EPA07 MBE 900 Service Manual - DDC-SVC-MAN-0034

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General Information

SCOPE AND USE OF THIS MANUAL

This manual contains complete instructions on operation, adjustments (including valve lash), preventive maintenance, and repair (including complete overhaul) for the MBE 900 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 900 engines, and apply to all engine models.

This manual is divided into numbered sections. Section One covers the engine (less major assemblies). The remaining 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 900 engine described in this manual is a water–cooled, four–stroke, direct–injection diesel engine. Only a 6–cylinder inline model is available. Each has a separate electronic unit pump (EUP) with a short injection line to the injection nozzle, which is located in the center of the combustion chamber. The EUP(s) are attached to the crankcase and are driven from the camshaft. Each cylinder has two intake valves and one exhaust valve.

Engines with a horsepower rating of 190–250 have a single stage turbocharger and engines with a horsepower rating of 260–350 are equipped with a dual stage turbocharger.

Charge–air cooling and an exhaust gas turbocharger are standard equipment on all MBE 900 engines (wastegate turbochargers are optional).

The engine is equipped with a fully electronic control system, Detroit Diesel Electronic Controls (DDEC®) VI. Besides the engine and its related sensors, this system is composed of the Motor Control Module (MCM), and the Common Powertrain Controller (CPC). The two units are connected by a proprietary datalink through which all necessary data and information can be exchanged.

Engine braking is controlled by either a pneumatically–operated exhaust brake or an electronic actuated brake located on the turbocharger Engine braking is also controlled by an optional constant–throttle system.

The cylinder block has integrated oil and water channels. The single–piece cylinder head is made of cast iron. The cylinder head gasket is a three–layer, adjustment–free seal with Viton® sealing elements.

The pistons are made of aluminum alloy with a shallow combustion chamber recess. The pistons are

cooled by oil spray nozzles.

The crankshaft is precision–forged with seven main bearings , six of which have custom–forged counterweights, 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 EUP. The valves are controlled by mushroom tappets, pushrods, and rocker arms. The intake valves are opened and closed by a valve–guided bridge.

There is a force–feed lubricating oil circuit supplied by a rotary oil pump. This pump is positioned at the front of the crankcase and driven by gears from the crankshaft. The oil cooler is located near the front of the crankcase on the right–hand side near the turbocharger. The high-horsepower engines, 260 -330 BHP, are equipped with an oil centrifuge. In the centrifuge filters larger dirt particles are removed then returns the coarsely cleaned engine oil back into the oil pan. The use of the oil centrifuge prolongs the oil change interval.

The gear–type fuel pump is bolted to the front of the crankcase. 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 (optional).

The vehicle is cooled by a closed system using recirculated coolant; temperature is regulated automatically by two thermostats.

The alternator and water pump (and other accessories) are driven by a belt with an automatic belt tensioner. Electrical equipment includes a starter and an alternator.

AFTERTREATMENT SYSTEM

In order to meet current emissions regulations, the traditional muffler has been replaced by a new aftertreatment device. This device consists of a diesel oxidation catalyst and a diesel particulate filter. Together these two components burn off collected particulate matter in a process called “Regeneration.” The key to successful regeneration is high exhaust temperature for an extended period of time. Without adequate temperatures for regeneration, the filter will continue to trap particulates and eventually plug. In order to avoid plugging, Detroit Diesel has designed an actively regenerated aftertreatment system. For additional information about the aftertreatment system refer to the Aftertreatment System Technician's Guide 7SE63.

ENGINE BRAKES - PNEUMATIC and SMART REMOTE ACTUATOR (SRA2)

The MBE 900 employs two types of engine brakes; the pneumatic actuated engine brake, which uses the air pressure created by the engines mounted air compressor, and the Smart Remote Actuator (SRA2), a solid state electronic actuator, controlled by the MCM. Either style is not used for engine braking, rather they are used only for controlling the position of the brake flap mounted on the turbocharger, which increases backpressure during the regeneration event, based on the temperature needed to sustain the regeneration operation.

The pneumatic operated engine brake uses air pressure from the engine driven air compressor, controlled by an engine mounted solenoid, to the brake flap actuator mounted between the turbocharger

and the Aftertreatment Device. This is an on-off solenoid with no modulation or position feedback control. The air powered actuator operates the brake flap, for the thermal management during the regeneration process.

The second type of engine brake is used on engines that do not have the engine driven air compressor. In this operation, a CAN-operated electronic actuator is used to operate the brake flap. Liquid cooling of the actuator is required to protect the actuator electronics from heat conducted from the turbocharger, Again, this is only used during the regeneration process, to control the thermal management of the engine. During the regeneration process, the Smart Remote Actuator (SRA2) is used to control the operating and closing of the brake flap. The actuator is operated through a “learning: cycle the initial power up of the actuator, learning the end points of its travel. These points are used throughout the operation of the engine brake system. In the un-powered condition, the actuator will move to a default (open) position. A linkage system translates the rotary motion of the actuator to the brake flap.

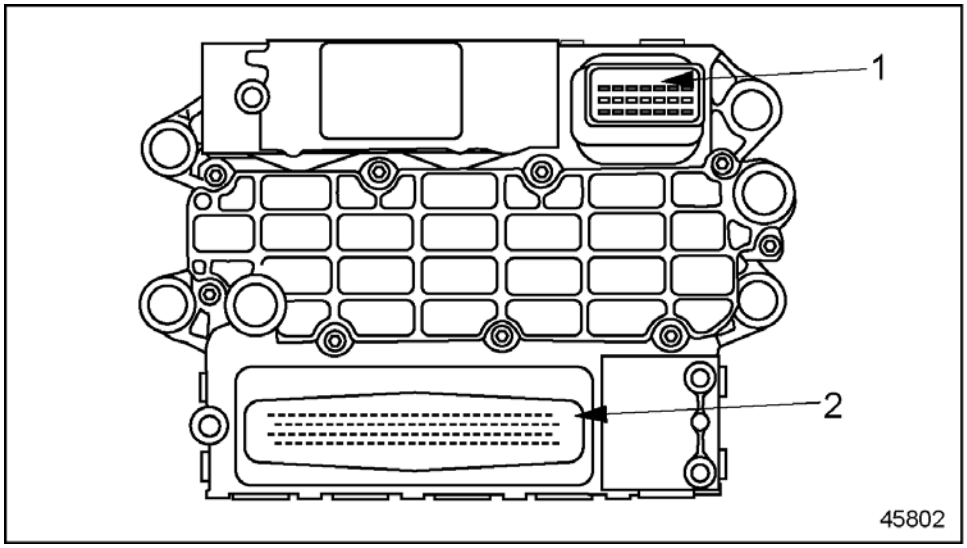
ELECTRONIC ENGINE CONTROL SYSTEM

The engine is equipped with a fully electronic control system, Detroit Diesel Electronic Controls (DDEC®) VI. Besides the engine and its related sensors, this system is composed of the Motor Control Module (MCM), and the Common Powertrain Controller (CPC). The two units are connected by a proprietary datalink through which all necessary data and information can be exchanged.

The MCM 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.

Motor Control Module (MCM)

The engine mounted MCM includes control logic to provide overall engine management. See Figure "Motor Control Module" . The MCM processes the data received from the CPC, 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 MCM. From these data, quantity and timing of injection are calculated and the electronic unit pumps are actuated accordingly through the solenoid valves.



1. 21–Pin Connector 2. 120–Pin Connector

Figure 1. Motor Control Module

Note: Do NOT ground the MCM. This can result in false codes being logged.

Engine Harness

The MCM has a 120–pin connector Engine Harness which is factory installed. It also has a 21–pin connector and 31–pin connector which are the responsibility of the OEM.

Common Powertrain Controller (CPC)

The CPC has three 18–pin connectors and one 21–pin connector. The following sections contain the connector pin-outs for truck, vocational, transit bus, fire truck, and crane applications.

The CPC is the interface between the MCM and the vehicle/equipment for engine control and manages other vehicle/equipment functions. See Figure "Common Powertrain Controller (CPC)" .

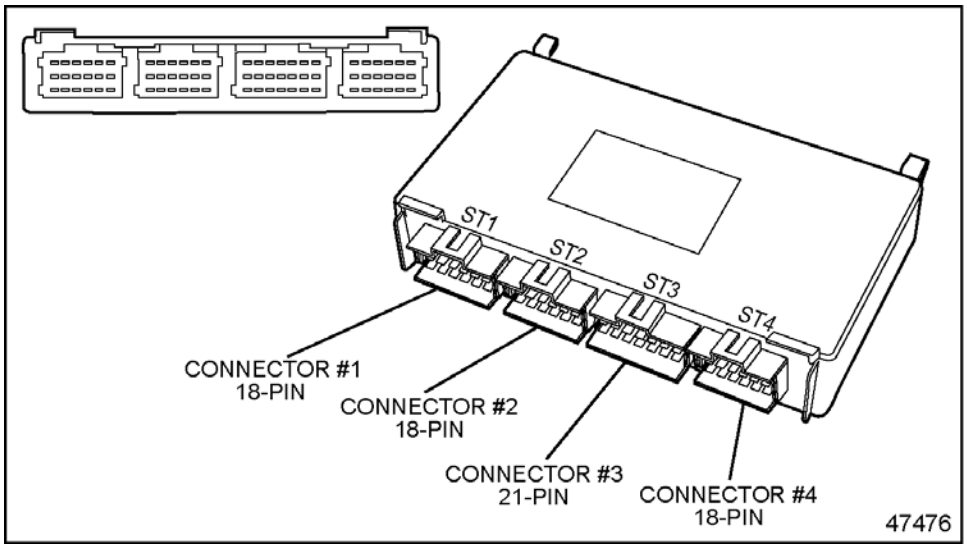


Figure 2. Common Powertrain Controller (CPC)

The OEM is responsible for mounting this part in an enclosed, protected environment. The mounting bracket is the responsibility of the OEM. There must be maximum physical separation of the Vehicle Interface Harness (VIH) from other vehicle/equipment electrical systems. Other electrical system wires should ideally be at least three feet away from the VIH and should not be parallel to the VIH. This will eliminate coupling electromagnetic energy from other systems into the VIH. See Figure "CPC Dimensions" .

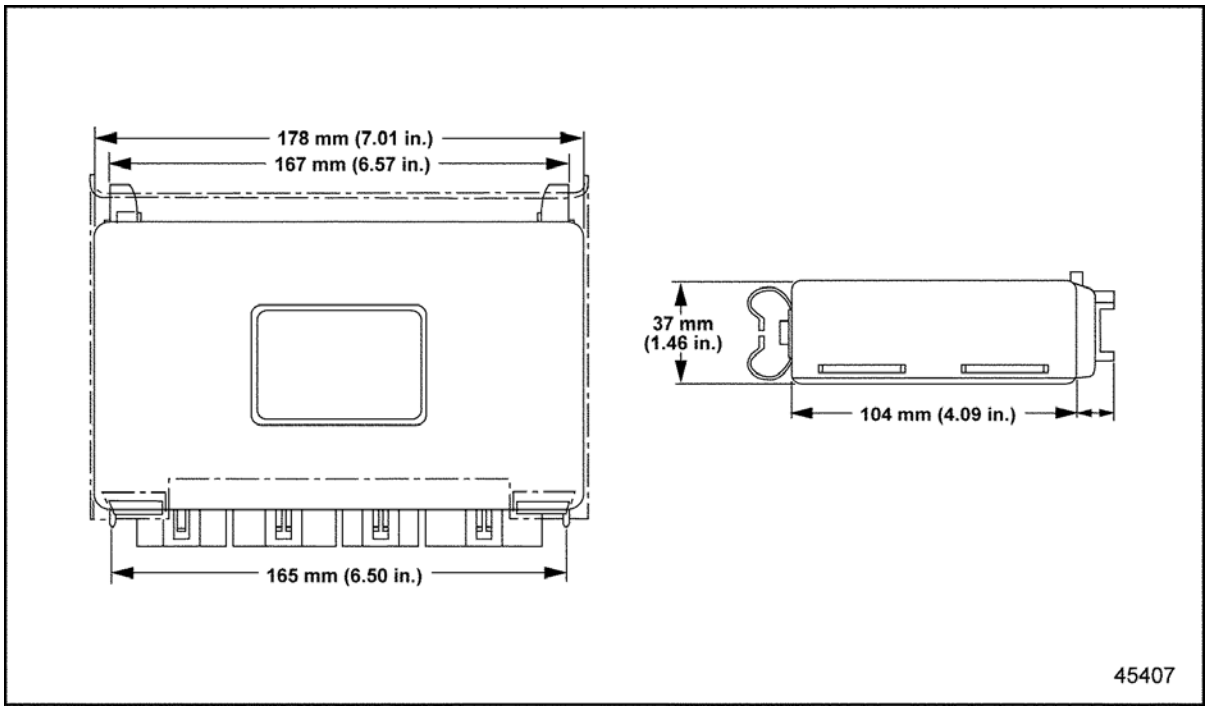


Figure 3. CPC Dimensions

The CPC receives data from the operator (accelerator pedal position, switches, various sensors) and other electronic control units.

Note: The CPC should be mounted with the connectors pointing down.

ENVIRONMENTAL CONDITIONS

Temperature, vibration, and water intrusion must be considered.

Temperature

The ambient operating temperature range is –40°F to 185°F (-40°C to 85°C).

Water Intrusion

The CPC is not water tight and cannot be subject to water spray. It must be mounted in an enclosed, protected environment.

CPC to MCM - VEHICLE INTERFACE HARNESS (VIH)

The OEM supplied VIH connects the CPC to the MCM and other vehicle systems See Figure "Vehicle Interface Harness" .

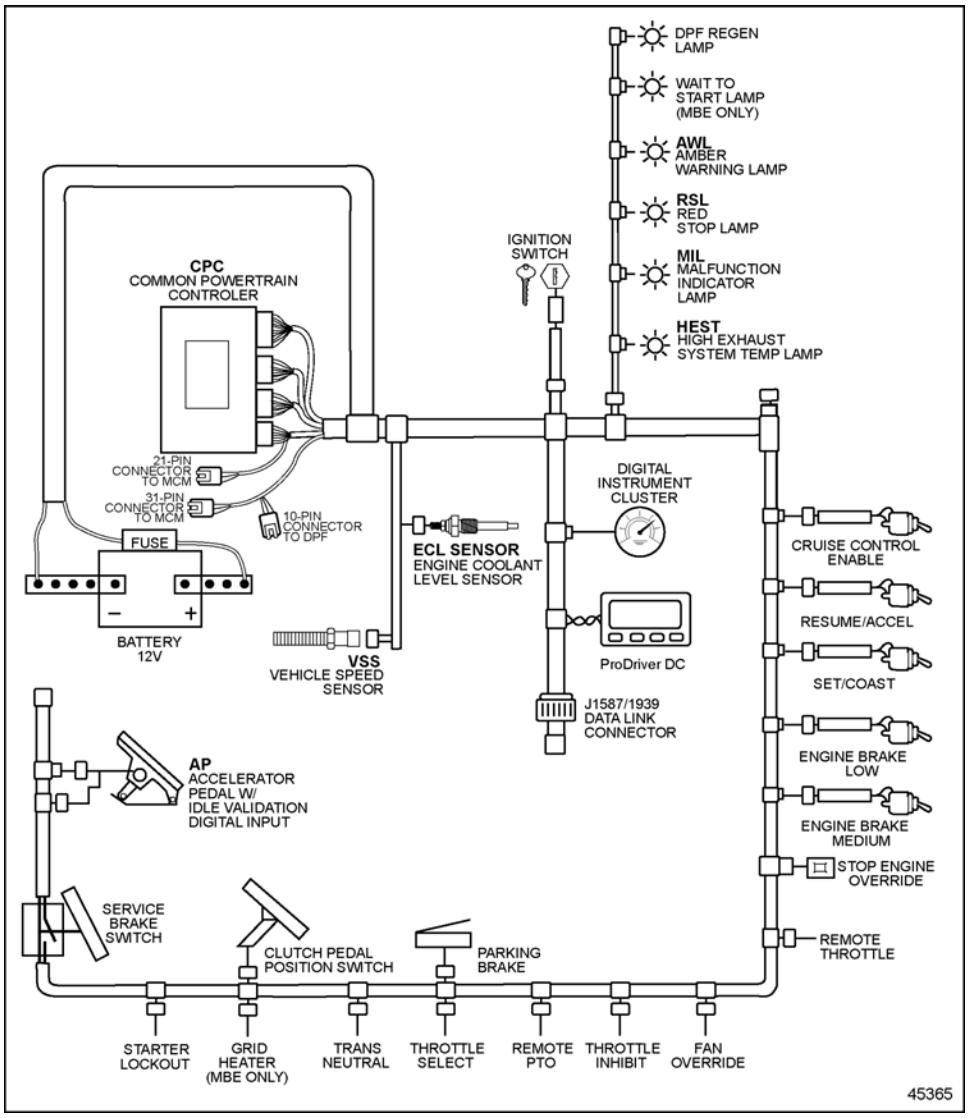


Figure 4. Vehicle Interface Harness

FACTORY INSTALLED SENSORS

The sensors integrated into the factory-installed Engine Harness are listed in Table "Function of Factory-installed Sensors" .

Sensor	Function
Camshaft Position Sensor (CMP Sensor)	Senses crankshaft position and engine speed for functions such as fuel control strategy.
Crankshaft Position Sensor (CKP Sensor)	Indicates a specific cylinder in the firing order.
DPF Inlet Pressure Sensor	Sensor measures pressure between the Diesel Oxidation Catalyst (DOC) and the Diesel Particulate Filter (DPF) in the aftertreatment assembly located in the exhaust system of the vehicle.
DPF Outlet Pressure Sensor	Sensor measures pressure on the outlet of the after-treatment device in the exhaust system of the vehicle. Located after the DPF that is within the aftertreatment device.

DPF Outlet Temperature Sensor	Temperature measured at the outlet of the after-treatment system that is installed within the exhaust system of the vehicle. It's located after the DPF that is within the aftertreatment unit.
DOC Inlet Temperature	DOC Temperature In - Temperature measured at the inlet of the after-treatment device in the exhaust system of the vehicle. Located before the DOC that is within the after-treatment device.
DOC Outlet Temperature	Temperature measured between the DOC and the DPF in the aftertreatment assembly located in the exhaust system of the vehicle.
EGR Delta Pressure Sensor EGR Delta P Sensor	Senses EGR pressure for EGR control.
EGR Temperature Sensor	Senses EGR exhaust temperature after EGR cooler. Used for EGR system diagnosis.
Engine Coolant Temperature Sensor (ECT Sensor)	Senses coolant temperature for functions such as engine protection, fan control and engine fueling.
Engine Oil Pressure Switch	Senses gallery oil pressure for functions such as engine protection.
Engine Oil Temperature Sensor (EOT Sensor)	Senses oil temperature for functions such as reducing variation in fuel injection and fan control.
Fuel Line Pressure Sensor	Senses fuel line pressure
Fuel Compensation Pressure Sensor	Compensates fuel line pressure
Intake Manifold Pressure Sensor (IMP Sensor)	Senses turbo boost for functions such as smoke control and engine protection.
Intake Manifold Temperature Sensor (IMT Sensor)	Senses boost temperature
Supply Fuel Temperature Sensor (SFT Sensor)	Senses fuel temperature for functions such as engine fueling.
Turbo Compressor Temperature Out Sensor	Senses turbo out air temperature.
Water-in-Fuel Sensor (MBE 900 only)	Detects water in the fuel filter that alerts the owner/driver that the fuel filter needs to be dried out.

Table 2. Function of Factory-installed Sensors

GENERAL DESCRIPTION OF MBE 900 EGR SYSTEM AND ENGINE VIEWS

The purpose of the Exhaust Gas Recirculation (EGR) System is to reduce engine exhaust gas emissions in accordance with Environmental Protection Agency (EPA) regulations.

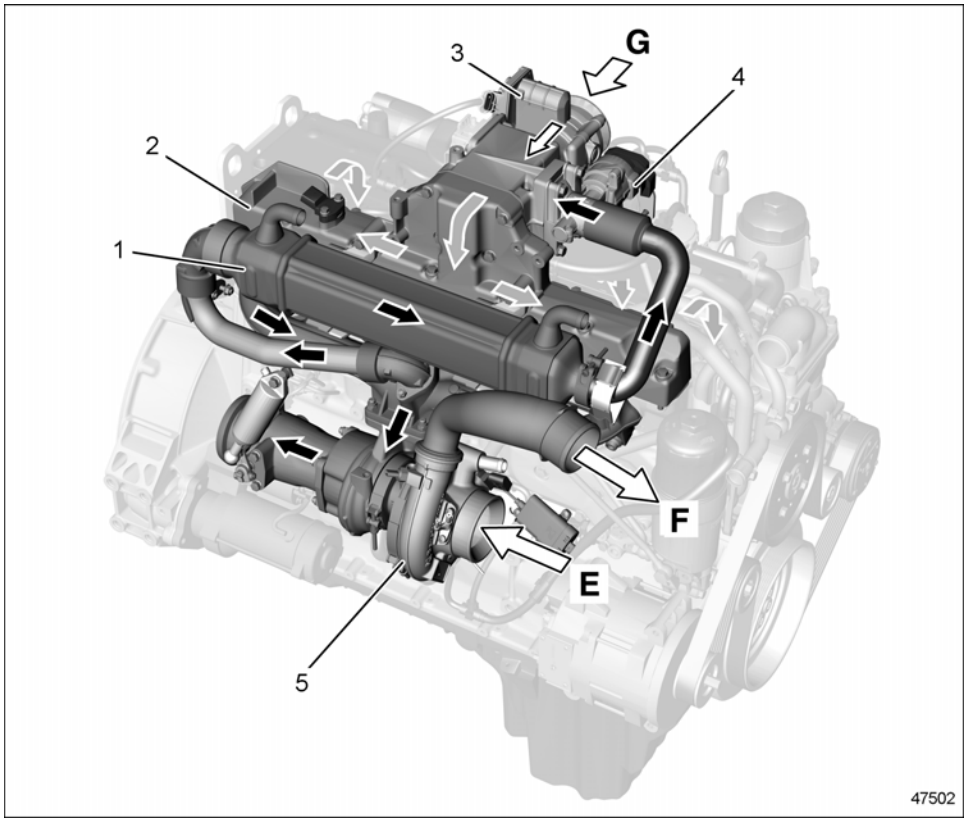
The EGR system consists of:

- Turbocharger
- EGR Cooler
- EGR Valve
- EGR Mixer

The MBE 900 engines for on-highway EPA 2007 regulation applications use a water cooled EGR system along with an Aftertreatment System to meet the emission standards. On engine model 926.961,

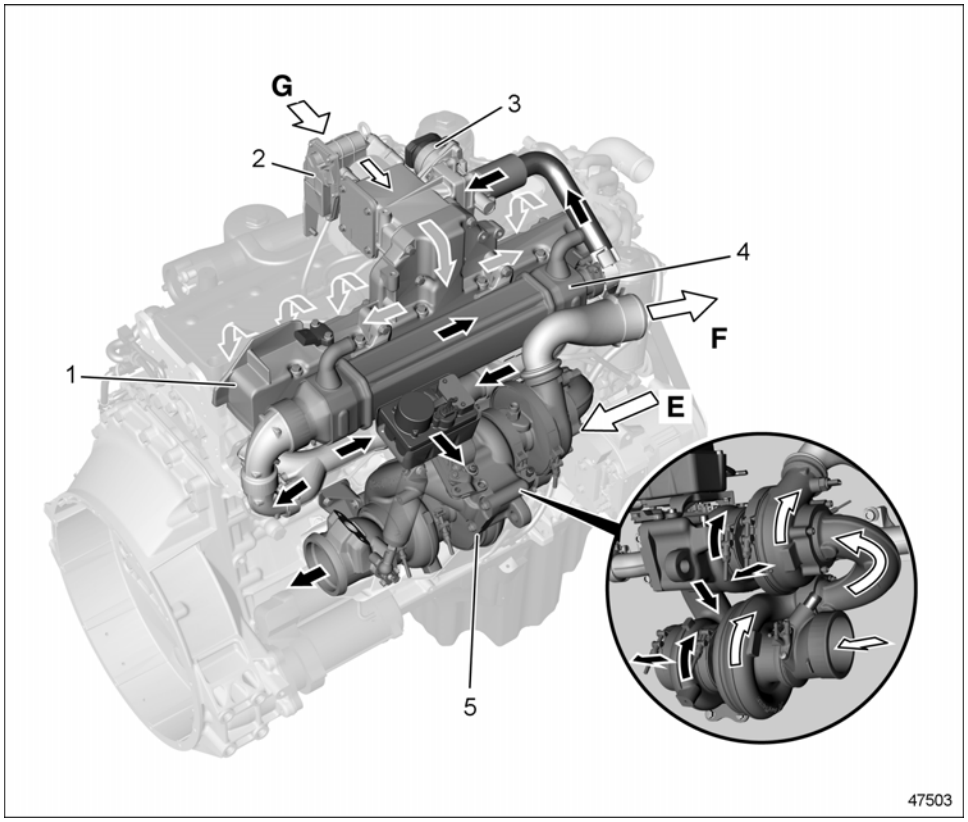
the EGR is fed by all six cylinders. Engine model 926.960 uses an asymmetric turbocharger with two entries, and the EGR is fed from the first three cylinder, taken from a small entry. The exhaust with a maximum exhaust gas temperature of 730°C (1346°F) is cooled to a maximum of 150°C (302°F) in the EGR cooler. The cooled exhaust gases then pass through the EGR valve and added to the mixer. The addition of cooled exhaust gases back into the combustion airflow reduces the peak in cylinder combustion temperature. Less oxides of nitrogen (NOx) are produced at lower combustion temperatures.

The recycled exhaust gases are cooled before engine consumption in a single pass EGR cooler. See Figure "Air Flow Diagram (Single-Stage Turbocharger)" for engine air flow for the single-stage turbocharger and see Figure "Air Flow Diagram (Dual-Stage Turbocharger)" for engine air flow for the dual-stage turbocharger.



1. EGR Cooler	5. Single-Stage Turbocharger
2. Air Intake Manifold	E — Intake Air from Air Cleaner
3. Throttle Valve	F — Charge Air to the Charge Air Cooler
4. EGR Valve	G — Charge Air from the Charge Air Cooler

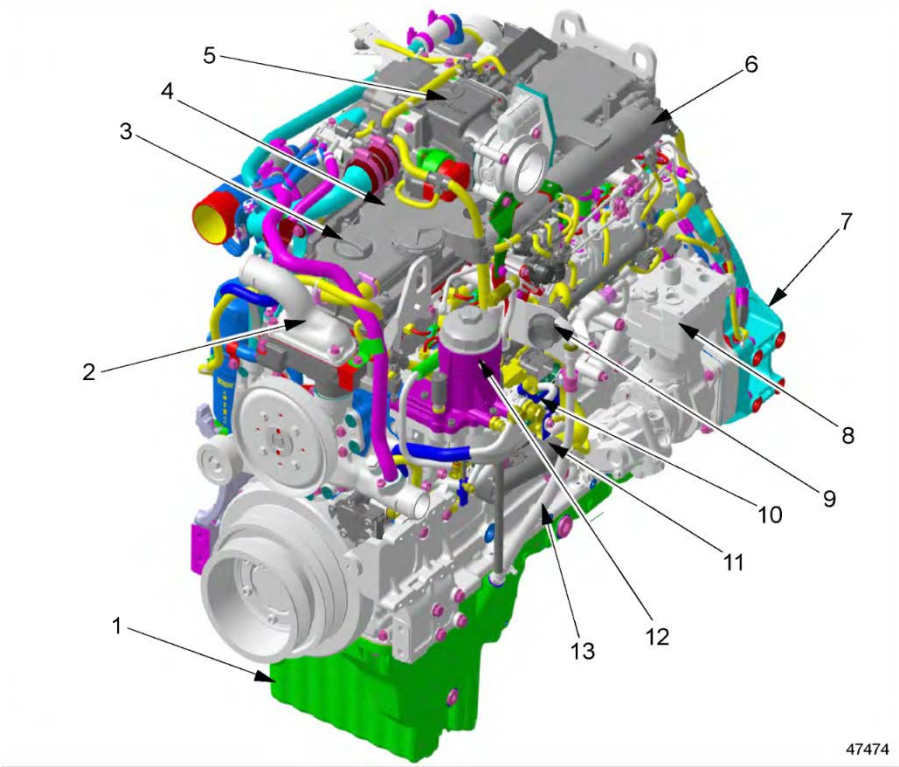
Figure 5. Air Flow Diagram (Single-Stage Turbocharger)



1. Air Intake Manifold	5. Dual-Stage Turbocharger
2. Throttle Valve	E — Intake Air from Air Cleaner
3. EGR Valve	F — Charge Air to the Charge Air Cooler
4. EGR Cooler	G — Charge Air from the Charge Air Cooler

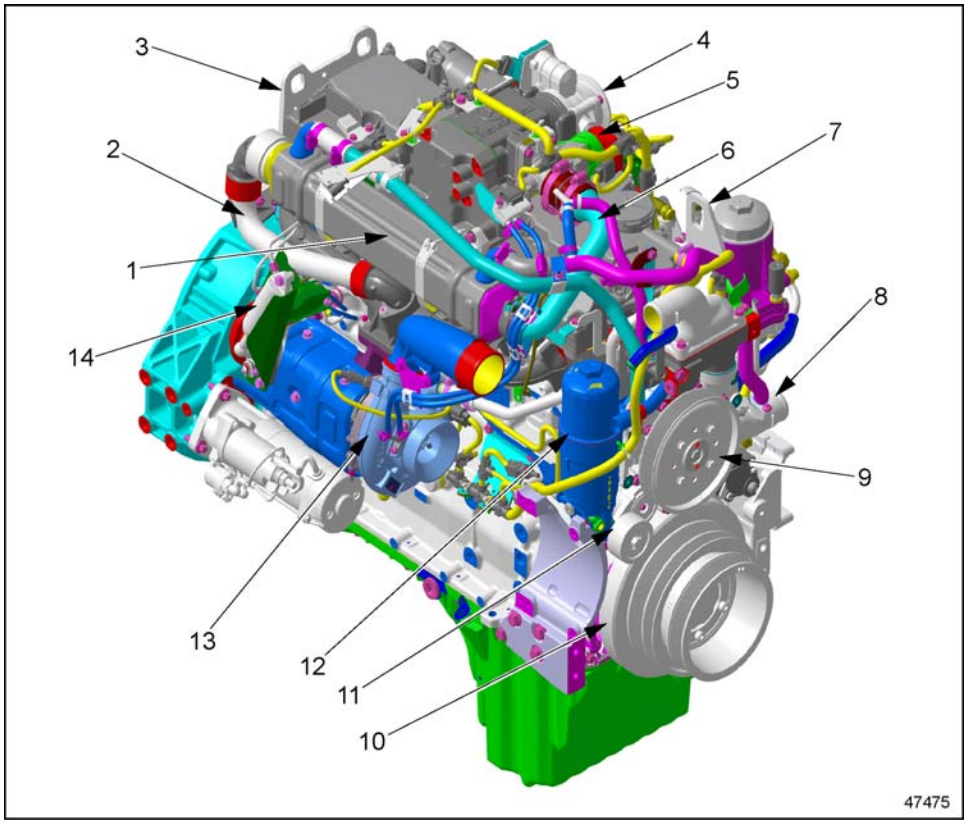
Figure 6. Air Flow Diagram (Dual-Stage Turbocharger)

See Figure "Left Side View of MBE 900 Engine (Single Stage Turbocharger) and Components" and see Figure "Right Side View of MBE 900 Engine (Single Stage Turbocharger) and Components" for the MBE 900 (Single-Stage Turbocharger) and component location. See Figure "Right Side View of MBE 900 Engine (Dual-Stage Turbocharger) and Components", and see figure "Left Side View of MBE 900 Engine (Dual-Stage Turbocharger) and Components" for the MBE 900 (Dual-Stage Turbocharger) and component location.



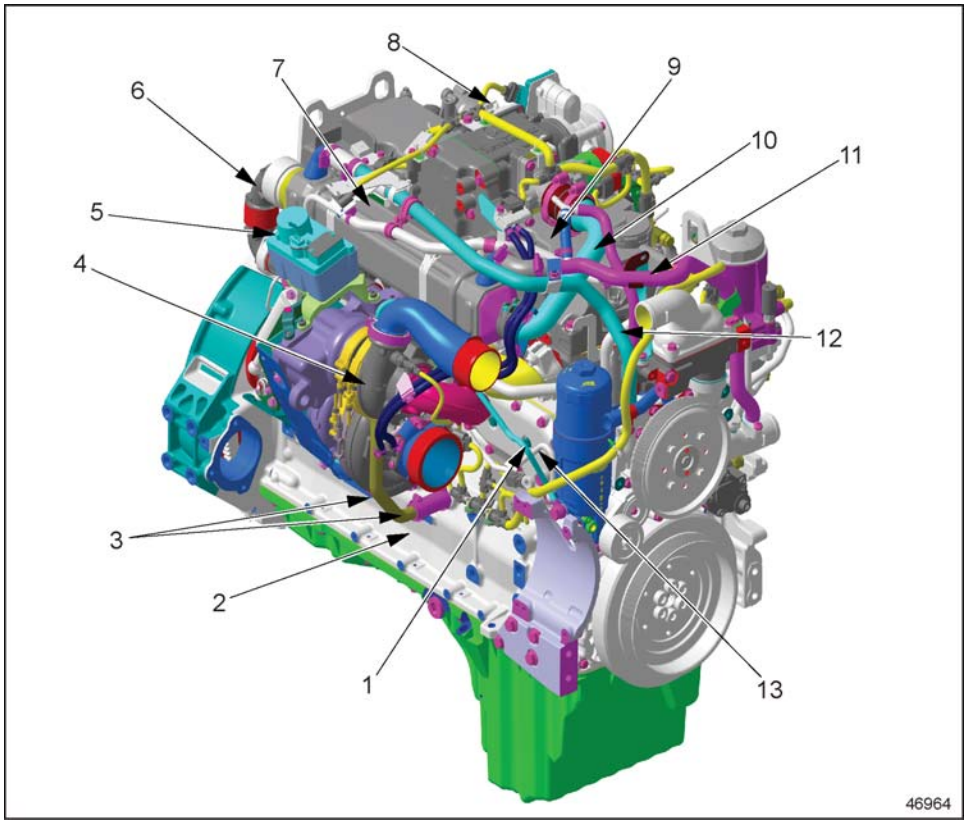
1. Oil Pan	8. Air Compressor
2. Thermostat Housing	9. 31–Pin Connector
3. Oil Fill Cap	10. Motor Control Module (MCM)
4. Cylinder Head Cover	11. 120–Pin Connector
5. EGR Mixer	12. Fuel Filter/Water Separator
6. Electrostatic Oil Separator	13. Oil Dipstick Tube
7. Flywheel Housing	

Figure 7. Left Side View of MBE 900 Engine (Single Stage Turbocharger) and Components



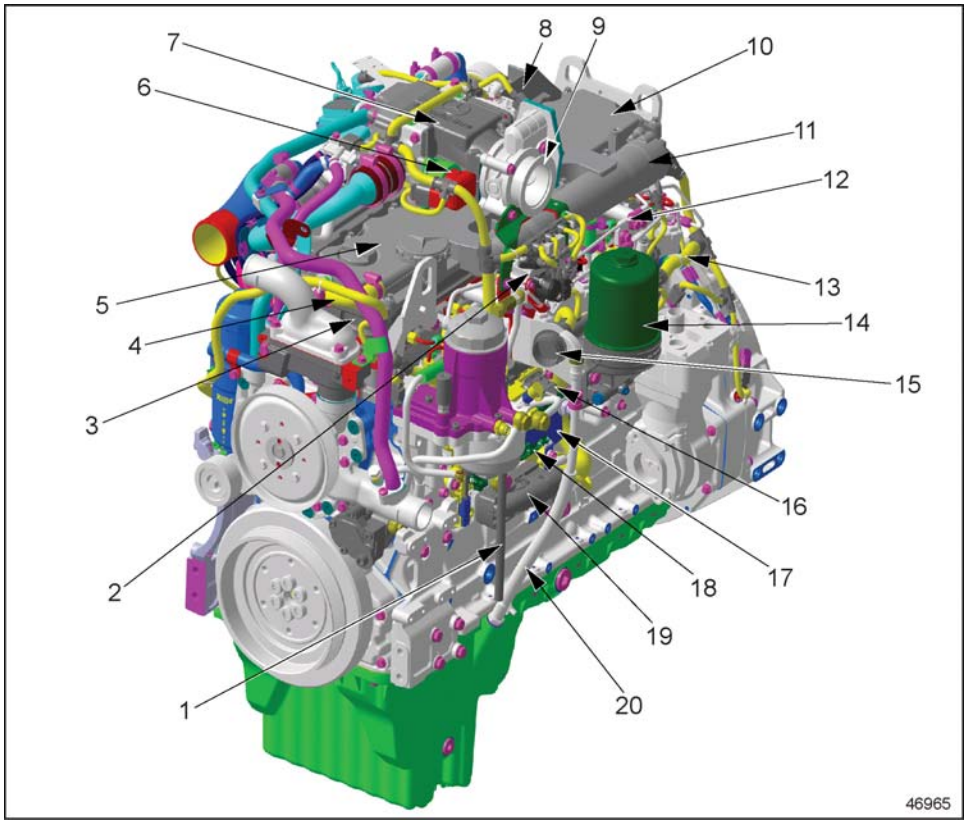
1. EGR Cooler	9. Fan Pulley
2. EGR Exhaust Elbow	10. Crankshaft Vibration Damper
3. Rear Lifting Bracket	11. Belt Tensioner
4. Air Intake Throttle Valve	12. Oil Filter
5. EGR Valve	13. Turbocharger (Single-Stage)
6. EGR Delivery Pipe	14. Exhaust Brake
7. Front Lifting Bracket	15. Pipe
8. Water Pump	

Figure 8. Right Side View of MBE 900 Engine (Single Stage Turbocharger) and Components



1. Oil Supply Line to Turbocharger	8. Grid Heater
2. Cylinder Block	9. Air Intake Manifold
3. Dual Turbo Oil Return to Block	10. EGR Delivery Pipe
4. Dual-Stage Turbocharger	11. EGR Cooler Coolant Return Tube
5. Wastegate Actuator	12. EGR Cooler Coolant Inlet Tube
6. Exhaust Elbow	13. Oil Supply Line to 2nd Turbocharger
7. EGR Cooler	

Figure 9. Right Side View of MBE 900 Engine (Dual-Stage Turbocharger) and Components



1. Drain Line for Water Separator	11. Electrostatic Oil Separator
2. Doser Block Assembly	12. Fuel Dosing Line
3. Rocker Arm Frame	13. Wire Harness
4. Fuel Injector (under cover)	14. Oil Centrifuge (260–350Horsepower models except motorcoach)
5. Breather Hose	15. 31–Pin Connector
6. EGR Valve	16. 21–Pin Connector
7. EGR Mixer Housing	17. Motor Control Module (MCM)
8. Air Intake Manifold	18. Fuel Heat Exchanger
9. Air Intake Throttle Valve	19. 120–Pin Connector
10. Cylinder Head Cover	20. Dipstick Tube

Figure 10. Left Side View of MBE 900 Engine (Dual-Stage Turbocharger) and Components

The general specifications for the MBE 900 EGR engines are listed in Table "General Technical Information for MBE 900 EGR Engines"

Descriptions	6–Cylinder EGR Engine
Engine Type	Vertical, inline cylinder block with turbocharger and charge–air cooler
Engine Length	1057 mm (41.6 in.)

Engine Width	862 mm (33.9 in.)
Engine Height	1138 mm (44.8 in.)
Cooling System	Liquid Circuit
Combustion Principle	4–Stroke direct–injection diesel
Number of Cylinders	6
Bore	106 mm (4.17 in.)
Stroke	136 mm (5.35 in.)
Displacement (total)	7.2 liters (439 in^3)
Compression Ratio	18:1
Starting Speed	Approximately 100 rpm
Direction of Engine Rotation (viewed from flywheel)	Counterclockwise
Starter	Electric Motor
Coolant Capacity of Engine (Does not include capacity of cooling system.)	Max. 12.5 liters (13.2 qt.)
Lubricating Oil Fill Capacity(In standard pan, including oil filter.)	Max. 29.0 liters (30.6 qt.)
Cold–Start Temperature Limit (Without starting aids and with battery 75 percent charged)	Down to –15°C (+5°F)
Engine "Dry" Weight — Single -Stage Turbocharger	613 kg (1362 lb)
Engine "Dry" Weight — Dual -Stage Turbocharger	648 kg (1428 lb)
Valve Lash (with engine cool)	Intake = 0.40 mm (0.016 in.)
	Exhaust = 0.60 mm (0.024 in.)
Valve Lift (at maximum valve clearance)	Intake = 9.7 mm (0.38 in.)
	Exhaust = 10.7 mm (0.42 in.)
Engine Oil Pressure	At idle rpm = 50 kPa (7 psi)
	At maximum rpm = 250 kPa (36 psi)
Fuel Injectors	Minimum opening pressure = 24,500 kPa (3553 psi)
	Maximum opening pressure = 25,700 kPa (3727 psi)
Coolant Thermostat	Opening temperature = 81° to 85°C (178° to 185° F)
	Normal operating temperature = 95°C (203°F)

Table 9. General Technical Information for MBE 900 EGR Engines

IDENTIFICATION

This engine has an engine identification number and an emissions label.

Engine Identification Number

On the EPA07 MBE 900 engines, all locations show a 14–digit engine serial number with a specific numbering sequence developed as follows:

- The first 3 digits show the series of the engine, 926 for the 900 Series Engine.
- The second group is the specific model identifier for the engine.
    - 961 for the EPA07 single-turbocharger engine, up to 230 HP/620 lb·ft.
    - 963 for the EPA07 single-turbocharger engine, up to 250 HP/660 lb·ft.
- The third in the sequence is a plant identification code, “S” indicates Detroit and a “0” indicates a Mannheim produced engine.
- Prior to the 6 digit sequential serial number is a “0” acting as a place holder for future volume.
- The forth grouping in the sequence is the 6 digit sequential serial number.

The engine identification number is located on the following surfaces:

- Right rear side, top of engine block See Figure "Location of Engine Identification Numbers" .
- Top rear of engine rocker cover.
- Top front of engine rocker cover.
- Top of flywheel housing.

The etched identification number contains the type reference followed by a sequential manufacturing number. See Figure "Location of Engine Identification Numbers" .

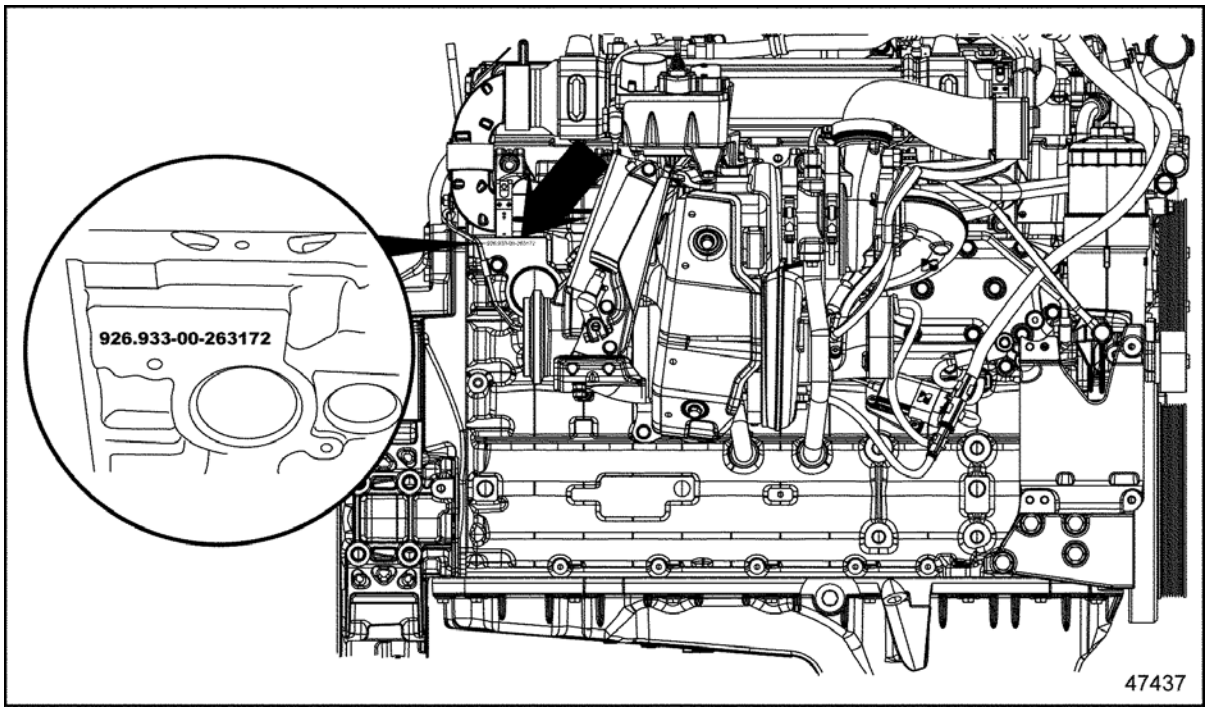


Figure 11. Location of Engine Identification Numbers

Emission Label

The MBE 900 EPA07 engine is built in accordance with sound technological principles and based on state–of–the–art technology. It complies with all United States Environmental Protection Agency (USEPA) and California Air Resources Board (CARB) emission standards. An emission label is attached to the cylinder head cover, as required by law. See Figure "Engine Emission Label — EPA07" for the emission label for the EPA07 EGR model label.

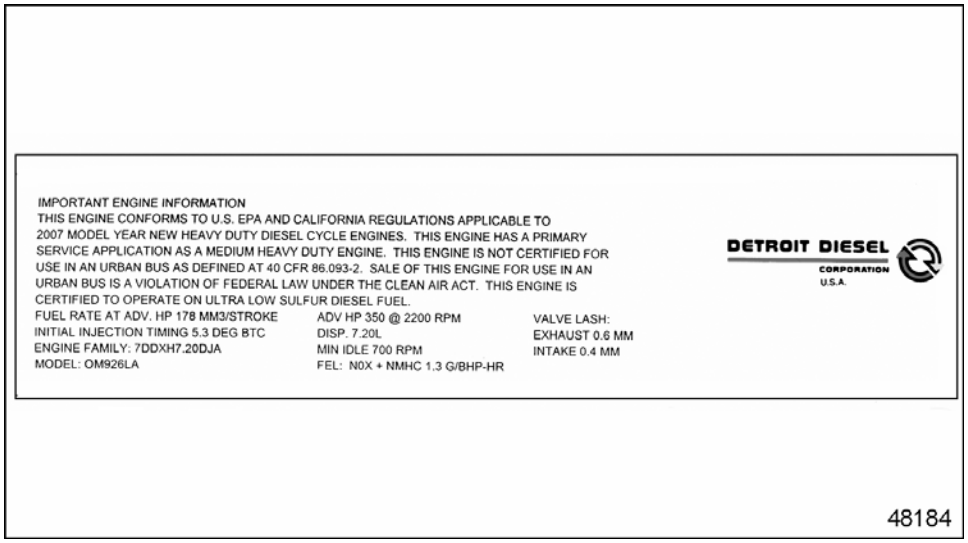
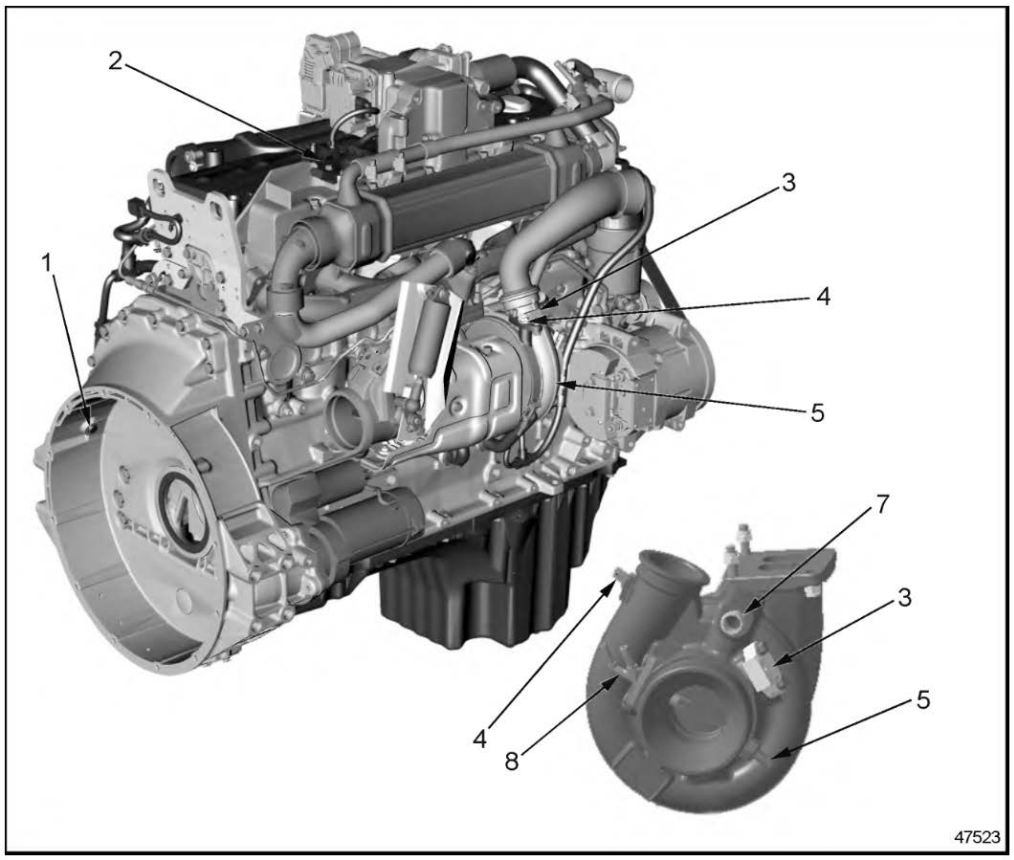


Figure 12. Engine Emission Label — EPA07

Note: The horsepower rating on the emission label is for the highest engine rating and not necessarily the rating of your engine.

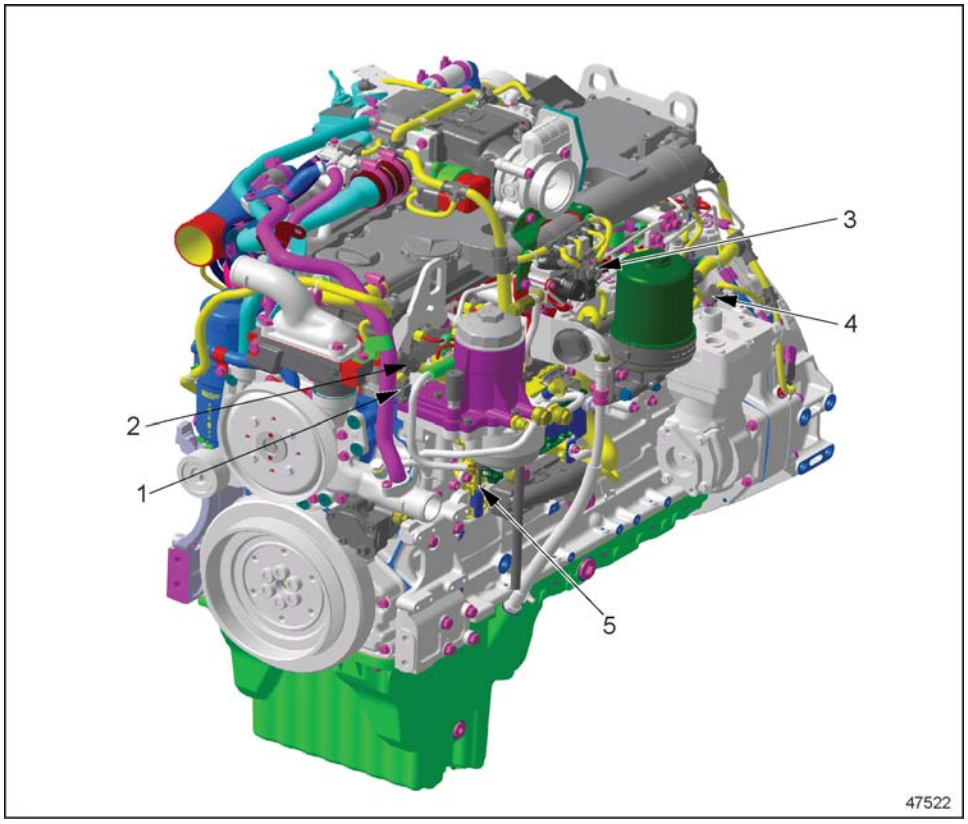
Sensor Locations

See Figure "Sensor Location on the Right Side of the MBE 900 EGR Engine" and see Figure "Sensor Location on the Left Side of the MBE 900 EGR Engine" for sensor locations for MBE 900 EGR engines.



1. Crankshaft Position (CKP) Sensor	5. Turbocharger Inlet Temperature Sensor
2. Air Intake Pressure/Temperature Sensor	6. Blow-by Return
3. Blow-by Return Insert	7. Delta P Air Inlet Fitting
4. Turbocharger Outlet Temperature Sensor	8. Delta P Insert

Figure 13. Sensor Location on the Right Side of the MBE 900 EGR Engine



1. Water-in-Fuel (WIF) Sensor (Optional)	4.Camshaft Position (CMP) Sensor
2. Fuel Temperature Sensor	5. Fuel Line Pressure Sensor
3. Coolant Temperature Sensor	

Figure 14. Sensor Location on the Left Side of the MBE 900 EGR Engine

SAFETY INSTRUCTIONS AND PRECAUTIONS

The following safety measures are essential when working on the MBE 900 engine.

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed:

- Proper service and repair are important to the service technician and the safe, reliable operation of the engine. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part number. Do not use a replacement part of lesser quality.

- The service procedures recommended and described in this manual are effective methods of performing a repair. Some of these procedures require the use of specially designed tools.

Accordingly, anyone who intends to use a replacement part, procedure or tool that is not recommended, must first determine that neither personal safety nor the safe operation of the engine or warranty will be jeopardized by the replacement part, procedure or tool selected.

Note: It is important to note that this manual contains various " Dangers", "Warnings", Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during repair or the possibility that improper repair may damage the engine or render it unsafe. It is also important to understand that these "Dangers", "Warnings", "Cautions" and "Notices" are not exhaustive, because it is impossible to warn personnel of all the possible hazardous consequences that might result from failure to follow these instructions.

Despite this, the engine may constitute a risk of damage to property or injury to persons under the following conditions:

- It is not used for its intended purpose.
- It is modified or converted in an incorrect manner.
- The safety instructions are disregarded.

Air

Cautions involving the use of compressed air are indicated throughout the manual.

WARNING:

EYE INJURY

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 276 kPa (40 psi) air pressure.

Batteries

Electrical storage batteries emit highly flammable hydrogen gas when charging and continue to do so for some time after receiving a steady charge.

WARNING:

Battery Explosion and Acid Burn

To avoid injury from battery explosion or contact with battery acid, work in a well ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:

- **Flush your skin with water.**
- **Apply baking soda or lime to help neutralize the acid.**
- **Flush your eyes with water.**

- **Get medical attention immediately.**

Always disconnect the battery cable before working on the electrical system.

WARNING:

PERSONAL INJURY

To avoid injury from accidental engine startup while servicing the engine, disconnect/disable the starting system.

Disconnect the batteries or disable an air starter when working on the engine to prevent accidental starting.

Cleaning Agent

Avoid the use of carbon tetrachloride as a cleaning agent because of the harmful vapors that it releases. Ensure the work area is adequately ventilated. Use protective gloves, goggles or face shield, and apron. Exercise caution against burns when using oxalic acid to clean the cooling passages of the engine.

WARNING:

PERSONAL INJURY

To avoid injury from harmful vapors or skin contact, do not use carbon tetrachloride as a cleaning agent.

Clothing

Make sure that safe work clothing fits and is in good condition. Use work shoes that are sturdy and rough–soled. Bare feet, sandals or sneakers are not acceptable foot wear when adjusting and/or servicing an engine. Do not wear rings, wrist watches, bracelets, necklaces and loose fitting clothing could catch on moving parts causing serious injury.

WARNING:

PERSONAL INJURY

To avoid injury when working near or on an operating engine, remove loose items of clothing and jewelry. Tie back or contain long hair that could be caught in any moving part causing injury.