



# OPERATOR HANDBOOK

# TSG 416

**LIQUIFIED PETROLEUM GAS (LPG)  
GASOLINE (EFI)  
NATURAL GAS (NG) ENGINES**

**FOR ENGINES SOLD PRIOR TO 01-01-07  
WITH FPP SERIAL NUMBERS**

January, 2009



## **WARNING:**



**WARNING: ENGINE EXHAUST, SOME OF ITS CONSTITUENTS, AND CERTAIN VEHICLE COMPONENTS CONTAIN OR EMIT CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM. IN ADDITION, CERTAIN FLUIDS CONTAINED IN VEHICLES AND CERTAIN PRODUCTS OF COMPONENT WEAR CONTAIN OR EMIT CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.**

# **FORD TSG 416 ENGINES**

**GASOLINE (EFI)**

**LIQUIFIED PETROLEUM GAS (LPG)**

**NATURAL GAS (NG)**

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## HEALTH & SAFETY



**WARNING: THE FOLLOWING HEALTH AND SAFETY RECOMMENDATIONS SHOULD BE CAREFULLY OBSERVED.**

Carrying out certain operations and handling some substances can be dangerous or harmful to the operator if the correct safety precautions are not observed. Some such precautions are recommended at the appropriate points in this book.

While it is important that these recommended safety precautions are observed, care near machinery is always necessary, and no list can be exhaustive. **ALWAYS BE ON YOUR GUARD!**

### **General Guidelines:**

The following recommendations are for general guidance:

1. Always wear correctly fitting protective clothing which should be laundered regularly. Loose or baggy clothing can be extremely dangerous when working on running engines or machinery. Clothing which becomes impregnated with oil or other substances can constitute a health hazard due to prolonged contact with the skin even through underclothing.
2. So far as practicable, work on or close to engines or machinery only when they are stopped. If this is not practicable, remember to keep tools, test equipment and all parts of the body well away from the moving parts of the engine or equipment—fans, drive belts and pulleys are particularly dangerous. The electric cooling fan used on some installations is actuated automatically when the coolant reaches a specified temperature. For this reason, care should be taken to ensure that the ignition/isolating switch is OFF when working in the vicinity of the fan as an increase in coolant temperature may cause the fan suddenly to operate.
3. Avoid contact with exhaust pipes, exhaust manifolds and silencers when an engine is, or has recently been running; these can be very hot and can cause severe burns.
4. Many liquids used in engines or vehicles are harmful if taken internally or splashed into the eyes. In the event of accidentally swallowing gasoline (petrol), oil, diesel fuel, antifreeze, battery acid etc., **DO NOT ENCOURAGE VOMITING AND OBTAIN QUALIFIED MEDICAL ASSISTANCE IMMEDIATELY.**

Wear protective goggles when handling liquids which are harmful to the eyes; these include ammonia and battery acid. If any of these substances are splashed in the eyes, wash out thoroughly with clean water and **OBTAIN QUALIFIED MEDICAL ASSISTANCE IMMEDIATELY.**

### **Important Safety Notice**

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all industrial engines as well as the personal safety of the individual doing the work. This operator handbook provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools and parts for servicing equipment, as well as in the skill of the individual doing the work. This

manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that neither personal safety nor equipment integrity are compromised by the choice of methods, tools or parts.

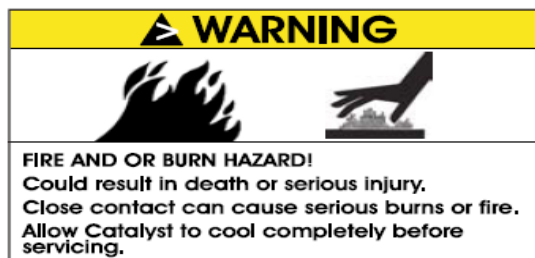
## Notes, Cautions, and Warnings

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES gives you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the equipment. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on the equipment.



### GENERAL WARNINGS:

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the equipment.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake (if equipped) when working on the equipment. If you have an automatic transmission, set it in PARK REVERSE (engine off) or NEUTRAL (engine on) unless instructed otherwise for a specific operation. Place wood blocks (4"x 4" or larger) to the front and rear surfaces of the tires to provide further restraint from inadvertent equipment movement.
- Operate the engine only in a well ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the equipment.
- To reduce the risk of injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on the equipment. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.





## **FORWARD**

This book contains operating and maintenance instructions for the engine(s) listed on the title page.

The life of your engine unit and the delivery of the high performance built into it will depend on the care it receives throughout its life. It is the operator's responsibility to ensure that the engine is correctly operated and that the maintenance operations outlined in this book are carried out regularly after the specified hours of operation have been reached. We consider it to be in your interests to enlist the aid of an authorized Ford Power Products Distributor not only when repairs are required but also for regular maintenance. Distributors are listed at the back of this handbook.

Regular maintenance will result in minimal operating costs.

Engines manufactured by Ford Motor Company are available through Ford Power Products Distributors. When in need of parts or service, contact your local Authorized Distributor. In overseas territories, in the event of difficulties, communicate directly with the supervising Ford affiliated Company in your area whose address appears at the end of this book.

Where the terms "Right" or "Left" occur in this publication, they refer to the respective sides of the engine when viewed from the rear or flywheel end.

Pistons and valves are numbered from the front or timing cover end of the engine commencing at No. 1.

You may find that your engine assembly includes optional equipment not specifically covered in the following text. Nevertheless, the maintenance procedures outlined in this book still apply to your engine


## **ENGINE IDENTIFICATION**

Because Ford Power Products Operations markets such a wide range of industrial gasoline and diesel engines - manufactured both in the U.S. and overseas - it is important that you have as complete identification of the engine as possible in order to provide the correct replacement parts. Review the list of Ford Power Product distributors for a distributor in your area. You can obtain a standard parts listing describing the parts. It remains a distributor function to identify the part number.

The key to identifying the engine is the identification decal mounted on the engine rocker cover. That decal provides not only the engine serial number, but also the exact model or type, configuration code and customer name. The combination of that data permits you to isolate the precise engine, build level and customer so you can determine the correct replacement parts.


## U.S.A. Engine Identification Decal

An identification Decal is affixed to the valve cover of the engine. The decal contains the engine serial number which identifies this unit from all others. Use all numbers when seeking information or ordering replacement parts for this engine.

	Serial Number:	
	Model Number: <b>TSG-416L</b>	
Base Engine Code:	Build Date:	
Customer Name:		
Configuration Code:		

For handy reference, transfer the data recorded on this decal onto your Ford Power Products Engine Warranty Registration copy (Form #194-103-D).

### Unique Engine Serial Number

	<b>IMPORTANT ENGINE INFORMATION</b>		4 U 1 E - 9 C 4 8 5 - A A
	THIS ENGINE CONFORMS TO 2004 CALIFORNIA REGULATIONS FOR OFF-ROAD LARGE SPARK-IGNITION ENGINES. THIS ENGINE IS CERTIFIED TO OPERATE ON UNLEADED GASOLINE ONLY.		
	ADJUSTMENTS: SPARK PLUG GAP 0.042" TO 0.046" NO OTHER ADJUSTMENTS NEEDED.		
	<b>CATALYST</b>	4FMXB04.2GAA TWC H02S SFI	


### Fuel Type

UNLEADED GASOLINE OR  
LIQUID PETROLEUM  
GAS ONLY

## Non-Certified Engine Decal

The identification decal shown below is an example (Non-certified engine build shown) OF THE DECAL THAT MUST BE AFFIXED to the valve cover of the engine for a Non-certified engine build or export of an engine outside of the United States.

### Unique Engine Serial Number

	<b>IMPORTANT ENGINE INFORMATION</b>		4 U 1 E - 9 C 4 8 5 - X A
	THIS ENGINE DOES NOT COMPLY WITH FEDERAL OR CALIFORNIA OFF-ROAD OR ON-HIGHWAY EMISSIONS REQUIREMENTS. SALE OR INSTALLATION OF THIS ENGINE FOR ANY PURPOSE OTHER THAN AS A REPLACEMENT ENGINE IN AN OFF-ROAD VEHICLE OR PIECE OF OFF-ROAD EQUIPMENT WHOSE ORIGINAL ENGINE WAS NOT CERTIFIED IS A VIOLATION OF FEDERAL AND CALIFORNIA LAW SUBJECT TO CIVIL PENALTY.		
	<b>NON CATALYST</b>		

## Federal Emissions Warranty Statement

Ford Power Products warrants that your **(2006 or later model year)** off-road large spark ignition (LSI) engine is designed, built and equipped to meet the applicable EPA emissions requirements and is free from defects in factory supplied materials and workmanship that could prevent it from conforming with these requirements.

Ford Power Products provides the following emissions warranty coverage for your off-road LSI engine:

- Three (3) years or 2500 hours, whichever occurs first, for emissions related parts (see list below).
- Five (5) years or 3500 hours, whichever occurs first, for high priced emissions related parts (see list below).

In cases where the Original Equipment Manufacturer has sourced components from suppliers other than Ford Power Products, the Original Equipment Manufacturer will be responsible for warranty related to those components. These parts are noted in the "What is Covered" section with the statement "(Supplied and Warranted by Original Equipment Manufacturer)".

You will not be charged for repair, replacement or adjustment of defective emissions related parts listed below.

Concerning parts that should be replaced during scheduled maintenance, these parts remain under warranty until the first scheduled maintenance specified in the maintenance schedule or the applicable coverage period listed above, whichever occurs first.

## California Emission control Warranty Statement

### *Your Warranty rights and Obligations*

The **California Air Resources Board** and Ford Power Products are pleased to explain the emission control system warranty on your **2006 or later model year**, compliant, certified off-road large spark ignition engine. In California, new off-road large spark ignition (LSI) engines must be designed, built and equipped to meet the state's stringent anti-smog standards. Ford Power Products must warrant the emission control system on your compliant, certified engine for the periods of time listed below provided there has been no abuse, neglect or improper maintenance of you engine.

Your emission control system may include parts such as the carburetor, regulator, or fuel injection system, ignition system, engine control module (ECM), catalytic convertor and air induction system. Also included may be sensors, hoses, belts, connectors and other emissions related assemblies.

Where a warrantable condition exists, Ford Power Products will repair your LSI compliant, certified engine at no cost to you, including diagnosis, parts and labor.

In cases where the Original Equipment Manufacturer has sourced components from suppliers other than Ford Power Products, the Original Equipment Manufacturer will be responsible for warranty related to those components. These parts are noted in the "What is Covered" section with the statement "(Supplied and Warranted by Original Equipment Manufacturer)".

## ***Manufacturer's Warranty Coverage***

The **2006 or later** off-road, large, spark ignited compliant certified engines are warranted for **three (3) years or 2500 hours, whichever occurs first**. High cost emissions related parts are warranted for **five (5) years or 3500 hours, whichever occurs first**. If any emissions related part fails to perform as designed within the warranty period, the part will be repaired or replaced by Ford Power Products. (See list below)

## ***Owner's Warranty Responsibilities***

As the off-road LSI engine owner, you are responsible for the performance of the **required maintenance listed in your owner's manual**. Ford Power Products recommends that you retain all receipts covering maintenance on your off-road engine but Ford Power Products cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all scheduled maintenance.

As the off-road large spark ignition engine owner, you should however, be aware that Ford Power Products may deny you warranty coverage if your off-road large spark ignition engine or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

Your compliant certified engine is designed to operate on **gasoline, liquefied propane gas or natural gas** when properly equipped. Use of any other fuel may result in your engine no longer operating in compliance with California's emissions requirements.

You are responsible for initiating the warranty process. The ARB suggests that you present your off-road, large spark ignition engine to a Ford Power Products Dealer as soon as a problem exists. The warranty repairs should be completed by an authorized FPP Distributor or Service Dealer as expeditiously as possible.

If you have any questions regarding your rights and responsibilities, you should contact a Ford Power Products Service Representative at 1-800-421-1821 or 1-800-833-4733.

## What Is Covered?

The Federal and California emission warranties cover the following parts.

1. Air / Fuel Feedback Control System and Sensors
2. Air Induction System (Supplied and Warranted by Equipment Manufacturer)
3. Carburetor system (internal parts and/or pressure regulator or fuel mixer or injection system)
4. Catalytic Converter
5. Electronic Engine Control Sensors and Switches
6. Electronic Ignition System
7. Exhaust Manifold and Gaskets
8. Exhaust Pipe between Exhaust Manifold and Catalyst (Supplied and Warranted by Equipment Manufacturer)
9. Fuel Injection System
10. Fuel Injector Supply Manifold
11. Fuel Pump
12. Fuel Pressure Regulator
13. Gaseous Fuel System Assembly
14. Idle Air Control Valve Block off Plate and Gasket
15. Ignition Coil and/or Control Module
16. Intake Manifold and Gaskets
17. Malfunction Indicator Lamp
18. PCV System and Oil Filler Cap
19. Engine Performance Module
20. Solenoid Assembly - Carburetor Feedback Control
21. Spark Control Components
22. Spark Plugs and Ignition Wires
23. Synchronizer Assembly
24. Thermostat Assembly
25. Throttle Body Assembly and Gaskets

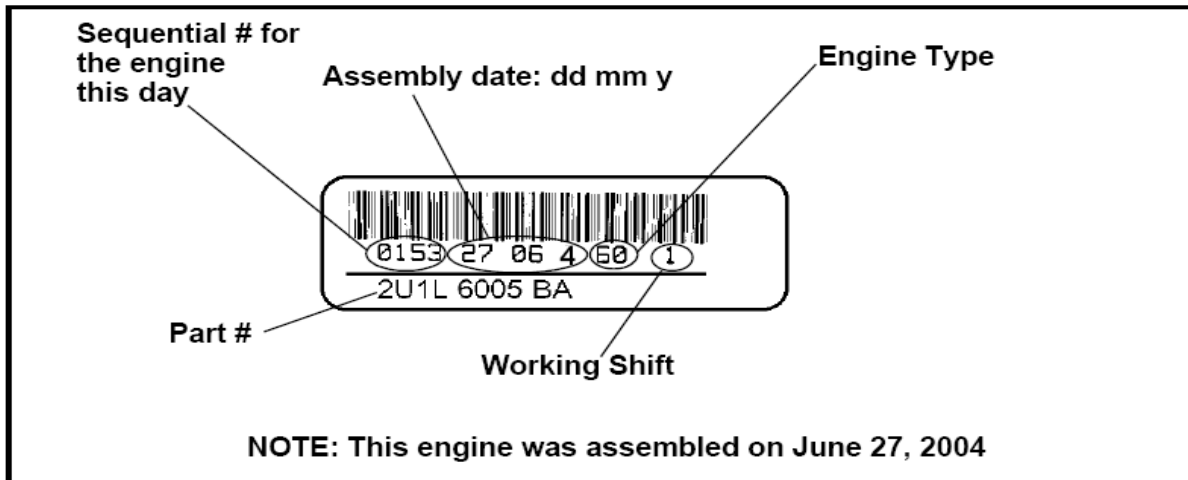
**NOTE:** All emissions related bulbs, hoses, clamps, brackets, tubes, gaskets, seals, belts, connectors, fuel lines, and wiring harnesses used with the above components are also covered.

### ***Components That Are Considered High Priced Parts***

1. Catalytic Converter
2. Catalytic Converter Muffler
3. Engine Performance Module
4. Engine Wiring Harness
5. Fuel System (Gaseous) - Mixer
6. Fuel System (Gaseous) - Regulator, Fuel Pressure
7. Fuel System (Gaseous) - Trimming Device
8. Exhaust Manifold (1.6L engine only)

## Engine Build Identification Label

The TSG-416 Engine Build Identification Label is located on the front side of the valve cover near the oil level indicator. This label contains assembly information as shown below.



## European Service Identification Plate

This plate is fixed to the engine in a prominent position. Panels 1 to 6 on the plate shown to the right, refer to various engine details as listed below:

1. **Serial No.:** This identifies the engine as supplied by Ford Power Products.

**Date:** The two letters following the serial No. indicate the year and month in which the specified build components were assembled - refer to the chart below:

YEAR		JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
1997	U	B	R	A	G	C	K	D	E	L	Y	S	T
1998	V	J	U	M	P	B	R	A	G	C	K	D	E
1999	W	L	Y	S	T	J	U	M	P	B	R	A	G
2000	X	C	K	D	E	L	Y	S	T	J	U	M	P
2001	Y	B	R	A	G	C	K	D	E	L	Y	S	T
2002	Z	J	U	M	P	B	R	A	G	C	K	D	E
2003	A	L	Y	S	T	J	U	M	P	B	R	A	G
2004	B	C	K	D	E	L	Y	S	T	J	U	M	P
2005	C	B	R	A	G	C	K	D	E	L	Y	S	T
2006	D	J	U	M	P	B	R	A	G	C	K	D	E

**NOTE:** The letters I, O and Q are not used in the year column. The letter representing the month repeats every five years.

- This identifies the country of origin of the engine.
- Engine capacity in liters.
- Engine model identification.
- The Build Number indicates the complete specification. The digit to the extreme right hand side is the build scheme chart issue number.
- This space is provided for Equipment Manufacturers' use when extra equipment is fitted outside of the Ford Motor Company. Reference should be made to the Equipment Manufacturer for any information or parts required.

## **PARTS AND SERVICE**

Replacement parts can be obtained through your local Ford Power Products Distributors listed in the back portion of this handbook. They also may be found in the yellow pages under "Engines" or contact Ford Power Products: 1-800 833-4773 U.S.A. or 44-1708-672-677 Europe.

Ford Power Products Distributors are equipped to perform major and minor repairs. They are anxious to see that all of your maintenance and service needs are quickly and courteously completed.

## **SERVICE LITERATURE**

A service manual can be purchased from your distributor. This publication will provide the necessary servicing and overhaul information for your Ford Power Products engine.

- SERVICE MANUAL FPP 194-355
- ENGINE SPECIFICATIONS MANUAL FPP 194-356
- OPERATOR PARTS LIST FPP 194-360
- OPERATOR HANDBOOK FPP 194-354
- ASSEMBLY MANUAL FPP 194-362

## **WARRANTY REGISTRATION**

The Warranty Registration form must be completed by the consumer or final purchaser and returned to Ford Power Products to establish an in-service date or warranty start date. When an in-service date is not established by a Warranty Registration form, the warranty start date for your new Ford Engine is calculated from the time a Ford Power Products Distributor purchased the engine.

The Warranty Registration form is supplied with all Ford Power Products engines and has a postage paid and addressed return envelope. Please complete this form when you receive your new Ford engine or product powered by a Ford engine. Retain the purchaser's copy and mail the remainder of the form using the pre-paid postage and addressed envelope. For more information or assistance please call your nearest Ford Power Products Distributor listed in the back of this manual, or contact Ford Power Products:

- USA: 1-800-833-4773
- Europe: 44-1708-672-677



## BEFORE OPERATING THE ENGINE

1. Before operating a new engine it should be thoroughly inspected to ensure that during transit and installation it has not suffered damage likely to affect its subsequent operation. Controls and instruments should be studied carefully in order that their functions are thoroughly understood.
2. Check that the radiator (where applicable) is full and top off as necessary -- Refer to "Cooling System" on page 34 for recommended coolant mixtures.
3. In the case of marine/industrial engines, ensure that there is coolant in the degas/expansion tank (where applicable).

**CAUTION:** Under no circumstances may the engine be started without liquid in the cooling system.

4. Check the engine oil level and top up or fill as necessary -- Refer to "Check Engine Oil Level" on page 27. For the correct type and grade of oil -- Refer to "Recommended Lubricants" on page 25.
5. Ensure that the battery is fully charged and, if necessary, top up with distilled water.

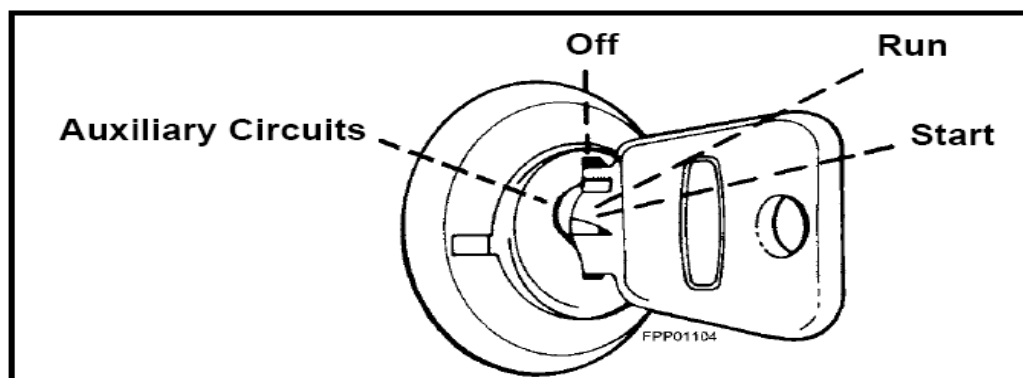
**NOTE:** Ensure that ALL wiring ground connections are properly made to a clean point on the chassis/frame.

6. The engine must be started in accordance with the starting instructions -- Refer to "STARTING THE ENGINE" on page 18.

## OPERATING CONTROLS

### Ignition or Isolation Switch

An ignition or isolation switch is usually fitted which connects the engine starter motor and other electrical equipment to the battery. The switch can be moved to any of the four positions shown by rotating the key. These positions are:



1. Auxiliary Circuits - When moved to this position the auxiliary electrical equipment such as radios and heater fans, can be operated without also connecting the starting circuit with the battery.
2. Off - When set to this position, the switch disconnects the auxiliary electrical equipment and the starting circuit from the battery. The key can be removed from the switch when it is in this position; this will help to prevent unauthorized operation of the engine.
3. Run - This switch position connects the auxiliary circuits as described previously, and the alternator is given initial excitation via the battery.

4. Start - In this position, the starter solenoid is energized and the starter motor cranks the engine. The switch, when released, automatically returns to the RUN position.

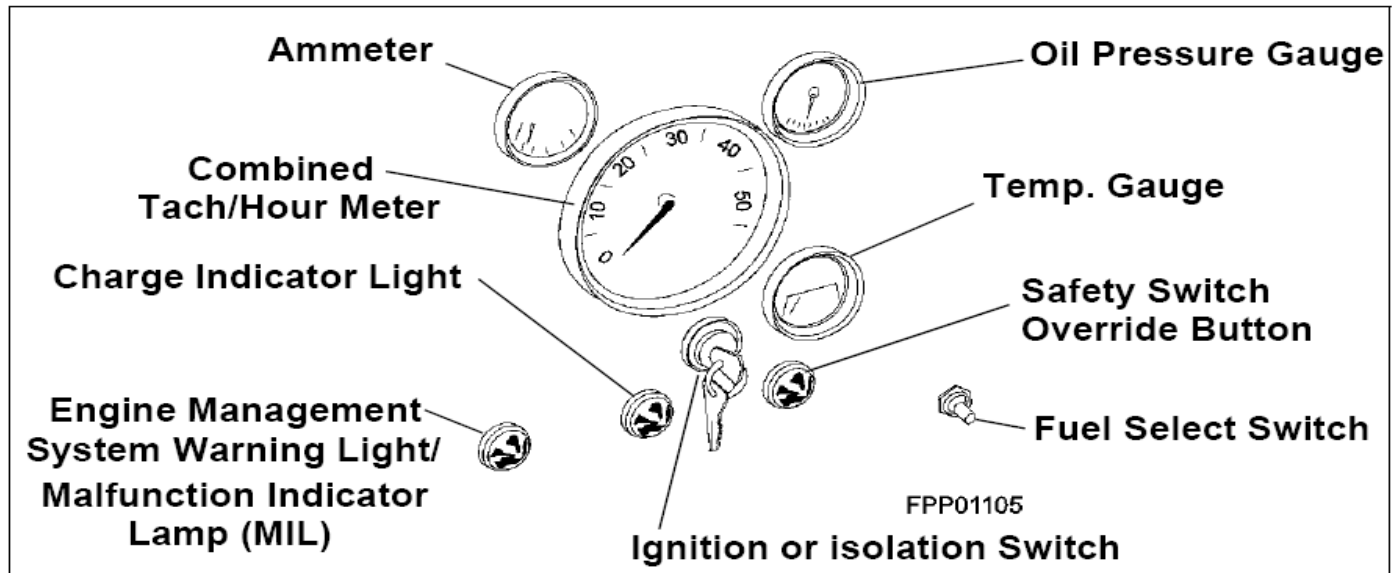
### **Throttle Control (where fitted)**

The throttle control adjusts engine speed. Initial engine speed adjustment is obtained by pressing the throttle control release button while pulling the throttle knob out to increase the engine speed or pushing it in to decrease the engine speed.

A final fine speed adjustment is obtained by turning the throttle control counterclockwise to increase engine speed or clockwise to decrease engine speed.

## INSTRUMENTS

Your Ford Powered Equipment will have been fitted with instruments selected by the manufacturer. The types of instruments most likely to be encountered are detailed here. A typical instrument panel is shown below.



### Ammeter (Where Fitted)

This instrument registers the charging current which is being passed to the battery from the alternator. It also registers a discharge equivalent to the amount of current being used by the electrical equipment when the alternator is not charging.

### Battery Condition Indicator (Where Fitted)

This is sometimes fitted instead of an ammeter and measures the battery voltage thus indicating the state of charge of the battery.

### Tachometer (Where Fitted)

The tachometer indicates the actual engine running speed in crankshaft revolutions per minute.

### Hourmeter (Where Fitted)

This instrument records the number of hours of operation which the engine has completed at the rated rpm. It is frequently combined with the tachometer and is used to determine when an engine service operation is required. If no hourmeter is fitted, a log should be kept.

### Oil Pressure Gauge (Where Fitted)

The oil pressure gauge registers the lubricating system pressure in bar ( $\text{kgf/cm}^2$  or  $\text{lbf/in}^2$ ) and should be frequently observed to ensure that the system is functioning correctly.

## **Temperature Gauge (Where Fitted)**

The temperature gauge enables a close check to be kept on the coolant temperatures.

## **Malfunction Indicator Light (Where Fitted)**

Used on all industrial engines. This light will illuminate whenever there is an engine malfunction such as low oil pressure, high engine temperature, low charging voltage, high charging voltage, fuel injection system fault. The engine can be programmed to shut down in the event of a malfunction.

## **Ignition or Isolation Switch**

-- Refer to "Ignition or Isolation Switch" on page 15.

## **Fuel Select Switch (Where Fitted)**

This switch is incorporated for use with dual fuels. Switch must point to selection of fuel being used.

## **Fuel Gauge (Where Fitted)**

This instrument indicates the quantity of fuel in the tank.

## **STARTING THE ENGINE**



**WARNING: ALL INTERNAL COMBUSTION ENGINES GIVE OFF VARIOUS FUMES AND GASES WHILE RUNNING. DO NOT START OR RUN THE ENGINE IN A CLOSED OR POORLY VENTILATED BUILDING WHERE THE EXHAUST GASES CAN ACCUMULATE. AVOID BREATHING THESE GASES AS THEY MAY CONTAIN POISONOUS CARBON MONOXIDE WHICH CAN ENDANGER YOUR HEALTH OR LIFE IF INHALED STEADILY FOR EVEN A FEW MINUTES.**

## **Initial Start-up**

On initial start-up follow the daily regular maintenance schedule illustration -- Refer to "RECOMMENDED MAINTENANCE SCHEDULES" on page 24.

## To Start From cold

1. Where possible, disconnect the driven equipment, eg, fully depress the clutch where a manual transmission is fitted.

If your unit is equipped with the engine warning light system, always turn the ignition switch to the ON position to make sure that each warning light is operating before starting engine.

2. Switch on the ignition and operate the starter motor until the engine fires.

**NOTE:** Where a safety switch is fitted, the override button must be depressed while the engine is being cranked.

3. Set the throttle to give a fast idle speed until normal operating temperature is reached (where fitted).

**NOTE:** For EFI Governor application there is no throttle cable. Turn key to crank to start engine. When engine starts release key to run position. The EPM/IPM will adjust for cold start and altitude automatically.

**CAUTION:** If the engine stalls or falters in starting, wait 3-4 seconds before re-engaging starter. This will prevent possible damage to the starter or engine. The starter should not operate for periods longer than 30 seconds at a time. An interval of at least two minutes should be observed between such cranking periods to protect the starter from overheating.

## Engine Flooded (EFI only)

Contact your nearest distributor located in the back section of this manual.

## LPG & NG Autocrank System (if equipped)

The operator will momentarily turn the ignition switch to the start position and release. Once the engine starts cranking, it will remain cranking until the engine starts or 8 seconds has elapsed, even when the operator releases the start switch. If the engine cranks for 8 seconds and doesn't start, the ignition input to the EPM must be switched off and then back on before another autocrank sequence can be initiated.

**NOTE:** The EPM must be calibrated for autocrank to operate.

## **STOPPING THE ENGINE**

### **Normal Conditions**

Following normal operating conditions, lower the engine speed to idle, disengage the clutch, and then turn the ignition switch to the OFF position. If the engine has been running under high power, let it run at fast idle speed a few minutes to cool the engine down.

### **Abnormal Conditions**

Under abnormally overheated conditions, the engine may continue to run after the ignition switch is turned off. If this case is ever encountered, turn on the ignition switch immediately and allow the engine to idle until it has cooled enough to stop. If the engine is overheated due to loss of coolant, it is best to stop the engine immediately, if necessary by applying the load. Add engine oil if necessary, then after the engine has returned to a normal temperature, add coolant slowly until the radiator is full.



**WARNING: TO REDUCE THE RISK OF INJURY WHEN CHECKING A HOT ENGINE. COVER THE RADIATOR CAP IN A THICK CLOTH AND TURN IT SLOWLY COUNTERCLOCKWISE TO THE FIRST STOP. AFTER THE PRESSURE HAS BEEN COMPLETELY RELEASED, PRESS THE CAP DOWNWARD AND FINISH REMOVING THE CAP.**

The above instructions also apply to engines that stop due to operation of the low oil pressure/high water temperature safety switch. However, if the engine stops due to low oil pressure, do not restart until the cause has been determined and corrected -- Refer to "Recommended Lubricants" on page 25.

### **Dry Fuel Run-On**

The certified LP & NG engine application will run-on 1-2 seconds after the ignition switch is turned to the off position, this allows the remaining pressurized gas to be used up after the dry fuel lock-off valve closes.

## **RUNNING-IN PROCEDURE**

A new or reconditioned engine must not be run at high speeds or on full load for the first 25 hours. The load and speed may be increased to a maximum over this period. After the first 50 hours running, carry out the maintenance operations listed -- Refer to "RECOMMENDED MAINTENANCE SCHEDULES" on page 24.

Check the instruments frequently and keep the coolant and oil filled to their recommended levels.

## FUEL RECOMMENDATION

This engine is designed to operate on unleaded 87 or 89 octane gasolines. The engine, with the proper fuel equipment, can also operate on commercial dry fuel such as LPG Grade HD5 and natural gas (1050 BTU/ft<sup>3</sup>).

**NOTE:** It is highly recommended that a fuel stabilizer, Ford part number PM-16 or an equivalent additive be used for any length of storage. It is imperative in any application where the fuel will not be consumed within thirty days. - Refer to "Storage - Indefinite Period" on page 40.

LPG fuel specifications must meet or exceed EN 589 (European), or HD% (USA).

NG fuel specification must meet or exceed 38.7 MJ/m<sup>3</sup> (UK), 39.0 MJ/m<sup>3</sup> (USA) (1050 BTU/ft<sup>3</sup>).

**CAUTION:** Use of commercial and non-commercial fuels rated lower than the grades specified above may cause persistent, heavy spark knock, which can lead to engine damage. If your engine knocks heavily or you hear continuous spark knock while maintaining constant operating speeds, consult your distributor or another qualified technician.

**CAUTION:** Commercial grade LPG that is not rated a Grade HD% rating can be susceptible to contamination with a tar like substance, which will greatly affect the dry fuel system performance and the warranty of the FPP certified dry fuel system. FPP recommends the use of a dry fuel filter to prevent this occurrence.

### Fuel Quality

Using a high quality gasoline will help maintain the power, fuel economy and emissions performance of your engine. A properly formulated gasoline will be comprised of well refined hydrocarbons and chemical additives and will perform the following functions:

- Minimize varnish, lacquer and other induction system deposits.
- Prevent gum formation or other deterioration during storage.
- Protect fuel tank and other fuel system components from corrosion or other degradation.
- Provide the correct seasonally and geographically adjusted volatility. This will provide easy starting in the winter and avoid vapor lock in the summer.
- Avoid fuel system icing.

In addition, the fuel will be free of water, debris and other impurities.

We also recommend that the fuel supply be kept fresh, when the equipment is in storage (especially in hot weather), the fuel tank should be kept at least  $\frac{3}{4}$  full.

If you anticipate storage of your engine in excess of two months, consult your distributor or other qualified technician. Also refer to the information on storage in the "Maintenance Instructions" section of this manual.

## Alcohol Gasoline Blends (Gasohol)

Gasohol is a mixture of gasoline and ethanol or methanol.

**CAUTION: If not properly formulated with appropriate cosolvents and corrosion inhibitors, such blends may cause performance problems or damage emissions and fuel system materials. Discontinue use if performance problems occur. To avoid jeopardizing the engine warranty and incurring unnecessary repair cost, do not use blends containing more than 10% ethanol by volume or 5% methanol by volume, or blends that do not contain cosolvents and corrosion inhibitors. Do not use such fuels unless they are unleaded.**

Ethanol ( $C_2H_5OH$ ) is an alcohol based fuel. There are basically two ways to produce ethanol. One way is the fermentative method. This method is based on the fermentation of ethanol from corn, sugar cane, cellulose, and other alternative crops. The other way is the catalytic hydrolysis of ethylene, a petroleum product, is the primary synthetic method. Compared to gasoline the energy content of ethanol is 66%. Ford engines should operate satisfactory on gasohol blends using unleaded gasoline and containing no more than 10% ethanol by volume.

Cosolvents and corrosion inhibitors must also be added. The blend must also have an octane (anti-knock) index of 87 or 89, reference to engine specification section.

Methanol ( $CH_3OH$ ) is also an alcohol based fuel. It can be produced in several ways. One is from natural gas. This process is an inefficient nonviable method of production. Another method is from coal. The problem with methanol produced from coal is that it yields a higher carbon dioxide emission. However coal reserves are much greater than oil or natural gas. A long-term supply of methanol can also be produced from biomass and urban refuse. The biomass process to methanol is prohibitive due to the amount of nonrenewable energy input required for conversion. Compared to gasoline the energy content of methanol is only 49%. Ford engines should operate satisfactory on gasohol blends using unleaded gasoline and containing no more than 5% methanol by volume. Cosolvents and corrosion inhibitors must also be added. The blend must also have an octane (anti-knock) index of 87 or 89, reference to engine specification section.

Gasohol, a mixture of gasoline and ethanol (grain alcohol), is available in some areas outside Europe. Ford engines should operate satisfactory on gasohol blends containing no more than 10% ethanol by volume and having an octane (anti knock) index of 87 or 89, reference engine specifications.

**CAUTION: In some cases, methanol (wood alcohol) or other alcohols may be added to gasoline. Ford engines should operate satisfactory on blends containing up to 5% methanol by volume when cosolvents and other necessary additives are used. If not properly formulated with appropriate cosolvents and corrosion inhibitors, such blends may cause performance problems or damage emissions and fuel system materials. Insufficient data is available to insure the suitability of all methanol/gasoline blends at this time. To avoid jeopardizing your engine warranty or incurring unnecessary repairs costs, DO NOT USE blends containing more than 5% methanol by volume, or blends that do not contain cosolvents and corrosion inhibitors.**



If you are uncertain as to the presence of alcohols in the gasoline you are purchasing, check the label on the pump or ask the station attendant.

**CAUTION: Discontinue use of any gasohol or alcohol/gasoline blend if performance problems occur. Do not use such fuels unless they are UNLEADED.**

**NOTE:** It is highly recommended that a Fuel Stabilizer, Ford Part Number E8AZ-19C544-A or an equivalent additive be used for any length of storage. It is imperative in any application where the fuel will not be consumed within thirty days. Refer to "STORAGE" in this section for further information.

## **LUBRICATION AND MAINTENANCE**

The importance of correct lubrication, periodic inspection and adjustment cannot be over-emphasized. It will determine, to a very large extent, the service the engine will give. Detailed instructions regarding this maintenance are given in the following pages.

Your Authorized Ford Power Products Distributor listed in the back section of this manual, will be pleased to carry out this regular maintenance for you. The various maintenance operations are listed -- Refer to "RECOMMENDED MAINTENANCE SCHEDULES" on page 24.

When carrying out any of the following maintenance operations, any fault or malfunction should be reported immediately to the supervisor or person responsible for engine overhaul or repair.

The following Maintenance Schedules give the maximum recommended service periods. Since operating conditions can vary, it may be advisable to carry out some operations, for example, changing the engine oil, at an interim period. Your operating experience is the best guide for determining this time.

# RECOMMENDED MAINTENANCE SCHEDULES

<div style="text-align: center;"> </div>	Daily	After 1st 50 hrs. (2500 km or 1500 miles)	Every 100 hrs. (5000 km or 3000 miles)	Every 200 hrs. (10,000 km or 6000 miles)	Every 400 hrs. (20,000 km or 12,000 miles)	Every 800 hrs. (40,000 km or 24,000 miles)	Every 2,400 hrs. (120,000 km or 80,000 miles)	Details on Page #
Check engine oil level and top up if necessary	X	X	X	X	X	X		27
Check engine coolant level and top up if necessary with correct mixture	X	X	X	X	X	X		31
Check visually for oil, fuel or coolant leaks	X	X	X	X	X	X		
Lubricate PTO release bearing	X	X	X	X	X	X		
Check all instruments, controls and warning lights. Check hot and cold starting functions	X	X	X	X	X	X		
Check coolant, oil, fuel, exhaust and vacuum hoses/pipes for leaks, damage, deterioration and correct routing. Check all visible electrical wiring for security, correct routing and evidence of chafing or heat damage		X	X	X	X	X		
Change engine oil and renew engine oil filter					X	X		26
Lubricate PTO bearings			X	X	X	X		
Check condition and adjust tension of drive belt(s)				X	X	X		30
*Check gasoline fuel filter element and renew as necessary				X	X	X		
*Check dry fuel filter element and renew as necessary				X	X	X		
Renew air cleaner element					X	X		31
Spark plugs - non-emission certified - Clean, adjust or replace					X	X		29
Spark plugs - emission certified - Replace							X	29
*Check all nuts & bolts for tightness					X	X		
*Adjust PTO clutch release & shaft bearings					X	X		
Renew PCV valve						X		33
Clean PCV hoses, tubes and fittings						X		33
Inspect and clean catalytic converter spark arrester clean out port.				X				

\*It is recommended that this operation is carried out by an authorized Ford Distributor. Depending upon the quality of the fuel used, it may be necessary to renew the filter element more frequently.

# RECOMMENDED MAINTENANCE OPERATIONS

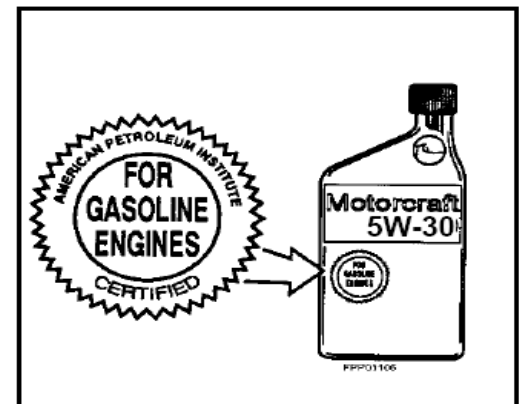
## Recommended Lubricants

**CAUTION:** Do not use supplemental oil additives or other engine treatments. They are unnecessary and could, under certain conditions, lead to engine damage which is not covered by Ford warranty.

Lubricating oil cleanliness is vital for the successful operation of your engine. The oil should be stored under the cleanest possible conditions. When changing or topping-up engine oil use only clean receptacles. Do not allow the oil to come into contact with rubber hoses on the engine.

-30°	-20°	-15°	-10°	0°	+30°	+40°
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		←	←	←	←	←
		←	←	←	←	←

**CAUTION:** Use Ford/Motorcraft “Formula E” SAE 5W-30 engine oil or equivalent that meets Ford Specification WSS-M2C205-A (API Classification – SJ). If SJ oils are not available, SH oils are NOT acceptable. Use only engine oil displaying the American Petroleum Institute Certification Mark on the front of the container, or API specification SJ or higher.



**NOTE:** Ford Power Products industrial engines are designed to perform with engine oils that are licensed by the American Petroleum Institute (API), and oils carrying the most current API classification should be used. API classifications are broken into two categories, gasoline and diesel engines. API's classification is designated by a two letter system. The first letter, the prefix, designates gasoline or diesel. An “S” designates gasoline and a “C” designates diesel. The second letter in the system designates the level of the classification. It should be noted that alternative fuel engines fall into the “gasoline” API category.

Gasoline engines that are converted for LPG or Natural Gas applications must use oils labeled SJ or higher. Do not use oils that are specifically formulated for Diesel Engines only. CC or CD classification, even when labeled Heavy Duty or for Natural Gas Engines, are not acceptable. The use of SAE 5W-30 is recommended for all temperatures:

## Used Engine Oils



**WARNING: PROLONGED AND REPEATED CONTACT MAY CAUSE SERIOUS SKIN DISORDERS INCLUDING DERMATITIS AND SKIN CANCER.**

**WARNING: AVOID EXCESSIVE CONTACT—WASH THOROUGHLY AFTER CONTACT. KEEP OUT OF THE REACH OF CHILDREN.**

**WARNING: PROTECT THE ENVIRONMENT: IT IS ILLEGAL TO POLLUTE DRAINS, WATER COURSES OR SOIL. USE AUTHORIZED FACILITIES FOR DISPOSAL. IF IN DOUBT, CONTACT YOUR LOCAL AUTHORITY FOR ADVICE.**



**WARNING: DO NOT HANDLE A HOT OIL FILTER WITH BARE HANDS. CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. PROTECT YOUR SKIN BY WASHING WITH SOAP AND WATER IMMEDIATELY AFTER CONTACT.**

## Change Engine Oil

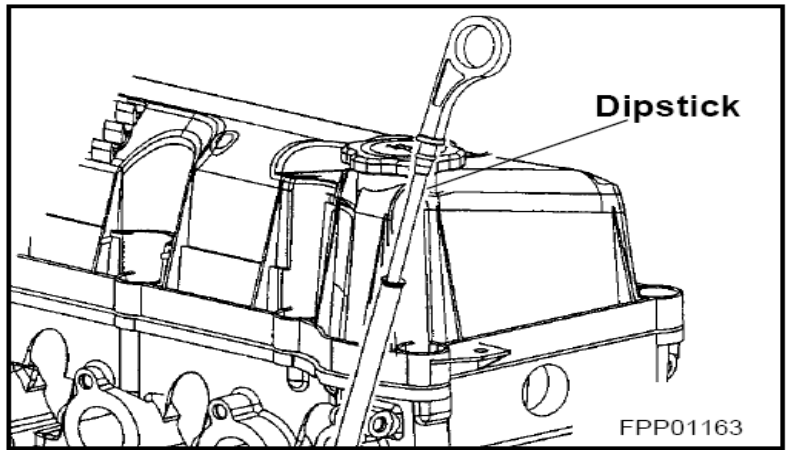
1. Warm the engine to normal operating temperature.
2. Make sure that the equipment is standing level and that the engine is stopped.
3. Obtain a sufficiently large draining pan to accommodate the engine oil -- Refer to "Service Oil fill capacity (including filter):" on page 43.
4. Remove the oil filler cap from the rocker cover, remove the drain plug from the oil pan and drain the oil into the draining pan.

**NOTE:** Modern high performance oils have a cleaning action on the engine which may turn the oil dark, but does not necessarily indicate inadequate oil changes.

5. Replace and tighten the drain plug, then fill the engine via the filler neck in the rocker cover with the correct quantity of oil -- Refer to "SPECIFICATIONS" on page 43.
6. Replace the oil filler cap and run the engine for no more than 30 seconds.
7. Check the oil level as described in the following section.

## Check Engine Oil Level

1. Make sure the equipment is standing level and that the engine is stopped.
2. Pull out the dipstick and wipe it with a clean rag.
3. Insert the dipstick fully and again remove it. At no time should the level of the oil fall below the lower mark on the dipstick.
4. If necessary, top up to the dipstick higher mark with an approved type and grade of oil.
5. Replace the dipstick, ensuring that it is fully inserted into its tube to maintain a sealed crankcase condition



## Renew Engine Oil Filter

**CAUTION:** The original oil filter is not available for service. Use the recommended Motorcraft FL-400S.

Your engine is equipped with a Motorcraft oil filter. A filter of this quality should be used throughout the life of the engine. It is designed to protect your engine by filtering harmful abrasive and sludgy particles without clogging up or blocking the flow of the oil to vital engine parts. This filter is especially designed for use in engines built by Ford to give successful operation with the recommended oil filter change intervals. Contact your nearest Ford Power Product Distributor/Dealer listed in the back section to obtain the correct filter. Before commencing, place a drain pan beneath the filter to catch any spilt oil.



1. Using a suitable strap wrench, unscrew the oil filter canister.
2. Thoroughly clean oil filter housing face.
3. Partly pre-fill the new filter with clean engine oil of the correct type and grade. Apply a thin film of clean engine oil to the oil filter sealing ring.
4. Screw on new oil filter canister until sealing ring abuts the filter head and tighten a further 1/2 turn. Do NOT use a strap wrench or similar tool to tighten the filter canister.
5. Run engine and check for any leaks from oil filter.
6. Stop engine, allow oil to settle and top up as necessary.

## Gasoline Fuel System - EFI

In the event that your engine is equipped with an EFI (Electronic Fuel Injection) system follow normal maintenance service. Any necessary service repairs should be made by your Ford Power Products Distributor. The adjusting procedure requires the use of tools which are not readily available to consumers. Please contact Ford Power Products Distributors listed in the back section of this manual.

## Fuel Filter - EFI

The fuel filter is located between the fuel pump and the fuel rail, and is not mounted on the engine.



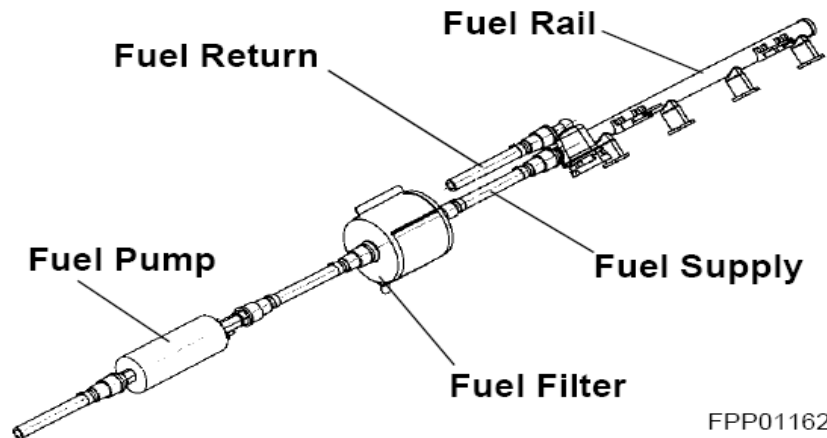
**WARNING: WHEN REMOVING THE FUEL FILTER, USE CAUTION SINCE THERE MAY BE FUEL PRESSURE PRESENT.**

The fuel filter should be replaced according to the maintenance schedule -- Refer to "RECOMMENDED MAINTENANCE SCHEDULES" on page 24, or more often if needed.

1. Block fuel flow by crimping fuel feed line with appropriate tool between fuel tank and filter.
2. Place suitable container beneath filter to collect spilled fuel.
3. Remove fuel line clamps and hose at each end of filter.
4. Replace fuel filter using Ford Power Products fuel filter service part number E7DZ-9155-A.
5. Dispose of fuel filter properly.



**NOTE: PROTECT THE ENVIRONMENT.** It is illegal to pollute drains, water courses or soil. Use authorized facilities for disposal. If in doubt, contact your local Authority for advice.



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## Fuel Filter Before Fuel Pump

The disposable filter is located on the inlet side of the electric fuel pump.

1. Backup filter using an open end wrench while removing fuel inlet line using a line wrench.
2. Disconnect hose clamp and remove filter from hose and discard.
3. Install new filter being careful not to overtighten.
4. Backup filter while tightening line.
5. Cycle ignition switch and check for leaks.

## Ignition System - DIS

The Distributorless Ignition System (DIS) used on this engine does not have a distributor or vacuum advance mechanism. Ignition timing is set by design and cannot be readily changed. In the event that the engine is converted to alternative fuels, the timing can be re-set by trained technicians. Please contact a Ford Distributor listed at the back of this manual.

### Renew Spark Plugs



**WARNING: THE DIS IGNITION SYSTEM COMMONLY CARRIES VOLTAGES IN EXCESS OF 60,000 VOLTS. PLEASE USE CAUTION.**

1. Remove the lead from each spark plug by grasping, twisting and then pulling the molded boot on the end of the lead.

**CAUTION: Do not pull directly on the lead as this could cause the wire connection inside the boot to become separated.**

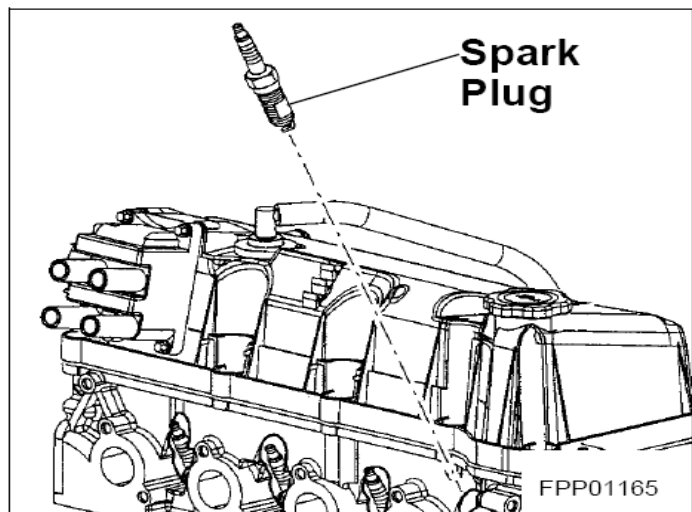
2. After loosening each spark plug one or two turns with a proper spark plug spanner, clean the area around each spark plug port with compressed air then remove the spark plugs.



**WARNING: PROTECTIVE GOGGLES MUST BE WORN TO PROTECT THE EYES WHEN USING COMPRESSED AIR.**

3. Check the gaps of the new spark plugs with a feeler gauge, and, where necessary, bend the outer ground extension to achieve the specified gap.
4. Use a proper spark plug spanner to avoid damaging the insulators, screw the new spark plugs into the cylinder head and tighten them to the specified torque -- Refer to "SPECIFICATIONS" on page 43.

**CAUTION: Do not over tighten spark plugs as the gap may change considerably due to the distortion of the plug outer shell.**



5. Coat the inside of each spark plug boot with Motorcraft Silicone Brake Caliper Grease and Dielectric Compound XG-3 or equivalent, using a small screwdriver blade.
6. Re-connect each high tension lead to the correct spark plug.

**NOTE:** The plug numbers are printed on the leads to aid correct re-assembly.

**NOTE:** Be sure each lead is fully pressed onto each plug and that the molded boot is firmly in place.

## Electronic Actuator

In the event that your engine is equipped with an FPP electronic actuator, no adjustment can be made.

## Check Condition of Ancillary Drive Belts



**WARNING: ENGINE SHOULD BE STOPPED AND ANY REMOTE STARTER DISABLED BEFORE CHECKING BELTS.**

The ancillary belts used to drive the fan, generator and water pump, are both manually adjusted.

The belts should be visually inspected for signs of wear or damage. It should be renewed if necessary. Refer to Service Manual.

**NOTE:** May be purchased from your local Ford Power Product Distributor listed on the back of this handbook.



## Check Engine Coolant Level



**WARNING: TO REDUCE THE RISK OF INJURY WHEN CHECKING A HOT ENGINE. COVER THE RADIATOR CAP WITH A THICK CLOTH AND TURN IT SLOWLY COUNTER-CLOCKWISE TO THE FIRST STOP. AFTER THE PRESSURE HAS BEEN COMPLETELY RELEASED, PRESS DOWNWARD AND FINISH REMOVING CAP. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY.**

**CAUTION: Do not add coolant to an engine that has become overheated until the engine cools. Adding coolant to an extremely hot engine can result in a cracked block or cylinder head.**

1. Allow the engine to cool down to 40°C (110°F).
2. Turn the radiator tank filler cap through 90° in a counter-clockwise direction. Pause to allow any pressure to drop, then turn cap fully counterclockwise and remove it.
3. The quantity of coolant in the tank is a direct indication of the coolant level in the complete system. The acceptable level of coolant in the expansion/degas tank is shown by the level indicators moulded into the tank wall. Top up as necessary with a mixture of plain water and antifreeze -- Refer to "Cooling System" on page 34 for information on mixing antifreeze solutions.

**NOTE:** It is essential that only the correct type of antifreeze is used -- Refer to "Cooling System" on page 34.

4. Replace the filter cap and turn down tightly.

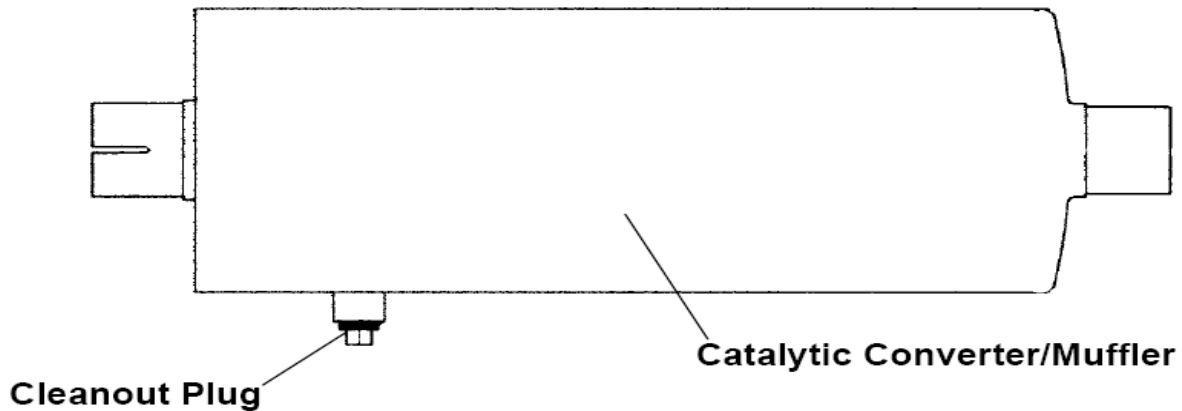
## Renew Air Cleaner Element

Your air cleaner filters air entering the engine induction system and acts as a silencer and a flame arrester. Air that contains dirt and grit produces an abrasive fuel mixture, and can cause severe damage to the cylinder walls and piston rings. Damage to the cylinder walls and piston rings will cause high oil consumption and short engine life. A restricted or dirty air cleaner will also cause a rich fuel mixture. Thus, it is extremely important that the air cleaner be serviced at recommended intervals.

**CAUTION: Service the air cleaner more frequently under severe dust conditions to prevent engine damage.**

1. Release the air cleaner lid retaining hardware.
2. Lift the air cleaner lid clear of the air cleaner body, then remove the air cleaner element and discard it.
3. Wipe the inside of the air cleaner body and lid clean, using a lint-free rag.
4. Insert the new element, ensuring that it fits properly and install air cleaner lid.

## Clean Muffler Spark Arrester



Instructions for cleaning the combination catalytic converter muffler with an internal spark arrester.



**WARNING: BEFORE TOUCHING ANY PART OF AN EXHAUST SYSTEM, BE ABSOLUTELY SURE THAT IT HAS HAD SUFFICIENT TIME TO COOL!**

Disposal of accumulated particles may be accomplished by following the steps listed below.

**CAUTION: Do not perform this operation in an area with combustible materials.**

**CAUTION: IN A SAFE AREA take precautions to collect and properly dispose of residue falling from the spark arrester trap.**

1. Remove the cleanout plug (pipe plug) on the bottom half or side of the spark arrester (muffler). Some particles may begin to drain out at this time. Soot mixed with condensation or other oily liquids may also empty out.



**WARNING: KEEP HEAD AND FACE AWAY FROM POSSIBLE DRAINAGE!**

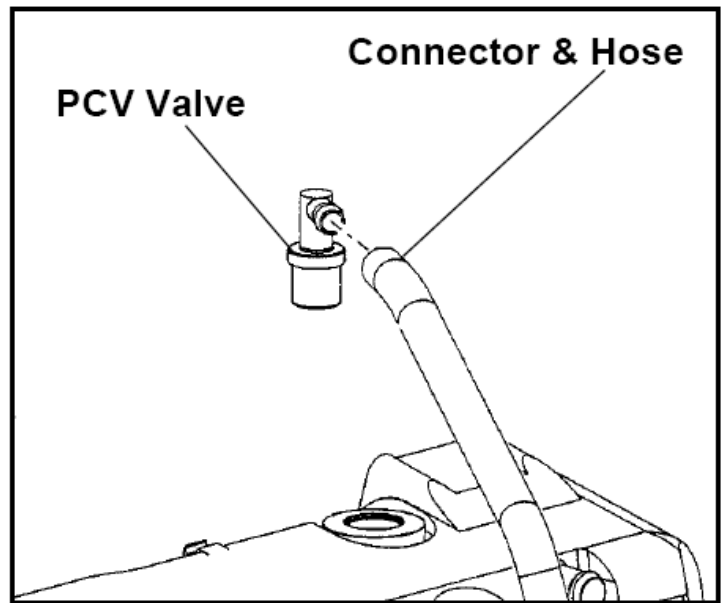
2. Without causing deformation (or any type of damage to the spark arrester) repeatedly tap on the arrester near the cleanout plug. This may be enough to begin drainage of the spark trap.
3. Cleaning can be accomplished by the following procedure:
  - Industrial vacuum cleaners can do a complete job
  - IN A SAFE AREA, start the engine. Idle in a neutral gear, if possible. Then alternate between low idle and high idle for two to three minutes
  - Operate the engine as required by the application for two to three minutes
4. If the engine was started, TURN OFF THE ENGINE AND LET THE ARRESTER COOL AGAIN.
5. Replace the cleanout plug and tighten securely.
6. Dispose of the accumulated particles.

## Renew PCV Valve

1. Detach the hose, from the top of the PCV valve located at the top rear of valve cover and from the intake manifold.
2. Withdraw the PCV valve from the valve cover grommet.
3. Discard the PCV valve.
4. Thoroughly clean the inside and outside of the hose.

**NOTE:** A small amount of engine oil may be used as a lubricant to aid the installation

5. Insert the new PCV valve into the valve cover grommet.
6. Re-connect the hose to the PCV valve and to the intake manifold.



## GENERAL MAINTENANCE INFORMATION

The following section outlines some aspects of general maintenance which will be of value to the operator.

### Cooling System

To obtain maximum engine service life, its operating temperature must be maintained by an efficient cooling system.

**CAUTION: Under no circumstances should the engine be started without liquid in the cooling system. This may cause permanent damage to the engine.**

**CAUTION: The use of straight water as a coolant will cause permanent damage to the engine.**

Inspect the exterior of the radiator for obstructions, remove all bugs, dirt or foreign material with a soft brush or cloth.

Use care to avoid damaging the fins. If available, use low pressure compressed air or a stream of water in the opposite direction to normal airflow. Check all hoses and connections for leaks. If any of the hoses are cracked, frayed, or feel spongy, they should be replaced.

**CAUTION: Never use a cold coolant mixture to top-up the radiator or degas tank of a hot engine if the coolant level is very low; this could cause serious engine damage.**

The radiator or degas tank is equipped with a pressure cap. It is dangerous to remove this when the system is very hot.



**WARNING: NEVER REMOVE THE PRESSURE RELIEF CAP WHILE THE ENGINE IS OPERATING OR WHEN THE COOLING SYSTEM IS HOT. MAY CAUSE PERSONAL INJURY OR DAMAGE TO COOLING SYSTEM OR ENGINE. TO REDUCE THE RISK OF HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE DEGAS BOTTLE WHEN REMOVING THE PRESSURE RELIEF CAP, WAIT UNTIL THE ENGINE HAS COOLED DOWN TO AT LEAST 40°C (110°F).**

1. Wrap a thick cloth around the pressure relief cap and turn it slowly one-half turn counterclockwise. Stepping back while the pressure is released from the cooling system.
2. When you are sure all the pressure has been released, (still with a cloth) turn counterclockwise and remove the pressure relief cap.

In territories where freezing conditions may occur, the coolant should consist of a mixture of 50% plain water and 50% Motorcraft Premium Gold coolant, or equivalent, . This antifreeze contains additional corrosion inhibitors designed to provide lasting protection for the engine.

Only this antifreeze, or proprietary antifreeze meeting Ford specification WSS-M97B51-A1 should be used when topping-up or re-filling the cooling system.

Motorcraft Premium Gold engine coolant, or equivalent, has long life characteristics and if the concentration is kept to a maximum of 50% it will provide adequate frost protection and inhibiting for the life of the engine.

**NOTE:** If a major component of the cooling system is renewed such as the radiator, water pump etc., the system should be flushed and re-filled with a 50% solution of Motorcraft Premium Gold engine coolant, or equivalent, and clean water.

In territories where the ambient temperature is such that no protection against freezing is required, it is recommended that a 25% concentration of Motorcraft Premium Gold engine coolant, or equivalent, is used. This will protect water pumps, core plugs, thermostat housings and radiators against corrosion for the life of the engine and raise boiling point when used at this concentration. See previous Note on renewing cooling system components.

The antifreeze concentration in a cooling system can be determined by using a suitable hydrometer.

- A reading of 1080 represents a 50% antifreeze concentration.
- A reading of 1040 represents a 25% antifreeze concentration.
- A reading of 1000 represents plain water.

**CAUTION:** Do not add or mix an orange-colored extended life coolant, such as Motorcraft Specialty Orange engine coolant with factory filled coolant WSS-M97B44-D. Mixing Motorcraft Specialty Orange engine coolant or any orange colored extended life product, with factory filled coolant, can result in degraded corrosion protection.



**WARNING: ANTIFREEZE CONTAINS MONO ETHYLENE GLYCOL AND OTHER CONSTITUENTS WHICH ARE TOXIC IF TAKEN INTERNALLY AND CAN BE ABSORBED IN TOXIC AMOUNTS ON REPEATED OR PROLONGED SKIN CONTACT. PERSONS USING ANTIFREEZE ARE RECOMMENDED TO ADHERE TO THE FOLLOWING PRECAUTIONS:**

- **ANTIFREEZE MUST NEVER BE TAKEN INTERNALLY. IF ANTIFREEZE IS SWALLOWED ACCIDENTALLY, MEDICAL ADVICE SHOULD BE SOUGHT IMMEDIATELY.**
- **PRECAUTIONS SHOULD BE TAKEN TO AVOID SKIN CONTACT WITH ANTIFREEZE. IN THE EVENT OF ACCIDENTAL SPILLAGE ONTO THE SKIN, ANTIFREEZE SHOULD BE WASHED OFF AS SOON AS PRACTICABLE. IF CLOTHING IS SPLASHED WITH ANTIFREEZE, IT SHOULD BE REMOVED AND WASHED BEFORE BEING WORN AGAIN, TO AVOID PROLONGED SKIN CONTACT.**
- **FOR REGULAR AND FREQUENT HANDLING OF ANTIFREEZE, PROTECTIVE CLOTHING (PLASTIC OR RUBBER GLOVES, BOOTS AND IMPERVIOUS OVERALLS OR APRONS) MUST BE USED TO MINIMIZE SKIN CONTACT.**

## Draining, Flushing and Filling the Cooling System



**WARNING: NEVER REMOVE THE PRESSURE RELIEF CAP WHILE THE ENGINE IS OPERATING OR WHEN THE COOLING SYSTEM IS HOT. MAY CAUSE PERSONAL INJURY OR DAMAGE TO COOLING SYSTEM OR ENGINE. TO REDUCE THE RISK OF HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE DEGAS BOTTLE WHEN REMOVING THE PRESSURE RELIEF CAP, WAIT UNTIL THE ENGINE HAS COOLED DOWN TO AT LEAST 40°C (110°F).**

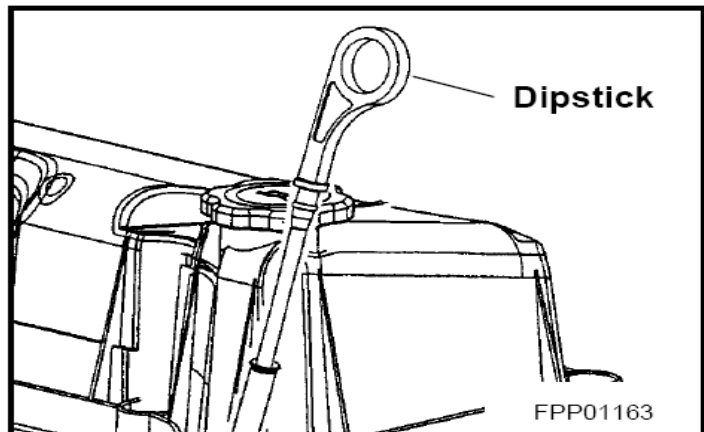
1. Wrap a thick cloth around the pressure relief cap and turn it slowly one-half turn counterclockwise. Stepping back while the pressure is released from the cooling system.
2. When you are sure all the pressure has been released, (still with a cloth) turn counterclockwise and remove the pressure relief cap.
3. Remove the radiator tank filler cap, then open the radiator drain cock, where fitted, or detach the bottom radiator hose.
4. Flush the system with water using a hose until clean water emerges and allow all water to drain out. Close the drain cock (or replace the bottom radiator hose). Recover all old antifreeze and dispose of properly. Contact your local municipal government for the proper disposal.
5. Fill the system with the correct coolant mixture via the filler neck. Fill the system slowly, to avoid air locks.
6. Run engine and check hose connections for leaks. Check, and, if necessary, top up the coolant in the radiator.

## Engine Lubrication System

The lubrication system should be maintained regularly -- Refer to "RECOMMENDED MAINTENANCE SCHEDULES" on page 24, with the correct grade of lubricant as specified in the maintenance summary -- Refer to "Recommended Lubricants" on page 25. The system is of the force feed type, the lubricating oil being circulated to the engine bearings under pressure by an oil pump driven from the crankshaft.

The dipstick provides some guide to the condition of the oil. An additive type of oil keeps soot in suspension, and even a small amount of soot causes the oil to darken rapidly.

However, if the dipstick is found to be heavily coated with sludge, then obviously the oil should be changed.



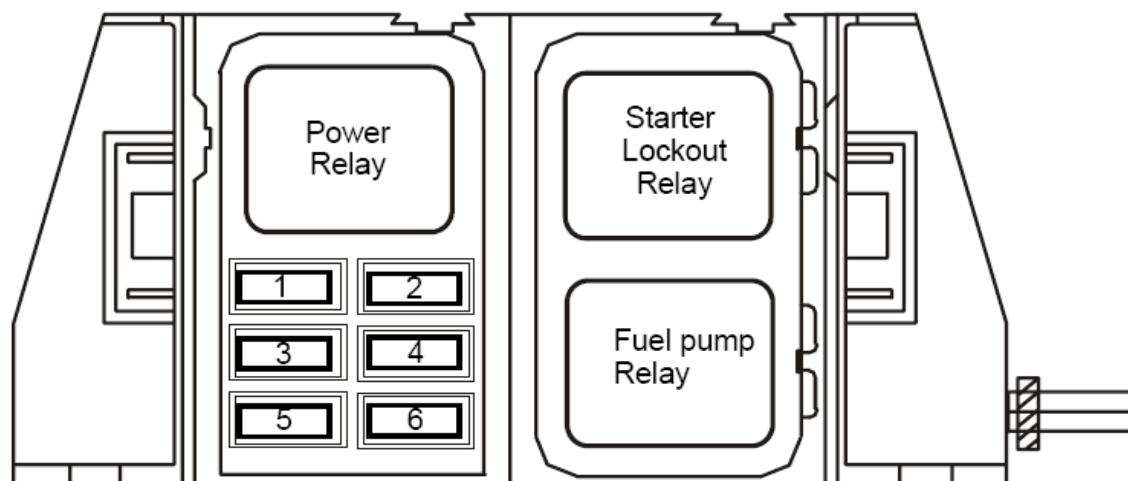
## Electrical System

A NEGATIVE EARTH (NEGATIVE GROUND) SYSTEM IS USED.

Recommended Battery Capacity: 750 CCA/140 RC

### ***EPM - Power Distribution Box***

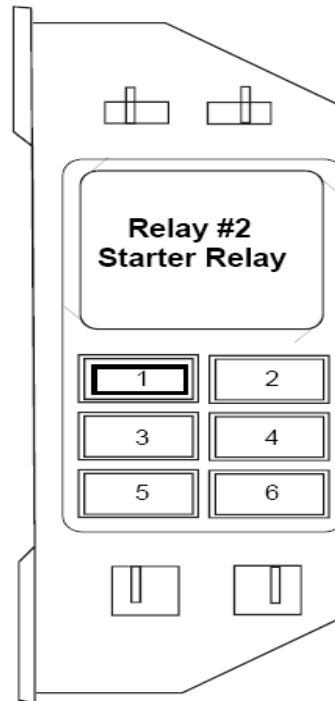
Part of -12A581- Wiring Harness



Fuse	Amps	Circuits protected
1	-	Not used
2	5	Ignition Voltage to EPM, Dry Fuel Lock-off, Starter Lockout Relay and Fuel Pump Relay
3	20	Battery Voltage to EPM and Power Relay
4	15	Fuel pump
5	15	Battery Voltage to the Megajector, HO2S Sensors & Ignition Coil
6	-	Not used

## ICM - Power Distribution Box

### Part of -12A200- Wiring Harness



Fuse	Amps	Circuits protected
1	10	Ignition Voltage to ICM, Starter Relay and Ignition Coil
2	-	Not Used
3	-	Not Used
4	-	Not Used
5	-	Not Used
6	-	Not Used

## Generator

This is mounted on a bracket at the front of the engine and is driven from the crankshaft by a serpentine belt.

The charging rate is adjusted automatically by the built-in regulator to provide sufficient electric current to keep the battery fully charged under normal operating conditions.

The generator requires no lubrication or maintenance.



**WARNING: IT IS ESSENTIAL THAT THE WIRING CONNECTIONS TO THE GENERATOR ARE NOT REMOVED WHILE THE ENGINE IS RUNNING, AS THIS WILL RESULT IN DAMAGE TO THE REGULATOR OR PERSONAL INJURY.**



## **Storage**

**NOTE:** It is highly recommended that fuel stabilizer, Ford part number PM-16 or an equivalent additive be used for any length of storage. It is imperative in any application where the fuel will not be consumed within thirty days. Ford Fuel Stabilizer comes in an 8 oz. bottle for consumer use and should be available through all Power Products Distributors. The correct ratio is 2 oz. Stabilizer to 5 gallons of gasoline. Without the use of an additive, the unused fuel in your fuel tank can and will go sour in a very short period of time, causing varnish and contaminants to form. This causes problems in fuel delivery by clogging fuel injectors.

### ***Storage - One Month***

- Add fuel stabilizer (See previous note).
- While the engine is running, treat upper cylinders by spraying engine fogging agent (available from your local aftermarket supplier) into the air intake for about two minutes. Open throttle for a short burst of speed, shut off engine and allow it to come to a stop while continuing to spray into the air intake.
- Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs and cover all openings into engine with dust proof caps or shields (suitable non-hygroscopic material).
- If engine is less transmission, spray flywheel and ring gear with mixture of one part recommended engine oil and one part Stoddard Solvent or equivalent.
- Check coolant protection. Store indoors in dry area.

### ***Storage - Indefinite Period***

- Add fuel stabilizer (See previous note).
- Drain crankcase completely and refill with recommended engine oil, (SAE 10) or equivalent.
- Run engine until completely out of fuel. Gasoline only: Restart and run on unleaded gasoline mixed with stabilizer for at least ten minutes. While engine is still running and completion of above run, treat upper cylinders by spraying engine fogging agent (available from your local aftermarket supplier) into the air intake for about two minutes. Open throttle for a short burst of speed, shut off engine and allow it to come to a stop while continuing to spray into the air intake.
- Check coolant protection.
- Disconnect and remove battery.
- Clean exterior surface of engine.
- Leave spark plugs in holes or seal spark plug holes with suitable threaded metal plugs.
- Seal all openings into engine and accessories with non-hygroscopic material. Mask off all areas to be used for electrical contacts.
- Make sure all surfaces are dry then spray all taped openings, all engine accessories including ignition wiring and all exterior surfaces of engine with insulation compound.
- If engines are equipped with automotive type clutch, block clutch in slightly disengaged position so that lining and pressure plates are not in contact.

# ENGINE SYSTEM CHECK

## EPM/ICM System Fault

**NOTE:** Items listed in the possible cause column generally will set a diagnostic trouble code (DTC) or illuminate the MIL light.

**NOTE:** FPP engines are used in many different applications and equipment. When performing any system diagnosis be aware of any OEM inputs or equipment monitoring devices that may have an effect on the engine's performance or any of the engine's operating systems.

### *Engine Performance - No Load*

SYMPTOM	POSSIBLE CAUSE
<b>Engine Runs Briefly and Shuts Down</b>	<ul style="list-style-type: none"> <li>• Loss of Spark</li> <li>• Frozen Fuel Regulator (Dry Fuel)</li> <li>• Cylinder Head Temperature Sensor Failure</li> <li>• Engine Overheating</li> <li>• Air Inlet Restriction</li> <li>• Oil Pressure Switch Failure</li> <li>• Low Oil Pressure</li> <li>• Low Fuel Pressure</li> <li>• Electronic Actuator Instability</li> <li>• Wiring Failure</li> <li>• Overspeed Shutdown</li> <li>• EPM/ICM Failure</li> </ul>
<b>Engine Cranks But No Start</b>	<ul style="list-style-type: none"> <li>• Coil Power Loss</li> <li>• EPM/ICM Ground Loss</li> <li>• EPM/ICM Power Loss</li> <li>• Severe Vacuum Leak (Dry Fuel)</li> <li>• Air Inlet Restriction</li> <li>• Air Inlet leak (Dry Fuel)</li> <li>• Fuel Lock-Off Inoperative (Dry Fuel)</li> <li>• Crankshaft Position Sensor Failure</li> <li>• Electronic Actuator Failure</li> <li>• Wiring Failure</li> <li>• Low Fuel Pressure</li> <li>• Ancillary Components Binding</li> </ul>
<b>Engine Runs Poorly</b>	<ul style="list-style-type: none"> <li>• Governing System failure</li> <li>• High Fuel Pressure</li> <li>• Wrong EPM/ICM Installed</li> <li>• Actuator Air Blockage</li> <li>• TMAP Sensor Leak</li> <li>• Contaminated Fuel</li> <li>• Crankshaft Position Sensor Harness Ground Shielding Failure</li> <li>• Poor Fuel Pressure</li> <li>• Incorrect Fuel Select Table Selected</li> <li>• Improper PCV Routing</li> <li>• Valve Timing Incorrect</li> <li>• Low Cylinder Compression</li> </ul>

SYMPTOM	POSSIBLE CAUSE
<b>Engine Cranks Slowly</b>	<ul style="list-style-type: none"> <li>• Excessive Engine Load (Hydraulic Pump Failing, Binding Ancillary Drive Components)</li> <li>• Incorrect Battery Specifications</li> <li>• Incorrect Battery Cable Size</li> <li>• Starter Relay</li> <li>• Low Battery Voltage</li> <li>• Starter Failure (Excessive Drain)</li> </ul>
<b>Engine Does Not Crank</b>	<ul style="list-style-type: none"> <li>• Dead Battery</li> <li>• Ancillary Components Binding or Seized</li> <li>• OEM Shutdown - Oil Level Safety</li> <li>• Starter Lockout Relay Failure</li> <li>• Bad Starter</li> <li>• Ignition Switch Failure</li> <li>• Crank Control Wire Failure</li> <li>• Loose Connection or Corrosion</li> </ul>

***Engine Performance - While Under Load***

SYMPTOM	POSSIBLE CAUSE
<b>Engine Stalls/Quits</b>	<ul style="list-style-type: none"> <li>• Low Battery Voltage</li> <li>• Low Fuel Pressure</li> <li>• OEM Safety Shutdowns</li> <li>• Missing or Wrong OEM EPM/ICM Calibration</li> <li>• Bad TMAP Sensor</li> <li>• Inlet Air Restriction</li> <li>• Electronic Actuator Failure</li> <li>• Coil Failure (weak)</li> <li>• Fuel Mixer Binding (Dry Fuel)</li> </ul>
<b>Runs Rough</b>	<ul style="list-style-type: none"> <li>• Ground Loss</li> <li>• Misrouted Spark Plug Wires</li> <li>• Fuel System Failure</li> <li>• Vacuum Leak</li> <li>• Wiring Failure (Engine Harness)</li> <li>• Coil Power Loss</li> <li>• Low Fuel Pressure</li> <li>• Spark Plugs Fouled</li> <li>• Incorrect Valve Timing</li> <li>• EPM/ICM Failure</li> <li>• Low Engine Compression</li> </ul>
<b>Misses</b>	<ul style="list-style-type: none"> <li>• Fuel System Failure</li> <li>• Misrouted Spark Plug Wires</li> <li>• Spark Plug Gap Incorrect</li> <li>• Spark Plugs Fouled</li> <li>• Cracked Spark Plug Insulator</li> <li>• Coil Power Loss</li> <li>• Incorrect Valve Timing</li> <li>• Compression Loss</li> </ul>
<b>Hesitation/Stumble</b>	<ul style="list-style-type: none"> <li>• Low Fuel Pressure</li> <li>• Fouled Spark Plugs</li> <li>• Electronic Actuator Failure</li> <li>• TMAP Sensor Vacuum Signal Loss</li> </ul>

SYMPTOM	POSSIBLE CAUSE
<b>Surges</b>	<ul style="list-style-type: none"> <li>• Low Fuel Pressure</li> <li>• Electronic Actuator Failure</li> <li>• TMAP Sensor Failure</li> </ul>
<b>Backfires</b>	<ul style="list-style-type: none"> <li>• Fouled Spark Plugs</li> <li>• Spark Plug Wire Broke</li> <li>• EPM/ICM Momentary Power Loss</li> <li>• EPM/ICM Momentary Ground Loss</li> <li>• Excess Lean Condition</li> <li>• Coil Failure</li> <li>• Intake Manifold Leak</li> <li>• Bad Intake Valve</li> <li>• Fuel Lock-Off Inoperative (Dry Fuel)</li> </ul>
<b>Lack of Power</b>	<ul style="list-style-type: none"> <li>• High Intake Air Temperature</li> <li>• Misrouted Spark Plug Wires</li> <li>• Fuel System Failure</li> <li>• Electronic Actuator Failure</li> <li>• Bad TMAP Reading</li> <li>• Low Fuel Pressure</li> <li>• Ancillary Components Binding</li> <li>• Low Cylinder Compression</li> </ul>
<b>Spark Knock</b>	<ul style="list-style-type: none"> <li>• Poor Quality or Contaminated Fuel</li> <li>• Carbon Build-up</li> <li>• Wrong Spark Plugs (Too High Heat Range)</li> <li>• High Intake Air Temperature</li> <li>• High Engine Temperature</li> <li>• Fuel Delivery System</li> <li>• PCV System</li> <li>• Fuel Selection Timing</li> </ul>

***Performance Concerns***

SYMPTOM	POSSIBLE CAUSE
<b>Diesels/Runs On</b>	<ul style="list-style-type: none"> <li>• Hot Spots in Cylinders <ul style="list-style-type: none"> <li>- Spark Plugs</li> <li>- Carbon Build-up</li> <li>- High Idle Speed</li> </ul> </li> <li>• Damaged Ignition System</li> <li>• Improper Sealing of Intake Manifold</li> <li>• Faulty Fuel Delivery System</li> <li>• EPM/ICM</li> </ul>

## SPECIFICATIONS

<b>GENERAL SPECIFICATIONS</b>	
<b>Engine Type:</b>	<b>I-4 Cylinder, 4 Stroke, Spark Ignition</b>
<b>Liter/CID:</b>	<b>1.6 / 97.5</b>
<b>Bore: mm (inch)</b>	<b>82.070 (3.23)</b>
<b>Stroke: mm (inch)</b>	<b>75.480 (2.97)</b>
<b>Number of Cylinders:</b>	<b>4</b>
<b>Compression Ratio:</b>	<b>9.5 :1</b>

<b>FUEL SYSTEM</b>	
<b>LPG Type: Fuel Specification:</b>	<b>Liquefied Petroleum Gas Fumigation EN 589 (European) HD-5 (USA)</b>
<b>NG Type: Fuel Specification:</b>	<b>Natural Gas Fumigation 38.7 MJ/m<sup>3</sup> (UK) 39.0 MJ/m<sup>3</sup> (USA)</b>
<b>Gasoline Type: Fuel Specification;</b>	<b>Gasoline (Petrol) Electronic Fuel Injection or Carbureted 87 or 89 Octane (Gasoline blends no to exceed 10% Ethanol by volume Octane index of 87 or 89)</b>
<b>Fuel Pump Pressure (Normal)</b>	<b>EFI 30-40 psi</b>

<b>LUBRICATION SYSTEM</b>	
<b>Max. Oil Pressure:</b>	<b>Hot @ 2500 RPM: 275.79 - 413.69 kPa (40 - 60 PSI)</b>
<b>Oil Type:</b>	<b>Motorcraft SAE 5W30 Full Synthetic WSS M2C929-A</b>
<b>Service Oil Fill Capacity (Including Filter)</b>	<b>4.44 qt. (4.2L)</b>
<b>Oil Filter</b>	<b>Ford Service Part Number: E4FZ-6731-A Motorcraft FL400-S</b>

<b>Cooling System</b>	
Thermostat:	Type: Wax element Commences opening: 82.2°C (180°F) Fully open: 94.5°C (202°F)
Coolant	50% Motorcraft Premium Gold engine coolant plus 50% clear water Ford Specification: WSS-M97B51-A1

<b>Drive Belts</b>	
Fan Belt Length:	4 Groove 860mm ± 5mm in length.
Generator Belt Length: Tension:	6 Groove 1055mm ± 5mm in length.
Fan and Generator Belt Tension New: Used:	311.38N (70 lbs.) 222.41 N (50 lbs.) (a used belt is one that has been in operation for 10 minutes or more)

<b>Electrical System</b>	
Polarity:	Negative to earth (ground)
Battery Capacity:	750 CCA / 140 RC
Generator Output	90 Amp

<b>Ignition System</b>	
Spark Plug (See Note)	Ford part number: 5G5E-12405-AA Motorcraft part number: AYFS-22FM    Gap: 1.06 - 1.16 mm (.042 - .046 in.)
Firing Order	1-3-4-2

NOTE: For dual fuel or dry fuel applications only - Set spark plug gap to the low range: 1.06mm (0.042 in).

## TIGHTENING TORQUES

ITEM	Nm	FT. LB.	LB. IN.
Oil Pan Drain Plug	25	18	221.3
Spark Plugs	13-17	9.6-12.5	115-150.5
Oil Filter	11-15	8-11	97.4-132.7

## CONVERSION TABLE

TO CONVERT FROM TO	TO FROM	MULTIPLY BY / DIVIDE BY
<b><i>DISTANCE</i></b>		
inches	mm	25.4
inches	m	0.0254
feet	mm	304.8
feet	m	0.3048
yards	m	0.9144
mile	km	1.609
<b><i>AREA</i></b>		
in2	mm2	645.16
ft2	m2	0.0929
yds2	m2	0.8361
<b><i>VOLUME</i></b>		
in3	cm3	16.3871
in3	l liter	0.016387
pint (US)	l liter	0.47318
pint (UK)	l liter	0.56826
quart (US)	l liter	0.94635
gallon (US)	l liter	3.7854
gallon (UK)	l liter	4.5461
ft3	l liter	28.3168
ft3	m3	0.02832
<b><i>MASS</i></b>		
oz.	g	28.3495
lb.	kg.	0.45359
ton (US)	tonne	0.90718
ton (UK)	tonne	1.01605
<b><i>Force</i></b>		
lbf	N	4.44822
<b><i>PRESSURE &amp; STRESS</i></b>		
kpa	bar	0.01
lbf/in2 (psi)	N/m2	6894.76
lbf/in2 (psi)	bar	0.0689
lbf/in2 (psi)	N/mm2	0.00689
lbf/in2 (psi)	mmHg	51.715
"H2O	mmH2O	25.4
"Hg	mmHG	25.4
ton(US)/in2	N/mm2	13.7894
ton(UK)/in2	N/mm2	15.4443
<b><i>VELOCITY</i></b>		
ft./sec.	m/s	0.3048
ft./sec.	km/h	1.09728
miles/h	m/s	0.44694
miles/h	km/h	1.609
<b><i>ACCELERATION</i></b>		
ft./sec.2	m/s2	0.3048
<b><i>ENERGY</i></b>		
Btu	J	1055.06
Kcal	J	4186.8
HP.h	kWh	0.7457
PS.h	kWh	0.7355
<b><i>TORQUE</i></b>		
ft./lb.	Nm	1.35582
<b><i>POWER</i></b>		
HP	kW	0.7457
PS	kW	0.7355
HP	PS	1.01387
<b><i>SPECIFIC FUEL CONSUMPTION</i></b>		
lb./hp.h	g/kW.h	608.277

## FORD POWER PRODUCTS SERVICE

Ford Service facilities are available in nearly every country of the world.

- Service in Europe is available via a network of Specialist Power Products distributors or any other Authorized Ford Dealer.
- Dealers outside Europe are supervised by Ford Affiliates, world wide. A distributor list is provided below for your information.

### Distributors

#### AUSTRALIA

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
AUSTRALIA	Lees Industries Australia PTY Ltd.	1244 Lytton Rd. Hemmant, Brisbane Wynnum Central Queensland 4178 Australia	Tel: 61-7-3390-5522 Fax: 61-7-3390-6571

#### EUROPE

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
FINLAND	Masino OY	Karkikuja 3, Fin-01740 Vantaa, Finland	Tel: 358-9-476-800 Fax: 358-9476-80300
FRANCE	Fornaut S.A.	45, Rue Charles Nodier, 93310 Le- Pre- St.- Gervais France	Tel: 33-148-450-394 Fax: 33-148-457-504
GERMANY	I.M.A.-H.D. Groeschler GmbH H.D. Groeschler	Westring 41 D-33818 Leopoldshoehe Germany	Tel: 49-5202-987-510 Fax: 49-5202-867-515
	Sauer & Sohn Sauer Motive Systems	Gross Zimmerner Strasse 51 D-64807 Dieburg, Germany	Tel: 49-6071-206-330 Fax: 49-6071-206-219
GREAT BRITAIN	Dalton Power Products Ltd. (Main Office)	Unit 6, Autumn Park Industrial Estate Dysart Road, Grantham, Lincolnshire NG31 7DD England	Tel: 44-1476-576-666 Fax: 44-1476-577-127
	Dalton Power Products Ltd.	Suite 3 Concord House Concord Washington Tyne & Wear NE37 1AS England	Tel: 44-191-416-1922 Fax: 44-191-415-3682
	Dalton Power Products Ltd.	Ellesmere Street Manchester M15 4LP England	Tel: 44-161-833-2932 Fax: 44-161-844-8465
	Hendy Power	Southampton Road, Cosham, Portsmouth, PO6 4RW United Kingdom	Tel: 44-7392-322900 Fax: 44-7392-323960
	Power Torque Engineering	Herald Way, Binley, Coventry Warwickshire CV3 2RQ England	Tel: 44-2476-635757 Fax: 44-2476-635878
ITALY	Compagnia Technica Motori S.p.A.	Via Magellano 1, I-20090 Cesano Biscione (Milano) Italy	Tel: 39-02-450-581 Fax: 39-02-450-582 60/62



**EUROPE (Continued)**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
SWITZERLAND	Minelli A.G.	Mattenstra 3, CH-8330 Pfaeffikon (ZH) Switzerland	Tel: 41-1-950-1720 Fax: 41-1-950-1132

**NEW ZEALAND**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
NEW ZEALAND	Lee's Industries Group Delta Centre	345 Gt. South Road Takanini, Papakura, Auckland New Zealand	Tel: 64-9-299-6019 Fax: 64-9-299-9986

**NORTH AMERICA - CANADA**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
BRITISH COLUMBIA	Industrial Engines Ltd.	1020 Cliveden Ave. Delta, Annacis Island, British Columbia, Canada V3M 5R5	Tel: 1-604-525-8529 1-877-438-6560 Fax: 1-604-525-0974
ONTARIO, QUEBEC, MANITOBA	M-K Power Products Corp.	5641 McAdam Road Mississauga, Ontario, Canada L4X 1N9	Tel: 1-905-890-5323 CAN. 1-800-263-5011 Fax: 1-905-890-6660
ALBERTA, SASKATCHEWAN	Industrial Engines Ltd.	14335 12th Avenue Edmonton, Alberta Canada T5L 2R8	Tel: 1-780-484-6213 CAN. 1-866-484-6213 Fax: 1-780-732-0400
NOVA SCOTIA, NEW BRUNSWICK, NEW FOUNDLAND, PRINCE EDWARD ISLAND	Lunenburg Industrial Foundry & Engineering	53 Falkland Street, PO 1240 Lunenburg, Nova Scotia Canada B0J 2C0	Tel: 1-902-634-8827 Fax: 1-902-634-8886

**NORTH AMERICA - UNITED STATES**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
ALABAMA	M&I Engine Company, Inc.	30762 State Highway 181 Daphne, AL. 36526	Tel: 1-251-626-8080 1-800-633-1834 Fax: 1-251-626-2744
ALASKA	E.C. Power Systems	3104 C Street Northeast Suite 200 Auburn, WA. 98002	Tel: 1-253-872-7011 1-800-247-5899 Fax: 1-253-872-6947
ARIZONA	E.C. Power Systems	8360 E. Via de Ventura Blvd. Suite L-200 Scottsdale AZ. 85258	Tel. 1-480-905-5585 Fax: 1-503-224-3907
ARKANSAS (Northern)	Kansas City Power Products Inc.	80 South James Kansas City KS.66118	Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341
(Extreme Southern Territory)	Lightbourn Equipment Co.	13649 Beta Road Dallas, TX. 75244	Tel: 1-972-233-5151 1-800-729-3131 Fax: 1-972-661-0738

**NORTH AMERICA - UNITED STATES - (Continued)**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
CALIFORNIA	Powertech Engines Inc. (Main Office)	2933 E. Hamilton Avenue Fresno, CA. 93721	Tel: 1-559-264-1776 1-800-891-1776 Fax: 1-559-264-2933
	Powertech Engines Inc.	2003 Leghorn Street Mountainview, CA. 94043	Tel: 1-650-968-2434 Fax: 1-650-969-1267
	Powertech Engines Inc.	1410 S. Acacia Avenue Suite B Fullerton, CA. 92831	Tel: 1-714-635-1774 1-800-784-1776 Fax: 1-714-635-1771
COLORADO	E.C. Power Systems	3233 Oakland Street Aurora, CO. 80010	Tel: 1-303-360-7110 1-800-678-3673 Fax: 1-303-360-9579
CONNECTICUT	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
DELAWARE	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
DISTRICT OF COLUMBIA	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
FLORIDA	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
HAWAII	Powertech Engines Inc. (Main Office)	2933 E. Hamilton Avenue Fresno, CA. 93721	Tel: 1-559-264-1776 1-800-891-1776 Fax: 1-559-264-2933
IDAHO	E.C. Power Systems	4499 Market Street Boise ID. 83705	Tel: 1-208-342-6541 1-800-354-6767 Fax: 1-208-345-3408
ILLINOIS (Central) (North Central) (Northeastern) (Southern)  (Northwestern)	Engine Power Inc.	1830 Executive Drive Oconomowoc, WI. 53066	Tel: 1-262-567-8575 1-800-242-2289 Fax: 1-262-567-2556
	Kansas City Power Products Inc.	80 South James Kansas City KS.66118	Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341
	Anderson Industrial Engines	5532 Center Street Omaha NE. 68106	Tel: 1-402-558-8700 1-800-747-1438 Fax: 1-402-558-8249
INDIANA	Engine Power Inc.	1830 Executive Drive Oconomowoc, WI. 53066	Tel: 1-262-567-8575 1-800-242-2289 Fax: 1-262-567-2556
IOWA	Anderson Industrial Engines	5532 Center Street Omaha NE. 68106	Tel: 1-402-558-8700 1-800-747-1438 Fax: 1-402-558-8249
KANSAS	Kansas City Power Products Inc.	80 South James Kansas City KS.66118	Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341

**NORTH AMERICA - UNITED STATES - (Continued)**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
<b>KENTUCKY</b> (Western)	<b>Engine Power Inc.</b>	<b>1830 Executive Drive Oconomowoc, WI. 53066</b>	<b>Tel: 1-262-567-8575 1-800-242-2289 Fax: 1-262-567-2556</b>
	<b>Pitt Auto Electric</b>	<b>1241 Freedom Road Cranberry Twp., PA. 16066</b>	<b>Tel: 1-724-778-8200 1-800-367-3463 Fax: 1-724-778-8206</b>
<b>LOUISIANA</b>	<b>Lightbourn Equipment Co.</b>	<b>13649 Beta Road Dallas, TX. 75244</b>	<b>Tel: 1-972-233-5151 1-800-729-3131 Fax: 1-972-661-0738</b>
	<b>Lightbourn Equipment Co.</b>	<b>8272 El Rio Suite 110 Houston, TX. 77054</b>	<b>Tel: 1-713-741-2003 1-800-827-1717 Fax: 1-713-741-1909</b>
<b>MAINE</b>	<b>Engine Distributors Inc.</b>	<b>400 University Court Blackwood N.J. 08012</b>	<b>Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)</b>
<b>MARYLAND</b>	<b>Engine Distributors Inc.</b>	<b>400 University Court Blackwood N.J. 08012</b>	<b>Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)</b>
<b>MASSACHUSETTES</b>	<b>Engine Distributors Inc.</b>	<b>400 University Court Blackwood N.J. 08012</b>	<b>Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)</b>
<b>MICHIGAN</b> (Lower Peninsula)	<b>Engine Center Inc.</b>	<b>2351 Hilton Road Ferndale, MI. 48220</b>	<b>Tel: 1-248-399-0002 1-800-726-8870 Fax: 1-248-399-3142</b>
	<b>Engine Power Inc.</b>	<b>1830 Executive Drive Oconomowoc, WI. 53066</b>	<b>Tel: 1-262-567-8575 1-800-242-2289 Fax: 1-262-567-2556</b>
<b>MINNESOTA</b>	<b>Northern Power Products Inc.</b>	<b>2859 Lexington Ave. S. Eagan, MN. 55121</b>	<b>Tel: 1- 651-452-8900 1-800-284-6247 Fax: 1-651-452-9182 (Sales) Fax: 1-651-452-9047 (Parts)</b>
<b>MISSISSIPPI</b> (Northern)	<b>Kansas City Power Products Inc.</b>	<b>80 South James Kansas City KS.66118</b>	<b>Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341</b>
	<b>Lightbourn Equipment Co.</b>	<b>8272 El Rio Suite 110 Houston, TX. 77054</b>	<b>Tel: 1-713-741-2003 1-800-827-1717 Fax: 1-713-741-1909</b>
<b>MISSOURI</b>	<b>Kansas City Power Products Inc.</b>	<b>80 South James Kansas City KS.66118</b>	<b>Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341</b>
<b>MONTANA</b> (Eastern) (Central) (Western)	<b>E.C. Power Systems</b>	<b>3233 Oakland Street Aurora, CO. 80010</b>	<b>Tel: 1-303-360-7110 1-800-678-3673 Fax: 1-303-360-9579</b>
	<b>E.C. Power Systems</b>	<b>4499 Market Street Boise ID. 83705</b>	<b>Tel: 1-208-342-6541 1-800-354-6767 Fax: 1-208-345-3408</b>
<b>NEBRASKA</b>	<b>Anderson Industrial Engines</b>	<b>5532 Center Street Omaha NE. 68106</b>	<b>Tel: 1-402-558-8700 1-800-747-1438 Fax: 1-402-558-8249</b>

**NORTH AMERICA - UNITED STATES - (Continued)**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
<b>NEVADA</b>	<b>Powertech Engines Inc. (Main Office)</b>	<b>2933 E. Hamilton Avenue Fresno, CA. 93721</b>	<b>Tel: 1-559-264-1776 1-800-891-1776 Fax: 1-559-264-2933</b>
<b>NEW HAMPSHIRE</b>	<b>Engine Distributors Inc.</b>	<b>400 University Court Blackwood N.J. 08012</b>	<b>Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)</b>
<b>NEW JERSEY</b>	<b>Engine Distributors Inc.</b>	<b>400 University Court Blackwood N.J. 08012</b>	<b>Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)</b>
<b>NEW MEXICO (Southern)</b>	<b>E.C. Power Systems</b>	<b>8360 E. Via de Ventura Blvd. Suite L-200 Scottsdale AZ. 85258</b>	<b>Tel. 1-480-905-5585 Fax: 1-503-224-3907</b>
<b>(Northern)</b>	<b>E.C. Power Systems</b>	<b>3233 Oakland Street Aurora, CO. 80010</b>	<b>Tel: 1-303-360-7110 1-800-678-3673 Fax: 1-303-360-9579</b>
<b>NEW YORK (New York City) (Nassau County) Suffolk County) (Upstate) (Hudson Valley)</b>	<b>Engine Distributors Inc.</b>	<b>400 University Court Blackwood N.J. 08012</b>	<b>Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)</b>
	<b>Pitt Auto Electric</b>	<b>1241 Freedom Road Cranberry Twp., PA. 16066</b>	<b>Tel: 1-724-778-8200 1-800-367-3463 Fax: 1-724-778-8206</b>
<b>NORTH CAROLINA</b>	<b>Engine Distributors Inc.</b>	<b>303 Interstate Drive Archdale, N.C. 27263</b>	<b>Tel: 1-336-434-6616 1-800-220-7080 Fax: 1-336-434-6612</b>
<b>NORTH DAKOTA</b>	<b>Northern Power Products Inc.</b>	<b>2859 Lexington Ave. S. Eagan, MN. 55121</b>	<b>Tel: 1-651-452-8900 1-800-284-6247 Fax: 1-651-452-9182 (Sales) Fax: 1-651-452-9047 (Parts)</b>
<b>OHIO (Northern)</b>	<b>Northcoast Ford Industrial Inc.</b>	<b>11885 Bellaire Road Cleveland, OH. 44135</b>	<b>Tel: 1-216-251-5800 1-800-423-1316 Fax: 1-216-251-8675</b>
<b>(Southern)</b>	<b>Pitt Auto Electric</b>	<b>1241 Freedom Road Cranberry Twp., PA. 16066</b>	<b>Tel: 1-724-778-8200 1-800-367-3463 Fax: 1-724-778-8206</b>
<b>OKLAHOMA (Except Panhandle)</b>	<b>Kansas City Power Products Inc.</b>	<b>80 South James Kansas City KS.66118</b>	<b>Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341</b>
<b>(Panhandle)</b>	<b>Lightbourn Equipment Co.</b>	<b>13649 Beta Road Dallas, TX. 75244</b>	<b>Tel: 1-972-233-5151 1-800-729-3131 Fax: 1-972-661-0738</b>
<b>OREGON</b>	<b>E.C. Power Systems</b>	<b>1805 N.W. 21 st Avenue Portland OR. 97210</b>	<b>Tel. 1-503-224-3623 1-800-452-1511 Fax: 1-503-224-3907</b>

**NORTH AMERICA - UNITED STATES - (Continued)**

IF YOU ARE IN	THEN CALL	ADDRESS	TELEPHONE NUMBERS
<b>PENNSYLVANIA</b> (Eastern)	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
	(Western)	Pitt Auto Electric	1241 Freedom Road Cranberry Twp., PA. 16066
<b>RHODE ISLAND</b>	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
<b>SOUTH CAROLINA</b>	Engine Distributors Inc.	303 Interstate Drive Archdale, N.C. 27263	Tel: 1-336-434-6616 1-800-220-7080 Fax: 1-336-434-6612
<b>SOUTH DAKOTA</b>	Northern Power Products Inc.	2859 Lexington Ave. S. Eagan, MN. 55121	Tel: 1- 651-452-8900 1-800-284-6247 Fax: 1-651-452-9182 (Sales) Fax: 1-651-452-9047 (Parts)
<b>TENNESEE</b> (Central) (Eastern) (Western)	M&I Engine Company, Inc.	30762 State Highway 181 Daphne, AL. 36526	Tel: 1-251-626-8080 1-800-633-1834 Fax: 1-251-626-2744
	Kansas City Power Products Inc.	80 South James Kansas City KS.66118	Tel: 1-913-321-7040 1-800-486 5277 Fax: 1-913-321-7341
<b>TEXAS</b>	Lightbourn Equipment Co.	13649 Beta Road Dallas, TX. 75244	Tel: 1-972-233-5151 1-800-729-3131 Fax: 1-972-661-0738
	Lightbourn Equipment Co.	8272 El Rio Suite 110 Houston, TX. 77054	Tel: 1-713-741-2003 1-800-827-1717 Fax: 1-713-741-1909
<b>UTAH</b>	E.C. Power Systems	3683 West 2270 South Suite A Salt lake City, UT. 84120	Tel: 1-801-886-1424 1-800-462-3370 Fax: 1-801-886-1464
<b>VERMONT</b>	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
<b>VIRGINIA</b> (Central) (Eastern)	Engine Distributors Inc.	400 University Court Blackwood N.J. 08012	Tel: 1-856-228-7298 1-800-220-2700 Fax: 1-856-228-5657 (Parts) Fax: 1-856-228-5531 (Sales)
	(Southwestern)	Pitt Auto Electric	1241 Freedom Road Cranberry Twp., PA. 16066
<b>WASHINGTON</b>	E.C. Power Systems	3104 C Street Northeast Suite 200 Auburn, WA. 98002	Tel: 1-253-872-7011 1-800-247-5899 Fax: 1-253-872-6947
<b>WEST VIRGINIA</b>	Pitt Auto Electric	1241 Freedom Road Cranberry Twp., PA. 16066	Tel: 1-724-778-8200 1-800-367-3463 Fax: 1-724-778-8206

**NORTH AMERICA - UNITED STATES - (Continued)**

<b>IF YOU ARE IN</b>	<b>THEN CALL</b>	<b>ADDRESS</b>	<b>TELEPHONE NUMBERS</b>
<b>WISCONSON</b> <b>(Eastern)</b> <b>(Central)</b>	<b>Engine Power</b> <b>Inc.</b>	<b>1830 Executive Drive</b> <b>Oconomowoc, WI. 53066</b>	<b>Tel: 1-262-567-8575</b> <b>1-800-242-2289</b> <b>Fax: 1-262-567-2556</b>
<b>(Northwestern)</b>	<b>Northern Power</b> <b>Products Inc.</b>	<b>2859 Lexington Ave. S.</b> <b>Eagan, MN. 55121</b>	<b>Tel: 1- 651-452-8900</b> <b>1-800-284-6247</b> <b>Fax: 1-651-452-9182 (Sales)</b> <b>Fax: 1-651-452-9047 (Parts)</b>
<b>WYOMING</b>	<b>E.C. Power</b> <b>Systems</b>	<b>3233 Oakland Street</b> <b>Aurora, CO. 80010</b>	<b>Tel: 1-303-360-7110</b> <b>1-800-678-3673</b> <b>Fax: 1-303-360-9579</b>





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