

# Service Manual Trucks

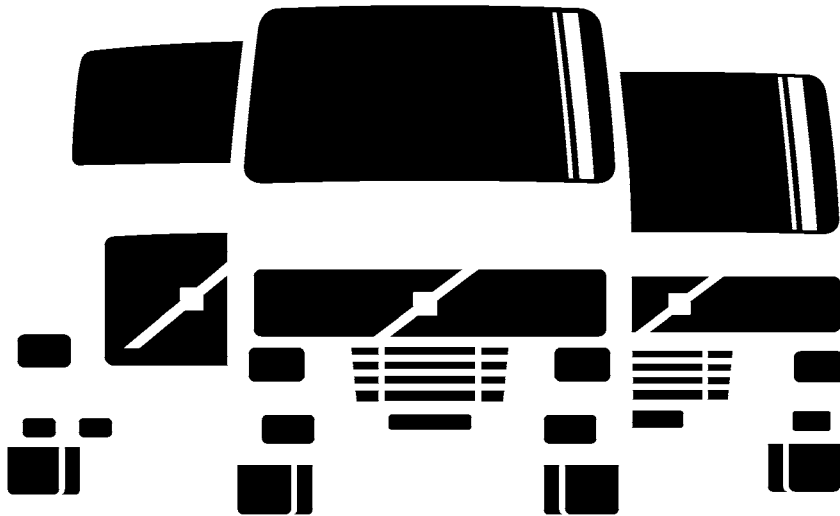
Group **200–850**

Specifications, D12B

D12B-345

D12B-385

D12B-425



# Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to February 98.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

**Note:** Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

**Caution:** Indicates an unsafe practice where damage to the product could occur.

**Warning:** Indicates an unsafe practice where personal injury or severe damage to the product could occur.

**Danger:** Indicates an unsafe practice where serious personal injury or death could occur.

**Volvo Trucks North America, Inc.**  
Greensboro, NC USA

**Order number: PV776-TSP25816/1SM**

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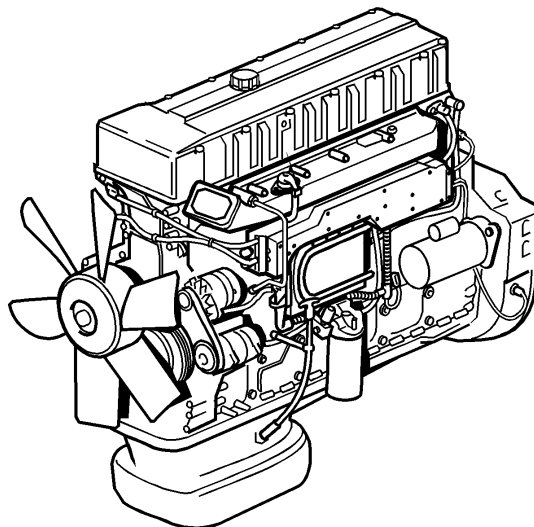
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# Specifications

## Engine Designation



W2002653

Type designation .....	D12B-345 D12B-385 D12B-425	
Max. output at 1700 rpm (28.3 r/s)		
D12B 345 .....	257 kW	345 bhp
D12B 385 .....	287 kW	385 bhp
D12B 425 .....	317 kW	425 bhp
Max. torque at 1200 rpm (20.0 r/s)		
D12B 345 .....	1850 Nm	(1350 ft-lb)
D12B 385 .....	1965 Nm	(1450 ft-lb)
D12B 425 .....	2100 Nm	(1550 ft-lb)
Number of cylinders .....	6	
Bore .....	131 mm	(5.2 in.)
Stroke .....	150 mm	(5.9 in.)
Displacement .....	12.13 liters	(740 in <sup>3</sup> )
Compression ratio .....	17.5:1	
Firing sequence .....	1-5-3-6-2-4	
Low idle .....	500-650 rpm	(8.3-10.8 r/s)
High idle .....	2100 +0/-40 rpm	(35 +0/-0.7 r/s)
Max. full load speed .....	1900 rpm	(31.6 r/s)
Weight, engine with flywheel, flywheel housing and starter (dry) ....	1060 kg	(2332 lb)
Max. length .....	1348 mm	(53 in.)
Max. width .....	780 mm	(30.7 in.)
Max. height .....	1138 mm	(44.8 in.)

## Engine

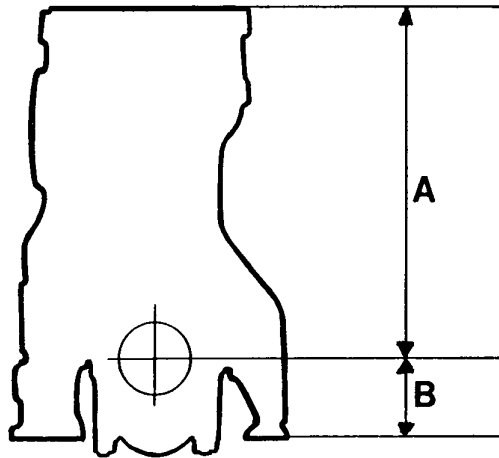
### Cylinder Head

Type .....	6 cylinder	
Length .....	1076 mm	(42.36 in.)
Width .....	373 mm	(14.68 in.)
Height .....	135 mm	(5.31 in.)

### Cylinder Head Bolts

Number .....	38	
Thread size .....	M16	
Length .....	200 mm	(7.87 in.)

### Cylinder Block



T2006964

Height, upper block face-crankshaft center (A) min. ....	422 mm	(16.61 in.)
Height, lower block face-crankshaft center (B) min. ....	120 mm	(4.72 in.)

### Cylinder Liner

Type .....	Wet, replaceable	
Sealing surface height above block face (protrusion) .....	0.15–0.20 mm	(0.0059–0.0078 in.)
Liner height variance between all cylinders .....	0.05 mm	(0.002 in.)
Number of O-rings, cylinder liner .....	4	

## Pistons

Height above cylinder block face .....	0.15-0.65 mm	(0.0059–0.0255 in.)
Diameter, combustion chamber .....	86 mm	(3.38 in.)
Depth, piston ball .....	19.7 mm	(0.775 in.)
Number of ring grooves .....	3	
Front marking .....	Arrow pointing forward	

## Piston Rings

### *Compression Rings*

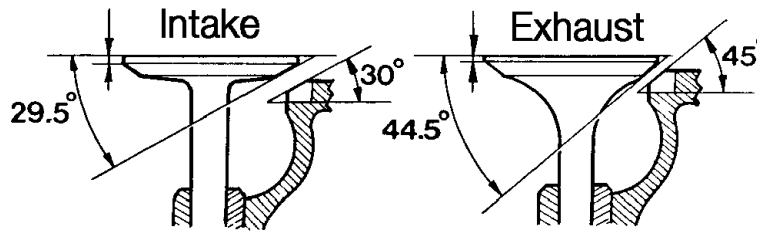
Number .....	2	
Piston ring clearance in groove:		
Upper compression ring .....	Keystone	
Lower compression ring .....	0.070–0.102 mm	(0.0027–0.004 in.)
Piston ring gap measured in ring opening:		
Upper ring .....	0.40–0.65 mm	(0.015–0.0255 in.)
Lower ring .....	0.8–1.0 mm	(0.031–0.039 in.)

### *Oil Scraper Ring*

Number .....	1	
Width, including spring .....	4.88 mm	(0.192 in.)
Piston ring clearance in groove .....	0.050–0.082 mm	(0.0019–0.0032 in.)
Piston ring gap measured in ring opening .....	0.40–0.75 mm	(0.0157–0.0295 in.)

# Valve Mechanism

## Valves



W2002665

Valve disc diameter:

Intake .....	40 ± 0.1 mm	(1.57 ± 0.0039 in.)
Exhaust .....	40 ± 0.1 mm	(1.57 ± 0.0039 in.)

Valve stem diameter:

Intake .....	7.964–7.975 mm	(0.3135–0.3140 in.)
Exhaust .....	7.951–7.962 mm	(0.313–0.3135 in.)

Valve seat angle:

Intake .....	29.5°
Exhaust .....	44.5°

Valve disc edge:

Intake .....	1.76 mm	(0.069 in.)
Exhaust .....	1.57 mm	(0.061 in.)

Seat angle in cylinder head:

Intake .....	30°
Exhaust .....	45°

Valve clearance, cold engine, setting value:

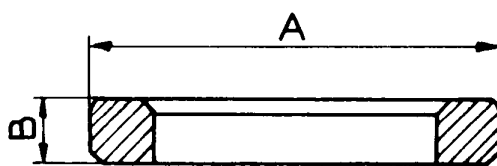
Intake .....	0.2 mm	(0.0078 in.)
Exhaust .....	0.5 mm	(0.0196 in.)
Exhaust, with VEB .....	1.6 mm	(0.0629 in.)

Valve clearance, cold engine, checking value:

Intake .....	0.15–0.25 mm	(0.0059–0.0098 in.)
Exhaust .....	0.45–0.55 mm	(0.0177–0.0216 in.)
Exhaust, with VEB .....	1.55–1.65 mm	(0.061–0.065 in.)



## Valve Seats



T2006961

Outer diameter (**meas. A**) standard :

Intake .....	43.070–43.086 mm	(1.695–1.696 in.)
Exhaust .....	43.070–43.086 mm	(1.695–1.696 in.)

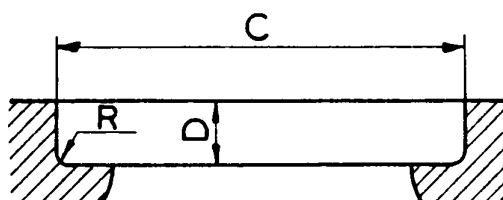
Oversize:

Intake .....	43.270–43.286 mm	(1.703–1.704 in.)
Exhaust .....	43.270–43.286 mm	(1.703–1.704 in.)

Height (**meas. B**):

Intake .....	8.5–8.7 mm	(0.335–0.343 in.)
Exhaust .....	8.4–8.6 mm	(0.331–0.339 in.)

## Valve Seat Location



T2006962

Diameter standard ( **meas. C**):

Intake .....	43.000–43.025 mm	(1.693–1.694 in.)
Exhaust .....	43.000–43.025 mm	(1.693–1.694 in.)

Diameter oversize ( **meas. C**):

Intake .....	43.200–43.225 mm	(1.701–1.702 in.)
Exhaust .....	43.200–43.225 mm	(1.701–1.702 in.)

Depth (**meas. D**):

Intake .....	11.2 ± 0.1 mm	(0.44 ± 0.004 in.)
Exhaust .....	11.2 ± 0.1 mm	(0.44 ± 0.004 in.)

Seat bottom radius ( **meas. R**) max.:

Intake .....	0.8 mm	(0.03 in.)
Exhaust .....	0.8 mm	(0.03 in.)

Measurement between valve disc and cylinder head face (recessed):

Intake .....	0.9–1.4 mm	(0.035–0.055 in.)
Exhaust .....	1.2–1.7 mm	(0.047–0.067 in.)

## Valve Guides

### Length:

Intake .....	83.2–83.5 mm	(3.28–3.29 in.)
Exhaust .....	83.2–83.5 mm	(3.28–3.29 in.)

### Inner diameter:

Intake .....	8.000–8.015 mm	(0.315–0.316 in.)
Exhaust .....	8.000–8.015 mm	(0.315–0.316 in.)

### Height above cylinder head spring face:

Intake .....	26.5 ± 0.35 mm	(1.0 ± 0.01 in.)
Exhaust .....	18.5 ± 0.35 mm	(0.73 ± 0.01 in.)

### Clearance valve stem-guide:

Intake .....	0.025–0.051 mm	(0.0009–0.003 in.)
Exhaust .....	0.038–0.064 mm	(0.001–0.003 in.)

### Rocker arms:

Bearing clearance .....	0.03–0.08 mm	(0.001–0.003 in.)
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## Valve Springs

### *Valve Springs Exhaust*

#### Outer valve spring:

Free length, unloaded .....	72.4 mm	(2.85 in.)
With load of 1076 N (242 lbf) .....	42.8 mm	(1.68 in.)
Rigid length, max. (fully compressed) .....	41.2 mm	(1.62 in.)

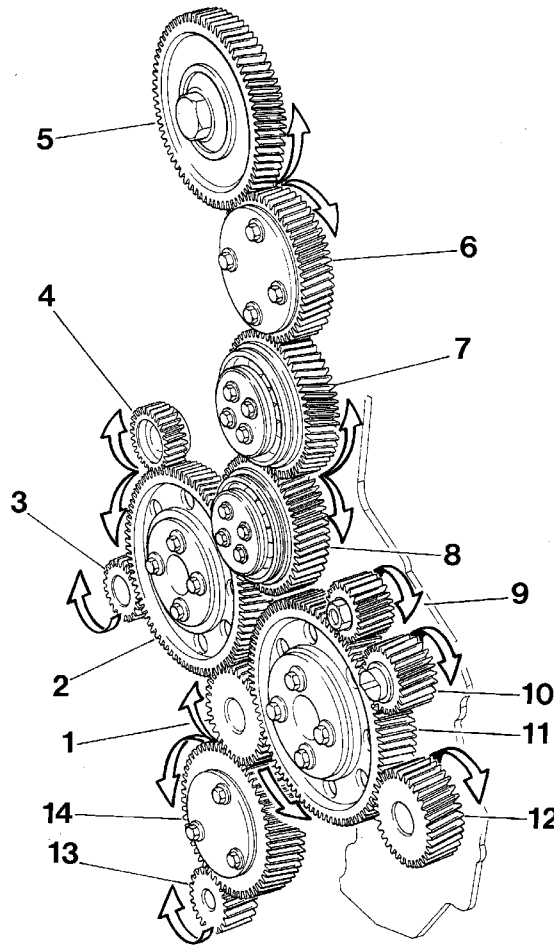
#### Inner valve spring:

Free length, unloaded .....	67.5 mm	(2.65 in.)
With load of 243 N (55 lbf) .....	51.9 mm	(2.04 in.)
With load of 447 N (100 lbf) .....	38.8 mm	(1.52 in.)
Rigid length, max. (fully compressed) .....	35.7 mm	(1.40 in.)

### *Valve Spring, Intake*

Free length, unloaded .....	72.4 mm	(2.85 in.)
With load of 600 N (135 lbf) .....	55.9 mm	(2.2 in.)
With load of 1076 N (242 lbf) .....	42.8 mm	(1.68 in.)
Rigid length, max. (fully compressed) .....	41.2 mm	(1.62 in.)

# Timing Gears



T2006852

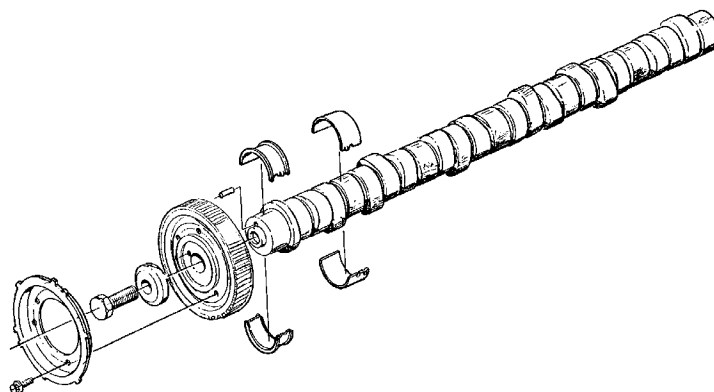
Backlash .....	0.05–0.17 mm	(0.0017–0.0067 in.)
Axle journal for idler gears (2, 6, 11), diameter .....	99.989 ± 0.011 mm	(3.9 ± 0.0004 in.)
Bushing for idler gears (2, 6, 11), diameter .....	100.037 ± 0.011 mm	(3.94 ± 0.0004 in.)
Radial clearance for idler gears (2, 6, 11) .....	0.026–0.070 mm	(0.001–0.003 in.)
Axial clearance for idler gears (2, 6, 11) .....	0.05–0.15 mm	(0.002–0.006 in.)

Ref. No.	Description	No. of Teeth
1	Crankshaft Drive Gear .....	36
2	Idler Gear (coolant pump) .....	87
	(thickness = 36 +0/-0.4 mm)	
3	Water Pump Drive Gear .....	24
4	Air Compressor Drive Gear .....	27
5	Camshaft .....	72
6	Idler Gear (adjustable) .....	58
7	Idler Gear (upper) .....	60
8	Idler Gear (lower) .....	58

Ref. No.	Description	No. of Teeth
9	Power Steering Pump Drive Gear .....	22
10	Drive Gear Arrangement (accessory drive pulley and fuel supply pump) .....	26
11	Idler Gear, Power Take-Off (PTO) .....	87
	(thickness = $28 \pm 0.2$ mm)	
12	Drive Gear (PTO) for Hydraulic Pump (power steering) .....	37
13	Oil Pump Drive Gear .....	24
14	Oil Pump Idler Gear .....	57

**Note:** Gear reference numbers 2 and 11 are the same diameter; however, they are not the same thickness. Please note thickness specifications. The gears are not interchangeable.

# Camshaft



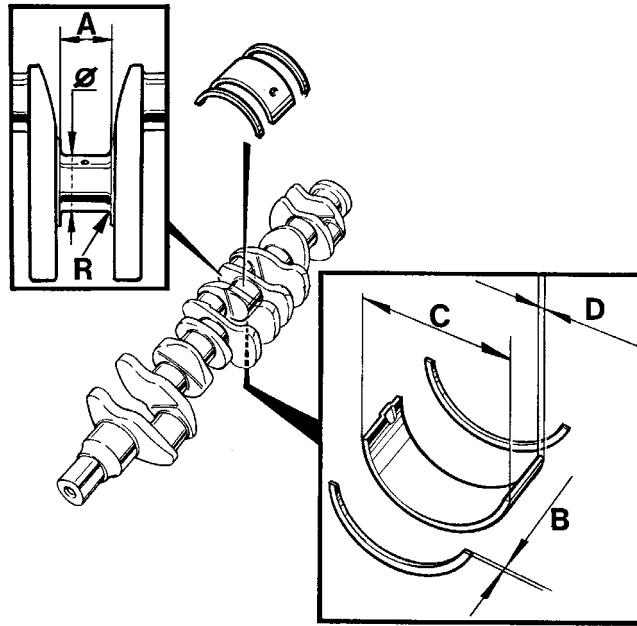
T2006872

Drive .....		Gear	
Number of bearings .....		7	
Diameter, bearing journals, min.:			
1st, and 2nd — 7th bearing journals .....	70-0.030 mm		(2.8-0.001 in.)
For check of camshaft setting see			
<b>TSI Service Bulletin</b>	210-600-02	"Camshaft Timing Checking and Setting"	
<b>IMPACT</b>	Function Group 2154	Information Type: Bulletin	
		"Camshaft Timing, Checking and Setting, All Models w/ VE D12"	
Valve lift, max.:			
Intake .....	13.1 mm		(0.5 in.)
Exhaust .....	13.1 mm		(0.5 in.)
Electronic unit injectors:			
Max. stroke .....	17 mm		(0.7 in.)

# Camshaft Bearings

Diameter, camshaft bearing housing:			
1st bearing (thrust) .....	73.9 ± 0.013 mm		(2.9 ± 0.0005 in.)
2nd-7th bearings .....	73.9 ± 0.013 mm		(2.9 ± 0.0005 in.)

# Crank Mechanism



T2006958

## Crankshaft

Length .....	1202.8 mm	(47.35 in.)
Crankshaft thrust clearance (end play) .....	0.07–0.31 mm	(0.0027–0.012 in.)
Main bearing, radial clearance .....	0.044–0.121 mm	(0.0017–0.0048 in.)

## Main Bearing Journals

Diameter for machining, standard .....	107.978–108.000 mm	(4.251–4.252 in.)
Undersize:		
0.25 mm .....	107.728–107.75 mm	(4.241–4.242 in.)
0.50 mm .....	107.478–107.50 mm	(4.231–4.232 in.)
0.75 mm .....	107.228–107.25 mm	(4.221–4.222 in.)
1.00 mm .....	106.978–107.00 mm	(4.211–4.212 in.)
1.25 mm .....	106.728–106.75 mm	(4.201–4.202 in.)
Surface finish, main bearing journal .....	Ra 0.25	
Surface finish, radius .....	Ra 0.40	
Width, thrust bearing journal (A) standard .....	46.975–47.025 mm	(1.849–1.851 in.)
Oversize (A):		
0.2 mm (thrust bearing 0.1) .....	46.575–46.625 mm	(1.833–1.835 in.)
0.4 mm (thrust bearing 0.2) .....	46.375–46.425 mm	(1.825–1.827 in.)
0.6 mm (thrust bearing 0.3) .....	46.375–46.425 mm	(1.825–1.827 in.)
Fillet radius (R) .....	3.75–4.00 mm	(0.147–0.157 in.)

## Thrust Bearings

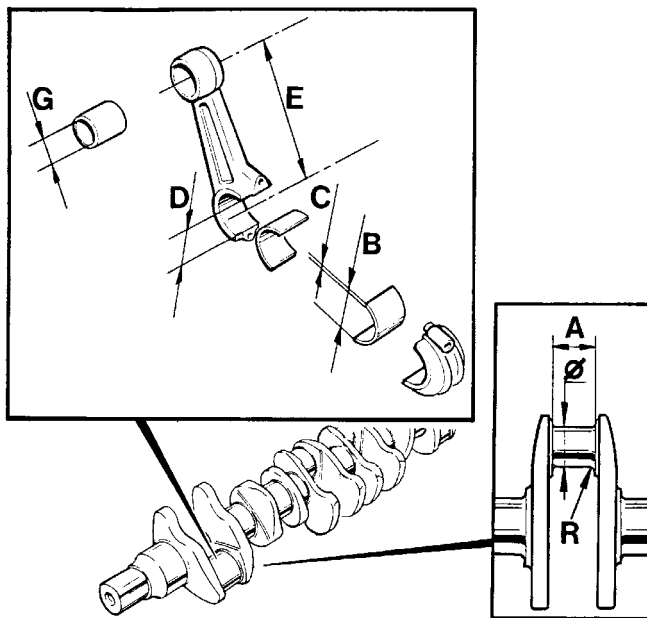
Width ( <b>B</b> ) standard .....	3.140–3.210 mm	(0.123–0.126 in.)
Oversize:		
0.1 mm (0.004 in.) .....	3.240–3.310 mm	(0.127–0.130 in.)
0.2 mm (0.008 in.) .....	3.340–3.410 mm	(0.131–0.134 in.)
0.3 mm (0.012 in.) .....	3.440–3.510 mm	(0.135–0.138 in.)

## Main Bearing Shells

Type .....	Replaceable	
Outer diameter ( <b>C</b> ) .....	113.065 mm	(4.45 in.)
Thickness ( <b>D</b> ) standard .....	2.483–2.498 mm	(0.097–0.098 in.)
Oversize:		
0.25 mm (0.01 in.) .....	2.608–2.623 mm	(0.102–0.103 in.)
0.50 mm (0.02 in.) .....	2.733–2.748 mm	(0.107–0.108 in.)
0.75 mm (0.03 in.) .....	2.858–2.873 mm	(0.0112–0.0113 in.)
1.00 mm (0.04 in.) .....	2.983–2.998 mm	(0.1174–0.1180 in.)
1.25 mm (0.05 in.) .....	3.108–3.123 mm	(0.1223–0.1229 in.)

# Connecting Rods

Length, center (E) .....	260 ± 0.05 mm	(10.2 ± 0.002 in.)
Marking:		
Connecting rod numbered resp. cap .....	1 to 6	
FRONT on rod turned .....	Forward	
Wrist pin bushing bore (G) .....	55.022-55.028 mm	(2.1662-2.1665 in.)
Axial clearance, connecting rod — crankshaft:		
Max. ....	0.35 mm	(0.013 in.)
Min. ....	0.15 mm	(0.006 in.)
Connecting rod bearing, radial clearance:		
Max. ....	0.102 mm	(0.004 in.)
Min. ....	0.045 mm	(0.0018 in.)
Diameter, bearing bore (D) .....	96.835-96.850 mm	(3.812-3.8129 in.)



T2007005

Connecting rod dimensions



## Connecting Rod Bearing Journals

Diameter ( $\emptyset$ ) for machining, standard .....	91.978–92.000 mm	(3.621–3.622 in.)
Undersize:		
0.25 mm (0.01 in.) .....	91.728–91.750 mm	(3.6113–3.6122 in.)
0.50 mm (0.02 in.) .....	91.478–91.500 mm	(3.601–3.602 in.)
0.75 mm (0.03 in.) .....	91.228–91.250 mm	(3.591–3.592 in.)
1.00 mm (0.04 in.) .....	90.978–91.000 mm	(3.581–3.582 in.)
1.25 mm (0.05 in.) .....	90.728–90.750 mm	(3.571–3.572 in.)
Surface finish, connecting rod bearing journal .....	Ra 0.25	
Surface finish, radius .....	Ra 0.4	
Width ( <b>A</b> ) thrust bearing journal .....	56.9–57.0 mm	(2.240–2.244 in.)
Fillet radius ( <b>R</b> ) (5.25–5.5) .....	3.75–4.00 mm	(0.1476–0.1574 in.)

## Connecting Rod Bearing Shells

Outer diameter ( <b>B</b> ) .....	96.85 mm	(3.81 in.)
Thickness ( <b>C</b> ) standard .....	2.385–2.395 mm	(0.0938–0.0942 in.)
Oversize:		
0.25 mm (1.0 in.) .....	2.510–2.520 mm	(0.0988–0.0992 in.)
0.50 mm (0.02 in.) .....	2.635–2.645 mm	(0.103–0.104 in.)
0.75 mm (0.03 in.) .....	2.760–2.770 mm	(0.1086–0.1090 in.)
1.00 mm (0.04 in.) .....	2.885–2.895 mm	(0.1135–0.1139 in.)
1.25 mm (0.05 in.) .....	3.010–3.020 mm	(0.1185–0.1188 in.)

## Flywheel

Max. allowable axial throw (runout) measuring radius 150 mm (5.9 in.) manual transmission .....	0.20 mm	(0.0079 in.)
Number of teeth on flywheel .....	153	

## Flywheel Housing, Installed

Max. allowable axial throw (runout) for contact surface against clutch housing .....	0.20 mm	(0.0079 in.)
Max. allowable radial throw (runout) for positioning against clutch housing .....	0.25 mm	(0.0098 in.)

## Lubrication and Oil System

### Oil

Heavy duty engine oil to API-CF, CF-4 or CG-4 specifications. For extended oil drain intervals, the oil must also meet Volvo Drain Specifications (VDS).

### Oil Pressure

Operating speed (1100 rpm or higher) .....	300-550 kPa	(44-80 psi)
Idle speed, min. ....	150 kPa	(22 psi)

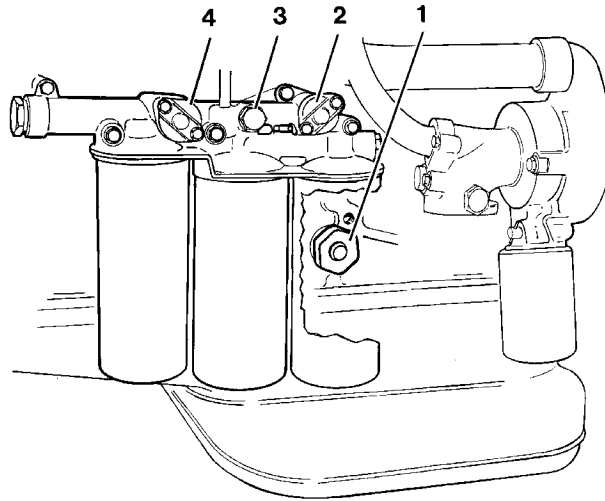
### Oil Pump

Type .....	Gear-driven	
<b>Number of teeth:</b>		
Drive gear .....	24	
Idler gear .....	57	
<b>Diameter:</b>		
Hub, oil pump idler gear .....	69.99 ± 0.0095 mm	(2.76 ± 0.0003 in.)
Bushing, oil pump idler gear .....	70.044 ± 0.019 mm	(2.76 ± 0.0007 in.)
<b>Axial clearance:</b>		
Drive gear, oil pump .....	0.110 mm	(0.0043 in.)
Oil pump idler gear .....	0.100 mm	(0.0039 in.)
Backlash .....	0.05-0.17 mm	(0.002-0.007 in.)

### Oil Filters

Number .....	3
Full-flow filter .....	2
Bypass filter .....	1

# Oil Valves



T2006673

## 1. Reduction Valve

Marking ..... Brown

## 2. Overflow Valve, Oil Cooler

Thermostat valve, total length ..... 40.1 mm (1.6 in.)

## 3. Overflow Valve, Oil Filter

Free length, unloaded ..... 68.8 mm (2.7 in.)

With load of 13-15 Nm (1.3-1.5 lb-ft) ..... 40.0 mm (1.6 in.)

## 4. Piston Cooling Valve

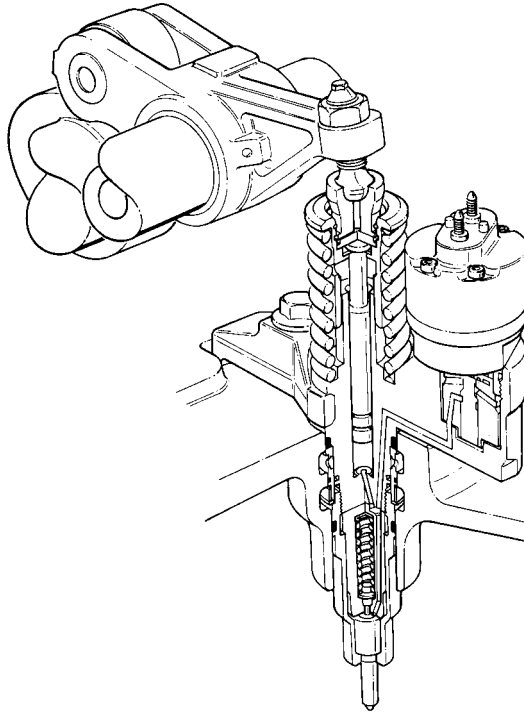
Marking ..... Orange

# Fuel System

## Fuel Pump

Fuel pressure ..... 450 kPa (65 psi)

## Electronic Unit Injectors



T2006849

Part number ..... 8170966  
 Pre-load setting ..... 0 lash + 3 to 4 flats  
 Nut, unit injector electrical connection ..... 1.4 Nm (1.0 ft-lb)

## Fuel Filters

Primary ..... 30 micron  
 Secondary ..... 5 micron

## Intake and Exhaust System

### Turbocharger

Lube system, turbocharger .....	Pressure lubrication	
<b>Boost pressure (minimum):</b>		
D12B 345 (1700 rpm), full load .....	128 kPa	(18.6 psi)
D12B 385 (1700 rpm), full load .....	142 kPa	(20.6 psi)
D12B 425 (1700 rpm), full load .....	165 kPa	(23.9 psi)

# Cooling System

## General

Type ..... Pressurized  
 Pressure valve opens at ..... 75 kPa (10.9 psi)


## Coolant

Antifreeze with corrosion protection meeting or exceeding ASTM D 4985 standard as a min. This applies to both standard and extended life coolants.

## Coolant Filter

Number ..... 1

## Anti-corrosion Additive

 <b>CAUTION</b>
Do not mix anti-corrosion additive with concentrated coolant or any other type of anti-corrosion fluid. Component damage may result.

## Coolant Pump

Type ..... Gear-driven centrifugal pump

## Thermostat

Type ..... Plunger  
 Opening temperature, standard ..... 86°C (187°F)

## Wear Tolerances

### Cylinder Head

Cylinder head should be replaced if the max. deviation on the flat surface (bottom face) is 0.2 mm (0.0079 in.) or greater.

### Cylinder Liner

Cylinder liners (pistons and piston rings) should be replaced with wear of 0.45–0.50 mm (0.018–0.019 in.).

### Crankshaft

Max. allowable out-of-round on main and connecting rod bearing journals .....	0.08 mm	(0.003 in.)
Max. allowable taper on main and connecting rod bearing journals .....	0.05 mm	(0.002 in.)
Max. thrust clearance on crankshaft (end play) .....	0.40 mm	(0.015 in.)
Max. runout on central journalling* .....	0.15 mm	(0.0059 in.)

\*Measured at the no. 4 main bearing journal while the crank is rotated on a centering device.

### Connecting Rods

Straightness, max. deviation on a measuring length of 100 mm (3.9 in.) .....	0.06 mm	(0.0024 in.)
Warp, max. deviation on a measuring length of 100 mm (3.9 in.) .....	0.15 mm	(0.0059 in.)

### Valves

Valve stem, max. allowable wear on diameter .....	0.010 mm	(0.00039 in.)
Max. allowable clearance between valve stem and valve guide:		
Intake .....	0.2 mm	(0.008 in.)
Exhaust .....	0.3 mm	(0.012 in.)
Valve disc edge should be min.:		
Intake .....	1.4 mm	(0.06 in.)
Exhaust .....	1.2 mm	(0.05 in.)
Valve seat may be ground down as long as the distance from valve disc (new valve) to cylinder head face does not exceed:		
Intake .....	1.5 mm	(0.06 in.)
Exhaust .....	1.8 mm	(0.07 in.)

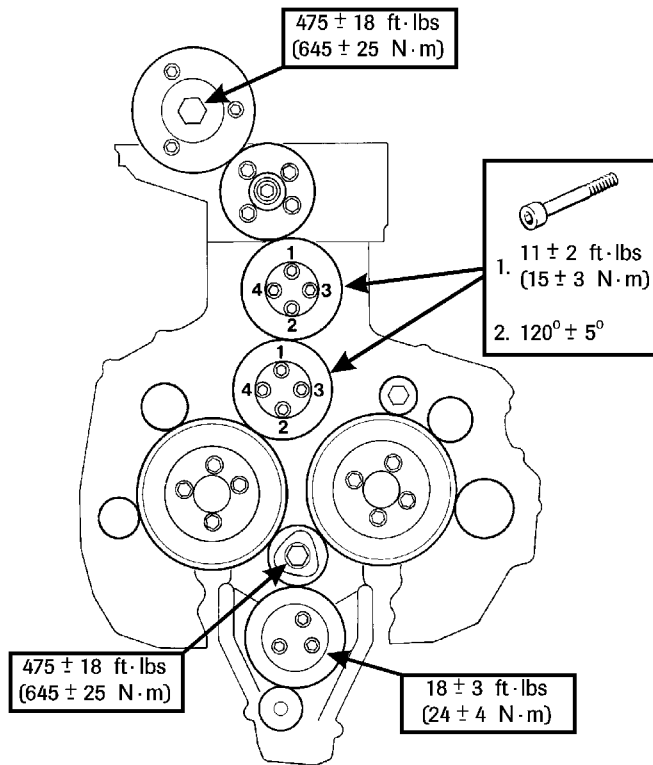
If distance exceeds specification, replace the valve seat.

## Camshaft

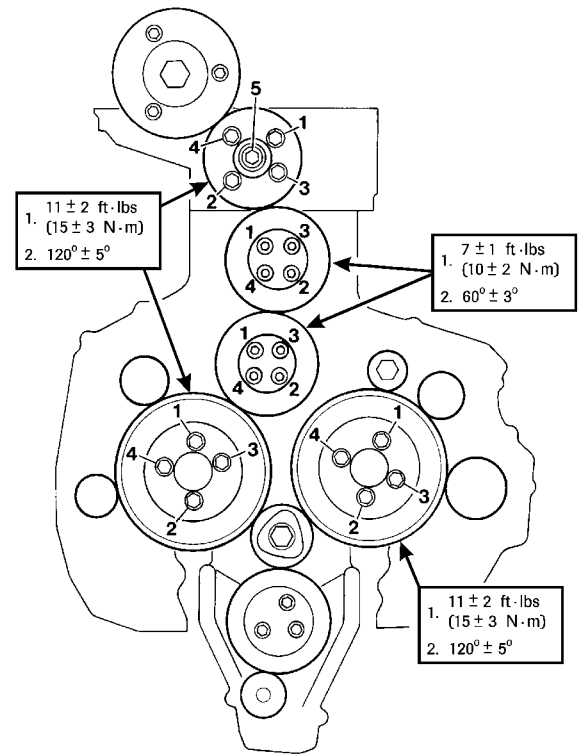
Max. allowable out-of-round (bearings) .....	0.01 mm	(0.0004 in.)
Bearings, max. allowable diametrical wear .....	0.01 mm	(0.0004 in.)
Cam profiles, allowable wear:		
Intake .....	0.2 mm	(0.008 in.)
Exhaust .....	0.2 mm	(0.008 in.)
Engine brake (VEB) .....	0.1 mm	(0.004 in.)
Unit injectors .....	0.1 mm	(0.004 in.)



# Tightening Torques and Patterns



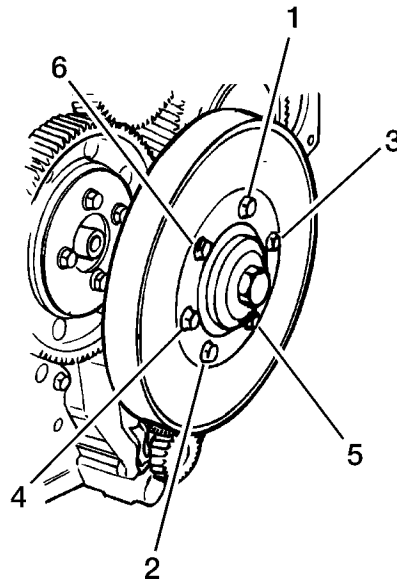
W2000700



W2000701

Torque sequences and procedures for timing gears

Component	Nm	ft-lb
Main bearing cap bolts Step 1 .....	150 ± 20	111 ± 14
Main bearing cap bolts Step 2 .....	Turn an additional 120° ± 5°	
Connecting rod bearing cap bolts .....	252 ± 12	186 ± 9
A/C compressor bolts .....	48 ± 8	35 ± 6
Fuel feed pump bolts M8 .....	33 ± 4	24 ± 3
Fuel feed pump bolts M10 .....	48 ± 8	35 ± 6
Starter mounting bolts .....	85 ± 15	63 ± 11
Power steering pump bolts .....	48 ± 8	35 ± 6
ECU mounting bolts .....	33 ± 4	24 ± 3

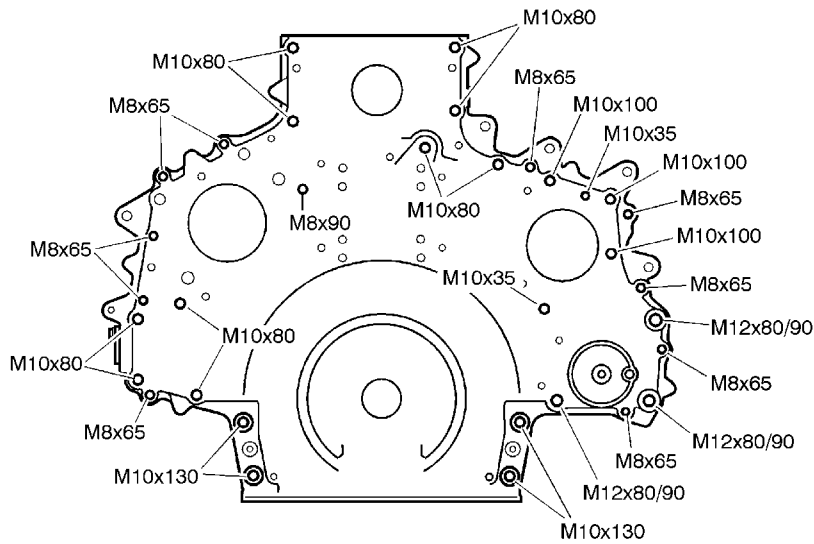


W2002133

Tightening sequence for vibration damper bolts

Component	Nm	ft-lb
Vibration damper bolts .....	35 + 90°	26 + 90°

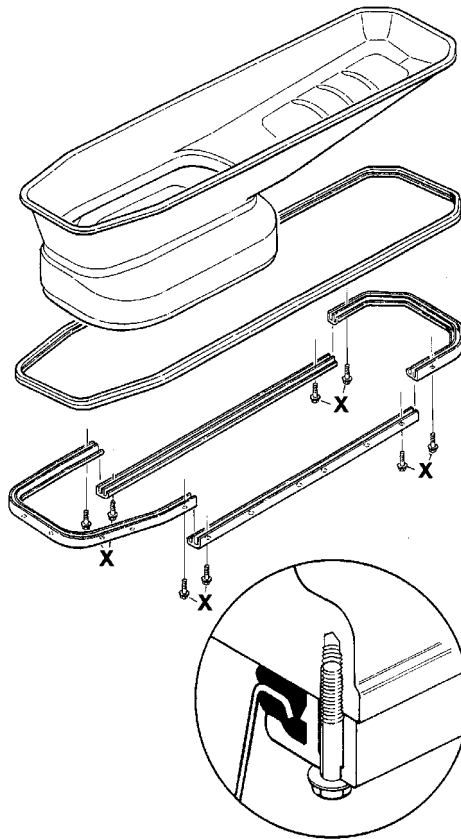
- The torque should be applied in a cross-wise pattern, beginning with bolt no. 1, as in the above illustration, and continuing through the sequence.
- The bolts are designed for a single use and CANNOT be re-torqued or reused.



W2002718

Timing gear cover, lower. Bolt lengths designated 80/90 indicate 80 without PTO, 90 with PTO.

Component	Nm	ft-lb
Timing gear bolts M8 .....	33 ± 4	24 ± 3
Timing gear cover bolts M10 .....	48 ± 8	35 ± 6
Timing gear cover bolts M12 .....	85 ± 15	63 ± 11
Timing gear cover bolts M14 .....	140 ± 12	103 ± 10

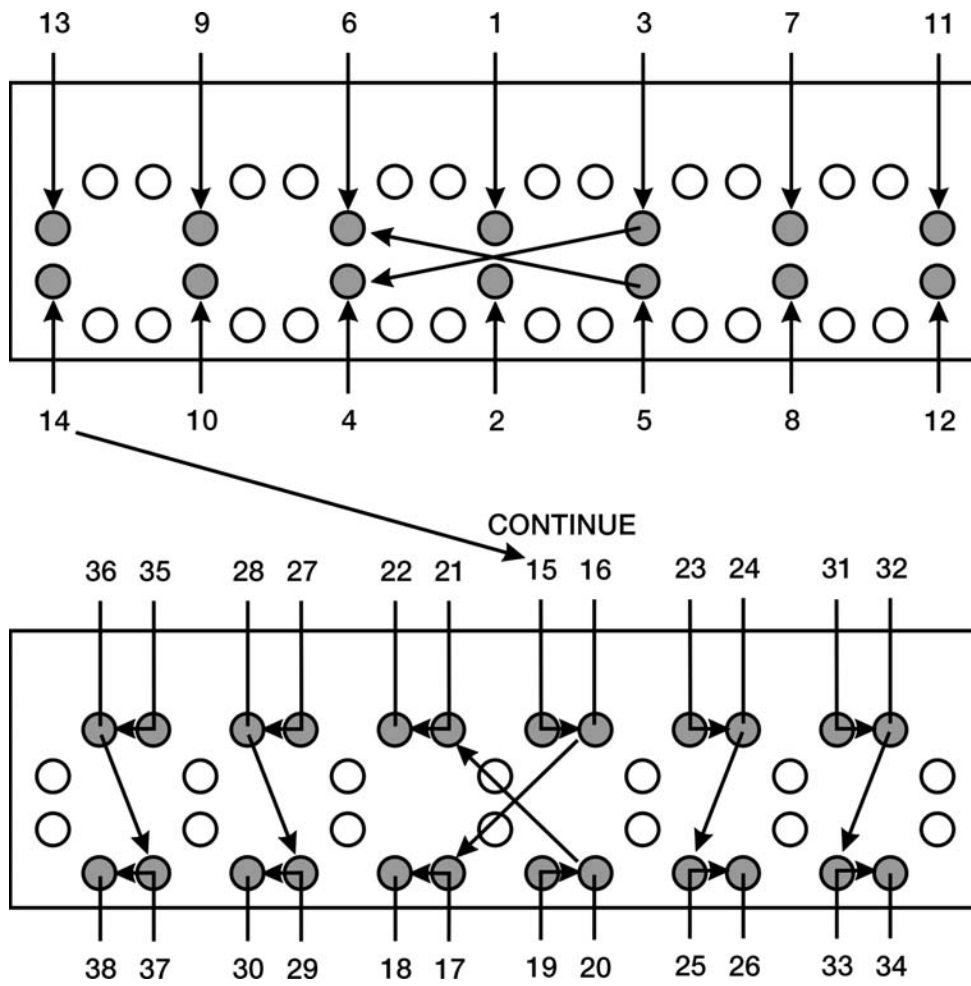


T2006802

Tightening sequence for oil pan bolts

**Note:** First tighten the bolts marked **X**, then tighten the remaining bolts.

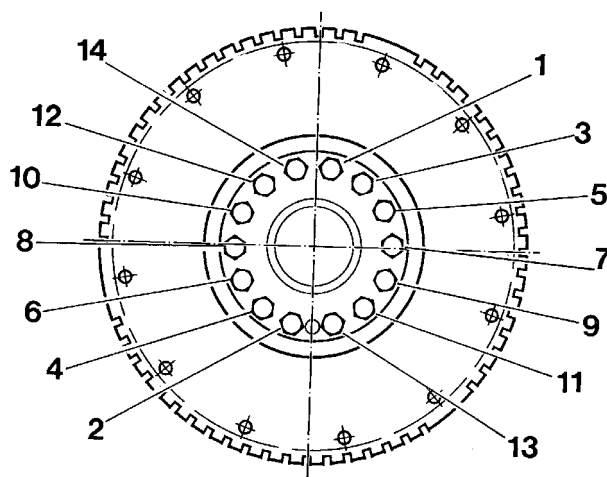
Component	Nm	ft-lb
Oil pan bolts .....	24 ± 4	18 ± 3
Drain plug, oil pan .....	60 ± 15	44 ± 11
Oil pump bracket bolts .....	24 ± 4	18 ± 3



W2002666

Tightening sequence for cylinder head bolts

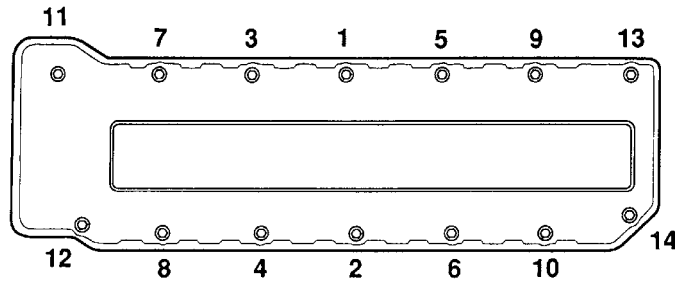
Component	Nm	ft-lb
Cylinder head bolts (1-38) Step 1 .....	60 ± 10	44 ± 7
Cylinder head bolts (1-38) Step 2 .....	Turn an additional 90° ± 5°	
Cylinder head bolts (1-38) Step 3 .....	Turn an additional 90° ± 5°	



T2006973

Tightening sequence for flywheel bolts

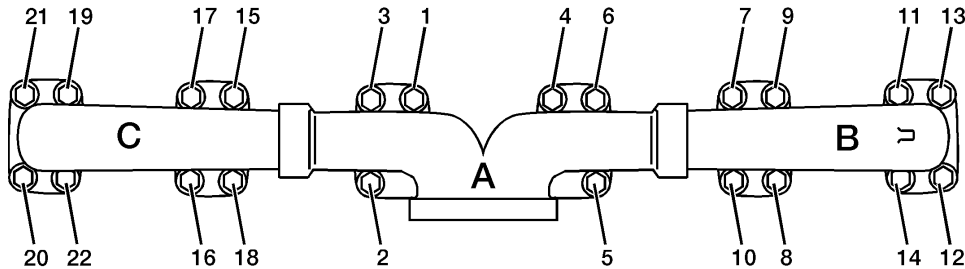
Component	Nm	ft-lb
Flywheel housing bolts .....	140 ± 14	103 ± 10
Flywheel bolts-Step 1 .....	85 ± 5	63 ± 4
Flywheel bolts-Step 2 .....	Turn an additional 30° ± 3°	
<b>Retainer bolt, unit injector with new copper sleeve</b>		
First tightening-Step 1 .....	20 ± 5	15 ± 4
First tightening-Step 2 .....	Turn an additional 180° ± 5°	
Loosen the retainer bolt for the unit injector prior to the second tightening		
Second tightening-Step 1 .....	20 ± 5	15 ± 4
Second tightening-Step 2 .....	Turn an additional 60° ± 5°	
<b>Retainer bolt, unit injector with used copper sleeve</b>		
Step 1 .....	20 ± 5	15 ± 4
Step 2 .....	Turn an additional 60° ± 5°	



T2007003

Tightening sequence for valve cover bolts

Component	Nm	ft-lb
Valve cover nuts .....	30 ± 3	22 ± 2
M14 engine mounting bolt .....	140 ± 25	103 ± 18



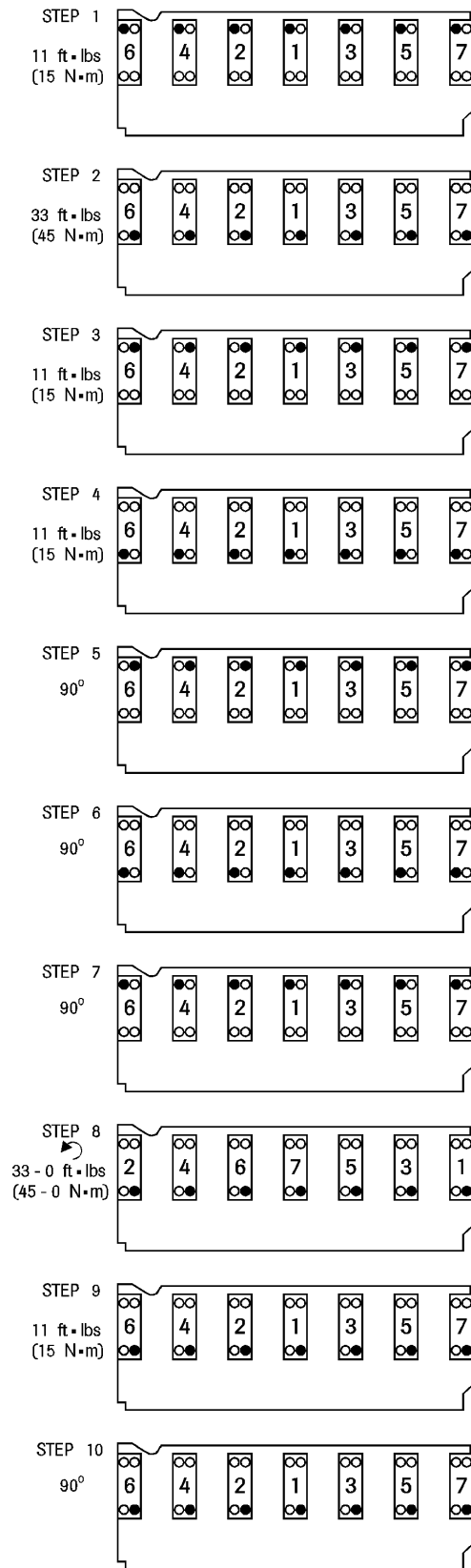
W2002224

Tightening sequence for exhaust manifold bolts

Component	Nm	ft-lb
Exhaust manifold bolts .....	48 ± 8	35 ± 6

- 1 Begin by lining up all three manifold sections onto the cylinder head, starting with section A.
- 2 After applying anti-seize to the manifold bolts and turbo studs, screw the bolts in by hand, starting with section A and then sections B and C.
- 3 Tighten the bolts cross-wise starting with section A, and then sections B and C. Torque to 25 Nm (18 ft-lb). Begin the torque sequence again; however, raise the torque to 48 ± 8 Nm (35 ± 6 ft-lb).
- 4 Start the engine and run it until it reaches operating temperature.
- 5 Verify the torque at 48 ± 8 Nm (35 ± 6 ft-lb).

Component	Nm	ft-lb
Intake manifold bolts	33 ± 4	24 ± 3
Piston cooling nozzle bolt .....	24 ± 4	18 ± 3
Cleaning plugs, cylinder head (M38 x 1.5) .....	60 ± 10	44 ± 7
Valve cover stud (Loctite) .....	48 ± 8	35 ± 6
Oil cooler mounting bolts .....	27 ± 4	20 ± 3
Oil strainer mounting bolts (in pump) .....	27 ± 4	20 ± 3
Valve adjustment locknut .....	38 ± 4	28 ± 3
Nut, unit injector electrical connection .....	1.4	1



W2000693

Torque values and procedure for camshaft housing bolts

**Note:** Loosen the marked bolts in step 8 before proceeding to steps 9 and 10.

When reinstalling a rocker arm shaft that has been loosened or removed, torque only the bolts holding the shaft, according to the diagram.







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