ENGINE SERVICE MANUAL

MaxxForce® 15L Diesel Engine

Navistar, Inc.

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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.

Technical Service Literature

1172042	MaxxForce® 15 *Engine Operation and Maintenance Manual*
0000001746	MaxxForce® 15 *Engine Service Manual*
EGES-515	MaxxForce® 15 *Engine Diagnostic Manual*
EGED-520	MaxxForce® 15 Hard Start and No Start Form
EGED-525	MaxxForce® 15 Engine Wiring Schematic Form
EGED-535	MaxxForce® 15 Performance Diagnostic Form

Technical Service Literature is revised periodically and mailed automatically to “Revision Service” subscribers. If a technical publication is ordered, the latest revision will be supplied.

NOTE: To order technical service literature, contact your MaxxForce® dealer.

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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Engine Identification

Engine Serial Number

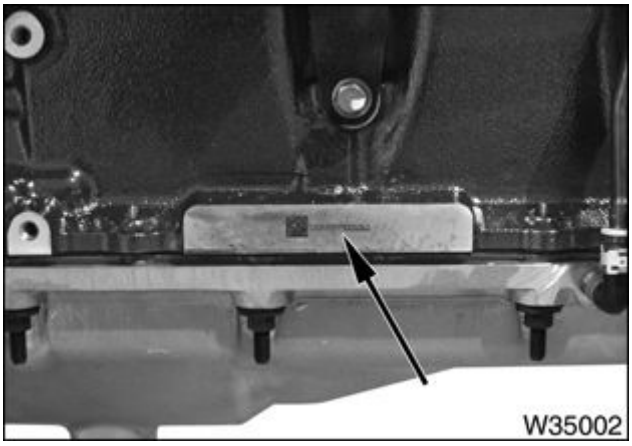

Figure 1 Engine serial number location

The engine serial number is located on the lower left side of the crankcase above the oil pan flange.

Engine Serial Number Example

152HM2YXXXXXXX

Engine Serial Number Codes

15.2 – Engine displacement
H – Diesel, turbocharged, Charge Air Cooler (CAC) and electronically controlled
M2 – Motor truck
Y – United States, Huntsville
7 digit suffix – Engine serial number sequence

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 on top of the valve cover (front left side). 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, OBD and reserved fields for specific applications

Engine Accessory Labels and Identification Plates

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

- Air compressor
- Air conditioning compressor
- Alternator
- Engine Control Module (ECM)
- Cooling fan clutch
- High-pressure fuel pump
- Power steering pump
- Starter motor
- Turbochargers

Engine Specifications

MaxxForce® 15 Diesel Engine	
Engine Configuration	4 stroke, inline six cylinder diesel
Advertised brake horsepower @ rpm	See EPA exhaust emission label
Peak torque @ rpm	See EPA exhaust emission label
Displacement	15.2 L (928 in^3)
Compression ratio	16.0:1
Stroke	171.5 mm (6.75 in)
Bore (sleeve diameter)	137.2 mm (5.40 in)
Engine weight (dry, without trim or accessories)	1 429 kg (3,150 lbs)
Firing order	1-5-3-6-2-4
Engine rotation (facing flywheel)	Counterclockwise
Aspiration	Dual turbocharged and Charge Air Cooled (CAC)
Combustion system	Direct injection turbocharged
Fuel system	High-pressure common rail
Lube system refill capacity (including filter)	
• Gravity drain from right rear and bottom front sump plugs	38 L (40 qts)
• Suction oil recovery option	34.5 L (36.5 qts)
Engine lubrication oil pressure at 99°C (210°F)	
• 600 rpm	Minimum 83 kPa (12 psi)
• 1,600 rpm	275 - 550 kPa (40 - 80 psi)
Idle speed (no load)	600 rpm, nominal
Thermostat transition range (start open — full open)	88°C - 103°C (190°F - 217°F)

Engine Description

The MaxxForce® 15 diesel engine has been designed for increased durability and reliability.

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 overhead camshaft is supported by seven bearings in the cylinder head. The camshaft gear is driven from the front of the engine. The overhead valve train includes roller rocker arms and dual valves that open using a valve bridge.

The MaxxForce® 15 engine uses one piece forged steel pistons. Cooling jet cutouts and feed holes are placed on both sides of the pistons. Pistons may be installed in either direction however pistons are originally installed with casting bump on bottom of pin boss toward rear of engine.

The one piece crankcase can withstand high-pressure loads during operation. The crankcase uses replaceable wet cylinder sleeves that are sealed by a system of three O-rings.

Sound shields are strategically placed on the engine to reduce noise.

The crankshaft has seven main bearings with fore and aft thrust controlled at the forth bearing. One connecting rod is attached at each crankshaft journal. The 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, and the front oil seal carrier is part of the front cover.

An oil pump is mounted within the oil pan to the bottom of the crankcase behind the front cover and is driven by the crankshaft. Pressurized oil is supplied to internal engine components, air compressor, power steering pump and turbochargers. All MaxxForce® 15 engines use an engine oil cooler and a spin-on can style engine oil filter element.

Fuel is drawn from the fuel tank through the frame-mounted fuel/water filter separator. A hand operated primer pump is located either on top of or next to the frame-mounted fuel/water separator. The fuel is then routed into the fuel pump and to the engine-mounted fuel filter. Conditioned fuel is then pumped to the fuel injectors.

The fuel injection system is direct common rail. The system includes a high-pressure fuel pump, fuel rail and fuel injectors. The injectors are installed in the cylinder head under the valve cover.

The MaxxForce® 15 engine uses dual turbochargers with an air-to-liquid Interstage Cooler (ISC) between turbochargers, and a chassis-mounted air-to-air Charge Air Cooler (CAC) to reduce air temperature before entering the intake.

The cold start assist system warms the incoming air supply before, during, and a short period after cranking to aid cold engine starting and reduce white smoke during warm-up.

The Exhaust Gas Recirculation (EGR) system circulates cooled exhaust into the intake air stream in the mixing duct. This cools the combustion process and reduces the formation of Nitrogen Oxides (NO_x) engine emissions. The EGR cooler assembly cools the exhaust gas in two stages.

An open crankcase breather system uses an oil separator to return oil to the crankcase and vent the crankcase gasses to the atmosphere. The oil separator is mounted on the cylinder head.

The engine brake is standard on the MaxxForce® 15. The engine brake is a compression release system that provides additional vehicle braking performance. The operator can control the engine brake for different operating conditions.

Optional Features

An oil pan heater and a coolant heater are available as optional cold climate features. Both heaters use an electric element to warm engine fluids in cold weather conditions.

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

The coolant heater warms the engine coolant surrounding the cylinders. Warmed engine coolant increases fuel economy and aids start-up in cold weather conditions.

Chassis Mounted Features

The aftertreatment system, part of the larger exhaust system, processes engine exhaust so that it meets tailpipe emission requirements. Most of the aftertreatment system is mounted on the chassis.

- The Pre-Diesel Oxidation Catalyst (PDOC) and Diesel Oxidation Catalyst (DOC) which is mounted on the chassis, oxidizes hydrocarbons and carbon monoxide, provides heat for exhaust system warm-up, and aids in temperature management for the Diesel Particulate Filter (DPF) for passive DPF regeneration.
- The DPF temporarily stores carbon-based particulates then oxidizes the particulates and stores the noncombustible ash.

The High-Pressure Charge Air Cooler (HPCAC) mounted on the vehicle cooling module, is connected between the outlet of the high-pressure turbocharger and the inlet to the engine throttle valve assembly. The HPCAC is an air-to-air cooler that uses ambient air to cool pressurized air before it enters the engine.

Engine Component Locations

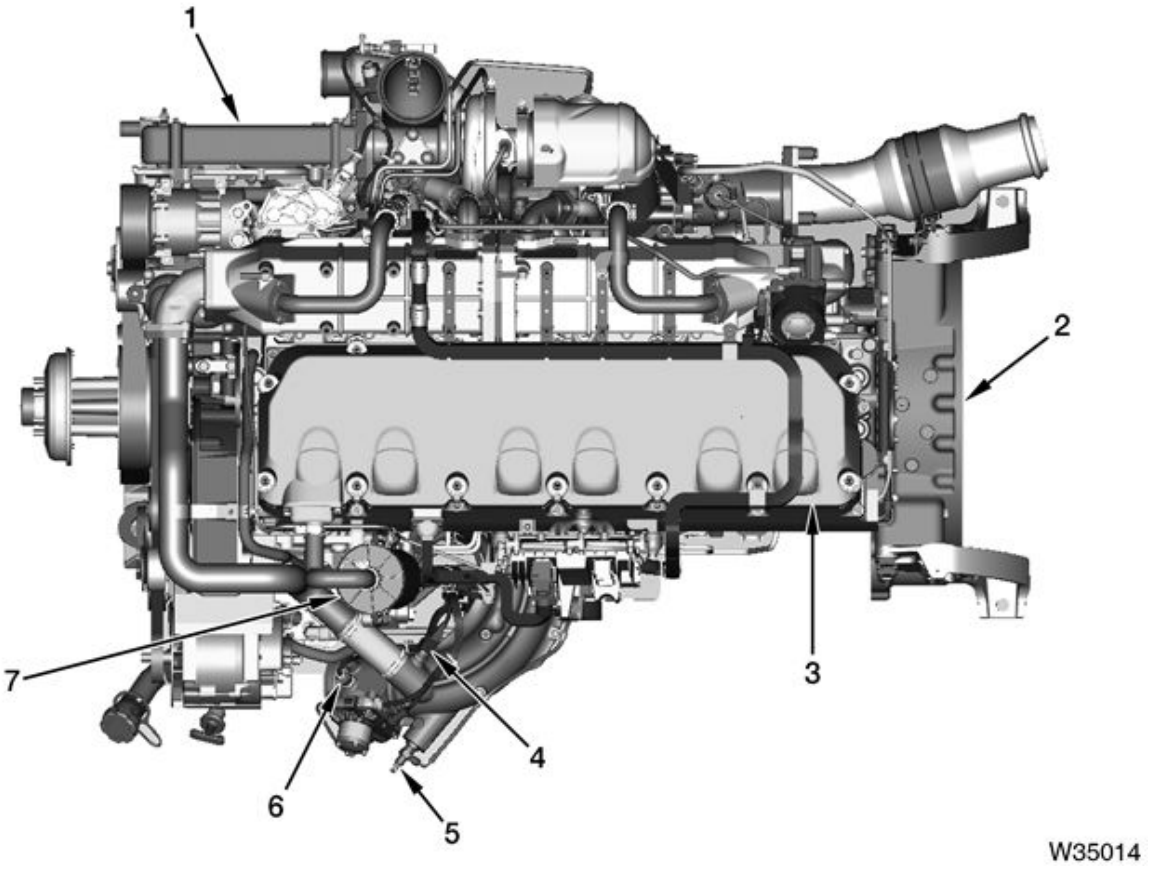

Figure 3 Component location – top

1. Turbocharger interstage cooler assembly
2. Flywheel housing assembly
3. Valve cover assembly
4. Exhaust gas temperature sensor
5. Cold Start Fuel Igniter (CSFI)
6. Charge Air Cooler Outlet Temperature (CACOT) sensor
7. Breather filter assembly

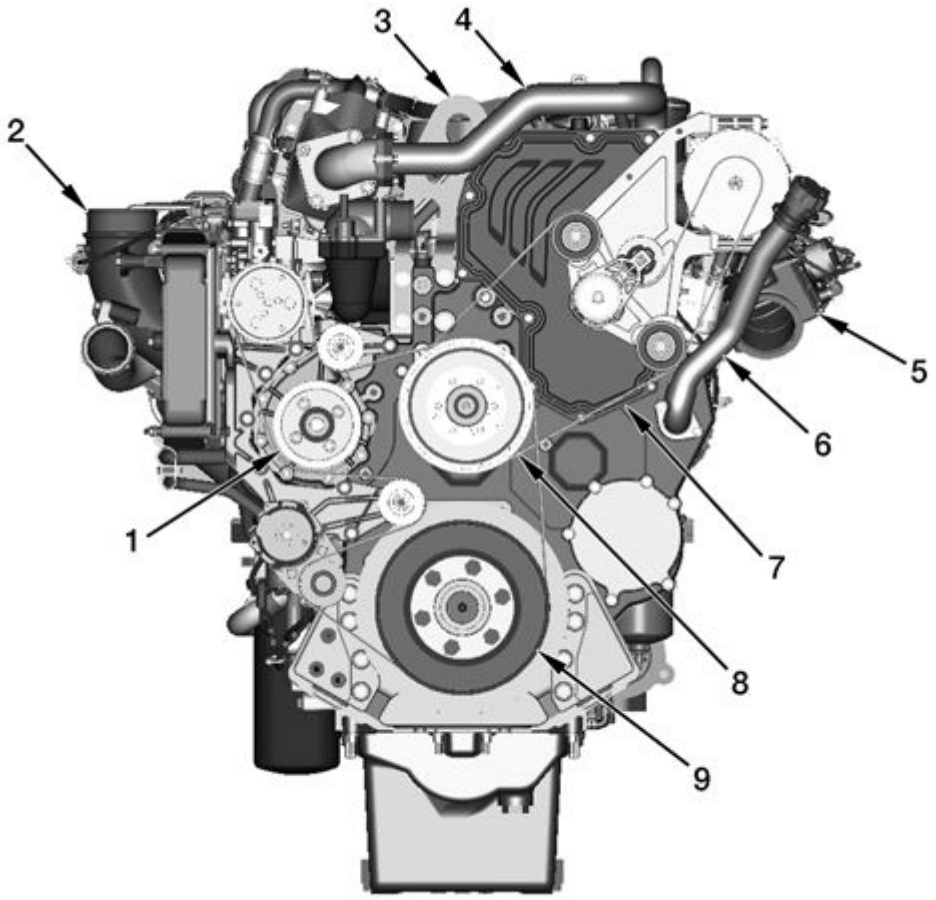

Figure 4 Component location – front

1. Water pump pulley
2. Air inlet duct (turbocharger)
3. Front lifting eye
4. EGR crossover tube assembly
5. Engine throttle valve assembly
6. Oil filler pipe assembly
7. Camshaft gear cover
8. Low mount fan drive
9. Damper (crankshaft)

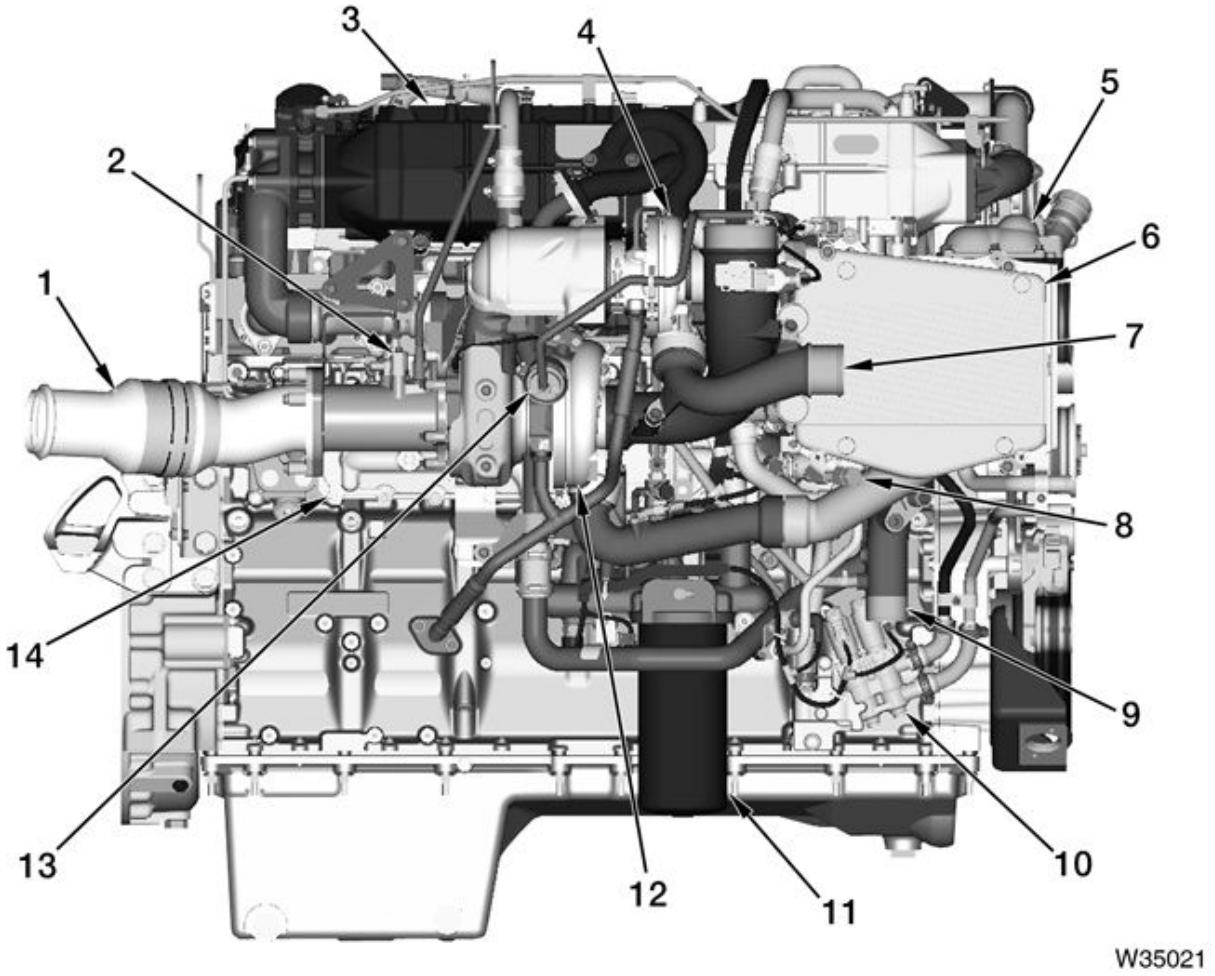

Figure 5 Component location – right

1. Pre-Diesel Oxidation Catalyst (PDOC) assembly
2. Fuel doser
3. Exhaust Gas Recirculation (EGR) cooler assembly
4. High-Pressure (HP) turbocharger assembly
5. Thermostat housing
6. Interstage cooler assembly
7. High-pressure turbocharger compressor outlet
8. Oil supply tube for secondary filtration (to soot filter)
9. Coolant inlet (from radiator)
10. Coolant Control Valve (CCV) assembly
11. Oil filter
12. Low-Pressure (LP) turbocharger assembly
13. High-pressure turbocharger wastegate actuator
14. Engine oil cooler assembly

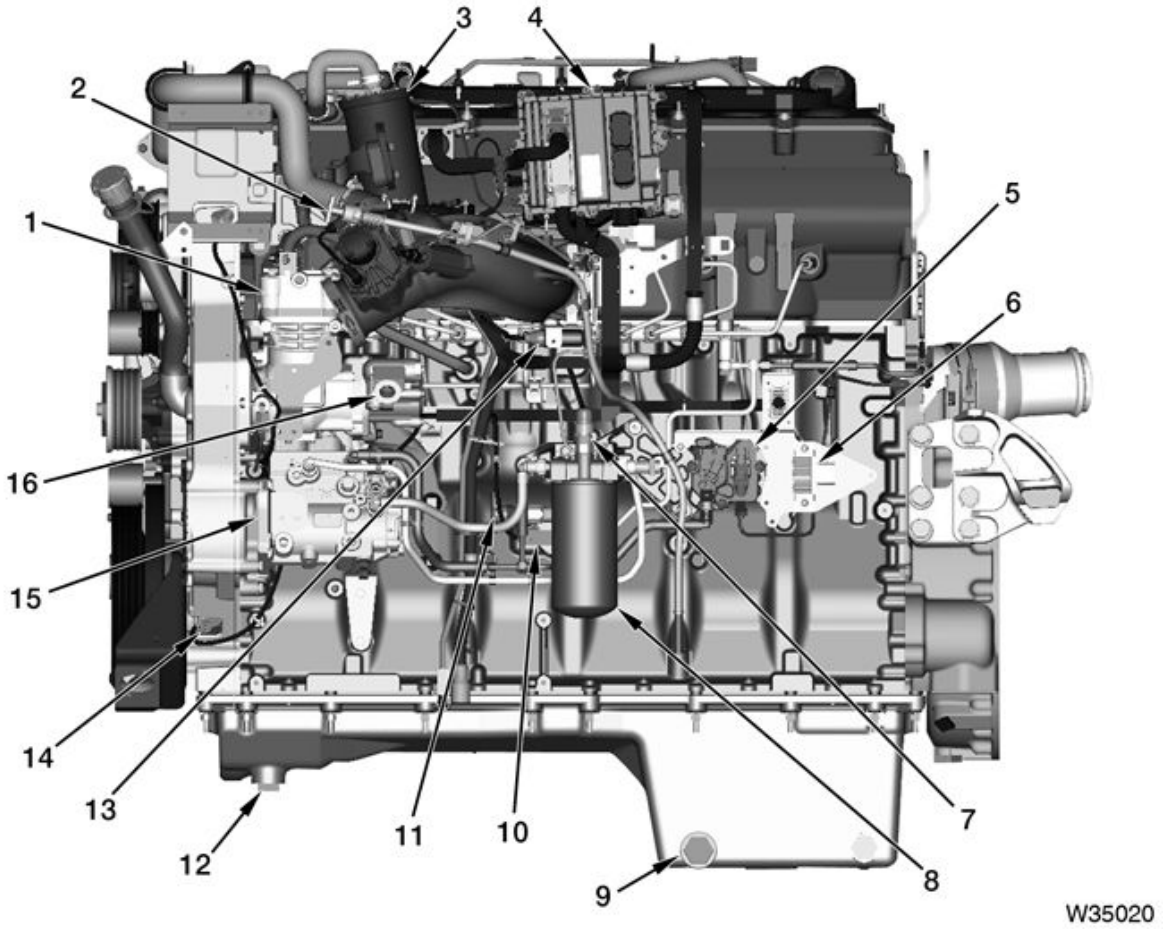

Figure 6 Component location – left

1. Air compressor
2. Oil level gauge assembly
3. Crankcase breather
4. Engine Control Module (ECM)
5. Down Stream Injection (DSI) assembly
6. 12V relay (for cold start assist solenoid)
7. Fuel Delivery Pressure (FDP) sensor
8. Fuel filter
9. Oil pan drain plug (rear sump)
10. Crankcase Pressure (CPS) sensor
11. Engine Oil Pressure (EOP) sensor
12. Oil pan drain plug (front sump)
13. Cold Start Fuel Solenoid (CSFS)
14. 5 mm 60 degree speed sensor (crankshaft position sensor)
15. High-pressure fuel pump
16. Power steering pump

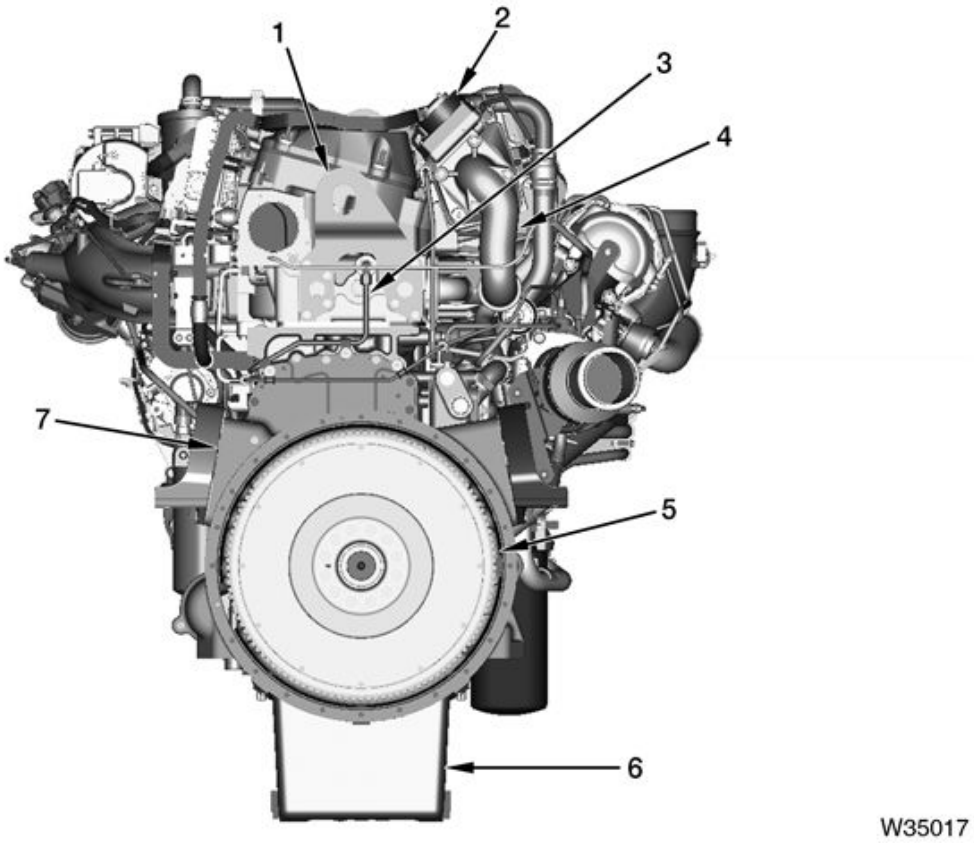

Figure 7 Component location – rear

1. Rear lifting eye
2. Exhaust Gas Recirculation (EGR) valve assembly
3. Fuel return tube assembly
4. EGR cooler supply tube
5. Flywheel
6. Oil pan
7. Flywheel housing

Air Management System (AMS)

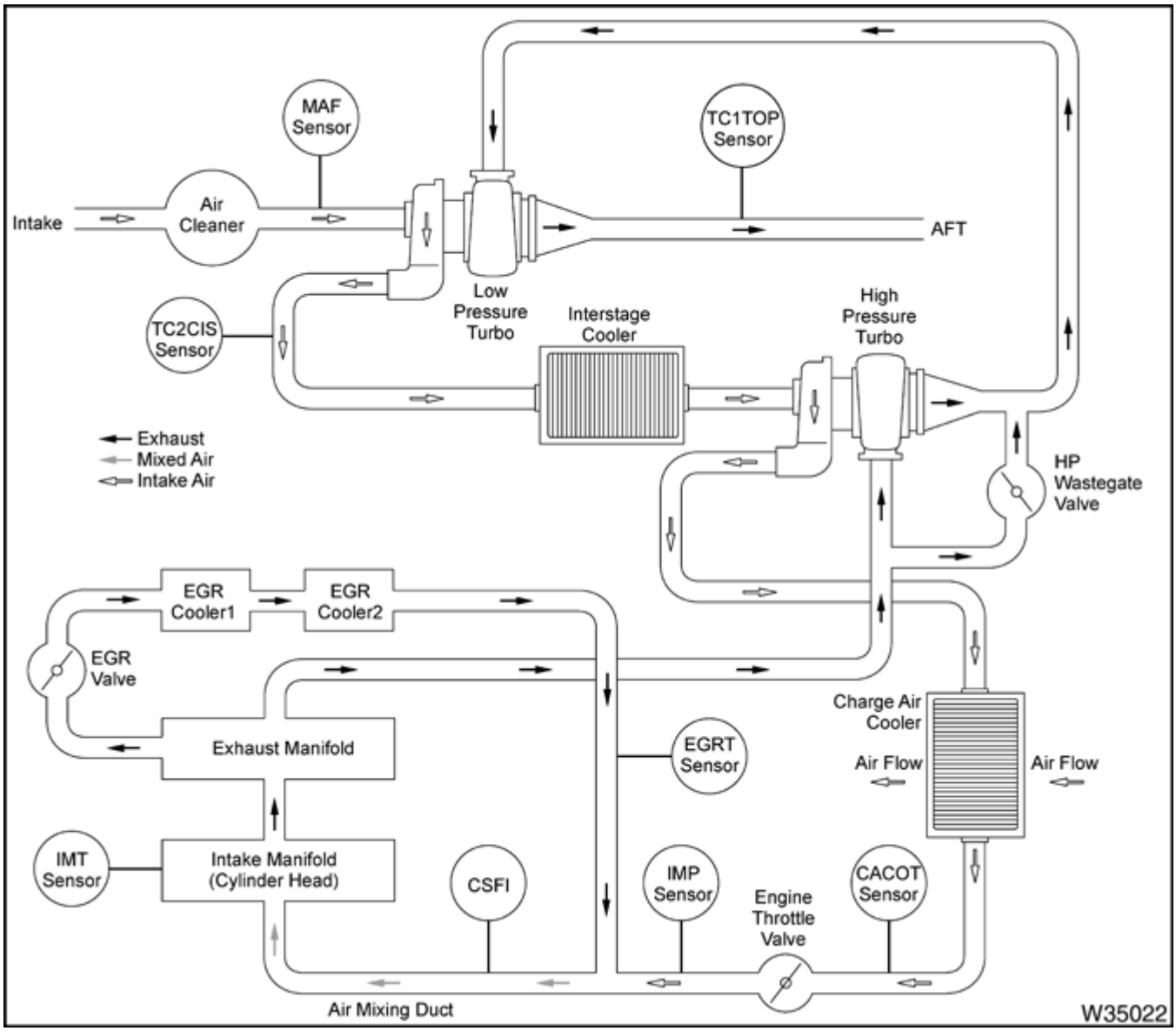

Figure 8 Air Management System (AMS)

Air Flow

Air flows through the air cleaner assembly and enters the low-pressure turbocharger. The low-pressure turbocharger increases the pressure, temperature, and density of the intake air before it enters the Interstage Cooler (ISC). Cooled compressed air flows from the ISC into the high-pressure turbocharger. The high-pressure turbocharger increases the intake air pressure up to 345 kPa (50 psi). The hot compressed air flows into the Charge Air Cooler (CAC) where it is cooled, and then directed to the Engine Throttle Valve (ETV) and mixing duct area of the throttle valve assembly.

If the EGR control valve is open, exhaust gas passes through the EGR system into the mixing duct where it is mixed with the filtered intake air. This mixture flows through the mixing duct into the intake manifold and

cylinder head. The intake manifold is an integral part of the cylinder head casting.

If the EGR control valve is closed, only filtered intake air flows through the ETV, mixing duct, and into the intake manifold.

During cold weather, the Cold Start Fuel Igniter (CSFI) rapidly heats the intake air by injecting and igniting small quantities of fuel into the mixing duct.

After combustion, gases exit through the cylinder head exhaust valves and ports. The exhaust gas is forced through the exhaust manifold where, depending on the EGR valve assembly position, is split between the EGR system and the exit path through the high-pressure turbocharger and low-pressure turbocharger.

The exhaust gases flow from the low-pressure turbocharger through the vehicle aftertreatment system to the exhaust tail pipe.

Air Management Components

Turbochargers

The MaxxForce® 15 engine is equipped with an electronically controlled, pneumatically actuated two stage turbocharging system. This system provides high levels of charge air pressure to improve engine performance and help reduce emissions. Because of its ability to generate very high charge air pressure levels, the system is fitted with an air control valve to control over-boost and surging conditions. The air control valve is supplied compressed air from the vehicle air supply tank. The compressed air flow to the wastegate actuator is electronically controlled by the air control valve based on the Pulse Width Modulated (PWM) signal supplied by the Engine Control Module (ECM). The high and low-pressure turbochargers are installed as an assembly on the exhaust manifold, on the right side of the engine.

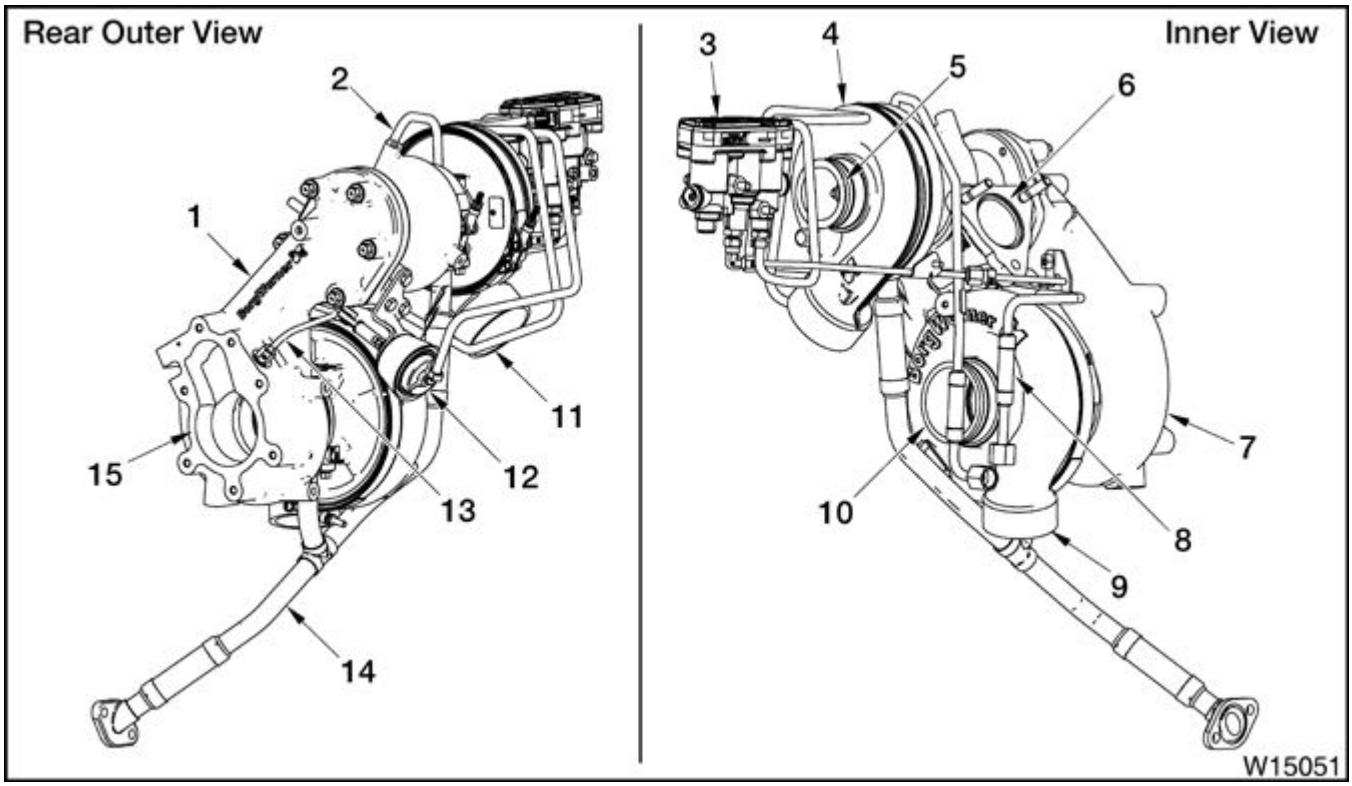

Figure 9 Low and high-pressure turbocharger components

1. Low-pressure turbocharger assembly
2. High-pressure turbocharger oil supply hose
3. Air control valve
4. High-pressure turbocharger assembly
5. High-pressure turbocharger compressor inlet
6. High-pressure turbocharger turbine inlet
7. Low-pressure turbocharger assembly
8. Low-pressure turbocharger oil supply hose
9. Low-pressure turbocharger compressor outlet
10. Low-pressure turbocharger compressor inlet
11. High-pressure turbocharger compressor outlet
12. High-pressure turbocharger wastegate actuator
13. Turbine output pressure tube
14. Turbocharger oil drain tube assembly
15. Low-pressure turbocharger turbine outlet

The low and high-pressure turbochargers are installed in series on the right side of the engine. The high-pressure turbocharger is connected directly to the exhaust manifold through the high-pressure turbine inlet. The turbine input of the low-pressure turbocharger is connected to the turbine outlet of the high-pressure turbocharger. The high-pressure turbocharger is equipped with a wastegate actuator which regulates turbocharger boost by controlling the amount of exhaust gases that pass through the turbine. When boost demand is low, the wastegate opens, allowing part of the exhaust gas flow to bypass the turbine.

Fresh air from the air filter enters the low-pressure compressor where it is compressed and directed into the Interstage Cooler (ISC). Cooled condensed air from the ISC enters the high-pressure compressor, where it is further compressed and directed to the High-Pressure Charge Air Cooler (HPCAC) mounted near the cooling module. Cooled and condensed air then flows directly into the engine throttle valve.

Interstage Cooler (ISC)

The ISC is installed between the low-pressure and the high-pressure turbochargers. The ISC air inlet

is connected to the low-pressure compressor outlet and uses engine coolant to regulate the charge air temperature. The ISC air outlet is connected to the compressor inlet on the high-pressure turbocharger.

High-Pressure Charge Air Cooler (HPCAC)

The HPCAC is installed between the high-pressure turbocharger compressor outlet and the Engine Throttle Valve (ETV). The HPCAC uses ambient air flow to regulate the charge air temperature. The HPCAC air outlet is connected to the ETV body.

Air Control Valve

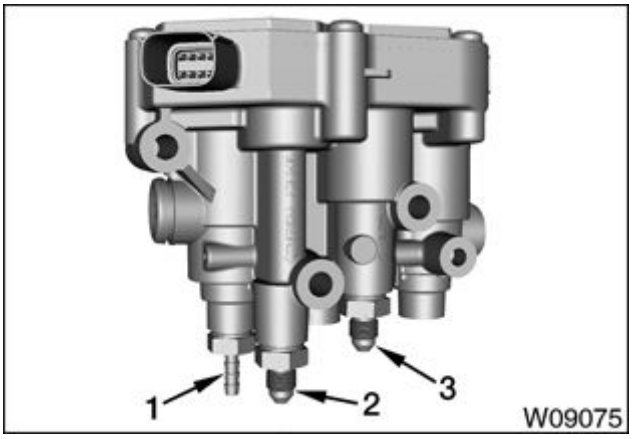

Figure 10 Air control valve

1. To high-pressure turbocharger wastegate actuator
2. Turbocharger 1 Turbine Output Pressure (TC1TOP) input to sensor
3. Compressed regulated air supply from chassis air tank

The air control valve controls air pressure to the high-pressure wastegate actuator based on turbine output pressure from a port on the output of the low-pressure turbocharger. The turbine output pressure sensor is integral to the air control valve. Air pressure to the air control valve is supplied from an air tank mounted on the chassis. The air control valve is controlled by the Engine Control Module (ECM).

The air control valve is normally closed. Thus, with no Pulse Width Modulated (PWM) signal, the air control valve remains closed and no air pressure is supplied to the wastegate actuator on the high-pressure turbocharger. When a decrease in charge air pressure is required, the ECM supplies a PWM ground voltage to the negative side of the wastegate control solenoid. The other side of the wastegate control solenoid is connected to 12V supply voltage. This causes the air control valve to open which supplies air pressure to the wastegate actuator.

The limit values of the PWM signal are between approximately 95%, corresponding to an open air control valve, and 5%, corresponding to a closed air control valve. When the air control valve closes, it interrupts the air supply to the wastegate actuator and at the same time relieves air pressure from the wastegate by allowing it to vent to atmosphere. The wastegate actuator then closes, resulting in increased charge air pressure.