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Foreword

International Truck and Engine Corporation 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 *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 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 International dealer.

Technical Service Literature

1171897R1	International® MaxxForce™ 5 Engine *Operation and Maintenance Manual*
EGES-390	International® MaxxForce™ 5 *Service Manual*
EGES-395	International® MaxxForce™ 5 *Diagnostic Manual*
EGED-410	International® MaxxForce™ 5 Electronic Control Systems Diagnostic Form

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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 and diagnostic test equipment
- 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

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Safety Information

This manual provides general and specific service 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.

Disregard for Safety Instructions, Warnings, Cautions, and Notes in this manual 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

Vehicle

Make sure the vehicle is in neutral, the parking brake is set, and the wheels are blocked before doing any work or diagnostic procedures on the engine or vehicle.

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.

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

Batteries produce highly flammable gas during and after charging.

- 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 open flames or sparks.
- Do not smoke in workplace.

Compressed air

- Use an OSHA approved blow gun rated at 207 kPa (30 psi).
- Limit shop 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.

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Tools

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

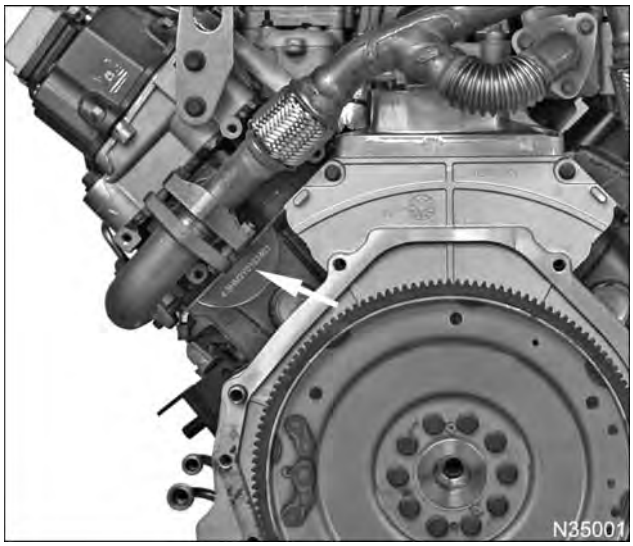

Figure 1 Engine serial number

The engine serial number is stamped on the crankcase pad, on the rear left side below the cylinder head.

Engine Serial Number Example

4.6HM2YXXXXXXX

4.6 – International® MaxxForce™ 5
H – Diesel, turbocharged, air intercooled and electronically controlled
M2 – Motor truck or **U2** power unit and OEM (Sold to original equipment manufacturer)
Y – United States, Huntsville
7 digit suffix – Sequence number

Emission Labels

An Environmental Protection Agency (EPA) Engine Emission Label is issued for the International® MaxxForce™ 5 diesel engine.

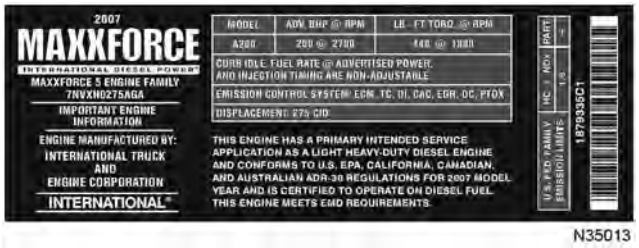

Figure 2 Example of U.S. Environmental Protection Agency (EPA) emission label (50 state)

The EPA exhaust emission label is on top of the crankcase breather, on the left valve cover. The label includes the following:

- Advertised brake horsepower ratings
- Engine model code
- Service applications
- Emission family and control systems
- Year the engine was certified to meet EPA emission standards

Engine Accessories

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

- Air conditioning compressor
- Alternator
- Cooling fan clutch
- Dual turbocharger assembly
- Power steering pump
- Starter motor

Labels or identification plates include information and specifications helpful to vehicle operators and technicians.

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Component Locations

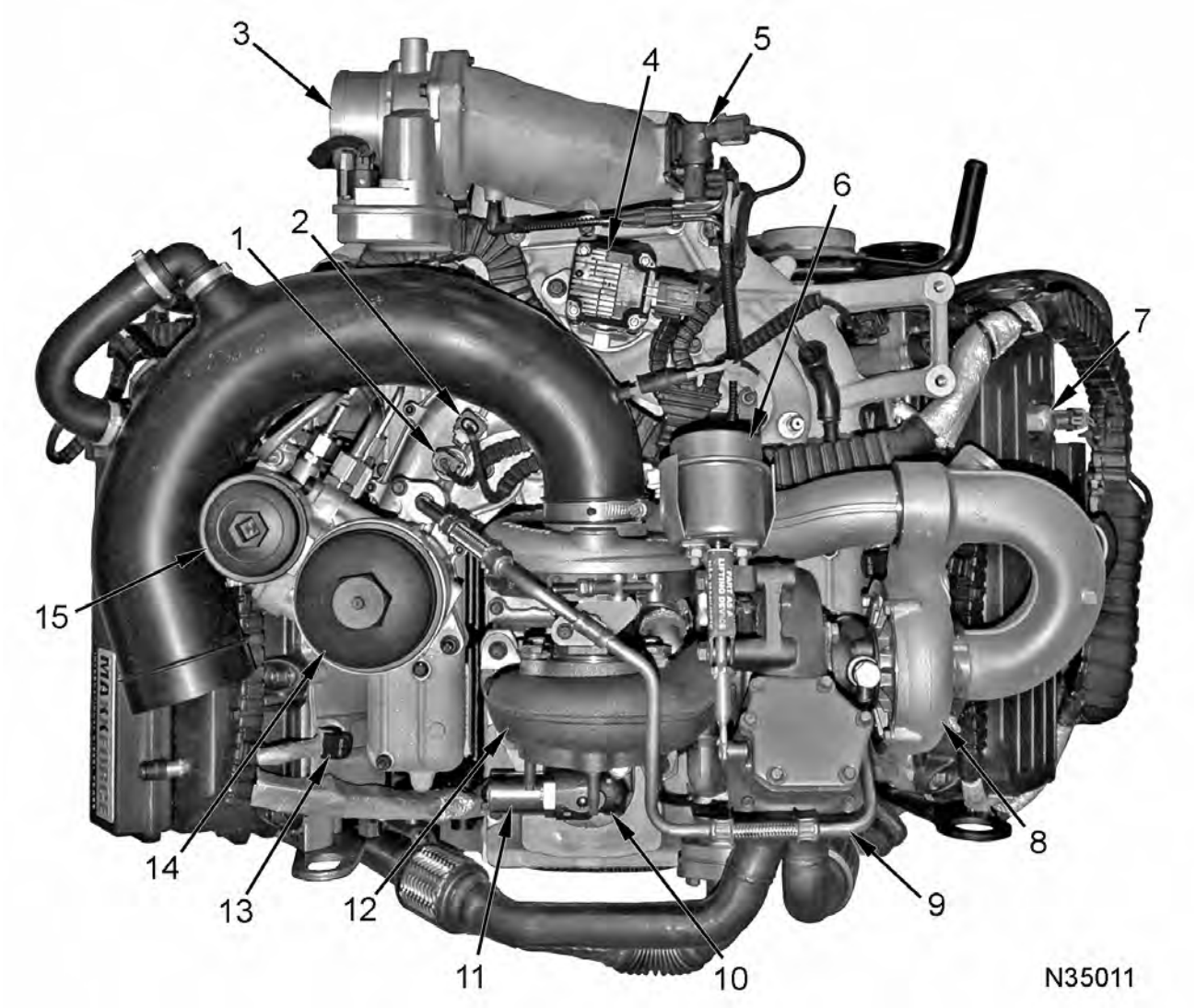

Figure 3 Top

1. Engine Oil Pressure (EOP) switch
2. Engine Oil Temperature (EOT) sensor
3. Intake Throttle Valve (ITV) assembly
4. Exhaust Gas Recirculation (EGR) valve
5. Boost Control Solenoid (BCS)
6. Turbocharger pneumatic actuator
7. Injection Control Pressure (ICP) sensor
8. Turbocharger high-pressure compressor
9. Turbocharger oil supply tube assembly
10. High-pressure oil pump assembly
11. Injection Pressure Regulator (IPR) valve
12. Turbocharger low-pressure turbine
13. Injector connection (6)
14. Oil filter housing assembly
15. Secondary fuel filter assembly

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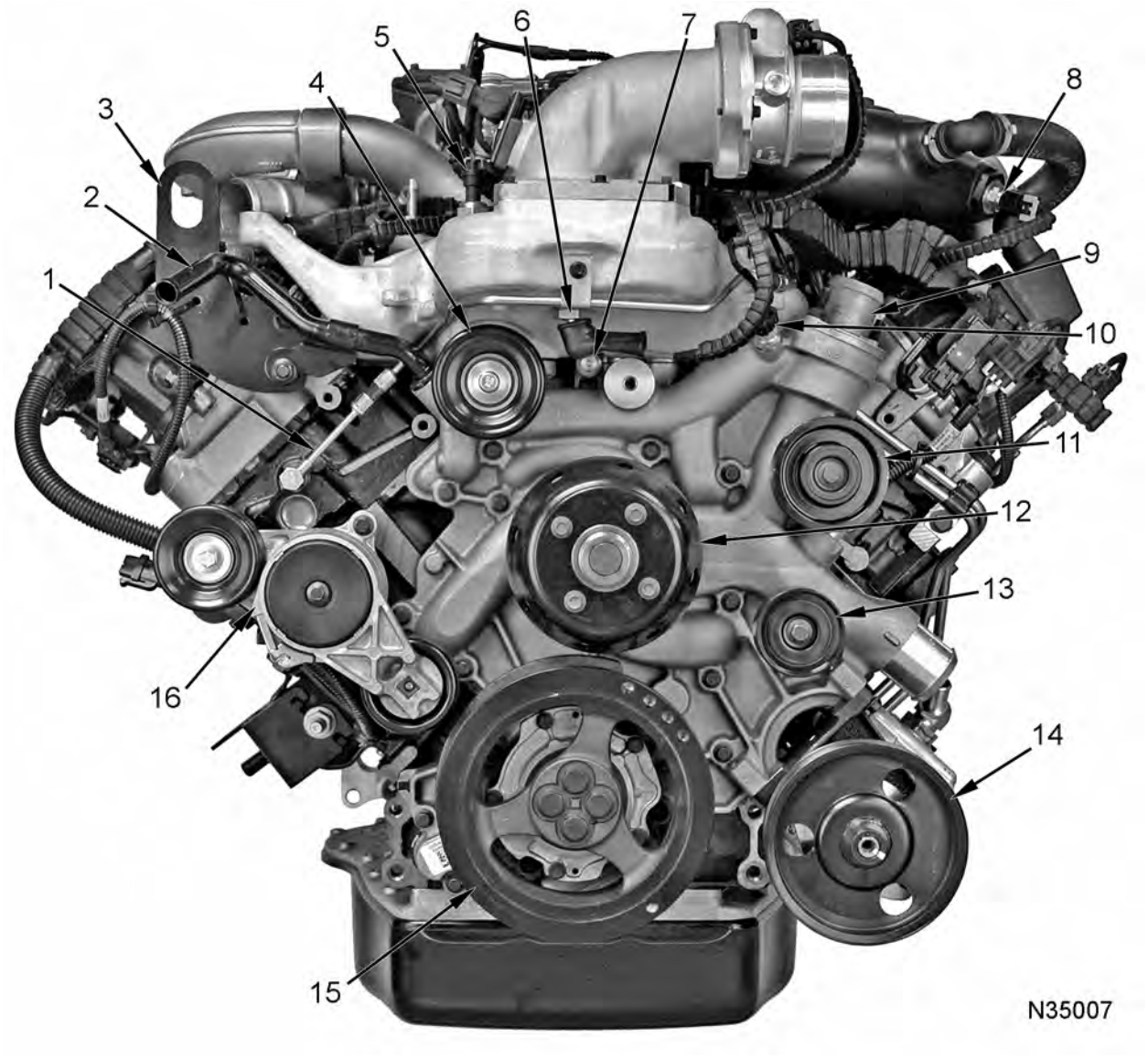

Figure 4 Front

1. Fuel filter to right cylinder head tube
2. Heater feed tube assembly
3. Lifting eye
4. Flat idler pulley
5. Manifold Absolute Pressure (MAP) sensor
6. Inlet Air Heater (IAH) element
7. Diagnostic port (oil cooler)
8. Intake Air Temperature (IAT) sensor
9. Thermostat assembly
10. Engine Coolant Temperature (ECT) sensor
11. 8-groove idler pulley
12. Water pump / fan drive pulley
13. Smooth idler pulley
14. Power steering pulley
15. Vibration damper
16. Belt tensioner assembly

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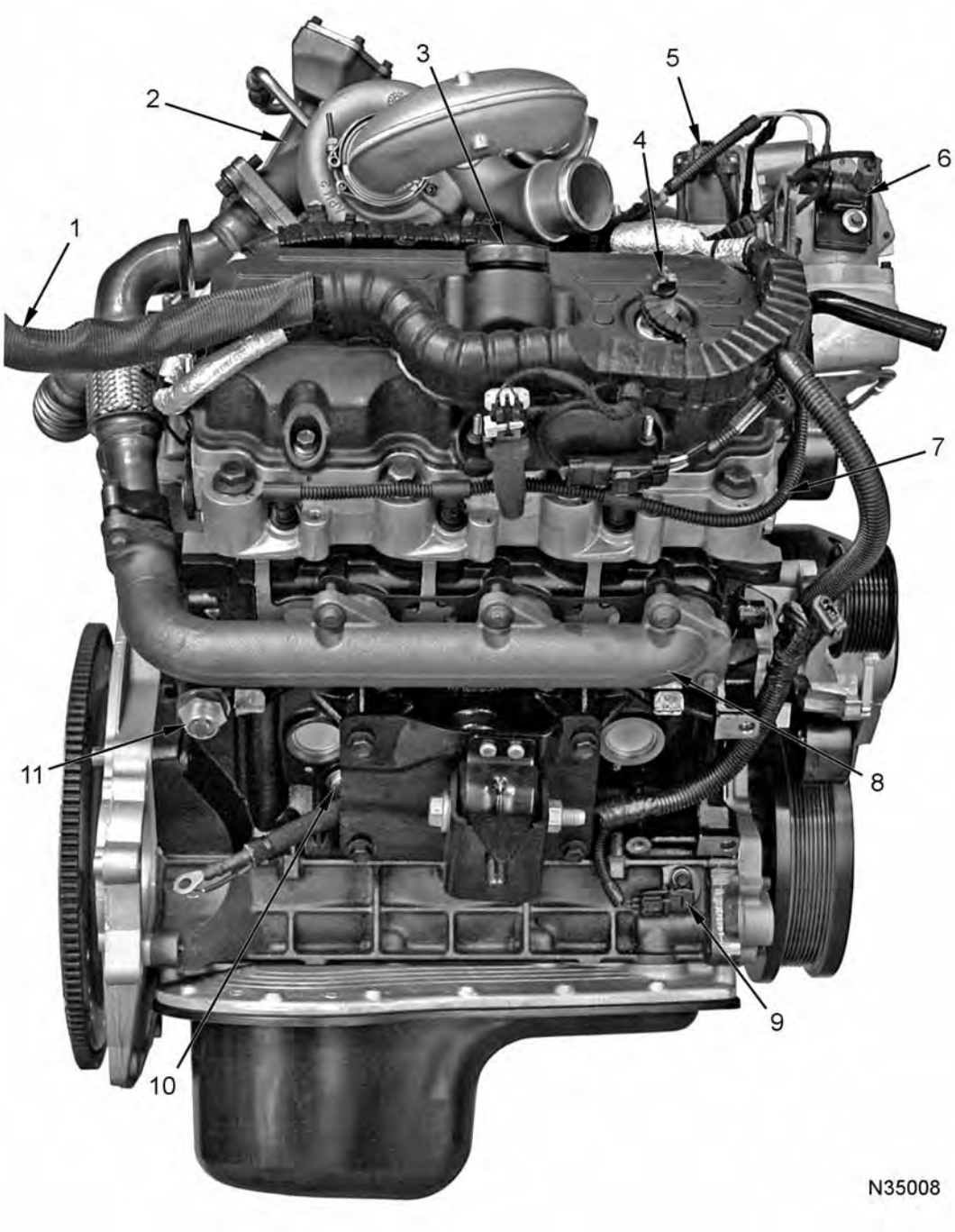

Figure 5 Right

1. Sensor wiring harnesses to chassis mounted ECM, IAH and glow plug relays
2. Dual turbocharger assembly
3. Oil fill cap
4. Injection Control Pressure (ICP) sensor
5. Exhaust Gas Recirculation (EGR) valve
6. Boost Control Solenoid (BCS)
7. Glow plug harness assembly (right)
8. Exhaust manifold (right)
9. Crankshaft Position (CKP) sensor
10. Crankcase coolant drain plug (right)
11. Coolant heater

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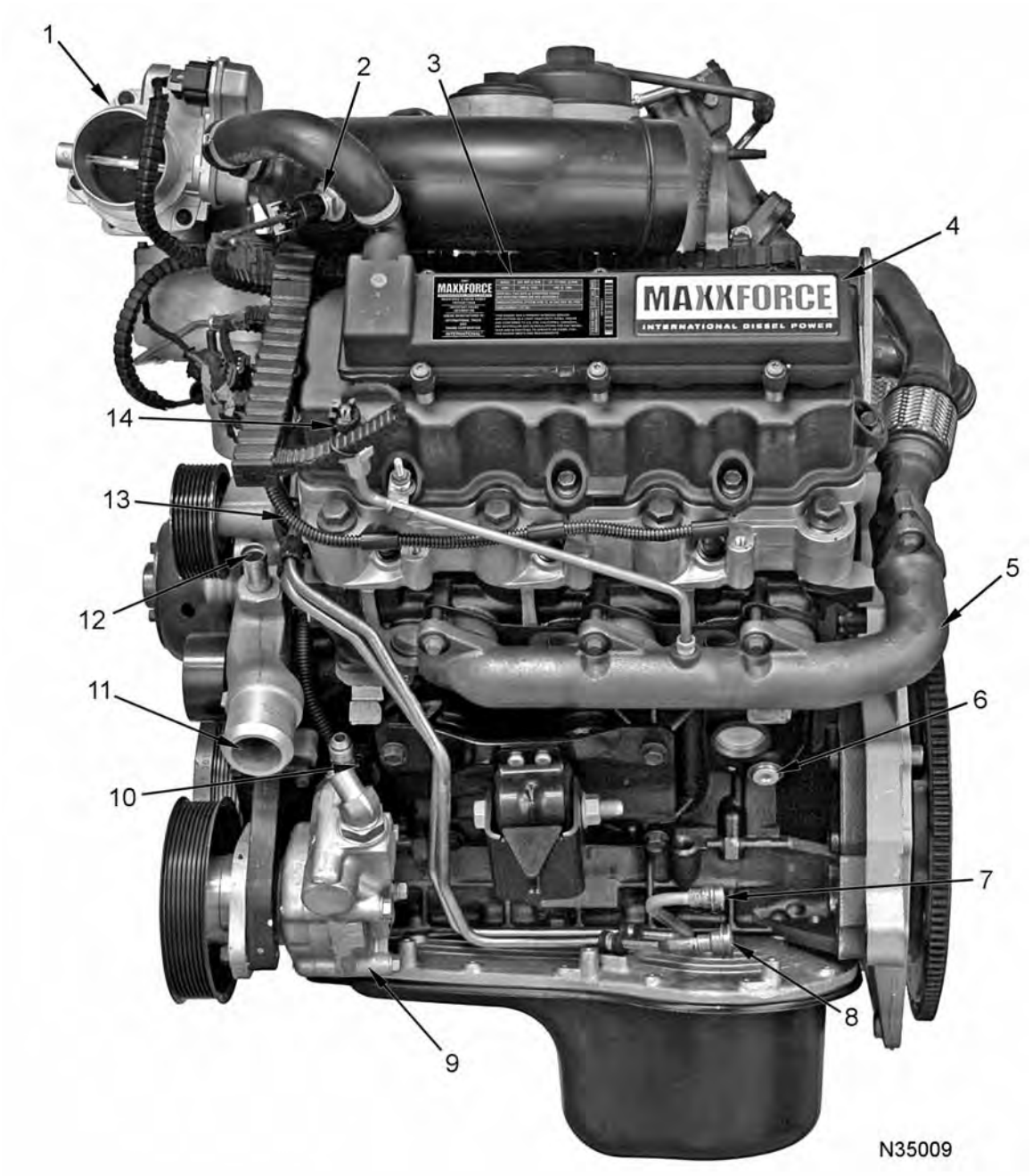

Figure 6 Left

1. Intake Throttle Valve (ITV) assembly
2. Intake Air Temperature (IAT) sensor
3. Exhaust emission label
4. Crankcase breather assembly
5. Exhaust manifold (left)
6. Crankcase coolant drain plug (left)
7. Fuel return to HFCM
8. Fuel supply to filter tube
9. Power steering pump
10. Camshaft Position (CMP) sensor
11. Coolant inlet
12. Heater return port
13. Glow plug harness assembly (left)
14. Exhaust Back Pressure (EBP) sensor

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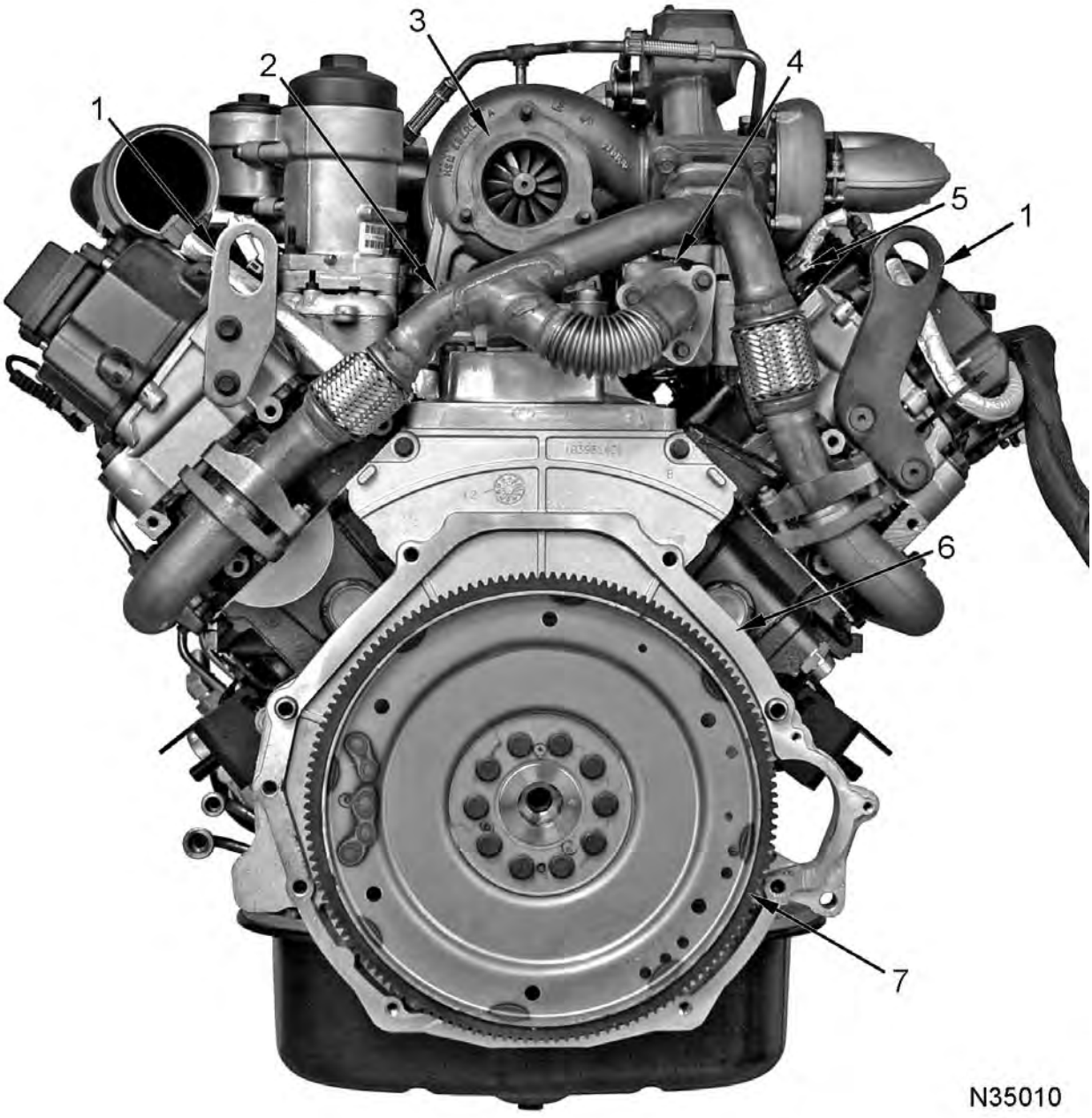

Figure 7 Rear

1. Lifting eye
2. Exhaust tube assembly
3. Turbocharger/exhaust outlet
4. Exhaust Gas Recirculation (EGR) cooler
5. Injector connector (6)
6. Rear cover
7. Flywheel assembly

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Engine Description, Specifications, and Features

Table 1 International® MaxxForce™ 5 Description and Specifications

Engine configuration	4 stroke V6 diesel, 4 valves/cylinder
Displacement	4.5 liters (275 in^3)
Bore (sleeve diameter)	95 mm (3.74 in.)
Stroke	105 mm (4.134 in.)
Compression ratio	18.0:1
Aspiration	Dual turbocharged and Charge Air Cooled (CAC)
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	International® electro-hydraulic generation 2 injection
Cooling system capacity (engine only)	11 liters (12 quarts US)
Lube system capacity (including filter)	13 liters (14 quarts US)
Lube system capacity (overhaul only, with filter)	14 liters (15 quarts US)
Firing order	1-2-5-6-3-4

Engine Features

Table 2 International® MaxxForce™ 5 Standard and Optional Features

Standard Features	**Optional Features**
Four valves per cylinder	Coolant heater wiring harness
Primary balancer shaft assembly	**Chassis Mounted Features**
Dual timing sensors	Horizontal Fuel Conditioning Module (HFCM)
Two-piece crankcase	Diamond Logic® Engine Control
One-piece aluminum alloy pistons	Inlet air heater relay
Fracture cap joint connecting rods	Glow plug relay
International® electro-hydraulic generation 2 injection system	Charge Air Cooler (CAC)
Dual turbocharger assembly	
Secondary fuel filter	

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Engine Description

Cylinder Heads

Each cylinder head has four valves per cylinder for improved air flow. The overhead valve train includes hydraulic roller tappets, push rods, rocker arms, and valve bridges to operate the four valves. Each fuel injector is centrally located between the four valves, directly over the piston combustion bowl, for improved performance and reduced emissions.

Crankcase Assembly

The crankcase assembly consists of an upper crankcase and a lower crankcase. The upper crankcase assembly includes the cylinders, main bearing saddles, and cast or machined coolant passages. The lower crankcase, a structural plate that mates to the upper crankcase, has machined main bearing caps for improved load retention and alignment.

Aluminum alloy pistons are mated to fractured cap joint connecting rods. Piston pins, secured with retaining rings, are free floating for lateral movement in the connecting rod and piston.

The crankshaft is supported by four main bearings with fore and aft thrust controlled at the upper half of the number 3 main bearing. Two connecting rods, attached to each crankshaft rod journal, are offset to minimize vibration.

The camshaft is supported by four bushings pressed into the crankcase. The camshaft is crankshaft driven and thrust is controlled by a plate mounted behind the number four cam journal.

A closed crankcase breather system separates crankcase vapors and oil. Vapors are vented through a hose to the air inlet duct, while oil drains back to the crankcase.

Fuel System

The Horizontal Fuel Conditioning Module (HFCM) includes an electric fuel pump, primary fuel filter, Diesel Thermo Recirculation Module (DTRM), fuel heater, water drain plug, and a Water In Fuel (WIF) sensor. An amber Water In Fuel lamp is illuminated when a predetermined quantity of water has accumulated.

- The HFCM is mounted on the inside of the frame rail (operator's side) for Cab Forward (CityStar™) vehicles
- The HFCM is mounted near the transmission and frame rail (passenger side) for stripped chassis vehicles.

A secondary fuel filter assembly (engine mounted) includes outlets for the fuel lines to each cylinder head fuel rail, a fuel pressure regulator, an Engine Fuel Pressure (EFP) switch, and an air bleed orifice to discharge air if the vehicle runs out of fuel.

The International® electrohydraulic generation 2 injection system includes a high-pressure oil pump, cast iron oil rail assemblies, and fuel injectors.

An Electronic Control Module (ECM) processes signals from the Crankshaft Position (CKP), Camshaft Position (CMP), exhaust aftertreatment, and other sensors. The ECM sends voltage pulses to opening and closing coils of each injector to control injection timing, quantity, and duration.

Lubrication System

The engine lubrication system is pressure regulated, full flow cooled, and full flow filtered. A crankshaft driven gerotor lube oil pump delivers oil through an oil filter element and oil cooler to engine components and an oil reservoir for the high-pressure fuel system. An oil pressure regulator, in the front cover, maintains the desired system pressure.

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Air Management System

A dual stage turbocharger provides boost pressure for a variety of engine speeds and load conditions. An electronic Boost Control Solenoid (BCS) and a pneumatic actuator control the turbocharger.

A Charge Air Cooler (CAC), an air-to-air heat exchanger, cools and increases the density of the air charge from the turbocharger. The cooled dense air flows to the intake manifold. An intake throttle valve restricts air flow to help heat exhaust gas during aftertreatment regeneration.

An Exhaust Gas Recirculation (EGR) system includes an EGR cooler and EGR valve. Some exhaust from the exhaust tube assembly flows through the EGR cooler into a passage in the intake manifold and to the EGR valve. When the EGR valve opens, cooled exhaust gases enter the intake manifold.

The Inlet Air Heater relay and glow plug relay work together to improve cold weather engine performance and starting. An Intake Air Heater (IAH) element, mounted in the intake manifold under the inlet air elbow, is controlled by an inlet air heater relay (chassis mounted). Six glow plugs are controlled by a glow plug relay (chassis mounted).

An Aftertreatment System processes engine exhaust to meet EPA emissions requirements.

- An oxidation catalyst burns oxygen and hydrocarbons in the exhaust stream.
- A Diesel Particulate Filter (DPF) captures and burns particulates in the exhaust stream.

Optional Features

Although a 1250 watt coolant heater is standard equipment, an optional 120 volt cable is available for operation. The coolant heater raises coolant temperature around the cylinders to improve cold engine starts.

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Engine Systems Interaction Diagram

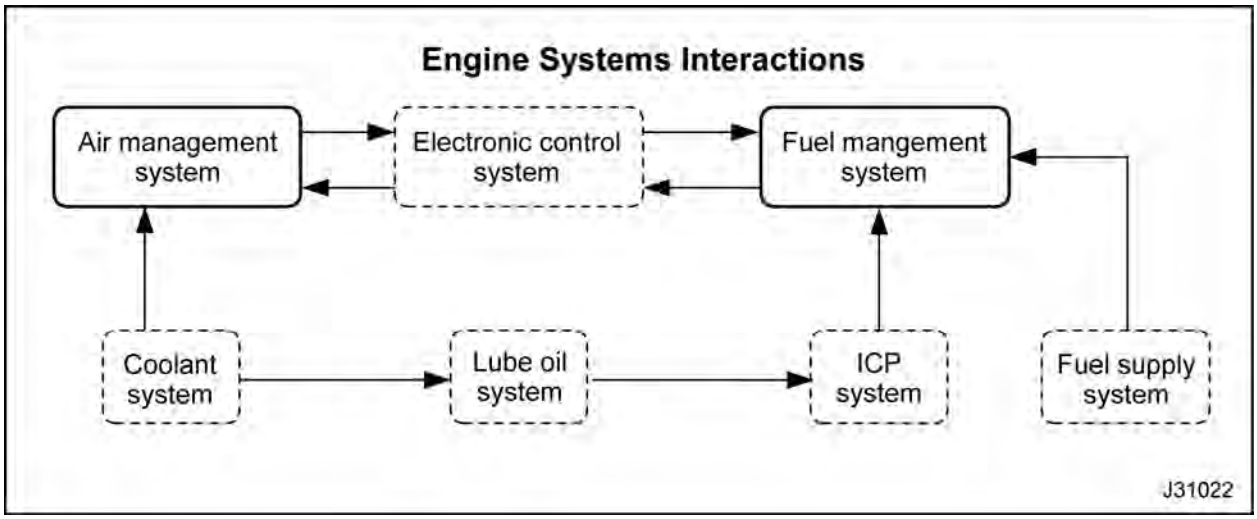

Figure 8 Engine systems interactions

The primary engine systems are air management and fuel management which share some subsystems or have a subsystem that contributes to their operation.

- The electronic control system controls the air management system and fuel management system.
- The Coolant System provides heat transfer for crankcase and cylinder sleeves, cylinder head, EGR gases, and lubrication oil.
- The lube oil system provides lubrication and heat transfer for engine components.
- The Injection Control Pressure (ICP) system uses engine oil to actuate the fuel injectors.
- The fuel supply system pressurizes fuel to the fuel injectors.

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