PART NO. KM-4HK1-E-02 (2/2)

HITACHI

Engine Manual (2/2)

4HK1
6HK1

This manual consists of the following sections.
Disassemble and Assemble Engine

4HK1 6HK1 ENGINE MANUAL (2/2)

Hitachi Construction Machinery Co., Ltd.

URL:http://www.hitachi-c-m.com

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Introduction

This Manual describes the structure and the troubleshooting of electronic control fuel injection system (common rail type) in 4HK1 and 6HK1 industrial engines.
Use this manual sufficiently to perform service work properly and quickly.

Hitachi Construction Machinery Co., Ltd

General Contents

GENERAL INFORMATION

General Information

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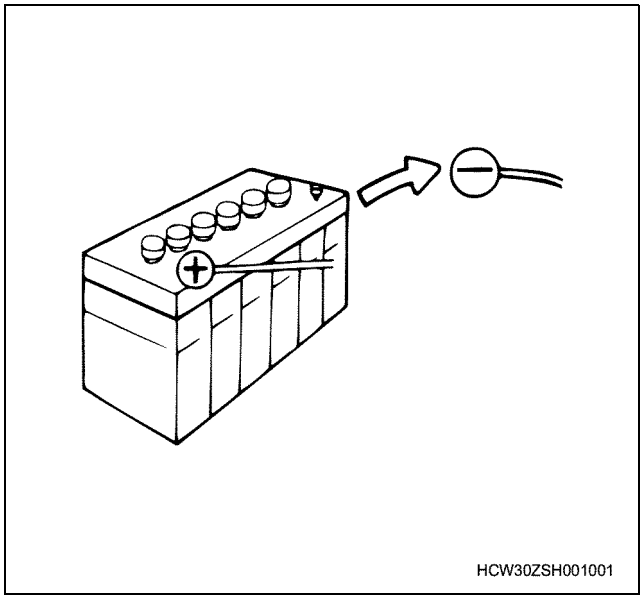
General Information

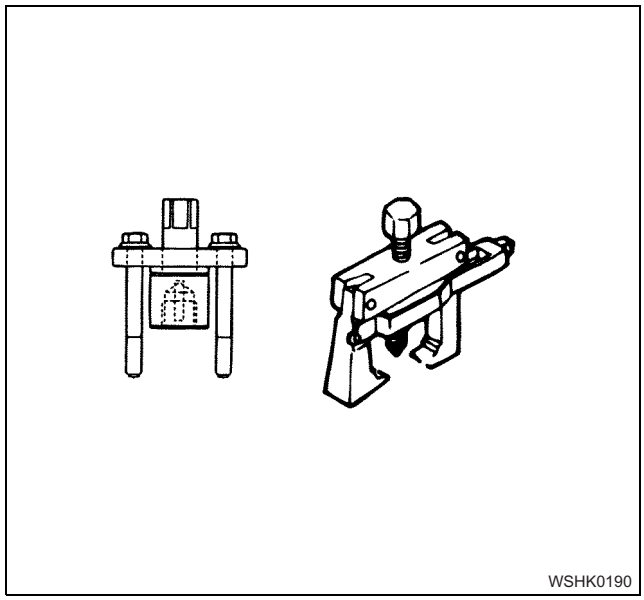
Service Precautions

In order to carry out work safely

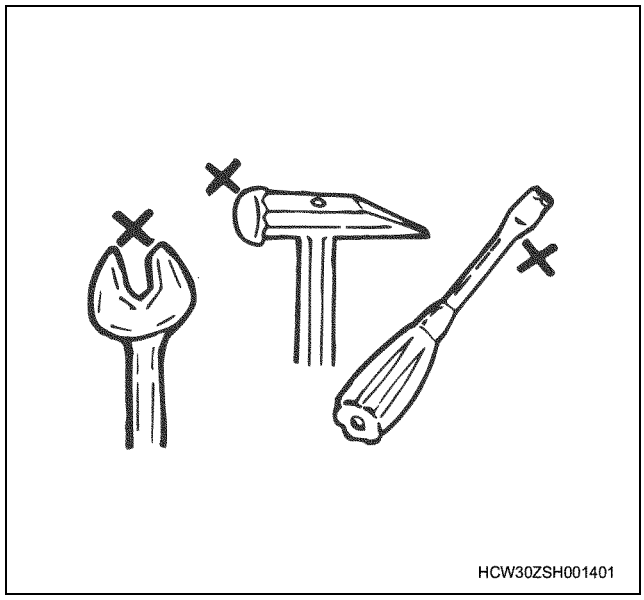
1. Always use an engine stand when taking the engine down from the vehicle.
   Do not place the engine directly onto the ground, or place in a manner that interferes with the oil pan.
2. If you are working together with others, always pay attention to each other's safety.
3. If you are repairing any part of the electrical system, always remove the minus side cable from the battery terminal before starting work. If you are removing the battery cover, always remove the cover in a place that is away from sources of fire/ heat.



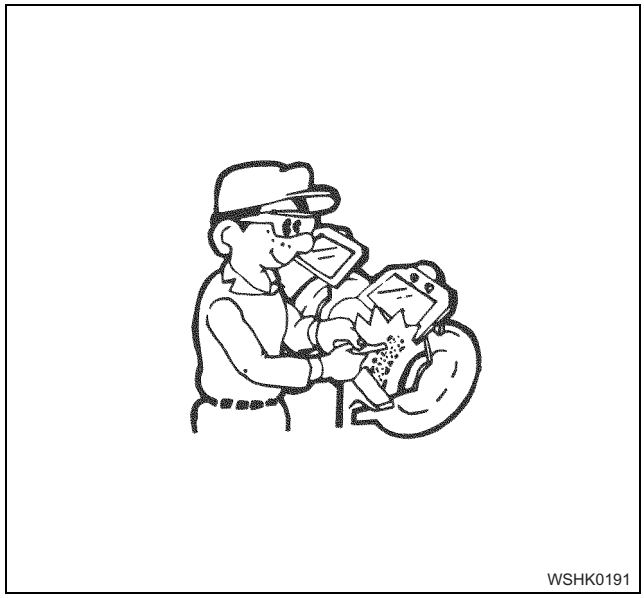
4. Do not perform painting work or leave the engine running for long periods of time in an enclosed or badly ventilated indoor workshop.
5. Always use the correct specialized tool indicated in the instructions. Using the incorrect tool may cause damage to the parts or injury to the person using the tool.



6. All regular tools, gauges and special tools should be regularly inspected, and prepared before starting work. Do not use bent spanners, hammers with damaged edges, chipped chisels, or any other faulty or damaged tools.



7. Always pay close attention to safety and handling requirements when using grinders, cranes, welders, and other such equipment.
   Moreover, always wear the correct protective garments and use the necessary safety tools for the job in hand.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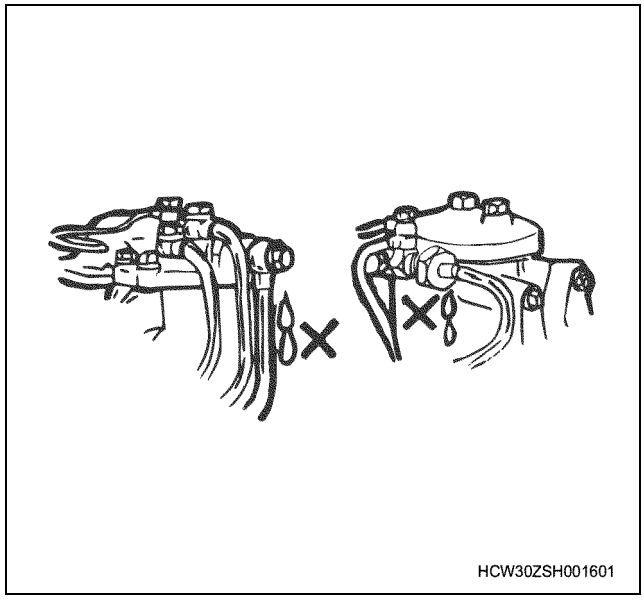
8. Always check that there are no fuel leaks when performing maintenance work on the fuel system. (It may cause a fire.)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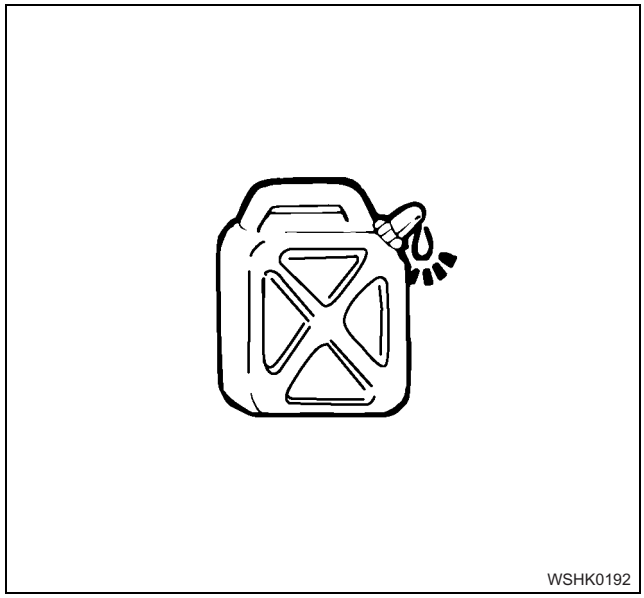
9. Pay close attention to the risk of ignition if you are handling parts that carry a high voltage.
   Furthermore, any oil or grease spilt onto rubber parts must be wiped off immediately, as it will cause deterioration of the rubber.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Replacement parts and part numbers.

1. Always replace packing, oil seals, o-rings, caulking lock nuts, folding lock plates, split pins and other such parts with brand new parts.
2. The parts numbers contained in this manual may not represent the supply condition of the parts, and the part numbers may be changed due to revisions. Therefore, parts should always be checked against a parts catalogue before use.

Liquid gasket

1. Each time you disassemble parts that use liquid gasket, completely remove the old gasket residue from each of the parts and matching sections using a scraper, then clean each of the parts to completely remove oil, water, and dirt etc. from the various surfaces. Using the specified type of liquid gasket, apply new liquid gasket to each of the surfaces before reassembling the parts.
2. In order to make it easier to clean liquid gasket surfaces, apply gasket remover liquid (Pando-391D made by Three Bond Co., Ltd.) and leave the part to stand for approximately 10 minutes, after which the old liquid gasket residue will be easier to remove.
   However, this should not be used on resin components or painted components.
3. Please take care not to apply too much or too little liquid gasket.
   Also, you should always re-apply the liquid gasket upon itself when you start and finish application.
4. Make sure that there are no gaps when re-installing the liquid gasket parts to each other. If there are gaps between the two parts, re-apply the liquid gasket. Some parts, especially the oil pan, use the same size studs as a guide to eliminate the need for knock pin positioning etc.
5. Re-install these parts within 7 minutes of applying the liquid gasket.

If more than 7 minutes passes, remove the previous liquid gasket and re-apply it.

6. Please wait for at least 30 minutes since the last part is installed before starting the engine.

Liquid gasket

Seal section	Product name	Manufacturer's name
Between cylinder block and – Flywheel housing	1207B	Three Bond
Between cylinder block and – Flywheel housing and – Crankcase	1207B	Three Bond
Between cylinder block and – Crank case	1207B	Three Bond
Between cylinder block and – Front cover	1207B	Three Bond
Cylinder block, head plug nipple, unit, switches	262	Loctite

- Always use the liquid gasket products listed above, or a liquid gasket identical to the ones listed above.
- Use the correct quantity of liquid gasket. Always follow the handling instructions for each product.

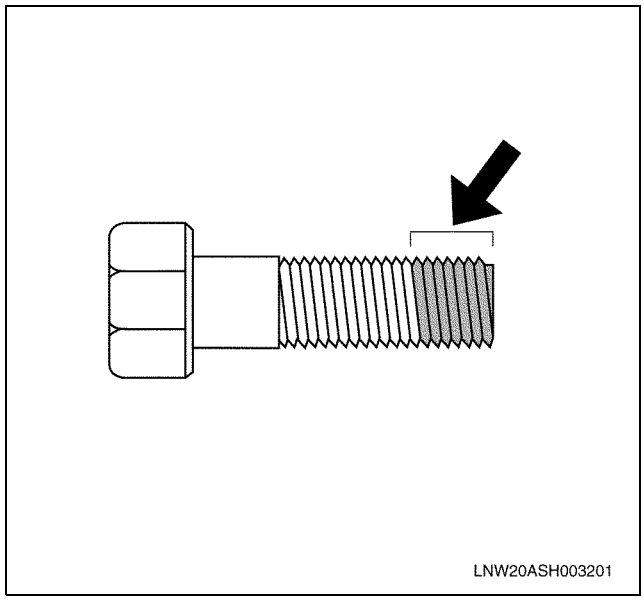
Application procedure

1. Wipe the contact surfaces clean of all water, grease or oil. The contact surfaces should be dry.
2. Apply a regular bead width of liquid gasket to one of the contact surfaces. Make sure that the bead does not break at this point.

Notes:
If there are special regulations concerning the application procedure in the repair document, please follow those regulations.

Work procedure

1. Wipe the joint surfaces of the bolt, bolt hole, and screw thread section clean of water, grease, and oil. The contact surfaces should be dry.
2. Apply Loctite to the top 1/3 of the screw.
3. Tighten the bolt to the correct tightening torque.



Important:
After tightening the bolt, do not apply excessive torque or try to rotate the bolt until at least one hour has passed, and the Loctite has hardened.

Procedure for using the Plastigauge

Type	Measurable range mm (in)
PG-1 (Green)	0.025 – 0.076 (0.001 – 0.003)
PR-1 (Red)	0.051 – 0.152 (0.002 – 0.006)
PB-1 (Blue)	0.102 – 0.229 (0.004 – 0.009)

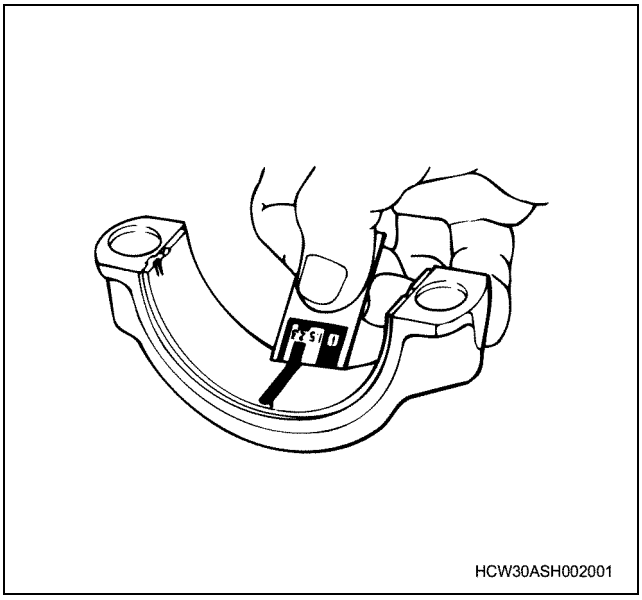
Example: Procedure for measuring the clearance between the connecting rod bearing and crank pin.

- Clean the connecting rod and bearing, and install the bearing to the rod.
- Cut the plastigauge to the same width as the crank pin, and while avoiding the oil pore of the crank pin lay the gauge parallel to the pin.

- Line up the marks on the connecting rod and cap and install the crank pin, apply molybdenum disulfide to the thread section and bearing surface of the fastening bolt, and rotate both cap and bolt to the correct torque.

Important:
Do not move the connecting rod while using the plastigauge.

- Gently remove the cap and connecting rod, and measure the crushed width of the plastigauge (clearance between rod and pin) using the scale printed on the bag.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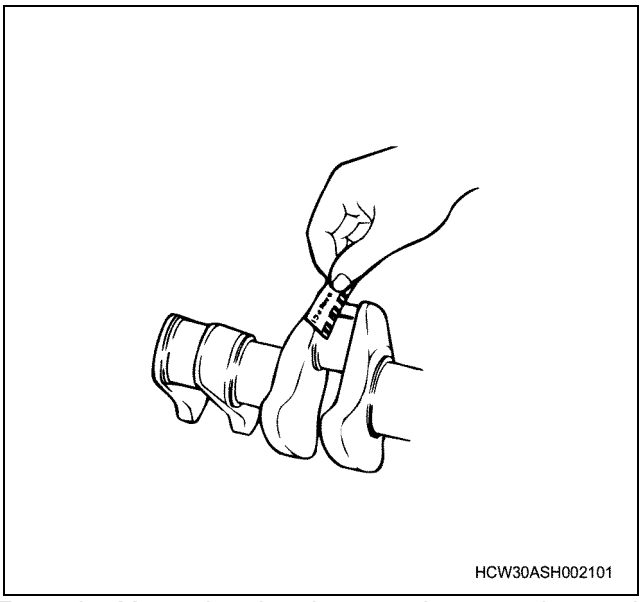
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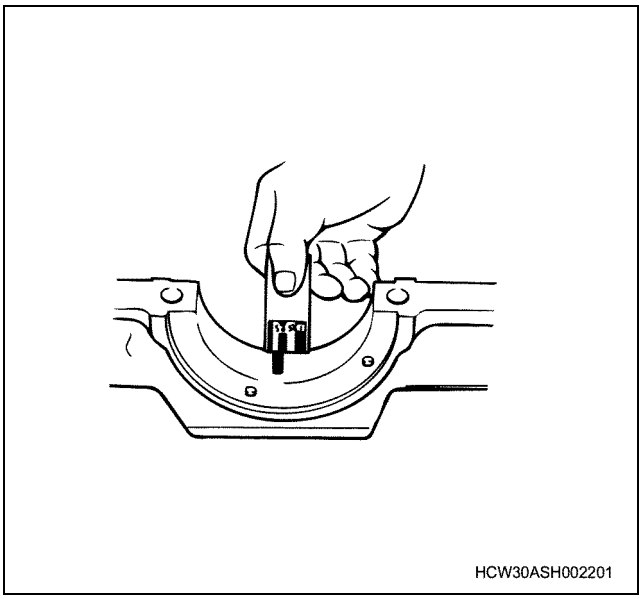
Example: Measuring the clearance between the crank bearing and crank journal

- Clean the clamp face of the cylinder block and crankcase bearing, and also the bearing, and install the cylinder block to the crankcase.
- Gently rest the crankshaft on the cylinder block, and rotate it approximately 30 degree to stabilize it.
- Cut the plastigauge to the same size as the journal width, and while avoiding the oil pore of the journal lay the gauge parallel to the journal.
- Gently rest the crank case on the cylinder block, apply molybdenum disulfide to the thread section and bearing surface of the fastening bolt, and tighten in sequence to the correct torque.

Important:
Do not rotate the crankshaft while using the plastigauge.

- Gently remove the crankcase, and measure the crushed width of the plastigauge (clearance between bearing and journal) using the scale printed on the bag.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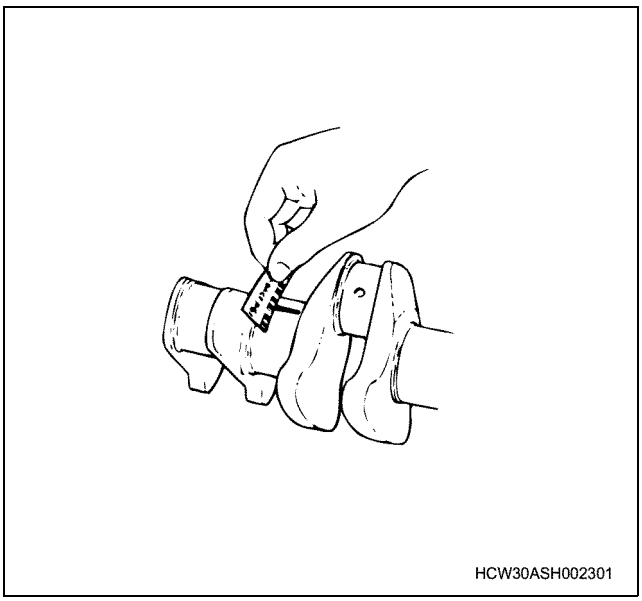
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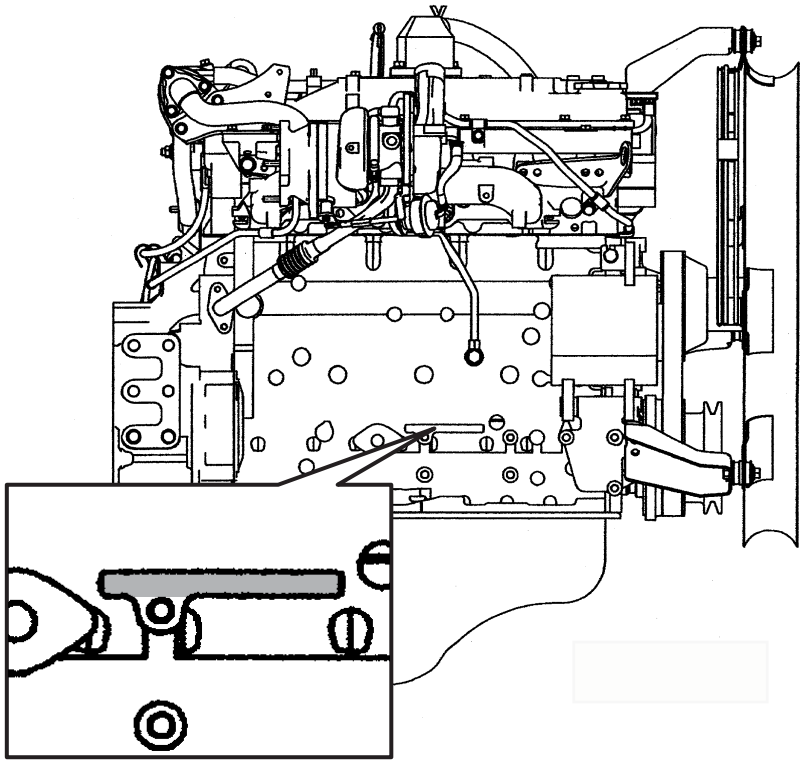
Reading the model

Engine number stamping position

4HK1



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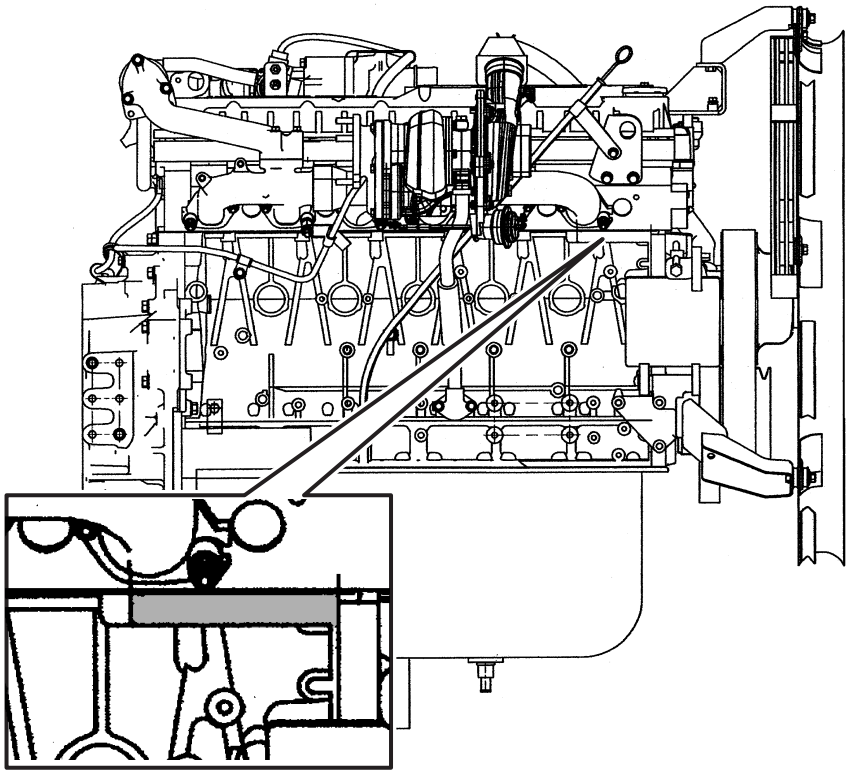
6HK1



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General information

Terminology, description of abbreviations

Terminology definitions

Term	Explanation
Maintenance standard	The generic name for reference values required for maintenance, such as nominal dimension, selection of a reference point, and limit.
Nominal dimension	Shows the standard value at the point of manufacture that does not include the common difference.
Selection of a reference point	Shows the standard value after assembling, repairing, or adjusting.
Limit	When this value (dimensions) is reached, it shows that the part has reached its full limit and must be replaced or repaired.
Front · rear, left · right, upper · lower	These show each orientations of parts installed to the vehicle when looking from the vehicle's forward direction.
Unit	Units written to SI conventions (mainly torque, pressure, force) [Example] Length: mm, Torque: N·m {kgf·m}
Warning	Items that carry the warning mark pose a danger to life or threat of serious injury if not strictly observed.
Caution	Items that carry the caution mark may cause injury or lead to accidents if not strictly observed.
Important	Items that carry the important mark may cause the vehicle to break down, or may prevent the guaranteed normal operation of the system or related parts if not strictly observed.

Term	Explanation
Notes	Items that should receive special mention within a work procedure.

Description of abbreviations

Abbreviation	Description
AC	Alternating Current Alternating Current
ACC	Accessory Accessory
ACG	Alternating Current Generator Alternating current generator
API	American Petrol Institute American Petroleum Institute
ASM (Assy)	Assembly Assembly
ATDC	After Top Dead Center After Top Dead Center
BAT, BATT	Battery Battery
BRG, Brg	Bearing Bearing
BKT, BRKT	Bracket Bracket
BTDC	Before Top Dead Center Before Top Dead Center
CO	Carbon Oxide Carbon Monoxide
CONN	Connector Connector
CPU	Central Processing Unit Central processing unit
C/U	Control Unit Control unit
DC	Direct Current Direct current
DI	Direct Injection Direct injection
ECU	Engine Control Unit / Electronic Control Unit Engine control unit / control unit
ECM	Engine Control Module Engine control module
EGR	Exhaust Gas Recirculation Exhaust gas recirculation
Exh, EXH	Exhaust Exhaust
Ft, FRT	Front Front

Abbreviation	Description
FWD	Forward Forward
F/C	Fuel Cut Fuel Cut
GND	Ground Earth
IC	Integrated Circuit Integrated circuit
ID Plate	Identification plate Identification plate, ID plate
IN	Intake, Intake Intake
ISO	International Organization for Standardization International Organization for Standardization
I/PUMP	Injection Pump Injection Pump
JIS	Japanese Industrial Standard Japanese Industrial Standard
L/H, LH	Left Hand Left hand side
M/V	Magnetic Valve Magnetic valve
NOx	Nitrogen Oxide Nitrogen Oxide
N-TDC	Number - Top Dead Center Top dead center rotational frequency
OPT	Option Option
P	Pole(S) Pole
PCV	Pump Control Valve/ Positive Crankcase Ventilation Pump control valve/ Positive crankcase ventilation
PM	Particulate Matter Particulate matter
PS	Pre-Stroke Pre-stroke
PTO	Power Take Off Power take off
QOS	Quick On System Rapid preheating system
Rr, RR	Rear Rear

Abbreviation	Description
R/H, RH	Right Hand Right hand side
R/L	Relay Relay
STD	Standard Standard
SW	Switch Switch
TICS	Timing & Injection rate Control System A type of injection system
VGS Turbo	Variable Geometry turbocharger System Adjustable turbo, VGS turbo
W/L	Warning Lamp Warning lamp

SI (International System of Units)

With regards the conversion to SI (International System of Units)

The introduction of the SI systems aims to internationally unify the metric system and the various units used by different countries (traditional weights and measures, the foot pound method etc.), and to curb the confusion that occurs between the different units (conversion calculations etc.).
The new calculating method which adopted SI units was completely adopted in Japan in 1992, and is standardized by JIS-Z-8203.
All of the units in this manual are written in line with the International System of Units SI units, and conventional units are written in { } brackets.

SI
French) Abbreviated name of Le Systeme International d'Unites

Connection between main SI units and conventional units

	SI	Conventional Unit	Item, unit conversion
Length	m	m	Same as the conventional unit
Weight (Mass)	kg	kg	Same as the conventional unit
Force	N	* kg, kgf	1 kgf = 9.80665 N
Torque	N·m	* kg·m, gf·m	1 kgf·m = 9.80665 N·m
Pressure	Pa	*kg/cm^2, mmHg	1 kgf/cm^2 = 9.80665 kPa, 1 mmHg = 133.3 Pa
Dynamic force, horsepower	W	PS	1 PS = 0.74 kW
Capacity, air volume displacement	m^3	Litle, L, cc	1 Litle = 1 dm^3, 1 cc = 1mLitle = 1cm^3
Fuel consumption	g/(kW·h)	g/(PS·h)	1 g/(PS·h) = 1.360 g/(kW·h)

*1 Published service data may conveniently use kg for force and mass (weight) instead of kgf.
*2 Some conversion results may be rounded off to 1 or 2 decimal places.

Converting expressions of quantity

When converting, prefixes such as k (kilo) or m (mili) are used.

M	Mega	10^6	1,000,000
k	Kilo	10^3	1,000
h	Hecto	10^2	100
d	Deci	10^{-1}	0.1
c	Centi	10^{-2}	0.01
m	Milli	10^{-3}	0.001
μ	Micro	10^{-6}	0.000001

- 200 kgf/cm^2 = 19,620 kPa = 19.6 MPa
- 40 mmHg = 5,332 Pa = 5.3 kPa

Conversion formula

Length

- km × 0.6214 = mile
- m × 3.281 = ft
- mm × 0.03937 = in

Pressure

- kPa × 0.0101972 = kg/cm^2
- kPa × 0.145038 = psi
- MPa × 10.197162 = kg/cm^2
- MPa × 145.03774 = psi

Tightening torque

- N·m × 0.101972 = kg·m
- N·m × 0.737562 = lb ft

Speed

- kg/h × 0.6214 = MPH

Temperature

- °C × 1.8 + 32 = °F

Table of tightening torque

The tightening torque values in the table below apply to all situations unless a special tightening torque is specified.

bolts, nuts

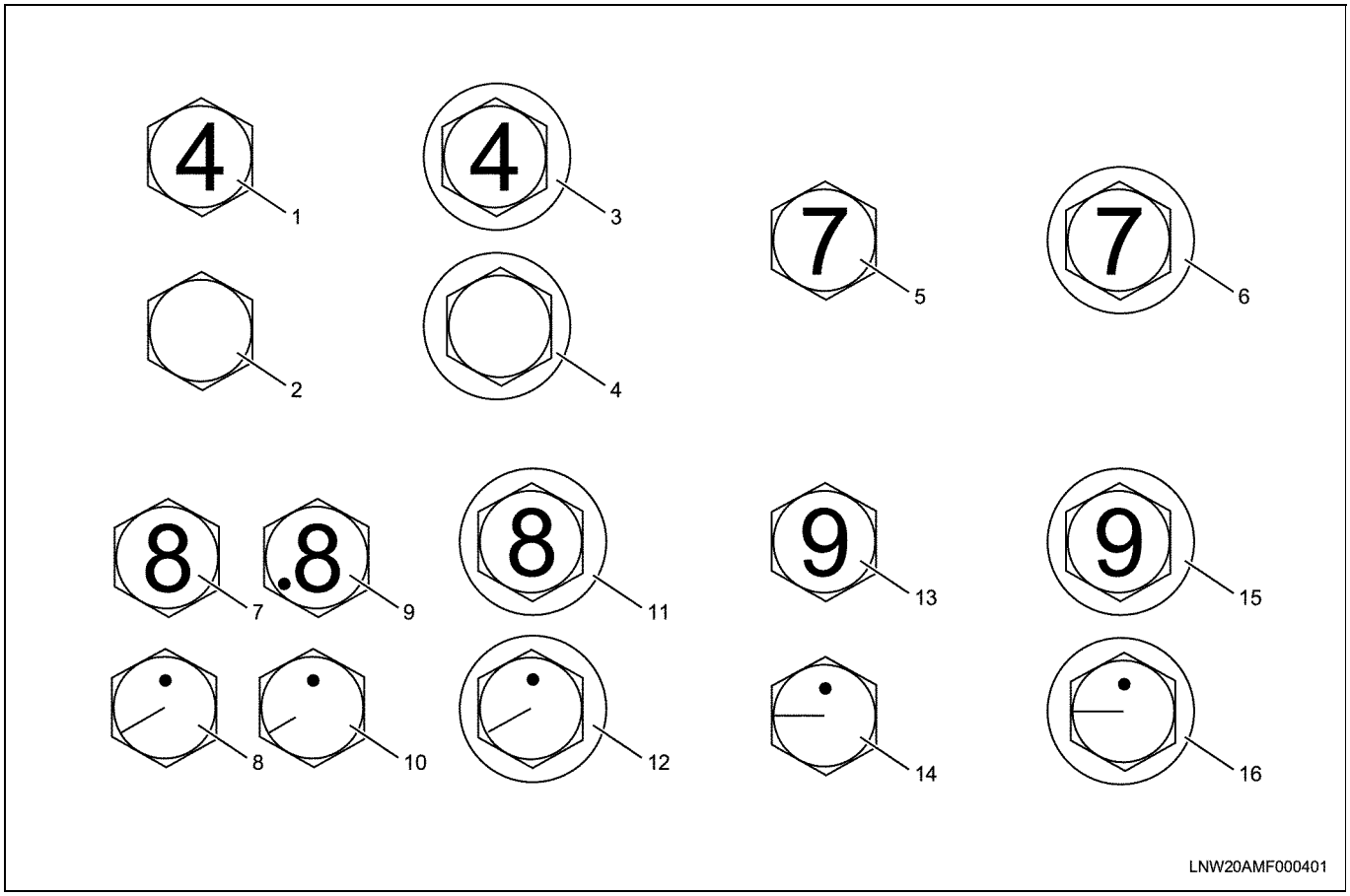
					N·m {kgf·m}
Strength classification	4.8 4T		7T		
Bolt head section shape	Hexagon head bolt	Flange bolt	Hexagon head bolt	Flange bolt	
* M10 × 1.5	19.6 ~ 33.3 {2.0 ~ 3.4}	22.3 ~ 37.2 {2.3 ~ 3.8}	27.5 ~ 45.1 {2.8 ~ 4.6}	30.3 ~ 50.4 {3.1 ~ 5.1}	
M12 × 1.25	49.0 ~ 73.5 {5.0 ~ 7.5}	54.9 ~ 82.3 {5.6 ~ 8.4}	60.8 ~ 91.2 {6.2 ~ 9.3}	68.1 ~ 102.1 {6.9 ~ 10.4}	
* M12 × 1.75	45.1 ~ 68.6 {4.6 ~ 7.0}	51.0 ~ 76.5 {5.2 ~ 7.8}	56.9 ~ 84.3 {5.8 ~ 8.6}	62.7 ~ 94.0 {6.4 ~ 9.6}	
M14 × 1.5	76.5 ~ 114.7 {7.8 ~ 11.7}	83.0 ~ 124.5 {8.5 ~ 12.7}	93.2 ~ 139.3 {9.5 ~ 14.2}	100.8 ~ 151.1 {10.3 ~ 15.4}	
* M14 × 2	71.6 ~ 106.9 {7.3 ~ 10.9}	77.2 ~ 115.8 {7.9 ~ 11.8}	88.3 ~ 131.4 {9.0 ~ 13.4}	94.9 ~ 142.3 {9.7 ~ 14.5}	
M16 × 1.5	104.0 ~ 157.0 {10.6 ~ 16.0}	115.6 ~ 173.3 {11.8 ~ 17.7}	135.3 ~ 204.0 {13.8 ~ 20.8}	150.1 ~ 225.2 {15.3 ~ 23.0}	
* M16 × 2	100.0 ~ 149.1 {10.2 ~ 15.2}	109.4 ~ 164.2 {11.2 ~ 16.7}	129.4 ~ 194.2 {13.2 ~ 19.8}	142.5 ~ 213.8 {14.5 ~ 21.8}	
M18 × 1.5	151.0 ~ 225.6 {15.4 ~ 23.0}	—	195.2 ~ 293.2 {19.9 ~ 29.9}	—	
* M18 × 2.5	151.0 ~ 225.6 {15.4 ~ 23.0}	—	196.1 ~ 294.2 {20.0 ~ 30.0}	—	
M20 × 1.5	206.0 – 310.0 {21.0 ~ 31.6}	—	269.7 ~ 405.0 {27.5 ~ 41.3}	—	
* M20 × 2.5	190.2 ~ 286.4 {19.4 – 29.2}	—	249.1 ~ 374.6 {25.4 ~ 38.2}	—	
M22 × 1.5	251.1 – 413.8 {25.6 ~ 42.2}	—	362.8 ~ 544.3 {37.0 ~ 55.5}	—	
* M22 × 2.5	217.7 ~ 327.5 {22.2 ~ 33.4}	—	338.3 ~ 507.0 {34.5 ~ 51.7}	—	
M24 × 2	358.9 ~ 539.4 {36.6 ~ 55.0}	—	430.5 ~ 711.0 {43.9 ~ 72.5}	—	
* M24 × 3	338.3 ~ 507.0 {34.5 ~ 51.7}	—	406.0 ~ 608.0 {41.4 ~ 62.0}	—	

The * mark indicates where soft materials have been used for internal thread sections, such as castings.

N·m {kgf·m}				
Strength classification	8.8		9.8 9T	
Bolt head section shape	Hexagon head bolt	Flange bolt	Hexagon head bolt	Flange bolt
M6 × 1	5.6 ~ 11.2 {0.6 ~ 1.1}	6.6 ~ 12.2 {0.6 ~ 1.2}	—	—
M8 × 1.25	13.4 ~ 25.7 {1.4 ~ 2.6}	15.3 ~ 28.4 {1.6 ~ 2.9}	16.7 ~ 30.4 {1.7 ~ 3.1}	18.1 ~ 33.6 {1.9 ~ 3.4}
M10 × 1.25	31.3 ~ 52.5 {3.2 ~ 5.4}	35.4 ~ 58.9 {3.6 ~ 6.1}	37.3 ~ 62.8 {3.8 ~ 6.4}	42.3 ~ 70.5 {4.3 ~ 7.2}
* M10 × 1.5	31.3 ~ 51.4 {3.2 ~ 5.2}	34.5 ~ 57.5 {3.5 ~ 5.8}	36.3 ~ 59.8 {3.7 ~ 6.1}	40.1 ~ 66.9 {4.1 ~ 6.8}
M12 × 1.25	69.3 ~ 104.0 {7.1 ~ 10.6}	77.7 ~ 116.5 {7.9 ~ 11.9}	75.5 ~ 113.8 {7.7 ~ 11.6}	85.0 ~ 127.5 {8.7 ~ 13.0}
* M12 × 1.75	64.8 ~ 96.1 {6.6 ~ 9.8}	71.4 ~ 107.2 {7.3 ~ 10.9}	71.6 ~ 106.9 {7.3 ~ 10.9}	79.5 ~ 119.2 {8.1 ~ 12.2}
M14 × 1.5	106.2 ~ 158.8 {10.8 ~ 16.2}	114.9 ~ 172.3 {11.7 ~ 17.6}	113.8 ~ 170.6 {11.6 ~ 17.4}	123.4 ~ 185.1 {12.6 ~ 18.9}
* M14 × 2	100.6 ~ 149.8 {10.3 ~ 15.3}	108.2 ~ 162.2 {11.1 ~ 16.6}	106.9 ~ 160.0 {10.9 ~ 16.3}	115.5 ~ 173.3 {11.8 ~ 17.7}
M16 × 1.5	154.3 ~ 232.5 {15.7 ~ 23.7}	171.1 ~ 256.7 {17.4 ~ 26.2}	160.0 ~ 240.3 {16.3 ~ 24.5}	176.9 ~ 265.3 {18.0 ~ 27.1}
* M16 × 2	147.6 ~ 221.4 {15.0 ~ 22.6}	162.5 ~ 243.8 {16.6 ~ 24.9}	153.0 ~ 229.5 {15.6 ~ 23.4}	168.5 ~ 252.7 {17.2 ~ 25.8}
M18 × 1.5	222.5 ~ 334.3 {22.7 ~ 34.1}	—	229.5 ~ 345.2 {23.4 ~ 35.2}	—
* M18 × 2.5	223.6 ~ 335.4 {22.8 ~ 34.2}	—	230.5 ~ 346.2 {23.6 ~ 35.3}	—
M20 × 1.5	307.4 ~ 461.7 {31.4 ~ 47.1}	—	316.8 ~ 475.6 {32.3 ~ 48.5}	—
* M20 × 2.5	284.0 ~ 472.1 {29.0 ~ 43.5}	—	293.2 ~ 440.3 {29.2 ~ 44.9}	—
M22 × 1.5	413.6 ~ 620.5 {42.2 ~ 63.3}	—	424.6 ~ 636.5 {43.3 ~ 64.9}	—
* M22 × 2.5	385.7 ~ 578.0 {39.3 ~ 58.9}	—	394.2 ~ 592.3 {40.0 ~ 60.4}	—
M24 × 2	490.8 ~ 810.5 {50.0 ~ 82.7}	—	554.1 ~ 830.6 {56.5 ~ 84.7}	—
* M24 × 3	462.8 ~ 693.1 {47.2 ~ 70.7}	—	520.7 ~ 781.6 {53.1 ~ 79.7}	—

The * mark indicates where soft materials have been used for internal thread sections, such as castings.

Designations for bolt heads



Legend

1. Hexagon head bolt(4.8, 4T)
2. Hexagon head bolt(4.8, 4T)
3. Flange bolt(4.8, 4T)
4. Flange bolt(4.8, 4T)
5. Hexagon head bolt(7T)
6. Flange bolt(7T)
7. Hexagon head bolt (refined 8.8)
8. Hexagon head bolt (refined 8.8)
9. Hexagon head bolt(Un-refined 8.8)
10. Hexagon head bolt(Un-refined 8.8)
11. Flange bolt(8.8)
12. Flange bolt(8.8)
13. Hexagon head bolt(9.8, 9T)
14. Hexagon head bolt(9.8, 9T)
15. Flange bolt(9.8, 9T)
16. Flange bolt(9.8, 9T)

Flare nut

	Pipe diameter	tightening torque (for medium and large size vehicles)	Flare nut 2 side width (mm)	
			Old	New
Flare nut tightening torque (service standard value) N·m {kgf·m}	ϕ4.76 mm	12.8 ~ 18.6 {1.3 ~ 1.9}	14	14
	ϕ6.35 mm	23.5 ~ 49 {2.4 ~ 5.0}	17	17
	ϕ8.0 mm	23.5 ~ 49 {2.4 ~ 5.0}	19	17
	ϕ10.0 mm	44.1 ~ 93.2 {4.5 ~ 9.5}	22	19
	ϕ12.0 mm	58.8 ~ 137.3 {6.0 ~ 14.0}	27	24
	ϕ15.0 mm	78.5 ~ 156.9 {8.0 ~ 16.0}	30	30