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## TABLE OF CONTENTS

Foreword.....	1
Service Diagnosis.....	2
Safety Information.....	3
Engine Systems.....	5
Mounting Engine on Engine Stand.....	59
Engine Electrical.....	71
Down Stream Injection (DSI) & Related Components.....	111
Dual Stage Turbocharger and Exhaust Brake.....	125
Exhaust Gas Recirculation (EGR) System.....	167
Intake, Inlet, and Exhaust Manifolds.....	187
Fuel and High-Pressure Oil Systems.....	203
Engine Brake.....	237
Air Compressor and Power Steering Pump.....	255
Oil System Module Assembly.....	267
Oil Pan and Oil Suction Tube.....	285
Front Cover, Cooling System, and Related Components.....	297
Cylinder Head and Valve Train.....	349
Flywheel and Flywheel Housing.....	401
Power Cylinders.....	429
Crankcase, Crankshaft, and Camshaft.....	467
Abbreviations and Acronyms.....	511
Terminology.....	519
Appendix A – Specifications.....	531
Appendix B – Torques.....	549
Appendix C – Special Service Tools.....	561

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## Foreword

Navistar, Inc. is committed to continuous research and development to improve products and introduce technological advances. Procedures, specifications, and parts defined in published technical service literature may be altered.

This *Engine Service Manual* provides a general sequence of procedures for out-of-chassis engine overhaul (removal, inspection, and installation). For in-chassis service of parts and assemblies, the sequence may vary.

**NOTE: Photo illustrations identify specific parts or assemblies that support text and procedures; other areas in a photo illustration may not be exact.**

See vehicle manuals and Technical Service Information (TSI) bulletins for additional information.

MaxxForce<sup>®</sup> DT, 9, and 10 *Engine Operations and Maintenance Manual*

MaxxForce<sup>®</sup> DT, 9, and 10 *Engine Service Manual*

MaxxForce<sup>®</sup> DT, 9, and 10 *Engine Diagnostic Manual*

MaxxForce<sup>®</sup> *Diagnostic Form*

MaxxForce<sup>®</sup> *Electronic Control System Form*

Technical Service Literature is revised periodically. If a technical publication is ordered, the latest revision will be supplied.

**NOTE: To order technical service literature, contact your International<sup>®</sup> dealer.**

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## Service Diagnosis

Service diagnosis is an investigative procedure that must be followed to find and correct an engine application problem or an engine problem.

If the problem is engine application, see specific vehicle manuals for further diagnostic information.

If the problem is the engine, see specific *Engine Diagnostic Manual* for further diagnostic information.

### Prerequisites for Effective Diagnosis

- Availability of gauges, diagnostic test equipment, and diagnostic software.
- Availability of current information for engine application and engine systems.

- Knowledge of the principles of operation for engine application and engine systems.
- Knowledge to understand and do procedures in diagnostic and service publications.

### Technical Service Literature required for Effective Diagnosis

- *Engine Service Manual*
  - *Engine Diagnostic Manual*
  - *Diagnostics Forms*
  - *Electronic Control Systems Diagnostics Forms*
  - Service Bulletins
-

## Safety Information

This manual provides general and specific maintenance procedures essential for reliable engine operation and your safety. Since many variations in procedures, tools, and service parts are involved, advice for all possible safety conditions and hazards cannot be stated.

Read safety instructions before doing any service and test procedures for the engine or vehicle. See related application manuals for more information.

Obey Safety Instructions, Warnings, Cautions, and Notes in this manual. Not following warnings, cautions, and notes can lead to injury, death or damage to the engine or vehicle.

### Safety Terminology

Three terms are used to stress your safety and safe operation of the engine: Warning, Caution, and Note

**Warning:** A warning describes actions necessary to prevent or eliminate conditions, hazards, and unsafe practices that can cause personal injury or death.

**Caution:** A caution describes actions necessary to prevent or eliminate conditions that can cause damage to the engine or vehicle.

**Note:** A note describes actions necessary for correct, efficient engine operation.

### Safety Instructions

#### Work Area

- Keep work area clean, dry, and organized.
- Keep tools and parts off the floor.
- Make sure the work area is ventilated and well lit.
- Make sure a First Aid Kit is available.

#### Safety Equipment

- Use correct lifting devices.
- Use safety blocks and stands.

#### Protective Measures

- Wear protective safety glasses and shoes.
- Wear correct hearing protection.
- Wear cotton work clothing.
- Wear sleeved heat protective gloves.

- Do not wear rings, watches or other jewelry.
- Restrain long hair.

#### Vehicle

- Shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.
- Clear the area before starting the engine.

#### Engine

- The engine should be operated or serviced only by qualified individuals.
- Provide necessary ventilation when operating engine in a closed area.
- Keep combustible material away from engine exhaust system and exhaust manifolds.
- Install all shields, guards, and access covers before operating engine.
- Do not run engine with unprotected air inlets or exhaust openings. If unavoidable for service reasons, put protective screens over all openings before servicing engine.
- Shut engine off and relieve all pressure in the system before removing panels, housing covers, and caps.
- If an engine is not safe to operate, tag the engine and ignition key.

#### Fire Prevention

- Make sure charged fire extinguishers are in the work area.

**NOTE: Check the classification of each fire extinguisher to ensure that the following fire types can be extinguished.**

1. Type A — Wood, paper, textiles, and rubbish
2. Type B — Flammable liquids
3. Type C — Electrical equipment

#### Batteries

- Always disconnect the main negative battery cable first.
- Always connect the main negative battery cable last.
- Avoid leaning over batteries.

- Protect your eyes.
- Do not expose batteries to flames or sparks.
- Do not smoke in workplace.

**Compressed Air**

- Use an OSHA approved blow gun rated at 207 kPa (30 psi).
- Limit air pressure to 207 kPa (30 psi).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in the work area.
- Do not direct compressed air at body or clothing.

**Tools**

- Make sure all tools are in good condition.
- Make sure all standard electrical tools are grounded.

- Check for frayed or damaged power cords before using power tools.

**Fluids Under Pressure**

- Use extreme caution when working on systems under pressure.
- Follow approved procedures only.

**Fuel**

- Do not over fill the fuel tank. Over fill creates a fire hazard.
- Do not smoke in the work area.
- Do not refuel the tank when the engine is running.

**Removal of Tools, Parts, and Equipment**

- Reinstall all safety guards, shields, and covers after servicing the engine.
  - Make sure all tools, parts, and service equipment are removed from the engine and vehicle after all work is done.
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## Table of Contents

Engine Identification.....	7
Engine Serial Number.....	7
Engine Emission Label.....	7
Engine Accessory Labels.....	7
Engine Description.....	8
Standard Features.....	9
Optional Features.....	10
Chassis Mounted Features.....	10
Engine Component Locations (245 hp and above).....	11
Air Management System (AMS).....	16
Air Flow – Pre Combustion.....	17
Air Flow – Post Combustion.....	17
Air Management Components.....	17
Turbochargers.....	17
Interstage Cooler (ISC).....	18
High-pressure Charge Air Cooler (HPCAC).....	18
Turbocharger 2 Wastegate Control (TC2WC) Valve.....	19
Exhaust Gas Recirculation (EGR) System.....	20
Crankcase Ventilation System.....	22
Aftertreatment (AFT) System.....	23
Fuel Management System.....	26
ICP System.....	27
High-Pressure Oil Flow.....	28
ICP Closed Loop System.....	28
ICP Control System.....	29
Fuel Injector.....	30
Fuel Supply System.....	32
Fuel Supply System Flow.....	33
Engine Lubrication System.....	36
Oil Flow.....	37
Engine Cooling System.....	39
Cooling System Description.....	39
Cooling System Components.....	40
Coolant Heater (optional).....	40
Thermostat Operation.....	40
Low Temperature Radiator (LTR) Thermostat Operation.....	42
Electronic Control System.....	43
Electronic Control System Components.....	43
Operation and Function.....	44
Reference Voltage (VREF).....	44

---

Microprocessor.....	44
Actuator Control.....	44
Actuators.....	44
Exhaust Gas Recirculation (EGR) Valve.....	44
Intake Air Heater (IAH) Relay.....	44
Engine Throttle Valve (ETV) and Position Sensor.....	44
Turbocharger 2 Wastegate Control (TC2WC) valve (turbocharger wastegate actuator)...	45
Exhaust Back Pressure Valve (EBPV).....	45
Engine Compression Brake (ECB) valve.....	45
Injection Pressure Regulator (IPR) valve.....	45
Engine and Vehicle Sensors.....	46
Temperature Sensors.....	46
Variable Capacitance Sensors.....	47
Magnetic Pickup Sensors.....	48
High-Pressure Sensors.....	49
Potentiometer.....	50
Switches.....	51
Engine Throttle Valve Control System.....	52
Exhaust and Engine Brake System.....	53
Exhaust Brake.....	53
Engine Brake.....	54
Operation.....	55
Operation Modes.....	56

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## Engine Identification

### Engine Serial Number

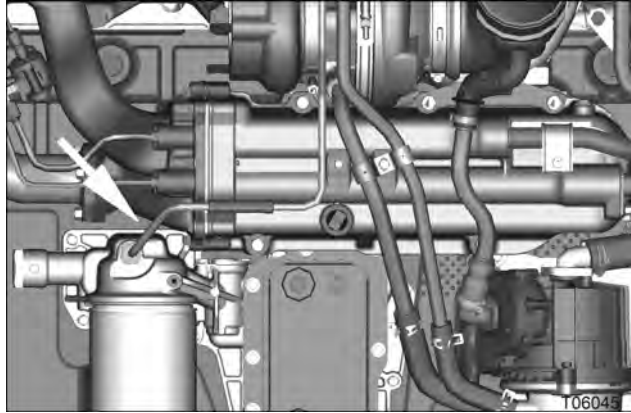


Figure 1 Engine Serial Number

The engine serial number is in two locations:

- Stamped on the right side of the crankcase, just above the oil filter header
- On the engine emission label on the valve cover

### Engine Serial Number Examples

MaxxForce® DT: 466HM2UXXXXXXXX

MaxxForce® 9 and 10: 570HM2UXXXXXXXX

### Engine Serial Number Codes

**466** – Engine displacement

**570** – Engine displacement

**H** – Diesel, turbocharged, Charge Air Cooler (CAC) and electronically controlled

**M2** – Motor truck

**U** – United States

**7 digit suffix** – Engine serial number sequence beginning with 3300001

### Engine Emission Label



Figure 2 U.S. Environmental Protection Agency (EPA) Exhaust Emission Label (Example)

The U.S. Environmental Protection Agency (EPA) exhaust emission label is attached on top of the valve cover. The EPA label typically includes the following:

- Model year
- Engine family, model, and displacement
- Advertised brake horsepower and torque rating
- Emission family and control systems
- Valve lash specifications
- Engine serial number
- EPA, EURO, and reserved fields for specific applications

### Engine Accessory Labels

The following engine accessories may have manufacturer's labels or identification plates:

- Air compressor
- Air conditioning compressor
- Alternator

- Cooling fan clutch
- Power steering pump
- Starter motor

### Engine Description

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#### MaxxForce<sup>®</sup> DT, 9, and 10 Diesel Engines

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Engine configuration	4 stroke, inline six cylinder diesel
MaxxForce <sup>®</sup> DT displacement	7.6 L (466 in <sup>3</sup> )
MaxxForce <sup>®</sup> 9 and 10 displacement	9.3 L (570 in <sup>3</sup> )
Bore (sleeve diameter)	116.6 mm (4.59 in)
Stroke	
• MaxxForce <sup>®</sup> DT	119 mm (4.68 in)
• MaxxForce <sup>®</sup> 9 and 10	146 mm (5.75 in)
Compression ratio	
• MaxxForce <sup>®</sup> DT	16.9 : 1
• MaxxForce <sup>®</sup> 9 and 10	16.5 : 1
Aspiration	Dual turbocharged and charge air cooled
Advertised brake horsepower @ rpm	See EPA exhaust emission label.
Peak torque @ rpm	See EPA exhaust emission label.
Engine rotation (facing flywheel)	Counterclockwise
Combustion system	Direct injection turbocharged
Fuel system	Electro-hydraulic injection
Total engine weight (oil and accessories)	
• MaxxForce <sup>®</sup> DT	824 kg (1816 lbs)
• MaxxForce <sup>®</sup> 9 and 10	845 kg (1864 lbs)
Cooling system capacity (engine only)	12.8 L (13.5 qts US)
Lube system capacity (including filter)	28 L (30 qts US)
Lube system capacity (overhaul only, with filter)	32 L (34 qts US)
Firing order	1-5-3-6-2-4

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### Standard Features

MaxxForce<sup>®</sup> DT, 9, and 10 diesel engines are designed for increased durability, reliability, and ease of maintenance.

The cylinder head has four valves per cylinder with centrally located fuel injectors directing fuel over the pistons. This configuration provides improved performance and reduces emissions.

The camshaft is supported by four insert bushings pressed into the crankcase. The camshaft gear is driven from the front of the engine. A thrust flange is located between the camshaft and the drive gear. The overhead valve train includes mechanical roller lifters, push rods, rocker arms, and dual valves that open using a valve bridge.

MaxxForce<sup>®</sup> DT engines use one-piece aluminum alloy pistons. MaxxForce<sup>®</sup> 9 and 10 engines use one-piece steel pistons. All pistons have zero pin offset and centered combustion bowls; therefore, pistons can be installed safely without orientation: there is NO front-of-engine arrow or "CAMSIDE" marking on the piston crown to indicate a necessary piston direction.

The one piece crankcase uses replaceable wet cylinder sleeves that are sealed by a single crevice seal ring. Some applications include a crankcase ladder which is designed to support heavier loads and reduce engine noise.

The crankshaft has seven main bearings with fore and aft thrust controlled at the rear bearing. One fractured cap connecting rod is attached at each crankshaft journal. A piston pin moves freely inside the connecting rod and piston. Piston pin retaining rings secure the piston pin in the piston. The rear oil seal carrier is part of the flywheel housing.

A lube oil pump is mounted on the front cover and is driven by the crankshaft. Pressurized oil is supplied to engine components and the high-pressure injection system. All MaxxForce<sup>®</sup> DT, 9, and 10 engines use an engine oil cooler and spin-on engine oil filter.

The coolant supply housing serves as the mounting bracket for the refrigerant compressor. Mounting capabilities for a dual refrigerant compressor are available as an option. The pad mounting design of the alternator and refrigerant compressor brackets provide easy removal and improved durability.

The electric low-pressure fuel supply pump draws fuel from the fuel tank through the fuel filter assembly. The assembly includes a strainer, filter, drain valve, Water in Fuel (WIF) sensor, and Fuel Delivery Pressure (FDP) sensor. If equipped, an optional fuel heater element is installed in the fuel filter assembly. Conditioned fuel is pumped through the intake manifold and cylinder head to the fuel injectors.

The WIF sensor detects water in the fuel system. When water reaches the level of the sensor located in the fuel filter assembly, the instrument panel's amber FUEL FILTER lamp will illuminate. The collected water must be removed immediately. Water is drained by opening the drain valve on the fuel filter assembly.

The fuel injection system is electro-hydraulic. The system includes an under-valve-cover high-pressure oil manifold, fuel injectors, and a high-pressure oil pump. The injectors are installed in the cylinder head, under the high-pressure oil manifold.

MaxxForce<sup>®</sup> DT, 9, and 10 engines use dual turbochargers with an air-to-air High Pressure Charge Air Cooler (HPCAC) after the second stage. An interstage cooler is used after the first stage for applications with 245 hp and above.

The Inlet Air Heater (IAH) system warms the incoming air to aid cold engine starting and to reduce white smoke and engine noise. The IAH system will initially illuminate the WAIT TO START lamp located on the instrument panel. When the lamp turns off, the engine can be started.

The Exhaust Gas Recirculation (EGR) system circulates cooled exhaust into the intake air stream in the intake manifold. This cools the combustion process and reduces the formation of NO<sub>x</sub> engine emissions.

A closed crankcase breather system uses an engine mounted oil separator to return oil to the crankcase and vent crankcase pressure into the intake system.

The Down Stream Injection (DSI) system aides in controlling emissions by injecting fuel into the exhaust stream. The fuel causes an exothermic reaction which increases the temperature of the exhaust gas. This increase in temperature allows for more efficient conversion of soot into ash within the Diesel Particulate Filter (DPF). Along with DSI, the Diesel Oxidation Catalyst (DOC) aids in creating the required exothermic reaction. DSI consists of the Doser Control Unit (DCU), Downstream Injection

(DSI) assembly, hydrocarbon injector assembly, fuel lines, and coolant lines. The Electronic Control Module (ECM) communicates with the DCU to control the timing and quantity of fuel sprayed from the hydrocarbon injector assembly. The ECM signals the exhaust brake valve assembly to control the position of the exhaust back pressure valve to increase or decrease the exhaust gas back pressure and temperature to allow the DOC and DPF to function efficiently.

The exhaust back pressure valve acts as an aftertreatment device to manage exhaust temperature. The resulting rise in back pressure, increases exhaust temperature.

### Optional Features

Optional features include the following:

- Air compressor
- Hydraulic pump
- Engine brake
- Exhaust brake

An air compressor is available for applications that require air brakes or air suspension.

A hydraulic power steering pump can be used with or without the air compressor.

Engine brake and exhaust brake systems are available for applications that could benefit from added speed reduction capability.

### Optional Cold Climate Features

Optional cold climate features include the following:

- Oil pan heater

- Coolant heater
- Fuel heater

All three heaters use an electric element to warm engine fluids in cold weather.

The oil pan heater warms engine oil to ensure optimum oil flow.

The coolant heater warms engine coolant surrounding the cylinders. Warmed engine coolant aids in cold engine start-up and performance.

The fuel heater is installed in the fuel filter assembly and warms the supply fuel. Warmed supply fuel prevents waxing, and improves performance and fuel economy during cold weather start-up.

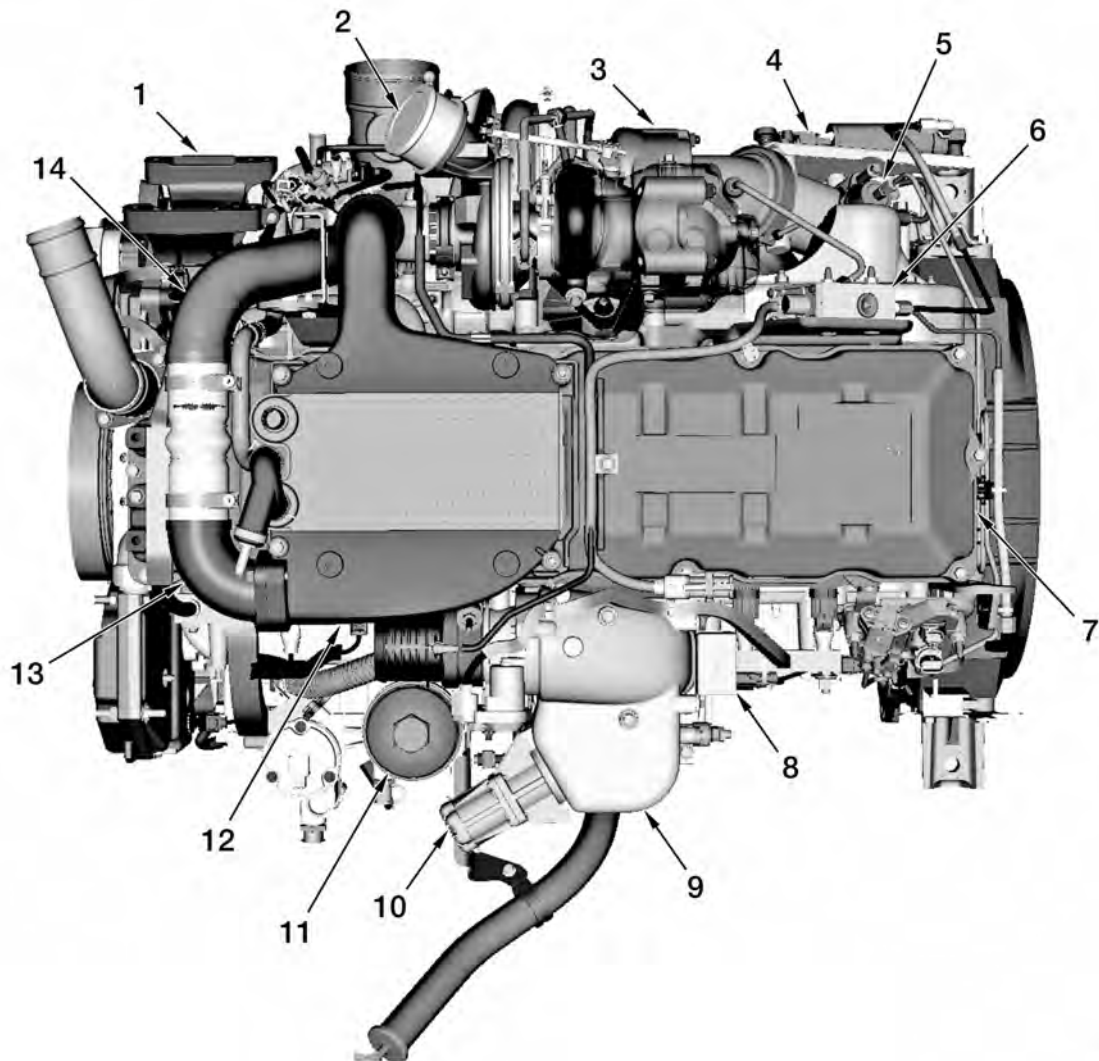
### Chassis Mounted Features

A Charge Air Cooler (CAC) is an air-to-air heat exchanger, which increases the density of the air charge.

The Aftertreatment System, part of the larger exhaust system, processes engine exhaust to meet tailpipe emission requirements.

- The Pre-Diesel Oxidation Catalyst (PDOC) aids in creating the required exothermic reaction before the exhaust gas enters the Diesel Oxidation Catalyst (DOC).
  - The Diesel Oxidation Catalyst (DOC) oxidizes carbon monoxide, hydrocarbons, and small amounts of nitrogen oxide in the exhaust stream.
  - The Diesel Particulate Filter (DPF) captures and oxidizes particulates in the exhaust stream and stores non-combustible ash.
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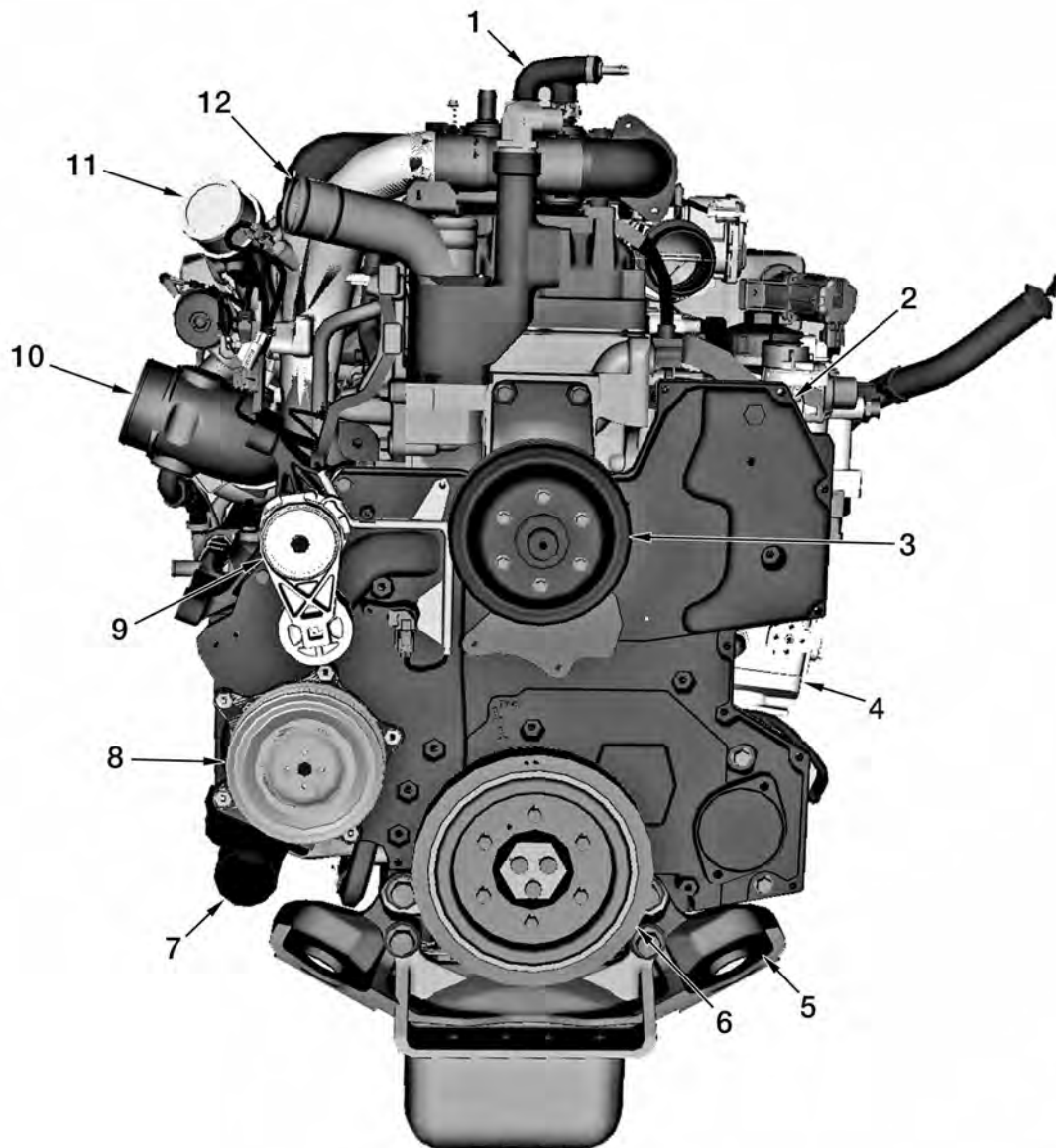
## Engine Component Locations (245 hp and above)



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Figure 3 Component Location – Top

- |                                      |   |  |
|--------------------------------------|---|--|
| 1. Alternator bracket                | 7. Valve cover                            | 12. Interstage cooler (245 hp and above)             |
| 2. High-pressure turbocharger outlet | 8. Intake Air Heater (IAH) relay assembly | 13. Interstage cooler inlet elbow (245 hp and above) |
| 3. Low-pressure turbocharger         | 9. Air and EGR mixer duct                 | 14. Interstage cooler inlet duct (245 hp and above)  |
| 4. Exhaust back pressure valve       | 10. EGR valve                             |  |
| 5. Hydrocarbon injector assembly     | 11. Fuel filter cap                       |  |
| 6. Exhaust brake valve assembly      |   |  |



T35053

**Figure 4 Component Location – Front**

- |                                  |                              |                                       |
|----------------------------------|------------------------------|---------------------------------------|
| 1. Deaeration hose elbow         | 6. Vibration damper assembly | 11. High-pressure turbocharger outlet |
| 2. Front cover                   | 7. Water inlet elbow         | 12. Water outlet tube assembly        |
| 3. Fan drive pulley              | 8. Water pump pulley         |                                       |
| 4. Air compressor assembly       | 9. Automatic belt tensioner  |                                       |
| 5. Front engine mounting bracket | 10. Turbo air inlet duct     |                                       |