International® 6.6

EPA 10, 2013 GHG, and 2018 HD-OBD Certified - US, Canada, Mexico

0001042993

4328507R3

August 2018

Operation and Maintenance Manual

International® 6.6

Engine Operation and Maintenance Manual

Navistar, Inc.

2701 Navistar Drive, Lisle, IL 60532 USA

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EPA 10, 2018 GHG, and 2018 HD-OBD Certified - US, Canada, Mexico
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IMPORTANT

The information, specifications, and illustrations contained in this manual are based on data that was current at the time of publication. Navistar, Inc. reserves the right to make changes and/or improvements at any time without notification, liability, or without applying those changes or improvements to vehicles previously manufactured and/or sold.

NOTICE

Be advised that this motor vehicle may be equipped with computer / recording devices. Their function is to allow an authorized individual to download data or information relating to the operation or performance of this vehicle.

The stored data or information may be neither downloaded nor retrieved except by the vehicle's registered owner, or, in the alternative, by another individual or entity authorized by the registered owner, (e.g., International® dealer) who may need this data or information to properly service or diagnose this vehicle for repair or following an accident.

Any access to this information without the owner's consent may be in violation of law and may subject that person or entity to criminal penalties.

CALIFORNIA
Proposition 65 Warning

WARNING Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

- Always start and operate the engine in a well-ventilated area
- If in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system.
- Do not idle the engine except as necessary.

For more information go to www.P65warnings.ca.gov/diesel

Battery posts, terminals and other related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Wash hands after handling.

Summary of Changes

Section	Description
Section 1	Emissions Label: Image and description of label has been updated. Added Engine Specifications table.
Section 2	Fuel: Updated information regarding unacceptable fuel blends.
Section 5	Cooling System: Updated deaeration tank check and fill procedures. Air Cleaner / Filter: Updated filter change procedure.
Entire manual	Revised wording of Warnings and Cautions. Updated terminology

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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.

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

This manual includes necessary information and specifications for operators to operate and maintain International® diesel engines. Contact your dealer for more information.

Refer to the applicable technical service literature:

Engine Service Manual

Engine Diagnostic Manual

Technical Service Literature is revised periodically. Use only up-to-date service information.

To order technical service literature, contact your dealer.

About the Manual

This manual contains information needed to correctly operate and maintain your engine as recommended by Navistar. Numerous illustrations, symbols, and feature descriptions are used to aid in understanding the meaning of the text. The illustrations, symbols, or feature descriptions may not be available for all applications, please reference your vehicle operations manuals for complete information. Both metric and U.S. customary values are listed in this manual. The U.S. customary is listed first, followed by the metric value in brackets. For additional service literature refer to Service Literature noted on this page. This manual does not cover vehicle or equipment maintenance procedures. Consult original vehicle or equipment manufacturer for specific maintenance recommendations.

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 performing any service and test procedures for 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 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 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 install wheel chocks before performing diagnostic or service procedures.
- Clear area before starting 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.
- If an engine is not safe to operate, tag engine and ignition key.

Fire Prevention

- Make sure charged fire extinguishers are in work area.

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

- Type A — Wood, paper, textiles, and rubbish
- Type B — Flammable liquids
- Type C — Electrical equipment

Batteries

- Always disconnect main negative battery cable first.
- Always connect 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 Occupational Safety and Health Administration (OSHA) approved blow gun. Limit blow gun air pressure to 30 psi (207 kPa).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in 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 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 overfill fuel tank. Overfill creates a fire hazard.
- Do not smoke in work area.
- Do not refuel fuel tank when engine is running.

Removal of Tools, Parts, and Equipment

- Install all safety guards, shields, and covers after servicing engine.
- Make sure all tools, parts, and service equipment are removed from engine and vehicle after all work is performed.

Warranty

Federal Emission System Warranty

WARRANTY PERIOD

Navistar, Inc. warrants that your heavy-duty diesel engine conforms with applicable emission regulations and is free from defects in materials and workmanship that would cause such engine to fail to conform with applicable emission regulations for the following warranty period (whichever comes first):

- 5 years
- 50,000 miles (80,000 km)
- Or if covered by any basic or extended warranty (if greater than above)

Your diesel engine conforms to U.S. Environmental Protection Agency (EPA) regulations for emission systems.

The engine model year, service class, and required emission information can be found on the emission label. This warranty is based on the engine model year, not the model year of the vehicle. The warranty period begins on the date the new vehicle is delivered to the first retail purchaser.

REQUIRED MAINTENANCE

As the vehicle owner, you are responsible for all required maintenance described in this manual. Navistar, Inc. recommends that you retain all maintenance receipts. Navistar will not deny an emission warranty claim solely because you have no record of maintenance. However, a claim may be denied if your failure to perform proper maintenance resulted in the failure of a warranted part and you cannot provide appropriate evidence of maintenance. Take your vehicle to an authorized service provider when a problem occurs.

WARRANTY REPAIRS AND SERVICE

All emission control system parts proven defective and causing the engine to fail to conform with applicable emission regulations during normal use will be repaired or replaced during the warranty period. Warranty repairs and service will be done by your dealer with no charge for parts, labor and diagnostics. Warranty repairs should be completed in a reasonable time, not to exceed 30 days. Navistar may deny warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance or unapproved modifications.

RECOMMENDED MAINTENANCE OR REPAIR PARTS

Service parts or ReNEWed® parts are recommended for maintenance or repairs to maintain the original quality of your emission certified engine. If parts not recommended by Navistar, Inc. cause damage to the engine or vehicle, the warranty is invalid and maintenance and repair costs will not be covered.

EMERGENCY REPAIRS

Emergency repairs are recognized if the parts are not available within 30 days or the repairs are not completed within 30 days. If an authorized service provider is not reasonably available, the vehicle owner or any service establishment can install replacement parts.

Navistar, Inc. will reimburse you for emergency repairs (including diagnostics) for the following:

- Replacement parts that do not exceed manufacturer's suggested retail price
- Labor charges based on manufacturer's recommended time allowance and geographic hourly rate

Replaced parts and paid invoices must be given to your dealer for reimbursement of emergency repairs.

WHAT IS NOT COVERED BY WARRANTY

Unauthorized parts or expendable parts:

- Parts other than service parts or ReNEWed® parts
- Aftermarket parts or service kits
- Nondefective parts replaced by an unauthorized service provider
- Parts requiring replacement at inspection or adjustment maintenance intervals for reasons other than being defective
- Replacement of expendable items made in connection with scheduled maintenance

Vehicle, engine, and part malfunctions caused by the following:

- Use of incorrect fuel, engine oil, or coolant
- Failure to maintain correct maintenance schedule
- Incorrect adjustments, modifications, alterations, tampering or disconnection of vehicle components
- Abuse or misuse of engine

- Accidents, acts of nature or other events beyond control of Navistar

Conditions not covered by warranty:

- Loss of time, inconvenience, use of vehicle / engine or commercial loss
- Vehicles with an altered or disconnected odometer or hour meter when mileage or hours cannot be determined

WARRANTY RIGHTS AND RESPONSIBILITIES

Navistar ensures the emission warranty is being properly administered. If you have not received satisfactory service or have questions regarding your warranty rights and responsibilities, contact the regional office for assistance. If additional assistance is required, contact the Manager of Customer Relations.

Manager, Customer Relations
Navistar, Inc.
2701 Navistar Drive
Lisle, Illinois 60532
(Telephone 1-800-448-7825)

California Emission System Warranty

WARRANTY PERIOD

The California Air Resources Board and Navistar, Inc. are pleased to explain the emission control system warranty on your heavy-duty diesel engine. In California, new motor vehicles must be designated, built and equipped to meet the State's stringent anti-smog standards.

Navistar, Inc. warrants your heavy-duty diesel engine for the following warranty period (whichever comes first):

- 5 years
- 100,000 miles
- 3,000 hours
- Or if covered by any basic or extended warranty (if greater than above)

Your heavy-duty diesel engine conforms to applicable CARB regulations. This vehicle is registered and certified for sale in California.

The engine model year, service class, and required emission information can be found on the emission label. This warranty is based on the engine model year, not the model year of the vehicle. The warranty period begins on the date the new vehicle is delivered to the first retail purchaser.

REQUIRED MAINTENANCE

As the vehicle owner, you are responsible for all required maintenance described in this manual. Navistar, Inc. recommends that you retain all receipts covering maintenance on your engine, but Navistar will not deny warranty solely for the lack of receipts or your failure to ensure the performance of all scheduled maintenance. However, a claim may be denied if Navistar demonstrates the (engine / vehicle) has been abused, neglected, or improperly maintained, and that such abuse, neglect, or improper maintenance was the direct cause of the need for the repair or replacement of the part. Take your vehicle to an authorized service provider when a problem occurs.

WARRANTY REPAIRS AND SERVICE

All emission control system parts proven defective, or failing to meet the requirements in the California Code of Regulations, Title 13, Sections 2700 to 2706, and 2710 during normal use will be repaired or replaced during the warranty period. Warranty repairs and service will be done by an authorized service provider with no charge for parts, labor and diagnostics. Warranty repairs should be completed in a reasonable time, not to exceed 30 days. Navistar may deny you warranty coverage if your vehicle or a part has failed due to abuse, neglect, improper maintenance, or unapproved modifications.

RECOMMENDED MAINTENANCE OR REPAIR PARTS

Service parts or ReNEWed® parts are recommended for maintenance or repairs to maintain the original quality of your emission certified engine. If parts not recommended by Navistar, Inc. cause damage to the engine or vehicle, the warranty is invalid and maintenance and repair costs will not be covered.

EMERGENCY REPAIRS

Emergency repairs are recognized if the parts are not available within 30 days or the repairs are not completed within 30 days. If an authorized service provider is not reasonably available, the vehicle owner or any service establishment can install any replacement part.

Navistar, Inc. will reimburse you for emergency repairs (including diagnostics) for the following:

- Replacement parts that do not exceed manufacturer's suggested retail price.
- Labor charges based on manufacturer's recommended time allowance and geographic hourly rate.

Replaced parts and paid invoices must be given to a your dealer for reimbursement of emergency repairs.

WHAT IS COVERED BY WARRANTY

Where a warrantable condition exists, Navistar will repair your diesel engine at no cost to you including diagnosis, parts, and labor. If your vehicle or truck fails a Smog Check inspection, all necessary repairs and adjustments will be made by Navistar to ensure that your emission control system is to Performance Warranty.

If any emission-related part on your diesel engine is defective, the part will be repaired or replaced by Navistar. This is your short-term emission control system Defects Warranty. For diesel-powered heavy-duty vehicles (except medium-duty vehicles), and motor vehicle engines used in such vehicles, a period of use of five years, 100,000 miles, or 3,000 hours of operation, whichever first occurs. However, in no case may this period be less than the basic mechanical warranty that the manufacturer provides (with or without additional charge) to the purchaser of the engine. Extended warranties on select parts do not extend the emissions warranty requirements for the entire engine but only for those parts. In cases where responsibility for an extended warranty is shared between the owner and the manufacturer, the emission warranty shall also be shared in the same manner as specified in the warranty agreement.

New vehicles and engines, registered and certified for sale in California, have the following items covered by the emission warranty when first installed on the engine as original equipment by Navistar:

- Fuel injection system
- Air induction system (includes turbocharger, exhaust manifold, Exhaust Gas Recirculation [EGR] system, EGR rate and feedback control system)
- Crankcase breather system
- Aftertreatment system
- Miscellaneous items used in above systems
    A. Hoses, clamps, fittings, and tubing
    B. Pulleys, belts, and idlers
    C. Electronic controls

WHAT IS NOT COVERED BY WARRANTY

Unauthorized parts or expendable parts:

- Parts other than service parts or ReNEWed® parts
- Aftermarket parts or service kits
- Non-defective parts replaced by other than your dealer
- Parts requiring replacement at inspection or adjustment maintenance intervals for reasons other than being defective

- Replacement of expendable items made in connection with scheduled maintenance

Vehicle, engine, and part malfunctions caused by the following:

- Use of incorrect fuel, engine oil, or coolant
- Failure to maintain correct maintenance schedule
- Incorrect adjustments, modifications, alterations, tampering or disconnection of vehicle components
- Abuse or misuse of engine
- Accidents, acts of nature or other events beyond control of Navistar

Conditions not covered by warranty:

- Loss of time, inconvenience, use of vehicle/engine or commercial loss
- Vehicles with an altered or disconnected odometer or hour meter when mileage or hours cannot be determined.

WARRANTY RIGHTS AND RESPONSIBILITIES

Navistar, Inc. ensures the emission warranty is being properly administered. If you have not received satisfactory service or have questions regarding your warranty rights and responsibilities, contact the regional office for assistance. If additional assistance is required, contact the Manager of Customer Relations.

Manager, Customer Relations
Navistar, Inc.
2701 Navistar Drive
Lisle, Illinois 60532
(Telephone 1-800-448-7825)

If further questions of warranty rights and responsibilities remain, contact:

The Air Resources Board
9528 Telstar Avenue
El Monte, California 91731

Vehicle Identification Number and Emissions Label

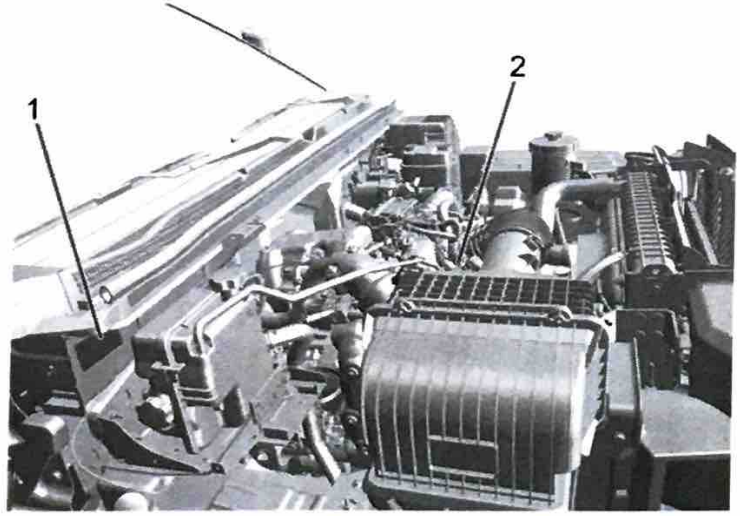

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Figure 1 Engine Emission Label Locations

1. Bulkhead / cowl wall
2. Engine air intake manifold

The Vehicle Identification Number (VIN) is located on the engine emission label, which is on the air intake manifold of the engine. Additionally, a copy of this label is attached to the passenger-side bulkhead in the engine compartment.

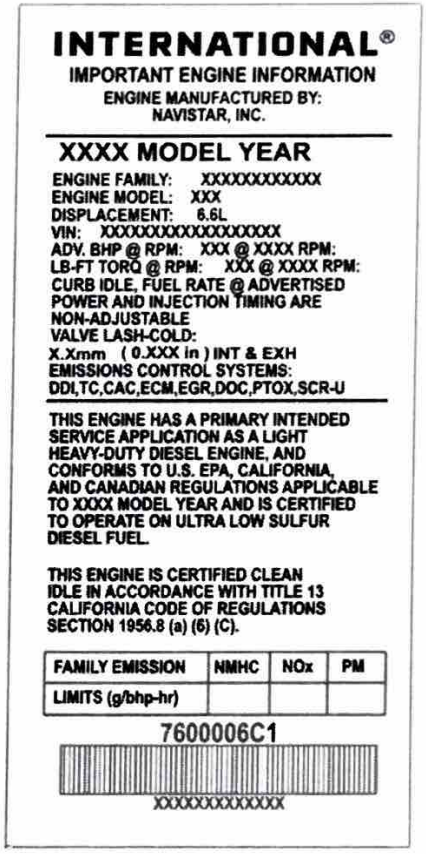

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Figure 2 U.S.A. Environmental Protection Agency (EPA) Engine Emissions Label (Example)

The EPA label typically includes the following:

- Model year
- Engine family, model, and displacement
- Advertised brake horsepower and torque rating
- Emission control systems
- Valve lash specifications
- Vehicle Identification Number (VIN)
- EPA, EURO, and reserved fields for specific applications

Engine Specifications – International® 6.6

Engine Configuration	90 degree V8 diesel
Advertised brake horsepower @ rpm	See engine emission label
Peak torque @ rpm	See engine emission label
Displacement	403 in^3 (6.6 L)
Compression ratio	16.0:1
Stroke	3.8976 in (99 mm)
Bore	4.0551 in (103 mm)
Firing order	1-2-7-8-4-5-6-3
Aspiration	Variable geometry turbocharger and charge air cooler
Combustion system	Direct injection turbocharged
Fuel system	High-pressure common rail
Lube system capacity (including filter)	10 qts (9.5 L)
Idle speed (no load)	680 rpm, nominal
Thermostat full open temperature	230°F (110°C)

Fuel

Top Tier Fuel

Navistar recommends the use of TOP TIER Diesel Fuel to keep the engine clean, reduce engine deposits, and maintain optimal vehicle performance. Look for the TOP TIER Logo or visit www.toptiergas.com for a list of TOP TIER Diesel Fuel marketers and applicable countries.

Figure 3 Top Tier Fuel Logo

Ultra Low Sulfur Diesel Fuel

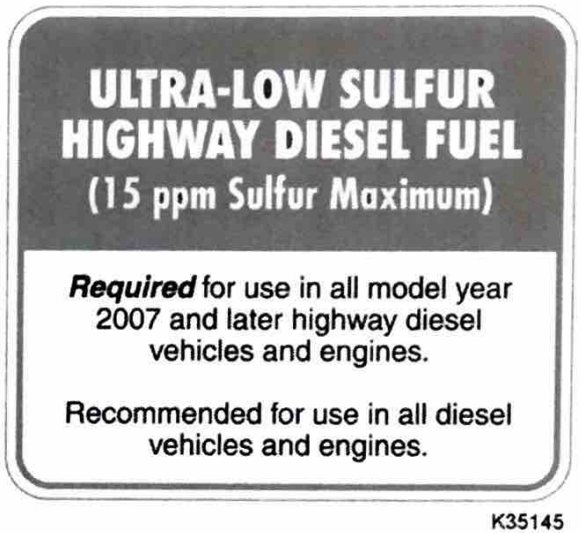

Figure 4 American Petroleum Institute (API) Diesel Pump Label

The API Diesel Pump Label is compliant with Environmental Protection Agency (EPA) CFR 80.570.

GOVERNMENT REGULATION: Diesel fuel sold for use in 2007 and later highway vehicles must be limited to a sulfur content of 15 parts per million (ppm).

Fuel for Diesel Engines

The selection of a high-quality fuel is important for maintaining optimum vehicle performance. Diesel fuel should meet or exceed the minimum requirements in the most current versions of the local fuel standards

Ultra Low Sulfur Diesel (ULSD) fuel is required for the International® 6.6 equipped with advanced aftertreatment systems. The fuel should meet all the specifications of ASTM D975 standard (current year revision), including the EPA specification for sulfur content (0.0015% mass or 15 ppm maximum). These specifications are included in the standard under the designation No. 2-D S15 fuel and No. 1-D S15 fuel. Grade No. 1-D fuel is a lighter fuel with higher volatility than grade No. 2-D; it may be blended with grade No. 2-D in wintertime to provide engine operability under low ambient temperature.

Do not use fuel with more than 15 ppm sulfur.

Do not use a diesel blend containing more than 20% biodiesel by volume.

Unacceptable Fuel and Blends

⚠ CAUTION

To prevent engine damage, power loss or increased wear that may void your warranty, do not use fuels that do not comply with the required technical standards.

Some improper fuels are:

- Diesel fuel with the addition of gasoline.
- Diesel fuel mixed with engine oil or automatic transmission fluid.
- Triglyceride fuels, such as raw vegetable oil or animal fat, in any form, including with blends of diesel or biodiesel.
- Marine diesel fuel and fuel oils.
- Diesel-water emulsions, such as Aquazole.
- Aftermarket diesel fuel additives, which contain alcohols, organo-metallic additives, or water emulsifiers.
- Diesel fuel with sulfur greater than 15 ppm.
- Low Sulfur Diesel (LSD) fuel 0.05% (500 ppm)
- Commercial Jet A or JP8 aviation fuel
- Heating or furnace oil
- Biodiesel B100 (neat biodiesel)

- Biodiesel blends higher than 20%
- Any fuel mixed with used motor oil

Some conditions, such as dirty fuel, may decrease fuel filter life and a CHANGE FUEL FILTER message may come on in the Driver Information Center (DIC).

Acceptable Fuel Blends

- Ultra low sulfur kerosene (No. 1-D S15 diesel fuel) blended with No. 2-D S15 fuel to improve cold weather performance. Blend rate would depend upon regional low temperatures.
- Lower biodiesel blends up to B5 (a blend of 5% neat biodiesel with 95% diesel fuel).

  Such blends have characteristics indistinguishable from diesel fuel, if the two components meet the requirements of their respective standards: ASTM D6751 current revision for neat biodiesel, and ASTM D975 current revision for ultra low sulfur diesel fuel.

  As of October 1, 2008, blends of up to 5% biodiesel are included in the diesel fuel Standard ASTM D975-08a. (D975-08a designates the 2008 revision of the standard.)

  Navistar, Inc. approves of blends up to B5, provided the two components satisfy current standard specifications. Quality biodiesel blends up to B5 should not cause engine or fuel system problems.

Hazards of Diesel Fuel / Gasoline Blends

WARNING

To prevent property damage, personal injury, and / or death, never add gasoline, gasohol, and / or alcohol to diesel fuel. This mixture creates an extreme fire and explosion hazard.

CAUTION

To prevent fuel system damage, do not attempt to drive the vehicle if it has been accidentally refueled with gasoline. Have the vehicle towed to a qualified technician to have the gasoline removed from the tank and fuel system. Refuel with Ultra Low Sulfur Diesel fuel. It is also recommended to have the fuel system flushed with Ultra Low Sulfur Diesel, to ensure all gasoline is removed.

Blending of gasoline and / or alcohol with diesel fuel is not recommended due to the hazards of fire / explosion and the detrimental effects on engine performance.

As little as 2% volume gasoline mixed with diesel fuel will create a flammable / explosive mixture in the fuel tank vapor space, which will pose an extreme fire / explosion hazard during refueling or engine operation.

Climate Grade Diesel Fuels

At temperatures below 32°F (0°C), avoid using biodiesel blends above 5% by volume. Using such a fuel may cause fuel filter plugging, system gelling, and freezing, which may adversely impact vehicle starting.

Severe winter grade diesel fuel, such as 1-D diesel fuel or Arctic grade diesel fuel, can be used in extreme cold temperatures (below 0°F or -18°C); however, doing so will reduce power and fuel economy. Avoid using severe winter grade fuel in warm or hot climates. It can result in stalling, poor starting, and damage to the fuel injection system.

Fuels improperly blended for cold temperature operation may result in restricted fuel filters. The vehicle is equipped with a fuel heating system to prevent gelling or waxing of conventional diesel fuel and biodiesel blends, but may not prevent all cases.

In case of severe winter conditions, the may become clogged by wax naturally present in the fuel. To unclog it, move the vehicle to a warm garage area and allow the filter to warm up. The fuel filter may need to be replaced. See *Fuel Filter Replacement* (page 58).

Biodiesel

Biodiesel fuels are methyl or ethyl esters derived from a broad variety of renewable sources such as vegetable oils, animal fats, and waste cooking oils. These oxygenated organic compounds have key properties that are comparable to those in diesel fuel.

⚠ CAUTION

To prevent engine and fuel system damage that would not be covered by the vehicle warranty, do not use home-made biodiesel or home test kits. The quality of this fuel cannot be verified by approved scientific methods. Do not use raw vegetable oil or other unmodified bio-oils, fats, or blends of vegetable oil with diesel.

Biodiesel Blends

Fuels with a biodiesel content up to 20% by volume may be used (e.g. named B20). Only use biodiesel blends up to 20% by volume that comply with your country's or region's fuel standards.

⚠ CAUTION

To prevent engine, fuel system or exhaust after-treatment system damage, do not use blends containing more than 20% biodiesel. Such damage would not be covered by the vehicle warranty.

Use of Higher Biodiesel Fuel Blends (B6 to B20)

Standard ASTM D7467 (current version) covers the specifications for blends between 6% to 20% (B6 to B20). These blends may be used in vehicles that operate in populated areas or in fleets that are required to use alternative fuels to reduce urban pollution.

Use of B6 to B20 blends is at the discretion of the customer / operator and will not automatically void an engine warranty. However, if engine component failure can be directly attributable to use of a B6 to B20 blend not provided by a BQ9000 certified fuel supplier or not meeting the ASTM D7467 (current version) Standard, Navistar, Inc. may, at its option, deny warranty on the affected engine or engine component.

Navistar recommends that users of B20 select a BQ9000 certified fuel supplier and request proof from the supplier the fuel meets ASTM D7467 (current version) Standard. Fuels not meeting the specification may cause fuel system deposits, plugged filters, contaminated engine oil, and fuel degradation.

If providers and customers follow correct storage and maintenance procedures for fuel and equipment, blends of B6 to B20 that meet ASTM D7467 (current version) Standard should perform satisfactorily in diesel engines. Contact your dealer for recommendations for correct storage and maintenance procedures.

Navistar, Inc. follows the official position of the Truck and Engine Manufacturers Association (EMA) on biodiesel fuel. See www.truckandenginemanufacturers.org for more information.

Special Considerations

As a renewable fuel, biodiesel provides some environmental benefits. However, biodiesel has unique properties and needs to be handled differently than diesel fuel. Its use presents additional risks and may not be appropriate in all situations. Certain vehicle operating modes increase these risks and should be avoided.

Biodiesel fuel quality degrades with time and exposure to high temperature quicker than Ultra Low Sulfur Diesel fuel. More frequent refueling provides the best opportunity to have a supply of fresh fuel. Storage at hot ambient temperatures will accelerate biodiesel degradation.

Owners who use little fuel, or who have vehicles stored for extended periods of the time, should avoid the use of biodiesel blended fuels above 5% by volume. When vehicles are stored for longer than one month, they should be run out of biodiesel to below one quarter tank, refueled with biodiesel-free fuel, and driven several miles before storage.

Fuel and Lubricant Additives

International® trucks are designed and built to operate satisfactorily on fuels and lubricants of good quality marketed by the petroleum industry. Use of any supplementary fuel or lubricant additives is not recommended. Malfunctions attributed to the use of such additives or failure to follow recommended fuel or lubricant recommendations may not be covered by any applicable warranty.

Additional Unsafe Practices

CAUTION

To prevent vehicle, and / or engine component damage, do not mix propane with diesel fuel. Warranty claims will not be honored against engines that have used propane.

CAUTION

To prevent vehicle, and / or engine component damage, do not mix engine oil with diesel fuel. Warranty claims will not be honored against engines that have used fuel mixed with oil.

Engine Oil

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (such as filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

To ensure proper engine performance and long life, careful attention must be paid to engine oil. Following these simple, but important steps will help protect your investment:

- Use engine oil approved to the proper specification and of the proper viscosity grade. See "Oil Specifications" in this section.
- Check the engine oil level regularly and maintain the proper oil level. See *Checking Engine Oil* (page 73) and *When to Add Engine Oil* (page 74).
- Change the engine oil at the appropriate time. See *When to Change the Oil* (page 75).
- Always dispose of engine oil properly. See "What to Do with Used Oil" in this section.

OIL SPECIFICATIONS

Oils designated as API CJ-4 or CK-4 are required for the vehicle. The CJ-4 or CK-4 designation can appear either alone or in combination with other American Petroleum Institute (API) designations, such as API CJ-4/SL. These letters show API levels of quality.

Figure 5 API CJ-4 Identification Symbol

This doughnut-shaped logo (symbol) is used on most oil containers to help you select the correct oil. It means that the oil has been certified by the American Petroleum Institute.

Look for this on the oil container, and use only those oils that display this logo.

CAUTION

To prevent property damage, look for this doughnut-shaped logo (symbol) on the oil container, and use only oils that display this logo. It means that the oil has been certified by the American Petroleum Institute and is there to help you select the correct oil.

VISCOSITY GRADE

Use SAE 15W-40 viscosity grade engine oil.

When it is very cold, below 0°F (-18°C), use SAE 5W-40 to improve cold starting. These numbers on the oil container show its viscosity, or thickness.

When selecting an oil of the appropriate viscosity grade, always select an oil of the correct specification. See "Oil Specifications" earlier in this section.

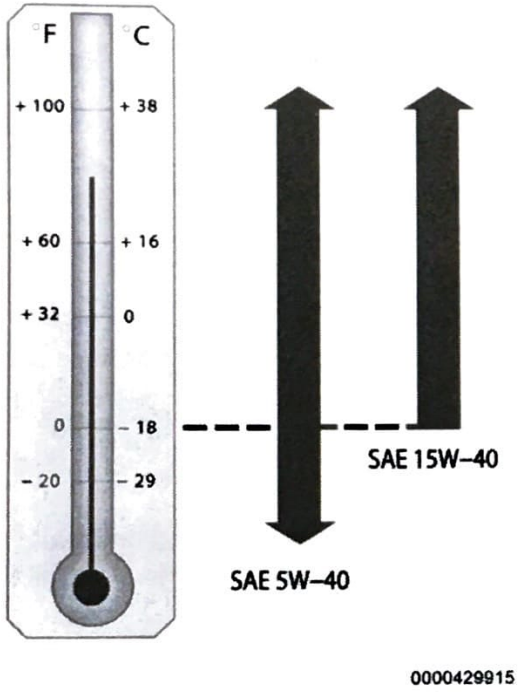

Figure 6 Oil Viscosity Grades and Temperature Ranges

ENGINE OIL ADDITIVES / ENGINE OIL FLUSHES

Do not add anything to the oil. The recommended oils with the API service symbol are all that is needed for good performance and engine protection.

Engine oil system flushes are not recommended and could cause engine damage not covered by the vehicle warranty.

WHAT TO DO WITH USED OIL

Used engine oil contains certain elements that can be unhealthy for your skin and could even cause cancer. Do not let used oil stay on your skin for very long. Clean your skin and nails with soap and water, or a good hand cleaner. Wash or properly dispose of clothing or rags containing used engine oil. See the manufacturer's warnings about the use and disposal of oil products.

Used oil can be a threat to the environment. If you change your own oil, be sure to drain all the oil from the filter before disposal. Never dispose of oil by putting it in the trash or pouring it on the ground, into sewers, or into streams or bodies of water. Recycle it by taking it to a place that collects used oil.

Engine Coolant

WARNING

To prevent property damage, personal injury and / or death, do not use plain water or other liquids, such as alcohol, in the radiator. With plain water or the wrong mixture, the engine could get too hot but there would not be an overheat warning. The engine could catch fire

The cooling system is filled at the factory with DEX-COOL® coolant.

Use a 50/50 mixture of clean, drinkable water and DEX-COOL® coolant which will not damage aluminum parts. If using this mixture, nothing else needs to be added. A 50/50 mixture of clean, drinkable water and DEX-COOL® coolant will:

- Give freezing protection down to -34°F (-37°C).
- Give boiling protection up to 265°F (129°C).
- Protect against rust and corrosion.
- Help keep the proper engine temperature.
- Let the warning lights and gauges work as they should.

CAUTION

To prevent damage to the engine cooling system and the vehicle, do not use anything other than a mix of DEX-COOL® coolant that meets the Navistar MPAPS B-44 standard and clean, drinkable water. Damage caused by other coolants would not be covered by the vehicle warranty.

Instrument Panel Gauge Cluster

During engine starts and engine operation, gauges and indicator lamps should be checked periodically.

Gauges may vary with vehicle applications. Warning and indicator lamps show conditions not indicated by the gauges.

See the vehicle *Operation and Maintenance Manual* for description of indicator lamps for the drivetrain, chassis components, and cabin.

Fuel Gauge

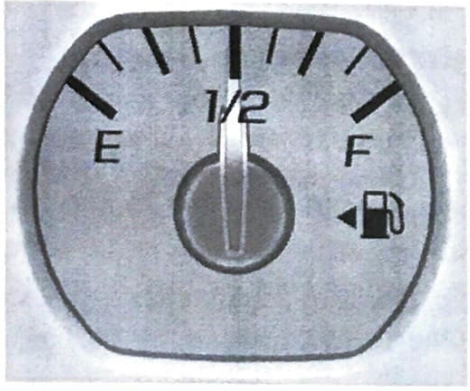

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Figure 7 English Fuel Gauge

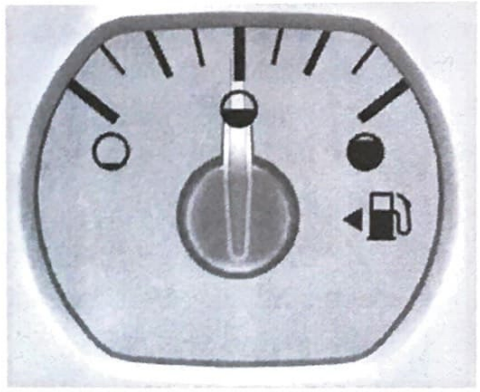

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Figure 8 Metric Fuel Gauge

When the ignition is on, the fuel gauge indicates about how much fuel is left in the tank.

There is an arrow near the fuel gauge pointing to the side of the vehicle the fuel filler is on.

When the indicator nears empty, the low fuel light comes on. There still is a little fuel left, but the vehicle should be refueled soon.

Here are four things that some owners ask about. None of these show a problem with the fuel gauge:

- At the service station, the fuel pump shuts off before the gauge reads full.
- It takes a little more or less fuel to fill up than the gauge indicated. For example, the gauge may have indicated the tank was half full, but it actually took a little more or less than half the tank's capacity to fill the tank.
- The gauge moves a little while turning a corner or speeding up.
- The gauge takes a few seconds to stabilize after the ignition is turned on, and goes back to empty when the ignition is turned off.

Engine Oil Pressure Gauge

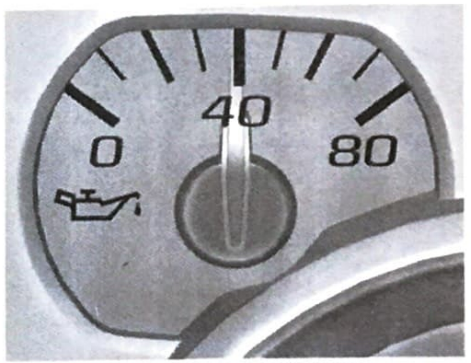

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Figure 9 English Oil Pressure Gauge

The engine oil pressure gauge shows the engine oil pressure in psi (pounds per square inch) or kPa (kilopascals) when the engine is running.

Oil pressure can vary with engine speed, outside temperature, coolant temperature, and oil viscosity.

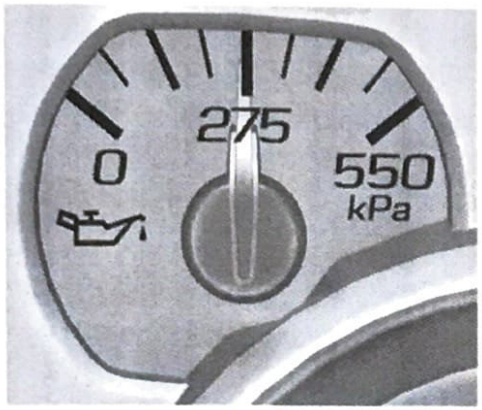

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Figure 10 Metric Oil Pressure Gauge

On some models, the oil pump will vary engine oil pressure according to engine needs. Oil pressure may change quickly as the engine speed or load varies. This is normal. If the oil pressure warning light or Driver Information Center (DIC) message indicates oil pressure outside the normal operating range, check the vehicle's oil as soon as possible.

See *Checking Engine Oil* (page 73).

CAUTION

To prevent engine damage, always follow the maintenance schedule for changing oil. Driving with the engine oil low can damage the engine and the repairs would not be covered by the vehicle warranty. Check the oil level as soon as possible. Add oil if required, but if the oil level is within the operating range and the oil pressure is still low, have the vehicle serviced.

Engine Coolant Temperature Gauge

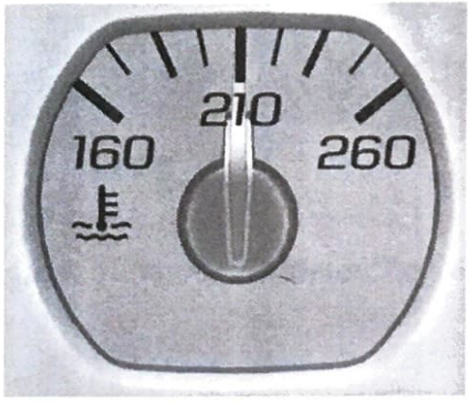

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Figure 11 English Coolant Temperature Gauge

This gauge measures the temperature of the vehicle's engine coolant.

While driving under normal operating conditions, if the needle moves into the red warning area, the engine is too hot. Pull off the road, stop the vehicle, and turn off the engine as soon as possible.

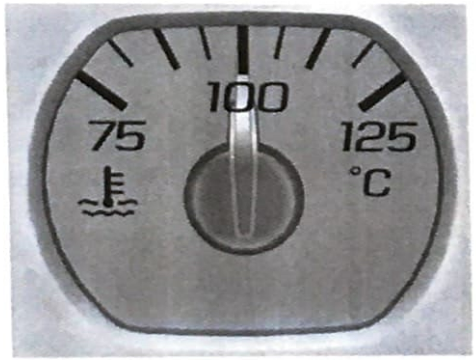

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Figure 12 Metric Coolant Temperature Gauge

Malfunction Indicator Lamp (Check Engine Light)

This light is part of the vehicle's emission control on-board diagnostic system. If this light is on while the engine is running, a malfunction has been detected and the vehicle may require service. The light should come on to show that it is working when the ignition is on with the engine not running. See *Ignition Positions* in the vehicle's Operation and Maintenance Manual.

This light may also come on when the system has detected a problem with the Diesel Exhaust Fluid (DEF) management system. See *Diesel Exhaust Fluid* (page 47).

0000429892

Figure 13 Check Engine Light

Malfunctions are often indicated by the system before any problem is noticeable. Being aware of the light and seeking service promptly when it comes on may prevent damage.

CAUTION

To prevent property damage, do not drive the vehicle continually with the check engine light on. The emission control system may not work as well, the fuel economy may be lower, and the vehicle may not run smoothly. This could lead to repairs that might not be covered by the vehicle warranty.

CAUTION

To prevent property damage, do not modify the engine, transmission, exhaust, intake, or fuel system, or use replacement tires that do not meet the original tire specifications. Such modifications can cause this light to come on and can lead to repairs not covered by the vehicle warranty. This could also affect the vehicle's ability to pass an Emissions Inspection / Maintenance test. See Engine Operation and Maintenance Manual.

When the light is on, a malfunction has been detected. Diagnosis and service may be required.

Poor fuel quality can cause inefficient engine operation and poor driveability, which may go away once the engine is warmed up. If this occurs, change the fuel brand.

It may require at least one full tank of the proper fuel to turn the light off. See *Fuel for Diesel Engines* (page 18). If the light remains on, see your dealer.

EMISSIONS INSPECTION AND MAINTENANCE PROGRAMS

If the vehicle requires an Emissions Inspection/Maintenance test, the test equipment will likely connect to the vehicle's Data Link Connector (DLC).

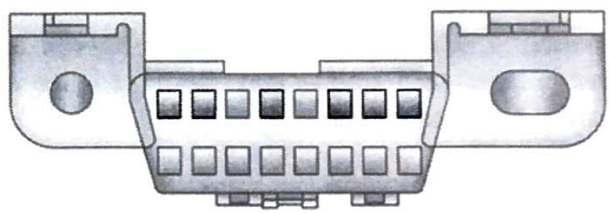

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Figure 14 Data Link Connector

The DLC is under the instrument panel to the left of the steering wheel. Connecting devices that are not used to perform an Emissions Inspection/Maintenance test or to service the vehicle may affect vehicle operation. See *Add-On Electrical Equipment* in the vehicle Operation and Maintenance Manual. See your dealer if assistance is needed.

The vehicle may not pass inspection if:

- The light is on when the engine is running.
- The light does not come on when the ignition is on with the engine not running.
- Critical emission control systems have not been completely diagnosed. If this happens, the vehicle would not be ready for inspection and might require several days of routine driving before the system is ready for inspection. This can happen if the 12-volt battery has recently been replaced or run down, or if the vehicle has recently been serviced.

See your dealer if the vehicle will not pass or cannot be made ready for the test.

Wait-to-Start Light

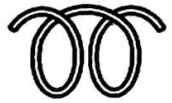

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Figure 15 Wait-to-Start Light

This light comes on briefly while starting the engine, as a check to show the light is working.

If the wait-to-start light comes on, the glow plug system is required and operating. Wait until the light turns off before starting the engine. This light may not come on in warm temperatures.

The fast warm-up glow plug system makes the wait-to-start light stay on for a shorter amount of time than most diesel engines.

See *Starting the Diesel Engine* (page 37).

Diesel Exhaust Fluid (DEF) Warning Light

0000429793

Figure 16 DEF Warning Light

This light, a Driver Information Center (DIC) message, and a chime come on when there is an issue with the Diesel Exhaust Fluid.

If the DEF level has not been corrected, the light will continue to flash when the vehicle is started. The vehicle's speed may also be limited.

Also see *Diesel Exhaust Fluid* (page 47).

Starting the Diesel Engine

The diesel engine starts differently than a gasoline engine.

CAUTION

To prevent damage to the hydraulic power steering system and possible loss of power steering assist, do not turn the steering wheel until it reaches the end of its travel and hold it in that position while starting the vehicle.

Move the shift lever to Park (P) or Neutral (N). To restart the engine when the vehicle is already moving, use Neutral (N) only.

CAUTION

To prevent transmission damage, do not try to shift to Park (P) while the vehicle is moving. Shift to Park (P) only when the vehicle is stopped.

STARTING THE ENGINE

1. Turn the ignition key to ON / RUN.

   Observe the wait-to-start light. See *Wait-to-Start Light* (page 32). This light may not come on if the engine is warm.

2. If the wait-to-start light is on, wait until this light goes off. Turn the ignition key to START, then release the ignition key. The engine will continue to crank until the engine starts.

   The engine has a fast warm-up glow plug system. The wait-to-start light will illuminate for a much shorter time than most diesel engines, due to the rapid heating of the glow plug system.

   CAUTION

   To prevent property damage, have the vehicle serviced right away if the wait-to-start light stays on after starting the vehicle. The vehicle may not run properly.

3. If the engine does not start after 15 seconds of cranking, turn the ignition switch to OFF. Wait one minute for the cranking motor to cool, then try the same steps again.

If you are trying to start the engine after you have run out of fuel, follow the steps in *Running Out of Fuel* (page 53).

When the engine is cold, let it run for a few minutes before driving. This lets oil pressure build up. The engine will sound louder when it is cold.

For turbo protection, engine power at speeds above idle may be limited if the engine is cold. This protection can last up to a maximum of 40 seconds at extreme cold coolant and ambient temperatures.

COLD WEATHER STARTING

Use the recommended engine oil when the outside temperature drops below freezing. See *Engine Oil* (page 24). When the outside temperature drops below 0°F (-18°C), use of the engine coolant heater is recommended.

If you experience longer cranking times, notice an unusual amount of exhaust smoke, or are at higher elevations (over 7,000 ft or 2 135m), you may use the engine coolant heater. See *Engine Heater* (page 38).

See *Fuel for Diesel Engines* (page 18) for information on what fuel to use in cold weather.

IF THE DIESEL ENGINE WILL NOT START

If the vehicle runs out of fuel, see *Running Out of Fuel* (page 53).

If the vehicle is not out of fuel, and the engine will not start:

Turn the ignition key to ON / RUN. After the wait-to-start light goes off, turn the ignition key to START.

If the light does not go off, wait a few seconds, then try starting the engine again. See your dealer as soon as possible for a starting system check.

If the light comes on and then goes off and you know the batteries are charged, but the engine still will not start, the vehicle needs service.

If the light does not come on when the engine is cold, the vehicle needs service. If the batteries do not have enough charge to start the engine, see *Battery* in Vehicle Operation and Maintenance Manual.

Check that the correct engine oil has been used and changed at appropriate intervals. If the wrong oil is used, the engine may be harder to start.

Be sure you are using the proper fuel for existing weather conditions. See *Fuel for Diesel Engines* (page 18).

If the engine starts, runs a short time, then stops, the vehicle needs service.

⚠ WARNING

To prevent property damage, personal injury, and / or death, do not use volatile starting aids such as ether, propane, or gasoline in the engine air intake system. Glow plugs and / or grid heater will ignite vapors, which are an explosion hazard.

ENGINE IDLE VARIATIONS

Under certain conditions the engine idle speed can vary or be elevated. Change in idle speed is normal and does not indicate a problem. Normal conditions that can raise idle speed are low voltage, DPF regeneration, air conditioning compressor loads, and engine warmup. These speeds can range from approximately 600 to 1,000 rpm.

ELEVATED IDLE

The engine has a cold temperature high idle feature which elevates the engine idle speed from base idle to 1,050 to 1,100 rpm when outside temperatures are below 32°F (0°C), and the engine coolant temperature is below 150°F (65°C). This feature enhances heater performance by raising the engine coolant temperature faster.

To turn this feature on or off, see *Vehicle Personalization* in the Vehicle Operation and Maintenance Manual.

When the engine is started, it will slowly ramp up to the high idle speed after a delay of a few seconds up to approximately two minutes. For this method to work properly there must be no throttle or brake pedal faults.

The engine idle speed will return to normal once the following conditions are met:

- Engine coolant temperature reaches 150°F (65°C).
- Air intake temperature reaches 32°F (0°C).

The high idle speed will be temporarily interrupted and the engine speed will return to normal if any of the following conditions occur:

- The brake pedal is applied.
- The accelerator pedal is pressed.
- The transmission is shifted out of Park (P) or Neutral (P).
- Vehicle speed is detected.

Once these inputs are removed, the engine idle speed will slowly ramp back up to high idle after the normal delay, if the conditions for engine coolant temperature and air intake temperature are still met.

Engine Heater

The engine heater can provide easier starting and better fuel economy during engine warm-up in cold weather conditions at or below 0°F (-18°C). Vehicles with an engine heater should be plugged in at least four hours before starting. An internal thermostat in the plug-end of the cord may exist, which will prevent engine heater operation at temperatures above 0°F (-18°C).

⚠ WARNING

To prevent property damage, personal injury and / or death, do not plug in the engine block heater while the vehicle is parked in a garage or under a carport. Always park the vehicle in a clear open area away from buildings or structures.

TO USE THE ENGINE HEATER

1. Turn the engine OFF.

   Check the heater cord for damage. If it is damaged, do not use it. See your dealer for a replacement. Inspect the cord for damage yearly.

2. Plug the cord into a normal, grounded 110 volt AC outlet.

⚠ WARNING

To prevent property damage, personal injury and / or death, follow these usage guidelines for the heater cord:

- **Plug the cord into a three-prong electrical utility receptacle that is protected by a ground fault detection function. An ungrounded outlet could cause an electric shock.**
- **Use a weatherproof, heavy-duty, 15 amp-rated extension cord if needed. Failure to use the recommended extension cord in good operating condition, or using a damaged heater or extension cord, could make it overheat and cause a fire, property damage, electric shock, and injury.**
- **Do not operate the vehicle with the heater cord permanently attached to the vehicle. Possible heater cord and thermostat damage could occur.**
- **While in use, do not let the heater cord touch vehicle parts or sharp edges. Never close the hood on the heater cord.**
- **Before starting the vehicle, unplug the cord, reattach the cover to the plug, and securely fasten the cord. Keep the cord away from any moving parts.**

3. Before starting the engine, be sure to unplug, remove the cord and keep it away from moving engine parts. If you do not, it could be damaged.

The length of time the heater should remain plugged in depends on several factors. Ask a dealer in the area where you will be parking the vehicle for the best advice on this.

Diesel Particulate Filter (DPF)

This vehicle is equipped with a Diesel Particulate Filter (DPF) to meet emissions requirements. The DPF traps exhaust particulate matter generated by normal engine usage.

The DPF requires a unique exhaust tailpipe with an exhaust cooler. The exhaust cooler mixes air with the exhaust to lower the temperature before it leaves the tailpipe.

The DPF, the tailpipe, or other exhaust system components must not be altered. Inspect regularly and clean any mud or dirt from the exhaust cooler, especially where the exhaust cooler connects to the tailpipe and the openings where fresh air enters the cooler.

REGENERATION

The DPF will clean itself as part of normal operation. Several factors including fuel consumed, hours of engine operation, and miles driven are monitored by the Engine Control Module (ECM). The self-cleaning occurs approximately once per tank of fuel.

⚠ CAUTION

To prevent damage to DPF or related components, always use the required Ultra Low Sulfur Diesel (15 ppm sulfur maximum) or low ash CK-4 engine oil. Damage caused by using engine oil that does not meet these requirements would not be covered by the vehicle warranty.

Under certain driving conditions, such as stop-and-go traffic, the filter cannot clean itself. A message comes on when the DPF is dirty and needs to perform a self cleaning.

For the filter to clean itself, the vehicle must be driven above 30 mph (50 km/h) until the message goes off. This will take about 30 minutes.

⚠ WARNING

To prevent property damage, personal injury and / or death, do not park or idle for an extended period of time near or over papers, leaves, dry grass, or other things that can burn. During DPF self cleaning or extended idling, the exhaust gases are very hot. Keep the exhaust area clear of material that could ignite or burn. See *Parking over Things That Burn* in the vehicle Operation and Maintenance Manual.

⚠ CAUTION

To prevent damage to the DPF, avoid extended idling while the DPF warning message is displayed. The DPF system is not capable of self- cleaning at idle. During any extended idle operation, monitor the Driver Information Center for messages and take appropriate indicated action.

You will also notice a change in the exhaust sound and engine idle speed. This is normal.

If you continue to drive with the DPF warning message on and the exhaust filter is not cleaned as required, the malfunction indicator lamp and the ENGINE POWER IS REDUCED message will come on and dealer service is necessary. See *Malfunction Indicator Lamp (Check Engine Light)* (page 31).

Vehicles with the DPF have specific fuel and engine oil requirements. See *What Fuel to Use in the U.S.* and *Engine Oil* (page 24).

Extended idling in Park (P) can cause exhaust parts and gases to become very hot. Keep the exhaust area clear of material that could ignite or burn. See *Parking over Things That Burn* in the Vehicle Operations and Maintenance Manual.

If equipped with Power Take-Off (PTO), monitor the instrument cluster for lights related to the DPF. See *Accessories and Modifications* for important information if you are considering adding accessories or modifying the vehicle.

CLEANING

If on-vehicle regeneration is unsuccessful at removing soot from the DPF, the DPF may need to be removed from the vehicle and be cleaned with the appropriate machinery and processes.

Ash residue in the DPF comes primarily from fuel and oil additives and will not burn or pass through the DPF. Ash residue accumulates very slowly in the DPF, but must eventually be removed to prevent excessive exhaust backpressure. If the DPF needs to have nonregenerable soot or the ash residue removed, please take the vehicle to a dealer.

MANUAL (PARKED) REGENERATION PROCEDURE

If equipped, this feature allows for manual cleaning/regeneration of the Diesel Particulate Filter (DPF) when it is unable to clean itself. It may be necessary to perform a manual regeneration if driving conditions — such as extended slow speed, stop-and-go traffic, extended idles, short drive cycles, or stationary PTO operation — prevent DPF self-cleaning.

To verify that the vehicle has this feature, refer to the Line Set Ticket. If the vehicle includes this feature, feature code 07XAA will be listed.

Manual regeneration can only be used when the DPF has become at least 90% full. At 100% full, it will attempt to automatically self-clean if proper driving conditions are met. The DPF will clean itself if the vehicle can be driven above 30 mph (50 km/h) for about 30 minutes.

⚠ WARNING

To prevent property damage, personal injury and / or death, never leave the vehicle unattended during a manual regeneration. The exhaust system and exhaust gases get very hot. Things that burn could touch the exhaust parts under than vehicle and catch fire.

1. Park the vehicle on level ground outdoors, safely off the roadway and away from flammable materials, walls, and buildings.
2. Scroll through the Driver Information Center (DIC) pages to find the Exhaust Cleaning menu. Depending on whether the vehicle has a base or uplevel cluster, it may be under the Settings menu.

   If the vehicle could not be stopped when the DIC message first indicated cleaning was available, automatic self-cleaning may have begun. If conditions cannot be met for self-cleaning to complete, and manual regeneration is selected, it may take up to four minutes for the system to switch to manual regeneration. When the switch occurs, a DIC message prompts to start the cleaning process.
3. Verify that the following safety conditions are met:
   - The vehicle is at least 10 ft (3 m) from any obstructions or materials that may combust or melt.
   - The shift lever is in Park (P).
   - The fuel tank is at least one-eighth full.
   - All fluids are at the proper level.
   - No diagnostic trouble codes have been set and the malfunction indicator lamp is not on.
   - The engine coolant temperature is above 160°F (71°C)
4. Press the trip odometer reset stem or ✓ on the steering wheel control for at least one second to select Start on the infotainment display.
5. Follow the instructions in the DIC messages. Touch ACCEPT to acknowledge that all of the safety conditions have been met and to activate regeneration.

   If the infotainment display returns to the previous screen, then one or more of the necessary operating conditions has not been met.
6. Continue to follow the instructions in the DIC messages. Hold the Exhaust Brake switch on the instrument panel below the climate controls for more than three seconds, and then release it, to begin the regeneration process.
   - If the EXHAUST BRAKE ON message displays, then the switch was released too soon. Press it again to turn off the exhaust brake. Then, try again when prompted by the DIC message.

7. When manual regeneration begins, the engine speed increases, the engine cooling fan sound increases, and a DIC message indicates that cleaning is in progress.
8. Cleaning could take up to 30 minutes. A DIC message will indicate when it is complete.
9. Upon completion, the engine will return to normal idle, but exhaust components will remain hot for several minutes. Do not move the vehicle until the exhaust has had time to cool.

Manual regeneration can be canceled at any time by pressing the brake pedal or turning the engine off. Unusual noises may be heard if regeneration is interrupted.

Diesel Exhaust Fluid

⚠ WARNING

To prevent property damage, personal injury and / or death, do not allow Diesel Exhaust Fluid (DEF) to come in contact with your skin, eyes, or the finished surfaces of the vehicle. DEF is corrosive. Wear skin and eye protection when handling. Inhalation may cause irritation to the upper respiratory tract. For more safety and storage information, see the label of the Diesel Exhaust Fluid container.

⚠ CAUTION

To prevent property damage, proper care should be taken when handling, dispensing, or transporting DEF, as it is corrosive to some metals and materials.

Diesel Exhaust Fluid (DEF) is nontoxic, nonflammable, and biodegradable. It is a carefully blended aqueous urea solution of 32.5% high-purity urea and 67.5% deionized water.

If stored between 10° and 90°F (-12° and 32°C), DEF has shelf life of 12 months minimum. For best shelf life, DEF containers should be stored in a controlled environment out of direct sunlight.

The amount of DEF consumption depends on engine speed, load, and altitude; therefore, it differs from vehicle to vehicle.

Navistar recommends using Fleetrite® brand Diesel Exhaust Fluid.

FILLING THE DEF TANK

CAUTION

To prevent property damage, do not use tap water to rinse components that will be used to deliver diesel exhaust fluid. Tap water will contaminate the diesel exhaust fluid and may cause the engine to be derated. If distilled water is not available, rinse with tap water and then rinse with diesel exhaust fluid.

CAUTION

To prevent property damage, Navistar, Inc. requires the use of Diesel Exhaust Fluid (DEF) that meets or exceeds ISO-22241-1. There is no acceptable substitute.

CAUTION

To prevent vehicle / property / component damage, ALWAYS verify the appropriate fluid is used when filling the DEF tank or the Fuel tank, significant damage can occur if incorrect fluid is used.

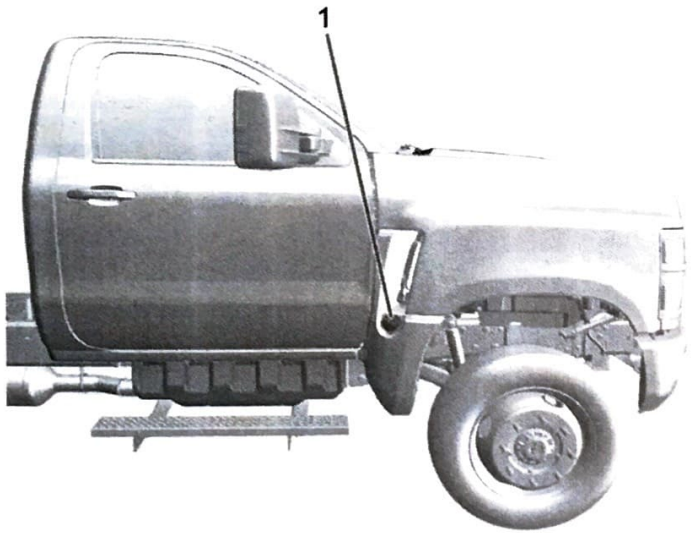

Figure 17 DEF Filler Cap Location

1. DEF filler cap

The DEF filler cap on this vehicle is BLUE in order to differentiate it from the fuel filler cap. It is located on the passenger side quarter fender, just in front of the passenger door.

Use only ISO 22241-1 approved DEF to ensure proper purity and concentration.

Do not overfill the DEF tank. When fluid reaches the top of the fill pipe, stop filling.

If you spill DEF on the vehicle while filling the tank, rinse the area with water and wipe the surface with a damp cloth.

In certain cold conditions, it is possible to find some frozen DEF in the DEF fill pipe. If this condition prevents the filling of the DEF tank, place the vehicle in a warm garage overnight.

EXHAUST FLUID LOW

WARNING

To prevent property damage, personal injury, and / or death, maintain the adequate Diesel Exhaust Fluid (DEF) level to avoid a loss of engine power and vehicle speed.

A full DEF tank will last for several thousand miles (kilometers), depending on vehicle usage.

As the DEF level drops, the Driver Information Center (DIC) will display warnings. DEF level status is available on the DIC under the vehicle Information button. See "Diesel Exhaust Fluid Level" in *Driver Information Center (DIC) (Base Level)* or *Driver Information Center (DIC) (Uplevel)* in the vehicle Operation and Maintenance Manual.

To avoid vehicle speed limitations, fill the DEF tank at the first opportunity after a low fluid level warning. If DEF is added before the EXHAUST FLUID EMPTY REFILL NOW message appears, it may take several mi/km for the DIC message to update.

If vehicle speed has been limited and DEF has been added, it may take up to 30 seconds after engine start with the vehicle stopped for the refill message to clear. If the vehicle is driven before the DIC message clears, vehicle speed will still be limited. If the DIC message clears while driving, the speed limitation will be removed gradually.

If DEF is added under freezing conditions, additional time may be required to remove speed limitations, and it may require less fluid to fill the DEF tank.

Fill the DEF tank. See *Filling the DEF Tank*, earlier in this section.

EXHAUST FLUID QUALITY POOR

WARNING

To prevent property damage, personal injury, and / or death, seek service immediately if a DEF contamination fault is detected. Failure to resolve the problems may result in a loss of engine power and vehicle speed, and may cause an accident.

CAUTION

To prevent property damage, Navistar, Inc. requires the use of Diesel Exhaust Fluid (DEF) that meets or exceeds ISO-22241-1. There is no acceptable substitute.

Poor quality DEF fluid may be the result of any of the following conditions:

- An incorrect liquid is detected in the DEF tank
- DEF fluid is contaminated or diluted
- DEF fluid has degraded significantly in quality over time (is past its expiration date)

If the system detects any of these conditions, the Driver Information Center (DIC) will display EXHAUST FLUID QUALITY POOR - SEE OWNERS MANUAL NOW and will show the distance until vehicle speed is limited.

The speed limitation will occur in a series of steps, with the final speed limitations being 5 mph (8 km/h) accompanied by a flashing warning light and chimes.

Adding fresh DEF to the system may resolve the problem, depending on several factors. If the message persists, see your dealer or additional messages may be displayed.

SERVICE EXHAUST FLUID SYSTEM

WARNING

To prevent property damage, personal injury, and / or death, seek service immediately if a ERVICE EXHAUST FLUID SYSTEM is detected. Failure to resolve the problems may result in a loss of engine power and vehicle speed, and may cause an accident.

When a problem with the Exhaust Fluid System is detected, a SERVICE EXHAUST FLUID SYSTEM — SEE OWNERS MANUAL NOW message appears in the Driver Information Center (DIC). Following this message, the DIC displays the distance until vehicle speed will be limited.

The speed limitation will occur in a series of steps, with the final speed limitations being 5 mph (8 km/h) accompanied by a flashing warning light and chimes.

In some cases, the message will clear itself, indicated that the DEF system was able to correct the condition. If the message persists, see your dealer or additional DIC messages may be displayed.

SERVICE EMISSION SYSTEM

⚠ WARNING

To prevent property damage, personal injury, and / or death, seek service immediately if a SERVICE EMISSION SYSTEM fault is detected. Failure to resolve the problems may result in a loss of engine power and vehicle speed, and may cause an accident.

If a problem occurs with the vehicle emission system, the Driver Information Center (DIC) will display the message SERVICE EMISSION SYSTEM - SEE OWNERS MANUAL NOW. Following this message, the DIC displays the distance until vehicle speed will be limited.

The speed limitation will occur in a series of steps, with the final speed limitations being 50 mph (80 km/h) accompanied by chimes.

In some cases, the message will clear itself, indicating that the emissions system was able to correct the condition. If the message persists, see your dealer or additional DIC messages may be displayed.

DEF TANK OPERATION

The DEF tank is located under passenger side of the vehicle cab.

The Selective Catalytic Reduction (SCR) system is designed to operate normally also under freezing conditions while containing DEF. Though DEF freezes at approximately 10°F (-12°C), no operator interaction is necessary when operating in cold temperatures.

Under cold or very dry conditions, water vapor can be seen coming from the vehicle tailpipe. This is normal system operation. The water vapor will disappear within a few minutes of normal vehicle operation.

After the key is turned OFF on a vehicle with an SCR system, a pumping sound may be heard from underneath the vehicle. The sound is made by the Aftertreatment DEF dosing unit while it purges any unused DEF from the system and returns it to the DEF tank. This is normal system operation. It takes about 70 seconds to complete.

⚠ CAUTION

To prevent vehicle / property damage, after turning the key OFF on a vehicle with SCR system, do not disconnect the vehicle batteries while you can hear a pumping sound from underneath the vehicle. The sound may last for about 60 seconds.

Exhaust Brake

The exhaust brake can be used to enhance the vehicle brake system and reduce brake lining wear.

Downshifts may be automatically selected to increase engine speed, which increases the effectiveness of the exhaust brake. The number of downshifts selected is determined by the length of time the brakes are applied and the rate the vehicle is slowing. The system delivers the correct amount of braking to assist in vehicle control. The heavier the vehicle load, the more active the engine exhaust brake will be. Use of the exhaust brake will help maintain vehicle speed when used with cruise control. See *Cruise Control* in the vehicle Operation and Maintenance Manual.

Automatic downshifts will not occur if the vehicle transmission is in Range Selection Mode. See *Manual Mode* in the vehicle Operation and Maintenance Manual.

The exhaust brake only activates when the transmission torque converter is locked. This can vary based on vehicle speed, gear, and load.

To activate the system, press the switch on the center stack.

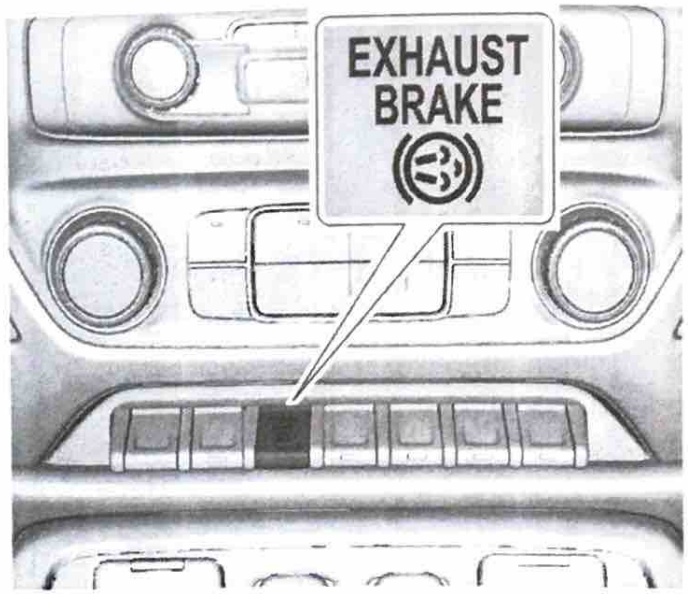

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Figure 18 Exhaust Brake Switch

A light in the switch will come on when the exhaust brake is activated. The switch must be pressed at each vehicle start for the system to be active.

The Driver Information Center (DIC) displays the message EXHAUST BRAKE ON for approximately three seconds, then clears.

To turn the brake off, press the exhaust brake switch a second time. The DIC displays the message EXHAUST BRAKE OFF for approximately three seconds, then clears.

The exhaust brake will be more active when in Tow / Haul Mode.

A light comes on in the instrument cluster when the exhaust brake and Tow / Haul are activated. The switch must be pressed at each vehicle start for the system to be active.

Engine Overheating

There is an engine coolant temperature gauge on the instrument cluster.

IF STEAM IS COMING FROM THE ENGINE COMPARTMENT

WARNING

To prevent property damage, personal injury and / or death, never turn the cap when the cooling system, including the pressure cap, is hot. Steam and scalding liquids from a hot cooling system are under pressure. Turning the pressure cap, even a little, can cause them to come out at high speed. Wait for the cooling system and pressure cap to cool.

CAUTION

To prevent property damage, do not run the engine if there is a leak in the engine cooling system. This can cause a loss of all coolant. Have any leaks fixed right away.

IF NO STEAM IS COMING FROM THE ENGINE COMPARTMENT

A Driver Information Center (DIC) message, along with a low coolant condition, can indicate a serious problem.

If there is an engine overheat warning and the vehicle does not have a low coolant condition, and no steam is heard or seen, the problem may not be too serious. Sometimes the engine can get a little too hot when the vehicle:

- Climbs a long hill on a hot day.
- Stops after high-speed driving.
- Idles for long periods in traffic.
- Tows a trailer. See "Driving on Grades" under *Driving Characteristics and Towing Tips* in the Vehicle Operation and Maintenance Manual.

If the DIC message comes on with no sign of steam, try this for a minute or so:

1. In heavy traffic, let the engine idle in Neutral (N) while stopped. If it is safe to do so, pull off the road, shift to Park (P) or Neutral (N), and let the engine idle.
2. Turn on the heater to full hot at the highest fan speed and open the window as necessary.

If the vehicle no longer has the overheat warning, the vehicle can be driven. Just to be safe, drive slower for about 10 minutes. If the warning does not come back on, drive normally and have the cooling system checked for proper fill and function.

If the warning continues, pull over, stop, and park the vehicle right away.

If there is still no sign of steam and the vehicle is equipped with an engine driven cooling fan, push down the accelerator until the engine speed is about twice as fast as normal idle speed for at least five minutes while the vehicle is parked. If the warning is still there, turn off the engine and get everyone out of the vehicle until it cools down.

The decision may be made not to open the hood, but to get service help right away.

Fuel

Filling the Tank

WARNING

To prevent property damage, personal injury and / or death:

- **Read and follow all the instructions on the fuel sending unit island.**
- **Turn off the engine when refueling.**
- **Keep sparks, flames, and smoking materials away from fuel.**
- **Do not leave the fuel pump unattended.**
- **Do not use a cell phone while refueling.**
- **Do not re-enter the vehicle while pumping fuel.**
- **Keep children away from the fuel pump and never let children pump fuel.**
- **Open the fuel cap slowly and wait for any hiss noise to stop, then unscrew the cap all the way. Fuel can spray out if the fuel cap is opened too quickly. This spray can happen if the tank is nearly full, and is more likely to occur in hot weather.**

To remove the fuel cap, turn it slowly counterclockwise.

Dual Tank Fueling

Dual tank vehicles are equipped with a master / slave transfer system which equalizes the fuel temperature and level between the dual tanks by feeding fuel from the rear tank to the mid-vehicle tank as needed. However, the tanks must be filled separately.

If your vehicle is equipped with dual fuel tanks, each tank must be filled through its own fill port. When refueling, be sure that both tanks are filled completely.

Fueling Precautions

WARNING

To prevent property damage, personal injury, and / or death, do not overfill the fuel tank. An overfilled tank may leak, causing fuel spray and fire. The advertised capacity of the fuel tank is the sum of the indicated capacity on the fuel gauge and the reserve fuel in the tank, after the gauge indicates empty.

Federal Motor Carrier Safety Regulations require the driver or any employee of a motor carrier to observe the following requirements:

- Do not fuel a motor vehicle with the engine running, except when it is necessary to run the engine to fuel the vehicle.
- Do not smoke or expose any open flame in the vicinity of a vehicle being fueled.
- Do not fuel a motor vehicle unless the nozzle of the fuel hose is continuously in contact with the intake pipe of the fuel tank.
- Do not permit any other person to engage in such activities as would be likely to result in fire or explosion.

Be careful not to spill fuel. Wait a few seconds after you have finished pumping before removing the nozzle. Clean fuel from painted surfaces as soon as possible.

Diesel fuel can foam when filling the tank. This can cause the automatic pump nozzle to shut off, even if the tank is not full. If this happens, wait for the foaming to stop, and then fill the tank more slowly.

⚠ WARNING

To prevent property damage, personal injury and / or death, fill the tank slowly and only until the nozzle shuts off. Do not top fuel off. Clean up any spilled fuel. Heat coming from the engine can cause the fuel to expand and force the fuel out of the tank. If something ignites the fuel, a fire could start.

When replacing the fuel cap, turn it clockwise until it clicks. Make sure the cap is fully installed.

⚠ WARNING

To prevent property damage, personal injury and / or death, do not remove the nozzle if a fire starts while you are refueling. Shut off the flow of fuel by shutting off the pump and / or by notifying the station attendant. Leave the area immediately.

⚠ CAUTION

To prevent damage to the fuel tank and emissions system, if a new fuel cap is needed, be sure to get the correct type of cap from your dealer. An incorrect type of cap might not fit properly.

Running Out of Fuel

WARNING

To prevent property damage, personal injury and / or death, catch any fuel from the air bleed value and wipe up any spilled fuel with a cloth. Diesel fuel is combustible. It could start a fire if it gets on hot engine parts.

If the engine has stalled due to running out of fuel, try the following steps to restart it:

1. If parked on a level surface, add at least 2 gal (7.6 L) of fuel. Up to 5 gal (18.9 L) may be needed if parked on a slope.
2. Follow the fuel priming procedure (page 57) to prime the fuel filter.
3. Turn the ignition key to START for 10 to 15 seconds at a time until the engine starts. If the engine tries to run, but does not run smoothly, increase the rpm slightly by using the accelerator pedal. This will help force air through the system.
4. Return to Step 2 if the engine stalls and will not restart.
5. After a few attempts, if the engine still does not start, see your dealer.

Accidental Refueling with Gasoline

CAUTION

To prevent fuel system damage, do not attempt to drive the vehicle if it has been accidentally refueled with gasoline. Have the vehicle towed to a qualified technician to have the gasoline removed from the tank and fuel system. Refuel with Ultra Low Sulfur Diesel fuel. It is also recommended to have the fuel system flushed with Ultra Low Sulfur Diesel, to ensure all gasoline is removed.

Cold Weather Operation

In cold weather, the fuel filter may become clogged by wax naturally present in the fuel. To unclog it, move the vehicle to a warm garage area and allow the filter to warm up. The fuel filter may need to be replaced. See *Fuel Filter Replacement* (page 58).

At temperatures below 32°F (0°C), it is recommended to avoid using biodiesel blends above 5% blend. This blend may cause fuel filter plugging, system gelling, and freezing that may affect vehicle starting. You may need to turn the ignition on and off a few times before the vehicle will start. Also, idle the vehicle for a couple of minutes before accelerating.

It is recommended to use Ultra Low Sulfur No. 1-D diesel fuel or a blend of No. 1-D and No. 2-D diesel fuel to enhance vehicle operation in cold weather at temperatures below 32°F (0°C). Use of No. 1-D diesel fuel may lower the fuel economy. For additional information for better cold weather operation, see *Engine Heater* (page 38).

Reserve Fuel

No extra supply of fuel for the propulsion of the vehicle or for the operation of accessories shall be carried on any motor vehicle, except in a properly mounted fuel tank or tanks.

Water in Fuel

Improper fuel tank inspection or cleaning, or contaminated fuel from suppliers, can cause water to be pumped into the fuel tank along with the diesel fuel. If a WATER IN FUEL SERVICE REQUIRED message displays, the water must be drained immediately.

⚠ WARNING

To prevent property damage, personal injury and / or death, if the fuel needs to be drained, keep sparks, flames, and smoking materials away from the mixture. Diesel fuel containing water is still combustible.

⚠ CAUTION

To prevent damage to the fuel system, do not allow water to stay in the fuel system. Water can corrode internal components and support fungus or bacteria growth. Even with a diesel fuel biocide, the fuel system may still need to be cleaned. Your dealer can advise of the appropriate solution.

If the fuel tank needs to be purged to remove water, see your dealer or a qualified technician. Improper purging can damage the fuel system and block the FOH.

Water in Fuel Troubleshooting

If the WATER IN FUEL SERVICE REQUIRED message comes on:

Problem	Recommended Action
Message displays but goes off during the ignition cycle.	The fuel filter is partially filled with water. Drain the water immediately. See "Removing Water from the Fuel Filter" following.
Message displays and stays on.	Drain the fuel filter immediately. If no water can be drained, and the temperature is below freezing, then water may be frozen in the filter. Move the vehicle to a warm location to thaw the water, then drain the fuel. If water still does not drain, see your dealer.
Immediately after refueling, message displays and stays on.	A large amount of water is in the fuel tank. Drain the fuel filter immediately. If the message stays on or comes back on without refueling, then fuel tank purging is required. See your dealer. If the message displays and the vehicle stalls or runs rough, do not drive until the water contaminated fuel is drained.

CAUTION

To prevent damage to the fuel injection system, do not drive while this message is displayed. If the message comes on right after a refuel, water was pumped into the fuel tank. Turn off the engine and drain the water immediately.

Removing Water from the Fuel Filter

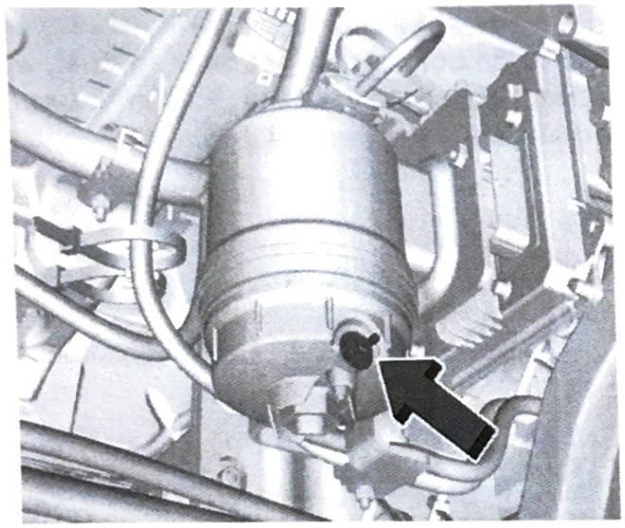

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Figure 19 Filter Drain Valve

To drain water:

1. Turn the engine OFF and set the parking brake.
2. Place a container under the filter drain valve. The filter drain valve is on the bottom of the fuel filter. The filter drain valve is under the vehicle on the driver side, inside the frame rail.
3. Open the drain valve by turning it counterclockwise. Allow the filter to drain until all of the water has been removed. Close the valve.
4. Properly dispose of the water contaminated fuel.
5. Start the engine and let it run for a few minutes. During the draining process, air may have entered the fuel system. If the engine stalls, the fuel system may need to be primed. See Fuel Priming following.

Fuel Priming

For the fuel system to work properly, the fuel lines must be full of fuel. If air gets in, the fuel lines need to be primed before operating the vehicle.

If air is present, the following may have happened:

- The vehicle ran out of fuel.
- The fuel filter was removed.
- The fuel lines were removed or disconnected.
- The fuel filter water drain valve was opened while the engine was running.

Priming the Fuel System

There is an electric priming pump that will bring fuel to the engine and eliminate air in the fuel lines. To prime the engine:

1. Correct any condition that caused the loss of prime.
2. Turn the ignition on for 30 seconds. Do not start the engine. The fuel sending unit will start priming.
3. Turn the ignition off, then back to START, and crank the engine for 15 seconds.
4. If the engine does not start, repeat Steps 2 and 3 until the engine starts. If the engine does not start after repeating Steps 2 and 3 three times, turn the ignition off for 60 seconds.
5. Repeat the above steps until the engine starts.
6. If the engine starts, but does not run smoothly, increase the engine speed slightly.
7. If the engine starts and runs but stalls again, turn the ignition off for 60 seconds.
8. When the engine starts, let it idle for a few minutes and check the filter for any leaks.

Fuel Filter Replacement

WARNING

To prevent property damage, personal injury and / or death, do not let diesel fuel get on hot engine parts, and keep matches or other ignition sources away. Diesel fuel is combustible. It could start a fire if something ignites it.

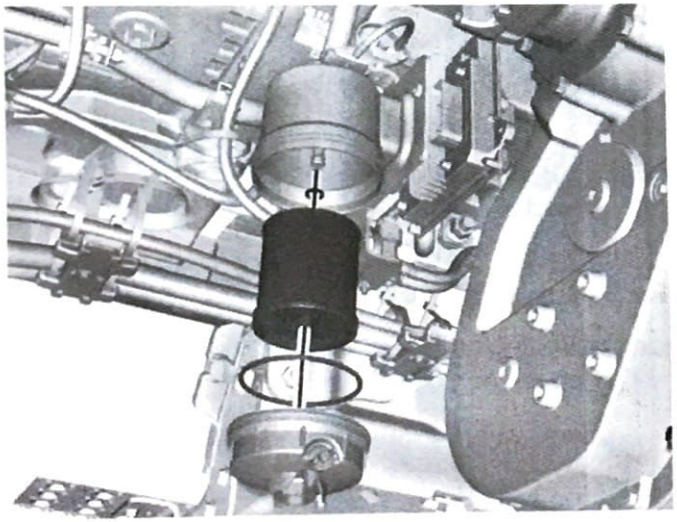

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Figure 20 Fuel Filter Element and Cap

The fuel filter is on the driver side, inside the frame rail.

To replace the fuel filter:

1. Drain any water from the filter. See "Removing Water from the Fuel Filter" in *Water in Fuel* (page 54).

   Keep the engine off until the procedure is completed.
2. Set the parking brake.
3. Remove the filter element cap by turning it counterclockwise.
4. Remove the filter element. If there is any dirt on the filter sealing surface, clean it off.
5. Install the new filter element and O-ring.
6. Reinstall and tighten the filter cap to the housing.
7. Use the fuel filter priming procedure to prime the fuel filter. See "Fuel Priming" in *Water in Fuel* (page 54).
8. Start the engine and let it idle for five minutes. Check the fuel filter and air bleed valve for leaks.
9. Reset the fuel filter monitor. See *Driver Information Center (DIC) (Base Level)* or *Driver Information Center (DIC) (Uplevel)* in the vehicle's Operation and Maintenance Manual.

Maintenance Schedule

Owner Checks and services

- At each fuel stop, check the engine oil level. See *Engine Oil* (page 73).

Required Services Every 7,500 mi / 12,000 km

- Check engine oil level and oil life percentage. If needed, change engine oil and filter, and reset oil life system. See *Engine Oil* (page 24) and *Engine Oil Life System* (page 75).
- Check engine coolant level. See *Cooling System* (page 61).
- Visually check for fluid leaks.
- Inspect engine air cleaner filter. See *Engine Air Cleaner/Filter* (page 68).
- Visually inspect fuel system for damage or leaks.

Service Interval Chart

	7,500 mi / 12,000 km	15,000 mi / 24,000 km	22,500 mi / 36,000 km	30,000 mi / 48,000 km	37,500 mi / 60,000 km	45,000 mi / 72,000 km	52,500 mi / 84,000 km	60,000 mi / 96,000 km	67,500 mi / 108,000 km	75,000 mi / 120,000 km	82,500 mi / 132,000 km	90,000 mi / 144,000 km	97,500 mi / 156,000 km	105,000 mi / 168,000 km	112,500 mi / 180,000 km	120,000 mi / 192,000 km	127,500 mi / 204,000 km	135,000 mi / 216,000 km	142,500 mi / 228,000 km	150,000 mi / 240,000 km
Perform *Required Services* (page 59).	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Replace engine air cleaner filter. (1)						✓						✓						✓		
Drain and fill engine cooling system. (2)																				✓
Replace fuel filter. (3)			✓			✓			✓			✓			✓			✓		

(1) Or every four years, whichever comes first. If driving in dusty conditions, inspect the filter at each oil change or more often as needed.

(2) Or every five years, whichever comes first. See *Cooling System* (page 61).

(3) Or every two years, or when the CHANGE FUEL FILTER message in the Driver Information Center (DIC) comes on, whichever comes first. The fuel filter may need to be replaced more often based on biodiesel usage, driving in climates with severe dust, off-road driving, or towing a trailer for extended periods.

Service Procedures

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (such as filters and rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING

To prevent personal injury and / or death, shift transmission to Park or Neutral, set parking brake, and install wheel chocks before performing diagnostic or service procedures.

WARNING

To prevent personal injury and / or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or dispose of clothing and rags contaminated with engine fluids.

Cooling System

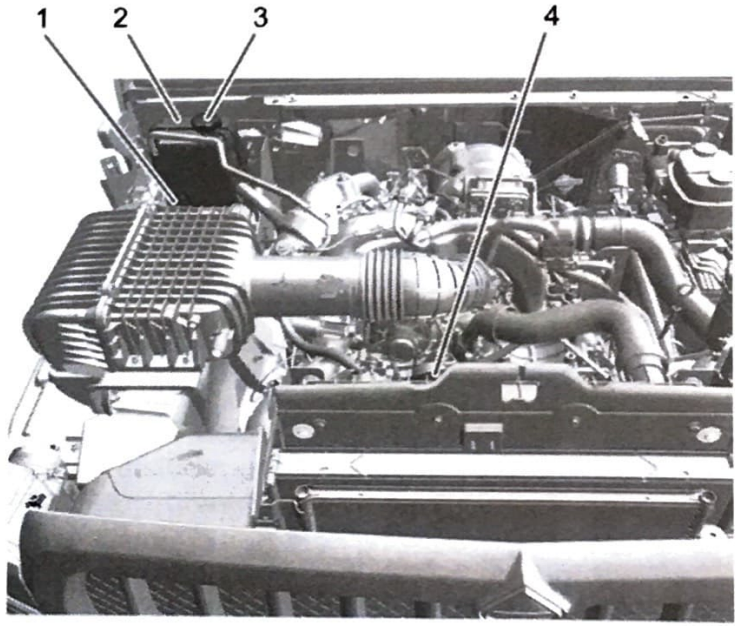

Figure 21 Cooling System Components

1. Coolant tank pressure cap (out of view)
2. Coolant deaeration tank
3. Coolant tank fill cap
4. Engine cooling fan (out of view)

The cooling system allows the engine to maintain the correct working temperature.

WARNING

To prevent property damage, personal injury and / or death, do not touch heater or radiator hoses, or other engine parts. They can be very hot. Do not run the engine if there is a leak; all coolant could leak out and cause an engine fire. Fix any leak before driving the vehicle.

The cooling system is filled at the factory with DEX-COOL® coolant. See *Engine Coolant* (page 25) for fluid requirements.

The following explains the cooling system and how to add coolant when it is low. If there is a problem with engine overheating, see *Engine Oveheating* (page 50).

Checking Coolant

The coolant level must be checked when the engine is cold and the vehicle must be on a level surface.

The coolant deaeration tank is in the engine compartment on the passenger side of the vehicle. See *Cooling System Components* (page 61) for location.

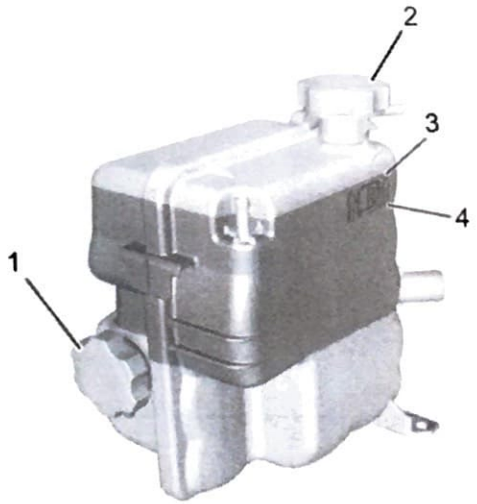

Figure 22 Coolant Deaeration Tank

1. Pressure cap (20 psi)
2. Fill cap
3. Max fill indicator (top of arrows)
4. Min fill indicator (bottom of arrows)

The coolant deaeration tank is divided into an upper reservoir and a lower reservoir. Coolant level in the upper reservoir should be at or above the bottom of the indicator arrows.

- If some coolant remains in the tank, add coolant until the coolant level reaches the top of the arrows. See *Coolant Topoff Procedure* (page 65).
- If the deaeration tank is empty, refill the tank according to the *Coolant Refill Procedure* procedure (page 66).

The lower portion will be mostly empty, depending on the operating temperature.

WARNING

To prevent property damage, personal injury and / or death, never turn the deaeration tank pressure cap — even a little — when the engine and radiator are hot. Turning the deaeration tank pressure cap when the engine and radiator are hot can allow steam and scalding liquids to blow out.

Coolant Fill Precautions

WARNING

To prevent property damage, personal injury and / or death, never turn the cap when the cooling system, including the pressure cap, is hot. Steam and scalding liquids from a hot cooling system are under pressure. Turning the pressure cap, even a little, can cause them to come out at high speed. Wait for the cooling system and pressure cap to cool.

WARNING

To prevent property damage, personal injury and / or death, avoid spilling coolant on hot engine parts. Coolant contains ethylene glycol and it will burn if the engine parts are hot enough.

WARNING

To prevent property damage, personal injury, and / or death, and to prevent hot coolant or steam, use only the following procedure to remove the pressure cap from the radiator or expansion tank. Allow the engine to cool first. Wrap a thick, heavy cloth around the cap. Unscrew the cap slowly to allow pressure to release from under the cap. After the pressure has been released, the pressure cap may be removed.

WARNING

To prevent property damage, personal injury, and / or death, do not exceed the pressure rating on the coolant deaeration tank cap. Ensure that the pressure rating of the coolant deaeration tank cap matches that listed on the side of the tank, or the tank may burst.

WARNING

To prevent property damage, personal injury and / or death, do not use plain water or other liquids, such as alcohol, in the radiator. With plain water or the wrong mixture, the engine could get too hot but there would not be an overheat warning. The engine could catch fire.

CAUTION

To prevent property damage, if the coolant should get extremely low and the engine very hot, let the engine cool for approximately 15 minutes before adding coolant; then, with the engine running, add coolant slowly. Adding cold coolant to a hot engine may crack the cylinder head or crankcase. Never use water alone.

CAUTION

To prevent property damage, follow the coolant fill procedures provided. Failure to do so could cause the engine to overheat.

If coolant level is not visible in the deaeration tank, follow provided refill procedure before attempting to drive the vehicle. If fluid remains low or returns to a low state within a few days, have the coolant system checked for leaks by a certified technician at the dealer.

CAUTION

To prevent engine damage, if coolant is changed or added, always add enough to fill the system completely.

Coolant Topoff Procedure

If some coolant remains in the tank, but the level is below the bottom of the arrows on tank side, add the proper DEX-COOL® coolant mixture at the deaeration tank, but be careful not to spill it.

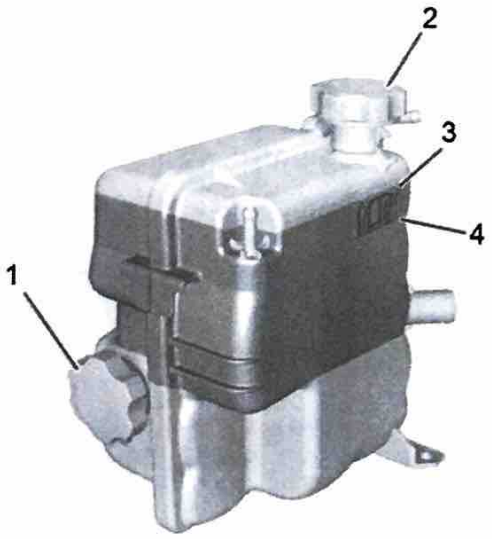

Figure 23 Coolant Deaeration Tank

1. Pressure cap (20 psi)
2. Fill cap
3. Max fill indicator (top of arrows)
4. Min fill indicator (bottom of arrows)

1. With the engine OFF, wait until the cooling system, including the coolant deaeration tank pressure cap and upper radiator hose, is no longer hot.
2. Remove coolant deaeration tank fill cap by turning the cap clockwise.
3. Slowly fill coolant deaeration tank from the fill cap opening. Continue filling until the coolant level in the bottle has reached the top of the arrows on the side of the tank.
4. Install fill cap and turn counterclockwise until tightly secured. Be sure both pressure cap and fill cap are securely installed and locked.

⚠ CAUTION

To prevent property damage, be sure the pressure cap is properly and tightly secured.

Coolant Refill Procedure

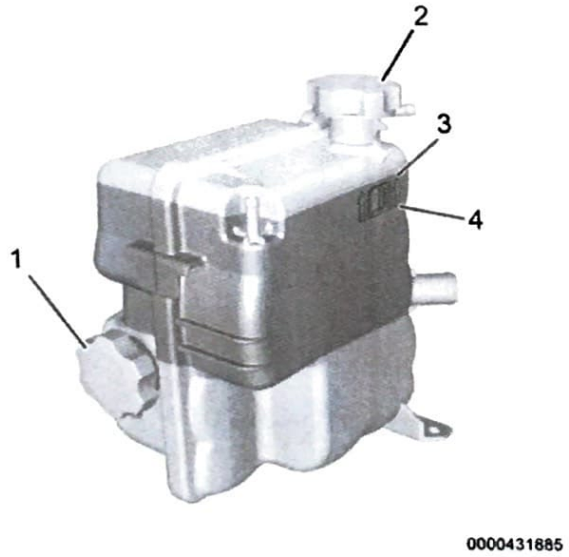

Figure 24 Coolant Deaeration Tank

1. Pressure cap (20 psi)
2. Fill cap
3. Max fill indicator (top of arrows)
4. Min fill indicator (bottom of arrows)

If the deaeration tank is empty, refill the tank according to the procedure below:

1. With the engine OFF, wait until the cooling system, including the coolant deaeration tank pressure cap and upper radiator hose, is no longer hot.
2. Turn the pressure cap slowly counterclockwise about one-half turn. If a hiss is heard, wait for it to stop. A hiss means there is still some pressure left. Keep turning the pressure cap slowly, and remove it.
3. Remove coolant deaeration tank fill cap by turning the cap clockwise.
4. Slowly fill coolant deaeration tank from the fill cap opening. Continue filling until the coolant level in the bottle has stabilized near top of fill neck.
5. Install fill cap and turn counterclockwise until tightly secured. DO NOT install pressure cap.
6. Start engine and let it run at idle for 5 minutes.
7. After 5 minutes at idle, press the accelerator to run the engine at high idle.
8. Run at high idle until the fan switches on and then continue at high idle for an additional 5 minutes.
9. Return the engine to idle speed, and turn ignition to OFF position.
10. Wait one hour for the vehicle cooling system to cool.
11. Check coolant level inside coolant deaeration tank. If level is lower than bottom of arrow on tank, slowly add more of recommended coolant mixture until it reaches top of fill neck.
12. Install pressure cap and turn clockwise until tightly secured. Be sure both pressure cap and fill cap are securely installed and locked.

13. Verify coolant level after engine is shut off and coolant is cold. If necessary, repeat coolant fill procedure steps 1-12.

If the coolant level is still low after having followed these steps twice, have the coolant system checked by a certified technician at the dealer for a possible leak.

CAUTION

To prevent property damage, be sure the pressure cap is properly and tightly secured.

Coolant Disposal

Never dispose of engine coolant by putting it in the trash, or by pouring it on the ground or into sewers, streams, or bodies of water. Have the coolant changed by an authorized service center, familiar with legal requirements regarding used coolant disposal. This will help protect the environment and your health.

Air Induction System

The air cleaner / filter assembly is on the front corner of the engine compartment on the passenger side of the vehicle.

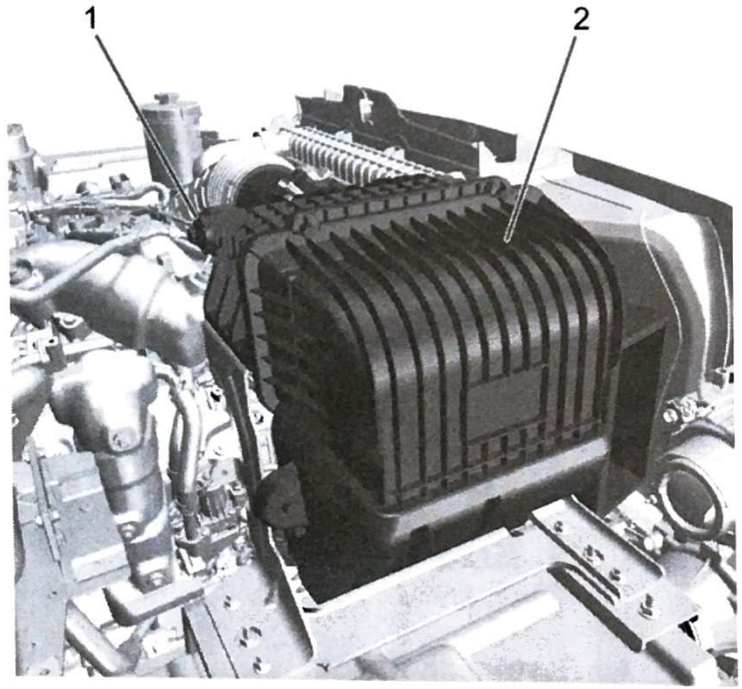

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Figure 25 Air Cleaner and Restriction Gauge

1. Air restriction gauge
2. Air cleaner

Air Restriction Gauge

An air restriction gauge is mounted on the rear of the engine air cleaner and is visible on the passenger side of the engine compartment.

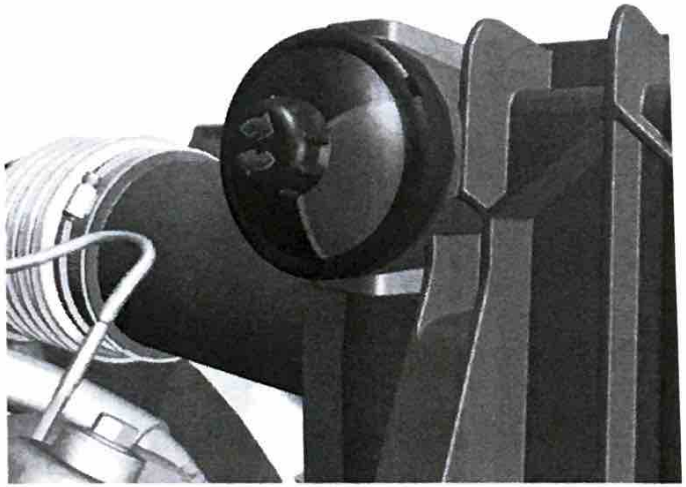

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Figure 26 Air Restriction Gauge

This gauge indicates how much engine air cleaner filter capacity has been used and how much filter capacity remains. It measures maximum restriction of the filter element when the engine is operated at full load and locks at that point. This feature gives the operator the capability of reading maximum restriction with the engine shut down.

If the gauge is in the RED zone, replace the air cleaner filter and then reset the gauge by twisting the BLACK knob until the gauge is in the GREEN zone.

The gauge should NOT be reset until it has been determined that air cleaner service is required.

Engine Air Cleaner / Filter

Do not start the engine or have the engine running with the engine air filter housing open. Before removing the engine air filter, make sure that the engine air filter housing and nearby components are free of dirt and debris. Remove the engine air filter. Lightly tap and shake the engine air filter (away from the vehicle) to release dust and dirt. Inspect the engine air filter for damage, and replace if damaged. Do not clean the engine air filter or components with water or compressed air. When changing the air filter, remove the dust valve from the front intake air duct and clean out any debris if necessary.

CAUTION

To prevent damage to the air filter or electrical components, do not spray water into or on the air intake box in the engine compartment.

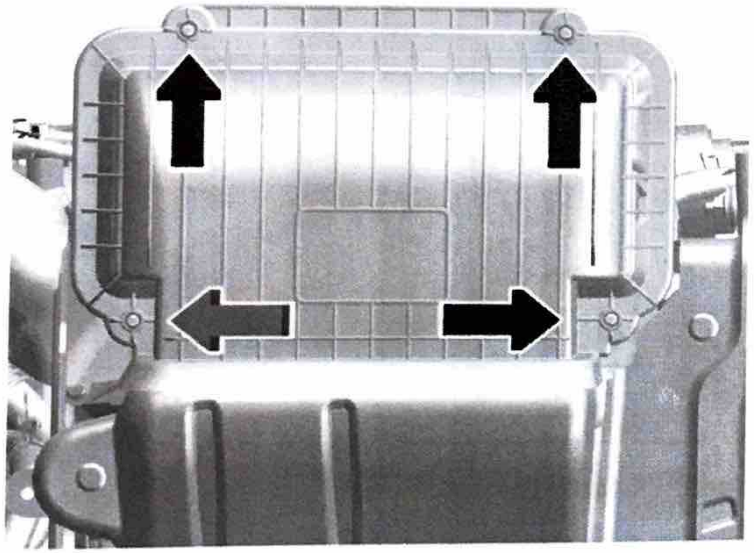

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Figure 27 Air Cleaner Housing Screws

To inspect and replace the filter:

1. Tilt the hood open. See *Hood* in the Vehicle Operation and Maintenance Manual.
2. Remove the four screws from the housing cover.
3. Raise the housing cover. Take care not to move the air cleaner / filter housing base, to avoid any air leaks.
4. Remove the air cleaner / filter from the housing base. Take care to dislodge as little dirt as possible.
5. Clean the air cleaner / filter sealing surface and the housing base.
6. Install the engine air cleaner/ filter.

⚠ CAUTION

To prevent damage to the air cleaner housing, do not overtighten the housing screws.

7. Lower the air cleaner / filter housing cover and secure with the four screws. Using a torque wrench, tighten screws to 25 - 35 lb-in (2.8 - 4.0 N•m).
8. Tilt the hood to close. See *Hood* in the vehicle Operation and Maintenance Manual.

See *Maintenance Schedule* (page 59) to determine when to replace the engine air cleaner / filter.

⚠ WARNING

To prevent property damage, personal injury and / or death, use caution when working on the engine and do not drive with the air cleaner / filter off. The air cleaner not only cleans the air; it helps to stop flames if the engine backfires.

⚠ CAUTION

To prevent engine damage, always have the air cleaner / filter in place when driving. If the air cleaner / filter is off, dirt can easily get into the engine.

Belt, Air Intake Piping and Clamps

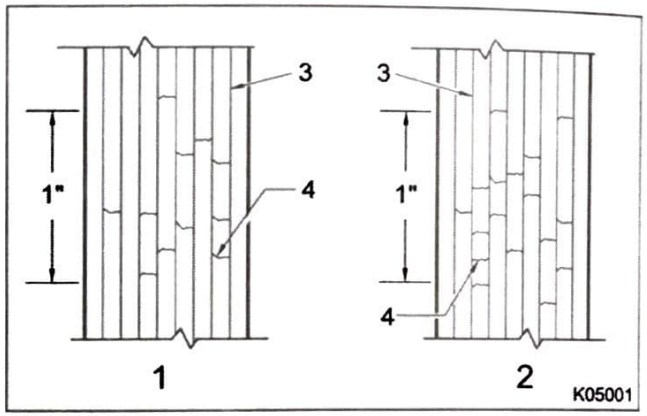

Figure 28 Cracks in Belt Ribs

1. Belt in good condition
2. Belt ready for replacement
3. Belt ribs
4. Cracks in belt

Inspect condition of all drive belts (Figure 28). Install a new belt if any of the following conditions exist:

- Excessive wear
- Missing material
- Grease or oil contamination
- Over three cracks per inch in a belt rib

AIR INTAKE PIPING AND CLAMPS

Inspect hoses, pipes, and clamps, and install new parts for any of the following conditions:

- Loose hoses or clamps (tighten or replace as required)
- Ruptured hoses
- Cracked air cleaner housing

Fan Belt Routing

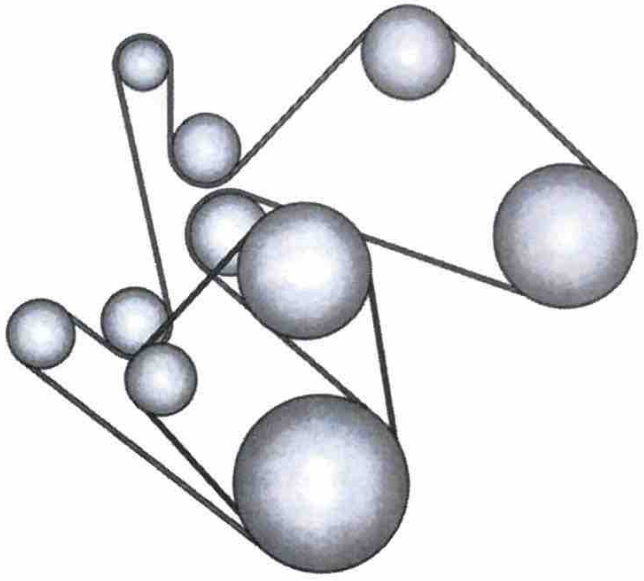

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Figure 29 Single Generator without Air Compressor

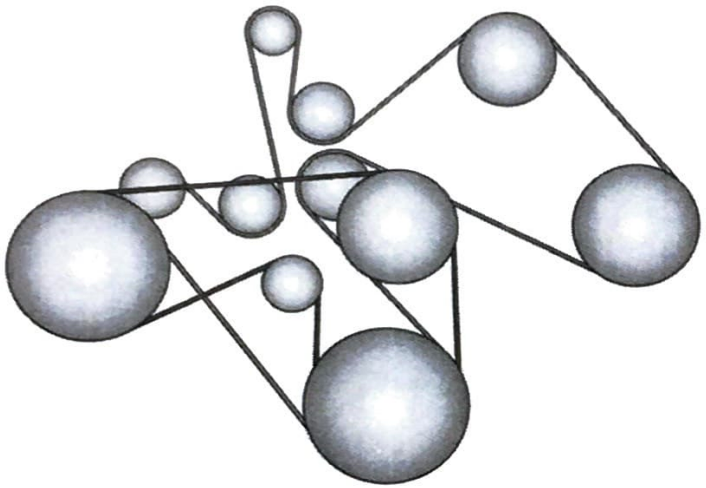

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Figure 30 Single Generator with Air Compressor

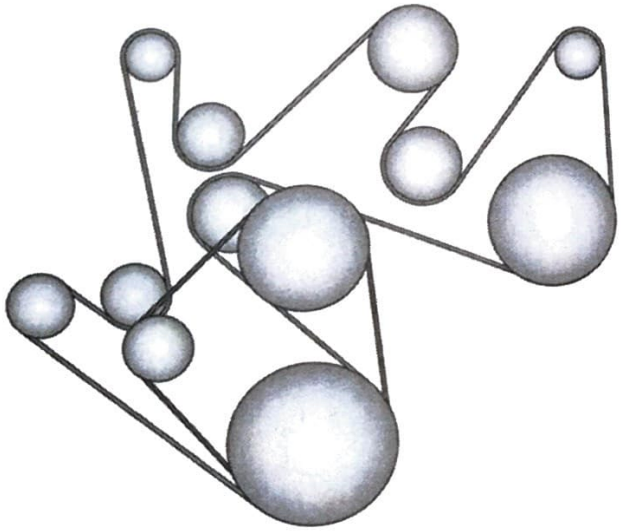

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Figure 31 Dual Generator without Air Compressor

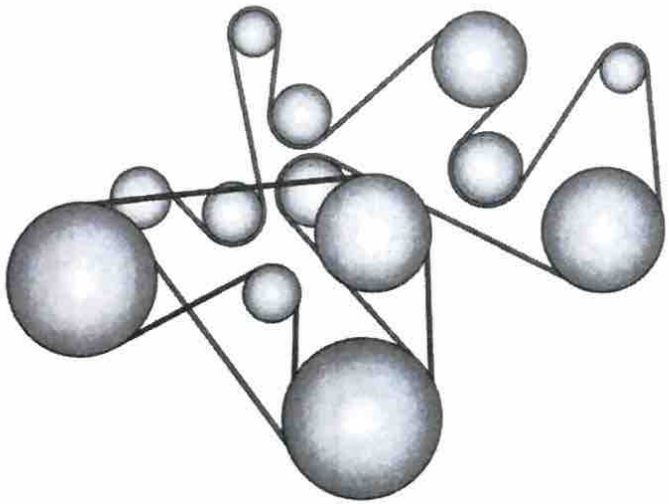

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Figure 32 Dual Generator with Air Compressor

Engine Oil

Checking Engine Oil

Check the engine oil level regularly, every 400 mi (650 km), especially prior to a long trip. The engine oil dipstick handle is a loop. See *Left-Side Engine Compartment* in the vehicle Operation and Maintenance Manual for the location.

⚠ WARNING

To prevent personal injury, use a towel or glove to touch the dipstick handle. The engine oil dipstick may be hot enough to burn you.

If a low oil Driver Information Center (DIC) message displays, check the oil level.

Follow these guidelines:

- To get an accurate reading, park the vehicle on level ground. Check the engine oil level after the engine has been off for at least two hours. Checking the engine oil level on steep grades or too soon after engine shutoff can result in incorrect readings. Accuracy improves when checking a cold engine prior to starting. Remove the dipstick and check the level.
- If unable to wait two hours, the engine must be off for at least 15 minutes if the engine is warm, or at least 30 minutes if the engine is not warm. Pull out the dipstick, wipe it with a clean paper towel or cloth, then push it back in all the way. Remove it again, keeping the tip down, and check the level.

When to Add Engine Oil

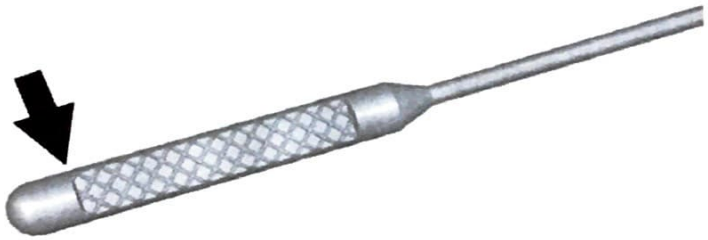

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Figure 33 Engine Oil Dipstick

If the oil is below the cross-hatched area at the tip of the dipstick and the engine has been off for at least 15 minutes, add 1 qt (1 L) of the recommended oil and then recheck the level. See "Selecting the Right Engine Oil" later in this section for an explanation of what kind of oil to use. For engine oil crankcase capacity, see *Engine Specifications* (page 15).

⚠ CAUTION

To prevent engine damage, do not add oil above the operating range shown on the dipstick. If you find that the oil level gets above the cross-hatched area that shows the proper operating range, the engine could be damaged. You should drain out the excess oil or limit driving of the vehicle and seek a service professional to remove the excess amount of oil.

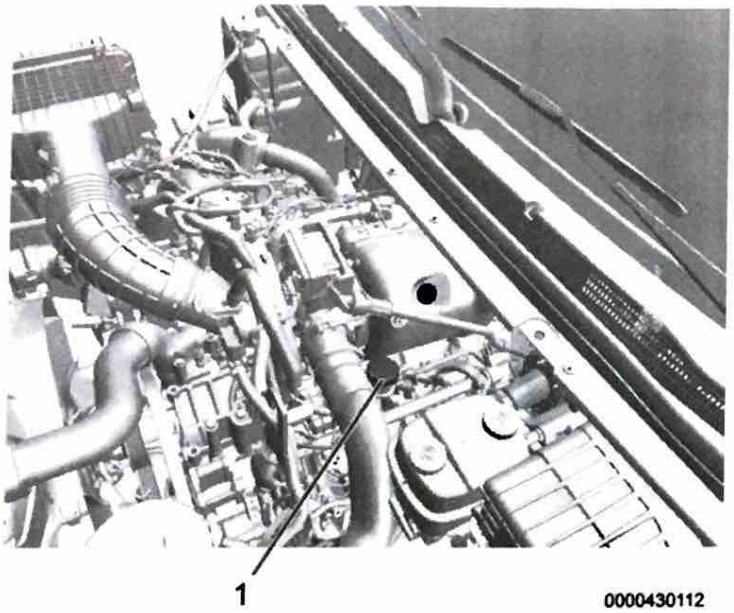

Figure 34 Engine Oil Fill Cap Location

1. Oil fill cap

Be sure to add enough oil to put the level somewhere in the proper operating range. Push the dipstick all the way back in when through.

When to Change the Oil

This vehicle has a computer system that indicates when to change the engine oil and filter. This is based on a combination of factors which include engine revolutions, engine temperature, and miles driven. Based on driving conditions, the mileage at which an oil change is indicated can vary considerably. For the oil life system to work properly, the system must be reset every time the oil is changed.

On some vehicles, when the system has calculated that oil life has been diminished, a CHANGE ENGINE OIL SOON message comes on to indicate that an oil change is necessary. Change the oil as soon as possible within the next 600 mi (1,000 km). It is possible that, if driving under the best conditions, the oil life system might indicate that an oil change is not necessary for up to a year. The engine oil and filter must be changed at least once a year and, at this time, the system must be reset. For vehicles without the CHANGE ENGINE OIL SOON message, an oil change is needed when the OIL LIFE REMAINING percentage is near 0%. Your dealer has trained service people who will perform this work and reset the system. It is also important to check the oil regularly over the course of an oil drain interval and keep it at the proper level.

If the system is ever reset accidentally, the oil must be changed at 3,000 mi (5,000 km) since the last oil change. Remember to reset the oil life system whenever the oil is changed.

How to Reset the Engine Oil Life System

Reset the system whenever the engine oil is changed so that the system can calculate the next engine oil change. Always reset the engine oil life to 100% after every oil change. It will not reset itself. To reset the engine oil life system:

1. Display the OIL LIFE REMAINING on the DIC. If the vehicle does not have DIC buttons, the vehicle must be in Park (P) to access this display. See *Driver Information Center (DIC) (Base Level)* or *Driver Information Center (DIC) (Uplevel)* in the vehicle's Operation and Maintenance Manual.

   Press and hold the checkmark icon, or the trip odometer reset stem if the vehicle does not have DIC buttons, for several seconds. The oil life will change to 100%.

The oil life system can also be reset as follows:

2. Display the OIL LIFE REMAINING on the DIC. See *Driver Information Center (DIC) (Base Level)* or *Driver Information Center (DIC) (Uplevel)* in the vehicle's Operation and Maintenance Manual.
3. Fully press the accelerator pedal slowly three times within five seconds.
4. Display the OIL LIFE REMAINING on the DIC. If the display shows 100%, the system is reset.

If the vehicle has a CHANGE ENGINE OIL SOON message and it comes back on when the vehicle is started and/or the OIL LIFE REMAINING is near 0%, the engine oil life system has not been reset. Repeat the procedure.

Electrical System

1. Check wiring harness for cracks, rubbing, and loose connections.
2. Check sensors for loose connections, corrosion, or cracks.
3. Check battery cables for the following conditions:
   - Broken insulation
   - Rubbing or chafing
   - Corroded or loose connections
4. Repair items identified.

General Information

To maintain warranty coverage, engines intended to be taken out of service or stored 30 days or longer require the following procedures. These procedures are also recommended for engines outside of warranty to ensure maximum engine life:

- Maintain a full fuel tank with the addition of diesel fuel stabilizer to minimize microbial growth within the fuel system. Run engine long enough to allow the fuel stabilizer to enter the entire fuel system. If the engine is utilized in a mobile application, drive vehicle to mix the stabilizer in the fuel tank.
- Before storage replace engine fuel filter(s) and drain all water separators of any water.
- Every 30 days or less, run engine until full operating temperature has been maintained.
- Before storage, change the engine oil and filter with the appropriate engine oil for conditions the engine will experience during storage.
- Cover air intake ducts to prevent moisture and debris intrusion during storage.
- Cover vertical exhaust pipe.
- Check the battery charge and recharge if needed. Disconnect the battery cables between batteries and between the batteries and vehicle. If freezing temperatures are expected, remove batteries and store in an area where the temperatures are above freezing. If battery removal is not required (warm climate), maintain the battery charge every 30 days.
- Test the cooling system, additive levels, and coolant freeze protection. Coolant freeze protection must be set below the coldest anticipated temperature during storage.

Maintenance Service Record

WARNING

To prevent property damage, personal injury, and / or death, read all safety instructions in the Safety Information section of this manual.

WARNING

To prevent property damage, personal injury, and / or death, shift transmission to Park or Neutral, set parking brake, and install wheel chocks before performing diagnostic or service procedures.

Save scheduled maintenance work orders and receipts for proof of correct maintenance. Failure to maintain work orders and receipts may affect your warranty coverage.

Maintenance Service Record

Date	Service Month	Service Hours	Miles (Km)	Item Serviced

Daily Care and Report

WARNING

To prevent property damage, personal injury, and / or death, read all safety instructions in the Safety Information section of this manual.

WARNING

To prevent property damage, personal injury, and / or death, shift transmission to Park or Neutral, set parking brake, and install wheel chocks before performing diagnostic or service procedures.

Check the following before engine operation to prevent engine failure. Report all problems for immediate service.

- Oil level
- Oil, air, fuel or coolant leaks
- Coolant system level
- Excessive consumption of crankcase lubricating oil, coolant or fuel
- Unusual engine noise

Perform the following before engine operation to prevent engine failure:

- Add coolant if necessary. Make sure filler cap seal is in good condition and the cap is installed tightly.
- Check the air filter element restriction gauge. When the YELLOW position indicator reaches and locks in the RED zone, a new air filter should be installed.
- Fill the fuel tank with correct fuel.
- Inspect external surfaces of the engine, around and between the radiators, and accessories. Clean as necessary.

Daily Care and Report

Model									
Serial No.									
Date	Miles	Fuel		Lube Oil	Parts		Labor		Service Performed
		Qty	Cost		Parts	Cost	Time	Cost	

List of Acronyms

ABS	Antilock Brake System
AFT	Aftertreatment
AIT	Air Intake Temperature
API	American Petroleum Institute
APP	Accelerator Pedal Position
AWL	Amber Warning Lamp
CAC	Charge Air Cooler
CAP	Cold Ambient Protection
CARB	California Air Resources Board
CKP	Crankshaft Position
CMP	Camshaft Position
CTC	Coolant Temperature Compensation
DEF	Diesel Exhaust Fluid
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
DSI	Down Stream Injection
DTC	Diagnostic Trouble Code
ECI	Engine Crank Inhibit
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EGR	Exhaust Gas Recirculation
ELC	Extended Life Coolant
EMA	Engine Truck and Manufacturers Association
EOP	Engine Oil Pressure
EOT	Engine Oil Temperature
EPA	Environmental Protection Agency
EST	Electronic Service Tool
EWPS	Engine Warning Protection System
GDP	Gear Down Protection
GVWR	Gross Vehicle Weight Rating
HD-OBD	Heavy-Duty On-Board Diagnostics
HEST	High Exhaust System Temperature
IAH	Intake Air Heater
IAHFI	Intake Air Heater Fuel Igniter
IAHFS	Intake Air Heater Fuel Solenoid
IAHR	Intake Air Heater Relay

IST	Idle Shutdown Timer
LSD	Low Sulfur Diesel
MIL	Malfunction Indicator Lamp
NO_x	Nitrogen Oxide
OEM	Original Equipment Manufacturer
PTO	Power Take Off
RESC	Remote Engine Speed Control
RSL	Road Speed Limiter
SAE	Society of Automotive Engineers
SCAs	Supplemental Coolant Additives
SCR	Selective Catalytic Reduction
ULSD	Ultra Low Sulfur Diesel
VSS	Vehicle Speed Sensor