

**DDC-SVC-MAN-0023**

# **EPA04 MBE 4000 Workshop Manual**



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**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.

## ABSTRACT

This manual provides instruction for servicing the MBE 4000 Diesel Engine. Specifically, a basic overview of each major component and the system, along with the recommendations for removal, cleaning, inspection, criteria for replacement, repair, installation, and mechanical troubleshooting are contained in this manual.

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## ENGINE EXHAUST

Consider the following before servicing engines:



### 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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## 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 MBE 4000 engine. 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 MBE 4000 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.

## GENERAL DESCRIPTION

The MBE 4000 Engine described in this manual is a water-cooled, four-stroke, direct injection diesel engine. The cylinders are arranged in line. Each cylinder has a separate fuel injection pump (unit pump) with a short injection line to the injection nozzle, which is located in the center of the combustion chamber. The unit pumps are attached to the crankcase and are driven from the camshaft. Each cylinder has two intake valves and two exhaust valves.

Charge-air cooling and an exhaust gas turbocharger are standard equipment on all MBE 4000 engines.

The engine has a fully electronic control system, which regulates the injection quantity and timing using solenoid valves, allowing extremely low-emission operation. The control system consists of an engine-resident pump and nozzle control unit (the DDEC-ECU) and a vehicle control unit (the DDEC-VCU). The two are connected by a proprietary datalink.

Engine braking is controlled by a pneumatically-operated exhaust brake on the turbocharger and by a constant-throttle system. For greater braking power, an optional turbo brake is available.

The cylinder block has integrated oil and water channels. The upper section of the cylinder bore is induction-hardened. The six individual cylinder heads are made of cast iron. The cylinder head gasket is an adjustment-free seal with rubber sealing elements.

The pistons are made of aluminum alloy with ring carriers and a shallow combustion chamber recess. The pistons are cooled by oil spray nozzles.

The crankshaft is precision-forged with seven main bearings and eight custom-forged counter weights, and a vibration damper at the front end.

The camshaft is made of induction-hardened steel and has seven main bearings. Each cylinder has cams for intake and exhaust valves and a unit pump.

The valves are controlled by mushroom tappets, pushrods, and rocker arms. The intake and exhaust valves are opened and closed by a valve-guided bridge.

There is a force-feed lubricating oil circuit supplied by a gear-type oil pump. This pump is positioned at the rear of the oil pan and driven by gears from the crankshaft. The oil heat exchanger is located near the front of the crankcase on the right-hand side near the turbocharger.

The gear-type fuel pump is located near the front of the crankcase on the left hand side. The pump is driven from the forward end of the camshaft.

The air compressor, with a power-steering pump attached, is driven by a gear on the camshaft.

The engine is cooled by a closed system using recirculated coolant; temperature is regulated automatically by a thermostat.

There are three drive belts, each with its own automatic belt tensioner. The alternator and coolant pump (and any other accessories) are driven by a main drive belt. The fan and the air conditioner compressor are each driven by their own drive belt.

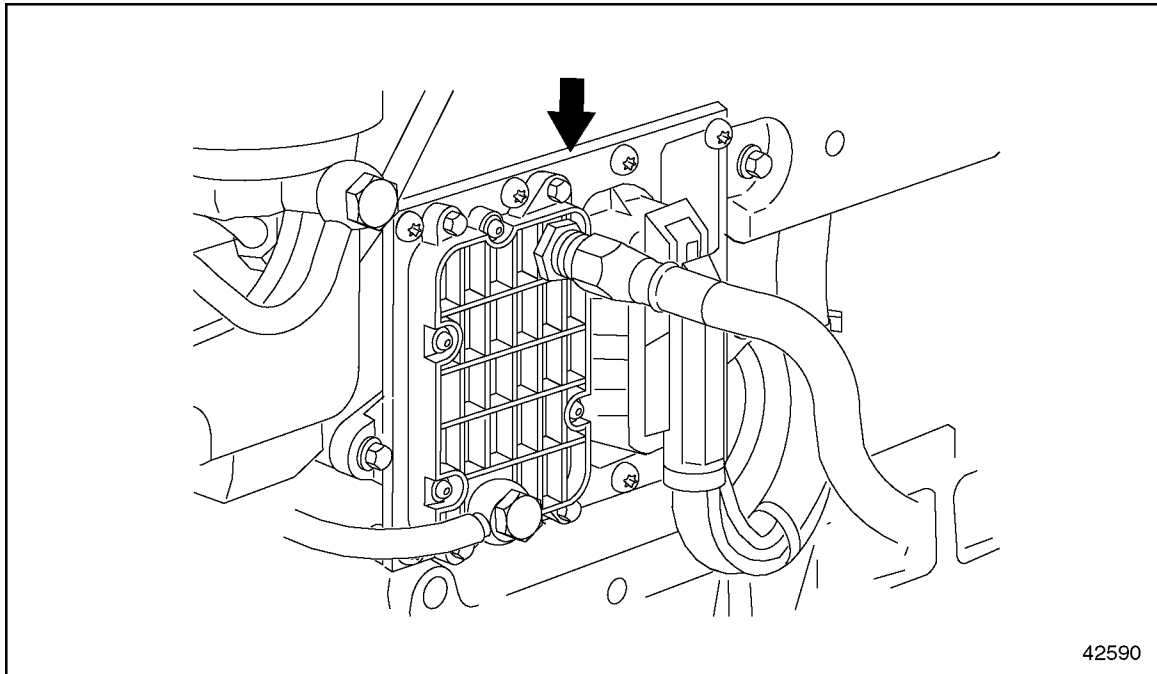
## **ELECTRONIC ENGINE CONTROL SYSTEM**

The engine is equipped with a fully electronic control system. Besides the engine and its related sensors, this system is composed of the DDEC-ECU, or engine control unit, and the DDEC-VCU, or vehicle control unit. The two control units are connected by a proprietary datalink through which all necessary data and information can be exchanged. The DDEC-VCU then broadcasts all information on the J1587 and J1939 datalinks, where it can be read by minidiag2, Nexiq™ Diagnostic Data Reader (DDR), or Detroit Diesel Diagnostic Link® (DDDL) PC software.

The DDEC-ECU monitors both the engine and the datalink. When a malfunction or other problem is detected, the system selects an appropriate response; for example, the emergency running mode may be activated.

## DDEC-ECU — Engine-Resident Control Unit

The DDEC-ECU control unit is located on the left-hand side of the engine. See Figure 1. The DDEC-ECU processes the data received from the DDEC-VCU, for example the position of the accelerator pedal, engine brake, etc. These data are evaluated together with the data from the sensors on the engine, such as, charge and oil pressure and coolant and fuel temperature. The data is then compared to the characteristic maps or lines stored in the DDEC-ECU. From these data, quantity and timing of injection are calculated and the unit pumps are actuated accordingly through the solenoid valves.



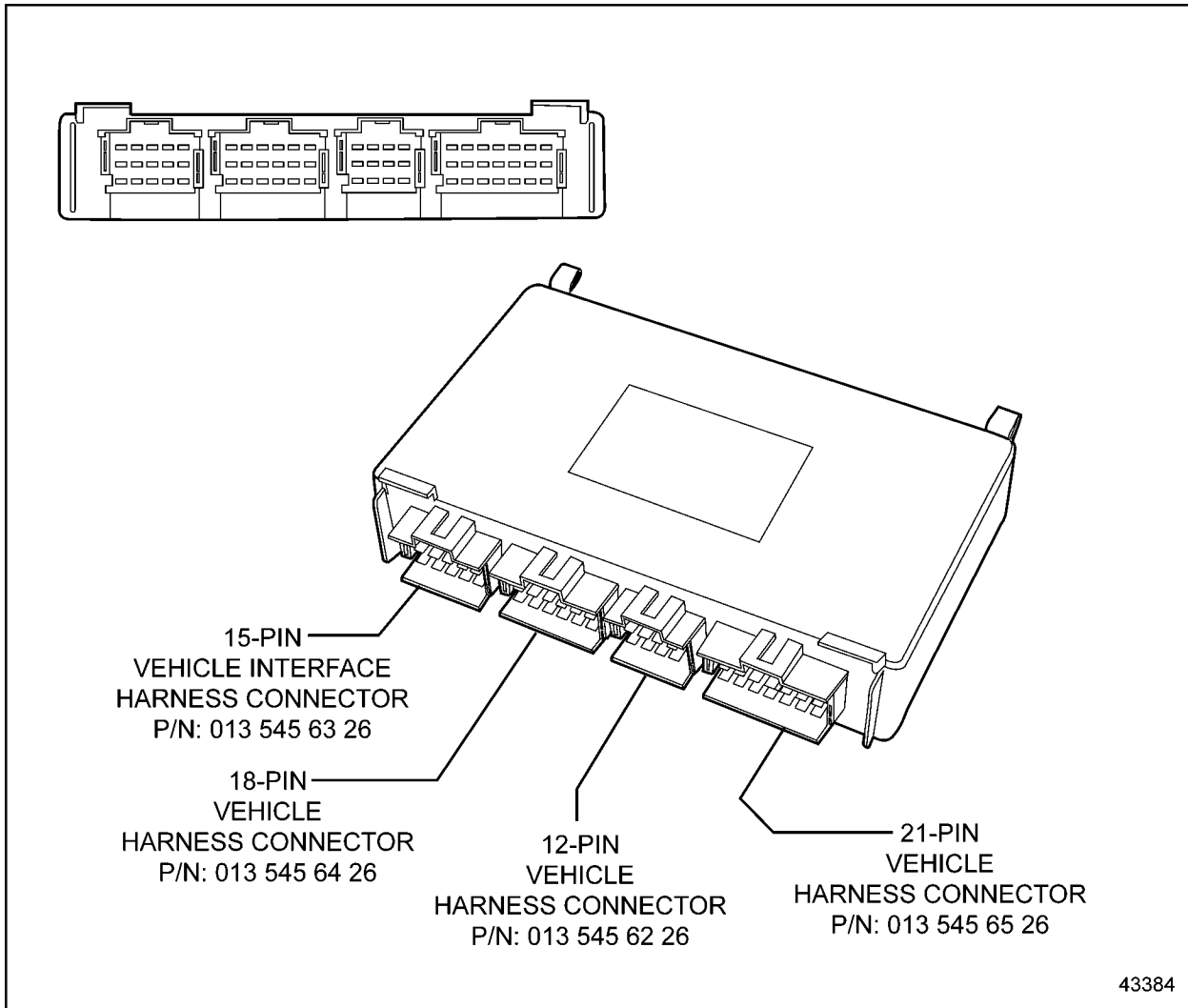
**Figure 1** DDEC-ECU Control Unit Location

**NOTE:**

To obtain a replacement DDEC-ECU, all the data given on the DDEC-ECU label are required.

## DDEC-VCU — Vehicle Control Unit

The vehicle control unit (DDEC-VCU) communicates with other electronic control units installed on the vehicle over the J1587 datalink. See Figure 2. Within the DDEC-VCU, sets of data for specific applications are stored. These include idle speed, maximum running speed, and speed limitation.



**Figure 2 Vehicle Control Unit (DDEC-VCU)**

The DDEC-VCU receives data from the following sources:

- ❑ The operator (accelerator pedal position, engine brake switch)
- ❑ Other electronic control units (for example, the antilock brake system)
- ❑ The DDEC-ECU control unit (data such as oil pressure and coolant temperature)

From these data, instructions are computed for controlling the engine and transmitted to the DDEC-ECU via the proprietary datalink. The DDEC-VCU controls various systems, for example, communications with the datalink, the engine brake, and the constant-throttle valves. If the engine control system detects a fault, the appropriate fault code is broadcast on the datalink and can be read using minidiag2. When there is a fault, the code for the control unit reporting the fault can be read directly on the display.

## **ENGINE BRAKING POWER**

### **Exhaust Brake/Constant-Throttle Valves**

To increase braking performance, the engine is equipped with an exhaust brake on the turbocharger in conjunction with constant-throttle valves on the cylinder head.

#### **NOTE:**

The constant-throttle valves are activated by engine oil pressure.

The exhaust back-pressure is used by the exhaust brake to increase braking performance.

### **Optional Turbo Brake**

For high braking output, the MBE 4000 engine can be equipped with an optional turbo brake. The turbo brake increases the air mass flow through the engine to provide up to 600 brake horsepower. The turbo brake can be operated either manually or automatically, through the cruise control function.

Because the charge air pressure is maintained at a high level during braking, full throttle response is available immediately, if the operator desires it, without any turbo lag.

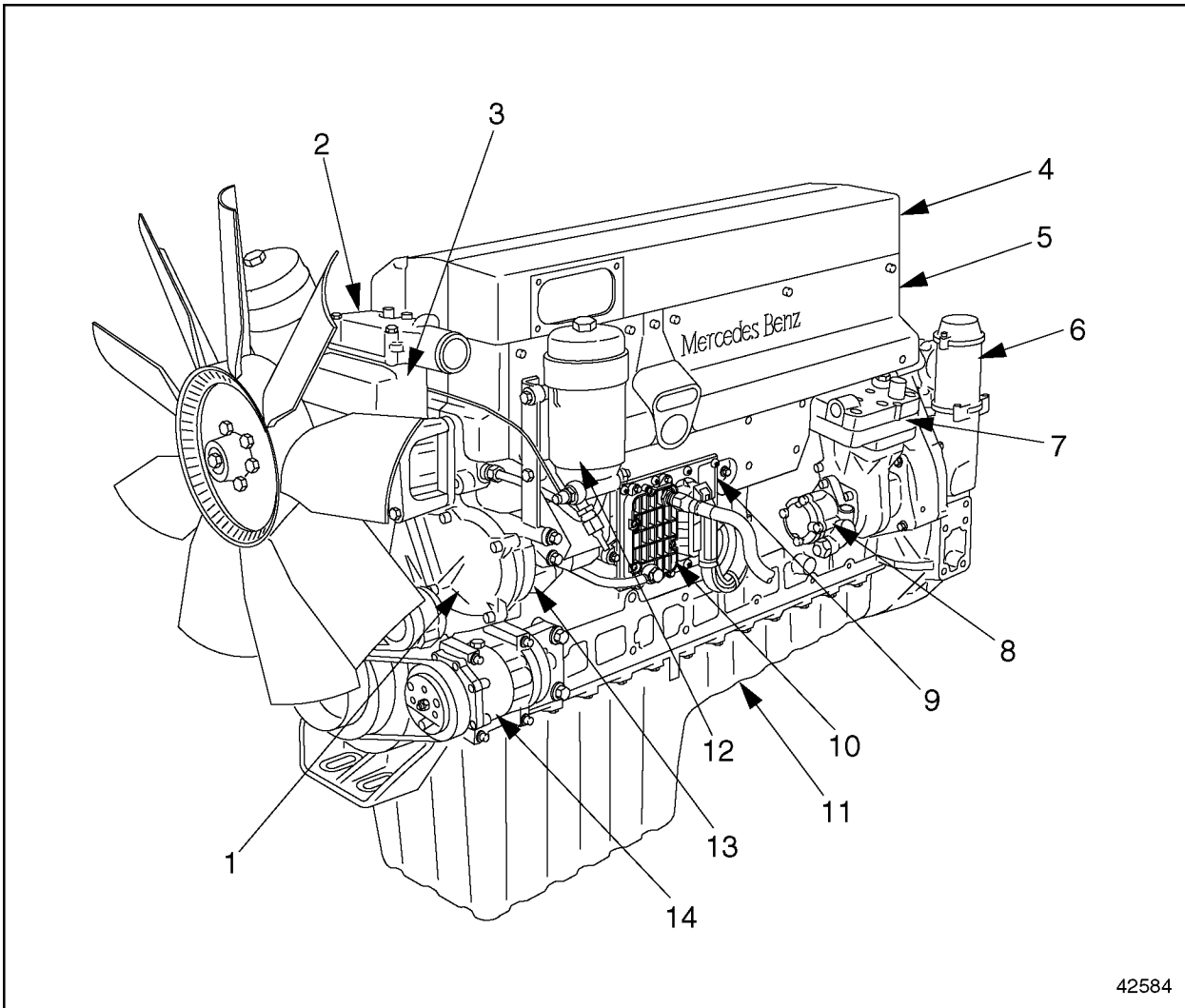
The turbo brake is maintenance-free, highly reliable, and adds virtually no weight to the engine.

## **GENERAL SPECIFICATIONS AND ENGINE VIEWS**

For a general view of the MBE 4000 engine, showing major components, see Figure 3 for the left-hand side, and see Figure 4 for the right-hand side.

For a general view of the MBE 4000 engine, showing ports and fluid lines, see Figure 5 for the left-hand side and see Figure 6 for the right-hand side.

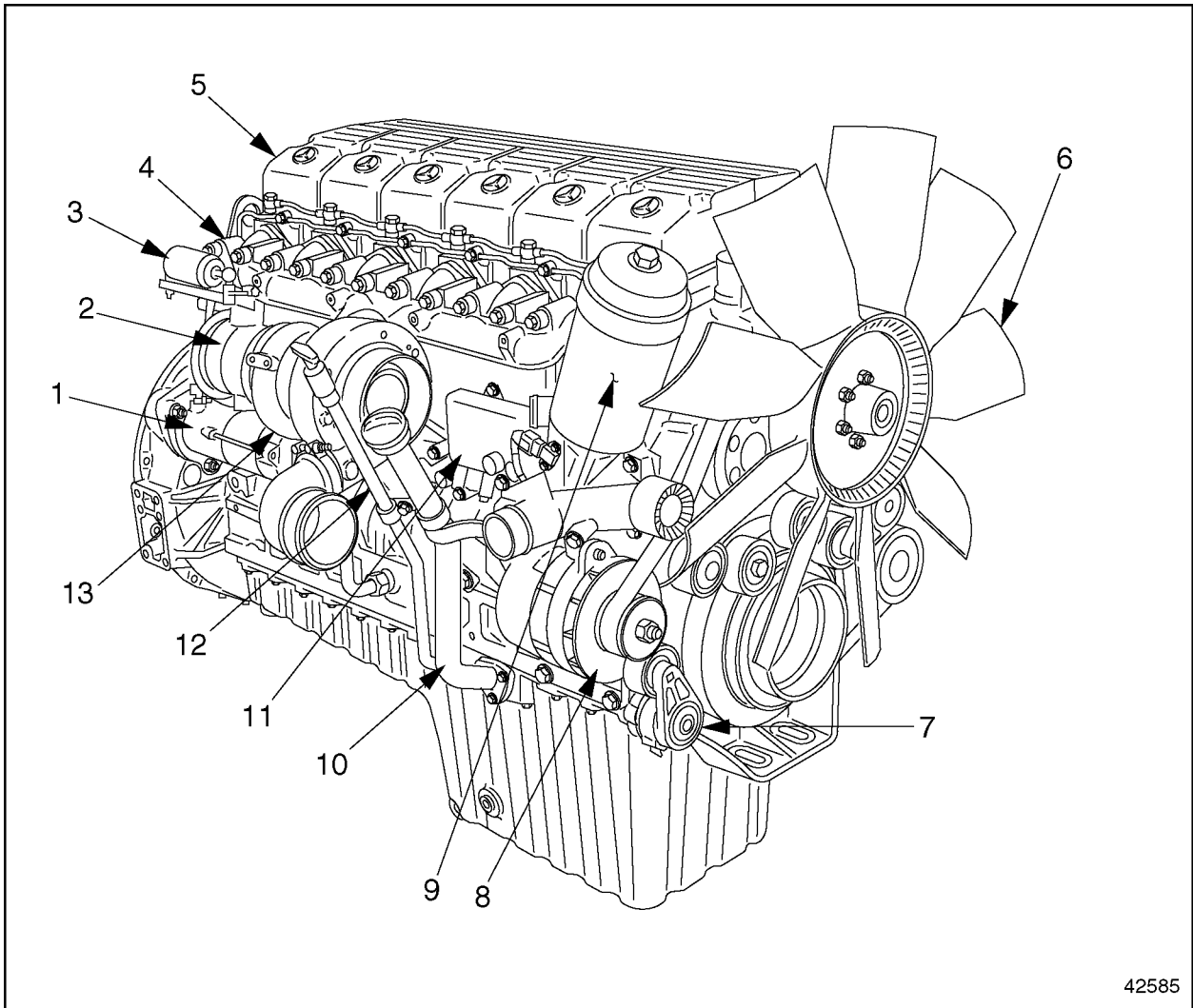
For a general view of the MBE 4000 engine, showing sensor locations, see Figure 7. Two sensors are not easily visible from the left-hand side of the engine: the charge pressure/temperature sensor, located on the right-hand side of the charge air manifold, and the oil pressure/temperature sensor located at the base of the oil filter.



- |                                 |                                |
|---------------------------------|--------------------------------|
| 1. Front Camshaft Cover         | 8. Power Steering Pump         |
| 2. Thermostat Housing           | 9. DDEC-ECU Control Unit       |
| 3. Coolant Pump                 | 10. Fuel Heat Exchanger        |
| 4. Charge-Air (Intake) Manifold | 11. Oil Pan                    |
| 5. Engine Trim Cover            | 12. Fuel Filter                |
| 6. Crankcase Breather           | 13. Fuel Pump                  |
| 7. Air Compressor               | 14. Air Conditioner Compressor |

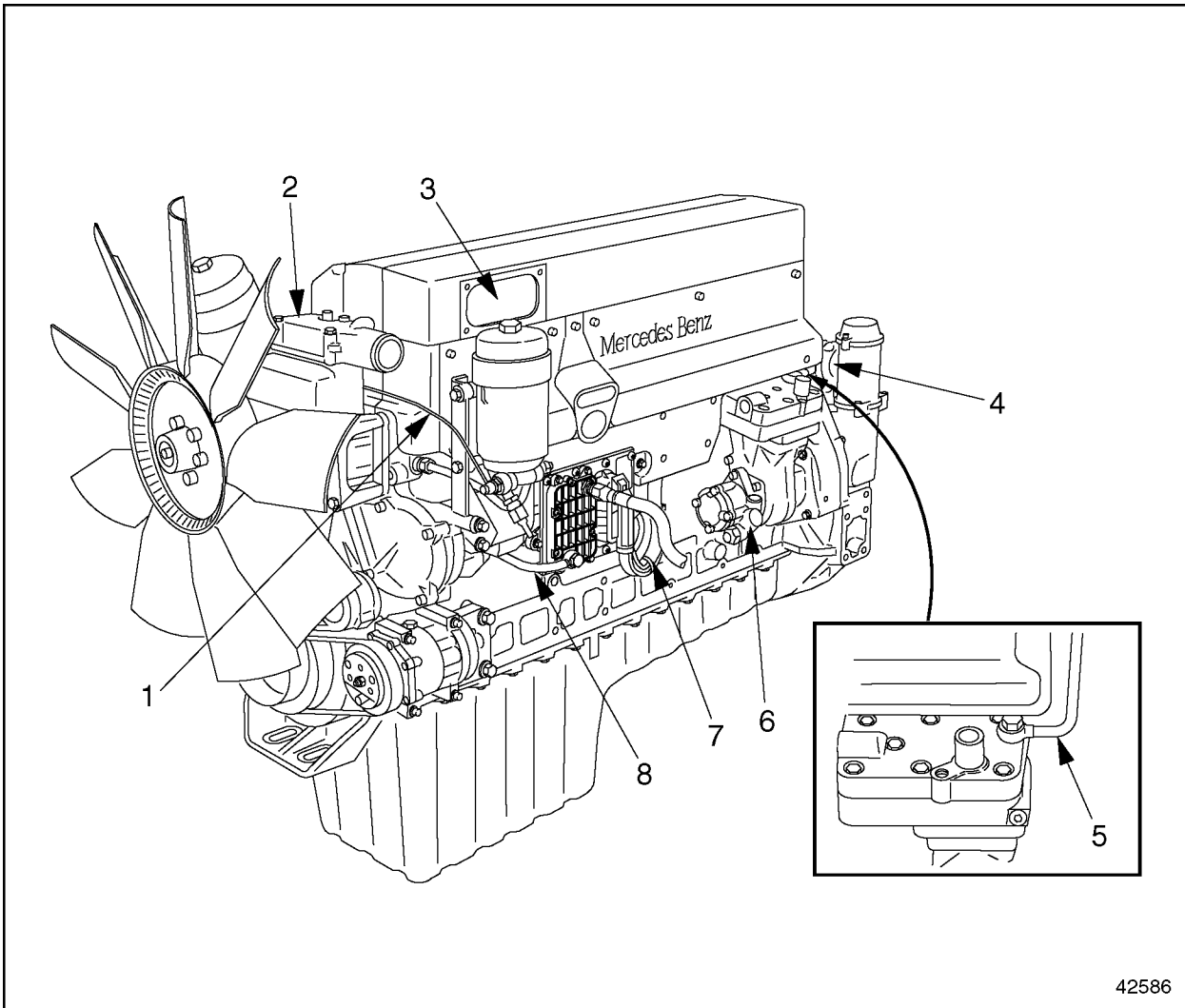
**Figure 3 Left Side, Major Engine Components**





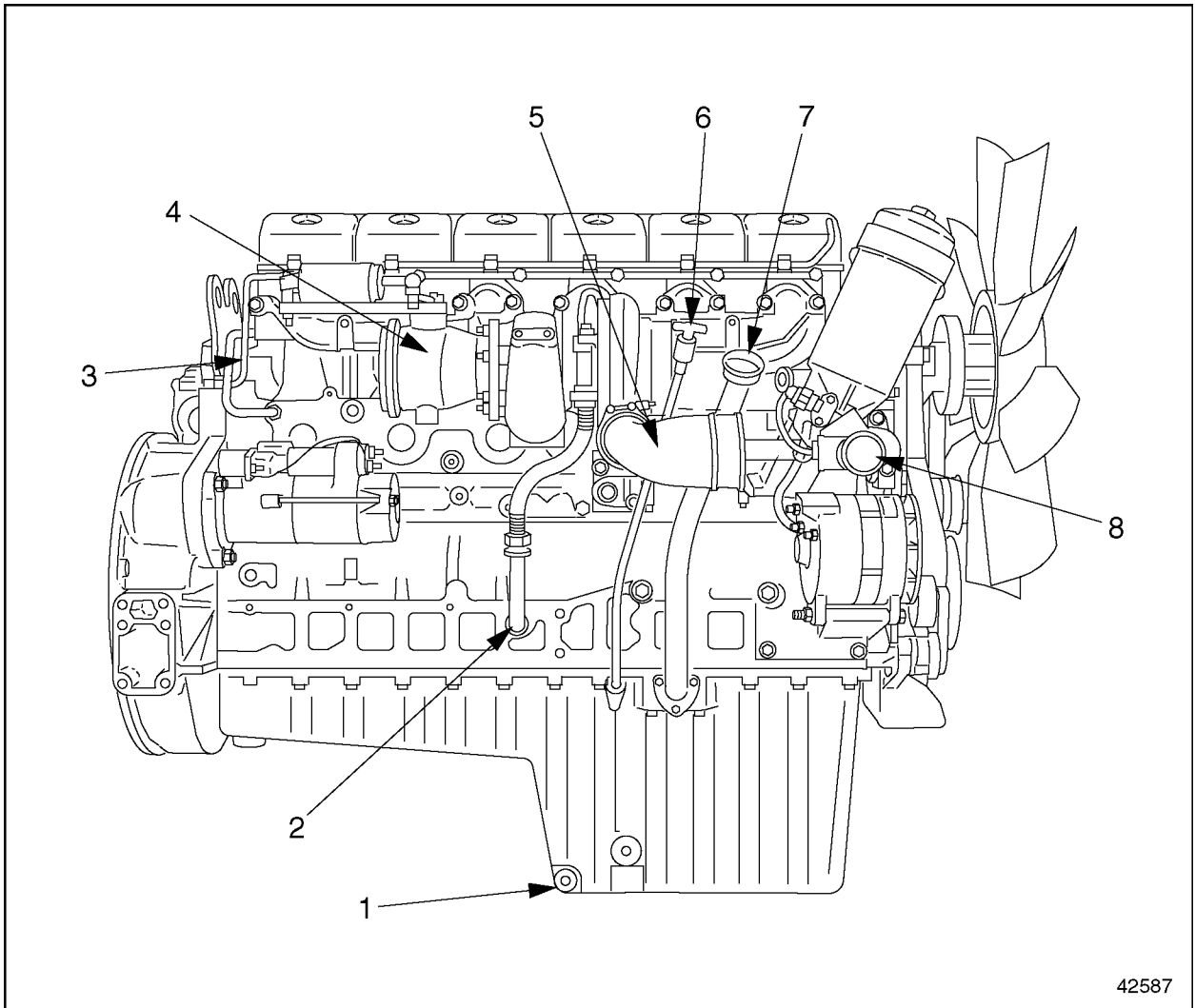
- |                           |                        |
|---------------------------|------------------------|
| 1. Starter                | 8. Alternator          |
| 2. Exhaust Brake Valve    | 9. Oil Filter          |
| 3. Exhaust Brake Cylinder | 10. Oil Fill Tube      |
| 4. Exhaust Manifold       | 11. Oil Heat Exchanger |
| 5. Cylinder Head Cover    | 12. Oil Dipstick       |
| 6. Fan                    | 13. Turbocharger       |
| 7. Belt Tensioner         |                        |

**Figure 4 Right Side, Major Engine Components**



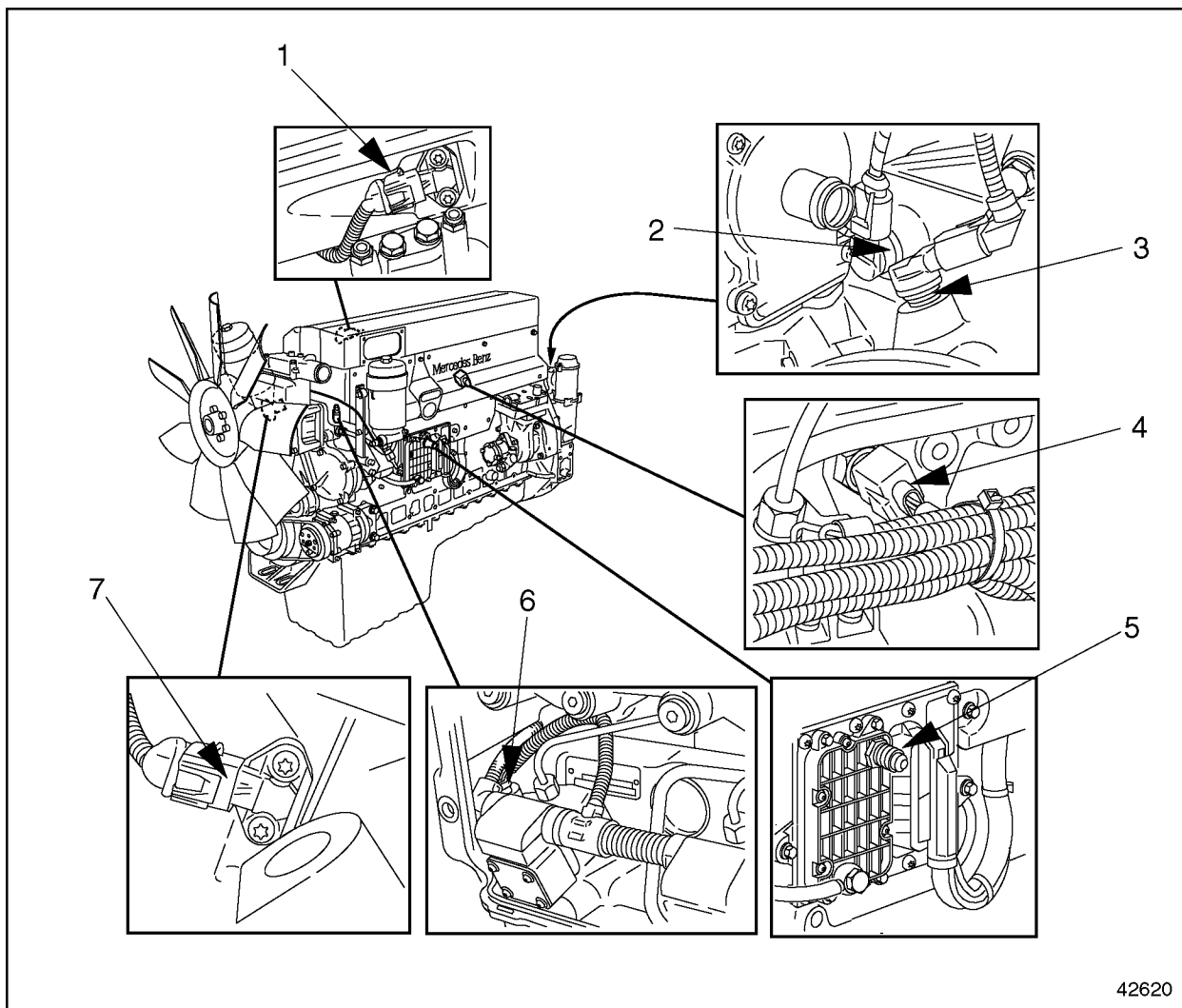
- 1. Fuel Spill Line
- 2. Thermostat Outlet
- 3. Charge Air Inlet
- 4. Open Breather Tube
- 5. Coolant Line (to air compressor)
- 6. Hydraulic Line (to power steering pump)
- 7. Electronic Engine Harness Connector
- 8. Fuel Feed Line

**Figure 5 Left Side, Ports and Lines**



- |                               |                             |
|-------------------------------|-----------------------------|
| 1. Oil Drain Plug             | 5. Turbocharger Outlet Pipe |
| 2. Turbo Oil Return Line      | 6. Dipstick                 |
| 3. Constant-Throttle Inlet    | 7. Oil Fill Cap             |
| 4. Exhaust Brake Valve Outlet | 8. Coolant Pump Inlet Pipe  |

**Figure 6 Right Side, Ports and Lines**



- 1. Intake Manifold Pressure/Temperature Sensor
- 2. TDC Sensor (on camshaft)
- 3. Crank Angle Position Sensor
- 4. Coolant Temperature Sensor
- 5. Barometric Pressure Sensor (integrated into DDEC-ECU)
- 6. Fuel Temperature Sensor
- 7. Oil Pressure/Temperature Sensor

**Figure 7      Sensor Locations**