

Operation and Maintenance Instructions Manual

PDFP SERIES ENGINES FOR FIRE PUMP APPLICATIONS

This manual covers Perkins 1000 Series engines
prepared by Clarke DD-A
for fire pump service



ABBREVIATIONS

AC	Alternating Current
AEC	Automatic Engine Controller
API	American Petroleum Institute
CDD-A	Clarke Detroit Diesel-Allison
DC	Direct Current
DDC	Detroit Diesel Corporation
PDFP	Perkins Diesel Engines approved for Fire Pump Service as certified by FM/UL/ULC for Clarke Detroit Diesel-Allison
FM	Factory Mutual Research
ID	Identification
IP	Instrument Panel
Y	1000 Series, Perkins Engine
N	Naturally Aspirated
NA	Naturally Aspirated
NFPA	National Fire Protection Association
P/N	Part Number
PSI	Pounds Per Square Inch
PTO	Power Take Off
RPM	Revolutions Per Minute
SAE	Society of Automotive Engineers
S/N	Serial Number
T	Turbocharged
W	Turbocharged and Intercooled
UL	Underwriters Laboratories Inc.
ULC	Underwriters Laboratories of Canada



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PRINCIPLES OF DIESEL ENGINE OPERATION

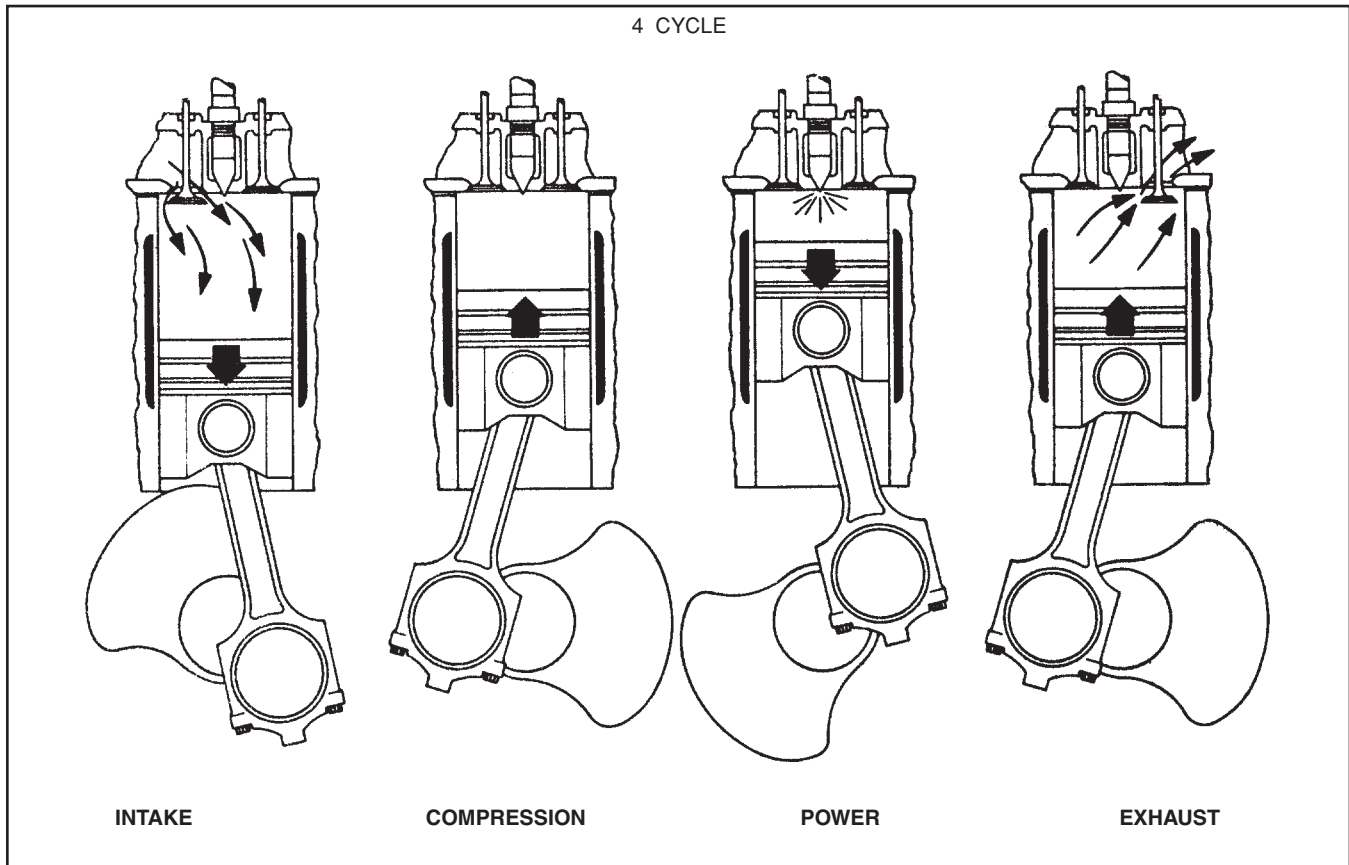


Fig. 1 - The Four Stroke Cycle
gasoline engines.

A reciprocating engine is an internal combustion power unit, in which the heat of burning fuel is converted into work in the cylinder of the engine. In the diesel engine, air is compressed in the cylinder; then, after the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition is accomplished by the heat of compression. The resulting expanding gas provides the force to turn the crankshaft.

THE FOUR CYCLE PRINCIPLE

The four piston strokes of the cycle occur in the following order: Intake, Compression, Power and Exhaust.

Intake Stroke:

During the intake stroke, the piston travels downward, the intake valve is open, and the exhaust valve is closed.

The downstroke of the piston permits air from outside to enter the cylinder through the open intake valve port. The turbocharger (when fitted) increases air pressure in the engine intake manifold and forces it into the cylinder. The intake of air is never restricted by carburetion or mixing valves such as those used on spark-ignited, automotive-type

The intake charge consists of air only with no fuel mixture.

Compression Stroke:

At the end of the intake stroke, the intake valve closes and the piston starts upward on the compression stroke. The exhaust valve remains closed.

At the end of the compression stroke, the air in the combustion chamber has been compressed by the piston to occupy a space about one-sixteenth in volume as it occupied at the beginning of the stroke. Thus, the compression ratio is 16:1.

Compressing the air into a small space causes the temperature of that air to rise. Near the end of the compression stroke, the pressure of the air above the piston is approximately 470 to 585 psi (3240 to 4034 kPa) and the temperature of that air is approximately 1000° F (538° C).

During the last part of the compression stroke and the early part of the power stroke, a small metered charge of fuel is injected in the combustion chamber.

Almost immediately after the fuel charge is injected into the combustion chamber, the fuel is ignited by the hot air and starts to burn.

By the time the piston reaches the end of the compression stroke, the burning fuel causes a further increase in the pressure above the piston. As the more fuel is added and burns the gases get hotter, the pressure increases, pushing the piston downward and adds impetus to crankshaft rotation.

Power Stroke:

During the power stroke, the piston travels downward and torque power is translated to the rotating crankshaft through connecting rods. Both intake and exhaust valves are closed.

Exhaust Stroke:

During the exhaust stroke, the intake valve is closed, the exhaust valve is open, and the piston is on its upstroke.

Burned gases are forced out of the combustion chamber through the open exhaust valve port by the upward travel of the piston.

From the preceding description of the Diesel Cycle, it is apparent that the proper operation of the engine depends upon the two separate functions - first compression for ignition, and, second, that fuel be measured and injected into the compressed air in the cylinder in the proper quantity and at the proper time.

GENERAL DESCRIPTION

Introduction

Model Numbering & Identification

FM/UL/ULC Certification Name Plate

Introduction

NFPA 20 states "The compression ignition diesel engine has proven to be the most dependable of the internal combustion engines for driving fire pumps." The diesel engine will operate under emergency power conditions where loss of utility or stand-by electric power renders electric motor driven pumps useless. The diesel driven fire pump system is preferred by most insurance companies.

This manual covers Perkins diesel engines as marketed through Detroit Diesel Corporation. These engines have been manufactured with specific options to function integrally with an automatic engine controller for stand-by fire protection service and to meet NFPA-20 requirements. These systems are designed to function under emergency conditions and to assist in holding fire damage to a minimum. Complete understanding of the operation and maintenance of this fire protection system is essential to achieve this objective.

A separate manual covers the operation and maintenance of the Automatic Engine Controller (AEC).

The four-cycle engines covered in this manual are of the four and six cylinder inline arrangement. The engines are either naturally aspirated (N) or turbocharged (T) and some units are turbocharged and intercooled (W).

The engines are clockwise (CW) rotating engines. Rotational reference is made from a front view (Heat

Exchanger End) of the engine to determine the rotation of the output shaft. Also cylinder designation is made from the front to rear of the engine in ascending sequence starting with one. All other engine references, (*right* or *left*) are made from a rear view of the engine, looking at the rear face of the flywheel.

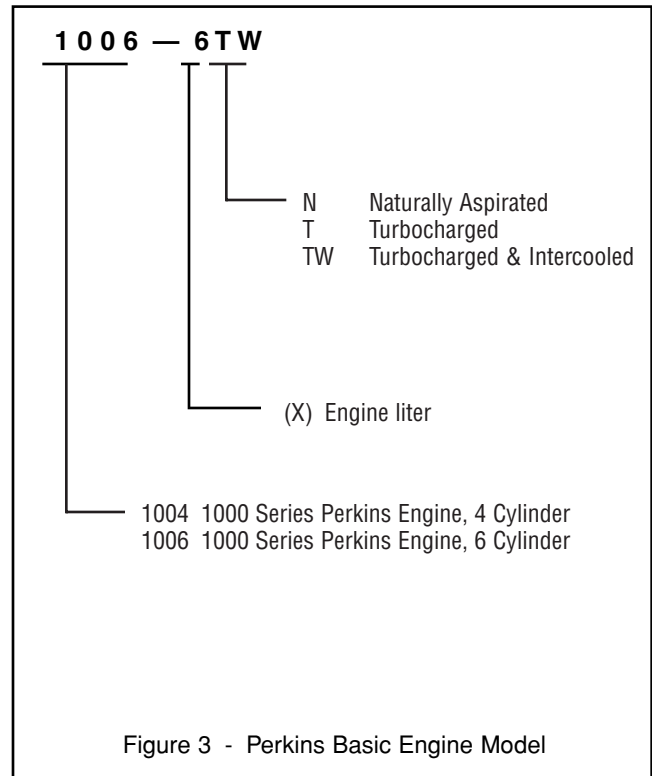
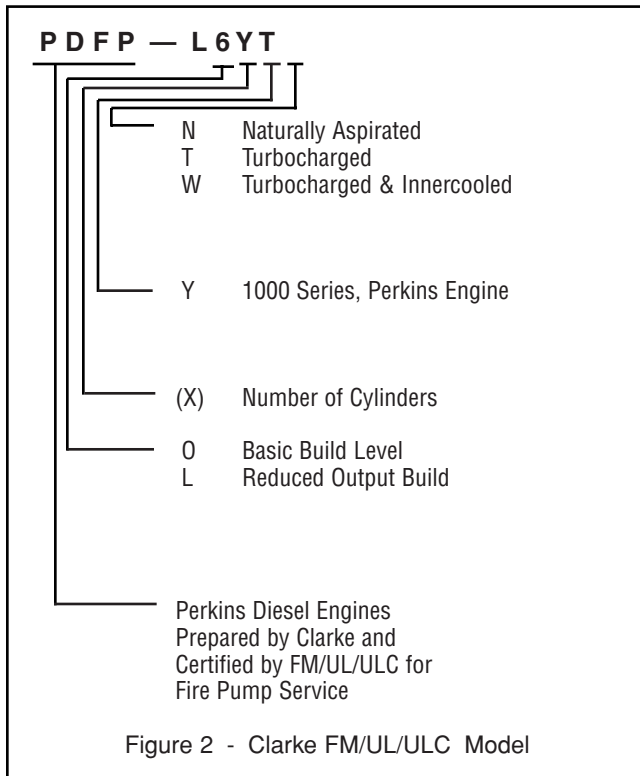
All PDFP engines are Underwriters Laboratories (UL) listed, Underwriters Laboratories of Canada (ULC) listed and/or Factory Mutual (FM) approved and meet the requirements of the National Fire Protection Association (NFPA) 20.

Model Numbering & Identification

There are two model numbers associated with this product. First is the Clarke FM/UL/ULC approved model number showing the prefix *PDFP*. Figure 2 explains the identification system on *PDFP* units. Second is the Perkins basic engine model number. Figure 3 provides details for understanding this number.

The Clarke model number appears on the FM/UL/ULC tag attached to the left rear engine mount. Perkins doesn't attach their model number to the engine.

The Perkins serial number is stamped on a label which is fastened to the left side of the cylinder block (Fig. 5) just under the cylinder head.



FM/UL/ULC Certification Name Plate

The standard nameplate (Fig. 6) contains the following information: FM/UL certified model number; Clarke specification number; production date; basic engine serial number; a rated horsepower range; and the associated full load engine speed range. The name plate is located on the left rear engine mount (Fig. 4).

All PDFP models are certified at a horsepower and speed range. These engines can be adjusted to a desired speed within the range listed on the FM/UL nameplate. To obtain

the power rating of these engines at an intermediate speed, use a linear interpolation. Interpolation must be made by consulting the power curves from the two ratings listed. Power curves are also available from Clarke. Speed adjustment is described in Section 4, Page 42 of this manual.

When requested, a ULC nameplate is provided in addition to the FM & UL nameplate. This plate is mounted separately on the engine.

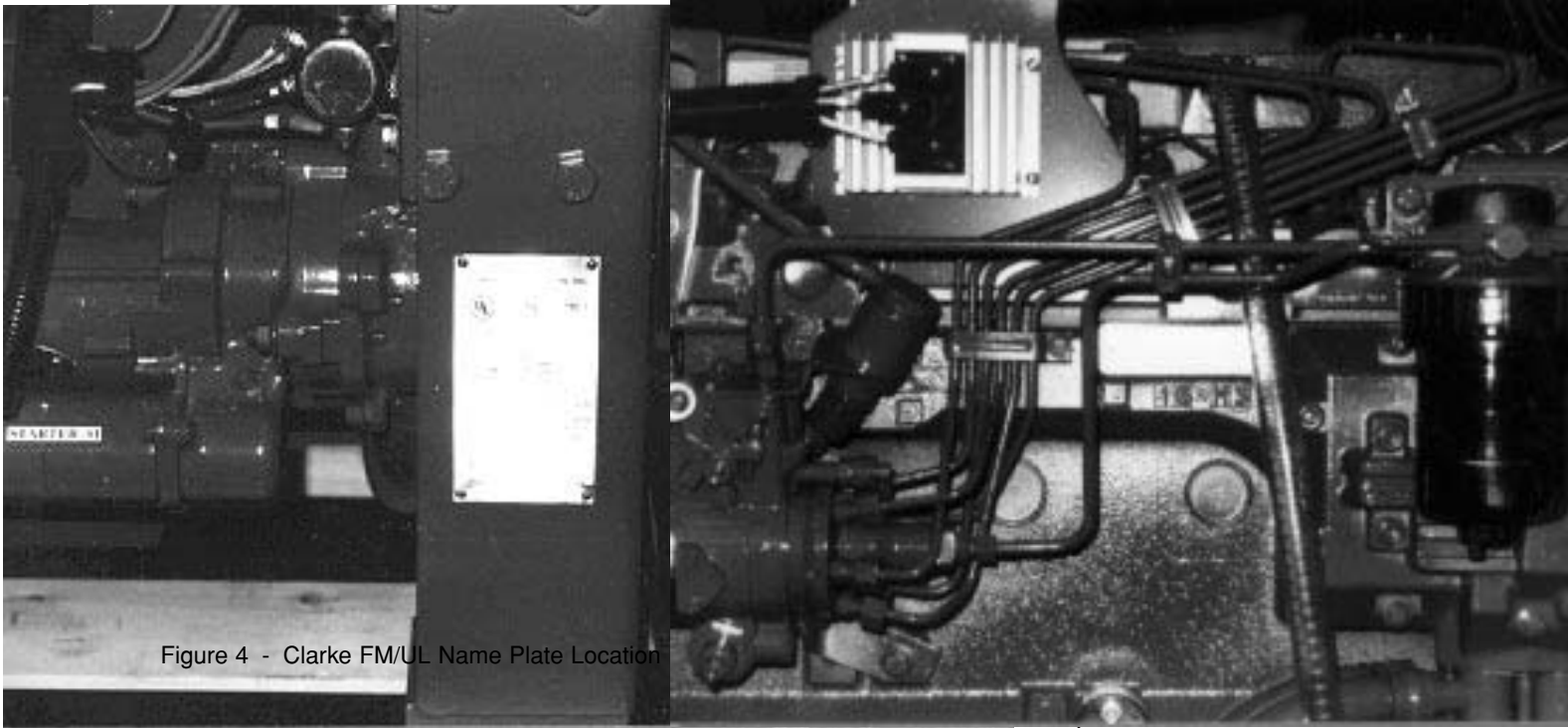


Figure 4 - Clarke FM/UL Name Plate Location




 LISTED 513Y	manufactured by CLARKE DETROIT DIESEL-ALLISON, INC CINCINNATI, OHIO	 c	 APPROVED
INTERNAL COMBUSTION ENGINE FOR DRIVING CENTRIFUGAL FIRE PUMPS			
MODEL _____			
MFG. S/N _____			
THIS ENGINE IS PROVIDED FOR AN OPERATING RANGE			
FROM _____ BHP@ _____ RPM			
UP TO _____ BHP@ _____ RPM			
HORSEPOWER RATINGS WITHIN THE SPECIFIED SPEED RANGE ARE TO BE DETERMINED BY THE USE OF LINEAR INTERPOLATION BETWEEN HORSEPOWERS DEVELOPED AT MINIMUM AND MAXIMUM SPEEDS			
MFD _____ MO _____ YEAR			

Figure 6 - Name Plate Dwg

PDFP STANDARD ENGINE EQUIPMENT LIST

- Air cleaner, oiled gauze type for protected environment.
- Battery charging alternator (12V-DC) negative ground
- Engine coolant heater with AC power cord (120V-AC S/P)
- Engine DC junction included in instrument panel
- Electric starting motors (two) (12V-DC)
- Exhaust manifold insulation
- Falk coupling direct mounted (engine half only), or drive plate for drive shaft
- Fuel filters - Primary and Secondary
- Governor speed regulation (10% Maximum No Load to Full Load)
- Heat Exchanger with pressure cap
- High water temperature switch
- Instrument panel with water temperature gauge, oil pressure gauge, two battery voltmeters, and tachometer with integral hourmeter
- Low oil pressure switch
- Manual over-ride of automatic operations
Instruction plate on instrument panel
- Mode selector switch for automatic or manual operation
- Manual start crank switches - two provided on engine instrument panel
- Oil cooler
- Oil filter(s) full flow with by-pass
- Overspeed control with reset switch on instrument panel face
- Solenoid Run/Stop control-energized to run
- Tamper proof throttle control-factory preset
- Warning indicator for mode selection in "manual" position
- Wiring harness on engine for DC control

GENERAL INSTRUCTIONS

Engine Storage

Preparing New Engine For Start-Up

Normal Running

Engine Storage

Storing engines requires special attention. Clarke PDFP engines, as prepared for shipment, may be stored for a maximum of six months. 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.

If a situation arises that extended storage is unavoidable (beyond six months), contact your local Distributor/Dealer for assistance. Do not store engines beyond this time without proper protection.

Preparing New Engine For Start-Up

Before starting a new or overhauled engine for the first time, carefully read and follow the check list below. Attempting to run the engine before studying these instructions may result in serious damage to the engine.

A. Make all raw water connections to heat exchanger tank. Discharge line should be one size larger than supply line. Discharge water is to be piped to an open waste cone.

NOTE: Do not allow raw water plumbing to stress on engine heat exchanger.

NOTE: All heat exchanger plumbing to be securely fastened to limit movement caused by engine vibration.

B. Install exhaust system. A vertical flexible exhaust outlet connection is furnished for customer/contractor installation.

NOTE: Do not exceed exhaust back pressure limits. See Section 5 for details for each engine model.

NOTE: Do not allow exhaust system plumbing to stress on engine.

C. Install all of the drain cocks or plugs in the cooling system (drain cocks are removed for shipping engines dry).

D. Fill engine cooling system with PRE-MIXED 50 percent water and 50 percent permanent type antifreeze solution. Fill to bottom of neck in heat exchanger tank.

NOTE: DO NOT USE 100% ANTIFREEZE.

Failure to premix antifreeze and water during initial fill may result in heater damage.

E. Connect fuel supply line and fuel return line to supply tank. Bleed fuel system of all air.

NOTE: Do not use galvanized material for any component of a diesel fuel system. The fuel will chemically react with the zinc coating.

F. Fill fuel tank with No. 2 diesel fuel.

NOTE: No. 2 diesel fuel is the only recommended fuel, low engine power or damage could result by using any other type. (See Page 11 for fuel recommendations.)

G. Fill engine crankcase with SAE 15W-40 weight oil per oil recommendations of Section 3. Oil filler locations will be found on the engine valve cover.

H. Pre-lubricate engine to a minimum 25 psi (172 KPA) to insure an immediate flow of oil to all bearings at the initial engine start-up. Contact the authorized Distributor/Dealer if you require assistance with this item.

I. Unbox and inspect air cleaner element for damage or deterioration. Install air cleaner element on engine.

J. Make all electrical (DC) connections between engine (DC) instrument panel and engine controller.

K. Install batteries, battery cables and service batteries as required by manufacturer. See battery recommendation under Section 3.

If any problems or questions develop in performing the above procedures, advise the authorized Distributor/Dealer of details when making arrangements for the installation inspection.

NOTE: Only one initial start-up inspection is provided at no charge for an installation review. Be sure to cover items A-K thoroughly before calling the authorized Distributor/Dealer.

Normal Running

Fire pump engines are run periodically to assure proper operation. Units may be run automatically as programmed within the AEC for systems evaluation or they may be run manually.

NOTE: For specific operating instructions, see Section 3 - Electrical System.

NORMAL MAINTENANCE CHECKS**Fuel System****Drive Belts****Battery****Oil Pressure****Coolant Temperature & Level****Crankcase****Running Inspection****Fuel System**

Periodically check fuel tank to assure it is full. Keep the fuel tank filled to reduce condensation to a minimum and to assure full running time during emergency operation. Per NFPA 25 specifications the fuel level should never be below 67% of tank capacity. Engine fuel filter should be changed annually or when fouled with contaminations. If contaminated, locate the source and correct. Check the gauze strainer of the fuel pump and clean if necessary. Refer to Page 13 for procedures to clean the pump strainer and change fuel filter.

Drive Belts

All drive belts should be checked every six months. Belts can be inspected by pressing down the belt with the thumb at the center of the longest free length and check the deflection. With moderate thumb pressure (10 lbs./70kPa) the deflection of the belt should be 3/8" (10mm).

Battery

Check the batteries to insure they are clean and dry, the terminals tight and protected, and the electrolyte must be at the proper level. They should be tested weekly to determine the condition of cells, and the state of charge.

Oil Pressure

Normal engine operating oil pressure is 40-60 psi (276-414 kPa). If operating pressure falls below 40 psi (276 kPa), stop engine and investigate cause.

Coolant Temperature & Level

When the engine is not running, the jacket water heater maintains the coolant between 120 -140 degrees F (49-60° C). When running, engine coolant temperature should register between 160-200 degrees F (71-93° C).

Coolant levels should be checked weekly by assuring that the level is filled to the bottom of the heat exchanger fill neck. If the level is not there, check for the reason then refill system.

Crankcase

The oil level should be maintained between the *Full* mark and *Low* mark. Check the oil level weekly prior to normal exercise. Do not check oil level when the engine is running. If the engine crankcase was refilled, stop the engine after normal operating temperature has been reached, allow the oil to drain back into the crankcase (approximately 10 minutes) and check the oil level. Add oil, if necessary, to bring it to the proper level on the dipstick.

NOTE: DO NOT OVER-FILL CRANKCASE.

Use only the recommended lubricating oil specified under Section 3 - Lubricating Oil.

Running Inspection

While the engine is running at operating temperature, check for coolant, fuel or lubricating oil leaks. If any leaks are observed shut the engine off by consulting Page 9 "Important". Correct problem as necessary and re-run engine to verify problem is corrected.

PREVENTIVE MAINTENANCE SCHEDULE

Item	Inspection Interval			
	Weekly	6 Months	1 Year	2 Year
1. Run Engine (per NFPA 25)	X			
2. General Inspection	X			
3. Lubricating Oil	X		R	
4. Fuel Tank	X			
5. Fuel Lines	X			
6. Cooling System	X			R
7. Coolant Inhibitor			X	
8. Coolant Hoses	X			R
9. Battery	X	C		R
10. Air Cleaner - Oil Gauze	X	X	C	
11. Belts		X		
12. Speed Control		X		
13. Fuel & Oil Filters			R	
14. Exhaust System	X	X		
15. Battery Charging Alternator		X		
16. Warning Light	X			
17. Operating Gauges	X			
18. Crankcase Vent System			X	
19. Heat Exchanger Electrode				X
20. Governor Run-Stop Control	X			
21. Jacket Water Heater	X			
22. Wiring System			X	
23. Remove Water From Fuel Filters	X			
24. Clean Fuel Lift Pump Strainer			X	

C – CLEAN R – REPLACE X – CHECK

NOTE: Refer to Section 3 for Maintenance Procedure.

IMPORTANT: Set AEC to "off" while servicing engine. Before turning the AEC to the "off" position, check with the maintenance and security supervisors to verify that all 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 AEC is connected by silent alarm to headquarters. When servicing is complete, return AEC selector to "Automatic" position and the manual operating lever to AUTO - OFF position. Advise the appropriate personnel the engine has been returned to the "Automatic Mode".

ENGINE SYSTEMS

Section 3.1	Fuel System
Section 3.2	Air Intake & Exhaust System
Section 3.3	Lubrication System
Section 3.4	Cooling System
Section 3.5	Electrical System
Section 3.6	Falk Coupling

In this **Engine Systems** section that follows, data is presented in a generalized way for a description of system operation. For specific operational data and system limits, refer to Section 5. In addition to knowing the specific PDFP

model being operated, make special note of the certified engine operating speed (RPM). Much of the data varies by operating RPM - check the FM/UL/ULC certification tag on the left rear engine mount for this information.

Section 3.1

FUEL SYSTEM

Operation
Diesel Fuel Recommendations
Maintenance Procedures
Service Procedures
Fuel System Priming

OPERATION

Fuel is drawn from the supply tank through the primary fuel filter with a transparent water separator bowl, then enters the fuel lift pump. Upon leaving the fuel lift pump under pressure, the fuel is forced through the secondary fuel filter and into the

fuel injection pump. The fuel injection pump raises the fuel pressure forcing the fuel through each injector and into the combustion chamber. A leak-off fuel line from the injectors and fuel injection pump returns fuel back to the fuel tank.

A. PRIMARY FILTER AND WATER TRAP

The primary fuel filter and water separator bowl, located between tank and lift pump, is designed to remove the larger dirt particles from the fuel and to collect water, which should be drained weekly from the bowl.

B. FUEL LIFT PUMP

The fuel lift pump is designed to circulate the fuel from the tank through the primary fuel filter, the secondary fuel filter and into the fuel injection pump. This pump is also equipped with a manual hand pump used for priming the system.

C. SECONDARY FUEL FILTER

The secondary filter is a higher performance type which is located between the lift pump and the fuel injector pump. This filter removes the smaller contaminants and any remaining fine water droplets.

D. FUEL INJECTION PUMP

The PDFP fuel injection pumps are described as an opposed plunger, inlet metered, positive displacement, distributor type pump. The function of the fuel injection pump is to pressurize, distribute the clean fuel received from the fuel filters equally, in the correct quantities and at the correct time to the injectors.

The fuel pump injection timing, governor setting and fuel delivery levels are accurately set before the engine leaves the manufacturer, and should not be altered.

E. ENGINE MECHANICAL GOVERNOR

A variable speed mechanical governor provides speed control of the engine. The certified engine speed, shown on the FM/UL/ULC label, has been preset at the factory. Speed adjustments can be made in the field to meet specific installation conditions. See Page 42 for Speed Adjustment Procedure.

A manual over-ride switch on the instrument panel, placed in the manual position, allows manual operation should the AEC malfunction. Should this be necessary, please refer to the manual operational steps on the instrument panel.

Important: Always leave the instrument panel switch in the auto position when the unit is unattended. The mode selector light will stay on while the switch is in manual. The AEC can start the engine when the switch is in the manual position but the engine AEC will be unable to stop the engine and damage may result.

F. INJECTORS

The injectors receive high pressure fuel via the high pressure pipes from the fuel injection pump, and inject the fuel into the combustion chamber in the form of a very fine spray.

G. FUEL LEAK-OFF

Surplus fuel delivered to the injectors is carried away by return lines connected to each injector. The pipe then connects with the fuel filter overflow pipe, which takes the surplus fuel out of the filter via the fuel injection pump overflow and delivers this fuel back through a fuel return line and into the fuel tank.

DIESEL FUEL RECOMMENDATIONS

The quality and grade of fuel used is a very important factor in obtaining satisfactory engine performance, long engine life and acceptable exhaust emission levels. Certified engine ratings are based at standard SAE conditions using the rec-

ommended #2-D Diesel Fuel. Refer to the Diesel Fuel Specifications chart Fig. 1 for verification of fuel properties. Fuel System specifics are found in technical data Section 5.

Cetane No., min.	Viscosity cSt at 40° C	Density kg/litre	Sulphur % mass, max.	Distillation
45	2.5 - 4.5	0.835 - 0.855	0.5	85% recov. at 350° C

Figure 1 - Diesel Fuel Specification Chart

MAINTENANCE PROCEDURES

Weekly

- 1). Fuel Tank: 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.

- 2). Fuel Filters: Both fuel filters have a drain located at the bottom of their body (Fig. 2), these filters should be drained each week to relieve built up water.

6 Months

Check condition of fuel lines for fraying, leaks or poor condition. Replace if necessary.

Yearly

- 1). Change primary and secondary fuel filters. Refer to Section 6 for recommended part numbers.
- 2). Clean the gauze strainer of the fuel lift pump.

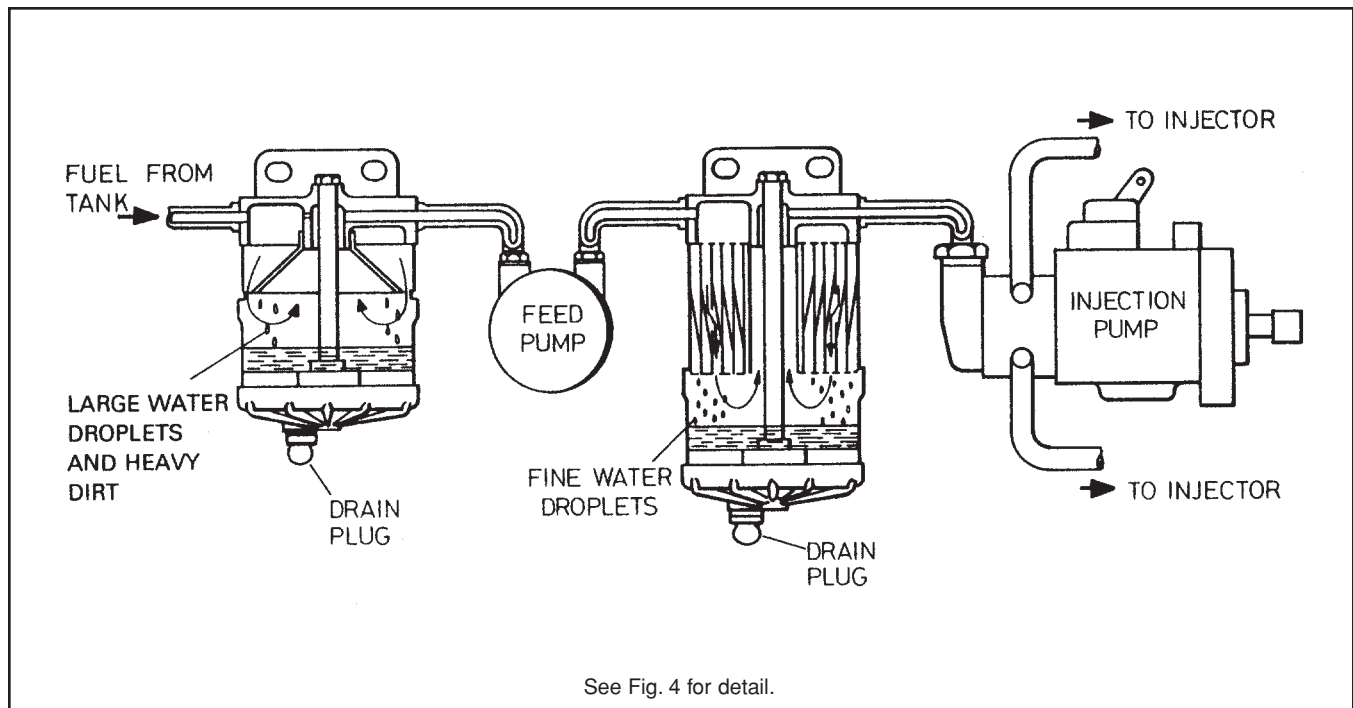


Figure 2 - Filtration System & Filter Drain

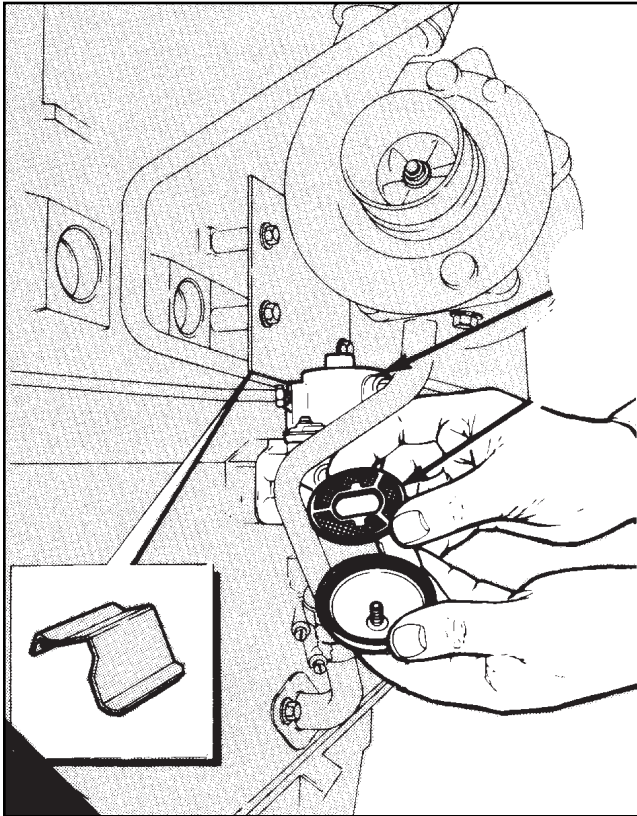


Figure 3 - Screen Strainer of the Fuel Lift Pump

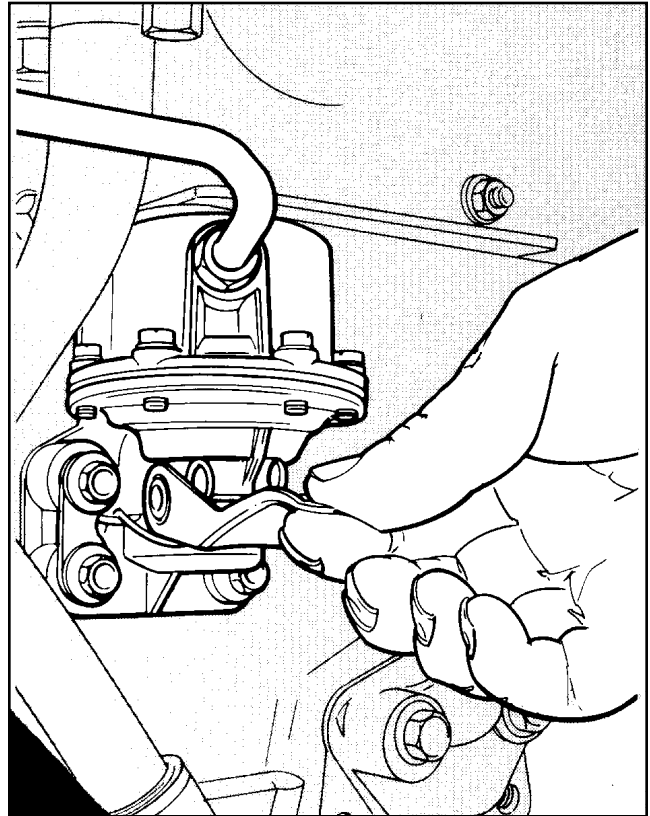


Figure 4 - Hand Priming Pump

SERVICE PROCEDURE:

A. How To Clean The Screen Strainer Of The Fuel Lift Pump:

- 1.) Remove the cover and seal from the top of the lift pump. (Fig. 3) Remove screen strainer. On 6T and 6TW engines it will be necessary to remove the small turbocharger heat shield which is mounted above the pump.

Caution: This shield must be replaced when finished.

- 2.) Carefully wash the screen and lift pump body.
- 3.) Reinstall screen being careful to align the hole.
- 4.) Install cover and seal making sure it is seated properly, if not leaks will occur and pump will not function. Do not over tighten cover screw. On 6T and 6TW engines reinstall the heat shield.
- 5.) Operate the hand priming pump to aid in purging air from the system. (Fig. 4)

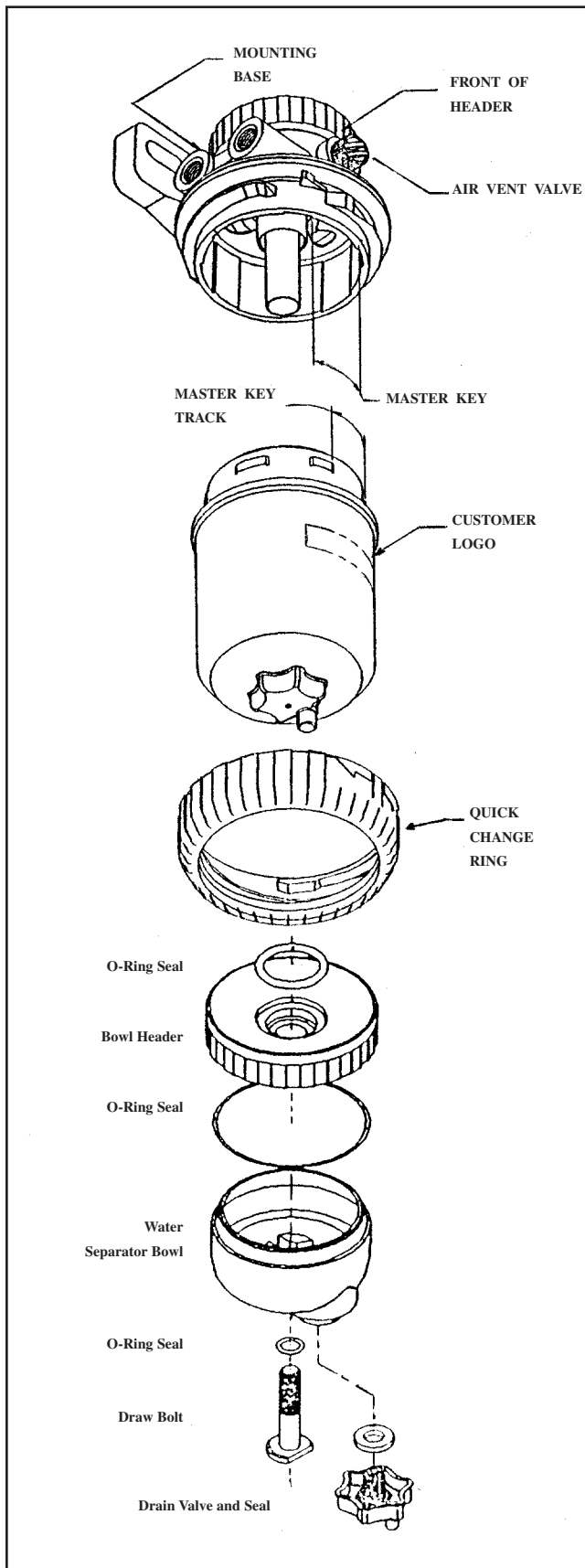


Figure 5 - Primary Fuel Filter

B. Fuel Filter Change:

Each PDFP engine has two fuel filters, for the purpose of identity, the primary filter incorporates the transparent water Separator. (Fig. 5)

Primary Filters:

- 1.) Using waste oil or fuel collector, open the drain valve on the bottom of the transparent water separator bowl. Drain until fuel can no longer be seen in the bowl.
- 2.) Unscrew the bowl and bowl header from the filter element.
- 3.) Turn the quick change ring of the filter element left until loose.
- 4.) Grasp the filter element and pull straight down until dislodged from filter base. Notice the six embossments on the side of the filter cap. These are used for alignment purposes.
- 5.) Fill new element with fuel making sure grommet is lubricated. Align and install by pushing element in place. Do not force into position.
- 6.) Install the quick change ring by turning right approximately 1/3 turn until it clicks into position. To verify its locked in position, the outside of the ring has two sets of arrows, one set will be located directly under the air vent in the filter base.
- 7.) Screw the bowl and bowl header back onto the bottom of the new element.
- 8.) Tighten drain valve.
- 9.) Prime the filter by operating the hand priming pump. If priming pump does not function, turn the engine crankshaft one full turn clockwise, then try priming pump again. To verify the filter is fully primed. Open the air vent valve on the filter base while priming until fuel is observed coming from the vent, when full, close vent.

C. Secondary Filter:

- 1.) Using a waste oil or fuel collector, open the drain valve on bottom of filter element. Drain until fuel stops running.
- 2.) Follow steps 2 thru 6 as described in the primary filter section.
- 3.) Tighten drain valve.
- 4.) Operate priming pump as described in step 9 of the pri-

mary filter section. To verify filter is primed loosen the cap ring on top of filter base, operate priming pump until fuel is observed around cap. Re-tighten cap ring.

Note: Both fuel filters can be primed by top filling, after installation of new element. To do so, remove the cap insert, O-ring and Cap seal located on the top of the filter. Remove the internal white plastic rod plug. Pour clean #2-D fuel into the filter base center hole until full. Reinstall plastic plug, O-ring, cap insert and cap nut. Start engine using manual start method.

FUEL SYSTEM PRIMING:

If air enters the fuel system, it must be eliminated prior to putting engine in service.

Air can enter system if:

- The fuel supply tank is emptied thru normal operation.
- Any low-pressure fuel lines are disconnected.
- Any component of the low-pressure system leaks during operation.

To Remove Entrapped Air Proceed As Follows:

- 1) Make certain the condition that caused air has been corrected. Do not attempt to loosen fuel injector lines to eliminate air.
- 2) Operate the hand priming pump located on the bottom of the fuel lift pump on the engines' right side.

Note: If the priming pump does not function it is possible the cam lift lobe is up. Turn the engines crankshaft one full turn clockwise. Retry priming pump.

- 3) Locate the air vent valve (black plastic valve with screw driver slot) in the primary fuel filter base. Slightly open

the vent, operate the hand primer until fuel is observed coming from vent. If this cannot be accomplished, there is an obstruction between the filter and tank which includes the lift pump. Locate and repair before any attempt to proceed.

- 4) Once fuel is observed at the air vent reclose.
- 5) Continue to operate hand primer but loosen the cap nut on top of secondary fuel filter. Once the filter is full, fuel should be observed coming out around the ring. If not remove cap nut, cap insert and O-ring. Remove the white plastic volume plug in the center of the filter. With an external fuel source fill the filter down thru the center hole until full. Reinstall volume plug, O-ring, cap insert and cap nut. Tighten nut making sure O-ring seated properly.
- 6) Start engine by manual crank Sw-#1 or Sw-#2, manual start instructions on instrument panel.
- 7) If engine fails to start or does start but runs erratic, recheck all fuel lines, connections and filters for something obvious. If a simple solution cannot be located it may be necessary to contact your local Distributor / Dealer for service assistance.

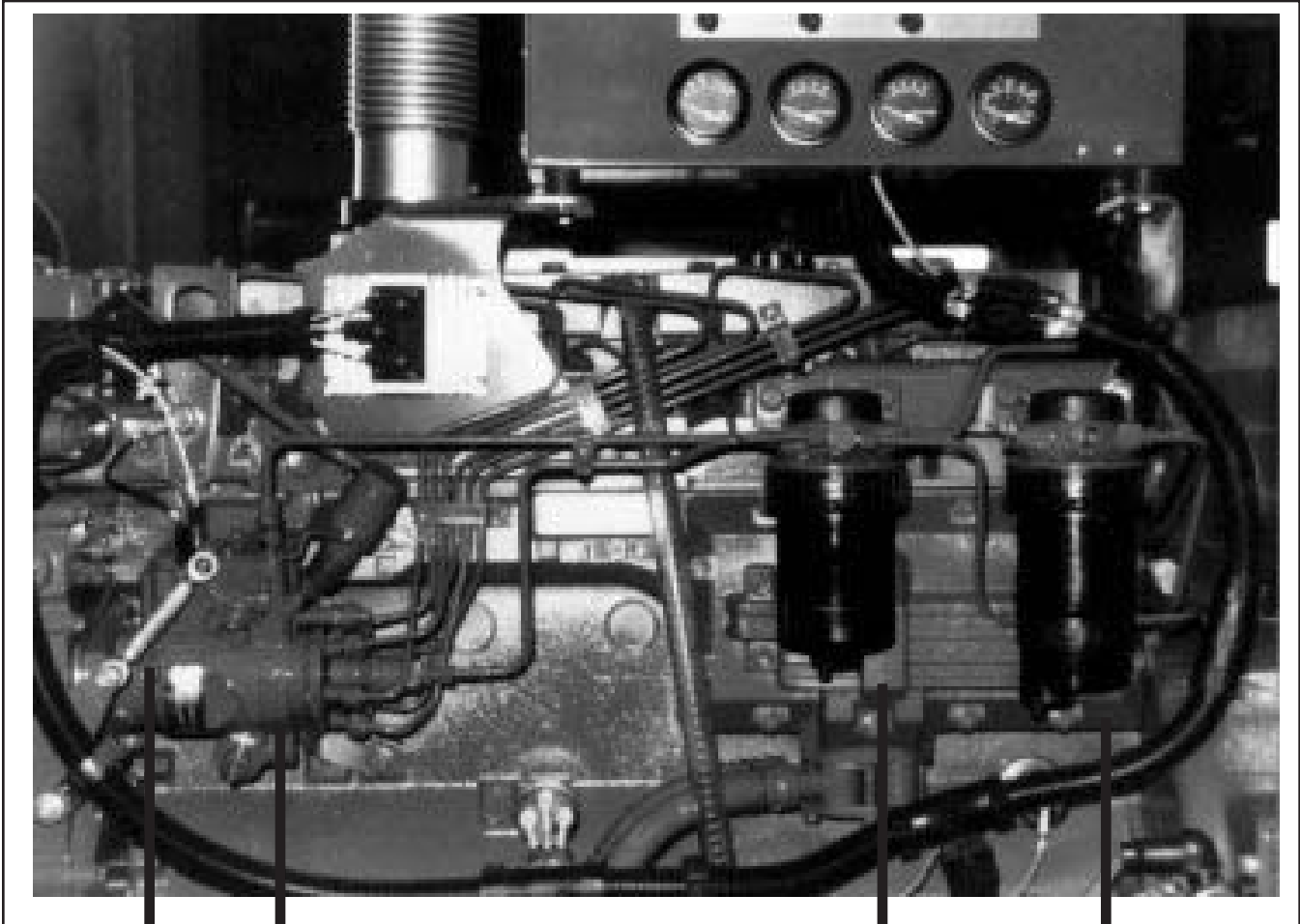


Figure 7 - Fuel System

Speed Adjustment

Fuel Injection Pump

Secondary Filter

Primary Filter

AIR INTAKE AND EXHAUST SYSTEM

Air Intake Operation

Air Cleaner

Crankcase Ventilation

Exhaust Operation

Maintenance And Service Procedures

AIR INTAKE OPERATION

During the intake stroke, the piston travels downward, the intake valve is open, and the exhaust valve is closed. The downstroke of the piston permits air to enter the cylinder that has been drawn from the air cleaner through the open intake valve. The intake air is never restricted by any controlling valve or mixing devices. The intake charge consists of fresh, clean air which provides for efficient combustion.

On some engines a turbocharger is introduced in the air system. Power to drive the turbocharger is extracted from the waste energy in the engine exhaust gas. The expanding exhaust gases turn a single stage turbo wheel which drives an impeller thus supplying air under pressure to the cylinders.

AIR CLEANER

The air cleaner is designed to remove foreign matter from the air, pass the required volume of air for proper combustion, and maintain efficient operation for a reasonable period of time before requiring service.

The importance of keeping foreign matter out of the engine cannot be over-emphasized, since clean air is essential to satisfactory engine operation and long engine life. Should dust in the air supply enter the engine it would be carried into the cylinders and due to its abrasive properties, cause premature wear of the moving parts. Dirt, which is allowed to build-up in the air cleaner passages, will eventually restrict the air supply to the engine and result in heavy carbon deposits on the valves and pistons due to incomplete combustion.

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

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 1 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.

AIR FILTER SERVICE INSTRUCTIONS

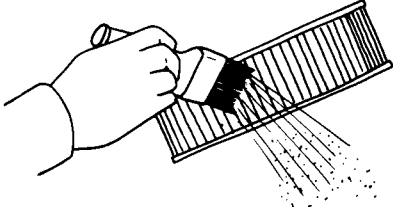
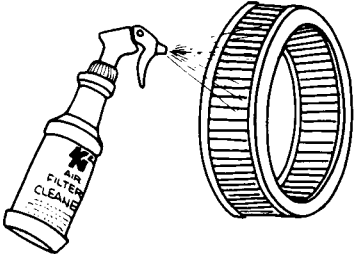
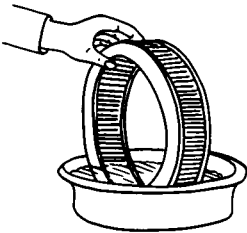
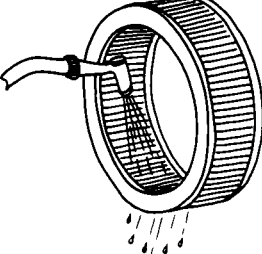
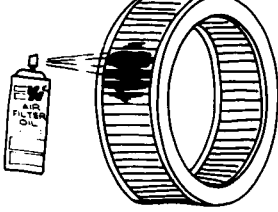
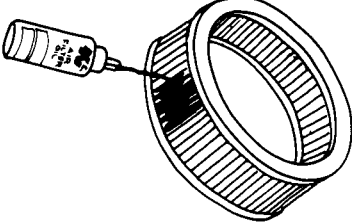
<p>1. PRE-CLEANING</p> <p>Tap the element to dislodge any large embedded dirt, then gently brush with a soft bristle brush. <i>(Note: If complete cleaning is not practical at this time, re-oil the element and re-install in your vehicle.)</i></p> 	<p>2. SPRAY ON CLEANER</p> <p>Spray K&N air filter cleaner liberally onto the entire element and let soak for 10 minutes.</p> 	<p>3. PAN CLEANING</p> <p>Large K&N elements can be rolled or soaked in a shallow pan of K&N air filter cleaner. Remove immediately and let soak for approximately 10 minutes.</p> 
<p>4. CLEANING HINTS</p> <p>Use only K&N air filter cleaner.</p> <p>NO gasoline cleaning. NO steam cleaning. NO caustic cleaning solutions. NO strong detergents. NO high pressure car wash. NO parts cleaning solvents.</p> <p>Any of these NO's can cause harm to the cotton filter media, plus shrink and harden the rubber end caps.</p>	<p>5. RINSE OFF</p> <p>Rinse off the element with low pressure water. Tap water is OK. Always flush from the clean side to dirty side. This removes the dirt and does not drive it into the filter.</p> 	<p>6. DRYING HINTS</p> <p>Always dry naturally. After rinsing, shake off all excess water and let the element dry naturally.</p> <p>DO NOT USE COMPRESSED AIR DO NOT USE OPEN FLAME DO NOT USE HEAT DRYERS</p> <p>EXCESS HEAT WILL SHRINK THE COTTON FILTER MEDIA.</p> <p>COMPRESSED AIR WILL BLOW HOLES IN THE ELEMENT.</p>
<p>7. AEROSOL OILING</p> <p>After cleaning air filter always re-oil before using. Spray K&N air filter oil down into each pleat with one pass per pleat. Wait 10 minutes and reoil any white spots still showing.</p> 	<p>8. SQUEEZE BOTTLE OILING</p> <p>After cleaning air filter always re-oil before using. Squeeze K&N air filter oil down into the bottom and along each pleat — only one pass per pleat. Let oil wick into cotton for 20 minutes. Re-oil any white spots still showing.</p> 	<p>9. OILING HINTS</p> <p>Never use a K&N air filter without oil. <i>(The filter will not stop the dirt without the oil.)</i> Use only K&N formulated air filter oil.</p> <p>K&N air filter oil is a compound of mineral and animal oil blended with special polymers to form a very efficient tack barrier. Red dye is added to show just where you have applied the oil. Eventually the red color will fade but the oil will remain and filter the air.</p> <p>NEVER USE Automatic Transmission Fluid. NEVER USE Motor Oil. NEVER USE Diesel Fuel. NEVER USE WD-40, LPS, or other light weight oils.</p>

Figure 1 - Air Filter Service Instructions

CRANKCASE VENTILATION

Vapors which may form within the engine are removed from the crankcase and gear train compartment by a continuous, pressurized ventilation system.

A s

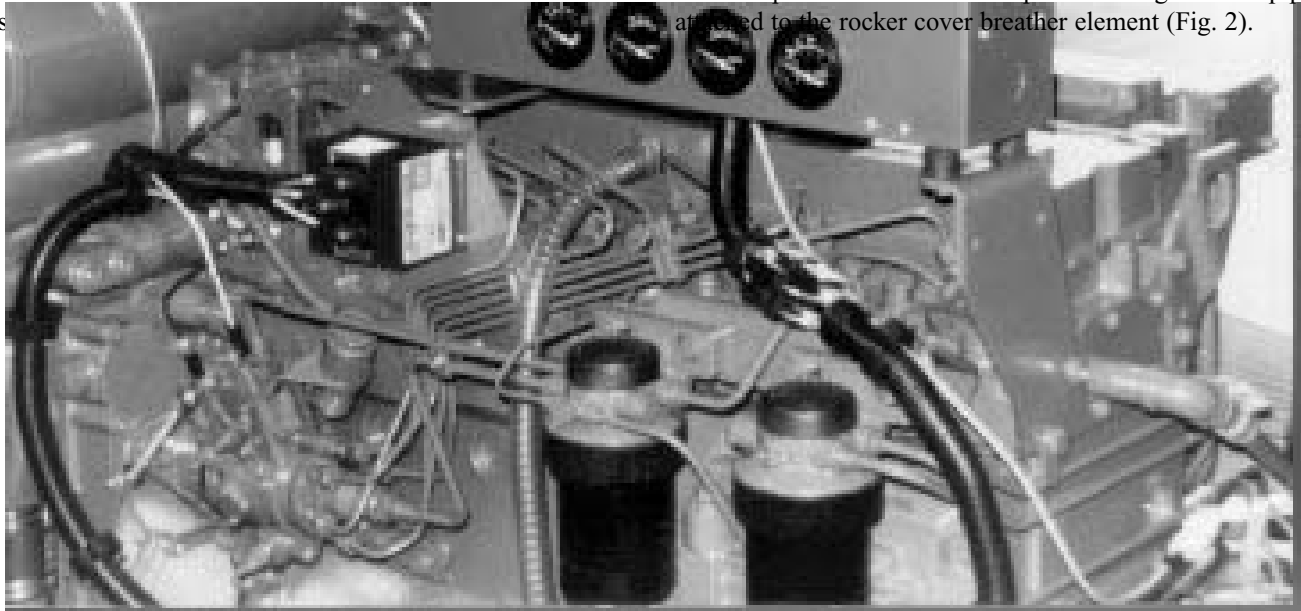


Figure 2 - Crankcase Ventilation

compartment. This crankcase pressure and resulting ventilation is accomplished by the air seepage past the piston rings sweeping up through the cylinder block and into the rocker arm compartment. Here it is expelled through a vent pipe attached to the rocker cover breather element (Fig. 2).

EXHAUST OPERATION

Internal combustion engines convert fuel energy into both useful work and wasted heat. The useful work is the fly-wheel rotation that drives the pump. The wasted heat involves the engine water cooling system, radiated heat and the exhaust gases. Approximately 2/3 of the fuel energy is wasted. Critical review must be made of these systems to assure that the engine delivers the useful power required and maintains the engine within the operating parameters established by the engine manufacturer.

Some engines are turbocharged (T). Turbochargers increase the air flow into the engine cylinder and permit increased horsepower by burning more fuel than is possible in a naturally aspirated (N) engine. Turbochargers enhance the efficiencies of engines and add power to a similar displacement (N) engine. Turbochargers are maintenance free.

The exhaust system is critical to the proper engine performance. When initially installed, consideration must be given to the exhaust gas flow requirements, the exhaust temperatures and the exhaust back-pressure limitations of the specific engine. Refer to Section 5 for specific engine model and operating speed back-pressure limitations. All the components in an exhaust system contribute to the back-pressure determination including the flexible section, muffler,

exhaust piping elbows and outlet. In addition to providing engine exhaust data and back-pressure limitations, Clarke offers a service to installers, through the local Pump OEM Dealer, for making recommendations on exhaust system sizing for specific installations.

If the exhaust system should become restricted, the hot exhaust gases cannot escape from the engine. This condition would cause a loss of power, extreme internal engine heat, and very high exhaust gas temperatures. These conditions can and will cause internal engine damage and a reduction of engine life.

Should any exhaust manifold studs or bolts break or come loose, engine exhaust gases can start leaking into the pump room. Under these conditions, the engine should be attended to immediately. Indications of an exhaust leak would be the smell of diesel exhaust, possible eye irritation and soot collecting on the engine around the leak. Contact your local Distributor/Dealer for repair.

NFPA-20 requirements are to have exhaust system high temperature personnel protection. Don't run PDFP engines without insulation blankets installed. Serious injuries may result by contact with hot exhaust system components.

MAINTENANCE AND SERVICE PROCEDURES**Weekly**

Prior to each engine run make a visual check of the exhaust system to verify condition of piping and muffler. Investigate thoroughly any areas that would appear to have rusty conditions such as rain water running down pipe and getting inside the engine. Severe internal engine damage could occur if water enters the engine exhaust system.

Inspect the engine air cleaner for dirt buildup or damage.

6 Months

Inspect exhaust system for leaks or plugging, if any are found, repair immediately. Inspect and tighten if necessary exhaust manifold, turbo mount (if equipped) and piping bolts/nuts. Inspect the insulations condition for any deterioration or looseness; repair as necessary. Check for any petroleum products on the blankets and replace if any are found.

Exhaust system back pressure limits are not to be exceeded.

Yearly

Re-oil and clean the air cleaner element per the manufacturers directions. Each engine is shipped with the cleaning instructions. Refer to Figure 1, Page 18.

NOTE: Exhaust back pressure, air inlet restriction and crankcase pressure limits are listed for each PDFP Model in Technical Data Section 5. These limits are not to be exceeded. To properly check these limits, the engine must be producing maximum required horsepower.

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 - too many areas to list for possibilities.
2. White Smoke — Possibility of water in cylinders
Source — Possible water in fuel or internal engine problem.

Should any of these or any other conditions be found, contact your local Distributor/Dealer for assistance. Check condition of the air inlet system ducting, clamp tightness hose condition.

LUBRICATION SYSTEM

Operation

Oil Cooler

Lube Oil Fill

Oil Level Dipstick

Lube Oil Filter

Lubricating Oil Requirements

Changing The Lubricating Oil

Lubricating Oil Analysis

Changing The Lubricating Oil Filter

Maintenance Procedure

OPERATION

The lubricating oil system is schematically illustrated in Figure 1.

Pressure lubrication is supplied by a rotor type pump. The pump is driven through an idler gear from the crankshaft gear. On all 4 cylinders a balancer unit is used, the pump is fitted to the balancer frame and is driven by the balancer drive shaft. The oil from this pump circulates through the balancer unit then passes through a full flow filter to the pressure rail. On 6 cylinder units the oil passes directly from the pump to the filters. The filter has a by-pass valve which lets oil pass directly to the pressure rail, if the filter becomes restricted. From the pressure rail, lubricating oil passes to the main bearings of the crankshaft and through passages in the crankshaft to the end bearings. The pistons and the cylinder bores are lubricated by splash and oil mist.

Lubricating oil for the camshaft journals is supplied from the main bearings and a reduced supply is sent from the camshaft journal, through passages in the cylinder block and the cylinder head, to the rocker assembly. Lubricating oil passes

through the rocker shaft to the bearings of the rocker levers. The valve stems and valve springs are lubricated by splash and oil mist.

The hub of the idler gear is supplied with lubricating oil from the pressure rail and the timing gears are splash lubricated.

The maximum pressure in the system is controlled by a relief valve. This valve controls the pressure of the oil and is located between the oil cooler and the oil filter.

All PDFP engines include oil coolers. The oil passes through the cooler before the filter. When cold oil increases the restriction in the cooler, a by-pass valve lets the lubricating oil pass directly to the oil filter.

The turbocharger is lubricated by oil from the pressure rail. The lubricating oil is sent through a passage across the cylinder block to an adaptor fitted to the right side of the engine and then by pipe to the turbocharger. The lubricating oil returns from the turbocharger to the sump.

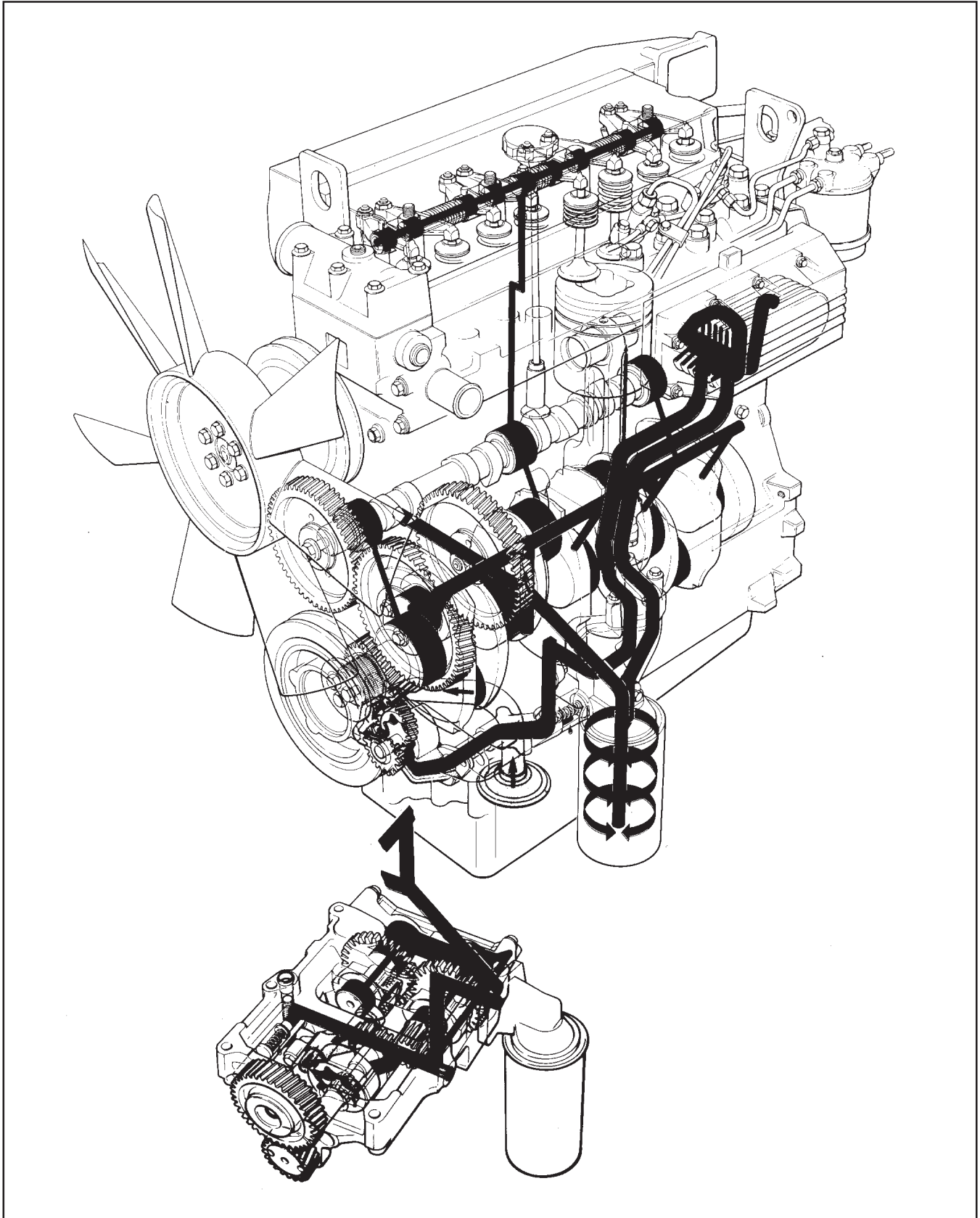


Fig. 1 - Typical PDFP 1000 Series Engine
Lubricating System Schematic

OIL COOLER

PDFP engines use a plate type oil cooler. The only difference is the number of plates used between the 4 and 6 cylinder models. The number of plates is determined by the amount of cooling that is required. All of the oil cooler systems incorporate oil bypass valves in the event of plate core plugging.

LUBE OIL FILL

On all models the oil fill is located on the rocker cover at the top of the engine. See Fig. 2, for typical oil fill location. (See Page 24 for lube oil requirements.)

OIL LEVEL DIPSTICK

On all PDFP engines the dipstick is located on the left center of the engines. Oil level can only be checked when the engine is not running and has been off for at least 10 minutes. See Page 24 for lube oil requirements if additional oil is needed.

LUBE OIL FILTER

All engines use full flow oil filters of the "spin on" type element. They have a non-replaceable pleated paper cartridge. Each engine has an integral bypass valve to bypass the filters in the event of plugging or for cold start purposes. The 6 cylinders have dual filters and the 4 cylinders have one.

Use only Perkins filters. Refer to Section 6 for proper service part numbers.

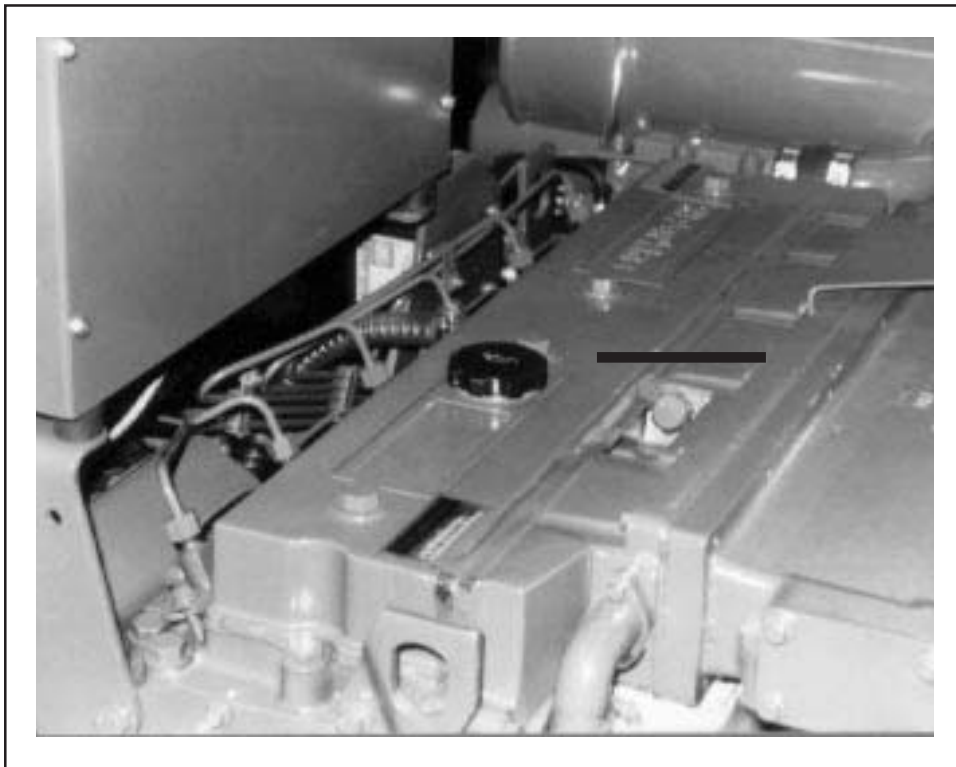


Figure 2 - Typical Oil Fill Location

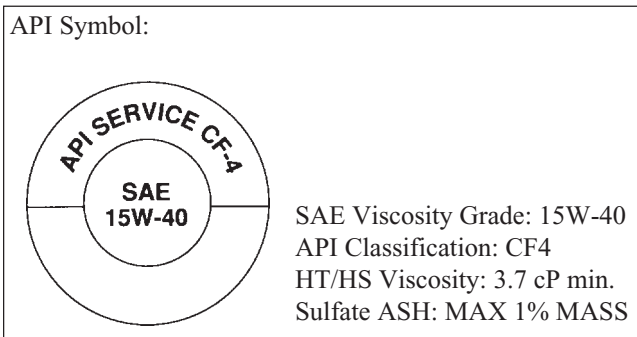
LUBRICATING OIL REQUIREMENTS

Hundreds of commercial oils are marketed today, but labeling terminology differs among suppliers and can be confusing. Some marketers may claim that their lubricant is suitable for all makes of diesel engines and may list engine makes and types, including Perkins, on their containers. Such claims, by themselves, are insufficient as a method of lubricant selection for PDFP engines.

The proper lubricating oil for all PDFP engines is selected, based on SAE Viscosity Grade and API (American Petroleum Institute) Service Designation. Both of these properties are displayed in the API Symbol, which is illustrated within the specific requirements. For PDFP engines, the proper lubricant must also possess a sulfated ash content below 1.0% mass.

LUBRICANT REQUIREMENTS

API Symbol:



This is the only oil recommended for Perkins Engines used in PDFP service. Lubricants meeting these criteria have provided maximum engine life when used in conjunction with recommended oil drain and filter maintenance schedules.

API Performance category CF-4 represents an enhanced level of lubricant performance over the API CE category which it replaces. Lubricants meeting this new performance level are preferred.

NOTICE: Monograde oils should not be used in these engines regardless of API Service Classification.

Sulfur content of the #2-D Diesel fuel used must be limited to 0.5% mass. The combustion of high sulfur (greater than 0.5%) will shorten engine life through accelerated wear of piston rings.

When the use of High Sulfur Diesel Fuel (greater than 0.5% mass) is unavoidable, the use of lubricants with higher Total Base Numbers (alkalinity) are recommended. Refer to Fig. 4 for min TBN numbers for normal service.

CHANGING THE LUBRICATING OIL

- 1 Operate the engine until it is warm. Refer to Page 33 "Manual Starting Instructions" for instructions.
- 2 Stop the engine. Remove the sump drain plug (Fig. 3 - Item 1) and its "O" ring and drain the lubricating oil from the sump. Ensure that the "O" ring is not damaged. Fit the drain plug and its "O" ring and tighten the plug to 34 Nm (25 lbf ft) 3,5 kgf m.
- 3 Fill the sump to the "MAX" mark on the dipstick (Fig. 3 - Item 2) with new and clean lubricating oil of an approved grade.
- 4 Return the unit back into service by returning the AEC selector to "automatic" position and the manual operating lever to manual stop position. Close cooling system manual by-pass valve.
- 5 Dispose used oil properly

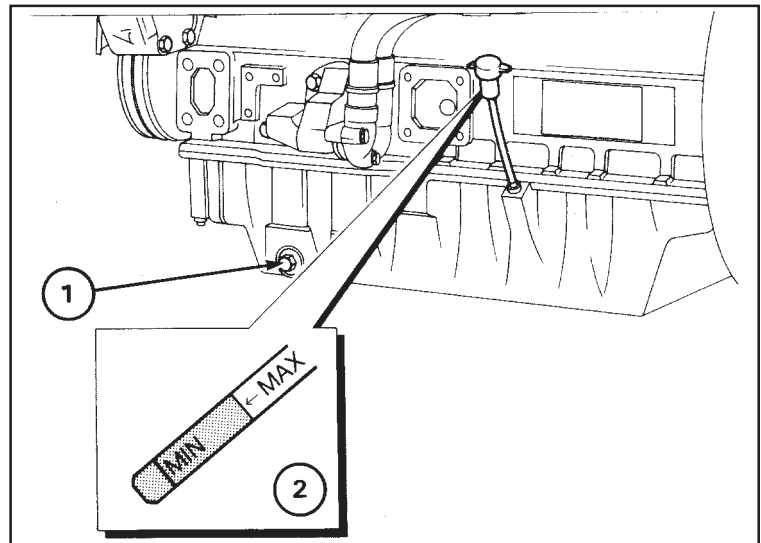


Figure 3 - Changing Oil

	ASTM Designation	Condition Measured	PDFP Limit
Pentane Insolubles % Max.	D 893	Engine Combust.	1.0
Carbon (Soot) Content, TGA Mass % Max.	E-1131	Engine Combust.	1.5
Viscosity at 40° C cS	D 445 & D 2161	Engine & Oil	
% Max. Increase			40.0
% Max. Decrease			15.0
Total Base Number (TBN) Min.	D 664 or D 4739	Oil	1.0
Min.	D 2896		2.0
Water Content (dilution) Vol. % Max.	D 95	Engine	0.30
Flash Point ° C Reduction Max.	D 92 *	Engine Fuel Dil.	20.0
Fuel Dillution Vol. % Max.		Engine	2.5
Glycol Dilution PPM Max.	D 2982	Engine	1,000
Iron Content PPM Fe Max.	**	Engine Wear	150
Copper Content PPM Cu Max.	**	Engine Wear	30
Sodium Content PPM NA Over Baselline Max.	**	Engine Coolant	50
Boron Content PPM B Over Baseline Max.	**	Engine Coolant	20

* Various Methods

** Elemental Analyses are conducted using either emission or atomic absorption spectroscopy. Neither method has an ASTM designation.

Figure 4 - Oil Analysis Warning Limits

LUBRICATING OIL ANALYSIS

Oil Analysis kits are available through the DDC Distributor/ Dealer Network for efficient monitoring of the lubricating oil in a PDFP engine. Refer to Parts Information Section 6 to order.

Oil analysis consists of a series of laboratory tests conducted on the engine's lubricant. Some tests show the condition of the engine and others show the condition of the lubricant. Refer to Fig. 4 for warning limits.

CHANGING THE LUBRICATING OIL FILTER

The filter can have one or two canisters. When equipped with two canisters, both must be replaced at the same time.

- 1 Turn engine off by referring to Page 9 "Important" for proper engine shutdown procedure.
- 2 Put a tray under the filter to retain spilt lubricating oil.
- 3 Remove the filter with a strap wrench or similar tool. Ensure that the adaptor (Fig. 5) is secure in the filter head. Then dispose of the filter properly.
- 4 Clean the filter head.
- 5 Add clean engine lubricating oil to the new filter. Allow the oil enough time to pass through the filter element.
- 6 Lubricate the top of the filter seal with clean engine lubricating oil.
- 7 Fit the new filter and tighten it by hand only. Do not use a strap wrench.
- 8 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.
- 9 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.
- 10 Return the unit back into service by returning the AEC selector to "automatic" position and the manual operating lever to AUTO-OFF position.



Attention: The filter contains a valve and special tube to ensure that lubricating oil does not drain from the filter. Therefore, ensure that the correct Perkins POWERPART filter is used. Refer to Section 6 for proper filter.

MAINTENANCE PROCEDURE

Weekly

- 1). Check oil level with the engine stopped.
- 2). During and after weekly maintenance run, check over entire engine for signs of oil leaks. Repair immediately if found or call your authorized Distributor/Dealer for service.

deterioration from combustion by-products and contamination. For these reasons, regardless of the appearance of the oil, change oil and filter(s) annually.

CAUTION: Use only recommended lube oil and oil filters. Internal engine damage and/or excessive wear could occur using unauthorized materials.

Yearly

Stationary diesel engines collect condensation in the engine oil pan while at rest. When in use, lubricating oil undergoes

OIL VOLUME

For specific oil quantities please refer to Technical Data Section 5 for each engine model listing.

- Operation**
- Engine Coolant**
- Water**
- Antifreeze**
- Coolant Inhibitor**
- Procedure For Filling Engine**
- Pressure Cap**
- Thermostat**
- Engine Coolant Heater**
- Heat Exchanger Cooling**
- Raw Water System (Cooling Loop)**
- Zinc Electrode**
- Maintenance And Service Procedures**

OPERATION

The heat resulting from combustion in the engine cannot be fully converted into kinetic energy. A major portion of that heat is absorbed by the coolant from the cylinder walls and cylinder heads, and must be carried away from the engine. It is the function of the Heat Exchanger to transfer waste engine heat to the raw cooling water.

Inside the heat exchanger tank is a heat exchanger core, somewhat similar to a miniature radiator. Engine coolant circulates around the heat exchanger core while cool raw water, from a tap on the pressure side of the fire pump, is circulated inside the core carrying away the heat. See Fig. 1 for the raw water supply connection to the engine. The installing contractor makes the raw water discharge connection at time of system installation.

Engine coolant from the heat exchanger passes through the centrifugal water pump which is fitted on the front of the timing case. The pump is gear driven from the crank shaft and provides flow of the coolant through the system. From the pump, the coolant passes through a passage in the timing case to the front of the cylinder block.

On four cylinder engines the coolant passes through a passage in the left side of the cylinder block to the rear of the cylinder block. Where a lubricating oil cooler is mounted, some of the coolant passes around the element of the cooler and then to the rear of the cylinder block. The coolant also passes around the cylinders and up into the cylinder head through a by-pass to the inlet side of the water pump. When the thermostat is open, it closes the by-pass and the coolant passes to the heat exchanger.

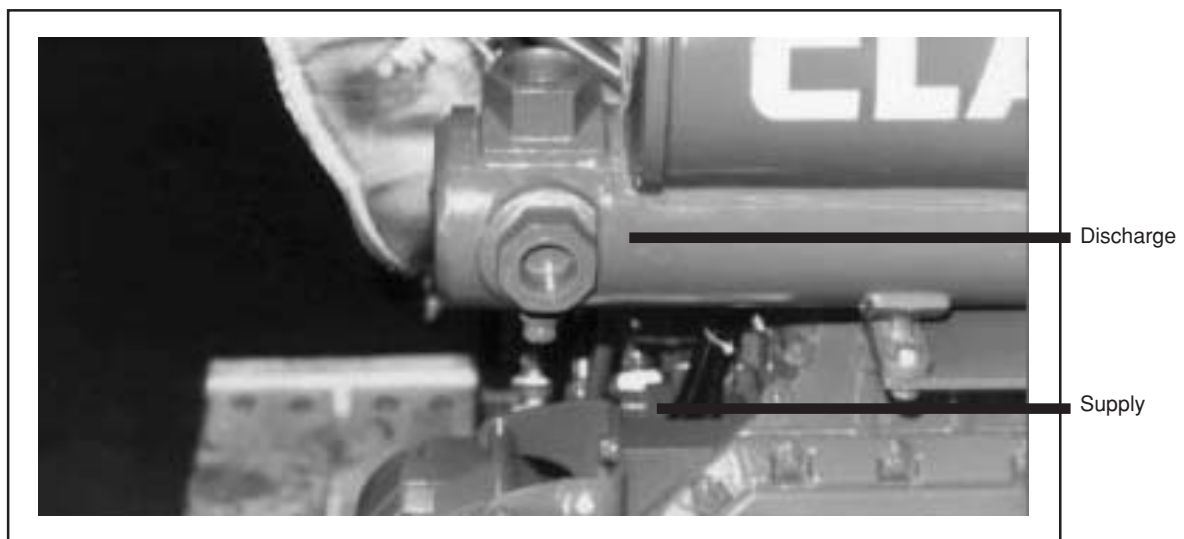


Fig. 1 - Raw Water Connections

On six cylinder engines the coolant divides as it enters the cylinder block. Most of the coolant passes along the right hand side of the cylinder block and around the outside of the cylinders to the rear of the cylinder block. The remainder of the coolant passes along a passage on the left hand side of the cylinder block to the lubricating oil cooler. The coolant flows around the element of the lubricating oil cooler to the rear of the cylinder block. The coolant then passes to the rear of the cylinder head.

Coolant passes forward through the cylinder head and into the thermostat housing. These engines have two thermostats. If the thermostats are closed, the coolant goes, through a by-pass, directly to the inlet side of the water pump. When the thermostats are open, it closes the by-pass and the coolant passes to the heat exchanger.

ENGINE COOLANT

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

The water/ethylene glycol/inhibitor coolant mixture used in PDFP 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 burn out the element. Please see the technical data Section 5 for proper cooling system capacities of each model.

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 Fig. 2 is satisfactory as an engine coolant when properly inhibited. Use of distilled water is preferred.

	PARTS PER MILLION	GRAINS PER GALLON
Chlorides (Maximum)	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10

Fig. 2 Satisfactory Water Limits

ANTIFREEZE

Use an ethylene glycol coolant (low silicate formulation) that meets or exceeds the standard of either the GM 6038-M formulation (GM 1899-M performance) or ASTM D 4985 requirements.

A 50% coolant/water solution is recommended. Concentrations over 70% are 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.

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 prevent 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 PDFP 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 to Fig. 3 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

Fig. 3 - Proper Concentrations Of Inhibitors

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

To properly check inhibitor concentrations it may be necessary to contact your local Distributor/Dealer for assistance. Refer to Parts Information Section 6, Page 46, to obtain the

part number for the Factory Coolant Analysis Kit. This kit can be purchased for a nominal fee for analyzing the condition of the engine's coolant.

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 up to the filler neck. Install the pressure cap, start and run engine until the temperature stabilizes at approximately 160° - 200° F (71° - 93° C). During this warming process, you may see coolant coming from the overflow tube attached at the pressure cap location. This is a normal condition since the coolant expands as it heats up. When the overflow ceases, stop the engine.

To verify that the coolant is at a safe operating level, it's best to wait until the engine temperature drops to approximately 120° F (49° C), or lower, before removing the pressure cap. After the cap is removed, fill as necessary up to the bottom of the fill neck.

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

PRESSURE CAP

Like most cooling systems, the heat exchanger type operates under pressure. A typical cap shown in Fig. 4 maintains system pressure to raise the coolant boiling point and permits a somewhat higher operating temperature without coolant loss. Pressure cap values are 9 psi (62 kPa) on PDFP engines.

All pressure caps include a vacuum valve which opens during cool down. This prevents an internal vacuum from being formed which could contribute to leaking seals and hoses collapsing.

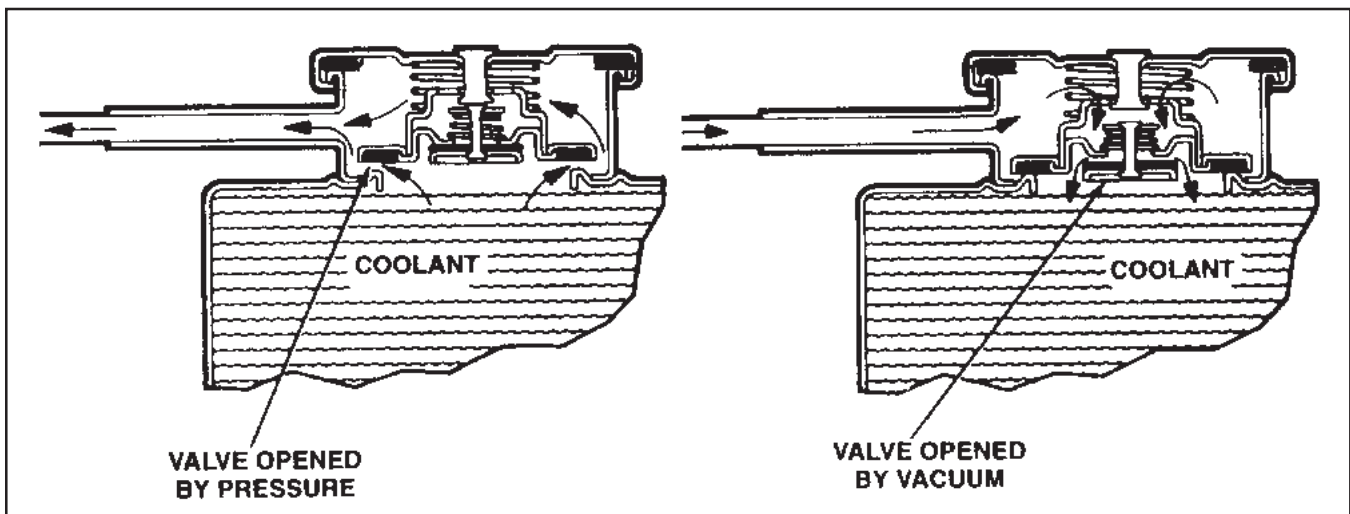


Fig. 4 - Typical Coolant Cap

THERMOSTAT

Each pump engine is equipped with a temperature controlling thermostat(s). Normal operating range of these thermostat(s) are: begin opening at 170° F (77° C), open fully at 198° F (92° C). The thermostat(s) are located at the front of the cylinder heads.

NOTE: Do not operate PDFP engines without a thermostat. The engine will overheat and may cause damage or injury.

ENGINE COOLANT HEATER

Fire pump engines must be able to assume full load immediately when used for emergency service. NFPA-20 specifications require an engine coolant heater Figure 5, to maintain a minimum temperature of 120° F. (49° C). Maintaining this temperature assists the engine to start easily and produce rated horsepower immediately. For fire pump units operation in cold climates optional oil heaters are available to keep the

engines lubricating oil at a safe temperature for emergency start purposes. If pump room temperatures drop below 32° F (0° C), consult the factory concerning oil heaters.

On the initial installation of each fire pump engine, it is the responsibility of the installing contractor to wire the heater to the pump room AC circuit. See Section 3.5 Electrical AC Wiring Diagram, Fig. 6, Page 38, for correct wiring to the heater.

NOTE: The factory has equipped the heater system with silicone hoses and constant torque clamps. Replacement parts should be original equipment to prevent coolant leaks.

CAUTION: Do not activate the AC circuit unless the engine cooling system has been filled.

A pre-mix solution must be used. Chemical reactions will occur if pure Ethylene Glycol anti-freeze is allowed to fill the heater cavity with AC circuits activated.

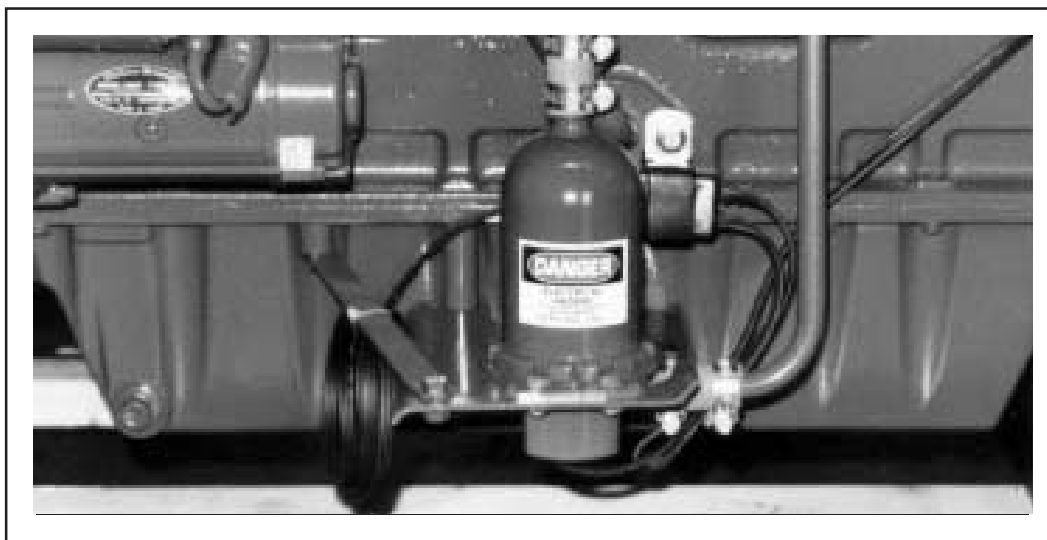


Fig. 5 - Engine Heaters

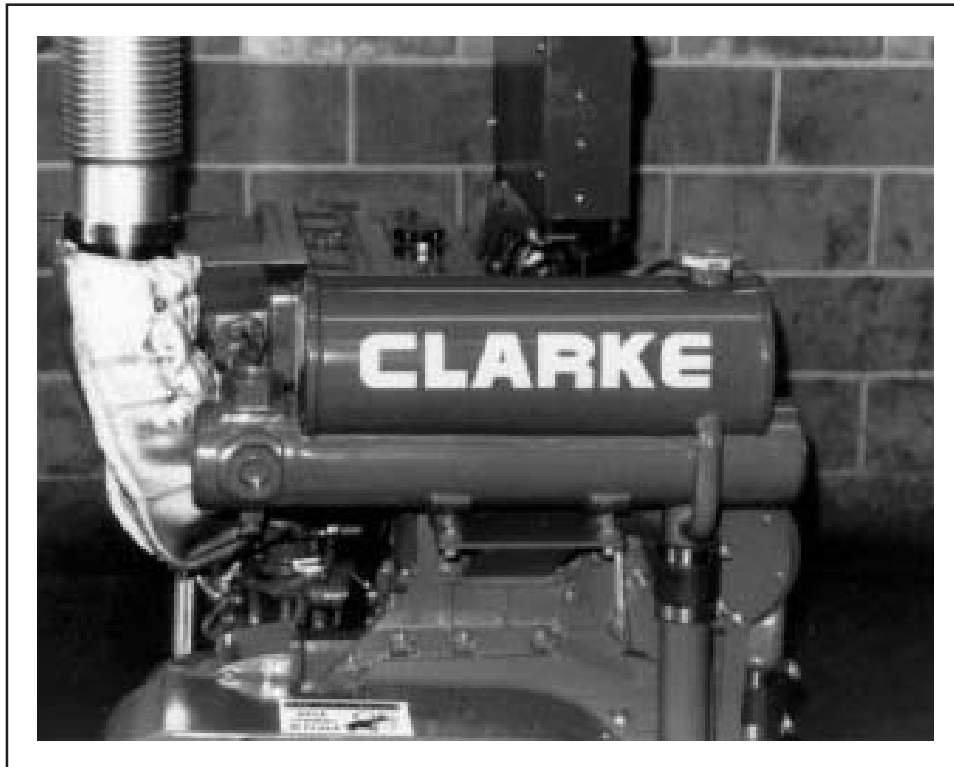


Fig. 6 - Heat Exchanger Cooling System

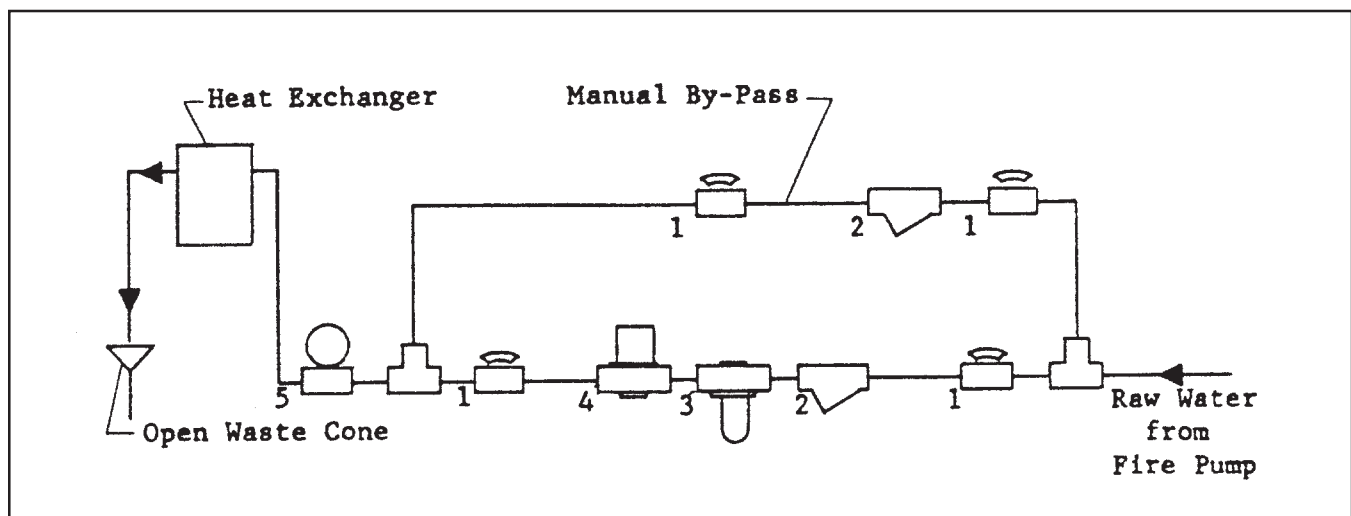
HEAT EXCHANGER COOLING

The heat exchanger cooling system is shown in Fig. 6. Raw water from the fire pump passes through the heat exchanger core where it lowers the engine coolant temperature. Typical raw water connection points on the heat exchanger are shown in Fig. 7.

NOTE: The heat exchanger has a maximum raw water pressure rating of 60 psi (414 KPa).

RAW WATER SYSTEM (Cooling Loop)

This system is provided by the pump manufacturer or the assembler as part of the complete engine-pump-controller package. Components for the raw water system are selected to ensure adequate flow through the heat exchanger as required by the engine at specific raw water temperature. The raw water system is generally referred to as the "cooling loop". A typical cooling loop includes the following components as shown in Fig. 7.



1. Indicating manual valves
2. Water strainers
3. Pressure regulator
4. Solenoid valve (DC)
5. Pressure gauge

The heat exchanger discharge line must be a minimum of one pipe size larger than the supply line. Discharge is to be made to an open waste cone as specified in NFPA-20.

CAUTION: Damage to the heat exchanger may result if raw water plumbing (supply or discharge) weight or stress is applied to the heat exchanger.

The solenoid valve may be omitted on vertical turbine pump installations where no static pressure exists in the heat exchanger supply line while the engine is not running. Each engine has a minimum requirement of raw water flow. Correct flow through the heat exchanger is critical for maintaining the proper engine operating temperature.

Engine coolant temperature can be adversely affected by insufficient raw water flow and by excessive ambient temperature of the raw water. See the technical data Section 5 for each engine model's minimum raw water flow requirements at 60° F (16° C) and 95° F (35° C) at specified engine RPM ranges. Do not exceed raw water pressure allowance within the heat exchanger.

NOTE: Although engine operating temperature may appear normal, engine cooling may be compromised and possible engine damage will result if raw water flow is reduced.

ZINC ELECTRODE

A sacrificial zinc anode is included with each heat exchanger. Over a period of time, normal electronic action will occur between dissimilar metals within the heat exchanger. The rate of material transfer is dependent on the electrolytic strength of the transfer media (raw water). It is the zinc anode that gives up material in this process and thus preserves the integrity of the heat exchanger.

MAINTENANCE AND SERVICE PROCEDURES

Weekly

- 1) Check coolant level weekly. The coolant (while being maintained by the coolant heater) level should be at the bottom of the filler neck. Because this is a closed system, when operating temperature is reached, the pressure relief cap may allow some excess coolant to expell out the overflow tube until a stabilized level is reached.

6 Months

Check the condition of the pressure relief cap. The rubber seat should be in sound condition. If it is cracked, split or frayed, do not use. Do not attempt to run engine without a pressure cap. The cap has a 9 P.S.I. (62 kPa) relief rating, which is not to be altered if a replacement cap be required.

Yearly

- 1) Zinc Electrode
Zinc electrode should be inspected and replaced if more than half deteriorated.
- 2) Inhibitor – Check the amount of inhibitor chemicals remaining and add if necessary.

NOTE: Coolant should be changed every two years.

ELECTRICAL SYSTEM

Engine Operating System
Manual Starting Instructions
Fuel Injection Pump Solenoid
Instrumentation And Controls
Speed Switch
Battery Charging Alternator
Starters
Alarms
Batteries
Battery Cables
Wiring Diagram
Maintenance And Service Procedures

ENGINE OPERATING SYSTEM

PDFP engines used for fire pump service include two electrical systems. The engine heater system (AC), and the engine starting and control system (DC). The starting and control circuits are integral with the DC wiring harness but are separated for explaining operation, maintenance and service procedures. This includes two starting motors, battery charging alternator, wiring harness, battery insulator, electric instrumentation, run-stop solenoid and two battery systems. For identification reasons only, usually 12V DC systems have 2 batteries. Under normal operating conditions, signals for running and shutdown are transmitted from the AEC. With the AEC switch on "automatic", a specific drop in the fire main line pressure or other pre-programmed signal will result in a start of the diesel engine. Reference the DC wiring diagram Fig. 5, Page 37.

CAUTION: These engines have been pre-set for a specific operational speed (RPM). When started, the engine will quickly reach this setting. The engines do not have idle speed settings.

With the AEC switch on "Test", the engine can be test started from the AEC using either battery system A or B. Engine stopping is accomplished by switching the controller selector to the "Off" position. Consult the AEC operation manual for specific operational instructions.

NOTE: Prior to turning the AEC to any position other than automatic, please read the paragraph labeled "IMPORTANT" in Section 2, Page 9.

The engine DC starting and control system terminates at the Instrument Panel (IP). From this point, the engine is electri-

cally connected to the (AEC). Both automatic operation and test signals are sent to the engine from the AEC. Under emergency conditions, or if the AEC should become defective or disconnected, it is possible to start the engine by operating manual crank switch #1 or #2. Both switches are located on the IP. See Fig. 1. Specific emergency operating instructions are attached to the IP and explained in detail under MANUAL STARTING of this section. The IP includes a warning indicator that will remain on when the mode selector is in manual mode. Engine wiring diagrams for AC and DC systems are shown in this section.

MANUAL STARTING INSTRUCTIONS

The engine can be operated without using the engine AEC. Use the following procedure when manual starting is required. Refer to Fig. 1.

TO START ENGINE

1. REFER TO PG. 9 "IMPORTANT" ON AEC OPERATION.
2. POSITION **MODE SELECTOR** TO **MANUAL RUN**. Fig. 1.
3. 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 VALVE.

TO STOP ENGINE

- RETURN **MODE SELECTOR** SWITCH TO **AUTOMATIC**, AND **MANUAL STOP** POSITION, ENGINE WILL STOP.
- CLOSE COOLING SYSTEM MANUAL BY-PASS VALVE.

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**).

FUEL INJECTION PUMP SOLENOID

The DC solenoid is an integral part of the fuel injection pump. This essential item, when energized allows the fuel injection pump internal governor to take control of fuel injection. This solenoid remains energized during engine operation, when De-energized the engine stops.

INSTRUMENTATION AND CONTROLS

Figure 1, shows the instrumentation panel which contains the following gauges:

- Tachometer with integral Hourmeter
- Oil Pressure In P.S.I.
- Two-Battery Voltmeters
- Engine Coolant Temperature

TACHOMETER AND INTEGRAL HOURMETER –

This meter receives its signal from the overspeed switch to read engine RPM, in addition the hourmeter records a cumulative total of engine operating hours.

OIL PRESSURE – This electrical gauge indicates engine oil pressure readings in English and Metric Units (PSI & KPA). The pressure sensor unit signaling the gauge is found on the Lower Rear Left Side of the engine.

ENGINE COOLANT TEMPERATURE – This electrical gauge indicates degrees of coolant operating temperature in fahrenheit (° F) and celsius (° C). The sensor is located in the right side of the thermostat housing.

VOLTMETERS – Each PDFP gauge panel contains two battery voltmeters, one for battery #1 and one for battery #2.

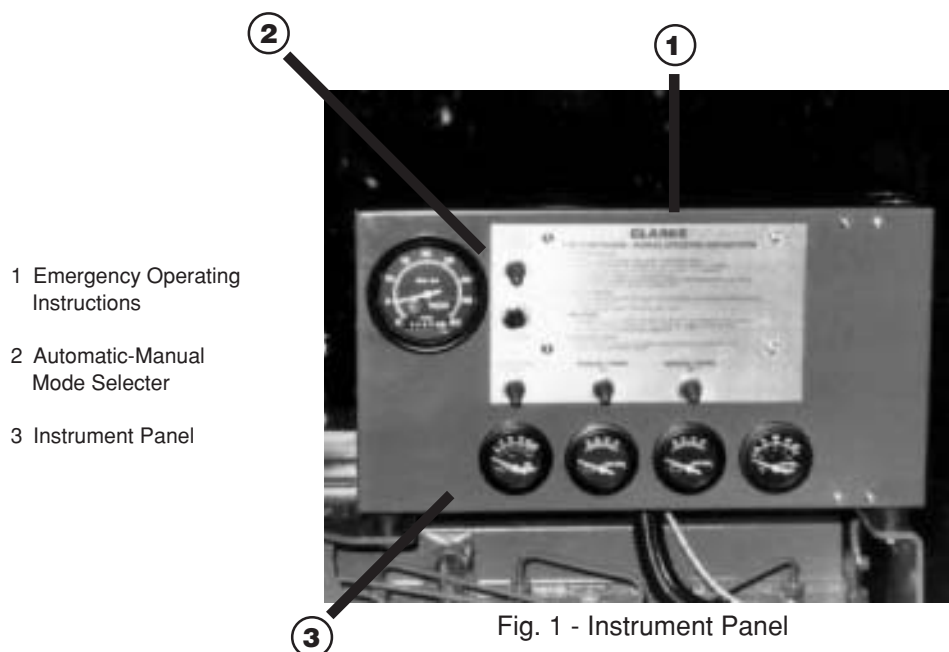


Fig. 1 - Instrument Panel



Fig. 2 - Engine Heaters

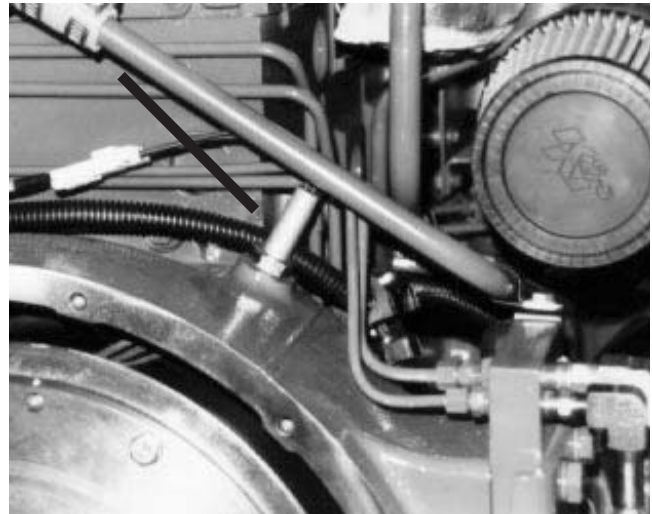


Fig. 3 - Magnetic Pickup

SPEED SWITCH

After the engine has started and reached 1000 RPM, the speed switch signals the AEC to terminate the starter cranking action. In the event of an engine overspeed, the speed switch signals the AEC and also effects an engine shutdown. The **OVERSPEED RESET** 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 to reset.

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

A magnetic-pickup mounted in the flywheel housing Fig. 3, provides the input signal for the overspeed switch. The magnetic-pickup senses the speed of the engine by counting flywheel ring gear teeth per second. There should be a 0.03" air gap between the top of the ring gear. With one tooth centered in the magnetic pickup 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.

CALIBRATION

Both crank terminate (SW#1) and overspeed (SW#2) set points, are set at the factory and should not require additional calibration. Adjustments can be made to the set points of SW#1 and/or SW#2 if required using a jewelers screw driver. Turning the corresponding adjustment screw CW to increase or CCW to decrease the set point. To access either adjustment

screw remove the small cover plate on the face of the speed switch located in the Instrument Panel.

Crank terminate (SW#1) adjustment should be done reading "engine crankshaft" speed at the front of the engine using a hand held tachometer. For starter protection and optimum engine stability, this switch should be calibrated to 1000 RPM.

Overspeed (SW#2) adjustment should be done reading "engine crankshaft" speed at the front of the engine using a hand held tachometer. This switch should be calibrated to 120% of rated speed, but never higher than 3300 RPM. Refer to the stainless steel nameplate located on the left rear engine mount for the correct rated speed.

OVERSPEED VARIFICATION

To varyify the function of the overspeed signal (SW#2) without overspeeding the engine, install a jumper wire on terminals "2 & 3" of the speed switch. This will provide the AEC with an overspeed signal and engine shutdown at 67% of the set overspeed RPM.

Start the engine via the AEC, the speed switch will effect an overspeed signal and shutdown protecting both the engine and pump.

EXAMPLE

Rated Speed	: 2100 RPM
Overspeed Shutdown	: 2520 RPM (120% of 2100 RPM)
Varification Shutdown	: 1688 RPM (67% of 2520 RPM)

CAUTION

After varification of SW#2 the jumper wire must be removed and the "reset button" pushed in to re-instate normal operation of the engine and speed switch.

WARNING: All current production PDFP engines use electronic overspeed protection controls. Due to the delicate nature of this device, it is mandatory that diagnostic probing or continuity checks of the circuitry be done with the electrical power off. Probing with any device that causes surges to exceed ratings will damage this control. This warning applies to terminals of the overspeed switch and terminal strip inside the IP. All failed speed switches must be returned to Clarke. Pending inspections will determine if the failed switch is warrantable.

BATTERY CHARGING ALTERNATOR

The belt driven alternator provides power to recharge both battery banks directly through the battery isolator. The battery isolator prevents cross current from one battery bank to the other. The alternator is mounted on the front of the engine as shown in Fig. 4. The alternator belt is driven from the crankshaft pulley.

STARTERS

The DC electric starting motors provide cranking effort to initiate an engine start. Two starters are mounted in the Flywheel Housing (one on each side). Starter #1 is on the left side, #2 on the right side of the engine. When a start signal is received the AEC will automatically alternate starters depending on available voltage. For automatic or test operation the start control signal is initiated from the AEC. Manual start is accomplished at the engine instrument panel. Refer to the panel for detail instructions.

NOTE: An over-running clutch is included on the starter drive to prevent damage from overspeeding.

ALARMS

Two alarm switches provide condition signals to the engine controller. A coolant temperature switch is provided and mounts at the right front of the thermostat housing. When the

coolant temperature reaches 205° F (96° C), the switch closes and causes a light to burn and sounds an alarm bell on the AEC. A dual switch oil pressure switch is also provided. If oil pressure drops to 20 PSI (138 kPA), the normally closed switch returns to a closed position, which causes a light to burn and sound an alarm on the AEC. The normally open switch is used to disable the high temperature circuit when the engine is not running.

Neither a high coolant temperature or a low oil pressure condition will cause the AEC to stop the engine. The alarm bell can be silenced at the AEC. Upon doing so an investigation must be made to determine the cause. AEC lights will continue to burn until the fault is corrected.

BATTERIES

NFPA-20 requires that fire pump systems include two independent battery units. Each battery bank must have capacity, at 40° F (4.5° C), sufficient to maintain cranking speed through a 6 minute cycle (15 seconds cranking and 15 seconds rest, in 12 consecutive cycles). Battery recommendations are shown for each engine on the respective model in Section 5.

BATTERY CABLES

Customer Supplied Battery Cables should be sized as recommended in Section 5.

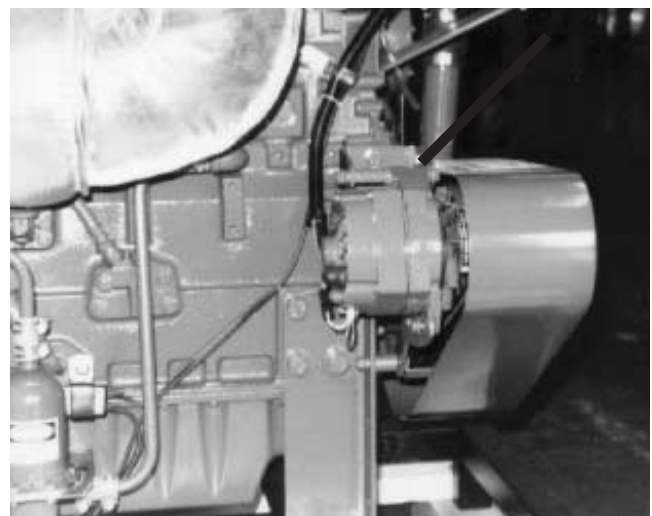


Fig. 4 - Typical Alternator

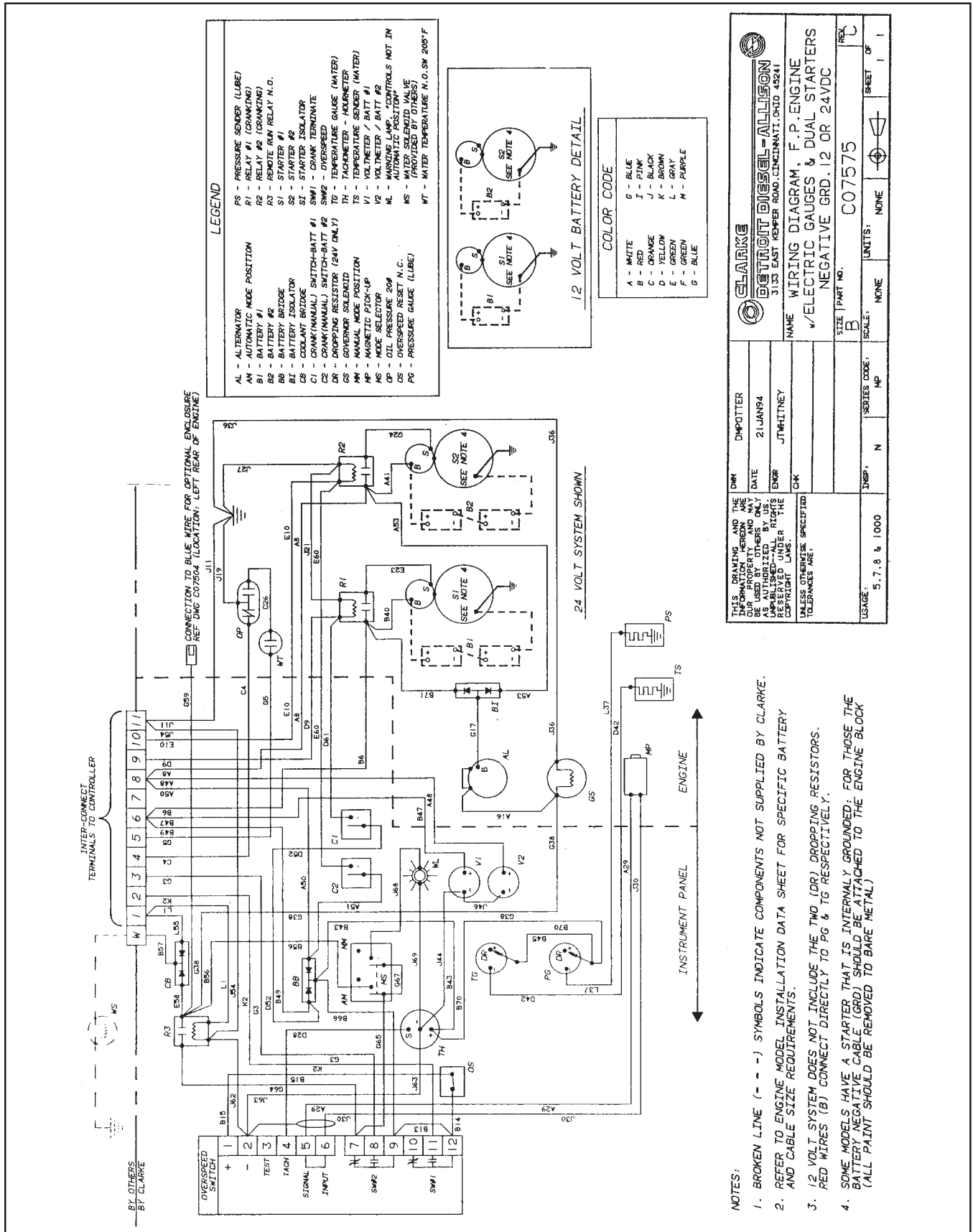
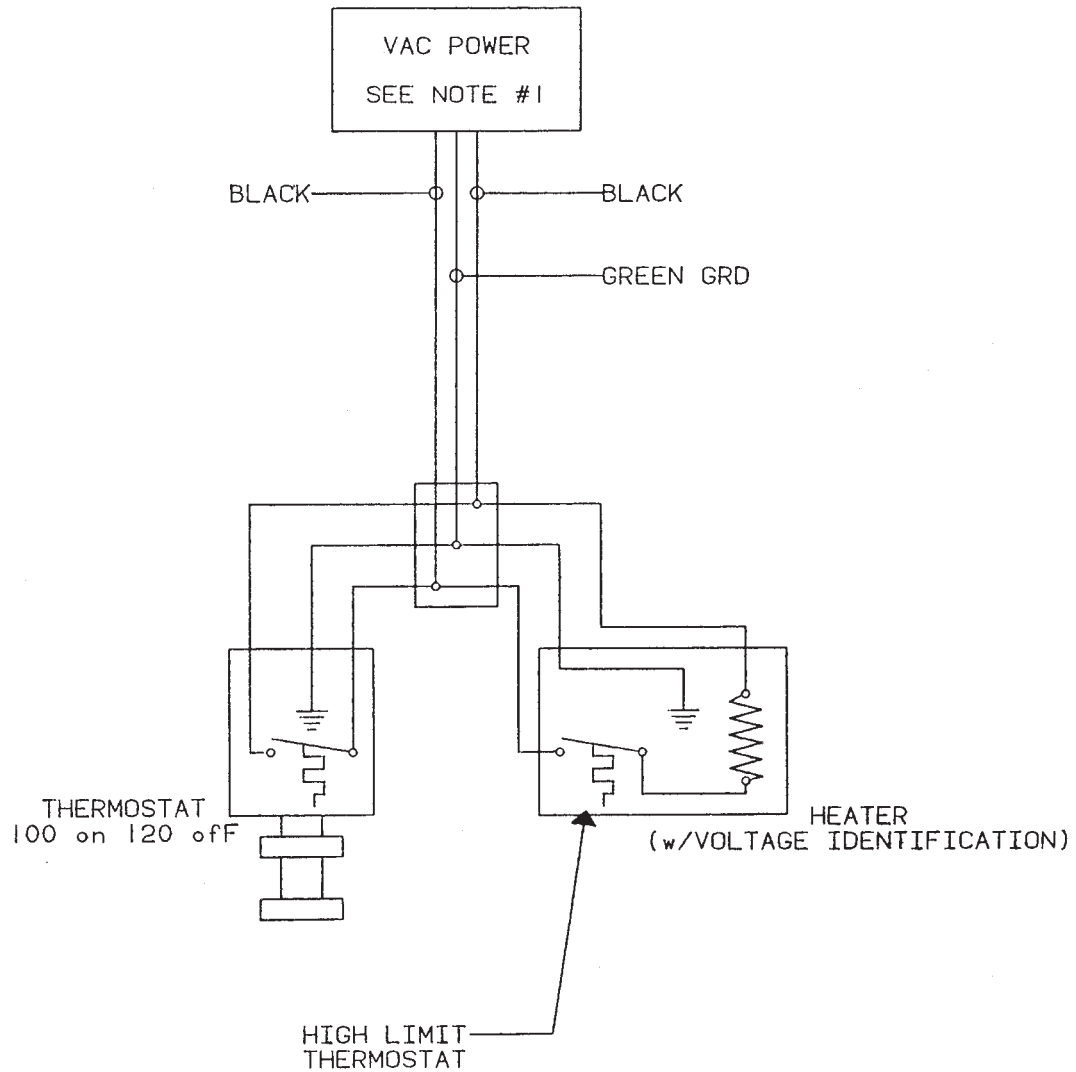


Fig. 5 - DC Wiring Diagram



NOTE #1 VARIIFY HEATER VOLTAGE PRIOR TO CONNECTING TO POWER SOURCE.

A	ISSUED WITH GENERAL CHANGES, ADDED 240VAC.		DMP	<i>[Signature]</i>	08MAR94	
SYM	REVISION		ENGR	APVD	DATE	
THIS DRAWING AND THE INFORMATION HEREON ARE OUR PROPERTY AND MAY BE USED BY OTHERS ONLY AS AUTHORIZED BY US. UNPUBLISHED--ALL RIGHTS RESERVED UNDER THE COPYRIGHT LAWS. UNLESS OTHERWISE SPECIFIED TOLERANCES ARE: DECIMAL .X ±1.5 ±0.06 .XX ±0.8 ±0.03 .XXX ±0.25 ±0.01 FRACTIONAL ±1/32 ANGULAR ±.5°	DWN	DMPOTTER	© CLARKE DETROIT DIESEL-ALLISON 3133 EAST KEMPER ROAD, CINCINNATI, OHIO 45241			
	DATE	01MAR94				
	ENGR	JTWHITNEY	NAME	WIRING DIAGRAM, JACKET WATER HEATER 120/240VAC - 1500 WATTS		
	CHK		SIZE	PART NO.	REV A	
USAGE: 1000 SERIES	INSP	SERIES CODE	SCALE	UNITS	SHEET OF	
	Y	MP	NONE	NONE	1 1	

Fig. 6 - AC Wiring Diagram Jacket Water Heater

WIRING DIAGRAM

In this section two wiring diagrams are provided Fig. 5, Drawing C07575 for DC circuits, Fig. 6, Drawing C07591 for AC circuits. All DC wiring is color coded on PDFP engines up to the strip connector inside the instrument panel. Connections made to the AEC from this point are the responsibility of

the installing contractor. The only AC wiring requirement is for the Engine Heaters. This is also the responsibility of the installing contractor.

NOTE: The Engine Coolant Heater is not to be energized unless the cooling system is filled.

MAINTENANCE AND SERVICE PROCEDURES

ENGINE HEATER

The engine heaters are required by NFPA-20 specification to maintain the engine coolant temperature. Check the engine temperature gauge. Temperature will cycle approximately 20° F (– 7° C). See Fig. 6 for AC wiring, diagram.

- A. Condition: - Maintains Temperature
Service: - No Service Required
- B. Condition: - Engine coolant at room temperature
Service: - 1. Check 120V-AC POWER SOURCE.
2. Check wiring connections.
3. Check thermostat function.
4. Replace element if defective.

CAUTION: DISCONNECT AC POWER TO HEATER SYSTEM BEFORE DRAINING ENGINE COOLANT.

INSTRUMENTS

Check instruments while running unit to be sure they are functional. Replace broken or defective instruments. If hour-meter is replaced, record accumulated hours from replaced hourmeter.

BATTERY CHARGING ALTERNATOR

Inspect the terminals for corrosion and loose connections and the wiring for broken wires. Replace or repair as necessary. Service alternator with authorized service dealer.

New standard V-belts will stretch after the first few hours of operation. Run the engine for 15 minutes to seat the belts, then readjust the tension. Check the belts and tighten after 1/2 hour and again after 6 months. Thereafter, check the tension of the

drive belts every 6 months and adjust if necessary as described in the drive belts section on Page 8.

Refer to "Important" Pg. 9 to turn off the AEC. Run engine by following steps 1-3 Pg. 33 "To Start Engine". While engine is running check the voltages on the instrument panel to verify a 12 volt system. Stop the engine by following step 1-2 Pg. 34 "To Stop Engine" and return the AEC selector to "Automatic" position and the manual operating lever to AUTO-OFF position.

STARTER

Inspect the terminals for corrosion and loose connections and the wiring for broken wires. Replace or repair as necessary. Service alternator with authorized service dealer.

BATTERIES

Check the specific gravity of the electrolyte in each cell of the battery each week. In warm weather it should be checked more frequently due to a more rapid loss of water from the electrolyte. The electrolyte level should be maintained in accordance with the battery manufacturer's recommendations. Keep all terminals clean and free from corrosion.

NOTE: Coating terminal connection with petroleum jelly will prevent rapid corrosion buildup.

WIRING SYSTEM

Annually, open the instrument panel to check tightness of all terminal connections. Additionally, reference DC wiring diagram, Fig. 5, Page 37, and check tightness of all terminal connections. Use caution during this process to prevent unintentional grounding of any circuits which may cause damage.

FALK COUPLING

Many PDFP engines shipped, are equipped with a standard FALK drive hub, (engine half only).

If your engine includes this type coupling, please read this Section for service and maintenance information.

Other pump drive options are available such as a standard engine flywheel which can be purchased through Clarke or for vertical turbine drives please refer to the OEM Pump manuals.

FALK
a good name in industry™

Steelflex® Couplings • Installation and Maintenance

Type T10 • Sizes 1020 –1140 & 20–140

(Page 1 of 6)

How To Use This Manual

This manual provides detailed instructions on maintenance, lubrication, installation, and parts identification. Use the table of contents below to locate required information.

Table of Contents

Introduction.....	Page 1
Lube Fittings.....	Page 1
Limited End Float.....	Page 1
Lubrication.....	Pages 1-2
Installation & Alignment Instructions.....	Pages 2-4
Annual Maintenance, Relube & Disassembly.....	Page 4
Installation & Alignment Data.....	Page 5
Parts Identification & Parts Interchangeability.....	Page 6

CAREFULLY FOLLOW THE INSTRUCTIONS IN THIS MANUAL FOR OPTIMUM PERFORMANCE AND TROUBLE FREE SERVICE.

INTRODUCTION

This manual applies to Sizes 1020T thru 1140T and 20T thru 140T10 Falk Steelflex Tapered Grid Couplings. Unless otherwise stated, information for Sizes 1020T thru 1140T applies to Sizes 20T thru 140T respectively, e.g. 1020T = 20T, 1100T = 100T, etc. These couplings are designed to operate in either the horizontal or vertical position without modification. Beginning in 1994, these couplings are being supplied with one set of inch series fasteners and one set of metric fasteners. Use either set of fasteners, depending on your preference. Refer to Page 6 for part interchangeability.

The performance and life of the couplings depend largely upon how you install and service them. Carefully follow the instructions in this manual for optimum performance and trouble free service.

CAUTION: Consult applicable local and national safety codes for proper guarding of rotating members. Observe all safety rules when installing or servicing couplings.

WARNING: Lockout starting switch of prime mover and remove all external loads from drive before installing or servicing couplings.

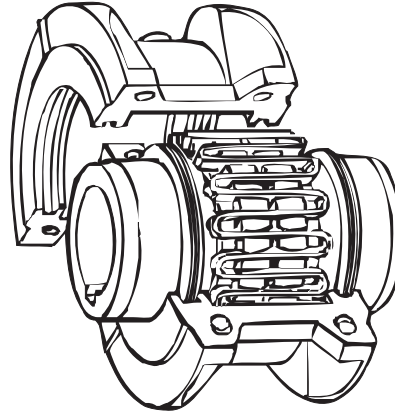
LUBE FITTINGS

Cover halves have 1/8 NPT lube holes. Use a standard grease gun and lube fitting as instructed on Page 4.

LIMITED END FLOAT

When electric motors, generators, engines, compressors and other machines are fitted with sleeve or straight roller bearings, limited axial end float kits are recommended for protecting the bearings. Falk Steelflex couplings are easily modified to limit end float; refer to Manual 428-820 for instructions.

TYPE T10 STEELFLEX COUPLING



LUBRICATION

Adequate lubrication is essential for satisfactory operation. Page 2 provides a list of typical lubricants and specifications for general purpose and long term greases. Because of its superior lubricating characteristics and low centrifuge properties, Falk Long Term Grease (LTG) is highly recommended. Sizes 1020T to 1090T10 are furnished with a pre-measured amount of grease for each coupling. The grease can be ordered for larger size couplings.

The use of general purpose grease requires re-lubrication of the coupling at least annually.

Long Term Grease (LTG)

The high centrifugal forces encountered in couplings separate the base oil and thickener of general purpose greases. Heavy thickener, which has no lubrication qualities, accumulates in the grid-groove area of Steelflex couplings resulting in premature hub or grid failure unless periodic lubrication cycles are maintained.

Falk Long Term Grease (LTG) was developed specifically for couplings. It resists separation of the oil and thickener and is an extreme pressure grease.

Steelflex couplings initially lubricated with LTG will not require re-lubrication until the connected equipment is stopped for servicing. If a coupling leaks grease, is exposed to extreme temperatures, excessive moisture, or experiences frequent reversals, more frequent lubrication may be required.

Although LTG grease is compatible with most other coupling greases, the mixing of greases may dilute the benefits of LTG.

USDA Approval

LTG has the United States Department of Agriculture Food Safety & Inspection Service approval for applications where there is no possibility of contact with edible products. (H-2 ratings).

CAUTION: Do not use LTG in bearings.

Installation and Maintenance • Steelflex® Couplings

(Page 2 of 6)

Type T10 • Sizes 1020 –1140 & 20–140

**Specifications — Falk LTG**

The values shown are typical and slight variations are permissible.

AMBIENT TEMPERATURE RANGE — -20°F (-29°C) to 250°F (121°C).

MINIMUM BASE OIL VISCOSITY — 3300SSU (715cST) @ 100°F (38°C)

THICKENER — less than 12% by weight.

CENTRIFUGE SEPARATION CHARACTERISTICS — ASTM #D4425 (Centrifuge Test) — K36 = 2/24 max., very high resistance to centrifuging.

NLGI GRADE (ASTM D-217) — 1/2

MINIMUM DROPPING POINT — with 60 stroke worked penetration value in the range of 320 to 365 — 350°F (177°C) min.

MINIMUM TIMKEN O.K. LOAD — 40 lbs.

ADDITIVES — Rust and oxidation inhibitors that do not corrode steel or swell or deteriorate synthetic seals.

Packaging

14 OZ. CARTRIDGES — For use in standard grease guns. Sufficient quantity to initially lubricate sizes thru 1090T.

35 LB. PAIL — Ideal for larger size couplings or many smaller sizes.

120 LB. KEG & 400 LB. DRUM — For plants with central storage areas. A pump with a pressurized follower plate is required for dispensing grease.

CASE LOTS OF 24-14 OZ. CARTRIDGES — also available.

General Purpose Grease

Annual Lubrication — The following specifications and lubricants for general purpose grease apply to Falk Steelflex couplings that are lubricated annually and operate within ambient temperatures of 0°F to 150°F (-18°C to 66°C). For temperatures beyond this range (see Table 1), consult the Factory.

If a coupling leaks grease, is exposed to extreme temperatures, excessive moisture or experiences frequent reversals, more frequent lubrication may be required.

Specifications — General Purpose Coupling Lubricants

The values shown are typical and slight variations are permissible.

DROPPING POINT — 300°F (149°C) or higher.

CONSISTENCY — NLGI No. 2 with 60 stroke worked penetration value in the range of 250 to 300.

SEPARATION AND RESISTANCE — Low oil separation rate and high resistance to separation from centrifuging.

LIQUID CONSTITUENT — Possess good lubricating properties ... equivalent to a high quality, well refined petroleum oil.

INACTIVE — Must not corrode steel or cause swelling or deterioration of synthetic seals.

CLEAN — Free from foreign inclusions.

General Purpose Greases Meeting Falk Specifications

Lubricants listed below are typical products only and should not be construed as exclusive recommendations.

TABLE 1 — General Purpose Greases

Ambient Temperature Range	0°F to 150°F (-18°C to +66°C)	-30°F to 100°F (-34°C to +38°C)
NLGI Grade	#2	#2
Manufacturer	Lubricant ²	Lubricant ²
Amoco Oil Co.	Amolith Grease #2	Amolith Grease #2
Atlantic Richfield Co.	Litholene HEP 2	Litholene HEP 2
Chevron U.S.A. Inc.	Chevron Dura-Lith EP-2	Chevron Dura-Lith EP 2
Cities Service Co.	Citgo HEP-2	Citgo HEP 2
Conoco Inc.	EP Conolith #2	EP Conolith #2
Exxon Company, USA	Ronex MP	Ronex MP
Gulf Oil Corp.	Gulfcrown Grease #2	Gulfcrown Grease #2
E. F. Houghton & Co.	Cosmolube #2	Cosmolube #1
Imperial Oil Ltd.	Esso MP Grease H	Lotemp EP
Kendall Refining Co.	Kenlube L-421 Grease	Kenlube L-427 Grease
Keystone Div. (Pennwalt)	#81 Light	#84 Light
Mobil Oil Corp.	Mobilux EP 111	Mobilux #1
Phillips Petroleum Co.	IB & RB Grease	Philube IB & RB Grease
Shell Oil Co.	Alvania Grease #2	Alvania Grease #2
Standard Oil Co. (OH)	Factran #2	Factran #2
Sun Oil Company	Prestige 42	Prestige 42
Texaco Lubricants	Starplex HD2	Multifak EP2
Texaco Canada Inc.	Marfak HD 2	Marfak AP
Union Oil Co. (CA)	Union Unoba #2	Union Unoba #2
Valvoline Oil Co.	Val-Lith EP #2	Val-Lith EP #2

¹ For northern climate applications. For continuous operation at constant ambient temperatures less than 0°F (-18°C) — for example, refrigeration systems; consult The Falk Corporation.

² Lubricants listed may not be suitable for use in the food processing industry; check with lube manufacturer for approved lubricants.

INSTALLATION OF TYPE T10 STEELFLEX TAPERED GRID COUPLINGS**Installation**

Only standard mechanics tools, wrenches, a straight edge and feeler gauges are required to install Falk Steelflex couplings. Coupling Sizes 1020T thru 1090T are generally furnished for CLEARANCE FIT with setscrew over the keyway. Sizes 1100T and larger are furnished for an INTERFERENCE FIT without a setscrew.

CLEARANCE FIT HUBS — Clean all parts using a non-flammable solvent. Check hubs, shafts and keyways for burrs. Do not heat clearance fit hubs. Install keys, mount hubs with flange face flush with shaft ends or as otherwise specified and tighten setscrews.

INTERFERENCE FIT HUBS — Furnished without setscrews. Heat hubs to a maximum of 275°F (135°C) using an oven, torch, induction heater or an oil bath.

When an oxy-acetylene or blow torch is used, use an excess acetylene mixture. Mark hubs near the center of their length in several places on hub body with a temperature sensitive crayon, 275°F (135°C) melt temperature. Direct flame towards hub bore using constant motion to avoid overheating an area.

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WARNING: If an oil bath is used, the oil must have a flash point of 350°F (177°C) or higher. Do not rest hubs on the bottom of the container. Do not use an open flame in a combustible atmosphere or near combustible materials.

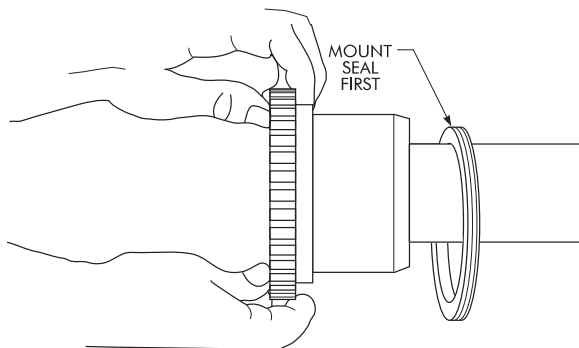
Heat hubs as instructed above. Mount hubs as quickly as possible with hub flange face flush with shaft end. Allow hubs to cool before proceeding. Insert setscrews (if required) and tighten.

Maximize Performance And Life

The performance and life of couplings depend largely upon how you install and maintain them. Before installing couplings, make certain that foundations of equipment to be connected meet manufacturers' requirements. Check for soft foot. The use of stainless steel shims is recommended. Measuring misalignment and positioning equipment within alignment tolerances is simplified with an alignment computer. These calculations can also be done graphically or mathematically.

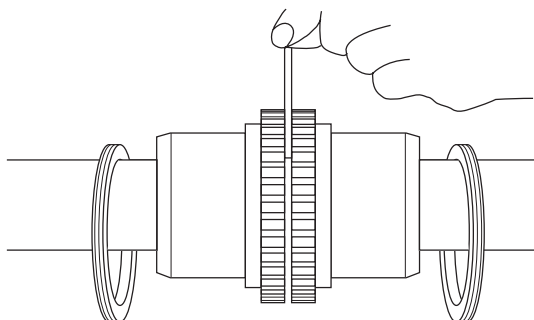
Alignment is shown using spacer bar and straight edge. This practice has proven to be adequate for many industrial applications. However, for superior final alignment, the use of dial indicators (see Manual 458-834 for instructions), lasers, alignment computers or graphical analysis is recommended.

1 — Mount Seals And Hubs



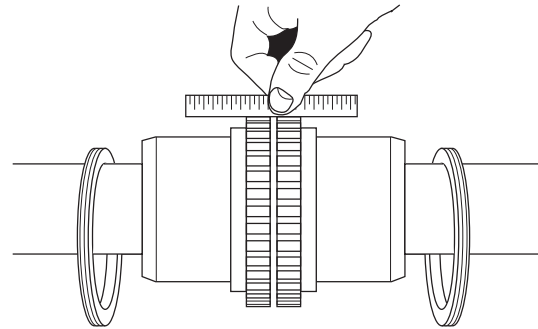
Lock out starting switch of prime mover. Clean all metal parts using a non-flammable solvent. Lightly coat seals with grease and place on shafts BEFORE mounting hubs. Heat interference fit hubs as previously instructed. Seal keyways to prevent leakage. Mount hubs on their respective shafts so the hub face is flush with the end of its shaft unless otherwise indicated. Tighten setscrews when furnished.

2 — Gap and Angular Alignment



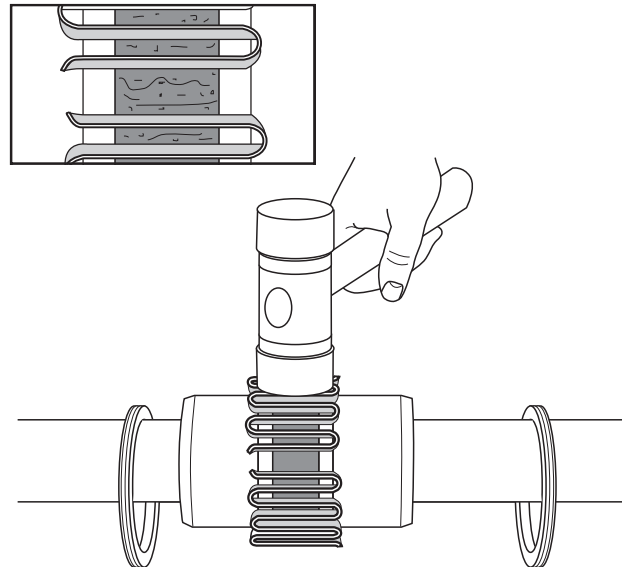
Use a spacer bar equal in thickness to the gap specified in Table 2, Page 5. Insert bar as shown below left, to same depth at 90° intervals and measure clearance between bar and hub face with feelers. The difference in minimum and maximum measurements must not exceed the ANGULAR installation limits specified in Table 2.

3 — Offset Alignment



Align so that a straight edge rests squarely (or within the limits specified in Table 2) on both hubs as shown above and also at 90° intervals. Check with feelers. The clearance must not exceed the PARALLEL OFFSET installation limits specified in Table 2. Tighten all foundation bolts and repeat Steps 2 and 3. Realign coupling if necessary.

4 — Insert Grid



Pack gap and grooves with specified lubricant before inserting grid. When grids are furnished in two or more segments, install them so that all cut ends extend in the same direction (as detailed in the exploded view picture above); this will assure correct grid contact with non-rotating pin in cover halves. Spread the grid slightly to pass over the coupling teeth and seat with a soft mallet.

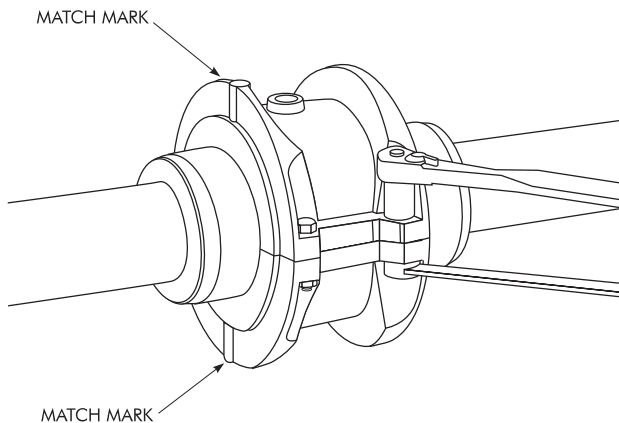
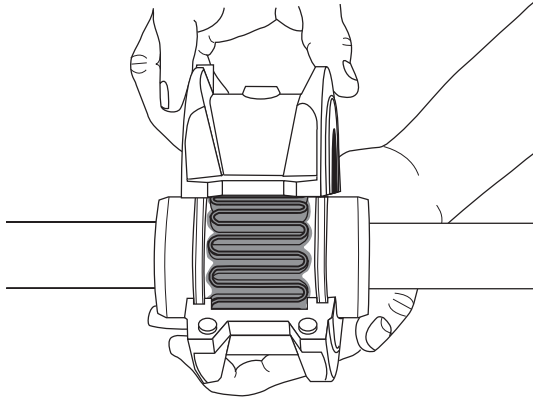
Installation and Maintenance • Steelflex® Couplings

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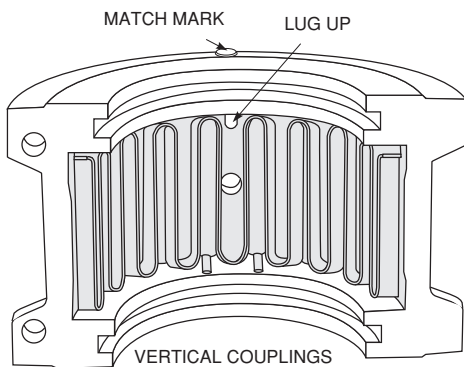
Type T10 • Sizes 1020 –1140 & 20–140

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5 — Pack With Grease And Assemble Covers



Pack the spaces between and around the grid with as much lubricant as possible and wipe off excess flush with top of grid. Position seals on hubs to line up with grooves in cover. Position gaskets on flange of lower cover half and assemble covers so that the match marks are on the same side (see above). If shafts are not level (horizontal) or coupling is to be used vertically, assemble cover halves with the lug and match mark



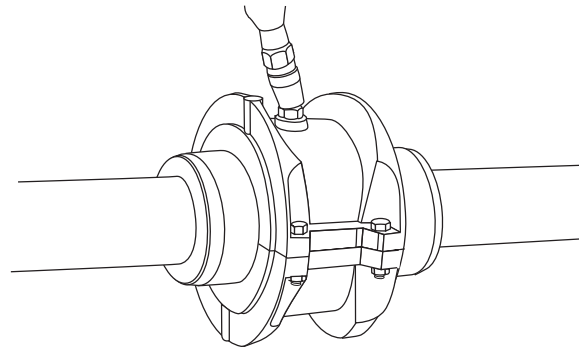
UP or on the high side. Push gaskets in until they stop against the seals and secure cover halves with fasteners, tighten to torque specified in Table 2. Make sure gaskets stay in position during tightening of fasteners. **CAUTION:** Make certain lube plugs are installed before operating.

ANNUAL MAINTENANCE

For extreme or unusual operating conditions, check coupling more frequently.

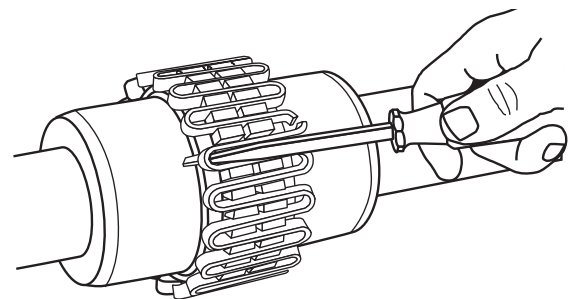
1. Check alignment per steps on Page 3. If the maximum operating misalignment limits are exceeded, realign the coupling to the recommended installation limits. See Table 2 for installation and operating alignment limits.
2. Check tightening torques of all fasteners.
3. Inspect seal ring and gasket to determine if replacement is required. If leaking grease, replace.
4. When connected equipment is serviced, disassemble the coupling and inspect for wear. Replace worn parts. Clean grease from coupling and repack with new grease. Install coupling using new gasket as instructed in this manual.

Periodic Lubrication



The required frequency of lubrication is directly related to the type of lubricant chosen, and the operating conditions. Steelflex couplings lubricated with common industrial lubricants, such as those shown in Table 1, should be relubed annually. The use of Falk Long Term Grease (LTG) will allow relube intervals to be extended to beyond five years. When relubing, remove both lube plugs and insert lube fitting. Fill with recommended lubricant until an excess appears at the opposite hole. **CAUTION:** Make certain all plugs have been inserted after lubricating.

Coupling Disassembly And Grid Removal



Whenever it is necessary to disconnect the coupling, remove the cover halves and grid. A round rod or screwdriver that will conveniently fit into the open loop ends of the grid is required. Begin at the open end of the grid section and insert the rod or screwdriver into the loop ends. Use the teeth adjacent to each loop as a fulcrum and pry the grid out radially in even, gradual stages, proceeding alternately from side to side.



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Type T10 • Sizes 1020 –1140 & 20–140 (Page 5 of 6)

TYPE T COUPLING INSTALLATION & ALIGNMENT DATA

Maximum life and minimum maintenance for the coupling and connected machinery will result if couplings are accurately aligned. Coupling life expectancy between initial alignment and maximum operating limits is a function of load, speed and lubrication. Maximum operating values listed in Table 2 are based on cataloged allowable rpm.

Values listed are based upon the use of the gaps listed, standard coupling components, standard assemblies and cataloged allowable speeds.

Values may be combined for an installation or operating condition. Example: 1060T max. operating misalignment is .016" parallel plus .018" angular.

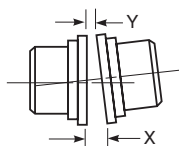
NOTE: For applications requiring greater misalignment, refer application details to the Factory.

Angular misalignment is dimension X minus Y as illustrated below.

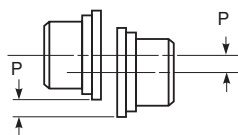
Parallel misalignment is distance P between the hub center lines as illustrated below.

End float (with zero angular and parallel misalignment) is the axial movement of the hubs(s) within the cover(s) measured from "O" gap.

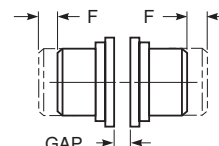
ANGULAR MISALIGNMENT



PARALLEL MISALIGNMENT



END FLOAT



Size	Installation Limits						Operating Limits						Cover Fastener Tightening Torque Values		Allow Speed (rpm)	Lube Wt.	
	Parallel Offset-P		Angular (x-y)		Hub Gap 10%		Parallel Offset-P		Angular (x-y)		End Float Physical Limit (Min.) 2 x F		In. Series Fasteners (lb-in.)	Metric Fasteners (Nm)		lb.	kg
	Max. In.	Max. mm	Max. In.	Max. mm	In.	mm	Max. In.	Max. mm	Max. In.	Max. mm	In.	mm					
1020T	.006	.15	.003	.08	.125	3	.012	.30	.010	.25	.210	5.33	100	11.3	4500	.06	.03
1030T	.006	.15	.003	.08	.125	3	.012	.30	.012	.30	.198	5.03	100	11.3	4500	.09	.04
1040T	.006	.15	.003	.08	.125	3	.012	.30	.013	.33	.211	5.36	100	11.3	4500	.12	.05
1050T	.008	.20	.004	.10	.125	3	.016	.41	.016	.41	.212	5.38	200	23.6	4500	.15	.07
1060T	.008	.20	.005	.13	.125	3	.016	.41	.018	.46	.258	6.55	200	23.6	4350	.19	.09
1070T	.008	.20	.005	.13	.125	3	.016	.41	.020	.51	.259	6.58	200	23.6	4125	.25	.11
1080T	.008	.20	.006	.15	.125	3	.016	.41	.024	.61	.288	7.32	200	23.6	3600	.38	.17
1090T	.008	.20	.007	.18	.125	3	.016	.41	.028	.71	.286	7.26	200	23.6	3600	.56	.25
1100T	.010	.25	.008	.20	.188	5	.020	.51	.033	.84	.429	10.90	312	35	2440	.94	.43
1110T	.010	.25	.009	.23	.188	5	.020	.51	.036	.91	.429	10.90	312	35	2250	1.1	.51
1120T	.011	.28	.010	.25	.250	6	.022	.56	.040	1.02	.556	14.12	650	73	2025	1.6	.74
1130T	.011	.28	.012	.30	.250	6	.022	.56	.047	1.19	.551	14.00	650	73	1800	2.0	.91
1140T	.011	.28	.013	.33	.250	6	.022	.56	.053	1.35	.571	14.50	650	73	1650	2.5	1.14

TABLE 3 — Coupling Cover Fastener Identification

SIZE	INCH SERIES FASTENERS				METRIC FASTENERS	
	Old Style		New Style			
1020-1070T10		SAE Grade 8		SAE Grade 8		Property Class 10.9
1080-1090T10		SAE Grade 8		SAE Grade 8		Property Class 10.9
1100-1140T10		SAE Grade 5		SAE Grade 5		Property Class 8.8

¹ Older style covers, Sizes 1020T10 thru1070T10 must utilize socket head cap screws and locknuts held by the cover.

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Type T10 • Sizes 1020 –1140 & 20–140

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PARTS IDENTIFICATION

All coupling parts have identifying part numbers as shown below. Parts 3 and 4 (Hubs and Grids), are the same for both Type T10 and T20 couplings. All other coupling parts are unique to Type T10. When ordering parts, always SPECIFY SIZE and TYPE shown on the COVER.

PARTS INTERCHANGEABILITY

Parts are interchangeable between Sizes 20T and 1020T, 30T and 1030T, etc. except as noted.

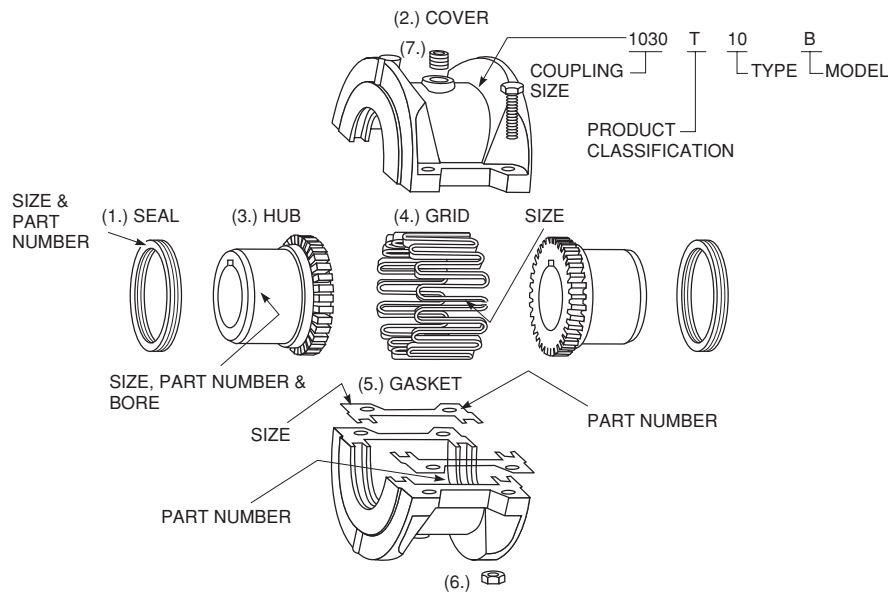
GRIDS — Size 1020T thru 1140T Steelflex couplings use blue grids. Older models, 20T thru 140T, use orange grids.

CAUTION: Blue grids may be used in all applications, but DO NOT substitute orange grids for blue.

COVERS — **CAUTION:** DO NOT mix cover halves of different designs. Sizes 1020T thru 1070T10 covers have been manufactured in several different two-rib designs and 80T thru 140T covers have been manufactured with two and three ribs.

HARDWARE ó Older style covers, Sizes 1020T10 thru 1070T10, utilized socket head cap screws with captured locknuts. The new style covers use hex head cap screws (either inch or metric) and unrestrained locknuts. Specify either inch series SOCKET head or inch or metric series HEX head cap screws when ordering replacement parts.

PART NUMBER LOCATION



PART NUMBERS

1. Seal (T10)
2. Cover (T10)
3. Hub (Specify bore and keyway)
4. Grid
5. Gasket (T10)
6. Fasteners (T10) ó Coupling may be supplied with one set each of inch series fasteners and metric fasteners.
7. Lube Plug

ORDER INFORMATION

1. Identify part(s) required by name above.
2. Furnish the following information.

EXAMPLE:

Coupling Size: 1030
Coupling Type: T10
Model: B
Bore: 1.375
Keyway: .375 x .187

3. Price parts from Price List 422-110 and appropriate discount sheet.

ENGINE TUNE-UP

There is no scheduled interval for performing an engine tune-up. As long as the engine is performing satisfactorily, no tune-up should be necessary.

SPEED CONTROL

The engine speed is pre-set at the factory to provide the horsepower indicated on the FM/UL nameplate. In accordance

with NFPA-20 requirements, this is a tamper-proof mechanism.

NOTE: This engine has no idle speed setting.

If engine performance is not satisfactory, contact your local Distributor/Dealer for assistance.

MECHANICAL GOVERNOR - SPEED ADJUSTMENT

A mechanical governor controls the engine speed. The governor on the PDFP engines is built into the fuel injection pump located on the left side of the engine. Figure 1 shows the governor and pump location on each engine.

All governors are adjusted to the FM/UL/ULC nameplate BHP and **full load** pump speed 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 Distributor Dealer representative.

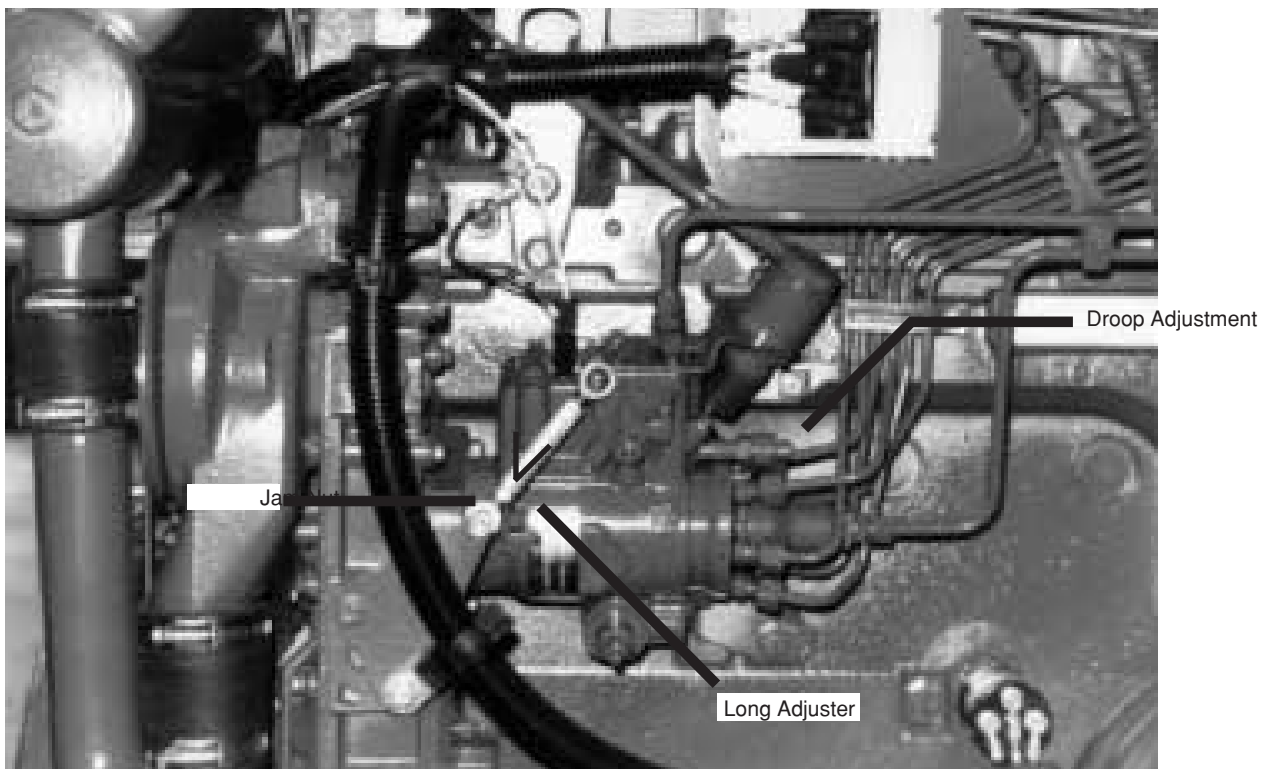


Figure 1 - Governor and Pump Location (Adjustments)

To adjust the speed on the PDFP engines requires adjustments of two settings on the governor. The first is the droop setting, and second is the speed setting which are accomplished as follows:

1.) Droop Adjustment:

A.) This adjustment requires a standard screwdriver and is located on the rear of the governor as shown in Figure 1.

B.) Rotate the set screw counter clockwise until it stops.

CAUTION: Do not use excess force.

C.) If the speed setting you require is between 1470 RPM and 1900 RPM turn the set screw clockwise one full turn, and if the speed you require is between 2100 RPM and 3000 RPM turn the set screw $4\frac{1}{2}$ times clockwise.

2.) Speed Adjustment:

A.) Start engine by following the "Important" instructions on Page 9 and manual starting instructions on Page 33.

B.) Let the engine warm-up. Loosen the jam nut (Fig. 1).

C.) While observing the instrument panel tach rotate the long adjustor clockwise to lower the RPM and counter clockwise to raise the RPMs, until desired speed is obtained (shown in Figure 1).

D.) Holding secure the long adjustor with a wrench tighten the jam nut.

E.) Stop engine by following "To Stop Engine" on Page 34.

TECHNICAL DATA

This section includes the Installation and Operating Data for all PDFP engine models. Additionally, the basic Engine Materials and Construction are also provided. The specific model and page reference are listed below.

Engine Model	Installation & Operation Data Page	Engine Mat'l & Construction Page
PDFP-L4YN	48 - A - 1 & 2	48 - Z - 1
PDFP-L4YT	48 - B - 1 & 2	48 - Z - 2
PDFP-04YT	48 - C - 1 & 2	48 - Z - 2
PDFP-L6YN	48 - D - 1 & 2	48 - Z - 1
PDFP-L6YT	48 - E - 1 & 2	48 - Z - 2
PDFP-06YT	48 - F - 1 & 2	48 - Z - 2
PDFP-L6YW	48 - G - 1 & 2	48 - Z - 2

	Fig.	Page
Engine Control Wiring Diagram - DC	5	37
Engine Heater Wiring Diagram - AC	6	38

PDFP-L4YN INSTALLATION & OPERATION DATA

Basic Engine Description	All Speeds
Engine Manufacturer	Perkins/Detroit Diesel
Ignition Type	Compression (Diesel)
Number of Cylinders	4
Bore and Stroke - in. (mm).....	3.937 (100) 5.0 (127)
Displacement - in. ³ (L)	243 (3.99)
Compression Ratio	16.5:1
Combustion System	Direct Injection
Engine Type.....	In-Line, 4 Cycle
Aspiration	Natural
Firing Order (CW Rotation)	1 - 3 - 4 - 2
Charge Air Cooling Type	None
Rotation (Viewed from Front)	
Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System.....	Open
Dimensions and Weight	
Length - in. (mm) (From Drive Flange).....	38.2 (971)
Width - in. (mm)	26.1 (663)
Height - in. (mm) (Above Crankshaft Center Line)	32.6 (828)
Weight, Dry - lb. (kg)	996 (452)
Wet - lb. (kg)	1054 (478)
Installation Drawing	D-472

Cooling System	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.)	32 (34)	35 (37)	39 (41)	42 (44)	45 (47)
Engine Radiated Heat - Btu/sec. (kJ/sec.).....	6 (6.3)	6.5 (6.9)	7.6 (8.0)	8.3 (8.8)	9.2 (9.7)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.)	3.9 (15)	4.6 (17)	6.2 (23)	6.7 (25)	7 (26)
95°F Raw H ₂ O - gal./min. (L/min.)	4.3 (16)	4.9 (18)	6.6 (25)	7 (26)	8.4 (32)
Heat Exchanger Maximum Cooling H ₂ O					
Inlet Pressure - lb./in. ² (kPa)			60 (414)		
Flow - gal./min. (L/min.)			40 (151)		
Thermostat, Start to Open - °F (°C)			170 (77)		
Fully Open - °F (°C)			198 (92)		
Engine Coolant Capacity - qt. (L)			21 (20)		
Coolant Pressure Cap - lb./in. ² (kPa)			9 (62)		
Maximum Engine H ₂ O Temperature - °F (°C).....			200 (93)		
Minimum Engine H ₂ O Temperature - °F (°C).....			160 (71)		

Electric System - DC	All Speeds
System Voltage (Nominal)	12
Battery Capacity for Ambients Above 32°F - CCA @ 0°F	640
Voltage (Nominal)	12
Qty. per Battery Bank	1
SAE size per J537	4D-640
Battery Cable Circuit*, Max Resistance - ohm	0.0017
Battery Cable Minimum Size	
0-120 in. Circuit* Length	No. 00
121-160 in. Circuit* Length	No. 000
161-200 in. Circuit* Length	No. 0000
Charging Alternator Output - Amp.	42
Starter Cranking Amps - @ 60° F	275

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

(Continued)
Page 48-A-1

PDFP-L4YN INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	242 (6.8)	319 (9.0)	357 (10)	414 (12)	429 (12)
Exhaust Temperature - °F (°C).....	923 (495)	1127 (608)	1088 (587)	1175 (635)	1097 (592)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	2.5 (64)	2.5 (64)	2.5 (64)	2.5 (64)	2.5 (64)

Fuel System	1470	1760	2100	2350	2600
Fuel Consumption - gal./hr. (L/hr.)	2.0 (7.6)	3.0 (11)	3.4 (13)	4.0 (15)	4.1 (16)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary			5		
Fuel Modulator/Setting			None/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	26 (6.5)	26 (6.5)	26 (6.5)	26 (6.5)	26 (6.5)
Clean Air Cleaner - in. H ₂ O (kPa)	12 (3.0)	12 (3.0)	12 (3.0)	12 (3.0)	12 (3.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	94 (2.6)	108 (3.1)	124 (3.5)	136 (3.8)	148 (4.2)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)***			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	7.3 (6.9)
Low - qt. (L).....	5.9 (5.6)
Total Oil Capacity with Filters - qt. (L).....	8.0 (7.6)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)					92.5 (638)
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve			CDDA - Y044 - 01		

**Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)

PDFP-L4YT INSTALLATION & OPERATION DATA

Basic Engine Description	All Speeds				
Engine Manufacturer.....	Perkins/Detroit Diesel				
Ignition Type.....	Compression (Diesel)				
Number of Cylinders.....	4				
Bore and Stroke - in. (mm).....	3.937 (100) 5.0 (127)				
Displacement - in. ³ (L).....	243 (3.99)				
Compression Ratio.....	16:1				
Combustion System.....	Direct Injection				
Engine Type.....	In-Line, 4 Cycle				
Aspiration.....	Turbocharged				
Firing Order (CW Rotation).....	1 - 3 - 4 - 2				
Charge Air Cooling Type.....	None				
Rotation (Viewed from Front)					
Clockwise.....	Standard				
Counter-Clockwise.....	Not Available				
Engine Crankcase Vent System.....	Open				
Dimensions and Weight					
Length - in. (mm) (From Drive Flange).....	38.2 (971)				
Width - in. (mm).....	25.5 (648)				
Height - in. (mm) (Above Crankshaft Center Line).....	32.6 (828)				
Weight, Dry - lb. (kg).....	1020 (463)				
Wet - lb. (kg).....	1080 (490)				
Installation Drawing.....	D-472				
Cooling System	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.).....	32 (34)	34 (36)	39 (41)	42 (44)	45 (48)
Engine Radiated Heat - Btu/sec. (kJ/sec.).....	6.7 (7.1)	7.5 (7.9)	8.8 (9.3)	9.7 (10)	10 (11)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.).....	4.2 (16)	4.8 (18)	5.7 (22)	7.2 (27)	8.4 (32)
95°F Raw H ₂ O - gal./min. (L/min.).....	5.5 (21)	6.0 (23)	7.8 (30)	8.4 (32)	10.5 (40)
Heat Exchanger Maximum Cooling H ₂ O					
Inlet Pressure - lb./in. ² (kPa).....	60 (414)				
Flow - gal./min. (L/min.).....	40 (151)				
Thermostat, Start to Open - °F (°C).....	170 (77)				
Fully Open - °F (°C).....	198 (92)				
Engine Coolant Capacity - qt. (L).....	22 (21)				
Coolant Pressure Cap - lb./in. ² (kPa).....	9 (62)				
Maximum Engine H ₂ O Temperature - °F (°C).....	200 (93)				
Minimum Engine H ₂ O Temperature - °F (°C).....	160 (71)				
Electric System - DC	All Speeds				
System Voltage (Nominal).....	12				
Battery Capacity for Ambients Above 32°F - CCA @ 0°F.....	640				
Voltage (Nominal).....	12				
Qty. per Battery Bank.....	1				
SAE size per J537.....	4D-640				
Battery Cable Circuit*, Max Resistance - ohm.....	0.0017				
Battery Cable Minimum Size					
0-120 in. Circuit* Length.....	No. 00				
121-160 in. Circuit* Length.....	No. 000				
161-200 in. Circuit* Length.....	No. 0000				
Charging Alternator Output - Amp.....	42				
Starter Cranking Amps - @ 60° F.....	275				

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

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PDFP-L4YT INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	294 (8.3)	411 (12)	519 (15)	618 (17)	742 (21)
Exhaust Temperature - °F (°C).....	900 (482)	992 (533)	956 (513)	953 (512)	953 (512)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	3.0 (76)	3.0 (76)	3.0 (76)	3.0 (76)	4.0 (102)

Fuel System	1470	1760	2100	2350	2600
Fuel Consumption - gal./hr. (L/hr.)	2.5 (9.5)	3.7 (14)	4.3 (16)	5.0 (19)	5.5 (21)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary			5		
Fuel Modulator/Setting			Boost/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)
Clean Air Cleaner - in. H ₂ O (kPa)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	116 (8.3)	152 (4.3)	197 (5.6)	235 (6.7)	282 (8.0)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)***			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	7.3 (6.9)
Low - qt. (L).....	5.9 (5.6)
Total Oil Capacity with Filters - qt. (L).....	8.0 (7.6)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)					
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve			CDDA - Y044 - 03		

**Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)

INSTALLATION & OPERATION DATA

Basic Engine Description	All Speeds
Engine Manufacturer.....	Perkins/Detroit Diesel
Ignition Type	Compression (Diesel)
Number of Cylinders	4
Bore and Stroke - in. (mm).....	3.937 (100) 5.0 (127)
Displacement - in. ³ (L)	243 (3.99)
Compression Ratio	16:1
Combustion System	Direct Injection
Engine Type.....	In-Line, 4 Cycle
Aspiration	Turbocharged
Firing Order (CW Rotation)	1 - 3 - 4 - 2
Charge Air Cooling Type	None
Rotation (Viewed from Front)	
Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System.....	Open
Dimensions and Weight	
Length - in. (mm) (From Drive Flange).....	38.2 (971)
Width - in. (mm)	25.5 (648)
Height - in. (mm) (Above Crankshaft Center Line)	32.6 (828)
Weight, Dry - lb. (kg)	1020 (463)
Wet - lb. (kg)	1080 (490)
Installation Drawing	D-472

Cooling System	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.)	35 (37)	38 (40)	43 (45)	46 (49)	50 (52)
Engine Radiated Heat - Btu/sec. (kJ/sec.).....	7.4 (7.8)	8.2 (8.7)	9.7 (10.2)	10.7 (11.3)	11.8 (12.4)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.)	5.0 (19)	5.8 (22)	7.2 (27)	7.5 (28)	9 (34)
95°F Raw H ₂ O - gal./min. (L/min.)	6.9 (26)	7.7 (29)	8.9 (34)	9.6 (36)	11 (42)
Heat Exchanger Maximum Cooling H ₂ O					
Inlet Pressure - lb./in. ² (kPa)			60 (414)		
Flow - gal./min. (L/min.)			40 (151)		
Thermostat, Start to Open - °F (°C)			170 (77)		
Fully Open - °F (°C)			198 (92)		
Engine Coolant Capacity - qt. (L)			22 (21)		
Coolant Pressure Cap - lb./in. ² (kPa)			9 (62)		
Maximum Engine H ₂ O Temperature - °F (°C)			200 (93)		
Minimum Engine H ₂ O Temperature - °F (°C).....			160 (71)		

Electric System - DC	All Speeds
System Voltage (Nominal)	12
Battery Capacity for Ambients Above 32°F - CCA @ 0°F	640
Voltage (Nominal)	12
Qty. per Battery Bank	1
SAE size per J537	4D-640
Battery Cable Circuit*, Max Resistance - ohm	0.0017
Battery Cable Minimum Size	
0-120 in. Circuit* Length	No. 00
121-160 in. Circuit* Length	No. 000
161-200 in. Circuit* Length	No. 0000
Charging Alternator Output - Amp.	42
Starter Cranking Amps - @ 60° F	275

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

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PDFP-04YT INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	316 (8.9)	445 (13)	556 (16)	645 (18)	754 (21)
Exhaust Temperature - °F (°C).....	954 (512)	1034 (557)	1004 (540)	977 (525)	970 (521)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	3.0 (76)	3.0 (76)	3.0 (76)	4.0 (102)	4.0 (102)

Fuel System					
Fuel Consumption - gal./hr. (L/hr.)	2.7 (10)	4.1 (16)	4.8 (18)	5.3 (20)	5.9 (22)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary			5		
Fuel Modulator/Setting			None/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)
Clean Air Cleaner - in. H ₂ O (kPa)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	120 (3.4)	160 (4.5)	204 (5.8)	241 (6.8)	283 (8.0)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)***			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	7.3 (6.9)
Low - qt. (L).....	5.9 (5.6)
Total Oil Capacity with Filters - qt. (L).....	8.0 (7.6)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)					
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve			CDDA - Y044 - 04		

**Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)

PDFP-L6YN INSTALLATION & OPERATION DATA

Basic Engine Description

Engine Manufacturer	Perkins/Detroit Diesel
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - in. (mm)	3.937 (100) 5.0 (127)
Displacement - in. ³ (L)	365 (5.98)
Compression Ratio	16.5:1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Cycle
Aspiration	Natural
Firing Order (CW Rotation)	1 - 5 - 3 - 6 - 2 - 4
Charge Air Cooling Type	None
Rotation (Viewed from Front)	
Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System	Open
Dimensions and Weight	
Length - in. (mm) (From Drive Flange)	47.9 (1217)
Width - in. (mm)	26.1 (663)
Height - in. (mm) (Above Crankshaft Center Line)	32.6 (828)
Weight, Dry - lb. (kg)	1206 (547)
Wet - lb. (kg)	1287 (584)
Installation Drawing	D-472

All Speeds

Cooling System

	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.)	46 (49)	47 (50)	55 (58)	59 (63)	64 (67)
Engine Radiated Heat - Btu/sec. (kJ/sec.)	8.4 (8.8)	9.3 (9.8)	10 (11)	12 (13)	13 (14)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.)	6.1 (23)	6.8 (26)	8.6 (33)	9.4 (36)	10 (38)
95°F Raw H ₂ O - gal./min. (L/min.)	8 (30)	9.0 (34)	13 (49)	14 (53)	14 (53)
Heat Exchanger Maximum Cooling H₂O					
Inlet Pressure - lb./in. ² (kPa)					
Flow - gal./min. (L/min.)					
Thermostat, Start to Open - °F (°C)					
Fully Open - °F (°C)					
Engine Coolant Capacity - qt. (L)					
Coolant Pressure Cap - lb./in. ² (kPa)					
Maximum Engine H ₂ O Temperature - °F (°C)					
Minimum Engine H ₂ O Temperature - °F (°C)					

Electric System - DC

System Voltage (Nominal)	12
Battery Capacity for Ambients Above 32°F - CCA @ 0°F	640
Voltage (Nominal)	12
Qty. per Battery Bank	1
SAE size per J537	4D-640
Battery Cable Circuit*, Max Resistance - ohm	0.0017
Battery Cable Minimum Size	
0-120 in. Circuit* Length	No. 00
121-160 in. Circuit* Length	No. 000
161-200 in. Circuit* Length	No. 0000
Charging Alternator Output - Amp.	42
Starter Cranking Amps - @ 60° F	394

All Speeds

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

(Continued)

PDFP-L6YN INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	361 (10)	457 (13)	555 (16)	610 (17)	668 (19)
Exhaust Temperature - °F (°C).....	1018 (548)	1073 (578)	1093 (589)	1101 (594)	1135 (613)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	3.0 (7.6)	3.0 (7.6)	3.0 (7.6)	3.0 (7.6)	3.0 (7.6)

Fuel System					
Fuel Consumption - gal./hr. (L/hr.)	3.7 (14)	4.6 (17)	5.4 (20)	5.7 (22)	6.2 (23)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary.....			5		
Fuel Modulator/Setting			None/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	26 (6.5)	26 (6.5)	26 (6.5)	26 (6.5)	26 (6.5)
Clean Air Cleaner - in. H ₂ O (kPa)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	131 (3.7)	160 (4.5)	192 (5.4)	210 (5.9)	225 (6.4)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)**			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	13.8 (13.1)
Low - qt. (L).....	11.5 (10.9)
Total Oil Capacity with Filters - qt. (L).....	15.2 (14.4)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)					
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve			CDDA - Y064 - 01		

***Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)*

PDFP-L6YT INSTALLATION & OPERATION DATA

Basic Engine Description

All Speeds

Engine Manufacturer	Perkins/Detroit Diesel
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - in. (mm)	3.937 (100) 5.0 (127)
Displacement - in. ³ (L)	365 (5.98)
Compression Ratio	16:1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Cycle
Aspiration	Turbocharged
Firing Order (CW Rotation)	1 - 5 - 3 - 6 - 2 - 4
Charge Air Cooling Type	None
Rotation (Viewed from Front)	
Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System	Open
Dimensions and Weight	
Length - in. (mm) (From Drive Flange)	47.9 (1217)
Width - in. (mm)	27.9 (709)
Height - in. (mm) (Above Crankshaft Center Line)	32.6 (828)
Weight, Dry - lb. (kg)	1223 (555)
Wet - lb. (kg)	1304 (591)
Installation Drawing	D-472

Cooling System

	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.)	49 (52)	52 (55)	58 (61)	6.3 (67)	68 (73)
Engine Radiated Heat - Btu/sec. (kJ/sec.)	10 (11)	11 (12)	12 (13)	13 (14)	15 (16)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.)	7 (26)	8.7 (33)	10 (38)	11 (42)	14 (53)
95°F Raw H ₂ O - gal./min. (L/min.)	8.8 (33)	11 (42)	12 (45)	14 (53)	16 (61)
Heat Exchanger Maximum Cooling H ₂ O					
Inlet Pressure - lb./in. ² (kPa)			60 (414)		
Flow - gal./min. (L/min.)			40 (151)		
Thermostat, Start to Open - °F (°C)			170 (77)		
Fully Open - °F (°C)			198 (92)		
Engine Coolant Capacity - qt. (L)			26 (25)		
Coolant Pressure Cap - lb./in. ² (kPa)			9 (62)		
Maximum Engine H ₂ O Temperature - °F (°C)			200 (93)		
Minimum Engine H ₂ O Temperature - °F (°C)			160 (71)		

Electric System - DC

All Speeds

System Voltage (Nominal)	12
Battery Capacity for Ambients Above 32°F - CCA @ 0°F	640
Voltage (Nominal)	12
Qty. per Battery Bank	1
SAE size per J537	4D-640
Battery Cable Circuit*, Max Resistance - ohm	0.0017
Battery Cable Minimum Size	
0-120 in. Circuit* Length	No. 00
121-160 in. Circuit* Length	No. 000
161-200 in. Circuit* Length	No. 0000
Charging Alternator Output - Amp.	42
Starter Cranking Amps - @ 60° F	394

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

(Continued)

PDFP-L6YT INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	444 (13)	591 (17)	738 (21)	862 (24)	1025 (29)
Exhaust Temperature - °F (°C).....	873 (467)	874 (468)	831 (444)	815 (435)	841 (449)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	3.0 (76)	3.0 (7.6)	4.0 (102)	4.0 (102)	4.0 (102)

Fuel System					
Fuel Consumption - gal./hr. (L/hr.)	4.3 (16)	5.3 (20)	6.1 (23)	6.7 (25)	7.7 (23)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary			5		
Fuel Modulator/Setting			None/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)
Clean Air Cleaner - in. H ₂ O (kPa)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	179 (5)	238 (7)	307 (9)	363 (10)	423 (12)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)***			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	13.8 (13.1)
Low - qt. (L).....	11.5 (10.9)
Total Oil Capacity with Filters - qt. (L).....	15.2 (14.4)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)	133 (917)	136 (938)	124 (855)	115 (793)	113 (779)
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve	CDDA - Y064 - 03				

**Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)

PDFP-O6YT INSTALLATION & OPERATION DATA

Basic Engine Description

All Speeds

Engine Manufacturer	Perkins/Detroit Diesel
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - in. (mm)	3.937 (100) 5.0 (127)
Displacement - in. ³ (L)	365 (5.98)
Compression Ratio	16:1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Cycle
Aspiration	Turbocharged
Firing Order (CW Rotation)	1 - 5 - 3 - 6 - 2 - 4
Charge Air Cooling Type	None
Rotation (Viewed from Front)	
Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System	Open
Dimensions and Weight	
Length - in. (mm) (From Drive Flange)	47.9 (1217)
Width - in. (mm)	27.9 (709)
Height - in. (mm) (Above Crankshaft Center Line)	32.6 (828)
Weight, Dry - lb. (kg)	1223 (555)
Wet - lb. (kg)	1304 (591)
Installation Drawing	D-472

Cooling System

	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.)	53 (56)	56 (59)	63 (66)	68 (72)	73 (77)
Engine Radiated Heat - Btu/sec. (kJ/sec.)	11 (12)	12 (13)	13 (14)	14 (15)	16 (17)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.)	7.2 (23)	9 (33)	11 (42)	12 (36)	15 (57)
95°F Raw H ₂ O - gal./min. (L/min.)	9 (30)	11 (42)	13 (49)	15 (53)	17 (64)
Heat Exchanger Maximum Cooling H₂O					
Inlet Pressure - lb./in. ² (kPa)			60 (414)		
Flow - gal./min. (L/min.)			40 (151)		
Thermostat, Start to Open - °F (°C)			170 (77)		
Fully Open - °F (°C)			198 (92)		
Engine Coolant Capacity - qt. (L)			26 (25)		
Coolant Pressure Cap - lb./in. ² (kPa)			9 (62)		
Maximum Engine H ₂ O Temperature - °F (°C)			200 (93)		
Minimum Engine H ₂ O Temperature - °F (°C)			160 (71)		

Electric System - DC

All Speeds

System Voltage (Nominal)	12
Battery Capacity for Ambients Above 32°F - CCA @ 0°F	640
Voltage (Nominal)	12
Qty. per Battery Bank	1
SAE size per J537	4D-640
Battery Cable Circuit*, Max Resistance - ohm	0.0017
Battery Cable Minimum Size	
0-120 in. Circuit* Length	No. 00
121-160 in. Circuit* Length	No. 000
161-200 in. Circuit* Length	No. 0000
Charging Alternator Output - Amp.	42
Starter Cranking Amps - @ 60° F	394

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

(Continued)

PDFP-O6YT INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	462 (13)	638 (18)	789 (22)	930 (26)	1068 (30)
Exhaust Temperature - °F (°C).....	934 (501)	932 (500)	877 (469)	858 (459)	865 (463)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	3.0 (76)	4.0 (102)	4.0 (102)	4.0 (102)	4.0 (102)

Fuel System					
Fuel Consumption - gal./hr. (L/hr.)	4.7 (18)	5.8 (22)	6.8 (26)	7.4 (28)	8.1 (31)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary.....			5		
Fuel Modulator/Setting			None/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)
Clean Air Cleaner - in. H ₂ O (kPa)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	178 (5.0)	246 (6.9)	317 (9.0)	379 (11)	433 (12)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)***			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	13.8 (13.1)
Low - qt. (L).....	11.5 (10.9)
Total Oil Capacity with Filters - qt. (L).....	15.2 (14.4)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)					
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve			CDDA - Y064 - 04		

**Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)

PDFP-L6YW INSTALLATION & OPERATION DATA

Basic Engine Description

All Speeds

Engine Manufacturer	Perkins/Detroit Diesel
Ignition Type	Compression (Diesel)
Number of Cylinders	6
Bore and Stroke - in. (mm)	3.937 (100) 5.0 (127)
Displacement - in. ³ (L)	365 (5.98)
Compression Ratio	16:1
Combustion System	Direct Injection
Engine Type	In-Line, 4 Cycle
Aspiration	Turbocharged
Firing Order (CW Rotation)	1 - 5 - 3 - 6 - 2 - 4
Charge Air Cooling Type	Jacket Water Cooled
Rotation (Viewed from Front)	
Clockwise	Standard
Counter-Clockwise	Not Available
Engine Crankcase Vent System	Open
Dimensions and Weight	
Length - in. (mm) (From Drive Flange)	47.9 (1217)
Width - in. (mm)	30.9 (785)
Height - in. (mm) (Above Crankshaft Center Line)	32.6 (828)
Weight, Dry - lb. (kg)	1252 (568)
Wet - lb. (kg)	1335 (606)
Installation Drawing	D-472

Cooling System

	1470	1760	2100	2350	2600
Engine H ₂ O Heat - Btu/sec. (kJ/sec.)	55 (59)	58 (61)	65 (69)	74 (78)	83 (88)
Engine Radiated Heat - Btu/sec. (kJ/sec.)	11 (12)	12 (13)	14 (15)	16 (17)	17 (18)
Heat Exchanger Minimum Flow					
60°F Raw H ₂ O - gal./min. (L/min.)	9 (34)	11 (33)	12 (45)	12 (45)	13 (49)
95°F Raw H ₂ O - gal./min. (L/min.)	11 (42)	13 (49)	14 (53)	14 (53)	15 (57)
Heat Exchanger Maximum Cooling H ₂ O					
Inlet Pressure - lb./in. ² (kPa)			60 (414)		
Flow - gal./min. (L/min.)			40 (151)		
Thermostat, Start to Open - °F (°C)			170 (77)		
Fully Open - °F (°C)			198 (92)		
Engine Coolant Capacity - qt. (L)			27 (26)		
Coolant Pressure Cap - lb./in. ² (kPa)			9 (62)		
Maximum Engine H ₂ O Temperature - °F (°C)			200 (93)		
Minimum Engine H ₂ O Temperature - °F (°C)			160 (71)		

Electric System - DC

All Speeds

System Voltage (Nominal)	12
Battery Capacity for Ambients Above 32°F - CCA @ 0°F	640
Voltage (Nominal)	12
Qty. per Battery Bank	1
SAE size per J537	4D-640
Battery Cable Circuit*, Max Resistance - ohm	0.0017
Battery Cable Minimum Size	
0-120 in. Circuit* Length	No. 00
121-160 in. Circuit* Length	No. 000
161-200 in. Circuit* Length	No. 0000
Charging Alternator Output - Amp.	42
Starter Cranking Amps - @ 60° F	394

*Positive and Negative Cables Combined Length

NOTE: This Engine Is Intended For Indoor Installation Or In A Weatherproof Enclosure.

(Continued)
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PDFP-L6YW INSTALLATION & OPERATION DATA (Continued)

Exhaust System	1470	1760	2100	2350	2600
Exhaust Flow - ft. ³ /min. (m ³ /min.).....	506 (14)	680 (19)	639 (18)	752 (21)	865 (24)
Exhaust Temperature - °F (°C).....	1008 (542)	977 (525)	921 (494)	898 (481)	875 (468)
Maximum Allowable Back Pressure - in. H ₂ O (kPa)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)	30 (7.5)
Minimum Exhaust Pipe Dia. - in. (mm)**	4.0 (102)	4.0 (102)	4.0 (102)	4.0 (102)	4.0 (102)

Fuel System					
Fuel Consumption - gal./hr. (L/hr.)	5.2 (20)	6.3 (24)	7.7 (29)	8.4 (32)	9.2 (35)
Fuel Pressure - lb./in. ² (kPa)			5-10 (35-70)		
Minimum Line Size - Supply - in. (mm)**			0.37 Sch. 40 - Black		
Minimum Line Size - Return - in. (mm)**			0.25 Sch. 40 - Black		
Maximum Allowable Fuel Pump Suction with Clean Filter - in. H ₂ O (kPa)			54 (100)		
Maximum Allowable Head on Fuel Pump - ft(m)			9.8 (3.0)		
Fuel Filter Micron Size - Primary.....			30		
Secondary.....			5		
Fuel Modulator/Setting			Boost/None		

Heater System	All Speeds
Jacket Water Heater	Standard
Wattage (Nominal)	1500
Voltage - AC, 1P	120 (+5%, -10%)
Optional Voltage - AC, 1P	240 (+5%, -10%)
Lube Oil Heater (Required When Ambient Is Below 32°F (0°C)).....	Consult Factory

Induction Air System	1470	1760	2100	2350	2600
Air Cleaner Type	Indoors Service Only - Washable				
Air Intake Restriction Maximum Limit					
Dirty Air Cleaner - in. H ₂ O (kPa)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)	32 (8.0)
Clean Air Cleaner - in. H ₂ O (kPa)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)	20 (5.0)
Engine Air Flow - ft. ³ /min. (m ³ /min.)	185 (5.0)	254 (7.0)	344 (10)	414 (12)	488 (14)
Maximum Allowable Temperature (Air To Engine Inlet) - °F (°C)***			130 (54)		

Lubrication System	All Speeds
Oil Pressure - normal - lb./in. ² (kPa)	40-60 (276-414)
In Pan Oil Temperature - °F (°C)	220-240 (88-116)
Oil Pan Capacity - High - qt. (L)	13.8 (13.1)
Low - qt. (L).....	11.5 (10.9)
Total Oil Capacity with Filters - qt. (L).....	15.2 (14.4)

Performance	1470	1760	2100	2350	2600
BMEP - lb./in. ² (kPa)					
Piston Speed - ft./min. (m/min.).....	1225 (373)	1467 (447)	1750 (583)	1958 (597)	2167 (660)
Noise - dB (A) @ 1m	100 (EST)	102 (EST)	103 (EST)	104 (EST)	96 (EST)
Power Curve			CDDA - Y064 - 05		

**Based On Nominal System. Flow Analysis Must Be Done To Assure Adherence To System Limitations.
(Minimum Exhaust Pipe Diameter is based on 15 feet of pipe, one elbow, and a silencer
pressure drop no greater than one half the max. allowable back pressure.)

PDFP-L4YN; -L6YN

ENGINE MATERIALS AND CONSTRUCTION

Air Cleaner

TypeIndoor Dry
Material.....Pleated Paper
Galvanized Steel Housing

Air Cleaner

TypeIndoor Usage Only
Oiled Fabric Pleats
Material.....Surgical Cotton
Aluminum Mesh

Balancer (-L4YN only)

TypeCounter Rotating Shafts
For Second Order Control

Camshaft

Material.....Cast Iron
Chill Hardened
LocationIn Block
DriveGear, Helical
Type of CamGround

Coolant Pump

TypeCentrifugal
DriveGear

Connecting Rod

TypeH Section
Material.....Forged Molybdenum
Steel Alloy

Crank Pin Bearings

TypePrecision Half Shell
Number.....1 Pair Per Cylinder
Material.....Aluminum
Tin Alloy

Crankshaft

Material.....Forged Chrome
Molybdenum Steel
Type of BalanceDynamic

Cylinder Block

TypeOne Piece With
Non-Siamese Cylinders
Material.....Cast Iron Alloy

Cylinder Head

TypeSlab 2 Valve
Material.....Cast Iron

Valves

TypePoppet
Arrangement.....Overhead Valve
Number/Cylinder.....1 Intake
.....1 Exhaust
Operating Mechanism.....Mechanical Rocker Arm
Type of LifterLarge Head
Valve Spring
Number/Valve2
Valve Seat Insert.....Replaceable

Fuel Pump

TypeDiaphragm
DriveCam Lobe

Heat Exchanger

TypeTube & Bundle
Materials
Tubes & Headers80/20 CU/NI
ShellCopper
Electrode.....Zinc

Injection Pump

TypeRotary Distributor
DriveGear

Liners

TypeDry Liner
Material.....Cast Iron
Silicon Carbide
Honed

Lubrication Pump

TypeRotor
DriveGear

Main Bearings

TypePrecision Half Shells
Material.....Steel Backed-Aluminum/
Tin

Piston

Type and MaterialAluminum Alloy With
Reinforce Top Ring
Groove

Piston Pin

TypeFull Floating

Piston Pin Bushing

Material.....Steel Backed Bronze

Piston Rings

Number/Piston3
TopBarrel Faced
SecondTaper Faced
ThirdChromium Faced

PDFP-L4YT; -04YT; -L6YT; -06YT; -L6YW

ENGINE MATERIALS AND CONSTRUCTION

Air Cleaner

TypeIndoor Dry
 Material.....Pleated Paper
 Galvanized Steel Housing

Air Cleaner

TypeIndoor Usage Only
 Oiled Fabric Pleats
 Material.....Surgical Cotton
 Aluminum Mesh

Balancer (-L4YT & -04YT only)

TypeCounter Rotating Shafts
 For Second Order Control

Camshaft

Material.....Cast Iron
 Chill Hardened
 LocationIn Block
 DriveGear, Helical
 Type of CamGround

Coolant Pump

TypeCentrifugal
 DriveGear

Connecting Rod

TypeH Section
 Material.....Forged Molybdenum
 Steel Alloy

Crank Pin Bearings

TypePrecision Half Shell
 Number.....1 Pair Per Cylinder
 Material.....Lead Bronze

Crankshaft

Material.....Forged Chrome
 Molybdenum Steel
 Type of BalanceDynamic

Cylinder Block

TypeOne Piece With
 Non-Siamese Cylinders
 Material.....Cast Iron Alloy

Cylinder Head

TypeSlab 2 Valve
 Material.....Cast Iron

Valves

TypePoppet
 Arrangement.....Overhead Valve
 Number/Cylinder.....1 Intake
 1 Exhaust
 Operating Mechanism.....Mechanical Rocker Arm
 Type of LifterLarge Head
 Valve Spring
 Number/Valve2
 Valve Seat Insert.....Replaceable

Fuel Pump

TypeDiaphragm
 DriveCam Lobe

Heat Exchanger

TypeTube & Bundle
 Materials
 Tubes & Headers80/20 CU/NI
 ShellCopper
 Electrode.....Zinc

Injection Pump

TypeRotary Distributor
 DriveGear

Liners

TypeDry Liner
 Material.....Cast Iron
 Silicon Carbide
 Honed

Lubrication Pump

TypeRotor
 DriveGear

Main Bearings

TypePrecision Half Shells
 Material.....Steel Backed-Aluminum/
 Tin

Piston

Type and MaterialAluminum Alloy With
 Reinforce Top Ring
 Groove
 CoolingOil Jet Spray

Piston Pin

TypeFull Floating

Piston Pin Bushing

Material.....Steel Backed Bronze

Piston Rings

Number/Piston3
 TopBarrel Faced
 SecondTaper Faced
 ThirdChromium Faced

PARTS INFORMATION

The parts that make up the PDFP diesel driver are provided from two sources. The basic engine is manufactured and assembled by Perkins. The basic engine is shipped to Clarke DD-A in Cincinnati, Ohio, U.S.A. and prepared to NFPA-20 requirements. Any parts required for this product can be obtained by ordering through the authorized DDC Distributor/Dealer in U.S. or Canada and at your local Perkins Distributor/Dealer outside U.S. or Canada.

The basic engine parts ordering data is contained in the "BASIC ENGINE PARTS" section that follows. The special parts to meet NFPA-20 requirements are detailed under the "OPTION PARTS" section provided as a supplement to this manual.

BASIC ENGINE PARTS

Progress in industry comes at a rapid pace. In order for the engine manufacturer to keep pace with progress, he needs a versatile product for the many models and arrangements of accessories and mounting parts needed to suit a variety of equipment. In addition, engine refinements and improvements are constantly being introduced. All of this dynamic action must be documented so that the equipment can be serviced if and when it's needed. It is fully documented in the manufacturer's plant and in dealer Parts Departments with Master Files and adequate supporting records. But, what about YOU the user of this equipment? You have neither the

time nor the inclination to search for specific part number data. Distributor/Dealer organization stands ready to meet your needs. When you contact the Distributor/Dealer, provide the following data from the engine data located on the left of the engine:

Serial Number _____

Other Useful Information:

To help identify basic engine items that may require periodic service, replacement or repair, the following parts are identified.

ITEM		Perkins P/N	Stanadyne P/N
Fuel Filters	Primary	26560920	30727
	Secondary	26560919	30729
Oil Filters		2654403	

ITEM	Clarke P/N
Air Filter	C03249
Cleaning Agent	C121158
Air Filter Oil	C121157

OPTION PARTS

At Clarke DD-A the following "OPTION PARTS" are added to the basic Perkins Diesel engine:

- Engine Heater System (jacket water)
- Speed Switch with magnetic pickup
- Battery Isolator, alternator charging system
- Air Cleaner System
- Speed Control (tamper proof)
- Heat Exchanger System
- Flex Fuel Lines - stainless steel
- Exhaust Flex Connection
- Front & Rear Engine Mounts
- Turbocharger outlet elbow (-L6YW only)
- Exhaust Blanket Insulation
- Falk Coupling, Engine Half
- Vertical Turbine Drive Plate (optional)
- FM/UL/ULC Nameplate
- Fuel Junction Block with Supply & Return Lines
- Wiring Harness
- DC Junction Terminal Strip (in Instrument Panel)
- Instrument Panel & Gauges
- Two Starting Motors
- Battery Charging Alternator & Guard
- Alternator Pulley, Fan, Drive Belt and Support System

Specific replacement parts for your engine can be ordered through the authorized Distributor/Dealer. When ordering "OPTION PARTS", provide Distributor/Dealer with the following data from the FM/UL/ULC Nameplate:

A. Engine Model No. _____

B. Engine Serial No. _____

C. Mfg. Date _____

And Part Number from the "Option Parts Supplement".

The authorized DDC Distribution/Dealer will obtain the replacement option parts through Clarke DDA, Cincinnati, Ohio.

ANALYSIS PROGRAM

Analysis Kits are currently available through your local DDC Distributor. These kits can be purchased for a nominal fee to provide the capability of taking oil or coolant samples and mailing them to a testing laboratory. By a series of laboratory test they can determine operating conditions that may be harmful to your engine. Sample results are mailed to the sender provided they have completed the sample processing form with the current address. Each kit contains sampling instructions and engine identification request. For the pur-

pose of laboratory uniformity, please use the DDC model and Serial number as found on the valve rocker cover.

Results will include warnings and recommendations should a problem be found.

Coolant Analysis Kit P/N 23508774

Oil Analysis Kit P/N 12345678

OWNER ASSISTANCE

The satisfaction and goodwill of the owners of PDFP diesel engines is of primary concern to the PDFP organization including their Distributors/Dealers.

As an owner/operator of a PDFP diesel engine, you have a complete network of Distributor locations plus their dealers in the United States, Canada and worldwide. Consult your "Yellow Page" telephone directory under ENGINES-DIESEL for the authorized agent serving your area. The Distributor/Dealer organization provide:

- Field service by trained personnel
- Emergency service 24 hours per day
- Complete parts support
- Sales assistance for your power needs
- Product information and literature

We recognize, however, that despite the best intentions of everyone concerned, misunderstandings may occur. Normally, any such situation that arises in connection with the sale, operation or service of your engine will be handled by the Distributor/Dealer in your area.

To further assure your complete satisfaction the following procedure should be followed in the event you have a problem that has not been handled satisfactorily.

Step 1 - Discuss your problem with a member of management from the distributorship or dealership in your area. Frequently, complaints are the result of a breakdown in communication and can quickly be resolved by a member of management. If you have already discussed the problem with the Sales or Service Manager, contact the General Manager. If your problem originates with a dealer, explain the matter to a management member of the distributorship with whom the dealer has his service agreement.

Step 2 - When it appears that your problem cannot be resolved at the Distributor level without additional assistance, contact:

Clarke Detroit Diesel-Allison
3133 E. Kemper Road
Cincinnati, OH 45241

Attention: Fire Pump Service Manager

Phone: 513-771-2200 ext 427

Fax: 513-771-5375

Prior to this call, have the following information available:

- Name and location of Distributor/Dealer contacted
- Pump OEM equipment: Model and Rating
- Engine Model and S/N
- Engine delivery date and hours of operation
- Nature of problem
- Chronological summary of units history

Step 3 - If the problem is still not resolved to your satisfaction, present the entire matter in writing or by phone to the factory:

If located in U.S. or Canada write to:

**Director,
Reliability and Materials Engr.**
Detroit Diesel Corporation
13400 Outer Drive, West
Detroit, Michigan 48239-4001
Phone: (313) 592-7357

If located outside U.S. or Canada write to:

Perkins Power Sales & Service Limited
Frank Perkins Way
Peterborough
PE1 5NA
United Kingdom
Tel: [44] (733) 67474
Fax: [44] (733) 582440
Telex: 32501 Perken G

If the additional review by the factory of all the facts involved indicates that some further action can be taken, the modification center and/or the Distribution/Dealer will be so instructed.

When contacting Clarke DD-A, please keep in mind that ultimately your problem will likely be resolved at the Distributorship/Dealership utilizing their facilities, equipment and personnel. Therefore, it is suggested that you follow the above steps in sequence when requiring assistance.

Eastern Region

187 Monmouth Park Hwy.
West Long Branch, New Jersey 07704
Phone: (908) 222-1888

Southeastern Region

5111 Bowden Rd.
Jacksonville, Florida 32216
Phone: (904) 448-8833

Central Region

13400 Outer Drive, West
Detroit, Michigan 48239-4001
Phone: (313) 592-5420

Southwestern Region

2711 LBJ Freeway, Suite 1036
Dallas, Texas 75234
Phone: (214) 247-4313

Western Region

10645 Studebaker Road
Downey, California 90241
Phone: (213) 929-7016

Canadian Region

150 Dufferin Ave.
Suite 701
London, Ontario N6A 5N6, Canada
Phone: (519) 661-0149

AUSTRALIA

Perkins Engines (Pty) Ltd
P.O. Box 470
Mornington 3931
Melbourne
Victoria

Contact

Mr R P Cook
Tel: [61] (59) 75 1877
Fax: [61] (59) 75 1305

Area of Responsibility

Australia
New Zealand
Pacific Islands

FRANCE

Moteurs Perkins SA
9 Avenue Michelet
93583 Saint Ouen
CEDEX

Mr P Chambrillon
Tel: [33] (1) 4010 4246
Fax: [33] (1) 4010 4245

France
Algeria
Morocco
Tunisia

GERMANY

Perkins Motoren GmbH
Postfach 1180
Saaläcker Str 4
8752 Kleinostheim

Mr R Dehm
Tel: [49] (6027) 501113
Fax: [49] (6027) 501130

Germany
Austria, Switzerland
Czechoslovakia
Hungary, Poland

ITALY

Motori Perkins Spa
Via Socrate 8
22070 Casnate Con Bernate
(Como)

Mr A Cantu
Tel: [39] (31) 564712
Fax: [39] (31) 249092

Italy

SINGAPORE

Perkins Engines Eastern
(Singapore) Pte Limited
4 Kian Tech Drive
Singapore 2262

Mr Wilson Choy
Tel: [65] (-) 265 6333
Fax: [65] (-) 264 1188
Telex: 37729 Perkoil RS

Singapore

SOUTH AMERICA

Perkins Engines (Latin America) Inc
Suite 620
999 Ponce de Leon Blvd
Coral Gables
Florida 22134

Mr G Reaves
Tel: [1] (305) 442 7413
Fax: [1] (305) 442 7419

Central and
South America

Identify the U.S. regional area from the map below:



Warranty On New Detroit Diesel

Series 53, 71, 92 and 149 Engines

Used In Stand-by Pump Applications



Terms of Coverage:

Uses

This warranty applies to the first retail purchaser and subsequent owners during the WARRANTY PERIOD of new Detroit Diesel Series 53, 71, 92 and 149 Engines (referred to as Engine) and attached air compressor, starting motor, alternator and hydraulic pump (referred to as Accessories) manufactured or supplied by Detroit Diesel Corporation* (referred to as DDC) which are used in stand-by pump applications operated in the United States or Canada and delivered on or after May 1, 1992.

Defects

This warranty covers Engine REPAIRS to correct any malfunction occurring during the WARRANTY PERIOD resulting from defects in material or workmanship.

Repairs

To obtain warranty repairs, you must request the needed repairs within the WARRANTY PERIOD from an authorized DDC service outlet. Only new genuine parts or remanufactured parts or components supplied or approved by DDC will be used. DDC may, at its discretion, replace rather than repair components. A reasonable time must be allowed to perform the warranty repair. Repairs will be performed during normal business hours. The owner is responsible for the percentage of repair costs shown under WARRANTY PERIOD.

Warranty Period

The WARRANTY PERIOD begins on the date the Engine is delivered to the first retail purchaser or put in use prior to sale at retail, whichever date occurs first, and ends at the time limits shown below:

WARRANTY PERIOD				
Item	Warranty Limitations (Whichever Occurs First)		Repair Charge To Be Paid By The Owner	
	MONTHS	ENGINE HOURS	PARTS	LABOR
Engine	0-24	0-1,500	No Charge	No Charge
	25-60	0-1,500	No Charge	100% of service outlet's normal charge
Accessories	0-12	0-1,500	No Charge	No Charge

Service Supplies

The cost of service supplies such as coolant, oil and filters which are not reusable due to needed repairs is covered by this warranty.

Like Replacement Engine

Engine(s) supplied by DDC as a replacement for an Engine still under warranty will assume the identity of the Engine being replaced and be entitled to the remaining warranty coverage.

Mechanic's Travel Expenses

DDC will pay reasonable travel expenses for the repairing mechanic to travel to and from the repair site.

*In Canada, the reference is to Detroit Diesel or Canada Limited.

This Warranty Does Not Cover:

Repairs Due To Accidents, Misuse, Storage Damage, Negligence Or Certain Modifications

Repairs due to an accident, misuse, misapplication, storage damage, negligence or modification exceeding DDC specifications, are not covered by this warranty.

Engine Removal And Reinstallation

Labor and material costs for engine removal and reinstallation, when necessary to make a warranty repair, are not covered by this warranty.

Non-DDC Supplied/Manufactured Components

DDC is not responsible for repair of components and/or assemblies which are manufactured or supplied by another manufacturer, such as power take-offs, intake and exhaust systems. Such items are covered by the equipment manufacturer.

Maintenance

DDC is not responsible for the cost of maintenance or repairs due to lack of performance of required maintenance services or the failure to use fuel, oil, lubricants and coolant meeting DDC-recommended specifications. Performance of required maintenance and use of proper fuel, oil, lubricants and coolant are the responsibility of the owner. See the Operator's Guide for full details.

Incidental or Consequential Damages

DDC is not responsible for incidental or consequential costs or expenses which the owner may incur as a result of a malfunction or failure covered by this warranty, such as communication expenses, meals, lodging, overtime, towing, loss of use of the Engine or equipment, loss of time, inconvenience, cargo loss or damage, and other similar costs and expenses.

Other Limitations

The performance of REPAIRS is the exclusive Owner's remedy under this warranty. DDC does not authorize any person to assume or create for it any other obligation or liability in connection with the Engine or the Accessories.

THIS WARRANTY IS THE ONLY WARRANTY APPLICABLE TO THE ENGINE AND ACCESSORIES AS USED IN STAND-BY PUMP APPLICATIONS. DETROIT DIESEL CORPORATION MAKES NO OTHER WARRANTIES EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. DETROIT DIESEL CORPORATION SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES AS DESCRIBED ABOVE.

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Warranty on New Perkins Engines

1. Products Covered

This warranty applies to Prima, 500 Series, 700 Series, 900 Series, 3.152 family, 4.41, 4.236 family, 6.354 family, 1000 Series, Phaser, 1300 Series, Peregrine, 100 Series, 200 Series, 2000 Series, 3000 Series Diesel and Spark Ignited Engines.

2. Duration

The duration of this warranty shall be for a period of 12 months from delivery of any new engine to the first user or for a period of 24 months from the date of dispatch of the engine from Perkins, whichever period expires first. In addition, the following major components will be covered for a further 12 months: cylinder block, casting, cylinder head casting, crankshaft (excluding bearings), camshaft and connecting rods.

3. Scope of Warranty

Perkins will, by repair or (at its option) replacement, remedy any failure of such engine which is due to a defect in the workmanship or materials thereof and will accept responsibility for labor and material costs which apply when effecting such remedy. Repair time will be as per Perkins Repair Time schedule or as agreed in cases of application difficulty. Parts and labor rates will be as agreed with Perkins. All repairs must be carried out by an authorized outlet.

Engine(s) or components supplied as replacements for engines under warranty will assume the identity of the engine or part being replaced and be entitled to the remaining warranty coverage. Any engine or component replaced by Perkins shall be disposed of in accordance with Perkins directions.

The warranty extends to the costs of engine removal and reinstallation where appropriate and necessary subject to a maximum of 15 hours labor for industrial, generating set and vehicle applications and a maximum of 18 hours for marine applications.

For 100 Series Engines, the maximum time allowed for removal and refit is 7 hours and 12 hours for 200 Series Engines.

4. Proprietary Equipment Fitted by Perkins

All proprietary equipment sourced and fitted by Perkins prior to dispatch of the engine is covered by this warranty except that:

Fuel injection equipment will be serviced and guaranteed through the Fuel Injection Suppliers Service organization who will carry out 'free of charge' any agreed warranty repair.

Electrical equipment fitted by Perkins will be serviced and guaranteed by the Electrical Suppliers Service organization who will carry out 'free of charge' any agreed warranty repair.

Labor charges to remove and refit such equipment will be paid by Perkins as per normal warranty procedures in line with the repair time schedule.

5. Low Usage Warranty

In cases where the total use of the engine is restricted to 250 hours or less within 12 months from the date of sale to the first user, the warranty will be extended to the second year of operation, providing

that the combined total use does not exceed 500 hours. Low usage extended warranty does not apply to 100 Series or 200 Series engines.

6. Long Storage

The standard warranty allows for a maximum of 12 months storage before sale. Long storage is not encouraged but at the same time Perkins realize that there will be occasions when the engine has not been sold. Validation Procedures and warranty limitations are available from a Perkins Distributor.

7. Limitations and Exclusions

Perkins shall not be liable under this warranty for:

- a. Any accessories or proprietary equipment not fitted by Perkins.
- b. Any engine used without the prior written approval of Perkins for a purpose for which it was not designed.
- c. Any engine or part which is in the opinion of Perkins has been altered, used, maintained, serviced or stored otherwise than in accordance with the Company's recommendations as published.
- d. Any engine or part from which the Perkins number or markings have been removed or altered.
- e. The costs of normal maintenance or regular servicing of the engine.
- f. Expenses such as towing, carriage, subsistence, overtime premiums, owners own labor charges, hire of special equipment.
- g. Component parts considered by Perkins to be consumable items as identified in the applicable users handbook except where replacement is necessary consequent to the nature of the failure and at a time when the owner could not reasonably be expected to pay for these items.
- h. Gradual reduction in operating performance commensurate with the age, kilometers covered or operating hours, including but not limited to, gradual loss of engine compression or gradual increase in oil consumption due to normal operating functions.
- i. Any failure to meet its obligations hereunder which are due to circumstances beyond its reasonable control including but not limited to industrial disputes, fire, severe weather conditions, government decisions, materials shortage, power or machinery breakdown or failure or war.
- j. Any claims made more than 60 days from the date of alleged failure. Perkins obligations under this warranty are limited to the proper costs incurred by its authorized agents of repair or replacement as set out herein.
- k. Perkins shall not be liable whether in contract or tort for any other loss, damage or expense, whether direct, indirect or consequential and whether suffered by the owner or any third party and any other warranties expressed or implied, statutory or otherwise are expressly excluded to the extent that the same may be lawfully so excluded.



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