Open front screen

INDUSTRIAL DIESEL ENGINE

AA-6HK1T, BB-6HK1T MODELS

WORKSHOP MANUAL

ISUZU MOTORS LIMITED

NOTICE

Before using this Workshop Manual to assist you in performing service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section 00 under the heading "GENERAL INFORMATION".

This manual is applicable to 2000 model year engines.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION NO.	CONTENTS
00	General Information
6A	Engine Mechanical
6B	Engine Cooling
6C	Engine Fuel
6D	Starting and Charging
6E	—
6F	—
6G	Engine Lubrication
6J	Engine Induction

GENERAL INFORMATION

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General Information. 0A
Service Information 0B

GENERAL INFORMATION

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General Repair Instruction

1. Before performing service operations, disconnect the ground cable from the battery to reduce the chance of cable damage and burning due to short circuiting.
2. Use a cover on body, seats and floor to protect them against damage and contamination.
3. Brake fluid and anti-freeze solution must be handled with care because they can cause paint damage.
4. The use of proper tools and special tools, where specified, is important for efficient and reliable performance of service repairs.
5. Use genuine Isuzu parts.
6. Used cotter pins, plastic clips, gaskets, O-rings oil seals, lock washers, and self-locking nuts should be discarded and new ones should be installed. Normal function of the parts cannot be maintained if these parts are reused.
7. To facilitate proper and smooth reassembly operation, keep disassembled parts neatly in groups. Keeping fixing nuts and bolts separate is very important, as they vary in hardness and design depending on position of installation.
8. Clean the parts before inspection or reassembly. Also clean oil ports, etc. using compressed air, and make certain they are free from restrictions.
9. Lubricate rotating and sliding faces of the parts with oil or grease before installation.
10. When necessary, use a sealer on gaskets to prevent leakage.
11. Carefully observe all specifications for nut and bolt torques.
12. When a service operation is completed, make a final check to be sure the service has been done properly and the problem has been corrected.
13. Allow the engine to cool before beginning any service procedure.

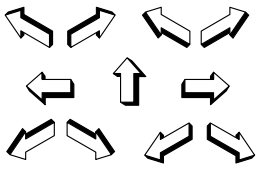
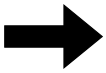
    This will eliminate the danger of fire and possible injury.
14. Hot steam under pressure may escape from the radiator if the coolant is drained while the engine is hot. This can result in serious burns. Allow the engine to cool before draining the coolant.
15. Hot engine oil can cause severe skin burns. Allow the engine to cool before draining the engine oil.
16. While working around a running engine, avoid contact with moving parts and hot surfaces to prevent injury.
17. Wear safety glasses when using compressed air. Flying particles may cause eye injury.
18. Always wear safety goggles when working with fuel to protect the eyes from fuel splash.
19. Test fluid from the injection nozzle tester will spray out of the injection nozzle under great pressure.

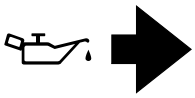
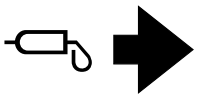
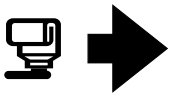
    It can easily puncture a person’s skin.

    Keep your hands away from the injection nozzle at all times.
20. Do not use your fingers to feel for fuel leaks at fittings. Fuel pressure is high enough to penetrate the skin.
21. Be careful when changing fuel system components: Diesel fuel is flammable. Be sure that the ignition key of OFF. Do not smoke or allow open flame in the area while changing fuel system components.

Illustration Arrows

Arrows help you to understand technical illustrations.

Arrow Type	Application
	Front of Engine
	Up
	Task Related
	View Detail
	View Angle
	Dimension (1:2)
	Sectioning (1:3)

Arrow Type	Application
	• Ambient/Clean air flow • Cool air flow
	• Gas other than ambient air • Hot air flow
	• Ambient air mixed with another gas • Temperature change
	Direction
	Lubrication point (Oil or fluid)
	Lubrication point (Grease)
	Lubrication point (Jelly)

Abbreviations

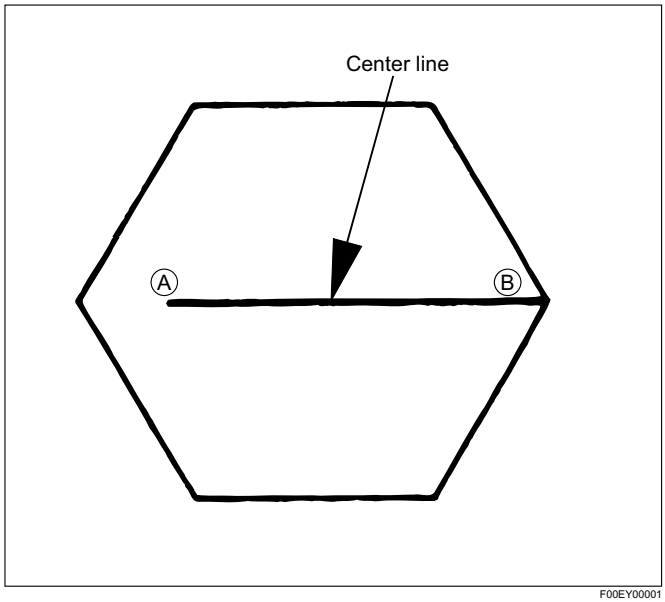
List of abbreviations which may be used in this manual

A – Ampere(s)
AC – Alternating Current
ACL – Air Cleaner
Adj – Adjust
AMP – Ampere(s)
ASM –Assembly
ATDC – After Top Dead Center
Auto – Automatic
Bat – Battery
B+ – Battery Positive Voltage
BHP – Brake Horsepower
BTDC – Before Top Dead Center
°C – Degrees Celsius
cc – Cubic Centimeter
CID – Cubic Inch Displacement
CO – Carbon Monoxide
Conn – Connector
Crank – Crankshaft
Cu. In. – Cubic Inch
Cyl – Cylinder(s)
DOHC – Double Overhead Camshaft
DTC – Diagnostic Trouble Code
DTM – Diagnostic Test Mode
DTT – Diagnostic Test Terminal
ECM – Engine Control Module
ECT – Engine Coolant Temperature
EGR – Exhaust Gas Recirculation
Exh – Exhaust
°F – Degrees Fahrenheit
FL – Fusible Link
FLW – Fusible Link Wire
FP – Fuel Pump
FRT – Front
ft – Foot
Gal – Gallon
GND – Ground
Gov – Governor
g – Gram
Harn – Harness
HC – Hydrocarbons
HD – Heavy Duty
Hg – Hydrargyrum (Mercury)
IC – Integrated Circuit / Ignition Control
ID – Identification / Inside Diameter
IGN – Ignition
INJ – Injection
Int – Intake
kg – Kilograms
km – Kilometers
km/h – Kilometer per Hour
kPa – Kilopascals
kV – Kilovolts (thousands of volts)
kW – Kilowatts
L – Liter
lb ft – Foot Pounds
lb in – Inch Pounds
LF – Left Front
LH – Left Hand
LR – Left Rear
LS – Left Side
L-4 – In-Line Four Cylinder Engine
Max – Maximum
Min – Minimum
mm – Millimeter
N – Newtons
NA – Naturally Aspirated
NC – Normally Closed
N·m – Newton Meters
NO – Normally Open
NOX – Nitrogen oxides
OD – Outside Diameter
OHC – Overhead Camshaft
PCV – Positive Crankcase Ventilation
PRESS – Pressure
PROM – Programmable Read Only Memory
psi – Pounds per Square Inch
PSP – Power Steering Pressure
Pt. – Pint
PWM – Pulse Width Modulate
Qt. – Quart
REF – Reference
RF – Right Front
RH – Right Hand
RPM – Revolutions Per Minute
RPM Sensor – Engine Speed Sensor
RR – Right Rear
RS – Right Side
RTV –Room Temperature Vulcanizing
SAE – Society of Automotive Engineers
Sec – Secondary
SI – System International
SOHC – Single Overhead Camshaft
Sol – Solenoid
SPEC – Specification
Speedo – Speedometer
ST – Start / Scan Tool
Sw – Switch
SYN – Synchronize
Tach – Tachometer
TDC – Top Dead Center
Term – Terminal
TEMP – Temperature
TURBO – Turbocharger
V – Volt(s)
VAC – Vacuum
V-ref – ECM Reference Voltage
VSS – Vehicle Speed Sensor
VSV – Vacuum Switch Valve
V-6 – Six Cylinder “Vee” Engine
V-8 – Eight Cylinder “Vee” Engine
W – Watt(s)
w/ – With
w/o – Without
WOT – Wide Open Throttle

Nut and Bolt Angular Tightening Method

The angular tightening method uses the plastic region of high tensile steel nuts and bolts to precision tighten important engine fasteners.
Because of the method's nature, there is a limit to the number of times a particular fastener may be reused. This limit is specified in this Manual where applicable.

1. Carefully wash the nuts and bolts to remove all oil and grease.
2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.
3. Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.
4. Draw a line Ⓐ–Ⓑ across the center of each nut or bolt.



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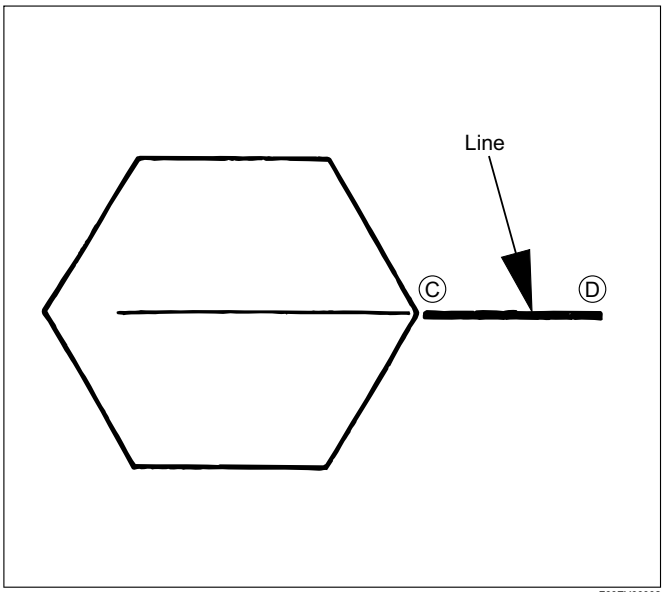
5. Draw another line Ⓒ – Ⓓ on the face of each of the parts to be clamped. This line should be an extension of the line Ⓐ – Ⓑ.



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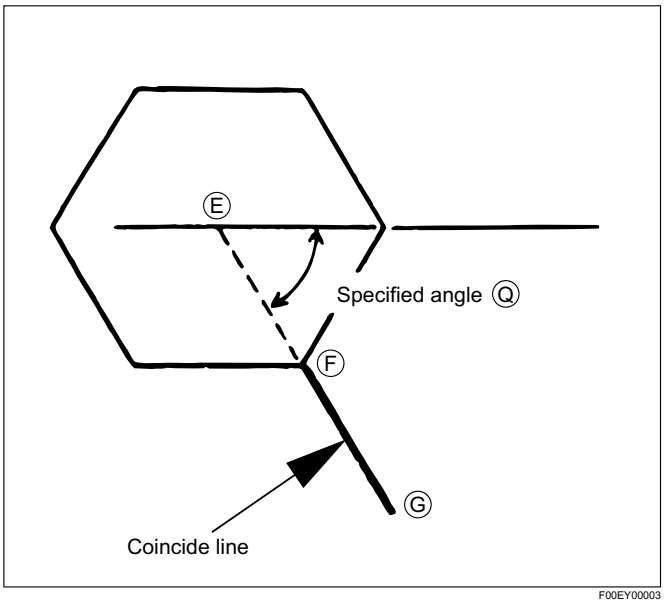
6. Draw another line Ⓕ – Ⓖ on the face of each of the parts to be clamped. This line will be in the direction of the specified angle Ⓠ across the center Ⓔ of the nut or bolt.



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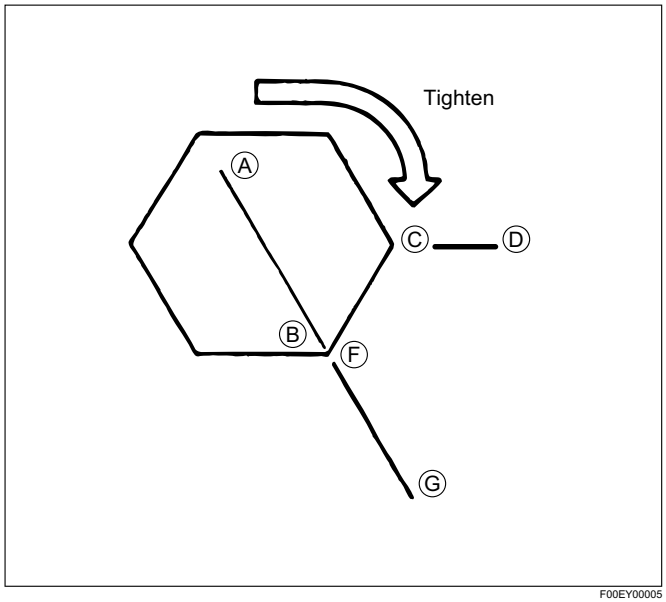
7. Use a socket wrench to tighten each nut or bolt to the point where the line Ⓐ – Ⓑ is aligned with the line Ⓕ – Ⓖ.



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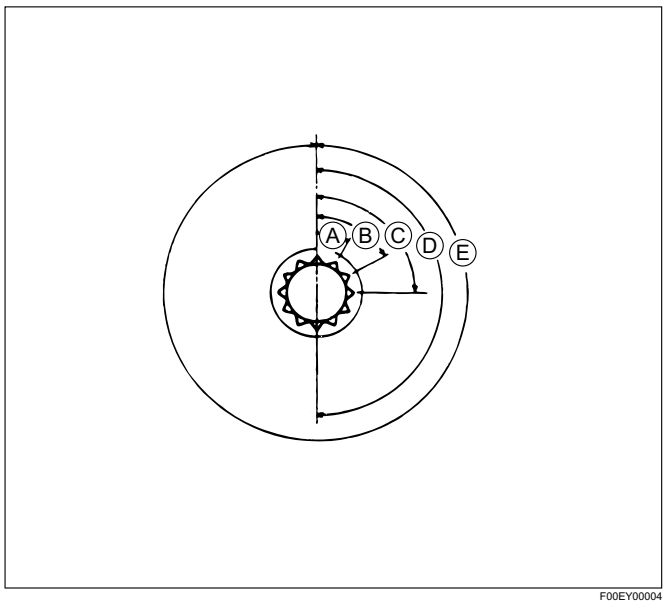
Example: Specified Angle and Tightening Rotation

A	30°	1 / 12 of a turn
B	60°	1 / 6 of a turn
C	90°	1 / 4 of a turn
D	180°	1 / 2 of a turn
E	360°	One full turn



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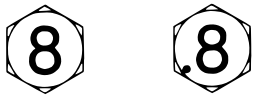
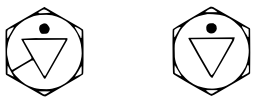
Standard Bolt Torque Specifications

The tightening torque values given in the table below are applicable to all bolts unless otherwise specified.

STANDARD BOLT

N·m (kgf·m/lb.ft)

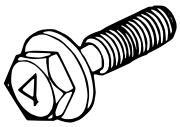
Bolt Identification / Bolt Diameter × pitch (mm)			
			
M6 × 1.0	4 – 8 (0.4 – 0.8/3 – 6)	5 – 10 (0.5 – 1.0/4 – 7)	—
M8 × 1.25	8 – 18 (0.8 – 1.8/6– 13)	12 – 23 (1.2 – 2.3/9 – 17)	17 – 30 (1.7 – 3.1/12 – 22)
M10 × 1.25	21 – 34 (2.1 – 3.5/5 – 25)	28 – 46 (2.8 – 4.7/20 – 33)	37 – 62 (3.8 – 6.4/28 – 46)
* **M10 × 1.5**	20 – 33 (2.0 – 3.4/15 – 25)	28 – 45 (2.8 – 4.6/20 – 33)	36 – 60 (3.7 – 6.1/27– 44)
M12 × 1.25	49 – 74 (5.0 – 7.5/36 – 54)	61 – 91 (6.2 – 9.3/45 – 67)	76 – 114 (7.7 – 11.6/56 – 84)
* **M12 × 1.75**	45 – 69 (4.6 – 7.0/33 – 51)	57 – 84 (5.8 – 8.6/42 – 62)	72 – 107 (7.3 – 10.9/53 – 79)
M14 × 1.5	77 – 115 (7.8 – 11.7/56 – 85)	93 – 139 (9.5 – 14.2/69 – 103)	114 – 171 (11.6 – 17.4/84 – 126)
* **M14 × 2.0**	72 – 107 (7.3 – 10.9/53 – 79)	88 – 131 (9.0 – 13.4/65 – 97)	107 – 160 (10.9 – 16.3/79 – 118)
M16 × 1.5	104 – 157 (10.6 – 16.0/77 – 116)	135 – 204 (13.8 – 20.8/100 – 150)	160 – 240 (16.3 – 24.5/118 – 177)
* **M16 × 2.0**	100 – 149 (10.2 – 15.2/74 – 110)	129 – 194 (13.2 – 19.8/96 – 143)	153 – 230 (15.6 – 23.4/113 – 169)
M18 × 1.5	151 – 226 (15.4 – 23.0/110 – 166)	195 – 293 (19.9 – 29.9/144 – 216)	230 – 345 (23.4 – 35.2/169 – 255)
* **M18 × 2.5**	151 – 226 (15.4 – 23.0/110 – 166)	196 – 294 (20.0 – 30.0/145 – 217)	231 – 346 (23.6 – 35.5/171 – 255)
M20× 1.5	206 – 310 (21.0 – 31.6/152 – 229)	270 – 405 (27.5 – 41.3/199 – 299)	317 – 476 (32.3 – 48.5/234 – 351)
* **M20× 2.5**	190 – 286 (19.4 – 29.2/140 – 211)	249 – 375 (25.4 – 38.2/184 – 276)	293 – 440 (29.9 – 44.9/216 – 325)
M22× 1.5	251 – 414 (25.6 – 42.2/185 – 305)	363 – 544 (37.0 – 55.5/268 – 401)	425 – 637 (43.3 – 64.9/313 – 469)
* **M22× 2.5**	218 – 328 (22.2 – 23.4/161 – 242)	338 – 507 (34.5 – 51.7/250 – 374)	394 – 592 (40.2 – 60.4/291 – 437)
M24× 2.0	359 – 540 (36.6 – 55.0/265 – 398)	431 – 711 (43.9 – 72.5/318 – 524)	554 – 831 (56.5 – 84.7/409 – 613)
* **M24× 3.0**	338 – 507 (34.5 – 51.7/250 – 374)	406 – 608 (41.4 – 62.0/299 – 448)	521 – 782 (53.1 – 79.7/384 – 576)

An asterisk (*) indicates that the bolts are used for female threaded parts that are made of soft materials such as casting.

The tightening torque values given in the table below are applicable to all bolts unless otherwise specified.

FLANGED HEAD BOLT

N·m (kgf·m/lb.ft)

Bolt Identification / Bolt Diameter × pitch (mm)			
M6 × 1.0	5 – 9 (0.5 – 0.9/4 – 7)	6 – 12 (0.6 – 1.2/4 – 9)	———
M8 × 1.25	11 – 20 (1.1 – 2.0/8 – 15)	15 – 28 (1.6 – 2.9/12 – 21)	18 – 34 (2.1 – 3.4/15 – 25)
M10 × 1.25	23 – 39 (2.4 – 3.9/17 – 28)	35 – 59 (3.6 – 6.1/26 – 44)	42 – 71 (4.3 – 7.2/31 – 52)
* **M10 × 1.5**	22 – 37 (2.3 – 3.8/17 – 28)	35 – 58 (3.5 – 5.8/25 – 42)	40 – 67 (4.1 – 6.8/30 – 49)
M12 × 1.25	55 – 82 (5.6 – 8.4/40 – 61)	77 – 117 (7.9 – 11.9/57 – 86)	85 – 128 (8.7 – 13.0/63 – 94)
* **M12 × 1.75**	51 – 77 (5.2 – 7.8/38 – 56)	71 – 107 (7.3 – 10.9/53 – 79)	80 – 119 (8.1 – 12.2/59 – 88)
M14 × 1.5	83 – 125 (8.5 – 12.7/62 – 92)	115 – 172 (11.7 –17.6/85 – 127)	123 – 185 (12.6 – 18.9/91 – 137)
* **M14 × 2.0**	77 – 116 (7.9 – 11.8/57 – 85)	108 – 162 (11.1 – 16.6/80 – 120)	116 – 173 (11.8 – 17.7/85 – 128)
M16 × 1.5	116 – 173 (11.8 – 17.7/85 – 128)	171 – 257 (17.4 – 26.2/126 – 190)	177 – 265 (18.0 – 17.1/130 – 196)
* **M16 × 2.0**	109 – 164 (11.2 – 16.7/81 – 121)	163 – 244 (16.6 – 24.9/120 – 180)	169 – 253 (17.2 – 25.8/124 – 187)

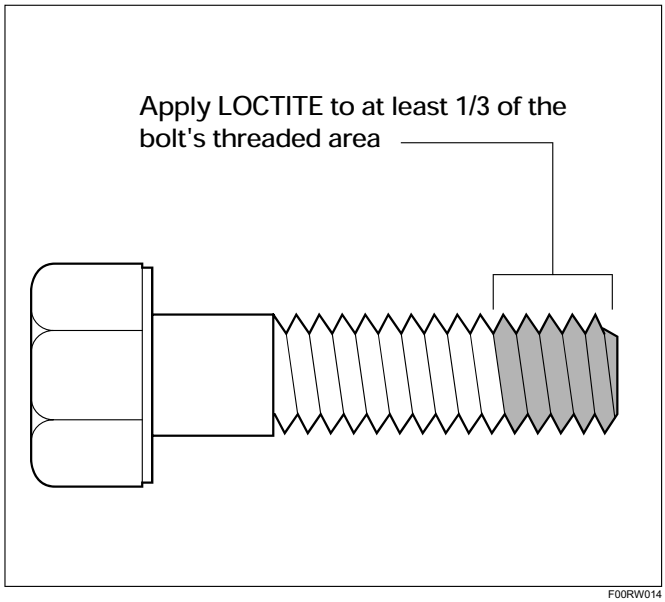
A bolt with an asterisk (*) is used for female screws that are made of soft materials such as cast iron.

Recommended Thread Locking Agents

LOCTITE Type	LOCTITE Color
LOCTITE 242	Blue
LOCTITE 262	Red
LOCTITE 271	Red

Application Steps

1. Completely remove all lubricant and moisture from the bolts and the female-threaded surfaces of the parts to be joined.
   The surfaces must be perfectly dry.
2. Apply LOCTITE to the bolts.



3. Tighten the bolts to the specified torque.
   After tightening, be sure to keep the bolts free from vibration and torque for at least an hour until the LOCTITE hardens.

NOTE: When the application procedures are specified in this manual, follow them.

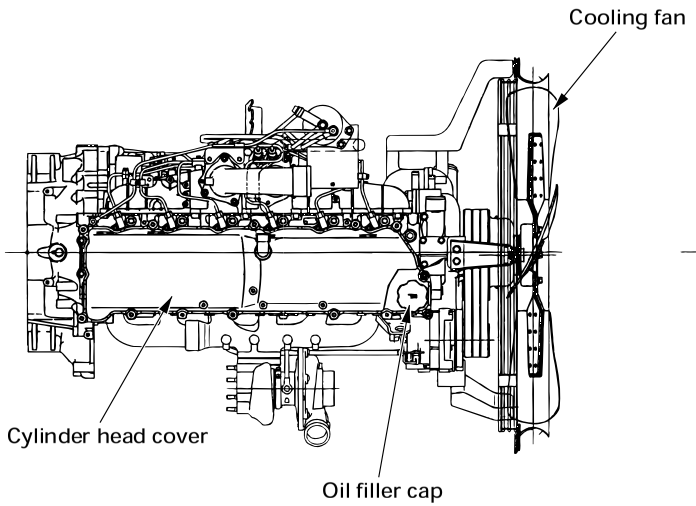
Main Data and Specifications

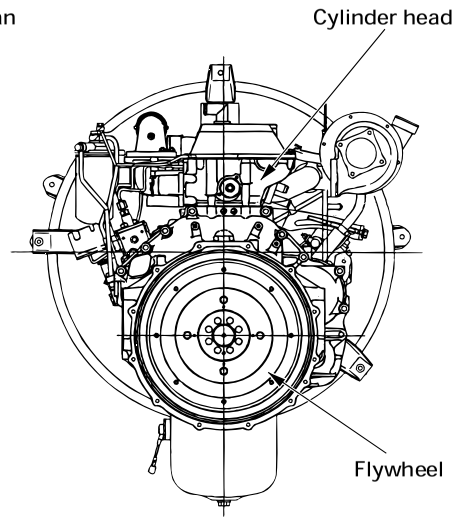
ITEMS			6HK1
Engine type			Four cycle, water cooled, in-line, overhead camshaft direct injection
Combustion chamber			Open type in piston crown
Cylinder liner			Dry
Timing drive system			Gear drive
No. of cylinders – bore × stroke		mm (in)	6 – 115 × 125 (4.53 × 4.92)
No. of piston rings			Four rings (Compression rings: 3, Oil ring: 1)
Total piston displacement		L (cid)	7.790 (475.4)
Compression ratio (to 1)			17.3
Compression pressure at 200 min^{-1}		MPa (kg/cm^2/psi)	3.24 (33/469) or more
Engine dimensions*		mm (in)	1,332 × 995 × 1,143 (52.4 × 39.2 × 45.0)
Engine weight (Dry)*			kg (lb) 650 (1,433)
Fuel injection order			1 – 5 – 3 – 6 – 2 – 4
Fuel injection timing (TDC)*		deg	9
Specified fuel type			SAE No.2 diesel fuel
Idling speed*		min^{-1}	1000
Valve clearances	Intake	mm (in)	0.40 (0.016)
	Exhaust	mm (in)	0.40 (0.016)
Intake valves	Open at (BTDC)	deg	15
	Close at (ABDC)	deg	44
Exhaust valves	Open at (BBDC)	deg	58
	Close at (ATDC)	deg	11
Injection pump			Bosch, in-line P-Type
Governor type*			Mechanical
Injection nozzles			Multi-hole
Injection nozzle opening pressure		MPa (kg/cm^2/psi)	1st stage: 18.1 (185/2630) 2nd stage: 22.1 (225/3200)
Main fuel filter			Paper element
Lubrication system			
Lubrication method			Full flow pressure circulation
Specified engine oil (API grade)			CD
Oil pressure (at oil gallery)		kPa (kg/cm^2/psi)/min^{-1}	290 – 490 (3.0 – 5.0/43–71)/2000 Condition: SAE 30 API CD grade engine oil at an oil temperature of 80°C (176°F)
Oil pump type			Gear (Timing gear drive)

ITEMS		6HK1
Relief valve opening pressure kPa (kg/cm^2/psi)		780 (8.0/114)
Oil pressure switch operating pressure* kPa (kg/cm^2/psi)		29 (0.3/4)
Main oil filter		Paper element
Bypass valve opening pressure kPa (kg/cm^2/psi)		200 (2.0/28.4)
Oil volume*	L (qts)	36 (38) with combined main and partial oil filter
Oil cooler		Plate type – Water cooled in water jacket
Cooling system		Pressured compulsory circulation water
Coolant volume	L (qts)	14.5 (15.3)
Water pump		Centrifugal impeller
Delivery volume Lit/min. (Imp. gal/US gal)		167 (37/44) Pump speed a 1,600 min^{-1}
Thermostat		Wax pellet
Valve initial opening temperature*	°C (°F)	82 (180)
Valve lift	mm (in)	10 (0.39)
Air cleaner		
Alternator capacity*	V – A	24 – 50
Regulator*		IC (Built-in)
Brush length*	mm (in)	Brushless
Starter motor output*	V – kW	24 – 5
Number of poles*		4
Turbocharger model*		RHG 6
Manufacturer		Ishikawajima-Harima Heavy Industries (IHI)

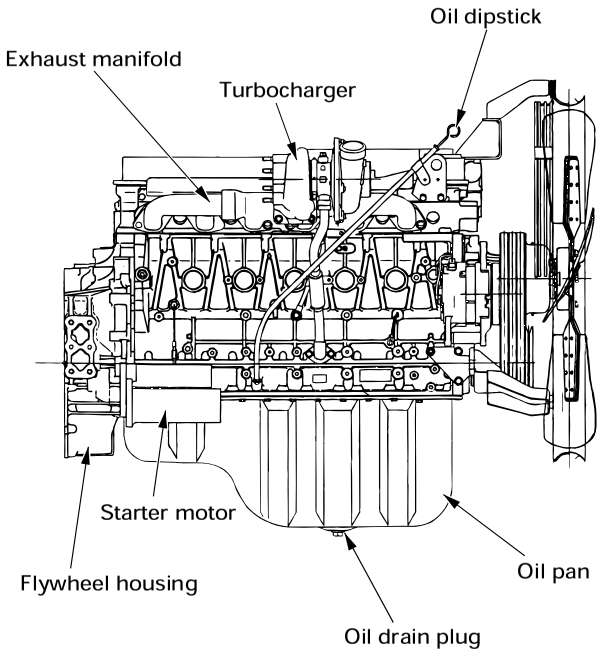
Specifications for items marked with an asterisk (*) may vary according to the type of equipment on which the engine is installed.

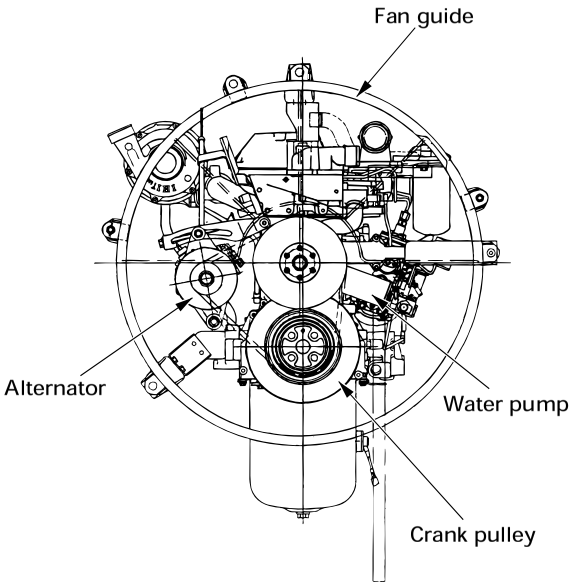
ENGINE EXTERNAL VIEW DRAWING
MODEL AA-6HK1

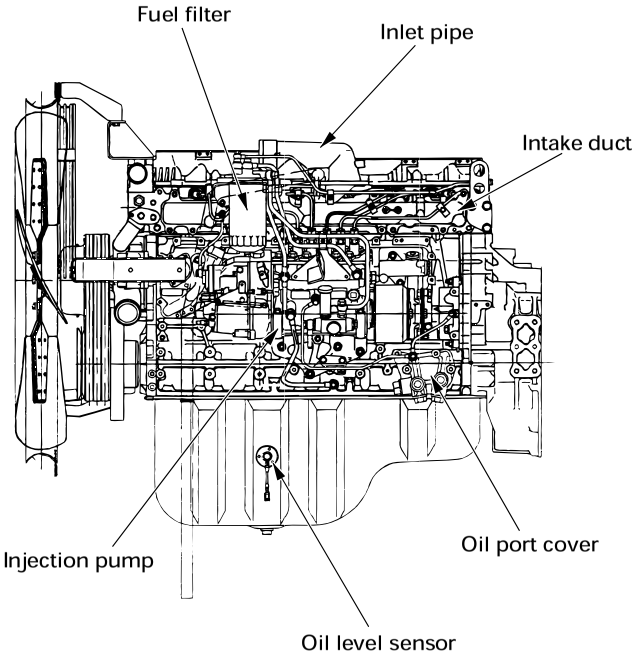




Note:
Engine details may vary depending on the specifications.







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Service Standards

ITEMS		SERVICE STANDARD	SERVICE LIMIT
Cylinder Head			
Lower Face Warpage	mm (in)	0.05 (0.002) or less	0.20 (0.008) Do not regrind the lower face.
Valve Guide			
Valve Stem Clearance			
Intake	mm (in)	0.04 – 0.06 (0.0016 – 0.0024)	0.20 (0.008)
Exhaust	mm (in)	0.06 – 0.10 (0.0024 – 0.0039)	0.25 (0.010)
Valve Stem Outside Diameter			
Intake	mm (in)	7.95 – 7.96 (0.3130 – 0.3134)	7.89 (0.3106)
Exhaust	mm (in)	7.92 – 7.94 (0.3118 – 0.3126)	7.89 (0.3106)
Valve Guide Upper End Height	mm (in)	14.1 (0.56)	—
Valve and Valve Seat Insert			
Valve Thickness			
Intake	mm (in)	1.71 (0.067)	1.30 (0.051)
Exhaust	mm (in)	1.75 (0.069)	1.30 (0.051)
Valve Depression			
Intake	mm (in)	1.0 (0.039)	2.5 (0.098)
Exhaust	mm (in)	1.3 (0.051)	2.8 (0.110)
Valve Contact Width			
Intake	mm (in)	2.5 (0.098)	3.2 (0.126)
Exhaust	mm (in)	2.0 (0.079)	2.8 (0.110)
Valve Face Angle			
Intake	deg	30	—
Exhaust	deg	45	—
Valve Spring			
Spring Height			
Intake	mm (in)	65.9 (2.59)	64.6 (2.54)
Exhaust	mm (in)	68.1 (2.68)	66.7 (2.63)
Spring Squareness			
Intake	mm (in)	2.9 (0.114)	3.0 (0.118)
Exhaust	mm (in)	3.0 (0.118)	3.0 (0.118)
Intake Valve Spring Tension/ Compression Height	N (kg / lb)	348 (35.5 / 78) / 46	
Exhaust Valve Spring Tension/ Compression Height	N (kg / lb)	383 (39.0 / 86) / 46	

ITEMS	SERVICE STANDARD	SERVICE LIMIT
Rocker Arm Shaft and Rocker Arm		
Rocker Arm Shaft Run-Out mm (in)		0.30 (0.012)
Rocker Arm Shaft Outside Diameter mm (in)	21.979 – 22.000 (0.865 – 0.866)	21.85 (0.860)
Rocker Arm Inside Diameter mm (in)	22.010 – 22.035 (0.867 – 0.868)	
Rocker Arm Shaft and Rocker Arm Clearance mm (in)	0.010 – 0.056 (0.0004 – 0.0022)	0.20 (0.008)
Rocker Arm Pin and Roller Clearance mm (in)	0.068 – 0.099 (0.0027 – 0.0039)	0.50 (0.02)
Valve Cap Worn mm (in)		0.10 (0.004)
Camshaft		
Camshaft Journal Diameter mm (in)	39.950 – 39.975 (1.5728 – 1.5738)	39.85 (1.5689)
Cam Lobe Height Intake mm (in)	7.851 (0.3091)	7.351 (0.2894)
Exhaust mm (in)	9.540 (0.3756)	9.040 (0.3559)
Camshaft Run-Out mm (in)	0.025 (0.001)	0.05 (0.002)
Camshaft Bearing Inside Diameter mm (in)	40.00 – 40.037 (1.575 – 1.576)	
Camshaft Bearing Clearance mm (in)	0.025 – 0.087 (0.001 – 0.003)	0.15 (0.006)
Crankshaft		
Crankshaft End Play mm (in)	0.040 – 0.205 (0.0026 – 0.008)	0.54 (0.021)
Crankshaft Run-Out mm (in)	0.06 (0.002) or less	0.45 (0.016)
Crankshaft Journal Diameter	See section 6A crankshaft journal diameter in this manual.	
Crankshaft Journal and Bearing Clearance mm (in)		
No. 4 Bearing	0.093 – 0.124 (0.00366 – 0.00488)	0.14 (0.0055)
Other Bearings	0.063 – 0.094 (0.00248 – 0.00370)	0.14 (0.0055)
Crankshaft Journal and Crankpin Uneven Wear mm (in)		0.05 (0.0020)

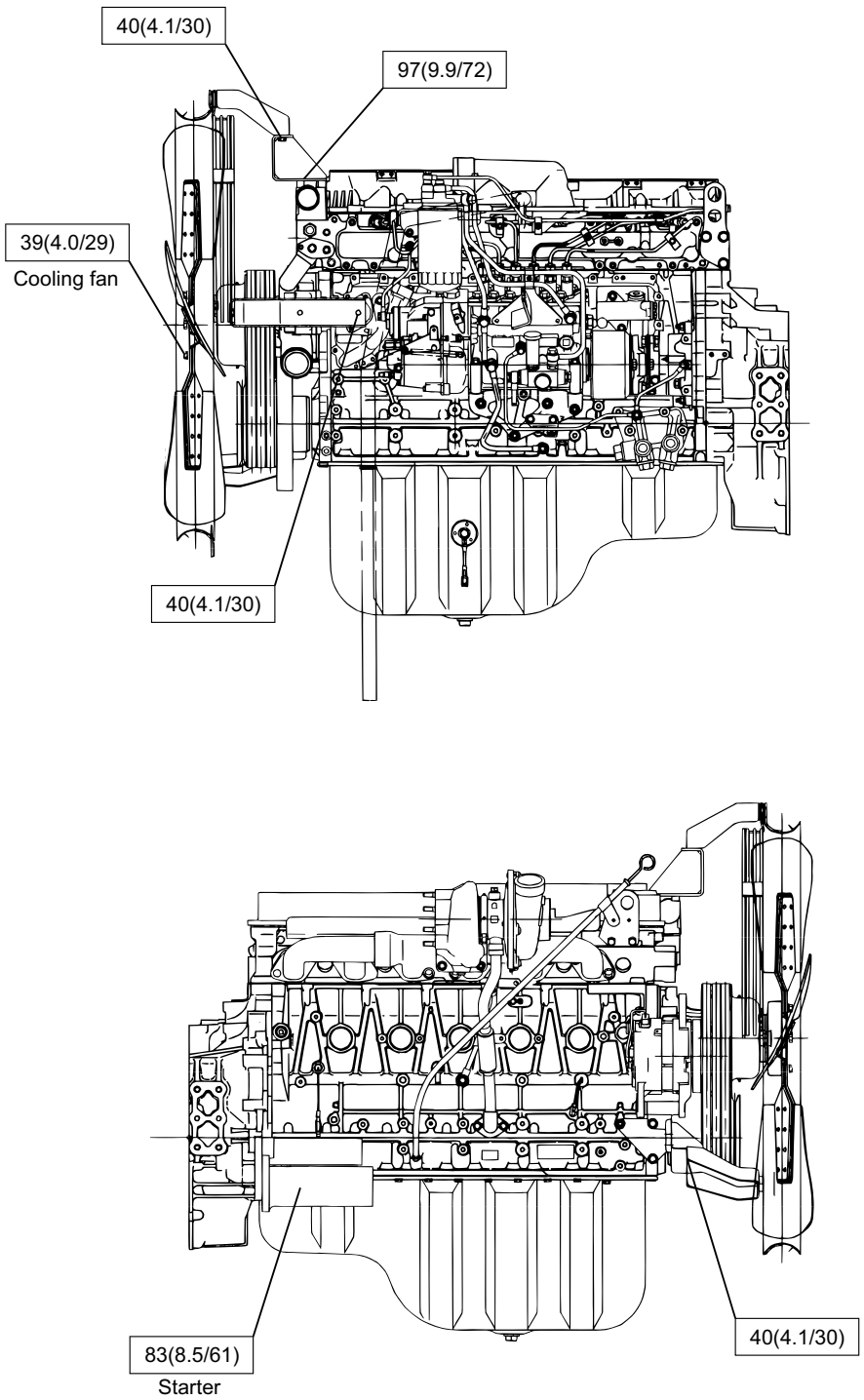
ITEMS	SERVICE STANDARD	SERVICE LIMIT
Piston and Piston Ring		
Piston Grade	Non	
Cylinder Liner and Piston Clearance mm (in)	0.122 – 0.156 (0.0048 – 0.0061)	—
Piston Ring and Piston Ring Groove Clearance mm (in)		
1st Compression Ring	0.057 – 0.097 (0.0022 – 0.0038)	0.20 (0.008)
2nd and 3rd Compression Ring	0.085 – 0.120 (0.0033 – 0.0047)	0.2 (0.008)
Oil Ring	0.02 – 0.06 (0.0008 – 0.0024)	0.15 (0.006)
Piston Ring Gap mm (in)		
1st Compression Ring	0.18 – 0.28 (0.0071 – 0.0110)	1.20 (0.047)
2nd and 3rd Compression Ring	0.35 – 0.50 (0.0138 – 0.0197)	1.20 (0.047)
Oil Ring	0.15 – 0.35 (0.0059 – 0.0138)	1.20 (0.047)
Piston Pin		
Piston Pin Diameter mm (in)	35.995 – 36.000 (1.4171 – 1.4173)	35.95 (1.4154)
Piston Pin Hole Diameter mm (in)	36.004 – 36.012 (1.4175 – 1.4178)	
Piston Pin and Piston Pin Hole Clearance mm (in)	0.004 – 0.017 (0.00016 – 0.00067)	
Connecting Rod		
Connecting Rod Alignment mm (in)	0.05 (0.002) or less	0.20 (0.008)
Connecting Rod Small End Bushing Diameter mm (in)	36.012 – 36.022 (1.4178 – 1.4182)	
Piston Pin and Connecting Rod Small End Bushing Clearance mm (in)	0.012 – 0.027 (0.00047 – 0.00106)	0.05 (0.002)
Crankpin and Bearing Clearance mm (in)	0.037 – 0.076 (0.0015 – 0.0030)	0.10 (0.004)
Connecting Rod Big End and Crankpin Side Face Clearance mm (in)	0.17 – 0.30 (0.0067 – 0.0118)	0.35 (0.014)
Flywheel		
Flywheel Friction Surface Roughness mm (in)	Less than 0.05 (0.0020)	

ITEMS		SERVICE STANDARD	SERVICE LIMIT
Idler Gear			
Idler Gear Shaft A Outside Diameter	mm (in)	49.950 – 49.975 (1.9665 – 1.9675)	49.90 (1.9646)
Idler Gear Shaft B and C Outside Diameter	mm (in)	29.959 – 29.980 (1.1795 – 1.1803)	29.9 (1.1772)
Idler Gear Shaft A and Idler Gear Clearance	mm (in)	0.025 – 0.075 (0.00098 – 0.00295)	
Idler Gear Shaft B and C and Idler Gear Clearance	mm (in)	0.020 – 0.062 (0.0008 – 0.0024)	0.20 (0.008)
Idler Gear Backlash	mm (in)	0.10 – 0.17 (0.0039 – 0.0067)	0.30 (0.012)
Idler Gear End Play			
Gear A and B	mm (in)	0.08 – 0.140 (0.00315 – 0.0052)	0.20 (0.008)
Gear C	mm (in)	0.07 – 0.135 (0.0027 – 0.0053)	0.20 (0.008)
Oil Pump			
Gear Teeth and Cover Inner Wall Clearance	mm (in)	0.125 – 0.221 (0.0049 – 0.0087)	0.221 (0.0087)
Gear and Body Clearance	mm (in)	0.064 – 0.109 (0.0025 – 0.0043)	0.109 (0.0043)
Gear Shaft Outside Diameter	mm (in)	15.989 – 16.000 (0.6295 – 0.6299)	15.9 (0.626)
Gear Shaft and Pump Body or Bushing Clearance	mm (in)	0.04 – 0.07 (0.0016 – 0.0028)	0.7 (0.0028)
Drive Gear and Drive Gear Shaft Interference	mm (in)	0.015 – 0.044 (0.0006 – 0.0017)	
Cylinder Block			
Cylinder Block Upper Face Warpage	mm (in)	0.05 (0.002) or less	0.20 (0.008)
Cylinder Liner Projection	mm (in)	0.06 – 0.10 (0.0024 – 0.0039)	—
Cylinder Block Bore and Cylinder Liner Outside Diameter Clearance	mm (in)	0.001 – 0.029 (0.00004 – 0.0011)	—
Cylinder Liner Grade (Reference)		See Section 6A (Cylinder liner grade selection & Clearance) in this manual.	

Torque Specifications

Auxiliary Parts

N·m (kgf·m/lb ft)



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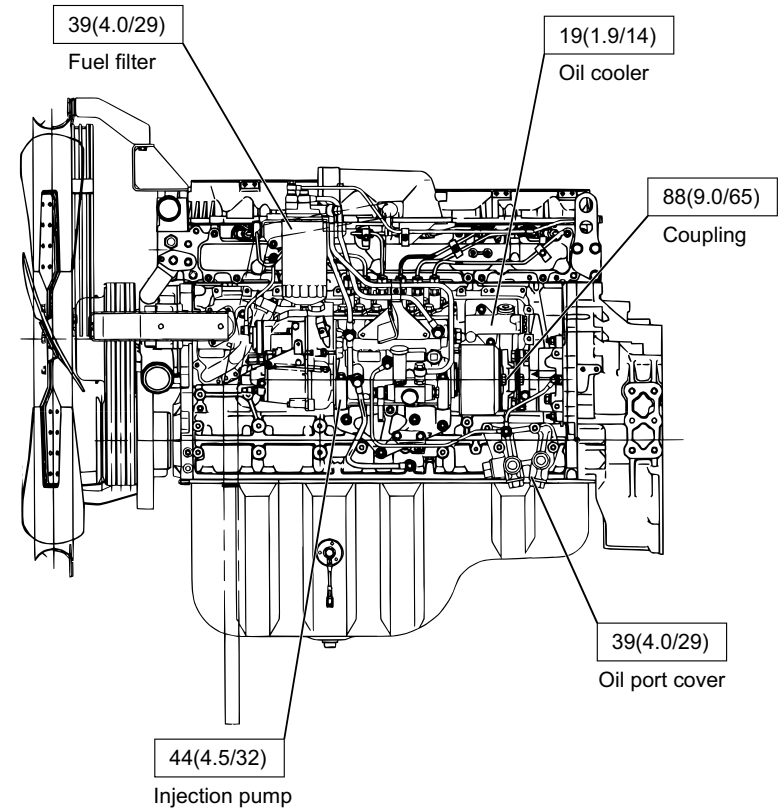
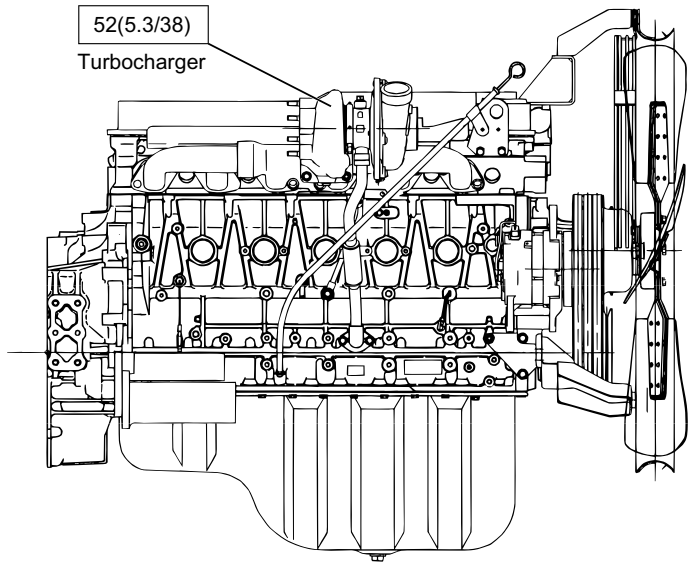
Engine External Parts

N·m (kgf·m/lb ft)





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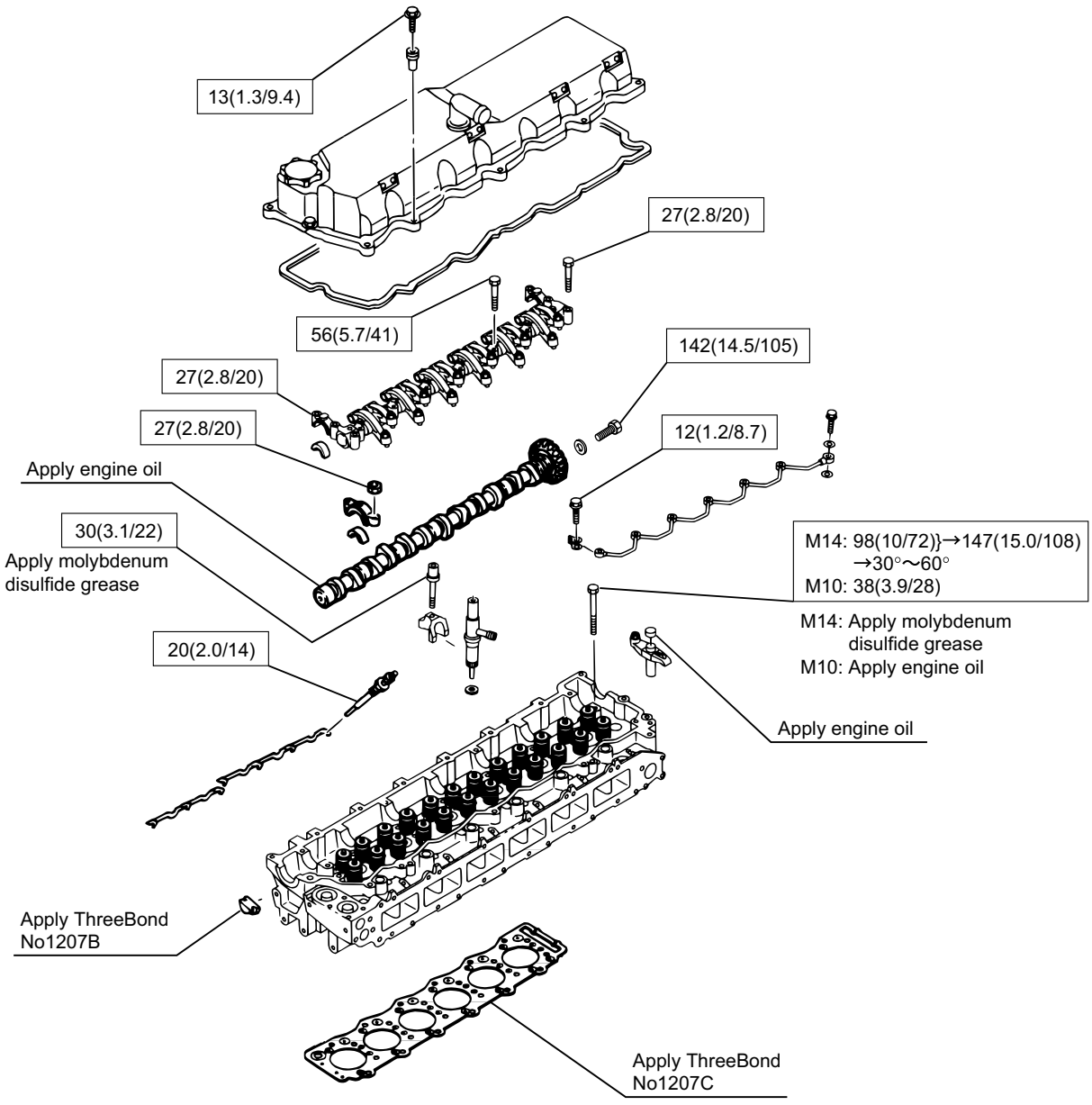
Cylinder Head

N·m (kgf·m/lb ft)



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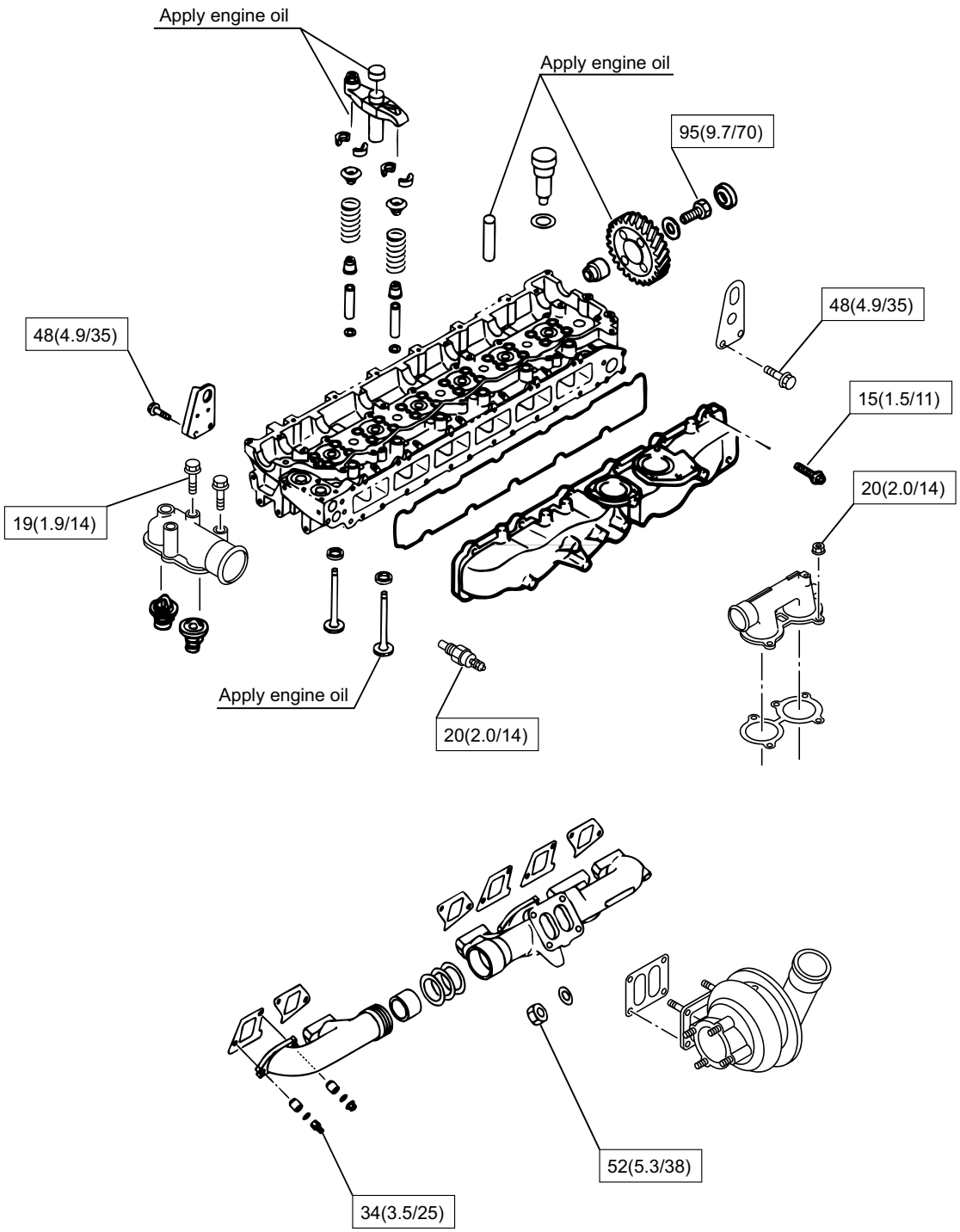
Cylinder Head

N·m (kgf·m/lb ft)



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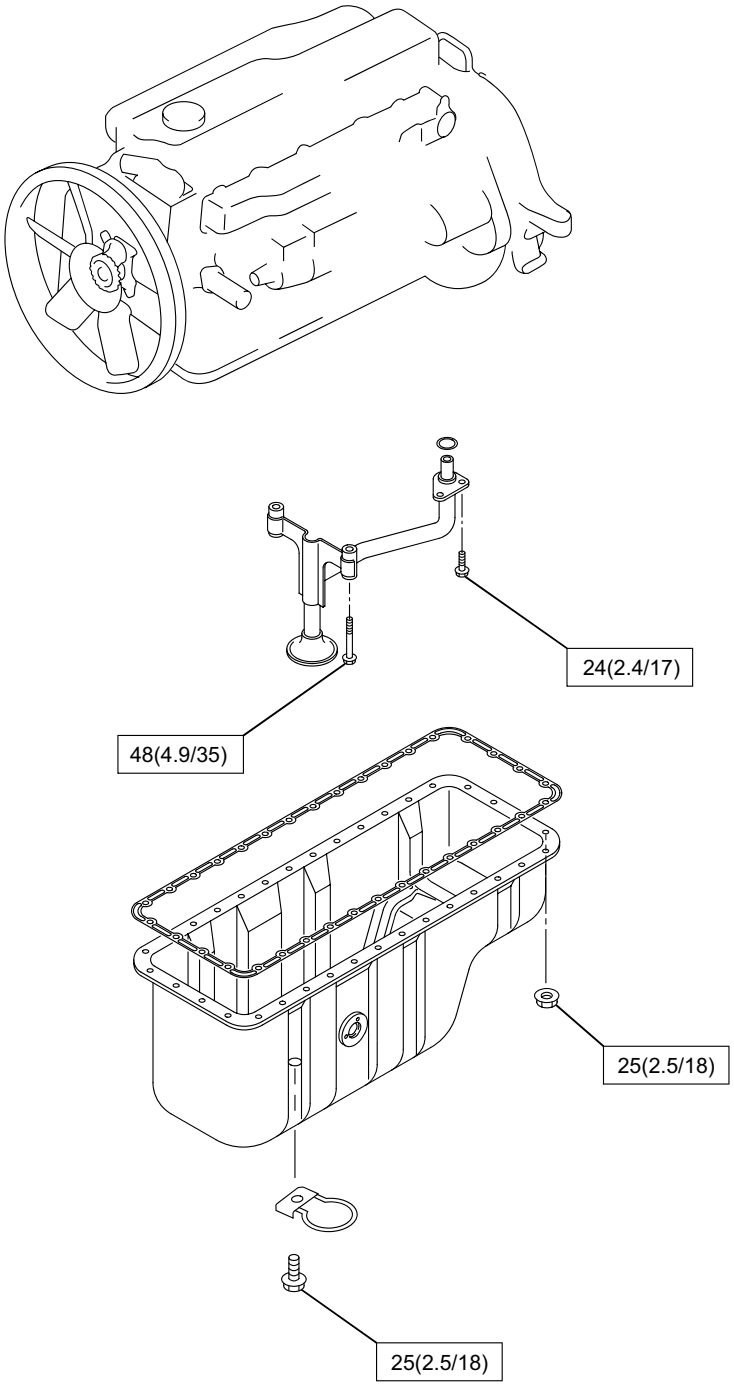
Oil Pan

N·m (kgf·m/lb ft)



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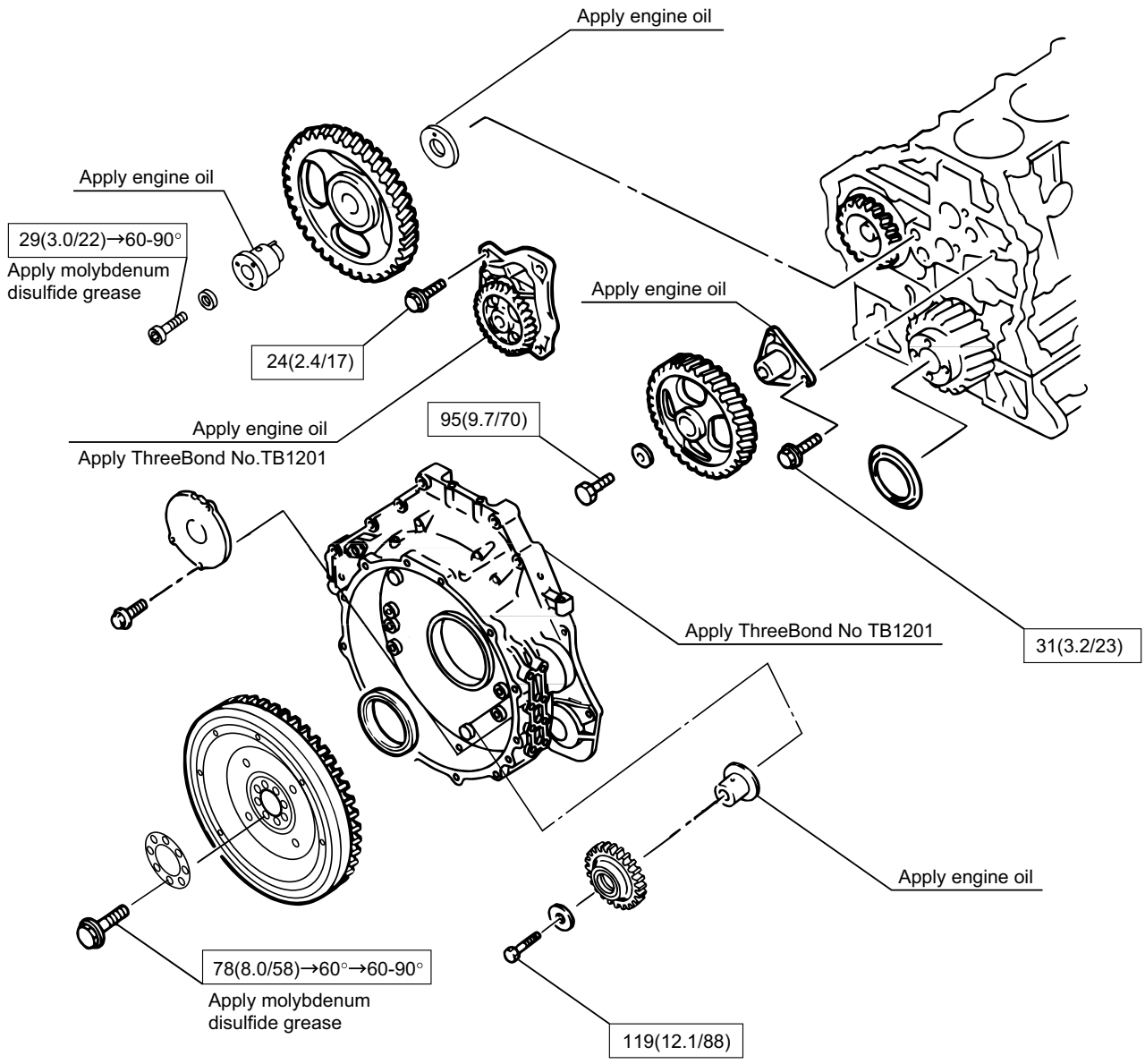
Timing Gears

N·m (kgf·m/lb ft)



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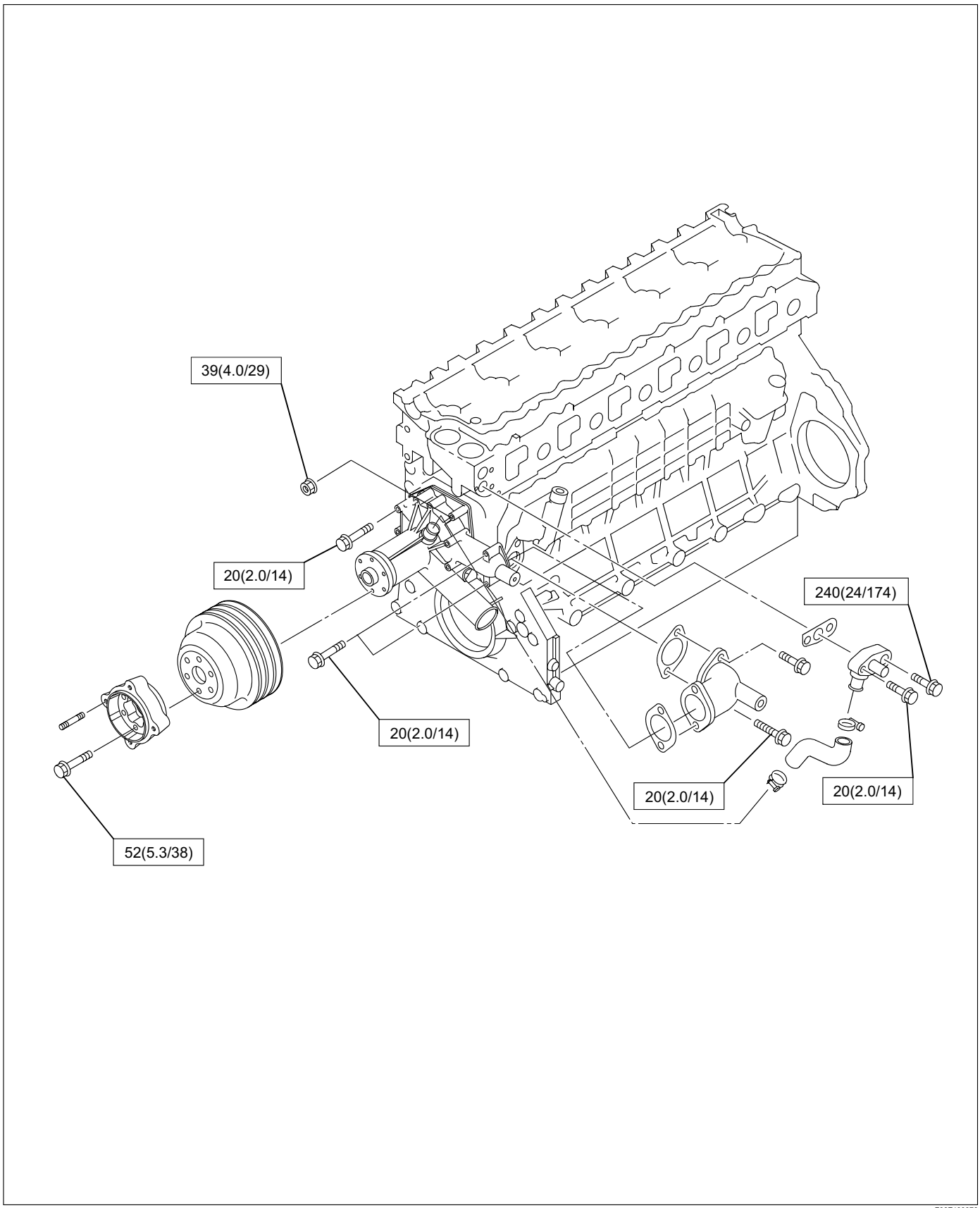
Water Pump

N·m (kgf·m/lb ft)



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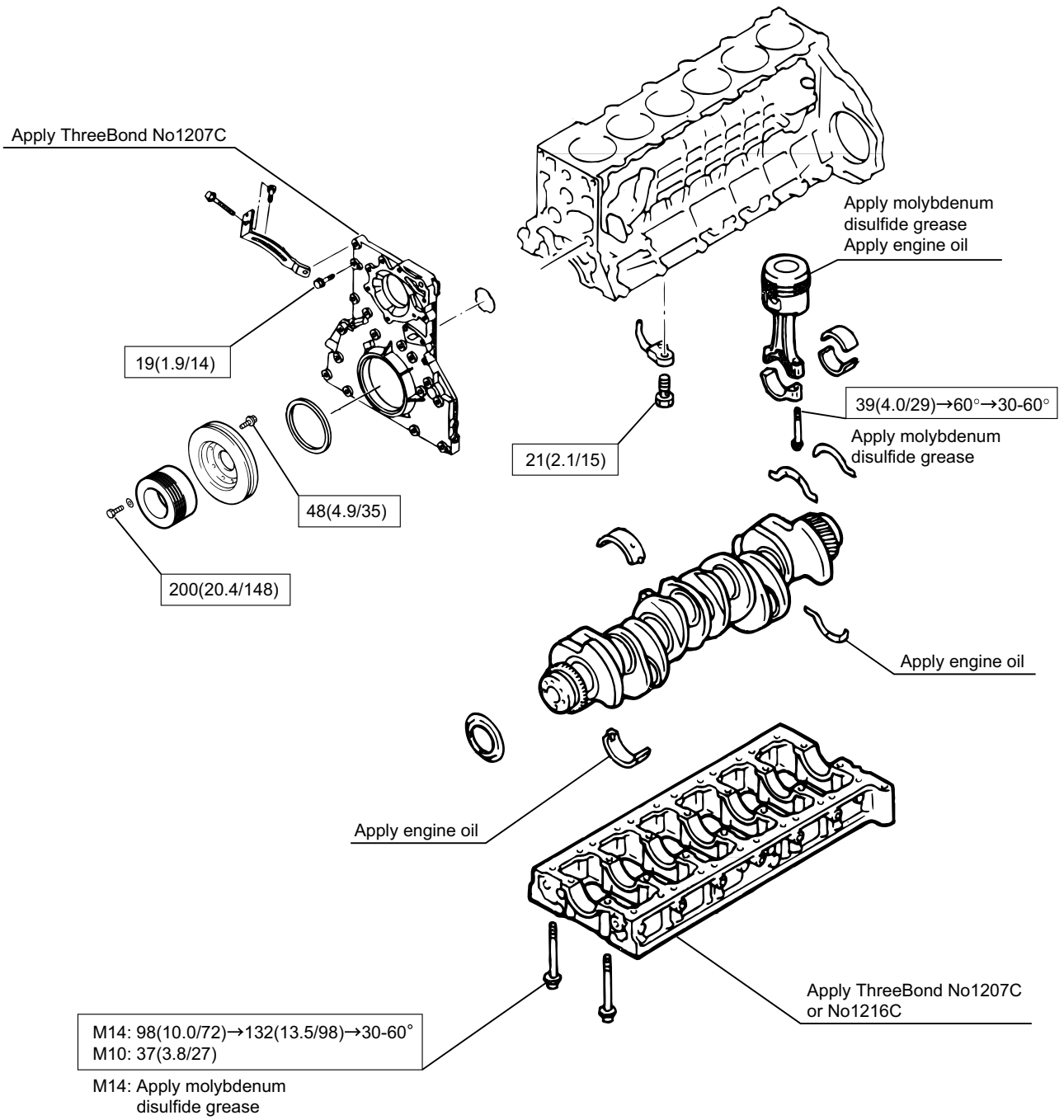
Piston, Connecting Rod and Crankshaft

N·m (kgf·m/lb ft)



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Special Tools

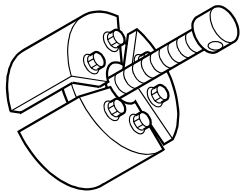
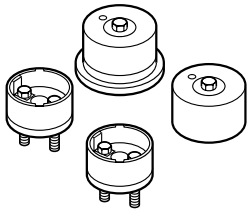
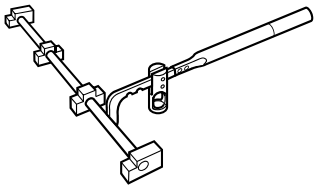
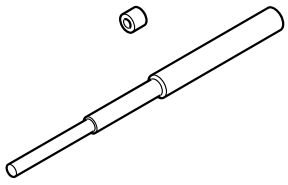
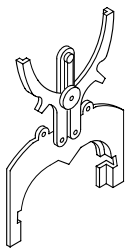
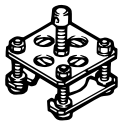
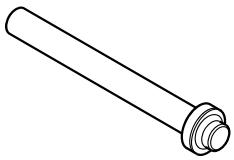
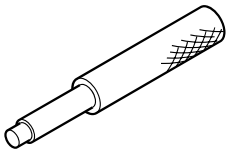
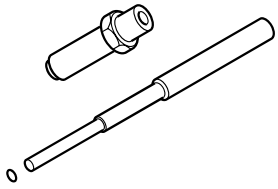
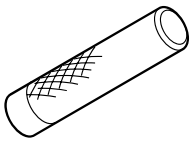
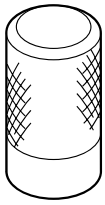
ILLUSTRATION	**TOOL NO.** TOOL NAME
	**8-94396-858-0** Replacer; Slinger
	**8-94396-856-0** Setting tool; Oil seal
 901MW002	**5-8840-2621-0** Remover; Valve spring
 011EY00037	**5-8840-2628-0** Remover/Installer; Valve guide
 901MX007	**1-85221-029-0** Setting tool; Piston ring
 901LX048	**8-94396-818-0** Remover; Crankshaft gear

ILLUSTRATION	**TOOL NO.** TOOL NAME
 901LX049	**8-94396-819-0** Installer; Crankshaft gear
 5884026270	**5-88402-627-0** Installer; oil seal cylinder head
	**5-8840-2623-0** Remover; Nozzle sleeve
	**5-8840-2624-0** Installer; Nozzle sleeve
	**5-8840-2626-0** Installer; Bridge guide
	**5-8840-2625-0** Installer; Valve guide oil seal

Troubleshooting

1. Hard starting

Condition	Possible Cause	Correction
Starter motor does not turn over	Loose battery cable terminals Poor battery connections due to rusting	Clean and/or retighten the battery cable terminals
	Battery discharged or weak	Recharge or replace the battery
	Fusible link shorted	Replace the fusible link
	Defective starter switch or starter relay	Replace the starter switch or starter relay
	Defective magnetic switch of starter motor or starter relay	Repair or replace the magnetic switch or starter relay
	Defective starter motor	Repair or replace the starter motor
Starter motor operates but engine does not turn over	Loose battery cable terminals Poor battery connections due to rusting	Clean and/or retighten the battery cable terminals
	Battery discharged or weak	Recharge or replace the battery
	Loose fan belt	Adjust the fan belt tension
	Defective starter motor pinion gear	Replace pinion gear
	Defective magnetic switch of the starter motor	Repair or replace the magnetic switch
	Worn starter motor Weak brush spring	Replace the brush and /or brush spring
	Piston,crank bearing seizure,or other damage	Repair or replace the related parts
Engine turns over but does not start	Air in the fuel system	Bleed air from the fuel system
	Defective engine stop mechanism	Replace the engine stop mechanism
	Control wire improperly adjusted	Adjust the control wire
	Fuel tank is empty	Fill the fuel tank
	Clogged or damaged fuel lines	Repair or replace the fuel lines
	Loose fuel line connections	Retighten the fuel line connections
	Clogged fuel filter element	Replace the fuel filter element or cartridge
	Fuel feed pump strainer is clogged	Clean the fuel pump strainer
	Defective feed pump	Repair or replace the feed pump
	Poor return of the engine stop button	Completely return the engine stop button
	Use of the wrong fuel	Use the recommended fuel
	Water particles in the fuel	Change fuel
	Air in the injection pump	Bleed air from the fuel system
	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
	Improper injection pump control rack operation	Repair or replace the injection pump control rack
	Injection pump plunger worn or stuck	Replace the injection pump plunger assembly
	Injection pump camshaft seizure or other damage	Replace the injection pump camshaft

2. Unstable Idling

Condition	Possible Cause	Correction
Trouble in the engine stop mechanism	Poor return of the engine stop button	Completely return the engine stop button
Trouble in the fuel system	Fuel system leakage or blockage	Repair or replace the fuel system
	Air in the fuel system	Bleed the air from the fuel system
	Water particles in the fuel	Replace fuel
	Clogged fuel filter element	Replace the fuel filter element or cartridge
	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Injection timing improperly adjusted	Adjust the injection timing
	Insufficient injection volume	Adjust the injection volume
	Broken plunger spring of the injection pump	Replace the plunger spring
	Worn plunger of the injection pump	Replace the plunger assembly
	Worn camshaft of the injection pump	Replace the camshaft
	Worn roller tappet of the injection pump	Replace the roller tappet
Trouble in the valve gear train	Valve clearance improperly adjusted	Adjust the valve clearance
	Worn camshaft	Replace the camshaft
Low compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and valve seat	Replace the related parts

3. Insufficient Power

Condition	Possible Cause	Correction
Trouble in the air intake system	Clogged air cleaner element	Clean or replace the air cleaner element
Trouble in the fuel system	Water particles in fuel system	Replace fuel
	Clogged fuel filter element	Replace the fuel filter element or cartridge
	Clogged strainer or defective fuel feed pump	Repair or replace the feed pump
	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle starting pressure too low	Adjust or replace the injection nozzle
	Improper spray condition	Adjust or replace the injection nozzle
	Fuel injection pipes damaged or obstructed	Replace the injection pipes
	Defective delivery valve	Replace the delivery valve
	Injection timing improperly adjusted	Adjust the injection timing Repair or replace the timing advancer
	Worn plunger of the injection pump	Replace the plunger assembly
	Worn camshaft of the injection pump	Replace the camshaft
Trouble in the turbocharger system	Exhaust gas leakage from the exhaust system	Repair or replace the related parts
	Air leakage from the intake system	Repair or replace the related parts
	Defective turbocharger assembly	Replace the turbocharger assembly
Low compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking or broken Improper seating between the valve and valve seat	Replace the related parts
Trouble in the valve gear train	Valve clearance improperly adjusted	Adjust the valve clearance
	Worn camshaft lobe	Replace the camshaft
	Valve spring weak or broken	Replace the valve spring
Trouble in the intercooler	Clogged intercooler	Clean the intercooler