6SE483 JULY 2005

SERIES 60®

Service Manual

Detroit Diesel® Series 60 Diesel and Natural Gas-Fueled Engines

DETROIT DIESEL CORPORATION

Detroit Diesel Corporation
13400 Outer Drive, West / Detroit, Michigan 48239-4001
Telephone: 313-592-5000
Fax: 313-592-3878
http://www.detroitdiesel.com

NOTE:
Additional copies of this service manual may be purchased from Detroit Diesel Corporation Distributors. See your yellow pages- under Engines, Diesel.

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

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ABSTRACT

This manual provides instruction for servicing on-highway applications of the Detroit Diesel Series 60 Diesel and Natural Gas-Fueled Engines.

Specifically a basic overview of each major component and system along with recommendations for removal, cleaning, inspection, criteria for replacement, repair and installation and mechanical troubleshooting are contained in this manual.

DDEC III/IV troubleshooting concerns are contained in the DDEC III/IV Single ECM Troubleshooting Guide, 6SE497.

DDEC V troubleshooting concerns are contained in the DDEC V Troubleshooting Guide, 6SE570.

ENGINE EXHAUST

Consider the following before servicing engines:

WARNING:

PERSONAL INJURY

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

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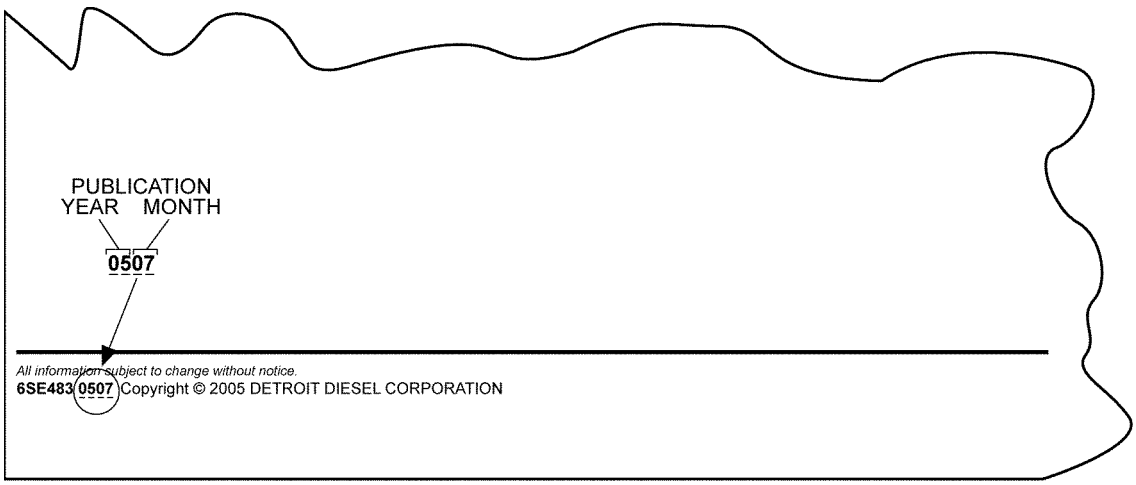
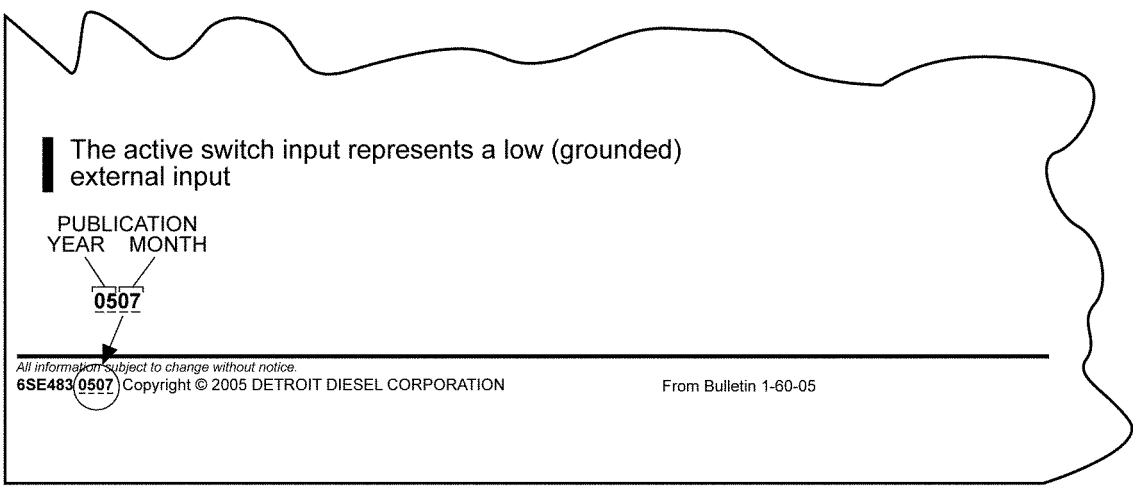
REVISION NOTIFICATION

Modifications to this manual are announced in the form of Service Information Bulletins. The bulletins include attachment pages and are posted on the World Wide Web (www.detroitdiesel.com/svc/sibindex.htm).

Revisions to this manual will be sent marked with a revision bar (see Example 2). Sections containing revisions will have a third line in the page footer (compare Examples 1 and 2).



Example 1 - Unchanged Pages



Example 2 - Changed Pages

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SCOPE AND USE OF THIS MANUAL

This manual contains complete instructions on operation, adjustment (tune-up), preventive maintenance, and repair (including complete overhaul) for the Series 60 Inline Diesel Engines. This manual was written primarily for persons servicing and overhauling the engine. In addition, this manual contains all of the instructions essential to the operators and users. Basic maintenance and overhaul procedures are common to all Series 60 Engines, and apply to all engine models.

This manual is divided into numbered sections. Section one covers the engine (less major assemblies). The following sections cover a complete system such as the fuel system, lubrication system, or air system. Each section is divided into subsections which contain complete maintenance and operating instructions for a specific engine subassembly. Each section begins with a table of contents. Pages and illustrations are numbered consecutively within each section.

Information can be located by using the table of contents at the front of the manual or the table of contents at the beginning of each section. Information on specific subassemblies or accessories within the major section is listed immediately following the section title.

CLEARANCE OF NEW PARTS AND WEAR LIMITS

New parts clearances apply only when all new parts are used at the point where the various specifications apply. This also applies to references within the text of the manual. The column entitled "Limits" must be qualified by the judgement of personnel responsible for installing new parts. For additional information, refer to the section entitled "Inspection" within this section. Refer to section ADDITIONAL INFORMATION, "Table of Specifications, New Clearances, and Wear Limits" under "Specifications", for a listing of clearances of new parts and wear limits on used parts.

THE FOUR CYCLE PRINCIPLE FOR DIESEL ENGINES

The diesel engine is an internal combustion engine, in which the energy of burning fuel is converted into energy to work the cylinder of the engine. In the diesel engine, air alone is compressed in the cylinder, raising its temperature significantly. 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 four piston strokes of the cycle occur in the following order: intake, compression, power and exhaust. See Figure 1.

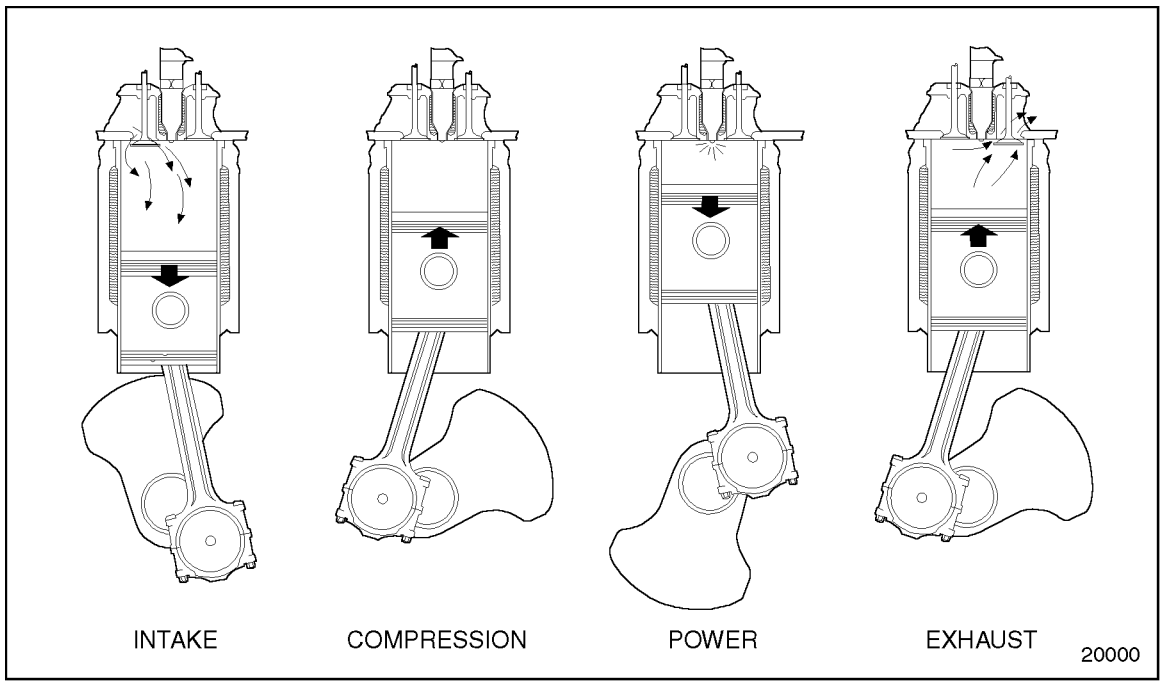

Figure 1 The Four Stroke Cycle (Diesel)

Intake Stroke

During the intake stroke, the piston travels downward, the intake valves are open, and the exhaust valves are closed. The down stroke of the piston facilitates air from the intake manifold to enter the cylinder through the open intake valve. The turbocharger, by increasing the air pressure in the engine intake manifold, assures a full charge of air is available for the cylinder.

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

Compression Stroke

At the end of the intake stroke, the intake valves close and the piston starts upward on the compression stroke. The exhaust valves remain 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-fifteenth as great in volume as it occupied at the beginning of the stroke. Thus, the compression ratio is 15:1.

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 3445 to 4134 kPa (500 to 600 lb/in.^{2}) and the temperature of that air is approximately 538°C (1000°F). During the last part of the compression stroke and the early part of the power stroke, a small metered charge of fuel is injected into 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, beginning the power stroke.

Power Stroke

During the power stroke, the piston travels downward and all intake and exhaust valves are closed.

As the fuel is added and burns, the gases get hotter, the pressure increases, pushing the piston downward and adding to crankshaft rotation.

Exhaust Stroke

During the exhaust stroke, the intake valves are closed; the exhaust valves are open, and the piston is on its up stroke.

The 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, 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.

FOUR CYCLE PRINCIPLE FOR NATURAL GAS ENGINES

This engine is a four cycle internal combustion engine, in which the energy of burning fuel is converted into energy to work the cylinder of the engine. However, unlike the diesel engine, a combustible air and fuel mixture is introduced to the cylinder during the intake stroke. Upon compression, the temperature of this mixture is increased to a temperature below its auto-ignition threshold. Combustion occurs through means of a spark plug which ignites the mixture.
See Figure 2 for the four stroke cycle utilized on the natural gas engine.

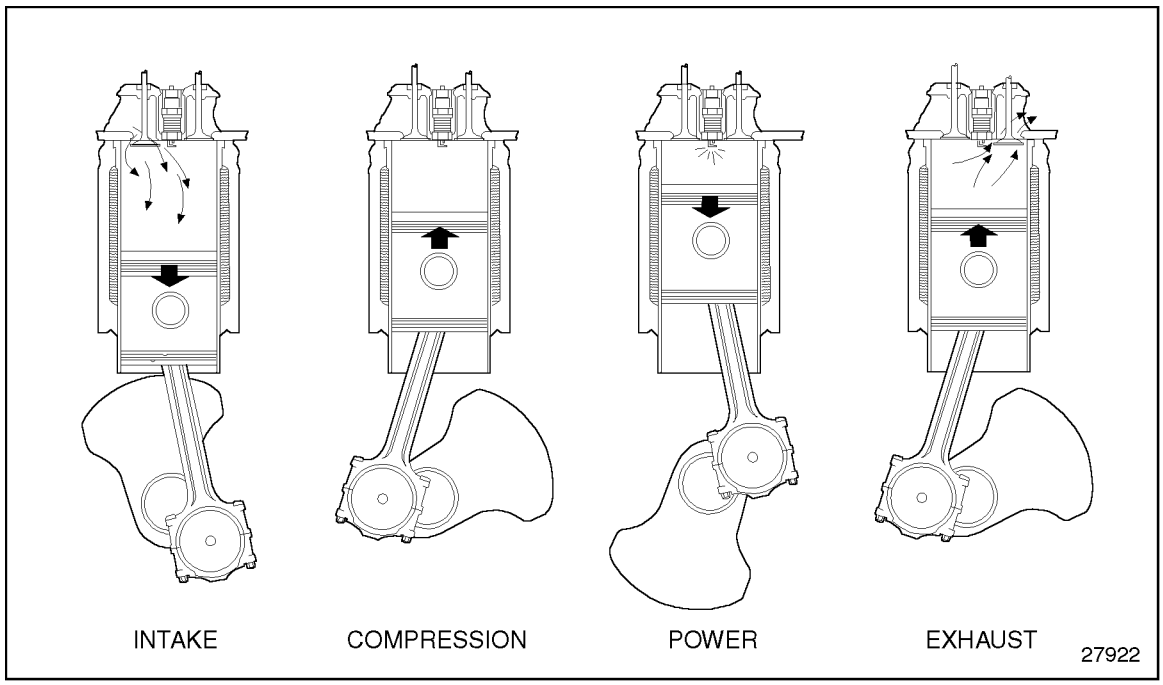

Figure 2 The Four Stroke Cycle (Series 60G Engine)

Intake Stroke

During the intake stroke, the piston travels downward, the intake valves are open, and the exhaust valve are closed. The downward stroke of the piston increases the volume in the cylinder and draws in a fresh air and fuel mixture through the intake valves.

Compression Stroke

At the end of the intake stroke, the intake valves close and the piston starts upward on the compression stroke. The exhaust valves remain closed.

At the end of the compression stroke, the air-fuel mixture in the combustion chamber has been compressed by the piston to occupy a space about one-tenth as great in volume as it occupied at the beginning the stroke. Thus, the compression ratio is 10:1. This act of compression dramatically increases the temperature of the air-fuel mixture, to a temperature below its auto-ignition threshold. It is a timed, externally supplied ignition through the spark plug that actually causes ignition to the mixture. The timed spark is introduced to the cylinder near the end of the compression stroke, which initiates combustion and begins the power stroke.

Power Stroke

During the power stroke, the piston travels downward and all intake and exhaust valves are closed.

As the throttle is opened to introduce a greater charge of air-fuel mixture to the cylinders, the increasing pressure of combustion against the pistons adds to crankshaft rotation.

Exhaust Stroke

During the exhaust stroke, the intake valves are closed, the exhaust valves are open, and the piston is on its up stroke.

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

GENERAL DESCRIPTION

The Series 60® Diesel Engine described in this manual is a four-stroke cycle, high speed, diesel engine.

It uses an inline cast iron block and has a cast iron cylinder head that contains a single overhead camshaft. The camshaft actuates all the valves (two intake, two exhaust per cylinder), and operates the fuel injectors. The vertically aligned gear train, located at the front end of the engine in a gear case, contains drive gears for the lubricating oil pump, crankshaft, camshaft, air compressor drive, fuel pump drive, water pump and alternator accessory drives.

Each current engine is equipped with dual full-flow oil filters, an oil cooler, one or two fuel oil filters, a turbocharger and an electronic engine control system.

Full pressure lubrication is supplied to all main, connecting, camshaft and rocker assembly bearings and to other moving parts. A gear-type pump draws oil from the oil pan through a screen and delivers it to the oil filters. From the filter, a small portion of the oil is delivered directly to the turbocharger by an external oil line. The remainder of the oil flows to the oil cooler, or bypasses the cooler, and then enters a longitudinal oil gallery in the cylinder block where the supply divides. Part of the oil goes to the cylinder head where it feeds the camshaft bearings and rocker assemblies. The remainder of the oil goes to the main bearings and connecting rod bearings via the drilled oil passages in the crankshaft. Drilled passages in the connecting rod feed oil to the piston pin and the inner surface of the piston crown.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator, is a closed system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats that regulate the flow of the coolant within the cooling system.

Fuel is drawn from the supply tank through the primary fuel filter by a gear-type fuel pump. From there, the fuel is forced through the secondary fuel filter and into the fuel inlet in the cylinder head and to the injectors. Excess fuel is returned, through a restricted fitting, to the supply tank through the outlet connecting line. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and to carry off any air in the fuel system. Air separators are available, as optional equipment.

Air is supplied by the turbocharger to the intake manifold and into the engine cylinders after passing through an air-to-air charge air cooler mounted ahead of the cooling system radiator. The charge air cooler cools the pressurized intake air charge coming from the turbocharger before it enters the intake manifold.

Engine starting may be provided by an electric or air starting motor energized by a storage battery or air pressure storage system. A battery charging alternator, with a suitable voltage regulator, serves to keep the battery charged.

The Series 60 diesel engine was designed to be electronically controlled. The Detroit Diesel Electronic Control (DDEC) system has evolved with the product.