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Abbreviations and Acronyms

ABS – Antilock Brake System
AC – Alternating Current
ACCEL – Accelerate
amp – Ampere
AMS – Air Management System
API – American Petroleum Institute
APS – Accelerator Position Sensor
ATA – American Trucking Association
AWA – Acoustic Wave Attenuator
BAP – Barometric Absolute Pressure
BCP – Brake Control Pressure
BDC – Bottom Dead Center
bhp – Brake horsepower
C – Celsius
CAC – Charge Air Cooler
CAN – Controller Area Network
CAN 1 – Controller Area Network (public)
CAN 2 – Controller Area Network (private)
CAP – Cold Ambient Protection
cc – Cubic centimeter
CDPF – Catalyzed Diesel Particulate Filter
cfs – Cubic feet per second
CKP – Crankshaft Position
CKPO – Crankshaft Position Output
cm – Centimeter
CMP – Camshaft Position
CMPO – Camshaft Position Output
CPU – Central Processing Unit
CTC – Coolant Temperature Compensation
DC – Direct Current
DDS – Driveline Disengagement Switch
DLC – Data Link Control
DMM – Digital Multimeter
DT – Diesel Turbocharged
DTC – Diagnostic Trouble Code
ECL – Engine Coolant Level
EBP – Exhaust Back Pressure
ECI – Engine Crank Inhibit
ECM – Electronic Control Module
ECT – Engine Coolant Temperature
EFAN – Engine Fan
EFRC – Engine Family Rating Code
EGR – Exhaust Gas Recirculating
EGRP – Exhaust Gas Recirculating Position
EOP – Engine Oil Pressure
EOT – Engine Oil Temperature
EPA – Environmental Protection Agency
EPR – Engine Pressure Regulator
ESC – Electronic System Controller
ESN – Engine Serial Number

EST – Electronic Service Tool
EURO – European
EVRT™ – Electronic Variable Response Turbocharger
EWPS – Engine Warning Protection System
F – Fahrenheit
ft – Feet
FMI – Failure Mode Indicator
gal – Gallon
gph – Gallons Per Hour
GVW – Gross Vehicle Weight
H₂O – Water
Hg – Mercury
hp – Horsepower
HT – High Torque
IAT – Intake Air Temperature
ICP – Injector Control Pressure
IDM – Injector Drive Module
IGN – Ignition
in – Inch
in Hg – Inches of mercury
in H₂O – Inches of water
INJ – Injector drive
IPR – Injection Pressure Regulator
ISIS® – International® Service Information Solutions
IST – Idle Shutdown Timer
IVS – Idle Validation Switch
kg – Kilogram
km – Kilometer
KOEO – Key-On Engine-Off
KOER – Key-On Engine-Running
kPa – Kilopascal
L – Liter
lb – Pound
lbf – Pounds of force
lbf•ft – Pounds of force per foot
lbf•in – Pounds of force per inch
m – Meter
m/s – Meters per second
MAP – Manifold Absolute Pressure
MAT – Manifold Air Temperature
mm – Millimeter
mph – Miles per hour
MY – Model Year
N – Newton
NEG – Negative
NETS – Navistar Electronics Technical Support
N•m – Newton meter
NO – Nitrogen Oxide
NO_x – Nitrogen Oxides
NSBU – Natural Start Backup Switch

OCC – Output Circuit Check
OL – Over Limit
PID – Parameter Identifier
P/N – Part Number
POS – Positive
POSE – Positive On Shaft Excluder
PROM – Programmable Read Only Memory
psi – Pounds per square inch
pt – Pint
PTO – Power Take Off
RAM – Random Access Memory
rev – Revolution
rpm – Revolutions per minute
ROM – Read Only Memory
RSE – Radiator Shutter Enable
SAE – Society of Automotive Engineers
SCCS – Speed Control Command Switches
SID – Subsystem Identifier
SO₂ – Sulfur Dioxide

SYNC – Synchronization
TACH – Tachometer output signal
TCAPE – Truck Computer Analysis of Performance and Economy
TDC – Top Dead Center
UVC – Under Valve Cover
V – Volt
V_{BAT} – Battery Voltage
V_{IGN} – Ignition Voltage
V_{REF} – Reference Voltage
V_{REF} A – Reference Voltage (engine)
V_{REF} B – Reference Voltage (chassis)
VGT – Variable Geometry Turbocharger
VIN – Vehicle Identification Number
VOP – Valve Opening Pressure
VSS – Vehicle Speed Sensor
WIF – Water In Fuel
WTEC – World Transmission Electronically Controlled automatic transmissions (Allison)

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Terminology

Accelerator Position Sensor (APS) – A potentiometer sensor that indicates the position of the accelerator pedal.

Accessory work – The work per cycle required to drive engine accessories (normally, only those essential to engine operation).

Actuator – A device that performs work in response to an input signal.

Aeration – The entrainment of gas (air or combustion gas) in the coolant, lubricant, or fuel.

After cooler (Charge Air Cooler) – A heat exchanger mounted in the charge air path between the turbocharger and engine intake manifold. The after cooler reduces the charge air temperature by transferring heat from the charge air to a cooling medium (usually air).

Air Management System (AMS) – The AMS controls and directs air through the intake and exhaust which affects engine performance and controls emissions.

Alternating Current (AC) – An electric current that reverses its direction at regularly recurring intervals.

Ambient temperature – The environmental air temperature in which a unit is operating. In general, the temperature is measured in the shade (no solar radiation) and represents the air temperature for other engine cooling performance measurement purposes. Air entering the radiator may or may not be the same ambient due to possible heating from other sources or recirculation. (SAE J1004 SEP81)

Ampere (amp) – The standard unit for measuring the strength of an electrical current. The flow rate of a charge in a conductor or conducting medium of one coulomb per second. (SAE J1213 NOV82)

Analog – A continuously variable voltage.

Analog to digital converter (A/D) – A circuit in the ECM processing section that converts an analog signal (DC or AC) to a usable digital signal for the microprocessor.

American Trucking Association (ATA) Data link – A serial data link specified by the American Trucking Association and the SAE.

Acoustic Wave Attenuator – A component of the high-pressure oil rail designed to reduce hydraulic fluctuations resulting in a decrease of acoustic energy.

Barometric Absolute Pressure (BAP) sensor – A variable capacitance sensor which, when supplied with a 5 volt reference signal from the ECM, produces a linear analog voltage signal indicating atmospheric pressure.

Boost pressure – 1. The pressure of the charge air leaving the turbocharger.

2. Inlet manifold pressure that is greater than atmospheric pressure. Obtained by turbocharging.

Bottom Dead Center (BDC) – The lowest position of the piston during the stroke.

Brake Control Pressure (BCP) sensor – The BCP sensor is a variable capacitance sensor that senses the oil pressure in the brake galley of the high-pressure oil rail.

Brake Horsepower (bhp) – The power output from an engine, not the indicated horsepower. The power output of an engine, sometimes called flywheel horsepower is less than the indicated horsepower by the amount of friction horsepower consumed in the engine.

Brake Horsepower (bhp) net – Net brake horsepower is measured with all engine components. The power of an engine when configured as a fully equipped engine. (SAE J1349 JUN90)

Calibration – The data values used by the strategy to solve equations and make decisions. Calibration values are stored in ROM and put into the processor during programming to allow the engine to operate within certain parameters.

Camshaft Position (CMP) sensor – The CMP sensor is a magnetic pickup sensor which indicates engine position. Speed is indicated by the number of vanes counted per revolution of the camshaft. Camshaft position is indicated by a single position peg that indicates Cylinder Number 1.

Catalyst – A substance that produces a chemical reaction without undergoing a chemical change itself.

Catalytic converter – An antipollution device in the exhaust system that contains a catalyst for chemically converting some pollutants in the exhaust gases (carbon monoxide, unburned hydrocarbons, and oxides of nitrogen) into harmless compounds.

Cavitation – A dynamic condition in a fluid system that forms gas-filled bubbles (cavities) in the fluid.

Cetane number – 1. The auto ignition quality of diesel fuel.

2. A rating applied to diesel fuel similar to octane rating for gasoline.

3. A measure of how readily diesel fuel starts to burn (autoignites) at high compression temperature.

Diesel fuel with a high cetane number autoignites shortly after injection into the combustion chamber. Therefore, it has a short ignition delay time. Diesel

fuel with a low cetane number resists autoignition. Therefore, it has a longer ignition delay time.

Charge air – Dense, pressurized, heated air discharged from the turbocharger.

Charge Air Cooler (CAC) – See **After cooler**.

Closed crankcase – Crankcase ventilation system that recycles crankcase gases through a breather, then back to the clean air intake.

Closed loop operation – A system that uses a sensor to provide feedback to the ECM. The ECM uses the sensor to continuously monitor variables and it make adjustments to match engine requirements.

Cloud point – The point when wax crystals occur in fuel, making fuel cloudy or hazy. Usually below -12°C (10°F).

Cold cranking ampere rating (battery rating) – The sustained constant current (in amperes) needed to produce a minimum terminal voltage under a load of 7.2 volts per battery after 30 seconds.

Continuous Monitor Test – An ECM function that continuously monitors the inputs and outputs to ensure that readings are within set limits.

Controller Area Network (CAN) – This is a J1939 high speed communication link. **CAN 1** is a public drive train data link between the vehicle modules and ECM. **CAN 2** is a private link between the ECM and IDM.

Coolant – A fluid used to transport heat from one point to another.

Coolant level switch – A switch used to indicate coolant level.

Cooling system capacity (volume) – The amount of coolant that completely fills a cooling system to its designated cold level mark. (SAE J1004 SEP81)

Crankcase – The housing that encloses the crankshaft, connecting rods, and allied parts.

Crankcase breather – A vent for the crankcase to release excess interior air pressure.

Crankcase pressure – The force of air inside the crankcase against the crankcase housing.

Crankshaft (CKP) sensor – The CKP sensor is a magnetic pickup sensor that indicates crankshaft speed and position.

Current – The flow of electrons passing through a conductor. Measured in amperes.

Damper – A device that reduces the amplitude of torsional vibration. (SAE J1479 JAN85)

Deaeration – The removal or purging of gases (air or combustion gas) entrapped in coolant or lubricating oil.

Deaeration tank – A separate tank in the cooling system used for one or more of the following functions:

- Deaeration
- Coolant reservoir (fluid expansion and after boil)
- Coolant retention
- Filling
- Fluid level indication (visible)

Diagnostic Trouble Code (DTC) – Formerly called a Fault Code or Flash Code. A DTC is a three digit numeric code used for troubleshooting.

Diamond Logic™ Engine Brake – The Diamond logic™ Engine Brake is a compression release braking system that uses a high-pressure oil rail components together with the VGT for additional braking. The operator controls the engine brake for different operating conditions.

Diamond Logic™ Exhaust Brake – The Diamond Logic™ Exhaust Brake is an exhaust brake system that uses only the VGT to restrict exhaust flow for additional braking. The operator controls the exhaust brake for different operating conditions.

Digital Multimeter (DMM) – An electronic meter that uses a digital display to indicate a measured value. Preferred for use on microprocessor systems because it has a very high internal impedance and will not load down the circuit being measured.

Direct Current (DC) – An electric current flowing in one direction only and substantially constant in value.

Disable – A computer decision that deactivates a system and prevents operation of the system.

Displacement – The stroke of the piston multiplied by the area of the cylinder bore multiplied by the number of cylinders in the engine.

Driveline Disengagement Switch (DDS) – A switch that indicates when the driveline is disengaged from the engine.

Driver (high side) – A transistor in an electronic module that controls the power to an actuator circuit.

Driver (low side) – A transistor in an electronic module that controls the ground to an actuator circuit.

Drivetrain data link (CAN 1) J1939 – The primary communication link for the ECM, ESC, and instrument cluster.

Duty cycle – A control signal that has a controlled on/off time measurement from 0 to 100%. Normally used to control solenoids.

Elastomer – An elastic, rubber like substance such as natural or synthetic rubber material. (SAE J111 MAR85)

Electronic Control Module (ECM) – The Electronic Control Module is an electronic microprocessor that monitors and controls engine performance, exhaust emissions, and vehicle system performance (cruise control, transmission control, starter engagement, etc.). The ECM provides diagnostic information for engine and vehicle systems and can be programmed at different levels for engine protection, warning, and shutdown.

Electronic Service Tool (EST) – A computer diagnostic and programming tool for the ECM and ESC. The hardware is typically a laptop computer or notebook computer. The diagnostic and programming software includes International Master Diagnostics, ISIS on-line documentation, and NETS for factory programming.

Electronic System Controller (ESC) – An electronic module that provides multiple analog and switched input interfaces to monitor vehicle functions through solid state switches, relay driver outputs, and serial data communication.

Engine Control Module (ECM) power relay – An ECM controlled relay that supplies power to the ECM.

Engine Coolant Temperature (ECT) sensor – A thermistor sensor that senses engine coolant temperature.

Engine Fuel Pressure (EFP) sensor – A variable capacitance sensor that senses fuel pressure.

Engine Family Rating Code (EFRC) – A readable code in the calibration list of the EST that identifies engine horsepower and emission calibrations.

Engine lamp – An instrument panel lamp that comes on when DTCs are set. DTCs can be read as flash codes (red and amber instrument panel lamps).

Engine OFF tests – Tests that are done with the ignition key ON and the engine OFF.

Engine RUNNING tests – Tests done with the engine running.

Engine Oil Pressure (EOP) sensor – A variable capacitance sensor that senses engine oil pressure.

Engine Oil Temperature (EOT) sensor – A thermistor sensor that senses engine oil temperature.

Exhaust brake – A brake device using engine exhaust back pressure as a retarding medium.

Exhaust Gas Recirculation (EGR) – The Exhaust Gas Recirculation is a system that recycles a controlled portion of exhaust gas back into the combustion chamber to reduce Nitrogen Oxide exhaust emissions.

Exhaust Gas Recirculation (EGR) drive module – The EGR drive module controls the position of the EGR valve.

Exhaust Gas Recirculation (EGR) cooler – The exhaust gas is cooled in the EGR cooler and flows through the EGR control valve to the EGR mixer duct.

Exhaust Gas Recirculation (EGR) valve – The EGR valve, when open, will mix exhaust gas with filtered intake air which flows into the intake manifold. The EGR valve, when closed, only allows filtered air to flow into the intake manifold.

Exhaust manifold – Exhaust gases flow through the exhaust manifold to the turbocharger exhaust inlet and are directed to the EGR cooler or out the exhaust system.

EVRT® electronic controlled turbocharger – International's version of a Variable Geometry Turbocharger (VGT).

EZ-Tech® interface cable – The EZ-Tech® interface cable connects to the EST to communicate with the Electronic Controlled Module (ECM).

Fault detection and management – An alternate control strategy that reduces adverse effects that can be caused by a system failure. If a sensor fails, the ECM substitutes a good sensor signal or assumed sensor value in its place. A lit amber or red instrument panel lamp signals that the vehicle needs service.

Filter restriction – A blockage, usually from contaminants, that prevents the flow of fluid through a filter.

Flash code – See **Diagnostic Trouble Code (DTC)**.

Fuel inlet restriction – A blockage, usually from contaminants, that prevents the flow of fluid through the fuel inlet line.

Fuel pressure – The force that the fuel exerts on the fuel system as it is pumped through the fuel system.

Fuel strainer – A pre filter in the fuel system that keeps larger contaminants from entering the fuel system.

Fully equipped engine – A fully equipped engine is an engine equipped with only those accessories necessary to perform its intended service. A fully equipped engine does not include components that are used to power auxiliary systems. If these components are integral with the engine or for any reason are included on the test engine, the power absorbed may be determined and add to the net brake power. (SAE J1995 JUN90)

Fusible link (fuse link) – A fusible link is a special section of low tension cable designed to open the

circuit when subjected to an extreme current overload. (SAE J1156 APR86)

Gradeability – The maximum percent grade which the vehicle can transverse for a specified time at a specified speed. The gradeability limit is the grade upon which the vehicle can just move forward. (SAE J227a)

Gross brake horsepower – The power of a complete basic engine, with air cleaner, without fan, and alternator and air compressor not charging.

Hall effect – The development of a transverse electric potential gradient in a current-carrying conductor or semiconductor when a magnetic field is applied.

Hall effect sensor – Generates a digital on or off signal that indicates speed or position.

High speed digital inputs – Inputs to the ECM from a sensor that generates varying frequencies (engine speed and vehicle speed sensors).

Horsepower (hp) – Horsepower is the unit of work done in a given period of time, equal to 33,000 pounds multiplied by one foot per minute. **1 hp = 33,000 lb x 1 ft /1 min.**

Hydrocarbons – Unburned or partially burned fuel molecules.

Idle speed – Low idle is the minimum engine speed. High idle is the maximum governed engine speed with no load.

Idle Validation Switch (IVS) – An On/Off switch that senses when the accelerator pedal is in the idle position. There is also a cold idle advance that increases low idle speed for a short period to aid in engine warm-up in cold temperatures.

Injector Drive Module (IDM) power relay – An IDM controlled relay that supplies power to the IDM.

Indicated horsepower – The theoretical power transmitted to the pistons by gas in the cylinders.

Injection Control Pressure (ICP) – High lube oil pressure generated by a high-pressure pump/pressure regulator used to hydraulically actuate the fuel injectors and the optional Diamond Logic™ engine brake.

Injection Pressure Regulator (IPR) – A Pulse Width Modulated (PWM) regulator valve, controlled by the ECM, that regulates injection control pressure.

Injection Control Pressure (ICP) sensor – A variable capacitance sensor that senses injection control pressure.

Intake Air Temperature (IAT) sensor – A thermistor sensor that senses intake air temperature.

Intake manifold – A plenum through which the air mixture flows from the charged air cooler piping to the intake passages of the cylinder head.

International NGV Tool Utilized for Next Generation Electronics (INTUNE) – The diagnostics software for chassis related components and systems.

Low speed digital inputs – Switched sensor inputs that generate an on/off (high/low) signal to the ECM. The input to the ECM from the sensor could be from a high input source switch (usually 5 or 12 volts) or from a grounding switch that grounds the signal from a current limiting resistor in the ECM that creates a low signal (0 volts).

Lubricity – Lubricity is the ability of a substance to reduce friction between solid surfaces in relative motion under loaded conditions.

Lug (engine) – A condition when the engine is operating at or below maximum torque speed.

Manifold Absolute Pressure (MAP) – Intake manifold pressure (boost pressure).

Manifold Absolute Pressure (MAP) sensor – A variable capacitance sensor that senses intake manifold pressure.

Manometer – A double-leg liquid-column gauge, or a single inclined gauge, used to measure the difference between two fluid pressures. Typically, a manometer records in inches of water.

Master Diagnostics (MD) – The diagnostics software for engine related components and systems to use on the electronic service tool or personal computer.

Manifold Air Temperature (MAT) – Intake manifold air temperature

Manifold Air Temperature (MAT) sensor – A thermistor style sensor housed in the intake manifold used to indicate air temperature after passing through the charge air cooler.

Microprocessor – An integrated circuit in a microcomputer that controls information flow.

Nitrogen Oxides (NO_x) – Nitrogen oxides form by a reaction between nitrogen and oxygen at high temperatures and pressures in the combustion chamber.

Normally closed – Refers to a switch that remains closed when no control force is acting on it.

Normally open – Refers to a switch that remains open when no control force is acting on it.

Ohm (Ω) – The unit of resistance. One ohm is the value of resistance through which a potential of one volt will maintain a current of one ampere. (SAE J1213 NOV82)

On demand test – A self test that the technician initiates using the EST. It is run from a program in the processor.

Output Circuit Check (OCC) – An On demand test done during an Engine OFF self test to check the continuity of selected actuators.

Output State Check (OSC) – An On demand test that forces the processor to activate actuators (High or Low) for additional diagnostics.

pH – A measure of the acidity or alkalinity of a solution.

Particulate matter – Particulate matter includes mostly burned particles of fuel and engine oil.

Piezometer – An instrument for measuring fluid pressure.

Positive On Shaft Excluder (POSE) – It is a separate piece from the rest of the front or rear seal used to keep out dust / debris.

Potentiometer – A potentiometer is a variable voltage divider that senses the position of a mechanical component. A reference voltage is applied to one end of the potentiometer. Mechanical rotary or linear motion moves the wiper along the resistance material, changing voltage at each point along the resistive material. Voltage is proportional to the amount of mechanical movement.

Power – Power is a measure of the rate at which work is done. Compare with **Torque**.

Power Take Off (PTO) – Accessory output, usually from the transmission, used to power a hydraulic pump for a special auxiliary feature (garbage packing, lift equipment, etc.).

Pulse Width Modulation (PWM) – The time that an actuator, such as an injector, remains energized.

Random Access Memory (RAM) – Computer memory that stores information. Information can be written to and read from RAM. Input information (current engine speed or temperature) can be stored in RAM to be compared to values stored in Read Only Memory (ROM). All memory in RAM is lost when the ignition switch is turned off.

Rated gross horsepower – Engine gross horsepower at rated speed as declared by the manufacturer. (SAE J1995 JUN90)

Rated horsepower – Maximum brake horsepower output of an engine as certified by the engine manufacturer. The power of an engine when configured as a basic engine. (SAE J1995 JUN90)

Rated net horsepower – Engine net horsepower at rated speed as declared by the manufacturer. (SAE J1349 JUN90)

Rated speed – The speed, as determined by the manufacturer, at which the engine is rated. (SAE J1995 JUN90)

Rated torque – Maximum torque produced by an engine as certified by the manufacturer.

Read Only Memory (ROM) – Computer memory that stores permanent information for calibration tables and operating strategies. Permanently stored information in ROM cannot be changed or lost by turning the engine off or when ECM power is interrupted.

Reference voltage (V_{REF}) – A 5 volt reference supplied by the ECM to operate the engine and chassis sensors.

Reserve capacity – Time in minutes that a fully charged battery can be discharged to 10.5 volts at 25 amperes.

Signal ground – The common ground wire from the ECM for the sensors.

Speed Control Command Switches (SCCS) – A set of switches used for cruise control, Power Take Off (PTO), and remote hand throttle system.

Steady state condition – An engine operating at a constant speed and load and at stabilized temperatures and pressures. (SAE J215 JAN80)

Strategy – A plan or set of operating instructions that the microprocessor follows for a desired goal. Strategy is the computer program itself, including all equations and decision making logic. Strategy is always stored in ROM and cannot be changed during calibration.

Stroke – Stroke is the movement of the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).

Substrate – Material that supports the wash coating or catalytic materials.

Sulfur dioxide (SO_2) – Sulfur dioxide is caused by oxidation of sulfur contained in fuel.

Switch sensors – Switch sensors indicate position. They operate open or closed, allowing or preventing the flow of current. A switch sensor can be a voltage input switch or a grounding switch. A voltage input switch supplies the ECM with a voltage when it is closed. A grounding switch grounds the circuit closed, causing a zero voltage signal. Grounding switches are usually installed in series with a current limiting resistor.

System restriction (air) – The static pressure differential that occurs at a given air flow from air entrance through air exit in a system. Usually

measured in inches (millimeters) of water. (SAE J1004 SEP81)

Tachometer output signal – Engine speed signal for remote tachometers.

Thermistor – A thermistor sensor changes its electrical resistance to temperature. Resistance in the thermistor decreases as temperature increases, and increases as temperature decreases. Thermistors works with a resistor that limits current in the ECM to form a voltage signal matched with a temperature value.

Thrust load – A thrust load pushes or reacts through a bearing in a direction parallel to the shaft.

Top Dead Center (TDC) – The highest position of the piston during the stroke.

Top Dead Center (compression) – Top Dead Center (compression) is when the piston is at the highest position and both intake and exhaust valves are closed.

Torque – Torque is a measure of force producing torsion and rotation around an axis. Torque is the product of the force, usually measured in pounds, and radius perpendicular to the axis of the force extending to the point where the force is applied or where it originates, usually measured in feet.

Truck Computer Analysis of Performance and Economy (TCAPE) – Truck Computer Analysis of Performance and Economy is a computer program that simulates the performance and fuel economy of trucks.

Turbocharger – A turbine driven compressor mounted to the exhaust manifold. The turbocharger increases the pressure, temperature and density of intake air to charge air.

Valve cover gasket – A valve cover gasket that contains the pass through electronic wiring harness connectors for the ICP and BCP sensors, the brake shutoff valve, and six fuel injectors.

Variable capacitance sensor – A variable capacitance sensor is a sensor that measures pressure. The pressure measured is applied to a

ceramic material. The pressure forces the ceramic material closer to a thin metal disk. This action changes the capacitance of the sensor.

Variable Geometry Turbocharger (VGT) – The VGT is a turbocharger with actuated vanes inside the turbine housing. The vanes modify flow characteristics of exhaust gases through the turbine housing for boost pressure control at various engine speeds and load conditions.

(VGT) control module – The VGT control module is an electronic microprocessor that converts a pulse width modulated signal from the ECM to control a DC motor that controls the VGT vane position.

Vehicle Electronic System Programming System – The computer system used to program electronically controlled vehicles.

Vehicle Retarder Enable/Engage – Output from the ECM to a vehicle retarder.

Vehicle Speed Sensor (VSS) – A magnetic pickup sensor mounted in the tail shaft housing of the transmission, used to calculate ground speed.

Viscosity – The internal resistance to the flow of any fluid.

Viscous fan – A fan drive that is activated when a thermostat, sensing high air temperature, forces fluid through a special coupling. The fluid activates the fan.

Volt (v) – A unit of electromotive force that will move a current of one ampere through a resistance of one Ohm.

Voltage – Electrical potential expressed in volts.

Voltage drop – Reduction in applied voltage from the current flowing through a circuit or portion of the circuit current multiplied by resistance.

Voltage ignition – Voltage supplied by the ignition switch when the key is ON.

Water In Fuel (WIF) switch – The WIF switch detects water in the fuel.

Water supply housing (Freon bracket) – The water supply housing (Freon Bracket) is a coolant supply housing with a deaeration port and a connection for cab heat.

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SPECIFICATIONS

NOTE: The following sections of the manual do not require any specifications for service work:

- *Mounting Engine on Stand*
- *Engine Electrical*
- *Air Compressor and Power Steering Pump*

Table 56 VGT Specifications

Turbine shaft axial end play	0.05-0.13 mm (0.002-0.005 in)
Turbine shaft radial movement	0.52-0.74 mm (0.020-0.029 in)
VGT axial linkage shaft	Must strike open and closed stops in actuator, 90° rotation

Table 57 Exhaust Manifold Specifications

Allowable warpage (max.)	0.10 mm (0.004 in) overall
Flange thickness (min.)	21.59 mm (0.850 in)

Table 58 Valve Specifications

Camshaft lobe lift	Intake: 6.68 mm (0.263 in) Exhaust: 6.91 mm (0.272 in)
Valve face angle	Intake: 59.75- 60.00° Exhaust: 44.75-45.00°
Valve face margin (min.)	Intake: 1.32 mm (0.052 in) Exhaust: 1.16 mm (0.046 in)
Valve face-to-valve stem runout (max.)	0.038 mm (0.0015 in)
Valve lash (cold), intake and exhaust	0.48 mm (0.019 in)
Valve stem diameter (new condition)	Intake: 7.928 ± 0.0089 mm (0.3121 ± 0.00035 in) Exhaust: 7.908 ± 0.0089 mm (0.3113 ± 0.00035 in)
Valve stem-to-valve guide clearance (max.)	Intake: 0.10 mm (0.004 in) Exhaust: 0.11 mm (0.005 in)

Table 59 Valve Spring Specifications

Intake and Exhaust Valve Springs	
Free length	52.35 mm (2.061 in)
Solid height (max.)	27.43 mm (1.080 in)
Test load	Valve closed: 410 N (92 lbs)
	Valve open: 764 N (172 lbs)
Test length	Valve closed: 40.01 mm (1.575 in)
	Valve open: 29.34 mm (1.155 in)

Table 60 Cylinder Head Specifications

Cylinder head gasket surface flatness	0.10 mm (0.004 in.) per 229 mm (9.0 in)
Cylinder head thickness	New: 160.48 mm (6.318 in) Minimum: 159.97 mm (6.298 in)
Exhaust	1.40 ± 0.13 mm (0.055 ± .005 in)
Exhaust valve seat insert counterbore diameter	Standard: 37.503 ± 0.003 mm (1.477 ± 0.001 in) Oversize: 0.05 mm (0.002 in) 37.55 ± 0.03 mm (1.478 ± 0.001 in)
Exhaust valve seat outside diameter	Standard: 37.56 mm (1.479 in) Oversize: 0.05 mm (0.002 in) 37.61 mm (1.481 in)
Intake	1.02 ± 0.13 mm (0.040 ± 0.005 in)
Intake valve seat insert counterbore diameter	Standard: 33.50 ± 0.03 mm (1.319 ± 0.001 in) Oversize: 0.05 mm (0.002 in) 35.55 ± 0.03 mm (1.321 ± 0.001 in)
Intake valve seat outside diameter	Standard: 40.20 mm (1.583 in) Oversize: 0.05 mm (0.002 in) 40.25 mm (1.585 in)
Valve guide bore diameter	14.308 ± 0.017 mm (0.5633 ± 0.0007 in)
Valve guide bore out-of-round (max.)	0.005 mm (0.0002 in)
Valve guide bore taper (max.)	0.013 mm (0.0005 in)
Valve guide height from cylinder head spring pocket (intake)	16.53 ± 0.13 mm (0.651 ± 0.005 in)
Valve guide insert inside diameter (installed)	7.98 - 8.00 mm (0.314 - 0.315 in)
Valve guide insert interference fit dimension	0.043 mm (0.0017 in)
Valve guide insert outside diameter	14.351 ± 0.010 mm (0.5650 ± 0.0004 in)
Valve guide length (overall)	65.71 mm (2.587 in)
Valve recession	Intake: 1.02 mm (0.040 in) Exhaust: 1.40 mm (0.055 in)
Valve seat angles	Intake: 59.75 - 60° Exhaust: 44.75 - 45°
Valve seat runout (max.)	0.05 mm (0.002 in)
Valve seat width	1.91 - 2.16 mm (0.075 - 0.085 in)

Table 61 Front Cover, Vibration Damper, Gerotor Oil Pump, Front Engine Mount, and Gear Train Specifications

Camshaft gear end play	0.33 mm (0.013 in)
Camshaft gear-to-upper idler gear backlash	0.46 mm (0.018 in)
High-pressure pump end play	0.45-1.22 mm (0.018-0.48 in)

Table 61 Front Cover, Vibration Damper, Gerotor Oil Pump, Front Engine Mount, and Gear Train Specifications (cont.)

Lower idler gear-to-air compressor gear backlash	0.508 mm (0.020 in)		
Lower idler gear-to-crankshaft gear backlash	0.36 mm (0.014 in)		
Oil pump end clearance	0.05-0.13 mm (0.002-0.005 in)		
Oil pump side clearance	0.36-0.48 mm (0.014-0.019 in)		
Upper idler gear-to-high-pressure oil pump gear backlash	0.48 mm (0.019 in)		
Upper idler gear-to-lower idler gear backlash	0.48 mm (0.019 in)		
Vibration damper face runout (max.)	1.52 mm (0.060 in)		
Vibration damper maximum allowable member misalignment	1.50 mm (0.060 in)		
Fan Drive Configurations Diameters and Ratios			
Engine fan drive configuration	Fan CL to Crankshaft CL, mm (in)	Pulley Diameter OBD, mm (in)	Drive Ratio
466 high-mount, (Horton DriveMaster)	508 (20)	242.8 (9.56)	0.894 : 1
570 high-mount, (Horton DriveMaster)	508 (20)	242.8 (9.56)	1.08 : 1
570 high-mount, (Horton DriveMaster)	508 (20)	219.4 (8.636)	1.2 : 1
570 high-mount, (Horton DriveMaster)	465 (18.3)	201.2 (7.92)	1.3 : 1
570 high-mount, (Horton DriveMaster)	465 (18.3)	201.2 (7.92)	1.3 : 1
466 high-mount, (Horton DriveMaster)	465 (18.3)	219.4 (8.636)	1.2 : 1
466 high-mount, (Horton DriveMaster)	465 (18.3)	219.4 (8.636)	0.99 : 1
466 mid-mount, (Horton DriveMaster)	411 (16.2)	201.2 (7.92)	1.08 : 1
466 high-mount, (spin-on)	465 (18.3)	201.2 (7.92)	1.08 : 1
570 high-mount, (spin-on)	465 (18.3)	201.2 (7.92)	1.3 : 1
466 mid-mount, (spin-on)	411 (16.2)	201.2 (7.92)	1.08 : 1
466 low-mount, (spin-on)	310 (12.2)	201.2 (7.92)	1.08 : 1
466 low-mount, Horton DriveMaster)	310 (12.2)	201.2 (7.92)	1.08 : 1
570 low-mount, (spin-on)	310 (12.2)	201.2 (7.92)	1.3 : 1

Table 61 Front Cover, Vibration Damper, Gerotor Oil Pump, Front Engine Mount, and Gear Train Specifications (cont.)

570 low-mount, (Horton DriveMaster)	310 (12.2)	201.2 (7.92)	1.3 : 1
466 low-mount, (bolt-on)	310 (12.2)	201.2 (7.92)	1.08 : 1
570 low-mount, (bolt-on)	310 (12.2)	201.2 (7.92)	1.3 : 1

NOTE: The high-mount and mid-mount fan drives share the same part number, however the fan drive is inverted depending upon application.

Table 62 Oil Fill Specifications

Dry engine (after rebuild and new filter)	34 L (36 quarts US)
Wet engine (after oil drain and filter change)	28 L (30 quarts US)

Table 63 Connecting Rod Specifications

Bend (max.)	0.06 mm (0.003 in)
Center-to-center distance between connecting rod bearing bore and piston pin bushing bore	219.4 - 219.5 mm (8.638 - 8.642 in)
Connecting rod bearing bore inside diameter	85.130 - 85.156 mm (3.3516 - 3.3526 in)
Connecting rod bearing inside diameter (installed)	80.05 - 80.10 mm (3.1518 - 3.1536 in)
Connecting rod bearing bore out-of-round (max.)	0.05 mm (0.002 in)
Connecting rod bearing bore taper (max.)	0.13 mm (0.005 in)
Connecting rod bearing running clearance	0.030 - 0.107 mm (0.0012 - 0.0042 in)
Connecting rod side clearance on crankshaft	0.13 - 0.48 mm (0.005 - 0.019 in)
Piston pin bushing inside diameter	46.393 - 46.401 mm (1.8265 - 1.8268 in)
Twist (max.)	0.05 mm (0.002 in)

Table 64 Piston Specifications

466 piston configuration	
Piston material	Aluminum alloy
Piston rings	
225 bhp and below	Top ring - keystone cross section Intermediate - rectangular cross section
230 bhp and above	Top ring - keystone cross section Intermediate - keystone cross section
570 piston configuration	
Piston crown	Steel crown, two-piece articulated
Piston skirt	Aluminum alloy
Piston rings	
All 570 series engines	Top ring – keystone cross section Intermediate – rectangular cross section
466 and 570 piston specifications	
Running clearance between piston and cylinder sleeve	466 piston: 0.076 - 0.128 mm (0.0030 - 0.0050 in) 570 piston: 0.063 - 0.115 mm (0.0025 - 0.0045 in)
Skirt diameter	466 piston: 116.44 - 116.49 mm (4.584 - 4.586 in) 570 piston: 116.48 - 116.51 mm (4.586 - 4.587 in)
Top compression ring groove width, 466 measure over 0.122 gauge pins	115.90 - 115.68 mm (4.563 - 4.554 in)
Top compression ring groove width, 570 measure over 0.126 gauge pins	116.74 - 116.50 mm (4.596 - 4.587 in)
Intermediate compression ring groove width (keystone shaped ring) measure over 0.110 gauge pins	115.92 - 115.73 mm (4.564 - 4.556 in)
Intermediate compression ring groove width (rectangular shaped ring), 466	3.05 - 3.03 mm (0.120 - 0.119 in)
Intermediate compression ring groove width (rectangular shaped ring), 570	3.05 - 3.03 mm (0.120 - 0.119 in)
Oil control ring, side clearance, 466	0.076 - 0.026 mm (0.0030 - 0.0010 in)
Oil control ring, side clearance, 570	0.080 - 0.030 mm (0.0031 - 0.0012 in)

Table 65 Piston Ring Specifications

Intermediate compression ring end gap	1.65 - 1.90 mm (0.065 - 0.075 in)
Oil control ring end gap	0.35 - 0.66 mm (0.014 - 0.026 in)
Piston ring gap with new cylinder sleeve (all engines)	
Top compression ring end gap	0.35 - 0.66 mm (0.014 - 0.026 in)

Table 66 Piston Pin Specifications

Clearance in piston	466 piston: 0.0165 - 0.0292 mm (0.00065 - 0.00115 in) 0.035 - 0.048 mm (0.0014 - 0.0019 in) 570 skirt (vertical plane): 0.0165 - 0.0292 mm (0.00065 - 0.00115 in) 570 skirt (horizontal plane): 0.0280 - 0.0574 mm (0.00114 - 0.00226 in) 570 crown: 0.038 - 0.053 mm (0.0015 - 0.0021 in)
Diameter	46.352 - 46.357 mm (1.8249 - 1.8251 in)
Length	96.57 - 96.82 mm (3.802 - 3.812 in)

Table 67 Cylinder Sleeve Specifications

Allowable variation of counterbore depth between four points (max.)	0.03 mm (0.001 in)
Counterbore depth before adding shims (max.)	10.49 mm (0.413 in)
Counterbore depth (including shims- if any)	8.84 - 8.89 mm (0.348 - 0.350 in)
Cylinder sleeve protrusion	0.05 - 0.13 mm (0.002 - 0.005 in)
Cylinder sleeve taper, at top of ring travel (max.)	0.10 mm (0.004 in)
Flange thickness	8.94 - 8.96 mm (0.352 - 0.353 in)
Inside diameter	114.50 - 116.60 mm (4.590 - 4.591 in)

Table 68 Crankshaft Specifications

Type	Steel forged, induction hardened, grindable
Main bearing journal diameter:	
0.254 mm (0.010 in) undersized	107.70 ± 0.0152 mm (4.240 ± 0.0006 in)
0.508 mm (0.020 in) undersized	107.44 ± 0.0152 mm (4.230 ± 0.0006 in)
0.762 mm (0.030 in) undersized	107.19 ± 0.0152 mm (4.220 ± 0.0006 in)
Damper mounting area runout (maximum)	0.03 mm (0.001 in)
Flywheel mounting surface runout (maximum)	0.05 mm (0.002 in)
Main bearing journal maximum out-of-round	0.05 mm (0.002 in)
Main bearing journal taper (maximum per inch)	0.071 mm (0.0028 in)

Table 68 Crankshaft Specifications (cont.)

Main bearing thrust face runout (TIR maximum)	0.03 mm (0.001 in)
Main bearing width (except rear thrust)	34.19 ± 0.13 mm (1.346 ± 0.005 in)
Number of main bearings	7
Rear oil seal journal runout (maximum)	0.08 mm (0.003 in)
Standard size	107.95 ± 0.015 mm (4.250 ± 0.0006 in)
Thrust taken by	No. 7 rear upper main bearing
Thrust Bearing Journal Length:	
0.76 mm (0.030 in) undersized	34.404 ± 0.025 mm (1.3545 ± 0.0010 in)
0.0254 mm (0.010 in) undersized	79.7 ± 0.0152 mm (3.1400 ± 0.0006 in)
0.508 mm (0.020 in) undersized	79.5 ± 0.0152 mm (3.1300 ± 0.0006 in)
0.762 mm (0.030 in) undersized	79.2 ± 0.0152 mm (3.1200 ± 0.0006 in)
Center line of main bearing bore to head deck	368.3 ± 0.05 mm (14.50 ± 0.002 in)
Connecting rod bearing to crankshaft running clearance	0.030 - 0.107 mm (0.0012 - 0.0042 in)
Connecting rod bearing width	40.01 mm (1.575 in)
Connecting rod journal diameter standard size	80.0 ± 0.0152 mm (3.1500 ± 0.0006 in)
Connecting rod journal maximum out-of-round	0.0064 mm (0.00025 in)
Connecting rod journal taper (maximum per inch)	0.0069 mm (0.00027 in)
Crankcase deck flatness	0.08 mm (0.003 in)
Crankshaft end play	0.15-0.31 mm (0.006 - 0.012 in)
Crankshaft end play maximum wear limit	0.51 mm (0.020 in)
Crankshaft flange outside diameter	155.58 mm (6.125 in)
Crankshaft gear backlash	0.08-0.41 mm (0.003 - 0.016 in)
Crankcase main bearing bore diameter	97.80 ± 0.01 mm (3.849 ± 0.001 in)
Main bearing to crankshaft running clearance	0.046 - 0.127 mm (0.0018 - 0.0050 in)
Rod to crankshaft side clearance	0.30 ± 0.11 mm (0.012 ± 0.005 in)
Standard size to 0.51 mm (0.020 in) undersized	34.404 ± 0.03 mm (1.3545 ± 0.010 in)

Table 69 Crankcase Specifications

Cap attachment	2 bolts per cap
Coolant heater rating	1250 W, 120 V
Counterbore dimension in crankcase	8.865 ± 0.025 at 132 mm (0.349 ± 0.001 at 5.189 in)
Cylinder sleeve counterbore maximum allowable depth	9.25 mm (0.364 in)
Main bearing type	Precision replaceable
Material	Steel-backed copper, lead, tin
Maximum allowable variation of counterbore depth (between four points)	0.025 mm (0.001 in)
Piston cooling tube dia. (spray hole) DT 466	1.91 - 2.06 mm (0.075 - 0.081 in)
Piston cooling tube dia. (spray hole) DT 570, HT 570	2.26 - 2.41 mm (0.089 - 0.095 in)
Roller tappet outside diameter	28.435 - 28.448 mm (1.1195 - 1.1200 in)
Sleeve protrusion above crankcase	0.05 - 0.13 mm (0.002 - 0.005 in)
Tappet bore diameter	28.51 - 28.55 mm (1.123 - 1.124 in)
Thrust taken by	No. 7 rear upper main bearing
Camshaft	
Bushing I.D. (installed)	58.03-58.12 mm (2.285-2.288 in)
Cam lobe lift, exhaust	6.91 mm (0.272 in)
Cam lobe lift, intake	6.68 mm (0.263 in)
Camshaft end play	0.18-0.33 mm (0.007-0.013 in)
Camshaft journal diameter	57.95-58.98 mm (2.282-2.283 in)
Camshaft radial clearance	0.05- 0.17 mm (0.002-0.007 in)
Maximum permissible cam lobe wear	0.25 mm (0.010 in)
Service bushings furnished to size	Yes
Thrust plate thickness (new)	6.96 - 7.01 mm (0.274 - 0.276 in)
Camshaft Bushing Bore Diameter in Crankcase	
Front	65.51 - 63.55 mm (2.501 - 2.502 in)
Intermediate front	63.01 - 63.04 mm (2.481 - 2.482 in)
Intermediate rear	63.01 - 63.04 mm (2.481 - 2.482 in)
Rear	65.51 - 63.55 mm (2.501 - 2.502 in)

Table 70 Oil System Module and Secondary Filter Special Torques

Coolant drain plug, M18	24 N·m (18 lbf·ft)
Lube adapter bolts	29 N·m (21 lbf·ft)
Oil system module mounting bolts	26 N·m (19 lbf·ft)
Oil pressure regulator valve	68 N·m (50 lbf·ft)
Oil thermal valve assembly	29 N·m (21 lbf·ft)
Oil cooler mounting bolts, M8	29 N·m (21 lbf·ft)
Oil cooler drain tube bracket bolt	26 N·m (19 lbf·ft)
Oil supply tube fitting (turbocharger)	24-26 N·m (17-19 lbf·ft)
Plug assembly, M12	5 N·m (46 lbf·in)
Secondary filter mounting bolts	26 N·m (19 lbf·ft)

Table 71 Fuel System Specifications

Fuel heater switching points	On: 2 °C (36 °F) Off: 24 °C (75 °F)
Fuel pressure regulator assembly opening pressure	448-517 kPa (65-75 psi)
Fuel strainer	150 micron
High-pressure oil manifold, range	5 - 28 MPa (725 - 4,075 psi)

Table 72 Flywheel Resurfacing Specifications

Flat flywheel minimum thickness after resurfacing	36.32 mm (1.430 in)
Pot flywheel minimum thickness after resurfacing	39.37 mm (1.550 in)
Requires measurement from crankshaft mounting surface of flywheel to clutch surface of flywheel.	

Table 73 Engine Brake Specifications

Brake actuator lash (cold)	0.48 mm (0.019 in)
Engine exhaust valve lash (cold)	Refer to (See Adjusting Valve Lash, page 132)

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General Torque Guidelines

CAUTION: To avoid engine damage, do not substitute fasteners. Original equipment standard hardware is defined as Class 10.9 metric or Grade 8 standard coarse thread bolts (Rockwell "C" 33-39), all phosphate coated.





CAUTION: To avoid engine damage, do not use this standard torque chart with other International brand engines or engines made by other manufacturers.

The standard torque chart provides the tightening values for general purpose applications using original equipment standard hardware as listed in the Parts Catalog for the application involved.

Table 74 Standard Torque Values – Class 10.9 Metric Flange Head Bolts and Studs

Thread Diameter (mm)	Thread Pitch (mm)	Torque ¹
6	1	13 N·m (120 lbf·in)
8	1.25	31 N·m (23 lbf·ft)
10	1.5	62 N·m (45 lbf·ft)
12	1.75	107 N·m (79 lbf·ft)
14	2	172 N·m (127 lbf·ft)
15	2	216 N·m (159 lbf·ft)
16	2	266 N·m (196 lbf·ft)
18	2.5	368 N·m (272 lbf·ft)
20	2.5	520 N·m (384 lbf·ft)

¹ Values listed are 80% of proof load.

DESIGNATION				HEAD MARKING	
INTERNATIONAL CLASS	ISO R 898 I	MATERIAL TYPE	THERMAL TREATMENT	PREFERRED	OPTIONAL
10.9	10.9	MEDIUM CARBON OR MEDIUM CARBON ALLOY STEEL OR LOW CARBON BORON STEEL	QUENCH AND TEMPERED		
10.9R	10.9R	MEDIUM CARBON , MEDIUM CARBON ALLOY STEEL	QUENCH AND TEMPERED, ROLL THREADED AFTER HEAT TREATMENT		

H31259

Figure 607 Classification and Identification – Metric and Special Use Fasteners

Many conditions affect torque and the results of torque applications. The major purpose in tightening a fastener to a specified torque is to obtain tension in the fastener (i.e., bolt, nut, etc.), which in turn develops a clamping load which exceeds any possible loading imposed on parts due to engine rpm or vibration.

Phosphate coated fasteners do not require oil lubrication during assembly and torque application. Reused fasteners, even if originally phosphate coated, do require a light film of engine oil lubrication to threads and under head area for proper torque application.

Threads that are dry, excessively rough, battered or filled with dirt require considerable effort just to rotate. Then when the clamping load is developed or the bolt tension is applied, the torque reading mounts rapidly (due to thread friction) to the specified torque value. However, the desired bolt tension and maximum clamping effect is not achieved. This condition can lead to failure of the fastener to maintain component integrity. The proper bolt tension and clamping effect can never be attained if the fastener is dry. The fastener threads must have a film of clean lubricant (engine oil) to be considered lubricated.

Using a Torque Wrench Extension

Occasionally the need will arise to use an extension, crowfoot, or other type of adapter with your torque wrench to torque a bolt or line fitting. Sometimes an extension or adapter is necessary to reach a bolt in a hard to reach location. Adding adapters or extensions will alter the actual clamping force at the fastener. By using the following formula you can determine what the torque wrench setting should be to achieve the known standard or special torque value.

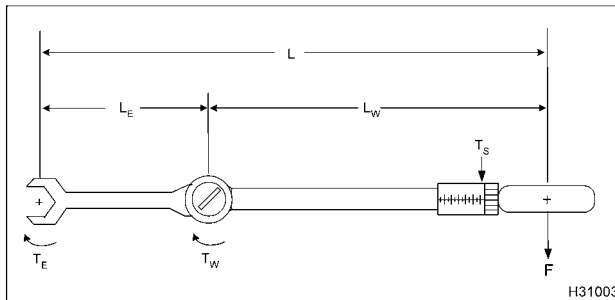


Figure 608 Torque wrench extension

- F – Force applied by service technician
- L – Length through which force is applied to fastener
- L_E – Length of extension
- L_W – Length of torque wrench
- T_E – Torque applied at fastener
- T_W – Torque applied at end of torque wrench
- T_S – Torque wrench setting

$$T_S = T_E (L_W / (L_W + L_E))$$

Example:

A component has a known torque value of 88 N·m (65 lbf·ft) and an extension is required to reach it. What will the torque wrench setting have to be in order to compensate for the additional extension?

- Torque wrench = 12 inches
- Extension = 6 inches

$$T_S = 65 \text{ lbf·ft} (12 \text{ in} / (12 \text{ in} + 6 \text{ in}))$$

$$T_S = 65 \text{ lbf·ft} (12 \text{ in} / 18 \text{ in})$$

$$T_S = 65 \text{ lbf·ft} (0.666)$$

$$T_S = \mathbf{43.3 \text{ lbf·ft or } 58.9 \text{ N·m}}$$

Special Torque

Table 75 Engine Mounting Special Torques

Oil pan drain plug (M25)	68 N·m (50 lbf·ft)
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Table 76 VGT Special Torques

Turbo mounting studs and nuts	71 N·m (52 lbf·ft)
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Table 77 Intake Manifold, Inlet and EGR Mixer, and Exhaust Manifold Special Torques

Exhaust manifold mounting torque and sequence.	See "Exhaust manifold torque sequence" page 82.
Fuel assembly valve	15 N·m (132 lbf·in)
Intake manifold mounting bolts	40 N·m (30 lbf·ft)
Intake plug assembly	25 N·m (18 lbf·ft)

Table 78 EGR Cooler Special Torques

EGR cooler bracket clamp	8 N·m (72 lbf·in)
EGR cooler bracket bolt, M12 x 120	116 N·m (85 lbf·ft)

Table 79 Cylinder Head and Valve Train Special Torques

BCP sensor	20-30 N·m (15-22 lbf·ft)
Cylinder head mounting bolts torque and sequence	(See Tightening Procedure for Torque-to-Yield Head Bolts, page 128)
Fuel injector mounting bolt	41 N·m (30 lbf·ft)
High-pressure oil hose fitting	46 N·m (34 lbf·ft)
ICP sensor	20-30 N·m (15-22 lbf·ft)
Rocker arm bolts torque and sequence	(See Installing Rocker Arms, page 129)
Valve adjustment locknut	27 N·m (20 lbf·ft)

Table 80 Front Cover, Vibration Damper, Gerotor Oil Pump, Front Engine Mount, and Gear Train Special Torques

Automatic belt tensioner assembly	50 N·m (37 lbf·ft)
Damper hub assembly	136 N·m (100 lbf·ft)
End cover adapter (PTO equipped engines only)	52 N·m (38 lbf·ft)
Fan drive, high-mount, Horton DriveMaster (20, 18.3 in.)	26 N·m (19 lbf·ft)
Fan drive, mid-mount, Horton DriveMaster (16.2 in.)	26 N·m (19 lbf·ft)
Fan drive, low-mount, Horton DriveMaster (12.2 in.)	26 N·m (19 lbf·ft)
Fan spacer retaining bolt, M10 x 20 (bolt-on drive only)	52 N·m (38 lbf·ft)
Front cover mounting bolts (rear half)	26 N·m (19 lbf·ft)
Front engine mounting bracket bolts (4)	386 N·m (284 lbf·ft)
Horton DriveMaster bearing retainer nut	177 N·m (130 lbf·ft)
Lower idler gear mounting bolt	639 N·m (470 lbf·ft)
Upper idler gear mounting bolt	326 N·m (240 lbf·ft)
Viscous or rubber vibration damper mounting bolts	54 N·m (40 lbf·ft)
Water outlet tube assembly at cylinder head	33 N·m (24 lbf·ft)
Water outlet tube assembly at front cover	33 N·m (24 lbf·ft)
Wear plate (water pump)	7 N·m (60 lbf·in)

Table 81 Oil Pan and Oil Suction Tube Special Torques

Oil pan drain plug	68 N·m (50 lbf·ft)
Oil pan heater plug	68 N·m (50 lbf·ft)
Oil pan mounting bolts	32 N·m (24 lbf·ft)
Oil suction tube bracket, M10 x 25	63 N·m (46 lbf·ft)
Oil suction tube, M8 x 35	27 N·m (20 lbf·ft)

Table 82 Connecting Rod Special Torque

Connecting rod bolts	163 N·m (120 lbf·ft)
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Table 83 Crankcase, Crankshaft and Camshaft Special Torques

Camshaft thrust plate bolts	26 N·m (19 lbf·ft)
Crankcase ladder, M12 x 35	122 N·m (90 lbf·ft)
Coolant heater bolt	2-3 N·m (20-25 lbf·in)
Crankcase ladder, M10 x 25	63 N·m (46 lbf·ft)
Crankshaft main bearing cap bolt torque and sequence	(See Tensioning Procedure for Torque-to-Yield Bearing Bolts, page 244)

Table 84 Oil System Module and Secondary Filter Special Torques

Coolant drain plug, M18	24 N·m (18 lbf·ft)
Lube adapter bolts	29 N·m (21 lbf·ft)
Oil system module mounting bolts	26 N·m (19 lbf·ft)
Oil pressure regulator valve	68 N·m (50 lbf·ft)
Oil thermal valve assembly	29 N·m (21 lbf·ft)
Oil cooler mounting bolts, M8	29 N·m (21 lbf·ft)
Oil cooler drain tube bracket bolt	26 N·m (19 lbf·ft)
Oil supply tube fitting (turbocharger)	24-26 N·m (17-19 lbf·ft)
Plug assembly, M12	5 N·m (46 lbf·in)
Secondary filter mounting bolts	26 N·m (19 lbf·ft)
Secondary filter stud assembly	20 N·m (15 lbf·ft)

Table 85 Engine Electrical Special Torques

ECM / IDM mounting bolts (2), M8 x 45	20 N·m (15 lbf·ft)
ECM / IDM mounting stud bolts (2), M8 x 45/19	20 N·m (15 lbf·ft)
Engine coolant temperature (ECT) sensor	15-20 N·m (11-15 lbf·ft)
Engine oil pressure (EOP) sensor	9-14 N·m (79-124 lbf·in)
Engine oil temperature (EOT) sensor	15-20 N·m (11-15 lbf·ft)
Injection control pressure (ICP) sensor and Brake Control (BCP) sensor	20-30 N·m (15-22 lbf·ft)
Intake Manifold Air Pressure (MAP) sensor	10-20 N·m (88-176 lbf·in)
Intake Manifold Air Temperature (MAT) sensor	10-20 N·m (88-176 lbf·in)

Table 86 Fuel System Special Torques

Bolt, M8 x 20	29 N·m (21 lbf·ft)
Bottom fitting assembly (AWA)	204 N·m (150 lbf·ft)
Drain valve	0.5 - 1 N·m (5-10 lbf·in)
End plug assembly (AWA)	204 N·m (150 lbf·ft)
Fitting assembly, 3/8 tube	27 N·m (20 lbf·ft)
Fuel bowl	39 N·m (29 lbf·ft)
Fuel drain plug	24 N·m (18 lbf·ft)
Fuel fitting	27 N·m (20 lbf·ft)
Fuel filter header mounting bolts, M8 x 100	27 N·m (20 lbf·ft)
Fuel filter housing cover	25 N·m (18 lbf·ft)
Fuel pressure regulator	1-1.7 N·m (10-15 lbf·in)
Fuel valve assembly (air bleed and pressure test port)	15 N·m (132 lbf·in)
High-pressure oil hose fitting, M18 (at head)	54 N·m (40 lbf·ft)
High-pressure oil hose (swivel nuts)	46 N·m (34 lbf·ft)
High-pressure oil manifold bolts, M8 x 90	27 N·m (20 lbf·ft)
High-pressure oil pump assembly bolts	30 N·m (22 lbf·ft)
High-pressure oil pump assembly (gear)	231-279 N·m (170-205 lbf·ft)
Injector hold down clamp assembly	41 N·m (30 lbf·ft)
IPR valve assembly	50 N·m (37 lbf·ft)
Low-pressure fuel supply pump bolts, M6 x 16	15-18 N·m (132-160 lbf·in)
Plug assembly, M12 (intake manifold fuel rail)	24 N·m (18 lbf·ft)
Post	8 N·m (72 lbf·in)
Self tapping screw	5 N·m (41 lbf·in)
Water In Fuel (WIF) sensor	1.7 N·m (15 lbf·in)

Table 87 Flywheel and Flywheel Housing Special Torques

Engine mounting bracket bolts	108 N·m (80 lbf·ft)
Flexplate mounting bolts	136 N·m (100 lbf·ft)
Flywheel housing mounting bolts	108 N·m (80 lbf·ft)
Flywheel mounting bolts	136 N·m (100 lbf·ft)
Rear engine mounting bracket bolts	108 N·m (80 lbf·ft)

Table 88 Engine Brake Special Torques

Brake Control Pressure (BCP) sensor	20-30 N·m (15-22 lbf·ft)
Brake housing bolts (M8 x 90)	27 N·m (20 lbf·ft)
Brake piston adjustment locknut	27 N·m (20 lbf·ft)
Brake shutoff solenoid tinnermann nut	7-11 N·m (5-8 lbf·in)
Brake shutoff valve	34 N·m (25 lbf·ft)
Injection Control Pressure (ICP) sensor	20-30 N·m (15-22 lbf·ft)
Oil pressure relief valve	41-48 N·m (30-35 lbf·ft)
Rail end plug assembly	204 N·m (150 lbf·ft)

Table 89 TF 550 and TF 750 Air Compressor and Power Steering Pump Special Torques

Air compressor gear nut	150 N·m (110 lbf·ft)
Bracket bolt to air compressor, M10 x 25	67 N·m (49 lbf·ft)
Bracket bolt to crankcase, M12 x 25	115 N·m (85 lbf·ft)
Elbow assembly, M10	15-16 N·m (132-141 lbf·in)
Elbow fitting assembly, M18	48 N·m (35 lbf·ft)
Hose connector assembly, M18	48 N·m (35 lbf·ft)
Power steering mounting bolts, M10 x 35	57 N·m (42 lbf·ft)
Power steering pump drive nut	90 N·m (66 lbf·ft)

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Description

Special service tools for the DT 466, DT 570 and HT 570 series engines can be ordered from the **SPX Corporation, 1-800-520-2584**.

NOTE: The following sections of the manual do not require any special tools for service work:

- *Intake, Inlet, and Exhaust Manifolds*
- *Oil Pan and Oil Suction Tube*
- *Engine Electrical*
- *Air Compressor and Power Steering Pump*

Table 90 Special Tools

Engine mounting plate	ZTSE4649
Engine stand	OTC1750A

Table 91 VGT Special Service Tools

Dial indicator set	Obtain locally
Intake guard	JDG576

Table 92 EGR System Special Service Tools

EGR cooler pressure test plates	ZTSE4636
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Table 93 Cylinder Head Special Service Tools

Cylinder head test plate	ZTSE4289A
Dye penetrant kit	Obtain locally
Head bolt thread gauge	ZTSE4667
Injector sleeve brush set (set of 2)	ZTSE4304
Injector sleeve installer	ZTSE4642
Injector sleeve remover	ZTSE4643
Pressure regulator	Obtain locally
Slide hammer puller set	ZTSE1879
Small hole gauge set	Obtain locally
Straightedge	Obtain locally
Thermostat opening pressure adapter	ZTSE4647
Valve guide deburring tool	ZTSE4393
Valve guide installer	ZTSE1943
Valve guide remover	ZTSE4377
Valve seat extractor kit (universal)	ZTSE1951C
Valve seat grinder	ZTSE1631A
Valve seat grinding stones 45° (exhaust)	Obtain locally
Valve seat grinding stones 60° (intake)	Obtain locally
Valve seat installer	ZTSE4641
Valve seat remover (collet)	ZTSE4640
Valve spring compressor	ZTSE1846
Valve spring compressor jaws	ZTSE4652
Water supply housing pressure adapter	ZTSE4648

Table 94 Front Cover, Vibration Damper, Gerotor Oil Pump, Front Engine Mounts, and Gear Train Special Service Tools

Dial indicator set	Obtain locally
Front seal and wear sleeve installer	ZTSE3004B
Hot plate	Obtain locally
Slide hammer puller set	ZTSE1879
Straightedge	Obtain locally

Table 95 Piston, Piston Ring, and Connecting Rod Special Service Tools

Counterbore cutting head	ZTSE25144A
Cylinder bore gauge	Obtain locally
Cylinder sleeve counterbore tool kit	ZTSE2514
Cylinder sleeve holding adapters (set of 3)	ZTSE4672
Cylinder sleeve puller	ZTSE2536
Dial indicator set	Obtain locally
EGR water coolant supply plate	ZTSE4648
Piston ring compressor tool	ZTSE4396
Piston ring expander	Obtain locally
Piston ring gauge pins (set of 3)	ZTSE4653
Telescoping gauge set	Obtain locally

Table 96 Crankcase, Crankshaft and Camshaft Special Service Tools

Cam gear puller	ZTSE4411
Camshaft bushing puller	ZTSE2893B
Hot plate	Obtain locally
Nylon brush	ZTSE4389
Tap, cylinder head bolt holes	ZTSE4671
Tap set	ZTSE4386
Stiff nylon brush	ZTSE4392

Table 97 Oil System Module Special Tools

Air pressure regulator	Obtain locally
Oil cooler test plate	ZTSE4654

Table 98 Fuel System Special Service Tools

Cap kit, injectors	ZTSE4660
Fuel injector rack cups	ZTSE4645
Fuel injector remover tool (#40 Torx®)	ZTSE4524
IPR removal / installation tool	ZTSE4666

Table 99 Flywheel and Flywheel Housing Special Service Tools

Crankshaft timing disk puller (H-bar)	Obtain locally
Dial indicator with magnetic base	Obtain locally
Guide pins	Obtain locally
Rear seal installer	ZTSE4637
Slide hammer puller set	ZTSE1879

Table 100 Engine Brake Special Service Tools

Feeler gauge (long)	Obtain locally
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Photos of Essential Tools

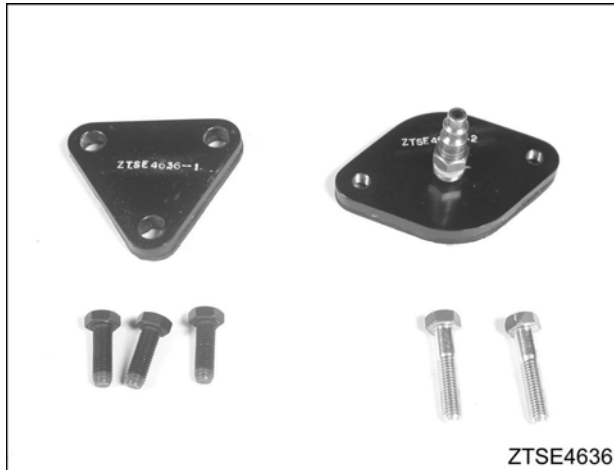


Figure 609 EGR cooler pressure test plates, ZTSE4636



Figure 610 Rear seal installer, ZTSE4637



Figure 611 Valve seat remover (collet), ZTSE4640



Figure 612 Valve seat installer, ZTSE4641



Figure 613 Injector sleeve installer, ZTSE4642

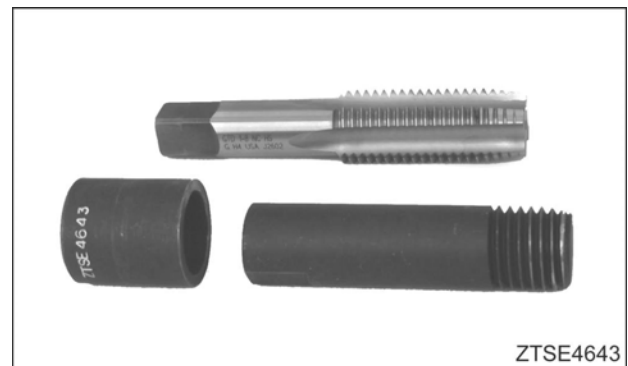


Figure 614 Injector sleeve remover, ZTSE4643



Figure 615 Injector rack – ZTSE4299B, Injector rack cups – ZTSE4645

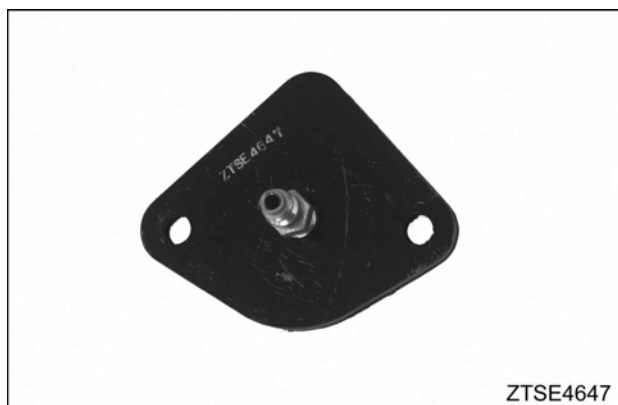


Figure 616 Thermostat opening pressure adapter– cylinder head, ZTSE4647



Figure 617 Water supply housing pressure adapter-cylinder head, ZTSE4648

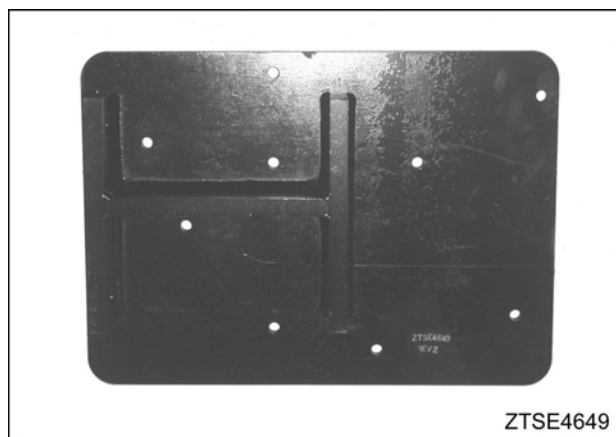


Figure 618 Engine mounting plate, ZTSE4649



Figure 619 Valve spring compressor jaws, ZTSE4652

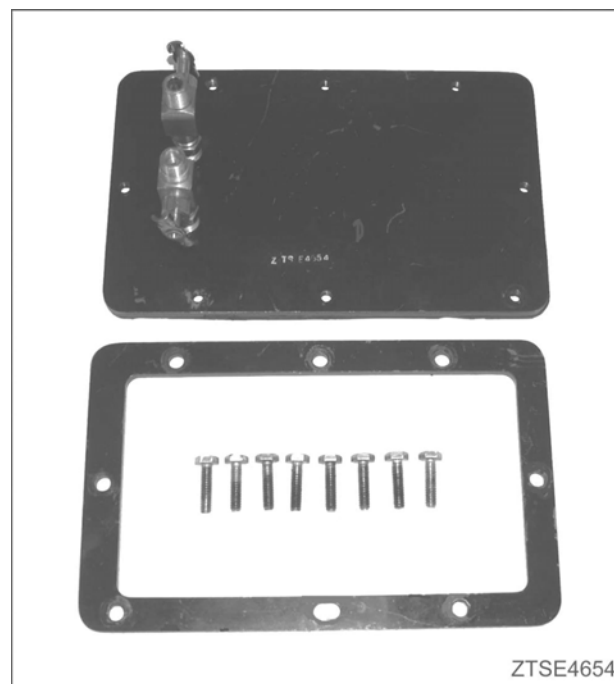


Figure 621 Oil cooler test plate, ZTSE4654



Figure 620 Piston gauge pins (set of three), ZTSE4653



Figure 622 Head bolt and main bolt thread gauge, ZTSE4667



Figure 623 Head bolt bottoming tap, ZTSE4671

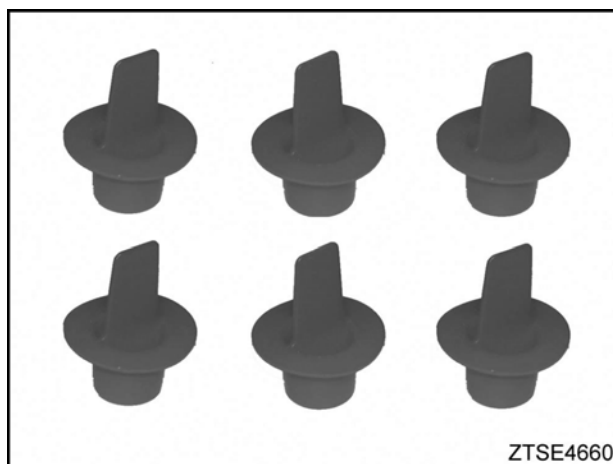


Figure 625 Cap kit-Injector, ZTSE4660



Figure 624 Sleeve protrusion hold down clamps, ZTSE4672

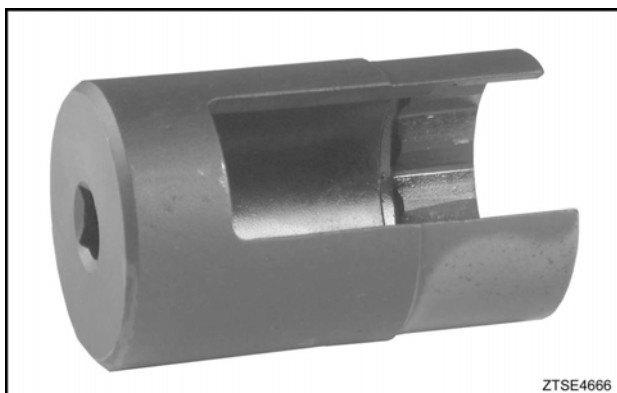


Figure 626 IPR valve removal and installation tool, ZTSE4666

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