VOLVO
Volvo Trucks North America
Greensboro, NC USA

Service Bulletin Trucks

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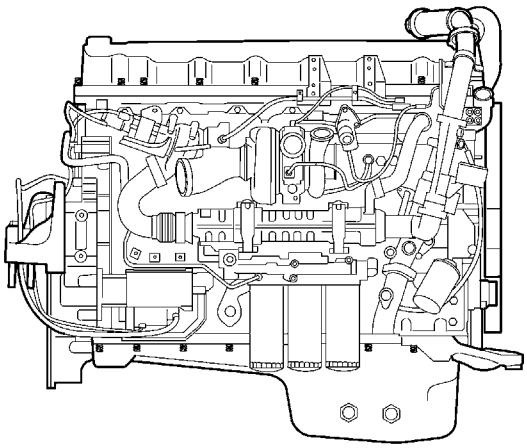
This service bulletin replaces bulletin 200-321 dated 3.2013.

Specifications



W2005779

Contents:

Note: Information is subject to change without notice.
Illustrations are used for reference only and may differ slightly from the actual vehicle being serviced. However, key components addressed in this information are represented as accurately as possible.

Specifications

General

Weights and Dimensions

Engine type	In-line direct injection diesel
Number of cylinders	6
Displacement	13 L
Swept volume	12.78 L
Cylinder bore and stroke	131 x 158 mm (5.16 x 6.22 inches)
Emissions level	EPA 07: 2.5g NOx; 0.1g Pt maximum US2010: 0.2 g/hp-hr NOx maximum
Fuel system	Dual solenoid electronic injector
Valve actuation	Single overhead camshaft, four valves per cylinder
Aspiration	Variable geometry turbocharger with sliding nozzle ring
Cylinder and piston type	Wet Sleeve; one-piece steel piston
Electronic control	Volvo VECTRO electronic management system
Emission controls	EPA 07: Cooled EGR; Diesel Particulate Filter (DPF) US2010: Cooled EGR; Diesel Particulate Filter (DPF); Selective Catalytic Reduction (SCR)
Peak power ratings	375–500 hp
Peak torque ratings	1965–2373 Nm (1450–1750 ft-lb)
Governed rpm	2100 rpm
Weight	Approximately 1,130 kg (2500 lb)
Firing order	1-5-3-6-2-4
Compression ratio	16:1
Fasteners and threads	Metric
Flywheel housing (standard)	Aluminum
Total length	1366 mm (54 inches)
Total width	971 mm (38 inches)
Total height	1281 mm (50 inches)

Component Features and Materials

Item	Description
Air compressor	Flange mounted, oil lubricated, water cooled
Camshaft	Induction hardened, gear driven
Coolant conditioner	Spin-on type, disposable
Connecting rods	Forged steel, cracked cap design
Crankshaft	Drop forged steel, induction hardened, seven main bearings
Cylinder block	In-line six cylinder, nodular iron, machined with bearing caps, stiffener plate, timing gear mounting plate, guide dowels for cylinder head; wet replaceable cylinder sleeves
Cylinder head	One-piece cast iron alloy; overhead camshaft, four valves per cylinder, injectors; cast iron valve guides and oil seals; steel valve seats; copper or stainless steel injector sleeves; integral fuel passages and thermostat housing; guide slots for installation on block
Valve cover	Plastic, 20 spring tension screws
Cylinder liner	Wet Sleeve; replaceable; with EDPM rubber and Viton seals
Cylinder head — Valve springs	Double springs on each exhaust valve
Cylinder head — Valve guides	Cast iron, replaceable; with oil seals
Cylinder head gasket	One-piece steel stamping; elastomer seals added; one-time bosses to aid in head installation
Cylinder head bolts	M16 (38)
Timing gear cover (rear of cylinder head)	Die-cast aluminum, elastomer seals
Flywheel housing	Die-cast aluminum
Fuel filters	One 30-micron primary, one 5–micron secondary
Fuel injection	Six individually programmed unit injectors: ECM controlled; common fuel gallery in head; constant supply pressure; over-pressure return
Fuel supply pump	Gear type pump integral with power steering pump; idler gear driven
Lubrication system	Crankshaft gear driven oil pump; system integrated with block and head; serves camshaft, rocker arm shaft, pistons, crankshaft, air compressor, turbocharger, EGR valve; three oil filters; oil level and temperature sensor in oil pan; pump pressure tube, strainer and pressure relief valve
Main bearing caps	Nodular iron; machined with block; No. 7 mounts oil pump; numbered for reassembly; sleeve guides for screws; thrust washers at No. 4 main bearing journal
Exhaust manifold	Three-piece, six port
Pistons	One-piece steel; three ring grooves
Piston rings — Compression	Two: one trapezoidal cross section, one rectangular cross section
Piston rings — Oil	One: garter spring type; scraping

Item	Description
Oil filters	Two 40–micron full flow, one 5-micron bypass; Filter capacity, two full flow: • 4.0–4.5 liters (4.2–4.8 quarts)
Oil pan	Plastic, steel; 22 spring tension screws Sump capacity: • 36 liters (38 quarts)
Thermostat	Sleeve type: 82°C (180°F)
Thermostat housing	Integrated in cylinder head
Turbocharger	Variable geometry type: Holset; exhaust driven; fixed vanes; sliding ring nozzle; infinitely variable volume; oil and water cooled
Valve lifters	Roller followers
Valve seat inserts	Pressed in head; replaceable
Vibration damper	Internal fluid-filled ring
Coolant pump	Centrifugal rotor impeller; belt driven

Engine

Cylinder Head

Maximum unevenness (bottom face)	0.1 mm (0.004 inch)

Cylinder Head Bolts

Quantity	38
Thread size	M16
Length	200 mm (7.87 inches)

Cylinder Block

Length	1052 mm (41.42 inches)
Height, upper block face — crankshaft center	422 mm (16.61 inches)
Height, lower block face — crankshaft center	120 mm (4.72 inches)

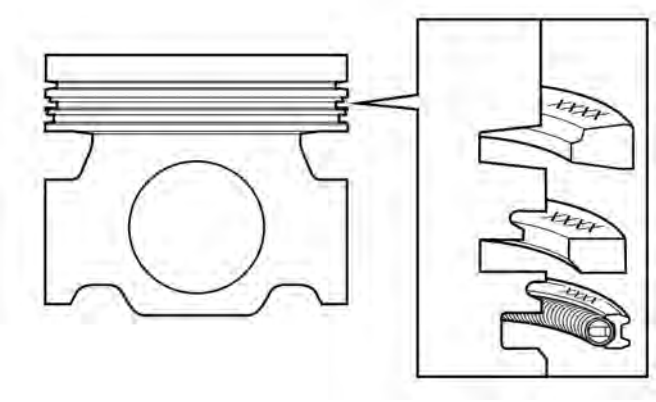
Cylinder Liner

Type	Wet, replaceable
Height of sealing surface above block face	0.15–0.21 mm (0.006–0.008 inch)
Number of sealing rings per cylinder liner	1 + 3

Piston

Number of ring grooves	3
Front marking	Arrow pointing forward

Piston Rings



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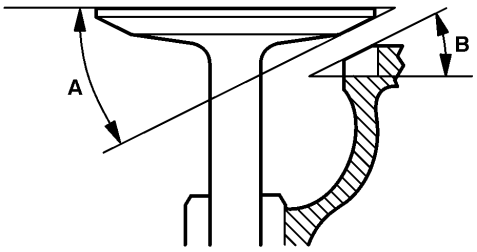
Compression Rings	
Quantity	2
Labelling	Up (color marking to left of gap)
Piston ring clearance in groove: Upper compression ring Lower compression ring	 Trapezium profile 0.09–0.14 mm (0.0035–0.0055 inch)
Oil Scraper Ring	
Quantity	1
Labelling	Up (color marking to left of gap)
Piston ring clearance in groove	0.05–0.10 mm (0.0019–0.0039 inch)

Valve Mechanism

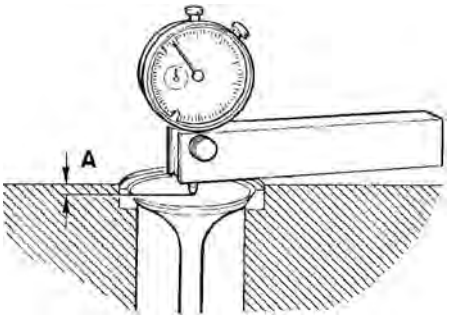
Valves



T2019432

Valve disc diameter:	
Inlet	42 mm (1.654 inches)
Exhaust	40 mm (1.575 inches)
Valve stem diameter:	
Inlet/Exhaust	8 mm (0.315 inch)
Valve face angle (A):	
Inlet	24.5 degrees
Exhaust	39.5 degrees
Valve seat angle in cylinder head (B):	
Inlet	25 degrees
Exhaust	40 degrees

Note: When replacing valve seats, also replace the valves.

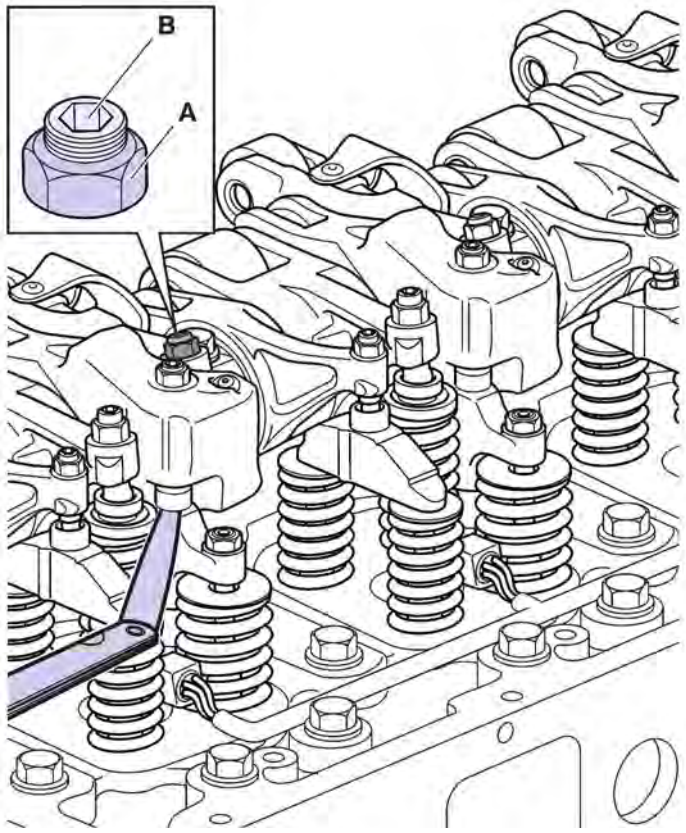


T2023980

Measurement (A) between valve head and cylinder head face:	
Inlet	1.0 mm (0.039 inch) minimum
Exhaust	1.35 mm (0.053 inch) minimum
Maximum wear value:	
Inlet	1.7 mm (0.067 inch)
Exhaust	1.5 mm (0.059 inch)

Valve lash (clearance) cold engine, adjustment value:	
Inlet	0.2 mm (0.008 inch)
Exhaust	0.8 mm (0.031 inch)
Exhaust, engine brake	1.0 mm (0.394 inch)
Valve lash (clearance) cold engine, check value:	
Inlet	0.15–0.25 mm (0.006–0.009 inch)
Exhaust	0.75–0.85 mm (0.029–0.033 inch)
Exhaust, engine brake	0.95–1.05 mm (0.037–0.041 inch)

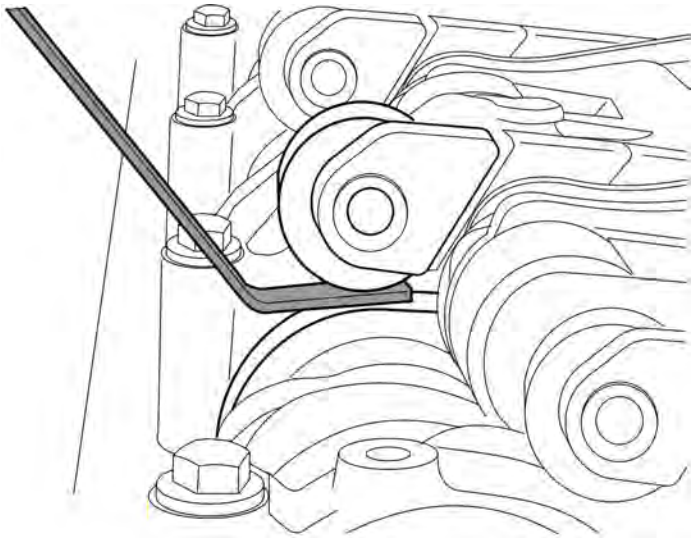
Engine Brake Rocker Arm, Engine Brake



T2027091

Shimmed engine brake rocker arm, adjustment:
Valve caliper pressed down by adjusting screw (B) .tighten the adjuster screw until it makes contact and then a further 1/2 turn until the valve yoke clearly moves down and the exhaust valve opens slightly

Non-Shimmed engine brake rocker arm, adjustment:
Adjust the brake rocker with a 2.5 mm gauge between the cam and the rocker arm roller. Tighten the adjusting screw (B) until the valve yoke clearly moves downward.



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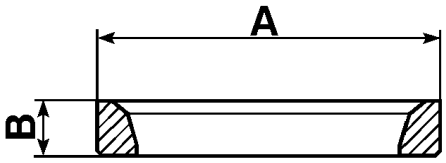
Shimmed engine brake rocker arm clearance	2.5 mm (0.098 inch)
Non-shimmed engine brake rocker arm clearance	3.2 mm (0.126 inch)

Rocker Arms

Rocker arm bearing clearance	0.08 mm (0.003 inch) maximum
Rocker arm roller clearance	0.1 mm (0.004 inch) maximum

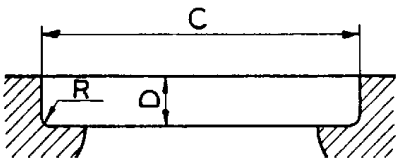
Valve Seats



T2014128

Standard outside diameter (A):	
Inlet	45.1 mm (1.776 inches)
Exhaust	43.1 mm (1.697 inches)
Oversize outside diameter (A):	
Inlet	45.3 mm (1.783 inches)
Exhaust	43.3 mm (1.705 inches)
Height (B):	
Inlet	7.55 mm (0.297 inch)
Exhaust	7.5 mm (0.295 inch)

Valve Seat Location

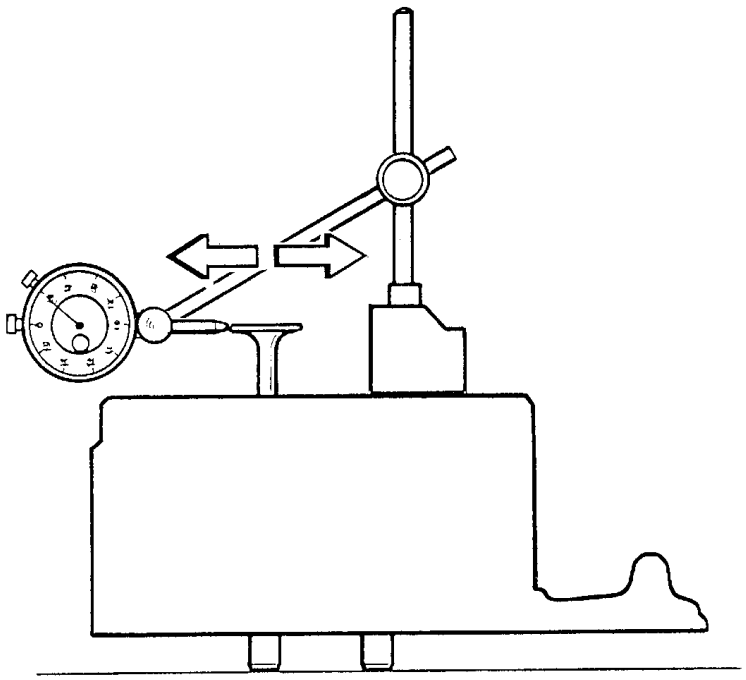


T2012872

Standard diameter (C):	
Inlet	45.0 mm (1.772 inches)
Exhaust	43.0 mm (1.693 inches)
Oversize diameter (C):	
Inlet	45.2 mm (1.78 inches)
Exhaust	43.2 mm (1.701 inches)
Depth (D):	
Inlet	11.8 ± 0.13 mm (0.465 ± 0.005 inch)
Exhaust	11.2 ± 0.13 mm (0.441 ± 0.005 inch)
Seat bottom radius (R):	
Inlet/Exhaust	0.8 mm (0.032 inch) maximum

Valve Guides

Length: Inlet/Exhaust.....83.5 mm (3.287 inches)
Inner diameter: Inlet/Exhaust.....8 mm (0.315 inch)
Height above cylinder head spring surface: Inlet/Exhaust.....24.5 ± 0.2 mm (0.965 ± 0.008 inch)



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Valve stem-to-guide wear clearance:[1] Inlet.....0.7 mm (0.027 inch) maximum Exhaust.....0.7 mm (0.027 inch) maximum

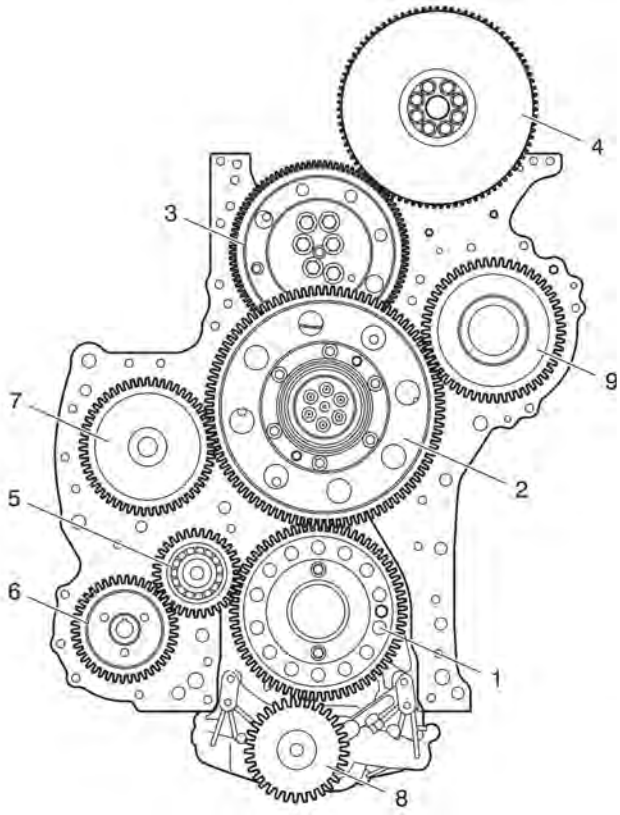
1 The measurements are calculated for the measurement method described in the service literature, see Function Group 214.

Valve Springs

Inlet valve spring: Length unloaded.....73.8 mm (2.91 inches)
Exhaust outer valve spring: Length unloaded.....73.8 mm (2.91 inches)
Exhaust inner valve spring: Length unloaded.....70.5 mm (2.78 inches)

Engine Timing Gears

Timing Gears



T2022797

Component	**Number of Teeth**
1. Drive gear, crankshaft	63
2. Idler gear, outer and inner drive	Outer: 84, Inner: 56
3. Idler gear, adjustable	73
4. Drive gear, camshaft	84
5. Idler gear, power steering pump	29
6. Drive gear, power steering pump	36
7. Drive gear, air compressor	48
8. Drive gear, lubricating oil pump	31
9. Engine power take-off (optional)	50
Idler gear to camshaft gear backlash (adjustable)	0.05–0.15 mm (0.002–0.006 inch)
Oil pump backlash	0.05–0.40 mm (0.002–0.016 inch)
Idler gear axle-to-bushing clearance	0.05 mm (0.002 inch) maximum
All other drive and idler gear, backlash	0.05–0.17 mm (0.002–0.007 inch)

Camshaft

Control of camshaft settings, cold engine and valve clearance for cylinder 1 inlet valve equals zero. Inlet valve for cylinder 1 should be open 1.6 ± 0.3 mm (0.063 ± 0.012 inch) at a flywheel position of 6 degrees after TDC. When checking, the timing gears must be rotated in the correct direction (counterclockwise) in order to take up all gear tooth clearance.
Axle arrangements ..... Gear
Number of bearings 7
Standard bearing journal diameter ..... 69.97–70.00 mm (2.754–2.760 inch)
Undersize bearing journal diameters: 0.25 mm (0.010 inch) ..... 69.72–69.78 mm (2.746–2.747 inches) 0.50 mm (0.020 inch) ..... 69.47–69.53 mm (2.735–2.737 inches) 0.75 mm (0.030 inch) ..... 69.22–69.28 mm (2.725–2.728 inches)

Valve lift at zero play: Inlet ..... 13.1 mm (0.520 inch) Exhaust engine brake ..... 12.5 mm (0.490 inch)
Permitted wear, entire camshaft profile ..... 0.1 mm (0.0039 inch) maximum
Injector, stroke ..... 18 mm (0.710 inch)

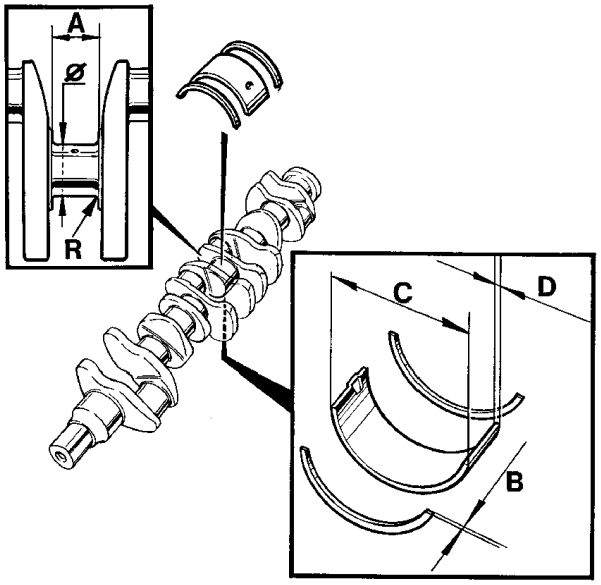
Wear value
Max end float ..... 0.24 mm (0.0094 inch)
Bearing, permitted diametrical wear ..... 0.1 mm (0.0039 inch) maximum

Camshaft Bearings

Camshaft bearing thickness, standard ..... 1.92 mm (0.075 inch) Oversize: 0.25 mm (0.010 inch) ..... 2.04 mm (0.080 inch) 0.50 mm (0.020 inch) ..... 2.17 mm (0.085 inch) 0.75 mm (0.030 inch) ..... 2.29 mm (0.090 inch)

Crank Mechanism

Crankshaft



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Wear value:	
Crankshaft axial clearance[1]	0.4 mm (0.016 inch) maximum
Machining value:	
Main bearing and connecting rod bearing journal out-of-round	0.006 mm (0.0002 inch) maximum
Main bearing and connecting rod bearing journal taper	0.02 mm (0.0008 inch) maximum
Runout of middle bearing	0.15 mm (0.006 inch) maximum

1 The measurements refer to lubricated components.

Main Bearing Journals

Standard diameter (Ø)	108.0 mm (4.25 inches)
Undersize diameter:	
0.25 mm (0.010 inch)	107.75 mm (4.2421 inches)
0.50 mm (0.020 inch)	107.50 mm (4.2323 inches)
0.75 mm (0.030 inch)	107.25 mm (4.2224 inches)
1.00 mm (0.040 inch)	107.00 mm (4.2126 inches)
1.25 mm (0.050 inch)	106.75 mm (4.2027 inches)
Surface finish, main bearing journal	Ra 0.25
Surface finish, radius	Ra 0.4
Width, axial bearing pin (A), standard	47.0 mm (1.850 inches)
Oversize:	
0.2 mm (0.008 inch), axial bearing 0.1 mm (0.004 inch)	47.2 mm (1.858 inches)
0.4 mm (0.016 inch), axial bearing 0.2 mm (0.008 inch)	47.4 mm (1.866 inches)
0.6 mm (0.241 inch), axial bearing 0.3 mm (0.012 inch)	47.6 mm (1.874 inches)
Recess radius (R)	4.0 mm (0.157 inch)

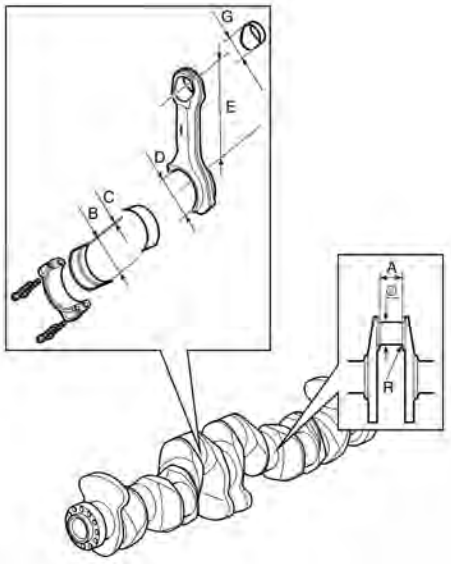
Thrust Washers (Axial Bearing)

Standard width (B)	3.18 mm (0.125 inch)
Oversize:	
0.1 mm (0.004 inch)	3.28 mm (0.129 inch)
0.2 mm (0.008 inch)	3.38 mm (0.133 inch)
0.3 mm (0.012 inch)	3.48 mm (0.137 inch)
0.4 mm (0.016 inch)	3.58 mm (0.141 inch)

Main Bearings

Standard thickness (D)	2.48 mm (0.098 inch)
Oversize:	
0.25 mm (0.010 inch)	2.61 mm (0.103 inch)
0.50 mm (0.020 inch)	2.74 mm (0.108 inch)
0.75 mm (0.030 inch)	2.86mm (0.112 inch)
1.00 mm (0.040 inch)	2.98mm (0.117 inch)
1.25 mm (0.050 inch)	3.11 mm (0.122 inch)
Main bearing maximum permitted diametrical wear value	0.05–0.12 mm (0.002–0.005 inch) max.

Connecting Rod Journals



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Diameter (Ø)	99.0 mm (3.898 inches)
Undersize:	
0.25 mm (0.010 inch)	98.75 mm (3.888 inches)
0.50 mm (0.020 inch)	98.50 mm (3.878 inches)
0.75 mm (0.030 inch)	98.25 mm (3.868 inches)
1.00 mm (0.040 inch)	98.00 mm (3.858 inches)
1.25 mm (0.050 inch)	97.75 mm (3.848 inches)
Surface finish, bearing journal	Ra 0.25
Surface finish, radius	Ra 0.4
Width (A)	57.0 mm (2.244 inches)
Recess radius (R)	4.0 mm (0.157 inch)

Connecting Rod Bearings

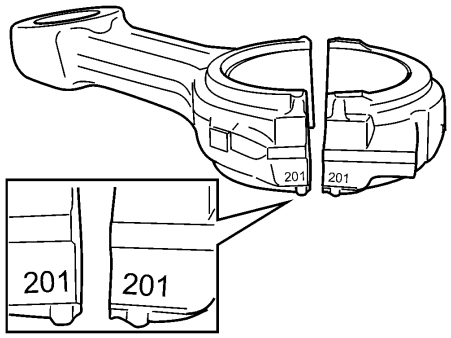
Standard thickness (C)	2.39 mm (0.094 inch)
Oversize:	
0.25 mm (0.010 inch)	2.64 mm (0.104 inch)
0.50 mm (0.020 inch)	2.89mm (0.114 inch)
0.75 mm (0.030 inch)	3.14 mm (0.124 inch)
1.00 mm (0.040 inch)	3.39 mm (0.134 inch)
1.25 mm (0.050 inch)	3.64 mm (0.143 inch)

Connecting Rod

Wear Value	
End play, connecting rod at crankshaft journal[1]	0.35 mm (0.0138 inch) maximum
Big-end bearing, diametrical play[1]	0.1 mm (0.004 inch)

1 The measurements refer to lubricated components.

Marking:
The FRONT marking on the connecting rod faces forward



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The connecting rod and cap are marked as a pair with a three-digit serial number.

Flywheel, mounted

Axial runout (manual transmission) measurement radius 150 mm (5.91 inches)	Less than 0.21 mm (0.008 inch)

Flywheel Housing, mounted

Axial runout of contact surface against clutch housing	0.2mm (0.008 inch) maximum
Radial runout of guide against clutch housing	0.26 mm (0.010 inch) maximum

Lubricating and Oil System

Oil

For oil change volume, specification and maintenance intervals, refer to Service Information, Function Group 175.

Oil Pressure

Operating speed (over 1,100 rpm)	300–550 kPa (45–80 psi)
Cold engine (above 1,100 rpm)	650 kPa (95 psi)
Low idle	250 kPa (35 psi) minimum
Piston cooling pressure, hot engine (above 1,100 rpm)	200–300 kPa (30–45 psi)

Oil Pressure, Rocker Arm Shaft

Engine brake non-activated	80–120 kPa (12–17 psi)
Engine brake activated (900–2300 rpm)	220 kPa (32 psi) minimum

Oil Temperature

Hot engine, engine running (coolant temperature 75–95°C (167–203°F)	90–110°C (194–230°F)[1]

1 Up to 125°C (257°F) with heavy load

Lubricating Oil Pump

Type	Gear driven
Number of teeth, drive gear	31
Backlash	0.05–0.40 mm (0.0019–0.0157 inch)

Oil Filters

Full flow filter	2
Bypass filter	1

Oil Filter Housing Valves

Note: Valves vary by engine.

Item	Spring Free Length	Spring Length Under Load
Safety valve, oil pump	74 mm (2.914 inches)	Load: 35 N (7.87 lbf) Length: 41 mm (1.61 inches)
Reduction valve marking — yellow	61 mm (2.402 inches)	Load: 66 N (14.84 lbf) Length: 39 mm (1.54 inches)
Control valve, piston cooling (balancing)	122 mm (4.803 inches)	Load: 95 N (21.36 lbf) Length: 63 mm (2.480 inches)
Opening valve, piston cooling	122 mm (4.803 inches)	Load: 95 N (21.36 lbf) Length: 63 mm (2.480 inches)
Overflow valve, full flow filter	69 mm (2.717 inches)	Load: 13–15 N (2.92–3.37 lbf) Length: 40 mm (1.575 inches)

Thermostatic valve, oil cooler: Opening temperature.....103–107°C (217-225°F) Total opening length @ 114–118°C (237-244°F)..... 9 mm (0.354 inch)

Piston cooling jet control solenoid valve: 9.5 - 11.5 ohms at 20°C (68°F)
Oil cooler thermostat solenoid valve: 6.8 - 11.2 ohms at 20°C (68°F)

Fuel System

Fuel Pump Pressure

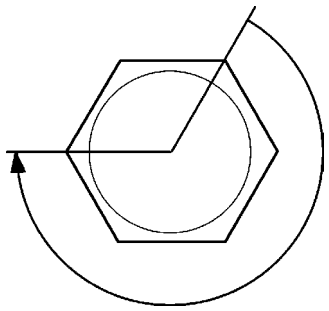
600 rpm	100 kPa (15 psi) minimum
1200 rpm	300 kPa (44 psi) minimum
Full load	300 kPa (44 psi) minimum

Overflow Valve

Opening pressure	300–550 kPa (44–80 psi)

Injectors

To adjust the rocker arm pretension for injectors:



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Tighten the rocker arm adjusting screw	Obtain zero clearance
Tighten the rocker arm adjusting screw	Additional 4 flats (2/3 turn) clockwise

Inlet and Exhaust System

Variable Geometry Turbocharger

Turbine rotor shaft axial clearance	0.040–0.090 mm (0.002–0.004 inch) maximum
Turbine rotor shaft radial clearance	0.330–0.500 mm (0.013–0.020 inch) maximum

Heat Retention Function

Heat retention activated:	
Coolant temperature	Less than 60°C (140°F)
Engine load	Less than approximately half load
Heat retention deactivated:	
Coolant temperature	Greater than 70°C (158°F)
Engine load	Greater than approximately half load
Ambient temperature	Greater than 13°C (55°F)

Inlet Manifold Air Temperature Sensor

Cold engine, engine off	Ambient temperature
Warm engine, engine running with coolant temperature at 75–95°C (167–203°F)	40°C (104°F) above ambient temperature

Engine Brake Activation

Braking Force (%)	Engine Brake (On/Off)
40%	Off
50%[1]	On
70%	On
100%	On
Cruise mode	On/Off

1 50% braking power can only be obtained in automatic position or with a 3-position switch.

Activated:	
Engine speed	Greater than approximately 700–800 rpm
Vehicle speed	Greater than approximately 5 km/h (3 mph)
Engine oil temperature	Greater than 20°C (68°F)
Boost pressure	Less than 150 kPa (22 psi)
Deactivated:	
Engine speed	Less than approximately 800–900 rpm
Vehicle speed	Less than approximately 5 km/h (3 mph)
Engine oil temperature	Less than 15°C (59°F)
Boost pressure	Greater than 170 kPa (24 psi)

Compression Brake Switch

2-way switch can give 0% or 100% braking power.
3-way switch can give 0%, 50% or 100% braking power.
4-way switch can give 0%, 40%, 70% or 100% braking power.
5/6-way switch can give 0%, 40%, 70% or 100% braking power, and also 50% in A-position.

Exhaust Back Pressure

Exhaust back pressure	30 kPa (4.35 psi) maximum

Cooling System

General

Pressure valve opens	90 kPa (13 psi)

Thermostat

Quantity	1
Opening temperature	82°C (180°F)

Coolant

For additional cooling system volumes, coolant requirements and maintenance intervals, refer to Service Information Function Group 18.

Type 1	Regular Coolant
Color	Purple/fuchia
Contains	Glycol and anti-corrosion additives
Mixed with	Water (STD 1285,1)
Type 2	Extended Life Coolant (ELC)
Color	Red
Contains	Glycol and anti-corrosion additives
Mixed with	Water (STD 1285,1)
Type 3	Extended Service Coolant (ESC)
Color	Blue
Contains	Glycol and anti-corrosion additives
Mixed with	Water (STD 1285,1)

Fan On/Off

Activated System	Conditions	Fan Engagement
Coolant temperature	100°C (212°F)	Activated
Coolant temperature	96°C (205°F)	Deactivated
Inlet manifold temperature	85°C (185°F)	Activated
Inlet manifold temperature	80°C (176°F)	Deactivated
Engine (ECM) temperature	Greater than 100°C (212°F)	Activated
Engine (ECM) temperature	Less than 95°C (203°F)	Deactivated
AC system	Greater than 20 bar (290 psi)	Activated

Electronically Controlled Viscous Fan

Activated System	Conditions	Fan Engagement
Coolant temperature	96°C (205°F)	Variable fan speed activation
Engine (ECM) temperature	Greater than 100°C (212°F) Less than 95°C (203°F)	1200 rpm Deactivated
Inlet manifold air temperature	Greater than 70°C (150°F) Greater than half of maximum engine torque	1200 rpm 7 second delay after engine brake activated
AC compressor clutch activated	Engine speed greater than 1500 rpm Ambient temperature greater than 40°C (104°F) Vehicle speed less than 45 km/h (28 mph)	1200 rpm
AC compressor clutch activated	Engine speed greater than 1200 rpm Ambient temperature greater than 30°C (86°F) Vehicle speed less than 45 km/h (28 mph)	1000 rpm
AC compressor clutch activated	Ambient temperature greater than 35°C (95°F) Vehicle speed less than 10 km/h (6 mph)	1200 rpm
AC compressor clutch activated	Ambient temperature greater than 20°C (68°F) Vehicle speed less than 20 km/h (12 mph)	600 rpm
AC compressor clutch activated	Refrigerant pressure greater than 20 bar (300 psi)	Full engagement

Engine Control System

Engine ECM

Number of pins	2 x 62

Sensors

Note: Use tech tool for component function and sensor values checks.

Note: Sensors vary by engine.

Charge Air Pressure Sensor

Check values	1.07 ± 0.1 volts at 100[1] kPa (14.5 psi)

1 Normal atmospheric pressure at sea level.

Camshaft Sensor

Distance to toothed gear	1.1 ± 0.4 mm (0.04 ± 0.02 inch)

Flywheel Sensor

Distance to flywheel	1.5 ± 0.5 mm (0.06 ± 0.02 inch)

Crankcase Pressure Sensor

Sensor alarm limit	8 kPa (1.2 psi)
Crankcase pressure, normal value	Less than 1.0 kPa (0.14 psi)

Tightening Torques and Patterns

Engine Component Torque Specifications (Critical Fasteners)

Note: All components are to be clean and free from foreign material or corrosion. Assemblies are to be made using suitable tools and procedures so that no permanent damage occurs as a result of the assembly.
Threads, washers under the head of the screw and the washer face of the nuts should be lubricated with clean engine oil unless otherwise specified.
The following listed fasteners require the use of a calibrated manual torque wrench. If an adaptor is required in combination with a torque wrench, a correction factor must be applied to the torque wrench settings (readings) in order to obtain accurate fastener torque values.

CAUTION

Repeated tightening of fasteners and threaded components reduces their capacity to function adequately. The following table describes the various items and the limits of their reusability. Failure to conform to these limits can result in severe component damage.

Fasteners	Examples	Reusable Limit	Reuse Recommendations
Highly loaded screws (phosphating plus oil)	Cylinder head Cylinder block Injector clamp Camshaft bearing housing Transmission Flywheel	5 times	Apply engine oil on threads and under screw head. Mark bolt head with an indentation. Dry mounting for new screws (delivered with oil pre-applied and anti-rust treatment for spare parts). If a part is replaced, e.g., cylinder head, also replace the screws.
Highly loaded screws (phosphating plus oil)	Connecting rods	5 times	
Special screws (specific shape)	Oil pan and valve cover	No limit	No limit if no cracks, corrosion or damage to the flat surfaces.
Stainless steel/bronze studs and flange locknuts (Spiralock)	Turbocharger Exhaust manifold EGR valve	Not reusable	If turbocharger, exhaust manifold or EGR valve studs or nuts are loosened, they must be replaced.
Prevailing torque feature screws (Dri-lock Plastic or Tuflock)	Piston cooling nozzles Timing gear plate	Not reusable	
Standard screws	Property class 8.8	Do not reuse	Torque and angle tightened or yield limit tightened bolts.
Standard screws	Property class 10.9 Property class 12.9	No limit	No limit if no cracks, corrosion or damage to the flat surfaces.
V-nipple with taper threads	With locking fluid pre-applied	Not reusable	Before fitting the new nipple, clean the hole with a nipple tap and apply sealant on the nipple thread, or use a new coated nipple.
Taper plugs or nipples	With sealer fluid pre-applied	Not reusable	Before fitting the new nipple, clean the hole with a nipple tap and apply sealant on the nipple thread, or use a new coated nipple.

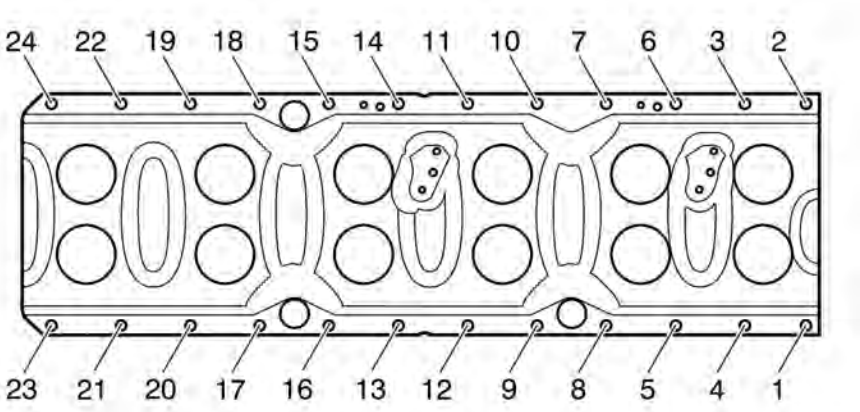
Tightening Torques Function Group 20

General Tightening Torques
M6 standard bolt 8.8 ..... 10± 1.5 Nm (7.4 ± 1 ft-lb) (89 ± 13 in-lb)
M8 standard bolt 8.8 ..... 24 ± 4 Nm (18 ± 3 ft-lb)
M10 standard bolt 8.8 ..... 48 ± 8 Nm (35 ± 6 ft-lb)
M12 standard bolt 8.8 ..... 85 ± 15 Nm (63 ± 11 ft-lb)
M14 standard bolt 8.8 ..... 140 ± 25 Nm (103 ± 18 ft-lb)
M16 standard bolt 8.8 ..... 190 ± 35 Nm (140 ± 26 ft-lb)

Bolts that have been torque-tightened only, can be reused.
Torque-tightened, angle-tightened, yield-limit-tightened bolts:
8.8 ..... Should not be reused
10.9 ..... Can be reused
12.9 ..... Can be reused
Note: Check bolts before reusing. Bolts showing damage, for example cut marks on the underside or distortion of the flats, should be discarded.

Tightening Torques Function Group 21

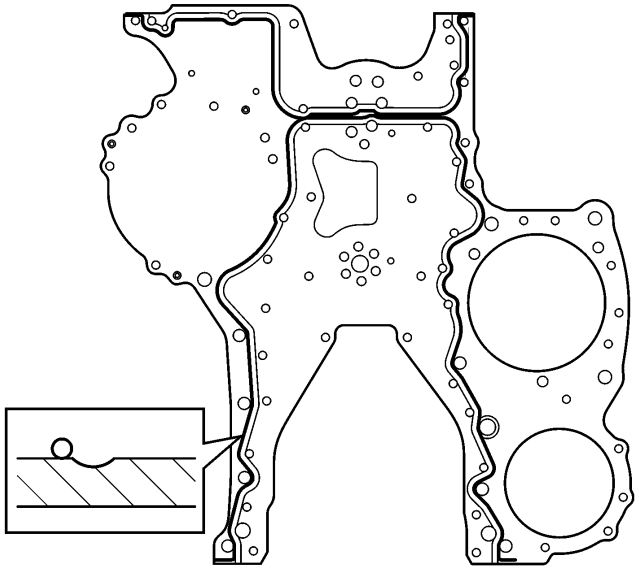
Intermediate front engine mounting brackets (accessories brackets):	
Step 1	105 ± 15 Nm (77.5 ± 11 ft-lb)
Step 2 (angle tightening)	60 ± 5 degrees
Front engine mounting:	
Bracket to engine block	275± 45 Nm (203 ± 33 ft-lb)
Bracket to engine cushion	140± 25 Nm (103 ± 18 ft-lb)
Cushion to cross member	85 ± 15 Nm (63 ± 11 ft-lb)
Rear engine mounting:	
Bracket to flywheel housing	300± 45 Nm (221 ± 33 ft-lb)
Bracket to engine cushion	540± 90 Nm (398 ± 66 ft-lb)
Cushion to frame	200± 30 Nm (148 ± 24 ft-lb)
Crankshaft main bearing cap:	
Step 1	150 ± 20 Nm (111 ± 15 ft-lb)
Step 2 (angle tightening)	120 ± 5 degrees
Connecting rod cap:	
Step 1	20 ± 3 Nm (15 ± 2 ft-lb)
Step 2	60 ± 3 Nm (44 ± 2 ft-lb)
Step 3 (angle tightening)	90 ± 5 degrees
Piston cooling nozzle	24 ± 4 Nm (18 ± 3 ft-lb)
Engine block plugs	50 ± 5 Nm (37 ± 7 ft-lb)



T2022728

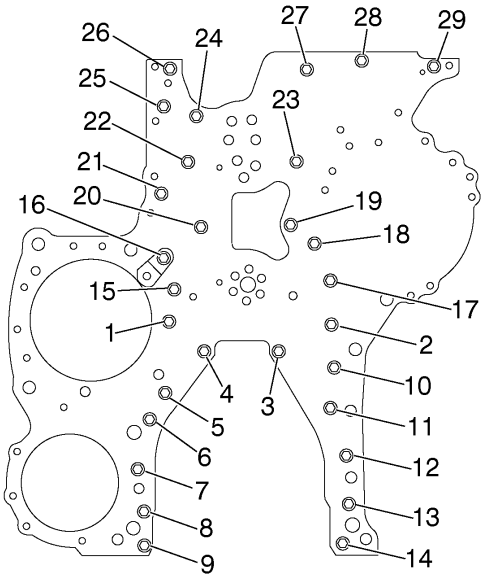
Engine stiffening frame:	
Step 1: Tighten the bolts 1-24 in numerical order	40 ± 5 Nm (30 ± 4 ft-lb)
Step 2: Tighten the bolts 1-24 in numerical order (angle tightening)	90 ± 5 degrees

Note: These bolts should not be reused.



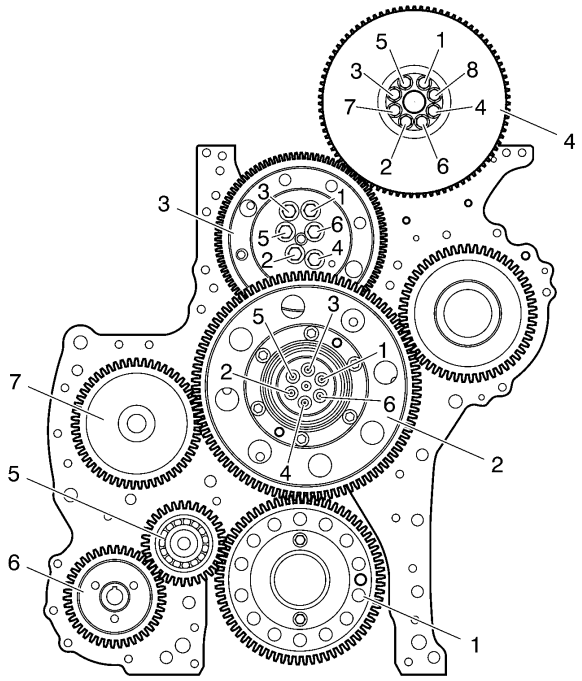
T2022337

Note: Apply sealant outside the groove as illustrated, maximum 20 minutes before mounting.
Thickness of sealant bead: 2 mm (0.079 inch)



W2005945

Timing gear plate, tighten in sequence shown	28 ± 4 Nm (21 ± 3 ft-lb)



W2006478

Timing gears:
1. Drive gear, crankshaft.....24 ± 4 Nm (18 ± 3 ft-lb)

2. Double idler gear:
Step 1.....25 ± 3 Nm (19 ± 2 ft-lb)
Step 2 (angle tightening).....110 ± 5 degrees

Note: Tighten following the order shown in the illustration.

3. Idler gear, adjustable:
Step 1.....35 ± 4 Nm (26 ± 3 ft-lb)
Step 2 (angle tightening).....120 ± 5 degrees

Note: Tighten following the order shown in the illustration.

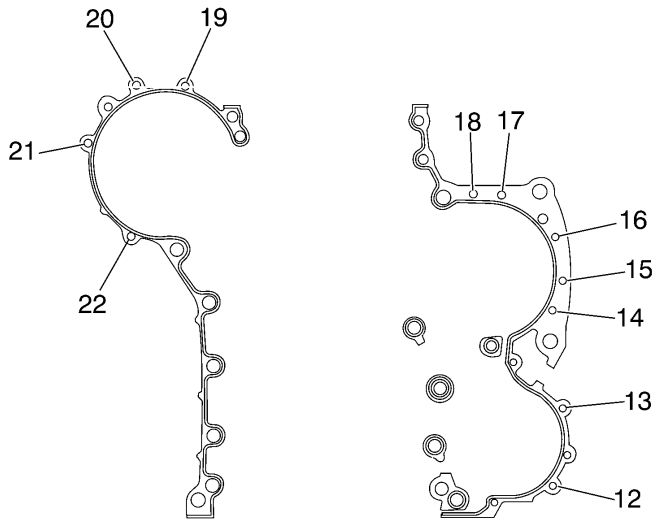
4. Drive gear, camshaft (includes vibration damper):
Step 1.....45 ± 5 Nm (33 ± 4 ft-lb)
Step 2 (angle tightening).....90 ± 5 degrees

Note: Tighten following the order shown in the illustration.

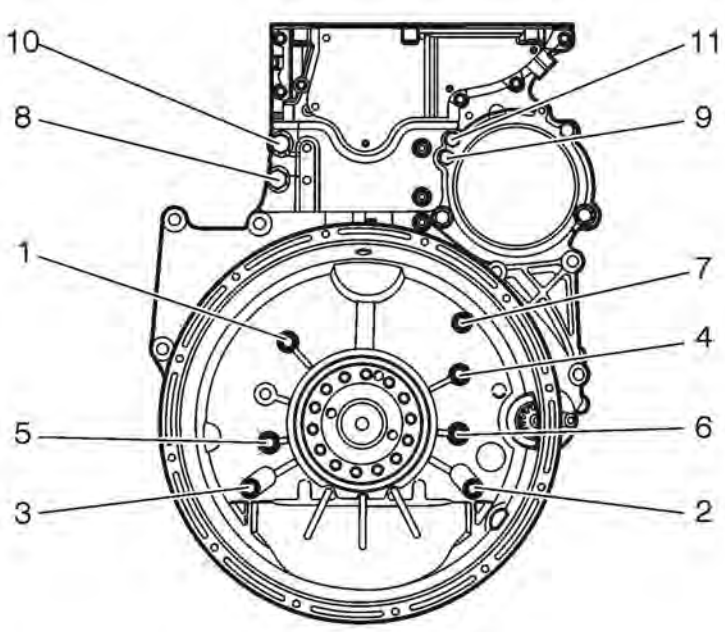
5. Idler gear: 140 ± 10 Nm (103 ± 7 ft-lb)

6. Drive gear, power steering pump: 100 ± 10 Nm (74 ± 7 ft-lb)

7. Drive gear, air compressor: 200 +50 -0 Nm (147 +37 -0 ft-lb)



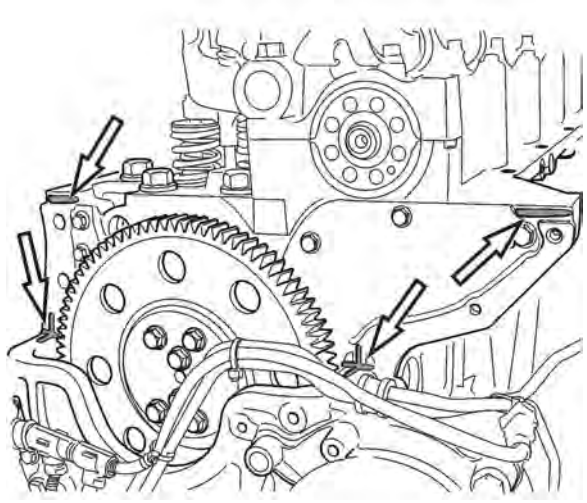
W2006480



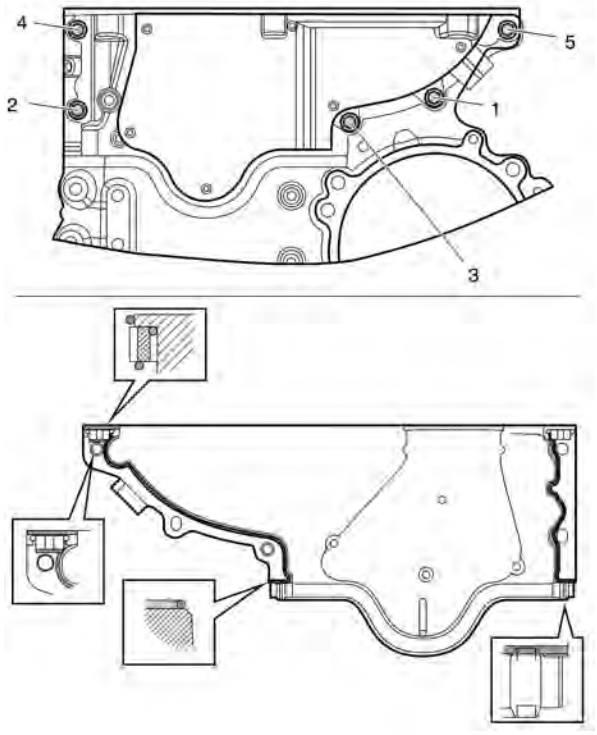
T2025683

Flywheel housing:
Step 1: Tighten all M14, M10, M8 bolts ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Step 2: Tighten all bolts in numerical order to the following torque:
M14 bolts (1–7) ..... 140 ± 20 Nm (103 ± 15 ft-lb)
M10 bolts (8–11) ..... 48 ± 8 Nm (36 ± 6 ft-lb)
M8 bolts (12–22) ..... 24 ± 4 Nm (18 ± 3 ft-lb)

Note: Apply sealant in a 2 mm (0.079 inch) thick bead as illustrated.



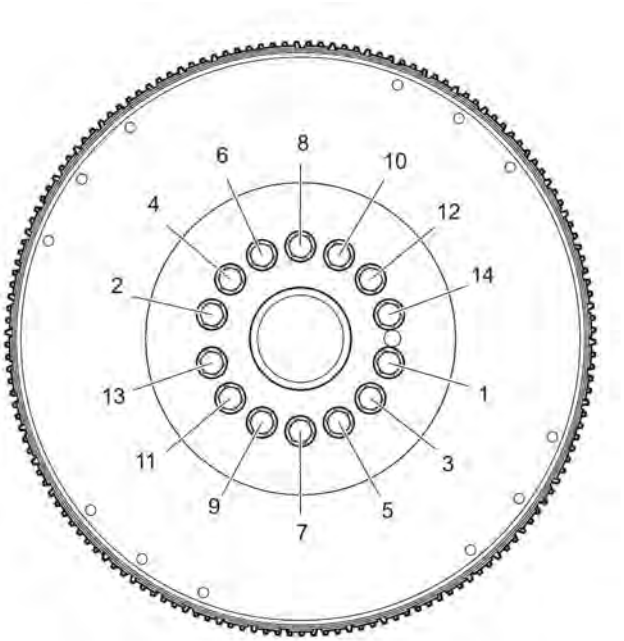
T2023649



T2022983

Timing gear cover:
Step 1: Position the cover in place with bolts 1 and 2 and install alignment tool.
Step 2: Tighten the bolts in the numerical order shown.....24 ± 4 Nm (18 ± 3 ft-lb)

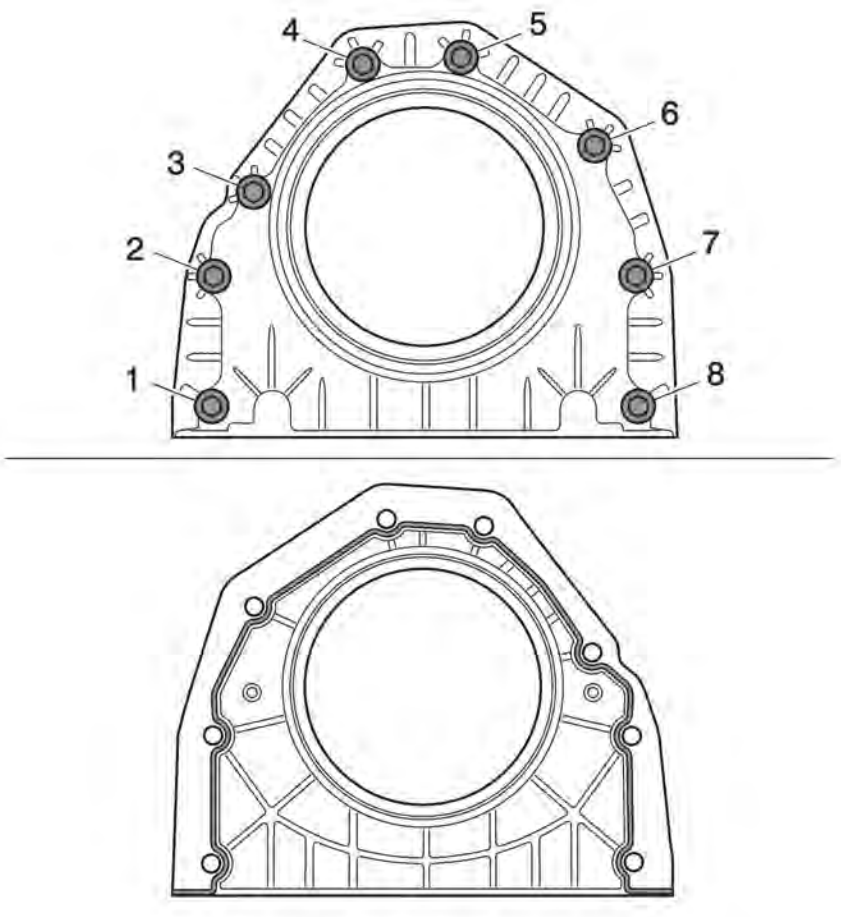
Note: Apply sealant in a 2 mm (0.079 inch) thick bead, maximum 20 minutes before mounting, and carefully tighten the contact surfaces shown in the enlarged parts of the illustration.



T2022729

Flywheel:
Step 1 ..... 60 ± 5 Nm (44 ± 4 ft-lb)
Step 2 (angle tightening) ..... 120 ± 10 degrees

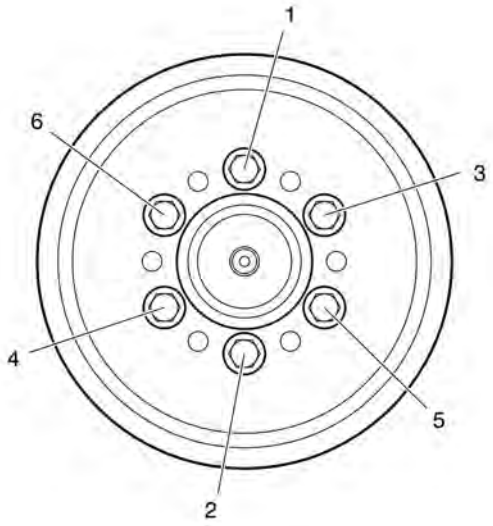
Note: Make sure the flange is dry and clean. Tighten the bolts in the numerical order as shown.



T2022739

Cover, crankshaft seal:
Step 1. Position the cover with bolts 2 and 7 and tighten to contact
Step 2: Tighten the bolts in numerical order 1–8 as shown.....24 ± 4 Nm (18 ± 3 ft-lb)

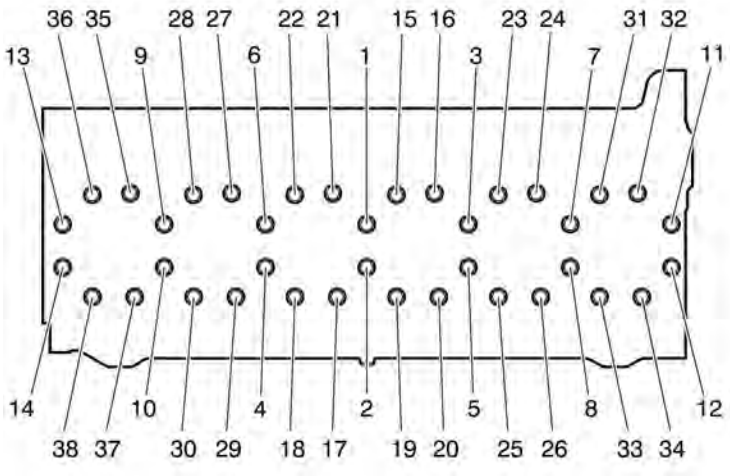
Note: Apply sealant in a 2 mm (0.079 inch) thick bead as illustrated and tighten bolts in numerical order.



T2022730

Crankshaft vibration damper:
Step 1 ..... 35 ± 5 Nm (26 ± 4 ft-lb)
Step 2 ..... 90 ± 10 Nm (66 ± 7 ft-lb)

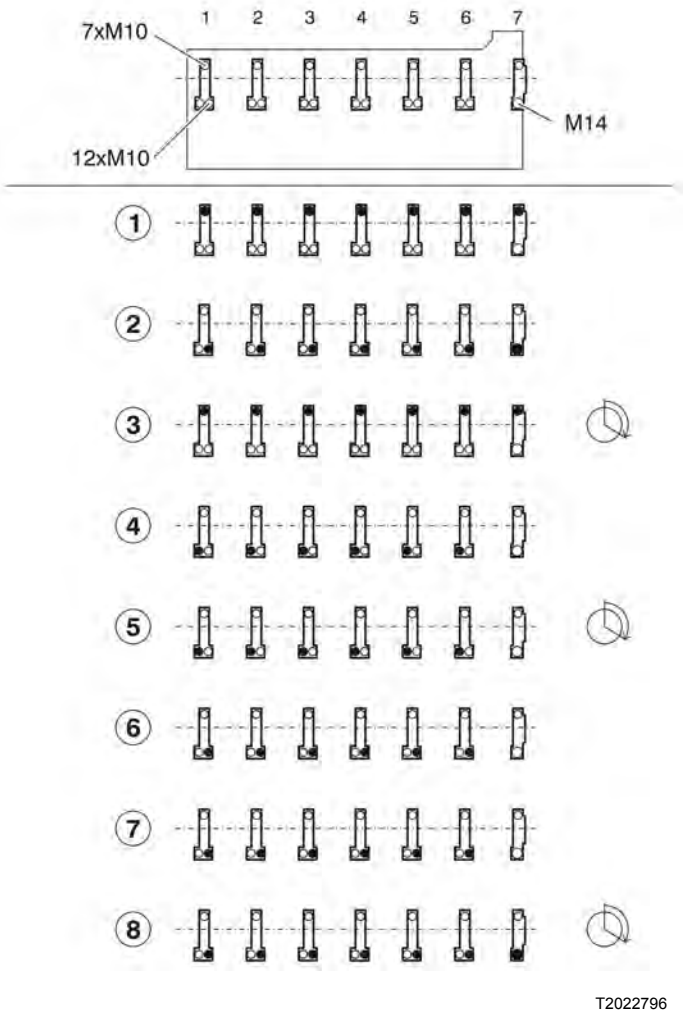
Note: Tighten the bolts in the numerical order 1, 2 ,3, 4, 5, 6, 1. The vibration damper 8.8 bolts should not be reused.



T2022734

Cylinder head:
Step 1 ..... 100 ± 5 Nm (74 ± 4 ft-lb)
Step 2 (angle tightening) ..... 120 ± 5 degrees
Step 3 (angle tightening) ..... 90 ± 5 degrees

Note: The cylinder head must be mounted according to instructions, see Cylinder Head, Replacement Function Group 21.



Bearing cap, camshaft/rocker arm shaft:
Bearing caps 1 to 6 are attached with one bolt on the engine right side and two bolts on the engine left side, while bearing cap 7 is attached with only one bolt per side. Tighten the bolts in the following steps as illustrated:

Note: Tighten the bolts in numerical order from bearing cap 1 to 7 or 7 to 1, except in step 2.

Step 1: With camshaft and bearing caps in place, tighten the marked bolts of bearing caps 1 to 7 ..... 25 ± 3 Nm (19 ± 2 ft-lb)

Step 2: With rocker shaft in place, tighten the marked bolts (in stages) in the order 4, 3, 5, 2, 6, 1, 7 ..... 60 ± 5 Nm (44 ± 4 ft-lb)

Note: The bolts must be tightened in stages to ensure that the rocker arm shaft is seated without bending.

Step 3: Angle tighten marked bolts of bearing caps 1 to 7 ..... 90 ± 5 degrees

Step 4: Tighten the marked bolts of bearing caps 1 to 6 ..... 25 ± 3 Nm (19 ± 2 ft-lb)

Step 5: Angle tighten the bolts of bearing caps 1 to 6 ..... 120 ± 5 degrees

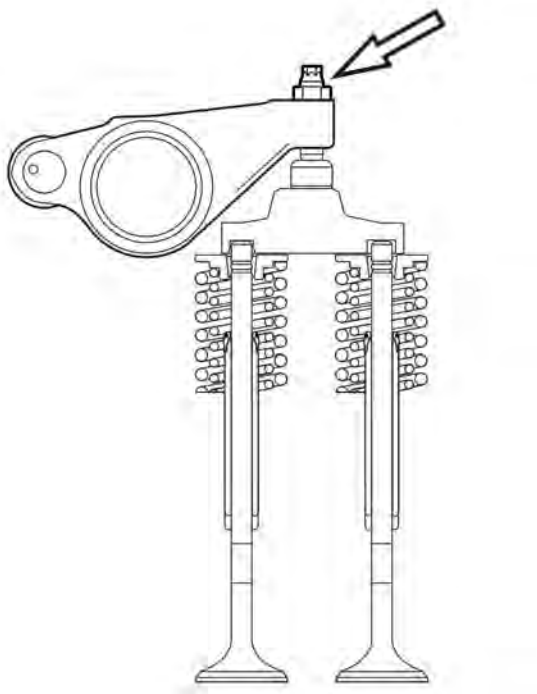
Step 6: Loosen the marked bolts of bearing caps 1 to 6.

Step 7: Tighten the marked bolts of bearing caps 1 to 6 ..... 25 ± 3 Nm (19 ± 2 ft-lb)

Step 8: Angle tighten the bolts of bearing caps 1 to 6 and the bolt of bearing cap 7 ..... 120 ± 5 degrees

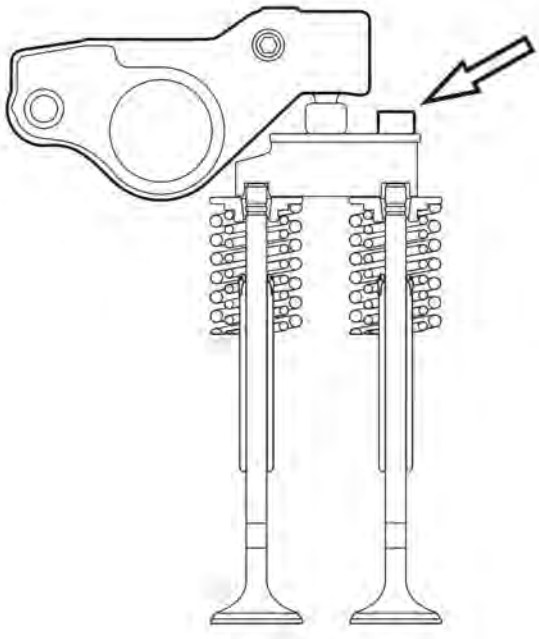
Note: When only the rocker arm has been loosened, step 1 and step 3 are not required.

Engine brake control valve ..... 24 ± 4 Nm (18 ± 3 ft-lb)



T2022965

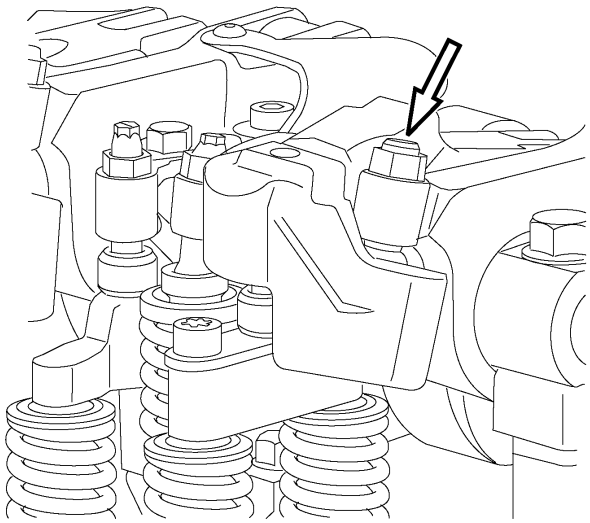
Locknut, valve adjustment screw (inlet/exhaust)	38 ± 4 Nm (28 ± 3 ft-lb)
or, angle tighten after contact	60 ± 5 degrees



T2022966

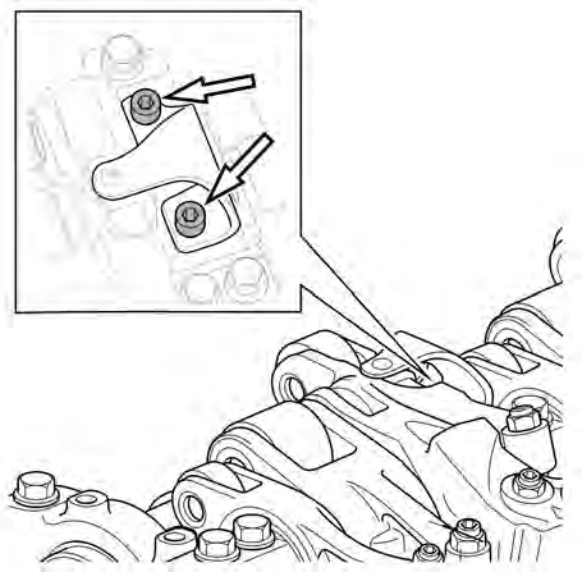
Locknut, valve adjustment screw (exhaust, engine brake)	38 ± 4 Nm (28 ± 3 ft-lb)
or, angle tighten after contact	30 +1.5 -0 degrees

Note: Hold the valve bridge while tightening.



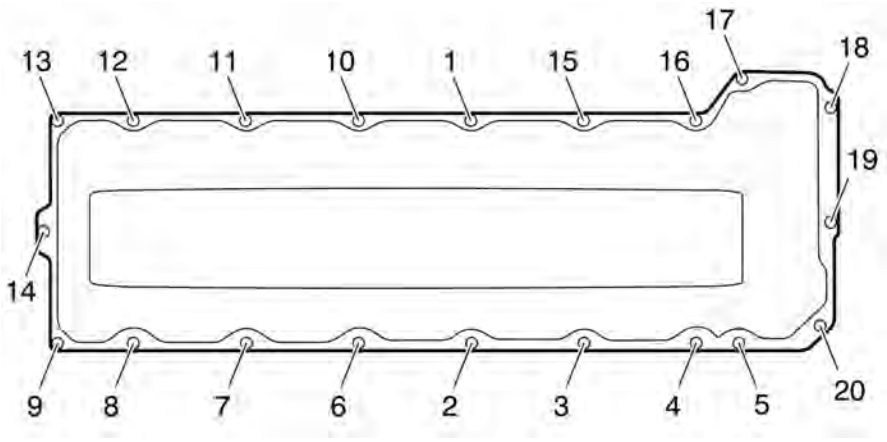
W2005946

Locknut, engine brake rocker arm	52 ± 4 Nm (38 ± 3 ft-lb)
or, angle tighten after contact	45 ± 5 degrees



T2022951

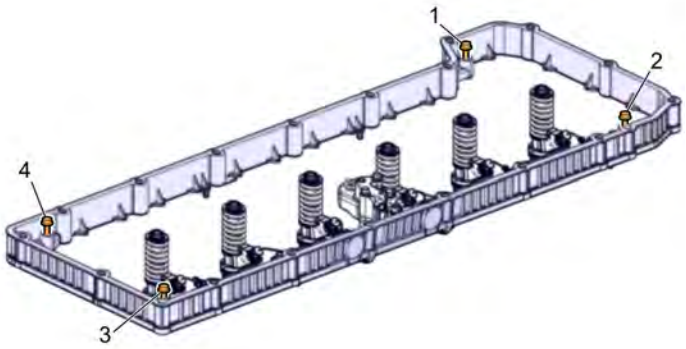
Camshaft bearing cap spring tab (engine brake only)	25 ± 3 Nm (18 ± 2 ft-lb)



T2022732

Valve cover	24 ±4 Nm (18 ±3 ft-lb)

Note: Tighten the bolts in the numerical order shown.

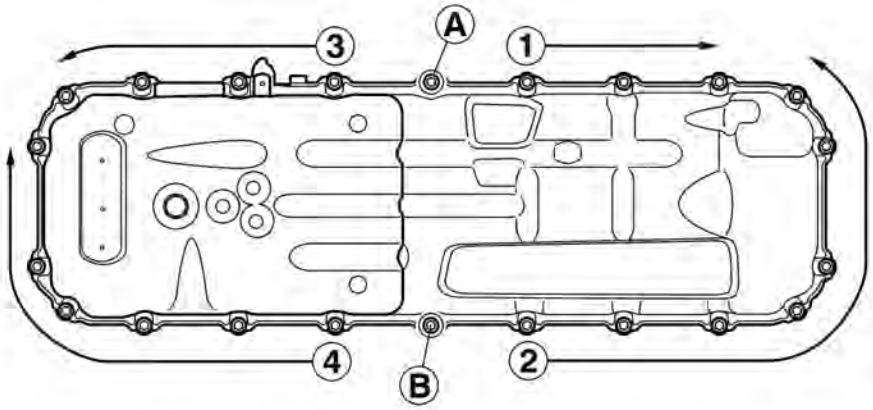


W2085322

Valve cover frame	24±4 Nm (18 ±3 ft-lb)

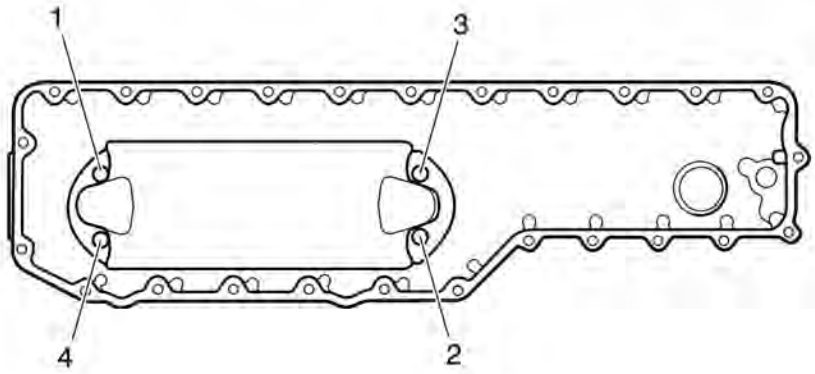
Tightening Torques Function Group 22

Oil pump, pickup tube	24±4 Nm (18 ±3 ft-lb)
Oil pump attaching screws Step 1 Step 2	 35 ±34 Nm (26 ±23 ft-lb) 90 ±5 degrees
Oil pressure pipe coupling nut	200 ±20 Nm (150 ±15 ft-lb)
Oil inlet pipe	24±3 Nm (18 ±2 ft-lb)
Oil plug	135 ±13 Nm (100 ±10 ft-lb)
Oil filter housing	24±4 Nm (18 ±3 ft-lb)
Oil filter	25 +5/–0 Nm (18.5 +3.5/–0 ft-lb)



T2023838

Oil pan (steel and plastic)	24 ±4 Nm (18 ±3 ft-lb)
Install the oil pan bolts A and B, and tighten	24 ±4 Nm (18 ±3 ft-lb)
Tighten the bolts from the middle and outwards in order 1–4 as shown	24 ±4 Nm (18 ±3 ft-lb)
Finish by checking the torque for bolts A and B	24 ±4 Nm (18 ±3 ft-lb)
Drain plug, oil pan (steel and plastic)	60 ± 10 Nm (44 ± 7 ft-lb)

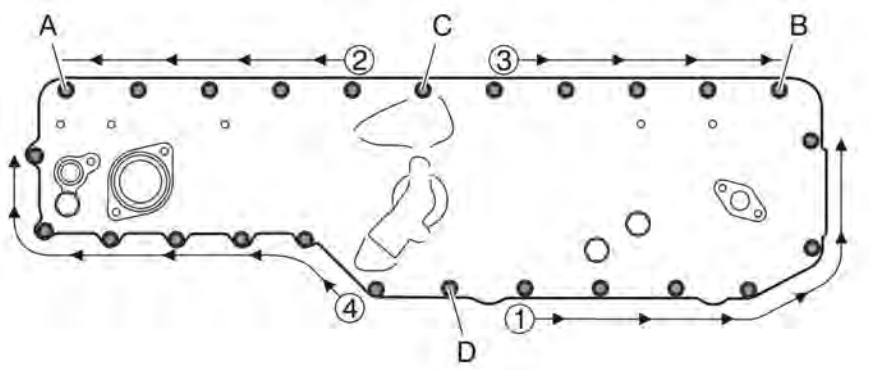


T2022733

Oil cooler, retaining bolts:

Step 1	5 ± 1 Nm (44 ± 9 in-lb)
Step 2	27 ± 4 Nm (20 ± 3 ft-lb)

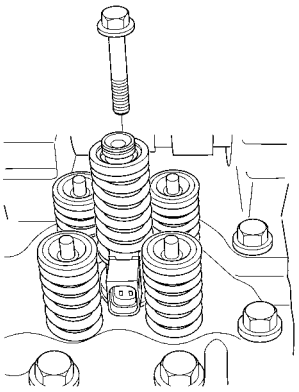
Note: Tighten the bolts diagonally and finish by tightening the first bolt again.



T2023837

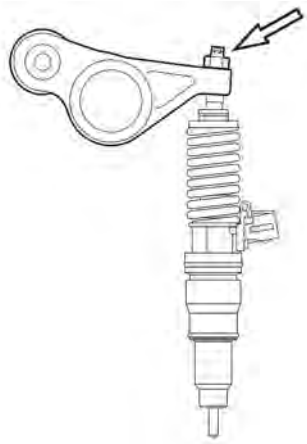
Oil cooler cover:
Position the cover to the engine block and install bolt (A) into the oval hole. Press the cover against the water pump housing using an assembly tool and install bolt (B). Check that the cover is positioned correctly.
Install bolts C and D and tighten ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Tighten the cover bolts from the middle and outwards in order 1–4 as shown ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Finish by checking the torque for bolts C and D ..... 24 ± 4 Nm (18 ± 3 ft-lb)

Tightening Torques Function Group 23



T2022208

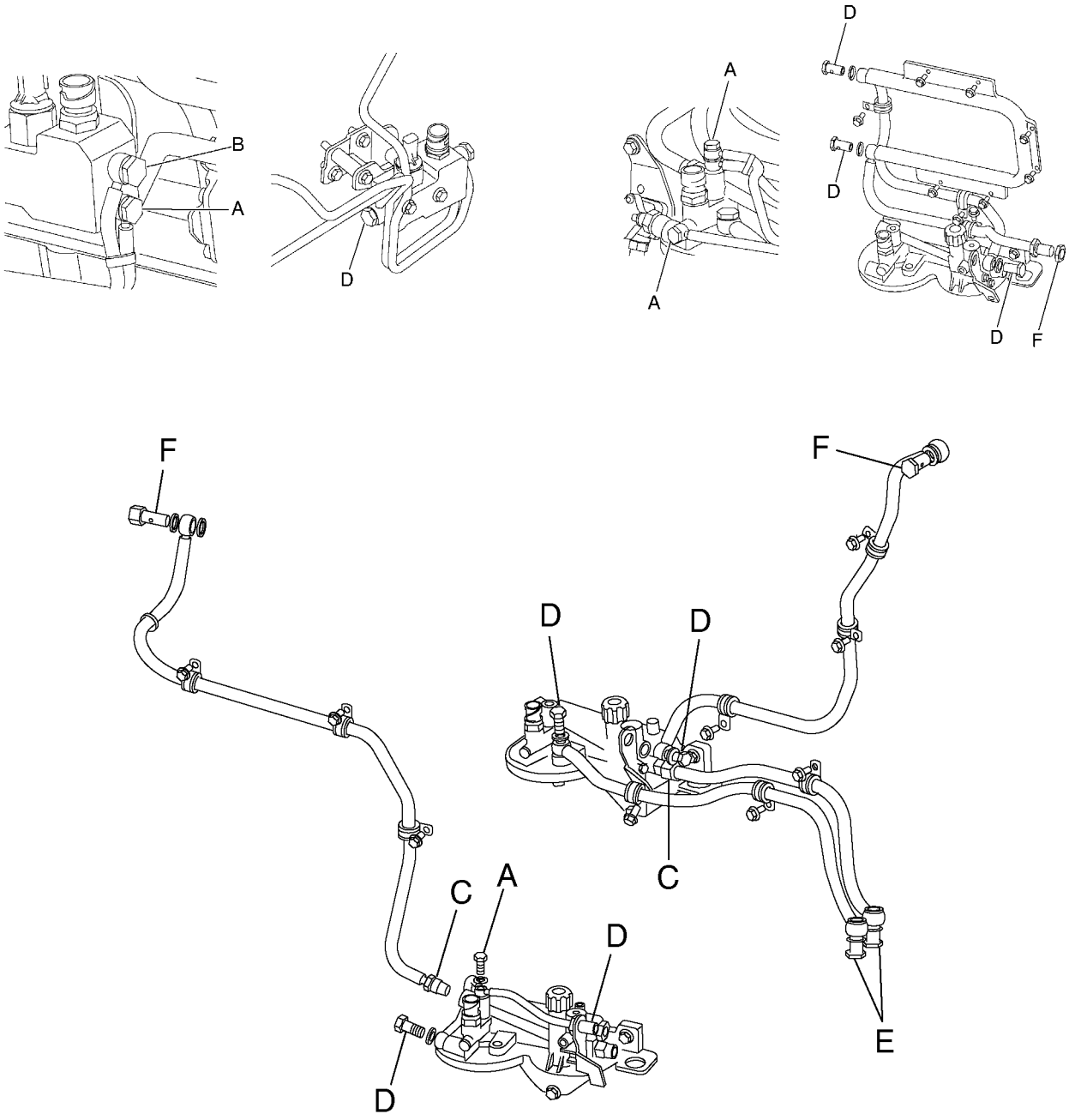
Retainer, injector:	
Step 1	20 +5/-0 Nm (15 +4/-0 ft-lb)
Step 2 Angle tightening	180 ±5 degrees
Step 3 Loosen until the torque is 10–15 Nm (7–11 ft-lb).	
Step 4	20 +5/-0 Nm (15 +4/-0 ft-lb)
Step 5 Angle tightening	90 ±5 degrees



T2022967

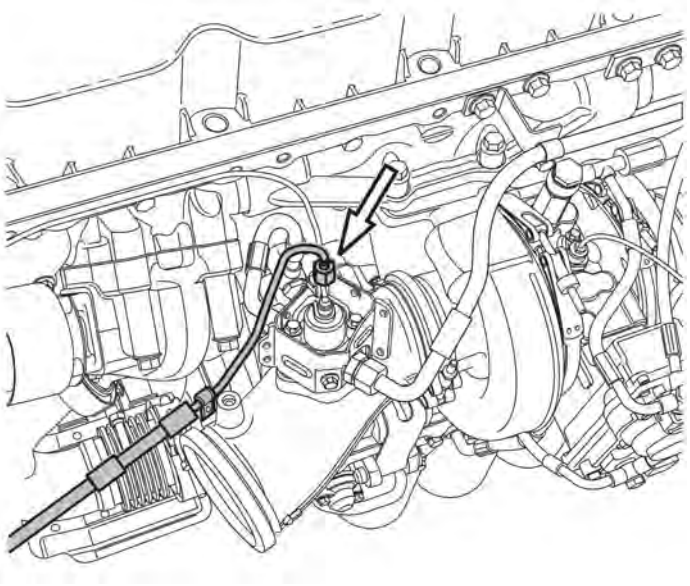
Locknut, injector adjusting screw	52 ± 4 Nm (38 ± 3 ft-lb)
or, angle tighten after contact	45 ± 5 degrees

Tandem pump mounting bolts	24 ± 4 Nm (18 ± 3 ft-lb)
Note: Torque all mounting nuts to specification twice.	
Fuel pump (mounted on power steering pump)	8 +2/-0 Nm (6 +1/-0 ft-lb)
Fuel filter housing	24 ± 4 Nm (18 ± 3 ft-lb)
Fuel filter (primary, secondary)	18 ± 3 Nm (13 ± 2 ft-lb)



Fuel line fittings:

A	18 ± 3 Nm (13 ± 2 ft-lb)
B	28 ± 4 Nm (20.5 ± 3 ft-lb)
C	30 ± 4 Nm (22 ± 3 ft-lb)
D	35 ± 5 Nm (26 ± 4 ft-lb)
E	40 ± 5 Nm (29.5 ± 4 ft-lb)
F	48 ± 5 Nm (35 ± 4 ft-lb)

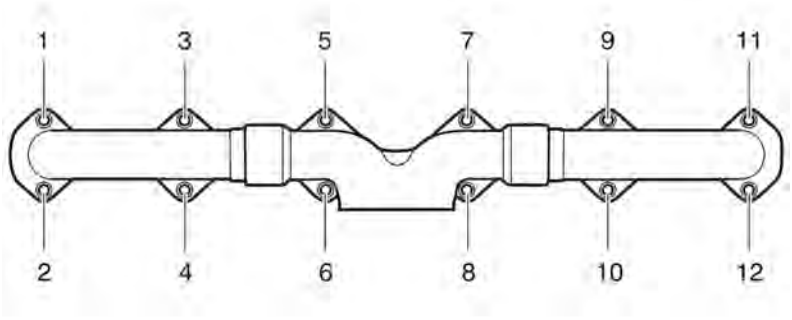


W2005926

Aftertreatment hydrocarbon doser, fuel supply line	15 ± 0.5 Nm (135 ± 5 in-lb)

Tightening Torques Function Group 25

Intake manifold **Note:** Tighten the bolts diagonally from the center outward.	37 ± 4 Nm (28 ± 3 ft-lb)
Housing, preheater: Step 1 Step 2 **Note:** Tighten the bolts diagonally.	 10 ± 2 Nm (8 ± 1 ft-lb) 24 ± 3 Nm (18 ± 2 ft-lb)
Preheater terminal connections	10 ± 1.5 Nm (8 ± 1 ft-lb)
Plug, M10	20 ± 3 Nm (15 ± 2 ft-lb)
Pressure/temperature sensor, boost air	10 ± 1 Nm (88 ± 9 in-lb)



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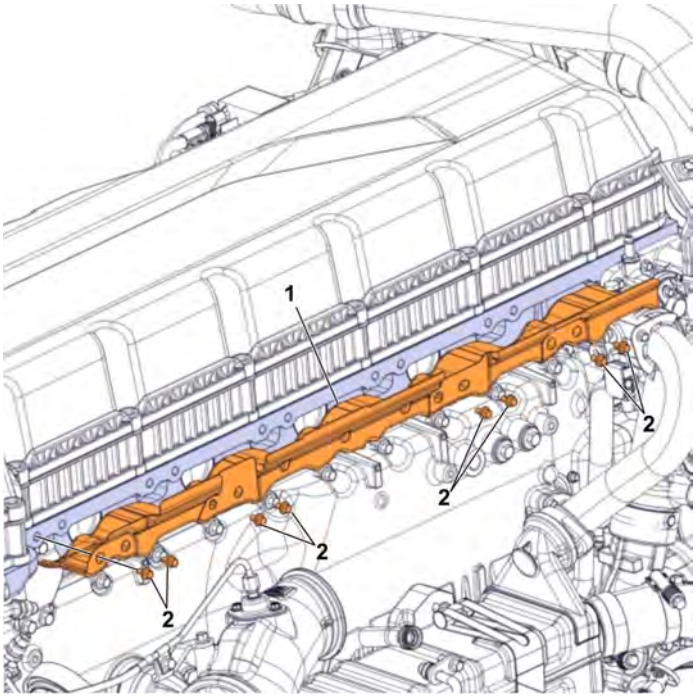
Exhaust manifold: Step 1: Tighten bolts 1 through 12 Step 2: Tighten bolts 1 through 12 Step 3: Tighten bolts 1 through 12 **Note:** Tighten the exhaust manifold bolts following the numbered sequence shown.	 5 - 10 Nm (4 - 7 ft-lb) 40 ± 4 Nm (30 ± 3 ft-lb) 52 ± 4 Nm (38 ± 3 ft-lb)



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Exhaust manifold heat shield	48 ± 8 Nm (35 ± 6 ft-lb)

Exhaust gas recirculation (EGR):
EGR valve mounting bolts:

Step 1	20 ± 4 Nm (15 ± 3 ft-lb)
Step 2	61 ± 3 Nm (45 ± 4 ft-lb)

Note: Tighten the bolts diagonally.

EGR hot pipe clamps	6 Nm (50 in-lb)
EGR cooler mounting screws and locknuts	12 ± 2 Nm (9 ± 1.5 ft-lb)
EGR cooler draincock mounting	15 ± 3 Nm (11 ± 2 ft-lb)
EGR cooler draincock valve	3 ± 0.5 Nm (27 ± 4 in-lb)
EGR cooler outlet hose clamps	8 ± 1 Nm (70 ± 9 in-lb)
EGR cold pipe hose clamps	7 ± 1 Nm (62 ± 9 in-lb)
V-band clamps	10 ± 2 Nm (90 ± 9 in-lb)
Mixing chamber inlet tube	24 ± 4 Nm (18 ± 3 ft-lb)
Venturi tube mounting fasteners	24 ± 4 Nm (18 ± 3 ft-lb)
Crossover pipe support bracket clamp screws	24 ± 4 Nm (18 ± 3 ft-lb)
Crossover hose clamps	12 ± 2 Nm (105 ± 18 in-lb)

Turbocharger:
Turbocharger mounting screws and nuts:
Step 1 ..... 20 ± 4 Nm (15 ± 3 ft-lb)
Step 2 ..... 48 ± 8 Nm (35 ± 6 ft-lb)

Note: Tighten diagonally.

Inlet elbow hose clamp ..... 9 ± 1 Nm (80 ± 9 in-lb)
Charge air cooler V-clamp ..... 7 ± 1 Nm (62 ± 9 in-lb)
Diffuser V-clamp ..... 12 ± 2 Nm (9 ± 1.5 ft-lb)
Turbocharger oil supply and return ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Turbocharger coolant supply ..... 48 ± 5 Nm (35 ± 4 ft-lb)
Turbocharger coolant return:
Hollow screw ..... 48 ± 5 Nm (35 ± 4 ft-lb)
Fitting nut ..... 60 ± 6 Nm (44 ± 5 ft-lb)
SRA coolant supply and return:
At turbocharger ..... 12 ± 3 Nm (9 ± 2 ft-lb)
At block ..... 48 ± 5 Nm (35 ± 4 ft-lb)

Closed crankcase ventilation (CCV):
Mounting bolts ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Hose clamps ..... 4 ± 0.6 Nm (35 ± 5 in-lb)

Diesel Particulate Filter (DPF):
Compact (under cab):
Lower mounting bracket ..... 48 ± 8 Nm (35 ± 6 ft-lb)
Mounting strap fastener ..... 27 ± 4 Nm (20 ± 3 ft-lb)
DPF V-band clamp ..... 20 ± 3 Nm (15 ± 2 ft-lb)
Vertical (back of cab):
Mounting bracket ..... 85 ± 15 Nm (63 ± 11 ft-lb)
Mounting strap fastener ..... 23 ± 1 Nm (17 ± 1 ft-lb)
Exhaust V-band clamp ..... 7 ± 2 Nm (62 ± 18 in-lb)
DPF V-band clamp ..... 20 ± 3 Nm (15 ± 2 ft-lb)
Aftertreatment hydrocarbon doser fasteners ..... 6 ± 2 Nm (53 ± 18 in-lb)

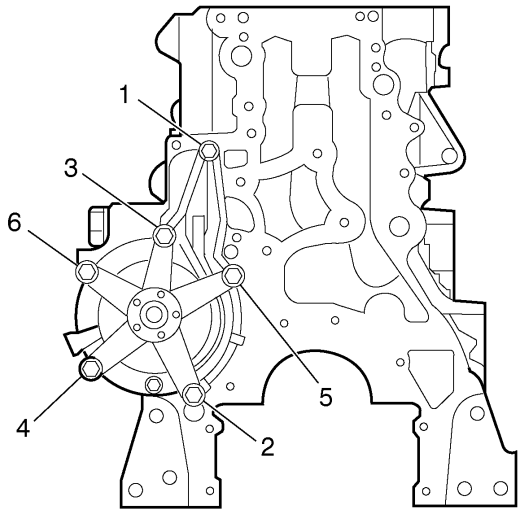
Selective Catalytic Reduction (SCR), vertical:
Mounting nuts ..... 271 Nm (200 ft-lb)
Cage fasteners ..... 68 Nm (50 ft-lb)
Heat shield fasteners ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Exhaust V-band clamp ..... 7 ± 2 Nm (62 ± 18 in-lb)
V-band clamps (DPF to SCR pipe) ..... 7 ± 0.5 Nm (60 ± 5 in-lb)

Selective Catalytic Reduction (SCR), horizontal:
Mounting strap nuts ..... 45 ± 5 Nm (400 ± 45 in-lb)
Frame rail mounting bracket nuts ..... 140 ± 25 Nm (103 ± 18 ft-lb)
Heat shield screws ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Exhaust V-band clamp ..... 7 ± 2 Nm (62 ± 18 in-lb)
V-band clamps (DPF to SCR pipe) ..... 7 ± 0.5 Nm (60 ± 5 in-lb)

Diesel Exhaust Fluid (DEF) tank:
DEF pump screws ..... 24 ± 4 Nm (18 ± 3 ft-lb)
ACM bracket screws ..... 24 ± 4 Nm (18 ± 3 ft-lb)
ACM mounting nuts ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Solenoid valve mounting bracket screws ..... 3 ± 0.5 Nm (27 ± 4 in-lb)
Tank cover screws ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Tank bracket to bracket screws ..... 24 ± 4 Nm (18 ± 3 ft-lb)
Tank bracket to tank screws ..... 48 ± 8 Nm (35 ± 6 ft-lb)
Frame rail mounting bracket to tank bracket fasteners ..... 85 ± 15 Nm (63 ± 11 ft-lb)
Frame rail mounting bracket to frame fasteners ..... 140 ± 25 Nm (103 ± 18 ft-lb)

Diesel Exhaust Fluid (DEF) Pump	
Filter cover	22.5 ± 2.5 Nm (16.5 ± 2 ft-lb)
Coolant connector	5.5 ± 0.5 Nm (50 ± 5 in-lb)
Inlet connector	4 ± 0.5 Nm (35 ± 5 in-lb)
Backflow connector	4.5 ± 0.5 Nm (40 ± 5 in-lb)
Outlet connector	4 ± 0.5 Nm (35 ± 5 in-lb)
Note: When a connector is replaced, a new O-ring must be used.	
Aftertreatment hydrocarbon doser (previous version):	
Doser:	
Mounting bolts	14 ± 0.5 Nm (125 ± 4.5 in-lb)
Fuel line fitting	15 ± 0.5 Nm (135 ± 5 in-lb)
Cooling lines	48 ± 5 Nm (35 ± 4 ft-lb)
Two-way check valve	24 Nm (18 ft-lb)
Air line	27 Nm (20 ft-lb)
Shut-off Valve:	
Mounting	13.5 ± 3 Nm (120 ± 24 in-lb)
Fuel line fittings	see Function Group 23
Aftertreatment hydrocarbon doser (new version)	
Doser:	
Mounting bolts	14 ± 0.5 Nm (125 ± 4.5 in-lb)
Air/Fuel line fitting	15 ± 2 Nm (135 ± 18 in-lb)
M10 P-clamp flange screw	28 ± 4 Nm (21 ± 3 ft-lb)
Connection joint between left and right fuel pipes	15 ± 2 Nm (135 ± 18 in-lb)
Aftertreatment hydrocarbon dosing module:	
Air/Fuel line fitting	15 ± 2 Nm (135 ± 18 in-lb)
Fuel line from housing to module fittings	Maximum 18 Nm (13 ft-lb)

Tightening Torques Function Group 26



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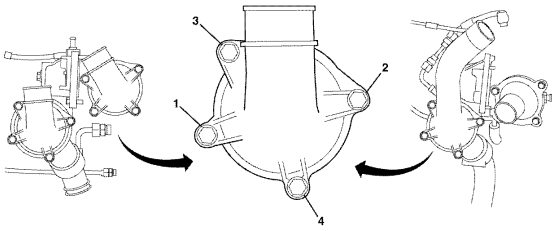
Coolant pump (Note: Tighten in sequence twice)	24 ± 4 Nm (18 ± 3 ft-lb)
Coolant pump pulley	24 ± 4 Nm (18 ± 3 ft-lb)
Coolant pump housing	48 ± 8 Nm (35 ± 6 ft-lb)



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Front and side cover, thermostat housing	28 Nm (21 ft-lb)
Tensioner	48 ± 8 Nm (35 ± 6 ft-lb)
Drive belt idler	24 ± 4 Nm (18 ± 3 ft-lb)
Fan hub:	
15mm hex (wrench size) nut	48 ± 8 Nm (35 ± 6 ft-lb)
VHD with 13L engine, 45mm stud length and 16mm hex (wrench size) nut	70 ± 12 Nm (52 ± 9 ft-lb)
Viscous fan drive:	
Drive-to-hub	24 ± 4 Nm (18 ± 3 ft-lb)
Upper radiator hose clamp:	
Screw-type band clamp	5 Nm (45 in-lb)
Screw-type band clamp with spring	10 Nm (90 in-lb)

Tightening Torques Function Group 28

Note: Sensors vary by engine.

Sensor and Location	Specification
Flywheel position/speed, top of flywheel housing	8 ± 2 Nm (6 ± 1 ft-lb)
Camshaft position, timing gear cover	8 ± 2 Nm (6 ± 1 ft-lb)
Turbocharger speed, top middle of turbocharger	8.5 ± 2 Nm (75 ± 18 in-lb)
Turbocharger discharge temperature	45 ± 4.5 Nm (33 ± 3 ft-lb)
Oil level/temperature, inside sump	10 ± 1 Nm (89 ± 9 in-lb)
Oil pressure, block, front of air compressor	30 ± 5 Nm (22 ± 4 ft-lb)
Coolant level, surge tank	Plug-in
Coolant temperature, front right side cylinder head	22 ± 3 Nm (16 ± 2 ft-lb)
Fuel pressure, fuel filter housing	25 ± 3 Nm (18.5 ± 2 ft-lb)
Aftertreatment fuel injector fuel pressure, behind fuel filter housing	25 ± 3 Nm (18.5 ± 2 ft-lb)
Crankcase pressure, block, front of air compressor	25 ± 3 Nm (18.5 ± 2 ft-lb)
Charge air pressure, mixing chamber	10 ± 1 Nm (89 ± 9 in-lb)
Charge air temperature, intake manifold	10 ± 1 Nm (89 ± 9 in-lb)
Humidity, fresh air pipe	27 ± 3 Nm (20 ± 2 ft-lb)
Charge air temperature and pressure, intake manifold	10 ± 1 Nm (89 ± 9 in-lb)
EGR temperature, EGR venturi	45 ± 4.5 Nm (33 ± 3 ft-lb)
EGR differential pressure, EGR venturi	20 ± 3 Nm (15 ± 2 ft-lb)
Piston cooling jet pressure sensor	25 ± 3 Nm (18.5 ± 2 ft-lb)
DPF temperature, DPF inlet, catalyst, outlet modules	45 ± 4.5 Nm (33 ± 3 ft-lb)
DPF differential pressure, DPF inlet, catalyst, outlet modules: Box Fitting nuts	 6 ± 1 Nm (53 ± 9 in-lb) 16.3 ± 2.7 Nm (12 ± 2 ft-lb)
NOx sensor, exhaust pipe after DPF	50 ± 10 Nm (37 ± 7 ft-lb)
NOx sensor, exhaust pipe after SCR	50 ± 10 Nm (37 ± 7 ft-lb)
NOx module, frame bracket	24 ± 4 Nm (18 ± 3 ft-lb)

Tightening Torques Function Group 3

Starter motor mounting nuts:	
M12 nuts	85 ± 15 Nm (63 ± 11 ft-lb)
Note: Torque all mounting nuts to specification twice.	
Starter cables (Bat+, E-):	
M12 nuts	25 ± 5 Nm (18.5 ± 4 ft-lb)
Starter control wire:	
M6 nuts	4 ± 1 Nm (35 ± 9 in-lb)
Alternator:	
Mounting bracket	48 ± 8 Nm (35 ± 6 ft-lb)
Pad mounts	65.5 ± 7.5 Nm (48 ± 5.5 ft-lb)
Pulley nut	101.5 ± 6.5 Nm (75 ± 5 ft-lb)
Battery terminal	6.5 ± 0.25 Nm (57.5 ± 2.5 in-lb)
Ground terminal	6.2 ± 0.5 Nm (55 ± 5 in-lb)
I, R terminals	2.3 ± 0.5 Nm (20 ± 5 in-lb)
AC refrigerant compressor mounting bolts	24 ± 4 Nm (18 ± 3 ft-lb)
Wiring harness conduit to block	24 ± 3 Nm (18 ± 2 ft-lb)
Wiring harness conduit cover	3.5 ± 0.5 Nm (31 ± 4.4 in-lb)
Cable channel cover	3.5 ± 0.5 Nm (31 ± 4.4 in-lb)

Tightening Torques Function Group 5

Air compressor mounting bolts	85 ± 15 Nm (63 ± 11 ft-lb)
Note: Torque all mounting nuts to specification twice.	
Air compressor out connection	130 ± 20 Nm (96 ± 15 ft-lb)
Air compressor gear	270 ± 20 Nm (200 ± 15 ft-lb)

Engine Lubricants and Sealants

Use only the following recommended sealing compounds and lubricants.

Note: All genuine cylinder head gaskets are pre-coated and do not require any type of sealing compound. When installing new gaskets, clean and degrease gasket sealing surfaces to avoid leaks.

Location	Sealant or Lubricant
Cup plugs/threaded plugs	Loctite® 277 or equivalent/Teflon® thread sealer
Cylinder liner seat	1161231 sealant
Oil filter seal	Clean engine oil
Holding metal parts in place	Petroleum jelly
Valve stems and guides	Clean engine oil
Engine front cover/flywheel housing/timing gear cover	3092340 sealant
Engine parts, fasteners and washers	Clean engine oil
Exhaust manifold studs and NOx sensors	High temperature 1161929 anti-seize
Oil cooler assembly O-ring	Clean engine oil
Oil cooler cover	Permatex 85409 or equivalent gasket dressing
O-rings, coolant, EPDM	Clean coolant, or Dow Corning® 55
O-rings (except as noted)	Dow Corning® 55 O-ring lubricant
Threaded sensors	Sealing compound on threads
Turbocharger mounting nuts	1161929 anti-seize