PART NO. ETDDN50-EN-01

HITACHI

Reliable solutions

Engine Manual
Technical Manual

6HK1
Tier 4 Compatible

6HK1 TIER 4 COMPATIBLE ENGINE MANUAL TECHNICAL MANUAL

Hitachi Construction Machinery Co., Ltd.
URL:http://www.hitachi-c-m.com

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Service Manual consists of the following sections.
Technical Manual (Operational Principle)
Technical Manual (Troubleshooting)
Workshop Manual
Engine Manual

FOREWORD

This manual describes the service procedures for the 6HK1 diesel engine (Tier 4/Stage 4 compatible).
The contents of this manual are current at the date of issue, but may differ slightly from your engine due to specification changes or other modifications made thereafter.

This manual consists of the following sub-sections.

Publication No.	Publication Name	Sub-sections	
IDE-2710	ENGINE	0	Introduction
		14A	Service Information Guide
		15B	Maintenance Information
		15C	Functional Inspection
		15D	Symptom
		15E	DTC Information
		1A	Engine Control
		1B	Mechanical
		1C	Fuel System
		1D	Cooling
		1E	Lubrication
		1F	Induction
		1G	Exhaust
		1H	Aux. Emission Control Devices
		1J	Electrical
		38B	Maintenance Information (Urea SCR System)
		38C	Functional Inspection (Urea SCR System)
		38D	Symptom (Urea SCR System)
		38E	DTC Information (Urea SCR System)
		10M	Emission Control (Urea SCR System)
		-	Wiring Diagram

Introduction

Introduction

(All models)

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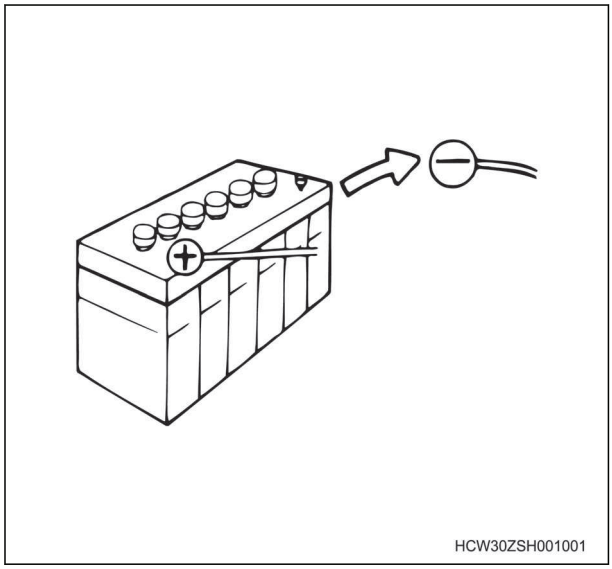
Introduction

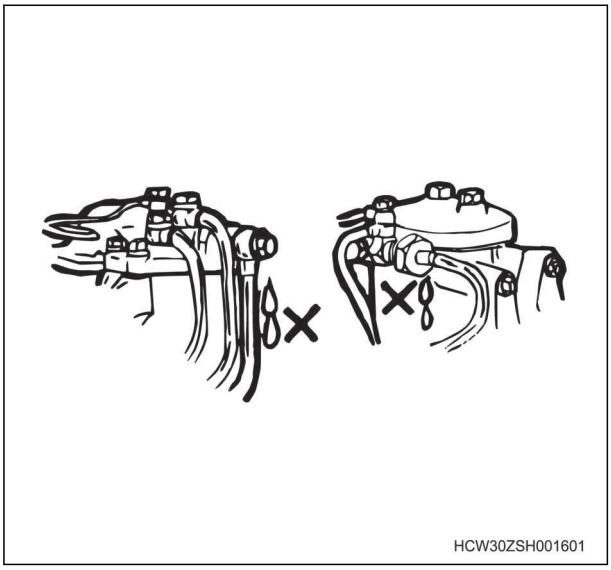
safety information

1. Repair work safety information

   1. Use an engine stand when demounting the engine from the equipment.
      Be sure not to place the engine directly on the ground or allow the oil pan to come into contact with the ground.
   2. When performing a procedure with two or more people, make sure to ensure each other's safety.
   3. Do not disconnect the battery cable for 3 minutes after turning OFF the ignition switch.
   4. When repairing the electrical system, make sure to disconnect the cable from the negative (-) battery terminal before working. Keep fire away when removing the battery cover.



   5. Do not leave the engine running for an extended period of time or perform painting in a poorly ventilated working environment.
   6. Make sure to use only the special tools if the procedure requires them for the work. Performing the procedure using other tools may cause damage to parts or personal injury.
   7. Inspect the tools, instruments, and special tools regularly, and prepare them before working. Do not use tools such as a wrench that has lost its edges, a hammer with frayed edges, or a chipped chisel.
   8. When performing work using a device such as a grinder, crane or welder, make sure to pay sufficient attention to the handling precautions.
      Wear work clothes and safety equipments in the other operations as well.
   9. Be sure to check that there is no fuel leaks when performing maintenance on fuel systems.



   10. When handling volatile materials, be extremely careful to not let them catch fire.
       Also make sure to wipe away any oil that sticks to rubber parts, as it can cause deterioration.

2. Replacement parts and parts number safety information

   1. Whenever disassembly is performed, make sure to replace the packing, oil seals, O-rings, crimping lock nuts, bending lock plate, and split pins, etc., with new ones.
   2. Since the part numbers indicated in this manual may differ from the supply system and are subject to change, make sure to check the supply system and part numbers in the parts catalog.

Description General Information

Service Information Guide

(All models)

Table of Contents

Contents included in service information

1. Contents included in service information

Removal
Includes the removal procedure for repairing parts and devices, etc.

Installation
Includes the installation procedure for repairing parts and devices, etc.

Disassembly
Includes the disassembly procedure for performing an overhaul of a unit or assembly part, etc.

Assembly
Includes the assembly procedure for performing an overhaul of a unit or assembly part, etc.

Inspection
Includes the inspection items for the parts that particularly require inspection to ensure continued performance of parts and devices.
The standard values, set values, and limits for use of parts are included if they have these specifications set.

Cleaning
Includes the cleaning procedure for parts and devices, etc.

Preparation
Includes the preparatory procedure necessary before removing parts and devices, etc.

Adjustment
Includes the adjustment procedure when parts have to be adjusted to set values or standard values when performing assembly or installation.

Measurement
Includes the measurement procedure to judge if parts are installed correctly, etc.

Drain
Includes the draining procedure of oil, etc.

Refill
Includes the refilling procedure of oil, etc.

Air removal
Includes the air removal procedure when air removal is necessary after replacing oil, etc.

Writing
Includes the writing procedure necessary after replacing the ECM or supply pump.

Precaution
Includes the maintenance precautions specific to each item.

Disconnection
Includes the disconnection procedures of wiring, piping, etc.

Connection
Includes the connection procedures for wiring, piping, etc.

Setting
Includes the setting procedure necessary after replacing the ECM, etc.

Replacement
Includes the replacement procedure for parts and oils, etc.

Prioritized DTC
Includes DTCs that need to be diagnosed and resolved before the relevant DTC when multiple DTCs are detected.

Diagnosis
Includes the diagnosis procedure for troubleshooting symptoms.
DTCs are listed in the descending order of priority.

Confirmation of problem resolution
Includes procedures to clear the DTC and any necessary confirmation steps using numeric values, etc.

Functional description
Includes detailed functional description related to functional inspection.

Symptom description
Includes detailed symptom descriptions related to diagnosis by symptom.

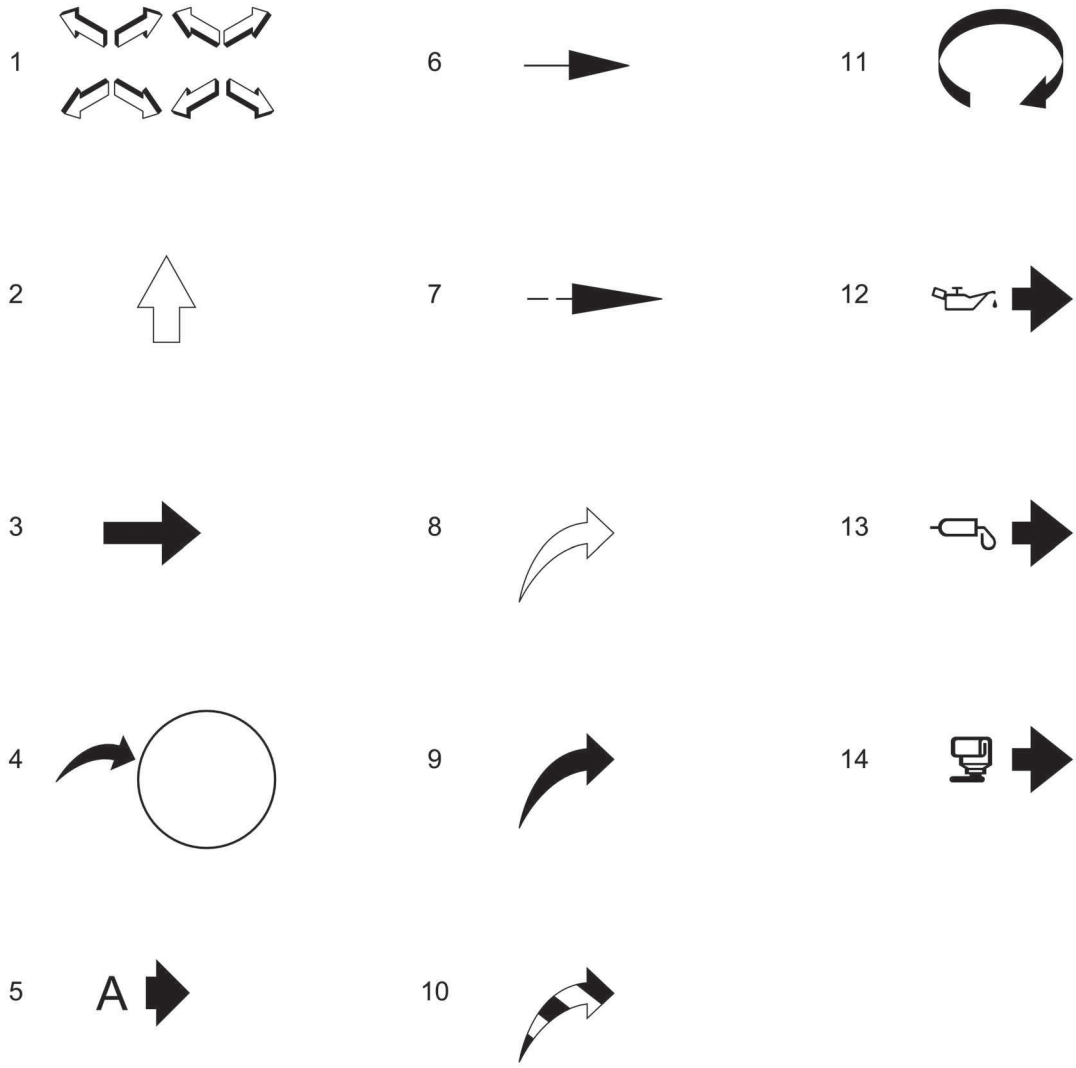
DTC description
Includes circuit description related to DTCs.

Setting conditions
Includes the preconditions and judgment conditions required for the ECU to detect a DTC.

Action upon setting
Includes information related to control actions taken by the ECU when DTCs are set.

Items related to ETM
Items related to the ETM are included in "Using the Wiring Diagram".

2. Arrows and symbols



1. Vehicle front
2. Upper
3. Operating section or operating direction
4. Detail on a section
5. Detailed view from the direction of A
6. Arrow indicates measurement
7. Arrow indicates cross-section
8. Outside air or cold air
9. Gas or warm air
10. Mixing of outside air and gas, or cold air and warm air
11. Rotation direction
12. Oil feeding
13. Lubrication
14. Application area of liquid gasket

Plastic gauge

1. Using the plasti-gauge

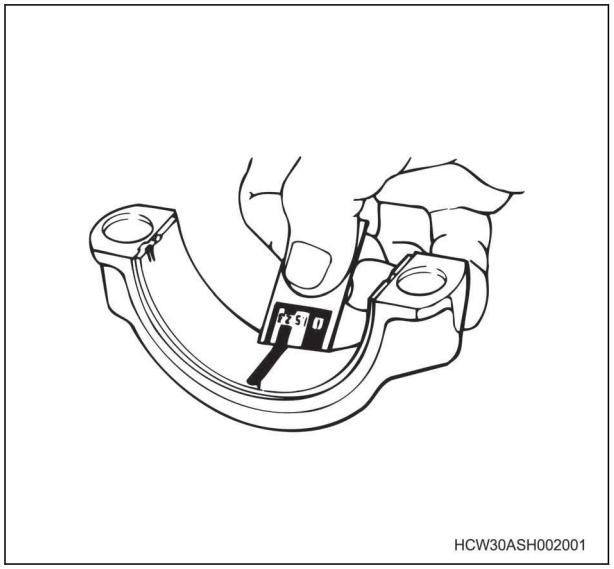
Type	Measurable range
PG-1 (Green)	: 0.025 to 0.076 mm { 0.00098 to 0.00299 in }
PR-1 (Red)	: 0.051 to 0.152 mm { 0.00201 to 0.00598 in }
PB-1 (Blue)	: 0.102 to 0.229 mm { 0.00402 to 0.00902 in }

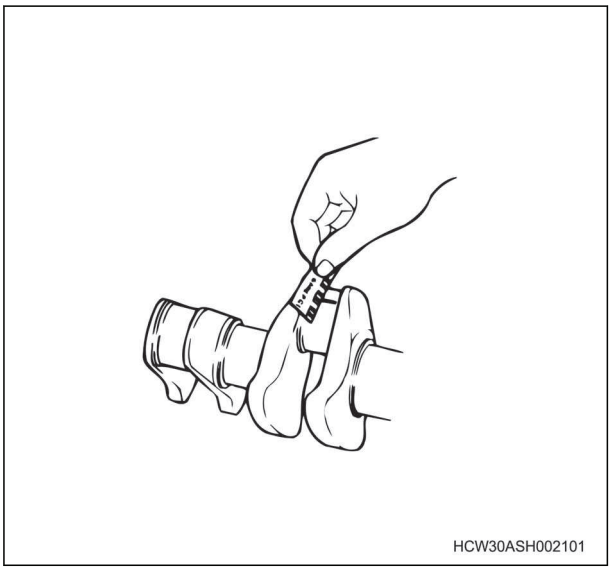
Method for measuring the gap between the connecting rod bearing and crank pin
Clean the connecting rod and bearing, and assemble them on the connecting rod. Cut the plasti-gauge to the width of the crank pin and lay it parallel avoiding the crank pin oil hole. Align the markings on the connecting rod and on the cap to assemble it on the crank pin. Apply molybdenum disulfide to the threaded portion and seat surface of the tightening bolts. Alternately tighten them so that the cap is at the specified torque.

Caution :

- Never move the connecting rod when the plasti-gauge is in use.

Gently remove the cap and connecting rod and use a scale printed on the packaging of the plasti-gauge to measure the flattened plasti-gauge.



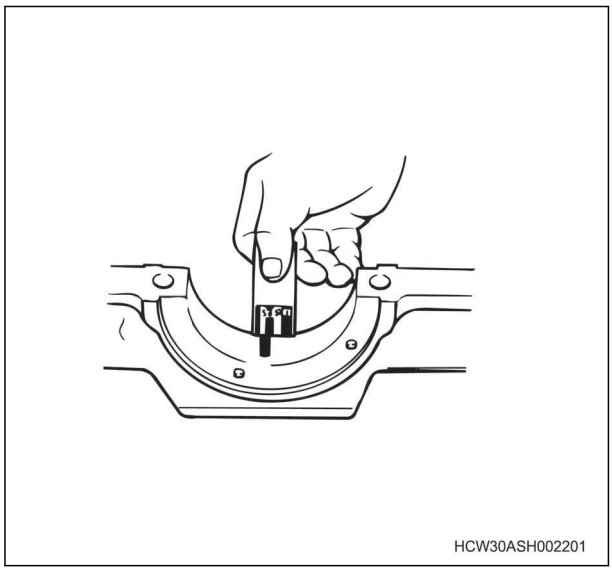


Method for measuring the gap between the crank bearing and crank journal
Clean the installation surfaces of the cylinder block and crankcase bearing, and assemble them on the cylinder block and crankcase. Gently place the crankshaft on the cylinder block, and lock it into place by turning it approximately 30 degrees. Cut the plasti-gauge to the width of the crank journal and lay it parallel avoiding the journal oil hole. Gently place the crankcase on the cylinder block, and apply molybdenum disulfide to the threaded portion and seat surface of the tightening bolts. Tighten in the specified order at the specified torques.

Caution :

- Never move the connecting rod when the plasti-gauge is in use.

Gently remove the crankcase and use a scale printed on the packaging of the plasti-gauge to measure the flattened plastic gauge.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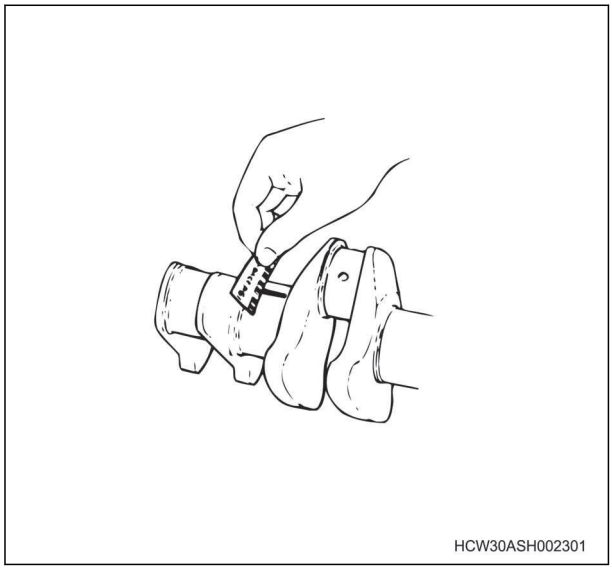
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Recommended liquid gasket

1. Using the thread liquid gasket

Type	Product name	Manufacturer name	Area used (reference)
Silicon type (room temperature vulcanization process)	ThreeBond 1207B ThreeBond 1207C ThreeBond 1201 ThreeBond 1215 ThreeBond 1216	ThreeBond ThreeBond ThreeBond ThreeBond ThreeBond	Engine oil seal retainer Engine oil pan Timing gear case Flywheel housing Cylinder head cover Fuel pump Water pump etc.
Water–soluble	ThreeBond 1141	ThreeBond	
Solvent type	ThreeBond 1104 ThreeBond 1194	ThreeBond ThreeBond	
Anaerobic	Loctite 515 Loctite 518 FMD127 (Loctite 5127) Loctite 271	Loctite Loctite Loctite Loctite Loctite	Engine oil seal retainer Water pump Plug etc.

Caution :

- Make sure to use a liquid gasket with the above product name or equivalent.
- Use an appropriate amount of liquid gasket.
- Follow the handling precautions for the product.
- Do not use Loctite 515/518 or FMD 127 (Loctite 5127), as they are anaerobic, and do not provide sufficient effect when there is a gap larger than 0.25 mm {0.0098 in} between the contact surfaces of metals.

Whenever disassembling, completely remove old liquid gasket using a scraper, and clean by removing any oil, moisture, filth, etc. from the locations of parts and the mating parts where liquid gasket was used by using a rag, etc. After cleaning, apply the specified liquid gasket to each location and assemble them.

Note :

- It is better to start the removal operation approximately 10 minutes after applying when using gasket remover to make the operation easier while cleaning.

Caution :

- Do not apply gasket remover to plastic parts and painted parts.

Apply liquid gasket of the specified bead width to one side of the contact surface thoroughly.

Caution :

- Be careful to apply a proper amount of the liquid gasket to avoid an excess or lack in application.
- Be sure to overlap the beginning and ending of the liquid gasket application.
- Be careful not to misalign the applied part with the mating part when assembling.

Note :

- When there is a misalignment, apply again.
- Use the same size studs as a guide when using with a section which has no positioning such as a knock pin.

Caution :

- After applying the liquid gasket, assemble within 15 minutes.

Note :

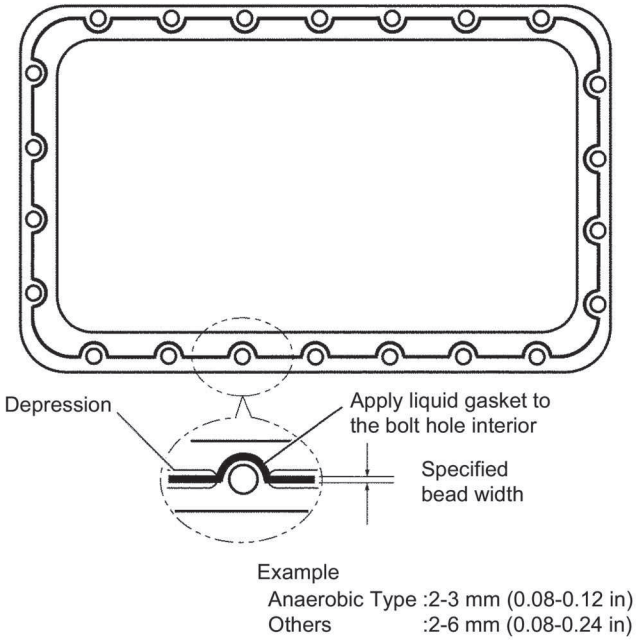
- When more than 15 minutes have passed after applying liquid gasket, remove the liquid gasket and apply it again.

Caution :

- Wait at least 30 minutes before starting the engine after assembling each part.

mm (in)

SCREW HOLE	DEPRESSION	JUDGE MENT
1~3 (0.04~0.12)		OK
1~3 (0.04~0.12)	More than 2 (0.08)	OK
		NG



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Caution :

- If the workshop manual specifies an application method, follow that method.

Thread locking adhesive agent

1. Using the thread locking adhesive agent

Type	Color
Loctite 242	Blue
Loctite 262	Red
Loctite 271	Red

Caution：

- Remove grime, fluid, oil, and grease off thoroughly from the bolts, bolt holes, and screw thread section of nuts to which thread locking adhesive agent will be applied.

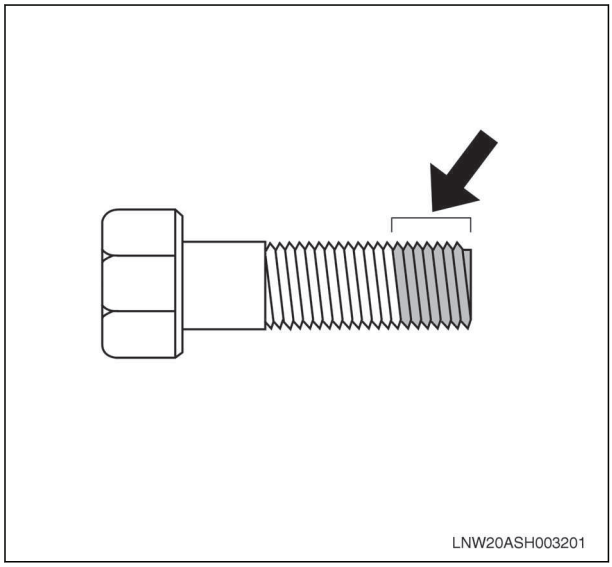
Note：

- Check if the cleaned sections are dry.

Caution：

- After tightening, do not apply excessive torque or vibrations for at least an hour until the thread locking adhesive agent hardens.

Apply thread locking adhesive agent to the end 1/3 of the screw and tighten at the specified torque.



Term

1. Term

Nominal dimensions
Refers to standard values for production.

Specified value
Refers to specified values for inspection, adjustment, assembly, and installation.

Limit
Refers to a maximum or minimum value that should not be exceeded during maintenance. If this value is exceeded, replacement or repair must be made.

Warning Refers to something which may cause serious injuries if it is not performed properly.

CAUTION
Refers to something which may cause physical loss or damage if it is not performed properly.

NOTE
Instruction, guidance, and usage conditions regarding usage, operation, and repair in the additional information.

Abbreviations

1. Abbreviations

Abbreviation	Description
A/D	Analog/Digital
ABDC	After bottom dead center
AC	Alternating current
ACC	Accessory
ACG	Alternating current generator
ACT	Actuator
API	American Petroleum Industry
ASM	Assembly
ATDC	After top dead center
ATF	Automatic transmission fluid
B+	Battery + terminal
BAT	Battery
BBDC	Before bottom dead center
BKT	Bracket
BRG	Bearing
BTDC	Before the top dead center
C/B	Circuit breaker
C/U	Control unit
CAN	A control unit communication method (Control area network)
CKP	Crankshaft position
CMP	Camshaft position
CO	Carbon monoxide
CPU	CPU (Central processing unit)
DC	Direct current
DI	Direct injection type
DLC	Data link connector
DPD	Diesel particulate diffuser
DTC	Self-diagnosis code
DMM	Digital multi–meter
ECM	Engine control module
ECT	Engine coolant temperature
ECU	Electronic control unit
EEPROM	Electrically erasable/programmable ROM
EGR	EGR (Exhaust gas recirculation)
EMI	Electromagnetic interference
EVRV	Electric vacuum regulating valve
EXH	Exhaust
F/B	Feedback
F/C	Fuel cut
F/L	Fusible link
FLW	Fusible link wire
FRT	Front
FT	Fuel temperature
FWD	Front

GEN	Generator
GND	Ground
HC	Hydrocarbon
HO2S	Superheat O2 sensor
IAC	Idle air control
IAT	Intake air temperature
IC	Integrated circuit
ID Plate	ID plate (Name plate)
IDSS	ISUZU Diagnostic Service System
IMT	Intake manifold temperature
INL	Intake
INJ	Injection
ISO	International Organization for Standardization
ISP	Intake shutter position
ITP	Intake throttle position
J/C	Joint connector
JIS	Japan Industrial Standard
KW	A communication method (Keyword)
LH	Left side
LLC	Long life coolant
M/V	Electromagnetic valve
MAF	Mass air flow
MAP	Manifold air pressure
Max	Maximum
MIL	Warning light (Diagnostic light)
Min	Minimum
MPU	Micro processing unit
NC	Normally closed
NC	Normally closed
NO	Normally open
NOx	Nitrogen oxide
N–TDC	Top dead center revolution speed
O2S	O2 sensor
OBD	On–board diagnosis
OEM	Original equipment manufacturer
OPT	Option
OT	Oil temperature
P/L	Pilot light
PCV	Pump control valve/Positive crankcase ventilation
P–I	Proportion–integration
PM	Particle material
PTO	Power take–off
PWM	Pulse width modulation wave
QOS	QOS (Quick on start system)
QWS	QWS (Quick warming up system)

RH	Right side
R/L	Relay
RAM	RAM (Random access memory)
REF	Reference
ROM	ROM (Read only memory)
RP	Rail pressure
Rr	Rear
Rr	Rear
RWD	Rear
SAE	Society of Automotive Engineers
SBF	Slow blow fuse
SCV	Suction control valve
SIG	Signal
SLD	Shield
ST	Starter/start
STD	Standards
SW	Switch
TDC	Top dead center
TEMP	Temperature
TP	Throttle position
VB	Battery voltage
VGS Turbo	Variable geometry system turbo, VGS turbo
W/H	Wire/harness
W/L	Warning light (Warning light)
W/S	Weld splice
WOT	Wide open throttle

Standard bolts

1. List of standard bolt and nut tightening torques

Note：

- The tightening torque values in the following table apply to locations where tightening torques are not specified.

Strength category	4.8 4T		7T	
Bolt head shape	Hex bolt	Flange bolt	Hex bolt	Flange bolt
M6 x 1	: 3.9 to 7.8 N・m { 0.4 to 0.8 kgf・m / 35 to 69 lb・in }	: 4.6 to 8.5 N・m { 0.5 to 0.9 kgf・m / 41 to 75 lb・in }	: 4.9 to 9.8 N・m { 0.5 to 1.0 kgf・m / 43 to 87 lb・in }	: 5.7 to 10.6 N・m { 0.6 to 1.1 kgf・m / 50 to 94 lb・in }
M8 x 1.25	: 7.8 to 17.7 N・m { 0.8 to 1.8 kgf・m / 69 to 157 lb・in }	: 10.5 to 19.6 N・m { 1.1 to 2.0 kgf・m / 93 to 173 lb・in }	: 11.8 to 22.6 N・m { 1.2 to 2.3 kgf・m / 9 to 17 lb・ft }	: 13.5 to 25.0 N・m { 1.4 to 2.5 kgf・m / 10 to 18 lb・ft }
M10 x 1.25	: 20.6 to 34.3 N・m { 2.1 to 3.5 kgf・m / 15 to 25 lb・ft }	: 23.1 to 38.5 N・m { 2.4 to 3.9 kgf・m / 17 to 28 lb・ft }	: 27.5 to 46.1 N・m { 2.8 to 4.7 kgf・m / 20 to 34 lb・ft }	: 31.0 to 51.7 N・m { 3.2 to 5.3 kgf・m / 23 to 38 lb・ft }
*M10 x 1.5	: 19.6 to 33.3 N・m { 2.0 to 3.4 kgf・m / 14 to 25 lb・ft }	: 22.3 to 37.2 N・m { 2.3 to 3.8 kgf・m / 16 to 27 lb・ft }	: 27.5 to 45.1 N・m { 2.8 to 4.6 kgf・m / 20 to 33 lb・ft }	: 30.3 to 50.4 N・m { 3.1 to 5.1 kgf・m / 22 to 37 lb・ft }
M12 x 1.25	: 49.0 to 73.5 N・m { 5.0 to 7.5 kgf・m / 36 to 54 lb・ft }	: 54.9 to 82.3 N・m { 5.6 to 8.4 kgf・m / 40 to 61 lb・ft }	: 60.8 to 91.2 N・m { 6.2 to 9.3 kgf・m / 45 to 67 lb・ft }	: 68.1 to 102.1 N・m { 6.9 to 10.4 kgf・m / 50 to 75 lb・ft }
*M12 x 1.75	: 45.1 to 68.6 N・m { 4.6 to 7.0 kgf・m / 33 to 51 lb・ft }	: 51.0 to 76.5 N・m { 5.2 to 7.8 kgf・m / 38 to 56 lb・ft }	: 56.9 to 84.3 N・m { 5.8 to 8.6 kgf・m / 42 to 62 lb・ft }	: 62.7 to 94.0 N・m { 6.4 to 9.6 kgf・m / 46 to 69 lb・ft }
M14 x 1.5	: 76.5 to 114.7 N・m { 7.8 to 11.7 kgf・m / 56 to 85 lb・ft }	: 83.0 to 124.5 N・m { 8.5 to 12.7 kgf・m / 61 to 92 lb・ft }	: 93.2 to 139.3 N・m { 9.5 to 14.2 kgf・m / 69 to 103 lb・ft }	: 100.8 to 151.1 N・m { 10.3 to 15.4 kgf・m / 74 to 111 lb・ft }
*M14 x 2	: 71.6 to 106.9 N・m { 7.3 to 10.9 kgf・m / 53 to 79 lb・ft }	: 77.2 to 115.8 N・m { 7.9 to 11.8 kgf・m / 57 to 85 lb・ft }	: 88.3 to 131.4 N・m { 9.0 to 13.4 kgf・m / 65 to 97 lb・ft }	: 94.9 to 142.3 N・m { 9.7 to 14.5 kgf・m / 70 to 105 lb・ft }
M16 x 1.5	: 104.0 to 157.0 N・m { 10.6 to 16.0 kgf・m / 77 to 116 lb・ft }	: 115.6 to 173.3 N・m { 11.8 to 17.7 kgf・m / 85 to 128 lb・ft }	: 135.3 to 204.0 N・m { 13.8 to 20.8 kgf・m / 100 to 150 lb・ft }	: 150.1 to 225.2 N・m { 15.3 to 23.0 kgf・m / 111 to 166 lb・ft }
*M16 x 2	: 100.0 to 149.1 N・m { 10.2 to 15.2 kgf・m / 74 to 110 lb・ft }	: 109.4 to 164.2 N・m { 11.2 to 16.7 kgf・m / 81 to 121 lb・ft }	: 129.4 to 194.2 N・m { 13.2 to 19.8 kgf・m / 95 to 143 lb・ft }	: 142.5 to 213.8 N・m { 14.5 to 21.8 kgf・m / 105 to 158 lb・ft }
M18 x 1.5	: 151.0 to 225.6 N・m { 15.4 to 23.0 kgf・m / 111 to 166 lb・ft }	-	: 195.2 to 293.2 N・m { 19.9 to 29.9 kgf・m / 144 to 216 lb・ft }	-
*M18 x 2.5	: 151.0 to 225.6 N・m { 15.4 to 23.0 kgf・m / 111 to 166 lb・ft }	-	: 196.1 to 294.2 N・m { 20.0 to 30.0 kgf・m / 145 to 217 lb・ft }	-
M20 x 1.5	: 206.0 to 310.0 N・m { 21.0 to 31.6 kgf・m / 152 to 229 lb・ft }	-	: 269.7 to 405.0 N・m { 27.5 to 41.3 kgf・m / 199 to 299 lb・ft }	-
*M20 x 2.5	: 190.2 to 286.4 N・m { 19.4 to 29.2 kgf・m / 140 to 211 lb・ft }	-	: 249.1 to 374.6 N・m { 25.4 to 38.2 kgf・m / 184 to 276 lb・ft }	-
M22 x 1.5	: 251.1 to 413.8 N・m { 25.6 to 42.2 kgf・m / 185 to 305 lb・ft }	-	: 362.8 to 544.3 N・m { 37.0 to 55.5 kgf・m / 268 to 401 lb・ft }	-
*M22 x 2.5	: 217.7 to 327.5 N・m { 22.2 to 33.4 kgf・m / 161 to 242 lb・ft }	-	: 338.3 to 507.0 N・m { 34.5 to 51.7 kgf・m / 250 to 374 lb・ft }	-

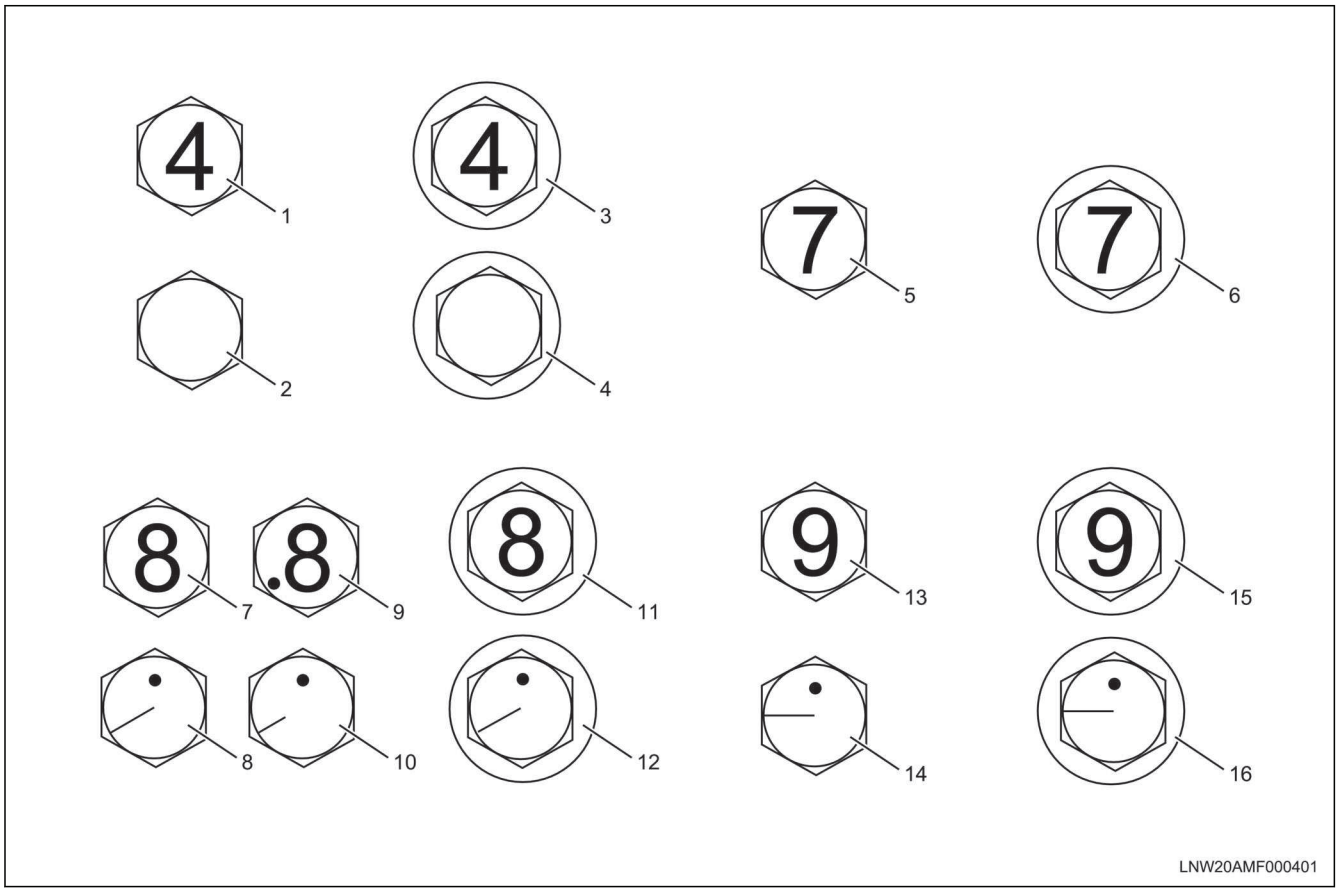
M24 x 2	: 358.9 to 539.4 N・m { 36.6 to 55.0 kgf・m / 265 to 398 lb・ft }	-	: 430.5 to 711.0 N・m { 43.9 to 72.5 kgf・m / 318 to 524 lb・ft }	-
*M24 x 3	: 338.3 to 507.0 N・m { 34.5 to 51.7 kgf・m / 250 to 374 lb・ft }	-	: 406.0 to 608.0 N・m { 41.4 to 62.0 kgf・m / 299 to 448 lb・ft }	-

Strength category	8.8		9.8 9T	
Bolt head shape	Hex bolt	Flange bolt	Hex bolt	Flange bolt
M6 x 1	: 5.6 to 11.2 N・m { 0.6 to 1.1 kgf・m / 50 to 99 lb・in }	: 6.6 to 12.2 N・m { 0.7 to 1.2 kgf・m / 58 to 108 lb・in }	-	-
M8 x 1.25	: 13.4 to 25.7 N・m { 1.4 to 2.6 kgf・m / 10 to 19 lb・ft }	: 15.3 to 28.4 N・m { 1.6 to 2.9 kgf・m / 11 to 21 lb・ft }	: 16.7 to 30.4 N・m { 1.7 to 3.1 kgf・m / 12 to 22 lb・ft }	: 18.1 to 33.6 N・m { 1.8 to 3.4 kgf・m / 13 to 25 lb・ft }
M10 x 1.25	: 31.3 to 52.5 N・m { 3.2 to 5.4 kgf・m / 23 to 39 lb・ft }	: 35.4 to 58.9 N・m { 3.6 to 6.0 kgf・m / 26 to 43 lb・ft }	: 37.3 to 62.8 N・m { 3.8 to 6.4 kgf・m / 28 to 46 lb・ft }	: 42.3 to 70.5 N・m { 4.3 to 7.2 kgf・m / 31 to 52 lb・ft }
*M10 x 1.5	: 31.3 to 51.4 N・m { 3.2 to 5.2 kgf・m / 23 to 38 lb・ft }	: 34.5 to 57.5 N・m { 3.5 to 5.9 kgf・m / 25 to 42 lb・ft }	: 36.3 to 59.8 N・m { 3.7 to 6.1 kgf・m / 27 to 44 lb・ft }	: 40.1 to 66.9 N・m { 4.1 to 6.8 kgf・m / 30 to 49 lb・ft }
M12 x 1.25	: 69.3 to 104.0 N・m { 7.1 to 10.6 kgf・m / 51 to 77 lb・ft }	: 77.7 to 116.5 N・m { 7.9 to 11.9 kgf・m / 57 to 86 lb・ft }	: 75.5 to 113.8 N・m { 7.7 to 11.6 kgf・m / 56 to 84 lb・ft }	: 85.0 to 127.5 N・m { 8.7 to 13.0 kgf・m / 63 to 94 lb・ft }
*M12 x 1.75	: 64.8 to 96.1 N・m { 6.6 to 9.8 kgf・m / 48 to 71 lb・ft }	: 71.4 to 107.2 N・m { 7.3 to 10.9 kgf・m / 53 to 79 lb・ft }	: 71.6 to 106.9 N・m { 7.3 to 10.9 kgf・m / 53 to 79 lb・ft }	: 79.5 to 119.2 N・m { 8.1 to 12.2 kgf・m / 59 to 88 lb・ft }
M14 x 1.5	: 106.2 to 158.8 N・m { 10.8 to 16.2 kgf・m / 78 to 117 lb・ft }	: 114.9 to 172.3 N・m { 11.7 to 17.6 kgf・m / 85 to 127 lb・ft }	: 113.8 to 170.6 N・m { 11.6 to 17.4 kgf・m / 84 to 126 lb・ft }	: 123.4 to 185.1 N・m { 12.6 to 18.9 kgf・m / 91 to 137 lb・ft }
*M14 x 2	: 100.6 to 149.8 N・m { 10.3 to 15.3 kgf・m / 74 to 110 lb・ft }	: 108.2 to 162.2 N・m { 11.0 to 16.5 kgf・m / 80 to 120 lb・ft }	: 106.9 to 160.0 N・m { 10.9 to 16.3 kgf・m / 79 to 118 lb・ft }	: 115.5 to 173.3 N・m { 11.8 to 17.7 kgf・m / 85 to 128 lb・ft }
M16 x 1.5	: 154.3 to 232.5 N・m { 15.7 to 23.7 kgf・m / 114 to 171 lb・ft }	: 171.1 to 256.7 N・m { 17.4 to 26.2 kgf・m / 126 to 189 lb・ft }	: 160.0 to 240.3 N・m { 16.3 to 24.5 kgf・m / 118 to 177 lb・ft }	: 176.9 to 265.3 N・m { 18.0 to 27.1 kgf・m / 130 to 196 lb・ft }
*M16 x 2	: 147.6 to 221.4 N・m { 15.1 to 22.6 kgf・m / 109 to 163 lb・ft }	: 162.5 to 243.8 N・m { 16.6 to 24.9 kgf・m / 120 to 180 lb・ft }	: 153.0 to 229.5 N・m { 15.6 to 23.4 kgf・m / 113 to 169 lb・ft }	: 168.5 to 252.7 N・m { 17.2 to 25.8 kgf・m / 124 to 186 lb・ft }
M18 x 1.5	: 222.5 to 334.3 N・m { 22.7 to 34.1 kgf・m / 164 to 247 lb・ft }	-	: 229.5 to 345.2 N・m { 23.4 to 35.2 kgf・m / 169 to 255 lb・ft }	-
*M18 x 2.5	: 223.6 to 335.4 N・m { 22.8 to 34.2 kgf・m / 165 to 247 lb・ft }	-	: 230.5 to 346.2 N・m { 23.5 to 35.3 kgf・m / 170 to 255 lb・ft }	-
M20 x 1.5	: 307.4 to 461.7 N・m { 31.3 to 47.1 kgf・m / 227 to 341 lb・ft }	-	: 293.2 to 440.3 N・m { 29.9 to 44.9 kgf・m / 216 to 325 lb・ft }	-
*M20 x 2.5	: 284.0 to 472.1 N・m { 29.0 to 48.1 kgf・m / 209 to 348 lb・ft }	-	: 293.2 to 440.3 N・m { 29.9 to 44.9 kgf・m / 216 to 325 lb・ft }	-
M22 x 1.5	: 413.6 to 620.5 N・m { 42.2 to 63.3 kgf・m / 305 to 458 lb・ft }	-	: 424.6 to 636.5 N・m { 43.3 to 64.9 kgf・m / 313 to 469 lb・ft }	-
*M22 x 2.5	: 385.7 to 578.0 N・m { 39.3 to 58.9 kgf・m / 284 to 426 lb・ft }	-	: 394.2 to 592.3 N・m { 40.2 to 60.4 kgf・m / 291 to 437 lb・ft }	-

M24 x 2	: 490.8 to 810.5 N・m { 50.0 to 82.6 kgf・m / 362 to 598 lb・ft }	-	: 554.1 to 830.6 N・m { 56.5 to 84.7 kgf・m / 409 to 613 lb・ft }	-
*M24 x 3	: 462.8 to 693.1 N・m { 47.2 to 70.7 kgf・m / 341 to 511 lb・ft }	-	: 520.7 to 781.6 N・m { 53.1 to 79.7 kgf・m / 384 to 576 lb・ft }	-

Note :

- Those indicated with an asterisk (*) are used for the female threaded portion of soft materials such as castings.
- Refer to the following diagram regarding the marking on the top of standard bolts.



1. Hex bolt, 4.8, 4 T
2. Hex bolt, 4.8, 4 T
3. Flange bolt, 4.8, 4 T
4. Flange bolt, 4.8, 4 T
5. Hex bolt, 7 T
6. Flange bolt, 7 T
7. Hex bolt, thermal refining 8.8
8. Hex bolt, thermal refining 8.8
9. Hex bolt, non-thermal refining 8.8
10. Hex bolt, non-thermal refining 8.8
11. Flange bolt 8.8
12. Flange bolt 8.8
13. Hex bolt, 9.8, 9 T
14. Hex bolt, 9.8, 9 T
15. Flange bolt, 9.8, 9 T
16. Flange bolt, 9.8, 9 T

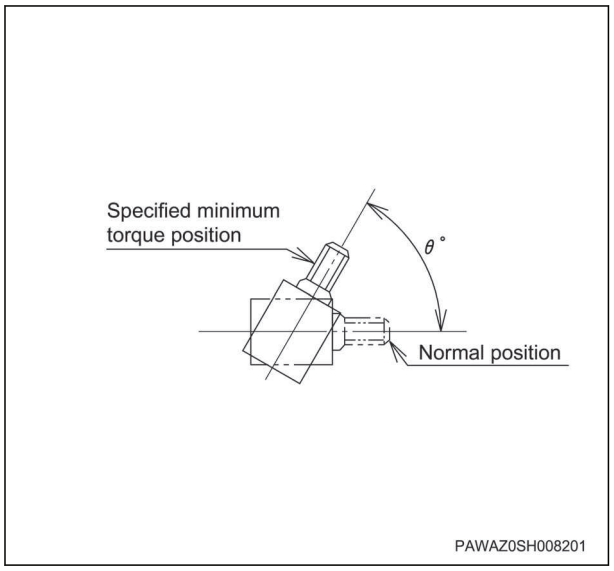
	Pipe diameter	Tightening torque for large/medium size vehicles	Flare nut width across flat	
			Previous	New
Tightening torque of the flare nut Service standard value	: 4.6 mm { 0.181 in }	: 12.8 to 18.6 N・m { 1.3 to 1.9 kgf・m / 9 to 14 lb・ft }	: 14 mm { 0.55 in }	: 14 mm { 0.55 in }
	: 6.35 mm { 0.25 in }	: 23.5 to 49.0 N・m { 2.4 to 5.0 kgf・m / 17 to 36 lb・ft }	: 17 mm { 0.67 in }	: 17 mm { 0.67 in }
	: 8.0 mm { 0.31 in }	: 23.5 to 49.0 N・m { 2.4 to 5.0 kgf・m / 17 to 36 lb・ft }	: 19 mm { 0.75 in }	: 17 mm { 0.67 in }
	: 10.0 mm { 0.39 in }	: 44.1 to 93.2 N・m { 4.5 to 9.5 kgf・m / 33 to 69 lb・ft }	: 22 mm { 0.87 in }	: 19 mm { 0.75 in }
	: 12.0 mm { 0.47 in }	: 58.8 to 137.3 N・m { 6.0 to 14.0 kgf・m / 43 to 101 lb・ft }	: 27 mm { 1.06 in }	: 24 mm { 0.94 in }
	: 15.0 mm { 0.59 in }	: 78.5 to 156.9 N・m { 8.0 to 16.0 kgf・m / 58 to 116 lb・ft }	: 30 mm { 1.18 in }	: 30 mm { 1.18 in }

Tapered thread for connectors and brass products				
Screw size	PT (R) 1/8	PT (R) 1/4	PT (R) 3/8	PT (R) 1/12
-	: 2.0 to 14.7 N・m { 0.20 to 1.50 kgf・m / 18 to 130 lb・in }	: 4.9 to 15.7 N・m { 0.5 to 1.6 kgf・m / 43 to 139 lb・in }	: 9.8 to 16.7 N・m { 1.0 to 1.7 kgf・m / 87 to 148 lb・in }	: 9.8 to 17.7 N・m { 1.0 to 1.8 kgf・m / 87 to 157 lb・in }

Tapered thread for products other than connectors and brass products					
Screw size	PT (R) 1/8	PT (R) 1/4	PT (R) 3/8	PT (R) 1/2	PT (R) 3/4
-	: 5.9 to 11.8 N・m { 0.6 to 1.2 kgf・m / 52 to 104 lb・in }	: 14.7 to 29.4 N・m { 1.5 to 3.0 kgf・m / 11 to 22 lb・ft }	: 29.4 to 39.2 N・m { 3.0 to 4.0 kgf・m / 22 to 29 lb・ft }	: 29.4 to 58.8 N・m { 3.0 to 6.0 kgf・m / 22 to 43 lb・ft }	: 58.8 to 98.0 N・m { 6.0 to 10.0 kgf・m / 43 to 72 lb・ft }

Note :

- The tightening torque of the tapered thread for products other than connectors and brass products is only applied when the opposite side is not made of aluminum.



Note :

- For the elbow-type connector, tighten it with the minimum torque shown above and then tighten it further until the angle matches.
- Apply Loctite 575 to the threaded portion and tighten. Completely dry then let air in after tightening.
- Do not use seal tape, etc.

Description Engine

Maintenance Information

(6HK1)

Table of Contents

Maintenance precautions

1. Maintenance precautions

1. Precautions on maintenance

To prevent the engine from being damaged and to ensure the reliability of engine performance, be careful of the following points when performing maintenance works.
When placing the engine on the ground, make sure that the bearing surface of the oil pan does not directly contact the ground.
Use an appropriate wood frame, etc. to support the engine at the engine foot portion and the flywheel housing portion.
There is only a small gap between the oil pan and oil pump strainer, so be careful not to damage the oil pan and oil strainer.

・While the air duct or air cleaner is removed, cover the open section of the intake to prevent foreign matters from entering the cylinder.
If a foreign matter enters the cylinder, it may seriously damage the cylinder when the engine starts.

・When maintaining the engine, be sure to disconnect the negative battery cable. Failure to do this may cause the harness or electrical components to be damaged.
If energizing is required for inspection, be careful not to cause a short.

・Before assembly, apply the engine oil to the slide contact surface of the engine.
This work ensures appropriate lubrication when first starting the engine.

・When the valve train component, piston, piston ring, connecting rod, connecting rod bearing, and/or crankshaft journal bearing are removed, line them up in the correct order so that their original positions are clear.

・When installing, install it in the same position as when it was removed.

・When assembling the engine, replace the gasket, oil seal, and O-ring with new ones.

For a component with the liquid gasket applied, carefully remove the old liquid gasket and clean the component so that no oil, water, and/or dust remain.
Thereafter, apply the specified liquid gasket to each component before assembly.

・Assemble components with the liquid gasket applied within 5 minutes of applying the liquid gasket.
If 5 minutes have passed, remove the old liquid gasket and apply liquid gasket again.

・When assembling or installing a component, make sure to tighten them at the specified torque to ensure secure installation.

Important precautions for handling the engine
The holes and gaps in the fuel system, including inside the injector where the fuel passes through, are manufactured with high precision. Therefore, these are extremely sensitive to any foreign material and may be severely damaged if foreign material accidentally enters. For this reason, extreme care must be taken to prevent any foreign material from entering. When performing maintenance on the fuel system, take extreme care to prevent any foreign material from entering the system.

・Before starting maintenance, clean the fuel line and its surroundings.

・Be sure to wash your hands before starting maintenance. Do not put on cotton work gloves.

・When the fuel hose or fuel pipe is removed, cover the opening with a plastic bag and fix it with a piece of tape.

・When the high-pressure piping of the fuel system is removed, be sure to replace it with a new one. If it is reused, the sealing surface may be damaged to cause fuel leakage.

・When replacing the fuel hose and/or fuel pipe, do not unpack new components before starting installation.

・When the fuel pipe, injection pipe, fuel injector, fuel supply pump, and/or common rail are removed, seal each opening immediately.

・Store the eyebolt and gasket in a clean parts box with a cover so that foreign matter does not attach to them.

・Fuel leakage may cause a fire. Therefore, be sure to wipe spilled fuel after completing the maintenance work and confirm that there is no fuel leakage before starting the engine.

2. Urea fluid precautions

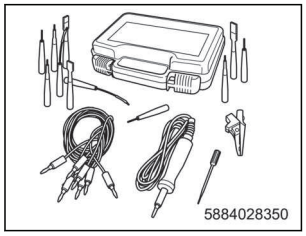
Urea fluid is a colorless, odorless, and harmless aqueous solution.
Although there are no problems associated with it coming in contact with skin, in rare instances such contact may result in irritation. Please take the following precautions.
Wash off with water when contact is made with skin.
If accidentally swallowed, drink 1 to 2 cups of water or milk and immediately seek the advice of a doctor.
If contact is made with eyes, immediately wash out with large amounts of water for 15 minutes or more and seek the advice of a doctor.

When using urea fluid, avoid the following. Failure to avoid the following may result in damage or breakage of the urea SCR system.
Do not dilute with water.
Do not add any substance to the system other than urea fluid, such as gasoline or diesel oil.

Do not add any urea fluid other than that specified.

3. Cautions on electronic system

Using circuit test tools
Unless specifically instructed in the diagnostic procedure, do not use a test light when diagnosing the powertrain electronic system. When a probe connector is required in the diagnostic procedure, use the connector test adapter kit.



SST: 5-8840-2835-0 - connector test adapter kit

Commercial electronic equipment
Commercial electronic equipment refers to commercially available electronic equipment attached to the unit after it has been shipped from the factory. Be careful, as such accessories are not taken into particular consideration at the machine design stage.
Commercial electronic equipment may cause malfunctions in the electronic control system, even if the equipment is properly attached. This includes equipment not connected to the electronic system of the machine, such as mobile telephones and radios. Therefore, when diagnosing power train problems, confirm whether such commercial electronic equipment is attached first and then remove them from the machine if such equipment is attached. If the problem has not been resolved after removing the equipment, perform the diagnosis using the regular procedure.

Caution：

- Make sure that commercial electronic equipment is connected to a circuit that is not involved with the circuits of the electronic control system for both power and ground.

Welding operation for the machine
When performing welding to the machine, make sure to disconnect the battery in prior to the operation.
Current that occurred during welding may lead to failure and/or damage to the electronic control system.

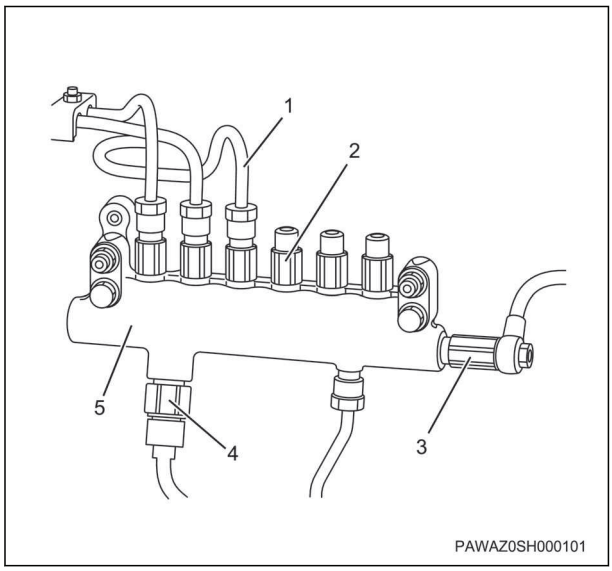
Damage caused by electrostatic discharge
As the electronic components used in the electronic control system are designed to operate at extremely low voltages, they can be easily damaged by electrostatic discharge, and some types of electronic components can be damaged by static electricity of 100 V or less, which cannot be felt by a person. Note that a voltage of 4000 V is required for a person to be able to detect electrostatic discharge.

There are various ways a person can build up an electrostatic charge. The most common way to build up an electrostatic charge is through methods based on friction or induction.
An example of when a person builds an electrostatic charge by friction is when he/she slides across the seat of the machine.
A person wearing insulated shoes can build an electrostatic charge by induction if he/she momentarily touches the ground while standing near a highly charged object. A charge of the same polarity flows out, and with a highly opposing polarity, that person becomes charged. As static electricity causes damage, be cautious when handling or testing electronic components.

Caution：

- To prevent damage due to electrostatic discharge, do not touch the connector pins of the ECM or the electronic components soldered onto the circuit board of the ECM.
- To prevent damage due to electrostatic discharge, do not open the packaging of a replacement part until installation preparation for the replacement part is completed.
- To prevent damage due to electrostatic discharge, connect the part packaging to a properly working ground connection of the actual unit before removing the part from its packaging.
- To prevent damage due to electrostatic discharge, when handling a part while sliding across the seat, sitting down from a standing position, or walking a certain distance, touch a properly working ground connection before attaching the part.

Fuel injection system
Fuel piping
The high pressure pipe and injector pipe in the fuel system should not be reused. When it is once removed, make sure to replace it with new one.
The pressure limiter or fuel pressure sensor should not be replaced individually. When a failure is found, the common rail assembly and all fuel pipes should be replaced.



1. Injector pipe
2. Flow damper
3. Pressure limiter
4. Fuel pressure sensor
5. Common rail

4. Programming

Programming guideline
When the ECM or injector has been replaced, use the trouble diagnosis scan tool to write each data into the ECM.
As for the programming method, refer to the instruction manual of the trouble diagnosis scan tool.

Prior confirmation item for programming
When performing programming, check the ECM part No. as necessary.
When performing programming, check the engine type as necessary.
When performing programming, check the engine No. as necessary.
When performing programming, check the injector ID code as necessary.

Items require programming
When the ECM has been replaced, perform programming.
When the engine has been replaced, perform programming.
When the injector has been replaced, perform programming.

Primary specifications

1. Primary specifications — Engine main specifications

Item		Engine model 6HK1
Type		Diesel/4-cycle/water-cooled, inline 6 cylinder OHC
Shape of combustion chamber		Direct injection type
Cylinder liner type		Dry type
Cylinder bore x stroke		115 mm {4.53 in} x 125 mm {4.92 in}
Displacement		7.790 L {475.35 cu·in}
Compression ratio		16.3
Compression pressure		: 3.04 MPa { 31.0 kgf/cm2 / 441 psi } 200 r/min
Idling speed		800 r/min
Valve clearance	Intake	: 0.4 mm { 0.016 in } While cool
	Exhaust	: 0.4 mm { 0.016 in } While cool
Ignition method		Compression ignition
Injection order		1, 5, 3, 6, 2, 4
Lubrication system		
Lubrication type		Compression type
Oil pump type		Gear type
Lubrication oil amount		: 36.0 to 46.0 L { 9.5 to 12.2 US gal }
Oil filter type		Full-flow filter (Cartridge type)
Oil cooling type		Built-in type, water cooling
Cooling system		
Cooling type		Water cooling
Radiator type		Corrugated fin (Pressure type)
Water pump type		Centrifugal type, belt type
Thermostat type		2-wax type unit
Thermostat valve open valve temperature	Type 1	: 76.5 ℃ { 170 °F } With jiggle valve
		: 82.0 ℃ { 180 °F } Without jiggle valve
	Type 2	: 85.0 ℃ { 185 °F } With jiggle valve
		: 82.0 ℃ { 180 °F } Without jiggle valve
Coolant capacity		: 16.0 L { 4.2 US gal }
Fuel system		
Injection pump type		Electronic control common rail (fuel rail) type
Governor type		Electronic type
Timer type		Electronic type
Injection nozzle type		Multi-hole type 7 holes, inner diameter φ0.14 mm {0.0055 in}
Charging system		
Generator type		AC type
Output		: 24 to 90 V 50 A
Regulator type		IC
Starter system		
Starter type		Reduction type
Output		: 24 V 5.0 kW
Preheat system type		Glow plug
Glow plug standard voltage/current		: 23 V 3.5 A

Cooling system main specifications

Item		Specifications
Water pump		Centrifugal impeller method
Pulley ratio	Type 1	0.80
	Type 2	0.85
Thermostat		Wax pellet type
Full open temperature	Type 1	: 90 ℃ { 194 °F } With jiggle valve
		: 95 ℃ { 203 °F } Without jiggle valve
	Type 2	: 100 ℃ { 212 °F } With jiggle valve
		: 95 ℃ { 203 °F } Without jiggle valve

Electrical system main specifications

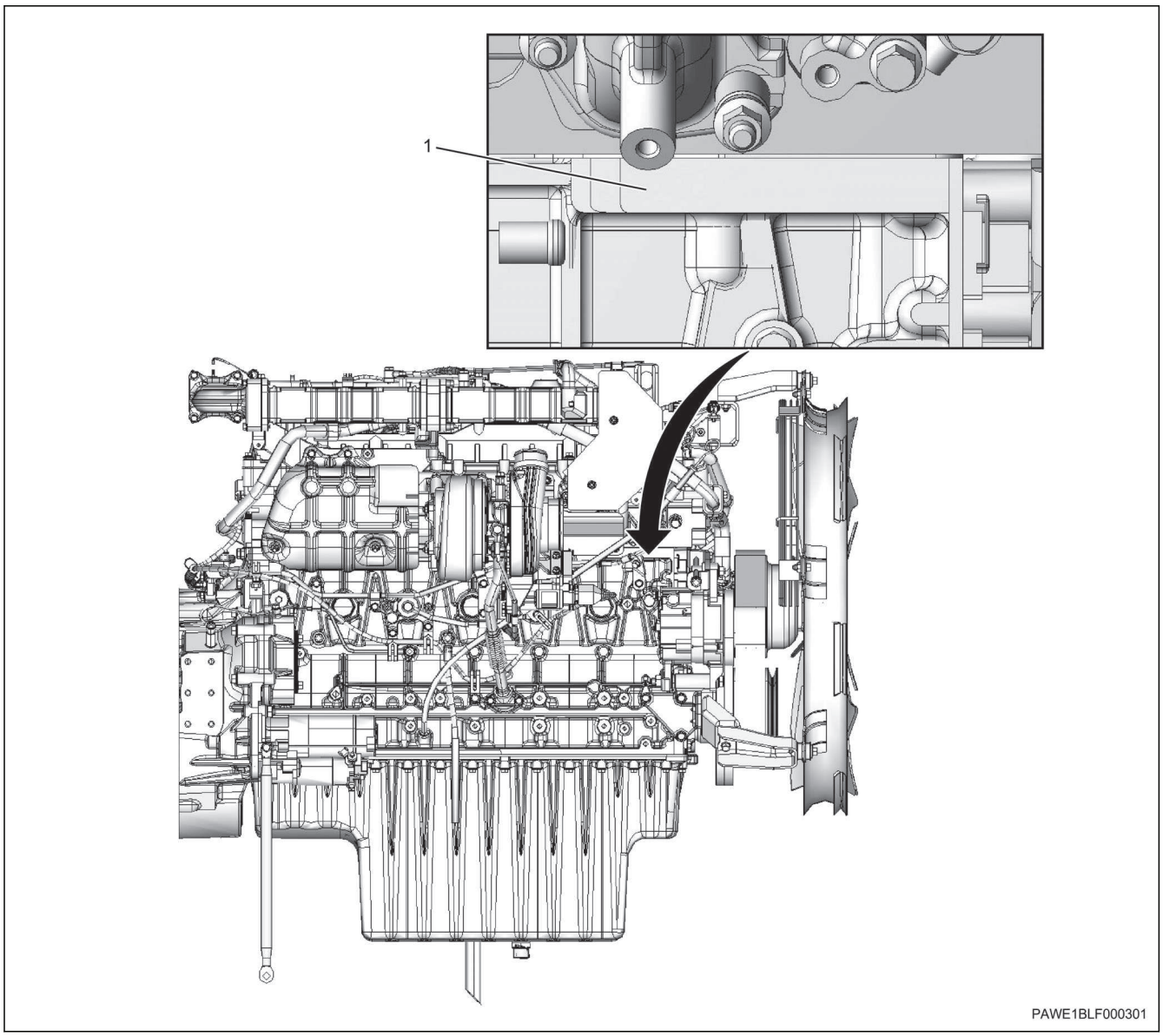
Generator		
Item	Specifications	
Manufacturer name	Mitsubishi Electric Corporation	
Isuzu parts number	1-81200-633-0	1-81200-603-2
Manufacturer type	A009TU3782	A004TU6285
Nominal voltage	: 24 V	
Output current	: 90 A	: 50 A
Rated rotation count	5000 rpm	
Output current/voltage	114 A/27 V/5000 rpm	50 A/27 V/5000 rpm
No-load voltage	: 24 V /900 rpm	
Rotational direction	Clockwise direction	
Polarity	(−)	
Pulley diameter (P.C.D)	: 90.0 mm { 3.54 in }	: 80.0 mm { 3.15 in }

Starter		
Item		Specifications
Manufacturer		Mitsubishi Electric Corporation
Isuzu parts number		181100-4140
Manufacturer code number		M008T60971
Output		24 V/5.0 kW
Rating		30 sec
York outer diameter		: 85.0 mm { 3.35 in }
Rotational direction		Right
Protection type		Dust proof, drip proof
Low speed mechanism		Inner contact gear
Weight		: 7.2 kg { 15.9 lb }
Pinion	Module	3
	Pressure angle	14.5
	Number of teeth	11
	Gear ratio {ring gear/pinion gear}	12.8{129/11}
No load	Voltage	23 V
	Current	85 A or less
	Rotational speed	3,300 rpm or more
Restraint	Voltage	9 V
	Current	1,400 or less
	Torque	88N・m{9kgf・m} or more
Pinion/engaged voltage		16.0 V or less

Glow plug	
Item	Type
Preheat device model	Glow plug
Glow plug rated voltage/current	: 23 V /3.5A

Function, Structure, Operation

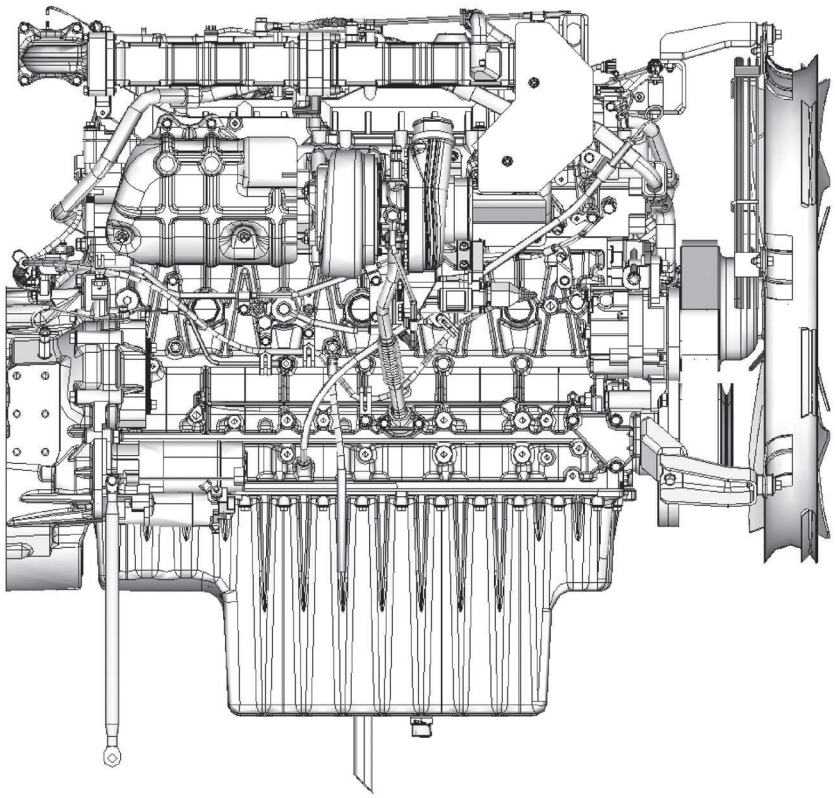
1. Engine number



1. Engine number stamping

2. Function, Structure, Operation

1. Engine structural diagram



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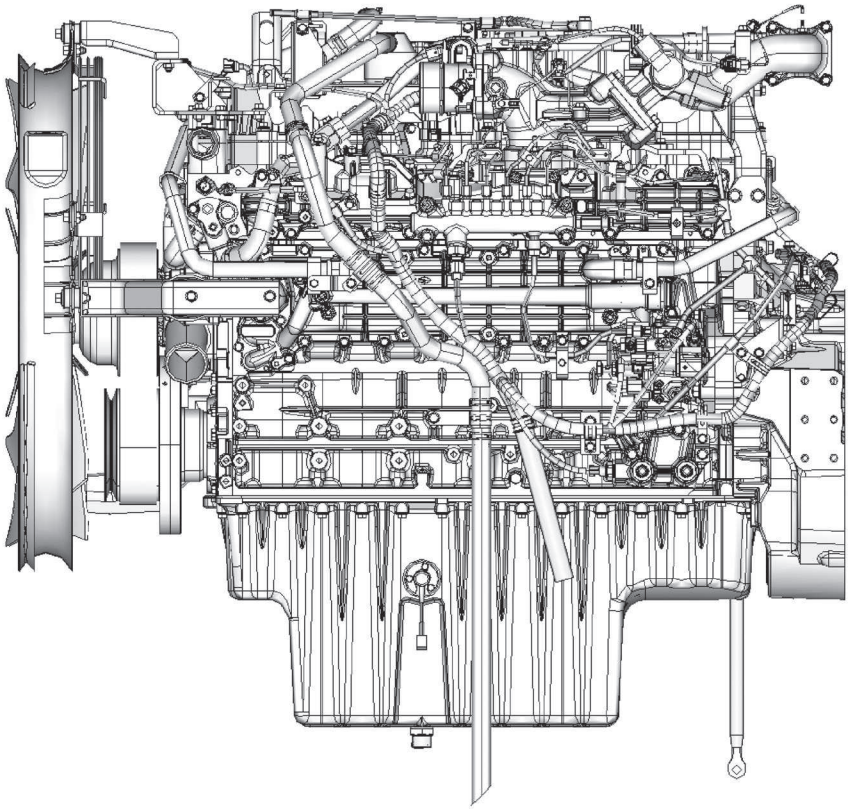

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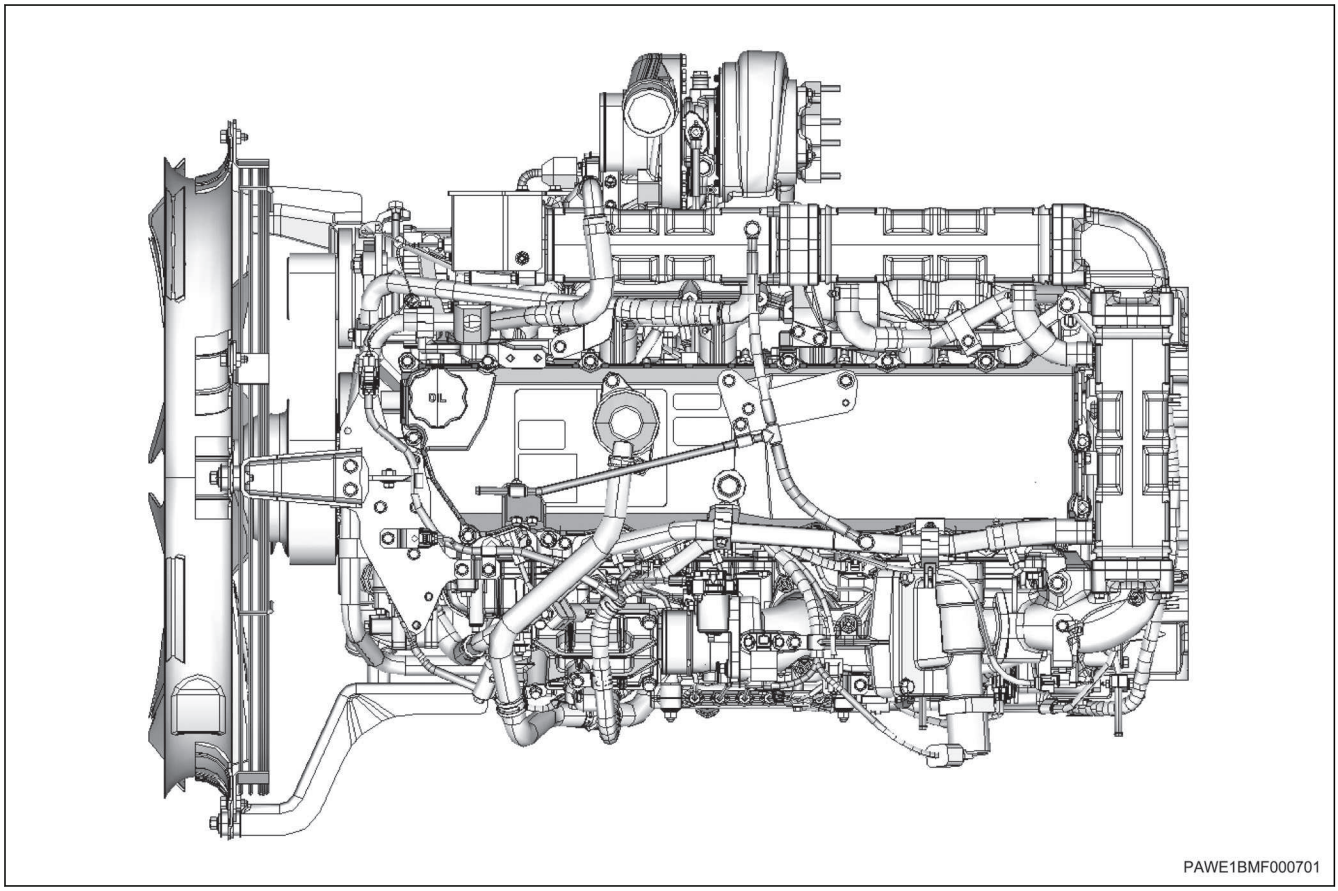


2. Description of functions and operations

Engine electronic control
The control provided by the control unit applies to the range from injection to air intake and exhaust, including fuel injection quantity, injection timing, air intake restriction, EGR, and idling speed.

Cylinder block
The cylinder block is made of cast iron, and it has an equal center distance for each bore and a high rigidity, and the center of the crankshaft matches the center of the block. Tighten the bearing cap using the plastic region rotational angle tightening method with the ladder frame structure.

Cylinder liner
A cylinder liner that matches with the cylinder block bore inner diameter is selected, and the identification number is stamped on the left side of the cylinder.

Piston
The piston is a strut cast auto-thermatic piston made of aluminum alloy, and the combustion chamber is the round re-entrant type.

Cylinder head
The cylinder head is made of cast iron and has four valves per cylinder. The angle tightening method has been adopted for the cylinder head bolt to further improve its reliability and durability.

Crankshaft
The crankshaft uses tufftrided steel, and each of the journal diameter grades are marked on the No. 1 balance weight.

EGR system
The EGR system is controlled by the engine control module (ECM) according to various data, including the water temperature, engine speed, and engine load, to recirculate the exhaust gas for purification.
The primary components are the EGR valve, EGR cooler, and various sensors.

Connecting rod cap bolt
The angle tightening method has been adopted for the connecting rod cap bolt to further improve its reliability and durability.

Common rail (fuel rail) type electronic control injection system
The common rail (fuel rail) type electronic control injection system consists of the fuel supply pump that sets the target pressure of the high-pressure fuel to supply the fuel, the common rail (fuel rail) that measures the high-pressure fuel, and the fuel injector that injects the fuel in the form of a fine mist. Each of these is controlled by the ECM based on various signals that control the injection timing and injection quantity in accordance with driving conditions.

Fuel injector

The fuel injector has adopted the 7-hole nozzle, and adjusts the fuel injection quantity and injection timing by opening or closing the electromagnetic valve on the injector head portion.
The ECM corrects variations in the fuel injection quantity between fuel injectors in accordance with the ID code data in the memory. When adjusting the fuel injector, the ID code data must be recorded in the ECM.

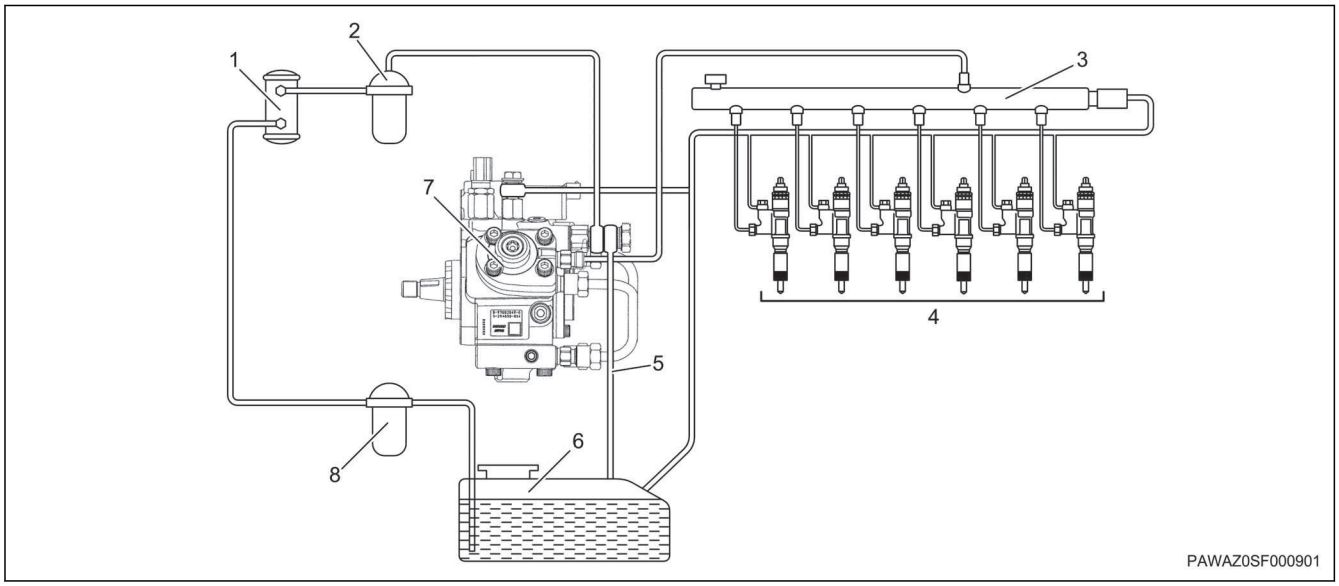
Fuel filter with sedimenter
The fuel filter with sedimenter removes water by using the difference in the specific gravity of diesel oil and water, and notifies the operator through the indicator when it becomes full of water.

Preheat system
The preheat system consists of the ECM, glow relay, glow plug, and glow indicator light. The preheat system is activated when the engine coolant temperature is low so as to help the engine start.

Lubrication system
An oil filter with a full-flow bypass is used, and the pistons are cooled down using the water-cooled oil cooler and the oil jet.

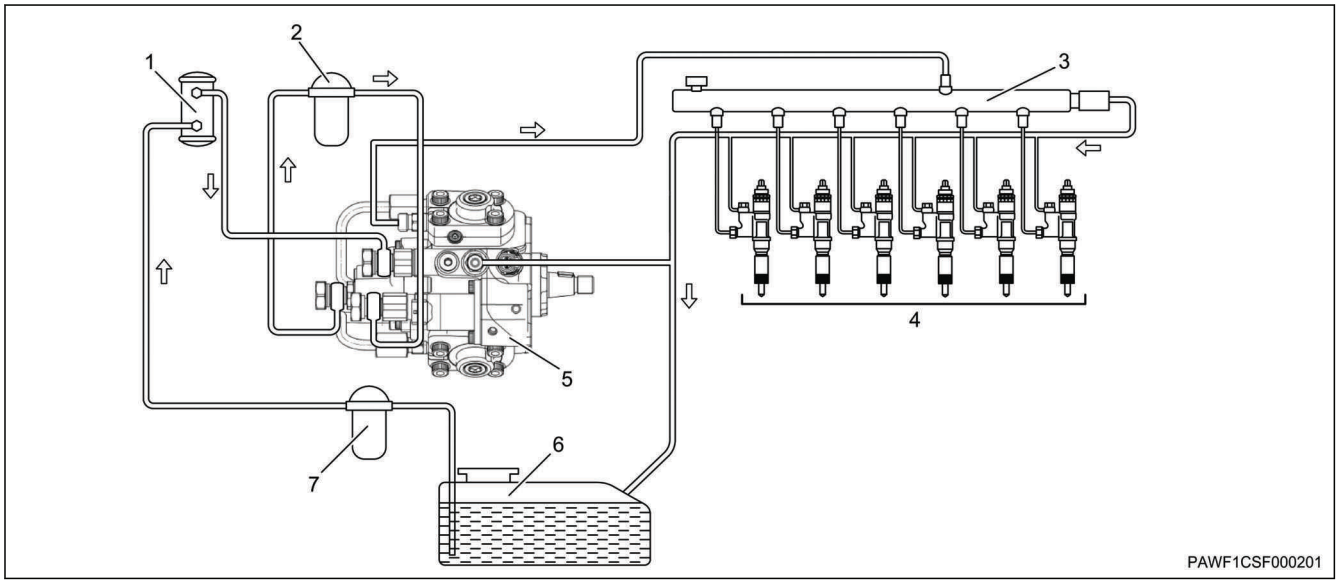
3. Fuel system

Fuel system diagram (Type 1)



1. Solenoid pump
2. Fuel filter
3. Common rail
4. Fuel injector
5. Fuel return pipe
6. Fuel tank
7. Supply pump
8. Pre-fuel filter

Fuel system diagram (Type 2)

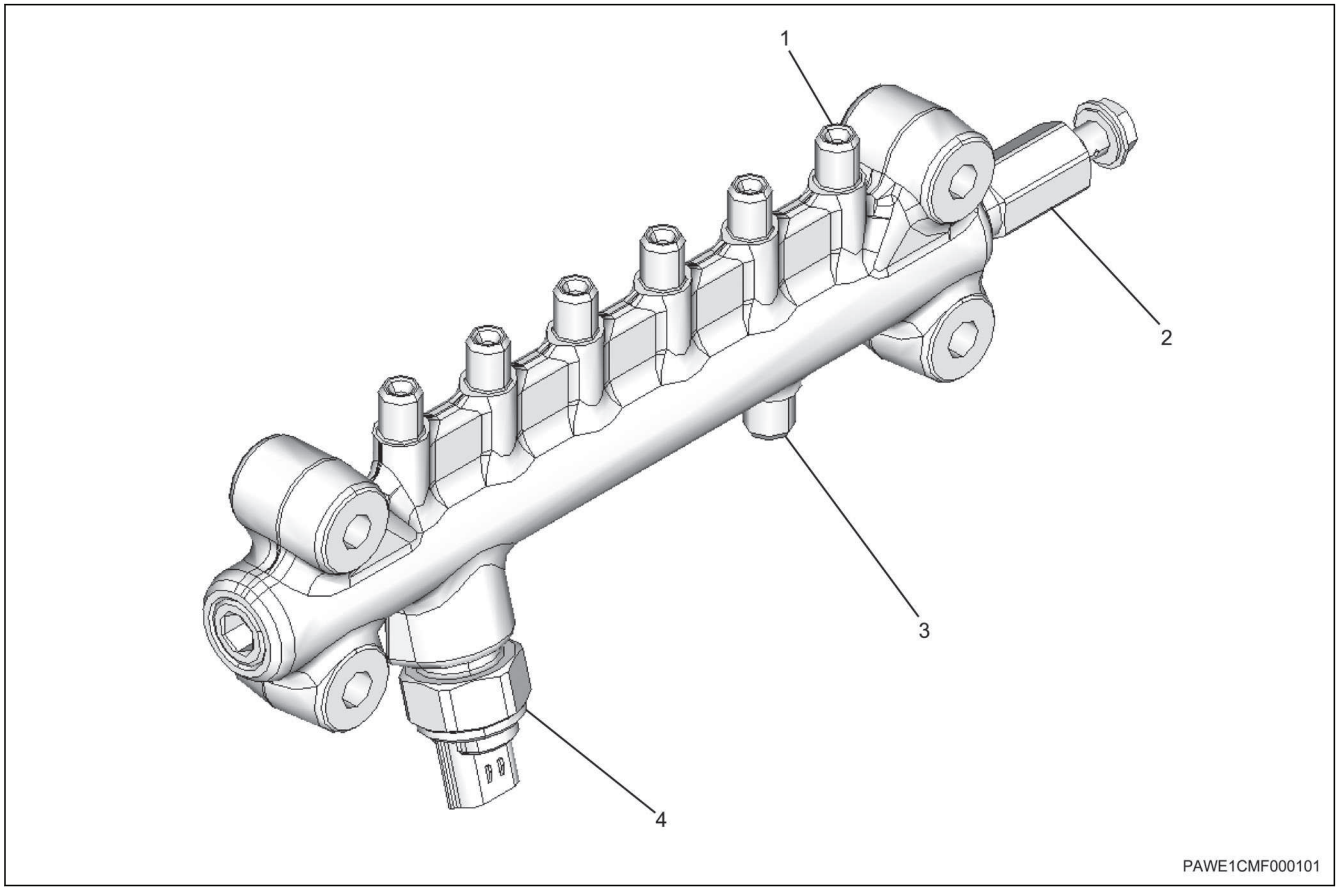


1. Electromagnetic pump
2. Fuel filter
3. Common rail (Fuel rail)
4. Fuel injector
5. Supply pump
6. Fuel tank
7. Pre-fuel filter

Caution :

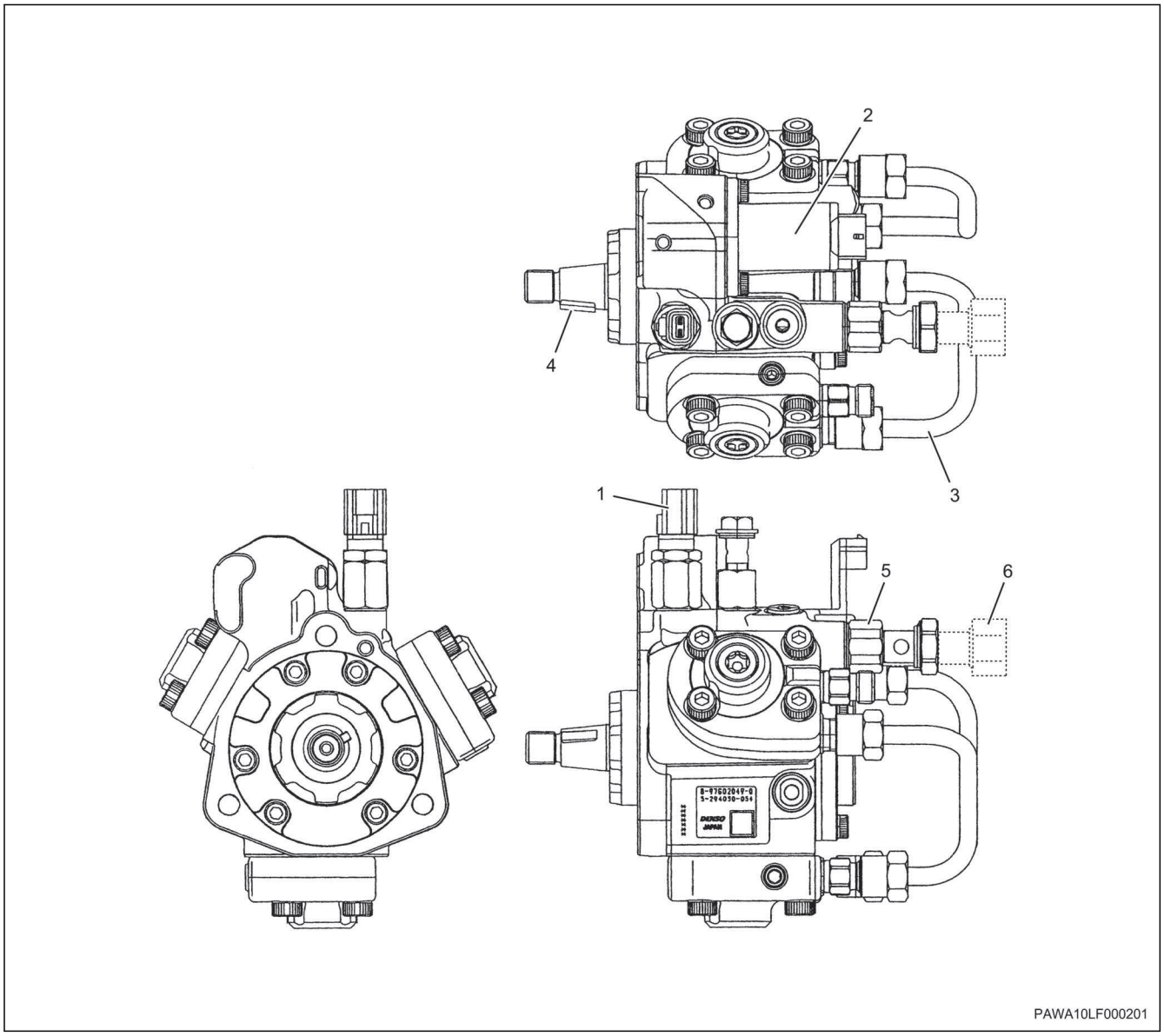
- Since the high-precision fuel system has been adopted, take care to prevent any foreign matter from entering the fuel system.

Common rail



1. Flow damper
2. Pressure limiter
3. Fuel inlet
4. Pressure sensor

Fuel supply pump



1. Fuel temperature sensor
2. Suction control valve
3. High pressure pipe
4. Camshaft nut
5. Union
6. Joint bolt

Caution :

- There is a gauze filter assembled inside the union of the fuel supply pump, but the union should not be removed to prevent any foreign matter from entering.