- Provide a corrosion/erosion-resistant environment within the cooling system.
- Prevent formation of scale or sludge deposits in the cooling system.
- Be compatible with engine hose and seal materials.
- Provide adequate freeze and boil over protection.

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 technical data section for proper cooling system capacities of each model.

3.4.3 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

Figure #22

3.4.4 Coolant Capacities

Use an ethylene glycol coolant (low silicate formulation) that meets the standard of either the GM 6038-N formulation (GM1899-M performance) or **ASTM D6210** requirements.

A 50% coolant water solution is recommended. A concentration over 70% is not recommended because of poor heat transfer capability, adverse freeze protection and possible silicate dropout.

Concentrations below 30% offer little freeze, boil over or corrosion protection.

IMPORTANT

Never use automotive-type coolants (such as those meeting only ASTM D3306 or ASTM D4656). These coolants do not contain the correct additives to protect heavy-duty diesel engines. They often contain a high concentration of silicates and may damage the engine or cooling system.ENGINE MODEL	**COOLANT CAPACITY QUARTS (LITERS)**
ALL DP6H	29 (28)
ALL DQ6H	36 (34)
ALL DR8H	30 (28)
ALL DS0H	33 (31)
DT2H-UFAA40, 58	38 (36)
DT2H-UFAA60, 98, 92, -FMAAX8,X2	109 (103) Max 97 (92) Min.

Figure #23

3.4.5 Coolant Inhibitor

The importance of a properly inhibited coolant cannot be over-emphasized. A coolant which has insufficient or no inhibitors at all, invites the formation of rust, scale, sludge and mineral deposits. These deposits can greatly reduce the cooling systems efficiency and protection capabilities.
Recommended supplemental coolant inhibitors are a combination of chemical compounds which provide corrosion protection, cavitation suppression, pH controls and prevents scale. These inhibitors are available in various forms, such as liquid packages or integral parts of anti-freeze.

It is imperative that supplemental inhibitors be added to all Clarke engine systems. A pre-charge dosage must be used at the initial fill and the maintenance dosage used at each service interval. Serious damage will occur unless inhibitors are used. Some of the more common corrosion inhibitors are borates, nitrates and silicates.

Inhibitors become depleted through normal operation; additional inhibitors must be added to the coolant as required to maintain original strength levels. Refer *Figure #24* for proper concentrations of inhibitors.

	Min. PPM	Max PPM
Boron (B)	1000	1500
Nitrite (NO^2)	800	2400
Nitrates (NO^3)	1000	2000
Silicon (Si)	50	250
Phosphorous (P)	300	500
PH	8.5	10.5

Figure #24

Do not use soluble oils or chromate inhibitors in Clarke engines. Detrimental effects will occur.

To properly check inhibitor concentrations it may be necessary to contact your local Service/Dealer for assistance. Refer to Parts Information Section to obtain the part number for the factory Coolant Analysis Kit. This kit can be purchased for a nominal fee for analyzing the conditions of the engine's coolant.

3.4.6 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.

Note: On DT2H engines, it is important to loosen the bolts in the banjo connections at the top of each turbo to provide a vent during the fill. Once the initial fill is complete, the bolts should be tightened and then follow the partial fill instructions below.

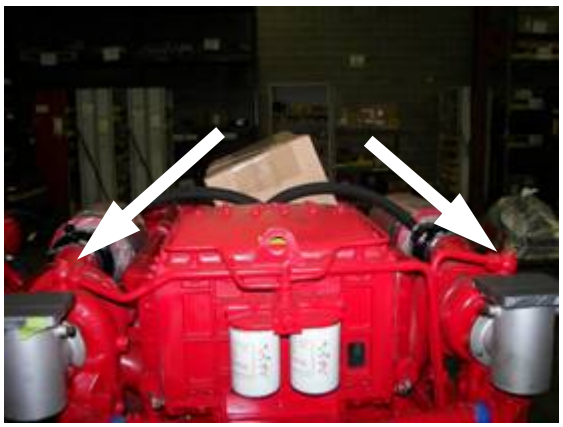


Figure #25A

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

3.4.6.1 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 120ºF (49ºC), 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.

3.4.7 Providing adequate Raw Water Supply to the Engine Heat Exchanger

3.4.7.1 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.

3.4.7.2 Cooling Loop

Figure #26 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 pumps 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 up 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.
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 (or CAC) and to control raw water flow rate. Typically the pressure regulators are set to limit downstream pressure to 60 psi (4 bar). There is a pressure gauge installed just upstream of the engine heat exchanger (or CAC) and downstream of the each pressure regulator. Under normal engine operating conditions with adequate cooling water flowing thru the heat exchanger (or CAC) this gauge should typically read below 20 psi (1.4 Bar).

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 3.4.7.5 regarding strainer maintenance.

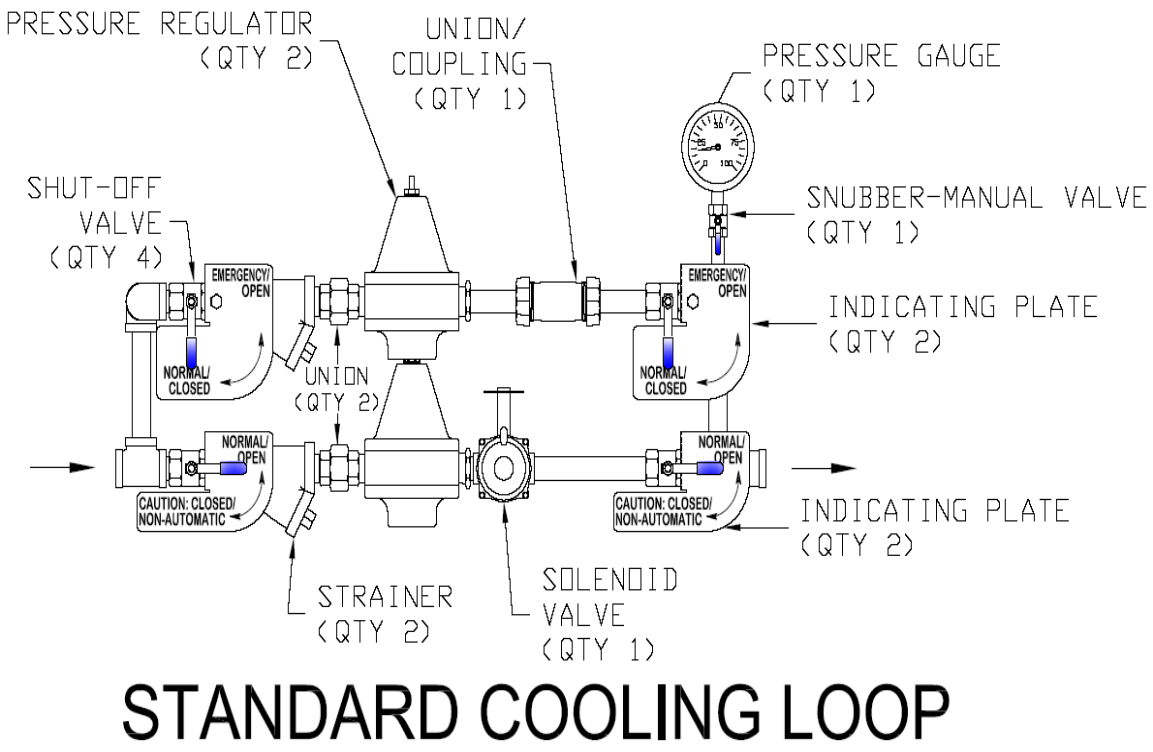


Figure #26

3.4.7.3 Setting Raw Water Flow Rate

The proper amount of raw water flow thru this line 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 piping to a floor drain 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 Technical Catalog 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. You will need to measure the raw water temperature and then find the value for recommended minimum raw water flow at your measured raw water temperature on the I&O Datasheet and then; with the fire pump flowing 150% of rated flow, and the Automatic flow line open; set minimum flow by using the adjusting screw at the top of the pressure regulator.

NOTE: To increase flow turn the adjusting screw clockwise and to reduce flow turn the adjusting screw counterclockwise.

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!*** After setting the pressure regulator in the Automatic flowline, open the Manual by-pass line valves, and then close the Automatic flowline valves and repeat the above process in order to set the flowrate going thru the pressure regulator in the Manual by-pass line. Once this is completed; close the Manual by-pass valves and open the Automatic flowline valves to restore conditions back to normal.

3.4.7.4 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:

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

3.4.7.5 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 replaced.

It can be not stressed enough how important it is to keep these strainers 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.

3.4.7.6 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.

3.4.7.7 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.

3.4.8 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, engine block and cylinder head, jacket water heater, thermostat, and expansion tank. On DT2H engine models the flow also cools the turbocharger and the exhaust manifolds.

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 #35E* for DP6H and DQ6H engine models and *#35F* for DT2H engine models for cooling system flow path diagrams.

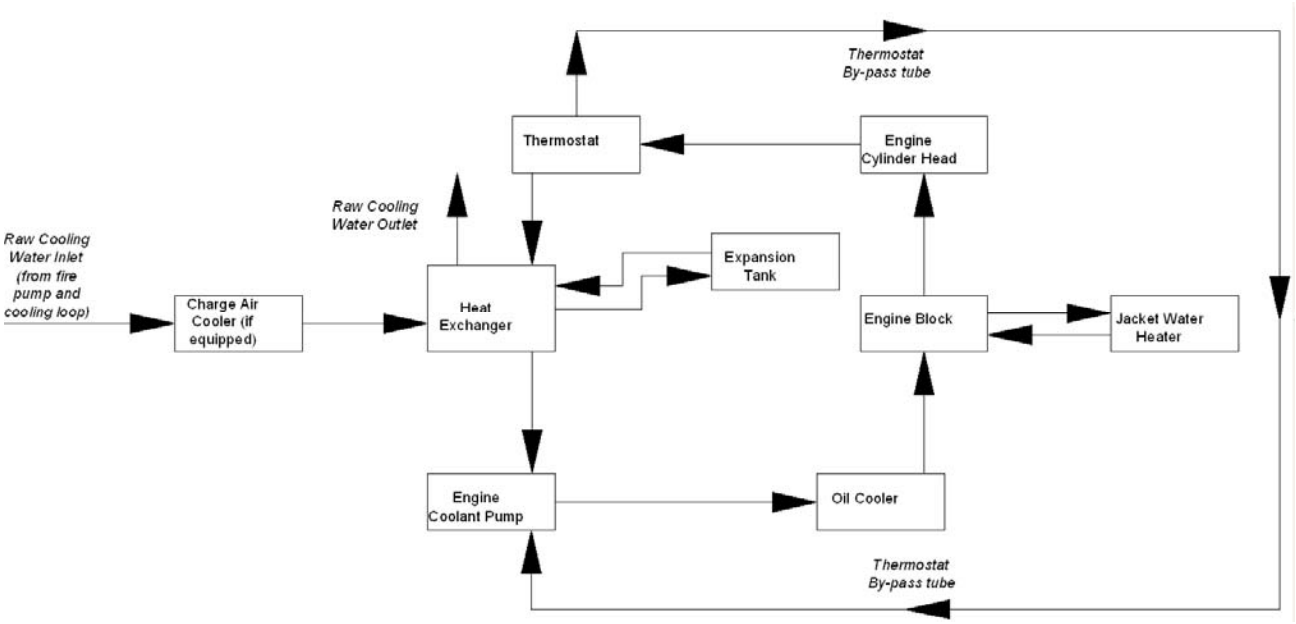


Figure #26A – DP6H & DQ6H engine models

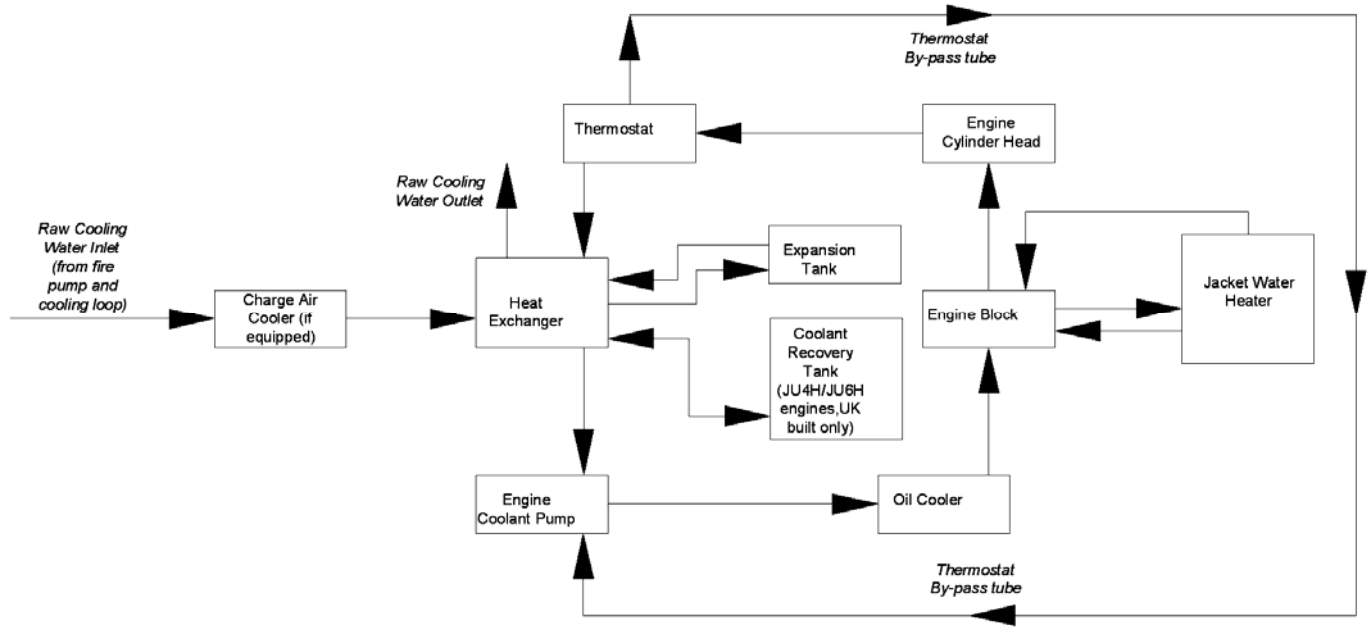


Figure #26B – DR8H, DS0H, DT2H-UFAA40, 58 engine models

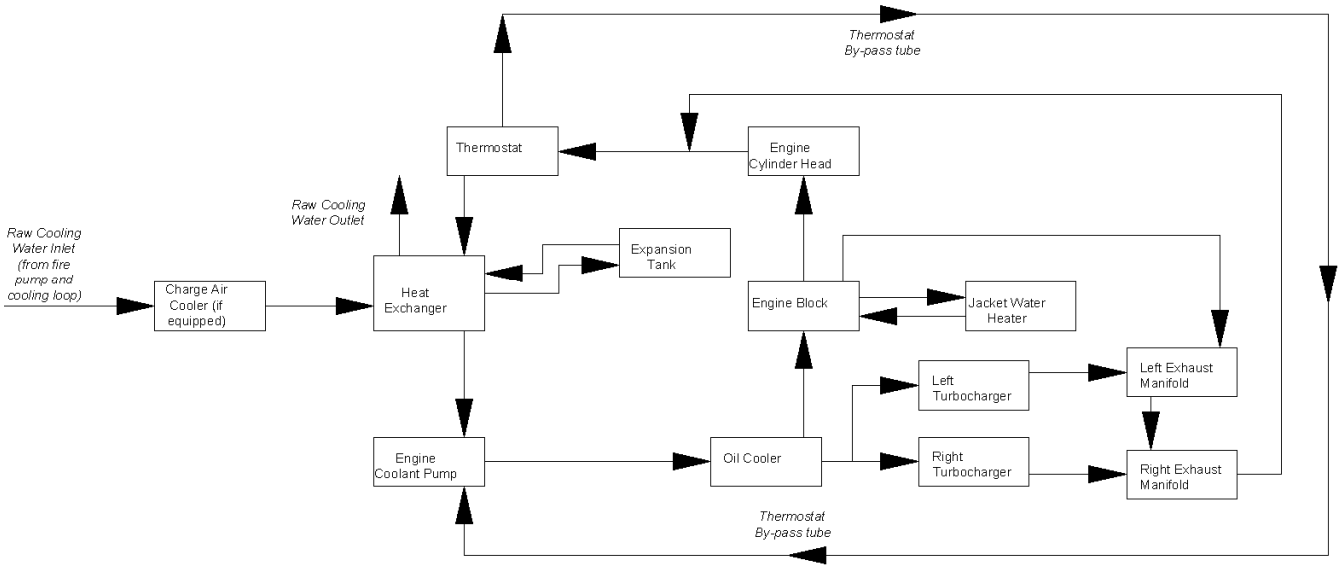


Figure #26C – DT2H-UFAA60,98,92,-FMAAX8,X2 engine models only

3.4.9 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.

1) The coolant shoud be drained (after de-energizing the coolant heater
2) Replace the engine thermostat(s)
3) 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.
4) Run the engine to verify normal operating temperature.

3.4.9.1 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

3.5 ELECTRICAL SYSTEM

3.5.1 Wiring Diagrams (Only with Engine Gauge Panel)

Run/Stop Solenoid	Drawing No.	Description (DC Voltage)	Reference Document
ETS = Energized to Stop	C071842	Mechanical Engines NFPA-20 and UL/FM engine gauge panel (NL Models - Optional)	See Technical Catalog C133941 (Mechanical Engines)

Drawing No.	Description (AC Voltage)	Reference Document
C07651	DP, DQ, DR, DS, DT – NFPA-20 and UL/FM Engine Jacket Water Heater	See Technical Catalogs C133941
C071613	DT2H-UFAA60,98,92,-FMAAX8,X2 only - NFPA-20 and UL/FM Engine Jacket Water Heater	See Technical Catalogs C133941

Figure #27

3.5.2 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 *Figures #28A,28B, 28C, 28D.*

Figure #28A – DP6H

Figure #28B – DQ6H

Figure #28C – DR8H / DS0H / DT2H

Figure #28D – DT2H

To adjust Belt Tension:
Check belt tension:
- Give at arrow must be 0.4" - 0.6" (10-15mm).

To increase tension of the water pump driving belts:
- Loosen alternator or belt tensioner mounting bolts A and B.
- Adjust to proper belt tension.
- Tighten mounting bolts A and B.

3.5.3 Speed Switch (when supplied)

Overspeed is defined as 120% of rated speed for engines rated from 1470 through 2600 rpm. In the event of an engine overspeed, the speed switch signals the main pump controller and also affects an engine shutdown. The OVERSPEED RESET (*Figure# 9*) switch is included on the instrument panel. Should an overspeed condition occur, investigate the cause and make necessary corrections before placing engine back in service. The OVERSPEED RESET must be manually lifted for two (2) seconds to reset.

NOTE: This reset operation must be completed to allow a restart. If not, the engine will not start thru the main pump controller or manually.

OVERSPEED VERIFICATION

Hold the OVERSPEED VERIFICATION switch in the "up" position. This will provide the main pump controller with an overspeed signal and engine shutdown at 67% of the set overspeed RPM. 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: 1410 RPM (67% of 2112 RPM)

CAUTION-after verification of overspeed, lift the OVERSPEED RESET switch for two (2) seconds and reset the main pump controller to re-instate normal operation of the engine and speed switch.

Refer to Engineering Technical Bulletin – ETB003, part number C133407, on the www.clarkefire.com

website for adjusting the overspeed setting for range rated engines.

3.5.4 Magnetic Pick-Up (when supplied)

A magnetic pick-up, mounted in the flywheel housing, provides the input signal for the tachometer overspeed switch, and/or the main pump controller. There should be approximately 0.03" air gap between the top of the ring gear and the center of the magnetic pick-up. With one tooth centered in the magnetic pick-up hole, thread the pickup in until it touches the gear tooth and then back it out 1/2 turn. Tighten jam nut while holding the pickup in position. Reconnect to wiring harness. With the engine operating at rated speed, the output voltage on the mag pickup should be between 7 VAC(rms) – 14 VAC(rms).

3.5.5 Mechanical Engine Control and Alarm Board (MECAB) Speed Switch Troubleshooting

This engine is equipped with a speed switch capable of sensing engine sensor malfunctions and/or electrical over-current(s) on engine alarm circuits and alerting the user via flashing status lamps. This flashing status indication is done so with the red "OVERSPEED SHUTDOWN" lamp on the outside of the Clarke instrument panel (Figure #29) and a red LED located on the middle of the speed switch inside of the Clarke instrument panel (Figure #30). In addition to these flashing status lamps, a "Low Engine Coolant Temperature Alarm" is sent via engine / fire pump controller inter-connect circuit #312 as a means to alert the user outside of the engine room.

Note: When first applying battery power to the engine, or after activating the overspeed reset switch, the OVERSPEED SHUTDOWN lamp and red LED on the speed switch will flash several times. This is an "INITIALIZATION PATTERN" and is normal. This will be referred to in the following troubleshooting section.

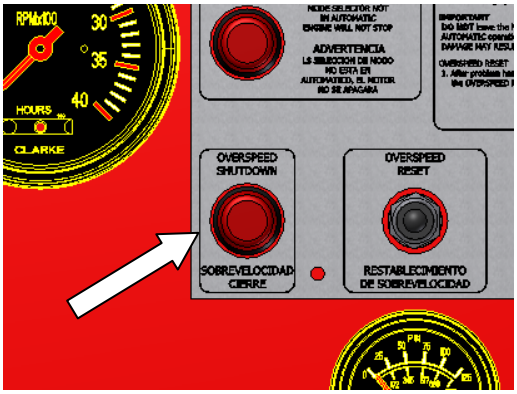


Figure #29

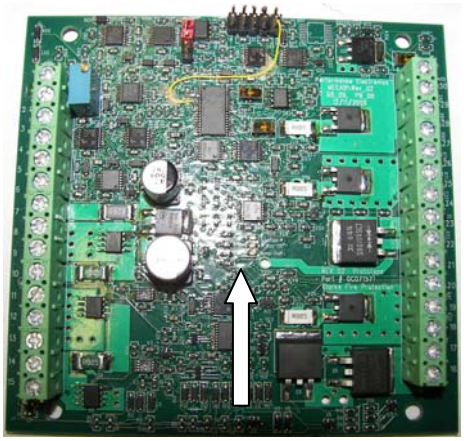


Figure #30 – MECAB speed switch

List of Troubleshooting Malfunctions

<u>Two (2) blinks – Electrical Current Exceeds 10 Amps on Alarm Circuits:</u> Status lamps will flash two times continuously on the Clarke instrument panel and a "Low Engine Coolant Temperature" alarm will be sent to the fire pump controller via circuit #312.

Cause:

Electrical current exceeds 10 amps on one or more engine / fire pump controller inter-connect circuits

Engine run alarm (#2)
Engine overspeed alarm (#3)
Engine low oil pressure alarm (#4)
Engine high coolant temperature alarm (#5)
Engine low coolant temperature alarm (#312)

Corrective actions:

Check each of the above circuits to determine which contains the current overload.

Once circuit(s) overload are corrected: On the Clarke instrument panel, operate the "OVERSPEED RESET" switch for two (2) seconds and release (*Figure #31*).

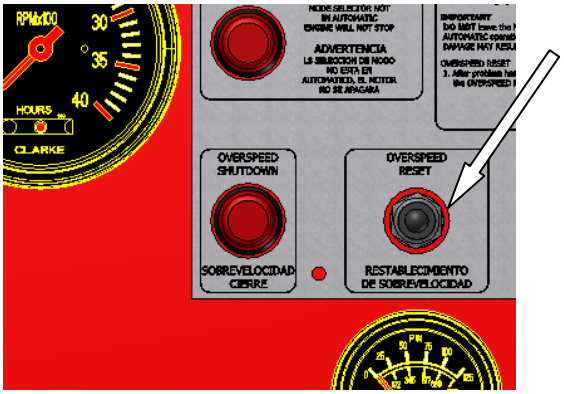


Figure #31

The "*INITIALIZATION PATTERN* will flash. This is normal. The continuous two (2) blink flash sequence should turn off at this point.

Three (3) blinks – Engine Coolant Temperature Sensor malfunction: Status lamps will flash three times continuously on the Clarke instrument panel and a "Low Engine Coolant Temperature" alarm will be sent to the fire pump controller via circuit #312.

Cause:

Engine coolant temperature sensor circuit is open or shorted.

Corrective Actions:

Verify wiring and connector plug at engine coolant temperature sensor are secure. Sensor is located on top of engine on DP6H and DQ6H engine models *(Figure #32A)*, at the front of the engine near the cylinder head on DR8H and DS0H models, and behind engine heat exchanger as shown on DT2H engine models (*Figure #32B*).

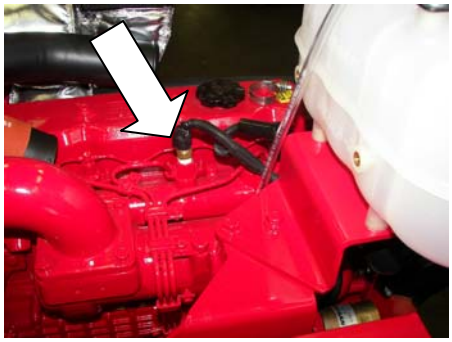


Figure #32A – DP6H & DQ6H engine models

Figure #32B – DR8H & DS0H models

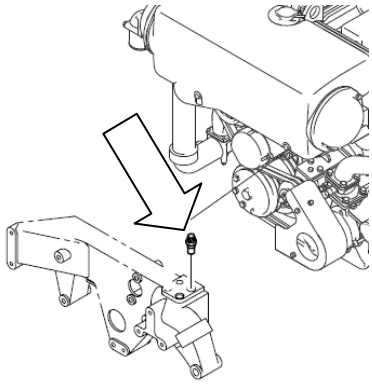


Figure #32C – DT2H engine models

On the Clarke instrument panel, operate the "OVERSPEED RESET" switch for four (4) seconds and release. (Refer to *Figure #31*).

The "*INITIALIZATION PATTERN"* will flash. This is normal. The continuous three (3) blink flash sequence should turn off at this point.

If problem still exists, replace engine coolant temperature thermistor.

Five (5) blinks on instrument panel – Oil pressure switch or Engine speed sensor (magnetic pick-up) malfunction: Status lamps will flash five times continuously on the Clarke instrument panel and a "Low Engine Coolant Temperature" alarm will be sent to the fire pump controller via circuit #312.

Cause:
Oil pressure switch failure or magnetic pick-up failure.

Corrective Actions:

Oil Pressure switch check

Verify wiring and connector at engine oil pressure switch are secure. Pressure switch is located on right side of engine next to the flywheel housing on DP6H & DQ6H engine models (Figures #33A) and near the oil filters on DR8H, DS0H, and DT2H engine models as shown. (*Figures #33B & #34*).

With engine off, check continuity between the two terminals on the oil pressure switch. Note, do not disconnect wires when performing this task.

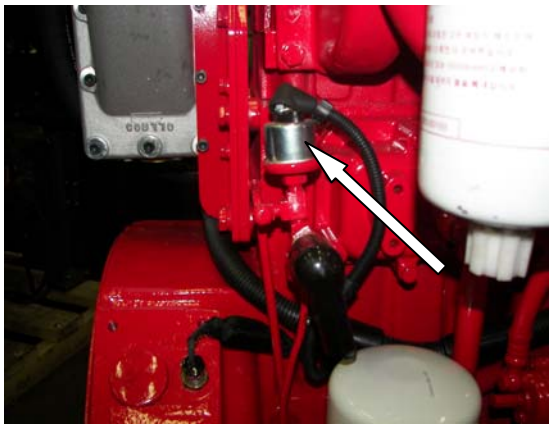


Figure #33A – DP6H & DQ6H engine models

Figure #33B – DT2H engine models

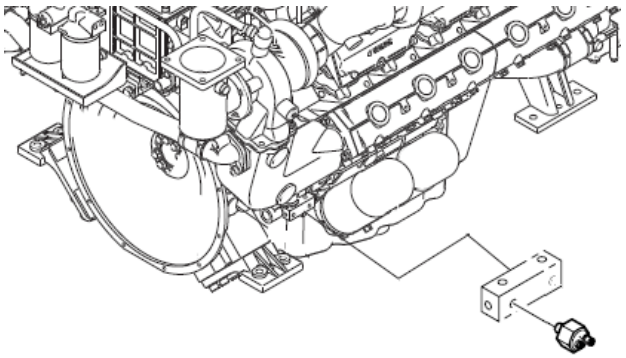


Figure #34- DT2H engine models

If circuit is open, replace oil pressure switch.

After new switch is replaced: On the Clarke instrument panel, operate the "OVERSPEED RESET" switch for two (2) seconds and release. (Refer to *Figure #9*)

The *"INITIALIZATION PATTERN'* will flash. This is normal. The continuous five (5) blink flash sequence should turn off at this point.
If circuit is closed, the oil pressure switch is not damaged and is working normally as expected. Proceed to engine speed sensor check, below.
Engine speed sensor (magnetic pick-up) check
Verify wiring and connector at engine speed sensor are secure. Magnetic pick-up is located on the right side of the engine on the flywheel housing. (*Figure #35*)

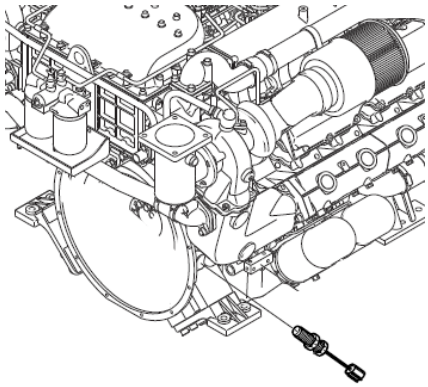


Figure #35

With engine running, verify that the tachometer is functioning normally.

Refer to section 3.5.4 of Engine Operator's Manual to properly reposition the magnetic pick-up if tachometer is not functioning.

Once magnetic pick-up is repositioned: On the Clarke instrument panel, operate the "OVERSPEED RESET" switch for two (2) seconds and release. (Refer to *Figure #9*).

The *"INITIALIZATION PATTERN"* will flash. This is normal. The continuous five (5) blink flash sequence should turn off at this point. If problem still exists, replace engine speed sensor (magnetic pick-up).

3.5.6 FIELD SIMULATION OF PUMP CONTROLLER ALARMS

Field simulation of (5) pump controller alarms

• Alarm 1: Over speed Shutdown: Follow over speed verification steps per section 3.5.3.

• Alarm 2: Low Oil Pressure: DP, DQ, DR, DS: With the engine running, jumper the engine mounted low oil pressure switch at terminal "WK" to "GROUND". DT only: With the engine running, jumper the engine mounted Low Oil Pressure switch (see *Figures #33A, 33B, 34* for location).
Wait for 15 seconds and controller alarm will activate.

• Alarm 3: High Engine Coolant Temperature: With the engine running, set the High Engine Coolant Temperature DIP switch to "ON" (see *Figure #36*). Use a fine pick or small screwdriver and slide the white slider to the left. Wait for 30 seconds and controller alarm will activate. Set white DIP switch slider to "OFF" (right) when simulation is complete.

• Alarm 4: Low Engine Coolant Temperature: With the engine not running, set the Low Engine Coolant Temperature DIP switch to "ON" (see *Figure #36*). Use a fine pick or small screwdriver and slide the white slider to the right. Controller alarm will activate immediately. Set white DIP switch slider to "OFF" (left) when simulation is complete.

• Alarm 5: Overcrank: Use manual stop override (ETS Governor Solenoid) to prevent the engine from starting during the cycle-crank testing. **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.

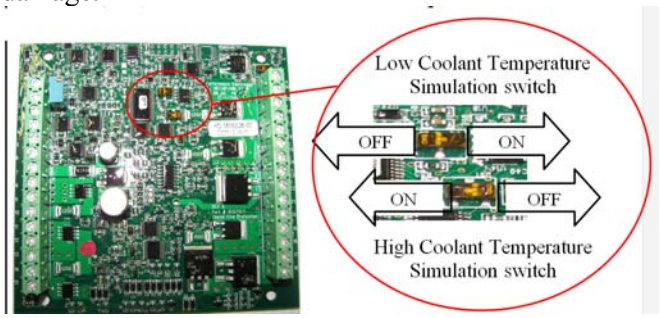


Figure #36

3.6 ENGINE SPEED ADJUSTMENT

A mechanical governor controls the engine speed. The governor is built into the fuel injection pump. All governors are adjusted to the rated speed at nameplate power or maximum allowed pump load before leaving Clarke. During Start-Up Inspection or when placing reconditioned units into service, some minor speed adjustment may be required. It is recommended that this adjustment be performed by the authorized Service Dealer representative.

To adjust the speed of the engine:

A. Start the engine by following the "To Start Engine" Procedure in this manual.
B. Let the engine warm-up. Loosen the jam nut(s) (*Figure #37B, C, D).*
C. While observing the instrument panel tach rotate the long adjustor clockwise to lower the RPM and counter clockwise to raise the RPM's until desired speed is obtained. Ref. *Figure #37B, C, D.*
D. Holding secure the long adjustor with a wrench tighten the jam nut.
E. Stop engine by following "To Stop Engine" Procedure in this manual.

If the engine has been designed and tested for range rating, stamp the metal tag titled "FIELD SETTING" with the final adjusted speed, horsepower, and 67% overspeed verify shutdown setting and keep with the engine. Refer to *Figure #38A*.

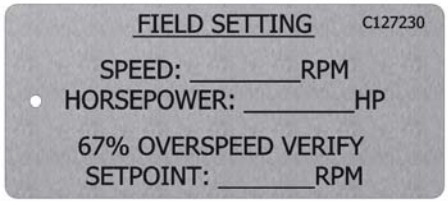


Figure #38A

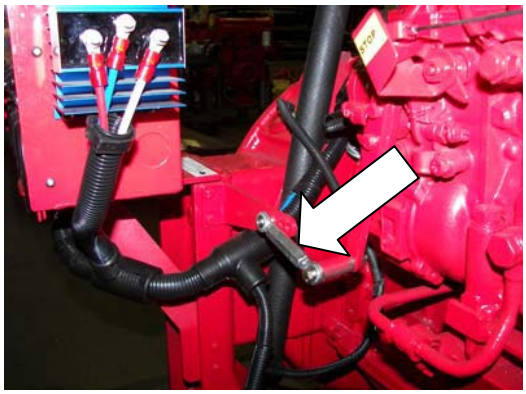


Figure #37B – DP6H models

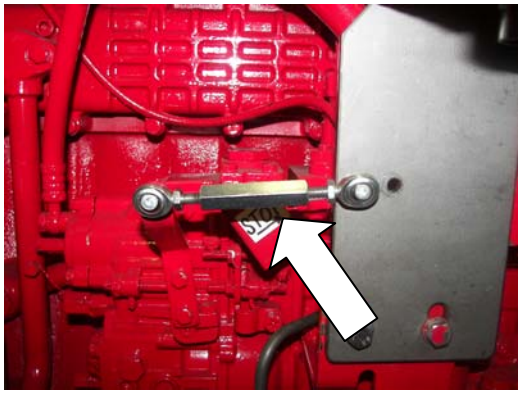


Figure #37C – DQ6H models

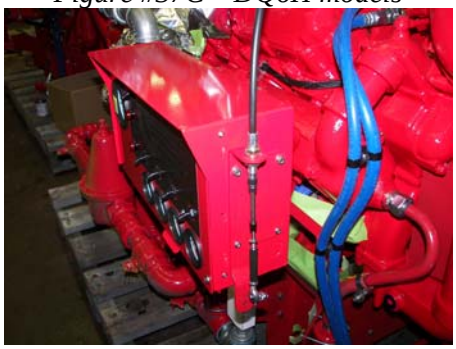


Figure # - DT2H models

4.0 MAINTENANCE SCHEDULE

4.1 ROUTINE MAINTENANCE

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.

LEGEND:
- ❑ Check
- ❖ Clean
- ➢ Replace
- o Lubricate

WEEKLY
- ❑ Air Cleaner
- ❑ Battery
- ❑ Belts
- ❑ Coolant Hoses
- ❑ Coolant Leaks
- ❑ Coolant Levels and Condition
- ❑ Cooling Loop Valves Position
- ❑ Cooling Water Solenoid Valve
- ❑ Cooling Water Discharge
- ❑ Exhaust System
- ❑ Fuel Tank
- ❑ General Inspection
- ❑ Governor Run-Stop Control
- ❑ Jacket Water Heater
- ❑ Lubrication Oil Level
- ❑ Operating Gauges
- ❑ Remove Water from Fuel Filter
- ❑ Run Engine
- ❑ Warning Light
- ❖ Cooling Water Strainers
- ❖ Clean Radiator Core Debris (if equipped)

EVERY 6 MONTHS
- ❖ Batteries
- ❑ Battery Charging Alternator
- ❑ Belt tension
- ❑ Coolant Protection Level
- ❑ Driveshaft U-Joints
- ❑ Fuel Lines

EVERY 1 YEAR
- ❖ Air Cleaner
- ❖ Fuel Priming Pump Strainer
- ❑ Coolant Inhibitor
- ❑ Crankcase Vent System
- o Driveshaft U-Joints
- ➢ Fuel & Oil Filters
- ❑ Heat Exchanger Electrode
- ➢ Lubricating Oil
- ❑ Mounting Isolators
- ❑ Wiring System

EVERY 2 YEARS
- ➢ Air Cleaner
- ➢ Batteries
- ➢ Belts
- ➢ Coolant Hoses
- ➢ Coolant
- ➢ Thermostat
- ➢ Remove Water Pump to Inspect Impeller and Seal

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”.

5.0 TROUBLE SHOOTING

Consult Clarke Service Dealer or Factory. Service dealers can be located by going to our website: www.clarkefire.com. For trouble shooting pertaining to the flashing of the "OVERSPEED SHUTDOWN" lamp, see section 3.5.5.

6.0 PARTS INFORMATION

6.1 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 section 6.2 or Parts Illustration in Technical Bulletin in C133941.

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

6.2 ENGINE MAINTENANCE PARTS LIST

Refer to Appendix "A" at the end of this manual.

ENGINE MODEL	Air Filter Service Kit	Air Filter Oil
All	99-55050	C121157

Figure #39

7.0 OWNER ASSISTANCE

Consult Clarke Service Dealer or Factory. Service Dealers can be located by going to our website: www.clarkefire.com.

8.0 WARRANTY

8.1 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 Doosan service organizations worldwide.

The Engine Manufacturer (Doosan) 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.

8.2 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 "Doosan New Engine Warranty" on the following page. Also contact Clarke direct 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.

8.3 DOOSAN WARRANTY

WARRANTY POLICY

SUPPLIER's liability under this warranty shall be IN LIEU OF ALL OTHER LIABILITIES OF SUPPLIER for defect in material or workmanship of Products or ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, statutory or at common law WHICH BUYER HEREBY WAIVES. In no event shall SUPPLIER be liable for consequential or indirect damages regarding Products or End-Products.

INDEMNIFICATION

Notwithstanding any other provisions in this Agreement, BUYER shall indemnify SUPPLIER and its subsidiaries and hold them harmless against and from any and all claims, damages, costs and expenses with respect to any loss of or damage to property, and any injury to or death of any person, arising out of or attributable to any use, application into other machines/systems or sale of the Products.

3RD PARTY'S RIGHT

SUPPLIER shall in no event warrant the any use, application into other machines/ systems or sale of Products is free from infringement of any 3rd party's right. BUYER shall indemnify SUPPLIER and its subsidiaries and hold them harmless against from any and all claims or actions against SUPPLIER or BUYER for infringement of any 3rd party's right in connection with BUYER's use, application into other machines/ systems of the Products.

DEFINTION OF ENGINE RATING

It is important to choose the proper engine rating to provide the optimum performance in a given application. Ratings in this Article show DOOSAN Firepump engine guidelines on applications.

FIRE PUMP POWER RATING

Fire PUMP POWER Rating is applicable for supplying emergency power for the duration of the utility power outage. NO OVERLOAD capability is available for this rating. Under no condition is an engine to operate in parallel with the public utility at the Fire PUMP POWER rating.

This rating should be applied where reliable utility power is available. A Fire Pump rated engine should be sized for a maximum of 70% average load factor and 200 hours of operation per year. When determining the actual average power output, power of less than 30% of the Fire PUMP POWER shall be taken as 30% and time at standstill shall not be counted.

Fire Pump ratings should never be applied except is true emergency power outages. Negotiated power outages contracted with a utility company are not considered an emergency.

NOTES:

- Total running time must not exceed 200hours per year.
- There is no overload capability.

WARRANTY PERIOD

The warranty period begins both on the shipping date of the Engine and on the first delivery date of the Engine to the customer, whichever date occurs first, and ends as shown in the APPENDIX-1 as attached.

WARRANTY LIMITATIONS

What is covered:

Any defect in Engines, arose only under normal conditions of storage, use and service due to defect in workmanship or material with the exception of items list under “what is not covered”.

What is not covered:

With any of following conditions, Warranty is not covered.

(1) Any defect and / or functional difficulty of Engines which are not operated according to the rating specifications specified in Article 1 above.

(2) Any defect and / or functional difficulty of Engines resulting from any change, modification or alteration of the Engine which result in any change in the specification of Engines without the prior written consent or proper instruction of SUPPLIER.

(3) Any defect and / or functional difficulty of Engines resulting from any incidental, consequential or rated costs such as costs for traveling transport, communication expenses, extra costs due to the installation in making the Engines accessible, docking and cranes, loss of use, loss of income, loss of time, loss of property, personal injury, or damages other parts or goods than the indicated Engines delivered by SUPPLIER.

(4) Any defect and / or functional Difficulty of Engines caused by operation of Engines in disregard of SUPPLIER’s operation or service manual and / or any other instruction by SUPPLIER.

(5) Any defect and / or functional Difficulty of

Engines due to improper handling or unsatisfactory repairing and maintenance of Engines.

(6) Any defect and / or functional Difficulty of Engines due to the parts replacement with non-genuine SUPPLIER service parts on non-equivalent in quality and design to genuine SUPPLIER service parts.

(7) Any defect and / or functional Difficulty of Engines due to the parts replacement with non-genuine SUPPLIER service parts on non-equivalent in quality and design to genuine SUPPLIER service parts.

(8) Any defect and / or functional Difficulty of Engines due to repair adjustment, service, or parts replacement by any personnel who are not authorized by SUPPLIER.

(9) Parts of Engines (Such as filter, belt, air cleaner, gasket, packing, rubber, light bulb, fuse, condenser, brush, electric wire harness and other similar wearing parts) to be replaced in the course of or in connection with the normal maintenance of Engines.

SUPPLIER and BUYER RESPONSIBLITIES

SUPPLIER and BUYER respectively shall have the following responsibilities in respect of defect in materials or workmanship covered by the warranty:

Warranty will be only applied for Engines for which SUPPLIER has received the warranty claim report or the equivalent written information when any Engines are delivered to the first customer.

SUPPLIER will compensate BUYER the genuine parts expenses used for replacing the defective parts under Warranty.

BUYER shall carry out all repairs and the fitting of all replacement parts covered by the Warranty and SUPPLIER will compensate BUYER the net labor expenses involved in the same (at an hourly rate to be decided by SUPPLIER). SUPPLIER reserves the right to limit the number of repair service hours according to SUPPLIER's repair labor time guide or the equivalent instruction.

With SUPPLIER's option and provision of replacement parts to BUYER to assist BUYER's activities covered by the Warranty specified in the Article 2.3 above. In no event shall SUPPLIER be liable for any expenses incurred in the replacement parts supply other than net freight cost.

Compensation of warranty claims shall be limited to what is attributable to SUPPLIER's responsibility and the reimbursement rate for the warranty claims follows APPENDIX-2 as attached.

APPLICATION OF WARRANTY CLAIMS

The application of Warranty Claims by BUYER shall be made in accordance with SUPPLIER's designated warranty claim application form he application.

The following points must be included in any warranty claim. If the claim does not provide all of this basic information, it will be incomplete and will not be acceptable.

(1) Engine Model & Engine Serial Number
(2) The repair date or Engine operation hour up to then
(3) BUYER's analysis of the cause of defect and the details of the original customer complaint with photographs of the defective parts as per SUPPLIER's requirement.
(4) Report and explanatory action of the repair or service.
(5) Amount of claim for materials, labor and any other allowable expenses.
(6) Signature of service manager or equivalent authorized personnel of BUYER on each claim to confirm that the claim is complete and accurate.

The warranty claims must be received by SUPPLIER within forty-five (45) days from the date BUYER furnished and / or installed the new parts to replace the defective parts (repair date). Warranty claims received beyond the forty-five (45) day period will automatically be denied.

If corrected or additional information is requested, the requested information shall be submitted by the BUYER within thirty (30) days from the receipt of the request to provide that information. Warranty claim returned beyond the thirty (30) day period will automatically be denied.

REMOVED PARTS

If BUYER makes any claim under this warranty that any parts of Engines are defective, the removed part

(s) must be kept by the BUYER for a period of six (6) months from the date of warranty claim application unless otherwise instructed by SUPPLIER for the disposal.

The removed parts must be kept in proper condition to prevent additional damage or corrosion. Warranty compensation may be charged-back, if the removed parts are not properly kept, lost or not returned to SUPPLIER as per request.

If requested by SUPPLIER, the removed parts shall be shipped to SUPPLIER with charges borne by SUPPLIER.

RECEIVING INSPECTION AND STORAGE OF THE ENGINES

BUYER shall inspect each shipment with respect to the conformity with specifications, missing parts and damage of Engines promptly upon receipt of Engines. In the event that BUYER finds any unsatisfactory condition through such inspection, BUYER shall make a claim in writing respect thereto within sixty (60) days after the shipping date of Engines.

SUPPLIER will not be liable for any claim made by BUYER after such period and also shall not be liable for damages of Engines where BUYER may make a claim for such damages under an applicable policy of insurance. In case the claims under this Article have been verified by SUPPLIER, upon request of BUYER, SUPPLIER will deliver free of charge such parts as are determined to be missing or damaged.

BUYER shall be responsible for the proper storage and maintenance not be decrease the performance of the Engines during the period of time from unloading of Engines by the carrier of Port of Destination until delivered to the first customer. Any damage occurring during such period will be the sole responsibility of BUYER.

PERFORMANCE OF SERVICES BY BUYER

BUYER shall from time to time perform maintenance and repair services in relation to Engines in accordance with the stipulation of "service information" in effect at the time when Engines are put into service and shall submit the required maintenance and service reports to SUPPLIER.

In the case of any functional difficulty and / or defect, BUYER shall immediately carry out any necessary repair or service and shall immediately notify SUPPLIER of any major problem.

BUYER s required to conform to all present and future instruction from SUPPLIER concerning maintenance and servicing of Engines in Territory.

SUPPLIER's LIABILTY UNDER THIS WARRANTY

SUPPLIER's liability under this warranty shall be IN LIEU OF ALL OTHER LIABILITIES OF SUPPLIER for defect in material or workmanship of Engines or ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, statutory or at common law WHICH BUYER HEREBY WAIVES. In no event shall SUPPLIER be liable for consequential or indirect damages regarding Engines.

SETTLEMENT OF DISPUTES

This agreement shall be construed in accordance with the Korean laws. All disputes, controversies, differences or claims arising out of or related to this Agreement which cannot be settled amicably by negotiation between the parties hereto shall be referred to and settled by arbitration in Seoul, Korea in accordance with the Arbitration Rules of the International Chamber of Commerce.

APPENDIX – 1 WARRANTY PERIOD

Rating	ENGINE COVERAGE *		
	MONTHS (from Shipping date)	MONTHS (from Delivery Date)	Engine Hours
Fire Pump	0 - 24	0 - 18	200

* WHICHEVER OCCURS FIRST

9.0 INSTALLATION & OPERATION DATA
(See Technical Catalog C133941)

10.0 WIRING DIAGRAMS
(See Technical Catalog C133941)

11.0 PARTS ILLUSTRATION DRAWING
(See Technical Catalog C133941)

12.0 APPENDIX (Alpha Index)

* See Technical Catalog C133941

Appendix "A"

DP6H & DQ6H ENGINE MODELS

Clarke Engine Models	DP6H	DQ6H
Part Description	**Part Number (standard items only, optional items not shown)**	
Oil Filter	C04571	C04569
Fuel Filter (Primary)	C02736	
Fuel Filter (Secondary)	N/A	
Air Filter	C03749	C03244
Alternator	Doosan 65.26101-7153C	Doosan 65.26101-7173A
Fuel Injection Pump	Doosan 65.11101-7430A	Doosan 65.11101-7313A
Heat Exchanger	C051529	
Starter Motor (12V)	N/A	
Starter Motor (24V)	Doosan 65.26201-7070D	
Switch, Oil Pressure	C07645 or C071884	
Switch, Speed	C071571	
Switch, Coolant Temperature	INCLUDED IN C071571 SPEED SWITCH or C071881	
Thermistor	C071607 or C051749	
Turbocharger	Doosan 65.09100-7047	Doosan 65.09100-7206
Thermostat	Doosan 65.06401-6039	Doosan 51.06402-0062
Nozzle, Injector	Doosan 65.10102-6051A	Doosan 65.10102-6050

Appendix “A” (continued)

DR8H, DS0H, & DT2H ENGINE MODELS

Clarke Engine Models	DR8H	DS0H	DT2H-UFAA20, DT2H-FMAA40, DT2H-UFAA58, DT2H-UFAA50 only
Part Description	**Part Number (standard items only, optional items not shown)**		
Oil Filter	C04569 R. A		
Fuel Filter (Primary)	C02736 R. A		
Air Filter	C03396 R. A	C03244 R. C	
Alternator	Doosan 65.26101-7153B		
Fuel Injection Pump	Doosan 65.11101-7332	Doosan 65.11101-7333	Doosan 65.11101-7246
Heat Exchanger	C051529 R. C	C051389 R. A	C051389 R. A
Starter Motor (12V)	N/A		
Starter Motor (24V)	Bosch 65.26201-7074D		
Switch, Oil Pressure	C07645 R. C OR C071273 R. A OR C071614 R. A OR C071884 R.A OR C072011 OR C072013		
Switch, Speed	C071963 R.A		
Switch, Coolant Temperature	INCLUDED IN C071963 R. A SPEED SWITCH OR C071881 R.A		
Thermistor	C071607 R. A OR C051749 R.A		
Turbocharger	Doosan 65.09100-7156 (RIGHT) Doosan 65.09100-7155 (LEFT)	Doosan 65.09100-7051 (RIGHT) Doosan 65.09100-7050 (LEFT)	Doosan 65.09100-7160 (RIGHT) Doosan 65.09100-7052 (LEFT)
Thermostat	Doosan 51.06402-0062		
Nozzle, Injector	Doosan 65.10101-7053		

Appendix “A” (continued)

DT2H ENGINE MODELS

Clarke Engine Models	DT2H-UFAA60,98,92,-FMAAX8,X2 only
Part Description	**Part Number (standard items only, optional items not shown)**
Oil Filter	C04558 (4)
Fuel Filter (Primary)	C02736 (4)
Fuel Filter (Secondary)	N/A
Air Filter	C03707 (2)
Alternator	Bosch 0-120-469-024
Fuel Injection Pump	Bosch 8902200100
Heat Exchanger	Doosan 65-06160-6017a
Starter Motor (24V)	Bosch 0001417-037
Switch, Oil Pressure	C071614 or C071884
Switch, Speed	C071273
Switch, Coolant Temperature	INCLUDED IN C071571 SPEED SWITCH or C071881
Thermistor	C071607 or C051749
Turbocharger	Doosan 65.09100-7116
Thermostat	Doosan 65.06402-0006
Nozzle, Injector	Doosan 65.10101-7097