ISUZU

DIESEL ENGINE 4LE2

TIER 4/STAGE Ⅲ B
EXHAUST EMISSION STANDARDS

WORKSHOP MANUAL

ENGINE

FOREWORD

This manual describes the service procedures for the 4LE2 diesel engine (Tier 4/Stage Ⅲ B 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-2650	ENGINE	0	Introduction
		14A	Service Information Guide
		15B	Maintenance Information
		15C	Functional Inspection
		15D	Sympton
		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
		-	Wiring Diagram

Introduction

Introduction

(All models)

Table of Contents

Introduction

safety information

1. Repair work safety information

Warning：

- Workshop manuals are created for qualified service technicians who have specialized training. If maintenance is performed by a person without the necessary qualifications or who has not received the appropriate training, damage may be caused to the machine, or harm may come to the service technician and people in the vicinity.
- If maintenance is performed without using the appropriate tools and devices, damage may be caused to the machine, or harm may come to the service technician and people in the vicinity.
- If maintenance is performed using procedures other than those indicated in the workshop manual, damage may be caused to the machine, or harm may come to the service technician and people in the vicinity.

Caution：

- When replacing parts, make sure to use only genuine parts because the appropriate maintenance and repair procedures are essential to maintain the safety of the service technician and the safety and reliability of the machine.
- Make sure to read the workshop manual thoroughly before starting the work because it contains procedures and information that must be followed when performing maintenance and repairs.
- When performing maintenance and repairs, correctly use the special tools specially designed for each purpose.
- In order to ensure the safety of the service technician and the safety and reliability of the machine, never perform procedures or use tools other than those recommended in the workshop manual.
- To ensure accidents do not occur during the maintenance and repair procedures, to prevent damage to the machine due to inappropriate procedures, and to ensure the safety and reliability of the machine, the workshop manuals indicate information that must be followed particularly using the terms "Warning", "Caution", and "Note". Therefore, make sure to read the workshop manuals thoroughly before starting the work.
- Prepare the tools, instruments, and special tools in advance.
- Prepare the parts that require replacement and parts that cannot be reused in advance.
- Disconnect the negative terminal of the battery cable in advance.
- Always focus on safety.
- When a procedure is performed by two or more people, make sure to ensure each other's safety before performing an action.
- Do not leave the engine running for an extended period of time or perform painting in a poorly ventilated working environment.
- Make sure to use the special tools if the procedure requires them for the work.
- Do not use tools such as an open-end wrench that has lost its edges, a hammer with frayed edges, or a chipped chisel.
- When performing work using a device such as a grinder, crane, or welder, make sure that a qualified technician performs the procedure while paying sufficient attention to the handling precautions.
- When performing maintenance on the fuel system, verify that there is no fuel leakage.
- When handling volatile materials, take care that they do not catch fire.
- Make sure to wipe away any oil adhering to rubber parts, as it can cause deterioration.
- Arrange removed parts in the correct order and ensure they do not get mixed up with parts that cannot be reused.
- Perform sufficient cleaning and washing when performing assembly/installation.
- Sufficiently remove grease for areas where liquid gasket, etc., will be applied.
- After completing the procedure, perform a final check to verify that the problem has been solved.
- Verify that there is no fuel, oil, or engine coolant leakage.
- Disconnect the battery cable before performing welding work.
- Disconnect all control cables before performing welding work.
- Turn OFF all switches before performing welding work.

- Make sure the ground connection for the welding machine is as close to the welding area as possible.

2. Replacement parts and parts number safety information

Caution :

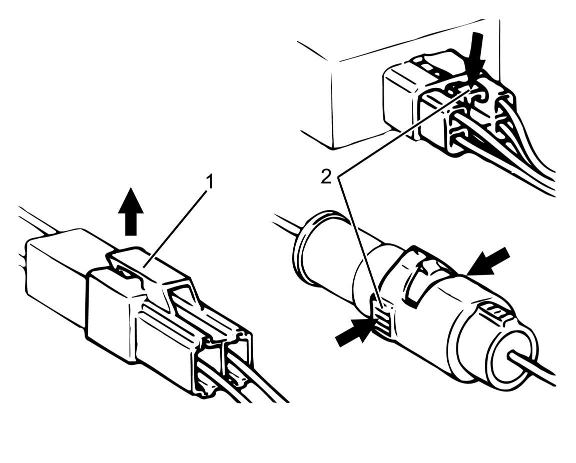
- Whenever disassembly is performed, make sure to replace the packing, oil seals, O-rings, staking lock nuts, bending lock plates, cotter pins, etc., with new ones.
- Make sure to check the supply system and part numbers in the parts catalog because the part numbers indicated in this manual may differ from the supply system and are subject to change.

3. Connector handling safety information

Disconnecting the connector

Caution :

- Many connectors have a lock to ensure secure connections.
- The types of locks generally used are those that open by lifting the release area of the lock, and those that open by pressing the release area.
- Before disconnecting the connector, determine in advance which type of lock the connector is using.



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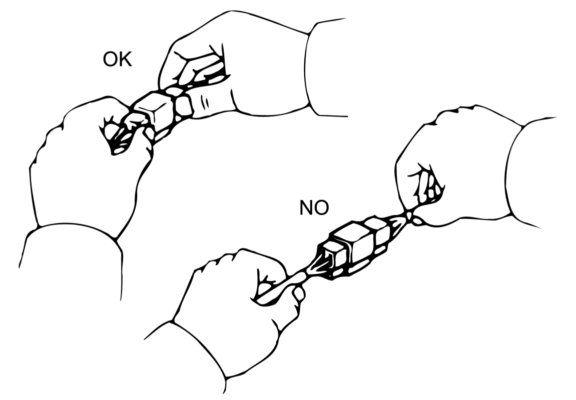
1. Lock
2. Release area

Caution :

- To disconnect the connector, firmly hold the male and female sides of the connector and pull them apart carefully after releasing the lock.
- When disconnecting the waterproof connector, remove dust or moisture adhering to the connector by blowing it with air, etc.
  If dust or moisture enters the connector, remove it before connecting the connector. As for moisture, dry well to prevent rust.
- Do not pull the harness when disconnecting the connector because this may cause the wiring to come out or to become cut.



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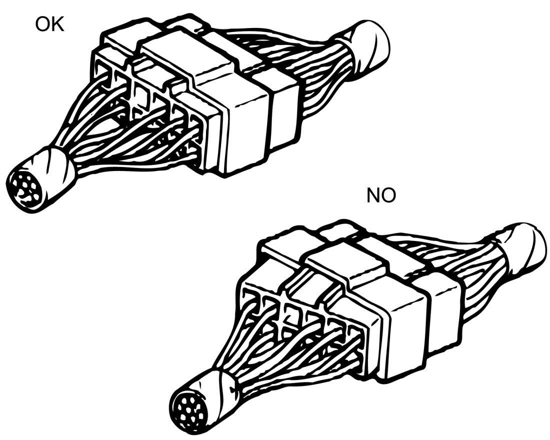
Connecting the connector

Caution :

- Firmly hold the male and female sides of the connector, and align them correctly.
- Firmly push them together until both sides click into place.



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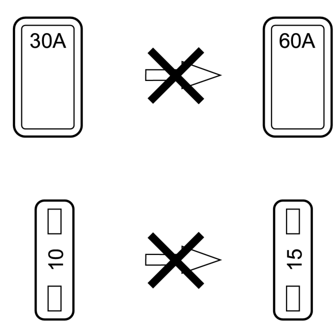
4. Electrical parts handling safety information

Warning :

- If the fuse blows out, identify the cause and replace with a known good fuse of the same capacity.
- If a fuse with high capacity is used, it will not function properly under an excess current.
- This may cause parts, wiring, etc., to burn, and can result in a fire.



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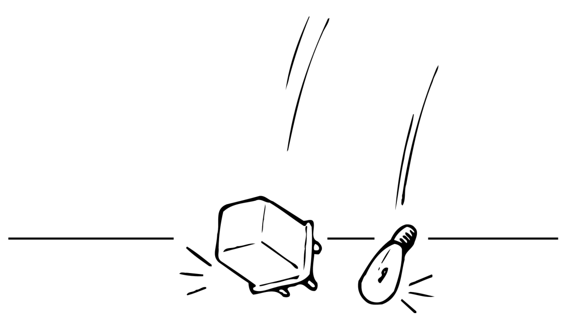
Caution :

- As for electric parts, even for those that are waterproofed, try to avoid exposing them directly to high pressure water when washing (cover them with plastic sheets, etc.) as much as possible.
- Handle electronic parts with sufficient care, and do not damage the parts by dropping, throwing, etc.



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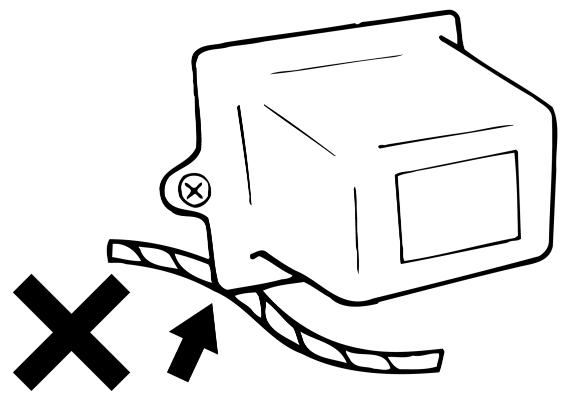
Caution :

- When installing electronic parts, take care to ensure the harnesses do not get pinched and do not forcibly push the harnesses in.



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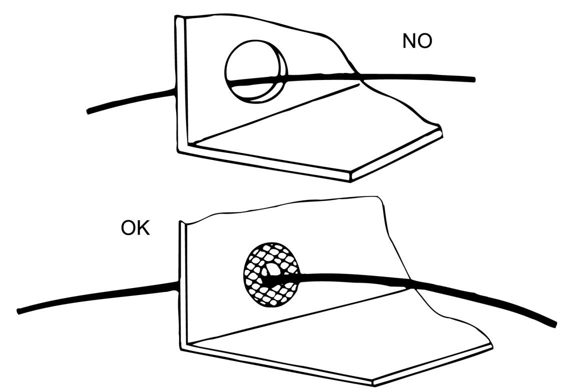
Caution :

- Make sure that all connections are clean and secure.
- If the harness is in contact with sharp edges or surfaces of other parts, protect the harness using a grommet or tube to prevent damage due to the contact.



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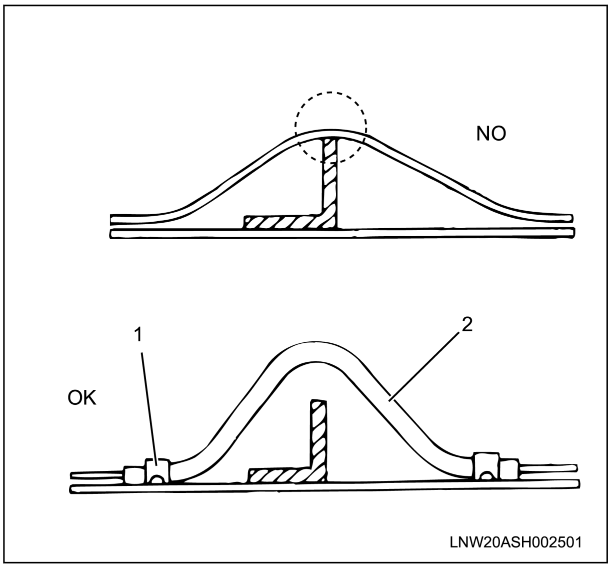
Caution :

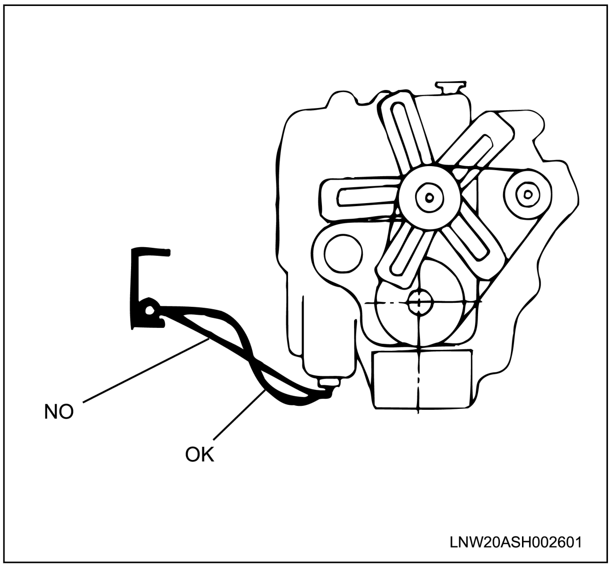
- When wiring the harness by diverting it around other parts, give the harness a sufficient amount of free length, and use a protective tube and clip to ensure it does not make contact with surrounding parts.



1. Clip
2. Protective tube

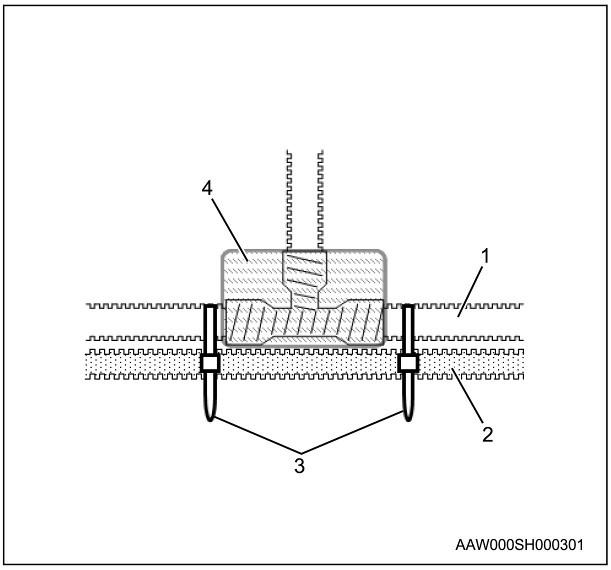
Caution :

- For wiring between the engine and chassis, give the wiring sufficient free length to prevent wear and damage caused by vibration.



Caution :

- When securing additional wires along the existing harnesses, install the band clips on areas of the existing harnesses protected by the protective material (corrugated tube, vinyl chloride tube, rigid tube, protector, etc.).



1. Existing harness (With protective material)
2. Additional harness
3. Band clip for securing harness
4. Prohibited area for securing band clip

5. Commercial electronic products   safety information

Caution :

- If additional electronic components such as lights, audio systems, or wireless devices are installed to the vehicle, turn OFF the power of the devices in advance.
- Otherwise, remove the additional electronic components before inspection or maintenance.

6. Failure by electrostatic discharge safety information

Caution :

- Because high voltage applied to related parts due to electrostatic discharge may cause failure, touch a known good ground before starting the work, and then inspect or replace the related parts.
- Do not directly touch the connector pins of related parts or rub them with parts or covers, etc.
- Connect replacement parts to a known good ground connection while still in their packaging, and remove them while making sure that the connector pins do not touch the packaging.

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, devices, etc.

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

Disassembly
Includes the disassembly procedure for overhauling a unit, assembly part, etc.

Assembly
Includes the assembly procedure for overhauling a unit, assembly part, etc.

Inspection
Includes inspection items for parts requiring special attention during inspection to ensure continued performance of parts, devices, etc.
Values are listed for parts whose specified values, setting values, and use conditions have been determined.

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

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

Adjustment
Includes the adjustment procedure if adjustment to the set or specified values is necessary following assembly or installation.

Measurement
Includes the measurement procedure for judging if parts are installed in the correct locations, 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 changing oil, etc.

Writing
Includes the writing procedure necessary following replacement of the ECM or supply pump.

Precaution
Includes the maintenance precautions specific to each item.

Disconnection
Includes the disconnection procedures for 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 procedure for replacing parts, oil, etc.

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

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

Confirmation of problem resolution
Includes the procedure for verifying the problem resolution by using numeric values, etc., other than the verification that any DTCs are cleared.

Functional description
Includes the detailed functional description related to the functional inspection.

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

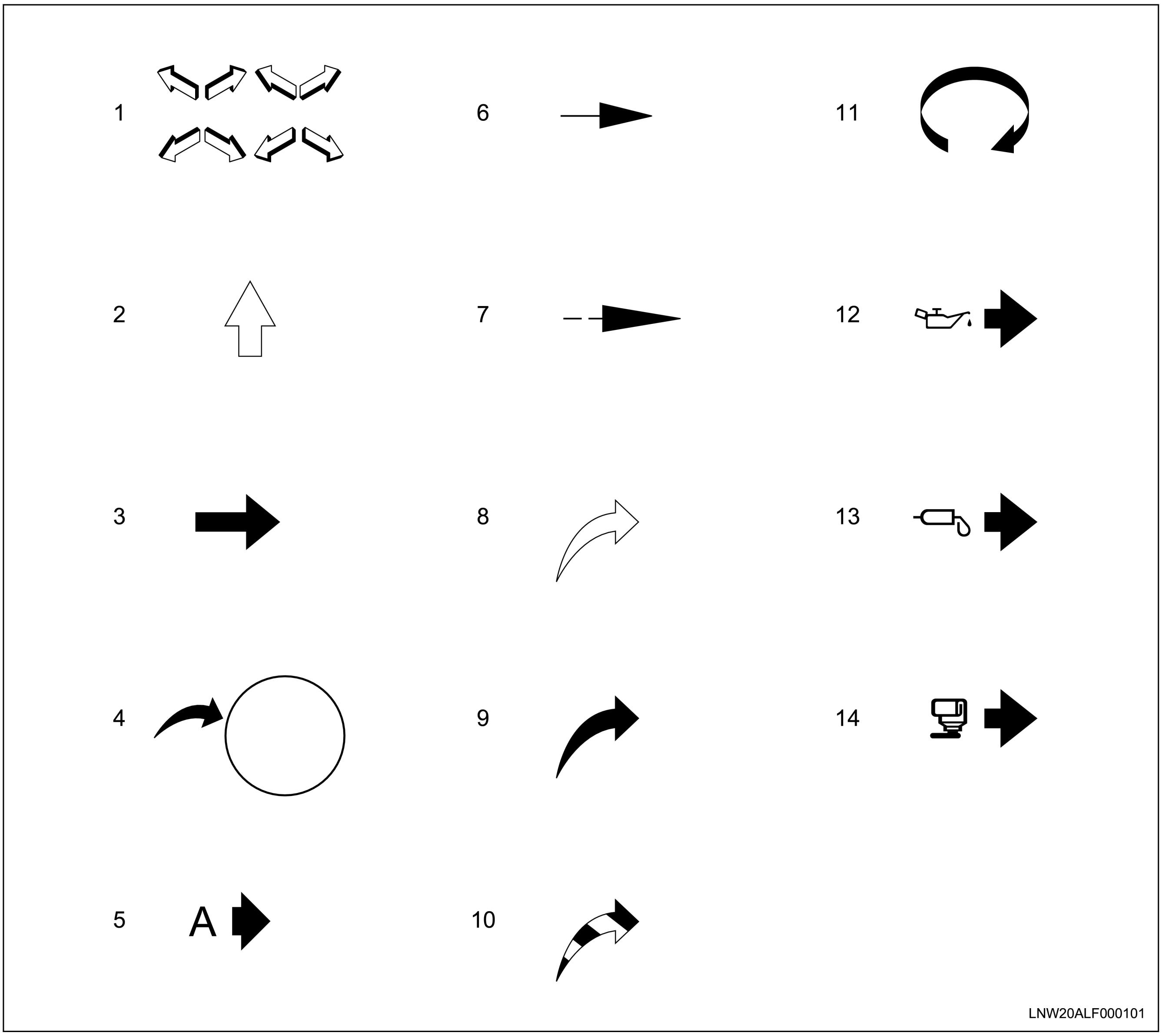
DTC description
Includes the circuit description related to DTCs.

Setting conditions
Includes the preconditions and the judgment conditions for the ECU to set DTCs.

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

Items related to ETM
Items related to the ETM are described in the instructions on how to view the wiring diagram.

2. Arrows and symbols



1. Vehicle front
2. Upward
3. Operating section or operating direction
4. Detail of a particular part
5. Detailed view from A
6. Arrow used for indicating a dimension
7. Arrow indicating a cross-section
8. Outside air or cold air
9. Gas or warm air
10. Mixing of outside air and gas or mixing of cold air and warm air
11. Rotation direction
12. Refuel
13. Lubrication
14. Liquid gasket application

Plastic gauge

1. Using the plasti-gauge

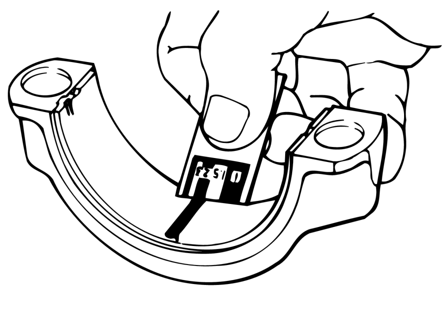
Type	Measurable range
PG-1 (Green)	: 0.025 to 0.076 mm { 0.00098 to 0.00299 in }
PR-1 (Red)	: 0.051 to 0.152 mm { 0.00201 to 0.00598 in }
PB-1 (Blue)	: 0.102 to 0.229 mm { 0.00402 to 0.00902 in }

Method for measuring the gap between the connecting rod bearing and the crank pin
Clean the connecting rod and the bearing, and assemble to 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 the cap, and assemble them on the crank pin. Apply molybdenum disulfide to the threaded portion and the seat surface of the tightening bolts, and tighten the caps alternately to the specified torque.

Caution :

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

Gently remove the cap and the connecting rod, and measure the width of the flattened plasti-gauge using the scale printed on the packaging.



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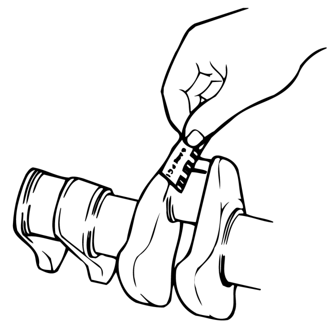

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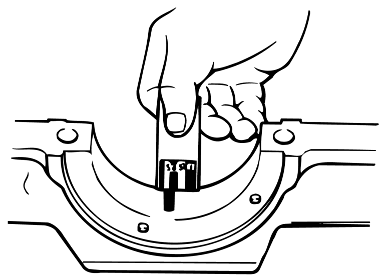
Method for measuring the gap between the crank bearing and the crank journal
Clean the bearing installing surfaces of the cylinder block and the crankcase, and clean the bearings. Then assemble to the cylinder block and the crankcase.
Gently place the crankshaft on the cylinder block, and settle it by 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 the seat surface of the tightening bolts. Tighten to the specified torque in the specified order .

Caution :

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

Gently remove the crankcase and measure the width of the flattened plasti-gauge using the scale printed on the packaging.



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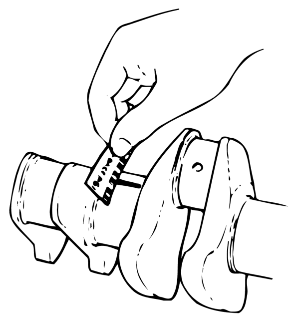

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Recommended liquid gasket

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 1215 ThreeBond 1216	ThreeBond ThreeBond ThreeBond ThreeBond	Engine oil seal retainer Engine oil pan Timing gear case Cylinder head cover Fuel pump Water pump etc.
Water-soluble	ThreeBond 1141	ThreeBond	
Solvent	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 product name above 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 if there is a gap larger than 0.25 mm {0.0098 in} between the contact surfaces of metals.

Whenever disassembling, completely remove the old liquid gasket on the parts and the mating parts where the liquid gasket was used using a scraper, and clean using a waste cloth, etc., so that any oil, moisture, dirt, etc., is removed. After cleaning, apply the specified liquid gasket to each location and assemble.

Note :

- If a gasket remover is used to make the operation during cleaning easier, it is better to wait approximately 10 minutes after applying before starting the removal operation.

Caution :

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

Thoroughly apply a liquid gasket with the specified bead width to one side of the contact surface.

Caution :

- Be careful not to excessively or insufficiently apply liquid gasket.
- Be sure to overlap the start and the end of the liquid gasket application.
- Be careful not to misalign the part with the mating part when assembling applied parts.

Note :

- Apply again if there is a misalignment.
- Use the same size studs as a guide when using for a section which has no positioning such as a knock pin.

Caution :

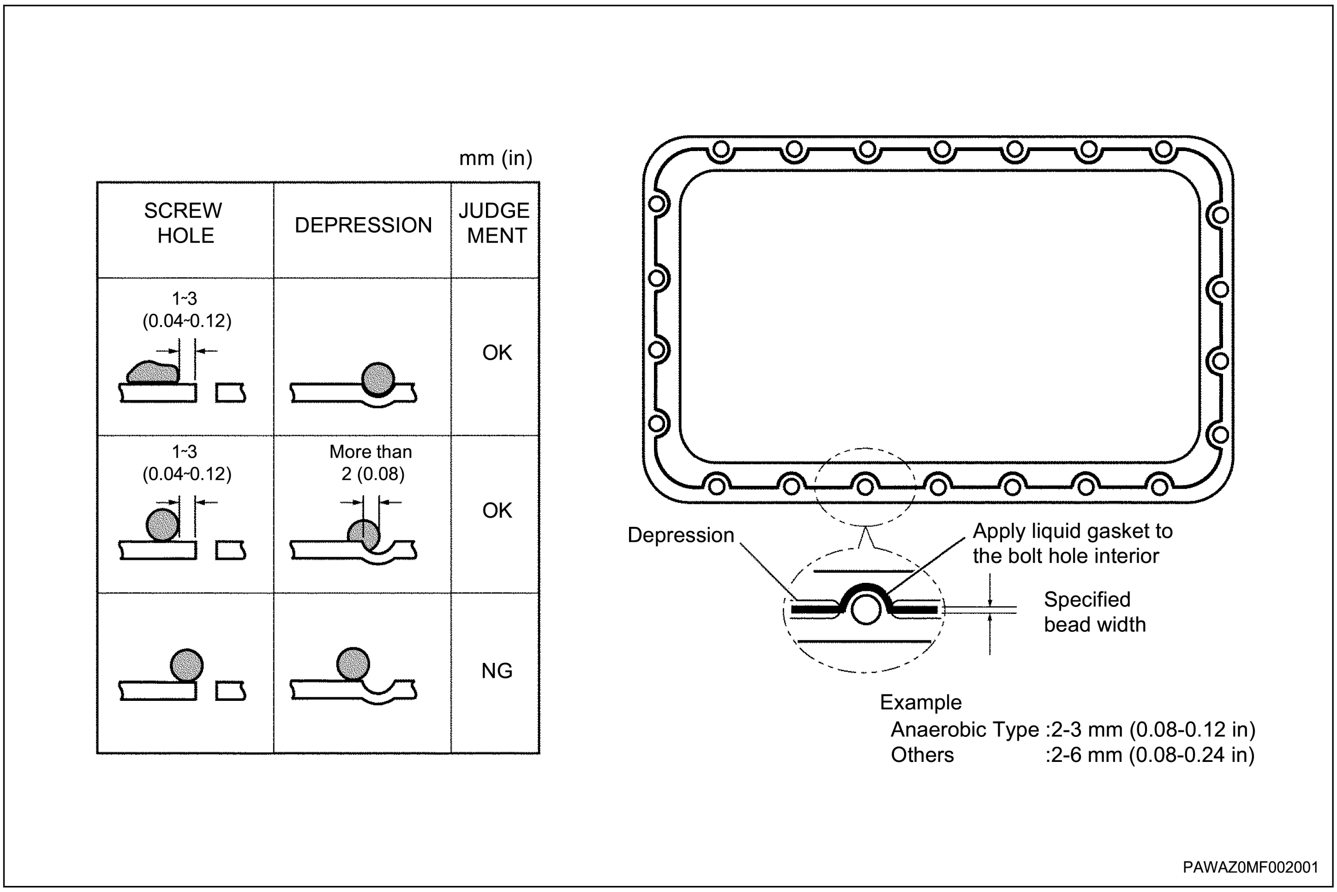
- After applying a liquid gasket, assemble within 15 minutes.

Note :

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

Caution :

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



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：

- Thoroughly remove grime, moisture, oil, and grease from the bolts, bolt holes, and screw thread portion of the nuts to which thread locking adhesive agent will be applied.

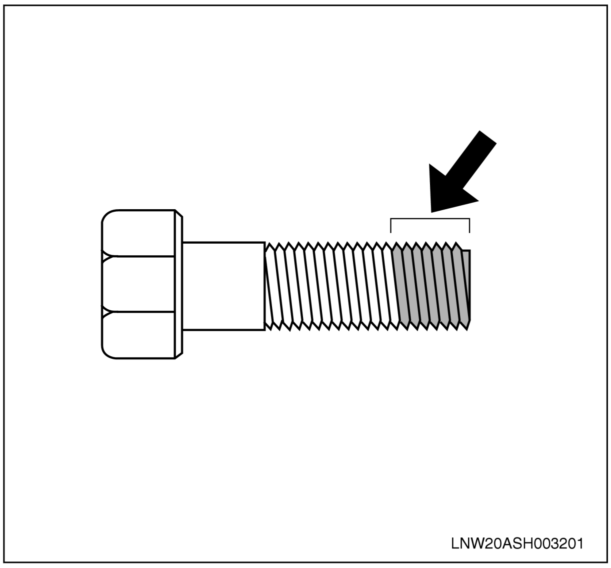
Note：

- Verify that the cleaned sections are dry.

Caution：

- After tightening, do not apply excessive torque or vibration for at least 1 hour until the thread locking adhesive agent hardens.

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



Term

1. Term

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 work.
If this value is exceeded, the relevant part must be replaced or repaired.

Warning
Indicates a precaution which may lead to injury if not observed.

Caution
Indicates a precaution which may lead to physical damage if not observed.

Supplement
Indicates a special note that gives instruction, guidance, or use conditions related to use, operation, repair, etc.

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 top dead center
C/B	Circuit breaker
C/U	Control unit
CAN	Control unit communication method (Control area network)
CKP	Crankshaft position
CMP	Camshaft position
CO	Carbon monoxide
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 multimeter
ECM	Engine control module
ECT	Engine coolant temperature
ECU	Electronic control unit
EEPROM	Electrically erasable/programmable ROM
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	Name plate (ID 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	Microprocessing 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	Particulate matter
PTO	Power take-off
PWM	Pulse width modulation wave
QOS	Quick on start system
QWS	Quick warming up system

RH	Right side
R/L	Relay
RAM	Random access memory
REF	Reference
ROM	Read-only memory
RP	Rail pressure
RR	Rear
Rr	Rear
RWD	Rear
SAE	Society of Automotive Engineers
SBF	Slow blow fuse
SCV	FRP regulator
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
W/H	Wire/Harness
W/L	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 no tightening torque is 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 }	—

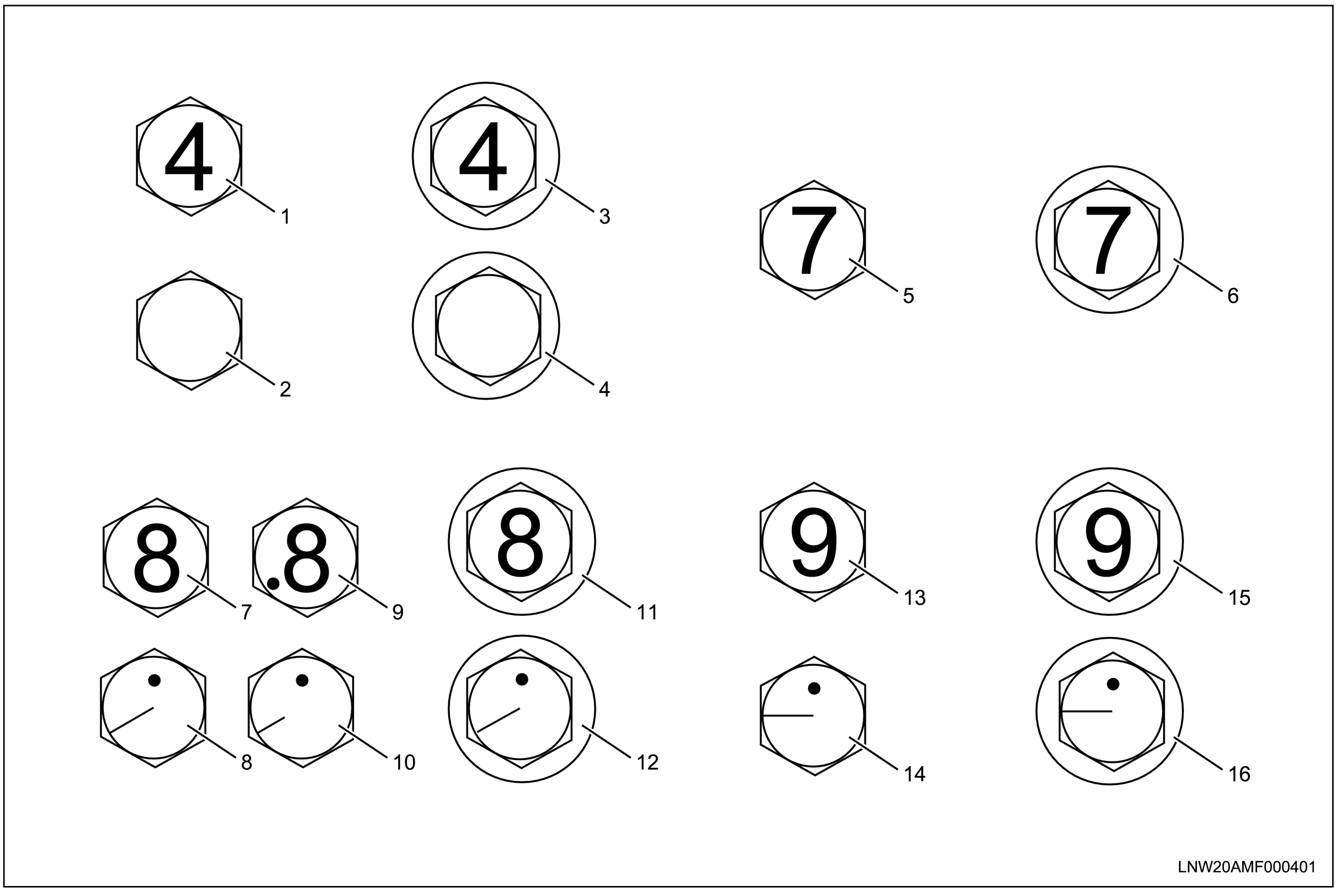
M24 x 2	: 358.9 to 539.4 N・m { 36.6 to 55.0 kgf・m / 265 to 398 lb・ft }	—	: 430.5 to 711.0 N・m { 43.9 to 72.5 kgf・m / 318 to 524 lb・ft }	—
*M24 x 3	: 338.3 to 507.0 N・m { 34.5 to 51.7 kgf・m / 250 to 374 lb・ft }	—	: 406.0 to 608.0 N・m { 41.4 to 62.0 kgf・m / 299 to 448 lb・ft }	—

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 threaded portion of castings made of soft material.
- Refer to the diagram below for the indication of the standard bolt head.



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

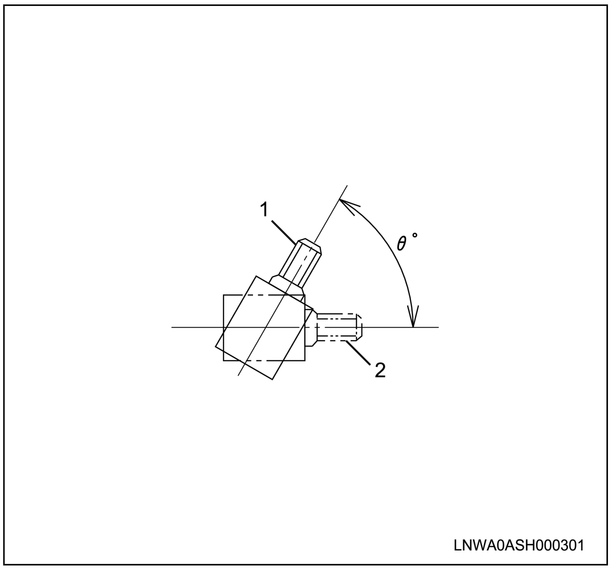
	Pipe diameter	Tightening torque for middle- and large-sized vehicles	Flare nut width across flats	
			Old	New
Tightening torque of the flare nut Service standard value	: 4.6 mm { 0.181 in }	: 12.8 to 18.6 N・m { 1.3 to 1.9 kgf・m / 9 to 14 lb・ft }	: 14 mm { 0.55 in }	: 14 mm { 0.55 in }
	: 6.35 mm { 0.25 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 { 0.2 to 1.5 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 mating side is not made of aluminum.



1. Specified minimum torque position
2. Normal position

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 and then let air in after tightening.
- Do not use seal tape, etc.

Description Engine

Maintenance Information

(4LE2)

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 work.
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 the oil pump strainer, so be careful not to damage the oil pan and the oil strainer.

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

・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 engine oil to the slide contact surfaces 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 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 gaskets, oil seals, and O-rings with new ones.

・For a component with liquid gasket applied, carefully remove the old liquid gasket and clean the component so that no oil, water, dust, etc., remains.
Then, apply the specified liquid gasket to each part before assembling.

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

・When assembling or installing a component, make sure to tighten to 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 wear cotton work gloves.

・When the fuel hose or fuel pipe is removed, cover the opening with a vinyl 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 and cause fuel leakage.

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

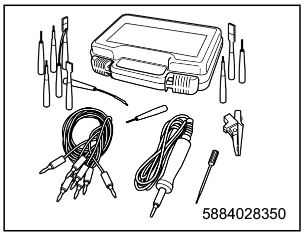
・When the fuel pipe, injection pipe, fuel injector, the fuel supply pump, or the common rail is removed, seal the opening immediately.

・Store the eyebolt and the gasket in a clean parts box with a cover so that foreign material does not become adhered.

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

2. Cautions on electronic system

Using circuit test tools
Unless instructed in the diagnostic procedures, 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

Aftermarket electronic equipment

Aftermarket electronic equipment refers to commercially available electronic equipment attached to the machine after it has been shipped from the factory. Be careful, as such accessories are not taken into particular consideration at the machine design stage.
Aftermarket 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 powertrain problems, confirm whether such aftermarket 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 aftermarket electronic equipment is connected to a circuit that is not involved with the circuits of the electronic control system for both power and ground.

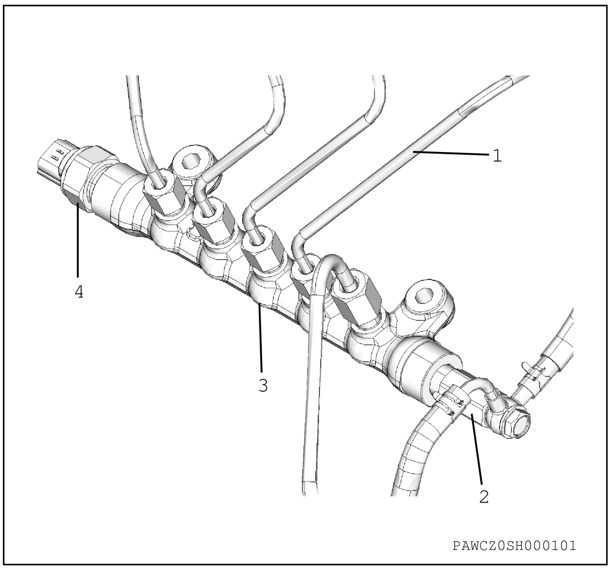
Welding work on the machine
When performing welding work on the machine, make sure to disconnect the battery prior to the work. Current that occurs during welding may lead to failure and/or damage to the electronic control system.

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 an electrostatic charge of 100 V or less, which cannot be felt by humans. Note that a voltage of 4000 V is required for a person to be able to detect an 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 when sliding across the seat of the machine.
A person wearing insulated shoes can build an electrostatic charge by induction if the ground is momentarily touched 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 machine before removing the part from its packaging.
- To prevent damage caused by electrostatic discharge, touch a properly working ground before installing the part when handling it while sliding across the seat, while sitting down from a standing position, or while walking a certain distance.

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



1. Injection pipe
2. Pressure limiter
3. Common rail (fuel rail)
4. FRP sensor

3. Programming

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

Items to check before 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 which 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 4LE2
Type		Diesel/4-cycle/water-cooled, inline 4 cylinder overhead valve
Shape of combustion chamber		Direct injection type
Cylinder liner type		No liner
Cylinder bore x stroke		85 mm {3.35 in} × 96 mm {3.78 in}
Displacement		2.179 L {133 cu in}
Compression ratio		17.6
Compression pressure		: 3.04 MPa { 31.0 kgf/cm2 / 441 psi } 250 r/min
Idling speed		1000 r/min
Valve clearance	Intake	: 0.40 mm { 0.016 in } While cool
	Exhaust	: 0.40 mm { 0.016 in } While cool
Ignition method		Compression ignition
Injection order		1-3-4-2
Lubrication system		
Lubrication type		Compression type
Oil pump type		Gear type
Lubrication oil amount Oil pan capacity		: 10.4 L { 3 US gal / 2 Imp.gal } MAX
		: 7.6 L { 2.0 US gal / 1.7 Imp.gal } MIN
Oil filter type		Combined type
Oil cooling type		Built-in type, water cooled
Cooling system		
Cooling type		Water cooling
Water pump type		Centrifugal type, belt type
Thermostat type		Wax type unit
Thermostat valve open valve temperature		: 82 ℃ { 180 °F }
Coolant capacity		: 4.1 L { 1.1 US gal / 0.9 Imp.gal } Engine only
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-hole
Charging system		
Generator type		AC type
Output	Mitsubishi	: 24 V / 50 A
	Hitachi	: 12 V / 35 A
Regulator type		IC
Starter system		
Starter type		Reduction type
Output	Mitsubishi	: 24 V / 3.2 kw
	Denso	: 12 V / 2.0 kw
Preheat system		
Preheat system type		Glow plug
Glow plug standard voltage/current	24 V	: 23 V / 3.0 A (Reference)
	12 V	: 11 V / 5.5 A (Reference)

Primary specifications of cooling system

Item	Specifications
Water pump	Centrifugal impeller method
Thermostat	Wax pellet type
Open valve temperature	: 82 ℃ { 180 °F } With jiggle valve
Full open temperature	: 95 ℃ { 203 °F } With jiggle valve
Valve lift amount when fully opened	: more than 9.5 mm { more than 0.374 in }

Primary specifications of electrical system

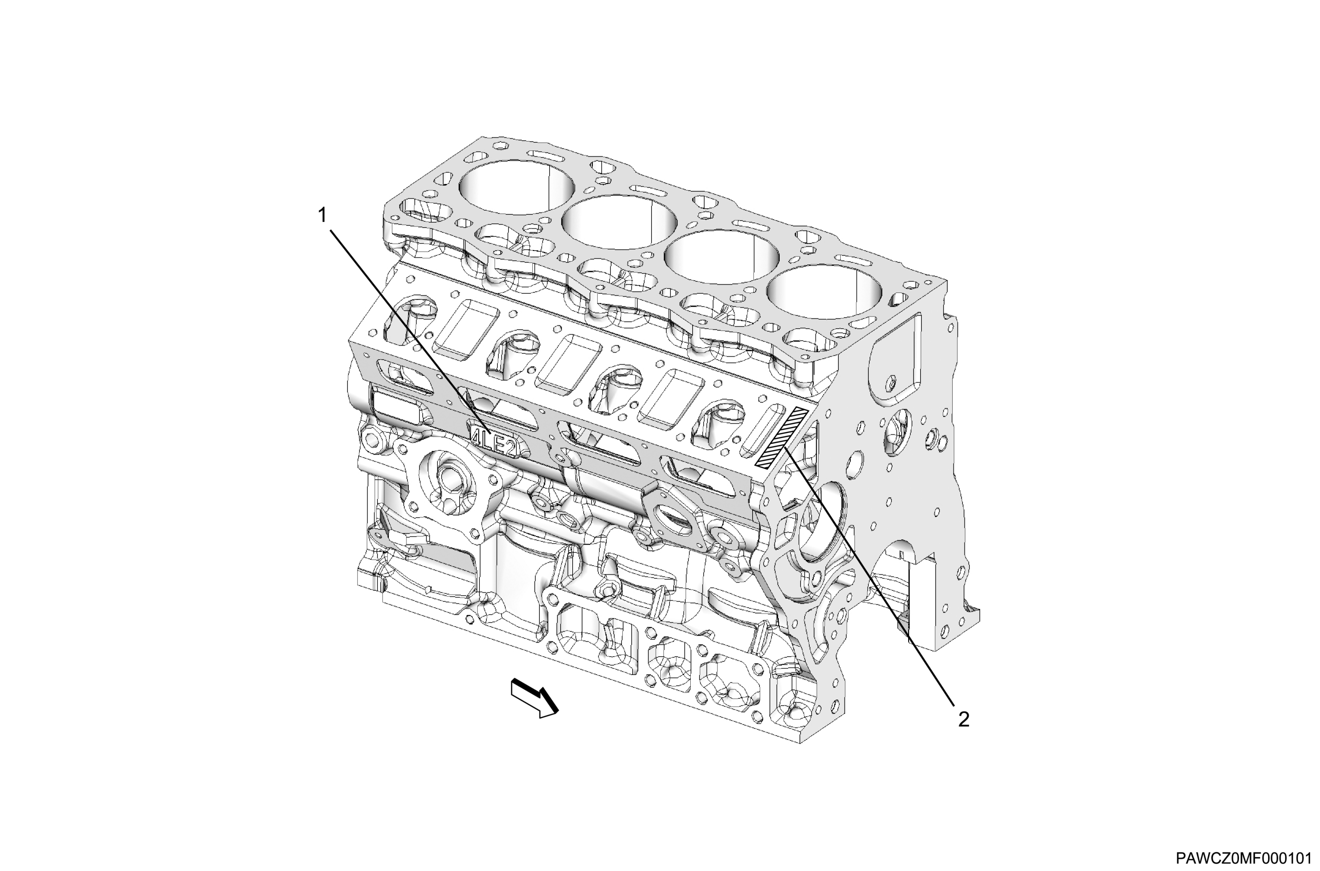
Generator		
Item	Specifications	
Isuzu part number	8980890631	8944237560
Nominal output	: 24 V / 50 A	: 12 V / 35 A
Rated speed	5,000 r/min	
Regulator type	IC type	
Regulated voltage	: 28 to 29 V	: 14.2 to 14.8 V
Weight	: 9.2 kg { 20.3 lb }	: 3.7 kg { 8.2 lb }

Starter			
Item		Specifications	
Type (Manufacturer)		Mitsubishi	Denso
Rating	Voltage	: 24 V	: 12 V
	Output	: 3.2 kW	: 2.0 kW
	Hours	: 30 s	: 30 s
Number of pinion teeth		11	9
Rotational direction (Facing the pinion)		Right	Right
Weight (Approx.)		: 5.8 kg { 12.8 lb }	: 4.7 kg { 10.4 lb }
No-load characteristic	Current/voltage	: less than 80 A / 23 V	: less than 100 A / 11.5 V
	Revolution speed	3750 r/min or more	: more than 4000 r/min
Load characteristic	Current/voltage	: 250 A / 18.6 V	: less than 500 A / 7.5 V
	Torque	: more than 12.9 N・m { more than 1.32 kgf・m }	: 12.7 N・m { 1.3 kgf・m }
	Revolution speed	1550 r/min or more	: more than 1300 r/min
Locking characteristic	Current/voltage	: less than 760 A / 8 V	: less than 800 A / 2.4 V
	Torque	: more than 47 N・m { more than 4.8 kgf・m }	: more than 16.7 N・m { more than 1.7 kgf・m }

Glow plug		
Item		Type
Preheat device model		Glow plug
Glow plug rated voltage/current	24 V	: 23 V / 3.0 A (Reference)
	12 V	: 11 V / 5.5 A (Reference)

Function, Structure, Operation

1. Engine number



1. Engine type stamping
2. Engine number stamping

2. Function, Structure, Operation
   1. 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.

Crankshaft
Do not reuse the crankshaft by grinding, as it has been applied with a tufftriding surface treatment. If a problem is found, replace with a new one.

Piston
The piston is a strut cast thermal flow 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 two valves per each cylinder. The angle tightening method has been adopted for the cylinder head bolt to further improve its reliability and durability.

Crankshaft
Do not reuse the crankshaft by grinding, as it has a tufftriding surface treatment applied. If a problem is found, replace with a new one.

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 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 to control the injection timing and injection amount in accordance with the driving condition.

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 variation in the fuel injection quantity from fuel injector to fuel injector in accordance with the ID code data in the memory. When adjusting the fuel injector, the ID code date must be recorded in the ECM.

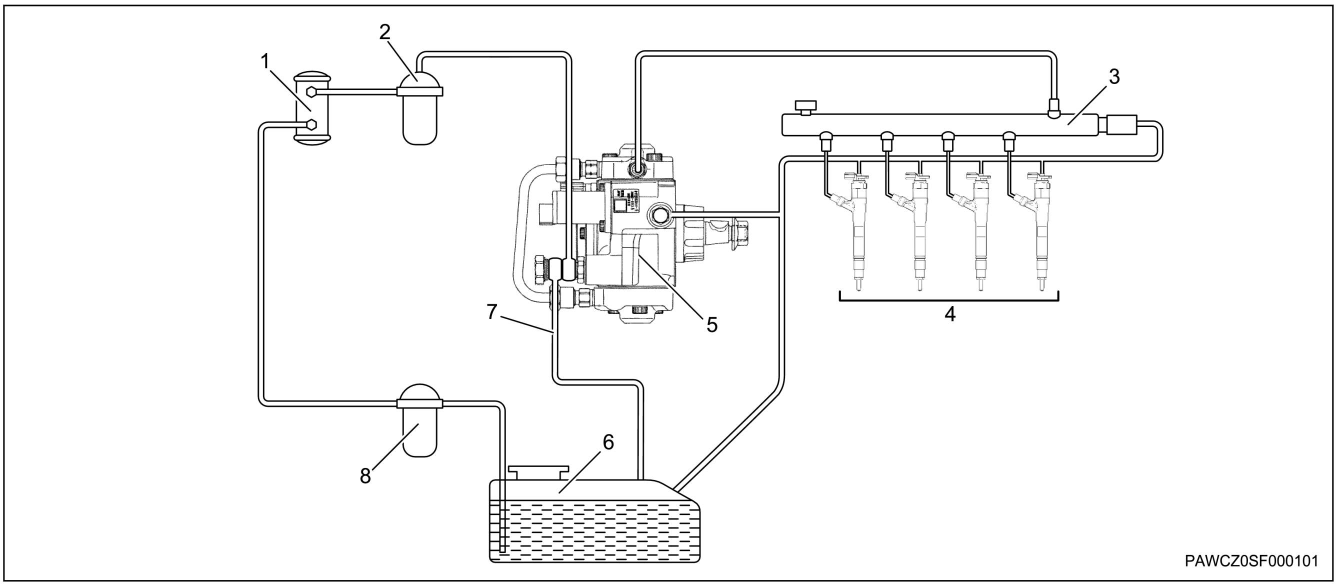
Fuel filter with sedimenter
The fuel filter with sedimenter removes water by using the difference in the specific gravity of diesel oil and water, and notifies the operator through the indicator when it becomes full of water.

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

2. Fuel system

Fuel system diagram

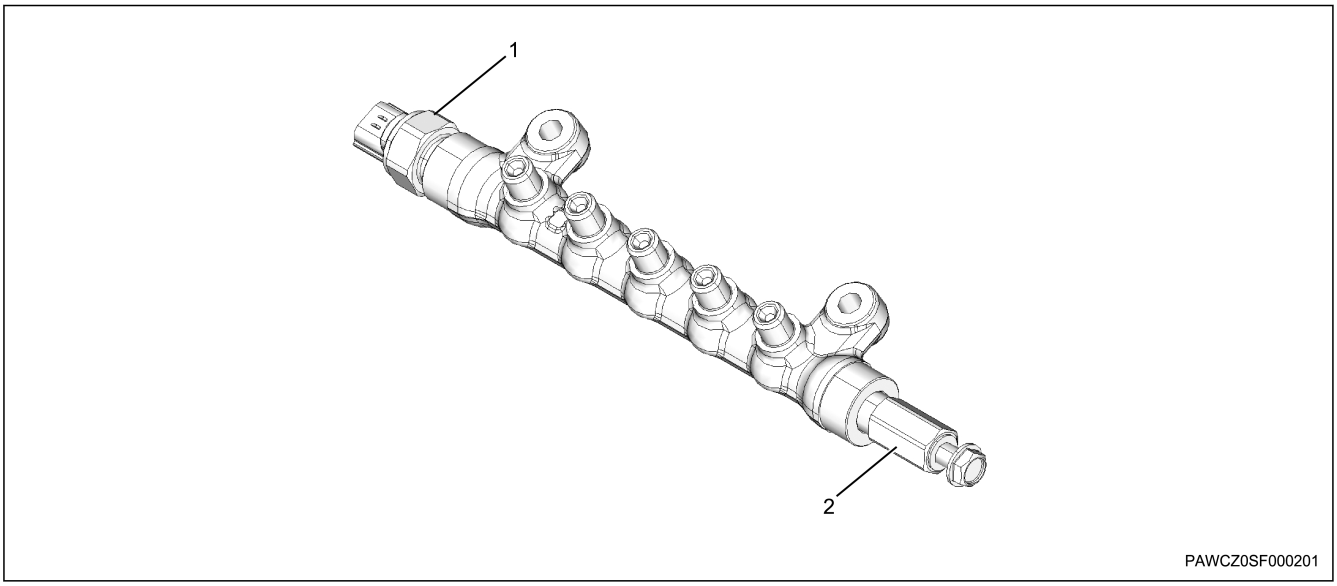


1. Electromagnetic pump
2. Fuel filter
3. Common rail (fuel rail)
4. Fuel injector
5. Supply pump
6. Fuel tank
7. Fuel return pipe
8. Pre-fuel filter

Caution :

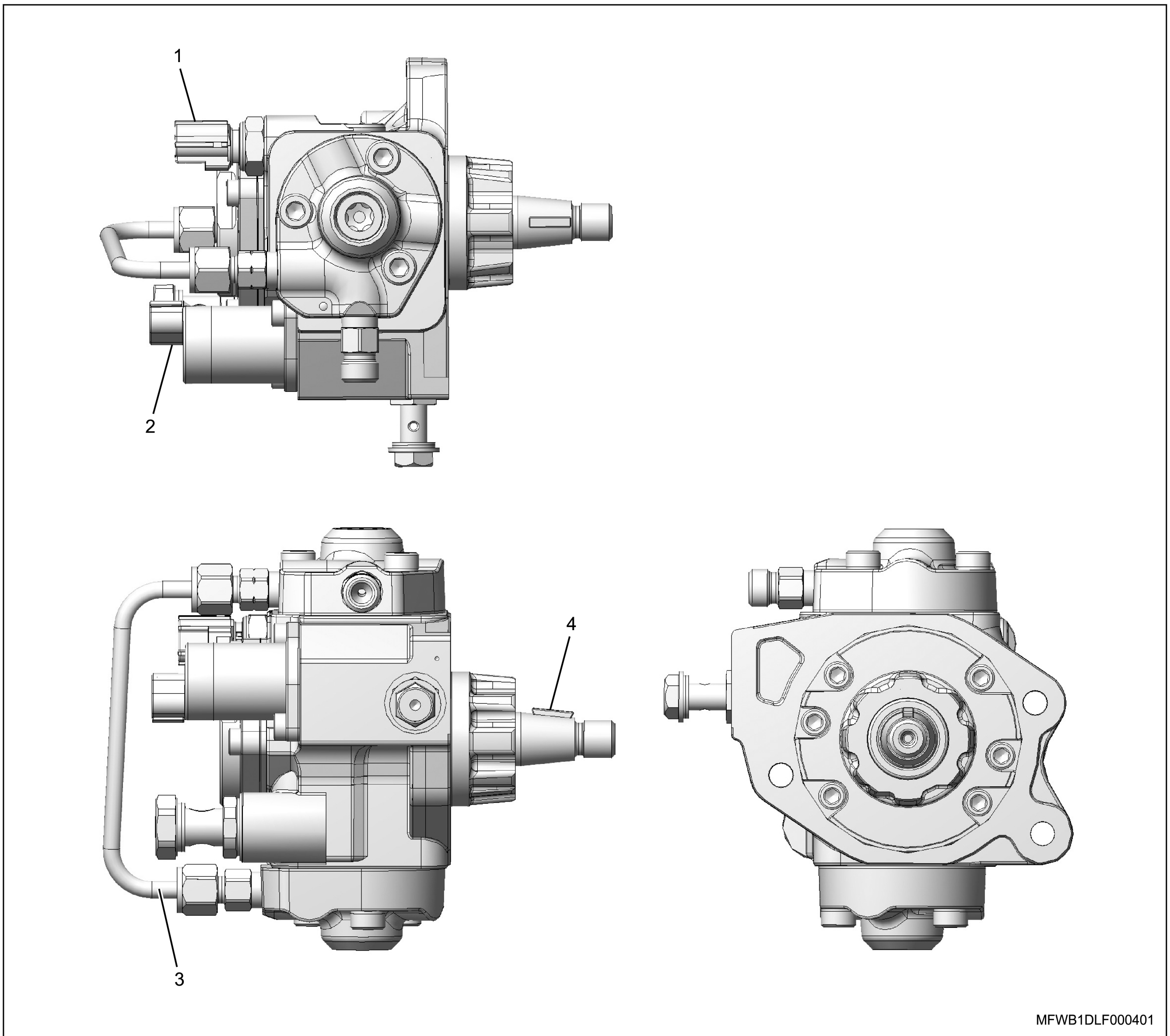
- Since a high-precision fuel system has been adopted, take care to prevent any foreign material from entering the fuel system.

Common rail (fuel rail)



1. FRP sensor
2. Pressure limiter

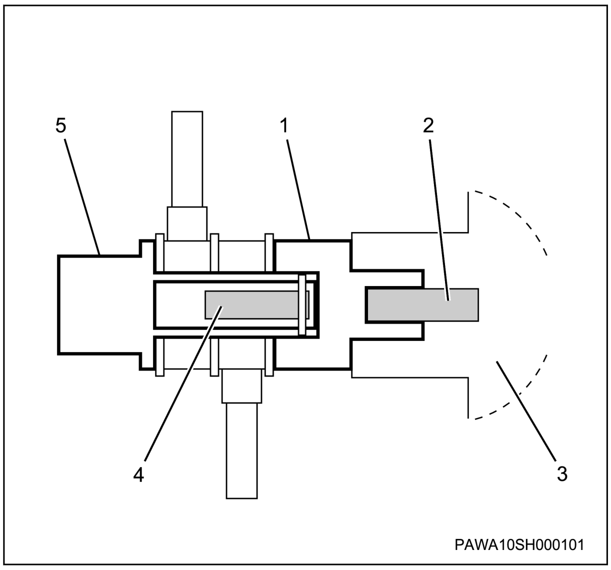
Fuel supply pump



1. Fuel temperature sensor
2. Suction control valve
3. High pressure pipe
4. Camshaft key

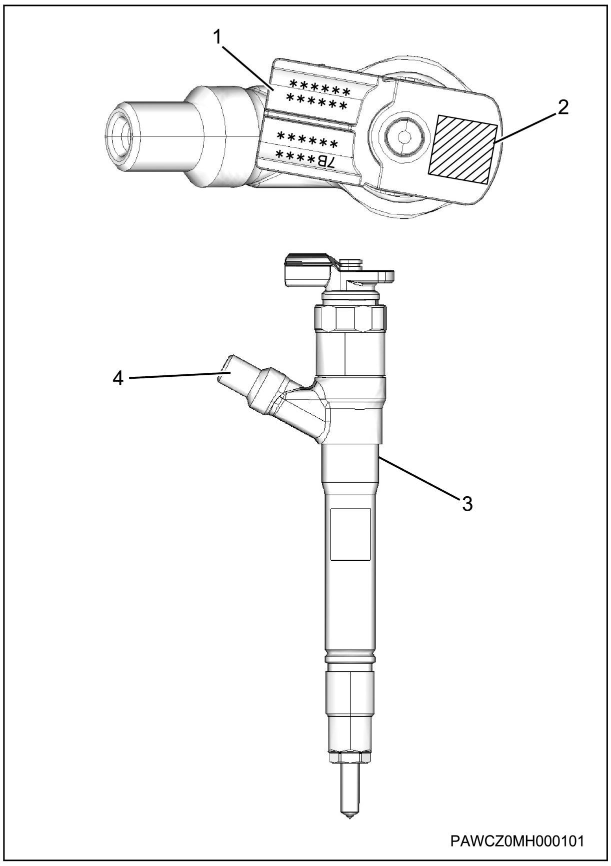
Caution：

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



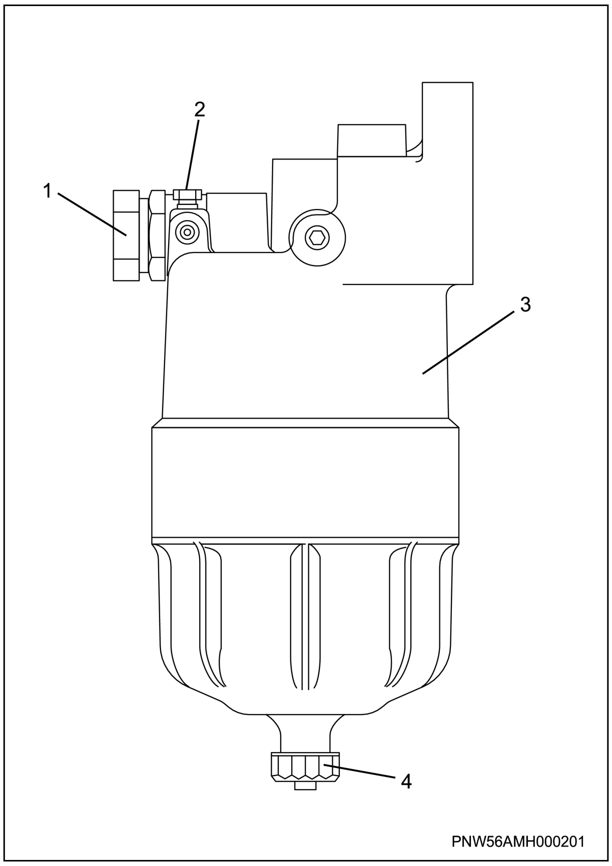
1. Union
2. Gauze filter
3. Supply pump
4. Strainer
5. Joint bolt

Injector



1. ID plate
2. 2D barcode
3. Injector
4. Fuel inlet

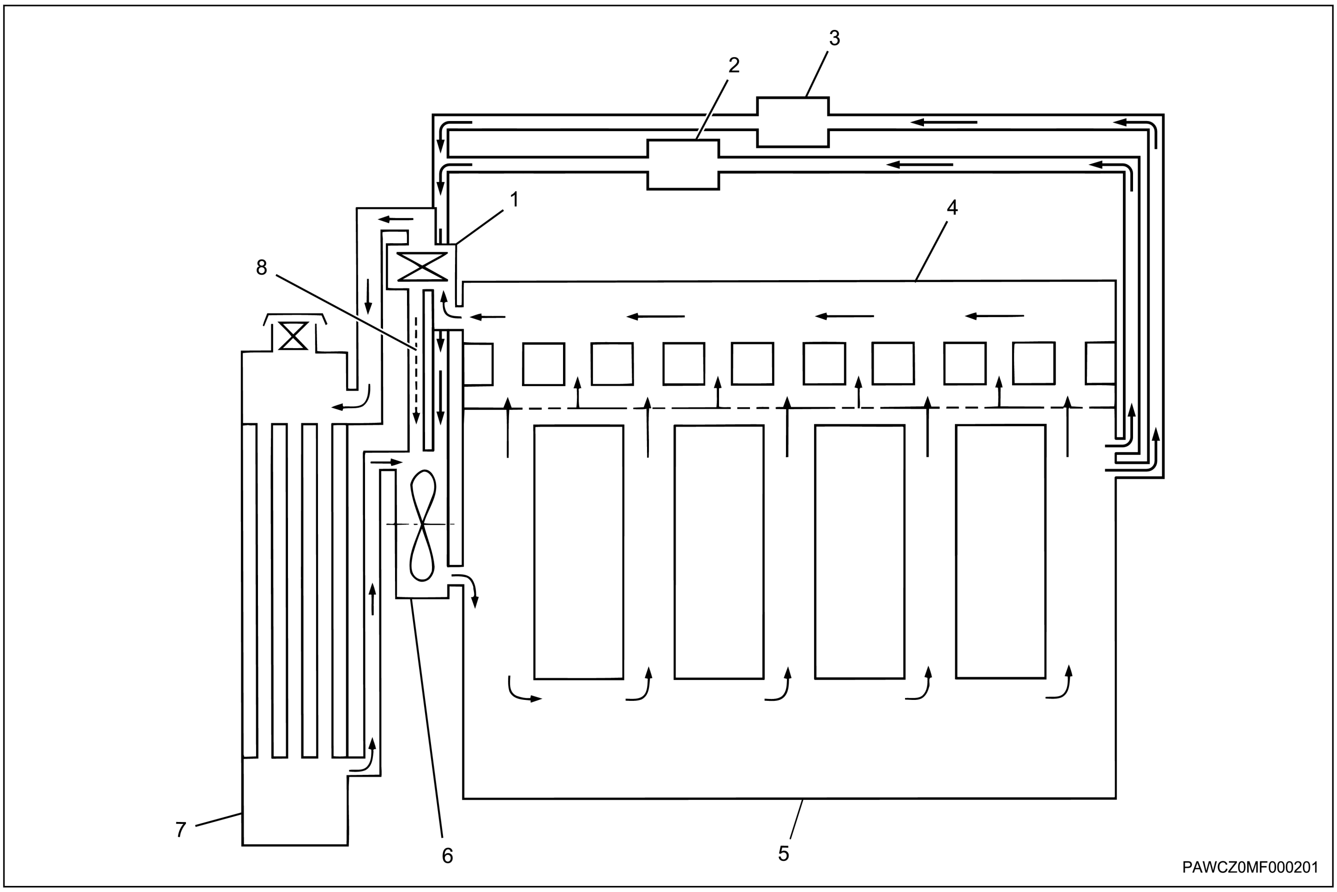
Fuel filter



1. Priming pump
2. Plug
3. Case
4. Drain plug

3. Cooling system

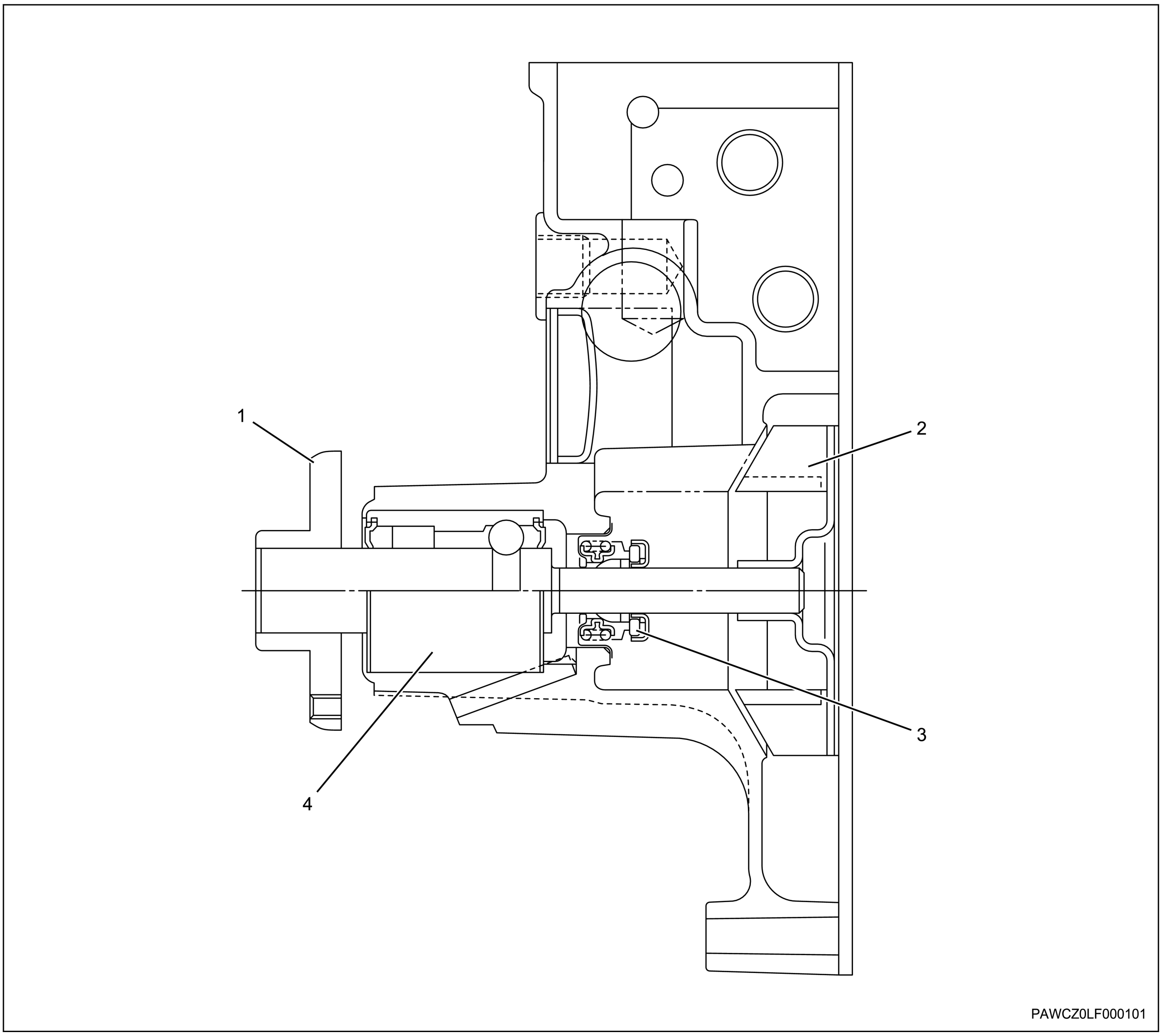
The coolant system is a forced-circulation system, and its main components are the water pump, the thermostat, and the radiator.



1. Thermostat
2. Oil cooler
3. EGR cooler
4. Cylinder head
5. Cylinder block
6. Water pump
7. Radiator
8. Bypass pathway

Water pump

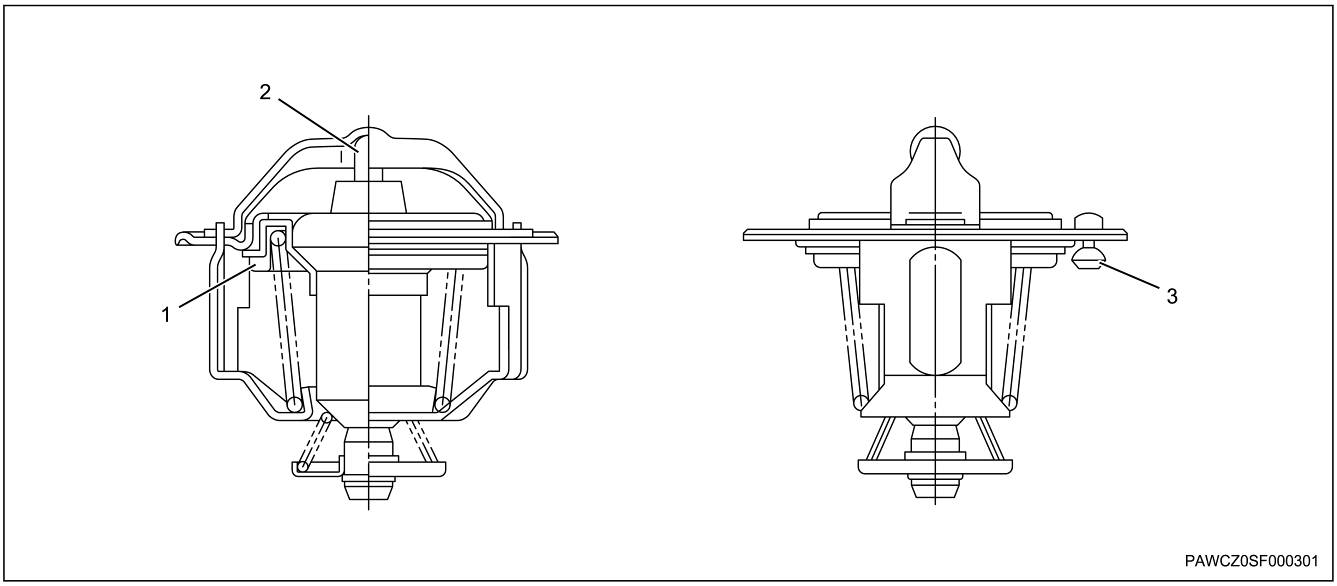
The water pump is a centrifugal impeller type pump and is driven by the engine fan belt.



1. Fan center
2. Impeller
3. Seal unit
4. Bearing unit

Thermostat

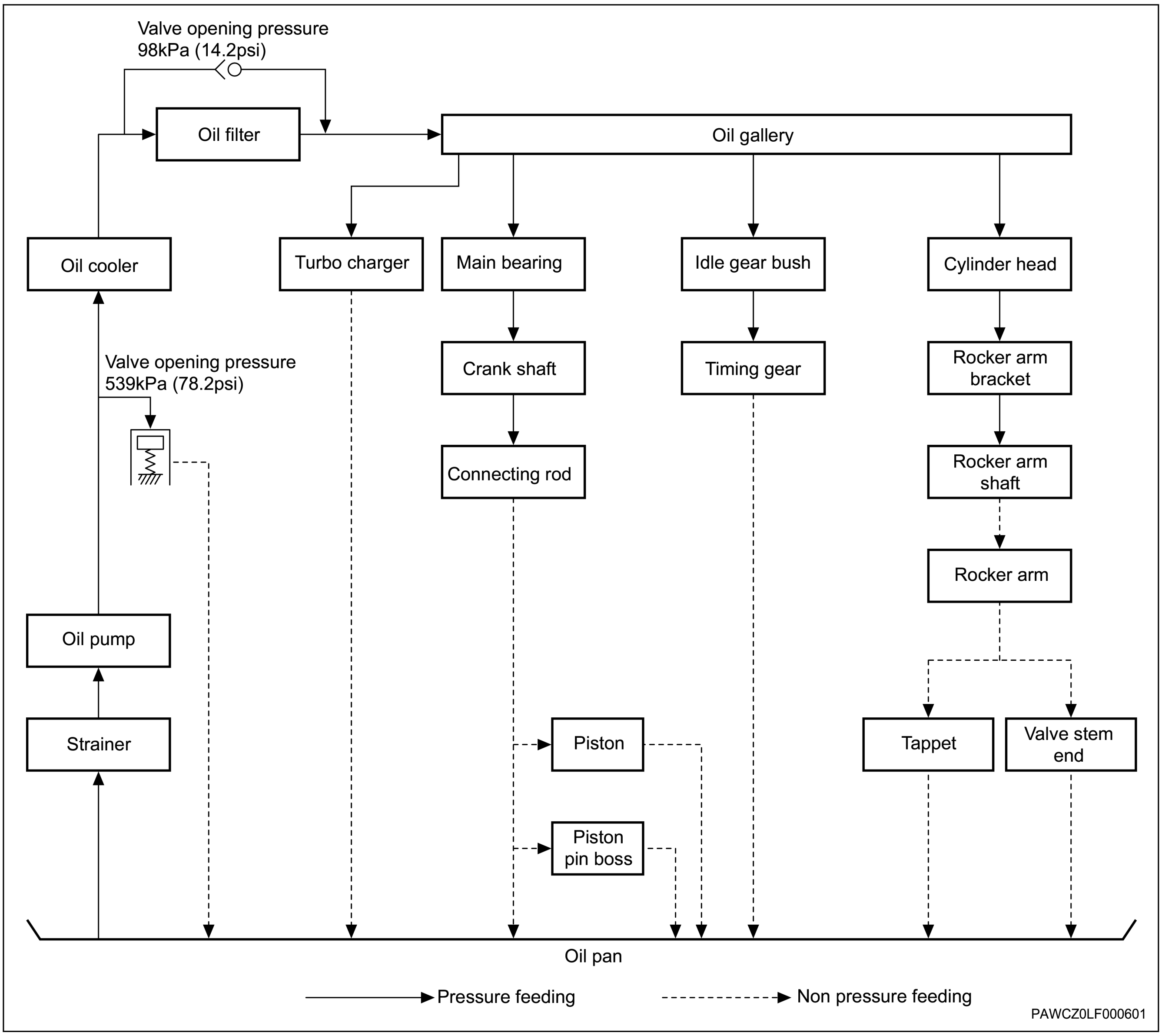
The thermostat is a wax pellet type. The unit is the bottom bypass type with an initial open valve temperature of 82°C {180°F}, and it is assembled inside the thermostat housing unit.



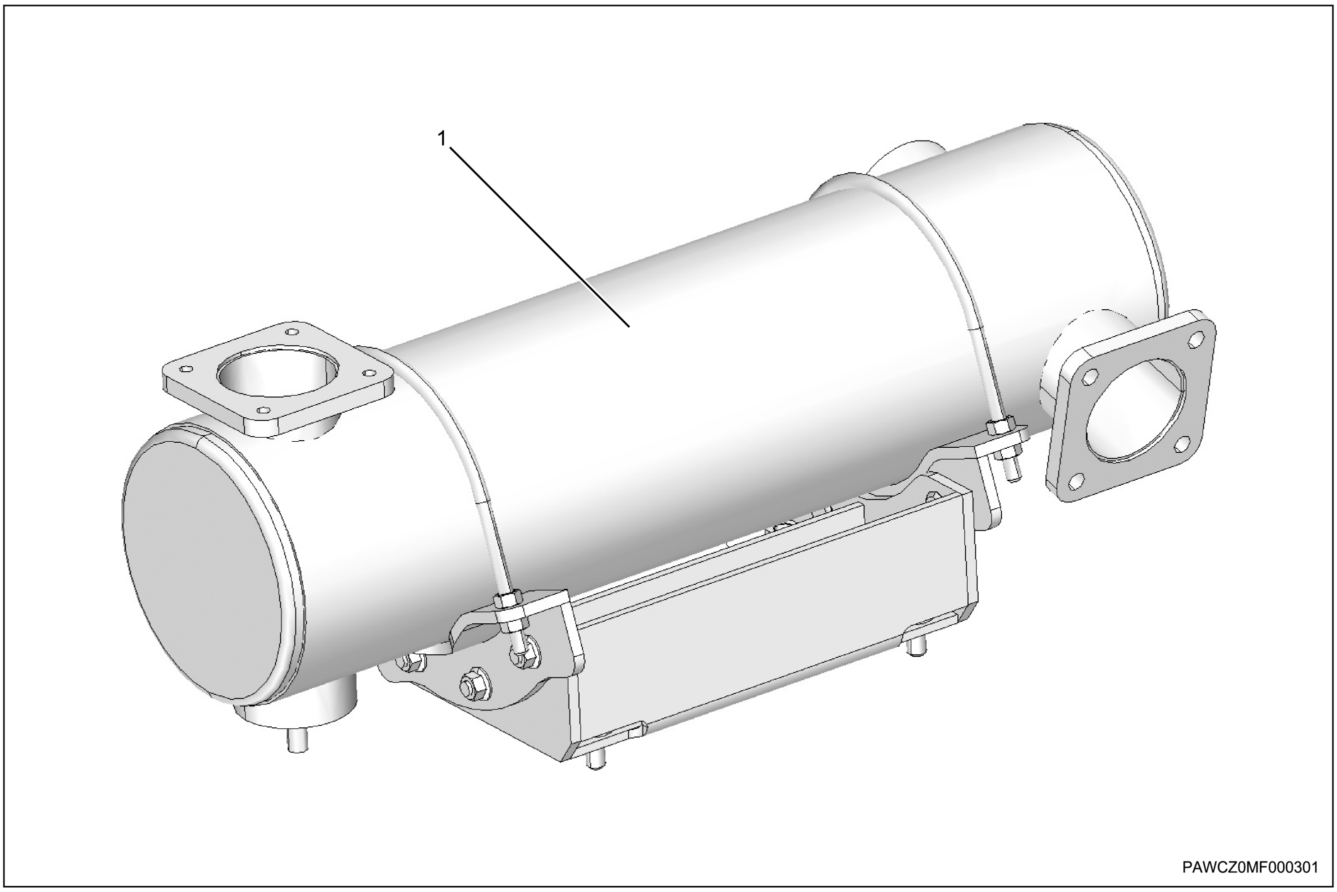
1. Valve
2. Piston
3. Jiggle valve

4. Lubrication type

A full-flow bypass integrated filter element, water cooling oil cooler, and piston coolant oil jet are adopted for the lubrication system.



5. Exhaust system

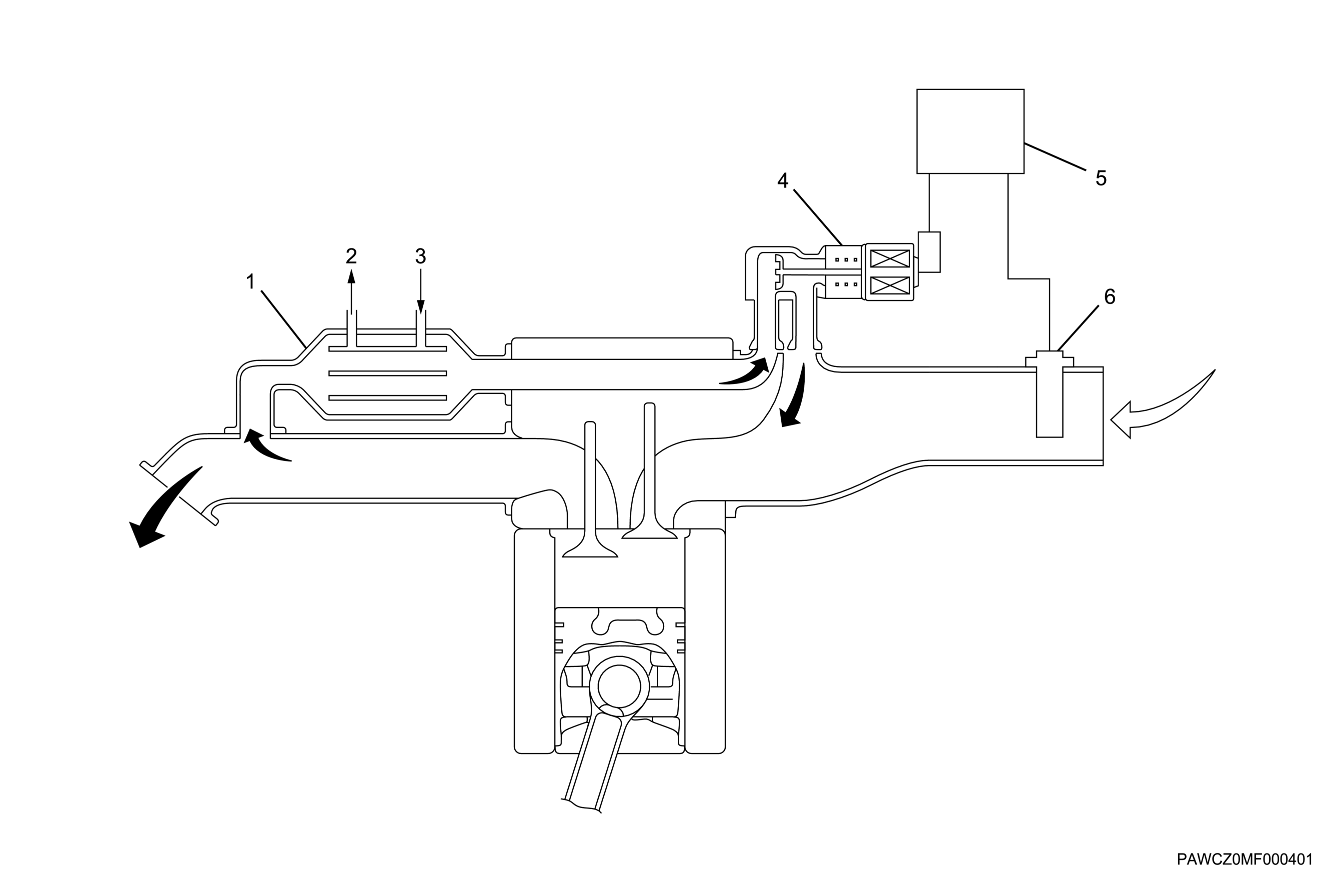


1. Integrated oxidation catalyst silencer

6. Emission control device

EGR
The EGR system recirculates a part of the exhaust gas to the intake chamber and the generation of NOx is suppressed. By controlling the EGR system, high operability and exhaust gas reduction are both achieved. The control current from the ECM activates the solenoid to control the EGR valve lift amount. The EGR position sensor detects the actual valve lift amount and the data is used for precise control of the EGR amount.

The EGR operates when the engine speed, engine coolant temperature, intake temperature, and barometric pressure satisfy certain criteria. Then, the valve opening angle is obtained based on engine speed and the target fuel injection quantity. From this valve opening angle, motor drive duty is determined, based on which the valve is driven.

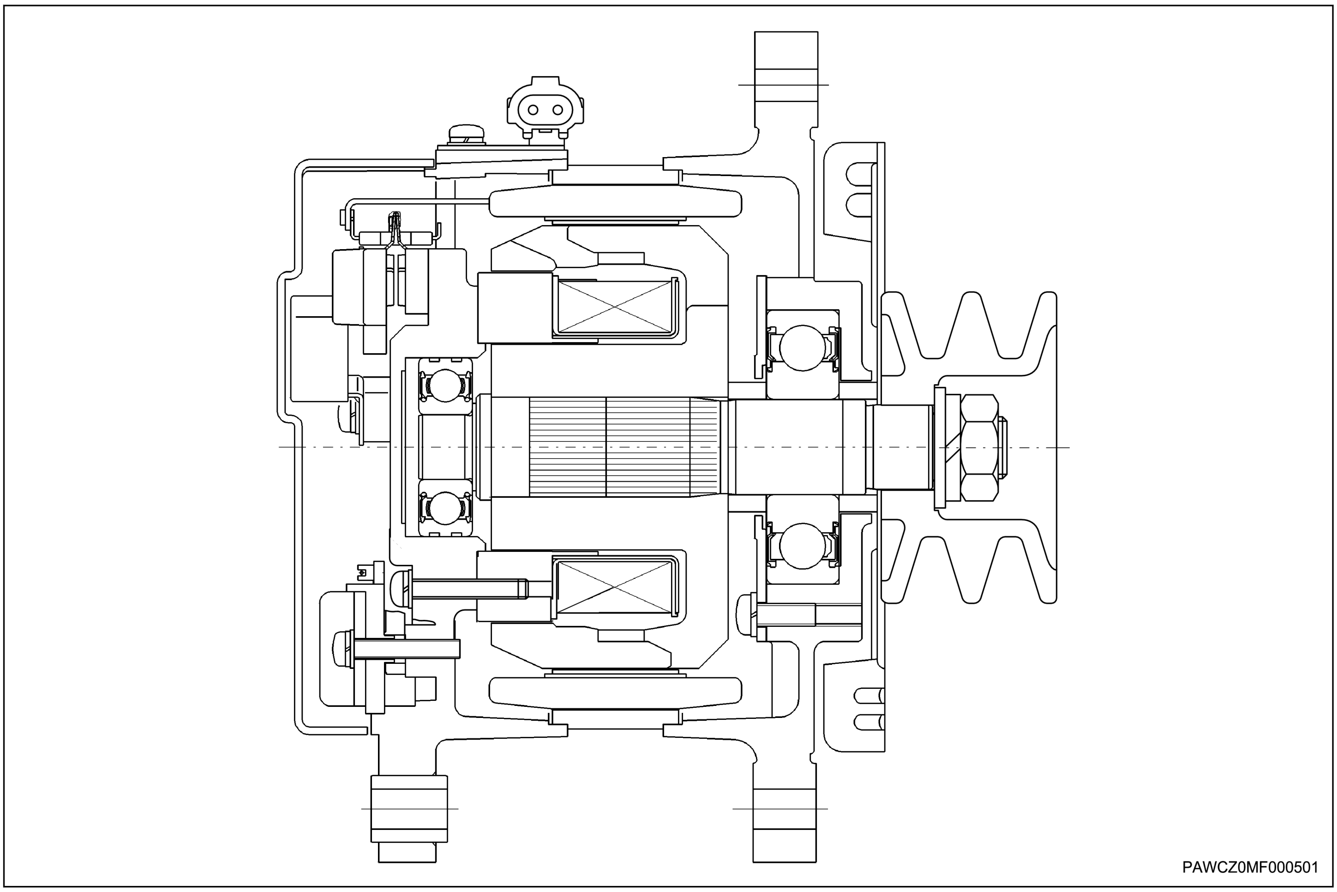


1. EGR cooler
2. Coolant outlet
3. Coolant inlet
4. EGR valve
5. ECM
6. Boost pressure sensor/boost temperature sensor

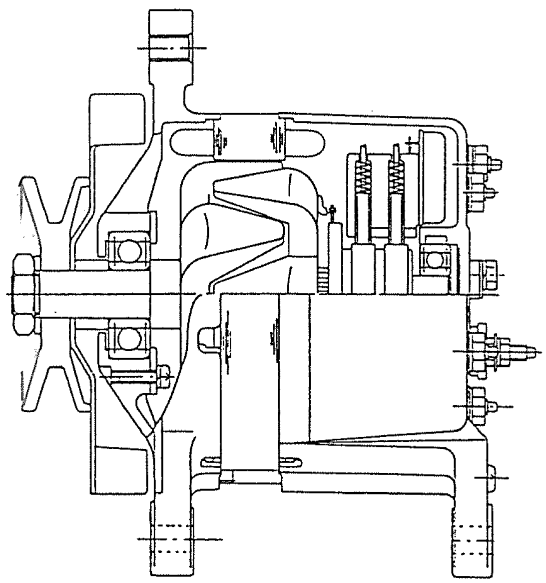
7. Electrical system

Charging system
The main components of the charging system are the battery, the generator, and the battery discharge indicator light circuit. The generator is the self-rectifier type with a regulator built in.

Generator (24 V - 50 A)
The generator is the brushless type.
The main components include the roller, the rectifier assembly, the front bracket, the rear bracket, the IC regulator, the bearing, and the pulley.
The moving parts are the roller and the pulley. The field coil is fixed to the rear bracket.
6 main diodes and 2 additional diodes are used to change the three-phase alternating current generated in the stator coil to a direct current.
3 out of the 6 main diodes are referred to as positive diodes, and the rest are referred to as negative diodes.
In addition, 3 small diodes that are referred to as trio-diode are used to supply the field current.
This generator has 3 terminals: the B terminal (direct current output terminal), the L terminal, and the R terminal.
Since the L terminal is connected to the field coil, it works as an input terminal of the initial excitation current together with the R terminal until the generator starts generating power.
Also, it functions as an output terminal. (Current capacity is 1 A.) When the L terminal voltage reaches the battery voltage, the charge light turns OFF.
Since the both bearings are sealed, periodic lubrication is not required.
The IC regulator cannot be disassembled, so it should be handled as an assembly.



Generator (12 V - 35 A)
The regulator is an integrated solid state type. It is installed together with the brush holder assembly to the rear end cover and is embedded in the generator.
The main components include the roller, the rectifier assembly, the front bracket, the rear bracket, the IC regulator, the bearing, and the pulley. The moving parts are the roller and the pulley.
The IC regulator cannot be disassembled, so it should be handled as an assembly.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Starter system
The starter is 24 V/3.2 kW or 12 V/2.0 kW and is a reduction type.
The gear housing and the armature end bearing housing are made of aluminum. Brush assembly is the replaceable type.
The starter circuit is started using the battery.
The battery cable is connected to a large terminal on the starter.
The wiring is connected from the terminal to the engine control switch and the starter relay.

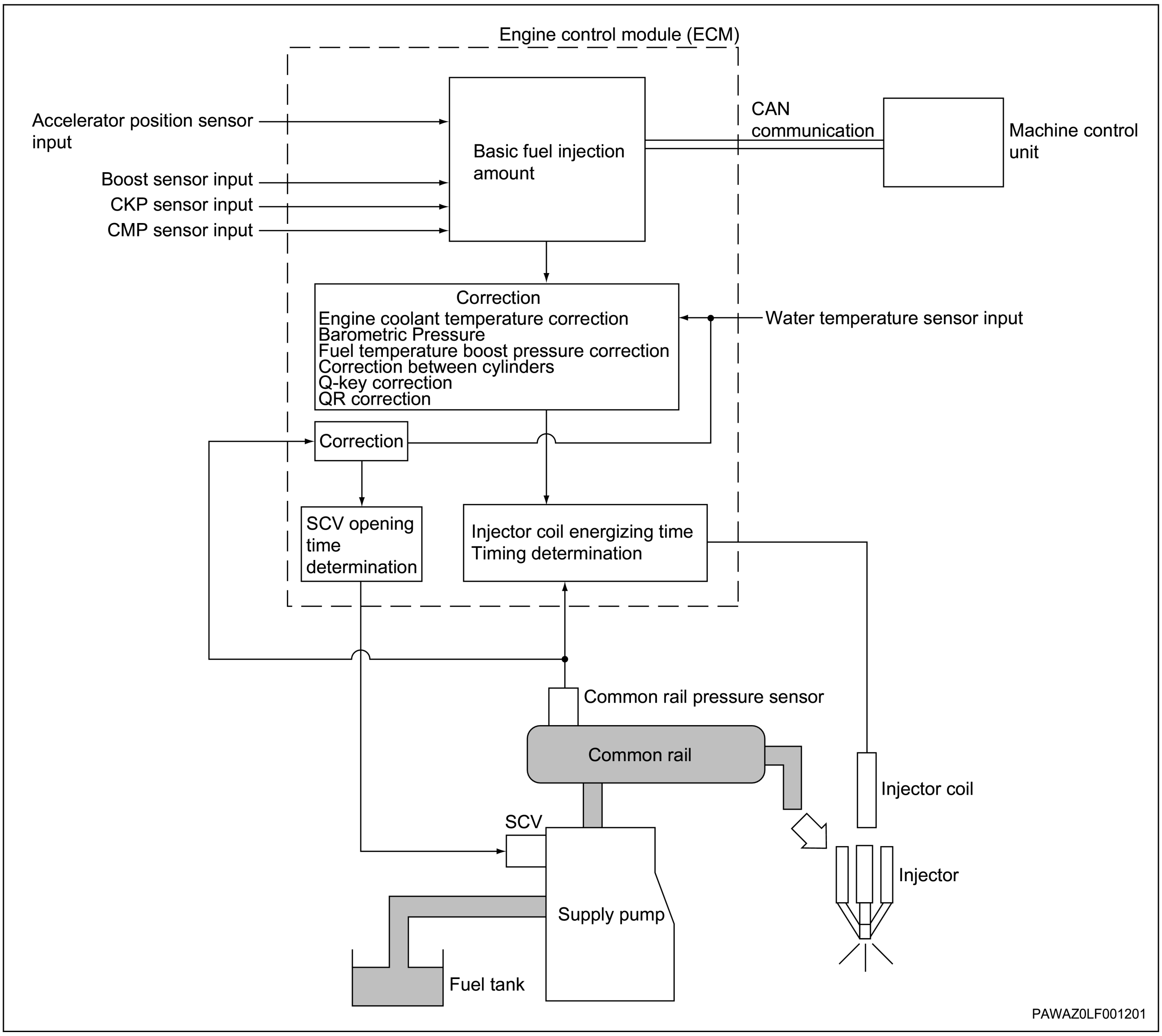
Starter
The starter is a magnetic shift type starter and is an outer gearing mesh method reduction starter.
When the ignition switch is turned ON, the plunger is drawn in, the contact point of the magnetic switch closes and the armature rotates. At the same time, the pinion is pushed to the front via the shift lever to mesh with the ring gear. When the ring gear rotates, the crankshaft is turned to start the engine. After the engine starts, the plunger returns, the pinion separates from the ring gear, and the armature stops rotating when the ignition switch is turned OFF. When the engine speed becomes faster than the pinion, the pinion is caused to turn in reverse, but the pinion just idles due to the one-way clutch function, so the armature is not driven.

Preheat system
The preheat system adopts the glow plug type QOS system. The energization is controlled by the ECM.

8. Engine control system

The engine control system is an electronic control system that controls the engine so as to be always in the optimal combustion state according to the driving condition, and consists of the electronic control fuel injection system, the EGR, and the idling control.
Also, besides controlling the engine, the engine control system has the QOS system, the engine speed signal output, the self-diagnosing function, and CAN communication SAE J1939/21 and SAE J1939/11 system control functions.

System control schematic
The specifications vary depending on the machine, so refer to the manual of the machine.

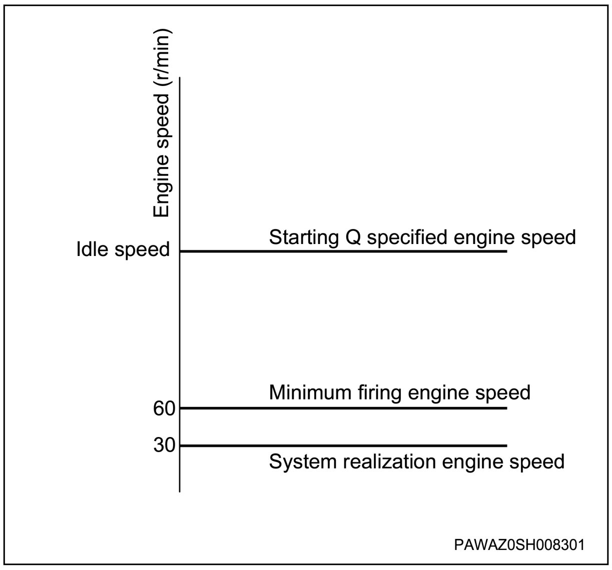


Fuel injection correction

The ECM calculates the basic injection quantity based on the signals from the accelerator position sensor, boost sensor, CKP sensor, CMP sensor, etc. At this time, the open or close timing of the SCV and the energizing time of the injector are controlled based on the conditions such as the common rail (fuel rail) pressure and engine coolant temperature to make optimal corrections to the injection timing and the injection quantity.

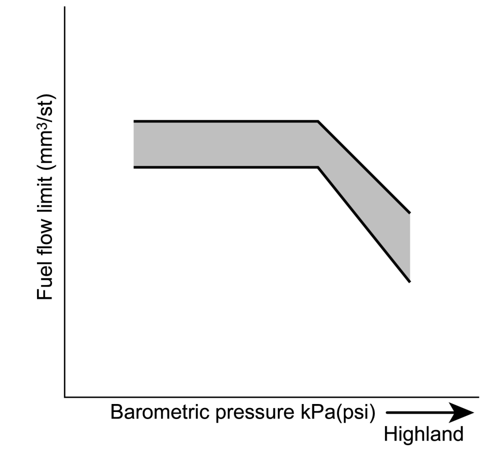
About the initial fuel delivery rate

The ECM implements the initial fuel delivery rate when the initial fuel delivery rate is less than the specified engine speed when the engine is started. Also, the ECM cannot implement the initial fuel delivery rate and cannot start the engine because it does not recognize the engine speed when it is less than an engine speed the system can recognize.



About high altitude correction

The ECM calculates the current altitude using signals from the barometric pressure sensor.
According to conditions such as the current altitude, the fuel flow rate is corrected properly.



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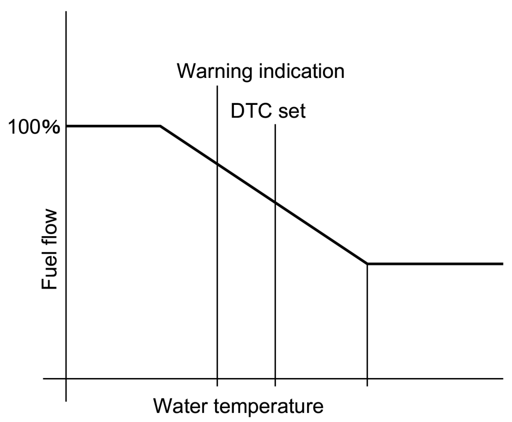
Control during overheat
To protect the engine, restriction on fuel flow is started when the engine coolant temperature exceeds the set temperature. When the engine coolant temperature increases further, the fuel flow is also restricted further. When the temperature reaches the certain value, a DTC is set and a failure is recorded in the ECM. After the DTC is set, the fuel flow is restricted to a certain level if the engine coolant temperature increases further.
The machine is designed to issue an alarm before a DTC is set by the machine. By reducing the load applied to the machine upon alarm issuance, it is possible to avoid an operation condition where fuel flow is restricted.

Note：
- The setting varies depending on the machine manufacturer.



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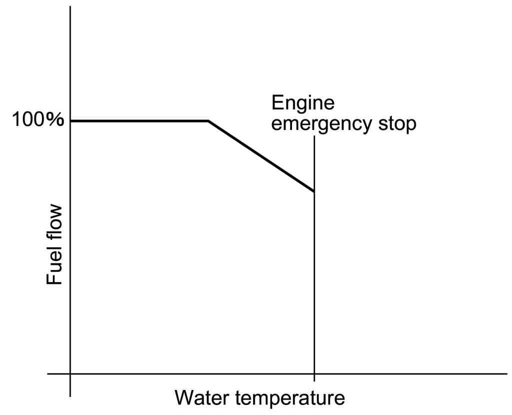
If the ECM is equipped with an emergency stop function by a high engine coolant temperature, it stops the engine when the temperature reaches a set temperature.



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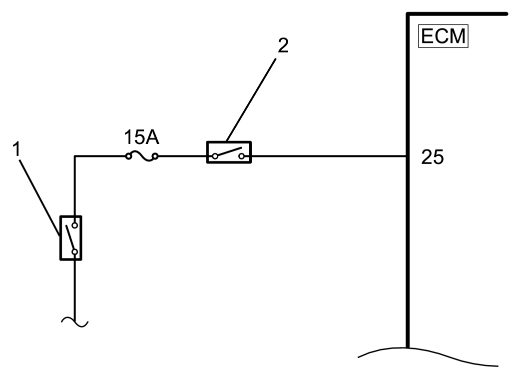
Engine emergency stop function
The ECM is designed to make an emergency engine stop when there is an input from the engine stop switch, when there is a decrease in the engine oil pressure, or when an increase in the engine coolant temperature or an overrun occurs.
For an emergency stop made due to a decrease in the engine oil pressure, an increase in the engine coolant temperature, or an overrun, the control is performed when the corresponding function is added to the calibration of the ECM.

Input from the engine stop switch
The engine stops when the battery voltage is applied to ECM terminal No. 25.



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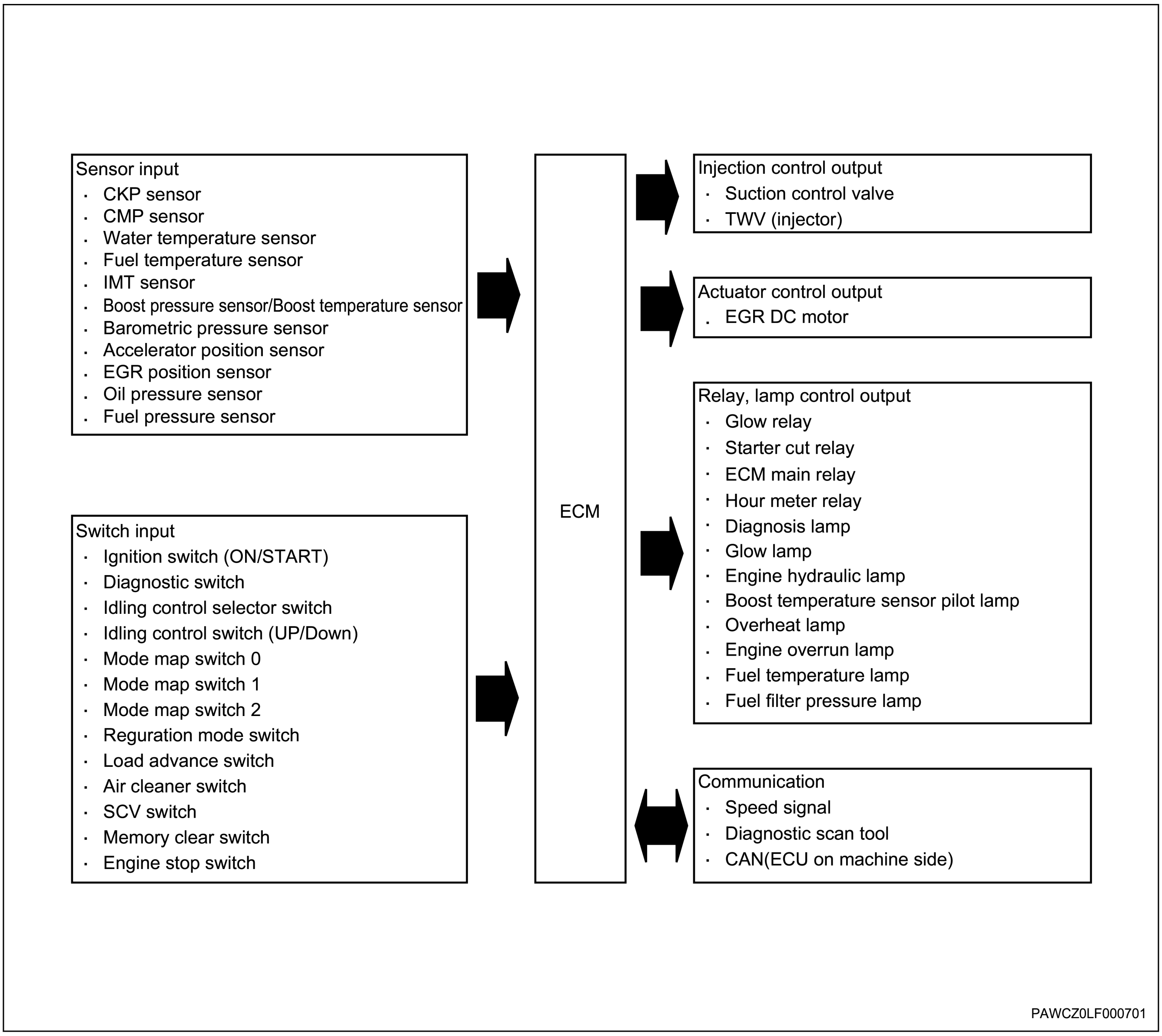
1. The ignition switch is ON
2. Engine stop switch

Decrease in engine oil pressure
When the engine oil pressure drops below the specified value, an alarm for the engine oil pressure decrease is issued, after which the engine is stopped.

Increase in engine coolant temperature
When the engine coolant temperature rises to more than the specified value, an alarm for engine coolant temperature increase is issued, after which the engine is stopped.

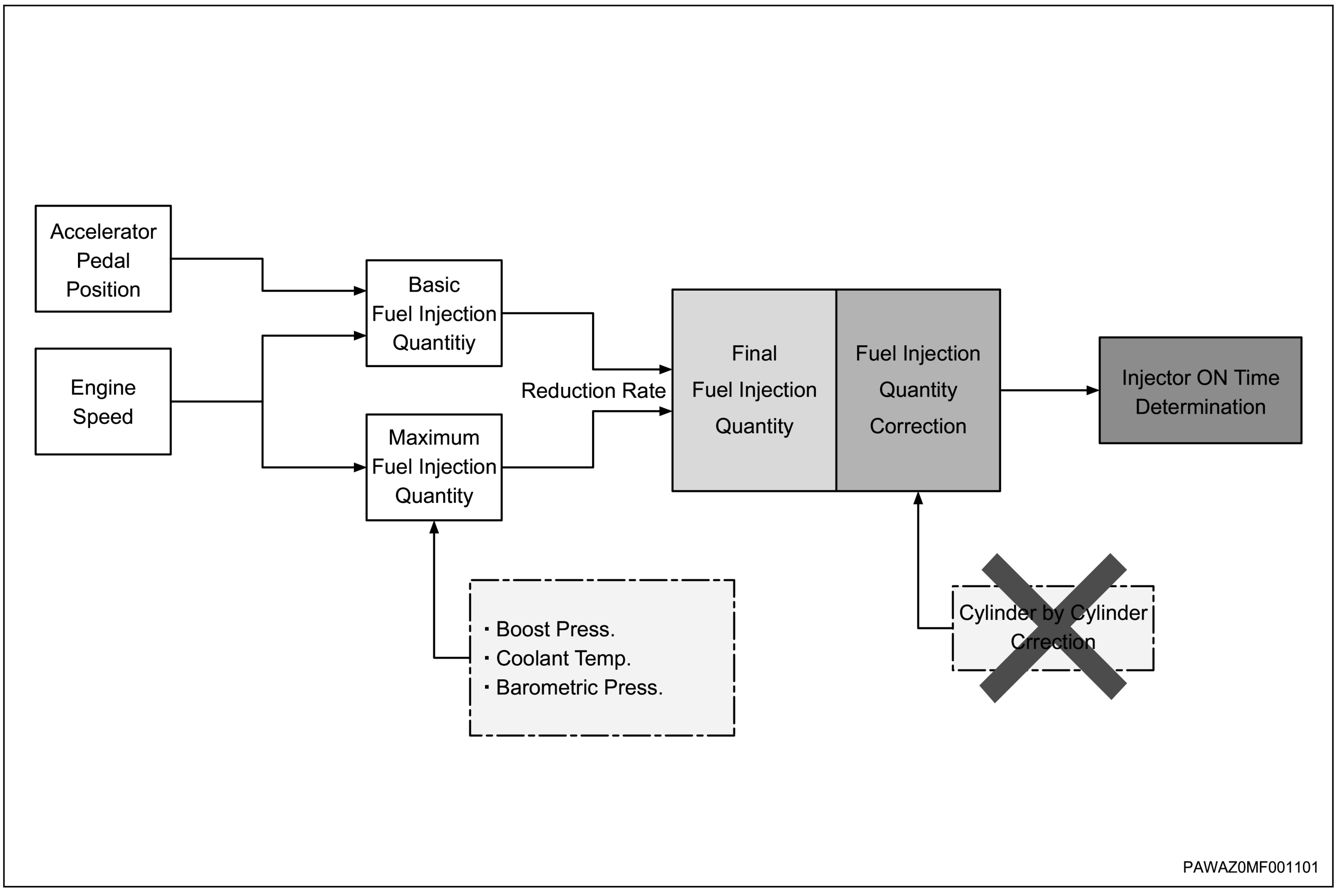
Overrun
When the engine speed reaches a specified value, an alarm for overrun is issued and the engine is stopped. The specified value varies depending on the machine manufacturer.

I/O Table



Electronic control fuel injection system
This is the system in which the ECM obtains information such as engine speed and engine load, and sends the electrical signals based on the information to the supply pump, injectors, etc., to properly control the fuel injection quantity and the injection timing for each cylinder.

Injection quantity control
To optimize the injection quantity, the fuel injection quantity is controlled by regulating the injector based mainly on the signals from the engine speed and the accelerator opening angle or the instructed rotation from the control unit in the machine.



Injection pressure control
The injection pressure is controlled by regulating the fuel pressure inside the common rail (fuel rail). The proper pressure inside the common rail (fuel rail) is controlled by calculations made from the engine speed, the fuel injection quantity, etc., and the appropriate amount of fuel is discharged by regulating the supply pump to be force-fed to the common rail (fuel rail).

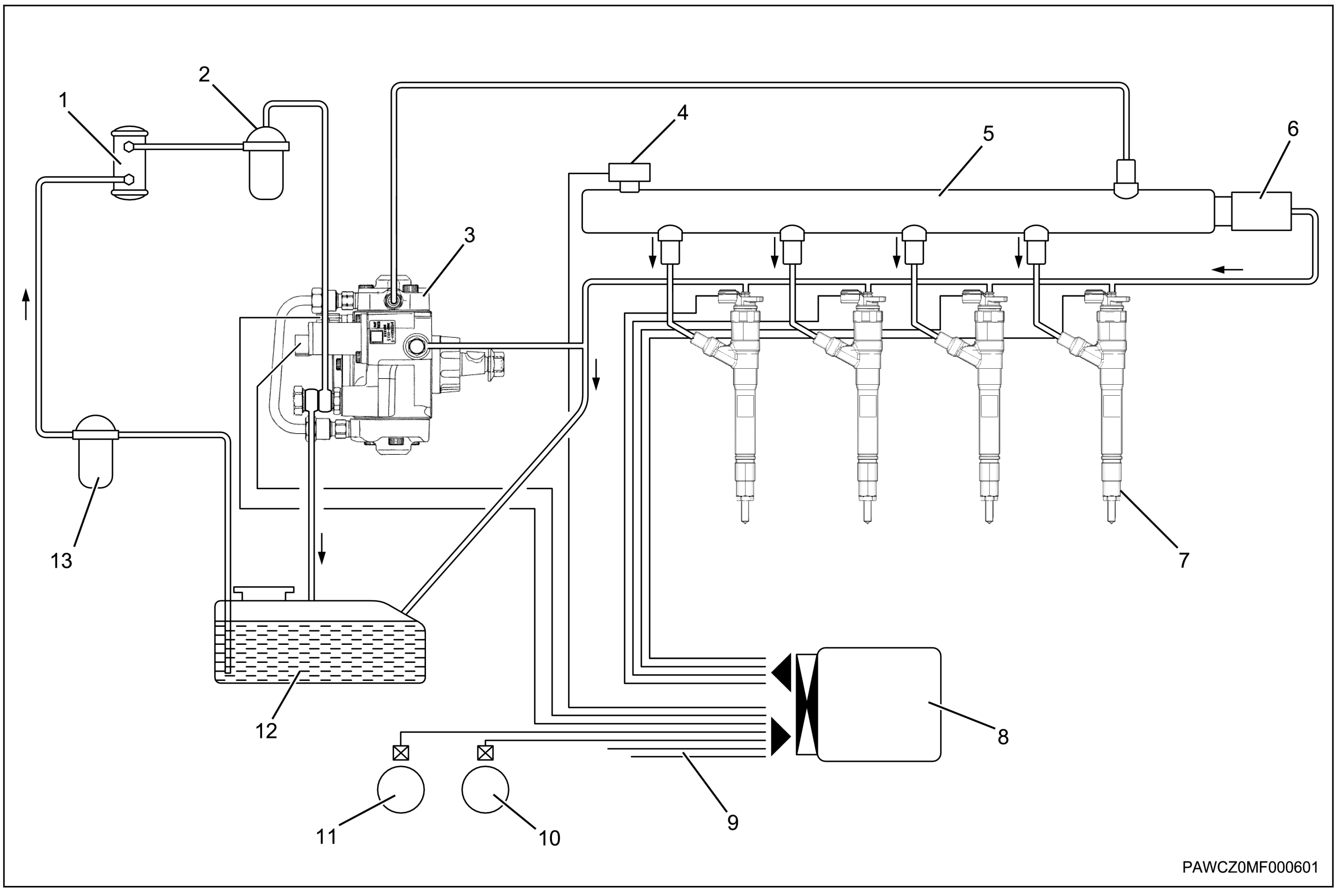
Injection timing control
This control is performed by calculating the proper fuel injection timing mainly from the engine speed or the injection quantity in substitution of the timer function to regulate the injector.

Injection rate control
To improve combustion inside the cylinder, only a small amount of fuel is injected first to be ignited, and then the second injection is performed when ignition is made. This control for injection timing and injection amount is performed by regulating the injector.

Maximum fuel injection quantity
The maximum fuel injection quantity is the quantity of fuel injection calculated by adjustment of the initial injection quantity under a certain water temperature, the limitation of the maximum injection quantity for the boost pressure, and the control of the injection quantity for high altitudes according to barometric pressure.

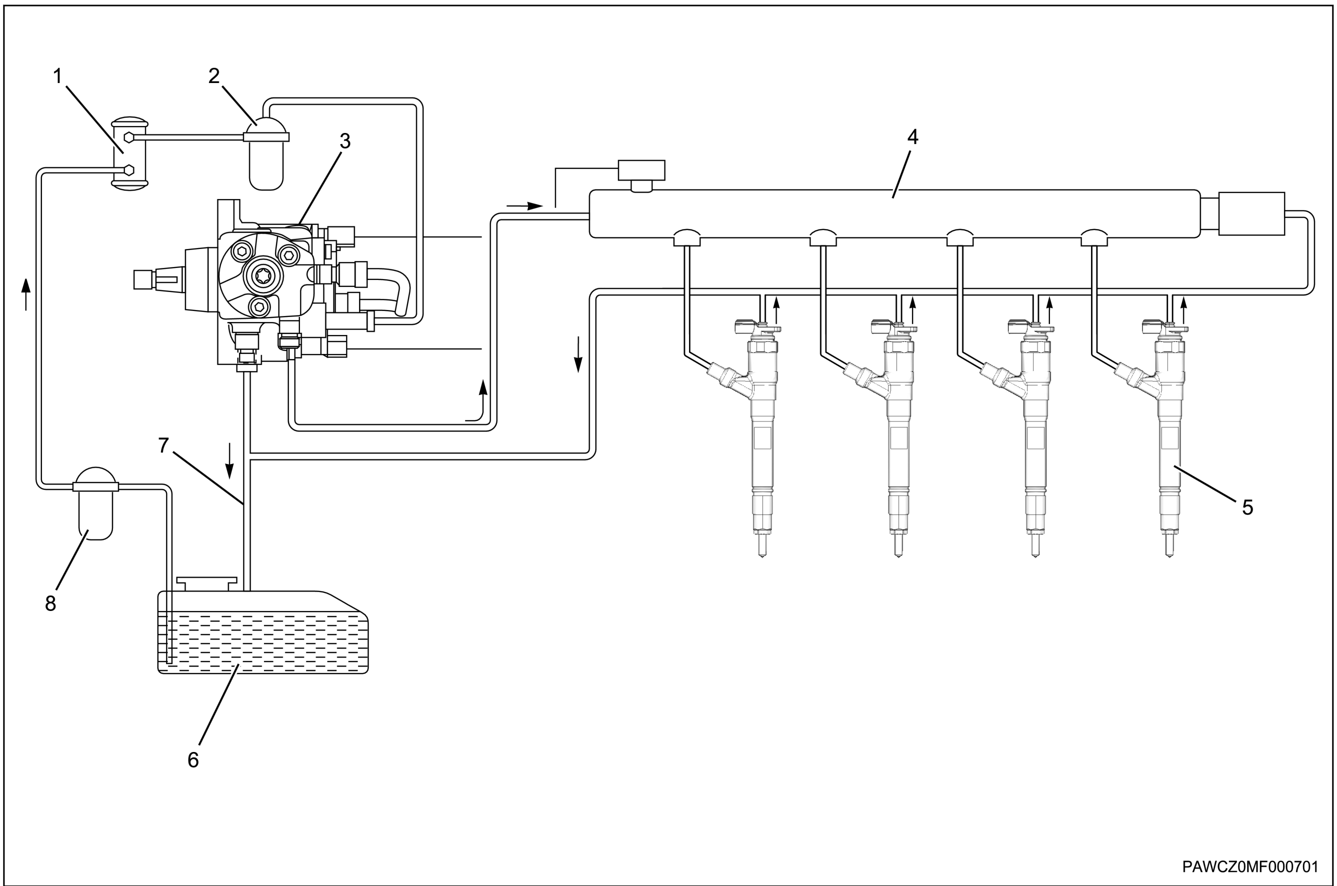
Inter-cylinder correction
It is not used for this engine.

System schematic



1. Electromagnetic pump
2. Fuel filter
3. Supply pump
4. FRP sensor
5. Common rail (fuel rail)
6. Pressure limiter
7. Injector
8. ECM
9. Various sensors (Accelerator, boost, water temperature)
10. CKP sensor
11. CMP sensor
12. Fuel tank
13. Pre-fuel filter

Fuel system
The fuel is supplied to the supply pump from the fuel tank, and then it is boosted by the pump before being supplied to the common rail (fuel rail). At this time, the fuel amount to be supplied to the common rail (fuel rail) is controlled by regulating the suction control valve based on the signal from the ECM.



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

Fuel filter clog warning function and engine speed restriction function

When use of a clogged fuel filter is continued, the ECM detects DTC P0093, and an output restriction is implemented.

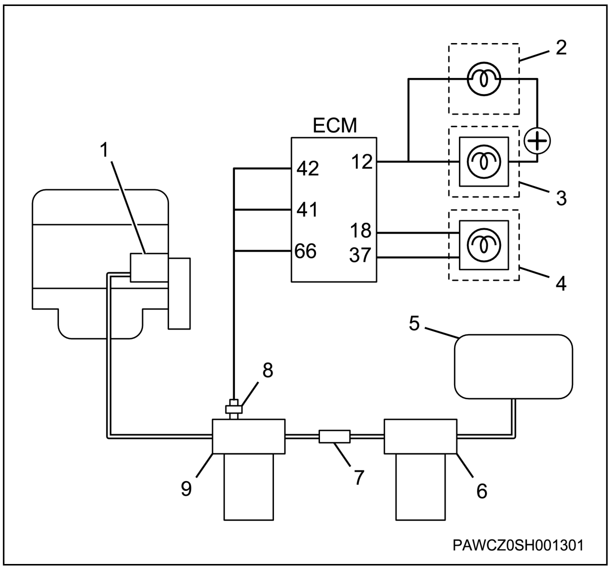
First stage

In order to notify of a filter clogging before DTC P0093 is set, the first stage alarm is issued when the output value from the fuel filter pressure sensor is less than the specified threshold value. Stop the alarm when the output value exceeds the threshold value.

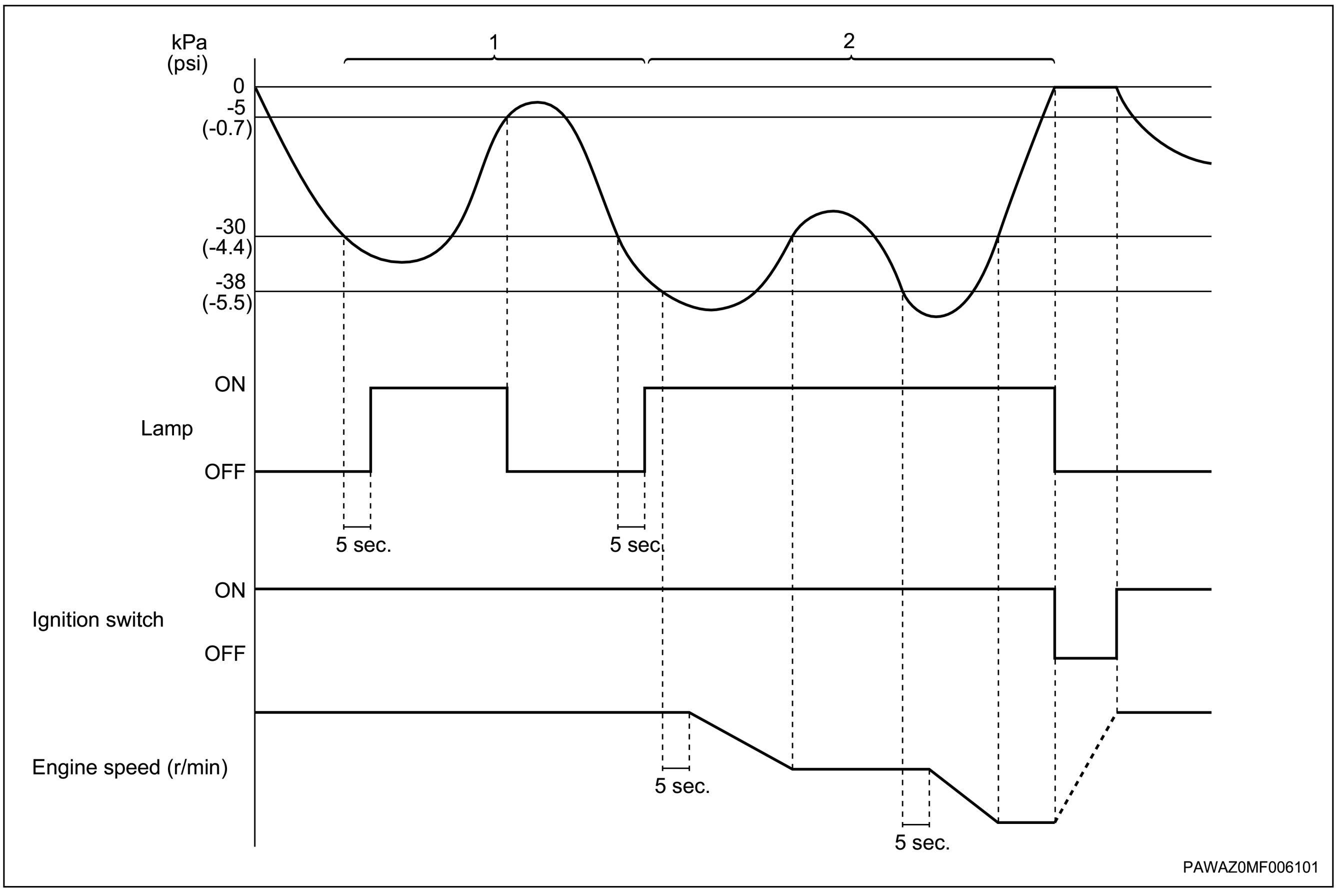
Second stage

The second stage alarm is issued when the output value from the fuel filter pressure sensor is less than the threshold value even after the first stage alarm occurs. The second stage alarm remains as issued until the ignition switch is turned OFF.

At the same time as the second stage alarm is issued, the target engine speed is reduced gradually at a constant rate. When the output value from the sensor exceeds the specified threshold value, reduction of the restricted engine speed is stopped, and the regulation is continued maintaining the restricted engine speed at that time. When the output value from the sensor falls below the threshold value again, the restricted engine speed is reduced further. When the ignition switch is turned OFF and then turned back ON, the restriction is canceled once.

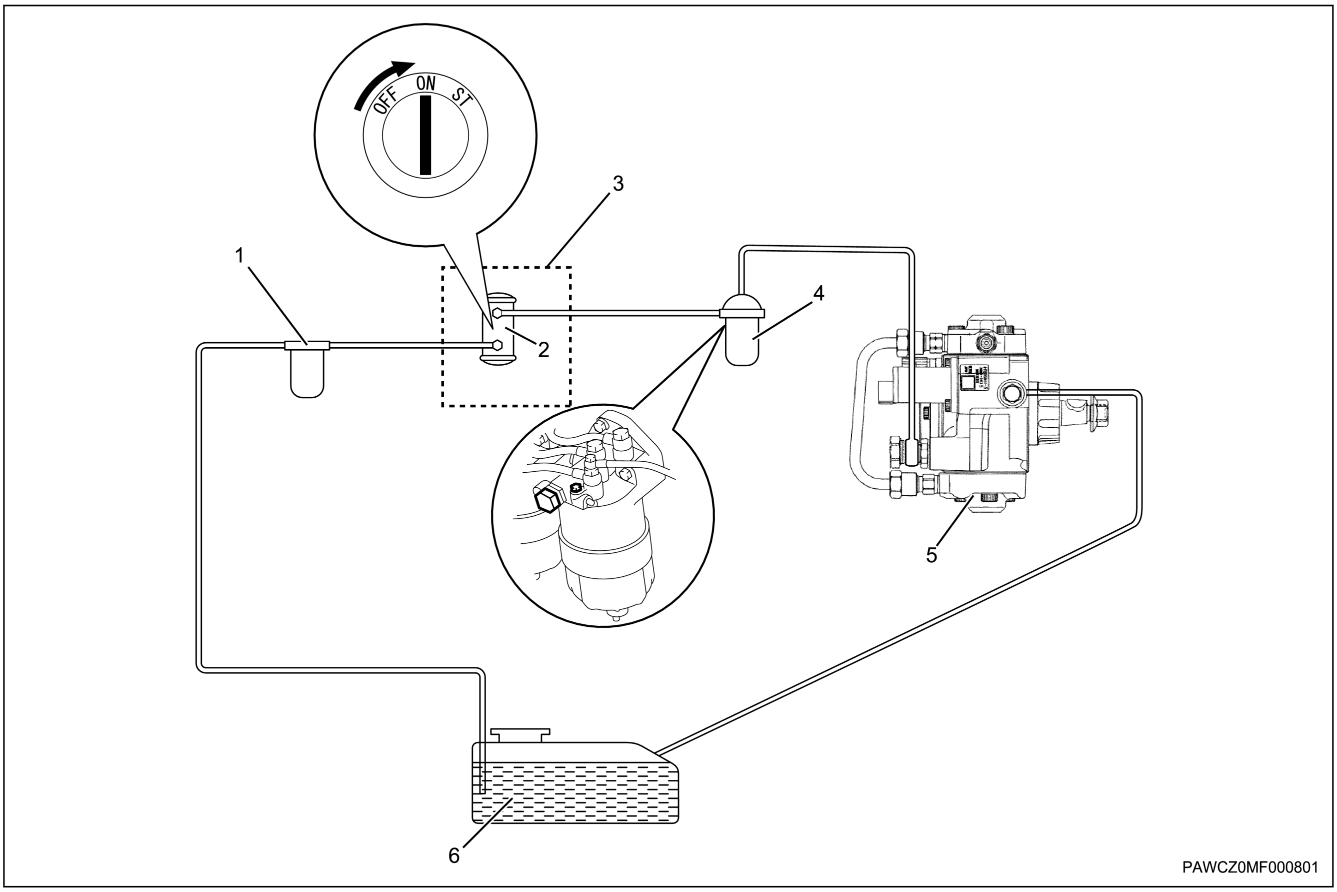


1. Supply pump
2. Warning light
3. Monitor
4. Monitor (CAN communication)
5. Fuel tank
6. Pre-fuel filter
7. Electromagnetic pump
8. Fuel filter pressure sensor
9. Main filter



1. First stage
2. Second stage

Removing air from the fuel system
Place an appropriate pan under the air removal plug.
Turn the ignition switch ON, and activate the electromagnetic pump.
Loose the air removal plug of the fuel filter sufficiently, and operate the priming pump 20 times or more until the fuel comes out from near the plug.
Tighten the plug, and operate the priming pump 10 times or more until the fuel permeates.
Wait for approx. 1 minute, and then loosen the plug to remove the air in the fuel filter. This should be repeated at least 3 times until no air comes out from the plug.
Securely tighten each plug, and wipe off the fuel spilled around. Operate the priming pump 10 - 15 times until the fuel permeates and then is fed to the engine.



1. Pre-fuel filter
2. Electromagnetic pump
3. Electromagnetic pump equipment machine
4. Fuel filter
5. Supply pump
6. Fuel tank

EGR

The EGR system recirculates a part of the exhaust gas to the intake chamber, and by mixing in inert gas to the intake air, the combustion temperature is lowered and the generation of NOx is suppressed.

The EGR amount is controlled by opening and closing the EGR valve provided between the exhaust manifold and intake chamber. The EGR amount is determined from the engine speed and engine load ratio, and the EGR valve is operated to control the EGR amount.

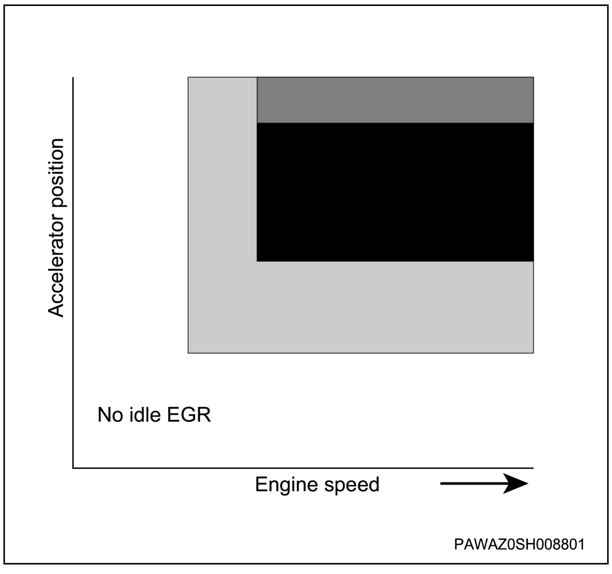
By providing the EGR cooler on the path of the EGR gas, high-temperature EGR gas is cooled by the EGR cooler and then mixed with air to further lower the combustion temperature in order to reduce NOx amount.

Further, the EGR system is also equipped with a check valve to prevent the EGR from flowing in the opposite direction to increase the EGR amount.

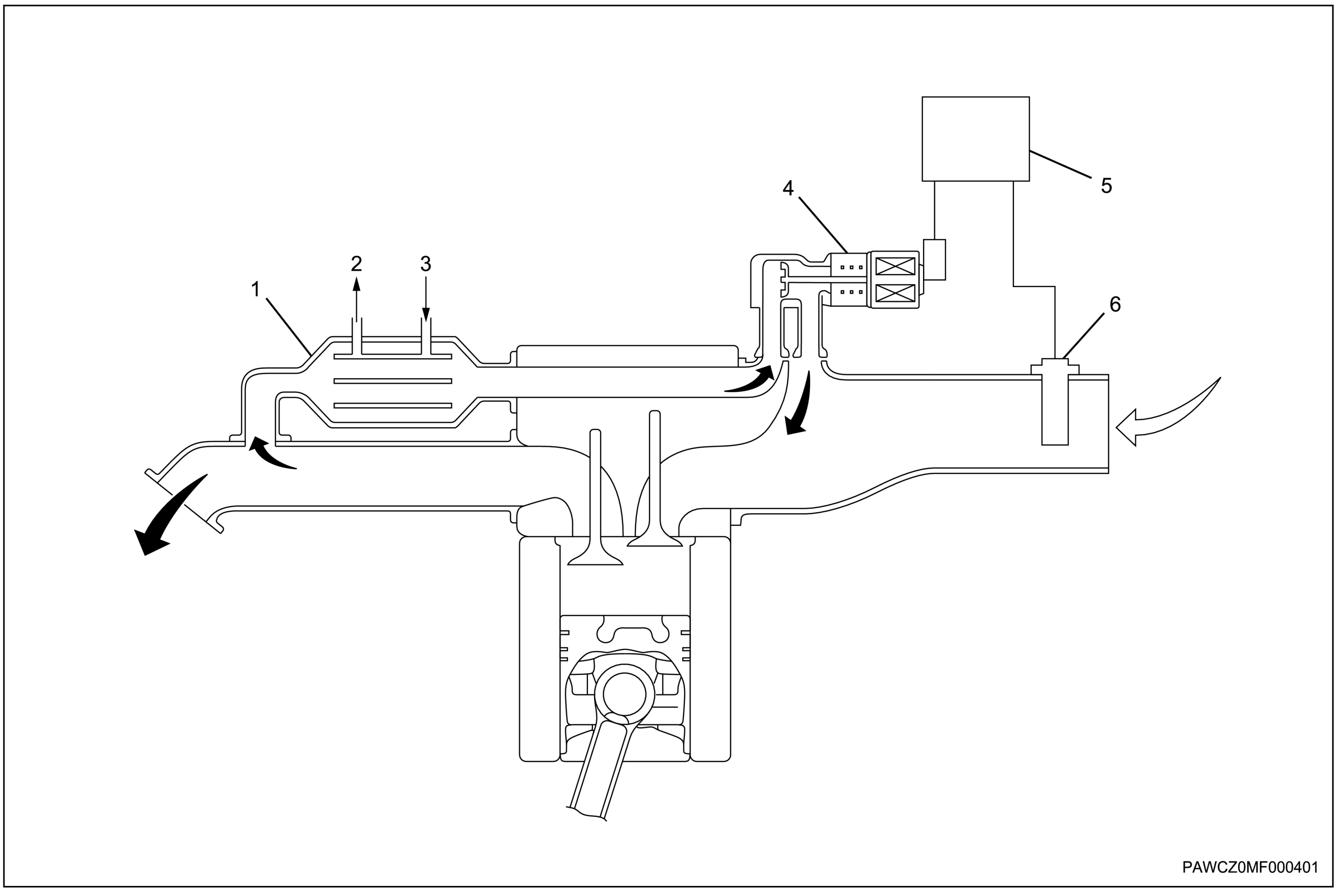
EGR control

The ECM controls the EGR valve lift amount by operating the motor according to the engine status, such as depending on the engine speed and engine load. The valve lift amount is detected by the EGR position sensor.

Darker portions in the diagram represent large valve lift amounts and the darkest portion represents the lift amount of nearly maximum.



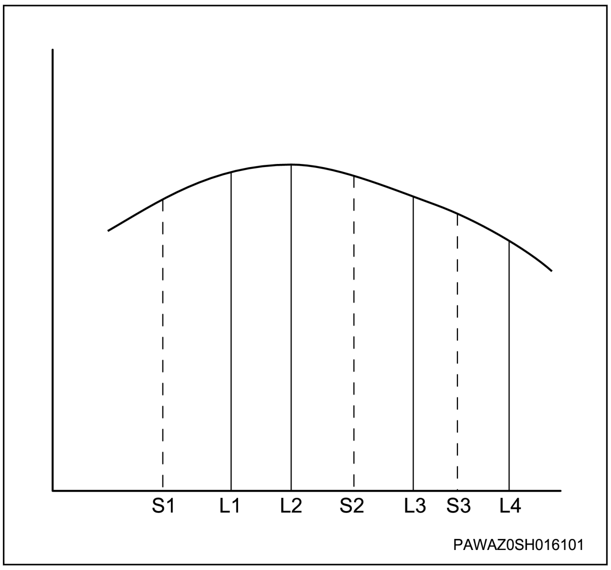
EGR system schematic diagram



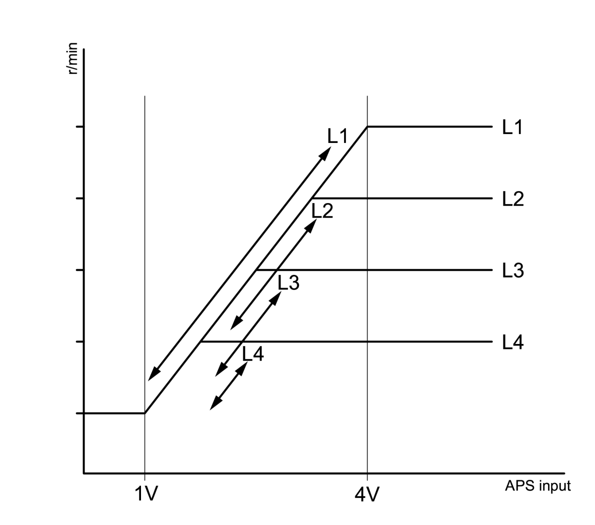
1. EGR cooler
2. Coolant outlet
3. Coolant inlet
4. EGR valve
5. ECM
6. Boost pressure sensor/boost temperature sensor

Engine operation control
There are the following 4 types of operation control instructions, and the selection varies depending on each specification.
Voltage input by APS, 1 - 4V
Accelerator opening angle instruction given through CAN communication control, 0 - 100%, speed instruction
Speed instruction given through mode map switch control, speed instruction and change instruction given by the APS
Increase and decrease instruction for each rotation given by idle switch

Mode map switch
Mode map switch
The mode map switch has 7 rotation control mode types: S1, S2, S3, L1, L2, L3, and L4.
L1, L2, L3, and L4 are the rotation control modes and can be operated between the idling speed and rotation settings.
S1, S2, and S3 are the fixed rotation control modes and cannot be changed from the APS.



Meaning of the mode map switch and each mode
In each mode of L1, L2, L3, and L4, the engine speed can be changed between the idling and rotation settings using the APS.
The set rotation for L1, L2, L3, and L4 are determined depending on the calibration of the ECM.



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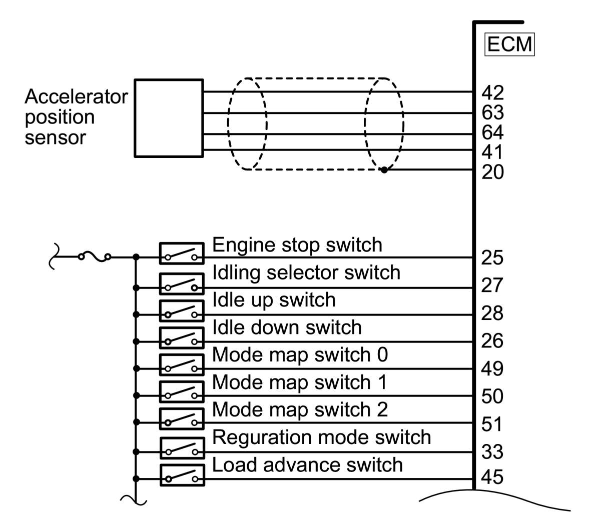

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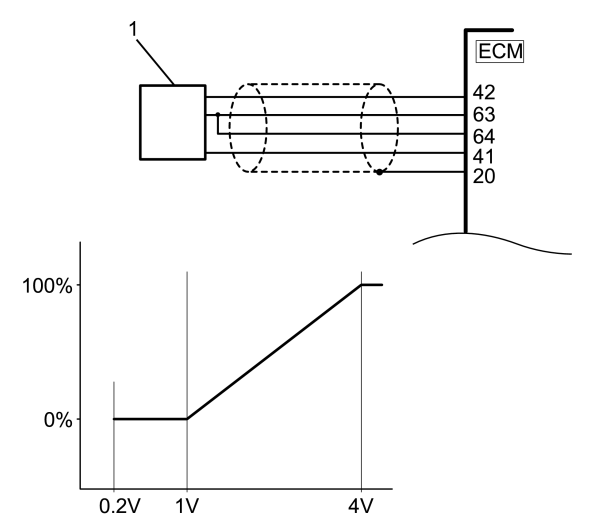
Mode map switch control

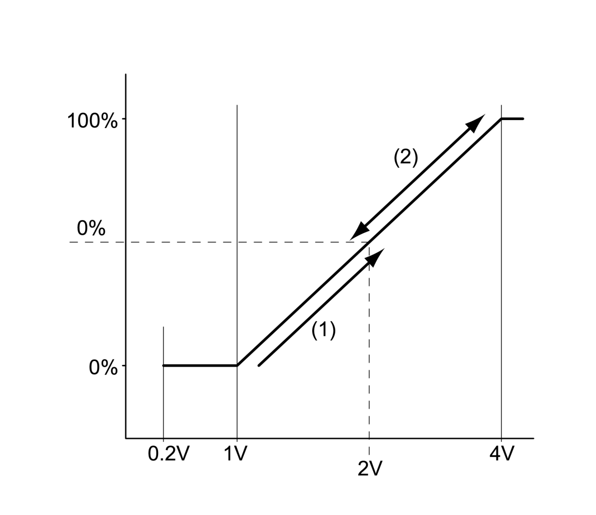
Operation mode	Outer switch			Control
	MAP0	MAP1	MAP2	
STD	OFF	OFF	OFF	Basic control
S1	ON	OFF	OFF	Fixed rotation control 1
S2	ON	ON	OFF	Fixed rotation control 2
S3	ON	ON	ON	Fixed rotation control 3
L1	OFF	ON	OFF	Maximum engine speed restriction control 1
L2	OFF	ON	ON	Maximum engine speed restriction control 2
L3	OFF	OFF	ON	Maximum engine speed restriction control 3
L4	ON	OFF	ON	Maximum engine speed restriction control 4

Accelerator position switch
By operating the accelerator position switch, the output voltage changes between 1 V and 4 V.
Voltages between 0.2 V and 1.05 V are recognized as 1 V. If below 0.2 V or above 4.8 V, an error is detected.



PAWCZ0SH001401

Accelerator position switch, with APS learning control
If the APS learning control is available, when the ignition cycle ends with the accelerator position as 2 V (1), the accelerator position learning causes the 2 V status to be recognized as the opening angle 0% and the control range changes from 2 V to 4 V (2).



PAWAZ0SH003101

The specifications vary depending on the machine, so the availability of functions also differs.

Note :

- The specifications vary depending on the machine, so availability of functions also differs.

Idling control change switch
By operating the idling control switch, the idling control functions can be switched.

Idling control switch
By operating the idling control switch, the idling speed can be adjusted.

Note :

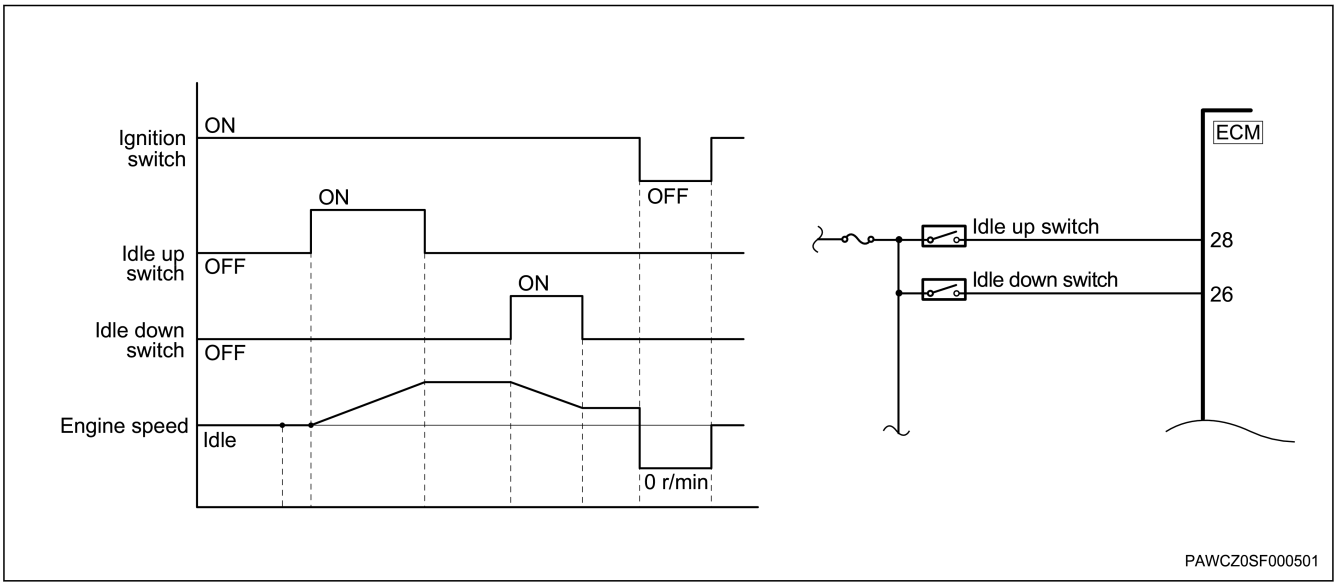
- For the installation positions of the idling control change switch and the idling control switch, refer to the manual of the machine. The engine speed upper limit varies depending on the engine type, the machine specifications, and the engine warm-up condition.

Up
While the Up side of the switch is pressed, the engine speed is increased and the idling speed can be raised.

Down
While the Down side of the switch is pressed, the engine speed is decreased and the idling speed can be lowered. However, the engine speed cannot be decreased below the minimum idling speed.

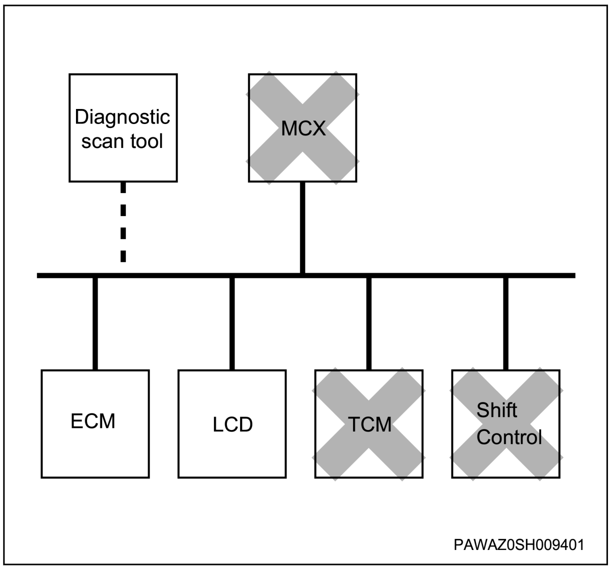
Control during ignition switch OFF state
There are 2 types of controls provided when the ignition switch is turned OFF after the idling control switch is operated, and either one of them is performed depending on the specification.
The engine speed adjusted by the idling control switch is recorded in the ECM, and the next operation is performed at the engine speed when the ignition switch is turned OFF.
The engine speed adjusted by the idling control switch is not recorded in the ECM, and the next operation is performed at the default engine speed.
For verification and questions regarding the specifications, contact an Isuzu service-related person.

Idle manual control

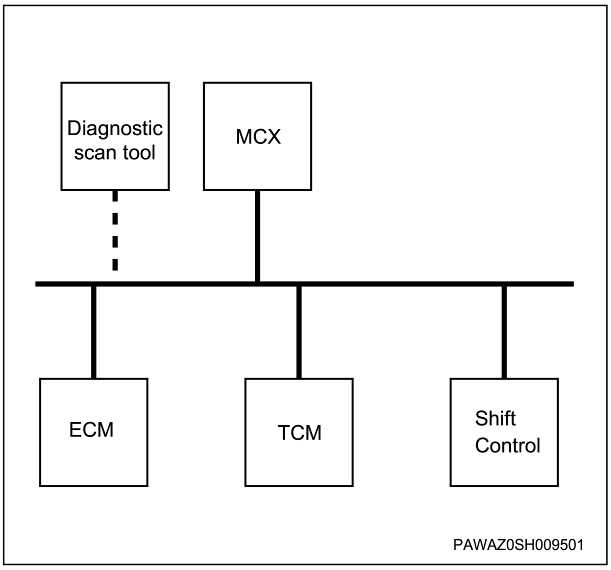


CAN communication

If a CAN controller does not exist on the machine side

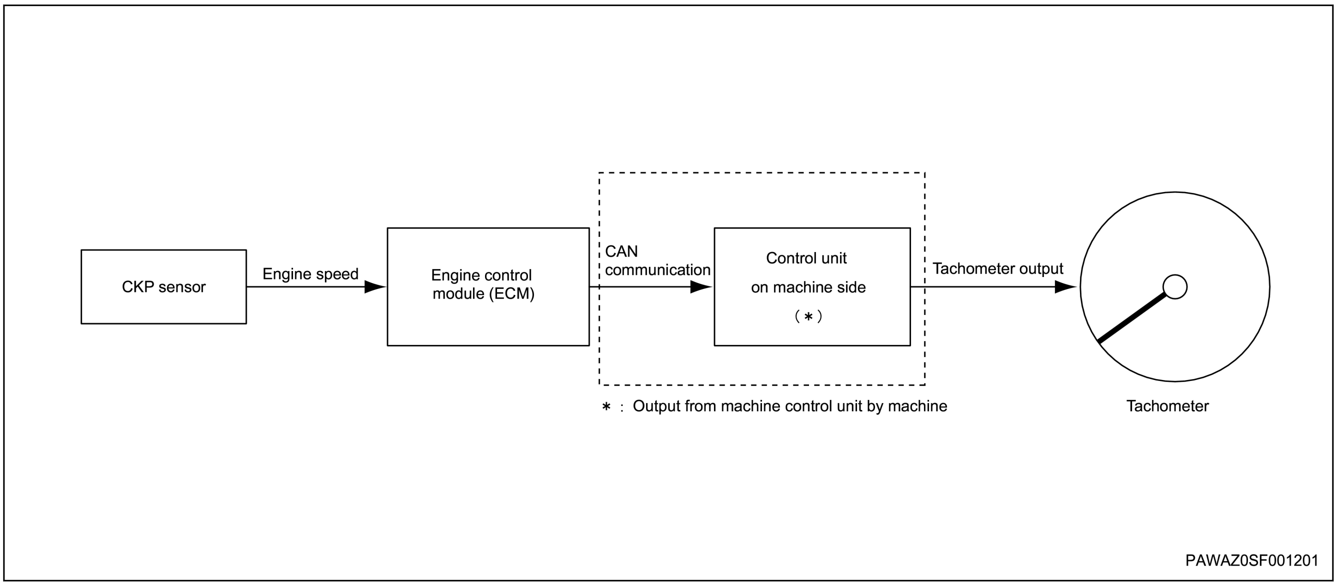


If a CAN controller exists on the machine side



Engine speed output to tachometer

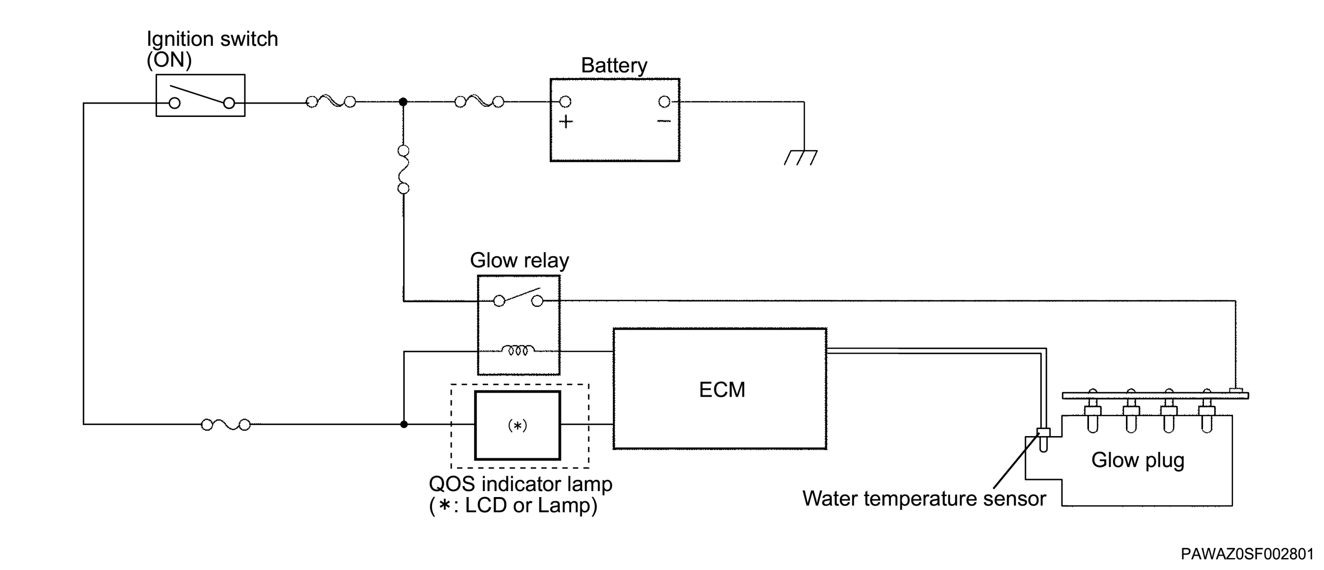
The ECM outputs the engine speed pulse to the tachometer as a tachometer output. The tachometer displays the engine speed based on the engine speed pulse sent from the ECM.



Preheat control

QOS system

The ECM determines the glow time according to the engine coolant temperature, and activates the glow relay and the QOC indicator light. The QOS system is a system to facilitate engine start in low temperatures as well as to reduce the amount of white smoke and noise generated immediately after the engine is started. When the ignition switch is turned ON, the ECM detects the temperature of the engine coolant based on the signal sent from the engine coolant temperature sensor to change the glow time, so the engine can always be started under optimum conditions. Also, the after-glow function can stabilize the idling immediately after the engine is started.



ECM

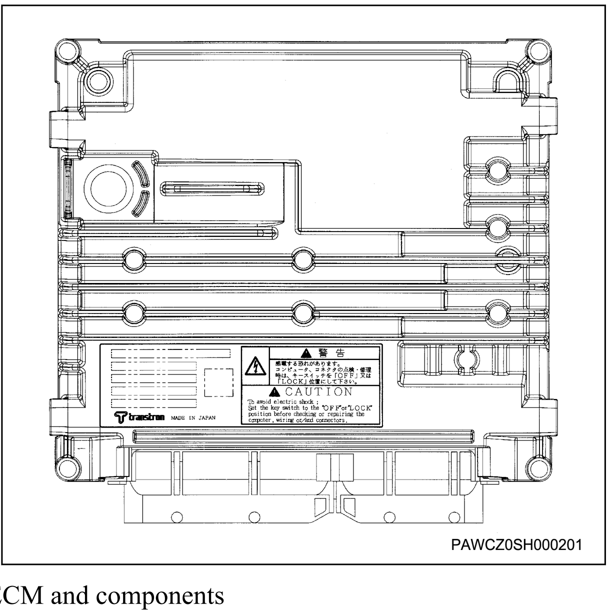
About ECM functions

The ECM constantly monitors the information sent from various sensors, and controls the various systems of the powertrain. The ECM performs the diagnostic functions of the system, detects operational problems of the system, warns the operator via the diagnosis light, and records the DTC. The DTC identifies the area where the problem has occurred to assist the repair operation performed by the technician.

The ECM outputs voltages (e.g., 5 V) to supply power to various sensors and switches. The ECM controls the output circuit by controlling the ground or power source circuit via one of the devices.

Note :

- For the ECM installation position, refer to the manual of the machine.



ECM and components

The ECM is designed to maintain regulation levels of exhaust gases while obtaining excellent performance and fuel efficiency. The ECM monitors various engine functions via sensors such as the CKP sensor.

ECM voltage

The ECM applies the reference voltage to various switches and sensors. The ECM is able to apply voltage in such a way because the ECM resistance value is very high, and the voltage that is actually applied to the circuit is low. Therefore, the test lamp may not illuminate even if it is connected to the circuit. The voltmeter that is normally used at maintenance factories may not display a correct reading because its input impedance is too low. An accurate voltage reading can be obtained by using a digital multimeter (for example, 5-8840-2691-0) with an input impedance of 10 MΩ.

Electrically erasable programmable read-only memory (EEPROM)

The EEPROM contains various programs and calibration information necessary for the ECM to control the powertrain operations.

If a malfunction is found with the EEPROM, replace the ECM.

The program and calibration information for the ECM powertrain control includes the engine type, engine number, ECM part number, DTC, inter-cylinder correction learning value, QR, Q tune, and EGR correction learning value.

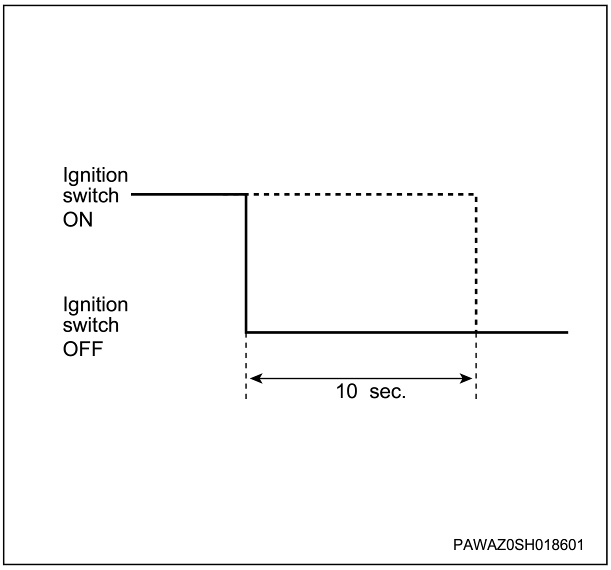
Notes on ECM maintenance

The ECM has been designed to withstand the regular current consumption associated with the machine operation. Make sure that the circuit does not overload. When performing tests for an open circuit or short circuit, do not ground or apply voltage to the circuit of the ECM, unless otherwise instructed. When performing these circuit tests, make sure to use digital multimeter 5-8840-2691-0.

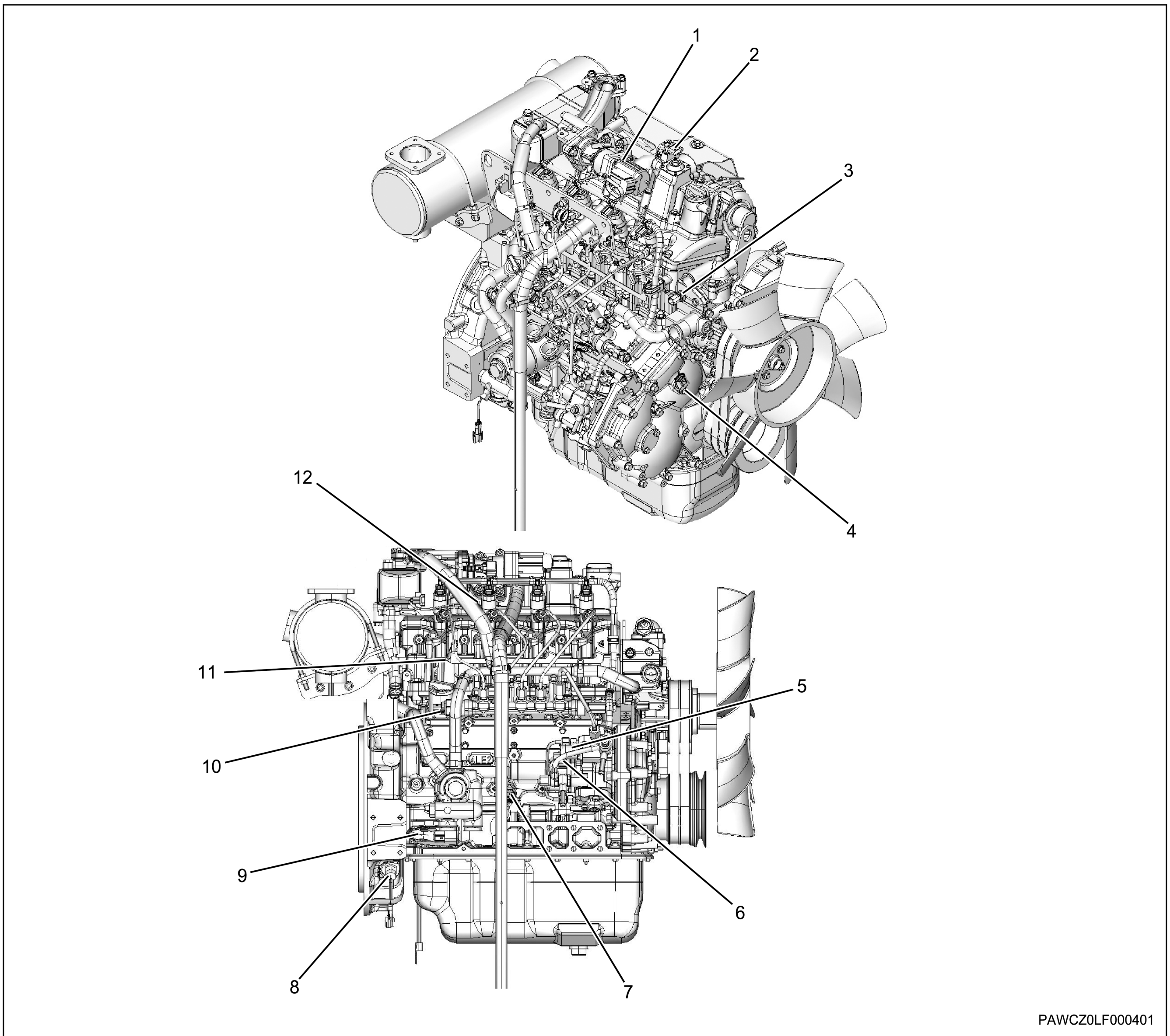
Note :

- Use the ECM with the part No. corresponding to the machine.
  When performing welding work on the machine, start the work after disconnecting the negative terminal of the battery.

Turning OFF the ECM power source
Approximately 10 seconds after turning the ignition switch OFF, the internal power source of the ECM is not turned OFF. When it is necessary to turn OFF the ECM power source, e.g., when clearing the memory, it is necessary to wait 10 seconds or more after turning the ignition switch OFF.

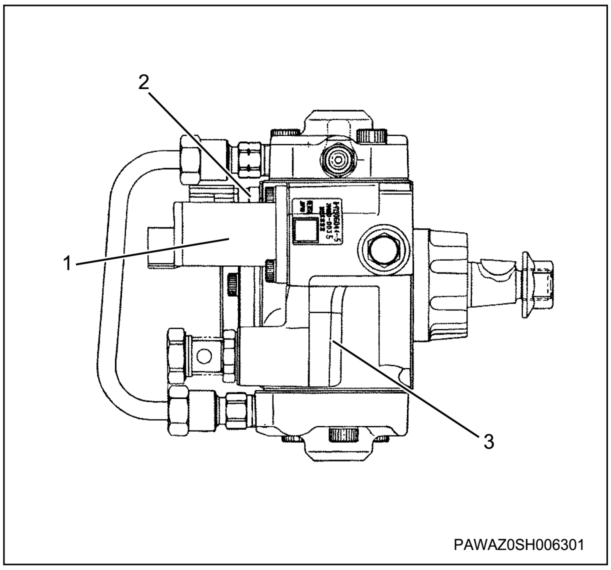


Engine components location diagram
The locations, shapes, and existence or nonexistence of components vary depending on the specifications of the machine.



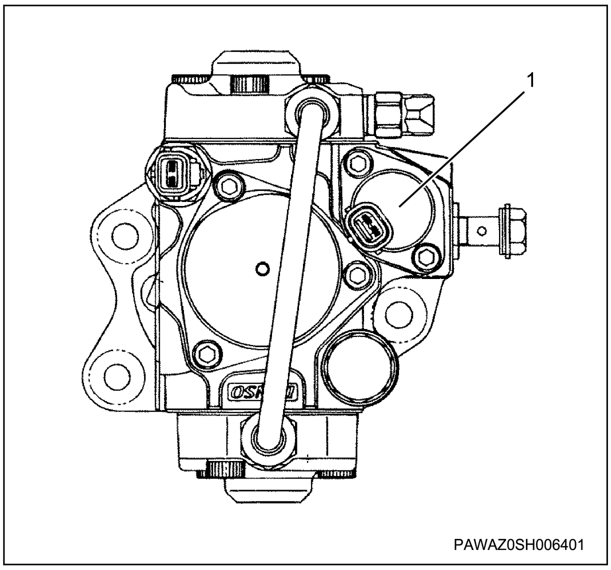
1. EGR valve
2. Boost pressure sensor/boost temperature sensor
3. Engine coolant temperature sensor
4. CMP sensor
5. Suction control valve
6. Fuel temperature sensor
7. Oil pressure sensor
8. Engine speed sensor
9. CKP sensor
10. FRP sensor
11. Glow plug
12. IMT sensor

Supply pump
The supply pump highly pressurizes the fuel using the engine torque, and force-feeds the fuel to the common rail (fuel rail). Also, the suction control valve, the fuel temperature sensor, the feed pump, etc., are installed on the supply pump.



1. Suction control valve
2. Fuel temperature sensor
3. Feed pump

Suction control valve
The suction control valve is installed on the supply pump and controls the fuel force-feed to the common rail (fuel rail). The ECM controls the fuel discharge amount by regulating the energizing time to the suction control valve.

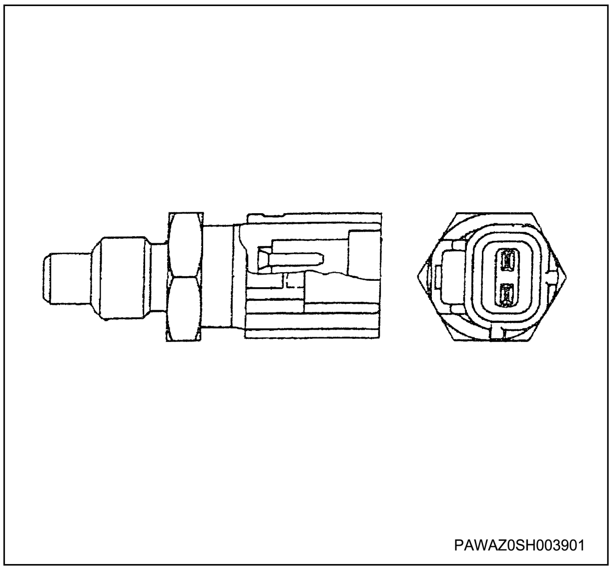


1. Suction control valve

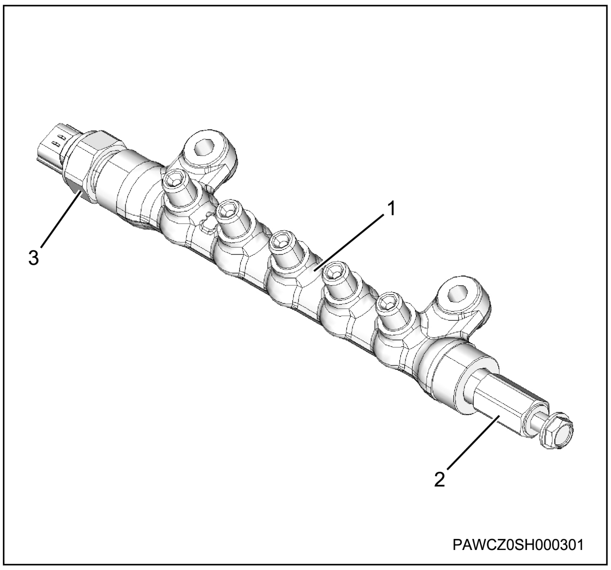
Fuel temperature sensor
The fuel temperature sensor is installed on the supply pump, and the thermistor changes the resistance according to changes in temperature. The resistance value becomes lower when the fuel temperature is high, and it becomes higher when the fuel temperature is low. The ECM applies 5 V to the fuel temperature sensor through the pull-up resistor, and it calculates the fuel temperature from changes in the voltage and uses it for controlling the supply pump, etc. The voltage becomes lower when the resistance is lower, and it becomes higher when the resistance is higher.

Note :

- Do not replace the fuel temperature sensor. When a malfunction is found, replace the supply pump assembly.



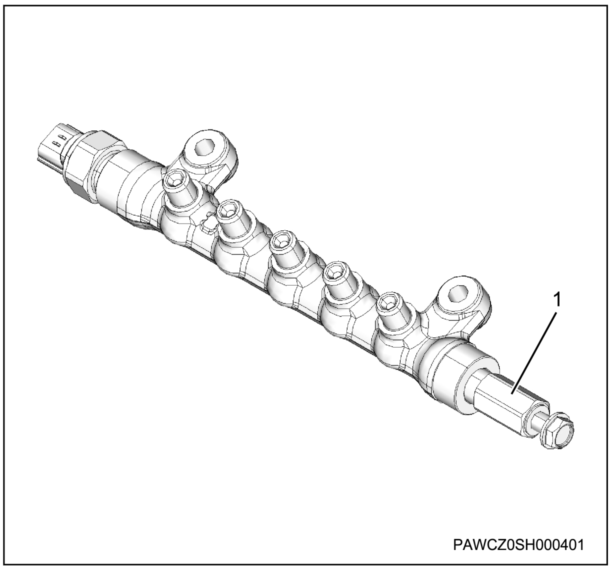
Common rail (fuel rail)
The common rail (fuel rail) receives the fuel from the supply pump, retains the fuel pressure, and distributes the fuel to each cylinder. The FRP sensor and the pressure limiter are installed on the common rail (fuel rail).



1. Common rail (fuel rail)
2. Pressure limiter
3. FRP sensor

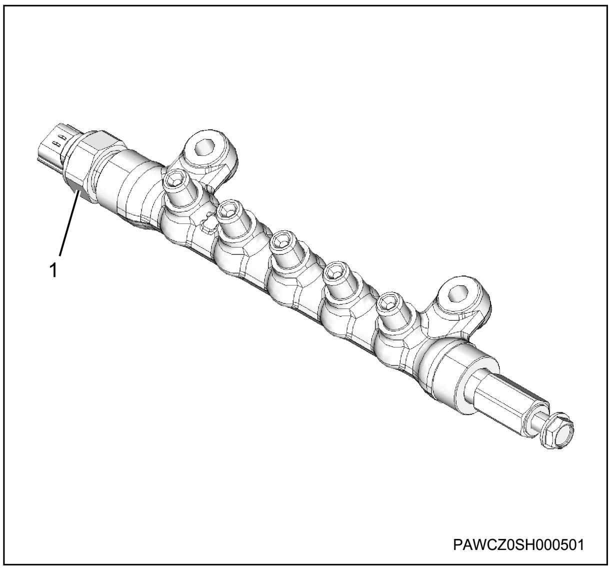
Pressure limiter

The pressure limiter is activated when the pressure in the common rail (fuel rail) becomes unusually high so as to release the pressure inside the common rail (fuel rail).



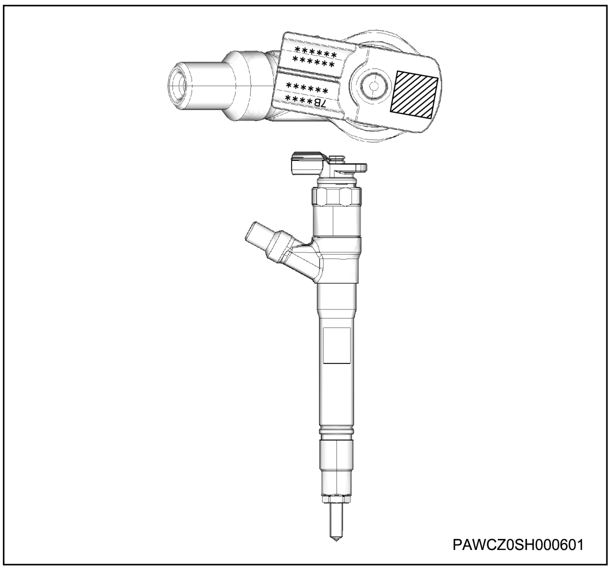
1. Pressure limiter

FRP sensor
The FRP sensor, installed on the common rail (fuel rail), detects the fuel pressure inside the common rail (fuel rail), converts pressure into a voltage signal, and sends it to the ECM. The voltage becomes higher when the pressure is higher, and it becomes lower when the pressure is lower. The ECM calculates the actual fuel pressure from the voltage signal sent from the sensor, and uses it to control the fuel injection, etc.

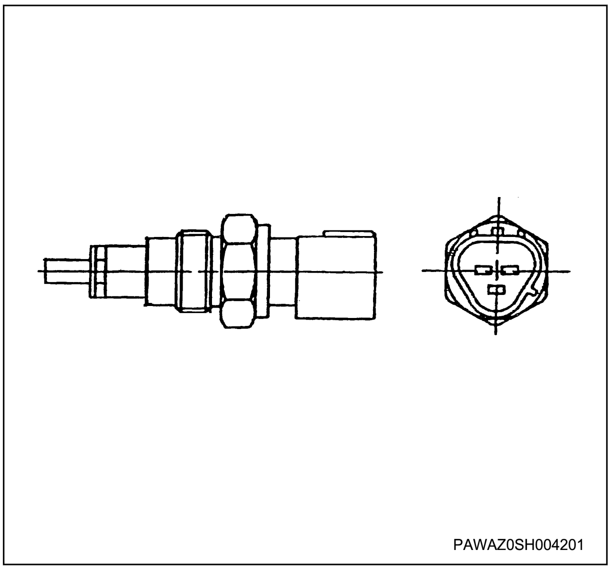


1. FRP sensor

Injector
The injector is installed on the cylinder head portion, and is controlled by the ECM to perform fuel injection. The ECM internally boosts the voltage for driving the injector to apply it to the injector, and uses it for fuel injection quantity control and injection timing control by regulating the energizing time of the injector.

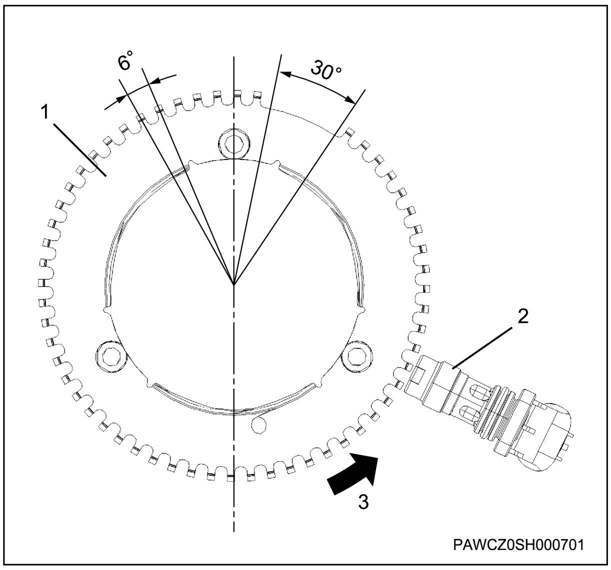


Engine coolant temperature sensor
The engine coolant temperature sensor is installed on the thermostat housing, and the thermistor changes the resistance according to changes in temperature. The resistance becomes smaller when the engine coolant temperature is high, and it becomes larger when the engine coolant temperature is low. The ECM applies 5 V to the engine coolant temperature sensor through the pull-up resistor, and calculates the engine coolant temperature from changes in the voltage. This value is used in various control mechanisms, such as for fuel injection control. The voltage becomes lower when the resistance is lower, and it becomes higher when the resistance is higher.



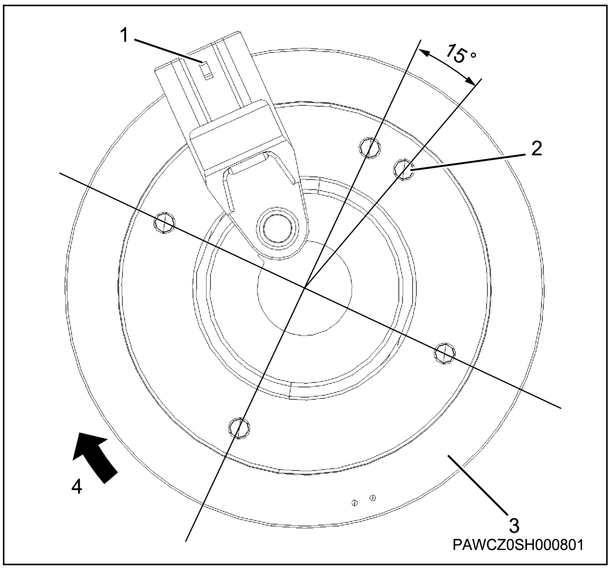
CKP sensor
The CKP sensor is installed on the left side of the cylinder block rear section and the backside of the fuel filter. The sensor rotor is fixed on the crankshaft. There

are 56 notches spaced 6° apart and a 30° section without notches. Top dead center of cylinder No. 1 can be detected through this section without notches, and a pulse signal is generated. By detecting the section without notches with the CKP sensor and the 1 reference projection with the CMP sensor, the ECM determines compression top dead center of cylinder No. 1 to verify that they correlate with each other.



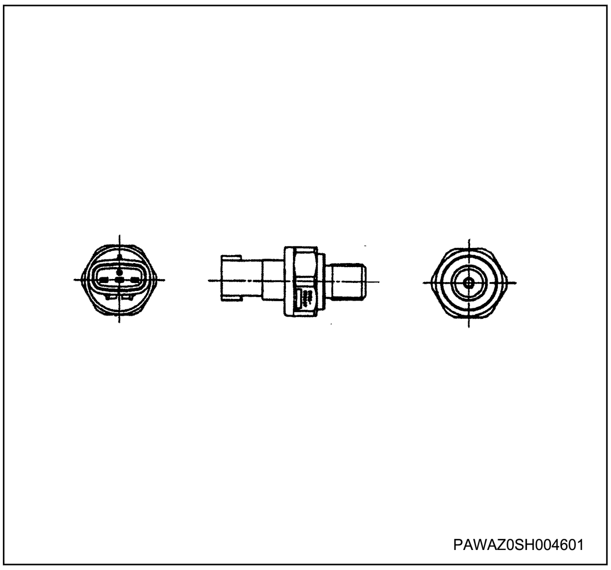
1. Sensor rotor
2. CKP sensor
3. Rotational direction

CMP sensor
The CMP sensor is installed to the gear case cover in the cylinder head front side. It detects 5 protrusions per 1 rotation of the engine and generates a pulse signal. The ECM determines the cylinder and specifies the crank angle using the CMP signal and the CKP signal input from the CKP sensor, and uses the information for the fuel injection control and the calculation of the engine speed.
While this control is usually performed using the CKP signal, the CMP signal is used instead when the CKP sensor is faulty.



1. CMP sensor
2. Projection
3. Timing chain sprocket
4. Rotational direction

Oil pressure sensor
The oil pressure sensor is installed near the oil cooler of the cylinder block, and it detects the pressure of the engine oil, converts it into a voltage signal, and sends it to the ECM.
The voltage becomes higher when the pressure is higher, and it becomes lower when the pressure is lower.



Accelerator position sensor
The accelerator position sensor is installed on the console panel of the machine and supplies to the ECM a voltage signal that varies in accordance with the accelerator volume angle. The ECM calculates the accelerator pedal position from the voltage signal, and uses it for fuel injection control and many other controls.

Note：

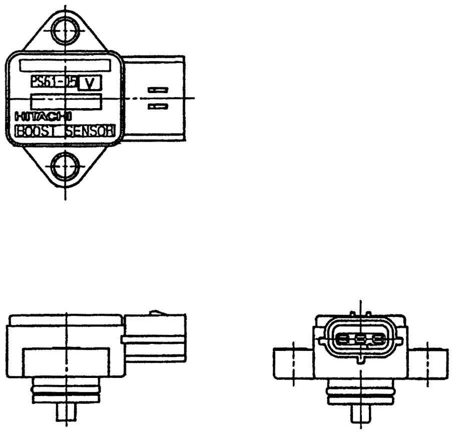
- For the installation position of the accelerator position sensor, refer to the manual of the machine.

Barometric pressure sensor

The barometric pressure sensor is installed on the machine side, and it replaces the barometric pressure with a voltage signal. The ECM calculates the barometric pressure from the voltage signal, and uses the barometric pressure to correct the fuel injection quantity.

Note：

- For the installation position of the barometric pressure sensor, refer to the manual of the machine.



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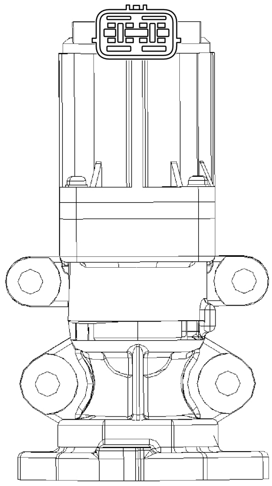
EGR position sensor

This sensor is installed inside the EGR valve to detect the EGR valve lift amount.

Note：

- Do not disassemble the EGR position sensor. When a malfunction is found, replace the EGR valve assembly.



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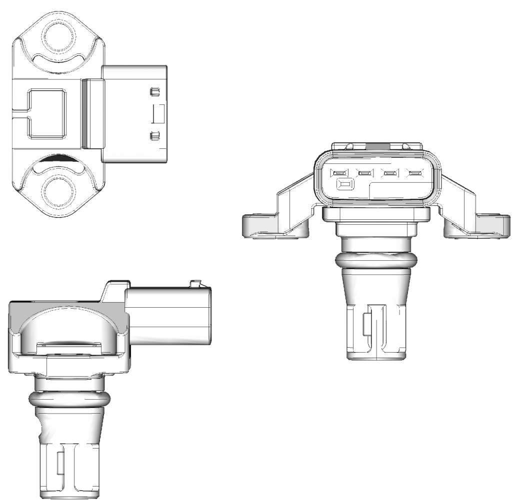
Boost pressure sensor/boost temperature sensor

Boost pressure sensor

The boost pressure sensor detects the boost pressure of the intake chamber and converts the pressure into a voltage signal to send to the ECM. The voltage becomes higher when the pressure is higher, and it becomes lower when the pressure is lower. The ECM calculates the boost pressure from the voltage signal sent from the sensor and uses it to control the fuel injection, etc.

Boost temperature sensor

The boost temperature sensor measures the temperature of air entering the intake chamber. When the sensor is cold, the resistance of the sensor is high. As the air temperature rises, the sensor resistance decreases. The ECM detects a high voltage in the signal circuit when the sensor resistance is high. For low sensor resistance, the ECM detects a low voltage of the signal circuit.



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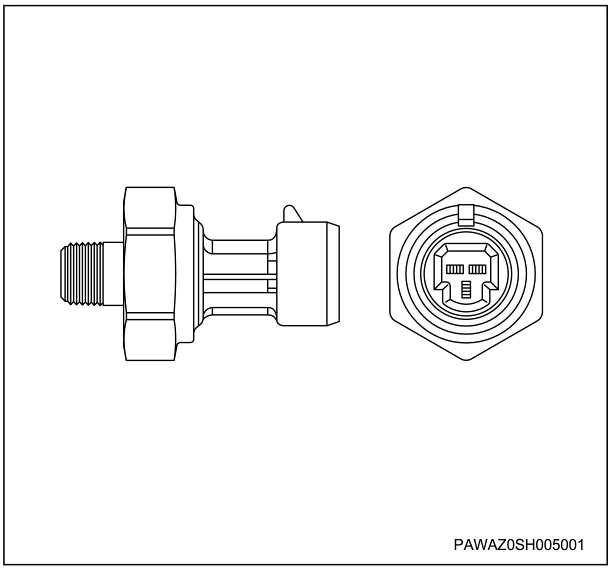
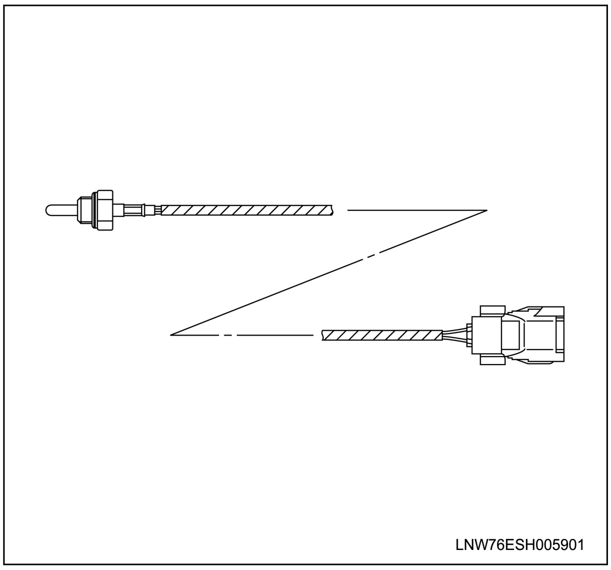
Fuel filter pressure sensor

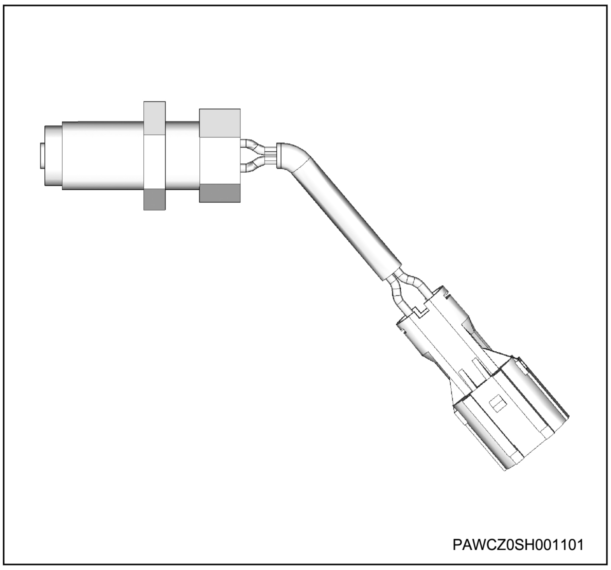
The fuel filter pressure sensor is installed on the fuel filter and converts the vacuum in the fuel filter into a voltage signal. The ECM calculates the vacuum in the fuel filter based on the voltage signal to determine clogging in the fuel filter.



IMT sensor
The IMT sensor is a variable resistor installed on the intake chamber and measures the intake temperature of the intake chamber. When the sensor is cold, the sensor resistance is high. When the intake temperature rises, the sensor resistance decreases. For low sensor resistance, the ECM detects a low voltage of the signal circuit.



Engine speed sensor
The engine speed sensor is installed on the flywheel housing. Output received from the engine speed sensor is directly transmitted to the tachometer without passing through the ECM.



Diagnosis light
By turning ON the diagnostic switch, the DTC is indicated by flashing.

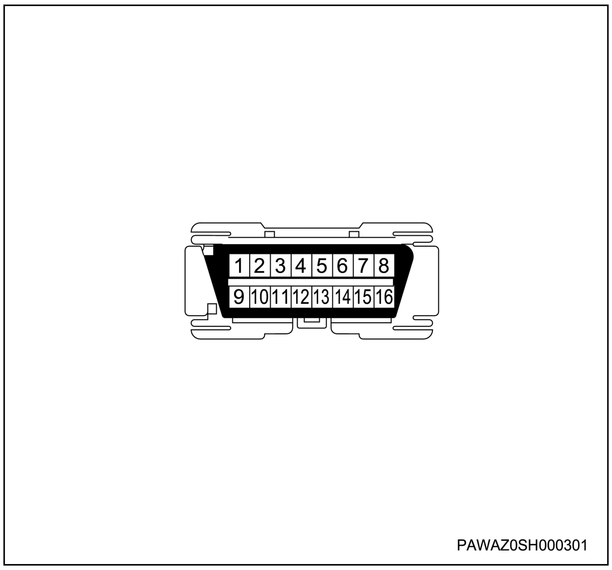
Note：

- For the installation position of the diagnostic light, refer to the manual of the machine.

DLC
The DLC is the connector for communication and connection between the trouble diagnosis scanning tool and various controllers.

Note：

- For the DLC installation position, refer to the manual of the machine.



Diagnostic switch
The diagnostic switch shorts DLC terminal No. 12 and No. 4 or No.5 and flashes the diagnostic light to indicate the DTC.

Note：

- For the installation position and shape of the diagnostic switch, refer to the manual of the machine.

Memory clear switch
This is used when clearing the recorded DTCs in the ECM by operating the diagnostic switch and the memory clear switch.

Note：

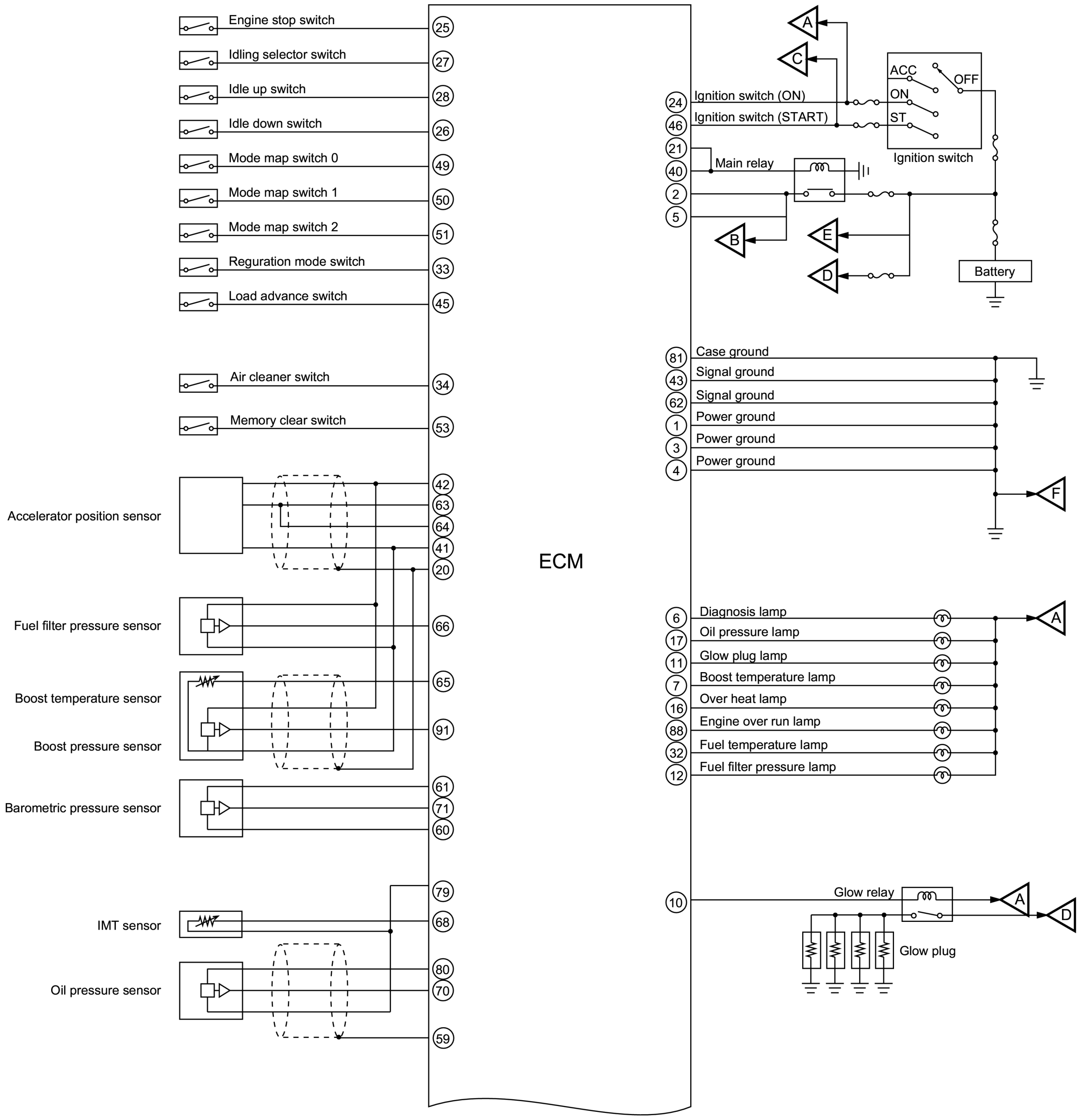
- For the installation position of the memory clear switch, refer to the manual of the machine.

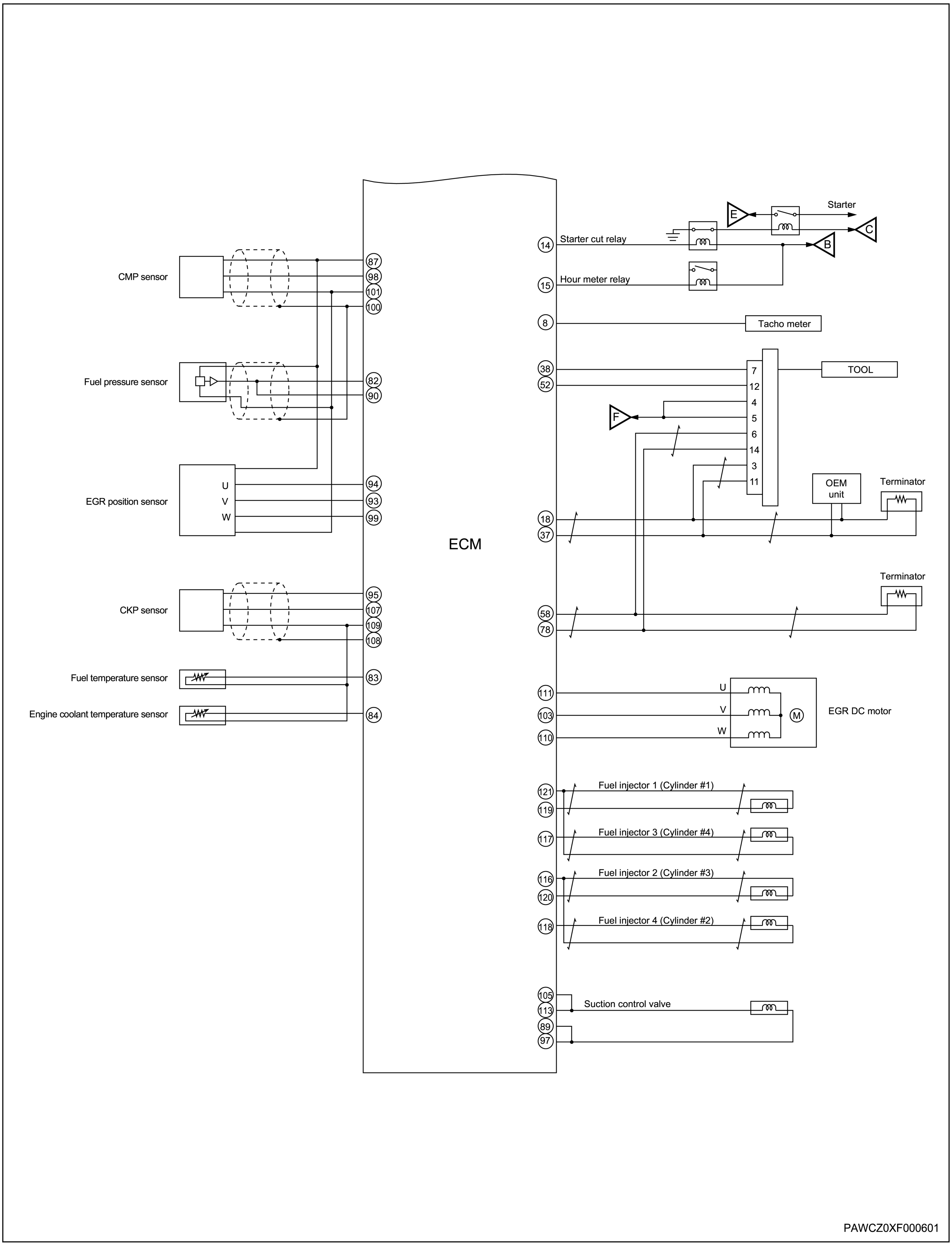
Mode change switch (0, 1, 2)
The operation can be performed at the engine speed specified for each mode by switching the mode change switch.

Note：

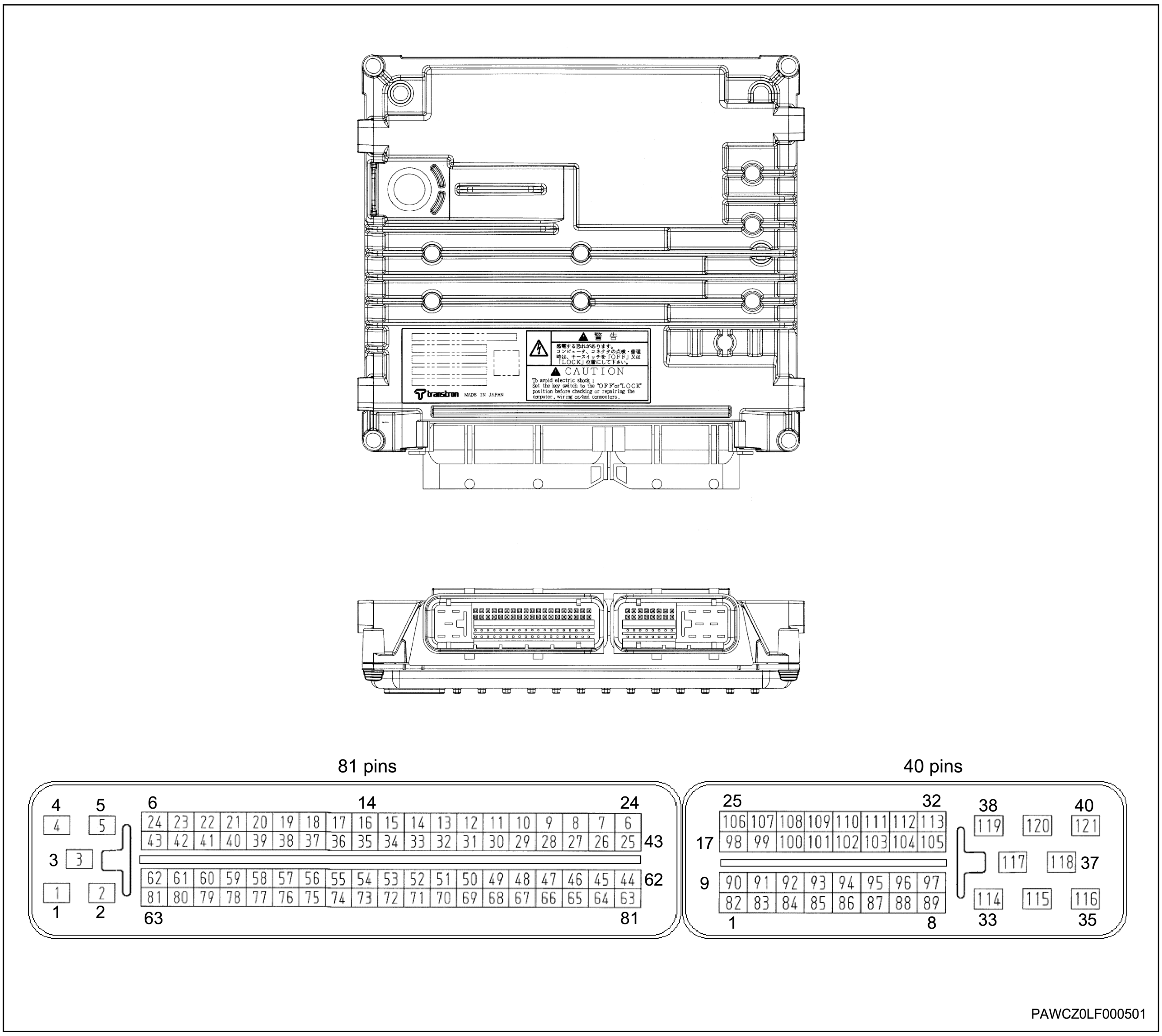
- For the installation position of the mode change switch, refer to the manual of the machine.

ECM power distribution diagram
Some sensors may not be connected to the ECM depending on the specifications of the machine.
Since some sensors may perform input/output with the ECM depending on CAN communication, check the specifications of the machine.


Engine stop switch
Idling selector switch
Idle up switch
Idle down switch
Mode map switch 0
Mode map switch 1
Mode map switch 2
Reguration mode switch
Load advance switch
Air cleaner switch
Memory clear switch
Accelerator position sensor
Fuel filter pressure sensor
Boost temperature sensor
Boost pressure sensor
Barometric pressure sensor
IMT sensor
Oil pressure sensor
ECM
Ignition switch (ON)
Ignition switch (START)
ACC
OFF
ON
ST
Ignition switch
Main relay
Battery
Case ground
Signal ground
Signal ground
Power ground
Power ground
Power ground
Diagnosis lamp
Oil pressure lamp
Glow plug lamp
Boost temperature lamp
Over heat lamp
Engine over run lamp
Fuel temperature lamp
Fuel filter pressure lamp
Glow relay
Glow plug
PAWCZ0XF000501



ECM pin assignment



81 pin connector

Pin No.	Pin name	Connection
1	PG-POWER	ECM power source GND
2	PS-+B	Battery power source
3	PG-POWER	ECM power source GND
4	PG-POWER	ECM power source GND
5	PS-+B	Battery power source
6	OS-DIAGL	Diagnosis light
7	OS-BOOSTL	Boost temperature sensor pilot light
8	OS-TACHO	Tachometer
9	-	-
10	OS-GLOWR	Glow relay
11	OS-GLOWL	Glow light
12	OS-FIPRESSL	Fuel filter clogging light
13	-	-
14	OS-STARTR	Starter cut relay
15	OS-HOUR	Hour meter relay
16	OS-OVHL	Overheat light
17	OS-OILPL	Engine hydraulic light
18	CC-CAN-H	CAN-High
19	-	-
20	SG-SLD1	Accelerator position sensor, boost pressure shield
21	OS-MAINR	ECM main relay control
22	-	-
23	-	-
24	IS-IGKEY	Ignition switch ON signal
25	IS-ENGSTP	Engine stop switch signal
26	IS-IDLDWN	Idling control switch Down signal
27	IS-IDLMNL	Idling control change switch signal
28	IS-IDLUP	Idling control switch Up signal
29	-	-
30	-	-
31	-	-
32	OS-THLL	Fuel temperature light
33	IS-REG	Regulation mode switch signal
34	IS-AC	Air cleaner switch signal
35	-	-
36	-	-
37	CC-CAN-L	CAN-Low
38	CC-KW2000	Data link connector
39	-	-
40	OS-MAINR	ECM main relay control
41	SG-5VRT1	Accelerator position sensor, boost pressure sensor, fuel filter pressure sensor GND
42	SP-5V1	Accelerator position sensor, boost pressure sensor, fuel filter pressure sensor power source
43	PG-SIGN	Signal GND
44	-	-

45	IS-LOAD	Load advance switch signal
46	IS-START	Ignition switch start signal
47	-	-
48	-	-
49	IS-MDMAP0	Mode map switch 0 signal
50	IS-MDMAP1	Mode map switch 1 signal
51	IS-MDMAP2	Mode map switch 2 signal
52	IS-DIAG	Diagnostic switch signal
53	IS-MEMCL	Memory clear switch
54	-	-
55	-	-
56	-	-
57	-	-
58	CC-ISOCAN-H	ISO CAN-High
59	SG-SLD3	Oil pressure shield
60	SG-5VRT2	Barometric pressure sensor GND
61	SP-5V2	Barometic pressure sensor power source
62	PG-SIGN	Signal GND
63	IA-ACCEL1	Accelerator position sensor 1 signal
64	IA-ACCEL2	Accelerator position sensor 2 signal
65	IA-THCO	Boost temperature sensor signal
66	IA-FLCLG	Fuel filter pressure sensor signal
67	-	-
68	IA-IMT	IMT sensor signal
69	-	-
70	IA-OILPRESS	Oil pressure sensor signal
71	IA-BARO	Barometric pressure sensor signal
72	-	-
73	-	-
74	-	-
75	-	-
76	-	-
77	-	-
78	CC-ISOCAN-L	ISO CAN-Low
79	SG-5VRT3	IMT sensor, oil pressure sensor GND
80	SP-5V3	Oil pressure sensor power source
81	PG-CASE	ECM case GND

40-pin connector

Pin No.	Pin name	Connection
82	IA-PFUEL	FRP sensor signal
83	IA-THL	Fuel temperature sensor signal
84	IA-THW	Engine coolant temperature sensor signal
85	-	-
86	-	-
87	SP-5V5	CMP sensor, fuel pressure sensor, EGR position sensor power source
88	OS-OVRL	Engine overrun light
89	IA-SCVLO	SCV-LO drive
90	IA-PFUEL	FRP sensor signal
91	IA-MAP	Boost pressure sensor signal
92	-	-
93	IS-EBMPOS2	EGR position sensor signal V
94	IS-EBMPOS1	EGR position sensor signal U
95	SP-5V4	CKP sensor power source
96	-	-
97	IA-SCVLO	SCV-LO drive
98	IF-CAM	CMP sensor signal
99	IS-EBMPOS3	EGR position sensor signal W
100	SG-SLD5	CMP sensor, FRP sensor shield
101	SG-5VRT5	CMP sensor, fuel pressure sensor, EGR position sensor GND
102	-	-
103	OM-EBM2	EGR valve DC servo motor drive V
104	-	-
105	OP-SCVHI	SCV-HI drive
106	-	-
107	IF-CRANK	CKP sensor signal
108	SG-SLD4	CKP sensor shield
109	SG-5VRT4	CKP sensor, fuel temperature sensor, coolant temperature sensor GND
110	OM-EBM3	EGR valve DC servo motor drive W
111	OM-EBM1	EGR valve DC servo motor drive U
112	-	-
113	OP-SCVHI	SCV-HI drive
114	-	-
115	-	-
116	OP-COM2	Injector power source 2, No. 2 cylinder, No. 3 cylinder
117	OS-INJ3	Injector 3 control, No.4 cylinder
118	OS-INJ4	Injector 4 control, No.2 cylinder
119	OS-INJ1	Injector 1 control, No.1 cylinder
120	OS-INJ2	Injector 2 control, No.3 cylinder
121	OP-COM1	Injector power source 1, No. 1 cylinder, No. 4 cylinder

Introduction to the trouble diagnosis

1. Introduction to the trouble diagnosis
   1. About trouble diagnosis
      The following trouble diagnosis procedure is extremely important to resolve problems of all electric/electronic systems.
      Neglecting to implement these steps may result in requiring unnecessary repairs. Read and understand the procedure carefully and proceed with the trouble diagnosis.
      Also, use available functions and the trouble diagnosis scan tool to perform the trouble diagnosis and system check.
      After repair work is performed, verify that DTCs are cleared. If a DTC is not cleared, move on to the next step.
      The wiring diagram also includes information such as the connector location diagram and the connector pin arrangement. Use the information to perform the trouble diagnosis.
   2. Trouble diagnosis procedure
      Checking complaints from customer
      ・Use the check sheet to organize the trouble situation.

Performing preliminary inspection
・Perform overall visual inspection.
・Check the maintenance history.
・Detect any malfunction such as abnormal noise and smell.
・Collect the failure trouble DTC information to provide effective repair.
・Inspect for a malfunction by comparing with the specified values.

Inspect the service information
・Check the market service bulletin.

Perform inspection for the DTC code
・Inspect the item displayed by the DTC.

Inspect for malfunctions based on symptom
・Inspection of the item that is not displayed by the DTC.

NOTE
System trouble diagnosis type
The system diagnosis method is a standardized method applied for repairing all electric/electronic systems.
Failures in electric/electronic systems differ from common machine failures, and often occur in the following steps.

Initial stage of failure
The failure occurs sporadically and for a short time.
Often times the driver does not notice it. At this stage, the customer's complaint is unclear, and the malfunction cannot be reproduced. However, the ECM may have recorded the failure.
Past malfunctions, past failures

Middle stage of failure
The failure occurs sporadically and for a short time, but may occur repeatedly at intervals, and occurs under specific conditions.
The customer complaint is clear, but the failure conditions are unclear.
Therefore, the person performing the diagnosis can reproduce the failure by understanding its conditions.
Intermittent failures, intermittent

Stage where failure is realistic
The occurrence of the failure is set, and the customer complaint is real and clear.
Therefore, the person performing the diagnosis can reproduce the failure. However, there may sometimes be multiple causes for the failure.
Current malfunction, current failures

3. Diagnosis
   Fully understand the description given by the customer using the Engine control system check sheet.

Note：
・ When questioning, do not ask randomly but focus on the system that is inferred to be defective based on the malfunction phenomenon.

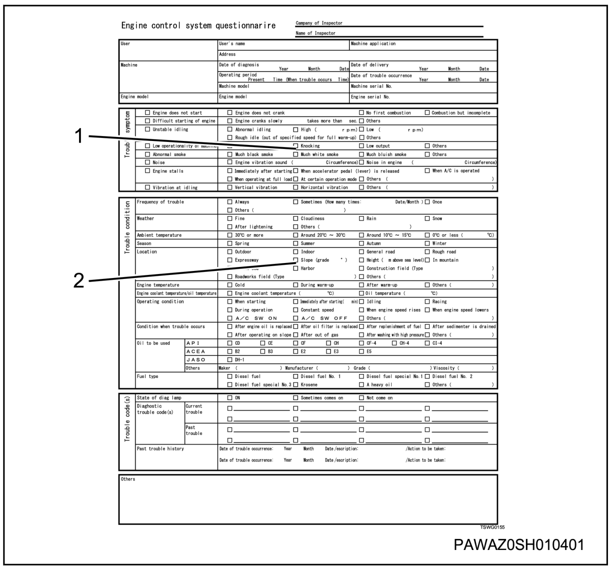
Determine failure information accurately.
Have a concrete understanding based on 5W1H.
Low air temperature, at start or on a steady basis, near the engine parts, metallic sound, etc.

Check points
・Failure symptoms
・Month and date, time, frequency of occurrence
・Road conditions
・Driving conditions, operation condition, weather
・Feeling of symptom

Engine control system check sheet
When receiving the machine from the customer at the service factory, the failure symptoms and the data on the occurrence of failures must be checked with the customer based on the engine control check sheet.

・Failure symptoms may not be able to be reproduced at the service factory.
・The customer's complaint may not always be a malfunction.
・Notification of incorrect malfunction conditions to the person in charge of repairs may result in unnecessary man-hours for repairs.

・The check sheet assists in onboard diagnosis, repair, and repair verification at the vehicle servicing station.



1. Failure symptoms
2. Failure frequency/failure conditions

Engine control system questionnarire

Campany of inspector

Name of inspector

User	User's name	Machine application
	Address	
Machine	Date of diagnosis Year Month Date	Date of delivery Year Month Date
	Operating period Present Time (When trouble occurs Time)	Date of trouble occurrence Year Month Date
	Machine model	Machine serial No.
Engine model	Engine model	Engine serial No.

Trouble symptom	☐ Engine does not start	☐ Engine does not crank		☐ No first combustion	☐ Combustion but imcomplete
	☐ Difficult starting of engine	☐ Engine cranks slowly	takes more than sec.	☐ Others	
	☐ Unstable idling	☐ Abnormal idling	☐ High (rpm)	☐ Low (rpm)	
		☐ Rough idle (out of specified speed for full warm-up)		☐ Others	
	☐ Low operationality of machine	☐ Surging	☐ Knocking	☐ Low output	☐ Others
	☐ Abnormal smoke	☐ Much black smoke	☐ Much white smoke	☐ Much bluish smoke	☐ Others
	☐ Noise	☐ Engine vibration sound (	Circumference)	☐ Noise in engine (	Circumference)
	☐ Engine stalls	☐ Immediately after starting	☐ When accelerator pedal (lever) is released		☐ When A/C is operated
		☐ When operating at full load	☐ At certain operation mode	☐ Others (	)
	☐ Vibration at idling	☐ Vertical vibration	☐ Horizontal vibration	☐ Others (	)

Trouble condition	Frequency of trouble		☐ Always	☐ Sometimes (How many times:	Date/Month)	☐ Once
			☐ Others ( )			
	Weather		☐ Fine	☐ Cloudiness	☐ Rain	☐ Snow
			☐ After lightening	☐ Others ( )		
	Ambient temperature		☐ 30℃ or more	☐ Around 20℃ ～ 30℃	☐ Around 10℃ ～ 15℃	☐ 0℃ or less (℃)
	Season		☐ Spring	☐ Summer	☐ Autumn	☐ Winter
	Location		☐ Outdoor	☐ Indoor	☐ General road	☐ Rough road
			☐ Expressway	☐ Slope (grade °)	☐ Height (m above sea level)	☐ In mountain
			☐ On the sea	☐ Harbor	☐ Construction field (Type	)
			☐ Roadworks field (Type	)	☐ Others (	)
	Engine temperature		☐ Cold	☐ During warm-up	☐ After warm-up	☐ Others ( )
	Engine coolant temperature/oil temperature		☐ Engine coolant temperature (℃)		☐ Oil temperature (℃)	
	Operating condition		☐ When starting	☐ Immediately after starting(min)	☐ Idling	☐ Racing
			☐ During operation	☐ Constant speed	☐ When engine speed rises	☐ When engine speed lowers
			☐ A／C SW ON	☐ A／C SW OFF	☐ Others (	)
	Condition when trouble occurs		☐ After engine oil is replaced	☐ After oil filter is replaced	☐ After replenishment of fuel	☐ After sedimenter is drained
			☐ After operating on slope	☐ After out of gas	☐ After washing with high pressure	☐ Others ( )
	Oil to be used	API	☐ CD ☐ CE	☐ CF ☐ CH	☐ CF-4 ☐ CH-4	☐ CI-4
		ACEA	☐ B2 ☐ B3	☐ E2 ☐ E3	☐ E5	
		JASO	☐ DH-1			
		Others	Maker ( )	Manufacturer ( )	Grade ( )	Viscosity ( )
	Fuel type		☐ Diesel fuel	☐ Diesel fuel No. 1	☐ Diesel fuel special No.1	☐ Diesel fuel No. 2
			☐ Diesel fuel special No.3	☐ Krosene	☐ A heavy oil	☐ Others ( )

Trouble code(s)	State of diag lamp		☐ ON	☐ Sometimes comes on	☐ Not come on	
	Diaghostic trouble code(s)	Current trouble	☐ ____	☐ ____	☐ ____	☐ ____
			☐ ____	☐ ____	☐ ____	☐ ____
		Past trouble	☐ ____	☐ ____	☐ ____	☐ ____
			☐ ____	☐ ____	☐ ____	☐ ____
	Past trouble history		Date of trouble occurrence: Year Month Date /escription: /Action to be taken:			
			Date of trouble occurrence: Year Month Date /escription: /Action to be taken:			

Others

PAWAZ0XF000501

4. Preliminary inspection
Visual inspection of engine room

When implementing the diagnostic procedures, carefully make a visual inspection of the engine room. This inspection can often lead to solving a problem without taking extra steps.

・Visually inspect all air hoses for punched holes, cuts, disconnections, and appropriate piping.
・Visually inspect the hoses that are difficult to see behind other components.
・For every harness in the engine room, visually inspect that all harnesses are properly connected. Inspect that there are no burned or worn areas, that the harnesses are properly fastened, and that they are not in contact with sharp edges or the hot exhaust manifold or pipes.

Checking the machine maintenance status
If the machine is not maintained properly, the diagnostic light illuminates. Restricted oil filters, fuel filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger machine malfunctions that were not previously monitored prior to the OBD system check. Poor machine maintenance cannot be classified as a non-machine failure, but since the sensitivity of OBD system checks is high, machine maintenance schedules must be followed more closely.

Non-OEM parts
All the OBD system checks are adjusted to operate with genuine parts. Therefore, when a commercially sold sensor, switch, etc., is installed, a wrong diagnosis is made, and the diagnostic light illuminates.
Aftermarket electronics, such as mobile phones, stereos, and anti-theft devices, may emit EMI into the control system when they are improperly installed. As a result, false sensor information is generated causing the diagnostic light to illuminate. When conducting a trouble diagnoses, either turn OFF the power for all aftermarket parts or remove them, and then check the failure again.

NOTE
Related system failure
Many OBD system checks go into the backup operation mode based on the instruction from the ECM which is given when the ECM detects a failure in the related systems or components. When the backup operation mode is activated, the output is reduced to protect the machine.

5. Trouble diagnosis
Basic knowledge of tools required

Note：

・ When performing the diagnostic procedure, lack of basic knowledge regarding this powertrain could result in an incorrect diagnosis or damage to the powertrain components. Do not attempt to diagnose a problem related to the powertrain without having the basic knowledge. A basic understanding of hand tools, such as the trouble diagnosis scan tools, is required to utilize the service manual effectively.

About the diagnostic test performed on the machine
Past failures
・The diagnostic tests of the previous ignition cycle have been completed.
・The diagnostic tests of the current ignition cycle have passed.
・Problems identified in the diagnostic tests currently do not exist.

Current failures
The diagnostic tests of the previous ignition cycle have been completed.
・Problems identified in the diagnostic tests currently exist.
・The diagnostic tests of the current ignition cycle have failed.

Glossary
DTC
Every time the ignition switch is turned ON, the ECM performs a self-test on most of the wiring and components, records any detected system failure in the memory of the ECM, and performs a backup control, depending on the DTC.
Also, for a malfunction that can affect driving, the diagnostic light illuminates to inform the operator.

Ignition cycle
Because the machine activates with a method that satisfies a predetermined diagnosis standard, an ignition cycle is defined as turning the key ON, running, then turning the key OFF.

Diagnostic light
Basically, the diagnostic light illuminates when a DTC is set due to a failure in the electronic control system such as the ECM.

DLC
The equipment for communicating with the control unit is the Data Link Connector (DLC). The DLC is also provided to establish a connection with the trouble diagnosis scan tool.
Identification of recorded DTC
Reading the serial data

Note：

・ The installation position of the DLC or the existence or nonexistence of a DLC varies depending on the machine, so refer to the manual of the machine.

ECM OFF
Approximately 10 seconds or more after the ignition switch is turned OFF, the ECM power source is completely down, turning to the ECM OFF status.

General diagnostic operations of the components monitor
To run the engine normally, a general diagnosis of the components is required.

Input components
Check the input components to inspect whether there is an open circuit in the circuit and whether the values are within range.
CKP sensor
CMP sensor
Engine coolant temperature sensor
Boost sensor
FRP sensor
Accelerator position sensor

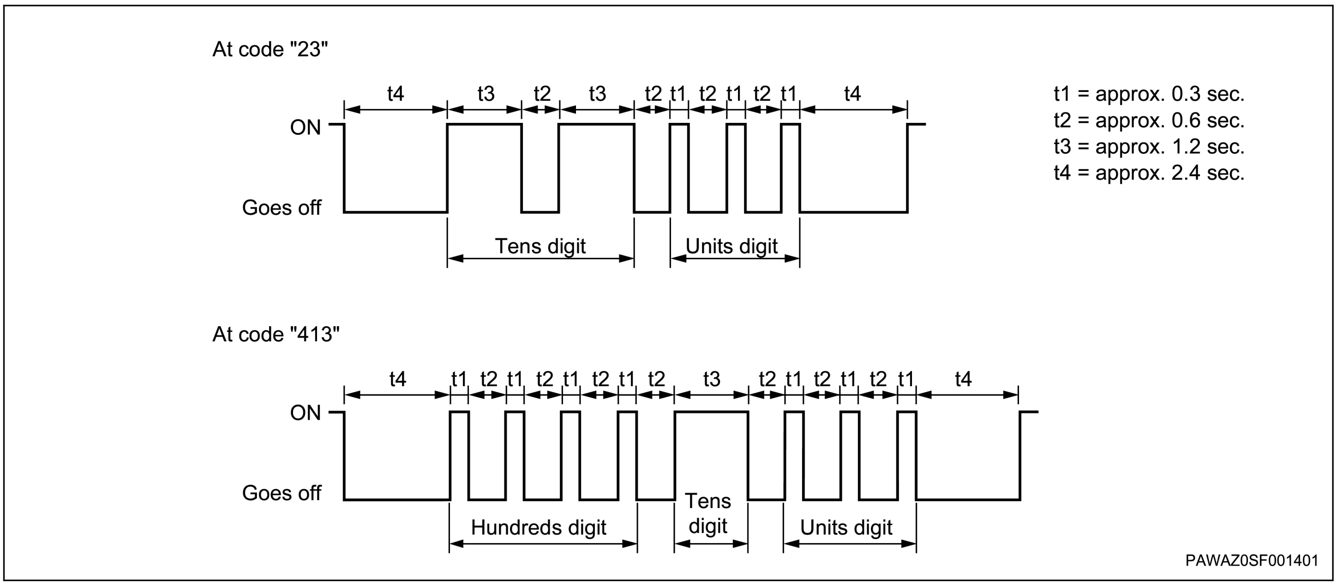
Output components
The output components are inspected to diagnose whether responses to commands from the control unit are appropriate. Inspect whether there are open circuits in the circuits and whether their values are within the range.
Suction control valve
Light, relay control
Magnetic valve
Diagnostic light

6. Procedure for reading the DTC
   Reading the DTC with a diagnostic light
   Current and past DTCs recorded in the ECM can be displayed by connecting the diagnostic switch and flashing the diagnostic light.
   ・Turn the ignition switch ON and check that the diagnostic light illuminates.
   ・Turn the ignition switch ON, but the engine OFF.
   ・Connect the diagnostic switch. For a machine with no diagnostic switch, short No. 12 and No. 4 or No. 5 of the DLC.
   ・Read the flashing count of the diagnostic light.
   ・The DTC determines the failure contents from the Diagnostic trouble code list.
   If the trouble diagnosis scan tool is connected, the diagnostic codes can be read by operating the trouble diagnosis scan tool.

Note：
・ For the installation position of the diagnostic light, refer to the manual of the machine.

Display when a DTC is not recorded
Code 1 (indicating the start of code display) is displayed repeatedly.

Display when a DTC is recorded
The recorded trouble code is displayed three times. If 2 or more trouble codes have been recorded, the DTCs will be output in ascending order with each DTC being displayed three times. After displaying all codes, the codes will be displayed again starting with the smallest code number. This display continues while the diagnosis connector is connected.



DTC indicated by diagnostic light flashing display
Current and past DTCs are both displayed while the engine is stopped.
While the engine is in operation, the light illuminates only when a current DTC exists.

Using the trouble display monitor to read the DTCs
When a DTC is set, the DTC can be displayed on the trouble display monitor of the machine.

Using the trouble diagnosis scan tool to read DTCs
DTCs can be read using the trouble diagnosis scan tool.

Note：
・ For the work procedure, refer to the manual of the trouble diagnosis scan tool.

If a DTC is recorded
Perform repairs accurately according to the specified DTC chart.

If there is no DTC
Select the symptom from Diagnosis by symptom.
Complete the repair according to the diagnostic

procedure. It is also possible to perform the inspection by referring to the functional diagnosis.

When the appropriate symptom is not found
Investigate the complaint in detail.
Create a diagnosis plan.
Utilize the schematics and operation principles.
When repair history for similar cases are available, request technical assistance. Combine technical knowledge and effective utilization of available service information.

Intermittent
A failure condition that does not always appear is referred to as "intermittent".
Observe the DTC information and the data display.
Verify the symptoms and conditions reported by the customer.
Use a check sheet or other method to check the circuit or electronic system components.

If no trouble is detected
This situation indicates that the machine is determined as operating properly. The condition reported by the customer may be normal. Check the customer complaint by comparing to other machines that are operating properly. However, depending on the condition, it may be intermittent. Before returning the machine, check the complaint under the conditions given by the customer.
Investigate the complaint again.
If the complaint cannot be adequately detected or checked, it is necessary to perform the diagnosis again to verify the complaint. As stated above in "Intermittent", the complaint may be an intermittent or normal condition.
Repair and verify.
Perform the repair when the cause has been checked.
Check that the operation is performed properly, and that the symptom has been corrected. This includes the verification test performed on the machine or other methods to check that the complaint has been resolved.
Check by testing under the conditions given by the customer.
When a DTC is diagnosed, verify that the malfunction has been repaired by reproducing the condition that appeared when the DTC was set while checking the scan tool data.

7. Verification after repair
   Machine repair verification
   When a repair has been performed for the electronic control system, it is necessary to verify that the repair is accurate after repairing the machine. If this check is not adequate, the diagnostic light may illuminate again while returning the machine to the customer, or drivability problems may occur.
   Especially for an intermittent failure, it is necessary to verify by reproducing the conditions of the customer complaint.

About the machine repair verification
It is effective to use the OBD system check for the machine repair verification.
After the repair is completed, the person who has performed the machine diagnosis shall review either the DTC that was diagnosed or the scan tool data, or both, and record it.
Clear the DTC.
Run the machine based on the scan tool data.
Check the DTC status information of the specified DTC that was diagnosed until the diagnosis test related to that DTC is implemented by the control unit.
The implementation of these steps is extremely important when checking the repair status with the OBD system check. Neglecting to implement these steps may result in unnecessary repairs.

8. Final check item list

Item	Item	Objective	Method
1	DTC check	Verification of the DTC display after the repair	Clear the previous DTCs. Keep the engine idling to sufficiently warm it up, then perform a racing operation with the engine speed raised up to No Load Max., and secure the test conditions.
2	Idling speed check after warming up the engine	To check whether the idling control is operating normally.	Verify that the idling speed is stable at a constant speed with no load after warming up the engine. If a problem is found, refer to Engine hunching, Rough Idle in Diagnosis by symptom.
3	Scan tool data list verification	Check whether the engine control and the communication status are normal or abnormal under normal conditions.	Monitor the scan tool data list, and check the values using a typical value sheet. Check the typical values of the scan tool data list.
4	Re-startability check	To check whether the starting control is normal.	After warming up the engine, verify that the cranking time is 5 seconds or less when restarting the vehicle, and that the engine rotation is stable after starting.
5	Powerful electromagnetic transmitter verification	When an electromagnetic transmitter such as a transceiver has been added to the vehicle, verify that no interfering waves are being emitted.	Check whether turning the electromagnetic transmitter, such as a transceiver, ON and OFF causes the idling engine speed to change. If a problem is found, let the customer know that the installation position and output of the electromagnetic transmitter need to be changed.

Supplementary information on the powerful electromagnetic transmitters verification
If a problem is found in this item, convey it to the customer as necessary.
・Install the antenna to a location distant from any electronic control system, such as the control units and sensors.
・Install the antenna cord at least 20 cm away from the electronic systems of the machine, such as the control units and sensors.
・Do not wire other cables together with the antenna. Also, locate the antenna cord as far away from other wiring as possible.
・Make sure to attach retrofitted equipment in accordance with their respective installation manuals.
・Do not install high output mobile communication devices.

Caution :

- Follow the steps when performing the OBD system check to verify the repair. Failure to follow these steps may result in performing unnecessary repair work.
- Review the scan tool data relating to the DTC that was diagnosed and make a record.
- Clear the DTC.
- Run the machine while checking the related scan tool data.

9. Method for clearing the DTC

Clearing the DTC
If an error occurs in the system and the DTC is recorded in the ECM, that DTC is not cleared from the memory even when the malfunctioning part is repaired, so use the following measures to execute a forced deletion.

Using the trouble diagnosis scan tool to clear DTCs
If the trouble diagnosis scan tool is connected, codes can be cleared by performing the clear function of the trouble diagnosis scan tool.

Clearing by ECM
A DTC recorded in the ECM is cleared if the same DTC is not met for 40 consecutive ignition cycles.

About the trouble diagnosis scan tool
This tool is effective for diagnosing electrical failures in the engine control system and performing system checks. If the SAE 16/19 adapter is connected to the DLC installed in the machine, it performs communication with the control units of the machine, and enables various diagnoses and tests to be performed.

Functions of the trouble diagnosis scan tool

Data display

Snapshot

Programming

Actuator test

Caution :

- When conditions such as the running state of the machine or the engine, water temperature, switches, and gear position are not met, or when a DTC has been set, each test may possibly not operate.

ECM reflash
The ECM can be updated by overwriting the control program using the most up-to-date control data issued every 3 months.
Normal reflash
The ECM is reflashed by automatically searching for the ECM part number compatible with the part number currently reflashed.
Forced reflash
The ECM is reflashed by specifying an arbitrary ECM part number.
In this case, a password dedicated for forced reflash is necessary.
Campaign reflash
The ECM is reflashed by selecting the part number during a campaign carried out by the manufacturer.

Rewriting the injector QR code
The injector QR code that is required when replacing the injector can be rewritten. This allows fuel compensation to be performed on each injector to optimize the engine condition.

Engine replacement mode
This should be used when changing back to the old ECM part number, which requires hardware changes such as addition of machine wiring, is performed along with engine replacement, etc.

ECM replacement
When replacing the ECM within the same model, the data can be updated from the current ECM to a trouble diagnosis scan tool and then downloaded from the trouble diagnosis scan tool to the new ECM after replacement.

Factory shipment settings
Based on the engine serial number, data such as the ECM injector QR code can be downloaded to the ECM.

Actuator test
The injector test, fuel injection test, rail pressure test, glow plug test, and EGR control test are performed to inspect the operation and function of each target component.

Caution :

- When conditions such as the running state of the machine or the engine, water temperature, switches, and gear position are not met, or when a DTC has been set, each test may possibly not operate.

Manual Display
This links with the DTC to display the manual along with the trouble diagnosis procedure.

Reading saved data
The saved snapshot data can be read and displayed again.

Caution :

- When using the trouble diagnosis scan tool, refer to the separate instruction manual for the trouble diagnosis scan tool.

10. Data list

Scan tool data display items are included in this list.
This data is used to check whether the condition of each item in the list is normal (machines, etc., before sales), and can be a useful for recording reference data when performing trouble diagnoses.
This data is used in trouble diagnosis by comparing each machine's data with the reference values, and checking whether the machine data is temporarily or always different from the reference values.
This display menu is subject to change without notice.

Data Display Items	Unit	Reference values
Battery Voltage	V	
Target Engine Speed	RPM	
Engine Speed	RPM	
Accelerator Pedal Position Sensor 1 (APP1)	V	
Accelerator Pedal Position Sensor 2(APP2)	V	
Accelerator Pedal Position (APP)	%	
Fuel Rail Pressure Sensor	V	
Fuel Rail Pressure Feedback		
Engine Coolant Temperature Sensor	V	
Engine Coolant Temperature	℃ {°F }	
Intake Air Temperature Sensor	V	
Intake Air Temperature	℃ {°F }	
Fuel Temperature Sensor	V	
Fuel Temperature	℃ {°F }	
Barometric pressure	kPa {psi}	
Manifold Absolute Temperature Sensor Voltage	V	
Manifold Absolute Pressure Sensor	kPa {psi}	
Manifold Absolute Pressure	kPa {psi}	
Cylinder 1 Balancing Fuel Compensation	mm3/st	
Cylinder 2 Balancing Fuel Compensation	mm3/st	
Cylinder 3 Balancing Fuel Compensation	mm3/st	
Cylinder 4 Balancing Fuel Compensation	mm3/st	
Engine Mode		
EGR Valve 1 Drive Duty	%	
EGR Brushless Position 1	ON/OFF	
EGR Brushless Position 2	ON/OFF	
EGR Brushless Position 3	ON/OFF	
Ignition Switch	ON/OFF	
Starter Switch	ON/OFF	
Glow Relay	ON/OFF	
Fuel Delivery Rate Data 1		
Fuel Delivery Rate Data 2		
Fuel Delivery Rate Data 3		
Engine Run Time	sec	
Accelerator Pedal Position (APP) 1	%	
Accelerator Pedal Position (APP) 2	%	
Starter Cut/On Relay	ON/OFF	
EGR Temperature Sensor Voltage	V	
Ignition Voltage	V	
Fuel Filter Pressure Sensor	V	
Actual Fuel Rail Pressure	mPa {psi}	
EGR Valve Zero Position Step Counter 1	steps	
EGR Valve Rotor Position 1	%	
EGR Temperature	℃ {°F }	

Fuel Filter Pressure Sensor	kPa {psi}	
Turbochager Drive Duty	%	
Target Fuel Injection Quantity	mm3/st	
Start Of Pilot Injection	°CA	
Target Fuel Rail Pressure	mPa {psi}	
Target Turbocharger Position	%	
Target EGR Valve Position	%	
Target Manifold Absolute Pressure	kPa {psi}	
Engine Rpm Overrun Count	Counts	
Coolant Over-temperature Count	Counts	
Intake Air Over-temperature Count	Counts	
Fuel Over-temperature Count	Counts	
RPM Limit Reserve Count		
SCV Sweep Switch	ON/OFF	
CAN Timeout Stop Switch	ON/OFF	
Memory Clear Switch	ON/OFF	
Regulation Select Switch	ON/OFF	
Load Switch	ON/OFF	
Mode Switch 0	ON/OFF	
Mode Switch 1	ON/OFF	
Mode Switch 2	ON/OFF	
Oil Pressure Sensor Voltage	V	
Engine Oil Pressure	kPa {psi}	
Manifold Absolute Temperature	℃ {°F }	
Manifold Absolute Temperature Count		
EGR Temperature Count		
Q Limit Max	mm3/st	
Q Limit Min	mm3/st	
Oil Pressure Emergency Stop Status		
Over Run Emergency Stop Status		
Over Heat Emergency Stop Status		
Engine Stop Status		
Engine Stop CAN Signal		
Engine Stop Switch		
Engine Stop Request		
Engine Shutoff Status		

Description Engine

Functional Inspection

(4LE2)

Table of Contents

Engine compression pressure inspection

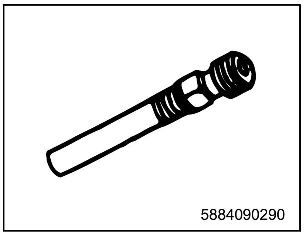
1. Engine compression pressure inspection inspection
   1. Start the engine.

      Note：
      - Warm up the engine.
   2. Turn OFF the ignition switch.
   3. Disconnect the battery ground cable from the battery.
   4. Remove the harness connector from the injector.
   5. Remove the glow plug from the cylinder head.

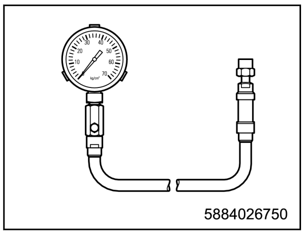
      Note：
      - Remove all the glow plugs.
   6. Connect the battery ground cable to the battery.
   7. Engage the starter.

      Note：
      - Crank the engine to discharge foreign material from inside the cylinders.
   8. Install the special tool to the cylinder head.

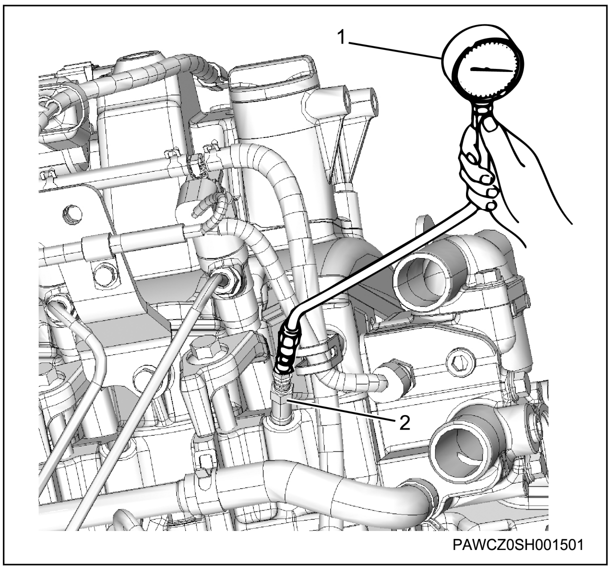
      Note：
      - Insert the compression gauge adapter into the glow plug installation hole and install the compression gauge.



SST: 5-8840-9029-0 - compression gauge adapter



SST: 5-8840-2675-0（5-8531-7002-0） - compression gauge



1. Compression gauge
2. Compression gauge adapter

   9. Measure the compression pressure.

      Note：
      - Engage the starter, and read the compression pressure when the compression gauge needle stabilizes.
      - Measure the compression pressure of all cylinders.

      values： 3.04 MPa { 441 psi } Engine speed 250 r/min

      limit： 2.5 MPa { 363 psi } Engine speed 250 r/min

      Note：
      - Cylinder differences are less than or equal to (-5) - 5% of the average value.

      Caution：
      - Use a fully charged battery.
      - Be careful because air will burst out through the glow plug hole during rotation.
      - Because a DTC is recorded when the ignition switch is turned ON with the injector harness connector removed, make sure to clear the DTC after completion of inspection.
   10. Remove the special tool from the cylinder head.
   11. Disconnect the battery ground cable from the battery.
   12. Install the glow plug to the cylinder head assembly.

       Note：
       - Install all the glow plugs.

       tightening torque： 22.5 N・m { 2.3 kgf・m / 17 lb・ft }

13. Connect the harness connector to the injector.
14. Connect the battery ground cable to the battery.

Fuel system check

1. Fuel system check description of function

The fuel system consists of the fuel tank, fuel filter, supply pump, common rail (fuel rail), and injectors, with each component being connected by the fuel pipe.

2. Fuel system check inspection

Inspection when there may be a malfunction in the fuel system

1. Inspect the fuel quality.

The appropriate fuel should be used.

2. Check the fuel amount.

The amount supplied must be sufficient.

3. Inspect the fuel discharge of the supply pump.

The fuel discharge should be normal and there should be no air intrusion.

4. Check whether any filter other than a genuine fuel filter, pre-filter, and electromagnetic pump filter has been added to the fuel pipe of the machine.

Note：

・ An additional filter increases the fuel resistance and may cause DTC P0093 to be detected.

5. If a filter has been added, remove it.

6. Inspect the main fuel filter, the pre-fuel filter, and the electromagnetic pump filter.

・There should be no excessive contamination or clogging.
・There should be no air intrusion.

7. If a problem is found, clean or replace.

8. Inspect the fuel pipe.

There should be no damage, clogging, or poor connections.

9. If a problem is found, repair or replace.

10. Inspect the fuel tank.

・There should be no intrusion of dirt.
・There should be no disconnection or damage to the fuel supply pipe.
・There should be no crushing or damage to the tank.
・There should be no incorrect piping of the fuel pipe.
・There should be no clogging in the fuel filler.
・There should be no water in the tank.

11. If a problem is found, repair or replace the fuel tank. Remove the air.

12. Remove the air.

Air intake system check

1. Air intake system check description of function

Caution：

- If the air intake system parts were installed by the machine manufacturer, refer to the machine manual.

The air intake system consists of the air cleaner, air intake pipe, turbocharger, and other components. The intake air is supplied to the engine through the air cleaner and the intake chamber.

2. Air intake system check inspection

Inspection when there may be a malfunction in the air intake system

1. Inspect the air cleaner.

・There should be no excessive contamination or clogging.

2. If a problem is found, clean or replace.
3. Inspect the air intake pipe.

・There should be no collapsing, damage, or air leakage.
・There should be no bending or inappropriate piping which may lead to increased air intake resistance.
・There should be no damage on the lead valve.

4. If a problem is found, repair or replace.
5. Inspect the turbocharger.

・There should be no abnormal looseness with the turbine shaft.
・There should be no oil leakage.

6. If a problem is found, repair or replace.

Exhaust system check

1. Exhaust system check description of function

The exhaust system consists of the exhaust pipe, tail pipe, etc.

2. Exhaust system check inspection

Inspection when there may be a malfunction in the exhaust system

1. Inspect the exhaust pipe and the tail pipe.

・There should be no collapsing, damage, or exhaust leakage.

2. If a problem is found, repair or replace.
3. Repair the machine.

EGR control system check

1. EGR control system check description of function

The ECM controls the EGR valve based on the engine speed, engine coolant temperature, intake air temperature, fuel injection quantity, and barometric pressure. The EGR valve is driven by the EGR motor, and the EGR valve opening is detected by the EGR position sensor.

2. EGR control system check inspection

Inspection when there may be a malfunction in locations relating to the EGR

1. Observe the DTC information.

Note :

- If a DTC is set, inspect the applicable DTC.

2. Start and warm up the engine until the coolant temperature reaches the specified value or more.

values : 65 ℃ { 149 °F }

3. Observe the EGR position display on the trouble diagnosis scan tool.

values : 30 to 45 %

4. Perform the actuator test EGR using a trouble diagnosis scan tool if the EGR position display is outside the specified range.

5. Command the EGR valve Up and Down, and observe the EGR position display.

Note :

- The difference between the desired EGR valve position display and the EGR valve 1 position display must be within the specified range of values.

Specified value : (-3) to 3 %

6. If the EGR position display is outside the specified range, inspect the EGR piping.

There should be no damage or gas leak.

7. If a problem is found, repair or replace.

8. Start and warm up the engine until the coolant temperature reaches the specified value or more.

values : 65 ℃ { 149 °F }

9. Observe the EGR position display on the trouble diagnosis scan tool.

values : 30 to 45 %

10. If the EGR position display is outside the specified range, replace the EGR valve.

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

Starting system check

1. Starting system check description of function

This diagnostic table is an organized approach to identifying a condition that causes an engine not to start. The appropriate system diagnostic can be performed using the diagnostic table.

The battery should be fully charged when performing this diagnostic.
The battery cable should be securely connected when performing this diagnostic.
The rotation speed during cranking should be normal when performing this diagnostic.
The appropriate fuel should be sufficiently supplied when performing this diagnostic.
No fuel leaks should be found when performing this diagnostic.
No air should be mixed into the fuel when performing this diagnostic.
The air cleaner element should be clean when performing this diagnostic.
The fuel filter should be clean when performing this diagnostic.
The fuse and slow blow fuse should be normal when performing this diagnostic.

2. Starting system check inspection

Inspection when the starter operates and cranks but the engine does not start

1. Turn OFF the ignition switch for 30 seconds.
2. Start the engine for 15 seconds.
3. Observe the DTC information with a scan tool.

Note :

- If a DTC is set, inspect the applicable DTC.

4. Turn OFF the ignition switch for 2 minutes.
5. Turn ON the ignition switch.
6. Observe the fuel rail pressure sensor display on the scan tool.

values : 0.8 to 0.9 V

Note :

- If the reading is outside the specified range, inspect for poor connections at the harness connector between the FRP sensor and ECM.

7. Crank the engine for 5 seconds.

Note :

- The fuel rail pressure sensor display should be more than or equal to the specified value.

values : 1.2 V

Note :

- If the reading is less than the specified value, crank the engine for 5 seconds while observing the SCV driving feedback current display on the scan tool.

values : 900 mA

Note :

- If the reading is less than the specified value, inspect the circuit between the ECM and the SCV for a short to GND.

8. Replace the FRP sensor.

Note :

- Because the FRP sensor cannot be replaced individually, replace the common rail (fuel rail) assembly.

Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

9. Inspect the engine coolant temperature sensor.

Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor inspection*".

10. Inspect the barometric pressure sensor.
11. Inspect the boost pressure sensor/boost temperature sensor.

Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor inspection*".

12. Inspect the EGR position sensor.
13. Inspect the idle gear.

Refer to "*1.Engine 1B.Mechanical(4LE2) Idle gear inspection*".

14. Inspect the air intake system for clogging.
15. Inspect the exhaust system for clogging.
16. Inspect the compression of the engine.
17. Inspect for contamination by water or gasoline in the fuel.

Glow control system check

1. Glow control system check description of function

Caution：

- For both the starter ECM control specification and the safety relay specification, the QOS circuit is the same.

The QOS system consists of the ECM, glow relay, glow plug, and QOS indicator light. When the ignition switch is turned ON under low engine coolant temperatures, the ECM determines the glow time according to the engine coolant temperature, and operates the glow relay and QOS indicator light. The ECM will turn OFF the glow relay and the QOS indicator light after a certain period of time.

2. Glow control system check inspection

Inspection when there may be a malfunction in locations relating to the QOS system control

1. Perform the OBD system check.
2. Observe the DTC information.

Note：

- If DTCs P0117, P0118, or P0380 are set, inspect the applicable DTC.

3. Turn ON the ignition switch.
4. Check the operation of the QOS indicator light.

Note：

- Even if the QOS does not operate, the QOS indicator light will illuminate due to the light check function when the ignition switch is turned ON.
- The QOS indicator light turns OFF within 10 seconds.

5. If the QOS indicator light does not illuminate or turn OFF, inspect the circuit.

・The fuse should not be blown out.
・There should be no open circuit between the fuse and the QOS indicator light.
・There should be no open circuit or short circuit between the QOS indicator light and the ECM.
・The QOS indicator light should not have a burned-out bulb.

6. If a problem is found, repair the circuit or replace.
7. Inspect the glow relay.
8. If a problem is found, replace the relay.
9. Remove all the glow plugs.
10. Measure the resistance between the glow plug terminal and GND using a DMM.

values： 6 Ω At room temperature

Note：

- If the reading is not the specified value, inspect the applicable glow plug.

11. If a problem is found, replace the glow plug.
12. Connect the DMM between the glow plug connector and GND.
13. Turn ON the ignition switch.
14. Perform the actuator test glow relay using a trouble diagnosis scan tool.

Note：

- Command OFF and observe the voltage display on the DMM.

values： 0 V

15. If the reading is not the specified value, inspect the circuit.

Note：

- There should be no short to the battery or to the ignition power supply between the glow relay and the glow plug.

16. If a problem is found, repair the circuit or replace.
17. Perform the actuator test glow relay using a trouble diagnosis scan tool.

Note：

- Command ON and observe the voltage display on the DMM.

voltage： 18 V (24 V specification)

voltage： 9 V (12 V specification)

18. If the reading is less than or equal to the specified value, inspect the circuit.

・The fuse should not be blown out.
・There should be no open circuit between the fuse and the glow relay.
・There should be no open circuit between the glow relay and the glow plug.
・There should be no open circuit between the glow relay and the ECM.

19. If a problem is found, repair the circuit or replace.
20. Replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

21. After replacing the ECM, set the injector ID code.

OBD system check

1. OBD system check description of function

The OBD system check is a systematic method for checking problems caused by a malfunction in the engine control system, and is also the starting point for all diagnostics for drivability complaints. By correctly using these diagnostic steps, it is possible to reduce the time for diagnostic and prevent replacing parts that are not defective.

Note :

- Important points to remember regarding the OBD system check

・If there are no complaints on drivability, do not perform these diagnostic steps unless otherwise instructed in other sections.
・Check for related Service Bulletins before starting the diagnostic.
・Do not clear the DTCs unless it is instructed in a diagnostic step.
・If a malfunction is found in the engine starting system, inspect the starting system.
・The battery should be fully charged.
・The battery cable should be normal and securely connected.
・The GND of the ECM should be securely connected to the correct position.
・The ECM harness connector should be clean and correctly connected.

2. OBD system check inspection

Inspection for determining the failure location in the OBD system

1. Turn ON the ignition switch.
2. Check if the diagnostic light illuminates.

Note :

- Do not perform this operation if the machine does not have a diagnostic light setting.
- If the diagnostic light is OFF, inspect the diagnostic light illumination circuit system.

3. Short the DLC.

Note :

- Short terminals No. 4 and No. 12.
- Do not perform this operation if the machine does not have a diagnostic light setting.

4. Check if the diagnostic light is flashing.

Note :

- Do not perform this operation if the machine does not have a diagnostic light setting.
- If the diagnostic light does not flash, inspect the diagnostic light flashing circuit system.

5. Observe the DTC information of the ECU with which the trouble diagnosis scan tool has established communication.
   If communication with the trouble diagnosis scan tool cannot be established, a malfunction has occurred in the communication circuit between the ECM and the trouble diagnosis scan tool.
6. Start the engine.

Note :

- If the starter does not operate, inspect starter circuit system.
- If the engine does not start, observe the DTC information.
- If a DTC is set, inspect the applicable DTC.
- If a DTC is not set, inspect the starting system.

7. Check for engine stalling.
8. Check for engine hunting or rough idling.
9. Check for lack of engine power failures.
10. Check for engine starting failures.
11. Check for abnormal noise.
12. Check for excessive fuel consumption failures.
13. Check for excessive black smoke in the exhaust gas.
14. Check for excessive white smoke in the exhaust gas.
15. Check for excessive oil consumption failures.

Inspection of the diagnostic light warning light illumination circuit system

1. Inspection of the diagnostic light warning light illumination circuit system description of function

Power supply voltage is provided to the diagnostic light via the ignition switch, and the light illuminates based on the signal from the ECM. The ECM illuminates the diagnostic light during the light check at the time the ignition switch is turned ON or when the DTC is set. The diagnostic light also flashes in accordance with the detected DTC if the DLC body ground and the diagnostic switch terminal are shorted. A monitor circuit is incorporated inside the ECM, and this circuit monitors the operation of the light.

2. Inspection of the diagnostic light warning light illumination circuit system inspection

Inspection when the diagnostic light does not illuminate when the ignition switch is turned ON

1. Perform the OBD system check.
2. Inspect the diagnostic light bulb.
3. If a problem is found, replace the bulb.
4. Inspect the diagnostic light circuit.

・There should be no open circuit or high resistance between the fuse and the diagnostic light.
・There should be no open circuit or high resistance between the diagnostic light and the ECM.

5. If a problem is found, repair the circuit.
6. Replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

7. After replacing the ECM, set the injector ID code.

Inspection of the diagnostic light warning light blinking circuit system

1. Inspection of the diagnostic light warning light blinking circuit system description of function

Power supply voltage is provided to the diagnostic light via the ignition switch, and the light illuminates based on the signal from the ECM. The ECM illuminates the diagnostic light during the light check at the time the ignition switch is turned ON or when the DTC is set. The diagnostic light also flashes in accordance with the detected DTC if the DLC body ground and the diagnostic switch terminal are shorted. A monitor circuit is incorporated inside the ECM, and this circuit monitors the operation of the warning light.

2. Inspection of the diagnostic light warning light blinking circuit system inspection

Inspection when the diagnostic light remains ON without flashing when the diagnostic switch is turned ON

1. Perform the OBD system check.
2. Turn OFF the ignition switch.
3. Connect the DMM between the DLC diagnostic switch terminal and GND.
4. Turn ON the ignition switch.
5. Verify that the voltage displayed on the DMM is more than or equal to the specified value.

values： 18 V (24 V specification)

voltage： 9 V (12 V specification)

6. If the reading is less than the specified value, inspect the diagnostic switch circuit between the ECM and the DLC using a DMM.

・There should be no open circuit or high resistance
Specified value: 100 Ω or less
・There should be no short to GND
Specified value: 10 MΩ or more

7. If a problem is found, repair.
8. Turn OFF the ignition switch.
9. Check that there is continuity between the DLC body ground and GND.
10. Turn ON the ignition switch.
11. Short the DLC.

Note：

- Short terminals No. 4 and No. 12.

12. Check if the diagnostic light is flashing.

Note：

- If it does not flash, inspect the diagnostic light flashing circuit system.

13. Replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

14. After replacing the ECM, set the injector ID code.
15. Turn ON the ignition switch.
16. Short the body ground terminal and diagnostic switch terminal of the DLC.
17. Check if the diagnostic light is flashing.
18. Perform the OBD system check.

Inspection of the starter circuit system

1. Inspection of the starter circuit system description of function

The ECM turns ON the starter relay when the ignition switch is placed in the START position. When the starter relay is turned ON, the starter is activated to start the engine.

2. Inspection of the starter circuit system inspection

Inspection when the starter does not operate

1. Turn OFF the emergency stop switch.

Note :

・ Do not perform this operation if the machine does not have an emergency stop switch setting.

2. Observe the DTC information.

Note :

・ If DTCs P0117, P0340, or P0651 are set, inspect the applicable DTC.

3. Turn OFF the ignition switch.
4. Remove the starter cut relay.
5. Inspect the starter cut relay.

・Check continuity between the switch side terminals.
Specified value: 100 Ω or less

6. If a problem is found, replace the relay.
7. Remove the starter relay.
8. Inspect the starter relay.

・Connect the battery between the coil side terminals to check continuity between the switch side terminals.
Specified value: 100 Ω or less

9. If a problem is found, replace the relay.
10. Inspect the ignition switch start signal circuit.

・There should be no open circuit or high resistance between the ignition switch and the ECM.
Specified value: 100 Ω or less
・There should be no short to GND between the ignition switch and the ECM.
Specified value: 10 MΩ or more

11. If a problem is found, repair the circuit.
12. Inspect the starter circuit.

・There should be no open circuit between the ignition switch and the starter cut relay.
・There should be no open circuit between the starter cut relay and the starter relay.
・There should be no open circuit between the starter relay and GND.
・There should be no open circuit between the starter relay and the starter.

13. If a problem is found, repair the circuit.
14. Inspect the starter.

Refer to "*1.Engine 1J.Electrical(4LE2) Starter motor inspection*".

15. If a problem is found, replace the starter.
16. Replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

17. After replacing the ECM, set the injector ID code.

Description Engine

Symptom

(4LE2)

Table of Contents

Engine start failure

1. Engine start failure description of symptom

The cranking speed is low.

The cranking speed is normal, but the engine does not start.

The engine starts, but the engine speed cannot be held stable or else does not rev up.

2. Engine start failure diagnostics

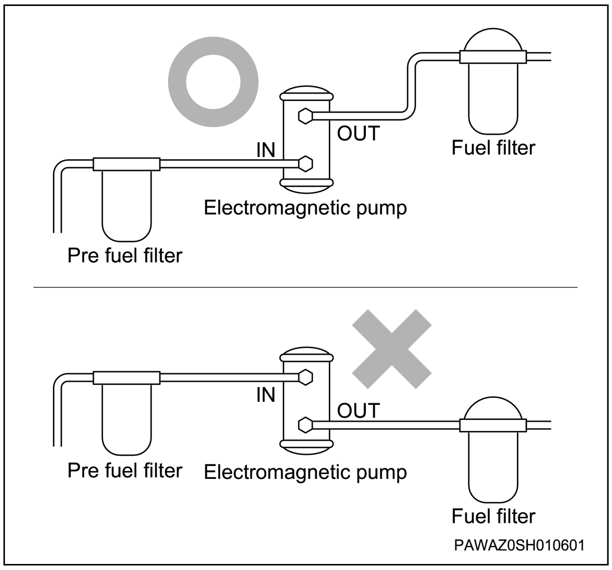
・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
Check the machine side for excessive loads.
The ECM and diagnostic light are operating properly.
DTC verification.
The scan tool data is within the normal operating range.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Whether there is dirt or clogging of the fuel filter.
Whether there are poor connections at the connectors. Especially for the CKP sensor and the CMP sensor.
Whether the battery terminal voltage has dropped.
Correct wiring connections, tightening, and disconnections
Whether the power source for any aftermarket accessories is being taken from the ECM power source.
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether structures in the layout of the fuel filter, pre-filter, and electromagnetic pump may cause air to accumulate.

Isuzu genuine pre-filters have no air removal plug, so check whether the layout may cause air to accumulate. Also, check whether the layout of the electromagnetic pump inlet and outlet is appropriate. Modify any layout where the inlet is positioned on the upper part of the electromagnetic pump or the outlet is positioned toward the direction in which the machine moves.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Malfunctions in air intake system parts
Malfunctions in exhaust system parts



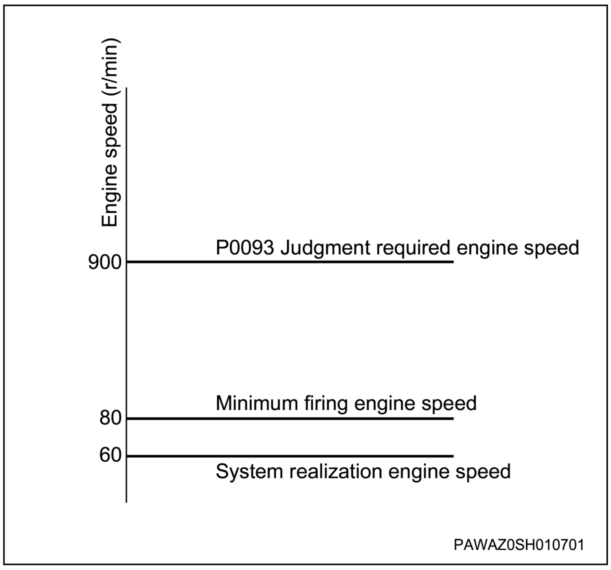
・Diagnostic aids

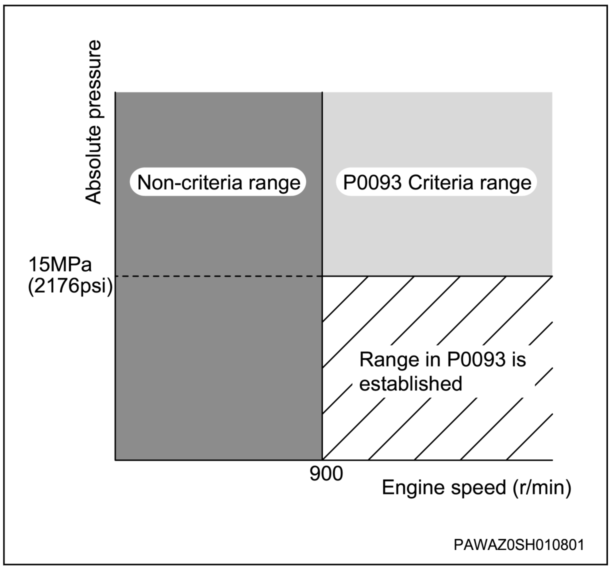
Malfunctions in the fuel system such as no fuel, fuel freezing, air in the fuel pipe, filter malfunctions, pipe malfunctions, poor fuel quality, and fuel tank malfunctions
Malfunctions in the air intake system such as filter clogging and air intake pipe malfunctions
The use of kerosene or other low viscosity fuel will accelerate wear and other problems of the supply pump plunger, possibly resulting in insufficient fuel discharge and engine start failure. In this case, it is necessary to replace the supply pump.
If an engine start failure occurs, check the fuel that the customer uses. If low viscosity fuel such as kerosene is used, the failure will occur again after replacing the supply pump. Advise the customer not to use any low viscosity fuel.
Oil blends of long-term storage fuel and biofuel containing organic substances are easily oxidized. Oxidized fuel will promote wear of the parts related to the camshaft in the supply pump, causing engine start failures due to insufficient discharge. In this case, it is necessary to replace the supply pump.
Charges for supply pump replacement due to use of oil blends of fuel after long storage periods and biofuel containing organic substances will be incurred. Therefore, advise customers not to use such oil.
When using fuel containing large amounts of water, add a large-size sedimenter to the pre-fuel filter to prevent water from entering the fuel system.
Malfunctions in the supply pump, a lack of fuel pressure feed
The ECM does not set the DTC for a lack of fuel pressure feed from the supply pump unless the engine speed is 900

r/min or less, and the absolute pressure is 15 MPa {153 kgf/cm2 / 2175 psi} or less, for 3 seconds or more. Therefore, if the engine does not start due to a lack of fuel pressure feed from the supply pump, a DTC will not be set.

Note :

- Malfunctions in the CKP sensor cannot be diagnosed without cranking 14 revolutions or more, so crank for 14 seconds or more at 60 r/min or more.
  In case of CKP sensor failure at low engine speeds, CKP sensor DTCs may not be set. In case of an intermittent failure, etc., raise the engine speed to No Load Max and check whether DTCs related to the CKP sensor are set.





Malfunctions of the common rail (fuel rail) such as activation of the pressure limiter or internal sealing deterioration
Malfunctions in the injector, failure to inject fuel
Decrease in system performance due to a failure
Malfunctions in the engine body such as seizure, insufficient compression pressure, and other mechanical failures
Failure of the ACG
Failures related to equipment on the machine side such as hydraulic pumps
Effects of aftermarket electrical components such as wireless devices and lights
Failure of the ECM
Check for poor connections at the connector and for malfunctions such as abrasion or bends at the harness. Check that the wire inside the harness has not come loose and caused a short circuit with other circuits. Perform functional diagnostic inspections, and check the operation and control, etc., of each part. Repair if a malfunction is detected.

Engine stalling

1. Engine stalling description of symptom

The engine cranks but does not start until after an extended period of time. The engine does eventually run, or starts but soon stops.

2. Engine stalling diagnostics

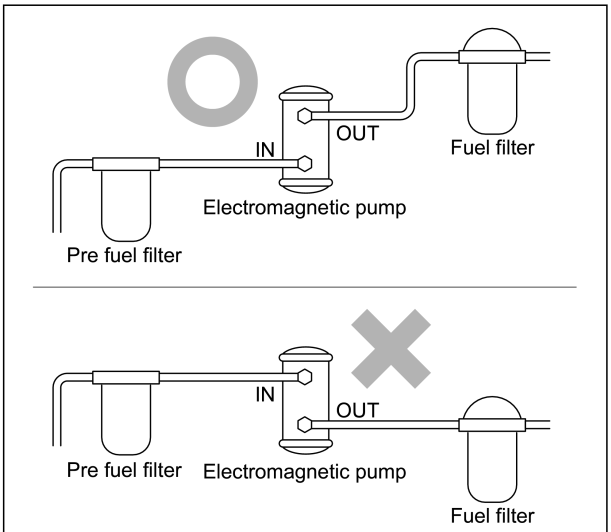
・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
Check the machine side for excessive loads.
The ECM and diagnostic light are operating properly.
Malfunctions in the CKP sensor cannot be diagnosed without cranking 14 revolutions or more, so crank for 14 seconds or more at 60 r/min or more.
DTC verification.
In case of CKP sensor failure at low engine speeds, CKP sensor DTCs may not be set. In case of an intermittent failure, etc., raise the engine speed to No Load Max and check whether DTCs related to the CKP sensor are set.
The scan tool data is within the normal operating range.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.
Verify that the fuel tank has enough fuel.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Whether there are poor connections at the connectors.
Especially for the CKP sensor and the CMP sensor.
Correct wiring connections, tightening, and disconnections
Whether the power source for any aftermarket accessories is being taken from the ECM power source.
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Whether structures in the layout of the fuel filter, pre-filter, and electromagnetic pump may cause air to accumulate.

Isuzu genuine pre-filters have no air removal plug, so check whether the layout may cause air to accumulate. Also, check whether the layout of the electromagnetic pump inlet and outlet is appropriate. Modify any layout where the inlet is positioned on the upper part of the electromagnetic pump or the outlet is positioned toward the direction in which the machine moves.
Malfunctions in air intake system parts
Malfunctions in exhaust system parts



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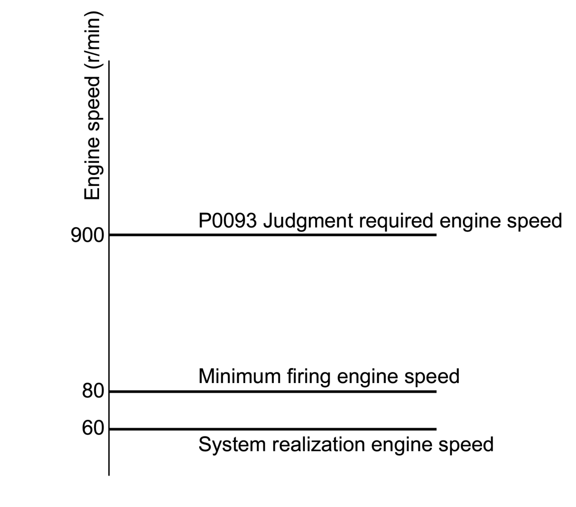
・Diagnostic aids

Malfunctions in the fuel system such as no fuel, fuel freezing, air in the fuel pipe, filter malfunctions, pipe malfunctions, poor fuel quality, and fuel tank malfunctions
Malfunctions in the air intake system such as filter clogging and air intake pipe malfunctions
Malfunctions in the supply pump, a lack of fuel pressure feed
The ECM does not set the DTC for a lack of fuel pressure feed from the supply pump unless the engine speed is 900 r/min or less, and the absolute pressure is 15 MPa {153 kgf/cm2 / 2175 psi} or less, for 3 seconds or more. Therefore, if the engine does not start due to a lack of fuel pressure feed from the supply pump, a DTC will not be set.



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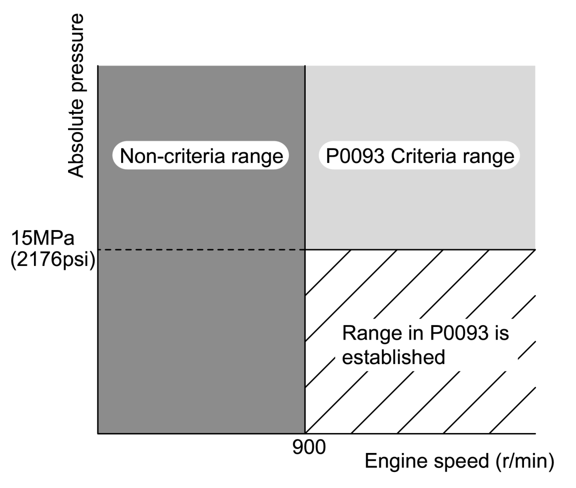

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Malfunctions of the common rail (fuel rail) such as activation of the pressure limiter or internal sealing deterioration

Malfunctions in the injector, failure to inject fuel

Decrease in system performance due to a failure

Malfunctions in the engine body such as seizure, insufficient compression pressure, and other mechanical failures

Failure of the ACG

Failures related to equipment on the machine side such as hydraulic pumps

Effects of aftermarket electrical components such as wireless devices and lights

Failure of the ECM

Check for poor connections at the connector and for malfunctions such as abrasion or bends at the harness. Check that the wire inside the harness has not come loose and caused a short circuit with other circuits. Perform functional diagnostic inspections, and check the operation and control, etc., of each part. Repair if a malfunction is detected.

Engine hunching, rough idling

1. Engine hunching, rough idling description of symptom

   There is variation in the engine idling speed or the engine idling speed changes. The engine or machine may shake in severe situations. In either case, if the problem worsens, it may cause engine stalling.

2. Engine hunching, rough idling diagnostics

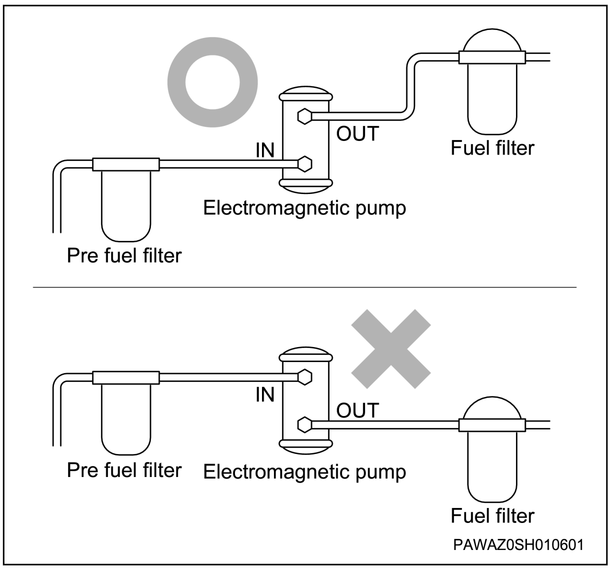
   ・Preliminary inspection

   Before using this section, perform functional inspections or OBD system checks to check the following.
   The ECM and diagnostic light are operating properly.
   DTC verification.
   The scan tool data is within the normal operating range.
   Check the machine condition to locate the indicated symptom.
   Check with the customer to verify whether they are using the specified engine oil and fuel.

   ・Visual inspection

   Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
   The inspection covers the following items.
   Whether there are poor connections at the connectors.
   Whether the battery terminal voltage has dropped.
   Correct wiring connections, tightening, and disconnections
   Whether the power source for any aftermarket accessories is being taken from the ECM power source.
   Whether the ECM ground is clean and securely installed to the correct position.
   Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
   Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
   Whether structures in the layout of the fuel filter, pre-filter, and electromagnetic pump may cause air to accumulate.

   Isuzu genuine pre-filters have no air removal plug, so check whether the layout may cause air to accumulate. Also, check whether the layout of the electromagnetic pump inlet and outlet is appropriate. Modify any layout where the inlet is positioned on the upper part of the electromagnetic pump or the outlet is positioned toward the direction in which the machine moves.
   Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
   Malfunctions in air intake system parts
   Malfunctions in exhaust system parts



   ・Diagnostic aids

   Malfunctions in the fuel system such as no fuel, fuel freezing, air in the fuel pipe, filter malfunctions, pipe malfunctions, poor fuel quality, and fuel tank malfunctions
   Malfunctions in the air intake system such as filter clogging and air intake pipe malfunctions
   Malfunctions in the supply pump, a lack of fuel pressure feed
   Malfunctions in the input circuit system of switches
   Malfunctions in the accelerator position sensor, harness, engine coolant temperature sensor, etc., of the sensor input circuit system
   Malfunctions in the accelerator position sensor system
   Malfunctions in the engine body such as seizure, insufficient compression pressure, and other mechanical failures
   Failures related to equipment on the machine side such as hydraulic pumps
   Effects of aftermarket electrical components such as wireless devices and lights
   Check for poor connections at the connector and for malfunctions such as abrasion or bends at the harness.
   Check that the wire inside the harness has not come loose and caused a short circuit with other circuits. Perform functional diagnostic inspections, and check the operation and control, etc., of each part. Repair if a malfunction is detected.

Excessive white smoke in the exhaust gas

1. Excessive white smoke in the exhaust gas description of symptom

Heavy white smoke is produced during operation.

2. Excessive white smoke in the exhaust gas diagnostics

・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
The ECM and diagnostic light are operating properly.
DTC verification.
The scan tool data is within the normal operating range.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Whether there are poor connections at the connectors.
Correct wiring connections, tightening, and disconnections
Whether the power source for any aftermarket accessories is being taken from the ECM power source.
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Malfunctions in air intake system parts
Malfunctions in exhaust system parts

・Diagnostic aids

Fuel quality when using a product with a low cetane value, a product other than those specified, etc.
If kerosene or other low viscosity fuels are used, abnormal wear of the injector seat will occur, resulting in abnormal injection, and possibly producing white smoke.
In this case, it is necessary to replace the injectors.
Because charges will be incurred for injector replacement required due to the use of kerosene or other low viscosity fuel, instruct the customer not to use kerosene or other low viscosity fuel.
Idling for a long period of time
Failure of the engine coolant temperature sensor, fuel temperature sensor, boost temperature sensor, boost pressure sensor, or barometric pressure sensor
Engine body failure such as insufficient compression pressure, piston related failure, turbocharger failure, or a decrease or increase in oil
Failure of the ECM

Excessive black smoke in the exhaust gas

1. Excessive black smoke in the exhaust gas description of symptom

Heavy black smoke is produced during operation.

2. Excessive black smoke in the exhaust gas diagnostics

・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
The ECM and diagnostic light are operating properly.
DTC verification.
The scan tool data is within the normal operating range.
Check the machine condition to locate the indicated symptom.
Check with the customer to verity whether they are using the specified engine oil and fuel.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Whether there is dirt or clogging of the air cleaner element.
Correct wiring connections, tightening, and disconnections
Whether the power source for any aftermarket accessories is being taken from the ECM power source.
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Malfunctions in air intake system parts
Malfunctions in exhaust system parts

・Diagnostic aids

Fuel quality when using a product other than those specified, etc.
Air intake system malfunctions such as filter clogging or air intake pipe malfunctions
EGR control system malfunction
Exhaust system malfunction such as an exhaust pipe malfunction
Engine coolant temperature sensor malfunction
Boost pressure sensor failure
Engine body failure such as insufficient compression pressure, piston related failure, turbocharger failure, or an increase in oil

Abnormal noise

1. Abnormal noise description of symptom

The engine combustion sound is abnormal.

2. Abnormal noise diagnostics

・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
Refer to the machine manual and inspect for abnormal sounds.
The ECM and diagnostic light are operating properly.
DTC verification.
The scan tool data is within the normal operating range.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Correct wiring connections, tightening, and disconnections
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Malfunctions in air intake system parts
Malfunctions in exhaust system parts

・Diagnostic aids

Malfunctions in the fuel system such as no fuel, fuel freezing, air in the fuel pipe, filter malfunctions, pipe malfunctions, poor fuel quality, and fuel tank malfunctions
Malfunctions in the air intake system such as EGR valve malfunctions
Malfunctions in the injector, failure to inject fuel
Malfunctions in the engine body such as seizure, insufficient compression pressure, and other mechanical failures
Failures related to equipment on the machine side such as hydraulic pumps
Failure of the ECM
Check for poor connections at the connector and for malfunctions such as abrasion or bends at the harness.
Check that the wire inside the harness has not come loose and caused a short circuit with other circuits. Perform functional diagnostic inspections, and check the operation and control, etc., of each part. Repair if a malfunction is detected.

Large fuel consumption

1. Large fuel consumption description of symptom

Fuel consumption is significantly greater than described in the manual for the machine.

2. Large fuel consumption diagnostics

・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
Because fuel consumption significantly varies depending on how the machine is operated, verify the estimated fuel consumption (A) provided by the machine manufacturer.
Estimated fuel consumption (L {qts} per hour)
Check the actual fuel consumption (B). Actual fuel consumption (L {qts} per hour)
If B is larger than A, refer to the machine instruction manual and check the machine settings.
Check the machine for excessive loads.
Refer to the inspection and maintenance list in the instruction manual to conduct inspections corresponding to operation time of the machine.
As for machines with operating times exceeding 3,000 hours, refer to the machine instruction manual to conduct inspection.
The ECM and diagnostic light are operating properly.
DTC verification.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.
Check that regular maintenance including engine oil replacement, air cleaner filter, fuel filter, etc. has been conducted.

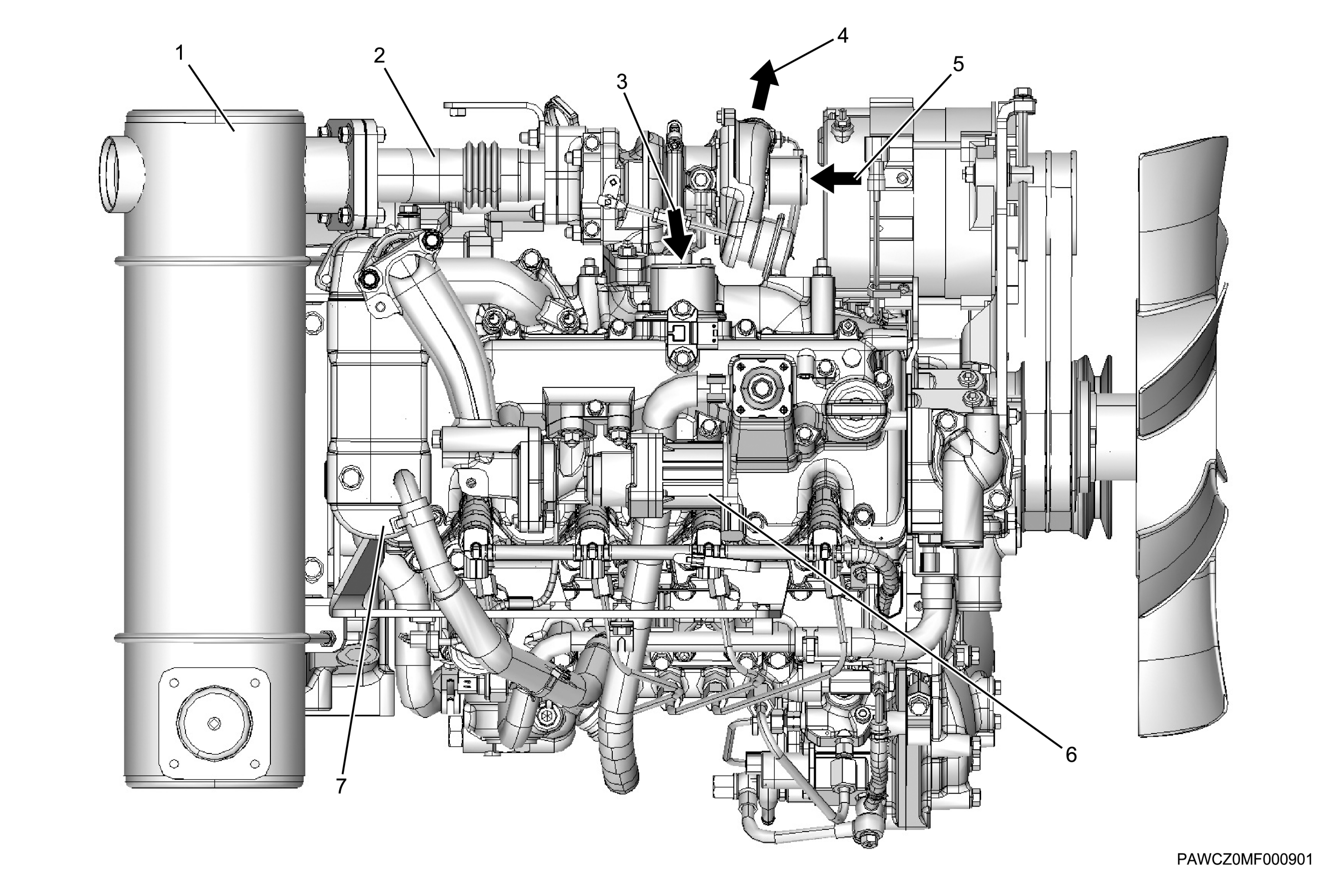
・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Correct wiring connections, tightening, and disconnections
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Malfunctions in air intake system parts
Malfunctions in exhaust system parts

・Diagnostic aids

Malfunctions in the fuel system such as no fuel, fuel freezing, air in the fuel pipe, filter malfunctions, pipe malfunctions, poor fuel quality, and fuel tank malfunctions
Malfunctions in the air intake system such as EGR valve malfunctions
Malfunctions of the injectors such as excessive fuel injection quantity
Malfunctions in the engine body such as seizure, insufficient compression pressure, and other mechanical failures
Failures related to equipment on the machine side such as hydraulic pumps
Failure of the ECM
Check for poor connections at the connector and for malfunctions such as abrasion or bends at the harness.
Check that the wire inside the harness has not come loose and caused a short circuit with other circuits. Perform functional diagnostic inspections, and check the operation and control, etc., of each part. Repair if a malfunction is detected.

Regarding inspection locations in the engine air intake and exhaust systems
Inspect for any malfunction such as clogging, collapsing, or damage in the air intake and exhaust systems.
Besides the inspection locations for the engine body, inspect the air cleaner, the intercooler, and the muffler.



1. Integrated oxidation catalyst silencer
2. Exhaust pipe
3. From intercooler
4. To intercooler
5. From air cleaner
6. EGR valve
7. EGR cooler

Large oil consumption

1. Large oil consumption description of symptom

Oil consumption is significantly greater than described in the manual for the machine.

2. Large oil consumption diagnostics

・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
Because fuel consumption significantly varies depending on how the machine is operated, verify the estimated fuel consumption (A) provided by the machine manufacturer.
Estimated fuel consumption per hour, estimated oil consumption for engine alone: 4 L {4.2 qts} per 100 hours
Check the actual oil consumption (B). Actual oil consumption per hour
Refer to the inspection and maintenance list in the instruction manual to conduct inspections corresponding to operation time of the machine.
As for machines with operating times exceeding 3,000 hours, refer to the machine instruction manual to conduct inspection.
The ECM and diagnostic light are operating properly.
DTC verification.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Whether blue-white smoke is emitted continuously when the engine is running.
Whether a large amount of blow-by gas is emitted.
Whether there is oil in the coolant.
Cracks and twists in the pipes and hoses related to oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there is any oil leakage, damage, or dents on the pipes in the lubricating system.
Malfunctions in air intake system parts related to turbocharger inspection

・Diagnostic aids

Malfunctions in the air intake system such as a decrease in oil, an increase in oil, and excessive blow-by gas
Malfunctions in the engine body such as oil burning and excessive blow-by gas

Perform functional diagnostic inspections, and check the operation, control, etc., of each part. Repair if a malfunction is detected.

Insufficient engine output

1. Insufficient engine output description of symptom

The engine output is below the predicted output, the output does not change even when the accelerator lever (throttle lever) is raised, or the response is poor.

2. Insufficient engine output diagnostics

・Preliminary inspection

Before using this section, perform functional inspections or OBD system checks to check the following.
The ECM and diagnostic light are operating properly.
DTC verification.
The scan tool data is within the normal operating range.
Check the machine condition to locate the indicated symptom.
Check with the customer to verify whether they are using the specified engine oil and fuel.
Various causes are conceivable for insufficient output. Therefore, carefully check the engine body and items related to the machine.
Check what kind of operations result in insufficient output.
If insufficient output phenomena include hesitation and lag, issues related to the machine may be involved. Contact the machine manufacturer.
If a malfunction diagnostic scan tool is available, the engine output at the rated point can be verified by simply checking the boost at the rated point.

・Visual inspection

Careful visual inspection is required for certain symptom procedures. This can lead to correcting a problem without further inspections, and can save valuable time.
The inspection covers the following items.
Whether there is dirt or clogging of the air cleaner element.
Correct wiring connections, tightening, and disconnections
Whether the power source for any aftermarket accessories is being taken from the ECM power source.
Whether the ECM ground is clean and securely installed to the correct position.
Cracks and twists in the pipes and hoses related to fuel, air, and oil, and correct connections thereof. Extensively check for any leaks or clogging.
Whether there are any fuel leaks, damage, or dents on the pipes in the fuel system.
Increases in resistance due to dirt and clogging in air intake system parts, especially the air cleaner element, or to collapsing of the air intake piping
Malfunctions in exhaust system parts

・Diagnostic aids

Malfunctions in the fuel system such as no fuel, fuel freezing, air in the fuel pipe, filter malfunctions, pipe malfunctions, poor fuel quality, and fuel tank malfunctions
Malfunctions in the air intake system such as filter clogging and air intake pipe malfunctions
Malfunctions in the exhaust system such as an exhaust pipe malfunction, etc.
Malfunctions in the accelerator position sensor, harness, etc., of the sensor input circuit system
Malfunctions in the input circuit system of switches
Malfunctions in the engine body such as insufficient compression pressure, valve clearance, turbocharger, supply pump, injector, common rail (fuel rail), and other mechanical failures
Failures related to equipment on the machine side such as hydraulic pumps
Effects of aftermarket electrical components such as wireless devices and lights
Check for poor connections at the connector and for malfunctions such as abrasion or bends at the harness.
Check that the wire inside the harness has not come loose and caused a short circuit with other circuits. Perform functional diagnostic inspections, and check the operation and control, etc., of each part. Repair if a malfunction is detected.
Decreased output due to fuel flow restriction caused by overheating
Insufficient output due to fuel flow restriction when operating at high elevations

Description Engine

DTC Information

(4LE2 (12V))

Table of Contents

DTC P0016 (Flash Code 16)
Crankshaft Position - Camshaft Position Correlation

1. DTC P0016 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° opening. Top dead center of cylinder No. 1 can be detected through this opening.
The CMP sensor is installed on the timing gear case. The CMP sensor detects 5 protrusions in total per 1 engine rotation. The camshaft gear has 4 protrusions evenly spaced 90° apart and 1 reference protrusion. By detecting the opening with the CKP sensor and the 1 reference protrusion with the CMP sensor, the ECM determines compression top dead center of cylinder No. 1 to verify that they correlate with each other. If the ECM detects that both signals are out of synchronization, the DTC is set.

2. DTC P0016 condition for setting the DTC

DTCs P0335, P0336, and P0340 are not set.
The ignition switch is ON.
The signal pulse of the CKP sensor is detected.
The signal pulse of the CMP sensor is detected.
The ECM detects that the CKP sensor signal and the CMP sensor signal are not synchronized while the engine is running.

3. DTC P0016 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0087 (Flash Code 225)
Fuel Rail/System Pressure - Too Low

1. DTC P0087 description of DTC

A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the supply pump, and a high pressure side between the supply pump and the injectors. The fuel is drawn from the fuel tank and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor. If the common rail (fuel rail) pressure becomes excessive, the common rail (fuel rail) pressure limiter valve opens to release the excessive pressure and returns the fuel to the fuel tank. The ECM sets the DTC if the common rail (fuel rail) pressure sharply decreases after the pressure goes excessively high. This DTC detects activation of the pressure limiter valve.

2. DTC P0087 condition for setting the DTC

DTCs P0192 and P0193 are not set.
The ignition switch is ON.
The ECM detects that the pressure limiter valve is activated with excessive pressure of 240 MPa {2,447 kgf/ cm2 / 34,800 psi} or more in the common rail (fuel rail) for 1 second or more.

3. DTC P0087 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P0089 (Flash Code 151)
Fuel Pressure Regulator Performance

1. DTC P0089 description of DTC

A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the supply pump, and a high pressure side between the supply pump and the injectors. The fuel is drawn from the fuel tank and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor. If the ECM detects that the fuel pressure is higher than the desired fuel pressure, this DTC is set.

2. DTC P0089 condition for setting the DTC

DTCs P0091, P0092, P0192, P0193, P0201 - P0204, P1261, P1262, P2146, and P2149 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the common rail (fuel rail) pressure is more than the desired fuel pressure by 40 MPa {408 kgf/cm2 / 5,800 psi} or more for 5 seconds or more.

3. DTC P0089 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P0091 (Flash Code 247)
Fuel Pressure Regulator Control Circuit Low

1. DTC P0091 description of DTC

The suction control valve is installed on the supply pump and controls the fuel amount sucked into the common rail (fuel rail). The suction control valve is fully opened in the normal state and larger drive current results in a smaller opening of the regulator. The ECM calculates the desired common rail (fuel rail) pressure and the fuel flow rate, and compares the calculated common rail (fuel rail) pressure to the actual pressure value to determine the opening angle of the suction control valve. If the actual common rail (fuel rail) pressure is higher than the desired pressure, the suction control valve closes to decrease the fuel flow rate. If the ECM detects an abnormally low feedback current of the suction control valve, the DTC is set.

2. DTC P0091 condition for setting the DTC

The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the feedback current of the FRP regulator is 50 mA or less, or lower than the desired current by 1000 mA or more, for 2 seconds or more.

3. DTC P0091 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The maximum engine speed is limited to 1,250 r/min.
The EGR control is disabled.

DTC P0092 (Flash Code 247)
Fuel Pressure Regulator Control Circuit High

1. DTC P0092 description of DTC

The suction control valve is installed on the supply pump and controls the fuel amount sucked into the common rail (fuel rail). The suction control valve is fully opened in the normal state and larger drive current results in a smaller opening of the regulator. The ECM calculates the desired common rail (fuel rail) pressure and the fuel flow rate, and compares the calculated common rail (fuel rail) pressure to the actual pressure value to determine the opening angle of the suction control valve. If the actual common rail (fuel rail) pressure is higher than the desired pressure, the suction control valve closes to decrease the fuel flow rate. If the ECM detects an abnormally high feedback current of the suction control valve, the DTC is set.

2. DTC P0092 condition for setting the DTC

The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the feedback current of the FRP regulator is 2400 mA or more, or higher than the desired current by 1000 mA or more, for 2 seconds or more.

3. DTC P0092 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The maximum engine speed is limited to 1,250 r/min.
The EGR control is disabled.

DTC P0093 (Flash Code 227)
Fuel System Leak Detected

1. DTC P0093 description of DTC

   A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the supply pump, and a high pressure side between the supply pump and the injectors. The fuel is drawn from the fuel tank and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor. If the ECM detects that the common rail (fuel rail) pressure is low compared with the engine speed, the DTC is set.

2. DTC P0093 condition for setting the DTC

   DTCs P0087, P0091, P0092, P0192, P0193, P0201, P0202, P0203, P0204, P1261, P1262, P2146, and P2149 are not set.
   The battery voltage is between 9 - 16 V.
   The ignition switch is ON.
   The engine speed is 900 r/min or more.
   The ECM detects that the actual common rail (fuel rail) pressure is 15 MPa {153 kgf/cm2 / 2,175 psi} or less for 3 seconds or more (this may not be a prerequisite depending on the machine manufacturer).

3. DTC P0093 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :

   - Depending on the machine manufacturer, the failure indication may not be shown.

   The engine is stopped.
   The fuel injection quantity is limited.
   The fuel flow rate is limited.
   The EGR control is disabled.

DTC P0097 (Flash Code 214)
Intake Manifold Temperature Sensor Circuit Low

1. DTC P0097 description of DTC

The IMT sensor is installed to the intake chamber. The IMT sensor is a thermistor type sensor and it measures the temperature of the intake air mixed with EGR gas. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the IMT sensor is cold, the resistance of the sensor is high. When the EGR gas amount increases, the intake air temperature rises and the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0097 condition for setting the DTC

DTC P060B is not set.
The ECM detects that the signal voltage of the IMT sensor is 0.1 V or less for 4 seconds or more.

3. DTC P0097 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default IMT value is assumed.

DTC P0098 (Flash Code 214)
Intake Manifold Temperature Sensor Circuit High

1. DTC P0098 description of DTC

The IMT sensor is installed to the intake chamber. The IMT sensor is a thermistor type sensor and it measures the temperature of the intake air mixed with EGR gas. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the IMT sensor is cold, the resistance of the sensor is high. When the EGR gas amount increases, the intake air temperature rises and the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0098 condition for setting the DTC

DTCs P0112, P0113, and P060B are not set.
3 minutes have passed with the engine speed at 800 r/min or more.
The ECM detects that the IMT sensor signal voltage is 4.9 V or more for 4 seconds or more.

3. DTC P0098 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default IMT value is assumed.

DTC P0112 (Flash Code 22) Intake Air Temperature Sensor Circuit Low

1. DTC P0112 description of DTC

The boost temperature sensor is a thermistor type sensor and it measures the temperature of the air flowing into the engine. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the boost temperature sensor is cold, the sensor resistance is high. As the air temperature rises, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0112 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the boost temperature sensor signal voltage is 0.1 V or less for 4 seconds.

3. DTC P0112 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default boost temperature value is assumed.
The boost pressure is limited.
The EGR control is disabled.

DTC P0113 (Flash Code 22)
Intake Air Temperature Sensor Circuit High

1. DTC P0113 description of DTC

The boost temperature sensor is a thermistor type sensor and it measures the temperature of the air flowing into the engine. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the boost temperature sensor is cold, the sensor resistance is high. As the air temperature rises, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0113 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine has been running for 3 minutes or more.
The ECM detects that the boost temperature sensor signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0113 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default boost temperature value is assumed.
The boost pressure is limited.
The EGR control is disabled.

DTC P0117 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit Low

1. DTC P0117 description of DTC

The engine coolant temperature sensor is installed in the thermostat housing. The engine coolant temperature sensor is a thermistor type sensor and measures the temperature of the engine coolant. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the engine coolant temperature sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0117 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the engine coolant temperature sensor signal voltage is 0.1 V or less for 4 seconds.

3. DTC P0117 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default water temperature value is assumed.
The EGR control is disabled.

DTC P0118 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit High

1. DTC P0118 description of DTC

The engine coolant temperature sensor is installed in the thermostat housing. The engine coolant temperature sensor is a thermistor type sensor and measures the temperature of the engine coolant. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the engine coolant temperature sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0118 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine has been running for 3 minutes or more.
The ECM detects that the engine coolant temperature sensor signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0118 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default water temperature value is assumed.
The EGR control is disabled.

DTC P0182 (Flash Code 211)
Fuel Temperature Sensor Circuit Low

1. DTC P0182 description of DTC

The fuel temperature sensor is installed on the supply pump. The fuel temperature sensor is a thermistor type sensor and measures the temperature of the fuel entering the supply pump. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the fuel temperature sensor is cold, the resistance of the sensor is high. When the fuel temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0182 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the fuel temperature sensor signal voltage is 0.1 V or less for 4 seconds.

3. DTC P0182 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default fuel temperature value is assumed.

DTC P0183 (Flash Code 211)
Fuel Temperature Sensor Circuit High

1. DTC P0183 description of DTC

The fuel temperature sensor is installed on the supply pump. The fuel temperature sensor is a thermistor type sensor and measures the temperature of the fuel entering the supply pump. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the fuel temperature sensor is cold, the resistance of the sensor is high. When the fuel temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0183 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine has been running for 3 minutes or more.
The ECM detects that the fuel temperature sensor signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0183 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default fuel temperature value is assumed.

DTC P0192 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit Low

1. DTC P0192 description of DTC

The barometric pressure sensor changes the signal voltage according to changes in the barometric pressure. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Barometric pressure sensor signal circuit
The barometric pressure sensor sends signals related to barometric pressure change to the ECM. The ECM detects low signal voltage at high altitudes and with low barometric pressure. The ECM detects high signal voltage with high barometric pressure. The ECM uses this voltage signal to adjust the fuel injection quantity and injection timing and make altitude correction. If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0192 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the common rail (fuel rail) pressure sensor signal voltage is 0.7 V or less for 1 second or more.

3. DTC P0192 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default common rail (fuel rail) pressure value is assumed.
The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0193 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit High

1. DTC P0193 description of DTC

The common rail (fuel rail) pressure sensor is installed to the common rail (fuel rail) and detects the fuel pressure in the common rail (fuel rail) and converts the pressure into a voltage signal. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Common rail (fuel rail) pressure sensor signal circuit
The ECM monitors the common rail (fuel rail) pressure sensor signal voltage. The signal voltage increases as the common rail (fuel rail) pressure rises, and decreases as the pressure declines. The ECM calculates the actual common rail (fuel rail) pressure from the voltage signal and uses the result in the fuel injection control and other control tasks.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0193 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the common rail (fuel rail) pressure sensor signal voltage is 4.85 V or more for 1 second or more.

3. DTC P0193 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default common rail (fuel rail) pressure value is assumed.
The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0201 (Flash Code 271)
Injector Circuit - Cylinder 1

1. DTC P0201 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 1 cylinder injector circuit, the DTC is set.

2. DTC P0201 condition for setting the DTC

DTCs P1261 and P2146 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0201 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The injection of the No. 1 cylinder is disabled.
The EGR control is disabled.

DTC P0202 (Flash Code 272)
Injector Circuit - Cylinder 2

1. DTC P0202 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 2 cylinder injector circuit, the DTC is set.

2. DTC P0202 condition for setting the DTC

DTCs P1262 and P2149 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0202 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The injection of the No. 2 cylinder is disabled.
The EGR control is disabled.

DTC P0203 (Flash Code 273)
Injector Circuit - Cylinder 3

1. DTC P0203 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 3 cylinder injector circuit, the DTC is set.

2. DTC P0203 condition for setting the DTC

DTCs P1262 and P2149 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0203 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The injection of the No. 3 cylinder is disabled.
The EGR control is disabled.

DTC P0204 (Flash Code 274)
Injector Circuit - Cylinder 4

1. DTC P0204 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 4 cylinder injector circuit, the DTC is set.

2. DTC P0204 condition for setting the DTC

DTCs P1261 and P2146 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0204 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The injection of the No. 4 cylinder is disabled.
The EGR control is disabled.

DTC P0217 (Flash Code 542)
Engine Coolant Over Temperature Condition

1. DTC P0217 description of DTC

The engine coolant temperature sensor is installed on the thermostat housing. The engine coolant temperature sensor is a thermistor type and measures the temperature of the engine coolant.
If the ECM detects an abnormally high coolant temperature, the DTC is set.

2. DTC P0217 condition for setting the DTC

DTCs P0117 and P0118 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the engine coolant temperature is 100°C {212°F} or more for 0.5 seconds.

Note：

- The setting varies depending on the machine manufacturer.

DTC P0219 (Flash Code 543)
Engine Overspeed Condition

1. DTC P0219 description of DTC

   The CKP sensor is installed on the right rear of the cylinder block. The ECM calculates the engine speed and accurate crankshaft position based on the signal pulse from the CKP sensor.
   If the ECM detects that the engine is in an overrun condition, the DTC is set.

2. DTC P0219 condition for setting the DTC

   The ECM detects that the engine speed is more than 2,070 r/min for 0.05 seconds.

DTC P0237 (Flash Code 32)
Turbocharger Boost Sensor Circuit Low

1. DTC P0237 description of DTC

The boost pressure sensor is located in the air intake pipe. This sensor changes the signal voltage in accordance with changes in air pressure in the air intake pipe. The boost pressure sensor has the following circuits.
5 V power supply circuit
GND circuit
Boost pressure sensor signal circuit
The boost pressure sensor sends the signal of pressure changes in the air intake pipe to the ECM. The ECM detects a high voltage signal when the air pressure is high, such as when the load on the engine is high.
If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0237 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the boost pressure sensor signal voltage is 0.1 V or less for 3 seconds.

3. DTC P0237 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default boost pressure value is assumed.
The EGR control is disabled.

DTC P0238 (Flash Code 32)
Turbocharger Boost Sensor Circuit High

1. DTC P0238 description of DTC

The boost pressure sensor is located in the air intake pipe. This sensor changes the signal voltage in accordance with changes in air pressure in the air intake pipe. The boost pressure sensor has the following circuits.
5 V power supply circuit
GND circuit
Boost pressure sensor signal circuit
The boost pressure sensor sends the signal of pressure changes in the air intake pipe to the ECM. The ECM detects a high voltage signal when the air pressure is high, such as when the load on the engine is high.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0238 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the boost pressure sensor signal voltage is 4.9 V or more for 3 seconds.

3. DTC P0238 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default boost pressure value is assumed.
The EGR control is disabled.

DTC P0335 (Flash Code 15)
Crankshaft Position Sensor Circuit

1. DTC P0335 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° opening. Top dead center of cylinder No. 1 can be detected through this opening. The CKP sensor generates pulse signals. The sensor has the following circuits.
5 V power supply circuit
GND circuit
CKP sensor signal circuit
The ECM monitors the signal pulses of the CKP sensor and the CMP sensor to verify that they correlate with each other. If the ECM receives a certain amount of CMP sensor signal pulses without a CKP sensor signal pulse, the DTC is set.

2. DTC P0335 condition for setting the DTC

DTCs P0016, P0336, and P0340 are not set.
The ignition switch is ON.
The signal pulse of the CMP sensor is detected.
The ECM detects that no CKP sensor signal pulse is generated while the engine is running.

3. DTC P0335 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.

DTC P0336 (Flash Code 15)
Crankshaft Position Sensor Circuit Range/Performance

1. DTC P0336 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° opening. Top dead center of cylinder No. 1 can be detected through this opening. The ECM monitors the signal pulses of the CKP sensor and the CMP sensor to verify that they correlate with each other.
If the ECM receives excessive or short CKP sensor signal pulses, the DTC is set.

2. DTC P0336 condition for setting the DTC

DTCs P0016, P0335, and P0340 are not set.
The ignition switch is ON.
The signal pulse of the CKP sensor is detected.
The ECM detects excessive or short CKP sensor signal pulses while the engine is running.

3. DTC P0336 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.

DTC P0340 (Flash Code 14)
Camshaft Position Sensor Circuit

1. DTC P0340 description of DTC

The CMP sensor is installed on the gear case cover. The CMP sensor detects 5 protrusions in total per 1 engine rotation. The camshaft gear has 4 protrusions evenly spaced 90° apart and 1 reference protrusion. The CMP sensor generates pulse signals. The sensor has the following circuits.
5 V power supply circuit
GND circuit
CMP sensor signal circuit
The ECM monitors the signal pulses of the CKP sensor and the CMP sensor to verify that they correlate with each other.
If the ECM receives a certain amount of CKP sensor signal pulses without a CMP sensor signal pulse, the DTC is set.

2. DTC P0340 condition for setting the DTC

DTCs P0016, P0335, and P0336 are not set.
The ignition switch is ON.
The signal pulse of the CKP sensor is detected.
The ECM detects that no CMP sensor signal pulse is generated while the engine is running.

3. DTC P0340 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0380 (Flash Code 66)
Glow Plug Circuit

1. DTC P0380 description of DTC

The glow relay stops providing power supply voltage to the glow plug, and ON is displayed if the signal from the ECM is entered. The ECM recognizes the ignition switch ON signal, and outputs the ON signal to the glow relay.

2. DTC P0380 condition for setting the DTC

Key switch input voltage is 9 - 16 V.
There is no glow relay monitoring signal to the glow relay drive instruction, or there is a glow relay monitoring signal to the glow relay stop instruction, for 3 seconds or more.

3. DTC P0380 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0404 (Flash Code 45)
Exhaust Gas Recirculation 1 Control Circuit Range/Performance

1. DTC P0404 description of DTC

The ECM controls the opening and closing of the EGR valve based on the driving condition of the engine by controlling the EGR solenoid. The EGR valve lift amount is detected by the position sensor and is sent to the ECM. If the ECM detects a difference between the actual EGR valve position and the desired EGR valve position for a predetermined period of time with the EGR commanded ON, the DTC is set.

2. DTC P0404 condition for setting the DTC

DTC P0409 is not set.
The battery voltage is between 8 - 16 V.
The ignition switch is ON.
The EGR control is commanded ON.
The ECM detects that the difference between the actual and desired EGR valve positions is 20% or more for 10 seconds or more.

3. DTC P0404 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.

DTC P0409 (Flash Code 44)
Exhaust Gas Recirculation 1 Sensor Circuit

1. DTC P0409 description of DTC

The EGR position sensor is on the EGR valve together with the control solenoid. This sensor is made up of 3 individual sensors within 1 housing. EGR position sensor 1, EGR position sensor 2, and EGR position sensor 3 are hall IC type sensors with the following circuits.
5 V power supply circuit
GND circuit
Signal circuit
The EGR position sensor sends a high and low signal status regarding changes in the EGR valve position to the ECM.
If the ECM detects that all high or low signal statuses from the EGR position sensor do not correlate, the DTC is set.

2. DTC P0409 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the signal from the EGR valve position sensor is kept in a low or high state for 3 seconds or more.

3. DTC P0409 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.

DTC P0521 (Flash Code 294)
Engine Oil Pressure Sensor Performance

1. DTC P0521 description of DTC

The oil pressure sensor detects the engine oil pressure. The oil pressure sensor is installed near the oil cooler of the cylinder block. The internal resistance of the oil pressure sensor changes in accordance with changes in pressure. The resistance is low when the pressure is high, and the resistance is high when the pressure is low.
The ECM is connected to the oil pressure sensor through the power supply circuit, the signal circuit, and the GND circuit, and applies +5 V power to the power supply circuit. The ECM detects changes in the signal voltage that occur according to changes in resistance based on the pressure of the oil pressure sensor as a signal (high voltage when the pressure is high, and low voltage when the pressure is low).
If the ECM detects an abnormally low engine oil pressure, the DTC is set.

2. DTC P0521 condition for setting the DTC

The engine has been running for 25 seconds or more.
The engine speed is 600 r/min or more.
The ECM detects that the engine oil pressure is 98 kPa {1.0 kgf/cm2 / 14 psi} or less for 0.5 seconds or more.

DTC P0522 (Flash Code 294)
Oil Pressure Sensor Circuit Low Input

1. DTC P0522 description of DTC

The oil pressure sensor detects the engine oil pressure. The oil pressure sensor is installed near the oil cooler of the cylinder block. The internal resistance of the oil pressure sensor changes in accordance with changes in pressure. The resistance is low when the pressure is high, and the resistance is high when the pressure is low. The ECM is connected to the oil pressure sensor through the power supply circuit, the signal circuit, and the GND circuit, and applies +5 V power to the power supply circuit.
The ECM detects changes in the signal voltage that occur according to changes in resistance based on the pressure of the oil pressure sensor as a signal.

2. DTC P0522 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ECM detects that the signal voltage of the oil pressure sensor is 0.1 V or less for 4 seconds.

3. DTC P0522 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default engine oil pressure value is assumed.

DTC P0523 (Flash Code 294)
Oil Pressure Sensor Circuit High Input

1. DTC P0523 description of DTC

The oil pressure sensor detects the engine oil pressure. The oil pressure sensor is installed near the oil cooler of the cylinder block. The internal resistance of the oil pressure sensor changes in accordance with changes in pressure. The resistance is low when the pressure is high, and the resistance is high when the pressure is low. The ECM is connected to the oil pressure sensor through the power supply circuit, the signal circuit, and the GND circuit, and applies +5 V power to the power supply circuit.
The ECM detects changes in the signal voltage that occur according to changes in resistance based on the pressure of the oil pressure sensor as a signal.

2. DTC P0523 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ECM detects that the oil pressure switch signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0523 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
A default engine oil pressure value is assumed.

DTC P0563 (Flash Code 35)
System Voltage High

1. DTC P0563 description of DTC

The ECM monitors the ignition voltage on the ignition feed terminal to verify that the voltage stays within the proper range.
If the ECM detects that the voltage of the ignition power source is abnormally high, the DTC is set.

2. DTC P0563 condition for setting the DTC

DTC P060B is not set.
The ECM detects that the voltage of the ignition power supply circuit is 16 V or more for 5 seconds.

3. DTC P0563 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0601 (Flash Code 53)
Internal Control Module Memory Check Sum Error

1. DTC P0601 description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P0601 condition for setting the DTC

The ECM detects that the calculated checksum does not agree with the ROM internal registered checksum.

3. DTC P0601 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel flow rate is limited.

DTC P0602 (Flash Code 154)
Control Module Programming Error

1. DTC P0602 description of DTC

The injector ID code and the fuel delivery rate data is stored in the EEPROM within the ECM. If no injector ID code or fuel delivery rate data is programmed in the ECM or the ECM detects an error in the programmed injector ID code, the DTC is set.

2. DTC P0602 condition for setting the DTC

The ignition switch is ON.
Either of the following conditions is met.
The ECM detects that no injector ID code is programmed.
The ECM detects an error in the programmed injector ID code.
The ECM detects that no fuel delivery rate data is programmed.

3. DTC P0602 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0604 (Flash Code 153)
Internal Control Module Random Access Memory (RAM)

1. DTC P0604 description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P0604 condition for setting the DTC

The battery voltage is 8 V or more.
The ECM detects a failure in the internal RAM.

3. DTC P0604 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel flow rate is limited.

DTC P0606 (Flash Code 51) ECM/PCM Processor

1. DTC P0606 description of DTC

   This diagnosis applies to the microprocessor inside the ECM.

2. DTC P0606 condition for setting the DTC

   The battery voltage is 8 V or more.
   The ignition switch is ON.
   The internal sub CPU detects a malfunction in the main CPU.

3. DTC P0606 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :

   - Depending on the machine manufacturer, the failure indication may not be shown.

   At CPU recovery
   The engine is stopped.
   The fuel injection quantity is limited.
   The fuel flow rate is limited.
   The maximum engine speed is limited to 1700 r/min.
   The EGR control is disabled.

DTC P060B (Flash Code 36)
Internal Control Module A/D Processing Performance

1. DTC P060B description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P060B condition for setting the DTC

The ECM detects a malfunction of the internal A/D converter.

3. DTC P060B action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited. (Engine stopped)
EGR control is disabled.

DTC P0615 (Flash Code 19)
Starter Relay Circuit

1. DTC P0615 description of DTC

The starter cut switch is provided to prevent the starter from operating when the engine is running. The starter cut relay is a normal closed relay and is positioned between the main relay and starter relay.
When the key switch is turned ON, the ECM sends a signal to the starter cut relay, and the relay is turned OFF. When the engine is started, the ECM stops signal output to the starter cut relay when the key switch is in the START position, and the relay is turned ON. After the engine is started, the ECM restarts sending signals to the starter cut relay when the key switch is returned to the ON position, and the relay is turned OFF. A monitor circuit is incorporated inside the ECM, and this circuit monitors the operation of the relay.
The ECM sets a DTC if the output to the starter cut relay and the operation of the starter cut relay do not match.

2. DTC P0615 condition for setting the DTC

There is no starter cut relay monitoring signal to the starter cut relay drive signal for 3 seconds or more.

3. DTC P0615 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0641 (Flash Code 55)
Sensor Reference Voltage 1 Circuit

1. DTC P0641 description of DTC

The ECM supplies 5 V power to the following sensors through power supply circuit 1.
Accelerator position sensor
Fuel filter pressure sensor
Boost pressure sensor
The ECM monitors the voltage of 5 V power supply circuit 1, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P0641 condition for setting the DTC

DTC P060B is not set.
The battery voltage is 8 - 16 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 1 is 4.5 V or less, or 5.5 V or more.

3. DTC P0641 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
The following assumes a default value.
Accelerator position
Fuel filter pressure
Boost pressure sensor/boost temperature

DTC P0651 (Flash Code 56)
Sensor Reference Voltage 2 Circuit

1. DTC P0651 description of DTC

The ECM supplies 5 V power to the following sensor through 5 V power supply circuit 2.
Barometric pressure sensor
The ECM also supplies 5 V power to the following sensors through 5 V power supply circuit 5.
CMP sensor
FRP sensor
EGR position sensor
5 V power supply circuits 2 and 5 are independent of each other outside of the ECM, but share the bus inside the ECM. Therefore, the entire 5 V power supply circuits 2 and 5 may be affected by a short circuit in either of the sensor 5 V power supply circuits. The ECM monitors the voltage of 5 V power supply circuits 2 and 5, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P0651 condition for setting the DTC

DTC P060B is not set.
The battery voltage is 8 - 16 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 2 or 5 is 4.5 V or less, or 5.5 V or more.

3. DTC P0651 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.
The following assumes a default value.
IMT
Barometric pressure
CMP
Fuel pressure
EGR position

DTC P0685 (Flash Code 416)
ECM/PCM Power Relay Control Circuit/Open

1. DTC P0685 description of DTC

   The ECM main relay is applied to supply the battery power to the ECM through the relay switch side when the ECM receives an ignition switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time has passed.
   If the ECM detects a low voltage status in the relay voltage supply circuit when the ECM main relay is commanded ON, the DTC is set.

2. DTC P0685 condition for setting the DTC

   The battery voltage is between 9 - 16 V.
   The ignition switch has been ON for 3 seconds.
   When the ECM commands the relay ON, the ECM detects that the main relay voltage supply circuit is 1 V or less for 3 seconds.

3. DTC P0685 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :

   - Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0687 (Flash Code 416)
ECM/PCM Power Relay Control Circuit High

1. DTC P0687 description of DTC

   The ECM main relay is applied to supply the battery power to the ECM through the relay switch side when the ECM receives an ignition switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time has passed.
   If the ECM detects that the ECM is ON when the ECM main relay is commanded OFF, the DTC is set.

2. DTC P0687 condition for setting the DTC

   The ignition switch is OFF.
   The ECM detects that the relay is ON for 5 seconds when the ECM commands the relay OFF.

3. DTC P0687 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：
   - Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0697 (Flash Code 57)
Sensor Reference Voltage 3 Circuit

1. DTC P0697 description of DTC

The ECM supplies 5 V power to the following sensors through power supply circuit 3.
Oil pressure sensor
The ECM monitors the voltage of 5 V power supply circuit 3, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P0697 condition for setting the DTC

DTC P060B is not set.
The battery voltage is 8 - 16 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 3 is 4.5 V or less, or 5.5 V or more.

3. DTC P0697 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
The following assumes a default value.
Engine oil pressure
IMT

DTC P06AF (Flash Code 277)
EDU Injector Custom IC,Check Sum,Communication Line

1. DTC P06AF description of DTC

This diagnosis applies to the injector IC inside the ECM.

2. DTC P06AF condition for setting the DTC

Note：

- Injector IC malfunction

The engine is running.
An injector IC malfunction was detected for 1.2 seconds or more.

Note：

- Injector IC checksum malfunction

The engine is running.
An injector IC reset was detected for 2.6 seconds or more.

Note：

- Injector IC communication malfunction

The engine is running.
A communication failure with the injector IC was detected for 2.6 seconds or more.

3. DTC P06AF action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
All injectors are inhibited.

DTC P1093 (Flash Code 227)
Fuel Rail Pressure (FRP) Too Low

1. DTC P1093 description of DTC

A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the fuel supply pump, and a high pressure side between the fuel supply pump and the injectors. The fuel is drawn from the fuel tank via the fuel supply pump and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the fuel supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor.
If the ECM detects that the actual fuel pressure is less than the desired fuel pressure, the DTC is set.

2. DTC P1093 condition for setting the DTC

DTCs P0087, P0091, P0092, P0192, P0193, P0201 - P0204, P1261, P1262, P2146, and P2149 are not set.
The battery voltage is between 9 - 16V.
The ignition switch is ON.
The engine is running.
The FRP regulator indicates a fuel flow rate higher than a certain level.
The ECM detects that the common rail (fuel rail) pressure is lower than the desired fuel pressure by 50 MPa (7,250 psi) or more for 5 seconds or more.

3. DTC P1093 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P1097 (Flash Code 213)
Boost Temperature Sensor Circuit Low

1. DTC P1097 description of DTC

The boost temperature sensor is installed in the intake chamber. The boost temperature sensor changes its resistance according to the temperature in the intake chamber. The resistance becomes lower when the intake air temperature is high, and higher when the intake air temperature is low. The ECM applies 5 V to the boost temperature sensor through the pull-up resistor, and calculates the boost temperature from changes in the voltage. This value is used in various control mechanisms, such as for fuel injection control. The voltage becomes lower when resistance is small (temperature is high), and higher when resistance is large (temperature is low).

2. DTC P1097 condition for setting the DTC

DTC P060B is not set.
The predetermined time has passed after starting the engine, and the engine speed and fuel injection quantity are more than the predetermined levels for longer than the predetermined time.
The ECM detects that the boost temperature sensor voltage is 0.1 V or less for 4 seconds or more.

3. DTC P1097 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost temperature value is assumed.

DTC P1098 (Flash Code 213)
Boost Temperature Sensor Circuit High

1. DTC P1098 description of DTC

The boost temperature sensor is installed in the intake chamber. The resistance changes according to the temperature in the intake chamber. The resistance becomes lower when the intake air temperature is high, and higher when the intake air temperature is low. The ECM applies 5 V to the boost temperature sensor through the pull-up resistor, and calculates the boost temperature from changes in the voltage. This value is used in various control mechanisms, such as for fuel injection control. The voltage becomes lower when resistance is small (temperature is high), and higher when resistance is large (temperature is low).

2. DTC P1098 condition for setting the DTC

DTCs P0112, P0113, and P060B are not set.
The battery voltage is between 9 - 16 V.
3 minutes have passed with the engine speed at 800 r/min or more.
The ECM detects that the boost temperature sensor voltage is 4.9 V or more for 4 seconds or more.

3. DTC P1098 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost temperature value is assumed.

DTC P1261 (Flash Code 34)
Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P1261 description of DTC

   The charge voltage circuit inside the ECM increases the voltage applied to the injector. The charge voltage circuit is divided into two banks: common power supply 1 and common power supply 2. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
   If an open circuit occurs in the injector charge voltage circuit of common power supply 1 or the common power supply 1 of the ECM, the DTC is set.

2. DTC P1261 condition for setting the DTC

   The battery voltage is between 9 - 16 V.
   The ignition switch is ON.
   The ECM detects an open circuit or short circuit in the common power supply 1 injector charge voltage circuit in the ECM for 2 seconds or more.

3. DTC P1261 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：

   - Depending on the machine manufacturer, the failure indication may not be shown.

   The engine is stopped.
   The EGR control is disabled.
   The fuel injection for the No. 1 and No. 4 cylinders is disabled.

DTC P1262 (Flash Code 34)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P1262 description of DTC

   The charge voltage circuit inside the ECM increases the voltage applied to the injector. The charge voltage circuit is divided into two banks: common power supply 1 and common power supply 2. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
   If an open circuit occurs in the injector charge voltage circuit of common power supply 2 or the common power supply 2 of the ECM, the DTC is set.

2. DTC P1262 condition for setting the DTC

   The battery voltage is between 9 - 16 V.
   The ignition switch is ON.
   The ECM detects an open circuit or short circuit in the common power supply 2 injector charge voltage circuit in the ECM for 2 seconds or more.

3. DTC P1262 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：
   - Depending on the machine manufacturer, the failure indication may not be shown.

   The engine is stopped.
   The EGR control is disabled.
   The fuel injection for the No. 2 and No. 3 cylinders is disabled.

DTC P1404 (Flash Code 45)
Exhaust Gas Recirculation 1 Closed Position Performance

1. DTC P1404 description of DTC

The ECM controls the opening and closing of the EGR valve based on the driving condition of the engine by controlling the EGR solenoid. The EGR opening angle is detected by the position sensor and is sent to the ECM.
For a closed position error DTC, if the ECM detects that the actual EGR valve opening angle is larger than a certain amount, this DTC is set.
For a learned position error DTC, if the ECM detects a difference between the learned closed position and the actual closed position, the DTC is set.

2. DTC P1404 condition for setting the DTC

The ECM detects that the EGR learned closed position is not within the predetermined range when the ignition switch is turned OFF.

3. DTC P1404 action taken when the DTC sets

When the following ignition switch is turned ON, the failure is indicated in the monitor on the machine, or the diagnosis light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.

DTC P1606 (Flash Code 51)
SW-IC 1 Internal failure,Communication line failure

1. DTC P1606 description of DTC

This diagnosis applies to the SW-IC1 inside the ECM.

2. DTC P1606 condition for setting the DTC

Note：

- SW-IC internal malfunction

A malfunction in the SW-IC circuit was detected.

Note：

- SW-IC communication circuit malfunction

A communication error with the SW-IC was detected.

3. DTC P1606 action taken when the DTC sets

Set the SW-IC switch status as the default action for the following switches.
Air cleaner switch, diagnostic switch, memory clear switch, mode map switch 0, mode map switch 2, idling control switch, idling control UP switch, ignition start switch

DTC P160B (Flash Code 36)
AD-IC failure

1. DTC P160B description of DTC

   This diagnosis applies to the AD-IC inside the ECM.

2. DTC P160B condition for setting the DTC

   The battery voltage is between 8 - 16 V.
   The ECM detects a malfunction in the AD-IC circuit for 2 seconds or more.

3. DTC P160B action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：
   - Depending on the machine manufacturer, the failure indication may not be shown.

   The engine is stopped.
   The following assumes a default value.
   Fuel filter pressure
   Barometric pressure
   IMT
   Coolant temperature
   Fuel temperature
   Boost temperature

DTC P1621 (Flash Code 54)
Control Module Long Term Memory Performance

1. DTC P1621 description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P1621 condition for setting the DTC

The ignition switch is ON.
The ECM detects that the calculated checksum does not agree with the EEPROM internal registered checksum.

3. DTC P1621 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P1655 (Flash Code 59)
Sensor Reference Voltage 4 Circuit

1. DTC P1655 description of DTC

The ECM supplies 5 V power to the following sensors through power supply circuit 4.
CKP sensor
The ECM monitors the voltage of 5 V power supply circuit 4, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P1655 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 8 - 16 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 4 is 4.5 V or less, or 5.5 V or more.

3. DTC P1655 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
The following assumes a default value.
CKP
Fuel temperature
Coolant temperature

DTC P2146 (Flash Code 158)
Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P2146 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from various sensors. The injector charge voltage circuits of common power supplies 1 and 2 supply high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
If an open circuit in the injector charge voltage circuit for common power supply 1 or 2 occurs, or a short to GND or a short to the voltage circuit occurs, the DTC is set, corresponding to a defective injector common power supply circuit.
Also, if the injector solenoid control circuit is shorted to GND, the DTC is set.

2. DTC P2146 condition for setting the DTC

DTCs P0201 and P0204 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the injector charge voltage circuit for common power supply 1 has an open circuit, is shorted to GND or shorted to the voltage circuit, or that the injector solenoid coil control circuit for cylinder No. 1 or No. 4 is shorted to GND, for 3 seconds or more.

3. DTC P2146 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
The fuel injection for the No. 1 and No. 4 cylinders is disabled.

DTC P2149 (Flash Code 159)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P2149 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector charge voltage circuits of common power supplies 1 and 2 supply high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
If an open circuit in the injector charge voltage circuit for common power supply 1 or 2 occurs, or a short to GND or a short to the voltage circuit occurs, DTC P2149 is set, corresponding to a defective injector common power supply circuit.
Also, if the injector solenoid control circuit is shorted to GND, the DTC is set.

2. DTC P2149 condition for setting the DTC

DTCs P0202 and P0203 are not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the injector charge voltage circuit for common power supply 2 has an open circuit, is shorted to GND or shorted to the voltage circuit, or that the injector solenoid coil control circuit for cylinder No. 2 or No. 3 is shorted to GND, for 3 seconds or more.

3. DTC P2149 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
The fuel injection for the No. 2 and No. 3 cylinders is disabled.

DTC P2228 (Flash Code 71)
Barometric Pressure Circuit Low

1. DTC P2228 description of DTC

The barometric pressure sensor changes the signal voltage according to changes in the barometric pressure. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Barometric pressure sensor signal circuit
The barometric pressure sensor sends signals related to barometric pressure change to the ECM. The ECM detects low signal voltage at high altitudes and with low barometric pressure. The ECM detects high signal voltage with high barometric pressure. The ECM uses this voltage signal to adjust the fuel injection quantity and injection timing and make altitude correction. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P2228 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the barometric pressure sensor signal voltage is 0.5 V or less for 5 seconds.

3. DTC P2228 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
A default barometric pressure value is assumed.

DTC P2229 (Flash Code 71)
Barometric Pressure Circuit High

1. DTC P2229 description of DTC

The barometric pressure sensor changes the signal voltage according to changes in the barometric pressure. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Barometric pressure sensor signal circuit
The barometric pressure sensor sends signals related to barometric pressure change to the ECM. The ECM detects low signal voltage at high altitudes and with low barometric pressure. The ECM detects high signal voltage with high barometric pressure. The ECM uses this voltage signal to adjust the fuel injection quantity and injection timing and make altitude correction. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P2229 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 9 - 16 V.
The ignition switch is ON.
The ECM detects that the barometric pressure sensor signal voltage is 4.0 V or more for 5 seconds.

3. DTC P2229 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The EGR control is disabled.
A default barometric pressure value is assumed.

DTC P256A (Flash Code 31)
Idle Up Volume Sensor Circuit Or Up/Down Switch Error

1. DTC P256A description of DTC

The idling control switch is a switch for adjusting the idling rpm speed during warm-up and can be used when the idling control selector switch is set to "manual". Power supply voltage is provided to the idling control switch via the key switch, and if UP or DOWN is pressed, each GND circuit is established and the signal is entered to the ECM.
The ECM sets a DTC if the signal input on both the UP side and the DOWN side of the idling control switch are detected at the same time.

2. DTC P256A condition for setting the DTC

The idling control up signal and idling control down signal are both ON.

3. DTC P256A action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC U0073 (Flash Code 84)
CAN-Bus Malfunction (J1939)

1. DTC U0073 description of DTC

The ECM communicates with the control unit of the machine via the CAN communication circuit. The ECM outputs data via the CAN-High circuit and inputs data from other ECUs via the CAN-Low circuit. CAN communication is continuously performed at a constant rate and the data output count and input count are always identical. The ECM sets a DTC when CAN communication fails.

2. DTC U0073 condition for setting the DTC

The battery voltage is between 10 - 16 V or more.
The ignition switch is ON.
The ECM detects a failure in the CAN communication circuit.

3. DTC U0073 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.

DTC mapping table

1. DTC mapping table

SPN-FMI	P code	
636-7	P0016	Crankshaft position - camshaft position correlation error
633-7	P0087	Fuel rail system pressure low pressure malfunction
157-15	P0089	Fuel rail pressure regulator control characteristic malfunction
1347-4	P0091	Fuel rail pressure regulator system low input
1347-3	P0092	Fuel rail pressure regulator control system high input
1239-1	P0093	Fuel system leakage detection
1131-4	P0097	IMT sensor system low input
1131-3	P0098	IMT sensor system high input
172-4	P0112	Intake air temperature sensor system low input
172-3	P0113	Intake air temperature sensor system high input
110-4	P0117	Engine coolant temperature sensor system low input
110-3	P0118	Engine coolant temperature sensor system high input
174-4	P0182	Fuel temperature sensor system low input
174-3	P0183	Fuel temperature sensor system high input
157-4	P0192	Fuel rail pressure sensor system low input
157-3	P0193	Fuel rail pressure sensor system high input
651-5	P0201	Injector system malfunction No. 1 cylinder
652-5	P0202	Injector system malfunction No. 2 cylinder
653-5	P0203	Injector system malfunction No. 3 cylinder
654-5	P0204	Injector system malfunction No. 4 cylinder
110-0	P0217	Engine coolant high temperature malfunction
190-0	P0219	High engine speed malfunction
102-4	P0237	Turbocharger boost pressure sensor circuit low input
102-3	P0238	Turbocharger boost sensor circuit high input
723-2	P0335	Crankshaft position sensor system malfunction
723-2	P0336	Crankshaft position sensor system characteristic malfunction
636-2	P0340	CMP sensor system malfunction
676-5	P0380	Glow plug system malfunction
10002-2	P0404	EGR 1 control system characteristic malfunction
10001-2	P0409	EGR 1 position sensor system malfunction
100-1	P0521	Engine oil low pressure malfunction
100-4	P0522	Engine oil pressure sensor malfunction (low voltage)
100-3	P0523	Engine oil pressure sensor malfunction (high voltage)
158-3	P0563	System voltage high input
628-2	P0601	Control module memory check sum error
10032-2	P0602	Control module program malfunction error
10033-2	P0604	Control module RAM malfunction random access memory error
1077-2	P0606	Control module processor error
10007-2		
10008-2	P060B	Control module A/D conversion processor characteristic error
677-5	P0615	Starter relay system malfunction
1079-2	P0641	Sensor voltage system malfunction (Reference 1)
1080-2	P0651	Sensor voltage system malfunction (Reference 2)
1485-5	P0685	ECM main relay control system low input

1485-6	P0687	ECM main relay control system high input
10009-2	P0697	Sensor voltage system malfunction (Reference 3)
10050-2	P06AF	Injector IC malfunction
10052-2		Injector IC checksum malfunction
10051-2		Injector IC communication malfunction
1239-17	P1093	Fuel rail pressure low pressure malfunction
105-4	P1097	Boost temperature sensor malfunction (low voltage)
105-3	P1098	Boost temperature sensor malfunction (high voltage)
10005-1	P1261	Fuel injector supply voltage system malfunction, group 1
10006-1	P1262	Fuel injector supply voltage system malfunction, group 2
10001-13	P1404	EGR 1 closed position characteristic malfunction
10046-2	P1606	SW-IC1 internal malfunction
10048-2		SW-IC1 communication circuit malfunction
10045-2	P160B	AD-IC malfunction
10013-2	P1621	Control module EEPROM/HD EEPROM malfunction
10010-2	P1655	Sensor voltage system malfunction (Reference 4)
10003-2	P2146	Fuel injector supply voltage system malfunction, group 1
10004-2	P2149	Fuel injector supply voltage system malfunction, group 2
108-4	P2228	Barometric pressure sensor system low input
108-3	P2229	Barometric pressure sensor system high input
968-2	P256A	Idle Up Volume Sensor Circuit Or Up/Down Switch Error
639-19	U0073	CAN bus malfunction (J1939)

Description Engine

DTC Information

(4LE2 (24V))

Table of Contents

DTC P0016 (Flash Code 16)
Crankshaft Position - Camshaft Position Correlation

1. DTC P0016 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° opening. Top dead center of cylinder No. 1 can be detected through this opening.
The CMP sensor is installed on the timing gear case. The CMP sensor detects 5 protrusions in total per 1 engine rotation. The camshaft gear has 4 protrusions evenly spaced 90° apart and 1 reference protrusion. By detecting the opening with the CKP sensor and the 1 reference protrusion with the CMP sensor, the ECM determines compression top dead center of cylinder No. 1 to verify that they correlate with each other. If the ECM detects that both signals are out of synchronization, the DTC is set.

2. DTC P0016 condition for setting the DTC

DTCs P0335, P0336, and P0340 are not set.
The ignition switch is ON.
The signal pulse of the CKP sensor is detected.
The signal pulse of the CMP sensor is detected.
The ECM detects that the CKP sensor signal and the CMP sensor signal are not synchronized while the engine is running.

3. DTC P0016 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0087 (Flash Code 225)
Fuel Rail/System Pressure - Too Low

1. DTC P0087 description of DTC

   A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the supply pump, and a high pressure side between the supply pump and the injectors. The fuel is drawn from the fuel tank and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor. If the common rail (fuel rail) pressure becomes excessive, the common rail (fuel rail) pressure limiter valve opens to release the excessive pressure and returns the fuel to the fuel tank. The ECM sets the DTC if the common rail (fuel rail) pressure sharply decreases after the pressure goes excessively high. This DTC detects activation of the pressure limiter valve.

2. DTC P0087 condition for setting the DTC

   DTCs P0192 and P0193 are not set.
   The ignition switch is ON.
   The ECM detects that the pressure limiter valve is activated with excessive pressure of 240 MPa {2,447 kgf/cm2 / 34,800 psi} or more in the common rail (fuel rail) for 1 second or more.

3. DTC P0087 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :
   - Depending on the machine manufacturer, the failure indication may not be shown.

   The fuel injection quantity is limited.
   The fuel flow rate is limited.
   The EGR control is disabled.

DTC P0089 (Flash Code 151)
Fuel Pressure Regulator Performance

1. DTC P0089 description of DTC

A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the supply pump, and a high pressure side between the supply pump and the injectors. The fuel is drawn from the fuel tank and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor. If the ECM detects that the fuel pressure is higher than the desired fuel pressure, this DTC is set.

2. DTC P0089 condition for setting the DTC

DTCs P0091, P0092, P0192, P0193, P0201 - P0204, P1261, P1262, P2146, and P2149 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the common rail (fuel rail) pressure is more than the desired fuel pressure by 40 MPa {408 kgf/cm2 / 5,800 psi} or more for 5 seconds or more.

3. DTC P0089 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.
A default barometric pressure value is assumed.

DTC P0091 (Flash Code 247)
Fuel Pressure Regulator Control Circuit Low

1. DTC P0091 description of DTC

The suction control valve is installed on the supply pump and controls the fuel amount sucked into the common rail (fuel rail). The suction control valve is fully opened in the normal state and larger drive current results in a smaller opening of the regulator. The ECM calculates the desired common rail (fuel rail) pressure and the fuel flow rate, and compares the calculated common rail (fuel rail) pressure to the actual pressure value to determine the opening angle of the suction control valve. If the actual common rail (fuel rail) pressure is higher than the desired pressure, the suction control valve closes to decrease the fuel flow rate. If the ECM detects an abnormally low feedback current of the suction control valve, the DTC is set.

2. DTC P0091 condition for setting the DTC

The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the feedback current of the suction control valve is 50 mA or less, or lower than the desired current by 1000 mA or more, for 2 seconds or more.

3. DTC P0091 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The fuel flow rate is limited.
The maximum engine speed is limited to 1,250 r/min.
The EGR control is disabled.

DTC P0092 (Flash Code 247)
Fuel Pressure Regulator Control Circuit High

1. DTC P0092 description of DTC

The suction control valve is installed on the supply pump and controls the fuel amount sucked into the common rail (fuel rail). The suction control valve is fully opened in the normal state and larger drive current results in a smaller opening of the regulator. The ECM calculates the desired common rail (fuel rail) pressure and the fuel flow rate, and compares the calculated common rail (fuel rail) pressure to the actual pressure value to determine the opening angle of the suction control valve. If the actual common rail (fuel rail) pressure is higher than the desired pressure, the suction control valve closes to decrease the fuel flow rate. If the ECM detects an abnormally high feedback current of the suction control valve, the DTC is set.

2. DTC P0092 condition for setting the DTC

The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the feedback current of the suction control valve is 2400 mA or more, or higher than the desired current by 1000 mA or more, for 2 seconds or more.

3. DTC P0092 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The fuel flow rate is limited.
The maximum engine speed is limited to 1,250 r/min.
The EGR control is disabled.

DTC P0093 (Flash Code 227)
Fuel System Leak Detected

1. DTC P0093 description of DTC

A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the supply pump, and a high pressure side between the supply pump and the injectors. The fuel is drawn from the fuel tank and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor. If the ECM detects that the common rail (fuel rail) pressure is low compared with the engine speed, the DTC is set.

2. DTC P0093 condition for setting the DTC

DTCs P0087, P0091, P0092, P0192, P0193, P0201, P0202, P0203, P0204, P1261, P1262, P2146, and P2149 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine speed is 900 r/min or more.
The ECM detects that the actual common rail (fuel rail) pressure is 15 MPa {153 kgf/cm2 / 2,175 psi} or less for 3 seconds or more (this may not be a prerequisite depending on the machine manufacturer).

3. DTC P0093 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P0112 (Flash Code 22)
Intake Air Temperature Sensor Circuit Low

1. DTC P0112 description of DTC

The boost temperature sensor is a thermistor type sensor and it measures the temperature of the air flowing into the engine. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the boost temperature sensor is cold, the sensor resistance is high. As the air temperature rises, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0112 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the boost temperature sensor signal voltage is 0.1 V or less for 4 seconds.

3. DTC P0112 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost temperature value is assumed.
The boost pressure is limited.
The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0113 (Flash Code 22)
Intake Air Temperature Sensor Circuit High

1. DTC P0113 description of DTC

The boost temperature sensor is a thermistor type sensor and it measures the temperature of the air flowing into the engine. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the boost temperature sensor is cold, the sensor resistance is high. As the air temperature rises, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0113 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine has been running for 3 minutes or more.
The ECM detects that the boost temperature sensor signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0113 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost temperature value is assumed.
The boost pressure is limited.
The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0117 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit Low

1. DTC P0117 description of DTC

   The engine coolant temperature sensor is installed in the thermostat housing. The engine coolant temperature sensor is a thermistor type sensor and measures the temperature of the engine coolant. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the engine coolant temperature sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0117 condition for setting the DTC

   DTC P060B is not set.
   The battery voltage is between 18 - 32 V.
   The ignition switch is ON.
   The ECM detects that the signal voltage of the engine coolant temperature sensor is 0.1 V or less for 4 seconds.

3. DTC P0117 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：
   - Depending on the machine manufacturer, the failure indication may not be shown.

   A default water temperature value is assumed.
   The boost pressure is limited.
   The EGR control is disabled.

DTC P0118 (Flash Code 23) Engine Coolant Temperature Sensor Circuit High

1. DTC P0118 description of DTC

The engine coolant temperature sensor is installed in the thermostat housing. The engine coolant temperature sensor is a thermistor type sensor and measures the temperature of the engine coolant. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the engine coolant temperature sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0118 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine has been running for 3 minutes or more.
The ECM detects that the engine coolant temperature sensor signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0118 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default water temperature value is assumed.
The boost pressure is limited.
The EGR control is disabled.

DTC P0182 (Flash Code 211)
Fuel Temperature Sensor Circuit Low

1. DTC P0182 description of DTC

The fuel temperature sensor is installed on the supply pump. The fuel temperature sensor is a thermistor type sensor and measures the temperature of the fuel entering the supply pump. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the fuel temperature sensor is cold, the resistance of the sensor is high. When the fuel temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0182 condition for setting the DTC

DTC P060B is not set.

The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the fuel temperature sensor signal voltage is 0.1 V or less for 4 seconds.

3. DTC P0182 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default fuel temperature value is assumed.

DTC P0183 (Flash Code 211)
Fuel Temperature Sensor Circuit High

1. DTC P0183 description of DTC

The fuel temperature sensor is installed on the supply pump. The fuel temperature sensor is a thermistor type sensor and measures the temperature of the fuel entering the supply pump. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and the GND circuit connects to GND. When the fuel temperature sensor is cold, the resistance of the sensor is high. When the fuel temperature increases, the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0183 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine has been running for 3 minutes or more.
The ECM detects that the fuel temperature sensor signal voltage is 4.85 V or more for 4 seconds.

3. DTC P0183 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default fuel temperature value is assumed.

DTC P0192 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit Low

1. DTC P0192 description of DTC

The barometric pressure sensor changes the signal voltage according to changes in the barometric pressure. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Barometric pressure sensor signal circuit
The barometric pressure sensor sends signals related to barometric pressure change to the ECM. The ECM detects low signal voltage at high altitudes and with low barometric pressure. The ECM detects high signal voltage with high barometric pressure. The ECM uses this voltage signal to adjust the fuel injection quantity and injection timing and make altitude correction. If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0192 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the common rail (fuel rail) pressure sensor signal voltage is 0.7 V or less.

3. DTC P0192 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default common rail (fuel rail) pressure value is assumed.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P0193 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit High

1. DTC P0193 description of DTC

The common rail (fuel rail) pressure sensor is installed to the common rail (fuel rail) and detects the fuel pressure in the common rail (fuel rail) and converts the pressure into a voltage signal. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Common rail (fuel rail) pressure sensor signal circuit
The ECM monitors the common rail (fuel rail) pressure sensor signal voltage. The signal voltage increases as the common rail (fuel rail) pressure rises, and decreases as the pressure declines. The ECM calculates the actual common rail (fuel rail) pressure from the voltage signal and uses the result in the fuel injection control and other control tasks.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0193 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the common rail (fuel rail) pressure sensor signal voltage is 4.8 V or more for 1 second or more.

3. DTC P0193 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default common rail (fuel rail) pressure value is assumed.
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P0201 (Flash Code 271)
Injector Circuit - Cylinder 1

1. DTC P0201 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 1 cylinder injector circuit, the DTC is set.

2. DTC P0201 condition for setting the DTC

DTCs P1261 and P2146 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0201 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The injection of the No. 1 cylinder is disabled.
The EGR control is disabled.

DTC P0202 (Flash Code 272)
Injector Circuit - Cylinder 2

1. DTC P0202 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 2 cylinder injector circuit, the DTC is set.

2. DTC P0202 condition for setting the DTC

DTCs P1262 and P2149 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0202 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The injection of the No. 2 cylinder is disabled.
The EGR control is disabled.

DTC P0203 (Flash Code 273)
Injector Circuit - Cylinder 3

1. DTC P0203 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 3 cylinder injector circuit, the DTC is set.

2. DTC P0203 condition for setting the DTC

DTCs P1262 and P2149 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0203 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The injection of the No. 3 cylinder is disabled.
The EGR control is disabled.

DTC P0204 (Flash Code 274)
Injector Circuit - Cylinder 4

1. DTC P0204 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector power supply circuit supplies high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. If the ECM detects a malfunction of the No. 4 cylinder injector circuit, the DTC is set.

2. DTC P0204 condition for setting the DTC

DTCs P1261 and P2146 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
Either of the following conditions is met.
The ECM detects an open circuit in the injector solenoid circuit.
The ECM detects that the injector solenoid control circuit is shorted to the voltage circuit or shorted to the charge voltage circuit.

3. DTC P0204 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The injection of the No. 4 cylinder is disabled.
The EGR control is disabled.

DTC P0217 (Flash Code 542)
Engine Coolant Over Temperature Condition

1. DTC P0217 description of DTC

The engine coolant temperature sensor is installed on the thermostat housing. The engine coolant temperature sensor is a thermistor type and measures the temperature of the engine coolant.
If the ECM detects an abnormally high coolant temperature, the DTC is set.

2. DTC P0217 condition for setting the DTC

DTCs P0117 and P0118 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the engine coolant temperature is 100 °C {212 °F} or more for 5 seconds.

Note :

- The setting varies depending on the machine manufacturer.

DTC P0219 (Flash Code 543)
Engine Overspeed Condition

1. DTC P0219 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The ECM calculates the engine speed and accurate crankshaft position based on the signal pulse from the CKP sensor.
If the ECM detects that the engine is in an overrun condition, the DTC is set.

2. DTC P0219 condition for setting the DTC

The ECM detects that the engine speed is more than 2,500 r/min for 5 seconds.

DTC P0237 (Flash Code 32)
Turbocharger Boost Sensor Circuit Low

1. DTC P0237 description of DTC

The boost pressure sensor is located in the air intake pipe. This sensor changes the signal voltage in accordance with changes in air pressure in the air intake pipe. The boost pressure sensor has the following circuits.
5 V power supply circuit
GND circuit
Boost pressure sensor signal circuit
The boost pressure sensor sends the signal of pressure changes in the air intake pipe to the ECM. The ECM detects a high voltage signal when the air pressure is high, such as when the load on the engine is high.
If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P0237 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the boost pressure sensor signal voltage is 0.1 V or less for 3 seconds.

3. DTC P0237 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost pressure value is assumed.
The EGR control is disabled.

DTC P0238 (Flash Code 32)
Turbocharger Boost Sensor Circuit High

1. DTC P0238 description of DTC

The boost pressure sensor is located in the air intake pipe. This sensor changes the signal voltage in accordance with changes in air pressure in the air intake pipe. The boost pressure sensor has the following circuits.
5 V power supply circuit
GND circuit
Boost pressure sensor signal circuit
The boost pressure sensor sends the signal of pressure changes in the air intake pipe to the ECM. The ECM detects a high voltage signal when the air pressure is high, such as when the load on the engine is high.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P0238 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the boost pressure sensor signal voltage is 4.9 V or more for 3 seconds.

3. DTC P0238 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：
- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost pressure value is assumed.
The EGR control is disabled.

DTC P0335 (Flash Code 15)
Crankshaft Position Sensor Circuit

1. DTC P0335 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° opening. Top dead center of cylinder No. 1 can be detected through this opening. The CKP sensor generates pulse signals. The sensor has the following circuits.
5 V power supply circuit
GND circuit
CKP sensor signal circuit
The ECM monitors the signal pulses of the CKP sensor and the CMP sensor to verify that they correlate with each other. If the ECM receives a certain amount of CMP sensor signal pulses without a CKP sensor signal pulse, the DTC is set.

2. DTC P0335 condition for setting the DTC

DTCs P0016, P0336, and P0340 are not set.
The ignition switch is ON.
The signal pulse of the CMP sensor is detected.
The ECM detects that no CKP sensor signal pulse is generated while the engine is running.

3. DTC P0335 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0336 (Flash Code 15)
Crankshaft Position Sensor Circuit Range/Performance

1. DTC P0336 description of DTC

The CKP sensor is installed on the right rear of the cylinder block. The sensor rotor is fixed on the crankshaft. There are 56 notches spaced 6° apart and a 30° opening. Top dead center of cylinder No. 1 can be detected through this opening. The ECM monitors the signal pulses of the CKP sensor and the CMP sensor to verify that they correlate with each other.
If the ECM receives excessive or short CKP sensor signal pulses, the DTC is set.

2. DTC P0336 condition for setting the DTC

DTCs P0016, P0335, and P0340 are not set.
The ignition switch is ON.
The signal pulse of the CKP sensor is detected.
The ECM detects excessive or short CKP sensor signal pulses while the engine is running.

3. DTC P0336 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0340 (Flash Code 14)
Camshaft Position Sensor Circuit

1. DTC P0340 description of DTC

The CMP sensor is installed on the gear case cover. The CMP sensor detects 5 protrusions in total per 1 engine rotation. The camshaft gear has 4 protrusions evenly spaced 90° apart and 1 reference protrusion. The CMP sensor generates pulse signals. The sensor has the following circuits.
5 V power supply circuit
GND circuit
CMP sensor signal circuit
The ECM monitors the signal pulses of the CKP sensor and the CMP sensor to verify that they correlate with each other.
If the ECM receives a certain amount of CKP sensor signal pulses without a CMP sensor signal pulse, the DTC is set.

2. DTC P0340 condition for setting the DTC

DTCs P0016, P0335, and P0336 are not set.
The ignition switch is ON.
The signal pulse of the CKP sensor is detected.
The ECM detects that no CMP sensor signal pulse is generated while the engine is running.

3. DTC P0340 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0380 (Flash Code 66)
Glow Plug Circuit

1. DTC P0380 description of DTC

   The glow relay stops providing power supply voltage (24 V) to the glow plug, and ON is displayed if the signal from the ECM is input. The ECM recognizes the ignition switch ON signal, and outputs the ON signal to the glow relay.

2. DTC P0380 condition for setting the DTC

   Key switch input voltage is 16 - 32 V.
   There is no glow relay monitoring signal to the glow relay drive instruction, or there is a glow relay monitoring signal to the glow relay stop instruction, for 3 seconds or more.

3. DTC P0380 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：

   - Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0404 (Flash Code 45)
Exhaust Gas Recirculation 1 Control Circuit Range/Performance

1. DTC P0404 description of DTC

The ECM controls the opening and closing of the EGR valve based on the driving condition of the engine by controlling the EGR solenoid. The EGR valve lift amount is detected by the position sensor and is sent to the ECM. If the ECM detects a difference between the actual EGR valve position and the desired EGR valve position for a predetermined period of time with the EGR commanded ON, the DTC is set.

2. DTC P0404 condition for setting the DTC

DTC P0409 is not set.
The battery voltage is between 20 - 32 V.
The ignition switch is ON.
The EGR control is commanded ON.
The ECM detects that the difference between the actual and desired EGR valve positions is 20% or more for 10 seconds or more.

3. DTC P0404 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0409 (Flash Code 44)
Exhaust Gas Recirculation 1 Sensor Circuit

1. DTC P0409 description of DTC

The EGR position sensor is on the EGR valve together with the control solenoid. This sensor is made up of 3 individual sensors within 1 housing. EGR position sensor 1, EGR position sensor 2, and EGR position sensor 3 are hall IC type sensors with the following circuits.
5 V power supply circuit
GND circuit
Signal circuit
The EGR position sensor sends a high and low signal status regarding changes in the EGR valve position to the ECM.
If the ECM detects that all high or low signal statuses from the EGR position sensor do not correlate, the DTC is set.

2. DTC P0409 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the signal from the EGR valve position sensor is kept in a low or high state for 3 seconds or more.

3. DTC P0409 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.

DTC P041C (Flash Code 52)
Intake Manifold Temperature Sensor Circuit High

1. DTC P041C description of DTC

The IMT sensor is installed to the intake chamber. The IMT sensor is a thermistor type sensor and it measures the temperature of the intake air mixed with EGR gas. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the IMT sensor is cold, the resistance of the sensor is high. When the EGR gas amount increases, the intake air temperature rises and the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P041C condition for setting the DTC

DTCs P0112, P0113, and P060B are not set.
The engine speed and the fuel injection quantity are more than the predetermined levels for longer than the predetermined time.
The ECM detects that the IMT sensor signal voltage is 4.94 V or more for 4 seconds or more.

3. DTC P041C action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default IMT value is assumed.

DTC P041D (Flash Code 52)
Intake Manifold Temperature Sensor Circuit Low

1. DTC P041D description of DTC

   The IMT sensor is installed to the intake chamber. The IMT sensor is a thermistor type sensor and it measures the temperature of the intake air mixed with EGR gas. This sensor has a signal circuit and a GND circuit. The ECM supplies 5 V to the signal circuit, and GND to the GND circuit. When the IMT sensor is cold, the resistance of the sensor is high. When the EGR gas amount increases, the intake air temperature rises and the sensor resistance decreases. The ECM detects a high voltage when the sensor resistance is high. The ECM detects a low voltage when the sensor resistance is low.
   If the ECM detects an abnormally low signal voltage, the DTC is set.

2. DTC P041D condition for setting the DTC

   DTC P060B is not set.
   The ECM detects that the signal voltage of the IMT sensor is 0.1 V or less for 4 seconds or more.

3. DTC P041D action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :
   - Depending on the machine manufacturer, the failure indication may not be shown.

   A default IMT value is assumed.

DTC P0521 (Flash Code 294)
Engine Oil Pressure Sensor Performance

1. DTC P0521 description of DTC

The oil pressure sensor detects the engine oil pressure. The oil pressure sensor is installed near the oil cooler of the cylinder block. The internal resistance of the oil pressure sensor changes in accordance with changes in pressure. The resistance is low when the pressure is high, and the resistance is high when the pressure is low.
The ECM is connected to the oil pressure sensor through the power supply circuit, the signal circuit, and the GND circuit, and applies +5 V power to the power supply circuit. The ECM detects changes in the signal voltage that occur according to changes in resistance based on the pressure of the oil pressure sensor as a signal (high voltage when the pressure is high, and low voltage when the pressure is low).
If the ECM detects an abnormally low engine oil pressure, the DTC is set.

2. DTC P0521 condition for setting the DTC

The engine has been running for 25 seconds or more.
The engine speed is 600 r/min or more.
The ECM detects that the engine oil pressure is 48 kPa {0.49 kgf/cm2 / 7 psi} or less for 4 seconds or more.

3. DTC P0521 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The maximum engine speed is limited to 1,700 r/min.

DTC P0522 (Flash Code 294)
Oil Pressure Sensor Circuit Low Input

1. DTC P0522 description of DTC

The oil pressure sensor detects the engine oil pressure. The oil pressure sensor is installed near the oil cooler of the cylinder block. The internal resistance of the oil pressure sensor changes in accordance with changes in pressure. The resistance is low when the pressure is high, and the resistance is high when the pressure is low. The ECM is connected to the oil pressure sensor through the power supply circuit, the signal circuit, and the GND circuit, and applies +5 V power to the power supply circuit.
The ECM detects changes in the signal voltage that occur according to changes in resistance based on the pressure of the oil pressure sensor as a signal.

2. DTC P0522 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ECM detects that the signal voltage of the oil pressure sensor is 0.1 V or less for 4 seconds.

3. DTC P0522 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default engine oil pressure value is assumed.

DTC P0523 (Flash Code 294)
Oil Pressure Sensor Circuit High Input

1. DTC P0523 description of DTC

The oil pressure sensor detects the engine oil pressure. The oil pressure sensor is installed near the oil cooler of the cylinder block. The internal resistance of the oil pressure sensor changes in accordance with changes in pressure. The resistance is low when the pressure is high, and the resistance is high when the pressure is low. The ECM is connected to the oil pressure sensor through the power supply circuit, the signal circuit, and the GND circuit, and applies +5 V power to the power supply circuit.
The ECM detects changes in the signal voltage that occur according to changes in resistance based on the pressure of the oil pressure sensor as a signal.

2. DTC P0523 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ECM detects that the signal voltage of the oil pressure switch is 4.85 V or more for 4 seconds.

3. DTC P0523 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default engine oil pressure value is assumed.

DTC P0563 (Flash Code 35)
System Voltage High

1. DTC P0563 description of DTC

The ECM monitors the ignition voltage on the ignition feed terminal to verify that the voltage stays within the proper range.
If the ECM detects that the voltage of the ignition power source is abnormally high, the DTC is set.

2. DTC P0563 condition for setting the DTC

DTC P060B is not set.
The ECM detects that the voltage of the ignition power supply circuit is 32 V or more for 5 seconds.

3. DTC P0563 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0601 (Flash Code 53)
Internal Control Module Memory Check Sum Error

1. DTC P0601 description of DTC

   This diagnosis applies to the microprocessor inside the ECM.

2. DTC P0601 condition for setting the DTC

   The ECM detects that the calculated checksum does not agree with the ROM internal registered checksum.

3. DTC P0601 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :

   - Depending on the machine manufacturer, the failure indication may not be shown.

   The engine is stopped.
   The fuel flow rate is limited.

DTC P0602 (Flash Code 154)
Control Module Programming Error

1. DTC P0602 description of DTC

The injector ID code and the fuel delivery rate data is stored in the EEPROM within the ECM. If no injector ID code or fuel delivery rate data is programmed in the ECM or the ECM detects an error in the programmed injector ID code, the DTC is set.

2. DTC P0602 condition for setting the DTC

The ignition switch is ON.
Either of the following conditions is met.
The ECM detects that no injector ID code is programmed.
The ECM detects an error in the programmed injector ID code.
The ECM detects that no fuel delivery rate data is programmed.

3. DTC P0602 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0604 (Flash Code 153)
Internal Control Module Random Access Memory (RAM)

1. DTC P0604 description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P0604 condition for setting the DTC

The battery voltage is 16 V or more.
The ECM detects a failure in the internal RAM.

3. DTC P0604 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The engine is stopped.
The fuel flow rate is limited.

DTC P0606 (Flash Code 51)
ECM/PCM Processor

1. DTC P0606 description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P0606 condition for setting the DTC

The battery voltage is 18V or more.
The ignition switch has been ON for 8 minutes or more.
The internal sub CPU detects a malfunction in the main CPU.

3. DTC P0606 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

At CPU recovery
The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.
The maximum engine speed is limited to 1,700 r/min.

DTC P060B (Flash Code 36)
Internal Control Module A/D Processing Performance

1. DTC P060B description of DTC

This diagnosis applies to the microprocessor inside the ECM.

2. DTC P060B condition for setting the DTC

The ECM detects a malfunction of the internal A/D converter.

3. DTC P060B action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.

DTC P0615 (Flash Code 19)
Starter Relay Circuit

1. DTC P0615 description of DTC

The starter cut switch is provided to prevent the starter from operating when the engine is running. The starter cut relay is a normal closed relay and is positioned between the main relay and starter relay. When the engine is started, the ECM stops signal output to the starter cut relay when the key switch is in the START position, and the relay is turned ON. When the key switch is turned ON, the ECM sends a signal to the starter cut relay, and the relay is turned OFF.
After the engine is started, the ECM restarts sending signals to the starter cut relay when the key switch is returned to the ON position, and the relay is turned OFF.
A monitor circuit is incorporated inside the ECM, and this circuit monitors the operation of the relay.
The ECM sets a DTC if the output to the starter cut relay and the operation of the starter cut relay do not match.

2. DTC P0615 condition for setting the DTC

There is no starter cut relay monitoring signal to the starter cut relay drive signal for 3 seconds or more.

3. DTC P0615 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0641 (Flash Code 55)
Sensor Reference Voltage 1 Circuit

1. DTC P0641 description of DTC

The ECM supplies 5 V power to the following sensors through power supply circuit 1.
Accelerator position sensor
Fuel filter pressure sensor
Boost pressure sensor
The ECM monitors the voltage of 5 V power supply circuit 1, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P0641 condition for setting the DTC

DTC P060B is not set.
The battery voltage is 16 - 32V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 1 is 4.5 V or less, or 5.5 V or more.

3. DTC P0641 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.
The following assumes a default value.
Accelerator position
Fuel filter pressure
Boost pressure sensor/boost temperature

DTC P0651 (Flash Code 56)
Sensor Reference Voltage 2 Circuit

1. DTC P0651 description of DTC

The ECM supplies 5 V power to the following sensor through 5 V power supply circuit 2.
Barometric pressure sensor
The ECM also supplies 5 V power to the following sensors through 5 V power supply circuit 5.
CMP sensor
FRP sensor
EGR position sensor
5 V power supply circuits 2 and 5 are independent of each other outside of the ECM, but share the bus inside the ECM. Therefore, the entire 5 V power supply circuits 2 and 5 may be affected by a short circuit in either of the sensor 5 V power supply circuits. The ECM monitors the voltage of 5 V power supply circuits 2 and 5, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P0651 condition for setting the DTC

DTC P060B is not set.
The battery voltage is 16 - 32 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 2 or 5 is 4.5 V or less, or 5.5 V or more.

3. DTC P0651 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.
The following assumes a default value.
IMT
Barometric pressure
CMP
Fuel pressure
EGR position

DTC P0685 (Flash Code 416)
ECM/PCM Power Relay Control Circuit/Open

1. DTC P0685 description of DTC

   The ECM main relay is applied to supply the battery power to the ECM through the relay switch side when the ECM receives an ignition switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time has passed.
   If the ECM detects a low voltage status in the relay voltage supply circuit when the ECM main relay is commanded ON, the DTC is set.

2. DTC P0685 condition for setting the DTC

   The battery voltage is between 18 - 32 V.
   The ignition switch has been ON for 3 seconds.
   When the ECM commands the relay ON, the ECM detects that the main relay voltage supply circuit is 1 V or less for 3 seconds.

3. DTC P0685 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note :

   - Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0687 (Flash Code 416)
ECM/PCM Power Relay Control Circuit High

1. DTC P0687 description of DTC

The ECM main relay is applied to supply the battery power to the ECM through the relay switch side when the ECM receives an ignition switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time has passed.
If the ECM detects that the ECM is ON when the ECM main relay is commanded OFF, the DTC is set.

2. DTC P0687 condition for setting the DTC

The ignition switch is OFF.
The ECM detects that the relay is ON for 5 seconds when the ECM commands the relay OFF.

3. DTC P0687 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P0697 (Flash Code 57)
Sensor Reference Voltage 3 Circuit

1. DTC P0697 description of DTC

The ECM supplies 5 V power to the following sensors through power supply circuit 3.
Oil pressure sensor
The ECM monitors the voltage of 5 V power supply circuit 3, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P0697 condition for setting the DTC

DTC P060B is not set.
The battery voltage is 16 - 32 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 3 is 4.5 V or less, or 5.5 V or more.

3. DTC P0697 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.
The following assumes a default value.
Engine oil pressure
IMT

DTC P06AF (Flash Code 277)
EDU Injector Custom IC,Check Sum,Communication Line

1. DTC P06AF description of DTC

This diagnosis applies to the injector IC inside the ECM.

2. DTC P06AF condition for setting the DTC

Note :

- Injector IC malfunction

The engine is running.
An injector IC malfunction was detected for 1.2 seconds or more.

Note :

- Injector IC checksum malfunction

The engine is running.
An injector IC reset was detected for 2.6 seconds or more.

Note :

- Injector IC communication malfunction

The engine is running.
A communication failure with the injector IC was detected for 2.6 seconds or more.

3. DTC P06AF action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

All injectors are inhibited.

DTC P1093 (Flash Code 227)
Fuel Rail Pressure (FRP) Too Low

1. DTC P1093 description of DTC

A typical common rail (fuel rail) system is composed of the following 2 fuel pressure sections. A suction side between the fuel tank and the fuel supply pump, and a high pressure side between the fuel supply pump and the injectors. The fuel is drawn from the fuel tank via the fuel supply pump and then pumped into the common rail (fuel rail) by 2 plungers that are located inside the fuel supply pump. The common rail (fuel rail) pressure is controlled by the ECM controlling the suction control valve based on signals from the common rail (fuel rail) pressure sensor.
If the ECM detects that the actual fuel pressure is less than the desired fuel pressure, the DTC is set.

2. DTC P1093 condition for setting the DTC

DTCs P0087, P0091, P0092, P0192, P0193, P0201 - P0204, P1261, P1262, P2146, and P2149 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
The suction control valve indicates a fuel flow rate higher than a certain level.
The ECM detects that the common rail (fuel rail) pressure is lower than the desired fuel pressure by 50 MPa (7,250 psi) or more for 5 seconds or more.

3. DTC P1093 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The fuel flow rate is limited.
The EGR control is disabled.

DTC P1112 (Flash Code 295)
Boost Temperature Sensor Circuit Low Input

1. DTC P1112 description of DTC

The boost temperature sensor is installed in the intake chamber. The boost temperature sensor changes its resistance according to the temperature in the intake chamber. The resistance becomes lower when the intake air temperature is high, and higher when the intake air temperature is low. The ECM applies 5 V to the boost temperature sensor through the pull-up resistor, and calculates the boost temperature from changes in the voltage. This value is used in various control mechanisms, such as for fuel injection control. The voltage becomes lower when resistance is small (temperature is high), and higher when resistance is large (temperature is low).

2. DTC P1112 condition for setting the DTC

DTC P060B is not set.
The predetermined time has passed after starting the engine, and the engine speed and fuel injection quantity are more than the predetermined levels for longer than the predetermined time.
The ECM detects that the boost temperature sensor voltage is 0.1V or less for 4 seconds or more.

3. DTC P1112 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost temperature value is assumed.

DTC P1113 (Flash Code 295)
Boost Temperature Sensor Circuit High Input

1. DTC P1113 description of DTC

The boost temperature sensor is installed in the intake chamber. The resistance changes according to the temperature in the intake chamber. The resistance becomes lower when the intake air temperature is high, and higher when the intake air temperature is low. The ECM applies 5 V to the boost temperature sensor through the pull-up resistor, and calculates the boost temperature from changes in the voltage. This value is used in various control mechanisms, such as for fuel injection control. The voltage becomes lower when resistance is small (temperature is high), and higher when resistance is large (temperature is low).

2. DTC P1113 condition for setting the DTC

DTCs P0112, P0113, and P060B are not set.
The battery voltage is between 18 - 32 V.
The engine speed and the fuel injection quantity are more than the predetermined levels for longer than the predetermined time.
The ECM detects that the boost temperature sensor voltage is 4.94 V or more for 4 seconds or more.

3. DTC P1113 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default boost temperature value is assumed.

DTC P1261 (Flash Code 34)
Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P1261 description of DTC

The charge voltage circuit inside the ECM increases the voltage applied to the injector. The charge voltage circuit is divided into two banks: common power supply 1 and common power supply 2. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
If an open circuit occurs in the injector charge voltage circuit of common power supply 1 or the common power supply 1 of the ECM, the DTC is set.

2. DTC P1261 condition for setting the DTC

The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects an open circuit or short circuit in the common power supply 1 injector charge voltage circuit in the ECM for 2 seconds or more.

3. DTC P1261 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.
The fuel injection for the No. 1 and No. 4 cylinders is disabled.

DTC P1262 (Flash Code 34)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P1262 description of DTC

The charge voltage circuit inside the ECM increases the voltage applied to the injector. The charge voltage circuit is divided into two banks: common power supply 1 and common power supply 2. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
If an open circuit occurs in the injector charge voltage circuit of common power supply 2 or the common power supply 2 of the ECM, the DTC is set.

2. DTC P1262 condition for setting the DTC

The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects an open circuit or short circuit in the common power supply 2 injector charge voltage circuit in the ECM for 2 seconds or more.

3. DTC P1262 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.
The fuel injection for the No. 2 and No. 3 cylinders is disabled.

DTC P1293 (Flash Code 221)
Fuel Filter Pressure Sensor Circuit Low

1. DTC P1293 description of DTC

The fuel filter pressure sensor detects the vacuum in the fuel filter. The fuel filter pressure sensor is installed on the fuel filter. The output voltage becomes lower when the vacuum in the fuel filter is smaller and becomes higher when the vacuum is larger. The output voltage of the fuel filter pressure sensor changes as the vacuum in the fuel filter changes. The ECM reads this change in output voltage, converts it to fuel vacuum, and uses it for control.

2. DTC P1293 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ECM detects that the fuel filter pressure sensor voltage is 0.1 V or less for 4 seconds.

3. DTC P1293 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default fuel filter pressure value is assumed.

DTC P1294 (Flash Code 221)
Fuel Filter Pressure Sensor Circuit High

1. DTC P1294 description of DTC

The fuel filter pressure sensor detects the vacuum in the fuel filter. The fuel filter pressure sensor is installed on the fuel filter. The output voltage becomes lower when the vacuum in the fuel filter is smaller and becomes higher when the vacuum is larger. The output voltage of the fuel filter pressure sensor changes as the vacuum in the fuel filter changes. The ECM reads this change in output voltage, converts it to fuel vacuum, and uses it for control.

2. DTC P1294 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ECM detects that the fuel filter pressure sensor voltage is 4.9 V or more for 4 seconds.

3. DTC P1294 action taken when the DTC sets

If it is detected for 2 consecutive ignition cycles, the failure is indicated in the monitor on the machine, or the diagnosis light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

A default fuel filter pressure value is assumed.

DTC P1404 (Flash Code 45)
Exhaust Gas Recirculation 1 Closed Position Performance

1. DTC P1404 description of DTC

The ECM controls the opening and closing of the EGR valve based on the driving condition of the engine by controlling the EGR solenoid. The EGR opening angle is detected by the position sensor and is sent to the ECM.
For a closed position error DTC, if the ECM detects that the actual EGR valve opening angle is larger than a certain amount, this DTC is set.
For a learned position error DTC, if the ECM detects a difference between the learned closed position and the actual closed position, the DTC is set.

2. DTC P1404 condition for setting the DTC

The ECM detects that the EGR learned closed position is not within the predetermined range when the ignition switch is turned OFF.

3. DTC P1404 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.

DTC P1606 (Flash Code 51)
SW-IC 1 Internal failure,Communication line failure

1. DTC P1606 description of DTC

This diagnosis applies to the SW-IC1 inside the ECM.

2. DTC P1606 condition for setting the DTC

Note：

- SW-IC internal malfunction

A malfunction in the SW-IC circuit was detected.

Note：

- SW-IC communication circuit malfunction

A communication error with the SW-IC was detected.

3. DTC P1606 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

Set the SW-IC switch status as the default action for the following switches.
Air cleaner switch, diagnostic switch, memory clear switch, mode map switch 0, mode map switch 2, idling control switch, idling control UP switch, ignition start switch

DTC P160B (Flash Code 36)
AD-IC failure

1. DTC P160B description of DTC

   This diagnosis applies to the AD-IC inside the ECM.

2. DTC P160B condition for setting the DTC

   The battery voltage is between 16 - 32 V.
   The ECM detects a malfunction in the AD-IC circuit for 2 seconds or more.

3. DTC P160B action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：

   - Depending on the machine manufacturer, the failure indication may not be shown.

   The following assumes a default value.
   Fuel filter pressure
   Barometric pressure
   IMT
   Coolant temperature
   Fuel temperature
   Boost temperature

DTC P1621 (Flash Code 54)
Control Module Long Term Memory Performance

1. DTC P1621 description of DTC

   This diagnosis applies to the microprocessor inside the ECM.

2. DTC P1621 condition for setting the DTC

   The ignition switch is ON.
   The ECM detects that the calculated checksum does not agree with the EEPROM internal registered checksum.

3. DTC P1621 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：

   - Depending on the machine manufacturer, the failure indication may not be shown.

DTC P1655 (Flash Code 59)
Sensor Reference Voltage 4 Circuit

1. DTC P1655 description of DTC

The ECM supplies 5 V power to the following sensors through power supply circuit 4.
CKP sensor
The ECM monitors the voltage of 5 V power supply circuit 4, and if it detects that the voltage is abnormally low or high, the DTC is set.

2. DTC P1655 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 16 - 32 V.
The ignition switch is ON.
The ECM detects that the voltage of 5 V power supply circuit 4 is 4.5 V or less, or 5.5 V or more.

3. DTC P1655 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.
The following assumes a default value.
CMP
Fuel temperature
Coolant temperature

DTC P20DE (Flash Code 221)
Fuel Filter Pressure Too Low 1

1. DTC P20DE description of DTC

The fuel filter clogging sensor detects the vacuum in the fuel filter. The fuel filter clogging sensor is installed on the fuel filter. The output voltage of the fuel filter clogging sensor changes as the vacuum in the fuel filter changes (the output voltage is low when the vacuum in the fuel filter is small, and becomes higher as the vacuum becomes larger). The ECM reads this change in output voltage, converts it to fuel vacuum, and uses it for control.

2. DTC P20DE condition for setting the DTC

DTCs P0182, P0183, and P2540 are not set.
The fuel temperature is 5°C or more.
The engine has been running for 3 minutes or more.
The fuel filter clogging sensor pressure is lower than -30 kPa {0.31 kgf/cm2 / 4 psi} for 60 seconds or more.

3. DTC P20DE action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC P2146 (Flash Code 158)
Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P2146 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from various sensors. The injector charge voltage circuits of common power supplies 1 and 2 supply high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
If an open circuit in the injector charge voltage circuit for common power supply 1 or 2 occurs, or a short to GND or a short to the voltage circuit occurs, the DTC is set, corresponding to a defective injector common power supply circuit.
Also, if the injector solenoid control circuit is shorted to GND, the DTC is set.

2. DTC P2146 condition for setting the DTC

DTCs P0201 and P0204 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the injector charge voltage circuit for common power supply 1 has an open circuit, is shorted to GND or shorted to the voltage circuit, or that the injector solenoid coil control circuit for cylinder No. 1 or No. 4 is shorted to GND, for 3 seconds or more.

3. DTC P2146 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.
The fuel injection for the No. 1 and No. 4 cylinders is disabled.

DTC P2149 (Flash Code 159)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P2149 description of DTC

The ECM calculates the optimum fuel injection ON time based on the data sent from sensors. The injector charge voltage circuits of common power supplies 1 and 2 supply high voltage, while the ECM grounds the injector solenoid control circuit and drives the injectors of each cylinder. Common power supply 1 serves the injectors of the No. 1 and No. 4 cylinders, while common power supply 2 serves the injectors of the No. 2 and No. 3 cylinders.
If an open circuit in the injector charge voltage circuit for common power supply 1 or 2 occurs, or a short to GND or a short to the voltage circuit occurs, DTC P2149 is set, corresponding to a defective injector common power supply circuit.
Also, if the injector solenoid control circuit is shorted to GND, the DTC is set.

2. DTC P2149 condition for setting the DTC

DTCs P0202 and P0203 are not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The engine is running.
The ECM detects that the injector charge voltage circuit for common power supply 2 has an open circuit, is shorted to GND or shorted to the voltage circuit, or that the injector solenoid coil control circuit for cylinder No. 2 or No. 3 is shorted to GND, for 3 seconds or more.

3. DTC P2149 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.
The fuel injection for the No. 2 and No. 3 cylinders is disabled.

DTC P2228 (Flash Code 71)
Barometric Pressure Circuit Low

1. DTC P2228 description of DTC

The barometric pressure sensor changes the signal voltage according to changes in the barometric pressure. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Barometric pressure sensor signal circuit
The barometric pressure sensor sends signals related to barometric pressure change to the ECM. The ECM detects low signal voltage at high altitudes and with low barometric pressure. The ECM detects high signal voltage with high barometric pressure. The ECM uses this voltage signal to adjust the fuel injection quantity and injection timing and make altitude correction. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P2228 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the barometric pressure sensor signal voltage is 0.5 V or less for 5 seconds.

3. DTC P2228 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note：

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.
A default barometric pressure value is assumed.

DTC P2229 (Flash Code 71)
Barometric Pressure Circuit High

1. DTC P2229 description of DTC

The barometric pressure sensor changes the signal voltage according to changes in the barometric pressure. The sensor has the following circuits.
5 V power supply circuit
GND circuit
Barometric pressure sensor signal circuit
The barometric pressure sensor sends signals related to barometric pressure change to the ECM. The ECM detects low signal voltage at high altitudes and with low barometric pressure. The ECM detects high signal voltage with high barometric pressure. The ECM uses this voltage signal to adjust the fuel injection quantity and injection timing and make altitude correction. If the ECM detects an abnormally high signal voltage, the DTC is set.

2. DTC P2229 condition for setting the DTC

DTC P060B is not set.
The battery voltage is between 18 - 32 V.
The ignition switch is ON.
The ECM detects that the barometric pressure sensor signal voltage is 4.0 V or more for 5 seconds.

3. DTC P2229 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The fuel injection quantity is limited.
The EGR control is disabled.
A default barometric pressure value is assumed.

DTC P2540 (Flash Code 221)
Fuel Filter Pressure Too Low 2

1. DTC P2540 description of DTC

The fuel filter clogging sensor detects the vacuum in the fuel filter. The fuel filter clogging sensor is installed on the fuel filter. The output voltage of the fuel filter clogging sensor changes as the vacuum in the fuel filter changes (the output voltage is low when the vacuum in the fuel filter is small, and becomes higher as the vacuum becomes larger). The ECM reads this change in output voltage, converts it to fuel vacuum, and uses it for control.

2. DTC P2540 condition for setting the DTC

DTCs P0182 and P0183 are not set.
The fuel temperature is 5°C {41°F} or more.
The engine has been running for 3 minutes or more.
The fuel filter clogging sensor pressure is lower than -38 kPa {0.39 kgf/cm2 / 6 psi} for 60 seconds or more.

3. DTC P2540 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

DTC U0073 (Flash Code 84)
CAN-Bus Malfunction (J1939)

1. DTC U0073 description of DTC

   The ECM communicates with the control unit of the machine via the CAN communication circuit. The ECM outputs data via the CAN-High circuit and inputs data from other ECUs via the CAN-Low circuit. CAN communication is continuously performed at a constant rate and the data output count and input count are always identical. The ECM sets a DTC when CAN communication fails.

2. DTC U0073 condition for setting the DTC

   The battery voltage is 22 V or more.
   The ignition switch is ON.
   The ECM detects a failure in the CAN communication circuit.

3. DTC U0073 action taken when the DTC sets

   Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

   Note：

   - Depending on the machine manufacturer, the failure indication may not be shown.

DTC U0101 (Flash Code 85) Lost Communication with Transmission Control Module

1. DTC U0101 description of DTC

The ECM communicates with the control unit of the machine via the CAN communication circuit. The ECM outputs data via the CAN-High circuit and inputs data from other ECUs via the CAN-Low circuit. CAN communication is continuously performed at a constant rate and the data output count and input count are always identical. The ECM sets a DTC if CAN communication with the control unit of the machine is lost.

2. DTC U0101 condition for setting the DTC

The battery voltage is 22 V or more.
The ECM detects that CAN data reception is not established for 5 seconds or more.

3. DTC U0101 action taken when the DTC sets

Failure is indicated in the monitor on the machine, or the diagnostic light illuminates.

Note :

- Depending on the machine manufacturer, the failure indication may not be shown.

The EGR control is disabled.

DTC mapping table

1. DTC mapping table

SPN-FMI	P code	
636-7	P0016	Crankshaft position - camshaft position correlation error
633-7	P0087	Fuel rail system pressure low pressure malfunction
157-15	P0089	Fuel rail pressure regulator control characteristic malfunction
1347-4	P0091	Fuel rail pressure regulator system low input
1347-3	P0092	Fuel rail pressure regulator control system high input
1239-1	P0093	Fuel system leakage detection
172-4	P0112	Intake air temperature sensor system low input
172-3	P0113	Intake air temperature sensor system high input
110-4	P0117	Engine coolant temperature sensor system low input
110-3	P0118	Engine coolant temperature sensor system high input
174-4	P0182	Fuel temperature sensor system low input
174-3	P0183	Fuel temperature sensor system high input
157-4	P0192	Fuel rail pressure sensor system low input
157-3	P0193	Fuel rail pressure sensor system high input
651-5	P0201	Injector system malfunction No. 1 cylinder
652-5	P0202	Injector system malfunction No. 2 cylinder
653-5	P0203	Injector system malfunction No. 3 cylinder
654-5	P0204	Injector system malfunction No. 4 cylinder
110-0	P0217	Engine coolant high temperature malfunction
190-0	P0219	High engine speed malfunction
102-4	P0237	Turbocharger boost sensor circuit low input
102-3	P0238	Turbocharger boost sensor circuit high input
723-2	P0335	Crankshaft position sensor system malfunction
723-2	P0336	Crankshaft position sensor system characteristic malfunction
636-2	P0340	CMP sensor system malfunction
676-5	P0380	Glow plug system malfunction
10002-2	P0404	EGR 1 control system characteristic malfunction
10001-2	P0409	EGR 1 position sensor system malfunction
1131-3	P041C	IMT sensor system high input
1131-4	P041D	IMT sensor system low input
100-1	P0521	Engine oil low pressure malfunction
100-4	P0522	Engine oil pressure sensor malfunction (low voltage)
100-3	P0523	Engine oil pressure sensor malfunction (high voltage)
158-3	P0563	System voltage high input
628-2	P0601	Control module memory check sum error
10032-2	P0602	Control module program malfunction error
10033-2	P0604	Control module RAM malfunction random access memory error
1077-2 10007-2	P0606	Control module processor error
10008-2	P060B	Control module A/D conversion processor characteristic error
677-5	P0615	Starter relay system malfunction
1079-2	P0641	Sensor voltage system malfunction (Reference 1)
1080-2	P0651	Sensor voltage system malfunction (Reference 2)
1485-5	P0685	ECM main relay control system low input

1485-6	P0687	ECM main relay control system high input
10009-2	P0697	Sensor voltage system malfunction (Reference 3)
10050-2	P06AF	Injector IC malfunction
10052-2	P06AF	Injector IC checksum malfunction
10051-2	P06AF	Injector IC communication malfunction
1239-17	P1093	Fuel rail pressure low pressure malfunction
105-4	P1112	Boost temperature sensor malfunction (low voltage)
105-3	P1113	Boost temperature sensor malfunction (high voltage)
10005-1	P1261	Fuel injector supply voltage system malfunction, group 1
10006-1	P1262	Fuel injector supply voltage system malfunction, group 2
1381-4	P1293	Fuel filter pressure sensor system low input
1381-3	P1294	Fuel filter pressure sensor system high input
10001-13	P1404	EGR 1 closed position characteristic malfunction
10046-2	P1606	SW-IC1 internal malfunction
10048-2	P1606	SW-IC1 communication circuit malfunction
10045-2	P160B	AD-IC malfunction
10013-2	P1621	Control module EEPROM/HD EEPROM malfunction
10010-2	P1655	Sensor voltage system malfunction (Reference 4)
1381-17	P20DE	Fuel filter clogging malfunction (First stage)
10003-2	P2146	Fuel injector supply voltage system malfunction, group 1
10004-2	P2149	Fuel injector supply voltage system malfunction, group 2
108-4	P2228	Barometric pressure sensor system low input
108-3	P2229	Barometric pressure sensor system high input
1381-1	P2540	Fuel filter clogging malfunction (Second stage)
639-19	U0073	CAN bus malfunction (J1939)
639-2	U0101	TCM communication malfunction

Engine Control

Engine Control (4LE2 (12V))

Table of Contents

DTC P0016 (Flash Code 16)
Crankshaft Position - Camshaft Position Correlation

1. DTC P0016 priority DTC

   DTC P0335

   DTC P0336

   DTC P0340

2. DTC P0016 diagnostics
   1. Inspect the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".
   2. If a problem is found, replace the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".
   3. Inspect the CMP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor inspection*".
   4. If a problem is found, replace the CMP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor removal*".

      Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor installation*".
   5. Inspect the sensor rotor.

      Note :
      - The sensor rotor should not be damaged.
      - The sensor rotor should not be improperly installed.
   6. If a problem is found, replace the sensor rotor.
   7. Inspect the camshaft gear.

      Note :
      - The camshaft gear should not be damaged.
      - The camshaft gear should not be improperly installed.
   8. If a problem is found, repair the camshaft gear.
3. DTC P0016 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.

      Note :
      - If the engine does not start, crank the engine for 10 seconds.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0087 (Flash Code 225)
Fuel Rail/System Pressure - Too Low

1. DTC P0087 priority DTC

   DTC P0089

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P0087 diagnostics

   1. Start the engine.
   2. Rev the engine several times while observing the DTC information with a trouble diagnosis scan tool.
   3. Observe the DTC information for DTC P0087.
   4. If DTC P0087 is not set, replace the fuel filter.

      Note：

      ・ An intermittent problem due to foreign material in the fuel is suspected.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".
   5. Turn OFF the ignition switch.
   6. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time： 2 min
   7. Turn ON the ignition switch.
   8. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

      voltage： 0.9 to 1.0 V
   9. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. Inspect each circuit for high resistance.
   14. If a problem is found, repair the circuit.
   15. If the harness connector and each circuit are normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

       Note：

       ・ Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.
   16. If the Fuel Rail Pressure (FRP) Sensor display is within the standard range, start the engine.
   17. Perform the injector stop test with a trouble diagnosis scan tool.
   18. Command each injector OFF and verify the engine speed changes for each injector.
   19. If there are any injectors that do not change the engine speed when instructed OFF, replace the applicable injector.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".
   20. If the injector has been replaced, set the injector ID code on the ECM.
   21. Inspect the fuel system between the fuel tank and the fuel supply pump for clogging.
   22. If a problem is found, repair the clogging in the fuel system.
   23. Inspect the fuel hose between the fuel tank and the fuel supply pump for cuts and cracks.
   24. If a problem is found, replace the fuel hose.

       Note：

       ・ The fuel hose from the fuel tank to the fuel supply pump becomes slightly vacuumed when the engine is running.

       ・ If the fuel hose is not connected securely, air may enter.

       ・ If the engine speed or the engine load increases when air has entered the fuel system, fluctuation in the common rail (fuel rail) pressure occurs, and DTC P0087 may be set.

25. Check that an appropriate clamp is used between the fuel tank and the fuel supply pump.
26. If a problem is found, replace the clamp.
27. Operate the priming pump until it becomes heavy.

Note :

- When a leakage exists in the fuel system between the priming pump and the fuel supply pump, the pressing weight of the priming pump does not become heavy.

28. Start the engine.
29. Inspect the high-pressure side of the fuel system and check for a fuel leak between the fuel supply pump and the common rail (fuel rail).

Note :

- Fuel may leak under the cylinder head cover from the inlet of the high pressure hose.
- If the fuel leaks under the cylinder head cover, the engine oil level will increase.
- Inspect for a fuel leakage into the engine oil.

30. If a fuel leakage is found, repair.
31. Turn OFF the ignition switch.
32. Inspect the fuel tank vent hose.
33. If a problem is found, repair the vent hose.
34. Check for foreign material in the fuel tank or for foreign material that can cause fuel clogging.
35. If a problem is found, repair.
36. Turn OFF the ignition switch.
37. Inspect for poor connections at the suction control valve harness connector.
38. If a problem is found, repair the harness connector.
39. Inspect for poor connections at the ECM harness connector.
40. If a problem is found, repair the harness connector.
41. Inspect each circuit for high resistance.
42. If a problem is found, repair the circuit.
43. If the suction control valve harness connector and the ECM harness connector are normal and there is no high resistance in each circuit, replace the fuel supply pump and the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

Note :

- When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

3. DTC P0087 confirm resolution

1. Clear the DTC with a trouble diagnosis scan tool.
2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0089 (Flash Code 151)
Fuel Pressure Regulator Performance

1. DTC P0089 priority DTC

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P0089 diagnostics

   1. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time : 2 min

   2. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

      values : 0.9 to 1.0 V

   3. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   4. If a problem is found, repair the harness connector.
   5. Inspect for poor connections at the ECM harness connector.
   6. If a problem is found, repair the harness connector.
   7. Inspect each circuit for high resistance.
   8. If a problem is found, repair the circuit.
   9. If the harness connector and each circuit are normal, replace the FRP sensor.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

      Note :

      - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   10. Inspect for poor connections at the suction control valve harness connector.
   11. If a problem is found, repair the harness connector.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. Inspect each circuit for high resistance.
   15. If a problem is found, repair the circuit.
   16. Turn OFF the ignition switch for 30 seconds or more.
   17. Start the engine.
   18. Rev the engine several times while observing the Actual Fuel Rail Pressure display on the trouble diagnosis scan tool.
   19. Observe the Actual Fuel Rail Pressure display on the trouble diagnosis scan tool, and verify that it is within the specified range at a sufficient rate.

       Specified value : (-5) - 5 MPa

       Note :

       - If possible, compare with other machines with the same engine equipped.

   20. If the reading is within the specified range, replace the fuel filter.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

   21. If the reading is outside the specified range, replace the fuel supply pump and the fuel filter.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

       Note :

       - When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

3. DTC P0089 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.

4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0091 (Flash Code 247)
Fuel Pressure Regulator Control Circuit Low

1. DTC P0091 diagnostics
   1. Observe the SCVRPCV Drive Electric Current Feedback display on the trouble diagnosis scan tool.

      current： 300 to 900 mA
   2. If the reading is more than or equal to the specified value, inspect the High side circuit between the ECM and the suction control valve for a short to the battery or a short to the ignition power supply.

      Note：
      - When the High side circuit is shorted to voltage, the engine stalls and does not start.
   3. If a problem is found, repair the High side circuit.
   4. If the reading is within the specified range, inspect the Low side circuit between the ECM and the suction control valve for a short to GND.

      Note：
      - When the Low side circuit is shorted to GND, DTC P0091 may not be set.
      - When the Low side circuit is shorted to GND, the engine stalls and does not start.
   5. If a problem is found, repair the Low side circuit.
   6. Turn OFF the ignition switch for 30 seconds or more.
   7. Disconnect the harness connector from the suction control valve.
   8. Connect a test lamp between the suction control valve High side circuit and a known good GND.
   9. Turn ON the ignition switch.
   10. Verify that the test lamp illuminates and then goes OFF.
   11. If it does not turn OFF, inspect the High side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
       - There should be no short to the Low side circuit.
   12. If a problem is found, repair the High side circuit.
   13. Turn OFF the ignition switch for 30 seconds or more.
   14. Connect a test lamp between the suction control valve Low side circuit and the battery power supply.
   15. Turn ON the ignition switch.
   16. Verify that the test lamp illuminates and then goes OFF.
   17. If it does not turn OFF, inspect the Low side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to the battery or the ignition power supply.
   18. If a problem is found, repair the Low side circuit.
   19. Inspect for poor connections at the suction control valve harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the suction control valve.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve installation*".
   22. Inspect for poor connections at the ECM harness connector.
   23. If a problem is found, repair the harness connector.
   24. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   25. Set the injector ID code on the ECM.
2. DTC P0091 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0092 (Flash Code 247)
Fuel Pressure Regulator Control Circuit High

1. DTC P0092 diagnostics
   1. Observe the SCVRPCV Drive Electric Current Feedback display on the trouble diagnosis scan tool.

      current： 300 to 900 mA
   2. If the reading is more than or equal to the specified value, inspect the High side circuit between the ECM and the suction control valve for a short to the battery or a short to the ignition power supply.

      Note：
      - When the High side circuit is shorted to voltage, the engine stalls and does not start.
   3. If a problem is found, repair the High side circuit.
   4. If the reading is within the specified range, inspect the Low side circuit between the ECM and the suction control valve for a short to GND.

      Note：
      - When the Low side circuit is shorted to GND, DTC P0092 may not be set.
      - When the Low side circuit is shorted to GND, the engine stalls and does not start.
   5. If a problem is found, repair the Low side circuit.
   6. Turn OFF the ignition switch for 30 seconds or more.
   7. Disconnect the harness connector from the suction control valve.
   8. Connect a test lamp between the suction control valve High side circuit and a known good GND.
   9. Turn ON the ignition switch.
   10. Verify that the test lamp illuminates and then goes OFF.
   11. If it does not turn OFF, inspect the High side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
       - There should be no short to the Low side circuit.
   12. If a problem is found, repair the High side circuit.
   13. Turn OFF the ignition switch for 30 seconds or more.
   14. Connect a test lamp between the suction control valve Low side circuit and the battery power supply.
   15. Turn ON the ignition switch.
   16. Verify that the test lamp illuminates and then goes OFF.
   17. If it does not turn OFF, inspect the Low side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to the battery or the ignition power supply.
   18. If a problem is found, repair the Low side circuit.
   19. Inspect for poor connections at the suction control valve harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the suction control valve.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve installation*".
   22. Inspect for poor connections at the ECM harness connector.
   23. If a problem is found, repair the harness connector.
   24. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   25. Set the injector ID code on the ECM.
2. DTC P0092 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0093 (Flash Code 227)
Fuel System Leak Detected

1. DTC P0093 priority DTC

   DTC P0087

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P0093 diagnostics

   1. Inspect the high pressure side between the fuel supply pump and the injector for a fuel leakage.

      Note：

      - There should be no fuel leakage from the fuel supply pump.
      - There should be no fuel leakage from the common rail (fuel rail).
      - There should be no fuel leakage from the pressure limiter valve.
      - There should be no fuel leakage from the FRP sensor.
      - There should be no fuel leakage from the fuel pipe between the fuel supply pump and the common rail (fuel rail).
      - There should be no fuel leakage from the fuel pipe between the common rail (fuel rail) and the injector.
      - There should be no fuel leakage from the sleeve nut of the fuel pipe.

   2. If a fuel leakage is found, repair.

      Note：

      - The fuel may leak under the cylinder head cover from the inlet of the high pressure pipe.
      - If the fuel leaks under the cylinder head cover, the engine oil level will increase.
      - Inspect for a fuel leakage into the engine oil.
      - Remove and inspect the high pressure pipe joints connected to the injectors to verify that fuel is not leaking from the sleeve nuts.
      - If contact is being made with foreign material, replace the injector and the high pressure pipe.

   3. Remove each glow plug from the cylinder head assembly.

      Refer to "*1.Engine 1J.Electrical(4LE2) Glow plug removal*".

   4. Inspect for fuel leakage into the combustion chamber.
   5. Inspect for a cylinder that is leaking fuel into the combustion chamber.
   6. If a fuel leakage is found, replace the applicable injector.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   7. If the injector has been replaced, set the injector ID code on the ECM.
   8. Turn OFF the ignition switch.
   9. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time：2 min

   10. Turn ON the ignition switch.
   11. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

       voltage：0.9 to 1.0 V

   12. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   13. If a problem is found, repair the harness connector.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. Inspect each circuit for high resistance.
   17. If a problem is found, repair the circuit.
   18. If the harness connector and each circuit are normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

Note：

- Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

19. If the Fuel Rail Pressure (FRP) Sensor display is within the standard range, start the engine.
20. Perform the injector stop test with a trouble diagnosis scan tool.
21. Command each injector OFF and verify the engine speed changes for each injector.
22. If there are any injectors that do not change the engine speed when instructed OFF, replace the applicable injector.

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

23. If the injector has been replaced, set the injector ID code on the ECM.
24. Inspect the fuel system between the fuel tank and the fuel supply pump for clogging.
25. If a problem is found, repair clogging.
26. Inspect the fuel hose in the fuel system between the fuel tank and the fuel supply pump for cuts or cracks.
27. If a problem is found, replace the fuel hose.

Note：

- The fuel hose between the fuel tank and the supply pump becomes slightly vacuumed when the engine is running.
- If the fuel hose is not connected securely, air may enter.
- If the engine speed or the engine load increases when air has entered the fuel system, fluctuation in the common rail (fuel rail) pressure occurs, and DTC P0093 may be set.

28. Check that an appropriate clamp is used between the fuel tank and the fuel supply pump.
29. If a problem is found, replace the clamp with a proper one.
30. Operate the priming pump until it becomes heavy.

Note：

- When a leakage exists in the fuel system between the priming pump and the fuel supply pump, the pressing weight of the priming pump does not become heavy.

31. Start the engine.
32. Inspect the high-pressure side of the fuel system and check for a fuel leak between the fuel supply pump and the common rail (fuel rail).

Note：

- Fuel may leak under the cylinder head cover from the inlet of the high pressure hose.
- If the fuel leaks under the cylinder head cover, the engine oil level will increase.
- Inspect for a fuel leakage into the engine oil.

33. If a fuel leakage is found, repair.
34. Turn OFF the ignition switch.
35. Inspect the fuel tank vent hose.
36. If a problem is found, repair the vent hose.
37. Check for foreign material in the fuel tank or for foreign material that can cause fuel clogging.
38. If a problem is found, repair.
39. Turn OFF the ignition switch.
40. Inspect for poor connections at the suction control valve harness connector.
41. If a problem is found, repair the harness connector.
42. Inspect for poor connections at the ECM harness connector.
43. If a problem is found, repair the harness connector.
44. Inspect each circuit for high resistance.
45. If a problem is found, repair the circuit.
46. If the suction control valve harness connector and the ECM harness connector are normal and there is no high resistance in each circuit, replace the fuel supply pump and the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

Note：

- When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

3. DTC P0093 confirm resolution

1. Clear the DTC with a trouble diagnosis scan tool.
2. Turn OFF the ignition switch for 30 seconds or more.

3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0097 (Flash Code 214)
Intake Manifold Temperature Sensor Circuit Low

1. DTC P0097 priority DTC

   DTC P0697

2. DTC P0097 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IMT sensor.
   3. Observe the manifold temperature sensor 5 V display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the IMT sensor.

      Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor removal*".

      Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor installation*".

   5. Inspect the signal circuit between the ECM and IMT sensor for a short to the GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P0097 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0098 (Flash Code 214)
Intake Manifold Temperature Sensor Circuit High

1. DTC P0098 priority DTC

   DTC P0697

2. DTC P0098 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IMT sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the IMT sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If it is at or above the standard value, inspect to see if there is a short circuit to the battery or ignition power supply with the signal circuit between the ECM and the IMT sensor.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the IMT sensor signal circuit and the GND circuit.
   8. Observe the manifold temperature sensor 5 V display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If it is at or below the standard value, inspect to see if there is a short circuit to the 5 V power supply circuit with the signal circuit between the ECM and IMT sensor.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the IMT sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the IMT sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor installation*".

   14. Connect a fused jumper wire between the IMT sensor signal circuit and a known good GND.
   15. Observe the manifold temperature sensor 5 V display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If it is at or below the standard value, inspect to see if there is an open circuit or high resistance with the GND circuit between the ECM and IMT sensor.

       Note :
       - The IMT sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the IMT sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0098 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.

      Note :
      - Run the engine for 3 minutes or longer.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0112 (Flash Code 22)
Intake Air Temperature Sensor Circuit Low

1. DTC P0112 priority DTC

   DTC P0641

2. DTC P0112 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IAT sensor.
   3. Observe the Intake Air Temperature Sensor display on the trouble diagnosis scan tool.

      values : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the IAT sensor.
   5. Inspect the signal circuit between the ECM and the IAT sensor for a short to GND.
   6. If a problem is found, repair the signal circuit.
   7. Turn OFF the ignition switch.
   8. Disconnect the harness connector from the ECM.
   9. Inspect for poor connections at the ECM harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   12. Set the injector ID code on the ECM.

3. DTC P0112 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0113 (Flash Code 22)
Intake Air Temperature Sensor Circuit High

1. DTC P0113 priority DTC

   DTC P0641

2. DTC P0113 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IAT sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the IAT sensor signal circuit and a known good GND.

      values : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the IAT sensor.

      Note :

      - There should be no short to the battery or the ignition power supply.

   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the IAT sensor signal circuit and the GND circuit.
   8. Observe the Intake Air Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the IAT sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the IAT sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the IAT sensor.
   14. Connect a fused jumper wire between the IAT sensor signal circuit and a known good GND.
   15. Observe the intake air temperature sensor display on the trouble diagnosis scan tool.

       values : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and the IAT sensor for an open circuit or high resistance.

       Note :

       - The IAT sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the IAT sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0113 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0117 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit Low

1. DTC P0117 priority DTC

   DTC P0697

2. DTC P0117 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the engine coolant temperature sensor.
   3. Observe the Coolant Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the engine coolant temperature sensor.

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor removal*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor installation*".

   5. Inspect the signal circuit between the ECM and engine coolant temperature sensor for a short to the GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P0117 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0118 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit High

1. DTC P0118 priority DTC

   DTC P0697

2. DTC P0118 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the engine coolant temperature sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the engine coolant temperature sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the engine coolant temperature sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the engine coolant temperature sensor signal circuit and the GND circuit.
   8. Observe the Coolant Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the engine coolant temperature sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the engine coolant temperature sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the engine coolant temperature sensor.

       Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor removal*".

       Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor installation*".

   14. Connect a fused jumper wire between the engine coolant temperature sensor signal circuit and a known good GND.
   15. Observe the coolant temperature sensor display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the engine coolant temperature sensor GND circuit for an open circuit or high resistance.

       Note :

       - The engine coolant temperature sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the engine coolant temperature sensor signal circuit for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0118 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0182 (Flash Code 211)
Fuel Temperature Sensor Circuit Low

1. DTC P0182 priority DTC

   DTC P1655

2. DTC P0182 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the fuel temperature sensor.
   3. Observe the Fuel Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the fuel temperature sensor.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

      Note :

      - Do not replace the fuel temperature sensor separately. If a problem is found, replace the fuel supply pump.

   5. Inspect the signal circuit between the ECM and fuel temperature sensor for a short to GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P0182 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0183 (Flash Code 211)
Fuel Temperature Sensor Circuit High

1. DTC P0183 priority DTC

   DTC P1655

2. DTC P0183 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the fuel temperature sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the fuel temperature sensor signal circuit and a known good GND.

      values： 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the fuel temperature sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the fuel temperature sensor signal circuit and the GND circuit.
   8. Observe the Fuel Temperature Sensor display on the trouble diagnosis scan tool.

      voltage： 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the fuel temperature sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the fuel temperature sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the fuel temperature sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

       Note：

       - Do not replace the fuel temperature sensor separately. If a problem is found, replace the fuel supply pump.

   14. Connect a fused jumper wire between the fuel temperature sensor signal circuit and a known good GND.
   15. Observe the Fuel Temperature Sensor display on the trouble diagnosis scan tool.

       voltage： 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and the fuel temperature sensor for an open circuit or high resistance.

       Note：

       - The fuel temperature sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the fuel temperature sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0183 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.

      Note：

      - Run the engine for 3 minutes or longer.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0192 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit Low

1. DTC P0192 priority DTC

   DTC P0641

2. DTC P0192 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the FRP sensor.
   3. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the FRP sensor for a short to GND.
   5. If a problem is found, repair the signal circuit.
   6. Measure the voltage between the FRP sensor 5 V power supply circuit and a known good GND.

      voltage : 4.5 V

   7. If the reading is more than or equal to the specified value, inspect for poor connections at the FRP sensor harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the FRP sensor.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

      Note :

      - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   10. Inspect the 5 V power supply circuit between the ECM and the FRP sensor for an open circuit or high resistance.

       Note :

       - The FRP sensor shares the 5 V power supply circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   11. If a problem is found, repair the 5 V power supply circuit.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   15. Set the injector ID code on the ECM.

3. DTC P0192 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0193 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit High

1. DTC P0193 priority DTC

   DTC P0641

2. DTC P0193 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the FRP sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the FRP sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the FRP sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Measure the voltage between the FRP sensor signal circuit and a known good GND.

      voltage : 4.5 V

   8. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the FRP sensor for a short to the 5 V power supply circuit.
   9. If a problem is found, repair the signal circuit.
   10. Connect a fused jumper wire between the FRP sensor signal circuit and the GND circuit.
   11. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   12. If the reading is less than or equal to the specified value, inspect for poor connections at the FRP sensor harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

       Note :

       - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   15. Inspect the GND circuit between the ECM and the FRP sensor for an open circuit or high resistance.

       Note :

       - The FRP sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   16. If a problem is found, repair the GND circuit.
   17. Inspect the signal circuit between the ECM and the FRP sensor for an open circuit or high resistance.
   18. If a problem is found, repair the signal circuit.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Set the injector ID code on the ECM.

3. DTC P0193 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0201 (Flash Code 271)
Injector Circuit - Cylinder 1

1. DTC P0201 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 1 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 1 injector.

      values : 1.0 Ω
   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 1 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 1 cylinder injector harness connector charge voltage circuit and the frame ground.

      values : 1.0 V
   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 1 cylinder injector.

      Note :
      - There should be no short to the charge voltage circuit.
   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 1 cylinder injector harness connector solenoid control circuit and the frame ground.

      values : 8.0 V
   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 1 cylinder injector.

       Note :
       - There should be no short to the battery power supply or no short to the ignition power supply circuit.
   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 1 cylinder injector harness connector solenoid control circuit and the frame ground.

       values : 6.0 V
   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 1 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 1 cylinder injector.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

       Note :
       - If the injector has been replaced, set the injector ID code on the ECM.
   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 1 cylinder injector.

       Note :
       - There should be no open circuit or high resistance.
   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   22. Perform the injector ID code setting on the ECM.
2. DTC P0201 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0202 (Flash Code 272) Injector Circuit - Cylinder 2

1. DTC P0202 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 2 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 2 injector.

   values : 1.0 Ω

   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 2 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 2 cylinder injector harness connector charge voltage circuit and the frame ground.

   values : 1.0 V

   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 2 cylinder injector.

   Note :

   - There should be no short to the charge voltage circuit.

   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 2 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 8.0 V

   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 2 cylinder injector.

   Note :

   - There should be no short to the battery power supply or no short to the ignition power supply circuit.

   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 2 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 6.0 V

   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 2 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 2 cylinder injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   Note :

   - If the injector has been replaced, set the injector ID code on the ECM.

   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 2 cylinder injector.

   Note :

   - There should be no open circuit or high resistance.

   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Perform the injector ID code setting on the ECM.
2. DTC P0202 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0203 (Flash Code 273)
Injector Circuit - Cylinder 3

1. DTC P0203 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 3 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 3 injector.

   values : 1.0 Ω

   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 3 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 3 cylinder injector harness connector charge voltage circuit and the frame ground.

   values : 1.0 V

   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 3 cylinder injector.

   Note :

   - There should be no short to the charge voltage circuit.

   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 3 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 8.0 V

   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 3 cylinder injector.

   Note :

   - There should be no short to the battery power supply or no short to the ignition power supply circuit.

   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 3 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 6.0 V

   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 3 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 3 cylinder injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   Note :

   - If the injector has been replaced, set the injector ID code on the ECM.

   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 3 cylinder injector.

   Note :

   - There should be no open circuit or high resistance.

   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Perform the injector ID code setting on the ECM.
2. DTC P0203 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0204 (Flash Code 274)
Injector Circuit - Cylinder 4

1. DTC P0204 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 4 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 4 injector.

   values : 1.0 Ω

   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 4 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 4 cylinder injector harness connector charge voltage circuit and the frame ground.

   values : 1.0 V

   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 4 cylinder injector.

   Note :
   - There should be no short to the charge voltage circuit.

   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 4 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 8.0 V

   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 4 cylinder injector.

   Note :
   - There should be no short to the battery power supply or no short to the ignition power supply circuit.

   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 4 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 6.0 V

   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 4 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 4 cylinder injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   Note :
   - If the injector has been replaced, set the injector ID code on the ECM.

   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 4 cylinder injector.

   Note :
   - There should be no open circuit or high resistance.

   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Perform the injector ID code setting on the ECM.
2. DTC P0204 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0217 (Flash Code 542)
Engine Coolant Over Temperature Condition

1. DTC P0217 priority DTC

   DTC P0117

2. DTC P0217 diagnostics

   1. Inspect the engine cooling system.

      Refer to "*1.Engine 1D.Cooling(4LE2) Coolant inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Cooling fan belt inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Thermostat inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Water pump assembly inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Radiator inspection*".

   2. While observing the Coolant Temperature display on the trouble diagnosis scan tool, start the engine.
   3. Wait until the engine has been completely warmed up.
   4. Observe the Coolant Temperature display on the trouble diagnosis scan tool, and verify that it is more than or equal to the specified value.

      values : 100 ℃ { 212 °F }

   5. If the reading is less than or equal to the specified value, check with the operator if the overheat has occurred due to low engine coolant level, etc.
   6. If engine overheat has occurred in the past, make sure to inspect the engine.
   7. Inspect the engine coolant temperature sensor.

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor inspection*".

   8. If an error is found in the inspection results, replace the engine coolant temperature sensor.

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor removal*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor installation*".

3. DTC P0217 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. While observing the Coolant Temperature display on the trouble diagnosis scan tool, start the engine and wait until it is completely warmed up.
   4. Verify that the Coolant Temperature display does not show a value more than or equal to the specified value.

      values : 100 ℃ { 212 °F }

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0219 (Flash Code 543) Engine Overspeed Condition

1. DTC P0219 priority DTC

   DTC P0335

   DTC P0336

2. DTC P0219 diagnostics

   1. Turn OFF the ignition switch for 30 seconds.
   2. Start the engine.
   3. Observe the Engine Speed display on the trouble diagnosis scan tool.
   4. Increase the engine speed as necessary.
   5. Observe the Engine Speed display on the trouble diagnosis scan tool.
   6. If the maximum revolution speed without load has not been exceeded, check with the operator if any operational error due to overrun has occurred.
   7. If engine overrun has occurred in the past, make sure to inspect the engine.
   8. Inspect the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".

   9. If an error is found in the inspection results, replace the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

3. DTC P0219 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start and rev the engine a few times in neutral between the idling speed and the maximum speed without load while observing the Engine Speed display on the trouble diagnosis scan tool.
   4. Verify that the Engine Speed display does not exceed the maximum speed without load.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0237 (Flash Code 32)
Turbocharger Boost Sensor Circuit Low

1. DTC P0237 priority DTC

   DTC P1655

2. DTC P0237 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between 5 V power supply circuit of the boost pressure sensor harness connector and a known good GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the boost pressure sensor for an open circuit or high resistance.

      Note :

      - The boost pressure sensor shares the 5 V power supply circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the boost pressure sensor harness connector 5 V power supply circuit and the signal circuit.
   8. Observe the Manifold Absolute Pressure Sensor display on the trouble diagnosis scan tool.

      values : 4.5 V

   9. If the reading is more than or equal to the specified value, inspect for poor connections at the boost pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the boost pressure sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   12. Inspect the signal circuit between the ECM and the boost pressure sensor.

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   17. Set the injector ID code on the ECM.

3. DTC P0237 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0238 (Flash Code 32)
Turbocharger Boost Sensor Circuit High

1. DTC P0238 priority DTC

   DTC P1655

2. DTC P0238 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost pressure sensor.
   3. Observe the boost pressure sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V
   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the boost pressure sensor.

      Note :
      - There should be no short to the battery or no short to the ignition power supply.
      - There should be no short to the 5 V power supply.
   5. If a problem is found, repair the signal circuit.
   6. Inspect the GND circuit between the ECM and the boost pressure sensor for an open circuit or high resistance.

      Note :
      - The boost pressure sensor shares the GND circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.
   7. If a problem is found, repair the GND circuit.
   8. Inspect for poor connections at the boost pressure sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. If the harness connector is normal, replace the boost pressure sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".
   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   14. Set the injector ID code on the ECM.

3. DTC P0238 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0335 (Flash Code 15)
Crankshaft Position Sensor Circuit

1. DTC P0335 priority DTC

   DTC P0340

   DTC P0641

2. DTC P0335 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the CKP sensor
   3. Turn ON the ignition switch.
   4. Measure the voltage between the 5 V power supply circuit of the CKP sensor harness connector and a known good GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the CKP sensor for an open circuit or high resistance.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Measure the voltage between the signal circuit of the CKP sensor harness connector and a known good GND.

      voltage : 5.5 V

   8. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CKP sensor for a short to the battery or a short to the ignition power supply.
   9. If a problem is found, repair the signal circuit.
   10. Measure the voltage between the CKP sensor harness connector signal circuit and a known good GND again.

       values : 4.5 V

   11. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the CKP sensor.

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   12. If a problem is found, repair the signal circuit.
   13. Connect a test lamp between the signal circuit of the CKP sensor harness connector and a known good GND.
   14. Measure the voltage between the probe of the test lamp and a known good GND.

       voltage : 4.5 V

   15. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CKP sensor for a short to the 5 V power supply circuit.
   16. If a problem is found, repair the signal circuit.
   17. Measure the voltage between the 5 V power supply circuit of the CKP sensor harness connector and the GND circuit.

       voltage : 4.5 V

   18. If the reading is more than or equal to the specified value, inspect for poor connections at the CKP sensor harness connector.
   19. If a problem is found, repair the harness connector.
   20. If the harness connector is normal, inspect the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".

   21. If a problem is found, replace the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

   22. Inspect the GND circuit between the ECM and the CKP sensor for an open circuit or high resistance.

       Note :

       - The CKP sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   23. If a problem is found, repair the GND circuit.
   24. Inspect for poor connections at the ECM harness connector.
   25. If a problem is found, repair the harness connector.
   26. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   27. Set the injector ID code on the ECM.

3. DTC P0335 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0336 (Flash Code 15)
Crankshaft Position Sensor Circuit Range/Performance

1. DTC P0336 priority DTC

   DTC P0335

   DTC P0340

   DTC P0641

2. DTC P0336 diagnostics
   1. Inspect the CKP sensor circuit.

      Note：
      - It should not be too close to the wiring or components of the fuel injection device.
      - It should not be too close to any electronic device that was additionally installed.
      - It should not be too close to the solenoid and relay
   2. If a problem is found, repair the CKP sensor circuit.
   3. Turn OFF the ignition switch.
   4. Disconnect the harness connector from the ECM.
   5. Inspect for poor connections at the ECM harness connector.
   6. If a problem is found, repair the harness connector.
   7. Disconnect the harness connector from the CKP sensor
   8. Inspect for poor connections at the CKP sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. Inspect the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".
   11. If a problem is found, replace the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

3. DTC P0336 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0340 (Flash Code 14)
Camshaft Position Sensor Circuit

1. DTC P0340 priority DTC

   DTC P0601

   DTC P0651

2. DTC P0340 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the CMP sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the 5 V power supply circuit of the CMP sensor harness connector and a known good GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the CMP sensor for an open circuit or high resistance.

      Note :

      - The CMP sensor shares the 5 V power supply circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   6. If a problem is found, repair the 5 V power supply circuit.
   7. Measure the voltage between the signal circuit of the CMP sensor harness connector and a known good GND.

      voltage : 5.5 V

   8. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CMP sensor for a short to the battery or a short to the ignition power supply.
   9. If a problem is found, repair the signal circuit.
   10. Measure the voltage between the CMP sensor harness connector signal circuit and a known good GND again.

       voltage : 4.5 V

   11. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the CMP sensor

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   12. If a problem is found, repair the signal circuit.
   13. Connect a test lamp between the signal circuit of the CMP sensor harness connector and a known good GND.
   14. Measure the voltage between the probe of the test lamp and a known good GND.

       voltage : 4.5 V

   15. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CMP sensor for a short to the 5 V power supply circuit.
   16. If a problem is found, repair the signal circuit.
   17. Measure the voltage between the 5 V power supply circuit of the CMP sensor harness connector and the GND circuit.

       voltage : 4.5 V

   18. If the reading is more than or equal to the specified value, inspect for poor connections at the CMP sensor harness connector.
   19. If a problem is found, repair the harness connector.
   20. If the harness connector is normal, inspect the CMP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor inspection*".

   21. If a problem is found, replace the CMP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor removal*".

       Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor installation*".

   22. Inspect the camshaft gear.

       Note :

       - The camshaft gear should not be damaged.
       - The camshaft gear should not be improperly installed.

   23. If a problem is found, repair the camshaft gear.
   24. Inspect the GND circuit between the ECM and the CMP sensor for an open circuit or high resistance.

       Note :

       - The CMP sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

25. If a problem is found, repair the GND circuit.
26. Inspect for poor connections at the ECM harness connector.
27. If a problem is found, repair the harness connector.
28. If the harness connector is normal, replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

29. Set the injector ID code on the ECM.

3. DTC P0340 confirm resolution
    1. Clear the DTC with a trouble diagnosis scan tool.
    2. Turn OFF the ignition switch for 30 seconds or more.
    3. Start the engine.
    4. Perform a test-run.
    5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0380 (Flash Code 66)
Glow Plug Circuit

1. DTC P0380 diagnostics
   1. Turn OFF the ignition switch.
   2. Replace the glow relay with a starter relay or a known good relay.
   3. Perform the glow relay test with a trouble diagnosis scan tool.
   4. Command the glow relay ON and OFF.
   5. Verify that the operation sound of the glow relay is heard upon execution of each command.
   6. If the operating sound of the glow relay can be heard, remove the glow relay.
   7. Inspect for poor connections at the glow relay terminal.
   8. If a problem is found, repair the glow relay terminal.
   9. If the glow relay terminal is normal, replace the glow relay.
   10. Turn OFF the ignition switch.
   11. Inspect circuit between the ignition switch and the glow relay coil side for an open circuit or high resistance.
   12. If a problem is found, repair the circuit between the ignition switch and the glow relay coil side.
   13. Inspect the control circuit between the ECM and glow relay.

   Note：
   - There should be no open circuit or high resistance.
   - There should be no short to GND.

   14. If a problem is found, repair the control circuit.
   15. Inspect for poor connections at the ECM harness connector.
   16. If a problem is found, repair the harness connector.
   17. If the ECM harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   18. Set the injector ID code on the ECM.
2. DTC P0380 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Perform the glow relay test with a trouble diagnosis scan tool, and command ON and OFF.
   4. Verify that the operation sound of the glow relay is made upon execution of each command.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0404 (Flash Code 45)
Exhaust Gas Recirculation 1 Control Circuit Range/Performance

1. DTC P0404 priority DTC

   DTC P0409

2. DTC P0404 diagnostics
   1. Remove the EGR valve assembly from the engine.

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".
   2. Inspect the EGR valve.

      Note :
      - There should be nothing to restrict the flow inside the EGR valve.
      - There should be no excessive deposits inside the EGR valve.
      - There should be no bending in the valve shaft or the valve itself in the EGR valve.
   3. Turn OFF the ignition switch.
   4. Disconnect the harness connector from the EGR valve.
   5. Inspect for poor connections at the EGR valve harness connector.
   6. If a problem is found, repair the harness connector.
   7. Disconnect the harness connector from the ECM.
   8. Inspect for poor connections at the ECM harness connector.
   9. If a problem is found, repair the harness connector.
   10. Inspect the EGR control circuit for an open circuit or high resistance.
   11. If a problem is found, repair the EGR control circuit.
   12. Inspect the EGR solenoid circuit between the ECM and the EGR valve.

       Note :
       - There should be no short to GND.
       - There should be no short to the battery or no short to the ignition power supply circuit.
       - There should be no short together between circuits.
       - There should be no short to the EGR position sensor circuit.
   13. If a problem is found, repair the EGR solenoid circuit.
   14. If the EGR solenoid circuit is normal, replace the EGR valve.

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".
   15. Restore the machine.
   16. Turn ON the ignition switch.
   17. Clear the DTC with a trouble diagnosis scan tool.
   18. Turn OFF the ignition switch for 30 seconds or more.
   19. Start the engine.
   20. Perform a test-run.
   21. Observe the DTC information with a trouble diagnosis scan tool.
   22. If DTC P0404 is set, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   23. Set the injector ID code on the ECM.
3. DTC P0404 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0409 (Flash Code 44)
Exhaust Gas Recirculation 1 Sensor Circuit

1. DTC P0409 priority DTC

   DTC P1655

2. DTC P0409 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the EGR valve.
   3. Turn ON the ignition switch.
   4. Observe the EGR Brushless Position 1, EGR Brushless Position 2, and EGR Brushless Position 3 data displays on the trouble diagnosis scan tool for any display that shows ON.
   5. If there is a data display showing ON, inspect the signal circuit between the ECM and the EGR valve of the EGR showing ON.

      Note：
      - There should be no short to the battery or the ignition power supply.
      - There should be no short to 5 V power supply circuit.

   6. If a problem is found, repair the signal circuit.
   7. Measure the voltage between the EGR position sensor 5 V power supply circuit and a known good GND circuit.

      voltage： 4.5 V

   8. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the EGR position sensor for an open circuit or high resistance.

      Note：
      - The EGR position sensor shares the 5 V power supply circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   9. If a problem is found, repair the 5 V power supply circuit.
   10. Measure the voltage between the EGR position sensor 5 V power supply circuit and the GND circuit.

       voltage： 4.5 V

   11. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and EGR position sensor for an open circuit or high resistance.

       Note：
       - The EGR position sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   12. If a problem is found, repair the GND circuit.
   13. While momentarily disconnecting the fused jumper wire from the EGR position sensor 1 signal circuit and the 5 V power supply circuit, observe the EGR Brushless Position 1 display on the trouble diagnosis scan tool.
   14. While momentarily disconnecting the fused jumper wire from the EGR position sensor 2 signal circuit and the 5 V power supply circuit, observe the EGR Brushless Position 2 display on the trouble diagnosis scan tool.
   15. While momentarily disconnecting the fused jumper wire from the EGR position sensor 3 signal circuit and the 5 V power supply circuit, observe the EGR Brushless Position 3 display on the trouble diagnosis scan tool.
   16. Check for a data display that does not display ON when the EGR position sensor signal circuit and the 5 V power supply circuit are shorted together.
   17. If there is a data display which does not display ON, inspect the EGR position sensor circuit which does not display ON.

       Note：
       - There should be no open circuit or high resistance between the ECM and the EGR position sensor.
       - There should be no short to GND between the ECM and the EGR position sensor.

   18. If a problem is found, repair the EGR position sensor circuit.
   19. Inspect for poor connections at the EGR valve harness connector.
   20. If a problem is found, repair the harness connector.
   21. Inspect the EGR solenoid circuit between the ECM and the EGR valve for a short to the EGR position sensor.
   22. If a problem is found, repair the EGR solenoid circuit.
   23. If the EGR solenoid circuit is normal, replace the EGR valve.

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

24. Inspect for poor connections at the ECM harness connector.
25. If a problem is found, repair the harness connector.
26. If the harness connector is normal, replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

27. Set the injector ID code on the ECM.

3. DTC P0409 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0521 (Flash Code 294)
Engine Oil Pressure Sensor Performance

1. DTC P0521 priority DTC

   DTC P0522

2. DTC P0521 diagnostics

   1. Inspect the following parts for engine oil leakage.

      Note :

      - Oil pump
      - Oil pressure sensor
      - Oil cooler
      - Oil filter
      - Pipe between oil cooler and oil filter

   2. If a problem is found, repair the applicable oil leakage.
   3. Turn OFF the ignition switch.
   4. Disconnect the harness connector from the oil pressure sensor.
   5. Inspect for poor connections at the oil pressure sensor harness connector.
   6. If a problem is found, repair the harness connector.
   7. Disconnect the harness connector from the ECM.
   8. Inspect for poor connections at the ECM harness connector.
   9. If a problem is found, repair the harness connector.
   10. Inspect the each circuit between the ECM and the oil pressure sensor for high resistance.
   11. If a problem is found, repair the applicable circuit.
   12. Replace the oil pressure sensor.

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

3. DTC P0521 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0522 (Flash Code 294)
Oil Pressure Sensor Circuit Low Input

1. DTC P0522 priority DTC

   DTC P0697

2. DTC P0522 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the oil pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the 5 V power supply circuit of the oil pressure sensor harness connector and a known good GND.

      voltage： 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the oil pressure sensor for an open circuit or high resistance.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the 5 V power supply circuit of the oil pressure sensor harness connector and the signal circuit.
   8. Observe the engine Oil Pressure Sensor Voltage display on the trouble diagnosis scan tool.

      voltage： 4.5 V

   9. If the reading is more than or equal to the specified value, inspect for poor connections at the oil pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the oil pressure sensor.

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

   12. Inspect the signal circuit between the ECM and the oil pressure sensor.

       Note：

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   17. Set the injector ID code on the ECM.

3. DTC P0522 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0523 (Flash Code 294)
Oil Pressure Sensor Circuit High Input

1. DTC P0523 priority DTC

   DTC P0697

2. DTC P0523 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the oil pressure sensor.
   3. Observe the engine Oil Pressure Sensor Voltage display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the oil pressure sensor.

      Note :
      - There should be no short to the battery or the ignition power supply.
      - There should be no short to the 5 V power supply.

   5. If a problem is found, repair the signal circuit.
   6. Inspect the GND circuit between the ECM and the oil pressure sensor for an open circuit or high resistance.

      Note :
      - The oil pressure sensor shares the GND circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   7. If a problem is found, repair the GND circuit.
   8. Inspect for poor connections at the oil pressure sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. If the harness connector is normal, replace the oil pressure sensor.

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   14. Set the injector ID code on the ECM.

3. DTC P0523 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0563 (Flash Code 35)
System Voltage High

1. DTC P0563 diagnostics
   1. Check if the battery charger has been connected to the battery recently.
   2. Start and idle the engine.
   3. Observe the Ignition Voltage display on the trouble diagnosis scan tool.

   voltage : 16.0 V

   4. If the reading is more than or equal to the specified value, inspect the charging system.

   Refer to "*1.Engine 1J.Electrical(4LE2) Generator inspection*".

   5. If a problem is found, repair the charging system.

   Refer to "*1.Engine 1J.Electrical(4LE2) Generator removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) Generator installation*".

   6. If the charging system is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   7. Set the injector ID code on the ECM.
2. DTC P0563 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start and idle the engine.
   4. Observe the Ignition Voltage display on the trouble diagnosis scan tool, and verify that the value does not exceed the specified value.

   voltage : 16.0 V

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0601 (Flash Code 53)
Internal Control Module Memory Check Sum Error

1. DTC P0601 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P0601 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0602 (Flash Code 154)
Control Module Programming Error

1. DTC P0602 diagnostics
   1. Verify that the connecting sections of all tools are securely connected.
   2. Verify that the programming device operates properly.
   3. Use a trouble diagnosis scan tool to verify that the correct injector ID code and fuel delivery rate data are input into the ECM.

   Note:

   - If the injector ID code and the fuel delivery rate are correctly input, clear the DTC with a trouble diagnosis scan tool.

   4. Turn OFF the ignition switch for 30 seconds or more.
   5. Turn ON the ignition switch.
   6. Observe the DTC information with a trouble diagnosis scan tool.
   7. If a DTC is set, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   8. Set the injector ID code on the ECM.
2. DTC P0602 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0604 (Flash Code 153)
Internal Control Module Random Access Memory (RAM)

1. DTC P0604 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P0604 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0606 (Flash Code 51)
ECM/PCM Processor

1. DTC P0606 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P0606 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P060B (Flash Code 36)
Internal Control Module A/D Processing Performance

1. DTC P060B diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P060B confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0615 (Flash Code 19) Starter Relay Circuit

1. DTC P0615 diagnostics
    1. Connect a trouble diagnosis scan tool.
    2. Turn OFF the ignition switch for 30 seconds or more.
    3. Turn ON the ignition switch. The engine must not be started.
    4. Observe the DTC information for DTC P0615 with a trouble diagnosis scan tool.
    5. If a DTC is not set, start the engine.
    6. Observe the DTC information for DTC P0615 with a trouble diagnosis scan tool.
    7. If a DTC is not set, an intermittent condition is suspected.
    8. If a DTC is set, inspect for a short to the battery power supply circuit or ignition power supply circuit in the control circuit of the ECM and starter cut relay.
    9. If a failure was found, repair the control circuit of the ECM and starter cut relay.
    10. If a DTC is set in [4.], replace with another known good starter cut relay.
    11. Turn ON the ignition switch. The engine must not be started.
    12. Observe the DTC information for DTC P0615 with a trouble diagnosis scan tool.
    13. If a DTC is not set, replace the starter cut relay.
    14. If a DTC is set, inspect for a short to ground in the control circuit of the ECM and starter cut relay.
    15. If a failure was found, repair the control circuit of the ECM and starter cut relay.
    16. Replace the ECM.

        Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

        Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
    17. Set the injector ID code on the ECM.
2. DTC P0615 confirm resolution
    1. Clear the DTC with a trouble diagnosis scan tool.
    2. Turn OFF the ignition switch for 30 seconds or more.
    3. Turn ON the ignition switch for 10 seconds.
    4. Start the engine.
    5. Perform a test-run.
    6. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0641 (Flash Code 55)
Sensor Reference Voltage 1 Circuit

1. DTC P0641 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the accelerator position sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the accelerator position sensor 5 V power supply circuit of the accelerator position sensor harness connector and GND.

      voltage： 5.5 V
   5. If the reading is more than or equal to the specified value, inspect the accelerator position sensor 5 V power supply circuit between the ECM and the accelerator position sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the accelerator position sensor 5 V power supply circuit.
   7. Inspect the fuel filter pressure sensor 5 V power supply circuit between the ECM and the fuel filter pressure sensor for a short to the battery or a short to ignition power supply.
   8. If a problem is found, repair the fuel filter pressure sensor 5 V power supply circuit between the ECM and the fuel filter pressure sensor.
   9. Inspect the boost pressure sensor 5 V power supply circuit between the ECM and the boost pressure sensor for a short to the battery or a short to the ignition power supply.
   10. If a problem is found, repair the boost pressure sensor 5 V power supply circuit.
   11. If the reading is less than or equal to the specified value, measure the voltage between the accelerator position sensor harness connector 5 V power supply circuit and GND.

       voltage： 4.5 V
   12. If the reading is more than or equal to the specified value, replace the accelerator position sensor.
   13. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   14. Disconnect the harness connector from the fuel filter pressure sensor.
   15. Turn ON the ignition switch.
   16. Measure the voltage between the fuel filter pressure sensor 5 V power supply circuit of the fuel filter pressure sensor harness connector and GND.

       voltage： 4.5 V
   17. If the reading is more than or equal to the specified value, replace the fuel filter pressure sensor.
   18. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   19. Disconnect the harness connector from the boost pressure sensor.
   20. Turn ON the ignition switch.
   21. Measure the voltage between the boost pressure sensor 5 V power supply terminal of the boost pressure sensor harness connector and GND.

       voltage： 4.5 V
   22. If the reading is more than or equal to the specified value, replace the boost pressure sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".
   23. If the reading is less than or equal to the specified value, inspect the accelerator position sensor 5 V power supply circuit between the ECM and the accelerator position sensor for a short to GND.
   24. If a problem is found, repair the accelerator position sensor 5 V power supply circuit.
   25. Inspect the fuel filter pressure sensor 5 V power supply circuit between the ECM and the fuel filter pressure sensor for a short to GND.
   26. If a problem is found, repair the fuel filter pressure sensor 5 V power supply circuit.
   27. Inspect the boost pressure sensor 5 V power supply circuit between the ECM and the boost pressure sensor for a short to GND.
   28. If a problem is found, repair the boost pressure sensor 5 V power supply circuit.
   29. Replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   30. Set the injector ID code on the ECM.
2. DTC P0641 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.

2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0651 (Flash Code 56) Sensor Reference Voltage 2 Circuit

1. DTC P0651 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the barometric pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the barometric pressure sensor harness connector 5 V power supply circuit of the barometric pressure sensor harness connector and GND.

   voltage： 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the barometric pressure sensor 5 V power supply circuit between the ECM and the barometric pressure sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the barometric pressure sensor 5 V power supply circuit.
   7. Inspect the CMP sensor 5 V power supply circuit between the ECM and the CMP sensor for a short to the battery or a short to ignition power supply.
   8. If a problem is found, repair the CMP sensor 5 V power supply circuit between the ECM and the CMP sensor.
   9. Inspect the FRP sensor 5 V power supply circuit between the ECM and the FRP sensor for a short to the battery or a short to the ignition power supply.
   10. If a problem is found, repair the FRP sensor 5 V power supply circuit.
   11. Inspect the EGR position sensor 5 V power supply circuit between the ECM and the EGR position sensor for a short to the battery a short to the ignition power supply.
   12. If a problem is found, repair the EGR position sensor 5 V power supply circuit.
   13. If the reading is less than or equal to the specified value, measure the voltage between the barometric pressure sensor harness connector 5 V power supply circuit and GND.

   voltage： 4.5 V

   14. If the reading is more than or equal to the specified value, replace the barometric pressure sensor.
   15. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   16. Disconnect the harness connector from the CMP sensor.
   17. Turn ON the ignition switch.
   18. Measure the voltage between the CMP sensor 5 V power supply circuit of the CMP sensor harness connector and GND.

   voltage： 4.5 V

   19. If the reading is more than or equal to the specified value, replace the CMP sensor.

   Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor removal*".

   Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor installation*".

   20. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   21. Disconnect the harness connector from the FRP sensor.
   22. Turn ON the ignition switch.
   23. Measure the voltage between the FRP sensor 5 V power supply circuit of the FRP sensor harness connector and GND.

   voltage： 4.5 V

   24. If the reading is more than or equal to the specified value, replace the FRP sensor.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

   Note：
   - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   25. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   26. Disconnect the harness connector from the EGR valve.
   27. Turn ON the ignition switch.
   28. Measure the voltage between the EGR position sensor 5 V power supply circuit of the EGR valve harness connector and GND.

   voltage： 4.5 V

   29. If the reading is more than or equal to the specified value, replace the EGR valve.

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

30. If the reading is less than or equal to the specified value, inspect the FRP sensor 5 V power supply circuit between the ECM and the barometric pressure sensor for a short to GND.

Note：

- If a problem is found, repair the barometric pressure sensor 5 V power supply circuit.

31. Inspect the CMP sensor 5 V power supply circuit between the ECM and the CMP sensor for a short to GND.

Note：

- If a problem is found, repair the CMP sensor 5 V power supply circuit.

32. Inspect the FRP sensor 5 V power supply circuit between the ECM and the FRP sensor for a short to GND.

Note：

- If a problem is found, repair the FRP sensor 5 V power supply circuit.

33. Inspect the EGR position sensor 5 V power supply circuit between the ECM and the EGR position sensor for a short to GND.

Note：

- If a problem is found, repair the EGR position sensor 5 V power supply circuit.

34. Replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

35. Set the injector ID code on the ECM.

2. DTC P0651 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0685 (Flash Code 416)
ECM/PCM Power Relay Control Circuit/Open

1. DTC P0685 diagnostics
   1. Turn OFF the ignition switch for 30 seconds or more.
   2. Replace the main relay with a glow relay or a known good relay.
   3. Turn ON the ignition switch.
   4. Observe the DTC information with a trouble diagnosis scan tool.
   5. If a DTC is not set, replace the main relay.
   6. Inspect for poor connections at the body ground.
   7. If a problem is found, repair the terminal.
   8. Inspect the slow blow fuse.
   9. If a problem is found, replace the slow blow fuse.

      Note：

      - If the fuse blows out again, repair the cause of the slow blow fuse blowout.
   10. Turn OFF the ignition switch.
   11. Disconnect the harness connector from the ECM.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   15. Set the injector ID code on the ECM.
2. DTC P0685 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Turn ON the ignition switch.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0687 (Flash Code 416)
ECM/PCM Power Relay Control Circuit High

1. DTC P0687 diagnostics
   1. Turn OFF the ignition switch.
   2. Remove the main relay.
   3. Turn ON the ignition switch.
   4. Observe the DTC information for DTC P0685 with a trouble diagnosis scan tool.
   5. If DTC P0685 is not set, repair the short to the battery power supply in the power supply circuit between the ECM and the main relay.
   6. Turn OFF the ignition switch for 30 seconds or more.
   7. Replace the main relay with a glow relay or a known good relay.
   8. Turn ON the ignition switch.
   9. Observe the DTC information for DTC P0687 with a trouble diagnosis scan tool.
   10. If DTC P0687 is not set, replace the main relay.
2. DTC P0687 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Turn ON the ignition switch.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0697 (Flash Code 57)
Sensor Reference Voltage 3 Circuit

1. DTC P0697 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the oil pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the oil pressure sensor 5 V power supply circuit of the oil pressure sensor harness connector and GND.

   voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the oil pressure sensor 5 V power supply circuit between the ECM and the oil pressure sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the oil pressure sensor 5 V power supply circuit.
   7. If the reading is less than or equal to the specified value, measure the voltage between the oil pressure sensor 5 V power supply circuit of the oil pressure sensor harness connector and GND.

   voltage : 4.5 V

   8. If the reading is more than or equal to the specified value, replace the oil pressure sensor.

   Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

   Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

   9. If the reading is less than or equal to the specified value, inspect the oil pressure sensor 5 V power supply circuit between the ECM and the oil pressure sensor for a short to GND.
   10. If a problem is found, repair the oil pressure sensor 5 V power supply circuit.
   11. Replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   12. Set the injector ID code on the ECM.
2. DTC P0697 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P06AF (Flash Code 277)
EDU Injector Custom IC,Check Sum,Communication Line

1. DTC P06AF diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P06AF confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1093 (Flash Code 227)
Fuel Rail Pressure (FRP) Too Low

1. DTC P1093 priority DTC

   DTC P0087

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P1093 diagnostics

   1. Turn OFF the ignition switch.
   2. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time : 2 min

   3. Turn ON the ignition switch.
   4. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool, and verify that it is within the specified range.

      voltage : 0.9 to 1.0 V

   5. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   6. If a problem is found, repair the harness connector.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. Inspect each circuit for high resistance.
   10. If a problem is found, repair the circuit.
   11. If the harness connector and each circuit are normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

       Note :

       - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   12. Inspect the fuel system between the fuel tank and the fuel supply pump for clogging.
   13. If a problem is found, repair the clogging in the fuel system.
   14. Inspect the fuel hose between the fuel tank and the fuel supply pump for cuts and cracks.
   15. If a problem is found, replace the fuel hose.

       Note :

       - A slight vacuum will form in the fuel hose leading from the fuel tank to the fuel supply pump when the engine is running.
       - If the fuel hose is not connected securely, air may enter.
       - If the engine speed or the engine load increases when air has entered the fuel system, fluctuation in the common rail (fuel rail) pressure occurs, and DTC P1093 may be set.

   16. Check that an appropriate clamp is used between the fuel tank and the fuel supply pump.
   17. If a problem is found, replace the clamp.
   18. Operate the priming pump until it becomes heavy.

       Note :

       - When a leakage exists in the fuel system between the priming pump and the fuel supply pump, the pressing weight of the priming pump does not become heavy.

   19. Start the engine.
   20. Inspect the high-pressure side of the fuel system and check for a fuel leak between the fuel supply pump and the common rail (fuel rail).

       Note :

       - Fuel may leak under the cylinder head cover from the inlet of the high pressure hose.
       - If the fuel leaks under the cylinder head cover, the engine oil level will increase.
       - Inspect for a fuel leakage into the engine oil.

   21. If a fuel leakage is found, repair.
   22. Turn OFF the ignition switch.
   23. Inspect the fuel tank vent hose.

24. If a problem is found, repair the vent hose.
25. Check for foreign material in the fuel tank or for foreign material that can cause fuel clogging.
26. If a problem is found, repair.
27. Inspect for poor connections at the suction control valve harness connector.
28. If a problem is found, repair the harness connector.
29. Inspect for poor connections at the ECM harness connector.
30. If a problem is found, repair the harness connector.
31. Inspect each circuit for high resistance.
32. If a problem is found, repair the circuit.
33. If the suction control valve harness connector and the ECM harness connector are normal and there is no high resistance in each circuit, replace the fuel supply pump and the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

Note：

- When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

34. Restore the fuel system.
35. Start the engine.
36. Perform the injector stop test with a trouble diagnosis scan tool.
37. Check for any injector that does not change the engine speed when instructed OFF.
38. If there are any injectors that do not change the engine speed when instructed OFF, replace the applicable injector.

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

39. If the injector has been replaced, set the injector ID code on the ECM.
40. If the engine speed changes when all injectors are commanded OFF, replace the pressure limiter valve.

Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

Note：

- The pressure limiter valve may be fixed open, or the operation pressure may decrease.
- Do not replace the pressure limiter valve separately. If a problem is found, replace the common rail (fuel rail) assembly.

3. DTC P1093 confirm resolution

1. Clear the DTC with a trouble diagnosis scan tool.
2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1097 (Flash Code 213)
Boost Temperature Sensor Circuit Low

1. DTC P1097 priority DTC

   DTC P0651

2. DTC P1097 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost temperature sensor.
   3. Observe the boost temperature sensor display on a trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the boost temperature sensor.

      Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

      Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   5. Inspect the signal circuit between the ECM and boost temperature sensor signal circuit for a short to the GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P1097 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1098 (Flash Code 213)
Boost Temperature Sensor Circuit High

1. DTC P1098 priority DTC

   DTC P0651

2. DTC P1098 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost temperature sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the boost temperature sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If it is at or above the standard value, inspect to see if there is a short circuit to the battery or ignition power supply with the signal circuit between the ECM and the boost temperature sensor.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the boost temperature sensor signal circuit and the GND circuit.
   8. Observe the boost temperature sensor display on a trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If it is at or below the standard value, inspect to see if there is a short circuit to the 5 V power supply circuit with the signal circuit between the ECM and the boost temperature sensor.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the boost temperature sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the boost temperature sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   14. Connect a fused jumper wire between the boost temperature sensor signal circuit and a known good GND.
   15. Observe the boost temperature sensor display on a trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If it is at or below the standard value, inspect to see if there is an open circuit or high resistance with the GND circuit between the ECM and the boost temperature sensor.

       Note :

       - The boost temperature sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the boost temperature sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P1098 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.

      Note :

      - Run the engine for 3 minutes or longer.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1261 (Flash Code 34)
Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P1261 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P1261 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1262 (Flash Code 34)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P1262 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P1262 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1404 (Flash Code 45)
Exhaust Gas Recirculation 1 Closed Position Performance

1. DTC P1404 priority DTC

   DTC P0404

   DTC P0409

2. DTC P1404 diagnostics

   1. Remove the EGR valve assembly from the engine.

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

   2. Inspect the EGR valve.

      Note :

      - There should be nothing to restrict the flow inside the EGR valve.
      - There should be no excessive deposits inside the EGR valve.
      - There should be no bending in the valve shaft or the valve itself in the EGR valve.

   3. If a problem is found, repair or replace the EGR valve.

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

   4. Turn OFF the ignition switch.
   5. Disconnect the harness connector from the EGR valve.
   6. Inspect for poor connections at the EGR valve harness connector.
   7. If a problem is found, repair the harness connector.
   8. Disconnect the harness connector from the ECM.
   9. Inspect for poor connections at the ECM harness connector.
   10. If a problem is found, repair the harness connector.
   11. Inspect the EGR valve circuit between the ECM and the EGR valve for an open circuit or high resistance.
   12. If a problem is found, repair the EGR valve circuit.
   13. Inspect the solenoid circuit between the ECM and the EGR valve.

       Note :

       - There should be no short to GND.
       - There should be no short to the battery or the ignition power supply.
       - There should be no short to other circuits.
       - There should be no short to the EGR position sensor circuit.

   14. If a problem is found, repair the solenoid circuit.
   15. If the circuit is normal, replace the EGR valve.

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

3. DTC P1404 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1606 (Flash Code 51)
SW-IC 1 Internal failure,Communication line failure

1. DTC P1606 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P1606 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P160B (Flash Code 36)
AD-IC failure

1. DTC P160B diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P160B confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1621 (Flash Code 54)
Control Module Long Term Memory Performance

1. DTC P1621 diagnostics
   1. Verify that the connecting sections of all tools are securely connected.
   2. Verify that the programming device operates properly.
   3. Turn OFF the ignition switch, and wait for 30 seconds.
   4. Turn ON the ignition switch.
   5. Observe the DTC information with a trouble diagnosis scan tool.
   6. If a DTC is set, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   7. Set the injector ID code on the ECM.
2. DTC P1621 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1655 (Flash Code 59)
Sensor Reference Voltage 4 Circuit

1. DTC P1655 diagnostics
   1. Turn OFF the ignition switch.
   2. Remove the harness connector from the CKP sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the CKP sensor 5 V power supply circuit of the CKP sensor harness connector and GND.

   voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the CKP sensor 5 V power supply circuit between the ECM and the CKP sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the CKP sensor 5 V power supply circuit.
   7. If the reading is less than or equal to the specified value, measure the voltage between the CKP sensor 5 V power supply circuit of the CKP sensor harness connector and GND.

   voltage : 4.5 V

   8. If the reading is more than or equal to the specified value, replace the CKP sensor.

   Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

   Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

   9. If the reading is less than or equal to the specified value, inspect the CKP sensor 5 V power supply circuit between the ECM and the CKP sensor for a short to the GND.
   10. If a problem is found, repair the CKP sensor 5 V power supply circuit.
   11. Replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   12. Set the injector ID code on the ECM.
2. DTC P1655 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2146 (Flash Code 158)
Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P2146 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the injector.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the solenoid control circuit and GND.

   Note :
   - No. 1 cylinder injector solenoid control circuit and GND
   - No. 4 cylinder injector solenoid control circuit and GND

   voltage : 10.0 V

   5. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the injector harness connector for a short to GND.
   6. If a problem is found, repair the control circuit.
   7. Inspect the charge voltage circuit between the ECM and the injector harness connector.

   Note :
   - There should be no short to the battery the ignition power supply.
   - There should be no short to GND.

   8. If a problem is found, repair the charge voltage circuit.
   9. If the charge voltage circuit between the ECM and the injector harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.
   11. Inspect for poor connections at the injector harness connector.
   12. If a problem is found, repair the injector harness connector.
   13. Disconnect the harness connector from the ECM.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. Inspect the charge voltage circuit between the ECM and the injector harness connector for an open circuit or high resistance.
   17. If a problem is found, repair the charge voltage circuit.
   18. Check if the insulation resistance of the No. 1 cylinder and No. 4 cylinder injectors is more than or equal to the specified value.

   resistance : 1 MΩ

   19. If the reading is less than or equal to the specified value, replace the applicable injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   20. Set the injector ID code on the ECM.
   21. If the reading is more than or equal to the specified value, repair or replace the injector harness.
2. DTC P2146 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2149 (Flash Code 159)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P2149 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the cylinder head injector harness intermediate connector.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the solenoid control circuit and GND.

   Note :

   - No. 2 cylinder injector solenoid control circuit and GND
   - No. 3 cylinder injector solenoid control circuit and GND

   voltage : 10.0 V

   5. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the injector harness intermediate connector for a short to GND.
   6. If a problem is found, repair the control circuit.
   7. Inspect the charge voltage circuit between the ECM and the injector harness intermediate connector.

   Note :

   - There should be no short to the battery or the ignition power supply.
   - There should be no short to GND.

   8. If a problem is found, repair the charge voltage circuit.
   9. If the charge voltage circuit between the ECM and the injector harness intermediate connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.
   11. Inspect for poor connections at the injector harness intermediate connector.
   12. If a problem is found, repair the injector harness intermediate connector.
   13. Disconnect the harness connector from the ECM.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. Inspect the charge voltage circuit between the ECM and the injector harness intermediate connector for an open circuit or high resistance.
   17. If a problem is found, repair the charge voltage circuit.
   18. Check if the insulation resistance of the No. 2 cylinder and No. 3 cylinder injectors is more than or equal to the specified value.

   resistance : 1.0 MΩ

   19. If the reading is less than or equal to the specified value, replace the applicable injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   20. Set the injector ID code on the ECM.
   21. If the reading is more than or equal to the specified value, repair or replace the injector harness.
2. DTC P2149 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2228 (Flash Code 71)
Barometric Pressure Circuit Low

1. DTC P2228 priority DTC

   DTC P0651

2. DTC P2228 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the barometric pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the barometric pressure sensor 5 V power supply circuit and GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the barometric pressure sensor for an open circuit or high resistance.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the barometric pressure sensor 5 V power supply circuit and the signal circuit.
   8. Observe the Barometric Pressure Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   9. If the reading is more than or equal to the specified value, inspect for poor connections at the barometric pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the barometric pressure sensor.
   12. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the barometric pressure sensor.

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   17. Set the injector ID code on the ECM.

3. DTC P2228 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2229 (Flash Code 71) Barometric Pressure Circuit High

1. DTC P2229 priority DTC

   DTC P0651

2. DTC P2229 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the barometric pressure sensor.
   3. Observe the Barometric Pressure Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the barometric pressure sensor.

      Note :

      - There should be no short to the battery or the ignition power supply.
      - There should be no short to the 5 V power supply.

   5. If a problem is found, repair the signal circuit.
   6. Connect a test lamp between the barometric pressure sensor GND circuit and the battery power supply.
   7. If the test lamp illuminates, inspect for poor connections at the barometric pressure sensor harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the barometric pressure sensor.
   10. If the test lamp does not illuminate, inspect the GND circuit between the ECM and the barometric pressure sensor for an open circuit or high resistance.
   11. If a problem is found, repair the GND circuit.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   15. Set the injector ID code on the ECM.

3. DTC P2229 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P256A (Flash Code 31)
Idle Up Volume Sensor Circuit Or Up/Down Switch Error

1. DTC P256A diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the idling control switch.
   3. Turn ON the ignition switch.
   4. Observe whether the idle up switch and idle down switch displays show OFF in the scan tool.
   5. If OFF is displayed, replace the idling control switch.
   6. If ON is displayed, inspect to see if there is a short circuit to the battery or ignition power supply to the circuit on the idle up side between the ECM and the idling control switch.
   7. If a problem is found, repair the circuit on the idle up side.
   8. If the circuit is normal, inspect to see if there is a short circuit to the battery or ignition power supply to the circuit on the idle down side between the ECM and idling control switch.
   9. If a problem is found, repair the circuit on the idle down side.
   10. If the circuit is normal, inspect for poor connections at the ECM harness connector.
   11. If a problem is found, repair the harness connector.
   12. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   13. Set the injector ID code on the ECM.
2. DTC P256A confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC U0073 (Flash Code 84)
CAN-Bus Malfunction (J1939)

1. DTC U0073 diagnostics
   1. Turn OFF the ignition switch.
   2. Measure the resistance between the terminals of the termination resistor harness connector.

      Note :
      - Make a measurement from the back with the harness connector connected.
      - Verify that the parallel resistance of the 120 ? resistor in the termination resistor and the 120 ? resistor in the ECM is 60 ?.

      resistance : 50.0 to 70.0 Ω
   3. If the resistance is outside the specified range, disconnect the harness connector from the termination resistor.
   4. Measure the resistance of the termination resistor.

      resistance : 110.0 to 130.0 Ω
   5. If the resistance is outside the specified range, replace the termination resistor.
   6. Connect the harness connector to the termination resistor.
   7. Disconnect the harness connector from the control unit of the machine.
   8. Measure the resistance between the terminals of the termination resistor harness connector.

      Note :
      - Make a measurement from the back with the harness connector connected.

      resistance : 50.0 to 70.0 Ω
   9. If the resistance is within the specified range, replace the control unit of the machine.
   10. Disconnect the harness connector from the ECM.
   11. Measure the resistance between the terminals of the termination resistor harness connector.

       Note :
       - Make a measurement from the back with the harness connector connected.

       resistance : 110.0 to 130.0 Ω
   12. If the resistance is within the specified range, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   13. Set the injector ID code on the ECM.
   14. Turn OFF the ignition switch.
   15. Connect the harness connector to the ECM.
   16. Turn ON the ignition switch.
   17. Measure the voltage between the termination resistor harness connector CAN-High terminal and GND.
   18. Measure the voltage between the termination resistor harness connector CAN-Low terminal and GND.

       voltage : 1.5 to 3.5 V
   19. If the voltage is outside the specified range, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   20. Set the injector ID code on the ECM.
   21. Turn OFF the ignition switch.
   22. Connect the harness connector to the control unit of the machine.
   23. Turn ON the ignition switch.
   24. Measure the voltage between the termination resistor harness connector CAN-High terminal and GND.
   25. Measure the voltage between the termination resistor harness connector CAN-Low terminal and GND.

       voltage : 1.5 to 3.5 V
   26. If the voltage is outside the specified range, replace the control unit of the machine.
   27. If the voltage is within the specified range, replace the termination resistor.
2. DTC U0073 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

Engine Control

Engine Control

(4LE2(24V))

Table of Contents

DTC P0016 (Flash Code 16)
Crankshaft Position - Camshaft Position Correlation

1. DTC P0016 priority DTC

   DTC P0335

   DTC P0336

   DTC P0340

2. DTC P0016 diagnostics

   1. Inspect the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".

   2. If a problem is found, replace the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

   3. Inspect the CMP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor inspection*".

   4. If a problem is found, replace the CMP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor removal*".

      Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor installation*".

   5. Inspect the sensor rotor.

      Note：

      - The sensor rotor should not be damaged.
      - The sensor rotor should not be improperly installed.

   6. If a problem is found, replace the sensor rotor.

   7. Inspect the camshaft gear.

      Note：

      - The camshaft gear should not be damaged.
      - The camshaft gear should not be improperly installed.

   8. If a problem is found, repair the camshaft gear.

3. DTC P0016 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.

   2. Turn OFF the ignition switch for 30 seconds or more.

   3. Start the engine.

      Note：

      - If the engine does not start, crank the engine for 10 seconds.

   4. Perform a test-run.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0087 (Flash Code 225)
Fuel Rail/System Pressure - Too Low

1. DTC P0087 priority DTC

   DTC P0089

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P0087 diagnostics

   1. Start the engine.
   2. Rev the engine several times while observing the DTC information with a trouble diagnosis scan tool.
   3. Observe the DTC information for DTC P0087.
   4. If DTC P0087 is not set, replace the fuel filter.

   Note：

   - An intermittent problem due to foreign material in the fuel is suspected.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

   5. Turn OFF the ignition switch.
   6. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

   specified time： 2 min

   7. Turn ON the ignition switch.
   8. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

   voltage： 0.9 to 1.0 V

   9. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. Inspect each circuit for high resistance.
   14. If a problem is found, repair the circuit.
   15. If the harness connector and each circuit are normal, replace the FRP sensor.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

   Note：

   - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   16. If the Fuel Rail Pressure (FRP) Sensor display is within the standard range, start the engine.
   17. Perform the injector stop test with a trouble diagnosis scan tool.
   18. Command each injector OFF and verify the engine speed changes for each injector.
   19. If there are any injectors that do not change the engine speed when instructed OFF, replace the applicable injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   20. If the injector has been replaced, set the injector ID code on the ECM.
   21. Inspect the fuel system between the fuel tank and the fuel supply pump for clogging.
   22. If a problem is found, repair the clogging in the fuel system.
   23. Inspect the fuel hose between the fuel tank and the fuel supply pump for cuts and cracks.
   24. If a problem is found, replace the fuel hose.

   Note：

   - The fuel hose from the fuel tank to the fuel supply pump becomes slightly vacuumed when the engine is running.
   - If the fuel hose is not connected securely, air may enter.
   - If the engine speed or the engine load increases when air has entered the fuel

system, fluctuation in the common rail (fuel rail) pressure occurs, and DTC P0087 may be set.

25. Check that an appropriate clamp is used between the fuel tank and the fuel supply pump.
26. If a problem is found, replace the clamp.
27. Operate the priming pump until it becomes heavy.

Note：

- When a leakage exists in the fuel system between the priming pump and the fuel supply pump, the pressing weight of the priming pump does not become heavy.

28. Start the engine.
29. Inspect the high-pressure side of the fuel system and check for a fuel leak between the fuel supply pump and the common rail (fuel rail).

Note：

- Fuel may leak under the cylinder head cover from the inlet of the high pressure hose.
- If the fuel leaks under the cylinder head cover, the engine oil level will increase.
- Inspect for a fuel leakage into the engine oil.

30. If a fuel leakage is found, repair.
31. Turn OFF the ignition switch.
32. Remove the fuel hose on the fuel supply pump side from the fuel filter.

Note：

- Use a pan to catch the fuel from the removed fuel hose.
- Clean the pressure gauge and the connection hose before connecting to the fuel pipe.
- The fuel supply pump may be damaged due to foreign material that has entered the connection hose.

33. Connect the pressure gauge between the fuel filter and the removed fuel hose.

Note：

- Verify that the fuel system is connected securely.

34. Remove the air using the priming pump, and crank the engine for the specified period of time or less.

specified time： 5 s

Note：

- Repeat the process until the engine starts.

35. Allow the engine to idle for the specified duration or longer.

specified time： 1 min

36. Observe the pressure gauge while maintaining the engine at the specified engine speed for the specified duration.

specified time： 1 min

rotational speed： 2300 r/min

37. Verify that the pressure gauge shows a vacuum of the specified value or more during inspection.

Specified value: (-17.0) kPa {5 inHg / (-2) psi}

Note：

- Checking the vacuum amount is a method used to check for clogging of the fuel system.

38. If the vacuum is more than or equal to the specified value, inspect the fuel system between the fuel supply pump and the fuel tank for collapsing and twisting.
39. If a problem is found, repair the fuel system.
40. Inspect the fuel tank vent hose.
41. If a problem is found, repair the vent hose.
42. Check for foreign material in the fuel tank or for foreign material that can cause fuel clogging.
43. If a problem is found, repair.
44. Replace the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

45. If the vacuum is less than or equal to the specified value, pinch the fuel hose at a position as close as possible to the fuel tank, so that the fuel does not flow.

Note：

- Disconnect the fuel pipe, and a plug can be applied.

46. Start the engine and use the idling control switch to increase the speed to the highest level.
47. Check the pressure gauge.

Specified value: (-27.0) kPa {8 inHg / (-4) psi}

Note：

- If the pressure gauge is likely to indicate a value exceeding the specified value during inspection, release the fuel being blocked.
- Checking the vacuum amount when the fuel flow is blocked is a method used to check for air intrusion.

48. If the specified vacuum cannot be generated, inspect the fuel hose for cuts or cracks.
49. If a problem is found, replace the fuel hose.
50. Inspect whether a proper clamp is used.
51. If a problem is found, replace the clamp with a proper one.
52. Turn OFF the ignition switch.
53. Inspect for poor connections at the suction control valve harness connector.
54. If a problem is found, repair the harness connector.
55. Inspect for poor connections at the ECM harness connector.
56. If a problem is found, repair the harness connector.
57. Inspect each circuit for high resistance.
58. If a problem is found, repair the circuit.
59. If the suction control valve harness connector and the ECM harness connector are normal and there is no high resistance in each circuit, replace the fuel supply pump and the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

Note :

- When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

3. DTC P0087 confirm resolution

1. Clear the DTC with a trouble diagnosis scan tool.
2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0089 (Flash Code 151)
Fuel Pressure Regulator Performance

1. DTC P0089 priority DTC

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P0089 diagnostics

   1. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time : 2 min

   2. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

      values : 0.9 to 1.0 V

   3. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   4. If a problem is found, repair the harness connector.
   5. Inspect for poor connections at the ECM harness connector.
   6. If a problem is found, repair the harness connector.
   7. Inspect each circuit for high resistance.
   8. If a problem is found, repair the circuit.
   9. If the harness connector and each circuit are normal, replace the FRP sensor.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

      Note :

      - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   10. Inspect for poor connections at the suction control valve harness connector.
   11. If a problem is found, repair the harness connector.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. Inspect each circuit for high resistance.
   15. If a problem is found, repair the circuit.
   16. Turn OFF the ignition switch for 30 seconds or more.
   17. Start the engine.
   18. Rev the engine several times while observing the Actual Fuel Rail Pressure display on the trouble diagnosis scan tool.
   19. Observe the Actual Fuel Rail Pressure display on the trouble diagnosis scan tool, and verify that it is within the specified range at a sufficient rate.

      Specified value : (-5) - 5 MPa

      Note :

      - If possible, compare with other machines with the same engine equipped.

   20. If the reading is within the specified range, replace the fuel filter.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

   21. If the reading is outside the specified range, replace the fuel supply pump and the fuel filter.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

      Note :

      - When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

3. DTC P0089 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.

4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0091 (Flash Code 247)
Fuel Pressure Regulator Control Circuit Low

1. DTC P0091 diagnostics
   1. Observe the SCVRPCV Drive Electric Current Feedback display on the trouble diagnosis scan tool.

      current： 300 to 900 mA
   2. If the reading is more than or equal to the specified value, inspect the High side circuit between the ECM and the suction control valve for a short to the battery or a short to the ignition power supply.

      Note：
      - When the High side circuit is shorted to voltage, the engine stalls and does not start.
   3. If a problem is found, repair the High side circuit.
   4. If the reading is within the specified range, inspect the Low side circuit between the ECM and the suction control valve for a short to GND.

      Note：
      - When the Low side circuit is shorted to GND, DTC P0091 may not be set.
      - When the Low side circuit is shorted to GND, the engine stalls and does not start.
   5. If a problem is found, repair the Low side circuit.
   6. Turn OFF the ignition switch for 30 seconds or more.
   7. Disconnect the harness connector from the suction control valve.
   8. Connect a test lamp between the suction control valve High side circuit and a known good GND.
   9. Turn ON the ignition switch.
   10. Verify that the test lamp illuminates and then goes OFF.
   11. If it does not turn OFF, inspect the High side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
       - There should be no short to the Low side circuit.
   12. If a problem is found, repair the High side circuit.
   13. Turn OFF the ignition switch for 30 seconds or more.
   14. Connect a test lamp between the suction control valve Low side circuit and the battery power supply.
   15. Turn ON the ignition switch.
   16. Verify that the test lamp illuminates and then goes OFF.
   17. If it does not turn OFF, inspect the Low side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to the battery or the ignition power supply.
   18. If a problem is found, repair the Low side circuit.
   19. Inspect for poor connections at the suction control valve harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the suction control valve.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve installation*".
   22. Inspect for poor connections at the ECM harness connector.
   23. If a problem is found, repair the harness connector.
   24. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   25. Set the injector ID code on the ECM.
2. DTC P0091 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0092 (Flash Code 247)
Fuel Pressure Regulator Control Circuit High

1. DTC P0092 diagnostics
   1. Observe the SCVRPCV Drive Electric Current Feedback display on the trouble diagnosis scan tool.

      current： 300 to 900 mA
   2. If the reading is more than or equal to the specified value, inspect the High side circuit between the ECM and the suction control valve for a short to the battery or a short to the ignition power supply.

      Note：
      - When the High side circuit is shorted to voltage, the engine stalls and does not start.
   3. If a problem is found, repair the High side circuit.
   4. If the reading is within the specified range, inspect the Low side circuit between the ECM and the suction control valve for a short to GND.

      Note：
      - When the Low side circuit is shorted to GND, DTC P0092 may not be set.
      - When the Low side circuit is shorted to GND, the engine stalls and does not start.
   5. If a problem is found, repair the Low side circuit.
   6. Turn OFF the ignition switch for 30 seconds or more.
   7. Disconnect the harness connector from the suction control valve.
   8. Connect a test lamp between the suction control valve High side circuit and a known good GND.
   9. Turn ON the ignition switch.
   10. Verify that the test lamp illuminates and then goes OFF.
   11. If it does not turn OFF, inspect the High side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
       - There should be no short to the Low side circuit.
   12. If a problem is found, repair the High side circuit.
   13. Turn OFF the ignition switch for 30 seconds or more.
   14. Connect a test lamp between the suction control valve Low side circuit and the battery power supply.
   15. Turn ON the ignition switch.
   16. Verify that the test lamp illuminates and then goes OFF.
   17. If it does not turn OFF, inspect the Low side circuit between the ECM and the suction control valve.

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to the battery or the ignition power supply.
   18. If a problem is found, repair the Low side circuit.
   19. Inspect for poor connections at the suction control valve harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the suction control valve.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Suction control valve installation*".
   22. Inspect for poor connections at the ECM harness connector.
   23. If a problem is found, repair the harness connector.
   24. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   25. Set the injector ID code on the ECM.
2. DTC P0092 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0093 (Flash Code 227)
Fuel System Leak Detected

1. DTC P0093 priority DTC
   - DTC P0087
   - DTC P0091
   - DTC P0092
   - DTC P0192
   - DTC P0193
   - DTC P0201
   - DTC P0202
   - DTC P0203
   - DTC P0204
   - DTC P2146
   - DTC P2149
2. DTC P0093 diagnostics
   1. Inspect the high pressure side between the fuel supply pump and the injector for a fuel leakage.

      Note：
      - There should be no fuel leakage from the fuel supply pump.
      - There should be no fuel leakage from the common rail (fuel rail).
      - There should be no fuel leakage from the pressure limiter valve.
      - There should be no fuel leakage from the FRP sensor.
      - There should be no fuel leakage from the fuel pipe between the fuel supply pump and the common rail (fuel rail).
      - There should be no fuel leakage from the fuel pipe between the common rail (fuel rail) and the injector.
      - There should be no fuel leakage from the sleeve nut of the fuel pipe.
   2. If a fuel leakage is found, repair.

      Note：
      - The fuel may leak under the cylinder head cover from the inlet of the high pressure pipe.
      - If the fuel leaks under the cylinder head cover, the engine oil level will increase.
      - Inspect for a fuel leakage into the engine oil.
      - Remove and inspect the high pressure pipe joints connected to the injectors to verify that fuel is not leaking from the sleeve nuts.
      - If contact is being made with foreign material, replace the injector and the high pressure pipe.
   3. Remove each glow plug from the cylinder head assembly.

      Refer to "*1.Engine 1J.Electrical(4LE2) Glow plug removal*".
   4. Inspect for fuel leakage into the combustion chamber.
   5. Inspect for a cylinder that is leaking fuel into the combustion chamber.
   6. If a fuel leakage is found, replace the applicable injector.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".
   7. If the injector has been replaced, set the injector ID code on the ECM.
   8. Turn OFF the ignition switch.
   9. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time： 2 min
   10. Turn ON the ignition switch.
   11. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

       voltage： 0.9 to 1.0 V
   12. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   13. If a problem is found, repair the harness connector.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. Inspect each circuit for high resistance.
   17. If a problem is found, repair the circuit.
   18. If the harness connector and each circuit are normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

Note :

- Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

19. If the Fuel Rail Pressure (FRP) Sensor display is within the standard range, start the engine.
20. Perform the injector stop test with a trouble diagnosis scan tool.
21. Command each injector OFF and verify the engine speed changes for each injector.
22. If there are any injectors that do not change the engine speed when instructed OFF, replace the applicable injector.

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

23. If the injector has been replaced, set the injector ID code on the ECM.
24. Inspect the fuel system between the fuel tank and the fuel supply pump for clogging.
25. If a problem is found, repair clogging.
26. Inspect the fuel hose in the fuel system between the fuel tank and the fuel supply pump for cuts or cracks.
27. If a problem is found, replace the fuel hose.

Note :

- The fuel hose between the fuel tank and the supply pump becomes slightly vacuumed when the engine is running.
- If the fuel hose is not connected securely, air may enter.
- If the engine speed or the engine load increases when air has entered the fuel system, fluctuation in the common rail (fuel rail) pressure occurs, and DTC P0093 may be set.

28. Check that an appropriate clamp is used between the fuel tank and the fuel supply pump.
29. If a problem is found, replace the clamp with a proper one.
30. Operate the priming pump until it becomes heavy.

Note :

- When a leakage exists in the fuel system between the priming pump and the fuel supply pump, the pressing weight of the priming pump does not become heavy.

31. Start the engine.
32. Inspect the high-pressure side of the fuel system and check for a fuel leak between the fuel supply pump and the common rail (fuel rail).

Note :

- Fuel may leak under the cylinder head cover from the inlet of the high pressure hose.
- If the fuel leaks under the cylinder head cover, the engine oil level will increase.
- Inspect for a fuel leakage into the engine oil.

33. If a fuel leakage is found, repair.
34. Turn OFF the ignition switch.
35. Remove the fuel hose on the fuel supply pump side from the fuel filter.

Note :

- Use a pan to catch the fuel from the removed fuel hose.
- Clean the pressure gauge and the connection hose before connecting to the fuel pipe.
- The fuel supply pump may be damaged due to foreign material that has entered the connection hose.

36. Connect the pressure gauge between the fuel filter and the removed fuel hose.

Note :

- Verify that the fuel system is connected securely.

37. Remove the air using the priming pump, and crank the engine for the specified period of time or less.

specified time : 5 s

Note :

- Repeat the process until the engine starts.

38. Allow the engine to idle for the specified duration or longer.

specified time : 1 min

39. Observe the pressure gauge while maintaining the engine at the specified engine speed for the specified duration.

specified time : 1 min

rotational speed : 2300 r/min

40. Verify that the pressure gauge shows a vacuum of the specified value or more during inspection.

Specified value: (-17.0) kPa {5 inHg / (-2) psi}

Note :

- Checking the vacuum amount is a method used to check for clogging of the fuel system.

41. If the vacuum is more than or equal to the specified value, inspect the fuel system between the fuel supply pump and the fuel tank for collapsing and twisting.
42. If a problem is found, repair the fuel system.
43. Inspect the fuel tank vent hose.
44. If a problem is found, repair the vent hose.
45. Check for foreign material in the fuel tank or for foreign material that can cause fuel clogging.
46. If a problem is found, repair.
47. Replace the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

48. If the vacuum is less than or equal to the specified value, pinch the fuel hose at a position as close as possible to the fuel tank, so that the fuel does not flow.

Note：

- Disconnect the fuel pipe, and a plug can be applied.

49. Start the engine and use the idling control switch to increase the speed to the highest level.
50. Check the pressure gauge.

Specified value: (-27.0) kPa {8 inHg / (-4) psi}

Note：

- If the pressure gauge is likely to indicate a value exceeding the specified value during inspection, release the fuel being blocked.
- Checking the vacuum amount when the fuel flow is blocked is a method used to check for air intrusion.

51. If the specified vacuum cannot be generated, inspect the fuel hose for cuts or cracks.
52. If a problem is found, replace the fuel hose.
53. Inspect whether a proper clamp is used.
54. If a problem is found, replace the clamp with a proper one.
55. Turn OFF the ignition switch.
56. Inspect for poor connections at the suction control valve harness connector.
57. If a problem is found, repair the harness connector.
58. Inspect for poor connections at the ECM harness connector.
59. If a problem is found, repair the harness connector.
60. Inspect each circuit for high resistance.
61. If a problem is found, repair the circuit.
62. If the suction control valve harness connector and the ECM harness connector are normal and there is no high resistance in each circuit, replace the fuel supply pump and the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

Note：

- When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

3. DTC P0093 confirm resolution

1. Clear the DTC with a trouble diagnosis scan tool.
2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0112 (Flash Code 22)
Intake Air Temperature Sensor Circuit Low

1. DTC P0112 priority DTC

   DTC P0641

2. DTC P0112 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IAT sensor.
   3. Observe the Intake Air Temperature Sensor display on the trouble diagnosis scan tool.

      values : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the IAT sensor.
   5. Inspect the signal circuit between the ECM and the IAT sensor for a short to GND.
   6. If a problem is found, repair the signal circuit.
   7. Turn OFF the ignition switch.
   8. Disconnect the harness connector from the ECM.
   9. Inspect for poor connections at the ECM harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   12. Set the injector ID code on the ECM.
3. DTC P0112 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0113 (Flash Code 22)
Intake Air Temperature Sensor Circuit High

1. DTC P0113 priority DTC

   DTC P0641

2. DTC P0113 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IAT sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the IAT sensor signal circuit and a known good GND.

      values : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the IAT sensor.

      Note :

      - There should be no short to the battery or the ignition power supply.
      - There should be no short to the 12 V power supply.

   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the IAT sensor signal circuit and the GND circuit.
   8. Observe the Intake Air Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the IAT sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the IAT sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the IAT sensor.
   14. Connect a fused jumper wire between the IAT sensor signal circuit and a known good GND.
   15. Observe the intake air temperature sensor display on the trouble diagnosis scan tool.

       values : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and the IAT sensor for an open circuit or high resistance.

       Note :

       - The IAT sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the IAT sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0113 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0117 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit Low

1. DTC P0117 priority DTC

   DTC P0697

2. DTC P0117 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the engine coolant temperature sensor.
   3. Observe the Coolant Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the engine coolant temperature sensor.

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor removal*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor installation*".

   5. Inspect the signal circuit between the ECM and engine coolant temperature sensor for a short to the GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P0117 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0118 (Flash Code 23)
Engine Coolant Temperature Sensor Circuit High

1. DTC P0118 priority DTC

   DTC P0697

2. DTC P0118 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the engine coolant temperature sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the engine coolant temperature sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the engine coolant temperature sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the engine coolant temperature sensor signal circuit and the GND circuit.
   8. Observe the Coolant Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the engine coolant temperature sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the engine coolant temperature sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the engine coolant temperature sensor.

       Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor removal*".

       Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor installation*".

   14. Connect a fused jumper wire between the engine coolant temperature sensor signal circuit and a known good GND.
   15. Observe the coolant temperature sensor display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the engine coolant temperature sensor GND circuit for an open circuit or high resistance.

       Note :
       - The engine coolant temperature sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the engine coolant temperature sensor signal circuit for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0118 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0182 (Flash Code 211)
Fuel Temperature Sensor Circuit Low

1. DTC P0182 priority DTC

   DTC P1655

2. DTC P0182 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the fuel temperature sensor.
   3. Observe the Fuel Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the fuel temperature sensor.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

      Note :

      - Do not replace the fuel temperature sensor separately. If a problem is found, replace the fuel supply pump.

   5. Inspect the signal circuit between the ECM and fuel temperature sensor for a short to GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P0182 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0183 (Flash Code 211)
Fuel Temperature Sensor Circuit High

1. DTC P0183 priority DTC

   DTC P1655

2. DTC P0183 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the fuel temperature sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the fuel temperature sensor signal circuit and a known good GND.

      values : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the fuel temperature sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the fuel temperature sensor signal circuit and the GND circuit.
   8. Observe the Fuel Temperature Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the fuel temperature sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the fuel temperature sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the fuel temperature sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

       Note :

       - Do not replace the fuel temperature sensor separately. If a problem is found, replace the fuel supply pump.

   14. Connect a fused jumper wire between the fuel temperature sensor signal circuit and a known good GND.
   15. Observe the Fuel Temperature Sensor display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and the fuel temperature sensor for an open circuit or high resistance.

       Note :

       - The fuel temperature sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the fuel temperature sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P0183 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.

      Note :

      - Run the engine for 3 minutes or longer.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0192 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit Low

1. DTC P0192 priority DTC

   DTC P0641

2. DTC P0192 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the FRP sensor.
   3. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the FRP sensor for a short to GND.
   5. If a problem is found, repair the signal circuit.
   6. Measure the voltage between the FRP sensor 5 V power supply circuit and a known good GND.

      voltage : 4.5 V

   7. If the reading is more than or equal to the specified value, inspect for poor connections at the FRP sensor harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the FRP sensor.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

      Note :

      - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   10. Inspect the 5 V power supply circuit between the ECM and the FRP sensor for an open circuit or high resistance.

       Note :

       - The FRP sensor shares the 5 V power supply circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   11. If a problem is found, repair the 5 V power supply circuit.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   15. Set the injector ID code on the ECM.

3. DTC P0192 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0193 (Flash Code 245)
Fuel Rail Pressure Sensor Circuit High

1. DTC P0193 priority DTC

   DTC P0641

2. DTC P0193 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the FRP sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the FRP sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the FRP sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Measure the voltage between the FRP sensor signal circuit and a known good GND.

      voltage : 4.5 V

   8. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the FRP sensor for a short to the 5 V power supply circuit.
   9. If a problem is found, repair the signal circuit.
   10. Connect a fused jumper wire between the FRP sensor signal circuit and the GND circuit.
   11. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   12. If the reading is less than or equal to the specified value, inspect for poor connections at the FRP sensor harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

       Note :

       - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   15. Inspect the GND circuit between the ECM and the FRP sensor for an open circuit or high resistance.

       Note :

       - The FRP sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   16. If a problem is found, repair the GND circuit.
   17. Inspect the signal circuit between the ECM and the FRP sensor for an open circuit or high resistance.
   18. If a problem is found, repair the signal circuit.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Set the injector ID code on the ECM.

3. DTC P0193 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0201 (Flash Code 271)
Injector Circuit - Cylinder 1

1. DTC P0201 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 1 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 1 injector.

   values : 1.0 Ω

   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 1 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 1 cylinder injector harness connector charge voltage circuit and the frame ground.

   values : 1.0 V

   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 1 cylinder injector.

   Note :
   - There should be no short to the charge voltage circuit.

   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 1 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 16.0 V

   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 1 cylinder injector.

   Note :
   - There should be no short to the battery power supply or no short to the ignition power supply circuit.

   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 1 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 12.0 V

   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 1 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 1 cylinder injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   Note :
   - If the injector has been replaced, set the injector ID code on the ECM.

   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 1 cylinder injector.

   Note :
   - There should be no open circuit or high resistance.

   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Perform the injector ID code setting on the ECM.
2. DTC P0201 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0202 (Flash Code 272)
Injector Circuit - Cylinder 2

1. DTC P0202 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 2 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 2 injector.

   values : 1.0 Ω

   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 2 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 2 cylinder injector harness connector charge voltage circuit and the frame ground.

   values : 1.0 V

   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 2 cylinder injector.

   Note :
   - There should be no short to the charge voltage circuit.

   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 2 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 16.0 V

   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 2 cylinder injector.

   Note :
   - There should be no short to the battery power supply or no short to the ignition power supply circuit.

   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 2 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 12.0 V

   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 2 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 2 cylinder injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   Note :
   - If the injector has been replaced, set the injector ID code on the ECM.

   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 2 cylinder injector.

   Note :
   - There should be no open circuit or high resistance.

   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Perform the injector ID code setting on the ECM.
2. DTC P0202 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0203 (Flash Code 273)
Injector Circuit - Cylinder 3

1. DTC P0203 diagnostics
    1. Turn OFF the ignition switch.
    2. Disconnect the harness connector from the No. 3 cylinder injector.
    3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 3 injector.

    values : 1.0 Ω

    4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 3 cylinder injector.
    5. Turn ON the ignition switch.
    6. Measure the voltage between the No. 3 cylinder injector harness connector charge voltage circuit and the frame ground.

    values : 1.0 V

    7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 3 cylinder injector.

    Note :
    - There should be no short to the charge voltage circuit.

    8. If a problem is found, repair the control circuit.
    9. If the reading is less than or equal to the specified value, measure the voltage between the No. 3 cylinder injector harness connector solenoid control circuit and the frame ground.

    values : 16.0 V

    10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 3 cylinder injector.

    Note :
    - There should be no short to the battery power supply or no short to the ignition power supply circuit.

    11. If a problem is found, repair the control circuit.
    12. If the reading is less than or equal to the specified value, measure the voltage between the No. 3 cylinder injector harness connector solenoid control circuit and the frame ground.

    values : 12.0 V

    13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 3 cylinder injector harness connector.
    14. If a problem is found, repair the harness connector.
    15. If the harness connector is normal, replace the No. 3 cylinder injector.

    Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

    Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

    Note :
    - If the injector has been replaced, set the injector ID code on the ECM.

    16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 3 cylinder injector.

    Note :
    - There should be no open circuit or high resistance.

    17. If a problem is found, repair the control circuit.
    18. Disconnect the harness connector from the ECM.
    19. Inspect for poor connections at the ECM harness connector.
    20. If a problem is found, repair the harness connector.
    21. If the harness connector is normal, replace the ECM.

    Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

    Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

    22. Perform the injector ID code setting on the ECM.
2. DTC P0203 confirm resolution
    1. Clear the DTC with a trouble diagnosis scan tool.
    2. Turn OFF the ignition switch for 30 seconds or more.
    3. Start the engine.
    4. Perform a test-run.
    5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0204 (Flash Code 274)
Injector Circuit - Cylinder 4

1. DTC P0204 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the No. 4 cylinder injector.
   3. Measure the resistance in the charge voltage circuit between the ECM and the cylinder No. 4 injector.

   values : 1.0 Ω

   4. If the reading is more than or equal to the specified value, repair an open circuit or high resistance in the charge voltage circuit between the ECM and the No. 4 cylinder injector.
   5. Turn ON the ignition switch.
   6. Measure the voltage between the No. 4 cylinder injector harness connector charge voltage circuit and the frame ground.

   values : 1.0 V

   7. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 4 cylinder injector.

   Note :
   - There should be no short to the charge voltage circuit.

   8. If a problem is found, repair the control circuit.
   9. If the reading is less than or equal to the specified value, measure the voltage between the No. 4 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 16.0 V

   10. If the reading is more than or equal to the specified value, inspect the control circuit between the ECM and the No. 4 cylinder injector.

   Note :
   - There should be no short to the battery power supply or no short to the ignition power supply circuit.

   11. If a problem is found, repair the control circuit.
   12. If the reading is less than or equal to the specified value, measure the voltage between the No. 4 cylinder injector harness connector solenoid control circuit and the frame ground.

   values : 12.0 V

   13. If the reading is more than or equal to the specified value, inspect for poor connections at the No. 4 cylinder injector harness connector.
   14. If a problem is found, repair the harness connector.
   15. If the harness connector is normal, replace the No. 4 cylinder injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   Note :
   - If the injector has been replaced, set the injector ID code on the ECM.

   16. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the No. 4 cylinder injector.

   Note :
   - There should be no open circuit or high resistance.

   17. If a problem is found, repair the control circuit.
   18. Disconnect the harness connector from the ECM.
   19. Inspect for poor connections at the ECM harness connector.
   20. If a problem is found, repair the harness connector.
   21. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   22. Perform the injector ID code setting on the ECM.
2. DTC P0204 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0217 (Flash Code 542)
Engine Coolant Over Temperature Condition

1. DTC P0217 priority DTC

   DTC P0117

2. DTC P0217 diagnostics

   1. Inspect the engine cooling system.

      Refer to "*1.Engine 1D.Cooling(4LE2) Coolant inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Cooling fan belt inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Thermostat inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Water pump assembly inspection*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Radiator inspection*".

   2. While observing the Coolant Temperature display on the trouble diagnosis scan tool, start the engine.
   3. Wait until the engine has been completely warmed up.
   4. Observe the Coolant Temperature display on the trouble diagnosis scan tool, and verify that it is more than or equal to the specified value.

      values： 100 ℃ { 212 °F }

   5. If the reading is less than or equal to the specified value, check with the operator if the overheat has occurred due to low engine coolant level, etc.
   6. If engine overheat has occurred in the past, make sure to inspect the engine.
   7. Inspect the engine coolant temperature sensor.

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor inspection*".

   8. If an error is found in the inspection results, replace the engine coolant temperature sensor.

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor removal*".

      Refer to "*1.Engine 1D.Cooling(4LE2) Engine coolant temperature sensor installation*".

3. DTC P0217 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. While observing the Coolant Temperature display on the trouble diagnosis scan tool, start the engine and wait until it is completely warmed up.
   4. Verify that the Coolant Temperature display does not show a value more than or equal to the specified value.

      values： 100 ℃ { 212 °F }

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0219 (Flash Code 543)
Engine Overspeed Condition

1. DTC P0219 priority DTC

   DTC P0335

   DTC P0336

2. DTC P0219 diagnostics
   1. Turn OFF the ignition switch for 30 seconds.
   2. Start the engine.
   3. Observe the Engine Speed display on the trouble diagnosis scan tool.
   4. Increase the engine speed as necessary.
   5. Observe the Engine Speed display on the trouble diagnosis scan tool.
   6. If the maximum revolution speed without load has not been exceeded, check with the operator if any operational error due to overrun has occurred.
   7. If engine overrun has occurred in the past, make sure to inspect the engine.
   8. Inspect the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".
   9. If an error is found in the inspection results, replace the CKP sensor.

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

      Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

3. DTC P0219 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start and rev the engine a few times in neutral between the idling speed and the maximum speed without load while observing the Engine Speed display on the trouble diagnosis scan tool.
   4. Verify that the Engine Speed display does not exceed the maximum speed without load.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0237 (Flash Code 32)
Turbocharger Boost Sensor Circuit Low

1. DTC P0237 priority DTC

   DTC P1655

2. DTC P0237 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between 5 V power supply circuit of the boost pressure sensor harness connector and a known good GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the boost pressure sensor for an open circuit or high resistance.

      Note :

      - The boost pressure sensor shares the 5 V power supply circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the boost pressure sensor harness connector 5 V power supply circuit and the signal circuit.
   8. Observe the Manifold Absolute Pressure Sensor display on the trouble diagnosis scan tool.

      values : 4.5 V

   9. If the reading is more than or equal to the specified value, inspect for poor connections at the boost pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the boost pressure sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   12. Inspect the signal circuit between the ECM and the boost pressure sensor.

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   17. Set the injector ID code on the ECM.

3. DTC P0237 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0238 (Flash Code 32)
Turbocharger Boost Sensor Circuit High

1. DTC P0238 priority DTC

   DTC P1655

2. DTC P0238 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost pressure sensor.
   3. Observe the boost pressure sensor display on the trouble diagnosis scan tool.

      voltage： 0.1 V
   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the boost pressure sensor.

      Note：
      - There should be no short to the battery or no short to the ignition power supply.
      - There should be no short to the 5 V power supply.
   5. If a problem is found, repair the signal circuit.
   6. Inspect the GND circuit between the ECM and the boost pressure sensor for an open circuit or high resistance.

      Note：
      - The boost pressure sensor shares the GND circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.
   7. If a problem is found, repair the GND circuit.
   8. Inspect for poor connections at the boost pressure sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. If the harness connector is normal, replace the boost pressure sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".
   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   14. Set the injector ID code on the ECM.

3. DTC P0238 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0335 (Flash Code 15)
Crankshaft Position Sensor Circuit

1. DTC P0335 priority DTC

   DTC P0340

   DTC P0641

2. DTC P0335 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the CKP sensor
   3. Turn ON the ignition switch.
   4. Measure the voltage between the 5 V power supply circuit of the CKP sensor harness connector and a known good GND.

      voltage : 4.5 V
   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the CKP sensor for an open circuit or high resistance.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Measure the voltage between the signal circuit of the CKP sensor harness connector and a known good GND.

      voltage : 5.5 V
   8. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CKP sensor for a short to the battery or a short to the ignition power supply.
   9. If a problem is found, repair the signal circuit.
   10. Measure the voltage between the CKP sensor harness connector signal circuit and a known good GND again.

       values : 4.5 V
   11. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the CKP sensor.

       Note :
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
   12. If a problem is found, repair the signal circuit.
   13. Connect a test lamp between the signal circuit of the CKP sensor harness connector and a known good GND.
   14. Measure the voltage between the probe of the test lamp and a known good GND.

       voltage : 4.5 V
   15. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CKP sensor for a short to the 5 V power supply circuit.
   16. If a problem is found, repair the signal circuit.
   17. Measure the voltage between the 5 V power supply circuit of the CKP sensor harness connector and the GND circuit.

       voltage : 4.5 V
   18. If the reading is more than or equal to the specified value, inspect for poor connections at the CKP sensor harness connector.
   19. If a problem is found, repair the harness connector.
   20. If the harness connector is normal, inspect the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".
   21. If a problem is found, replace the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".
   22. Inspect the GND circuit between the ECM and the CKP sensor for an open circuit or high resistance.

       Note :
       - The CKP sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.
   23. If a problem is found, repair the GND circuit.
   24. Inspect for poor connections at the ECM harness connector.
   25. If a problem is found, repair the harness connector.
   26. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   27. Set the injector ID code on the ECM.

3. DTC P0335 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0336 (Flash Code 15)
Crankshaft Position Sensor Circuit Range/Performance

1. DTC P0336 priority DTC

   DTC P0335

   DTC P0340

   DTC P0641

2. DTC P0336 diagnostics

   1. Inspect the CKP sensor circuit.

      Note :

      - It should not be too close to the wiring or components of the fuel injection device.
      - It should not be too close to any electronic device that was additionally installed.
      - It should not be too close to the solenoid and relay

   2. If a problem is found, repair the CKP sensor circuit.
   3. Turn OFF the ignition switch.
   4. Disconnect the harness connector from the ECM.
   5. Inspect for poor connections at the ECM harness connector.
   6. If a problem is found, repair the harness connector.
   7. Disconnect the harness connector from the CKP sensor
   8. Inspect for poor connections at the CKP sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. Inspect the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor inspection*".

   11. If a problem is found, replace the CKP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

       Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

3. DTC P0336 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0340 (Flash Code 14)
Camshaft Position Sensor Circuit

1. DTC P0340 priority DTC

   DTC P0601

   DTC P0651

2. DTC P0340 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the CMP sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the 5 V power supply circuit of the CMP sensor harness connector and a known good GND.

      voltage： 4.5 V
   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the CMP sensor for an open circuit or high resistance.

      Note：
      - The CMP sensor shares the 5 V power supply circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Measure the voltage between the signal circuit of the CMP sensor harness connector and a known good GND.

      voltage： 5.5 V
   8. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CMP sensor for a short to the battery or a short to the ignition power supply.
   9. If a problem is found, repair the signal circuit.
   10. Measure the voltage between the CMP sensor harness connector signal circuit and a known good GND again.

       voltage： 4.5 V
   11. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the CMP sensor

       Note：
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
   12. If a problem is found, repair the signal circuit.
   13. Connect a test lamp between the signal circuit of the CMP sensor harness connector and a known good GND.
   14. Measure the voltage between the probe of the test lamp and a known good GND.

       voltage： 4.5 V
   15. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the CMP sensor for a short to the 5 V power supply circuit.
   16. If a problem is found, repair the signal circuit.
   17. Measure the voltage between the 5 V power supply circuit of the CMP sensor harness connector and the GND circuit.

       voltage： 4.5 V
   18. If the reading is more than or equal to the specified value, inspect for poor connections at the CMP sensor harness connector.
   19. If a problem is found, repair the harness connector.
   20. If the harness connector is normal, inspect the CMP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor inspection*".
   21. If a problem is found, replace the CMP sensor.

       Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor removal*".

       Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor installation*".
   22. Inspect the camshaft gear.

       Note：
       - The camshaft gear should not be damaged.
       - The camshaft gear should not be improperly installed.
   23. If a problem is found, repair the camshaft gear.
   24. Inspect the GND circuit between the ECM and the CMP sensor for an open circuit or high resistance.

       Note：
       - The CMP sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

25. If a problem is found, repair the GND circuit.
26. Inspect for poor connections at the ECM harness connector.
27. If a problem is found, repair the harness connector.
28. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

29. Set the injector ID code on the ECM.

3. DTC P0340 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0380 (Flash Code 66)
Glow Plug Circuit

1. DTC P0380 diagnostics
   1. Turn OFF the ignition switch.
   2. Replace the glow relay with a starter relay or a known good relay.
   3. Perform the glow relay test with a trouble diagnosis scan tool.
   4. Command the glow relay ON and OFF.
   5. Verify that the operation sound of the glow relay is heard upon execution of each command.
   6. If the operating sound of the glow relay can be heard, remove the glow relay.
   7. Inspect for poor connections at the glow relay terminal.
   8. If a problem is found, repair the glow relay terminal.
   9. If the glow relay terminal is normal, replace the glow relay.
   10. Turn OFF the ignition switch.
   11. Inspect circuit between the ignition switch and the glow relay coil side for an open circuit or high resistance.
   12. If a problem is found, repair the circuit between the ignition switch and the glow relay coil side.
   13. Inspect the control circuit between the ECM and glow relay.

   Note :
   - There should be no open circuit or high resistance.
   - There should be no short to GND.

   14. If a problem is found, repair the control circuit.
   15. Inspect for poor connections at the ECM harness connector.
   16. If a problem is found, repair the harness connector.
   17. If the ECM harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   18. Set the injector ID code on the ECM.
2. DTC P0380 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Perform the glow relay test with a trouble diagnosis scan tool, and command ON and OFF.
   4. Verify that the operation sound of the glow relay is made upon execution of each command.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0404 (Flash Code 45)
Exhaust Gas Recirculation 1 Control Circuit Range/Performance

1. DTC P0404 priority DTC

   DTC P0409

2. DTC P0404 diagnostics
   1. Remove the EGR valve assembly from the engine.

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".
   2. Inspect the EGR valve.

      Note :
      - There should be nothing to restrict the flow inside the EGR valve.
      - There should be no excessive deposits inside the EGR valve.
      - There should be no bending in the valve shaft or the valve itself in the EGR valve.
   3. Turn OFF the ignition switch.
   4. Disconnect the harness connector from the EGR valve.
   5. Inspect for poor connections at the EGR valve harness connector.
   6. If a problem is found, repair the harness connector.
   7. Disconnect the harness connector from the ECM.
   8. Inspect for poor connections at the ECM harness connector.
   9. If a problem is found, repair the harness connector.
   10. Inspect the EGR control circuit for an open circuit or high resistance.
   11. If a problem is found, repair the EGR control circuit.
   12. Inspect the EGR solenoid circuit between the ECM and the EGR valve.

       Note :
       - There should be no short to GND.
       - There should be no short to the battery or no short to the ignition power supply circuit.
       - There should be no short together between circuits.
       - There should be no short to the EGR position sensor circuit.
   13. If a problem is found, repair the EGR solenoid circuit.
   14. If the EGR solenoid circuit is normal, replace the EGR valve.

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".
   15. Restore the machine.
   16. Turn ON the ignition switch.
   17. Clear the DTC with a trouble diagnosis scan tool.
   18. Turn OFF the ignition switch for 30 seconds or more.
   19. Start the engine.
   20. Perform a test-run.
   21. Observe the DTC information with a trouble diagnosis scan tool.
   22. If DTC P0404 is set, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   23. Set the injector ID code on the ECM.
3. DTC P0404 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0409 (Flash Code 44)
Exhaust Gas Recirculation 1 Sensor Circuit

1. DTC P0409 priority DTC

   DTC P1655

2. DTC P0409 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the EGR valve.
   3. Turn ON the ignition switch.
   4. Observe the EGR Brushless Position 1, EGR Brushless Position 2, and EGR Brushless Position 3 data displays on the trouble diagnosis scan tool for any display that shows ON.
   5. If there is a data display showing ON, inspect the signal circuit between the ECM and the EGR valve of the EGR showing ON.

   Note：
   - There should be no short to the battery or the ignition power supply.
   - There should be no short to 5 V power supply circuit.

   6. If a problem is found, repair the signal circuit.
   7. Measure the voltage between the EGR position sensor 5 V power supply circuit and a known good GND circuit.

   voltage： 4.5 V

   8. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the EGR position sensor for an open circuit or high resistance.

   Note：
   - The EGR position sensor shares the 5 V power supply circuit with other sensors.
   - DTCs on sensors that share this circuit may be set.

   9. If a problem is found, repair the 5 V power supply circuit.
   10. Measure the voltage between the EGR position sensor 5 V power supply circuit and the GND circuit.

   voltage： 4.5 V

   11. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and EGR position sensor for an open circuit or high resistance.

   Note：
   - The EGR position sensor shares the GND circuit with other sensors.
   - DTCs on sensors that share this circuit may be set.

   12. If a problem is found, repair the GND circuit.
   13. While momentarily disconnecting the fused jumper wire from the EGR position sensor 1 signal circuit and the 5 V power supply circuit, observe the EGR Brushless Position 1 display on the trouble diagnosis scan tool.
   14. While momentarily disconnecting the fused jumper wire from the EGR position sensor 2 signal circuit and the 5 V power supply circuit, observe the EGR Brushless Position 2 display on the trouble diagnosis scan tool.
   15. While momentarily disconnecting the fused jumper wire from the EGR position sensor 3 signal circuit and the 5 V power supply circuit, observe the EGR Brushless Position 3 display on the trouble diagnosis scan tool.
   16. Check for a data display that does not display ON when the EGR position sensor signal circuit and the 5 V power supply circuit are shorted together.
   17. If there is a data display which does not display ON, inspect the EGR position sensor circuit which does not display ON.

   Note：
   - There should be no open circuit or high resistance between the ECM and the EGR position sensor.
   - There should be no short to GND between the ECM and the EGR position sensor.

   18. If a problem is found, repair the EGR position sensor circuit.
   19. Inspect for poor connections at the EGR valve harness connector.
   20. If a problem is found, repair the harness connector.
   21. Inspect the EGR solenoid circuit between the ECM and the EGR valve for a short to the EGR position sensor.
   22. If a problem is found, repair the EGR solenoid circuit.
   23. If the EGR solenoid circuit is normal, replace the EGR valve.

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

24. Inspect for poor connections at the ECM harness connector.
25. If a problem is found, repair the harness connector.
26. If the harness connector is normal, replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

27. Set the injector ID code on the ECM.

3. DTC P0409 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P041C (Flash Code 52)
Intake Manifold Temperature Sensor Circuit High

1. DTC P041C priority DTC

   DTC P0697

2. DTC P041C diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IMT sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the IMT sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the IMT sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the IMT sensor signal circuit and the GND circuit.
   8. Observe the Manifold Temperature Sensor 5 V display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the IMT sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the IMT sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the IMT sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor installation*".

   14. Connect a fused jumper wire between the IMT sensor signal circuit and a known good GND.
   15. Observe the Manifold Temperature Sensor 5 V display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and the IMT sensor for an open circuit or high resistance.

       Note :

       - The IMT sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the IMT sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P041C confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.

      Note :

      - Run the engine for 3 minutes or longer.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P041D (Flash Code 52)
Intake Manifold Temperature Sensor Circuit Low

1. DTC P041D priority DTC

   DTC P0697

2. DTC P041D diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the IMT sensor.
   3. Observe the Manifold Temperature Sensor 5 V display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the IMT sensor.

      Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor removal*".

      Refer to "*1.Engine 1F.Induction(4LE2) IMT sensor installation*".

   5. Inspect the signal circuit between the ECM and the IMT sensor for a short to GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P041D confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0521 (Flash Code 294)
Engine Oil Pressure Sensor Performance

1. DTC P0521 priority DTC

   DTC P0522

2. DTC P0521 diagnostics
   1. Inspect the following parts for engine oil leakage.

      Note :
      - Oil pump
      - Oil pressure sensor
      - Oil cooler
      - Oil filter
      - Pipe between oil cooler and oil filter
   2. If a problem is found, repair the applicable oil leakage.
   3. Turn OFF the ignition switch.
   4. Disconnect the harness connector from the oil pressure sensor.
   5. Inspect for poor connections at the oil pressure sensor harness connector.
   6. If a problem is found, repair the harness connector.
   7. Disconnect the harness connector from the ECM.
   8. Inspect for poor connections at the ECM harness connector.
   9. If a problem is found, repair the harness connector.
   10. Inspect the each circuit between the ECM and the oil pressure sensor for high resistance.
   11. If a problem is found, repair the applicable circuit.
   12. Replace the oil pressure sensor.

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

3. DTC P0521 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0522 (Flash Code 294)
Oil Pressure Sensor Circuit Low Input

1. DTC P0522 priority DTC

   DTC P0697

2. DTC P0522 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the oil pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the 5 V power supply circuit of the oil pressure sensor harness connector and a known good GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the oil pressure sensor for an open circuit or high resistance.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the 5 V power supply circuit of the oil pressure sensor harness connector and the signal circuit.
   8. Observe the engine Oil Pressure Sensor Voltage display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   9. If the reading is more than or equal to the specified value, inspect for poor connections at the oil pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the oil pressure sensor.

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

   12. Inspect the signal circuit between the ECM and the oil pressure sensor.

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   17. Set the injector ID code on the ECM.

3. DTC P0522 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0523 (Flash Code 294)
Oil Pressure Sensor Circuit High Input

1. DTC P0523 priority DTC

   DTC P0697

2. DTC P0523 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the oil pressure sensor.
   3. Observe the engine Oil Pressure Sensor Voltage display on the trouble diagnosis scan tool.

      voltage： 0.1 V

   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the oil pressure sensor.

      Note：

      - There should be no short to the battery or the ignition power supply.
      - There should be no short to the 5 V power supply.

   5. If a problem is found, repair the signal circuit.
   6. Inspect the GND circuit between the ECM and the oil pressure sensor for an open circuit or high resistance.

      Note：

      - The oil pressure sensor shares the GND circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   7. If a problem is found, repair the GND circuit.
   8. Inspect for poor connections at the oil pressure sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. If the harness connector is normal, replace the oil pressure sensor.

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

       Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   14. Set the injector ID code on the ECM.

3. DTC P0523 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0563 (Flash Code 35)
System Voltage High

1. DTC P0563 diagnostics
   1. Check if the battery charger has been connected to the battery recently.
   2. Start and idle the engine.
   3. Observe the Ignition Voltage display on the trouble diagnosis scan tool.

   voltage : 32.0 V

   4. If the reading is more than or equal to the specified value, inspect the charging system.

   Refer to "*1.Engine 1J.Electrical(4LE2) Generator inspection*".

   5. If a problem is found, repair the charging system.

   Refer to "*1.Engine 1J.Electrical(4LE2) Generator removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) Generator installation*".

   6. If the charging system is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   7. Set the injector ID code on the ECM.
2. DTC P0563 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start and idle the engine.
   4. Observe the Ignition Voltage display on the trouble diagnosis scan tool, and verify that the value does not exceed the specified value.

   voltage : 32.0 V

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0601 (Flash Code 53)
Internal Control Module Memory Check Sum Error

1. DTC P0601 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P0601 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0602 (Flash Code 154)
Control Module Programming Error

1. DTC P0602 diagnostics
   1. Verify that the connecting sections of all tools are securely connected.
   2. Verify that the programming device operates properly.
   3. Use a trouble diagnosis scan tool to verify that the correct injector ID code and fuel delivery rate data are input into the ECM.

   Note：
   - If the injector ID code and the fuel delivery rate are correctly input, clear the DTC with a trouble diagnosis scan tool.

   4. Turn OFF the ignition switch for 30 seconds or more.
   5. Turn ON the ignition switch.
   6. Observe the DTC information with a trouble diagnosis scan tool.
   7. If a DTC is set, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   8. Set the injector ID code on the ECM.
2. DTC P0602 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0604 (Flash Code 153)
Internal Control Module Random Access Memory (RAM)

1. DTC P0604 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P0604 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0606 (Flash Code 51)
ECM/PCM Processor

1. DTC P0606 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P0606 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P060B (Flash Code 36)
Internal Control Module A/D Processing Performance

1. DTC P060B diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P060B confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0615 (Flash Code 19)
Starter Relay Circuit

1. DTC P0615 diagnostics
   1. Connect a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Turn ON the ignition switch. The engine must not be started.
   4. Observe the DTC information for DTC P0615 with a trouble diagnosis scan tool.
   5. If a DTC is not set, start the engine.
   6. Observe the DTC information for DTC P0615 with a trouble diagnosis scan tool.
   7. If a DTC is not set, an intermittent condition is suspected.
   8. If a DTC is set, inspect for a short to the battery power supply circuit or ignition power supply circuit in the control circuit of the ECM and starter cut relay.
   9. If a failure was found, repair the control circuit of the ECM and starter cut relay.
   10. If a DTC is set in [4.], replace with another known good starter cut relay.
   11. Turn ON the ignition switch. The engine must not be started.
   12. Observe the DTC information for DTC P0615 with a trouble diagnosis scan tool.
   13. If a DTC is not set, replace the starter cut relay.
   14. If a DTC is set, inspect for a short to ground in the control circuit of the ECM and starter cut relay.
   15. If a failure was found, repair the control circuit of the ECM and starter cut relay.
   16. Replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   17. Set the injector ID code on the ECM.
2. DTC P0615 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Turn ON the ignition switch for 10 seconds.
   4. Start the engine.
   5. Perform a test-run.
   6. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0641 (Flash Code 55)
Sensor Reference Voltage 1 Circuit

1. DTC P0641 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the accelerator position sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the accelerator position sensor 5 V power supply circuit of the accelerator position sensor harness connector and GND.

   voltage： 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the accelerator position sensor 5 V power supply circuit between the ECM and the accelerator position sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the accelerator position sensor 5 V power supply circuit.
   7. Inspect the fuel filter pressure sensor 5 V power supply circuit between the ECM and the fuel filter pressure sensor for a short to the battery or a short to ignition power supply.
   8. If a problem is found, repair the fuel filter pressure sensor 5 V power supply circuit between the ECM and the fuel filter pressure sensor.
   9. Inspect the boost pressure sensor 5 V power supply circuit between the ECM and the boost pressure sensor for a short to the battery or a short to the ignition power supply.
   10. If a problem is found, repair the boost pressure sensor 5 V power supply circuit.
   11. If the reading is less than or equal to the specified value, measure the voltage between the accelerator position sensor harness connector 5 V power supply circuit and GND.

   voltage： 4.5 V

   12. If the reading is more than or equal to the specified value, replace the accelerator position sensor.
   13. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   14. Disconnect the harness connector from the fuel filter pressure sensor.
   15. Turn ON the ignition switch.
   16. Measure the voltage between the fuel filter pressure sensor 5 V power supply circuit of the fuel filter pressure sensor harness connector and GND.

   voltage： 4.5 V

   17. If the reading is more than or equal to the specified value, replace the fuel filter pressure sensor.
   18. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   19. Disconnect the harness connector from the boost pressure sensor.
   20. Turn ON the ignition switch.
   21. Measure the voltage between the boost pressure sensor 5 V power supply terminal of the boost pressure sensor harness connector and GND.

   voltage： 4.5 V

   22. If the reading is more than or equal to the specified value, replace the boost pressure sensor.

   Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

   Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   23. If the reading is less than or equal to the specified value, inspect the accelerator position sensor 5 V power supply circuit between the ECM and the accelerator position sensor for a short to GND.
   24. If a problem is found, repair the accelerator position sensor 5 V power supply circuit.
   25. Inspect the fuel filter pressure sensor 5 V power supply circuit between the ECM and the fuel filter pressure sensor for a short to GND.
   26. If a problem is found, repair the fuel filter pressure sensor 5 V power supply circuit.
   27. Inspect the boost pressure sensor 5 V power supply circuit between the ECM and the boost pressure sensor for a short to GND.
   28. If a problem is found, repair the boost pressure sensor 5 V power supply circuit.
   29. Replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   30. Set the injector ID code on the ECM.
2. DTC P0641 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.

2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0651 (Flash Code 56)
Sensor Reference Voltage 2 Circuit

1. DTC P0651 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the barometric pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the barometric pressure sensor harness connector 5 V power supply circuit of the barometric pressure sensor harness connector and GND.

   voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the barometric pressure sensor 5 V power supply circuit between the ECM and the barometric pressure sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the barometric pressure sensor 5 V power supply circuit.
   7. Inspect the CMP sensor 5 V power supply circuit between the ECM and the CMP sensor for a short to the battery or a short to ignition power supply.
   8. If a problem is found, repair the CMP sensor 5 V power supply circuit between the ECM and the CMP sensor.
   9. Inspect the FRP sensor 5 V power supply circuit between the ECM and the FRP sensor for a short to the battery or a short to the ignition power supply.
   10. If a problem is found, repair the FRP sensor 5 V power supply circuit.
   11. Inspect the EGR position sensor 5 V power supply circuit between the ECM and the EGR position sensor for a short to the battery a short to the ignition power supply.
   12. If a problem is found, repair the EGR position sensor 5 V power supply circuit.
   13. If the reading is less than or equal to the specified value, measure the voltage between the barometric pressure sensor harness connector 5 V power supply circuit and GND.

   voltage : 4.5 V

   14. If the reading is more than or equal to the specified value, replace the barometric pressure sensor.
   15. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   16. Disconnect the harness connector from the CMP sensor.
   17. Turn ON the ignition switch.
   18. Measure the voltage between the CMP sensor 5 V power supply circuit of the CMP sensor harness connector and GND.

   voltage : 4.5 V

   19. If the reading is more than or equal to the specified value, replace the CMP sensor.

   Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor removal*".

   Refer to "*1.Engine 1B.Mechanical(4LE2) CMP sensor installation*".

   20. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   21. Disconnect the harness connector from the FRP sensor.
   22. Turn ON the ignition switch.
   23. Measure the voltage between the FRP sensor 5 V power supply circuit of the FRP sensor harness connector and GND.

   voltage : 4.5 V

   24. If the reading is more than or equal to the specified value, replace the FRP sensor.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

   Note :
   - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.

   25. If the reading is less than or equal to the specified value, turn OFF the ignition switch.
   26. Disconnect the harness connector from the EGR valve.
   27. Turn ON the ignition switch.
   28. Measure the voltage between the EGR position sensor 5 V power supply circuit of the EGR valve harness connector and GND.

   voltage : 4.5 V

   29. If the reading is more than or equal to the specified value, replace the EGR valve.

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

30. If the reading is less than or equal to the specified value, inspect the FRP sensor 5 V power supply circuit between the ECM and the barometric pressure sensor for a short to GND.

Note :

- If a problem is found, repair the barometric pressure sensor 5 V power supply circuit.

31. Inspect the CMP sensor 5 V power supply circuit between the ECM and the CMP sensor for a short to GND.

Note :

- If a problem is found, repair the CMP sensor 5 V power supply circuit.

32. Inspect the FRP sensor 5 V power supply circuit between the ECM and the FRP sensor for a short to GND.

Note :

- If a problem is found, repair the FRP sensor 5 V power supply circuit.

33. Inspect the EGR position sensor 5 V power supply circuit between the ECM and the EGR position sensor for a short to GND.

Note :

- If a problem is found, repair the EGR position sensor 5 V power supply circuit.

34. Replace the ECM.

Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

35. Set the injector ID code on the ECM.

2. DTC P0651 confirm resolution
    1. Clear the DTC with a trouble diagnosis scan tool.
    2. Turn OFF the ignition switch for 30 seconds or more.
    3. Start the engine.
    4. Perform a test-run.
    5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0685 (Flash Code 416)
ECM/PCM Power Relay Control Circuit/Open

1. DTC P0685 diagnostics
   1. Turn OFF the ignition switch for 30 seconds or more.
   2. Replace the main relay with a glow relay or a known good relay.
   3. Turn ON the ignition switch.
   4. Observe the DTC information with a trouble diagnosis scan tool.
   5. If a DTC is not set, replace the main relay.
   6. Inspect for poor connections at the body ground.
   7. If a problem is found, repair the terminal.
   8. Inspect the slow blow fuse.
   9. If a problem is found, replace the slow blow fuse.

   Note：
   - If the fuse blows out again, repair the cause of the slow blow fuse blowout.

   10. Turn OFF the ignition switch.
   11. Disconnect the harness connector from the ECM.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   15. Set the injector ID code on the ECM.
2. DTC P0685 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Turn ON the ignition switch.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0687 (Flash Code 416)
ECM/PCM Power Relay Control Circuit High

1. DTC P0687 diagnostics
   1. Turn OFF the ignition switch.
   2. Remove the main relay.
   3. Turn ON the ignition switch.
   4. Observe the DTC information for DTC P0685 with a trouble diagnosis scan tool.
   5. If DTC P0685 is not set, repair the short to the battery power supply in the power supply circuit between the ECM and the main relay.
   6. Turn OFF the ignition switch for 30 seconds or more.
   7. Replace the main relay with a glow relay or a known good relay.
   8. Turn ON the ignition switch.
   9. Observe the DTC information for DTC P0687 with a trouble diagnosis scan tool.
   10. If DTC P0687 is not set, replace the main relay.
2. DTC P0687 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Turn ON the ignition switch.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P0697 (Flash Code 57)
Sensor Reference Voltage 3 Circuit

1. DTC P0697 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the oil pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the oil pressure sensor 5 V power supply circuit of the oil pressure sensor harness connector and GND.

   voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the oil pressure sensor 5 V power supply circuit between the ECM and the oil pressure sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the oil pressure sensor 5 V power supply circuit.
   7. If the reading is less than or equal to the specified value, measure the voltage between the oil pressure sensor 5 V power supply circuit of the oil pressure sensor harness connector and GND.

   voltage : 4.5 V

   8. If the reading is more than or equal to the specified value, replace the oil pressure sensor.

   Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor removal*".

   Refer to "*1.Engine 1E.Lubrication(4LE2) Oil pressure sensor installation*".

   9. If the reading is less than or equal to the specified value, inspect the oil pressure sensor 5 V power supply circuit between the ECM and the oil pressure sensor for a short to GND.
   10. If a problem is found, repair the oil pressure sensor 5 V power supply circuit.
   11. Replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   12. Set the injector ID code on the ECM.
2. DTC P0697 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P06AF (Flash Code 277)
EDU Injector Custom IC,Check Sum,Communication Line

1. DTC P06AF diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P06AF confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1093 (Flash Code 227) Fuel Rail Pressure (FRP) Too Low

1. DTC P1093 priority DTC

   DTC P0087

   DTC P0091

   DTC P0092

   DTC P0192

   DTC P0193

   DTC P0201

   DTC P0202

   DTC P0203

   DTC P0204

   DTC P2146

   DTC P2149

2. DTC P1093 diagnostics

   1. Turn OFF the ignition switch.
   2. Wait for the specified time to reduce the fuel pressure from the common rail (fuel rail).

      specified time : 2 min
   3. Turn ON the ignition switch.
   4. Observe the Fuel Rail Pressure (FRP) Sensor display on the trouble diagnosis scan tool, and verify that it is within the specified range.

      voltage : 0.9 to 1.0 V
   5. If the Fuel Rail Pressure (FRP) Sensor display is outside the specified range, inspect for poor connections at the FRP sensor harness connector.
   6. If a problem is found, repair the harness connector.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. Inspect each circuit for high resistance.
   10. If a problem is found, repair the circuit.
   11. If the harness connector and each circuit are normal, replace the FRP sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

       Note :

       - Do not replace the FRP sensor separately. If a problem is found, replace the common rail (fuel rail) assembly.
   12. Inspect the fuel system between the fuel tank and the fuel supply pump for clogging.
   13. If a problem is found, repair the clogging in the fuel system.
   14. Inspect the fuel hose between the fuel tank and the fuel supply pump for cuts and cracks.
   15. If a problem is found, replace the fuel hose.

       Note :

       - A slight vacuum will form in the fuel hose leading from the fuel tank to the fuel supply pump when the engine is running.
       - If the fuel hose is not connected securely, air may enter.
       - If the engine speed or the engine load increases when air has entered the fuel system, fluctuation in the common rail (fuel rail) pressure occurs, and DTC P1093 may be set.
   16. Check that an appropriate clamp is used between the fuel tank and the fuel supply pump.
   17. If a problem is found, replace the clamp.
   18. Operate the priming pump until it becomes heavy.

       Note :

       - When a leakage exists in the fuel system between the priming pump and the fuel supply pump, the pressing weight of the priming pump does not become heavy.
   19. Start the engine.
   20. Inspect the high-pressure side of the fuel system and check for a fuel leak between the fuel supply pump and the common rail (fuel rail).

       Note :

       - Fuel may leak under the cylinder head cover from the inlet of the high pressure hose.
       - If the fuel leaks under the cylinder head cover, the engine oil level will increase.
       - Inspect for a fuel leakage into the engine oil.
   21. If a fuel leakage is found, repair.
   22. Turn OFF the ignition switch.

23. Remove the fuel hose on the fuel supply pump side from the fuel filter.

Note :

- Use a pan to catch the fuel from the removed fuel hose.
- Clean the pressure gauge and the connection hose before connecting to the fuel pipe.
- The fuel supply pump may be damaged due to foreign material that has entered the connection hose.

24. Connect the pressure gauge between the fuel filter and the removed fuel hose.

Note :

- Verify that the fuel system is connected securely.

25. Remove the air using the priming pump, and crank the engine for the specified period of time or less.

specified time : 5 s

Note :

- Repeat the process until the engine starts.

26. Allow the engine to idle for the specified duration or longer.

specified time : 1 min

27. Observe the pressure gauge while maintaining the engine at the specified engine speed for the specified duration.

specified time : 1 min

rotational speed : 2300 r/min

28. Verify that the pressure gauge shows a vacuum of the specified value or more during inspection.

Specified value: (-17.0) kPa {5 inHg / (-2) psi}

Note :

- Checking the vacuum amount is a method used to check for clogging of the fuel system.

29. If the vacuum is more than or equal to the specified value, inspect the fuel system between the fuel supply pump and the fuel tank for damage and twisting.
30. If a problem is found, repair the fuel system.
31. Inspect the fuel tank vent hose.
32. If a problem is found, repair the vent hose.
33. Check for foreign material in the fuel tank or for foreign material that can cause fuel clogging.
34. If a problem is found, repair.
35. Replace the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

36. If the vacuum is less than or equal to the specified value, pinch the fuel hose at a position as close as possible to the fuel tank, so that the fuel does not flow.

Note :

- Disconnect the fuel pipe, and a plug can be applied.

37. Start the engine and use the idling control switch to increase the speed to the highest level.
38. Check the pressure gauge.

Specified value: (-27.0) kPa {8 inHg / (-4) psi}

Note :

- If the pressure gauge is likely to indicate a value exceeding the specified value during inspection, release the fuel being blocked.
- Checking the vacuum amount when the fuel flow is blocked is a method used to check for air intrusion.

39. If the specified vacuum cannot be generated, inspect the fuel hose for cuts or cracks.
40. If a problem is found, replace the fuel hose.
41. Inspect whether a proper clamp is used.
42. If a problem is found, replace the clamp with a proper one.
43. Turn OFF the ignition switch.
44. Inspect for poor connections at the suction control valve harness connector.
45. If a problem is found, repair the harness connector.
46. Inspect for poor connections at the ECM harness connector.
47. If a problem is found, repair the harness connector.
48. Inspect each circuit for high resistance.
49. If a problem is found, repair the circuit.
50. If the suction control valve harness connector and the ECM harness connector are normal and there is no high resistance in each circuit, replace the fuel supply pump and the fuel filter.

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel supply pump installation*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter installation*".

Note :

- When replacing the fuel supply pump, the fuel filter must be replaced at the same time.

51. If the vacuum is normal, turn OFF the ignition switch.
52. Restore the fuel system.
53. Start the engine.
54. Perform the injector stop test with a trouble diagnosis scan tool.
55. Check for any injector that does not change the engine speed when instructed OFF.
56. If there are any injectors that do not change the engine speed when instructed OFF, replace the applicable injector.

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

57. If the injector has been replaced, set the injector ID code on the ECM.
58. If the engine speed changes when all injectors are commanded OFF, replace the pressure limiter valve.

Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly removal*".

Refer to "*1.Engine 1C.Fuel System(4LE2) Common rail assembly installation*".

Note :

- The pressure limiter valve may be fixed open, or the operation pressure may decrease.
- Do not replace the pressure limiter valve separately. If a problem is found, replace the common rail (fuel rail) assembly.

3. DTC P1093 confirm resolution

1. Clear the DTC with a trouble diagnosis scan tool.
2. Turn OFF the ignition switch for 30 seconds or more.
3. Start the engine.
4. Perform a test-run.
5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1112 (Flash Code 295)
Boost Temperature Sensor Circuit Low Input

1. DTC P1112 priority DTC

   DTC P0651

2. DTC P1112 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost temperature sensor.
   3. Observe the Manifold Absolute Temperature Sensor Voltage display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   4. If the reading is more than or equal to the specified value, replace the boost temperature sensor.

      Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

      Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   5. Inspect the signal circuit between the ECM and the boost temperature sensor for a short to GND.
   6. If a problem is found, repair the signal circuit.
   7. Inspect for poor connections at the ECM harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.

3. DTC P1112 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1113 (Flash Code 295)
Boost Temperature Sensor Circuit High Input

1. DTC P1113 priority DTC

   DTC P0651

2. DTC P1113 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the boost temperature sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the boost temperature sensor signal circuit and a known good GND.

      voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the boost temperature sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the signal circuit.
   7. Connect a fused jumper wire between the boost temperature sensor signal circuit and the GND circuit.
   8. Observe the Manifold Absolute Temperature Sensor Voltage display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   9. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the boost temperature sensor for a short to the 5 V power supply circuit.
   10. If a problem is found, repair the signal circuit.
   11. Inspect for poor connections at the boost temperature sensor harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the boost temperature sensor.

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor removal*".

       Refer to "*1.Engine 1F.Induction(4LE2) Pressure sensor/boost temperature sensor installation*".

   14. Connect a fused jumper wire between the boost temperature sensor signal circuit and a known good GND.
   15. Observe the Manifold Absolute Temperature Sensor Voltage display on the trouble diagnosis scan tool.

       voltage : 0.1 V

   16. If the reading is less than or equal to the specified value, inspect the GND circuit between the ECM and the boost temperature sensor for an open circuit or high resistance.

       Note :

       - The boost temperature sensor shares the GND circuit with other sensors.
       - DTCs on sensors that share this circuit may be set.

   17. If a problem is found, repair the GND circuit.
   18. Inspect the signal circuit between the ECM and the boost temperature sensor for an open circuit or high resistance.
   19. If a problem is found, repair the signal circuit.
   20. Inspect for poor connections at the ECM harness connector.
   21. If a problem is found, repair the harness connector.
   22. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   23. Set the injector ID code on the ECM.

3. DTC P1113 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.

      Note :

      - Run the engine for 3 minutes or longer.

   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1261 (Flash Code 34) Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P1261 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P1261 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1262 (Flash Code 34)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P1262 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P1262 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1293 (Flash Code 221) Fuel Filter Pressure Sensor Circuit Low

1. DTC P1293 priority DTC

   DTC P0641

2. DTC P1293 diagnostics

   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the fuel filter pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the fuel filter pressure sensor harness connector 5 V power supply circuit and a known good GND.

      voltage : 4.5 V

   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the fuel filter pressure sensor for an open circuit or high resistance.

      Note :

      - The fuel filter pressure sensor shares the 5 V power supply circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the fuel filter pressure sensor harness connector 5 V power supply circuit and the signal circuit.
   8. Observe the Fuel Filter Pressure Sensor (clogging) display on the trouble diagnosis scan tool.

      voltage : 4.5 V

   9. If the reading is more than or equal to the specified value, inspect for poor connections at the fuel filter pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the fuel filter pressure sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter pressure sensor removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter pressure sensor installation*".

   12. Inspect the signal circuit between the ECM and the fuel filter pressure sensor.

       Note :

       - There should be no open circuit or high resistance.
       - There should be no short to GND.

   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   17. Set the injector ID code on the ECM.

3. DTC P1293 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1294 (Flash Code 221)
Fuel Filter Pressure Sensor Circuit High

1. DTC P1294 priority DTC

   DTC P0641

2. DTC P1294 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the fuel filter pressure sensor.
   3. Observe the Fuel Filter Pressure Sensor (clogging) display on the trouble diagnosis scan tool.

      voltage： 0.1 V

   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the fuel filter pressure sensor.

      Note：
      - There should be no short to the battery or the ignition power supply.
      - There should be no short to the 5 V power supply.

   5. If a problem is found, repair the signal circuit.
   6. Inspect the GND circuit between the ECM and the fuel filter pressure sensor for an open circuit or high resistance.

      Note：
      - The fuel filter pressure sensor shares the GND circuit with other sensors.
      - DTCs on sensors that share this circuit may be set.

   7. If a problem is found, repair the GND circuit.
   8. Inspect for poor connections at the fuel filter pressure sensor harness connector.
   9. If a problem is found, repair the harness connector.
   10. If the harness connector is normal, replace the fuel filter pressure sensor.

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter pressure sensor removal*".

       Refer to "*1.Engine 1C.Fuel System(4LE2) Fuel filter pressure sensor installation*".

   11. Inspect for poor connections at the ECM harness connector.
   12. If a problem is found, repair the harness connector.
   13. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   14. Set the injector ID code on the ECM.

3. DTC P1294 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1404 (Flash Code 45)
Exhaust Gas Recirculation 1 Closed Position Performance

1. DTC P1404 priority DTC

   DTC P0404

   DTC P0409

2. DTC P1404 diagnostics

   1. Remove the EGR valve assembly from the engine.

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

   2. Inspect the EGR valve.

      Note :

      - There should be nothing to restrict the flow inside the EGR valve.
      - There should be no excessive deposits inside the EGR valve.
      - There should be no bending in the valve shaft or the valve itself in the EGR valve.

   3. If a problem is found, repair or replace the EGR valve.

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

      Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

   4. Turn OFF the ignition switch.
   5. Disconnect the harness connector from the EGR valve.
   6. Inspect for poor connections at the EGR valve harness connector.
   7. If a problem is found, repair the harness connector.
   8. Disconnect the harness connector from the ECM.
   9. Inspect for poor connections at the ECM harness connector.
   10. If a problem is found, repair the harness connector.
   11. Inspect the EGR valve circuit between the ECM and the EGR valve for an open circuit or high resistance.
   12. If a problem is found, repair the EGR valve circuit.
   13. Inspect the solenoid circuit between the ECM and the EGR valve.

       Note :

       - There should be no short to GND.
       - There should be no short to the battery or the ignition power supply.
       - There should be no short to other circuits.
       - There should be no short to the EGR position sensor circuit.

   14. If a problem is found, repair the solenoid circuit.
   15. If the circuit is normal, replace the EGR valve.

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve removal*".

       Refer to "*1.Engine 1H.Aux. Emission Control Devices(4LE2) EGR valve installation*".

3. DTC P1404 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1606 (Flash Code 51)
SW-IC 1 Internal failure,Communication line failure

1. DTC P1606 diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P1606 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P160B (Flash Code 36)
AD-IC failure

1. DTC P160B diagnostics
   1. Replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   2. Set the injector ID code on the ECM.
2. DTC P160B confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1621 (Flash Code 54)
Control Module Long Term Memory Performance

1. DTC P1621 diagnostics
   1. Verify that the connecting sections of all tools are securely connected.
   2. Verify that the programming device operates properly.
   3. Turn OFF the ignition switch, and wait for 30 seconds.
   4. Turn ON the ignition switch.
   5. Observe the DTC information with a trouble diagnosis scan tool.
   6. If a DTC is set, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   7. Set the injector ID code on the ECM.
2. DTC P1621 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P1655 (Flash Code 59) Sensor Reference Voltage 4 Circuit

1. DTC P1655 diagnostics
   1. Turn OFF the ignition switch.
   2. Remove the harness connector from the CKP sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the CKP sensor 5 V power supply circuit of the CKP sensor harness connector and GND.

   voltage : 5.5 V

   5. If the reading is more than or equal to the specified value, inspect the CKP sensor 5 V power supply circuit between the ECM and the CKP sensor for a short to the battery or a short to the ignition power supply.
   6. If a problem is found, repair the CKP sensor 5 V power supply circuit.
   7. If the reading is less than or equal to the specified value, measure the voltage between the CKP sensor 5 V power supply circuit of the CKP sensor harness connector and GND.

   voltage : 4.5 V

   8. If the reading is more than or equal to the specified value, replace the CKP sensor.

   Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor removal*".

   Refer to "*1.Engine 1B.Mechanical(4LE2) CKP sensor installation*".

   9. If the reading is less than or equal to the specified value, inspect the CKP sensor 5 V power supply circuit between the ECM and the CKP sensor for a short to the GND.
   10. If a problem is found, repair the CKP sensor 5 V power supply circuit.
   11. Replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   12. Set the injector ID code on the ECM.
2. DTC P1655 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P20DE (Flash Code 221) Fuel Filter Pressure Too Low 1

1. DTC P20DE priority DTC

   DTC P1294

2. DTC P20DE diagnostics

   Note :

   - This DTC is set due to clogging of the fuel filter.

   1. Replace the fuel filter.
   2. Turn ON the ignition switch.
   3. Clear the DTC with a trouble diagnosis scan tool.
   4. Turn OFF the ignition switch for 30 seconds or more.
   5. Start the engine.
   6. Perform a test-run.
   7. Observe the DTC information with a trouble diagnosis scan tool.
   8. Inspect the fuel pipe between the fuel tank and the fuel filter for clogging, twisting, and bending.
   9. If a problem is found, repair or replace the fuel pipe.
   10. Turn OFF the ignition switch.
   11. Disconnect the harness connector from the fuel filter pressure sensor.
   12. Inspect for poor connections at the fuel filter pressure sensor harness connector.
   13. If a problem is found, repair the harness connector.
   14. Disconnect the harness connector from the ECM.
   15. Inspect for poor connections at the ECM harness connector.
   16. If a problem is found, repair the harness connector.
   17. Inspect each circuit between the ECM and the fuel filter pressure sensor for high resistance.
   18. If a problem is found, repair the applicable circuit.
   19. Replace the fuel filter pressure sensor.

3. DTC P20DE confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2146 (Flash Code 158) Fuel Injector Group 1 Supply Voltage Circuit

1. DTC P2146 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the injector.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the solenoid control circuit and GND.

      Note :

      - No. 1 cylinder injector solenoid control circuit and GND
      - No. 4 cylinder injector solenoid control circuit and GND

      voltage : 12.0 V
   5. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the injector harness connector for a short to GND.
   6. If a problem is found, repair the control circuit.
   7. Inspect the charge voltage circuit between the ECM and the injector harness connector.

      Note :

      - There should be no short to the battery the ignition power supply.
      - There should be no short to GND.
   8. If a problem is found, repair the charge voltage circuit.
   9. If the charge voltage circuit between the ECM and the injector harness connector is normal, replace the ECM.

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

      Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   10. Set the injector ID code on the ECM.
   11. Inspect for poor connections at the injector harness connector.
   12. If a problem is found, repair the injector harness connector.
   13. Disconnect the harness connector from the ECM.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. Inspect the charge voltage circuit between the ECM and the injector harness connector for an open circuit or high resistance.
   17. If a problem is found, repair the charge voltage circuit.
   18. Check if the insulation resistance of the No. 1 cylinder and No. 4 cylinder injectors is more than or equal to the specified value.

      resistance : 1.0 Ω
   19. If the reading is less than or equal to the specified value, replace the applicable injector.

      Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

      Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".
   20. Set the injector ID code on the ECM.
   21. If the reading is more than or equal to the specified value, repair or replace the injector harness.
2. DTC P2146 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2149 (Flash Code 159)
Fuel Injector Group 2 Supply Voltage Circuit

1. DTC P2149 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the cylinder head injector harness intermediate connector.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the solenoid control circuit and GND.

   Note：
   - No. 2 cylinder injector solenoid control circuit and GND
   - No. 3 cylinder injector solenoid control circuit and GND

   voltage： 12.0 V

   5. If the reading is less than or equal to the specified value, inspect the control circuit between the ECM and the injector harness intermediate connector for a short to GND.
   6. If a problem is found, repair the control circuit.
   7. Inspect the charge voltage circuit between the ECM and the injector harness intermediate connector.

   Note：
   - There should be no short to the battery or the ignition power supply.
   - There should be no short to GND.

   8. If a problem is found, repair the charge voltage circuit.
   9. If the charge voltage circuit between the ECM and the injector harness intermediate connector is normal, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   10. Set the injector ID code on the ECM.
   11. Inspect for poor connections at the injector harness intermediate connector.
   12. If a problem is found, repair the injector harness intermediate connector.
   13. Disconnect the harness connector from the ECM.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. Inspect the charge voltage circuit between the ECM and the injector harness intermediate connector for an open circuit or high resistance.
   17. If a problem is found, repair the charge voltage circuit.
   18. Check if the insulation resistance of the No. 2 cylinder and No. 3 cylinder injectors is more than or equal to the specified value.

   resistance： 1.0 MΩ

   19. If the reading is less than or equal to the specified value, replace the applicable injector.

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector removal*".

   Refer to "*1.Engine 1C.Fuel System(4LE2) Injector installation*".

   20. Set the injector ID code on the ECM.
   21. If the reading is more than or equal to the specified value, repair or replace the injector harness.
2. DTC P2149 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2228 (Flash Code 71) Barometric Pressure Circuit Low

1. DTC P2228 priority DTC

   DTC P0651

2. DTC P2228 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the barometric pressure sensor.
   3. Turn ON the ignition switch.
   4. Measure the voltage between the barometric pressure sensor 5 V power supply circuit and GND.

      voltage : 4.5 V
   5. If the reading is less than or equal to the specified value, inspect the 5 V power supply circuit between the ECM and the barometric pressure sensor for an open circuit or high resistance.
   6. If a problem is found, repair the 5 V power supply circuit.
   7. Connect a fused jumper wire between the barometric pressure sensor 5 V power supply circuit and the signal circuit.
   8. Observe the Barometric Pressure Sensor display on the trouble diagnosis scan tool.

      voltage : 4.5 V
   9. If the reading is more than or equal to the specified value, inspect for poor connections at the barometric pressure sensor harness connector.
   10. If a problem is found, repair the harness connector.
   11. If the harness connector is normal, replace the barometric pressure sensor.
   12. If the reading is less than or equal to the specified value, inspect the signal circuit between the ECM and the barometric pressure sensor.

       Note :
       - There should be no open circuit or high resistance.
       - There should be no short to GND.
   13. If a problem is found, repair the signal circuit.
   14. Inspect for poor connections at the ECM harness connector.
   15. If a problem is found, repair the harness connector.
   16. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".
   17. Set the injector ID code on the ECM.

3. DTC P2228 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2229 (Flash Code 71)
Barometric Pressure Circuit High

1. DTC P2229 priority DTC

   DTC P0651

2. DTC P2229 diagnostics
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the barometric pressure sensor.
   3. Observe the Barometric Pressure Sensor display on the trouble diagnosis scan tool.

      voltage : 0.1 V

   4. If the reading is more than or equal to the specified value, inspect the signal circuit between the ECM and the barometric pressure sensor.

      Note :

      - There should be no short to the battery or the ignition power supply.
      - There should be no short to the 5 V power supply.

   5. If a problem is found, repair the signal circuit.
   6. Connect a test lamp between the barometric pressure sensor GND circuit and the battery power supply.
   7. If the test lamp illuminates, inspect for poor connections at the barometric pressure sensor harness connector.
   8. If a problem is found, repair the harness connector.
   9. If the harness connector is normal, replace the barometric pressure sensor.
   10. If the test lamp does not illuminate, inspect the GND circuit between the ECM and the barometric pressure sensor for an open circuit or high resistance.
   11. If a problem is found, repair the GND circuit.
   12. Inspect for poor connections at the ECM harness connector.
   13. If a problem is found, repair the harness connector.
   14. If the harness connector is normal, replace the ECM.

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

       Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   15. Set the injector ID code on the ECM.

3. DTC P2229 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC P2540 (Flash Code 221)
Fuel Filter Pressure Too Low 2

1. DTC P2540 priority DTC

   DTC P1294

2. DTC P2540 diagnostics

   Note：
   - This DTC is set due to clogging of the fuel filter.

   1. Replace the fuel filter.
   2. Turn ON the ignition switch.
   3. Clear the DTC with a trouble diagnosis scan tool.
   4. Turn OFF the ignition switch for 30 seconds or more.
   5. Start the engine.
   6. Perform a test-run.
   7. Observe the DTC information with a trouble diagnosis scan tool.
   8. Inspect the fuel pipe between the fuel tank and the fuel filter for clogging, twisting, and bending.
   9. If a problem is found, repair or replace the fuel pipe.
   10. Turn OFF the ignition switch.
   11. Disconnect the harness connector from the fuel filter pressure sensor.
   12. Inspect for poor connections at the fuel filter pressure sensor harness connector.
   13. If a problem is found, repair the harness connector.
   14. Disconnect the harness connector from the ECM.
   15. Inspect for poor connections at the ECM harness connector.
   16. If a problem is found, repair the harness connector.
   17. Inspect each circuit between the ECM and the fuel filter pressure sensor for high resistance.
   18. If a problem is found, repair the applicable circuit.
   19. Replace the fuel filter pressure sensor.

3. DTC P2540 confirm resolution

   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds or more.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC U0073 (Flash Code 84)
CAN-Bus Malfunction (J1939)

1. DTC U0073 diagnostics
   1. Turn OFF the ignition switch.
   2. Measure the resistance between the terminals of the termination resistor harness connector.

   Note :
   - Make a measurement from the back with the harness connector connected.
   - Verify that the parallel resistance of the 120 ? resistor in the termination resistor and the 120 ? resistor in the ECM is 60 ?.

   resistance : 50.0 to 70.0 Ω

   3. If the resistance is outside the specified range, disconnect the harness connector from the termination resistor.
   4. Measure the resistance of the termination resistor.

   resistance : 110.0 to 130.0 Ω

   5. If the resistance is outside the specified range, replace the termination resistor.
   6. Connect the harness connector to the termination resistor.
   7. Disconnect the harness connector from the control unit of the machine.
   8. Measure the resistance between the terminals of the termination resistor harness connector.

   Note :
   - Make a measurement from the back with the harness connector connected.

   resistance : 50.0 to 70.0 Ω

   9. If the resistance is within the specified range, replace the control unit of the machine.
   10. Disconnect the harness connector from the ECM.
   11. Measure the resistance between the terminals of the termination resistor harness connector.

   Note :
   - Make a measurement from the back with the harness connector connected.

   resistance : 110.0 to 130.0 Ω

   12. If the resistance is within the specified range, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   13. Set the injector ID code on the ECM.
   14. Turn OFF the ignition switch.
   15. Connect the harness connector to the ECM.
   16. Turn ON the ignition switch.
   17. Measure the voltage between the termination resistor harness connector CAN-High terminal and GND.
   18. Measure the voltage between the termination resistor harness connector CAN-Low terminal and GND.

   voltage : 1.5 to 3.5 V

   19. If the voltage is outside the specified range, replace the ECM.

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

   Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

   20. Set the injector ID code on the ECM.
   21. Turn OFF the ignition switch.
   22. Connect the harness connector to the control unit of the machine.
   23. Turn ON the ignition switch.
   24. Measure the voltage between the termination resistor harness connector CAN-High terminal and GND.
   25. Measure the voltage between the termination resistor harness connector CAN-Low terminal and GND.

   voltage : 1.5 to 3.5 V

   26. If the voltage is outside the specified range, replace the control unit of the machine.
   27. If the voltage is within the specified range, replace the termination resistor.
2. DTC U0073 confirm resolution
   1. Clear the DTC with a trouble diagnosis scan tool.
   2. Turn OFF the ignition switch for 30 seconds.
   3. Start the engine.
   4. Perform a test-run.
   5. Observe the DTC information with a trouble diagnosis scan tool.

DTC U0101 (Flash Code 85)
Lost Communication with Transmission Control Module

1. DTC U0101 diagnostics
    1. Inspect the CAN-Low circuit and CAN-High circuit between the ECM and the control unit of the machine.

    Note :

    - There should be no short to the battery or the ignition power supply.
    - There should be no open circuit or high resistance.
    - There should be no short to GND.

    2. If a problem is found, repair the CAN circuit.
    3. If the CAN circuit is normal, connect all harnesses.
    4. Clear the DTC with a trouble diagnosis scan tool.
    5. Turn OFF the ignition switch for 30 seconds or more.
    6. Perform a test-run.
    7. Observe the DTC information.
    8. If a DTC is set, replace the control unit of the machine.
    9. Connect all harnesses.
    10. Clear the DTC with a trouble diagnosis scan tool.
    11. Turn OFF the ignition switch for 30 seconds or more.
    12. Perform a test-run.
    13. Observe the DTC information.
    14. If a DTC is set, replace the ECM.

    Refer to "*1.Engine 1J.Electrical(4LE2) ECM removal*".

    Refer to "*1.Engine 1J.Electrical(4LE2) ECM installation*".

    15. Set the injector ID code on the ECM.
2. DTC U0101 confirm resolution
    1. Clear the DTC with a trouble diagnosis scan tool.
    2. Turn OFF the ignition switch for 30 seconds or more.
    3. Start the engine.
    4. Perform a test-run.
    5. Observe the DTC information with a trouble diagnosis scan tool.

Engine

Mechanical

(4LE2)

Table of Contents

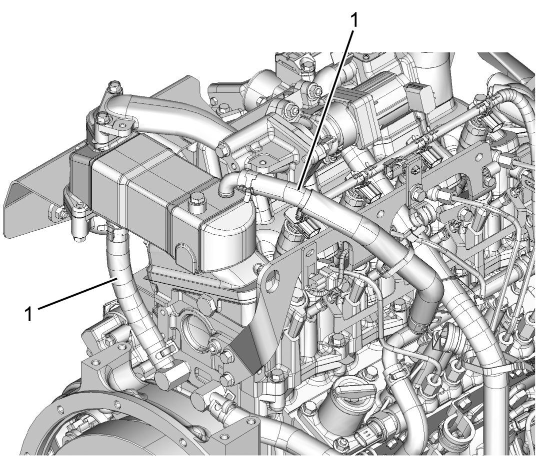
Cylinder head cover

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Pressure sensor/boost temperature sensor disconnect
   1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

   Note :
   - Remove the harness clip.
4. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.



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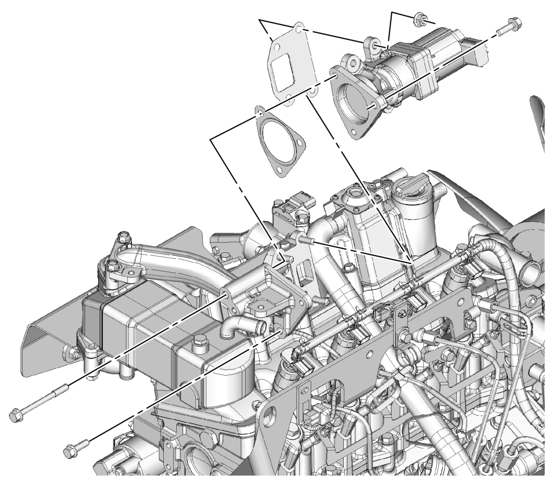
1. Water rubber hose

   4. Remove the EGR valve from the intake chamber.



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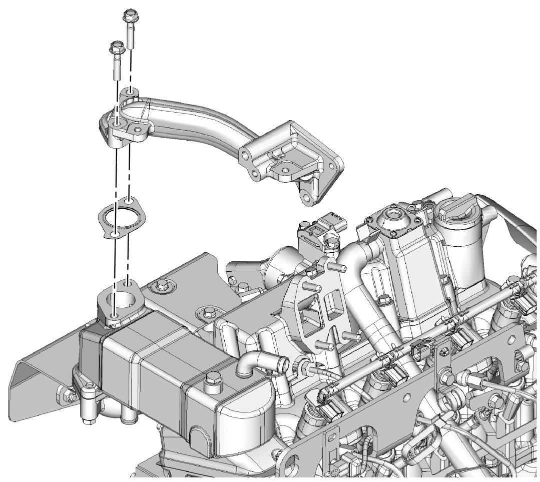
   5. Remove the EGR pipe from the EGR cooler.



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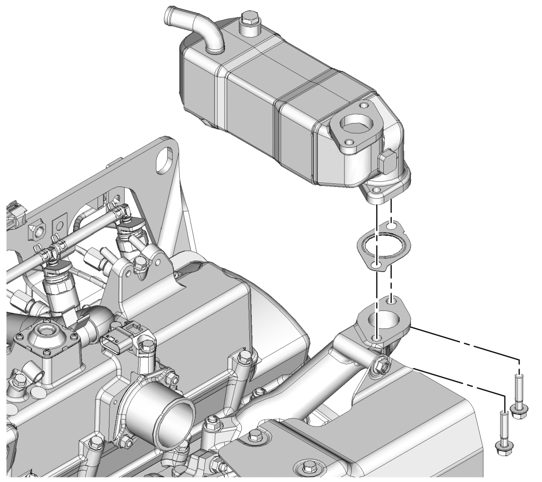
   6. Remove the EGR cooler from the EGR pipe.



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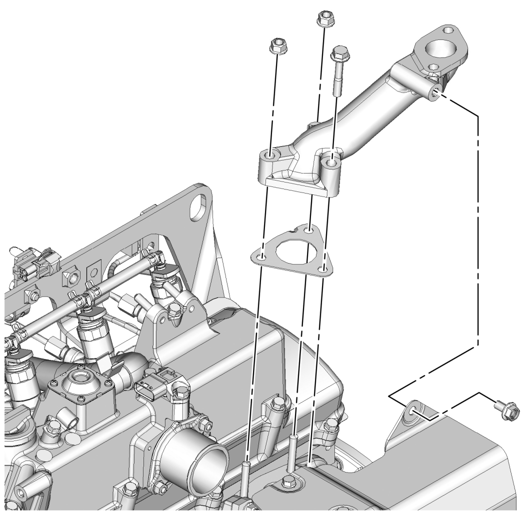
7. Remove the EGR pipe from the exhaust manifold.



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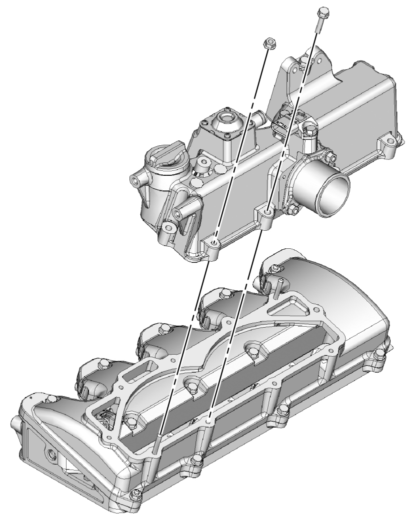
5. PCV hose removal
   1. Remove the PCV hose from the intake chamber.
6. IMT sensor removal
   1. Disconnect the harness connector from the IMT sensor.
   2. Remove the IMT sensor from the intake chamber.
7. Intake chamber removal
   1. Remove the intake chamber from the cylinder head cover.



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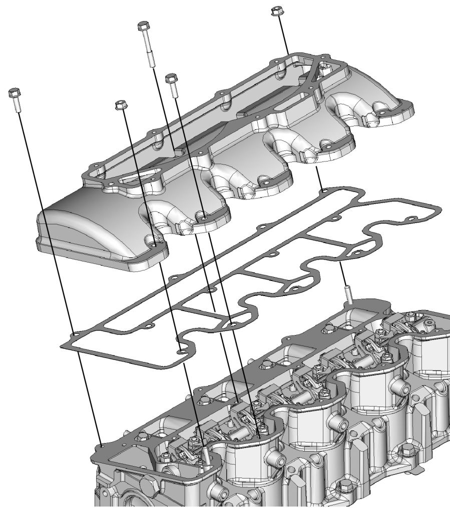
8. Cylinder head cover removal
   1. Remove the cylinder head cover from the rocker arm bracket.



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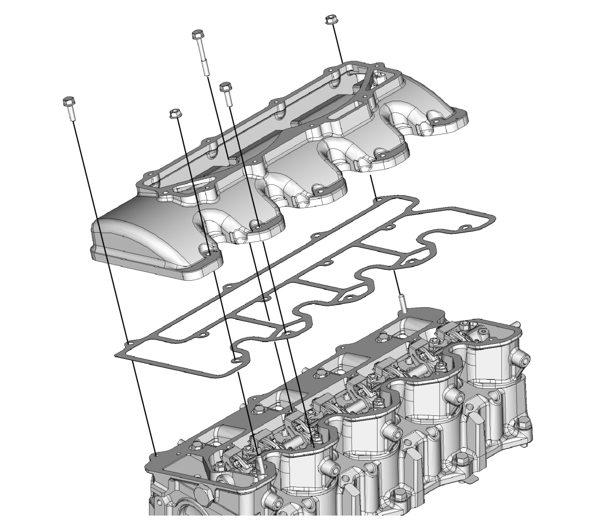
installation

1. Cylinder head cover installation
   1. Install the cylinder head cover to the rocker arm bracket.

   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



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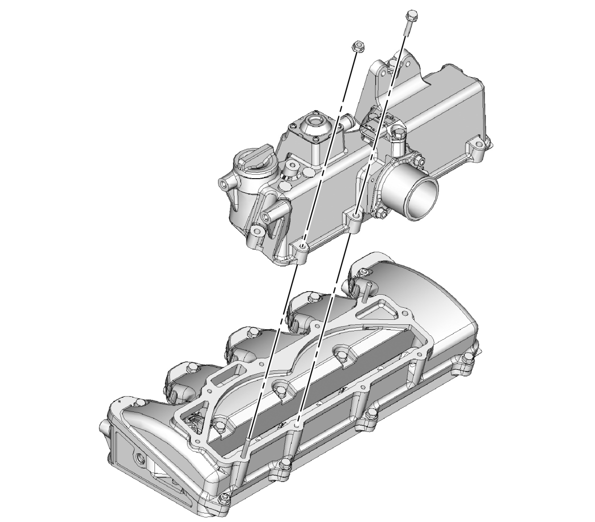
2. Intake chamber installation
   1. Install the intake chamber to the cylinder head cover.

   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



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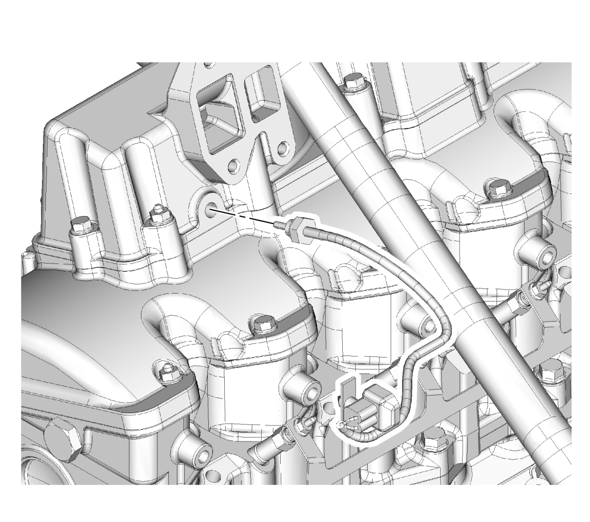
3. IMT sensor installation
   1. Install the IMT sensor to the intake chamber.

   tightening torque : 20 N・m { 2.0 kgf・m / 15 lb・ft }



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   2. Connect the harness connector to the IMT sensor.

4. PCV hose installation
   1. Install the PCV hose to the intake chamber.

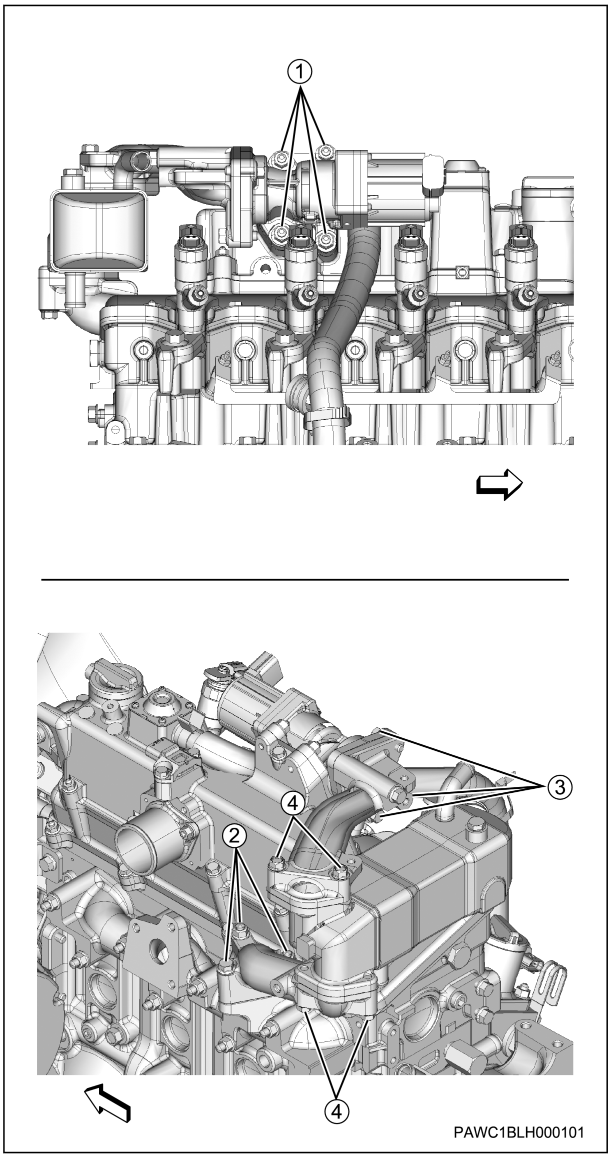
5. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

   Note :
   - Temporarily tighten the entire component until seated.

   5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

   Note :
   - After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

   tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }

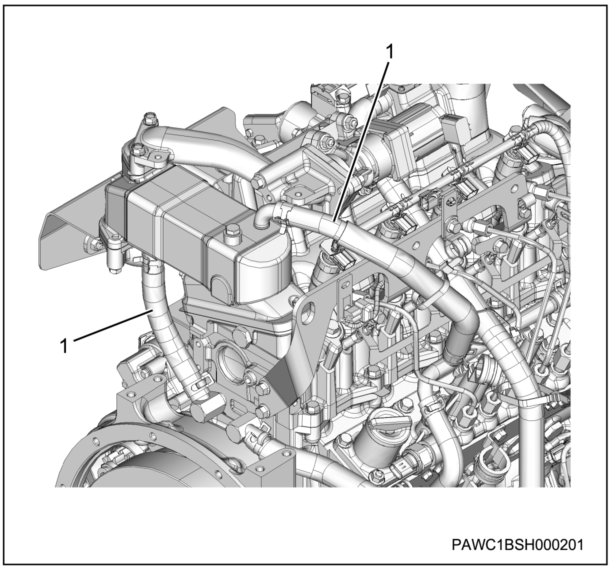


Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

6. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

- Install the harness clip.

7. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

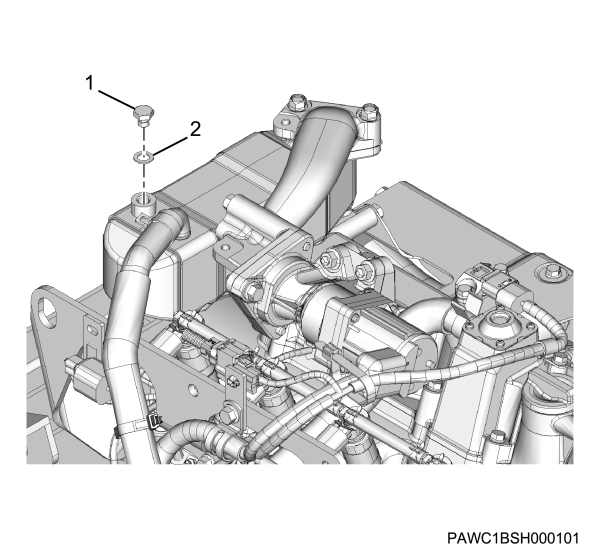
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug
2. Gasket

8. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

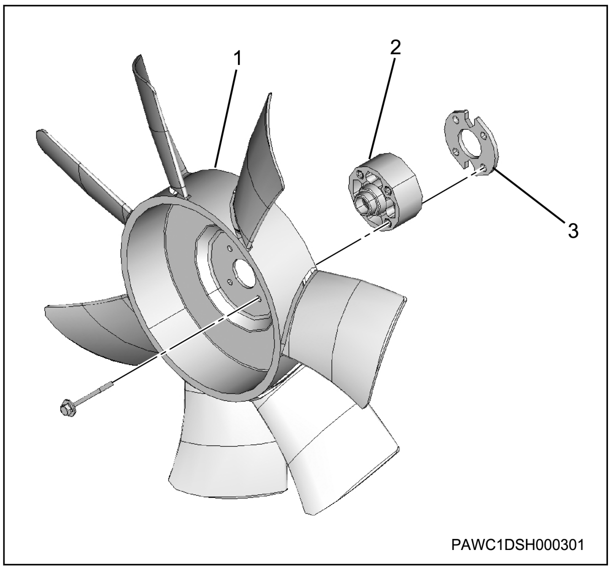
Cylinder head assembly

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.

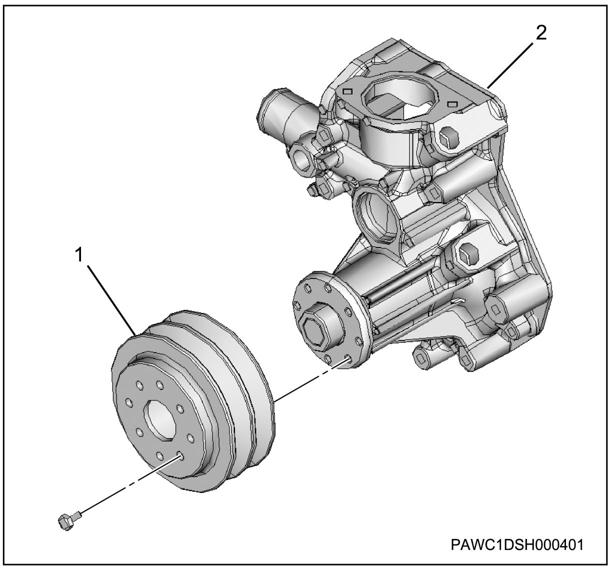


1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

   Note :

   - Loosen the generator adjust bolt and remove the belt.
5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

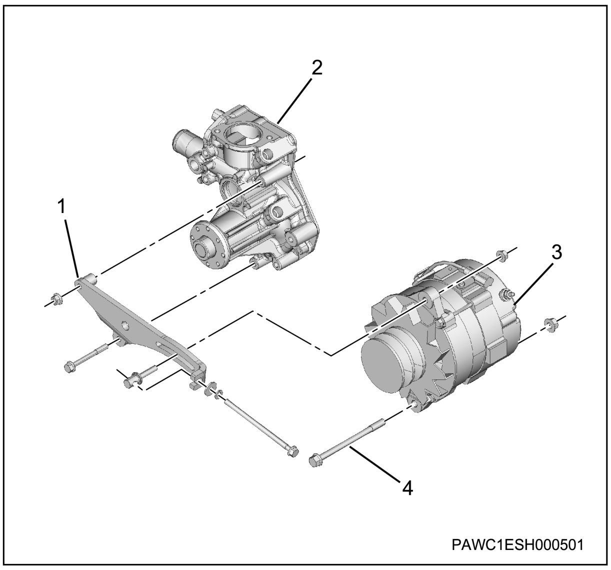


1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :

   - The diagram shows the 24 V - 50 A specification.



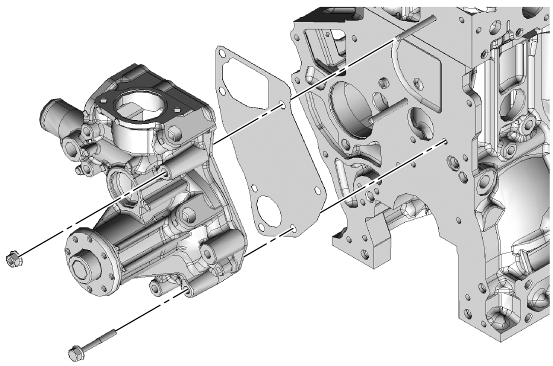
1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
8. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

Note :
- Remove the hose clip.

9. Water pump assembly removal
   1. Remove the water pump assembly from the cylinder block and the cylinder head.

Note :
- Remove the water pump assembly and the gasket.

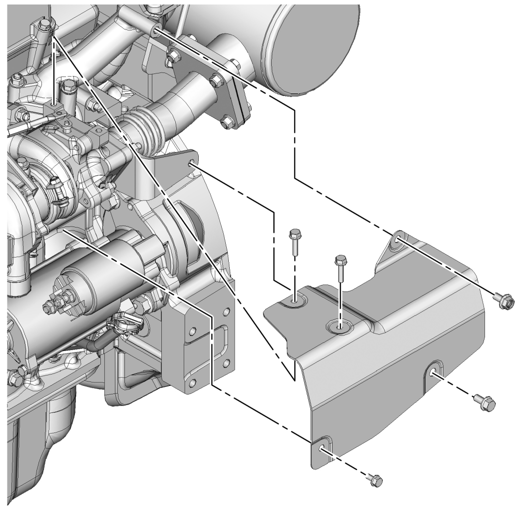


PAWC1DSH000201

10. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

Note :
- Remove the harness clip.

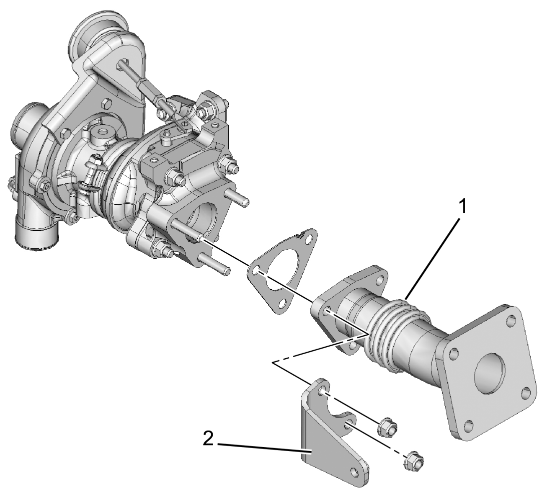
11. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.



PAWC1BSH001101

12. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

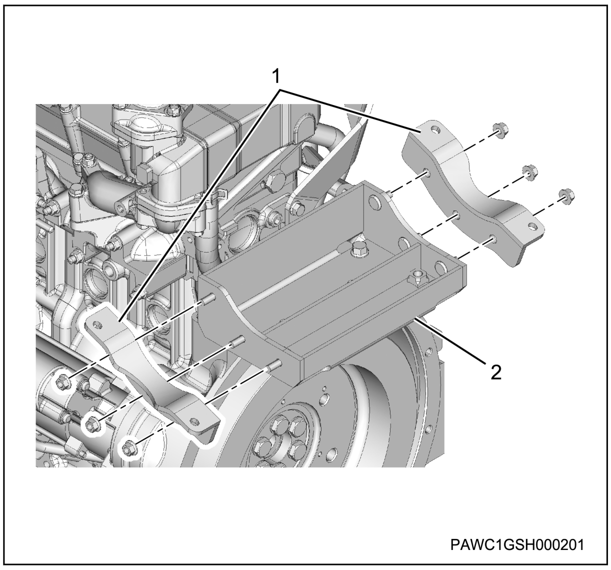
Note :
- Remove together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

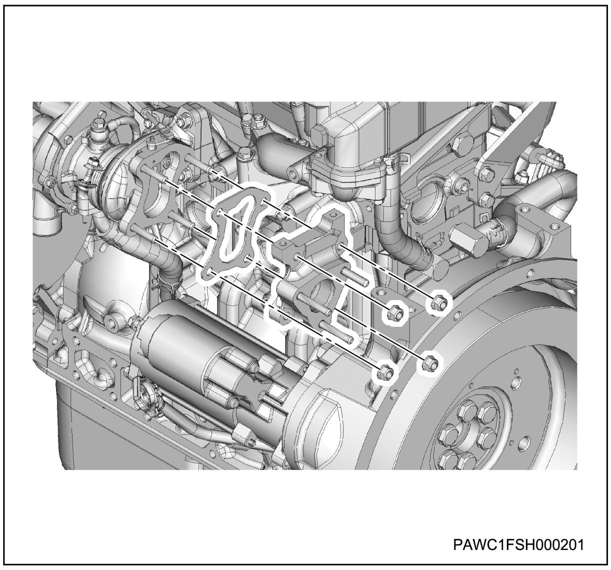
3. Remove the support bracket from the silencer bracket.



1. Support bracket
2. Silencer bracket

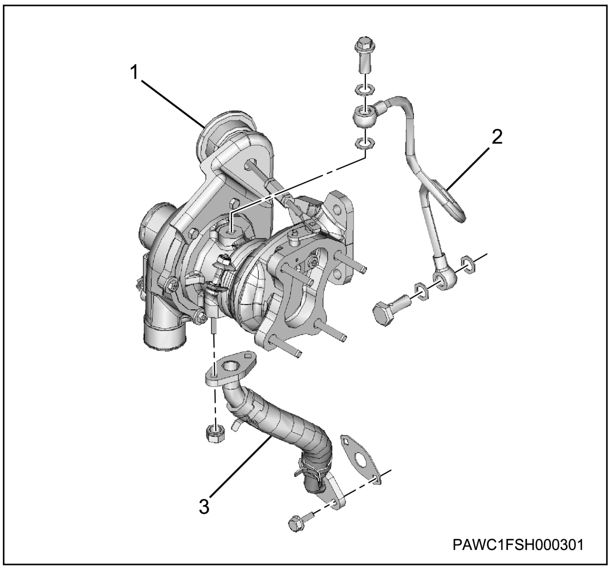
13. Turbocharger assembly removal

1. Remove the exhaust pipe adapter from the turbocharger assembly.



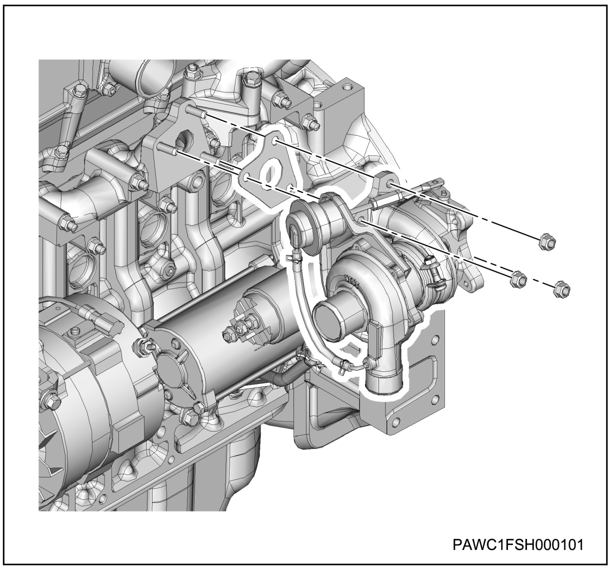
2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.

3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

4. Remove the turbocharger assembly from the exhaust manifold.

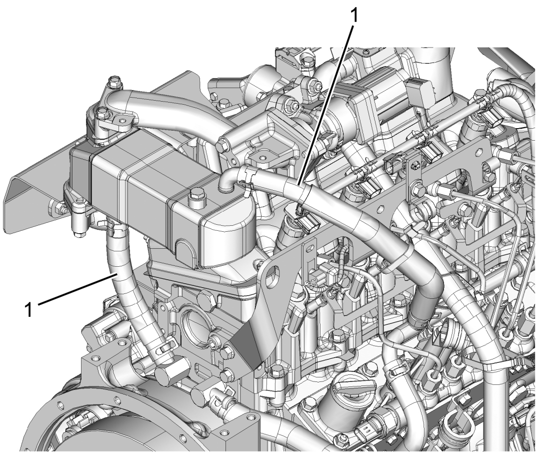


14. EGR valve removal

1. Disconnect the harness connector from the EGR valve.

2. Disconnect the harness clip from the EGR pipe.

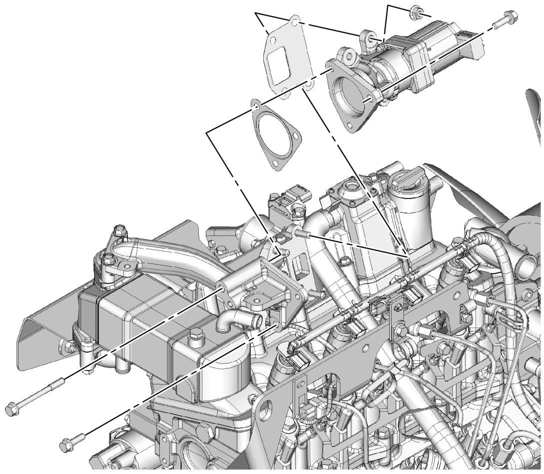
3. Disconnect the water rubber hose from the EGR cooler assembly.



PAWC1BSH000201

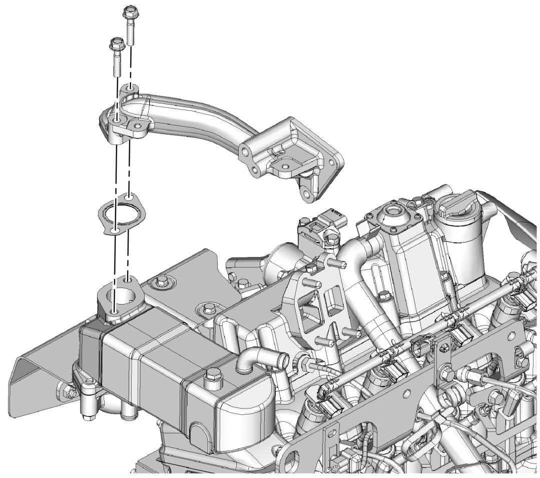
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.



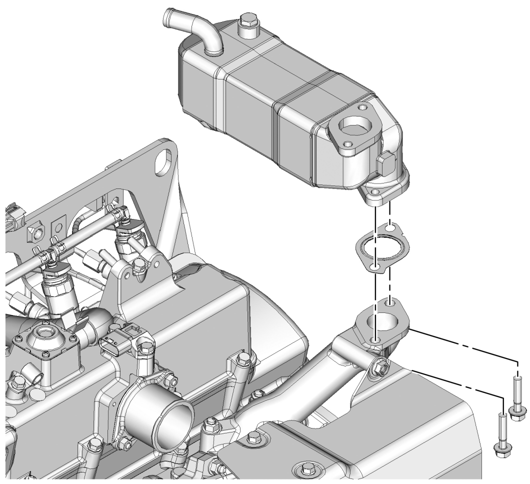
PAWC1BSH000301

5. Remove the EGR pipe from the EGR cooler.



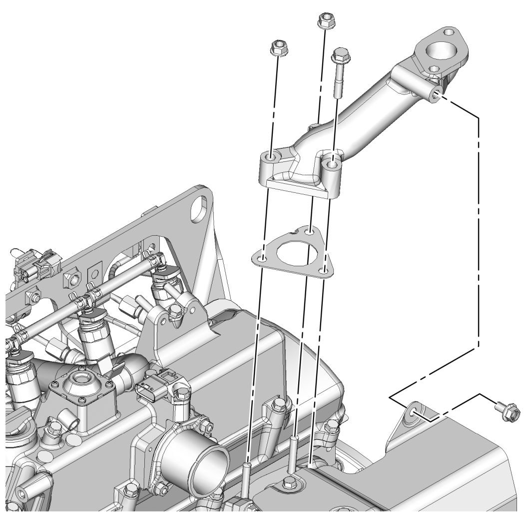
PAWC1BSH000401

6. Remove the EGR cooler from the EGR pipe.



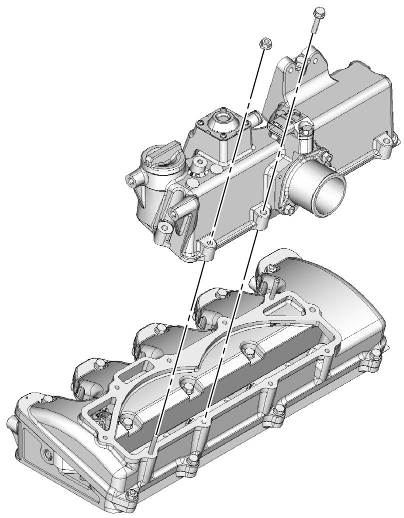
PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.



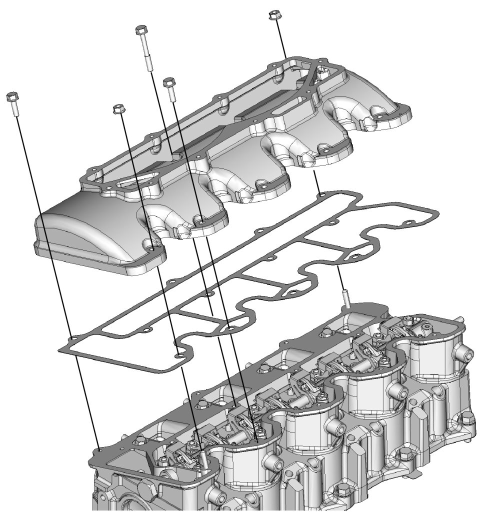
PAWC1BSH000601

15. PCV hose removal
    1. Remove the PCV hose from the intake chamber.
16. IMT sensor removal
    1. Disconnect the harness connector from the IMT sensor.
    2. Remove the IMT sensor from the intake chamber.
17. Intake chamber removal
    1. Remove the intake chamber from the cylinder head cover.



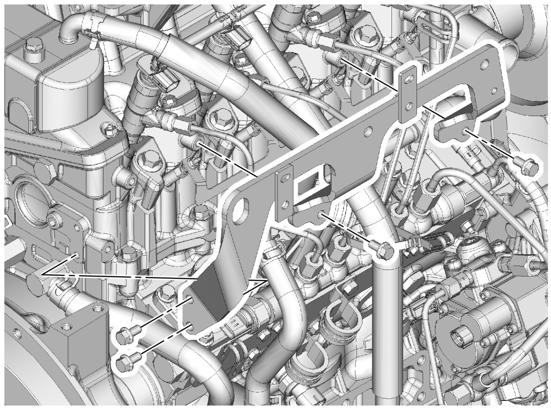
PAWC1BSH000701

18. Cylinder head cover removal
    1. Remove the cylinder head cover from the rocker arm bracket.



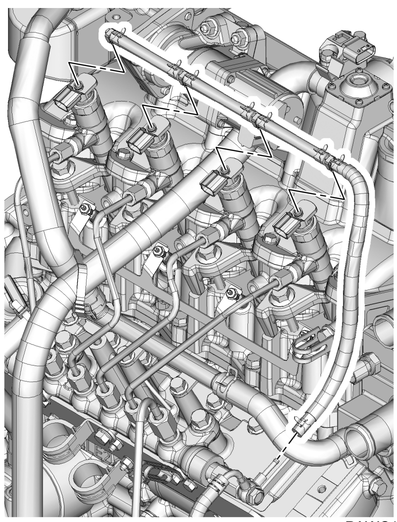
PAWC1BSH001001

19. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



PAWC1CSH000301

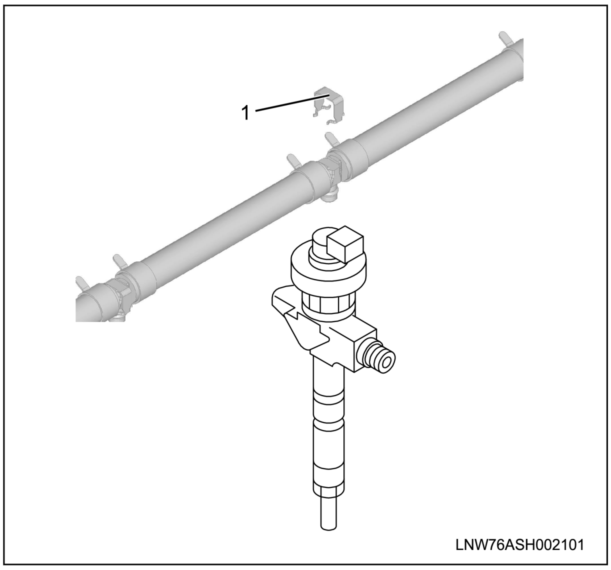
20. Fuel leak-off hose removal
    1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note：

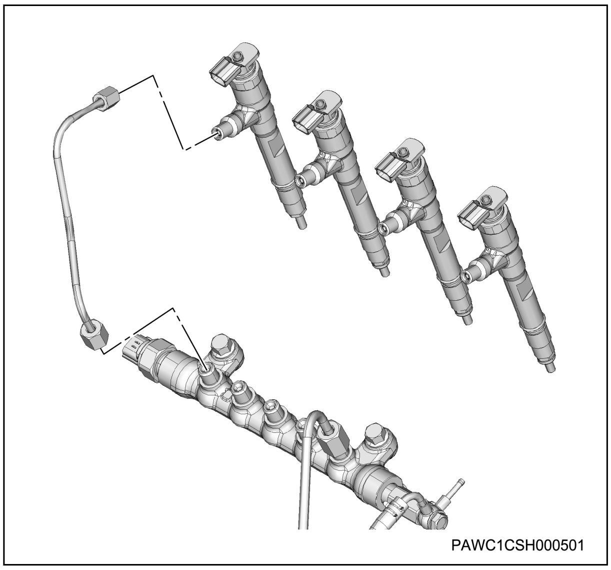
- Do not reuse the leak-off pipe clip.



1. Clip

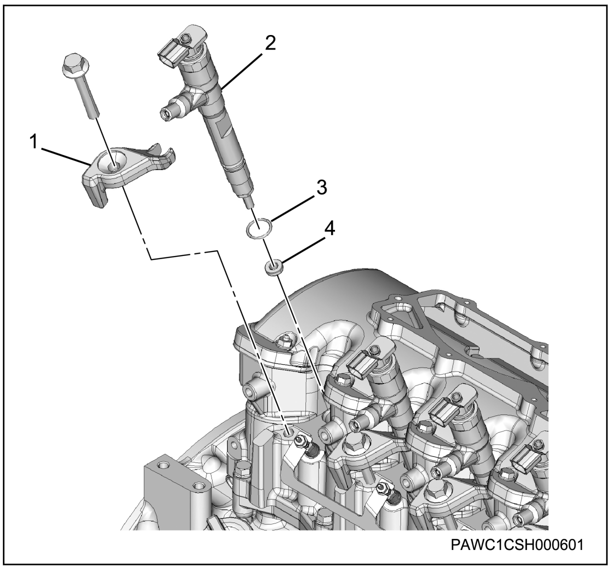
21. Injection pipe removal
    1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note :
- Do not reuse the injection pipe.



22. Injector removal
    1. Disconnect the harness connector from the injector.
    2. Remove the injector from the cylinder head assembly.
    3. Remove the injector gasket from the injector.
    4. Remove the O-ring from the injector.

Note :
- Do not reuse the injector gasket or the O-ring.

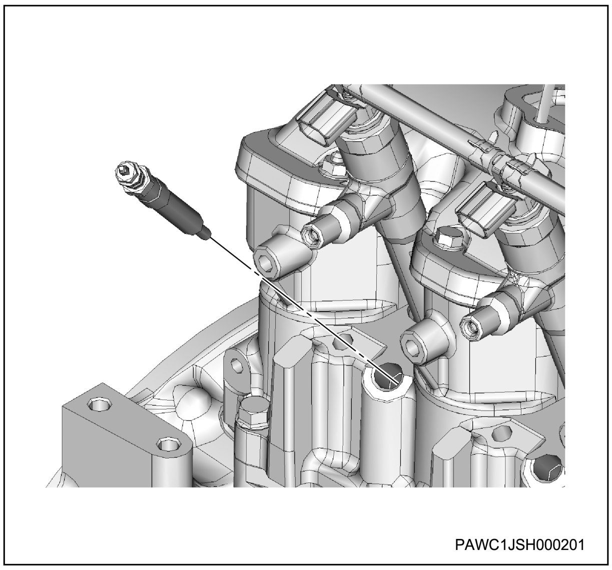


1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

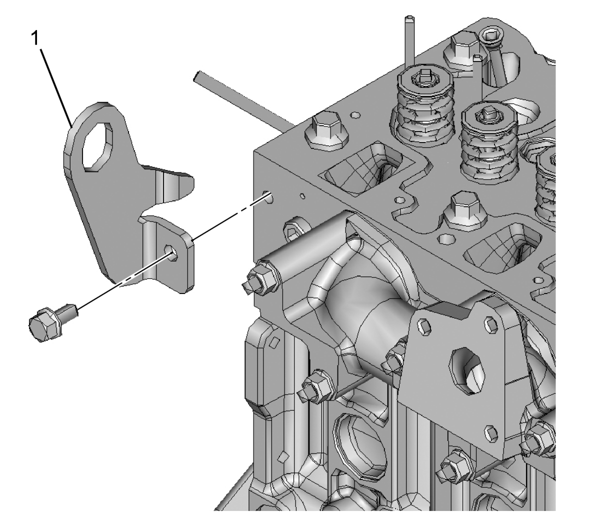
Note :
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

23. Glow plug connector removal
    1. Remove the glow plug connector from the glow plug.

24. Glow plug removal
    1. Remove the glow plug from the cylinder head.



25. Engine hanger removal
    1. Remove the engine hanger from the cylinder head.



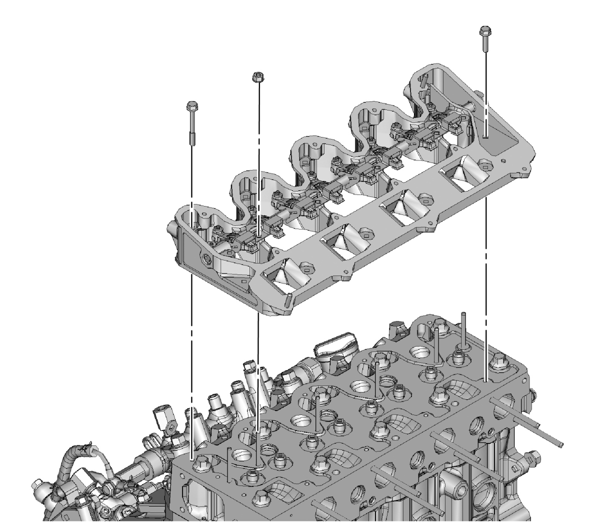
PAWC1BSH002701

1. Engine hanger

26. Rocker arm bracket removal
    1. Remove the rocker arm bracket from the cylinder head.

Caution :

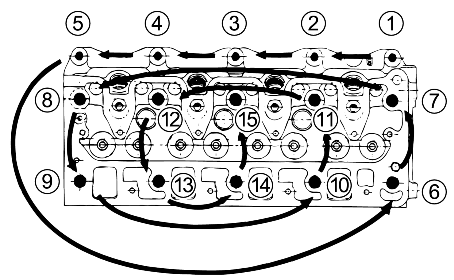
- Be careful not to damage the rocker arm bracket when removing.


PAWC1BSH002901

27. Push rod removal
    1. Remove the push rod from the cylinder block.
28. Cylinder head assembly removal
    1. Remove the cylinder head assembly from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



PAWC1BSH002801

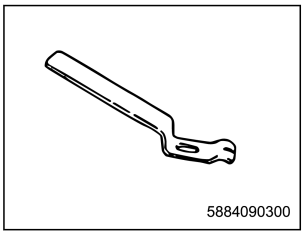
2. Remove the cylinder head gasket from the cylinder block.

disassembly

1. Exhaust manifold removal
   1. Remove the exhaust manifold from the cylinder head.
   2. Remove the gasket from the cylinder head.
2. Split collar removal
   1. Remove the split collar from the valve using a special tool.

   Note :

   - Using a replacer, compress the valve spring and remove the split collar.

   SST: 5-8840-9030-0 - valve spring compressor
3. Spring seat removal
   1. Remove the spring seat from the valve.
4. Valve spring removal
   1. Remove the valve spring from the cylinder head.
5. Inlet valve removal
   1. Remove the inlet valve from the cylinder head.

   Note :

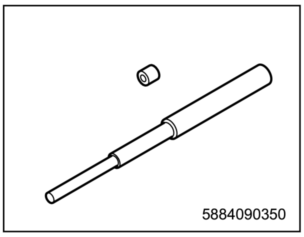
   - Organize the removed valves according to the cylinders using tags, etc.
6. Exhaust valve removal
   1. Remove the exhaust valve from the cylinder head.

   Note :

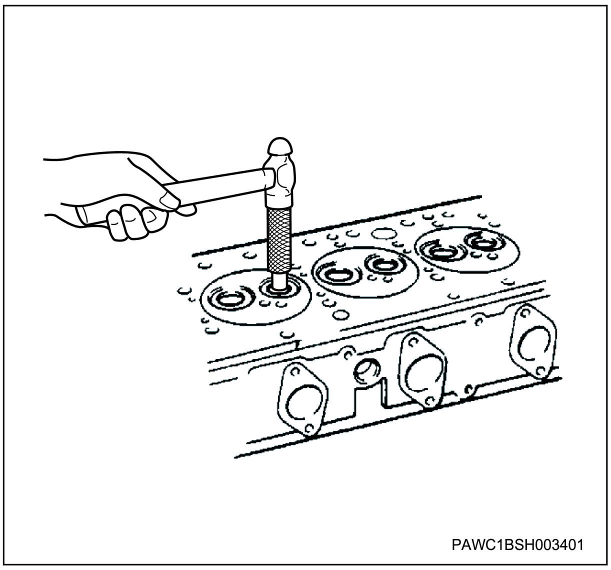
   - Organize the removed valves according to the cylinders using tags, etc.
7. Valve stem oil seal removal
   1. Remove the valve stem oil seal from the cylinder head using pliers.
8. Valve guide removal
   1. Remove the valve guide from the cylinder head using a special tool.

   Note :

   - Using a valve guide remover, tap out the valve guide from the lower surface side of the cylinder head.



SST: 5-8840-9035-0 - valve guide replacer



inspection

1. Cylinder head assembly inspection

Caution：

- Before inspecting the cylinder head assembly, clean each section of the cylinder head assembly.
- Be careful not to damage the cylinder head when cleaning the cylinder head assembly.

1. Inspect the cylinder head assembly.

Note：

- Cylinder head gasket installation surface
- Combustion chamber
- Exhaust port
- Valve seat
- Glow plug hole
- If cracks or other damage is found as a result of the inspection, replace the cylinder head.
- Repair if repairing is possible.

2. Perform the dye penetrant check.

Note：

- Check for problems that cannot be detected by visual inspection.

3. Inspect for water leaks using a water pressure tester.

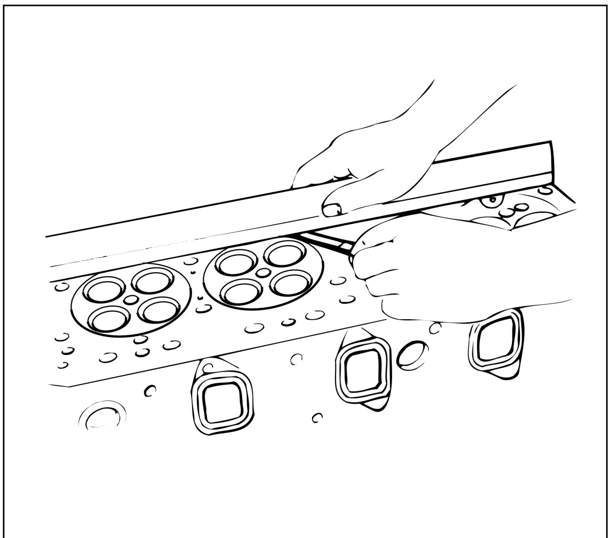
specified pressure： 490 kPa { 71 psi }

specified time： 3 min

4. Align a simple straight ruler to the cylinder head assembly.
5. Measure the clearance using a feeler gauge.

Note：

- Place a simple straight ruler in the direction of the 4 sides and the 2 diagonal lines, and use a feeler gauge to measure deformation.



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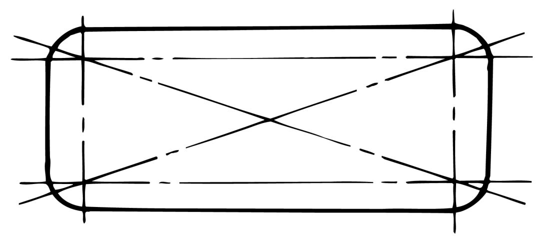


LNWA1BSH000901

specified value： less than 0.075 mm { less than 0.00295 in }

limit： 0.3 mm { 0.012 in } Maximum polish allowance

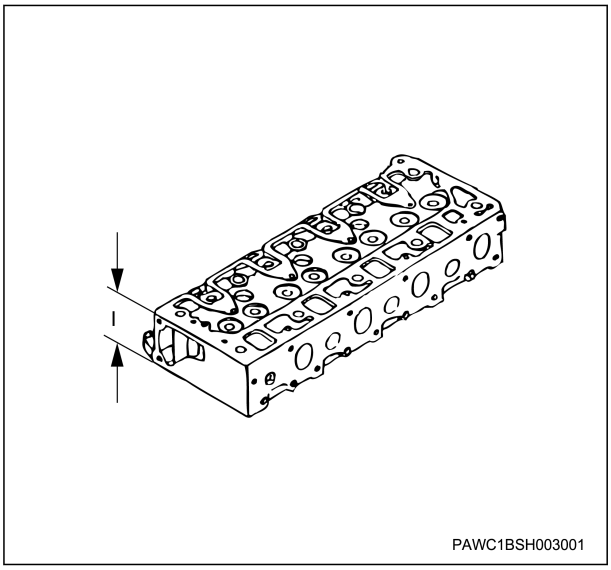
Caution：

- If the measured value exceeds the maximum polish allowance, replace the cylinder head.

Note：

- Measure the cylinder head height.

specified value： 63.90 to 64.10 mm { 2.516 to 2.524 in } 4LE2X



1. Cylinder head height

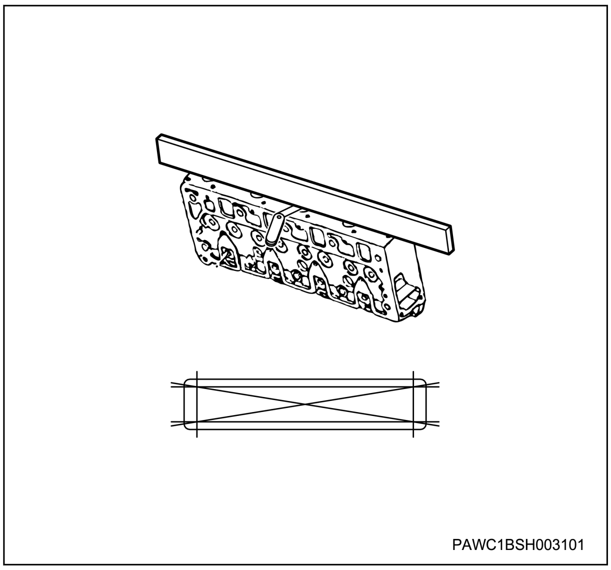
6. Measure the deformation using a feeler gauge.

Note :

- Measure the flatness of the exhaust manifold installation surface.
- Use a feeler gauge and a simple straight ruler to measure deformation of the installation surface.
- Measure the 4 sides and the diagonal lines.
- Replace if the measured value exceeds the limit.

specified value : less than 0.05 mm { less than 0.002 in }

limit : 0.2 mm { 0.008 in }



2. Exhaust valve measurement

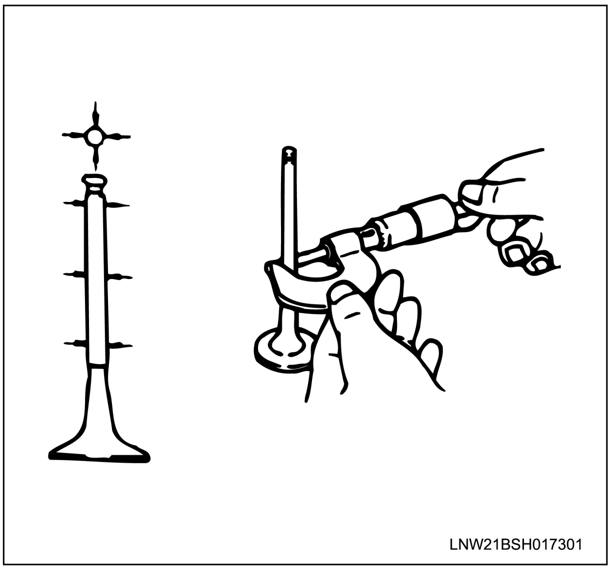
1. Measure the exhaust valve using a micrometer.

Note :

- Measure the diameter of the valve stem.
- If the diameter of the valve stem is smaller than the limit, replace the valve and the valve guide as a set.

specified value : 7.0 mm { 0.276 in }

limit : 6.8 mm { 0.268 in }



2. Measure the valve guide clearance using a dial gauge.

Note :

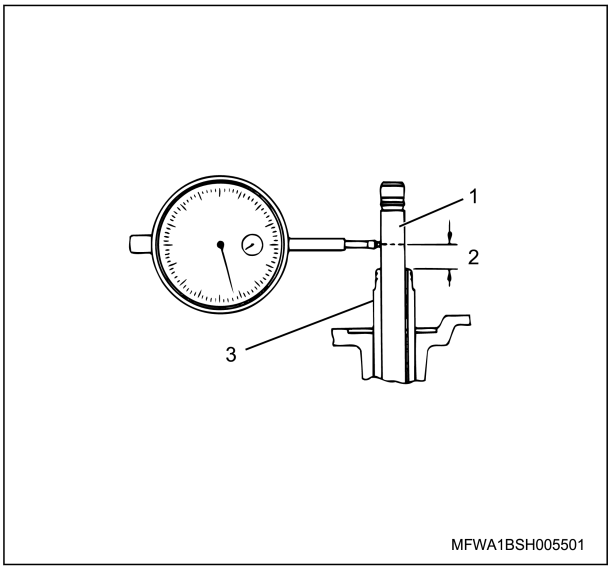
- Measure the clearance between the valve guide and the valve stem at a position within 10 mm {0.3937 in} of the valve guide.

Caution :

- Replace the valve and the valve guide together as an assembly if the measured value exceeds the limit.

specified value : 0.030 to 0.063 mm { 0.0012 to 0.0025 in }

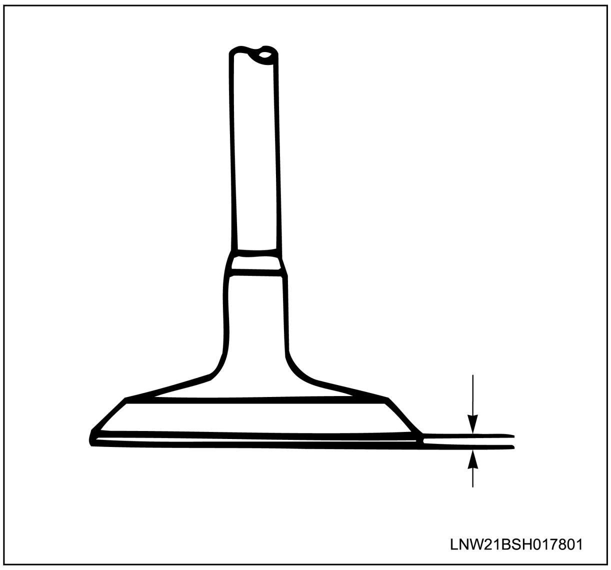
limit : 0.25 mm { 0.0098 in }



1. Valve
2. Position 10 mm {0.3937 in} from the top end of the valve guide
3. Valve guide

Note :

- Inspect the thickness of the valve.



specified value : 0.8 mm { 0.031 in }

limit : 0.5 mm { 0.020 in }

Caution :

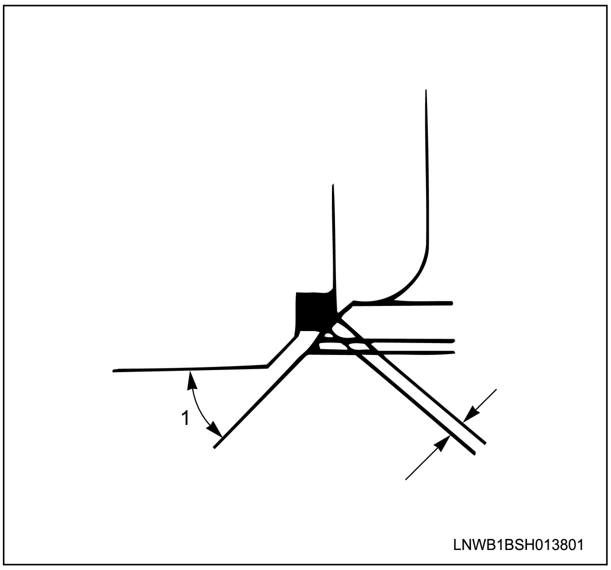
- If the measured value exceeds the limit, replace the exhaust valve and the valve guide.

Note :

- Measure the contact width of the valve seat.
- Repair if the seat contact surface is damaged or rough, or when the wear of the contact surface exceeds the limit.

specified value : 2.0 mm { 0.079 in }

limit : 2.5 mm { 0.098 in }



1. 45°

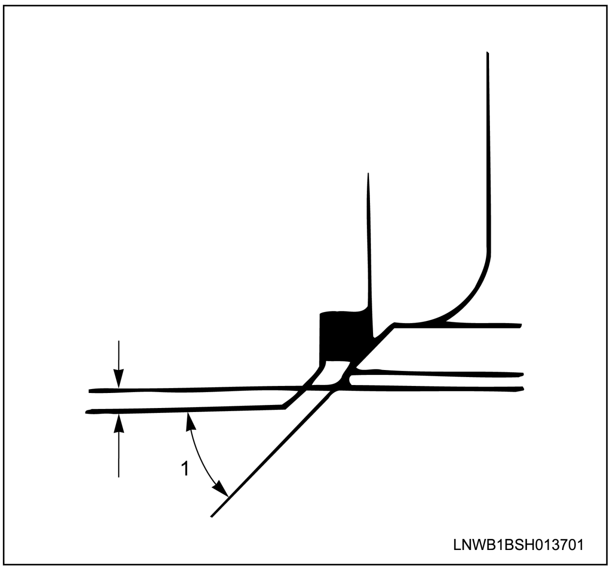
3. Measure the exhaust valve using a depth gauge.

Note :

- Use a depth gauge or a simple straight ruler to measure the sinking amount of the valve from the bottom surface of the cylinder head.
- If the measured value exceeds the limit, replace the valve insert.

specified value : 0.9 mm { 0.035 in }

limit : 1.5 mm { 0.059 in }



1. 45°

3. Inlet valve measurement

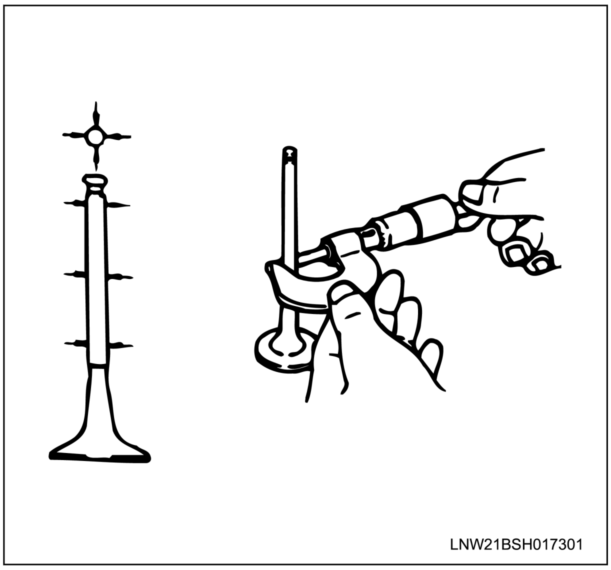
1. Measure the inlet valve using a micrometer.

Note :

- Measure the diameter of the valve stem.
- If the diameter of the valve stem is smaller than the limit, replace the valve and the valve guide as a set.

specified value : 7.0 mm { 0.276 in }

limit : 6.85 mm { 0.270 in }



2. Measure the valve guide clearance using a dial gauge.

Note :

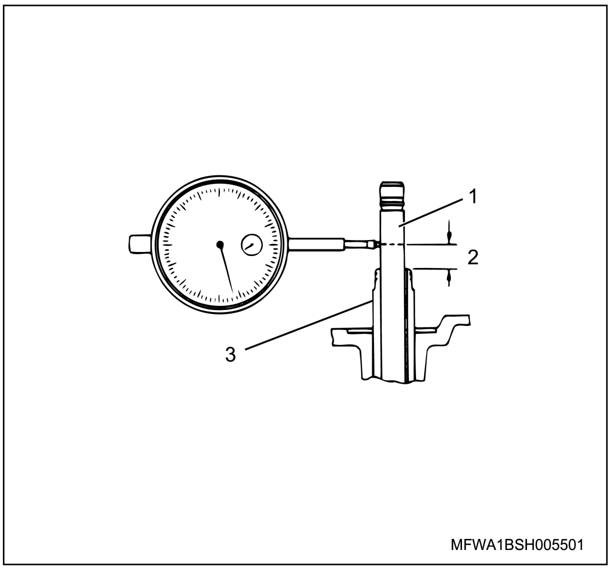
- Measure the clearance between the valve guide and the valve stem at a position within 10 mm {0.3937 in} of the valve guide.

Caution :

- Replace the valve and the valve guide together as an assembly if the measured value exceeds the limit.

specified value : 0.023 to 0.056 mm { 0.0009 to 0.0022 in }

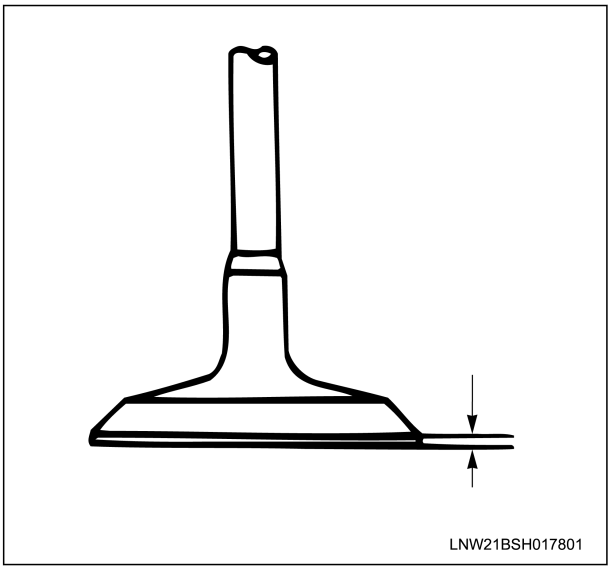
limit : 0.2 mm { 0.008 in }



1. Valve
2. Position 10 mm {0.3937 in} from the top end of the valve guide
3. Valve guide

Note :

- Inspect the thickness of the valve.



specified value : 1.0 mm { 0.039 in }

limit : 0.7 mm { 0.028 in }

Caution :

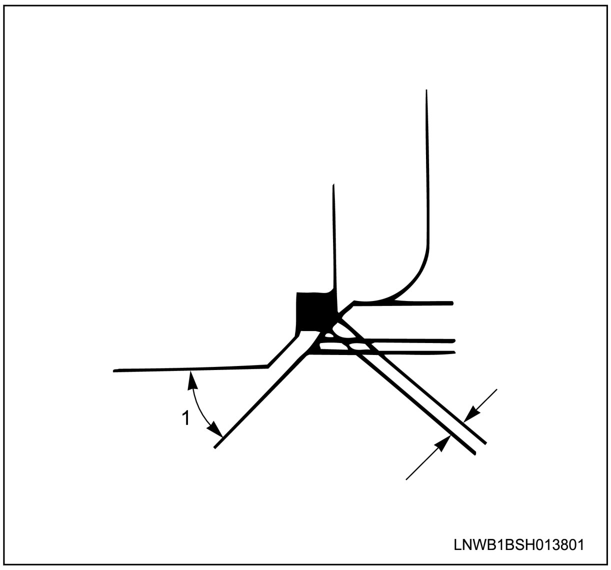
- If the measured value exceeds the limit, replace the inlet valve and the valve guide.

Note :

- Measure the contact width of the valve seat.
- Repair if the seat contact surface is damaged or rough, or when the wear of the contact surface exceeds the limit.

specified value : 2.0 mm { 0.079 in }

limit : 2.5 mm { 0.098 in }



1. 45°

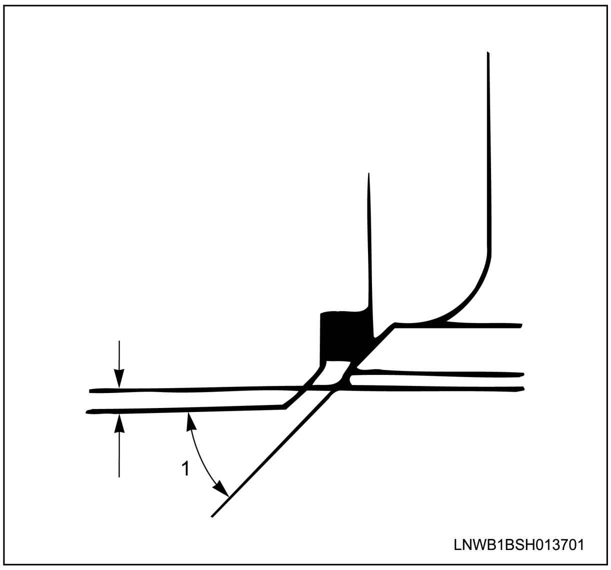
3. Measure the inlet valve using a depth gauge.

Note :

- Use a depth gauge or a simple straight ruler to measure the sinking amount of the valve from the bottom surface of the cylinder head.
- If the measured value exceeds the limit, replace the valve seat insert.

specified value : 0.7 mm { 0.028 in }

limit : 1.2 mm { 0.047 in }



1. 45°

4. Valve seat insert adjustment

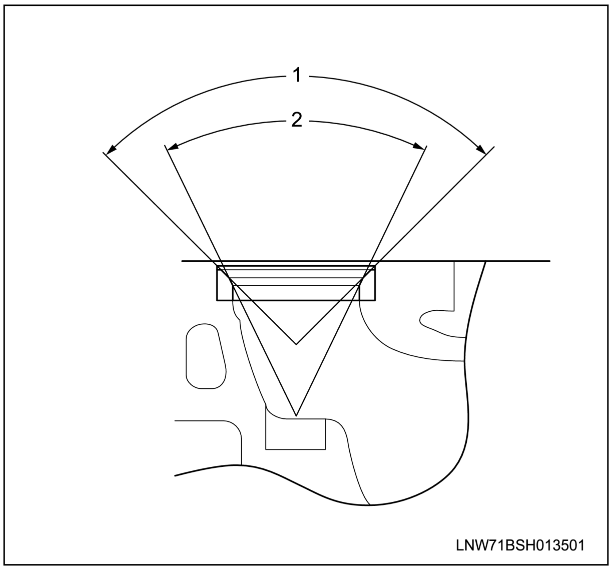
Note :

- Remove carbon from the surface of the valve seat insert.

1. Adjust the valve seat to the specified value using a seat cutter.

Note :

- Use a seat cutter to minimize scratches and other uneven parts, and return the contact width to the specified value.



1. 90°
2. 50°

Note :

- Fit after repairing.

2. Apply compound to the valve seat insert.

Note :

- Apply compound to the valve seat surface.

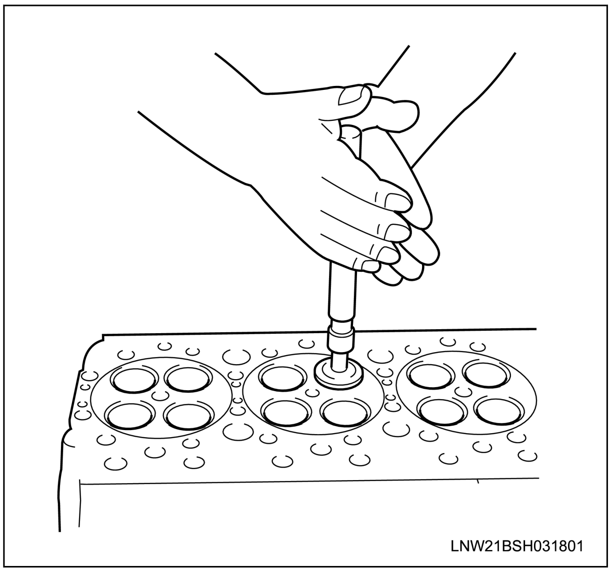
3. Install the valve to the valve guide.

Note :

- Fit while turning the valve.
- Check the contact surface of the valve seat.
- Verify that it is touching evenly around the entire circumference.

Caution :

- After fitting, completely remove the compound.



5. Valve seat insert removal

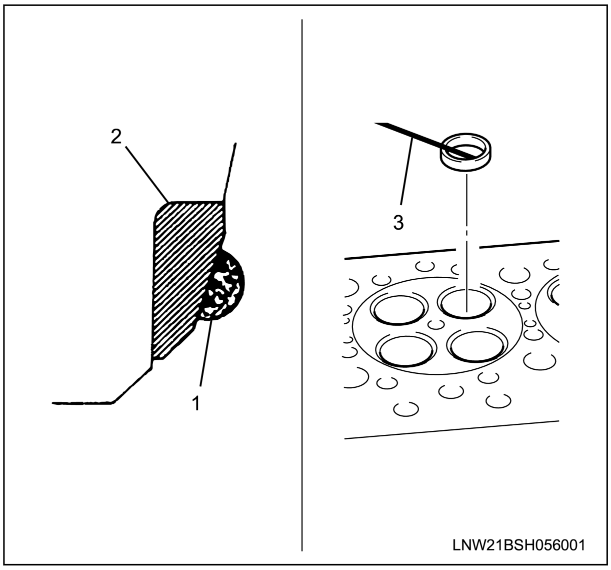
Note：

- Arc weld the entire inner circumference of the valve seat insert.
- Cool the valve seat insert for 2 to 3 minutes.
- Contraction due to cooling makes it easier to remove the valve seat insert.

1. Remove the valve seat insert from the cylinder head using a driver.

Caution：

- Be careful not to damage the cylinder head.



1. Arc welding
2. Valve seat insert
3. Driver

6. Valve seat insert installation

1. Put a dolly block on the valve seat insert.

Note：

- Carefully place a dolly block with an outer diameter that is less than the valve seat insert onto the valve seat insert.

2. Install the valve seat insert to the cylinder head using a press.

Note：

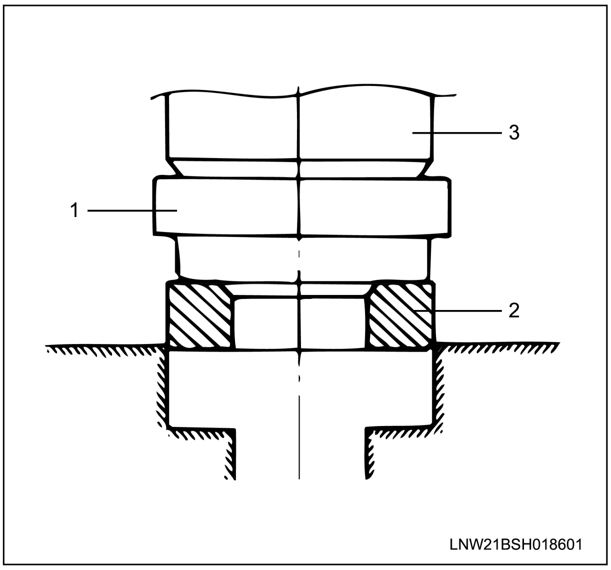
- Gradually apply pressure to the dolly block and push in the valve seat insert.

Caution：

- Do not apply excessive pressure with the press.

Note：

- Add compound to the valve seat surface and gently tap the valve while turning it to fit.
- Verify that it is touching evenly around the entire circumference.



1. Dolly block
2. Valve seat insert
3. Press

7. Valve guide inspection

1. Inspect the valve guide.

Note：

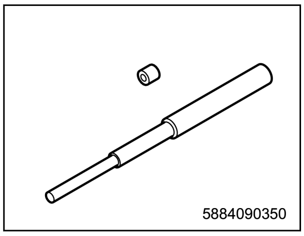
- If there are scratches or abnormal wear on the valve stem or the inner diameter of the valve guide, replace the valve guide as a set.

reassembly

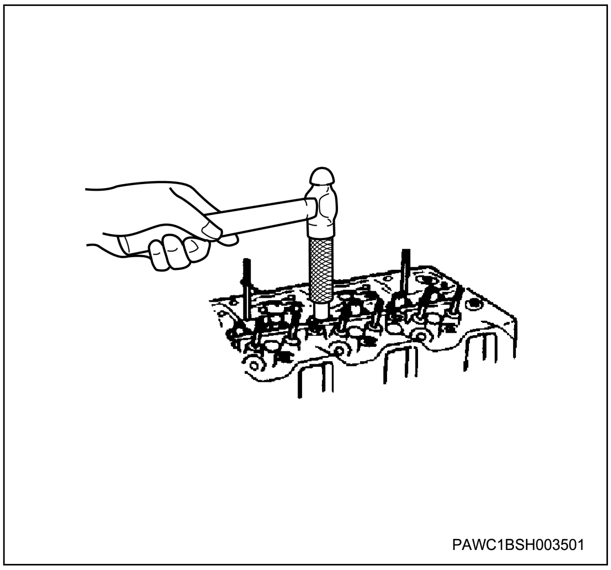
1. Valve guide installation
   1. Install the valve guide to the cylinder head using a special tool.

Note：

- Using a valve guide installer, tap in the valve guide from the upper surface side of the cylinder head.



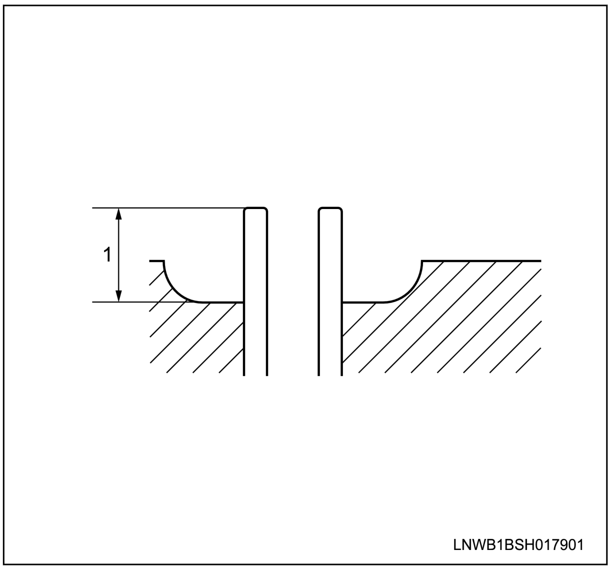
SST: 5-8840-9035-0 - valve guide replacer



valve stem height： 9.5 mm { 0.374 in }

Caution：

- When replacing the valve guide, replace with the valve as a set.



1. Height from the upper surface of the cylinder head to the end surface of the valve guide

2. Valve stem oil seal installation
   1. Apply engine oil to the valve guide.

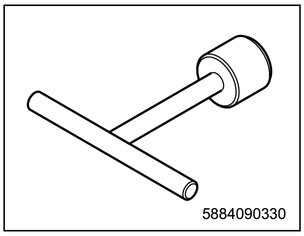
Note：

- Apply engine oil to the outer circumference of the valve guide.

   2. Install the valve stem oil seal to the cylinder head using a special tool.

Note：

- Using a valve stem seal installer, tap until the protruding section of the oil seal is securely fixed in the valve guide groove.



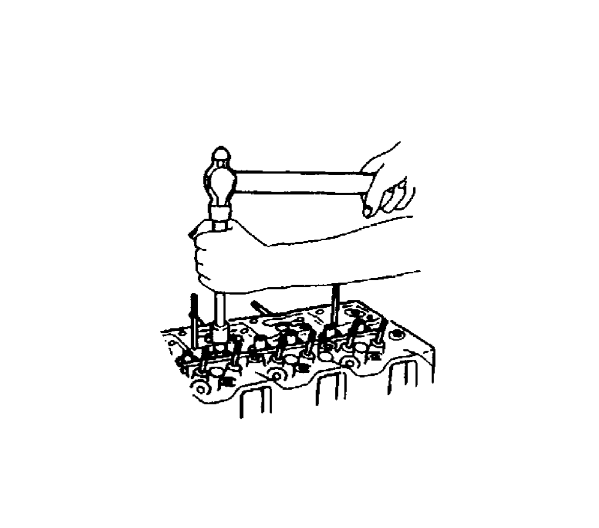
SST: 5-8840-9033-0 - valve stem seal installer

Note：

- Verify that the spring has not come off.

Caution：

- Be careful not to damage the lip section of the seal.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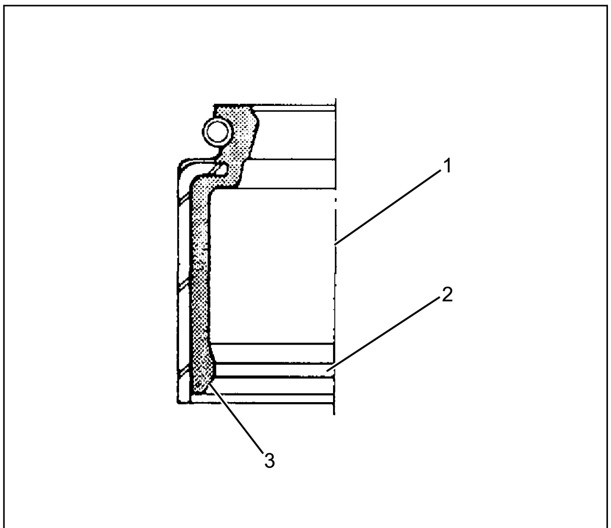


PAWC1BSH003701

1. Valve guide
2. Groove
3. Protruding section

3. Exhaust valve installation
   1. Apply engine oil to the exhaust valve.

   Note :
   - Apply engine oil to the valve stem section.

   2. Install the exhaust valve to the cylinder head.

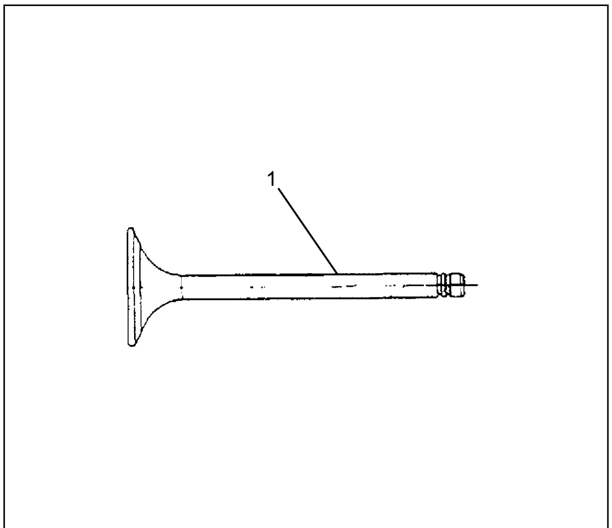
   Caution :
   - Be careful not to allow the installed valve to fall down from the cylinder head.

4. Inlet valve installation
   1. Apply engine oil to the inlet valve.

   Note :
   - Apply engine oil to the valve stem section.

   2. Install the inlet valve to the cylinder head.

   Caution :
   - Be careful not to allow the installed valve to fall down from the cylinder head.

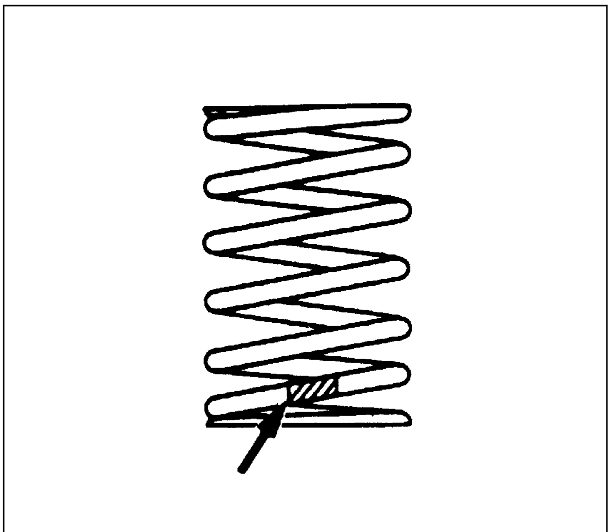


PAWC1BSH003801

1. Valve stem

5. Valve spring installation
   1. Install the valve spring to the cylinder head.

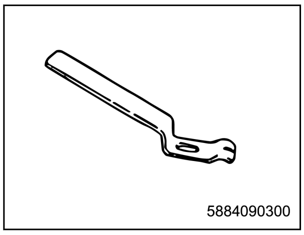
   Note :
   - Install so that the painted side faces the cylinder head side.


LNWC1BSH013301

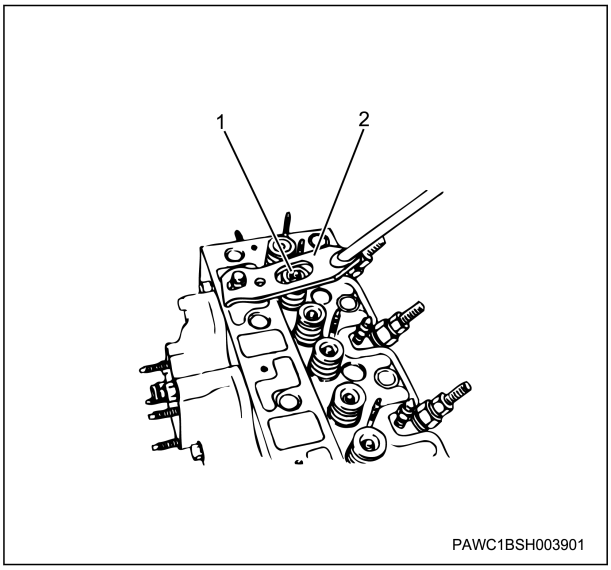
6. Spring seat installation
   1. Install the spring seat to the valve.
7. Split collar installation
   1. Install the split collar to the valve using a special tool.

Note：

- Using a replacer, compress the valve spring and install the split collar.



SST: 5-8840-9030-0 - valve spring compressor



1. Split collar
2. Replacer

8. Exhaust manifold installation

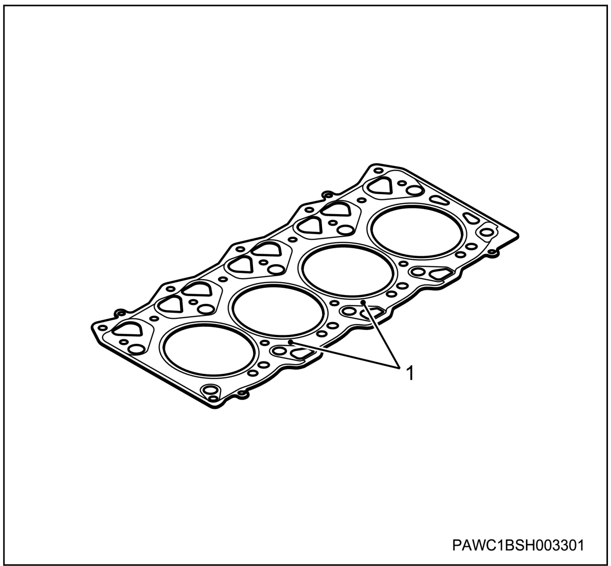
1. Install the gasket to the cylinder head.
2. Install the exhaust manifold to the cylinder head.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

installation

1. Cylinder head assembly installation
   1. Install the cylinder head gasket to the cylinder block.

Note：
- Install with the marked side facing upward.



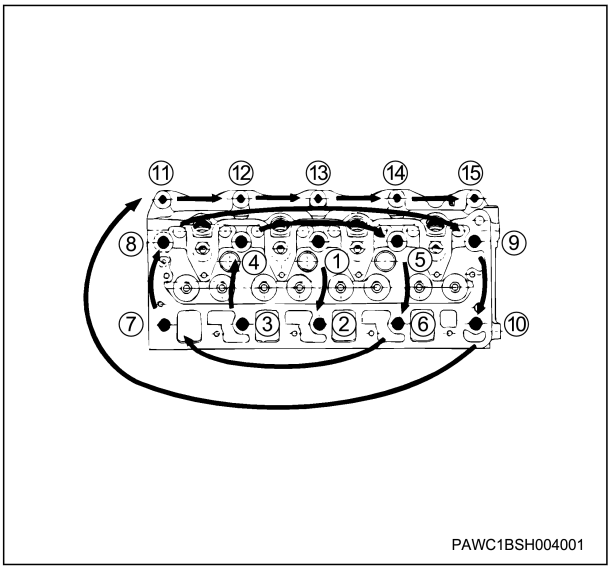
1. Mark

2. Apply engine oil to the bolt.

Note：
- Apply engine oil to the threaded portion and the seat surface of the head bolt.

3. Install the cylinder head assembly to the cylinder block.
4. Tighten the head bolts using a torque wrench.

Note：
- Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle： 60 ° 3rd time

Note：
- Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

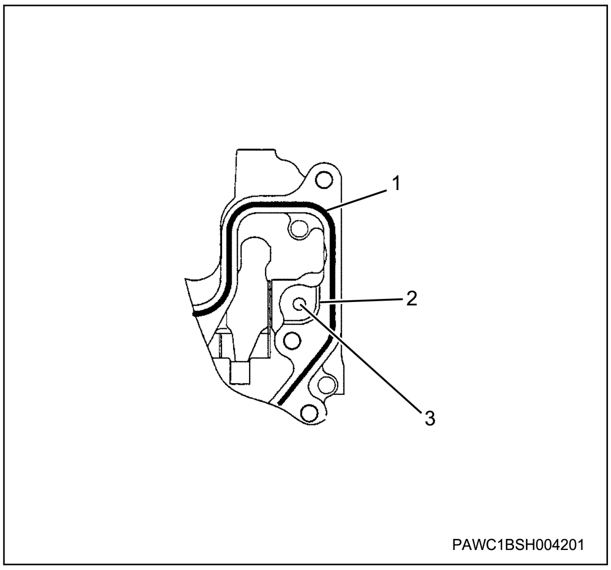
2. Push rod installation
   1. Install the push rod to the cylinder block.

Note：
- Pass it through the cylinder block and insert it into the tappet.

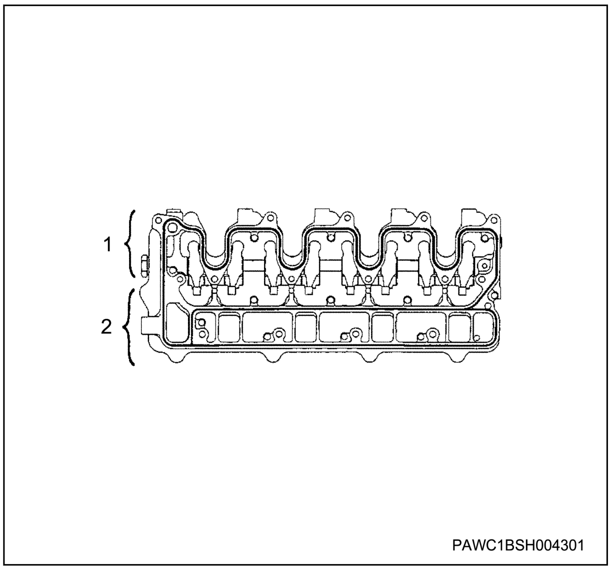
3. Rocker arm bracket installation
   1. Apply liquid gasket to the rocker arm bracket.

Note：
- Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

Caution：
- Do not apply liquid gasket to the groove around the oil gallery.



1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



1. Liquid gasket application area
2. Oil gallery groove

Note：

- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note：

- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.
4. Securely tighten the rocker arm bracket to the cylinder head.

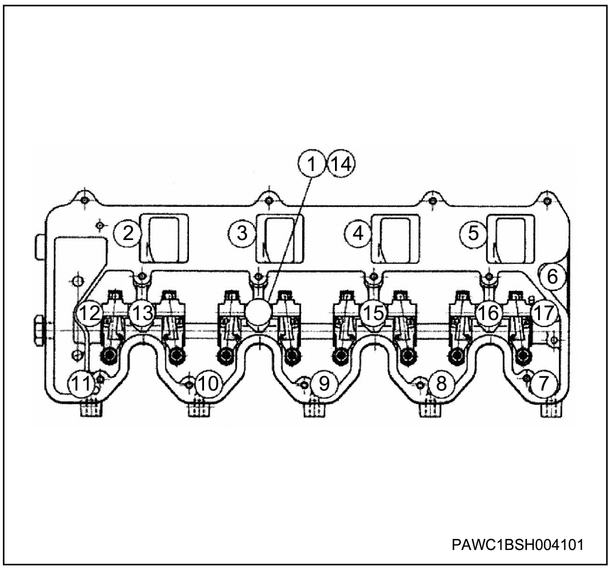
Note：

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution：

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



4. Rocker arm shaft adjustment

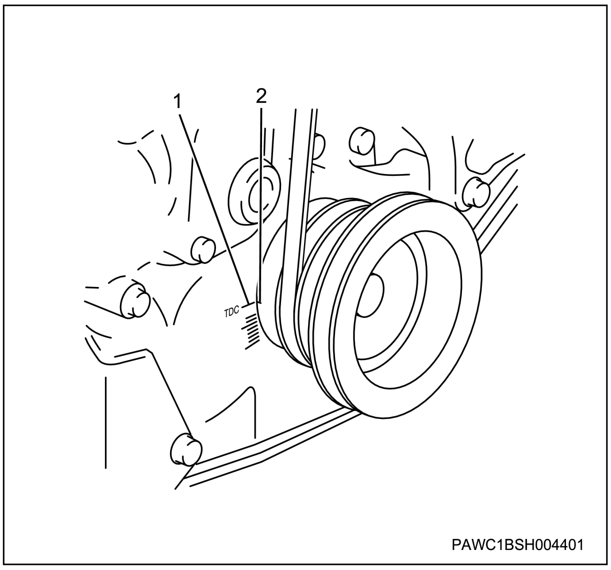
Note：

- Valve clearance adjustment

Caution：

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note :

- Insert the feeler gauge between the rocker arm and the bridge cap.

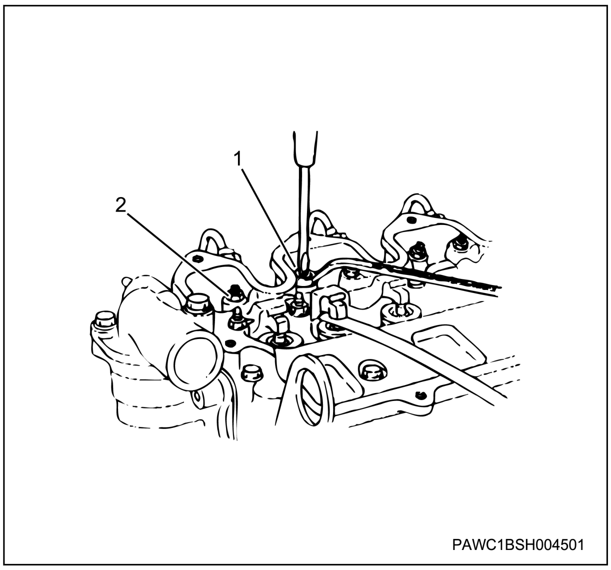
specified value : 0.40 mm { 0.016 in } Inlet valve

specified value : 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note :

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



1. Adjust screw
2. Lock nut

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note :

- Rotate the crankshaft in the forward direction and measure the valve clearance.

Caution :

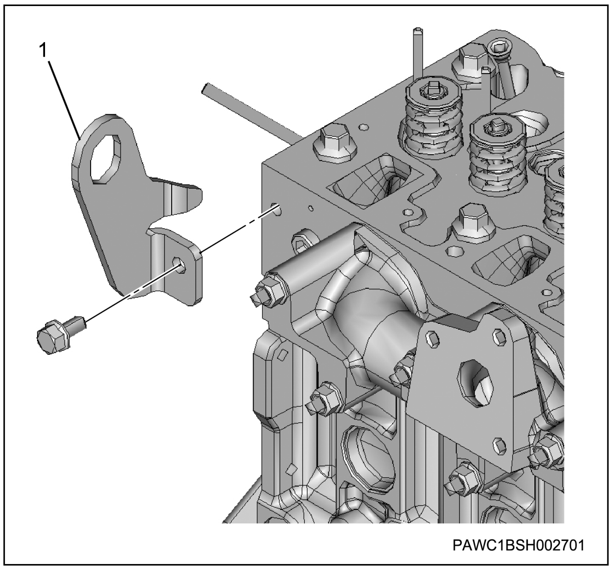
- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

5. Engine hanger installation

1. Install the engine hanger to the cylinder head.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }

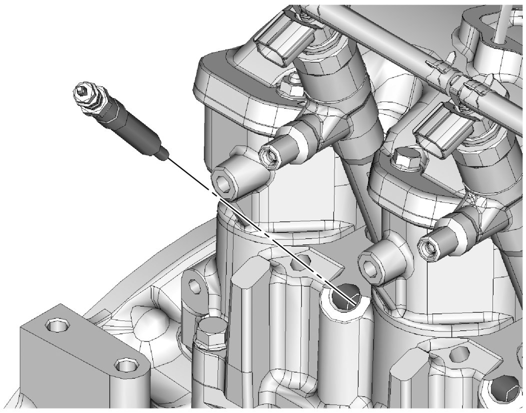


1. Engine hanger

6. Glow plug installation

1. Install the glow plug to the cylinder head.

tightening torque : 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1JSH000201

7. Glow plug connector installation

   1. Install the glow plug connector to the glow plug.

   tightening torque : 1.0 N・m { 0.1 kgf・m / 9 lb・in }

8. Injector installation

   Caution :

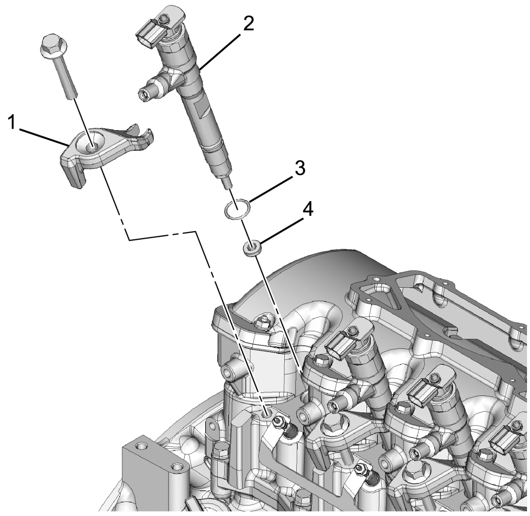
   - Do not change the installation position of the injectors when reusing the injectors.

   1. Install the O-ring to the injector.
   2. Install the injector gasket to the injector.

   Note :

   - Do not reuse the injector gasket or the O-ring.

   3. Temporarily tighten the injector to the cylinder head assembly.

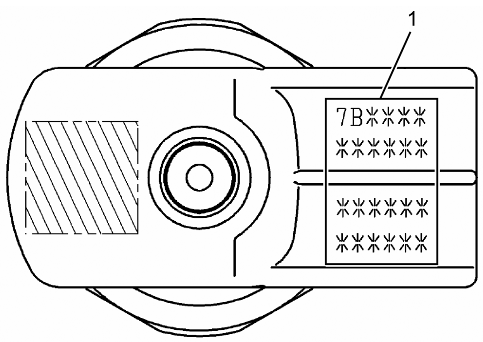


PAWC1CSH000601

1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Caution :

- If the injector has been replaced, record the injector ID code of the new injector.



PAWC1CSH000701

1. Injector ID code

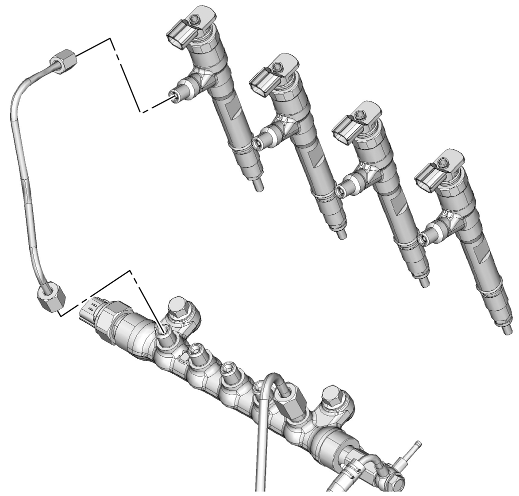
   4. Connect the harness connector to the injector.

9. Injection pipe installation

   1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

   Note :

   - Do not reuse the injection pipe.



PAWC1CSH000501

   2. Securely tighten the injector to the cylinder head assembly.

   tightening torque : 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

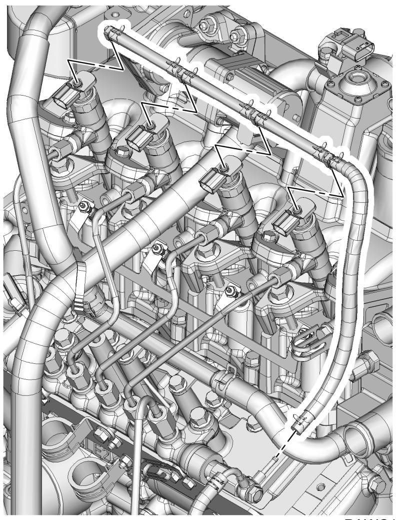
Note：
- Securely tighten the injector side.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

Note：
- Securely tighten the common rail (fuel rail) side.

tightening torque： 30 N・m { 3.1 kgf・m / 22 lb・ft }

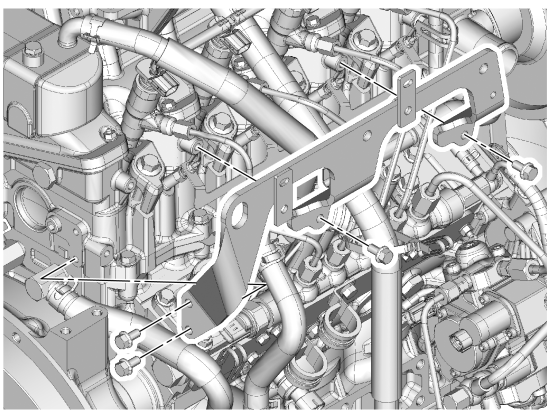
10. Fuel leak-off hose installation
    1. Install the fuel leak-off hose to the injector.



PAWC1CSH000401

11. Harness bracket installation
    1. Install the harness bracket to the cylinder head.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

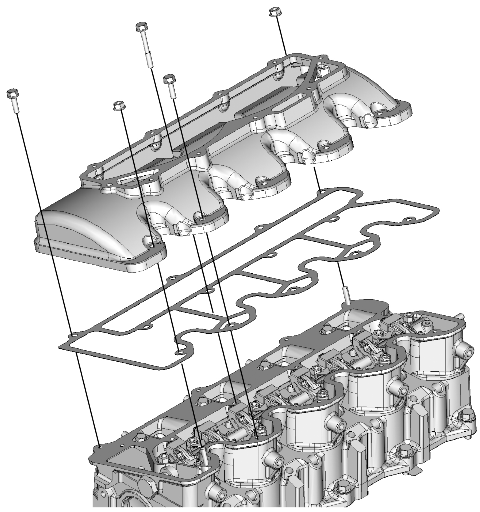


PAWC1CSH000301

2. Connect the engine harness to the harness bracket.

12. Cylinder head cover installation
    1. Install the cylinder head cover to the rocker arm bracket.

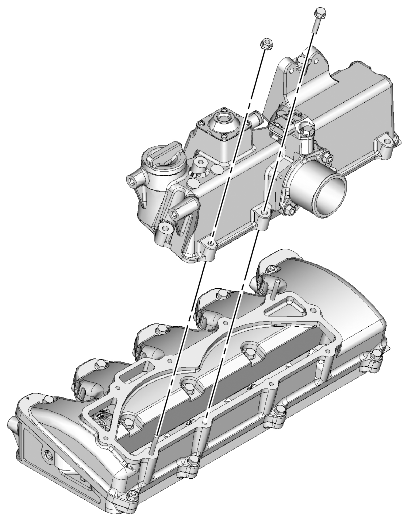
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH001001

13. Intake chamber installation
    1. Install the intake chamber to the cylinder head cover.

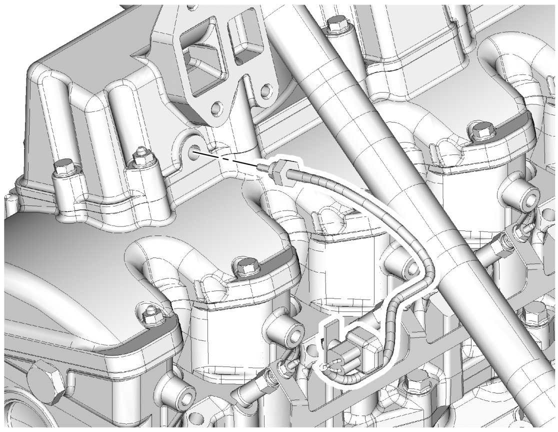
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH000701

14. IMT sensor installation
    1. Install the IMT sensor to the intake chamber.

tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }


PAWC1FSH000401

2. Connect the harness connector to the IMT sensor.

15. PCV hose installation

1. Install the PCV hose to the intake chamber.

16. EGR valve installation

1. Temporarily tighten the EGR valve to the intake chamber.
2. Temporarily tighten the EGR pipe to the exhaust manifold.
3. Temporarily tighten the EGR pipe to the EGR valve.
4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

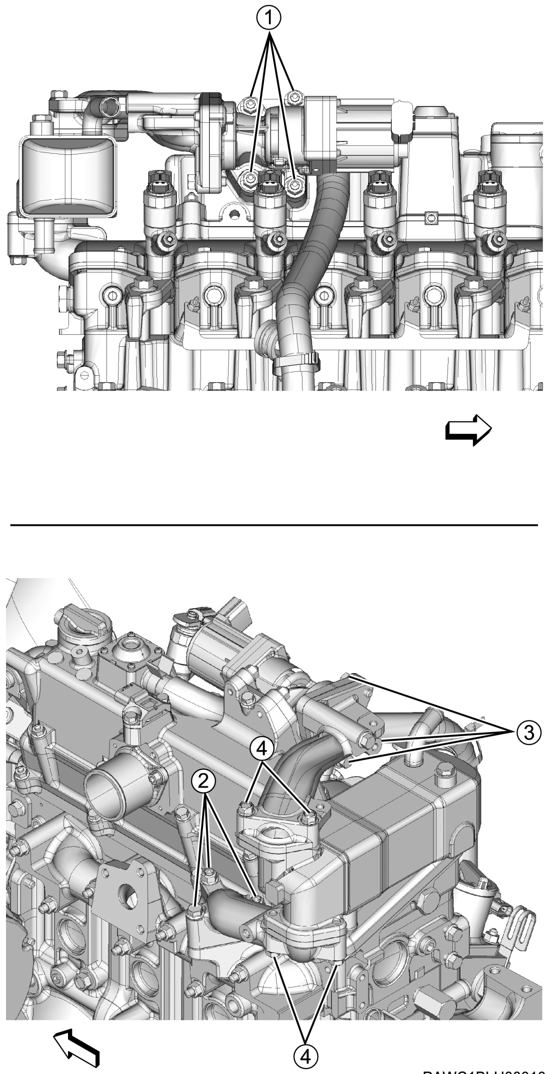
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



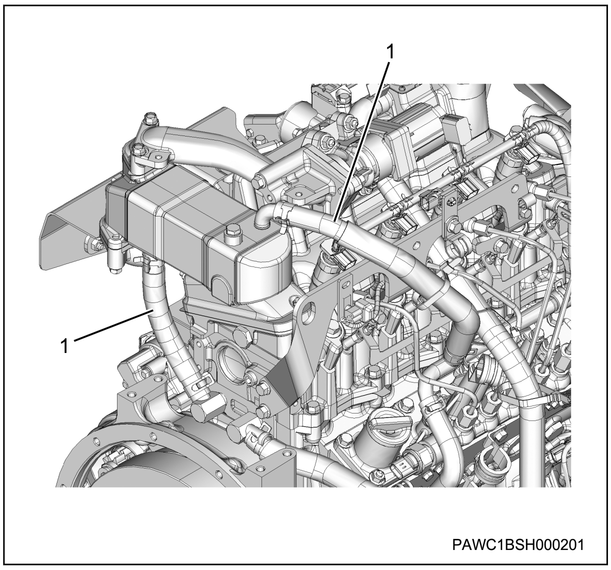
PAWC1BLH000101

Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

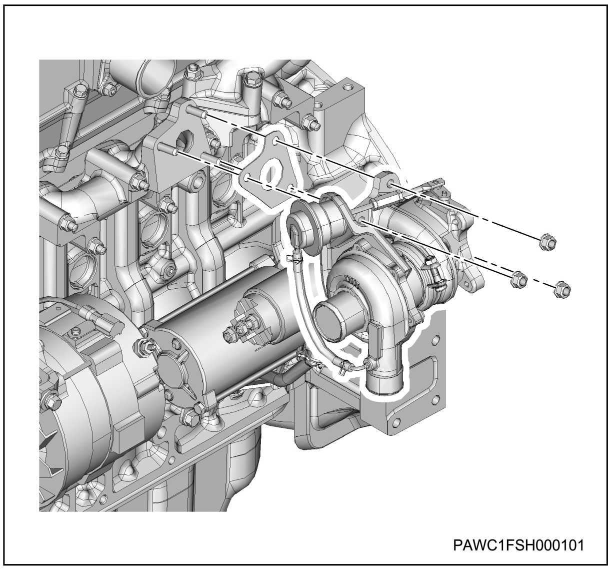
17. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note：

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



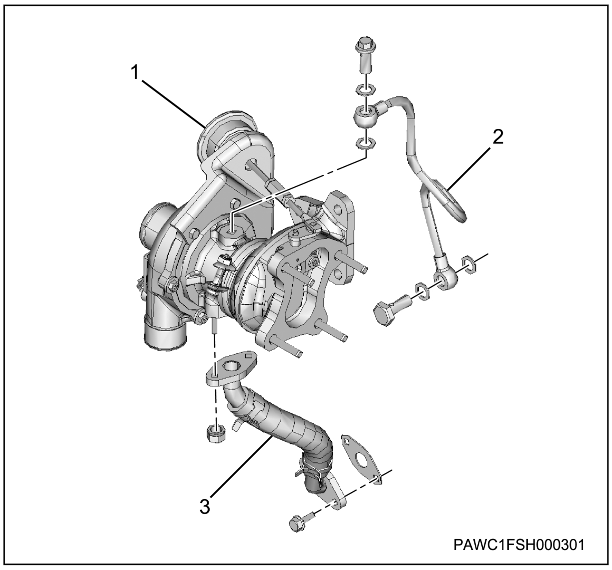
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }
Cylinder block side

tightening torque： 22 N・m { 2.2 kgf・m / 16 lb・ft }
Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

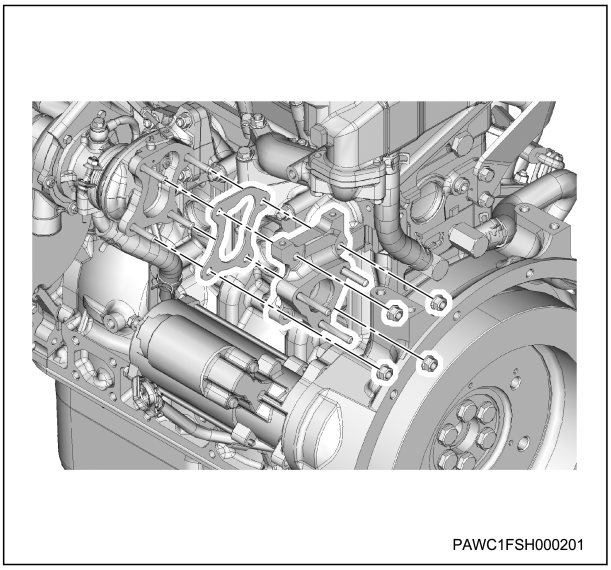
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

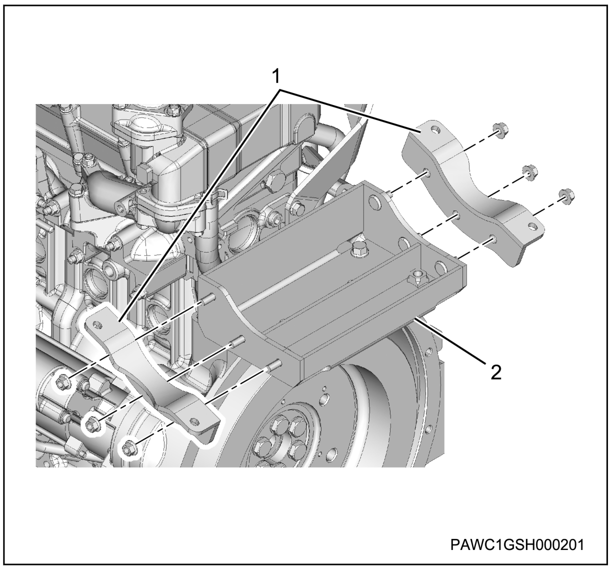
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



18. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

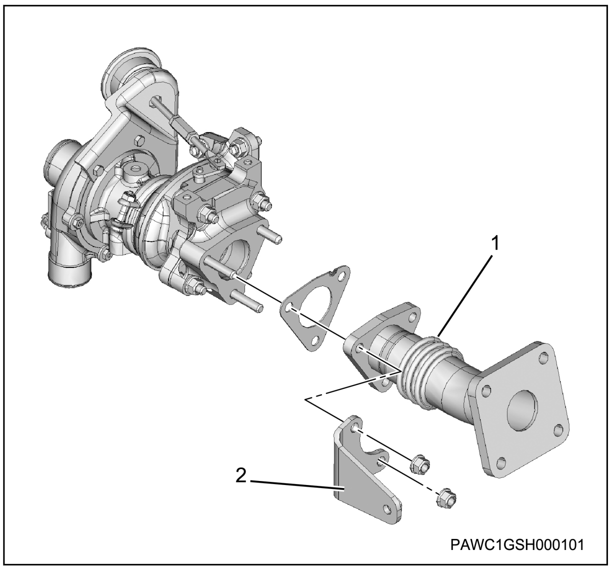


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

・ Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

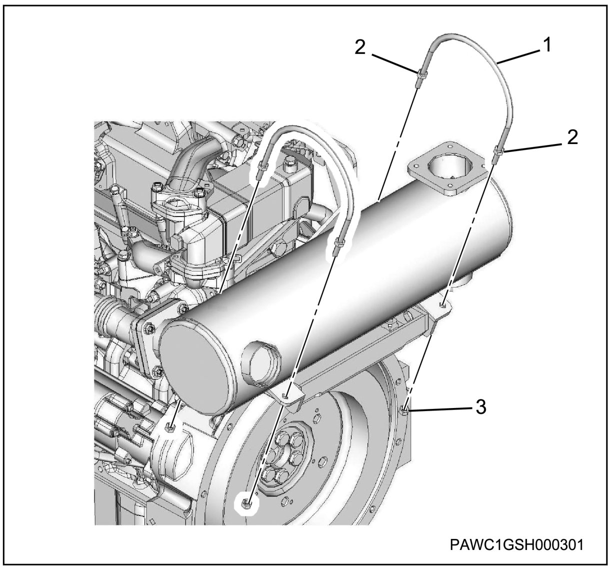
Note：

・ Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
・ With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
・ Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

・ Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
・ Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

・ Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
・ Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

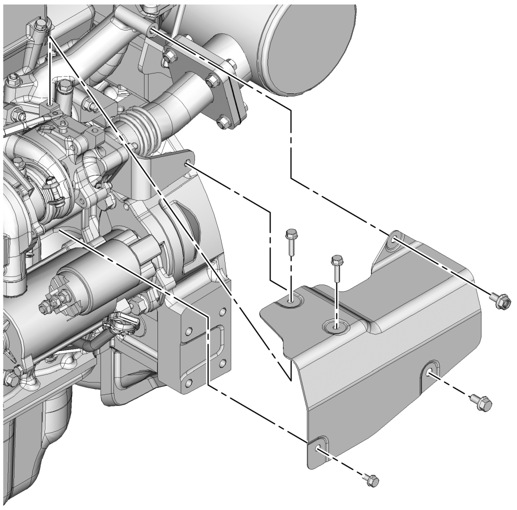
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

19. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M6



PAWC1BSH001101

20. Pressure sensor/boost temperature sensor connect
    1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note :

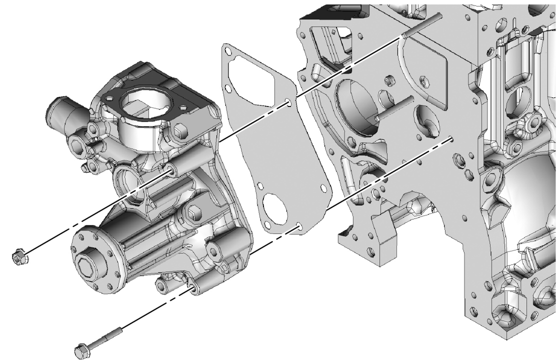
・ Install the harness clip.

21. Water pump assembly installation
    1. Install the water pump assembly to the cylinder block and the cylinder head.

Note :

・ Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1DSH000201

22. Water hose connect
    1. Connect the water hose to the water pump assembly.

Note :

・ Install the hose clip.

23. Engine coolant temperature sensor connect
    1. Connect the harness connector to the engine coolant temperature sensor.
24. Generator installation
    1. Install the adjust plate to the water pump assembly.

tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

2. Temporarily tighten the generator to the generator bracket.
3. Temporarily tighten the generator to the adjust plate.

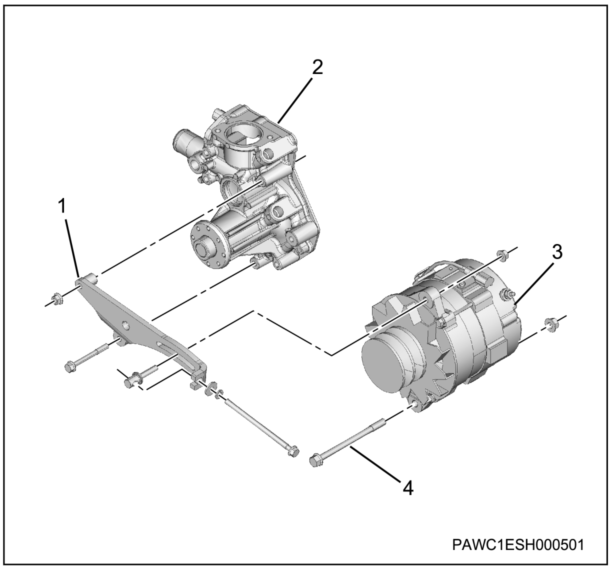
Note :

・ Securely tighten the bolt and the nut after adjusting the cooling fan belt.

4. Connect the harness connector to the generator.

Note :

・ The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

25. Fan pulley installation
   1. Install the fan pulley to the water pump assembly.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

26. Cooling fan belt installation
   1. Install the cooling fan belt to the pulley.

27. Cooling fan belt adjustment
   1. Check the tension of the cooling fan belt.

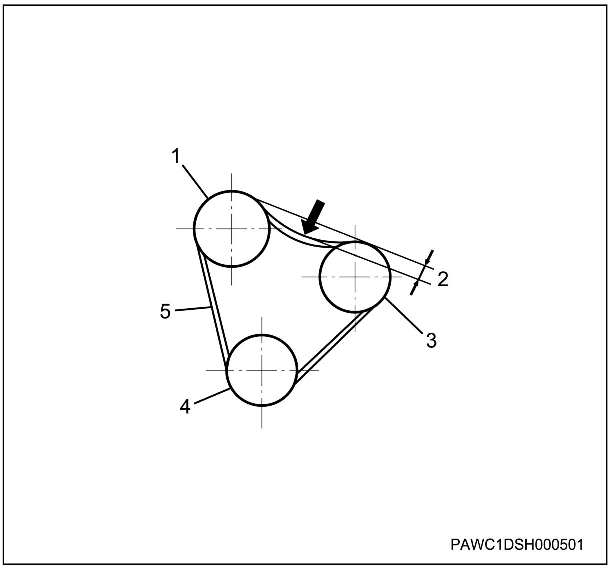
Note :

- Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard : 98 N { 10.0 kg / 22 lb }

specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

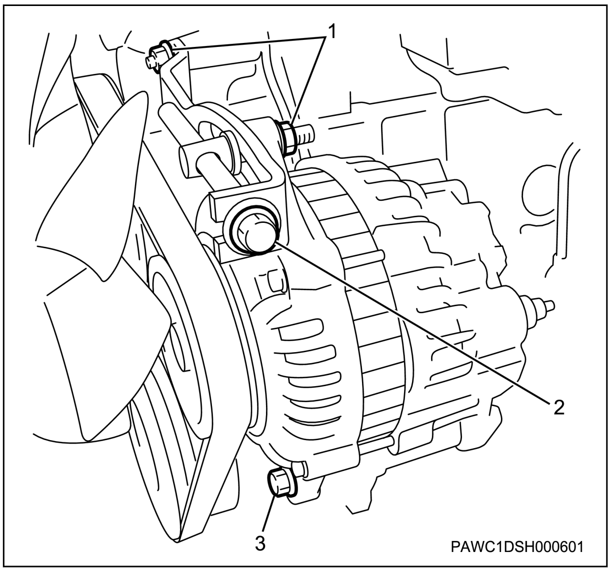


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

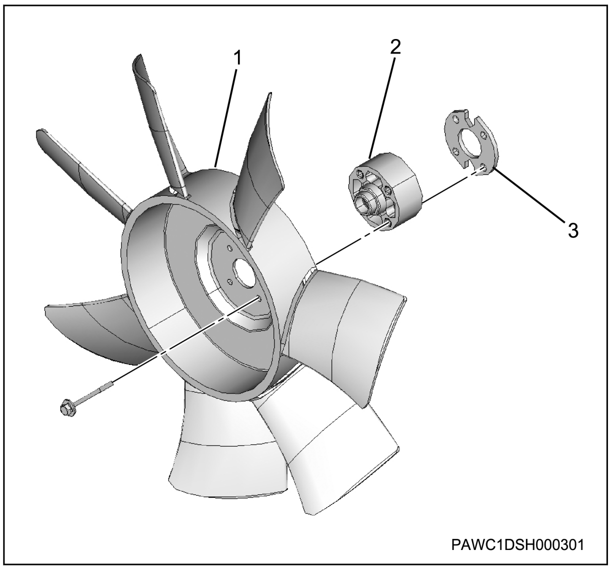
tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25



1. Nut
2. Adjust bolt
3. Mounting bolt

28. Cooling fan installation
   1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

29. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

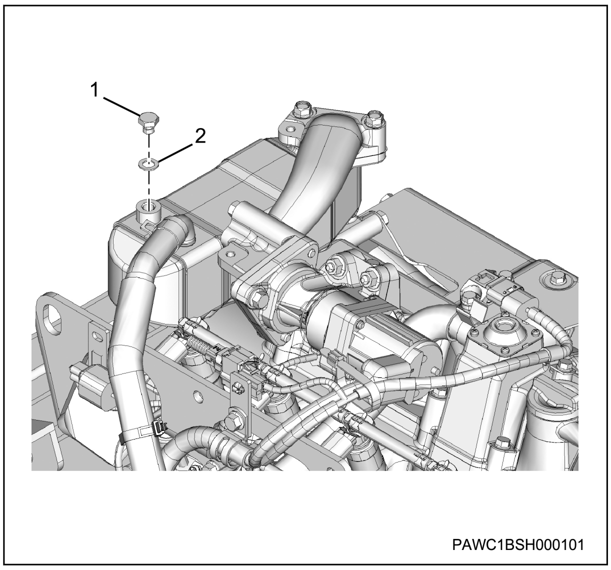
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug
2. Gasket

30. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Idle gear

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Engine oil drain
   1. Drain the engine oil from the oil pan.

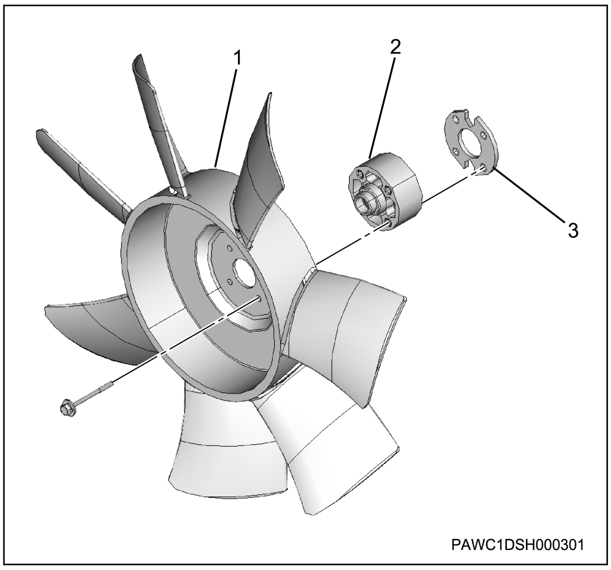
   Note :

   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

   Caution :

   - Do not forget to tighten the drain plug.
3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.

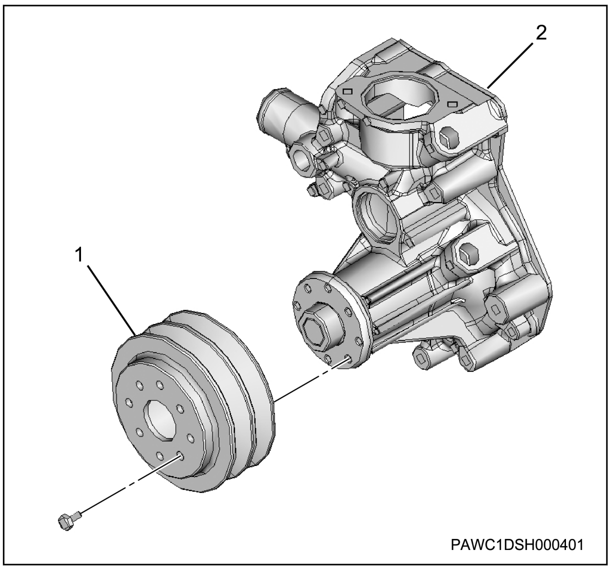


1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

   Note :

   - Loosen the generator adjust bolt and remove the belt.
5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

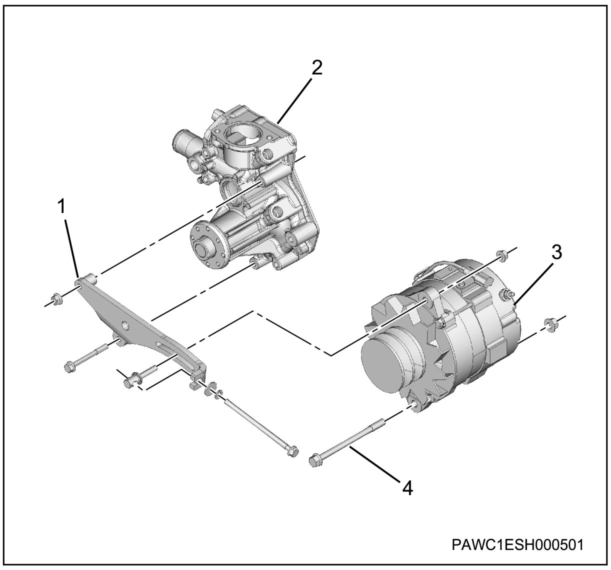


1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :

   - The diagram shows the 24 V - 50 A specification.

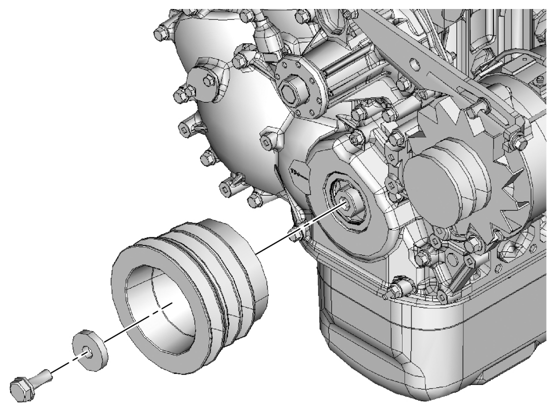


1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Generator bracket removal
   1. Remove the generator bracket from the cylinder block.
8. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

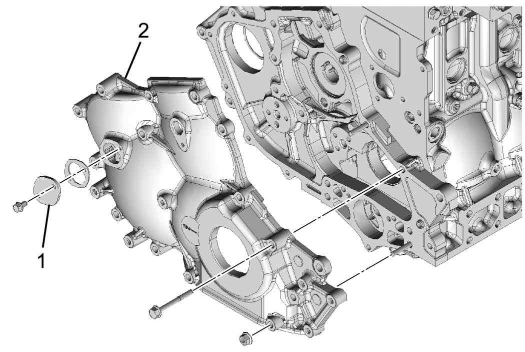
   Note :
   - Remove after stopping the crankshaft from turning.

   Caution :
   - Do not reuse the bolt and the washer.



PAWC1BSH001601

9. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.
   3. Remove the O-ring from the CMP sensor.
10. Timing gear case removal
    1. Remove the idle gear cover from the timing gear case.
    2. Remove the timing gear case from the front oil pump plate.



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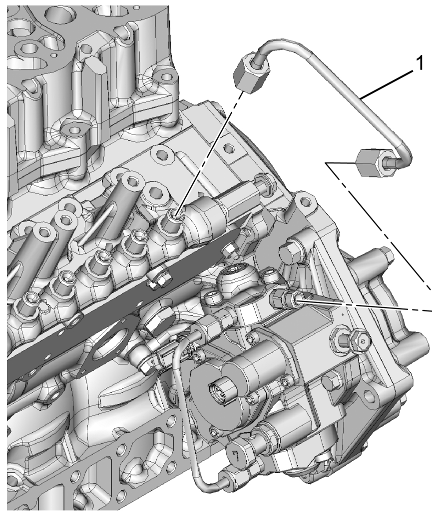
1. Idle gear cover
2. Timing gear case

11. Fuel pipe removal
    1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



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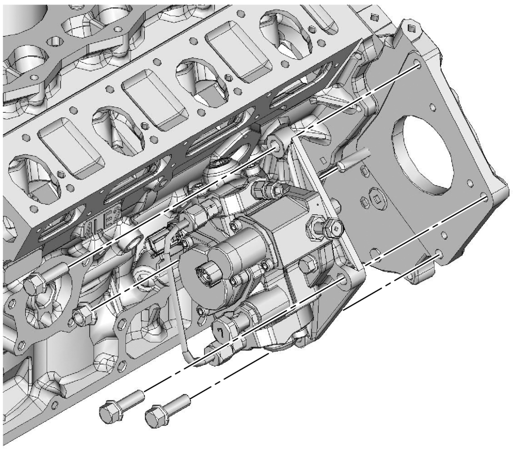
1. Fuel pipe

12. Fuel return pipe removal
    1. Remove the fuel return pipe from the fuel supply pump.
13. Fuel supply pump removal
    1. Disconnect the harness connector from the fuel supply pump.
    2. Remove the fuel supply pump from the front oil pump plate.

Note：

- Remove the tightening bolts, and remove together with the bracket.



PAWC1CSH000101

14. Idle gear A measurement

Caution：

- Before removing the idle gear, measure the end play of the gear.

1. Measure the backlash using a dial gauge.

Note：

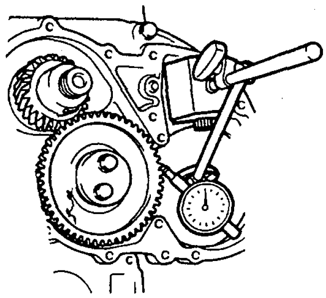
- Install the dial gauge as shown in the diagram, and measure by turning the gear left and right.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.04 mm { 0.0016 in } Crank gear, idle gear

limit： 0.2 mm { 0.008 in } Crank gear, idle gear

specified value： 0.03 mm { 0.0012 in } Camshaft gear, idle gear

limit： 0.2 mm { 0.008 in } Camshaft gear, idle gear



PAWC1BSH001401

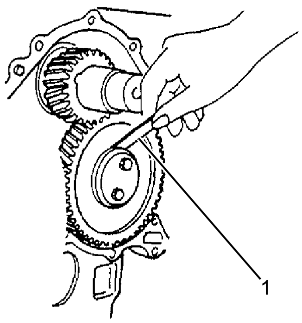
2. Measure the idle gear using a feeler gauge.

Note：

- Measure the gap between the idle gear and the thrust collar.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value： 0.058 to 0.115 mm { 0.0023 to 0.0045 in }

limit： 0.2 mm { 0.008 in }



PAWC1BSH001301

1. Feeler gauge

15. Idle gear B removal

1. Remove idle gear B from the idle gear shaft.

Note：

- Remove the idle gear B shaft and the thrust plate.

16. Idle gear A removal

1. Remove idle gear A from the idle gear shaft.

Note：

- Remove the idle gear A shaft and the thrust plate.

17. Camshaft gear removal

1. Remove the camshaft gear from the camshaft.

inspection

1. Idle gear inspection
   1. Inspect the idle gear.

Note：

- Inspect the thrust surface and the bushing inner surface of the idle gear and idle gear shaft for wear and damage.

Caution：

- If there is wear or damage, replace the idle gear or the shaft.

Note：

- Inspect the idle gear and the thrust collar for wear.

Caution：

- If there is wear, replace the idle gear or the thrust collar.

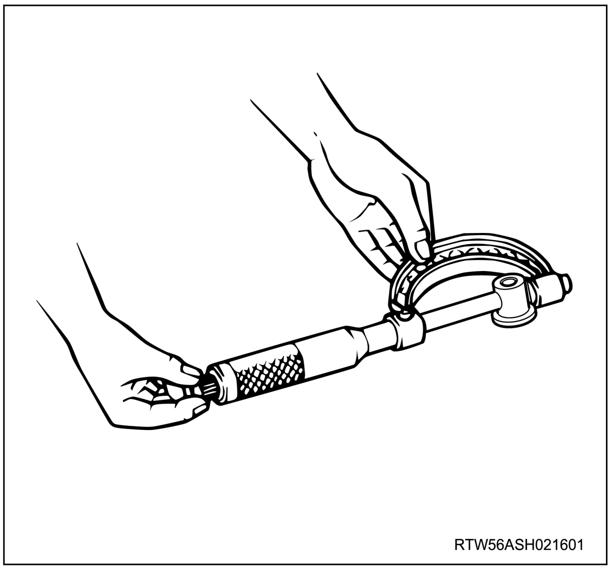
2. Idle gear shaft measurement
   1. Measure the idle gear shaft using a micrometer.

Note：

- Measure the outer diameter of the idle gear A shaft.
- If the measured value exceeds the limit, replace the shaft.

specified value： 45 mm { 1.772 in }

limit： 0.1 mm { 0.004 in }



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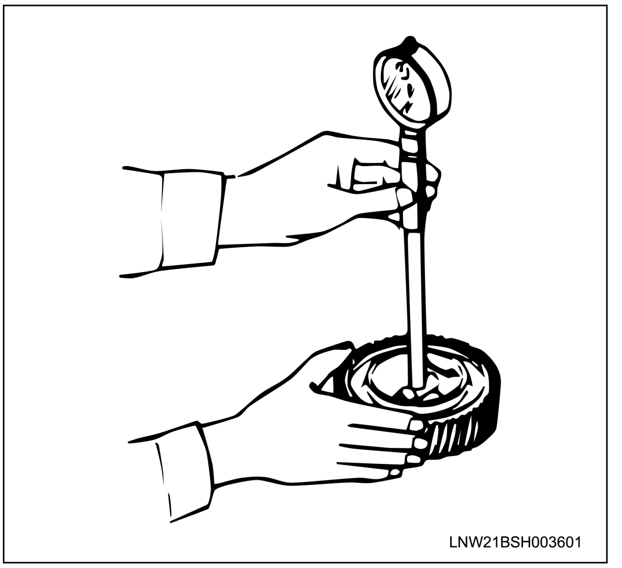
   2. Measure the idle gear using a cylinder gauge.

Note：

- Measure the inner diameter of the idle gear bushing.



LNW21BSH003601

   3. Calculate the clearance from the measured value.

Note：

- The difference between the inner diameter of the idle gear bushing and the outer diameter of the idle gear shaft is the clearance.

specified value： 0.025 to 0.085 mm { 0.00098 to 0.00335 in }

limit： 0.2 mm { 0.008 in }

installation

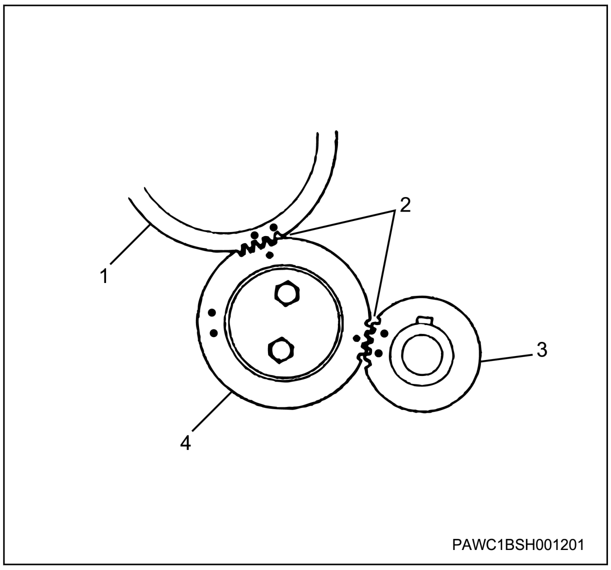
1. Idle gear A installation
   1. Align the No. 1 cylinder to compression top dead center.

      Note：
      - Rotate the crankshaft in the forward direction and align the No. 1 cylinder piston to compression top dead center.
   2. Install the idle gear shaft to the cylinder block.
   3. Apply engine oil to the idle gear.

      Note：
      - Apply to idle gear A and the idle gear shaft.
   4. Install idle gear A to the idle gear shaft.

      Note：
      - Install after meshing so that the alignment mark of the crankshaft gear is as shown in the diagram.

      tightening torque： 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



1. Camshaft gear
2. Timing point
3. Crank gear
4. Idle gear A

   5. Apply engine oil to the idle gear.

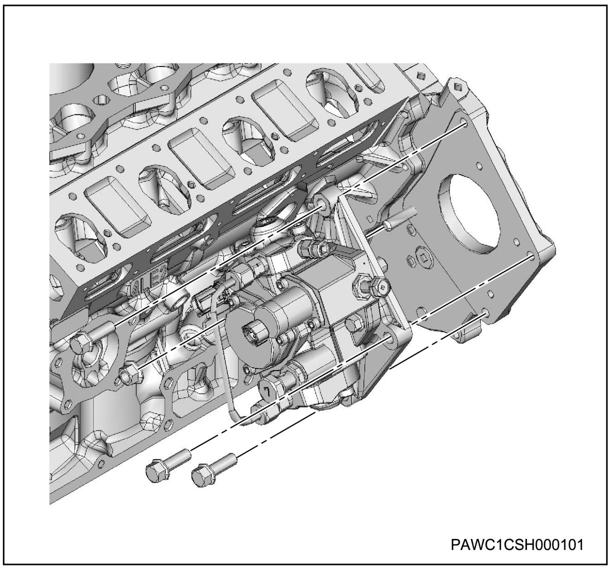
      Note：
      - Apply engine oil to the thrust collar, the bolt, and the threaded portion.
   6. Install the thrust collar to the idle gear.

      Note：
      - Install so that the chamfered side of the thrust collar faces the outside.
2. Camshaft gear installation
   1. Install the camshaft gear to the camshaft.

      Note：
      - Install after meshing so as to align the idle gear alignment marks.

      tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft }
3. Fuel supply pump installation
   1. Install the fuel supply pump to the front oil pump plate.

      tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }

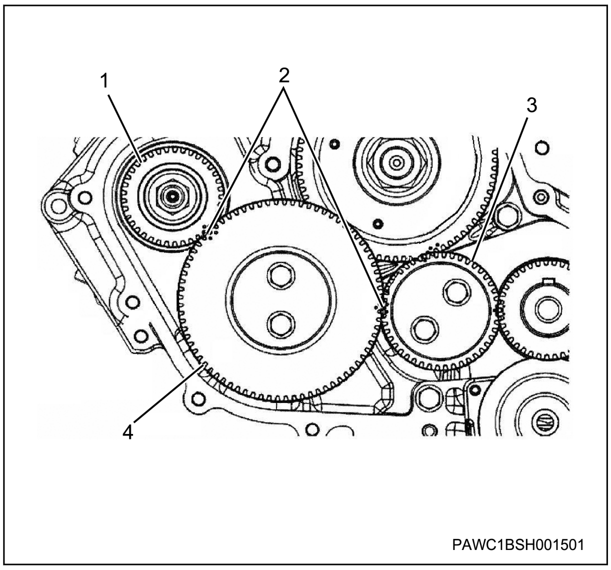


   2. Connect the harness connector to the fuel supply pump.
4. Idle gear B installation
   1. Install the idle gear shaft to the cylinder block.
   2. Apply engine oil to the idle gear.

      Note：
      - Apply to idle gear B and the idle gear shaft.
   3. Install idle gear B to the idle gear shaft.

      Note：
      - Install after meshing so as to align the idle gear B alignment marks with idle gear A and the supply pump gear.

      tightening torque： 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

4. Apply engine oil to the idle gear.

Note :

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

5. Install the thrust collar to the idle gear.

Note :

- Install so that the chamfered side of the thrust collar faces the outside.

5. Fuel return pipe installation

1. Install the fuel return pipe to the fuel supply pump.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M10

tightening torque : 17 N・m { 1.7 kgf・m / 13 lb・ft } M14

6. Fuel pipe installation

1. Temporarily tighten the fuel pipe to the fuel supply pump.
2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

Caution :

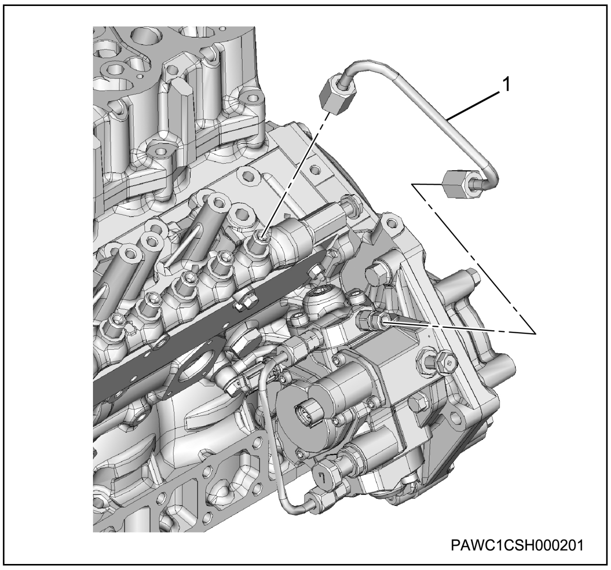
- Use a new fuel pipe.

Note :

- Verify that there is no dirt in the fuel pipe.

3. Securely tighten the fuel pipe to the fuel supply pump.
4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque : 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

7. Timing gear case installation

1. Apply liquid gasket to the front oil pump plate.

Note :

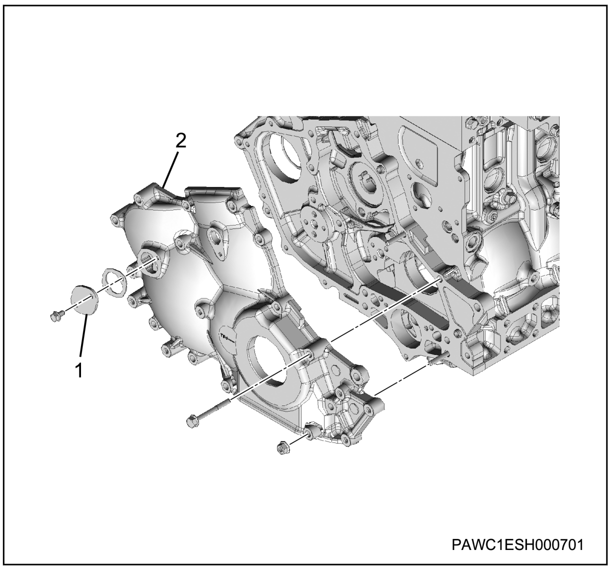
- Apply ThreeBond 1207B.

2. Install the timing gear case to the front oil pump plate.

tightening torque : 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

3. Install the idle gear cover to the timing gear case.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Idle gear cover
2. Timing gear case

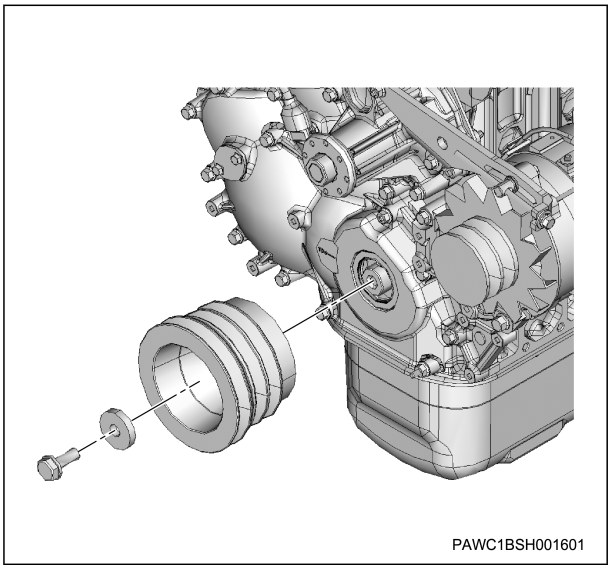
8. CMP sensor installation
   1. Apply engine oil to the O-ring.
   2. Install the CMP sensor to the timing gear case.

   tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

   3. Connect the harness connector to the CMP sensor.
9. Crankshaft pulley installation
   1. Install the crankshaft pulley to the crankshaft.

   Caution：
   - Do not reuse the bolt and the washer.

   tightening torque： 177 N・m { 18.0 kgf・m / 131 lb・ft }



10. Generator bracket installation
    1. Install the generator bracket to the cylinder block.

    tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft } M8

    tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft } M10
11. Generator installation
    1. Install the adjust plate to the water pump assembly.

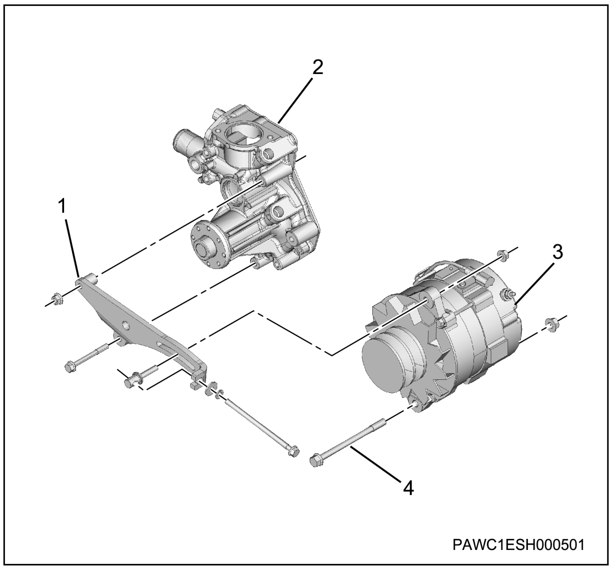
    tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

    2. Temporarily tighten the generator to the generator bracket.
    3. Temporarily tighten the generator to the adjust plate.

    Note：
    - Securely tighten the bolt and the nut after adjusting the cooling fan belt.

    4. Connect the harness connector to the generator.

Note：
- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

12. Fan pulley installation
    1. Install the fan pulley to the water pump assembly.

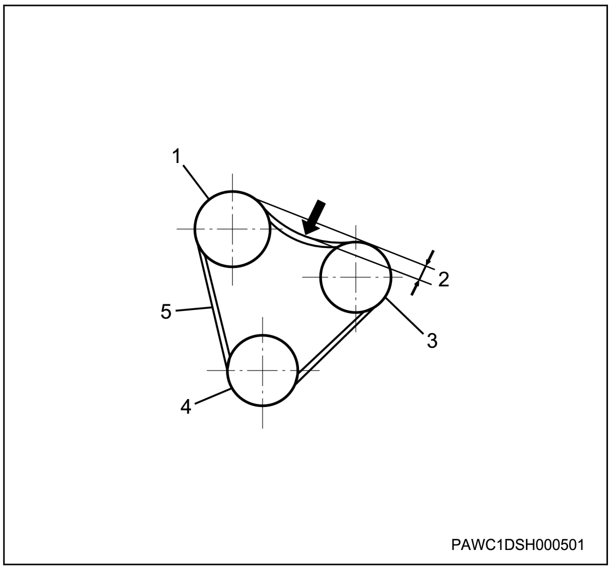
    tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }
13. Cooling fan belt installation
    1. Install the cooling fan belt to the pulley.
14. Cooling fan belt adjustment
    1. Check the tension of the cooling fan belt.

    Note：
    - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

    standard： 98 N { 10.0 kg / 22 lb }

    specified value： 7.7 to 8.7 mm { 0.303 to 0.343 in } New product

    specified value： 8.3 to 9.3 mm { 0.327 to 0.366 in } Reuse

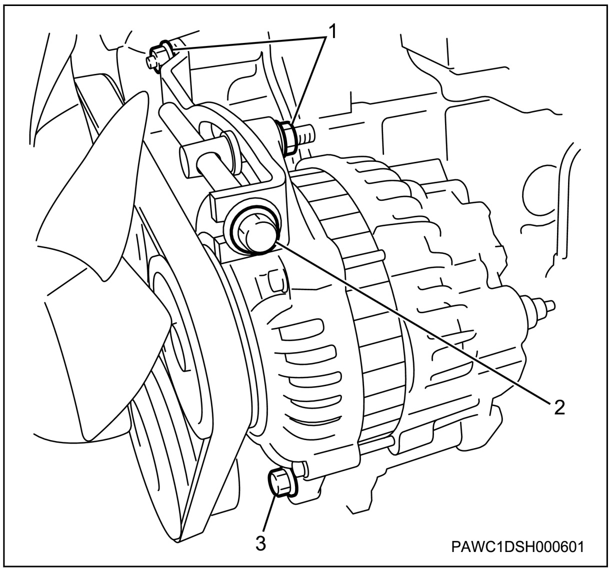


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

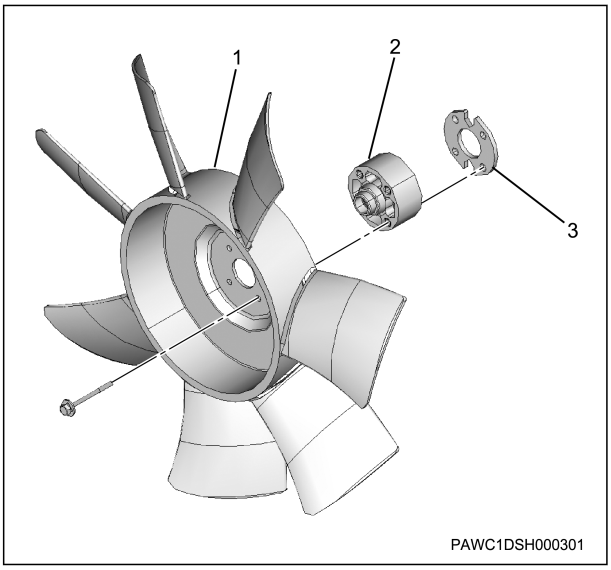


1. Nut
2. Adjust bolt
3. Mounting bolt

15. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

16. Engine oil filling

1. Refill the engine with engine oil.

Note：

- Check the tightening of the oil pan drain plug again.

17. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Cylinder block

removal

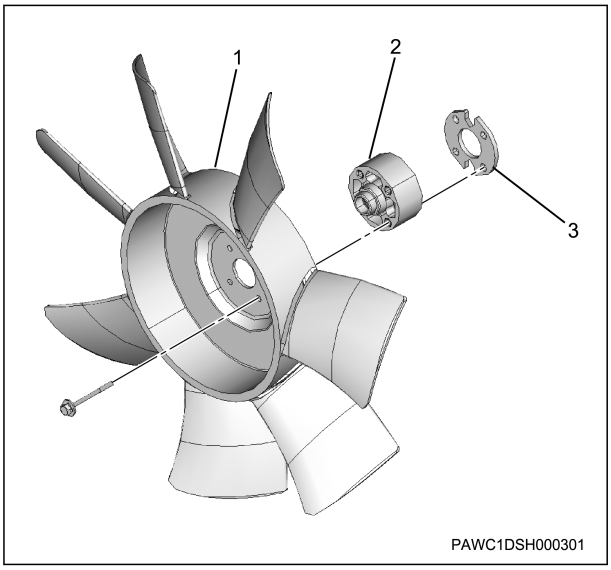
1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Engine oil drain
   1. Drain the engine oil from the oil pan.

   Note :
   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

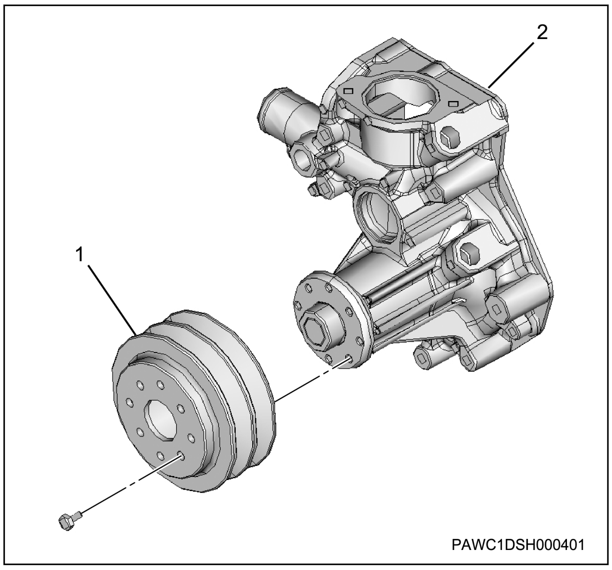
   Caution :
   - Do not forget to tighten the drain plug.
4. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



1. Cooling fan
2. Adapter
3. Spacer

5. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

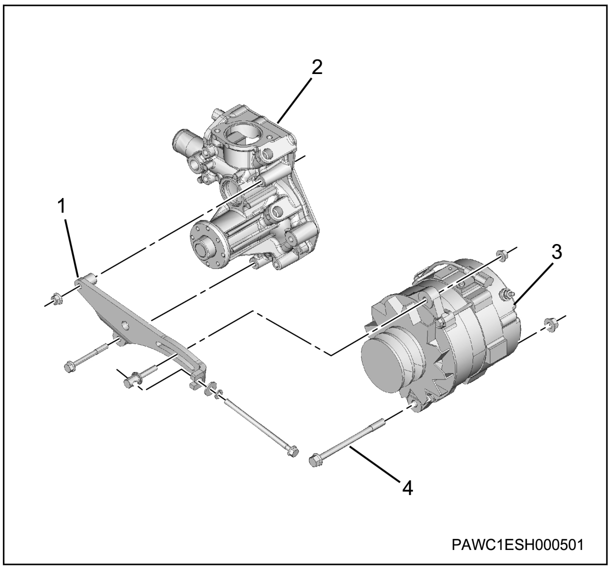
   Note :
   - Loosen the generator adjust bolt and remove the belt.
6. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.



1. Fan pulley
2. Water pump assembly

7. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :
   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate

2. Water pump assembly
3. Generator
4. Bolt

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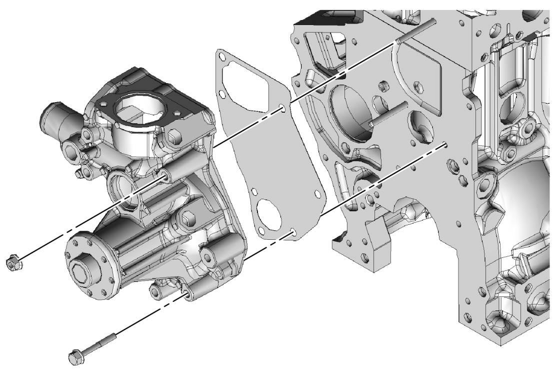
8. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
9. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

   Note :
   - Remove the hose clip.
10. Water pump assembly removal
    1. Remove the water pump assembly from the cylinder block and the cylinder head.

    Note :
    - Remove the water pump assembly and the gasket.



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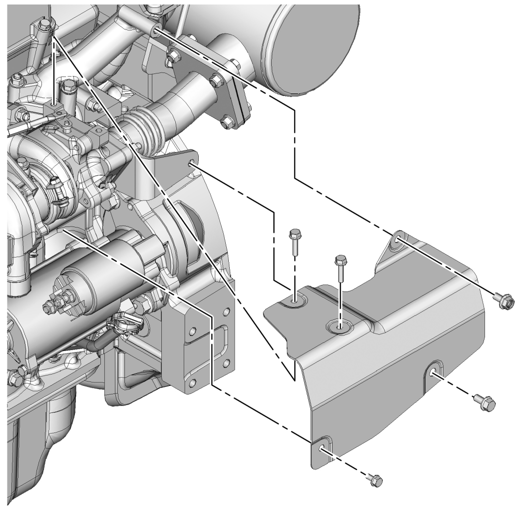
11. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

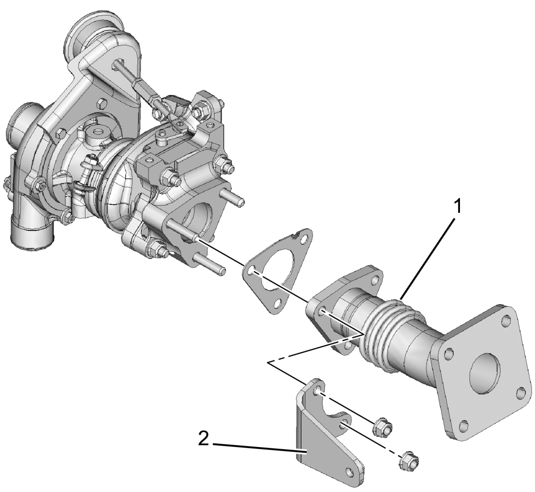
    Note :
    - Remove the harness clip.
12. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.



PAWC1BSH001101

13. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

    Note :
    - Remove together with the bracket.

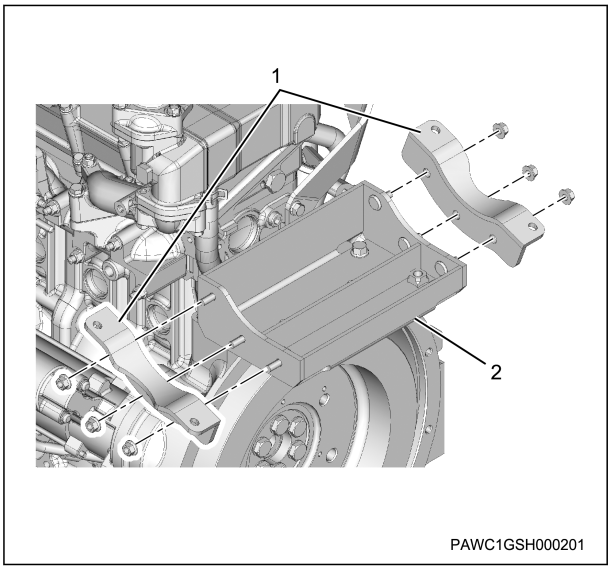


PAWC1GSH000101

1. Exhaust pipe
2. Bracket

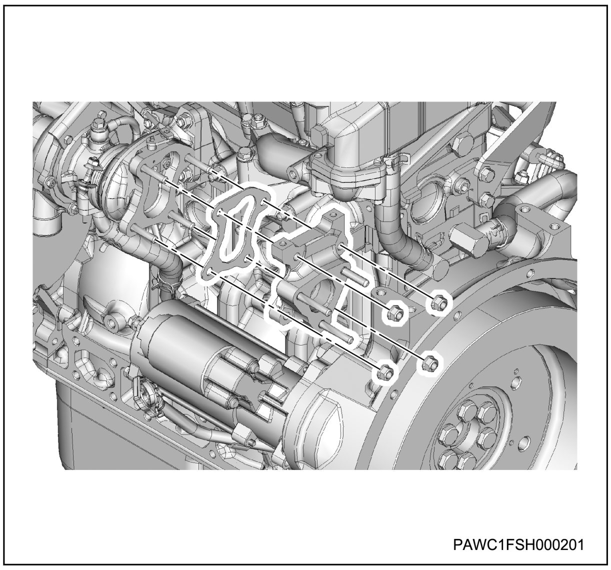
---

3. Remove the support bracket from the silencer bracket.

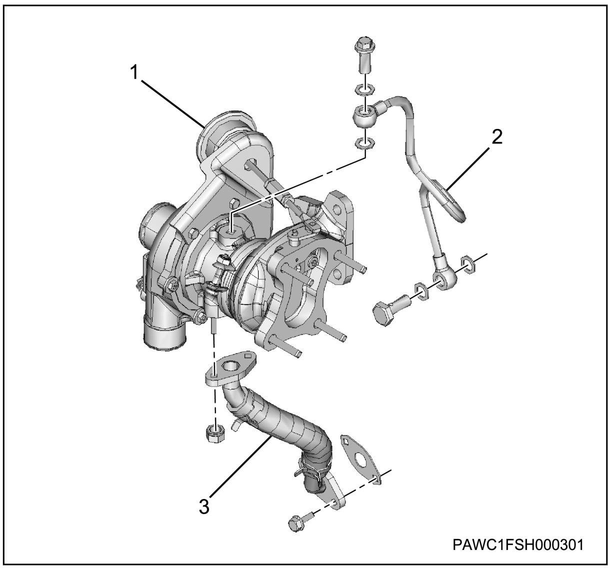


1. Support bracket
2. Silencer bracket

14. Turbocharger assembly removal
    1. Remove the exhaust pipe adapter from the turbocharger assembly.

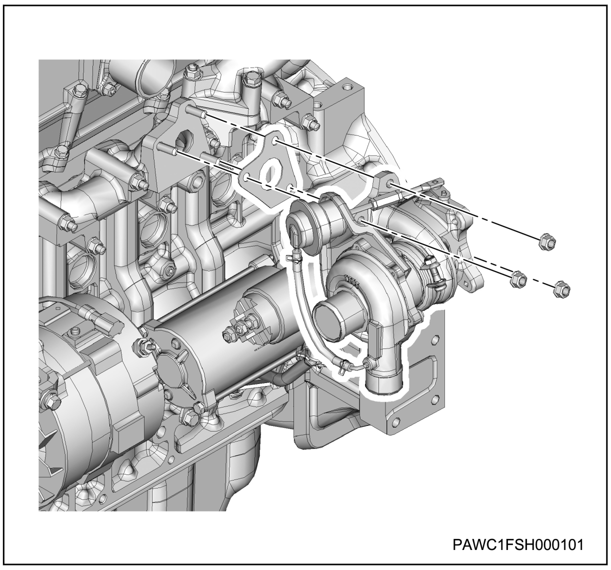


    2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
    3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.

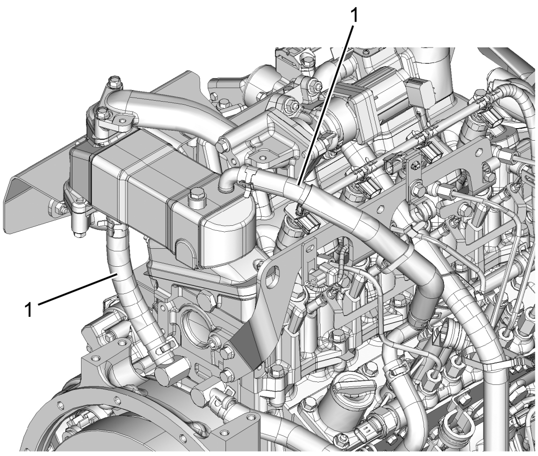


1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

    4. Remove the turbocharger assembly from the exhaust manifold.



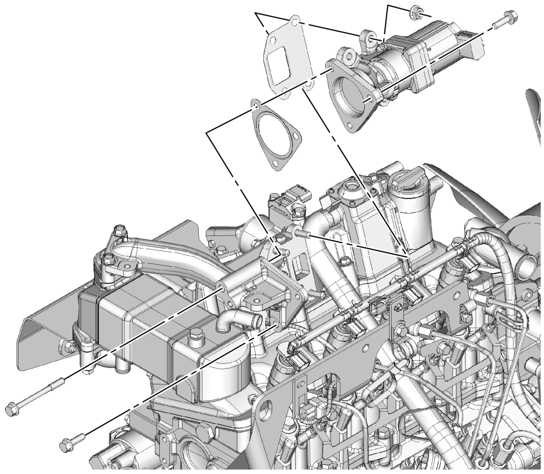
15. EGR valve removal
    1. Disconnect the harness connector from the EGR valve.
    2. Disconnect the harness clip from the EGR pipe.
    3. Disconnect the water rubber hose from the EGR cooler assembly.



PAWC1BSH000201

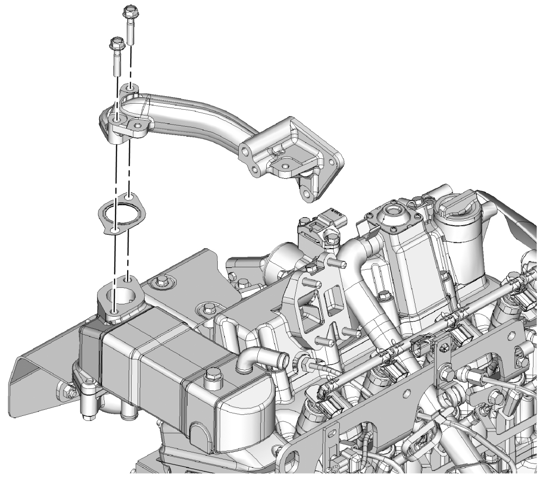
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.



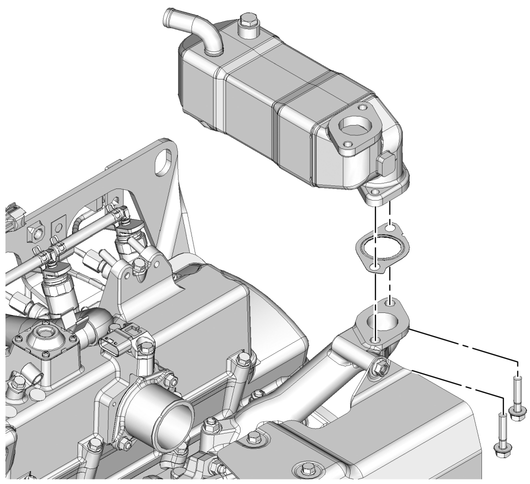
PAWC1BSH000301

5. Remove the EGR pipe from the EGR cooler.



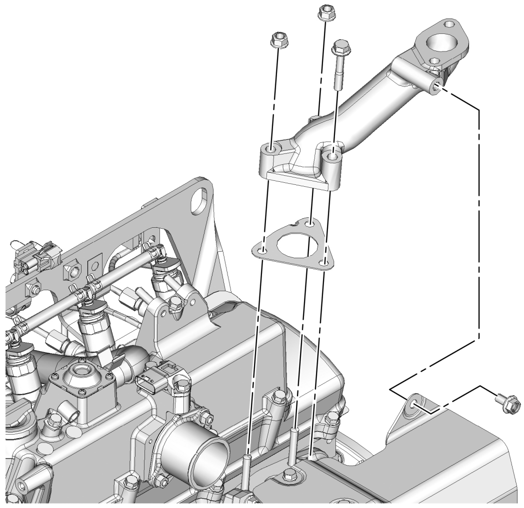
PAWC1BSH000401

6. Remove the EGR cooler from the EGR pipe.



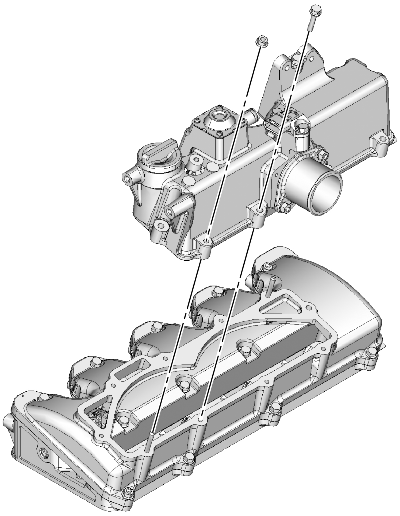
PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.



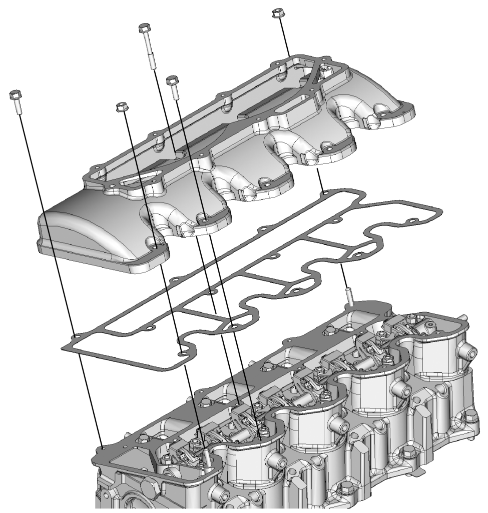
PAWC1BSH000601

16. PCV hose removal
    1. Remove the PCV hose from the intake chamber.
17. IMT sensor removal
    1. Disconnect the harness connector from the IMT sensor.
    2. Remove the IMT sensor from the intake chamber.
18. Intake chamber removal
    1. Remove the intake chamber from the cylinder head cover.



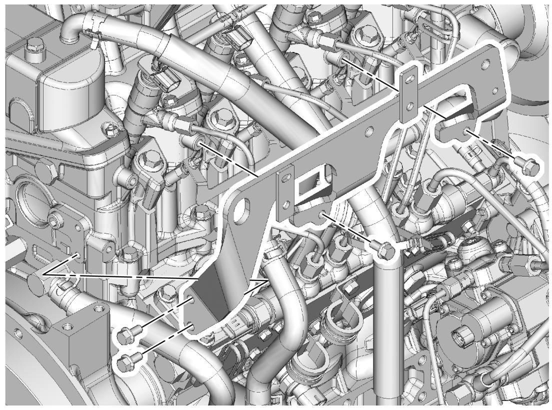
PAWC1BSH000701

19. Cylinder head cover removal
    1. Remove the cylinder head cover from the rocker arm bracket.



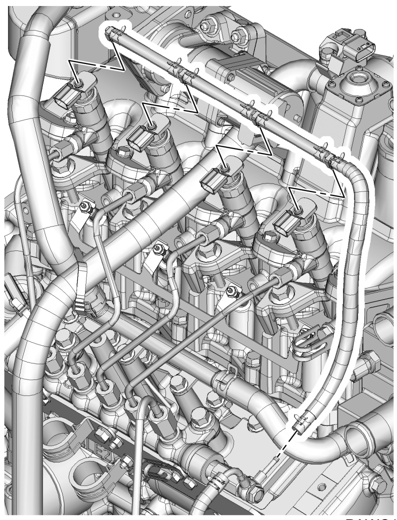
PAWC1BSH001001

20. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



PAWC1CSH000301

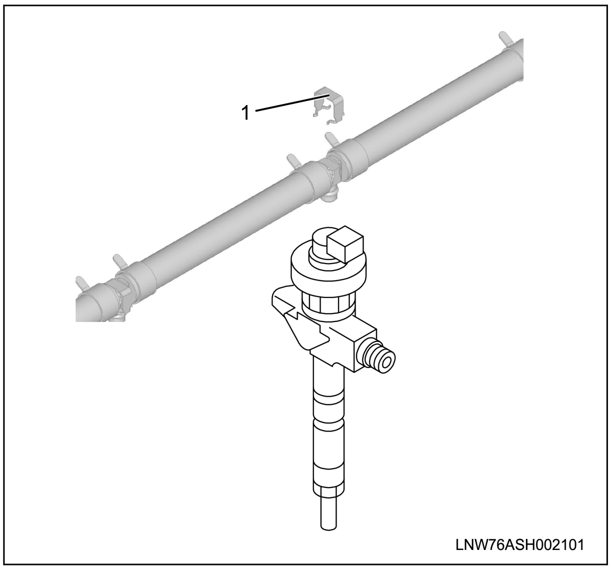
21. Fuel leak-off hose removal
    1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note :

- Do not reuse the leak-off pipe clip.



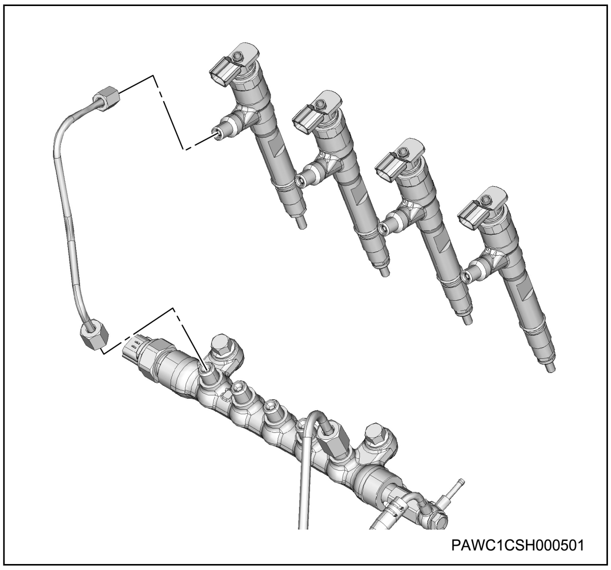
1. Clip

22. Injection pipe removal

   1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note :

- Do not reuse the injection pipe.

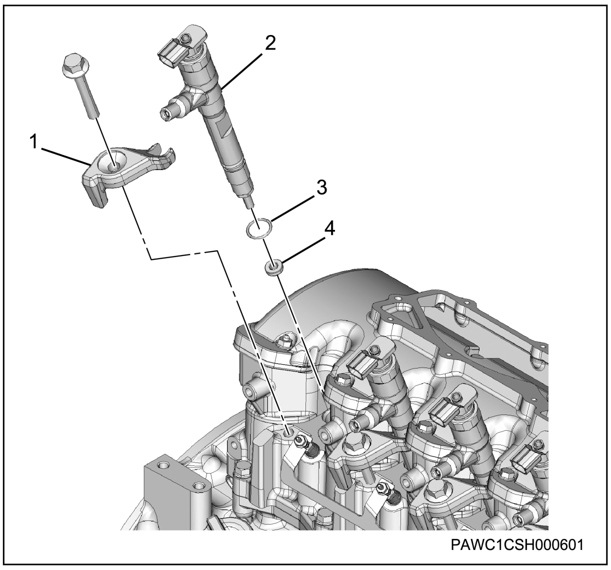


23. Injector removal

   1. Disconnect the harness connector from the injector.
   2. Remove the injector from the cylinder head assembly.
   3. Remove the injector gasket from the injector.
   4. Remove the O-ring from the injector.

Note :

- Do not reuse the injector gasket or the O-ring.



1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Note :

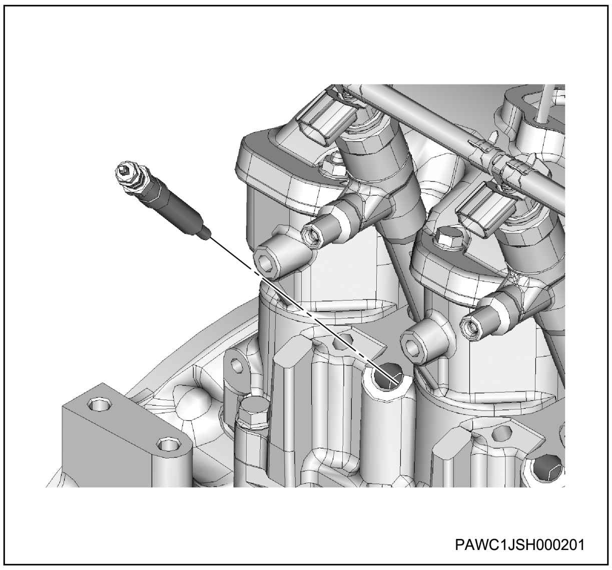
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

24. Glow plug connector removal

   1. Remove the glow plug connector from the glow plug.

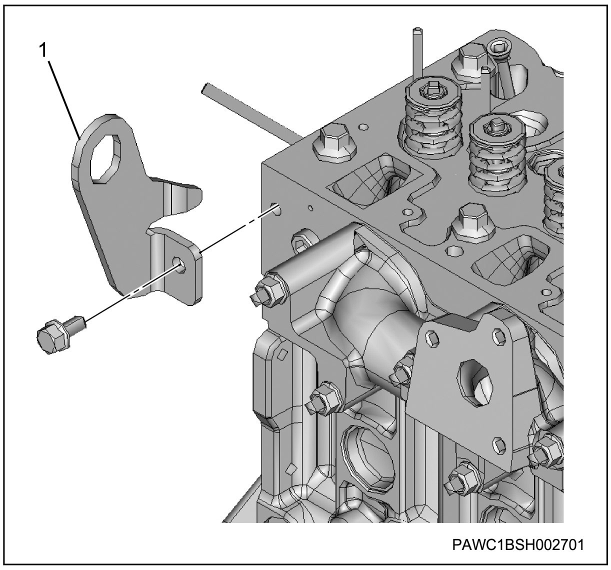
25. Glow plug removal

   1. Remove the glow plug from the cylinder head.



26. Engine hanger removal

   1. Remove the engine hanger from the cylinder head.



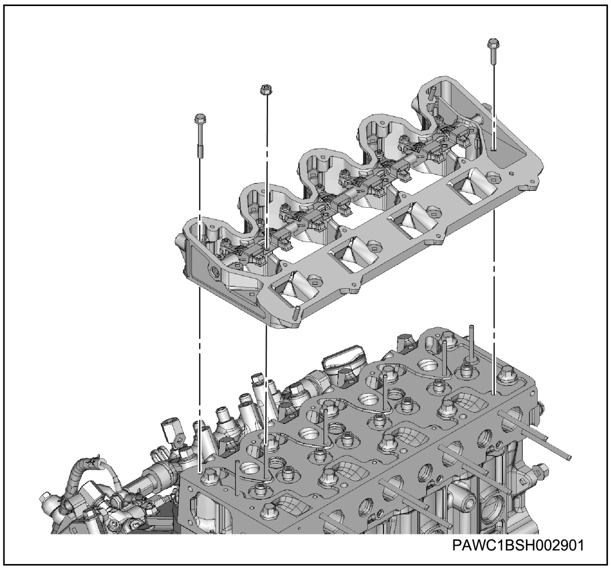
1. Engine hanger

27. Rocker arm bracket removal

1. Remove the rocker arm bracket from the cylinder head.

Caution :

- Be careful not to damage the rocker arm bracket when removing.



28. Push rod removal

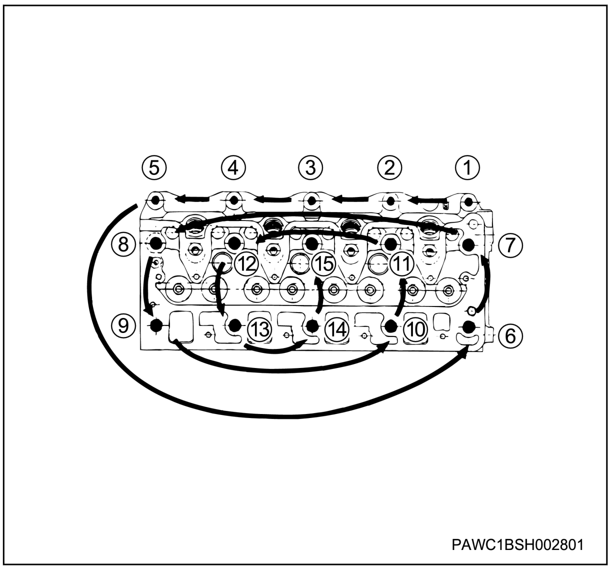
1. Remove the push rod from the cylinder block.

29. Cylinder head assembly removal

1. Remove the cylinder head assembly from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



2. Remove the cylinder head gasket from the cylinder block.

30. Tappet removal

1. Remove the tappet from the cylinder block.

31. Crankshaft pulley removal

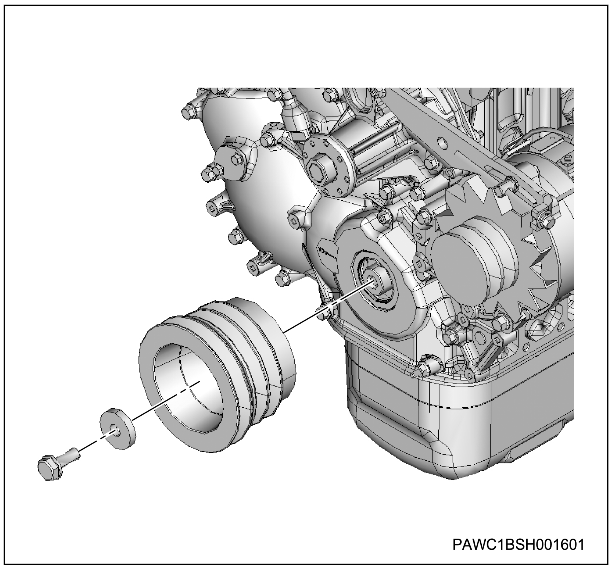
1. Remove the crankshaft pulley from the crankshaft.

Note :

- Remove after stopping the crankshaft from turning.

Caution :

- Do not reuse the bolt and the washer.



32. CMP sensor removal

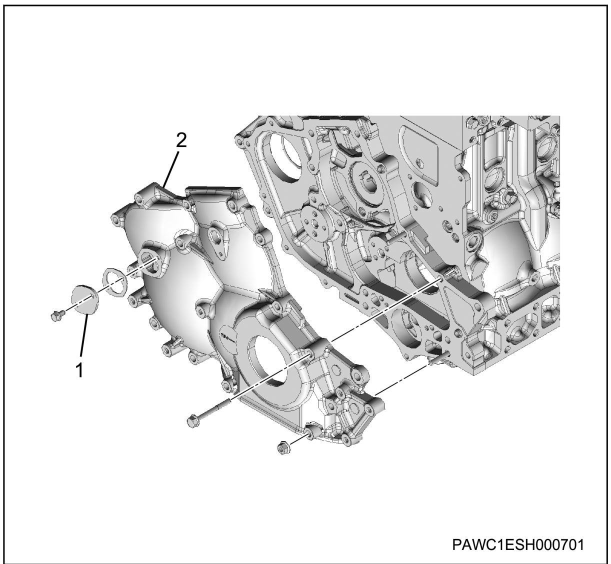
1. Disconnect the harness connector from the CMP sensor.

2. Remove the CMP sensor from the timing gear case.

3. Remove the O-ring from the CMP sensor.

33. Timing gear case removal

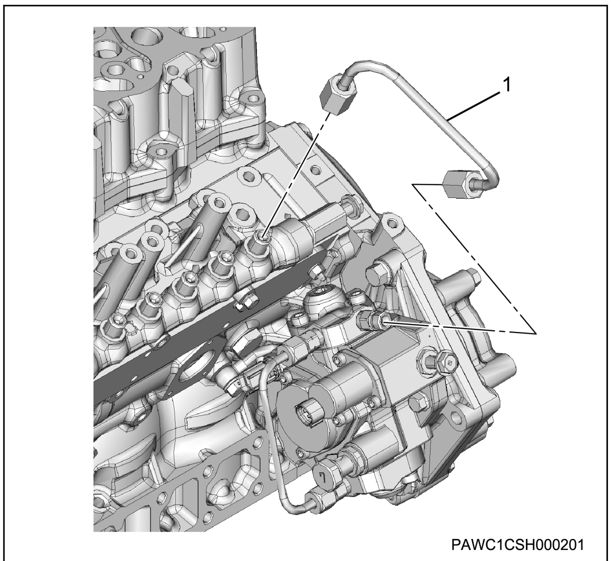
1. Remove the idle gear cover from the timing gear case.
2. Remove the timing gear case from the front oil pump plate.



1. Idle gear cover
2. Timing gear case

34. Fuel pipe removal

1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



1. Fuel pipe

35. Fuel return pipe removal

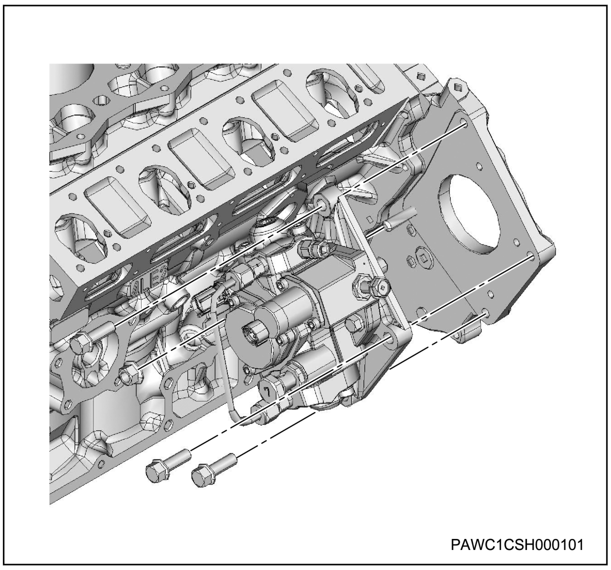
1. Remove the fuel return pipe from the fuel supply pump.

36. Fuel supply pump removal

1. Disconnect the harness connector from the fuel supply pump.
2. Remove the fuel supply pump from the front oil pump plate.

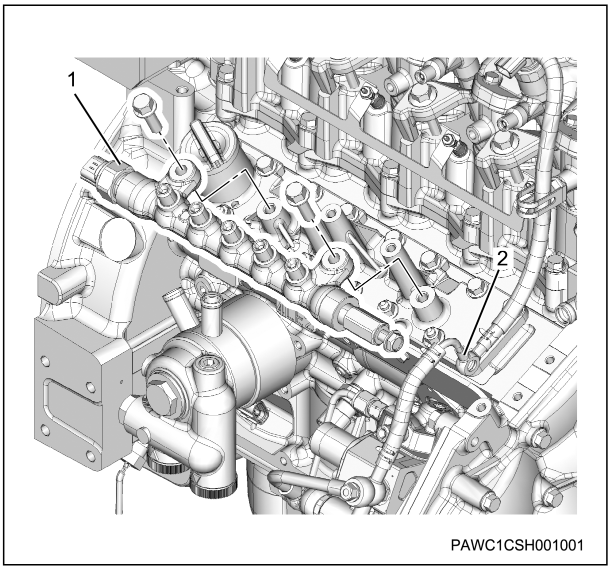
Note：

- Remove the tightening bolts, and remove together with the bracket.



37. Common rail assembly removal

1. Disconnect the harness connector from the common rail (fuel rail) assembly.
2. Remove the fuel leak-off pipe from the common rail (fuel rail) assembly.
3. Remove the common rail (fuel rail) assembly from the common rail (fuel rail) bracket.



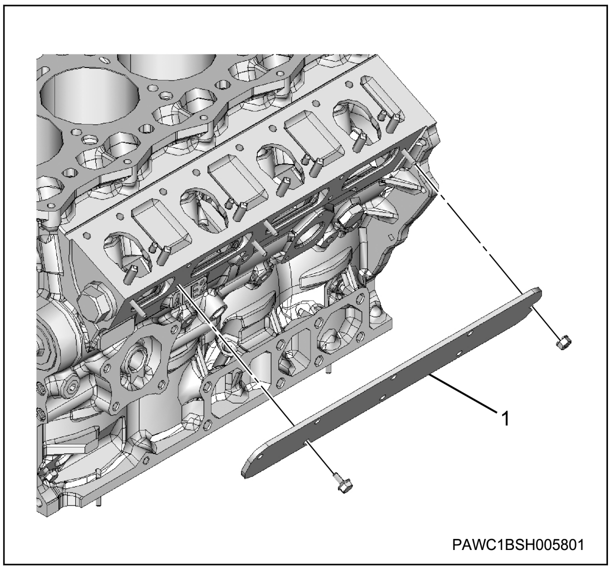
1. Common rail (fuel rail) assembly
2. Fuel leak-off pipe

38. Housing cover removal

1. Remove the housing cover from the cylinder block.

Caution :

- Be careful not to deform when removing.



1. Housing cover

39. Idle gear A measurement

Caution :

- Before removing the idle gear, measure the end play of the gear.

1. Measure the backlash using a dial gauge.

Note :

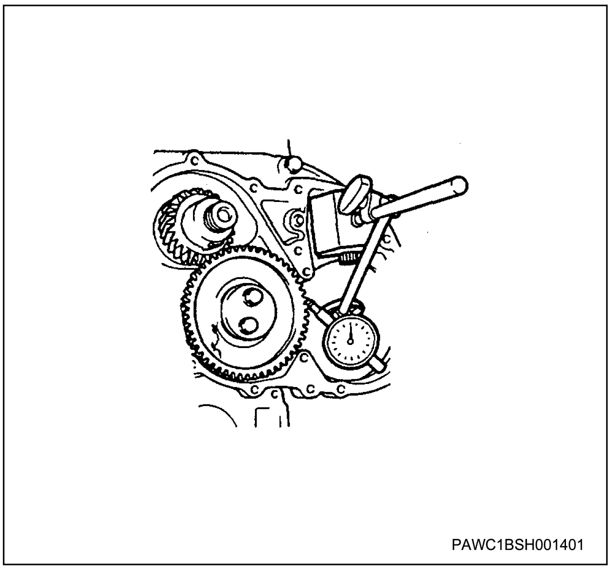
- Install the dial gauge as shown in the diagram, and measure by turning the gear left and right.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.04 mm { 0.0016 in } Crank gear, idle gear

limit : 0.2 mm { 0.008 in } Crank gear, idle gear

specified value : 0.03 mm { 0.0012 in } Camshaft gear, idle gear

limit : 0.2 mm { 0.008 in } Camshaft gear, idle gear



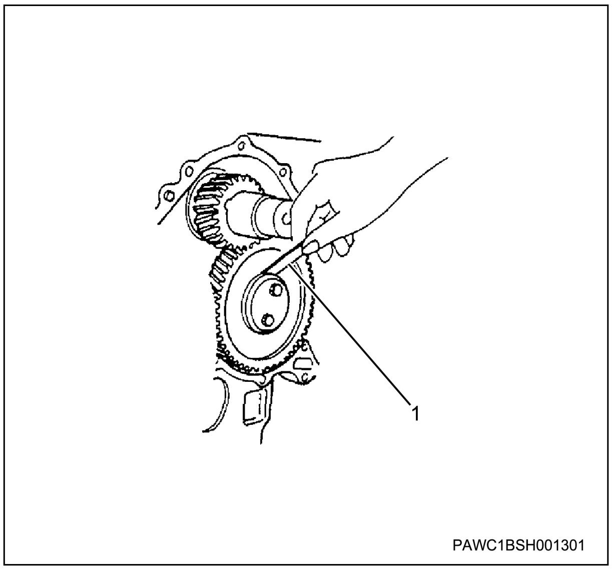
2. Measure the idle gear using a feeler gauge.

Note :

- Measure the gap between the idle gear and the thrust collar.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.058 to 0.115 mm { 0.0023 to 0.0045 in }

limit : 0.2 mm { 0.008 in }



1. Feeler gauge

40. Idle gear B removal

1. Remove idle gear B from the idle gear shaft.

Note :

- Remove the idle gear B shaft and the thrust plate.

41. Idle gear A removal

1. Remove idle gear A from the idle gear shaft.

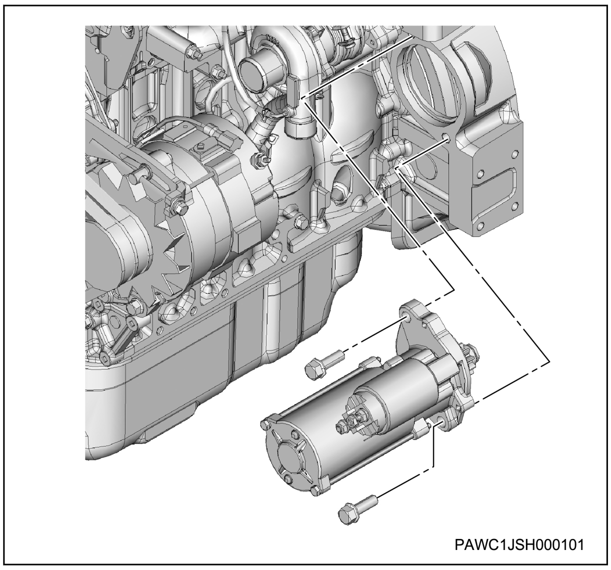
Note :

- Remove the idle gear A shaft and the thrust plate.

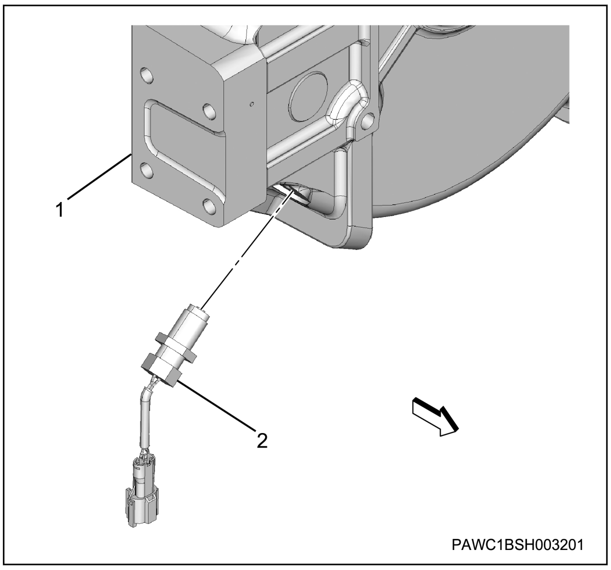
42. Camshaft gear removal
   1. Remove the camshaft gear from the camshaft.
43. Oil level gauge guide tube removal
   1. Remove the oil level gauge from the oil level gauge guide tube.
   2. Remove the oil level gauge guide tube from the cylinder block.
44. Starter motor removal
   1. Remove the ground cable from the starter motor.
   2. Remove the starter motor from the flywheel housing.

Note :

- The diagram shows the 24 V - 3.2 kW specification.



45. Engine speed sensor removal
   1. Disconnect the harness connector from the engine speed sensor.
   2. Remove the engine speed sensor from the flywheel housing.

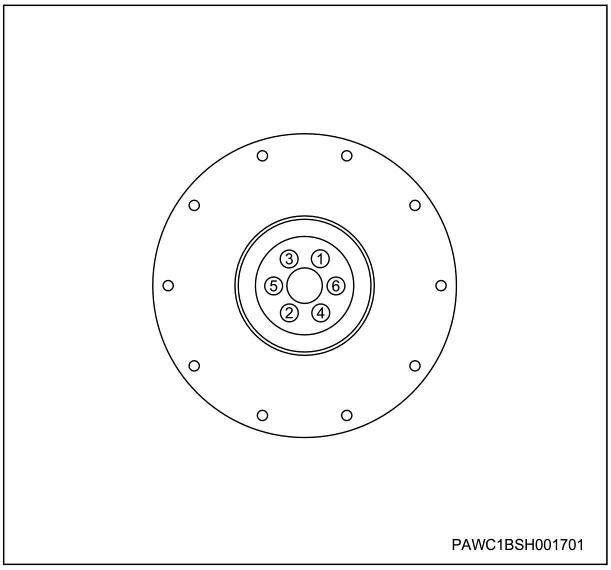


1. Flywheel housing
2. Engine speed sensor

46. Flywheel removal
   1. Remove the flywheel from the crankshaft.

Note :

- Make an alignment mark before removing.
- Gradually loosen the flywheel mounting bolts in the order shown in the diagram while making sure that the flywheel does not rotate.



Note :

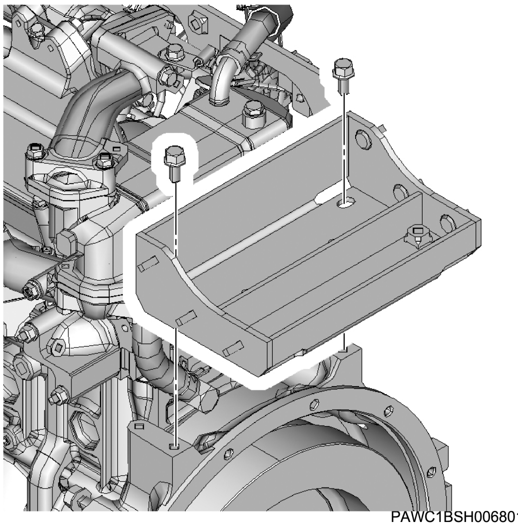
- Remove the flywheel while lightly tapping with a plastic hammer.

Caution :

- Do not damage the ring gear.

47. Flywheel housing removal

1. Remove the silencer bracket from the flywheel housing.



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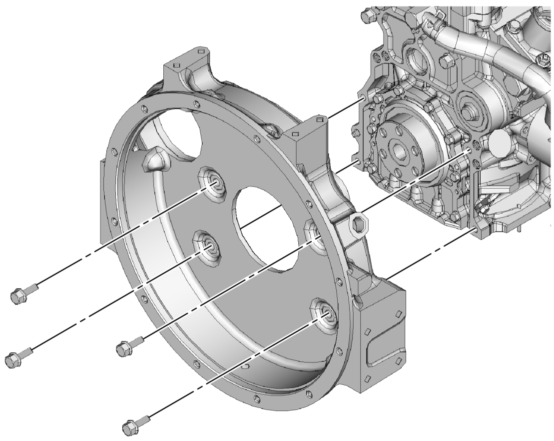
2. Remove the flywheel housing from the cylinder block.

Note :

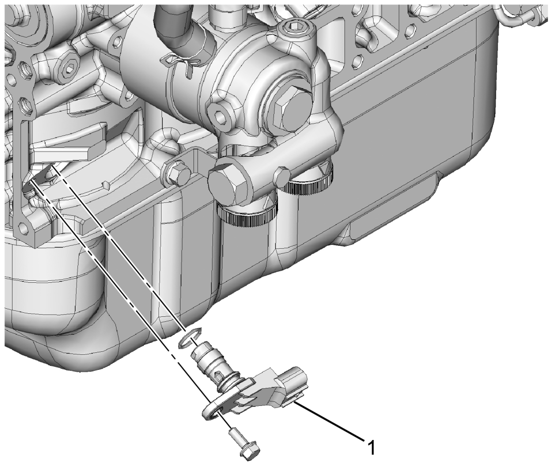
- Remove while lightly tapping the housing with a plastic hammer.



PAWC1BSH002401

48. CKP sensor removal

1. Disconnect the harness connector from the CKP sensor.
2. Remove the CKP sensor from the cylinder block.



PAWC1BSH001901

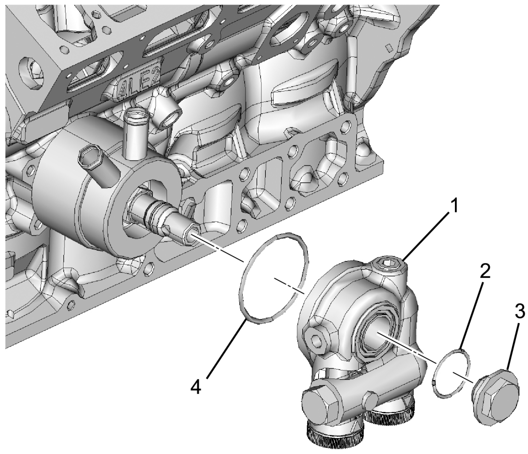
1. CKP sensor

49. Oil cooler assembly removal

1. Remove the oil cooler cover from the oil cooler assembly.

Note :

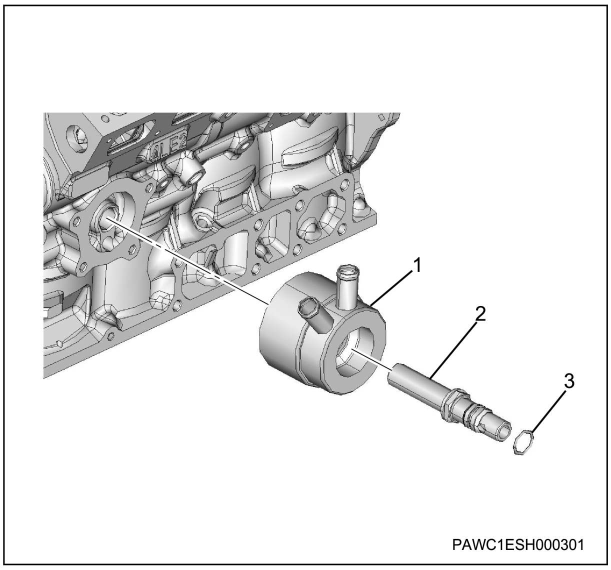
- Remove the plug, and remove the oil cooler cover and the O-ring.



PAWC1ESH000101

1. Oil cooler
2. O-ring
3. Plug
4. O-ring

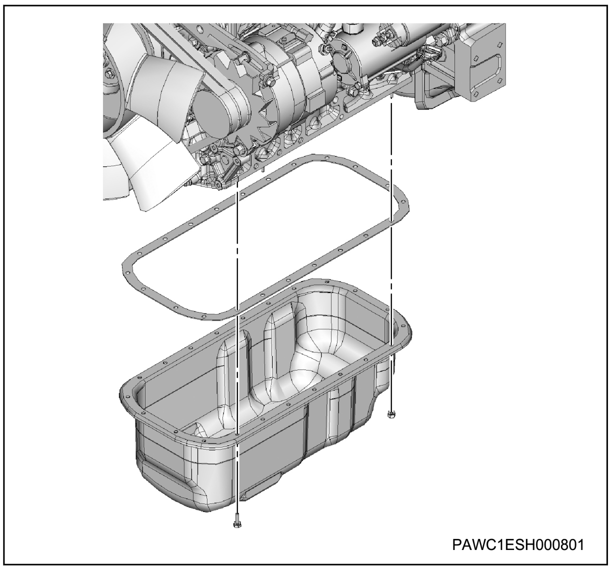
2. Remove the center bolt from the oil cooler assembly.
3. Remove the oil cooler assembly from the cylinder block.



1. Oil cooler
2. Center bolt
3. O-ring

50. Oil pan removal

1. Remove the oil pan from the cylinder block.

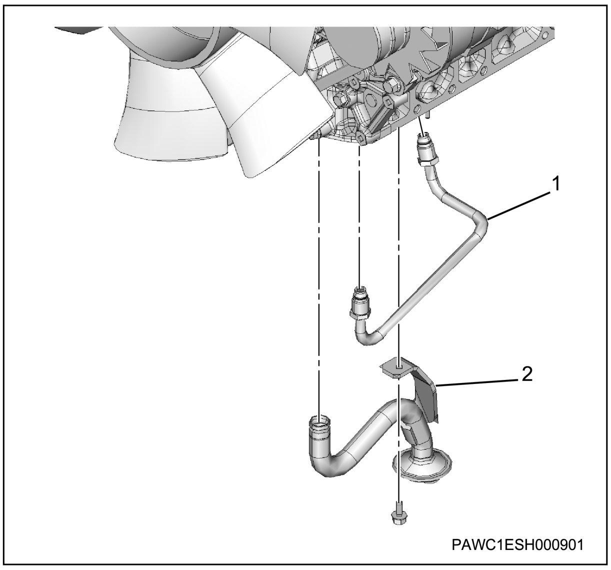


51. Oil strainer removal

1. Remove the oil pipe from the front oil pump plate and the cylinder block.
2. Remove the oil strainer from the front oil pump plate and the cylinder block.

Note :

- Remove the O-ring.



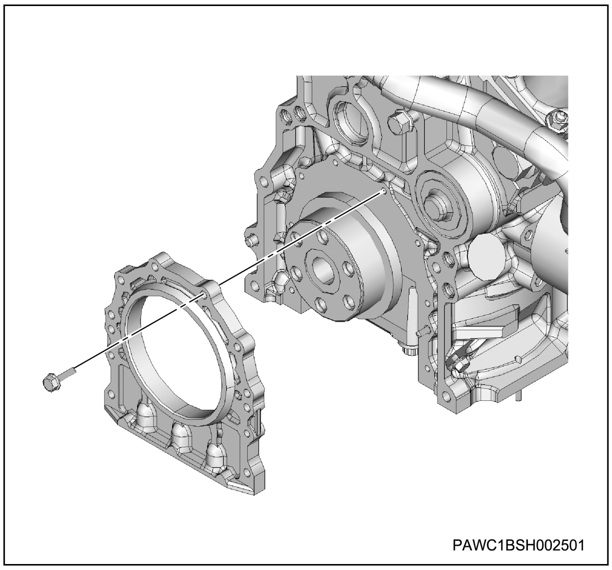
1. Oil pipe
2. Oil strainer

52. Oil seal retainer removal

1. Remove the oil seal retainer from the cylinder block.

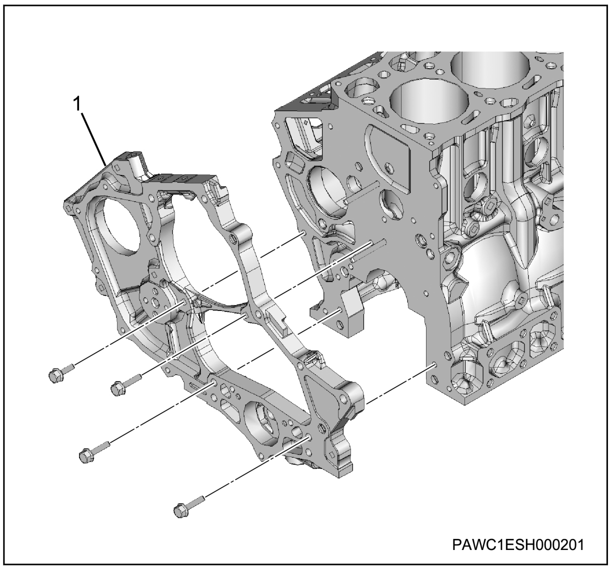
Caution :

- Be careful not to damage or deform when removing.



53. Front oil pump plate removal

1. Remove the front oil pump plate from the cylinder block.



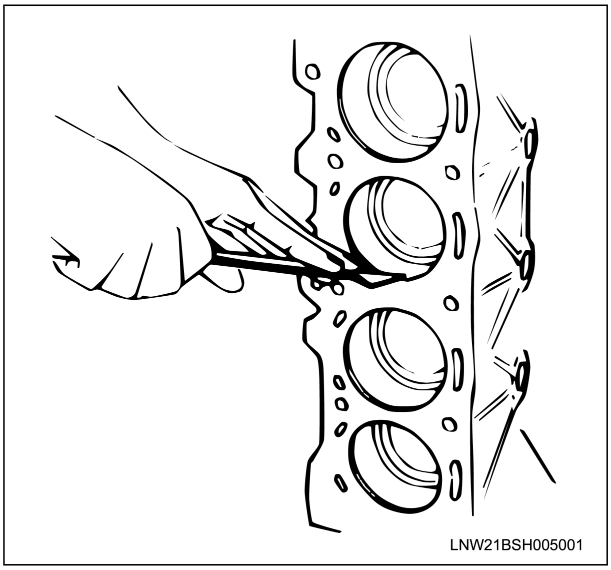
1. Front oil pump plate

54. Piston removal

1. Clean the cylinder block using a scraper.

Note：

- Remove carbon from the inside of the cylinder using a scraper.



2. Remove the connecting rod bearing cap from the connecting rod.

Note：

- Put the piston of the cylinder to be removed in the bottom dead center position.

3. Remove the connecting rod bearing from the connecting rod bearing cap.

Note：

- Organize the removed bearings according to the cylinders using tags, etc.

4. Remove the piston from the cylinder block.

Note：

- Pull the piston as a unit with the connecting rod out to the cylinder head side.

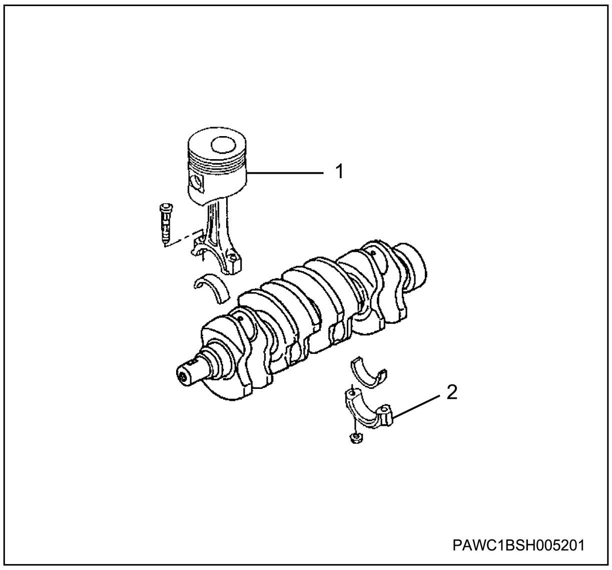
Caution：

- Be careful not to damage the inner wall of the cylinder.

5. Remove the connecting rod bearing from the connecting rod.

Note：

- Organize the removed bearings according to the cylinders using tags, etc.



1. Piston
2. Connecting rod bearing cap

55. Crankshaft removal

1. Measure the clearance using a feeler gauge.

Note：

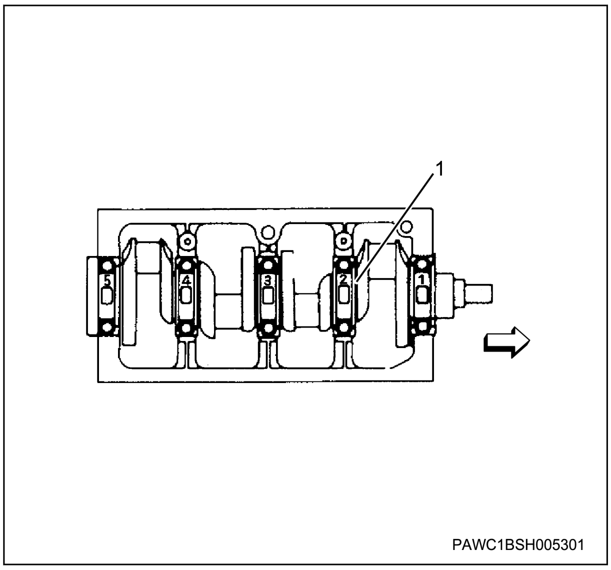
- Measure the end play of the crankshaft.
- Push the crankshaft toward the front, and insert a feeler gauge in the front side of the No. 2 journal section.

Caution：

- If the measured value exceeds the limit, replace the thrust bearing.

specified value： 0.058 to 0.208 mm { 0.0023 to 0.0082 in }

specified value： 0.3 mm { 0.012 in }

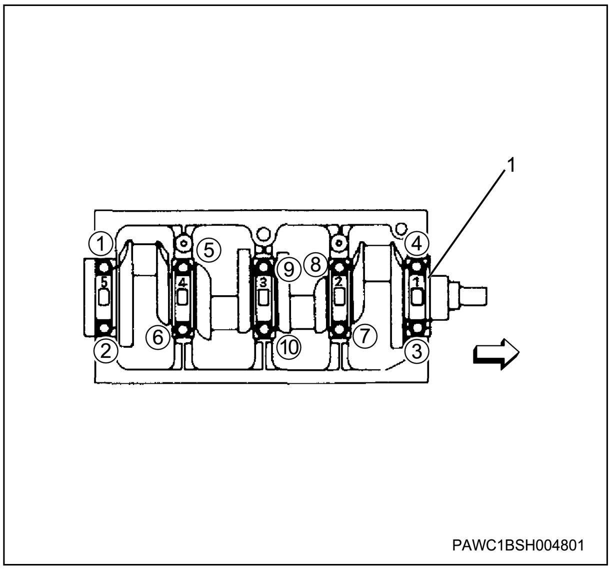


1. Measurement point

2. Remove the bearing cap from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.
- Lightly tap with a hammer and remove together with the bearing.



1. Arrow

3. Remove the crankshaft from the cylinder block.
4. Remove the crankshaft bearing from the cylinder block.

Note :

- Organize the removed bearing caps and bearings according to the cylinders using tags, etc.

inspection

1. Cylinder block inspection
   1. Inspect the cylinder block.

   Note：
   - Inspect the cylinder block for wear or damage.

   Caution：
   - If cracks or other damage is found as a result of the inspection, replace the cylinder block.

   2. Inspect for water leaks using a water pressure tester.

   Note：
   - Plug the water passage with a wooden plug, etc., and inspect for water leakage.

   specified pressure： 490 kPa { 71 psi }

   specified time： 3 min

   Caution：
   - If cracks or other damage is found as a result of the inspection, replace the cylinder block.

   3. Perform the dye penetrant check.

   Note：
   - Check for problems that cannot be detected by visual inspection.

   Caution：
   - If cracks or other damage is found as a result of the inspection, replace the cylinder block.

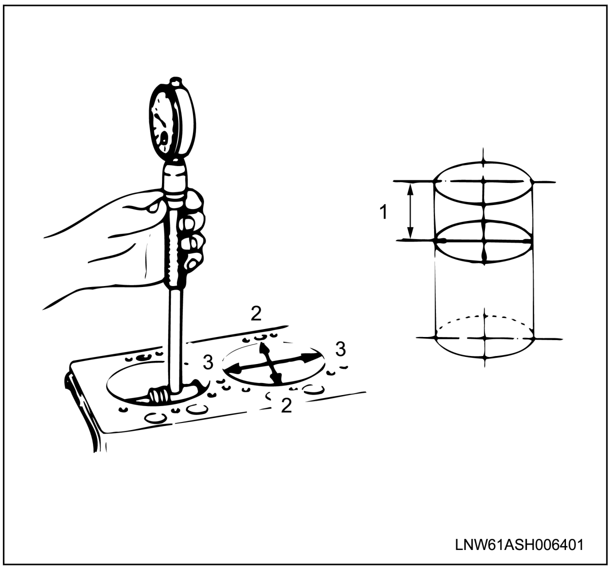
2. Cylinder block measurement
   1. Measure the cylinder block using a cylinder gauge.

   Note：
   - Measure the inner diameter of the cylinder in the axis direction and the thrust direction at the specified locations.

   measurement position： 13 mm { 0.512 in } From the top surface of the cylinder block

   specified value： 85 mm { 3.346 in }

   limit： 85.2 mm { 3.354 in }



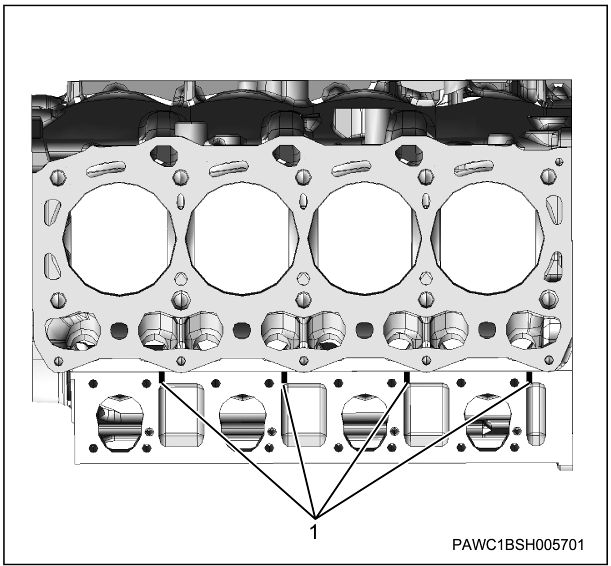
1. Measurement position
2. Axis direction
3. Thrust direction

Note：
- Align with the piston, and polish the cylinder inner diameter.

Caution：
- Oversized pistons and piston rings are set to 0.25 mm {0.0098 in}.
- For oversized dimensions, use 0 - 0.03 mm {0 - 0.0012 in}.
- The inner diameter difference of each cylinder should be less than or equal to 0.02 mm {0.0008 in}.

Note：
- Cylinder bore grade mark

Specified value	Grade
： 85.000 to 85.010 mm { 3.3465 to 3.3468 in }	A
： 85.011 to 85.020 mm { 3.3469 to 3.3472 in }	B
： 85.021 to 85.030 mm { 3.3473 to 3.3476 in }	C



1. Cylinder bore grade mark

2. Measure the deformation using a simple straight ruler.

Note：

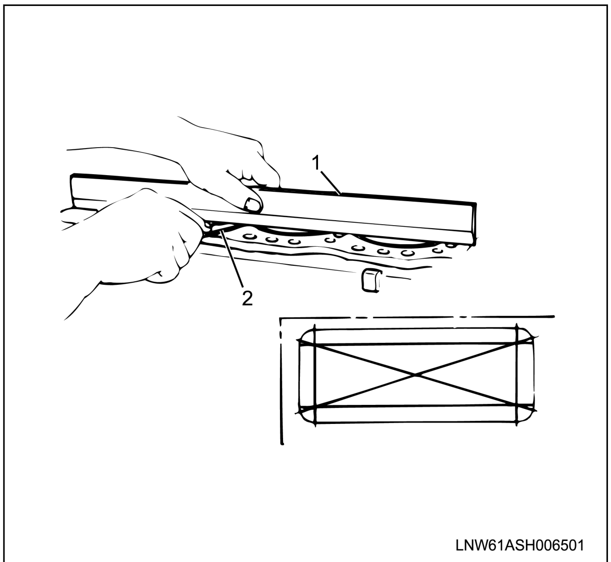
- Use a simple straight ruler and a feeler gauge to measure the 4 sides and 2 diagonal lines of the cylinder block top surface.
- Polish at a correction amount with the cylinder head not exceeding a range of 0.3 mm {0.012 in}.

Caution：

- If the measured value exceeds the limit, replace the cylinder block.

specified value： 0.075 mm { 0.0030 in }

limit： 0.15 mm { 0.006 in }

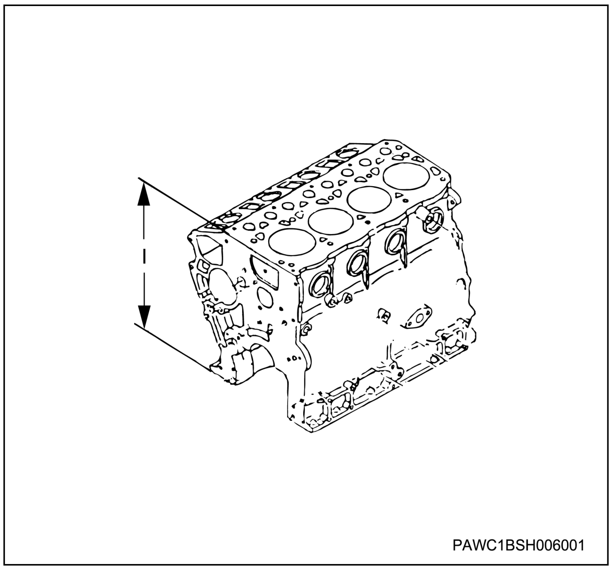


1. Simple straight ruler
2. Feeler gauge

Note：

- Measure the cylinder block height.

specified value： 307.94 to 308.06 mm { 12.124 to 12.128 in }



1. Cylinder block height

installation

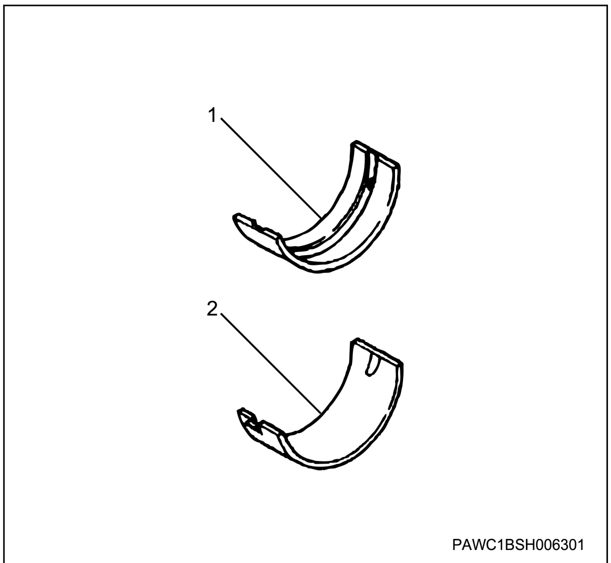
1. Crankshaft installation
   1. Clean the crankshaft bearing using a shop cloth.

      Note :
      - Verify that there is no foreign material on the back side of the crankshaft bearing and on crankshaft bearing housing of the cylinder block.
   2. Install the crankshaft bearing to the cylinder block.

      Note :
      - Install the crankshaft upper bearing to the cylinder block.
      - Securely fit the bearing claw to the notched section of the cylinder block and assemble.
   3. Apply engine oil to the crankshaft bearing.

      Note :
      - Sufficiently apply engine oil to the sliding surface of the crankshaft upper bearing.

      Caution :
      - Because the lower bearing does not have an oil hole or an oil groove, be careful when assembling.



1. Upper bearing
2. Lower bearing

   4. Install the crankshaft to the cylinder block.

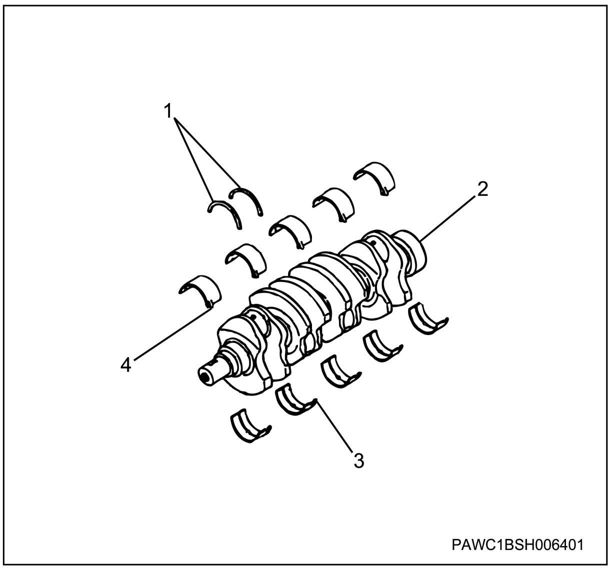
      Note :
      - Carefully install the crankshaft.
   5. Install the thrust bearing to the cylinder block.

      Note :
      - Assemble to the No. 2 journal section so that the oil groove faces the outside.
   6. Apply engine oil to the crankshaft bearing.

      Note :
      - Sufficiently apply engine oil to the sliding surface of the crankshaft lower bearing.
   7. Install the crankshaft bearing to the crankshaft.

      Note :
      - Install the crankshaft lower bearing to the crankshaft.

      Caution :
      - Verify that there is no foreign material on the installation section or the sliding surface of the bearing.
      - Verify that there is no oil adhering to the installation section of the bearing.



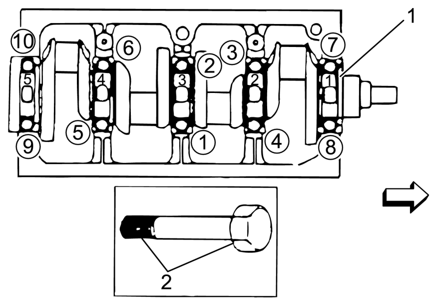
1. Thrust bearing
2. Crankshaft
3. Upper bearing claw section
4. Lower bearing claw section

   8. Install the bearing cap to the cylinder block.

      Note :
      - Align with the front mark of the crankshaft bearing cap, and install.
   9. Apply engine oil to the bolt.

      Note :
      - Apply engine oil to the threaded portion and the seat surface of the bearing cap bolt.
      - Gradually and uniformly tighten in the numerical order shown in the diagram.

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft }



PAWC1BSH006201

1. Arrow
2. Engine oil application area

Caution :

- Verify that the crankshaft rotates after installing.

2. Piston installation
   1. Apply engine oil to the piston.

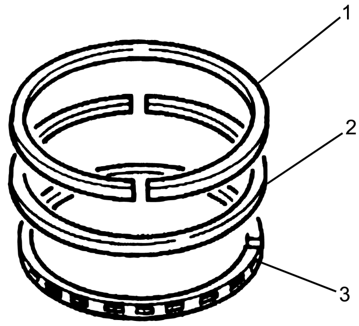
Note :

- Thoroughly apply to the piston side surface.

   2. Apply engine oil to the piston rings.

Note :

- Thoroughly apply to the piston rings and the ring grooves.
- Set the piston rings as shown in the diagram so that the joints are not perpendicular to the piston pin.



PAWC1BSH006701

1. Top ring
2. Second ring
3. Oil ring

3. Rotate the crankshaft gear.

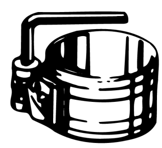
Note :

- Before installing the pistons, put every cylinder in the top dead center position.

4. Install the connecting rod bearing to the connecting rod.
5. Install the piston to the cylinder block using a special tool.

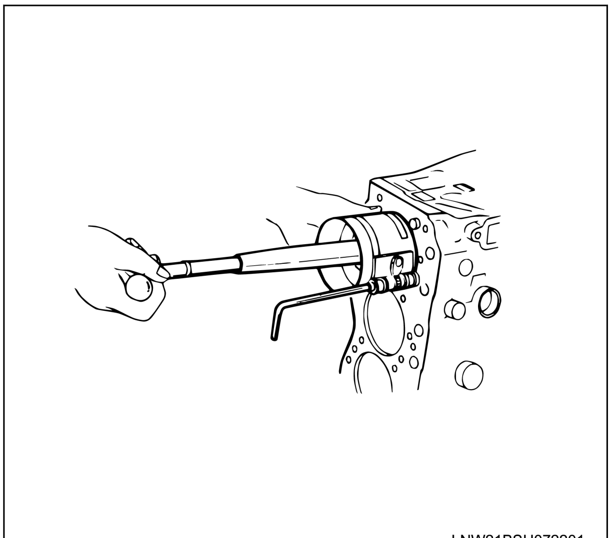
Note :

- Face the piston front mark toward the front, and insert the piston into the cylinder block.



5884090180

SST: 5-8840-9018-0 - piston setting tool


LNW21BSH072201

6. Rotate the crankshaft gear.

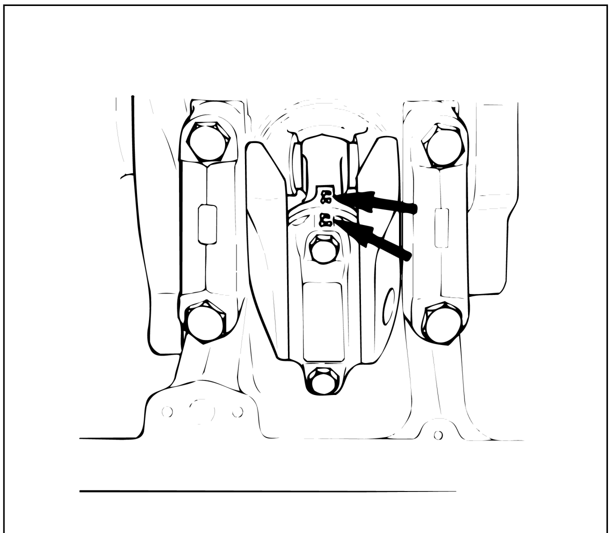
Note :

- Slowly rotate the crankshaft and put each cylinder at bottom dead center.

7. Apply engine oil to the connecting rod bearing.
8. Install the connecting rod bearing to the connecting rod bearing cap.
9. Install the connecting rod bearing cap to the connecting rod.

Note :

- Align the cap and the connecting rod number markings, and install the cap.


LNW61ASH004801

10. Apply engine oil to the bolt.

Note :

- Apply to the threaded portion and the seat surface of the tightening bolts.
- Check that the crankshaft turns smoothly after installing the connecting rod.

11. Tighten the bolts using a torque wrench.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft } 1st time

specified angle : 100 ° 2nd time

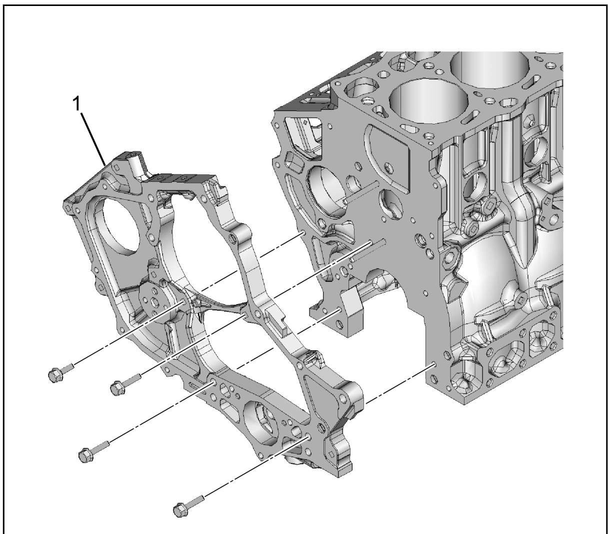
3. Front oil pump plate installation
   1. Apply liquid gasket to the front oil pump plate.

   Note :

   - Apply ThreeBond 1207B.

   2. Install the front oil pump plate to the cylinder block.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }



PAWC1ESH000201

1. Front oil pump plate

4. Oil seal retainer installation
   1. Apply engine oil to the crankshaft rear oil seal.

   Note :

   - Thinly apply engine oil to the lip section of the rear oil seal.

   2. Apply liquid gasket to the oil seal retainer.

   Note :

   - Apply ThreeBond 1207B.

   Caution :

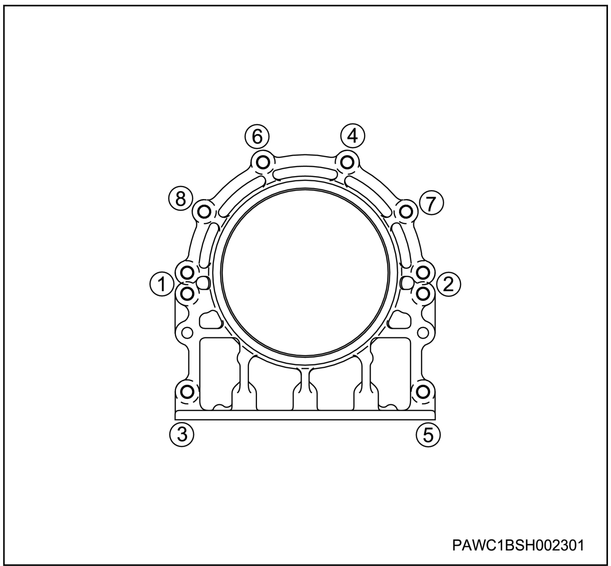
   - Verify that there is no dirt on the large end of the crankshaft.

   3. Install the oil seal retainer to the cylinder block.

   Note :

   - Tighten the bolts in the tightening order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

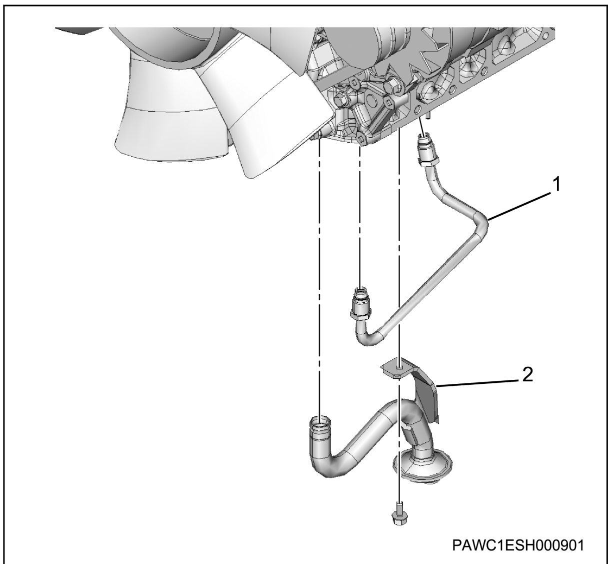


5. Oil strainer installation
   1. Apply engine oil to the O-ring.
   2. Install the oil strainer to the front oil pump plate and the cylinder block.

tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

   3. Install the oil pipe to the front oil pump plate and the cylinder block.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }



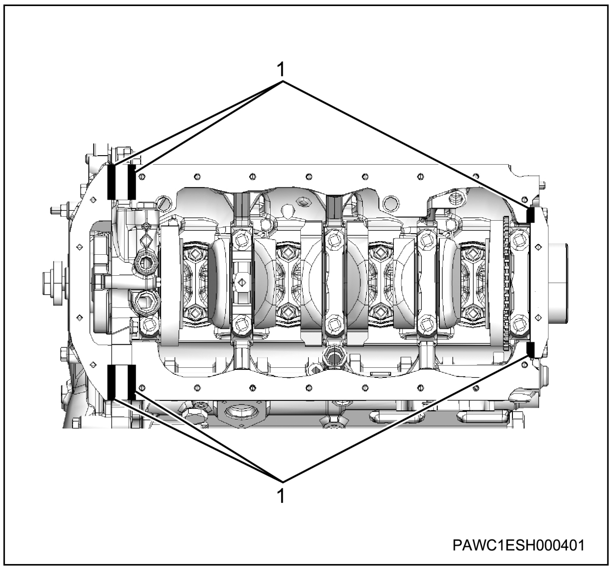
1. Oil pipe
2. Oil strainer

6. Oil pan installation
   1. Apply liquid gasket to the cylinder block.

Note :

- Apply ThreeBond 1207B to the installation surface between the cylinder block and the front oil pump plate.

bead width : 3 mm { 0.12 in }



1. Liquid gasket application area

   2. Install the oil pan to the cylinder block.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

7. Oil cooler assembly installation
   1. Apply engine oil to the O-ring.

Note :

- Apply oil to the entire O-ring of the center bolt.

   2. Install the oil cooler assembly to the cylinder block.

Note :

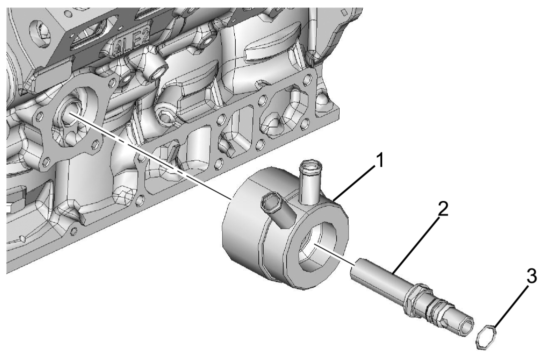
- Apply LOCTITE 262 or equivalent to the center bolt.

   3. Install the center bolt to the oil cooler assembly.

Caution :

- Be careful not to twist the O-ring.

tightening torque : 29.4 N・m { 3.0 kgf・m / 22 lb・ft }

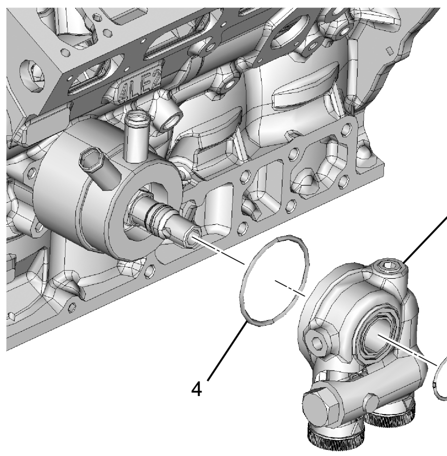


PAWC1ESH000301

1. Oil cooler
2. Center bolt
3. O-ring

4. Install the oil cooler cover to the oil cooler assembly.

tightening torque： 29.4 N・m { 3.0 kgf・m / 22 lb・ft }



PAWC1ESH000101

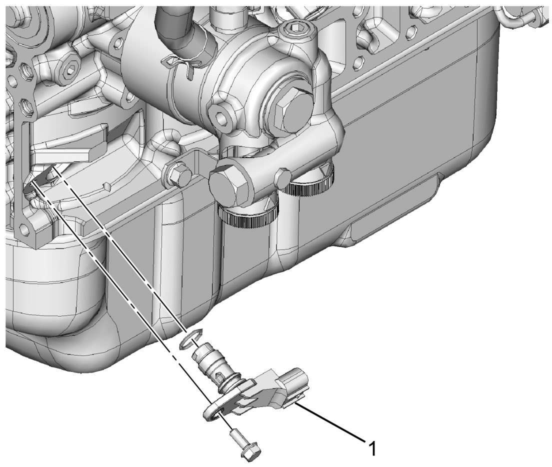
1. Oil cooler cover
2. O-ring
3. Plug
4. O-ring

8. CKP sensor installation

1. Install the CKP sensor to the cylinder block.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

2. Connect the harness connector to the CKP sensor.



PAWC1BSH001901

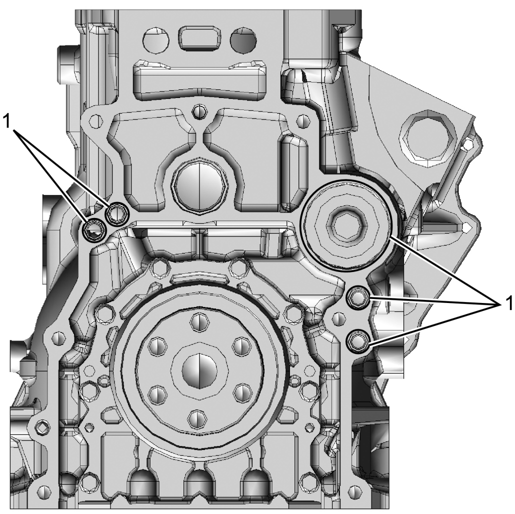
1. CKP sensor

9. Flywheel housing installation

1. Apply liquid gasket to the cylinder block.

Note：

- Apply ThreeBond 1207B to the 5 places indicated in the diagram.

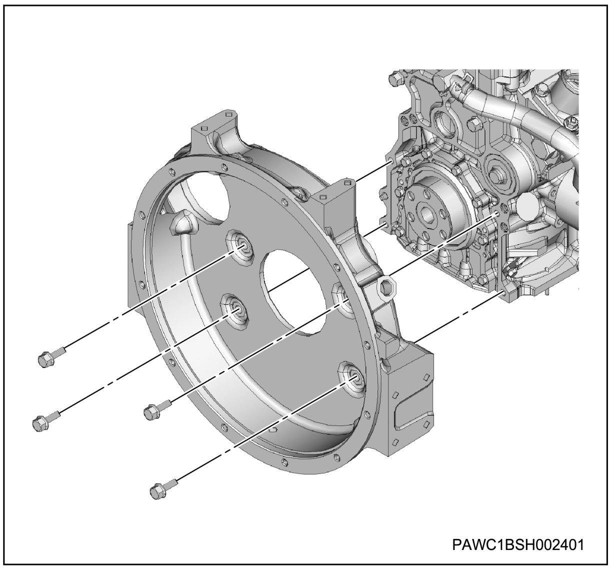


PAWC1BSH002601

1. Liquid gasket application area

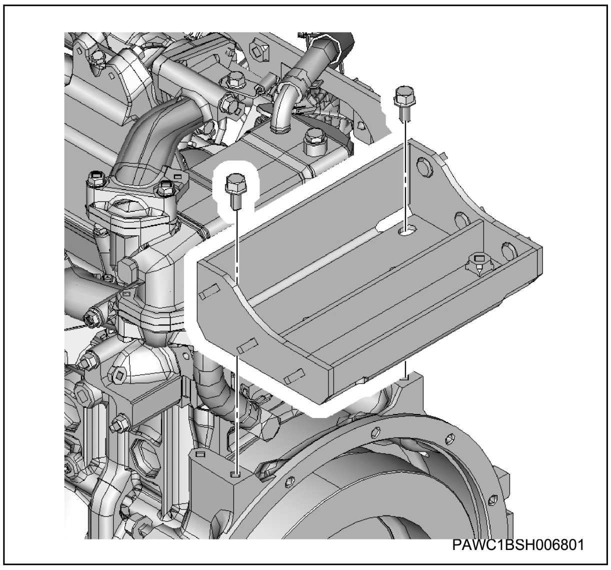
2. Install the flywheel housing to the cylinder block.

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }



3. Install the silencer bracket to the flywheel housing.

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }

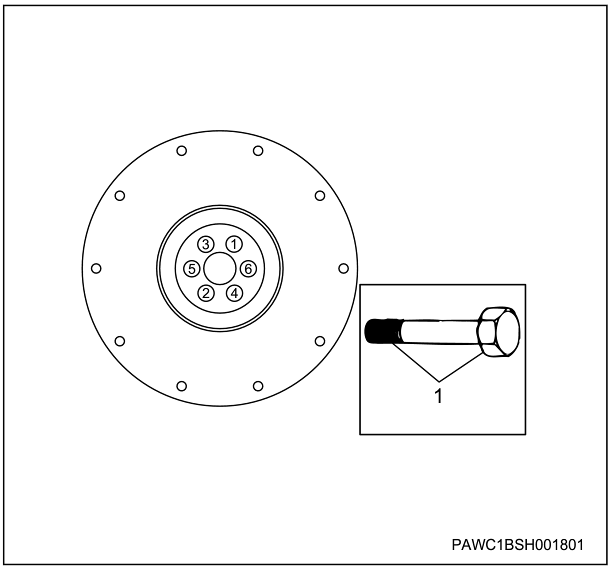


10. Flywheel installation

1. Apply engine oil to the bolt.

Note：

- Apply to the seat surface and the threaded portion of the flywheel mounting bolts.



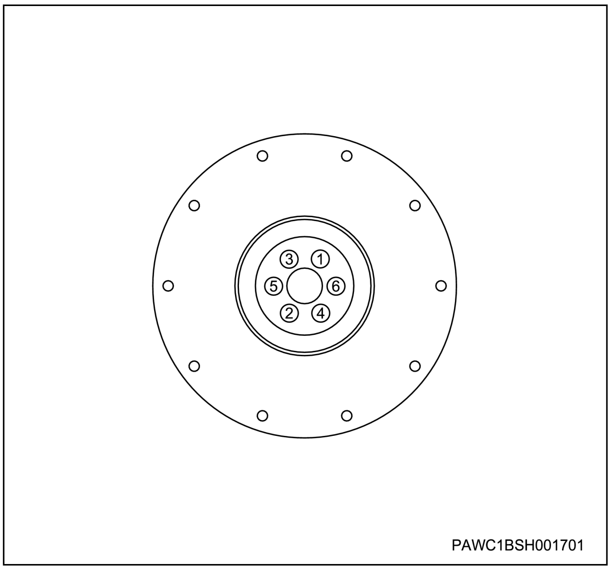
1. Engine oil application area

2. Install the flywheel to the crankshaft.

Note：

- Gradually tighten the mounting bolts in the order shown in the diagram.

tightening torque： 98 N・m { 10.0 kgf・m / 72 lb・ft }



Caution：

- Install while verifying the installation position.

11. Engine speed sensor installation

1. Install the engine speed sensor to the flywheel housing.

Note：

- Screw in the engine speed sensor until it reaches the end.

Caution：

- Be careful not to damage the sensor tip.

Note :

- Return the engine speed sensor 1 rotation, and secure with a nut.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }

2. Inspect the engine speed sensor.

Note :

- Check the output voltage at maximum speed without load and low speed without load.

	Specified output voltage	
Engine speed	Voltage waveform	AC voltage
Maximum speed without load	: 20 to 72 V	: 7.1 to 25.5 V
Low speed without load	: 9 to 40 V	: 3.2 to 14.2 V

Note :

- If the measured value is outside the specified output voltage, adjust the engine speed sensor until it is within the specified output voltage.

12. Starter motor installation

1. Install the starter motor to the flywheel housing.

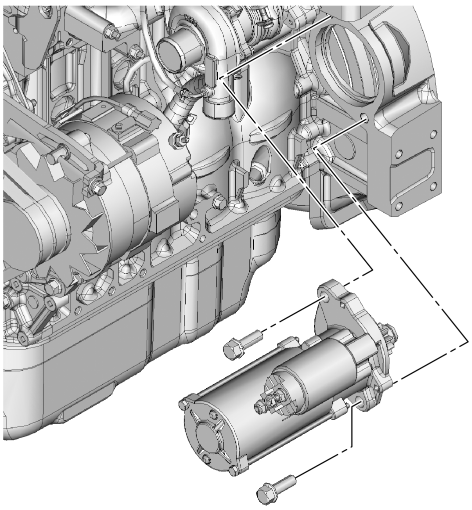
tightening torque : 103 N・m { 10.5 kgf・m / 76 lb・ft }

2. Install the ground cable to the starter motor.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

Note :

- The diagram shows the 24 V - 3.2 kW specification.



13. Oil level gauge guide tube installation

1. Install the oil level gauge guide tube to the cylinder block.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

2. Install the oil level gauge to the oil level gauge guide tube.

14. Idle gear A installation

1. Align the No. 1 cylinder to compression top dead center.

Note :

- Rotate the crankshaft in the forward direction and align the No. 1 cylinder piston to compression top dead center.

2. Install the idle gear shaft to the cylinder block.
3. Apply engine oil to the idle gear.

Note :

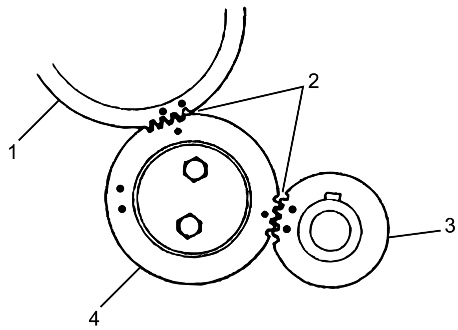
- Apply to idle gear A and the idle gear shaft.

4. Install idle gear A to the idle gear shaft.

Note :

- Install after meshing so that the alignment mark of the crankshaft gear is as shown in the diagram.

tightening torque : 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



1. Camshaft gear
2. Timing point
3. Crank gear
4. Idle gear A

5. Apply engine oil to the idle gear.

Note :

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

6. Install the thrust collar to the idle gear.

Note :

- Install so that the chamfered side of the thrust collar faces the outside.

15. Camshaft gear installation

1. Install the camshaft gear to the camshaft.

Note :

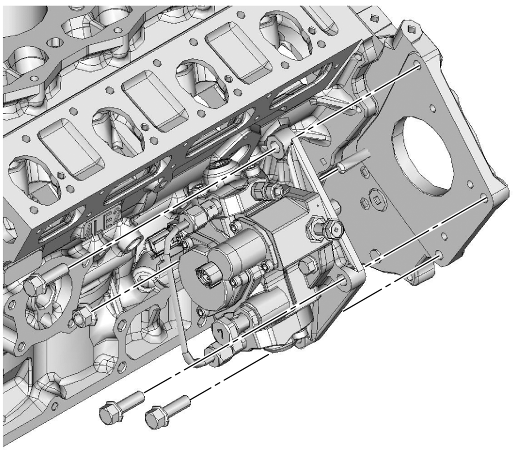
- Install after meshing so as to align the idle gear alignment marks.

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft }

16. Fuel supply pump installation

1. Install the fuel supply pump to the front oil pump plate.

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



PAWC1CSH000101

2. Connect the harness connector to the fuel supply pump.

17. Idle gear B installation

1. Install the idle gear shaft to the cylinder block.
2. Apply engine oil to the idle gear.

Note :

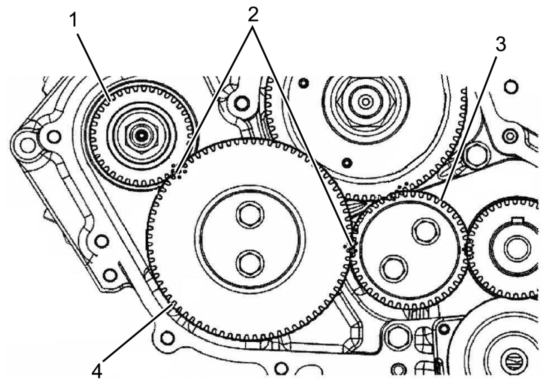
- Apply to idle gear B and the idle gear shaft.

3. Install idle gear B to the idle gear shaft.

Note :

- Install after meshing so as to align the idle gear B alignment marks with idle gear A and the supply pump gear.

tightening torque : 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



PAWC1BSH001501

1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

4. Apply engine oil to the idle gear.

Note :

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

5. Install the thrust collar to the idle gear.

Note :

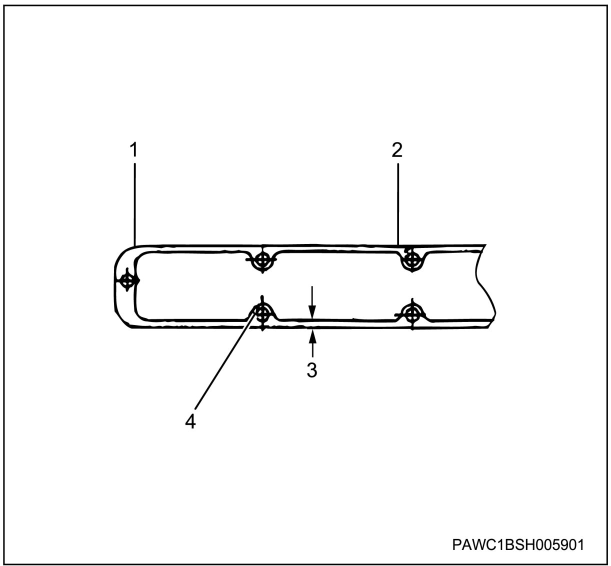
- Install so that the chamfered side of the thrust collar faces the outside.

18. Housing cover installation

1. Apply liquid gasket to the housing cover.

bead width : about 4 mm { about 0.157 in } From the end of the cover

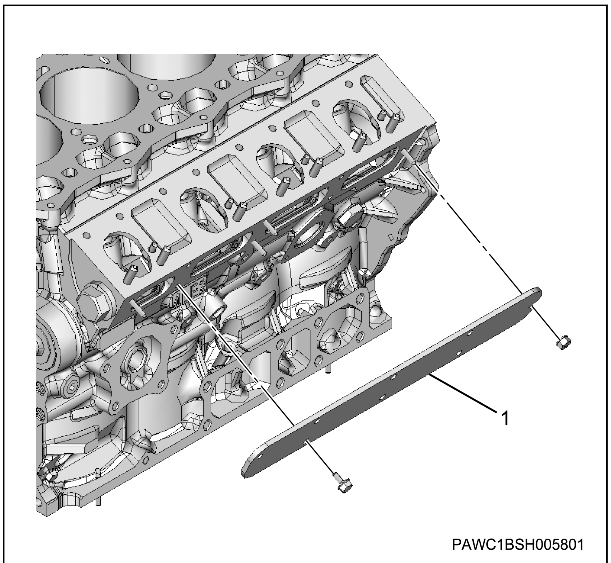
bead width : about 2 mm { about 0.079 in } Around the bolt



1. Housing cover
2. Liquid gasket application area
3. Approx. 4 mm {0.157 in}
4. Approx. 2 mm {0.079 in}

2. Install the housing cover to the cylinder block.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Housing cover

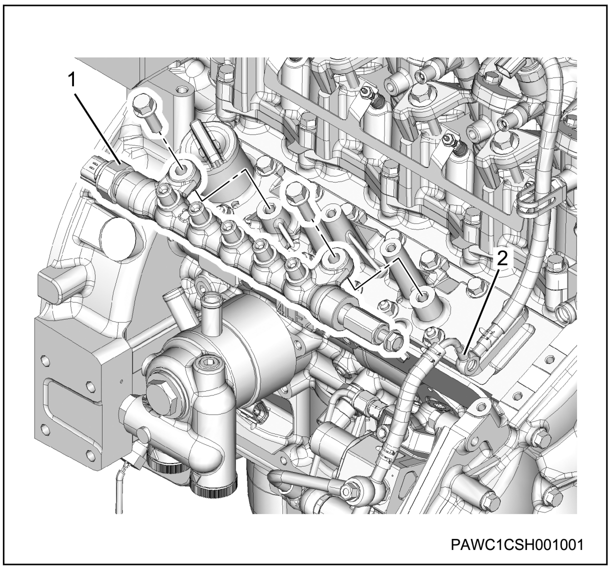
19. Common rail assembly installation

1. Install the common rail (fuel rail) assembly to the common rail (fuel rail) bracket.

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }

2. Install the fuel leak-off pipe to the common rail (fuel rail) assembly.

tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



1. Common rail (fuel rail) assembly
2. Fuel leak-off pipe

3. Install the harness connector to the common rail (fuel rail) assembly.

20. Fuel return pipe installation

1. Install the fuel return pipe to the fuel supply pump.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M10

tightening torque： 17 N・m { 1.7 kgf・m / 13 lb・ft } M14

21. Fuel pipe installation

1. Temporarily tighten the fuel pipe to the fuel supply pump.
2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

Caution：

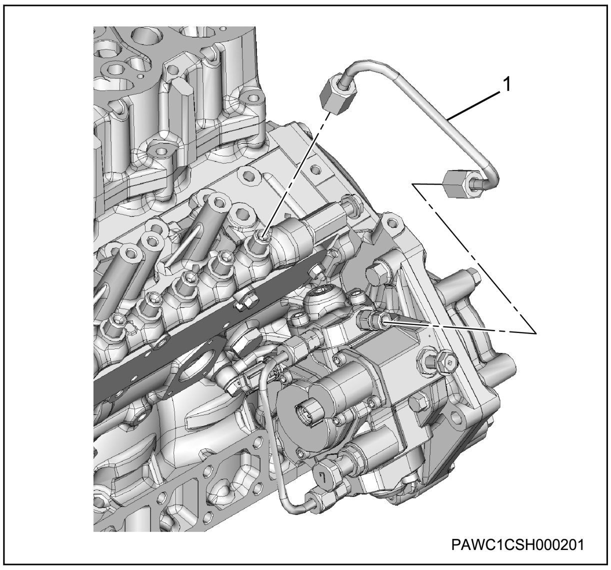
・ Use a new fuel pipe.

Note：

・ Verify that there is no dirt in the fuel pipe.

3. Securely tighten the fuel pipe to the fuel supply pump.
4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque： 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

22. Timing gear case installation
   1. Apply liquid gasket to the front oil pump plate.

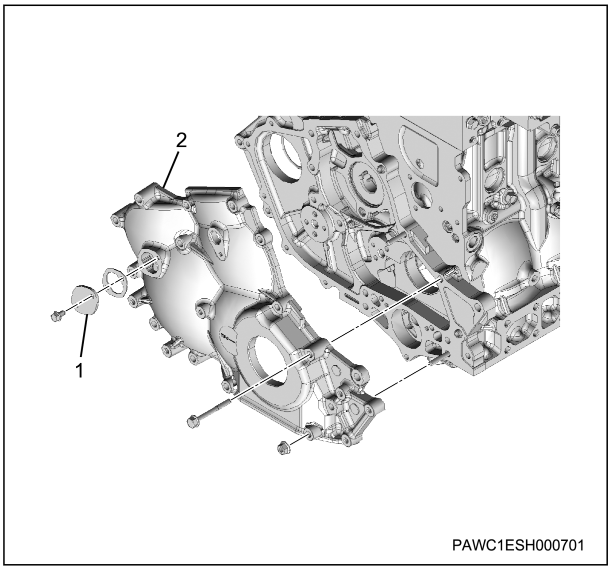
   Note :
   - Apply ThreeBond 1207B.

   2. Install the timing gear case to the front oil pump plate.

   tightening torque : 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

   3. Install the idle gear cover to the timing gear case.

   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Idle gear cover
2. Timing gear case

23. CMP sensor installation
   1. Apply engine oil to the O-ring.
   2. Install the CMP sensor to the timing gear case.

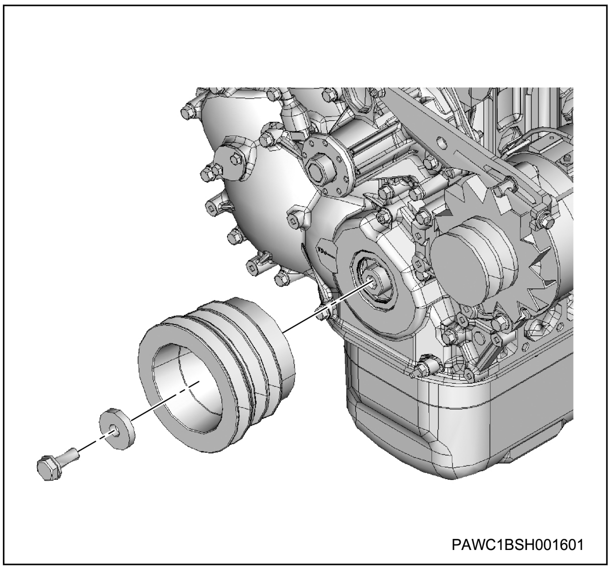
   tightening torque : 5 N・m { 0.5 kgf・m / 44 lb・in }

   3. Connect the harness connector to the CMP sensor.

24. Crankshaft pulley installation
   1. Install the crankshaft pulley to the crankshaft.

   Caution :
   - Do not reuse the bolt and the washer.

   tightening torque : 177 N・m { 18.0 kgf・m / 131 lb・ft }



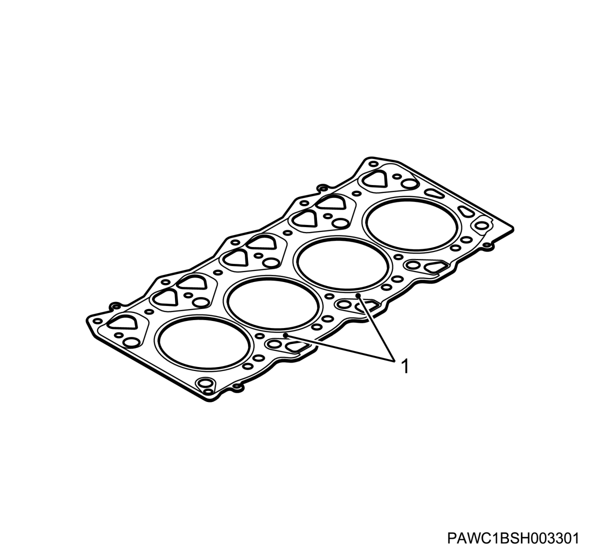
25. Tappet installation
   1. Apply engine oil to the tappet.

   Note :
   - Apply to the bottom surface and the outer circumference of the tappet.

   2. Install the tappet to the cylinder block.

26. Cylinder head assembly installation
   1. Install the cylinder head gasket to the cylinder block.

   Note :
   - Install with the marked side facing upward.



1. Mark

2. Apply engine oil to the bolt.

Note :

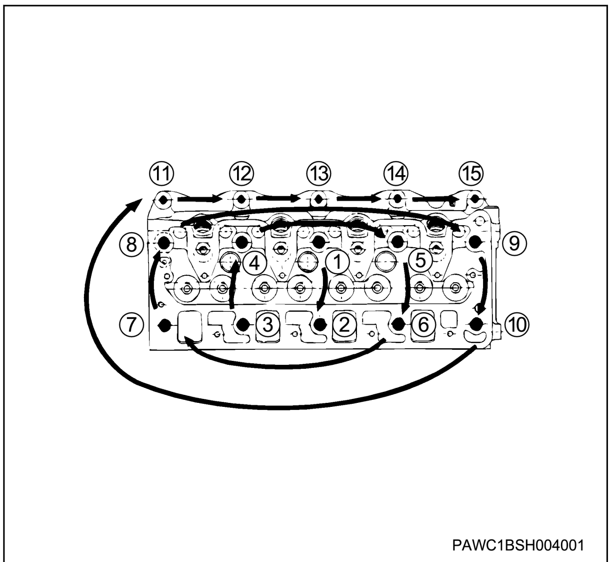
- Apply engine oil to the threaded portion and the seat surface of the head bolt.

3. Install the cylinder head assembly to the cylinder block.

4. Tighten the head bolts using a torque wrench.

Note :

- Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle : 60 ° 3rd time

Note :

- Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }

27. Push rod installation

1. Install the push rod to the cylinder block.

Note :

- Pass it through the cylinder block and insert it into the tappet.

28. Rocker arm bracket installation

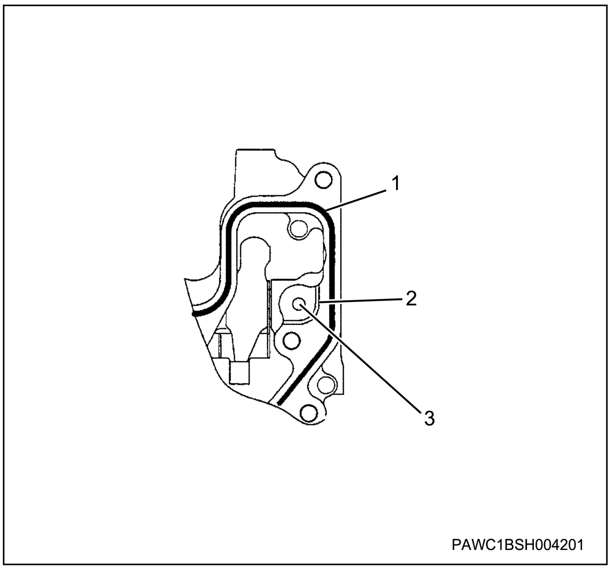
1. Apply liquid gasket to the rocker arm bracket.

Note :

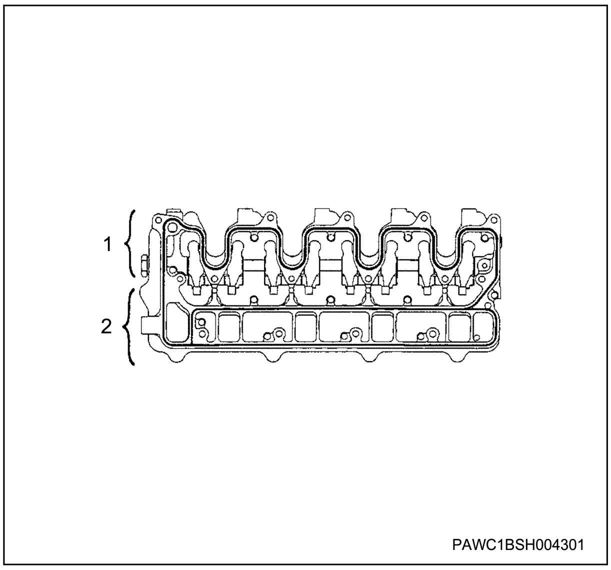
- Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

Caution :

- Do not apply liquid gasket to the groove around the oil gallery.



1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



1. Liquid gasket application area
2. Oil gallery groove

Note :

- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note :

- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.
4. Securely tighten the rocker arm bracket to the cylinder head.

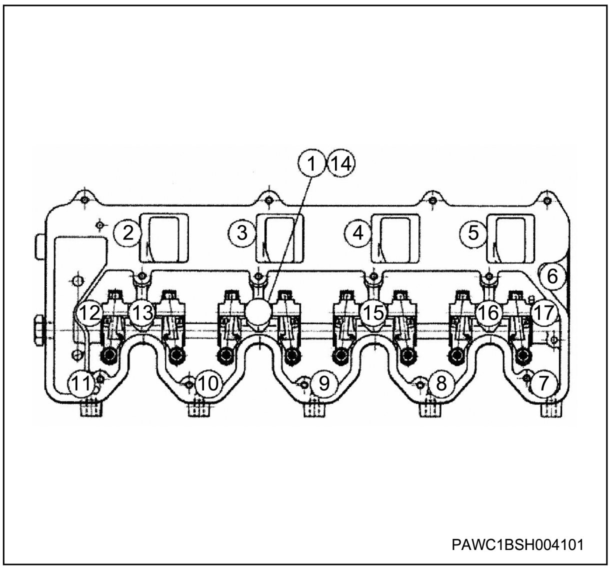
Note :

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution :

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



29. Rocker arm shaft adjustment

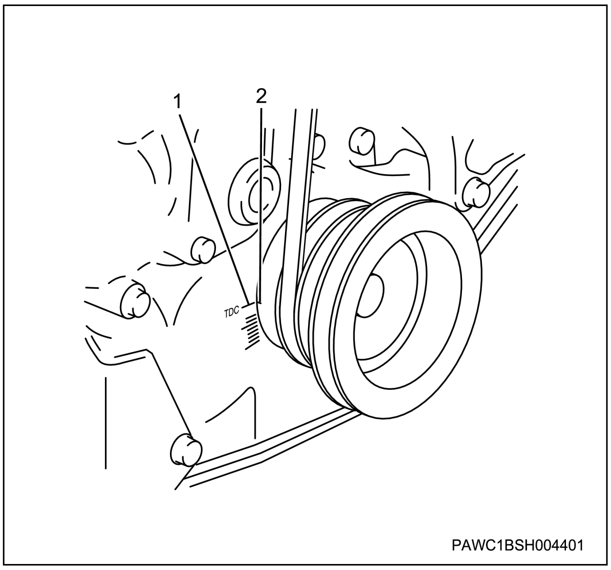
Note :

- Valve clearance adjustment

Caution :

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note :

- Insert the feeler gauge between the rocker arm and the bridge cap.

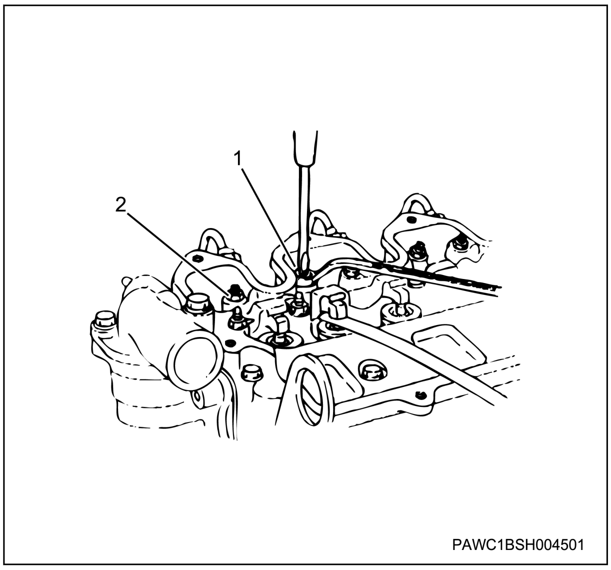
specified value : 0.40 mm { 0.016 in } Inlet valve

specified value : 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note：

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



1. Adjust screw
2. Lock nut

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note：

- Rotate the crankshaft in the forward direction and measure the valve clearance.

Caution：

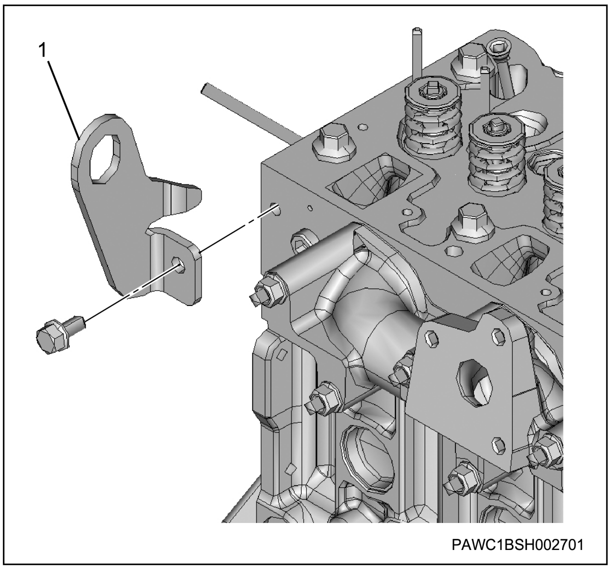
- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

30. Engine hanger installation

1. Install the engine hanger to the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }

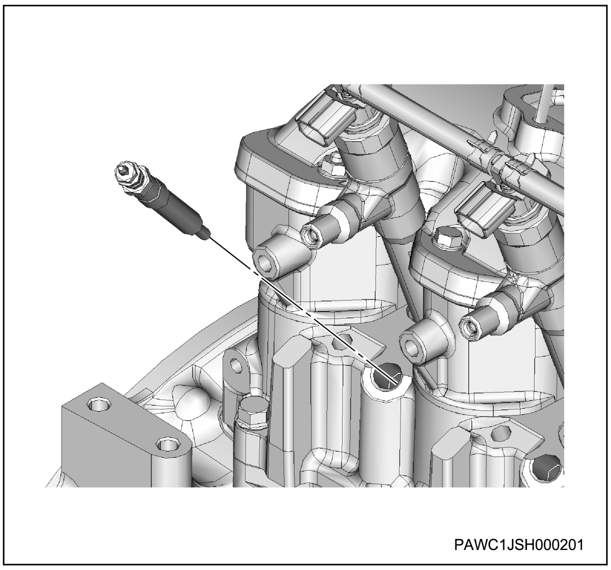


1. Engine hanger

31. Glow plug installation

1. Install the glow plug to the cylinder head.

tightening torque： 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



32. Glow plug connector installation

1. Install the glow plug connector to the glow plug.

tightening torque： 1.0 N・m { 0.1 kgf・m / 9 lb・in }

33. Injector installation

Caution：

- Do not change the installation position of the injectors when reusing the injectors.

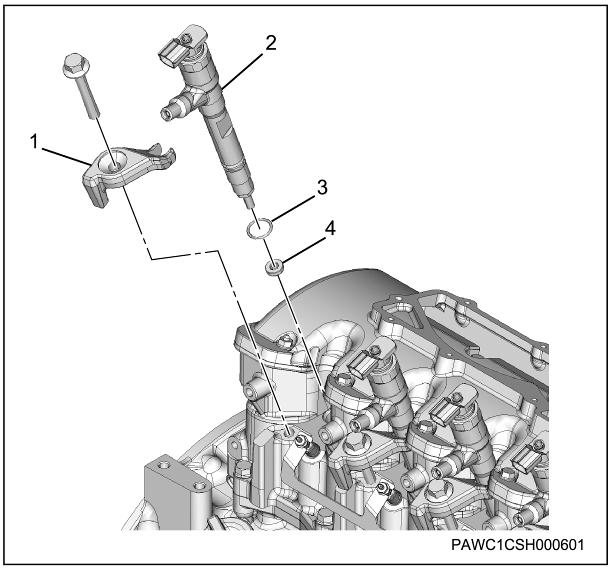
1. Install the O-ring to the injector.

2. Install the injector gasket to the injector.

Note：

- Do not reuse the injector gasket or the O-ring.

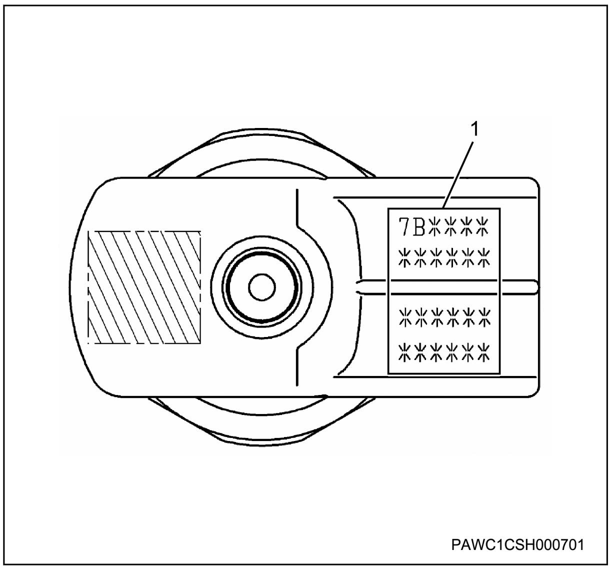
3. Temporarily tighten the injector to the cylinder head assembly.



1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Caution：

- If the injector has been replaced, record the injector ID code of the new injector.



1. Injector ID code

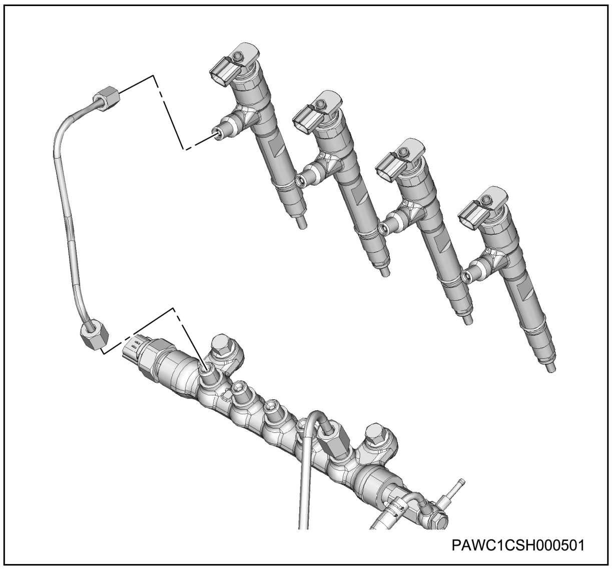
4. Connect the harness connector to the injector.

34. Injection pipe installation

1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

- Do not reuse the injection pipe.



2. Securely tighten the injector to the cylinder head assembly.

tightening torque： 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

- Securely tighten the injector side.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

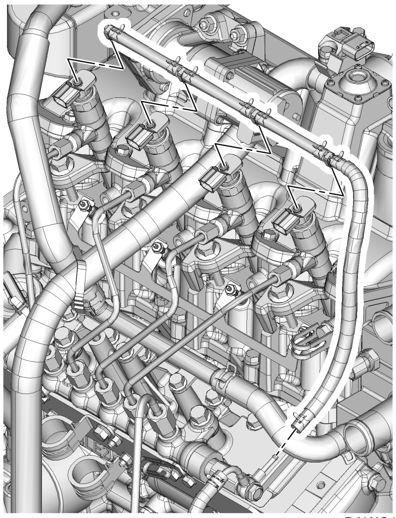
Note：

- Securely tighten the common rail (fuel rail) side.

tightening torque： 30 N・m { 3.1 kgf・m / 22 lb・ft }

35. Fuel leak-off hose installation

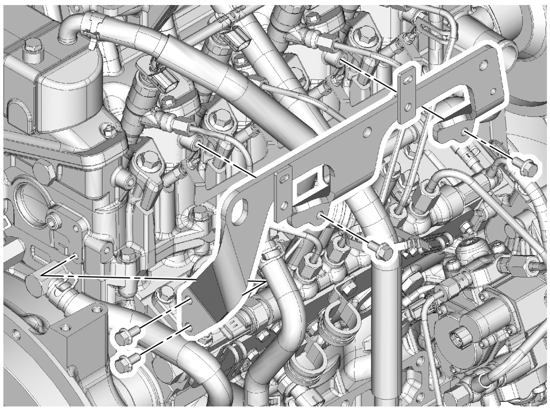
1. Install the fuel leak-off hose to the injector.



PAWC1CSH000401

36. Harness bracket installation
   1. Install the harness bracket to the cylinder head.

   tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

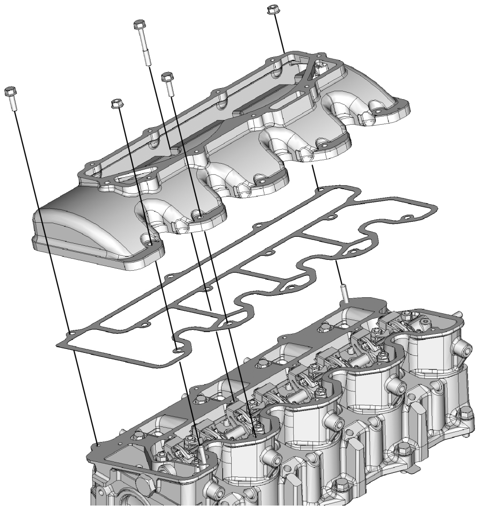


PAWC1CSH000301

   2. Connect the engine harness to the harness bracket.

37. Cylinder head cover installation
   1. Install the cylinder head cover to the rocker arm bracket.

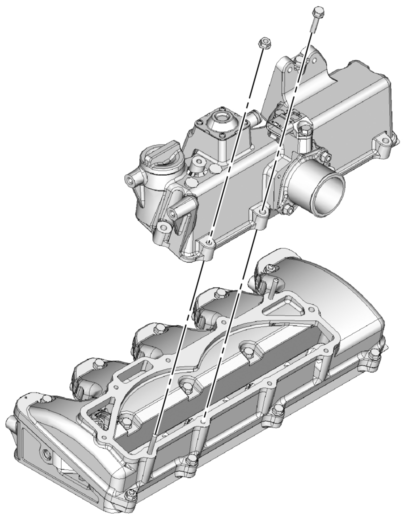
   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH001001

38. Intake chamber installation
   1. Install the intake chamber to the cylinder head cover.

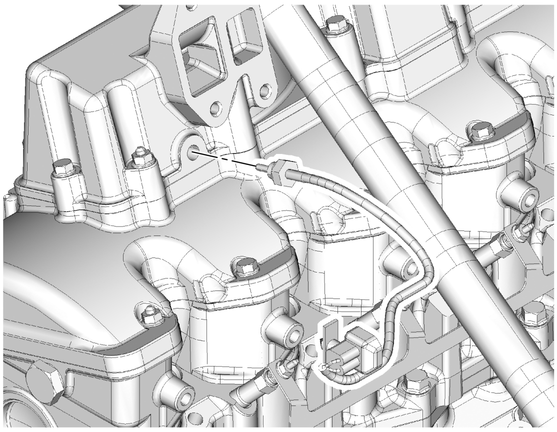
   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH000701

39. IMT sensor installation
   1. Install the IMT sensor to the intake chamber.

   tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

2. Connect the harness connector to the IMT sensor.

40. PCV hose installation

1. Install the PCV hose to the intake chamber.

41. EGR valve installation

1. Temporarily tighten the EGR valve to the intake chamber.
2. Temporarily tighten the EGR pipe to the exhaust manifold.
3. Temporarily tighten the EGR pipe to the EGR valve.
4. Temporarily tighten the EGR cooler to the EGR pipe.

Note :

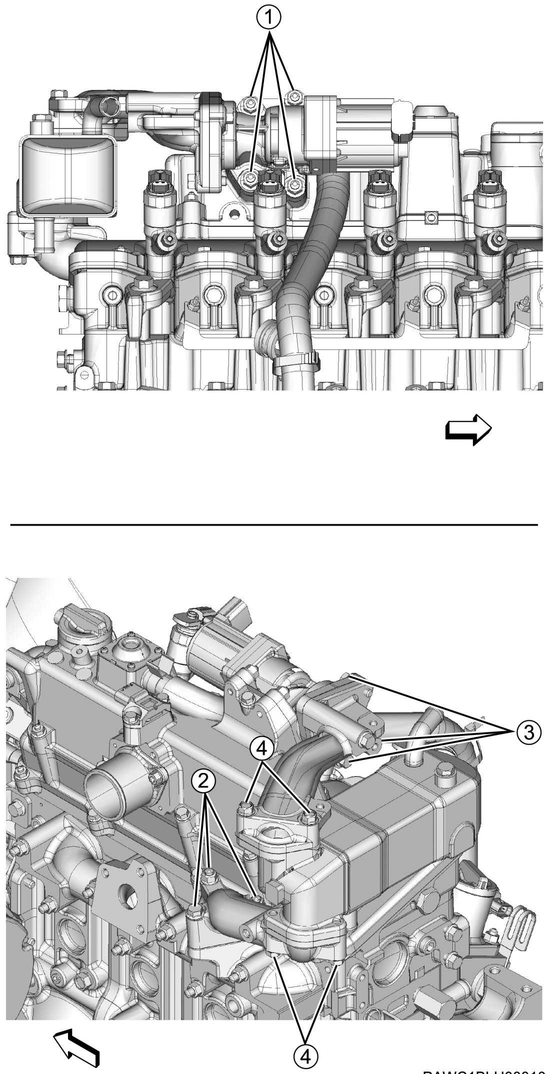
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note :

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



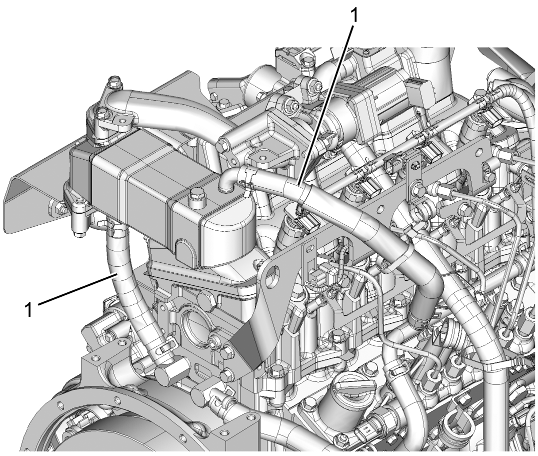
PAWC1BLH000101

Note :

- Tighten the heat protector tightening bolts.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



PAWC1BSH000201

1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

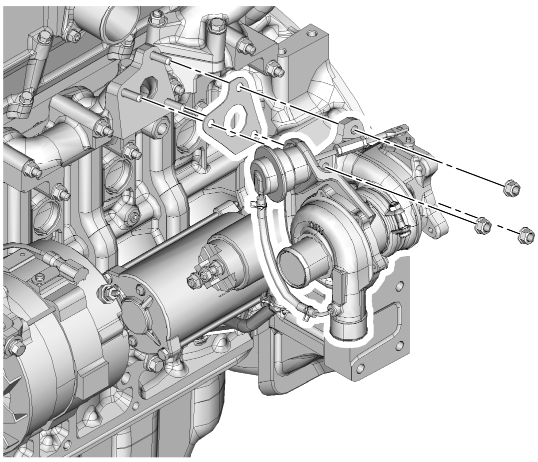
42. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note :

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



PAWC1FSH000101

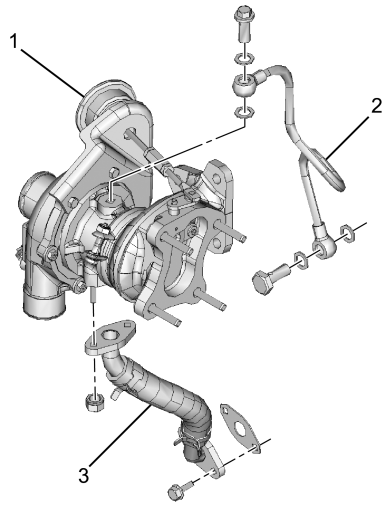
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft } Cylinder block side

tightening torque : 22 N・m { 2.2 kgf・m / 16 lb・ft } Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

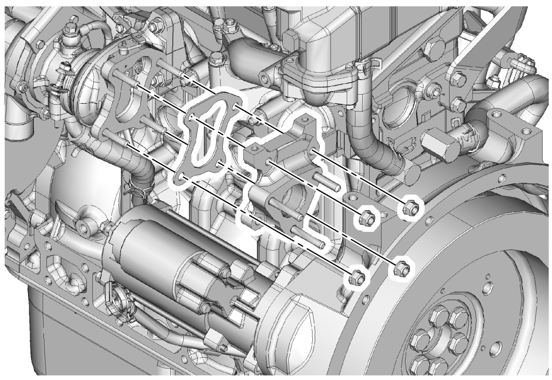


PAWC1FSH000301

1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

4. Install the exhaust pipe adapter to the turbocharger assembly.

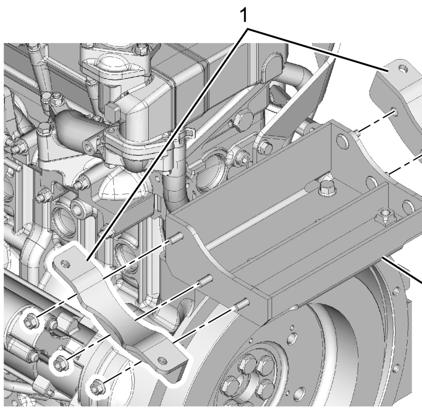
tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



PAWC1FSH000201

43. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.



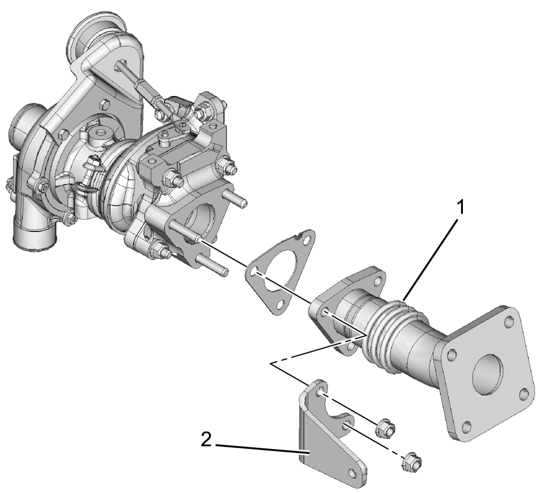
PAWC1GSH000201

1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

・ Install together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

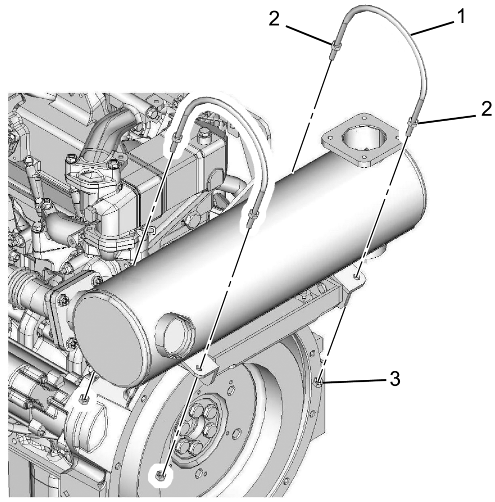
Note：

・ Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
・ With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
・ Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

・ Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
・ Install so that the U-bolts are not tilted.



PAWC1GSH000301

1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

・ Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
・ Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

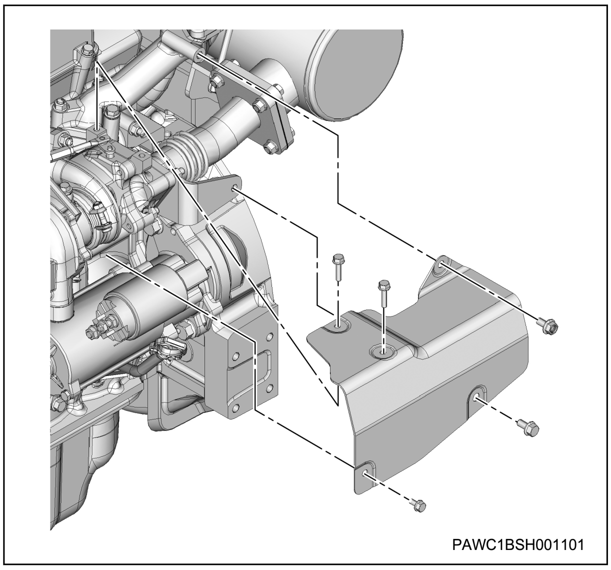
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

44. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M6



45. Pressure sensor/boost temperature sensor connect
    1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

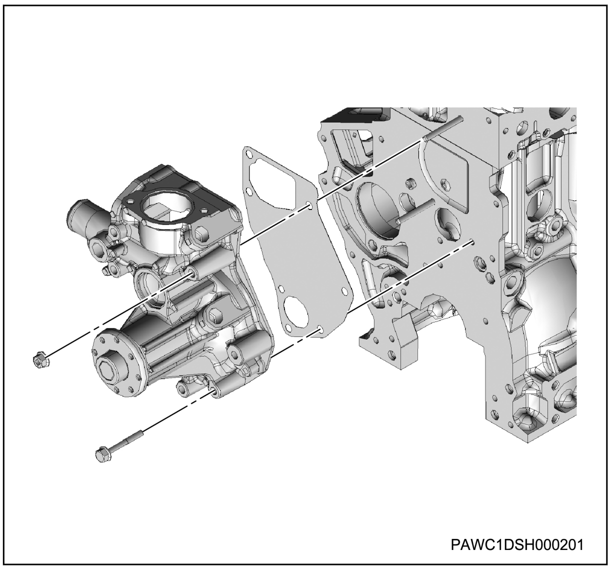
- Install the harness clip.

46. Water pump assembly installation
    1. Install the water pump assembly to the cylinder block and the cylinder head.

Note：

- Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }



47. Water hose connect
    1. Connect the water hose to the water pump assembly.

Note：

- Install the hose clip.

48. Engine coolant temperature sensor connect
    1. Connect the harness connector to the engine coolant temperature sensor.
49. Generator installation
    1. Install the adjust plate to the water pump assembly.

tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

2. Temporarily tighten the generator to the generator bracket.
3. Temporarily tighten the generator to the adjust plate.

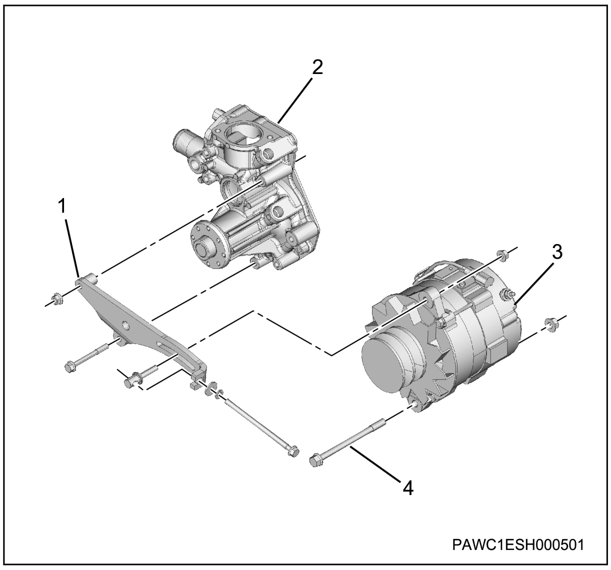
Note：

- Securely tighten the bolt and the nut after adjusting the cooling fan belt.

4. Connect the harness connector to the generator.

Note：

- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

50. Fan pulley installation

1. Install the fan pulley to the water pump assembly.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

51. Cooling fan belt installation

1. Install the cooling fan belt to the pulley.

52. Cooling fan belt adjustment

1. Check the tension of the cooling fan belt.

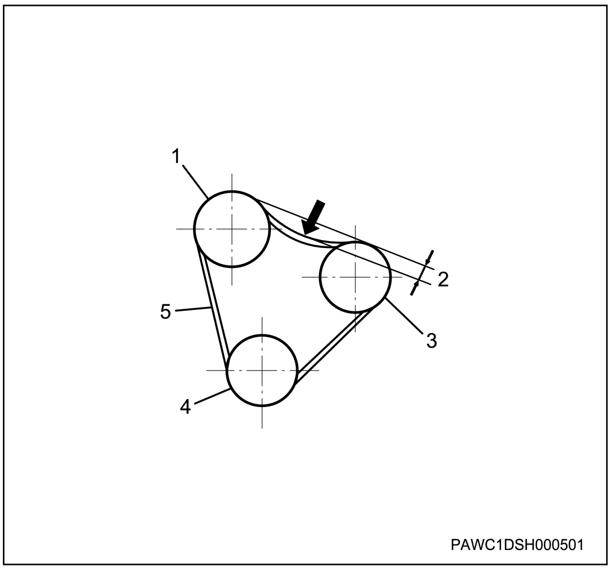
Note :

- Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard : 98 N { 10.0 kg / 22 lb }

specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

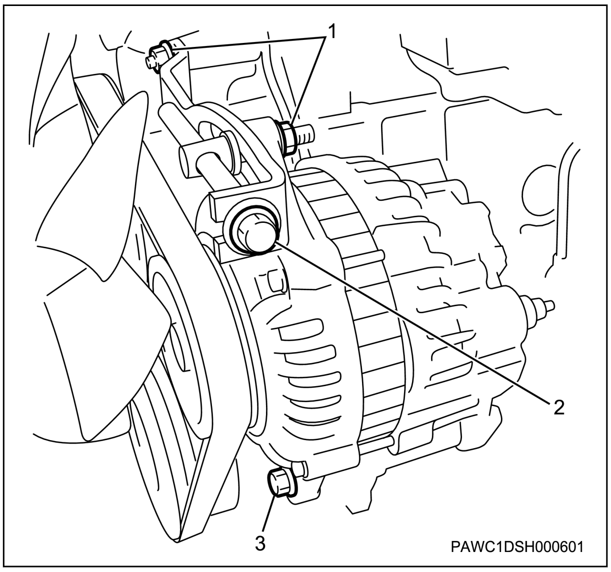


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25

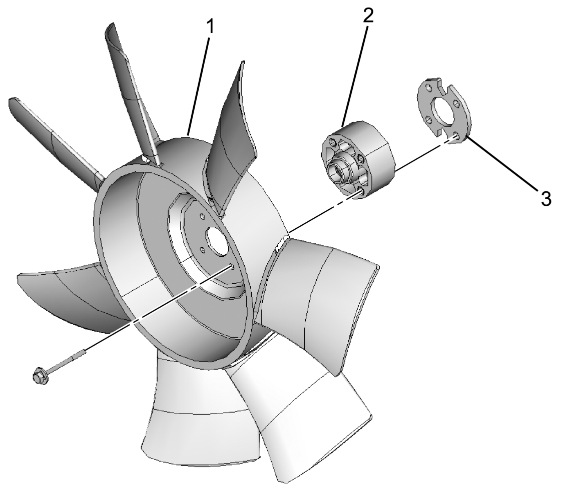


1. Nut
2. Adjust bolt
3. Mounting bolt

53. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1DSH000301

1. Cooling fan
2. Adapter
3. Spacer

54. Engine oil filling

1. Refill the engine with engine oil.

Note：

- Check the tightening of the oil pan drain plug again.

55. Coolant filling

1. Loosen the plug using a wrench.

2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

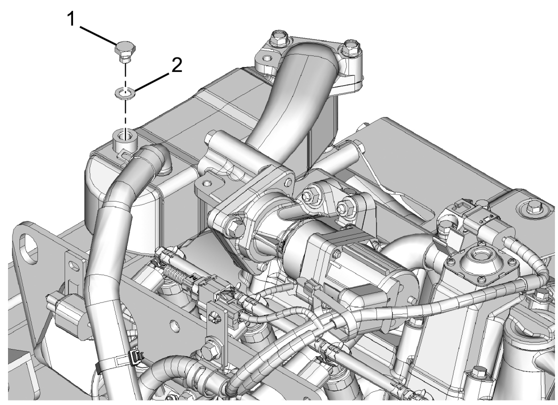
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



PAWC1BSH000101

1. Plug
2. Gasket

56. Battery ground cable connect

1. Connect the battery ground cable to the battery.

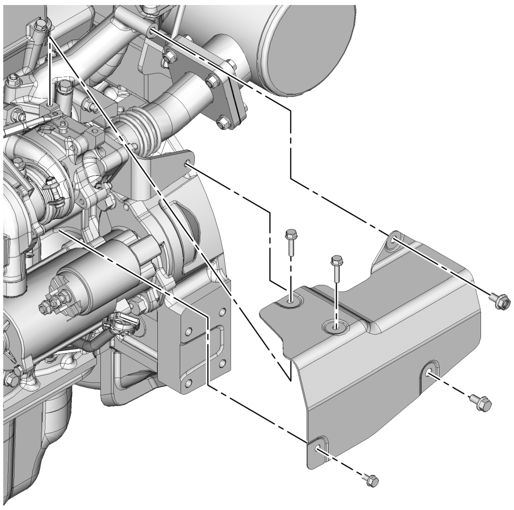
Exhaust manifold

removal

1. Battery ground cable disconnect
    1. Disconnect the battery ground cable from the battery.
2. Coolant drain
    1. Drain coolant from the radiator.

    Caution :

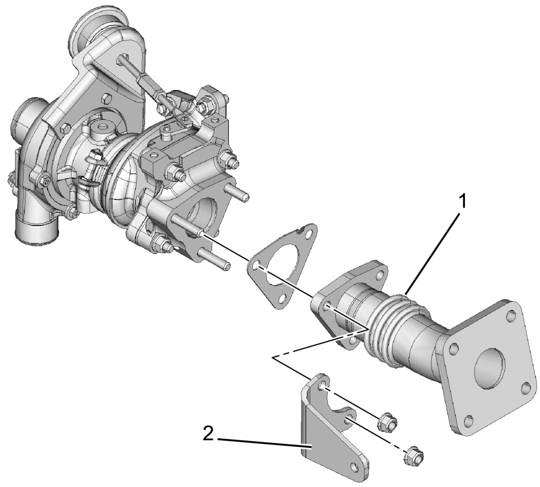
    - After draining the coolant, do not forget to tighten the drain plug.
3. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.


PAWC1BSH001101

4. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

    Note :

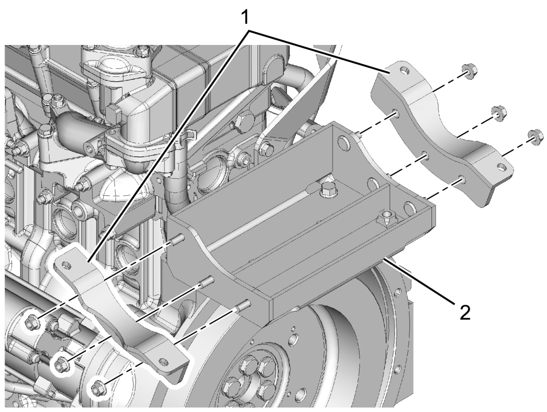
    - Remove together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

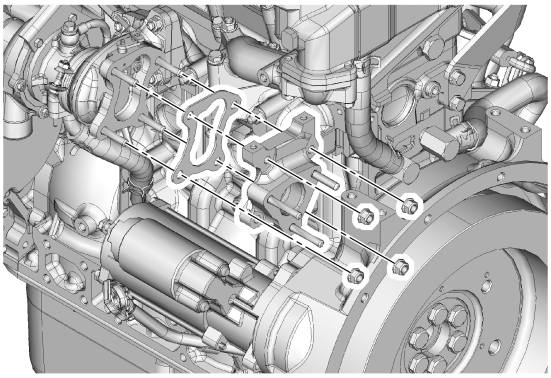
3. Remove the support bracket from the silencer bracket.



PAWC1GSH000201

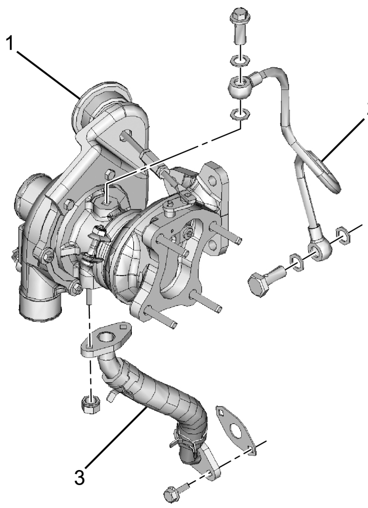
1. Support bracket
2. Silencer bracket

5. Turbocharger assembly removal
    1. Remove the exhaust pipe adapter from the turbocharger assembly.



PAWC1FSH000201

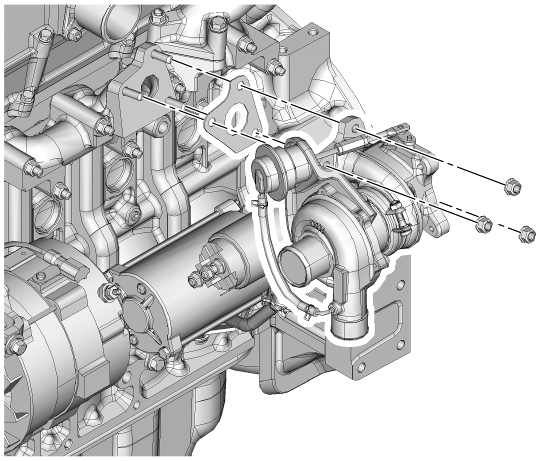
2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.



PAWC1FSH000301

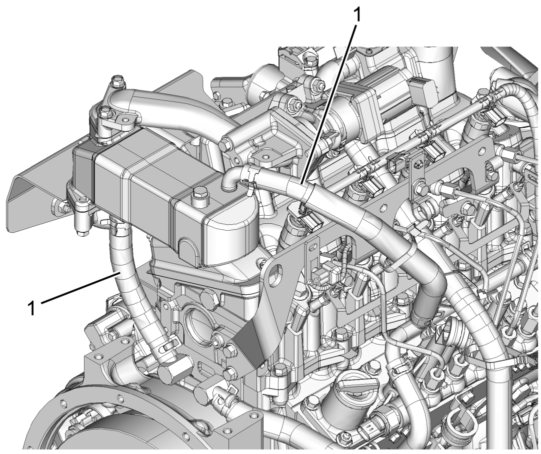
1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

4. Remove the turbocharger assembly from the exhaust manifold.



PAWC1FSH000101

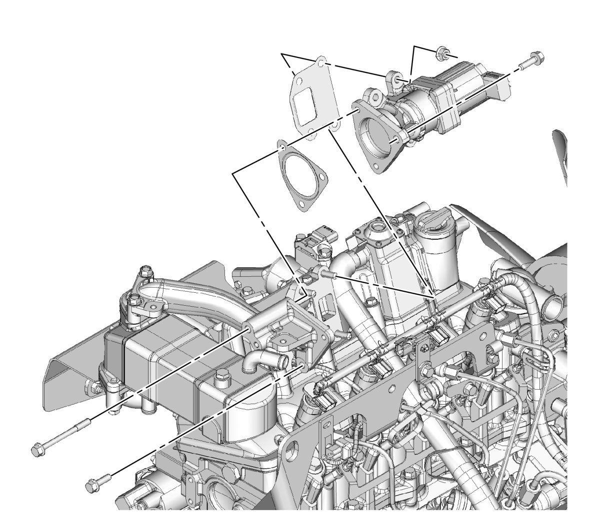
6. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.



PAWC1BSH000201

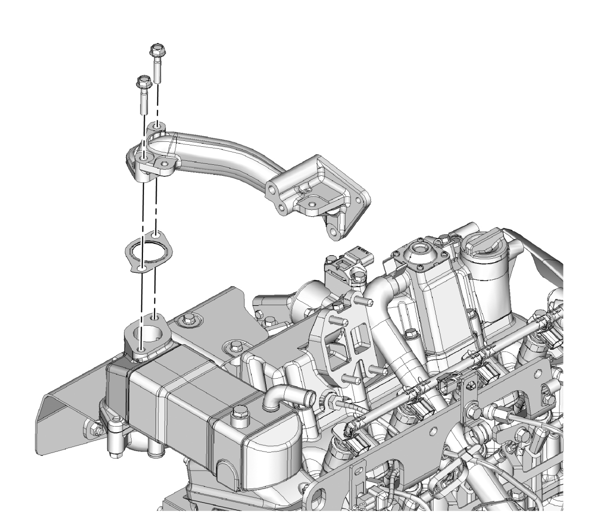
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.



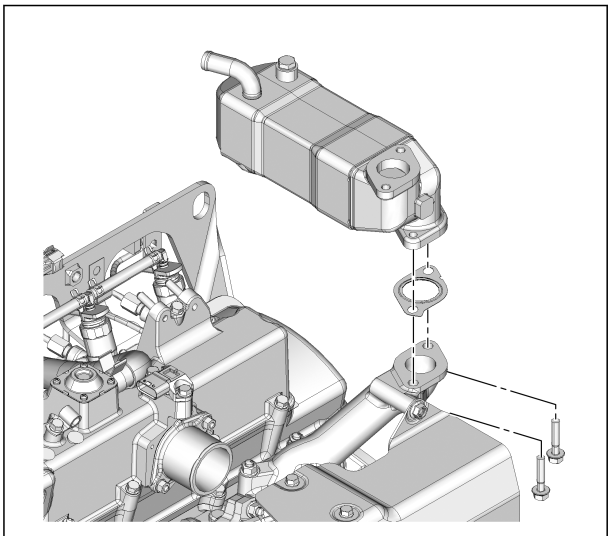
PAWC1BSH000301

5. Remove the EGR pipe from the EGR cooler.



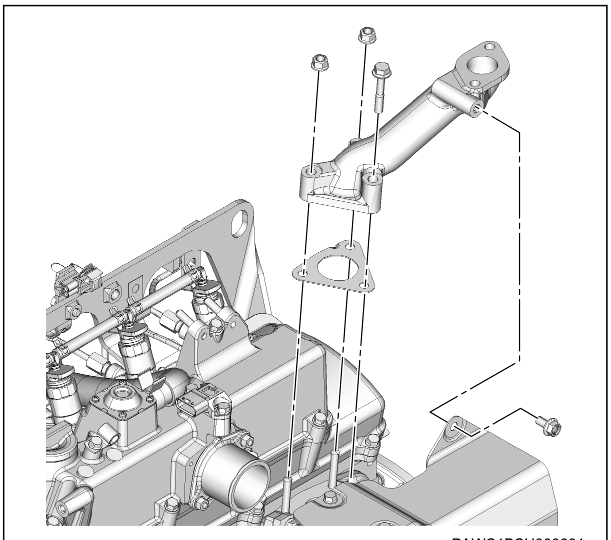
PAWC1BSH000401

6. Remove the EGR cooler from the EGR pipe.



PAWC1BSH000501

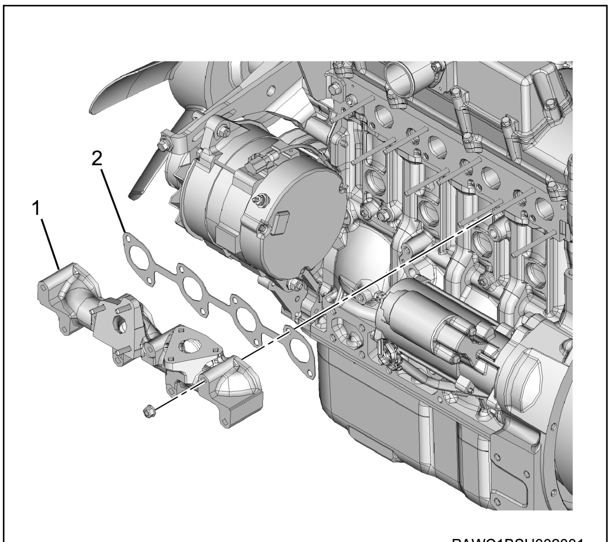
7. Remove the EGR pipe from the exhaust manifold.



PAWC1BSH000601

7. Exhaust manifold removal

1. Remove the exhaust manifold from the cylinder head.
2. Remove the gasket from the cylinder head.



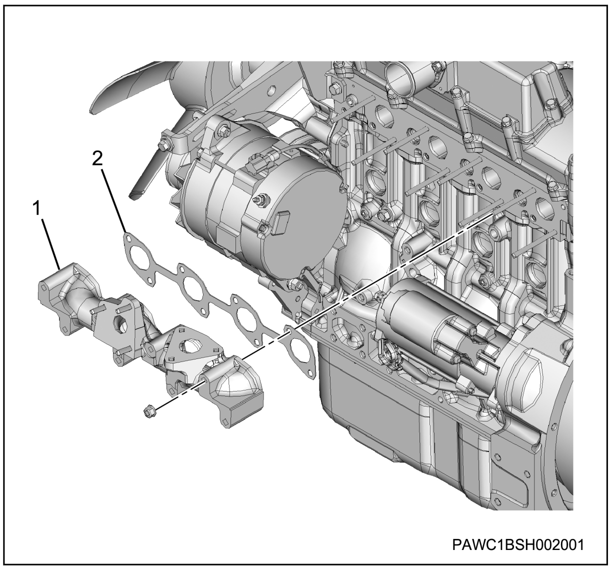
PAWC1BSH002001

1. Exhaust manifold
2. Gasket

installation

1. Exhaust manifold installation
   1. Install the gasket to the cylinder head.
   2. Install the exhaust manifold to the cylinder head.

   tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



1. Exhaust manifold
2. Gasket

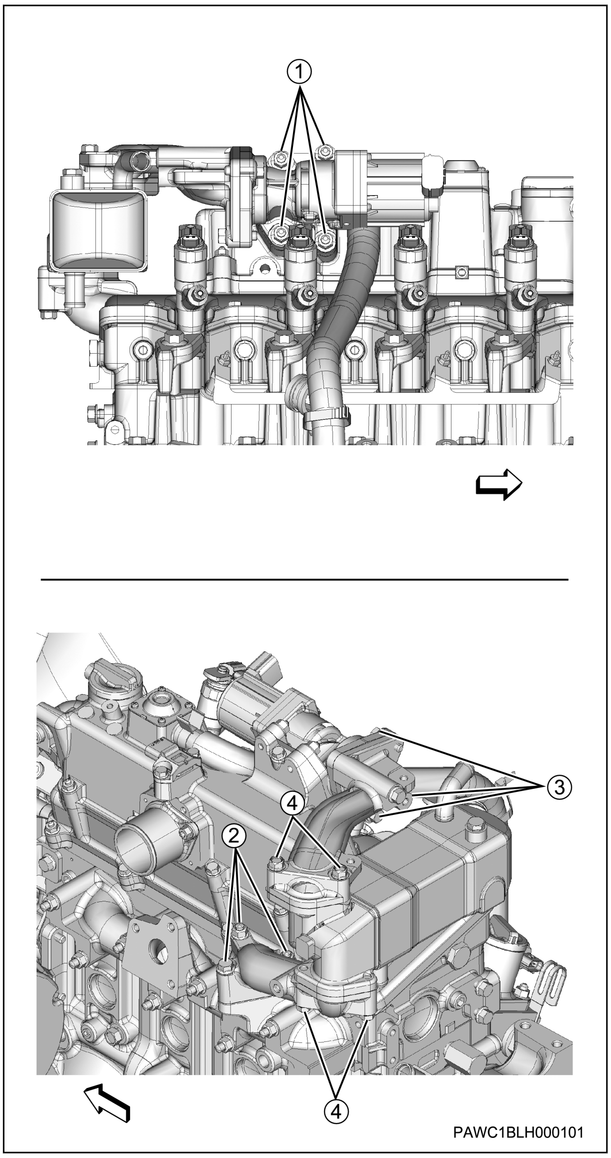
2. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

   Note：
   - Temporarily tighten the entire component until seated.

   5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

   Note：
   - After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

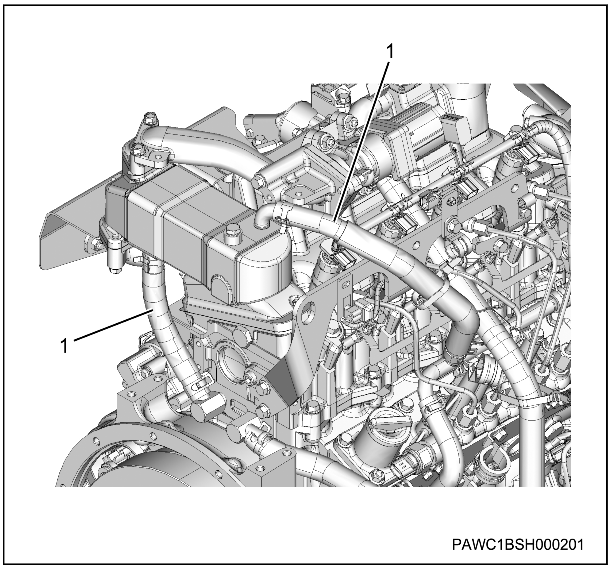
   tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



Note：
- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

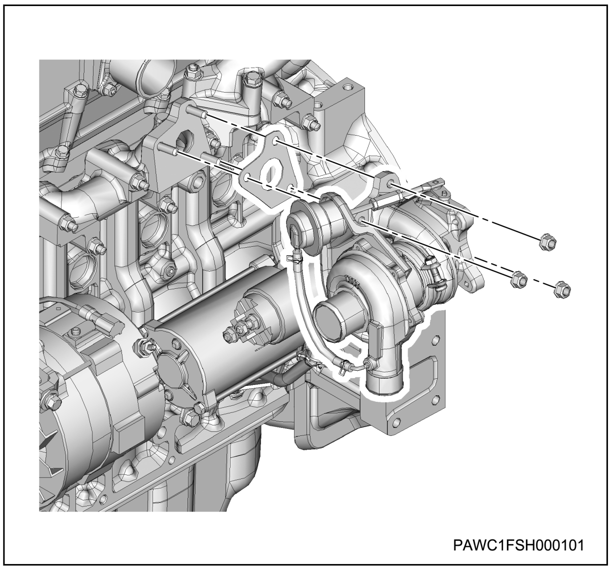
3. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note：

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



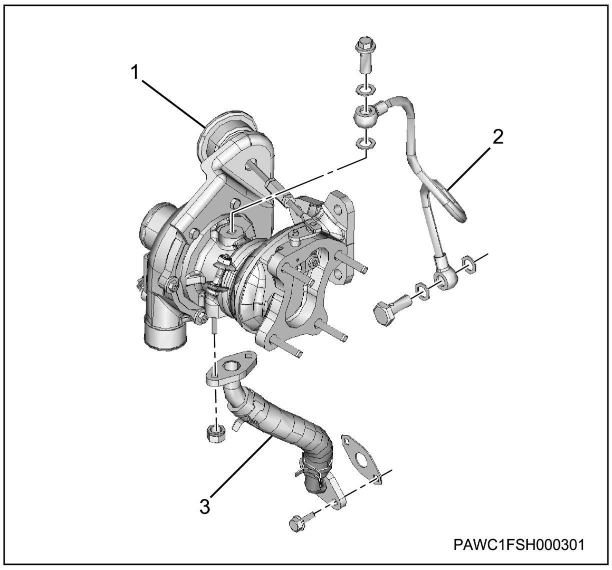
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft } Cylinder block side

tightening torque： 22 N・m { 2.2 kgf・m / 16 lb・ft } Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

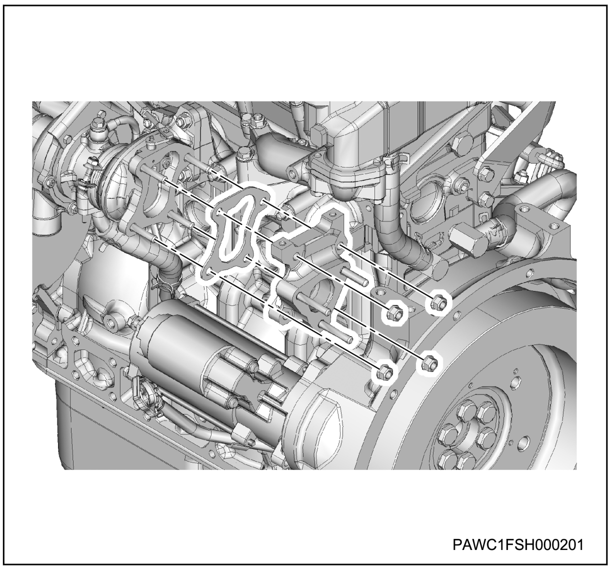
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

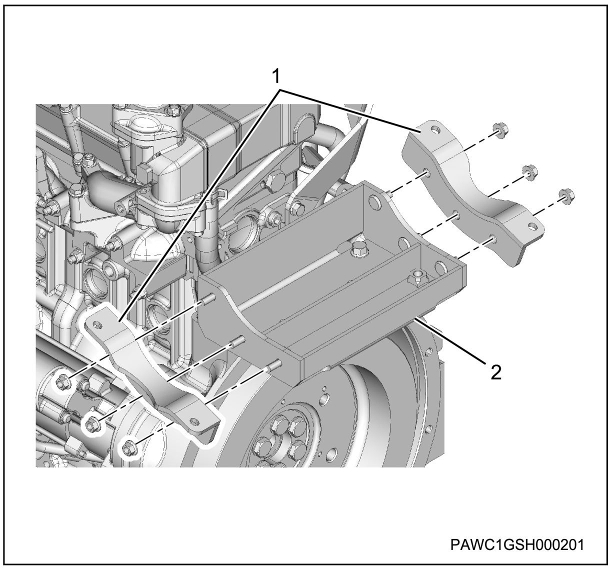
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



4. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

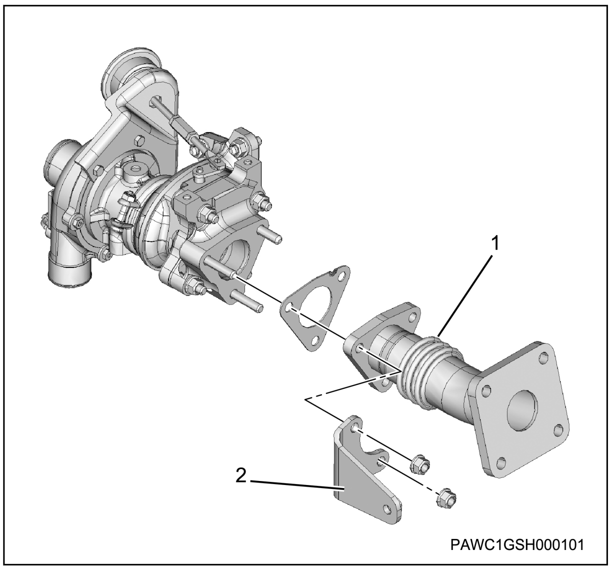


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

・ Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

・ Temporarily tighten nut A until the end of the threaded portion of the U-bolt.

・ With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.

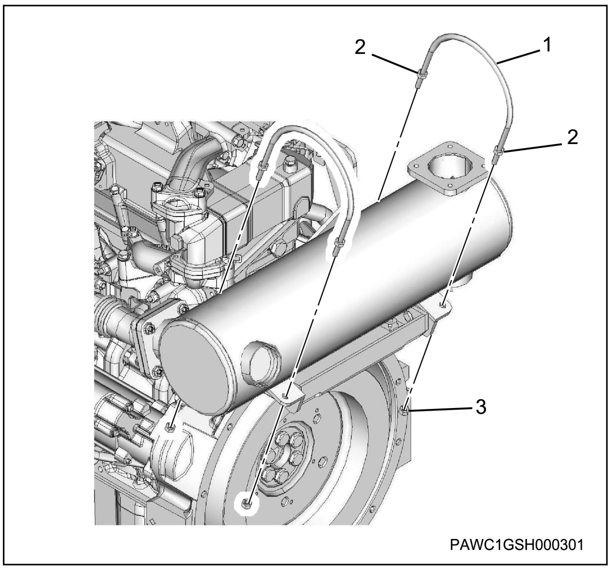
・ Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

・ Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.

・ Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

・ Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.

・ Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

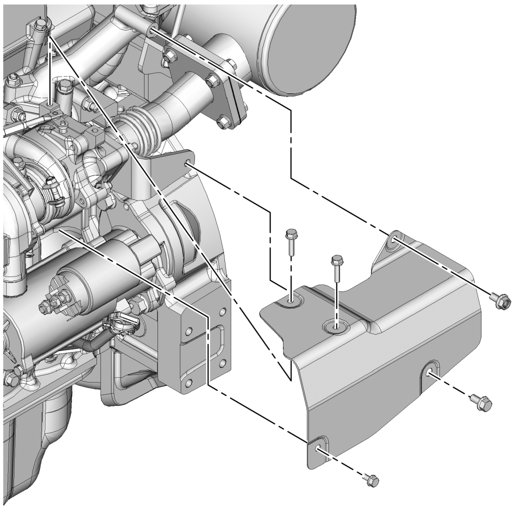
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

5. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M6



PAWC1BSH001101

6. Coolant filling

1. Loosen the plug using a wrench.

2. Replenish the radiator with coolant.

Caution :

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

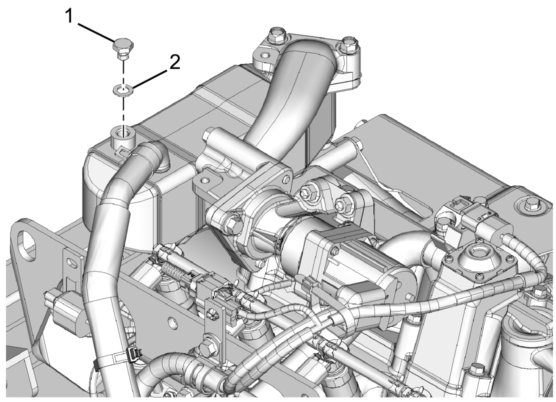
3. Tighten the plug using a wrench.

Caution :

- Use a new gasket.

tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



PAWC1BSH000101

1. Plug
2. Gasket

7. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Crankshaft

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. Engine oil drain
   1. Drain the engine oil from the oil pan.

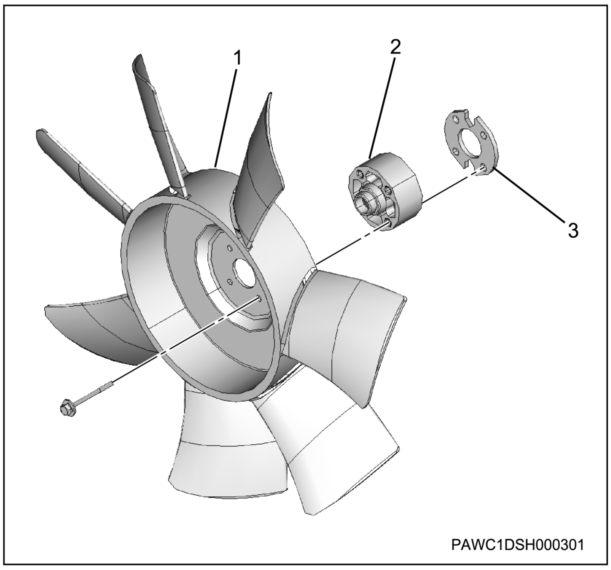
   Note :

   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

   Caution :

   - Do not forget to tighten the drain plug.
4. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.

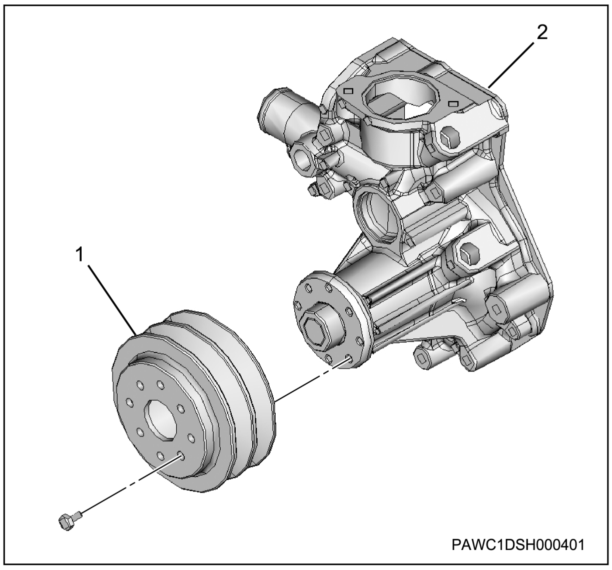


1. Cooling fan
2. Adapter
3. Spacer

5. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

   Note :

   - Loosen the generator adjust bolt and remove the belt.
6. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

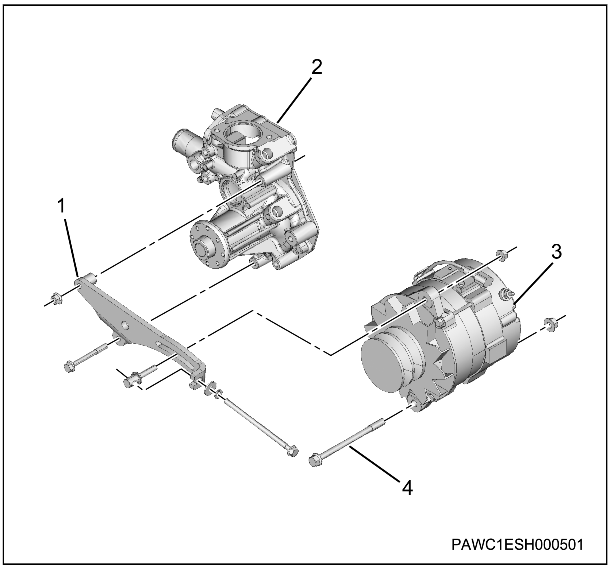


1. Fan pulley
2. Water pump assembly

7. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :

   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate

2. Water pump assembly
3. Generator
4. Bolt

8. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
9. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

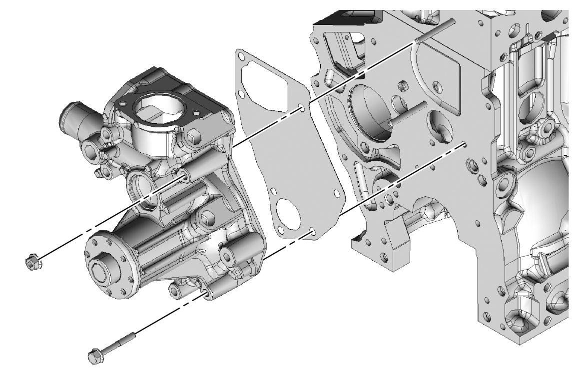
Note :

- Remove the hose clip.

10. Water pump assembly removal
    1. Remove the water pump assembly from the cylinder block and the cylinder head.

Note :

- Remove the water pump assembly and the gasket.



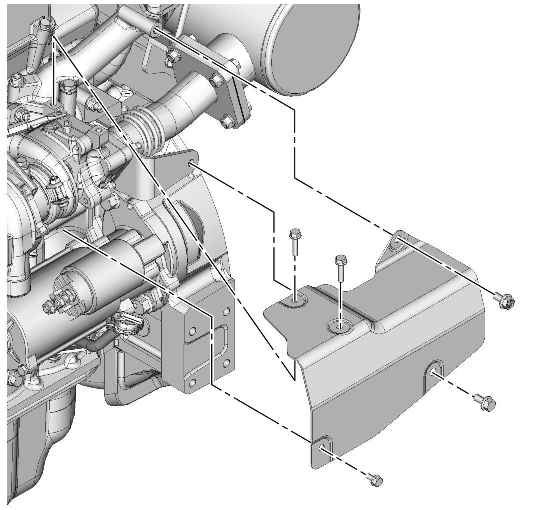
PAWC1DSH000201

11. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

Note :

- Remove the harness clip.

12. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.

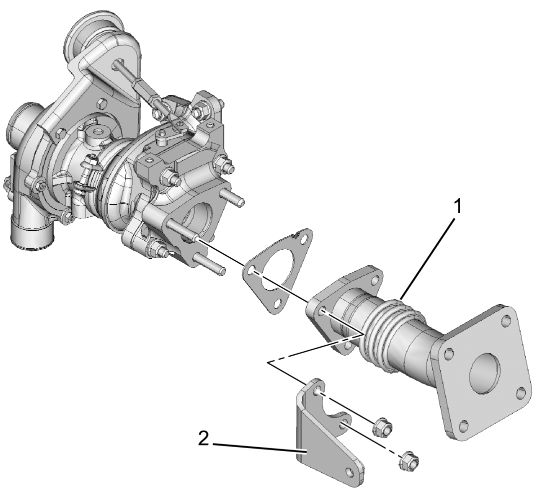


PAWC1BSH001101

13. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

Note :

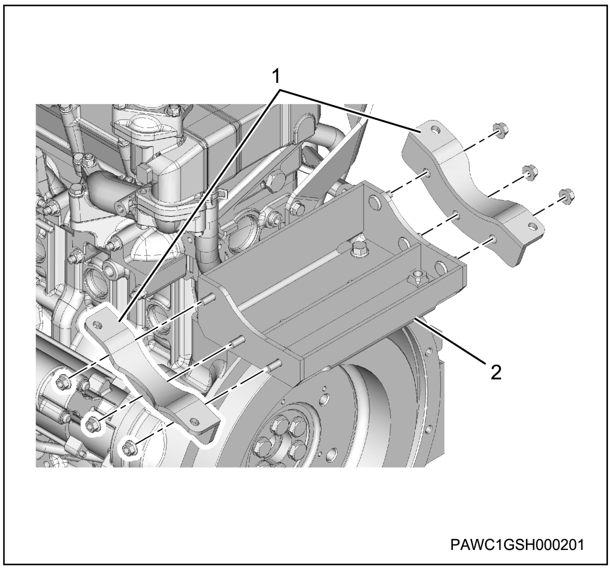
- Remove together with the bracket.



PAWC1GSH000101

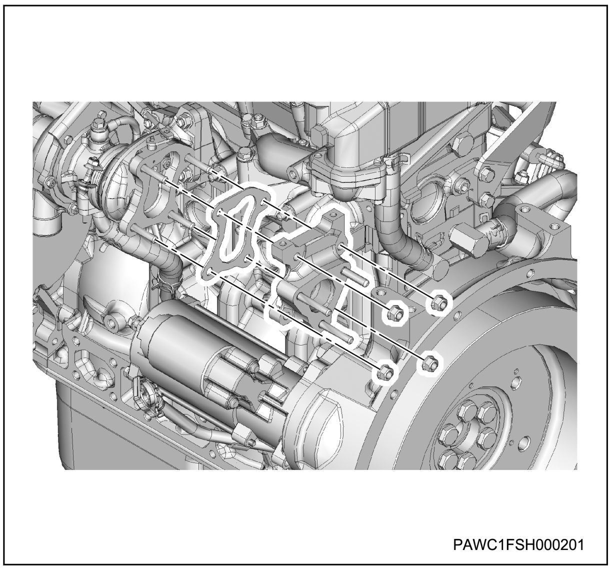
1. Exhaust pipe
2. Bracket

3. Remove the support bracket from the silencer bracket.

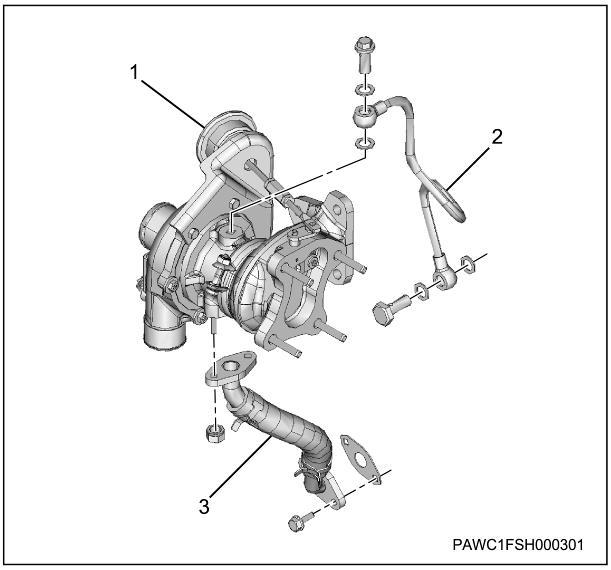


1. Support bracket
2. Silencer bracket

14. Turbocharger assembly removal
    1. Remove the exhaust pipe adapter from the turbocharger assembly.

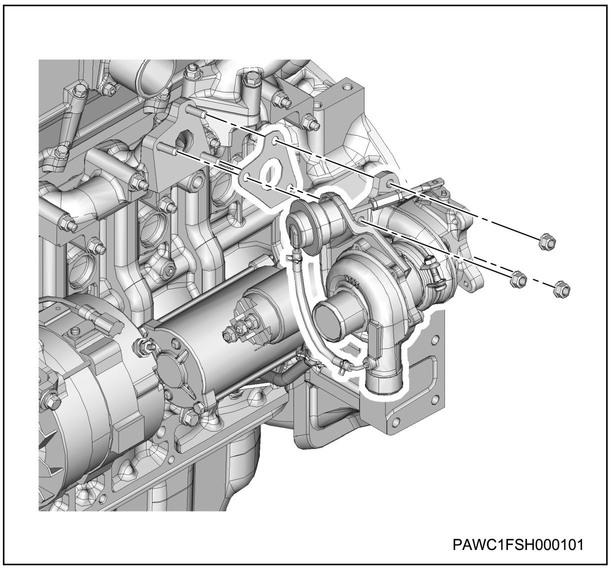


    2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
    3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.

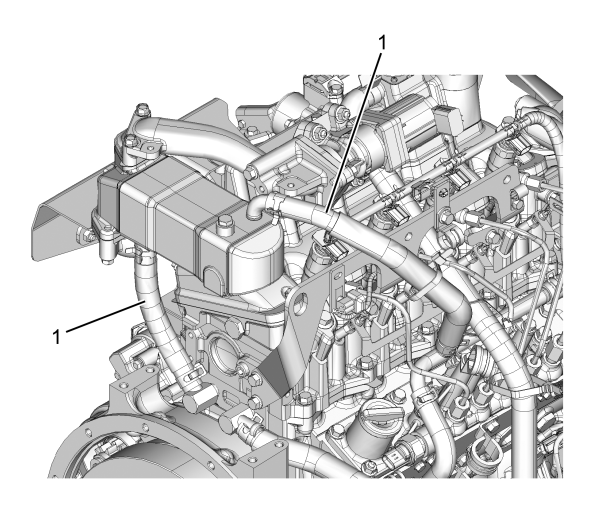


1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

    4. Remove the turbocharger assembly from the exhaust manifold.



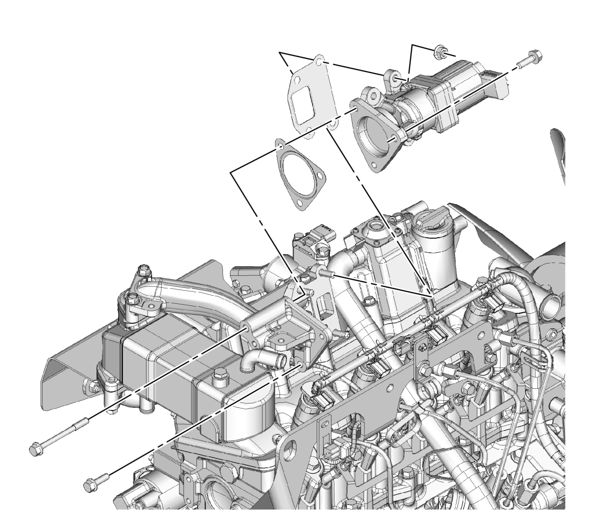
15. EGR valve removal
    1. Disconnect the harness connector from the EGR valve.
    2. Disconnect the harness clip from the EGR pipe.
    3. Disconnect the water rubber hose from the EGR cooler assembly.



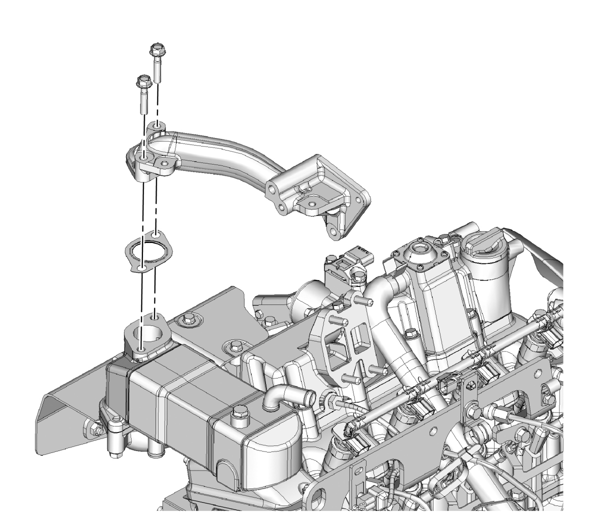
PAWC1BSH000201

1. Water rubber hose

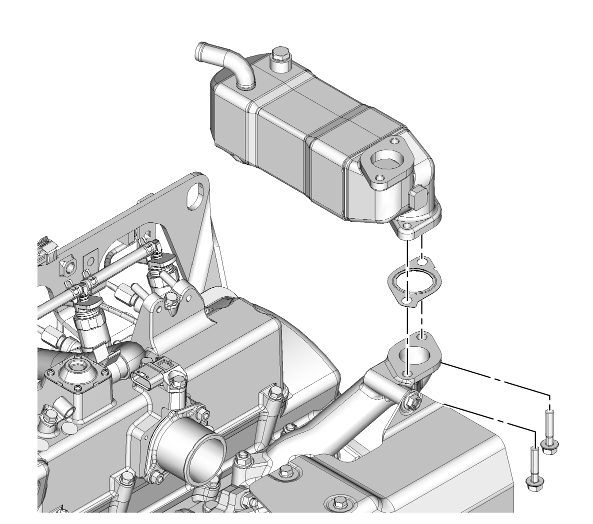
4. Remove the EGR valve from the intake chamber.


PAWC1BSH000301

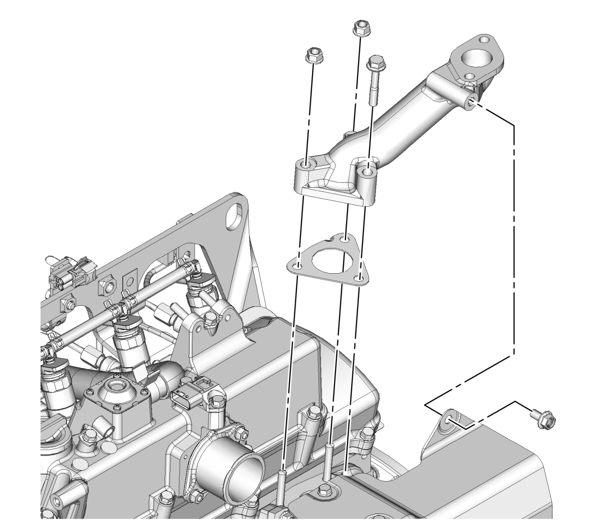
5. Remove the EGR pipe from the EGR cooler.


PAWC1BSH000401

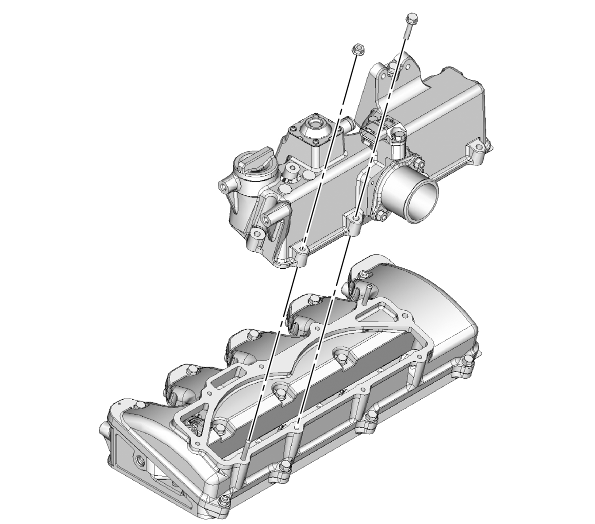
6. Remove the EGR cooler from the EGR pipe.


PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.

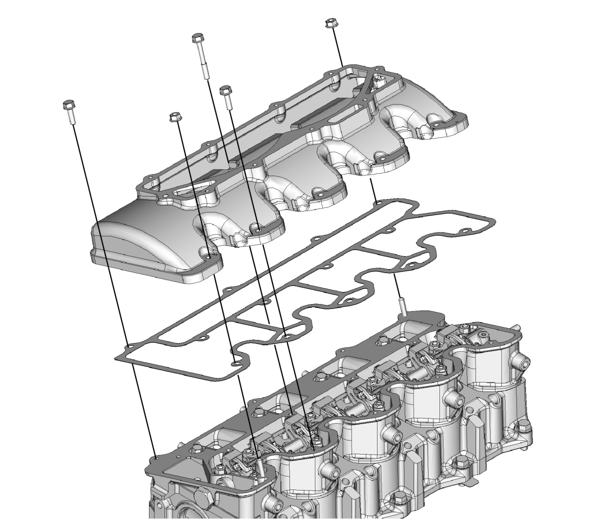

PAWC1BSH000601

16. PCV hose removal
    1. Remove the PCV hose from the intake chamber.
17. IMT sensor removal
    1. Disconnect the harness connector from the IMT sensor.
    2. Remove the IMT sensor from the intake chamber.
18. Intake chamber removal
    1. Remove the intake chamber from the cylinder head cover.



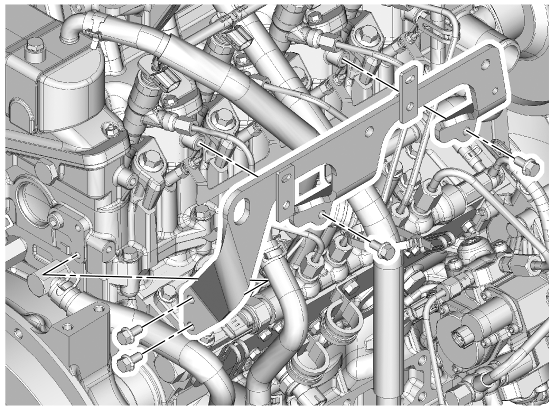
PAWC1BSH000701

19. Cylinder head cover removal
    1. Remove the cylinder head cover from the rocker arm bracket.



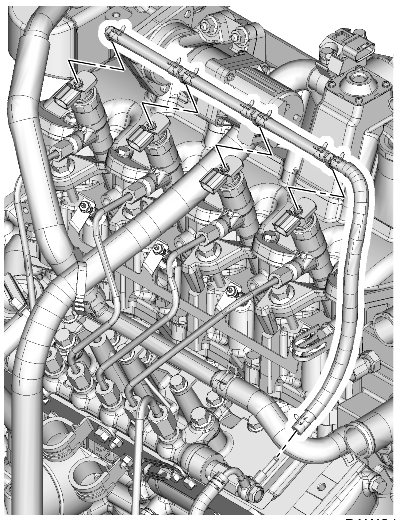
PAWC1BSH001001

20. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



PAWC1CSH000301

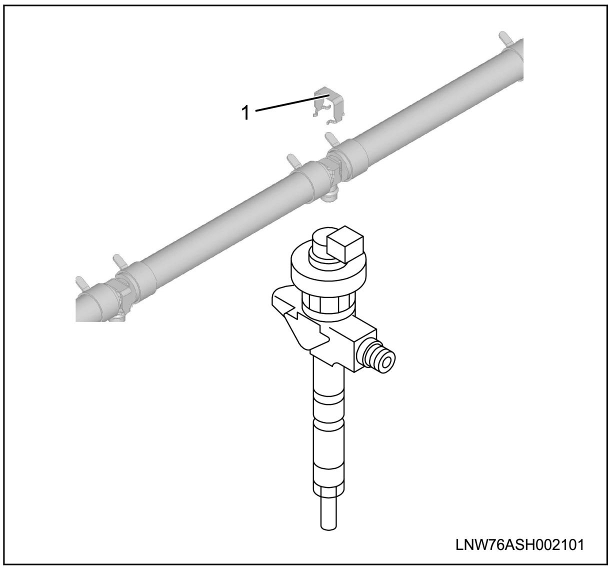
21. Fuel leak-off hose removal
    1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note：

- Do not reuse the leak-off pipe clip.



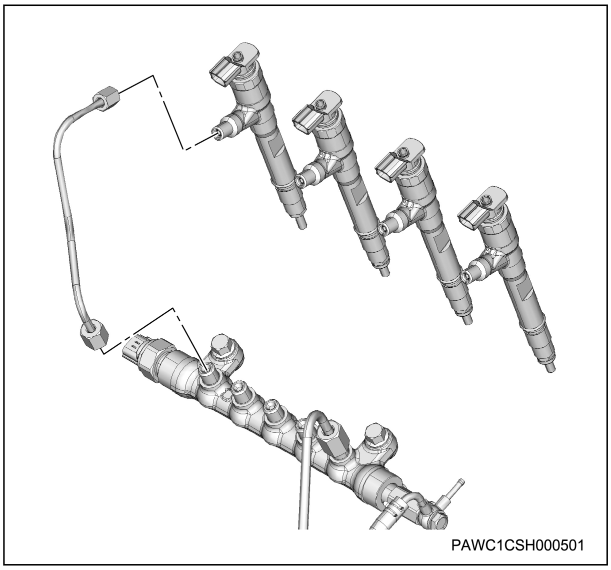
1. Clip

22. Injection pipe removal

1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note :

- Do not reuse the injection pipe.

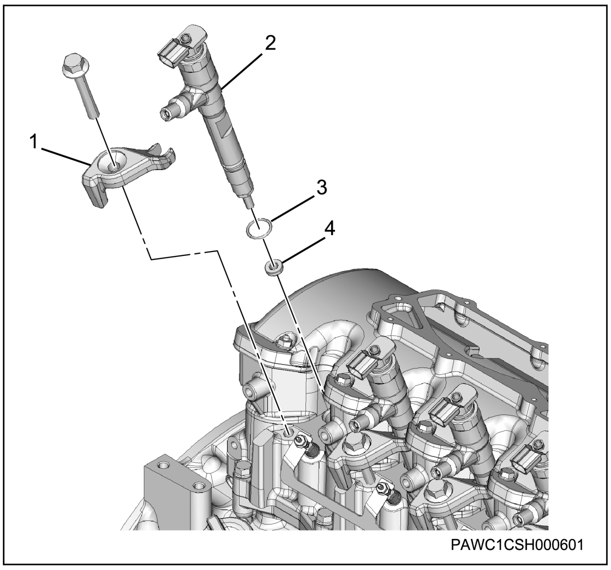


23. Injector removal

1. Disconnect the harness connector from the injector.
2. Remove the injector from the cylinder head assembly.
3. Remove the injector gasket from the injector.
4. Remove the O-ring from the injector.

Note :

- Do not reuse the injector gasket or the O-ring.



1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Note :

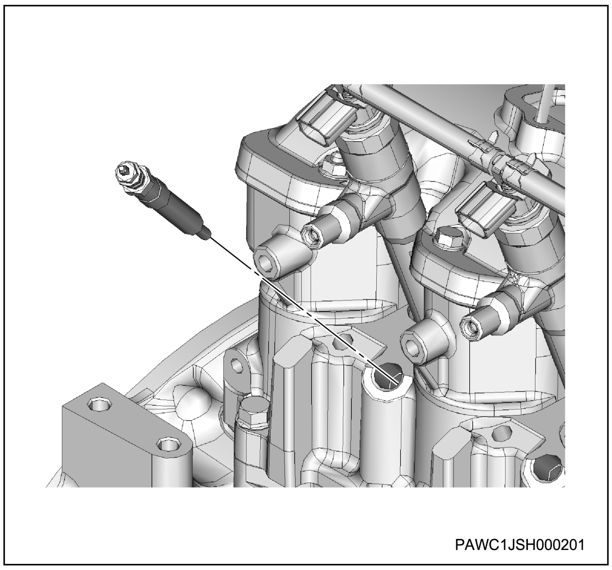
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

24. Glow plug connector removal

1. Remove the glow plug connector from the glow plug.

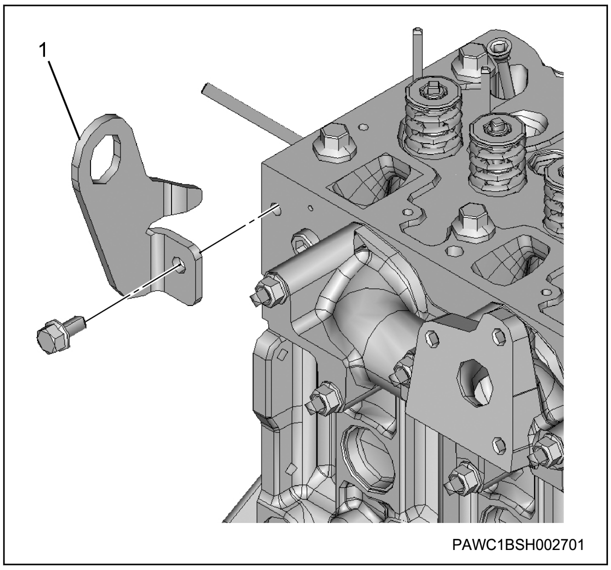
25. Glow plug removal

1. Remove the glow plug from the cylinder head.



26. Engine hanger removal

1. Remove the engine hanger from the cylinder head.



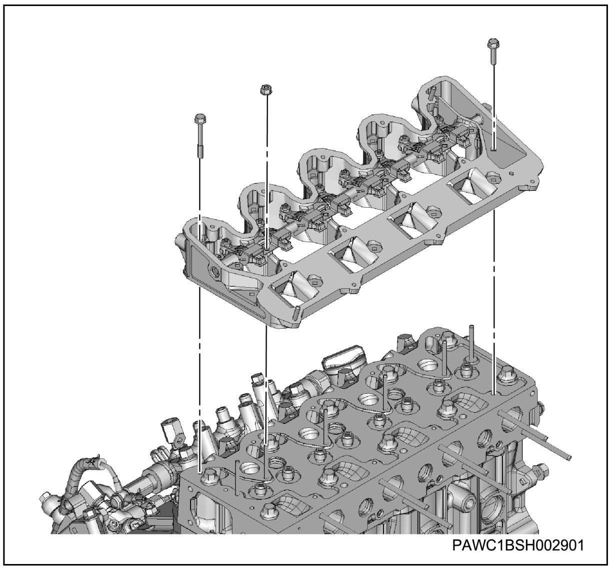
PAWC1BSH002701

1. Engine hanger

27. Rocker arm bracket removal
   1. Remove the rocker arm bracket from the cylinder head.

Caution :

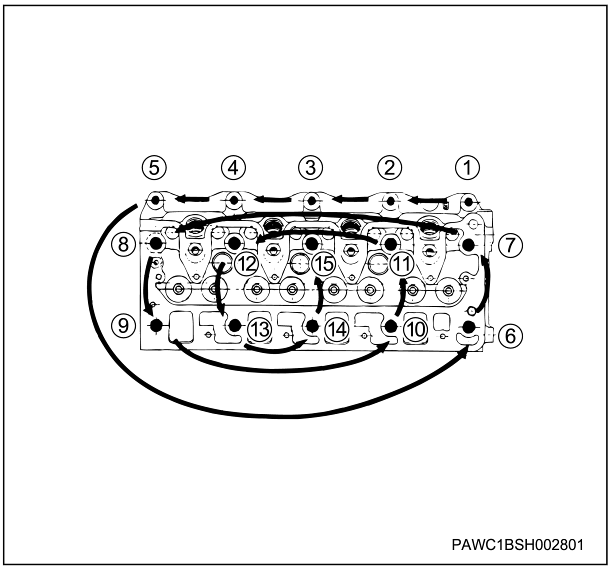
- Be careful not to damage the rocker arm bracket when removing.


PAWC1BSH002901

28. Push rod removal
   1. Remove the push rod from the cylinder block.
29. Cylinder head assembly removal
   1. Remove the cylinder head assembly from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



PAWC1BSH002801

2. Remove the cylinder head gasket from the cylinder block.

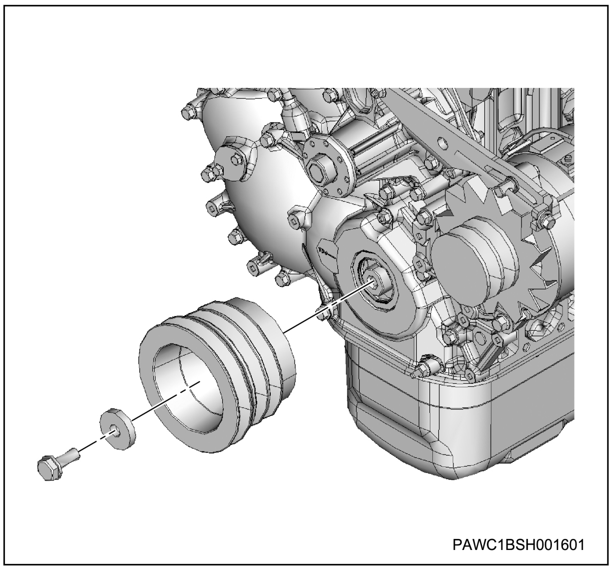
30. Tappet removal
   1. Remove the tappet from the cylinder block.
31. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

Note :

- Remove after stopping the crankshaft from turning.

Caution :

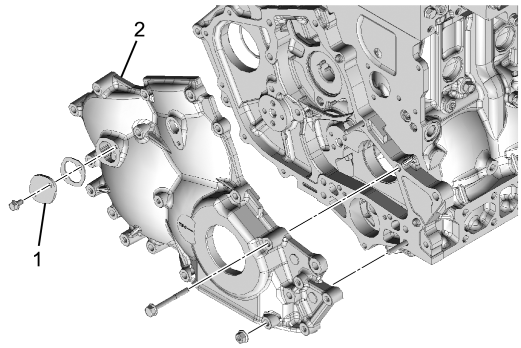
- Do not reuse the bolt and the washer.


PAWC1BSH001601

32. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.

3. Remove the O-ring from the CMP sensor.

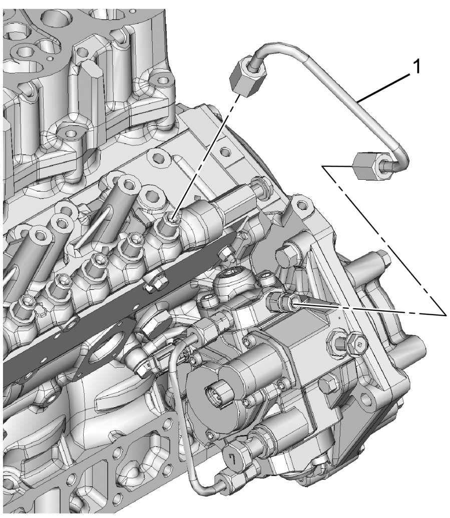
33. Timing gear case removal
   1. Remove the idle gear cover from the timing gear case.
   2. Remove the timing gear case from the front oil pump plate.



PAWC1ESH000701

1. Idle gear cover
2. Timing gear case

34. Fuel pipe removal
   1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



PAWC1CSH000201

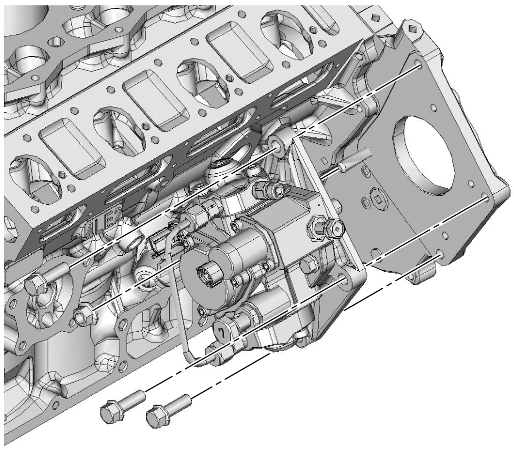
1. Fuel pipe

35. Fuel return pipe removal
   1. Remove the fuel return pipe from the fuel supply pump.

36. Fuel supply pump removal
   1. Disconnect the harness connector from the fuel supply pump.
   2. Remove the fuel supply pump from the front oil pump plate.

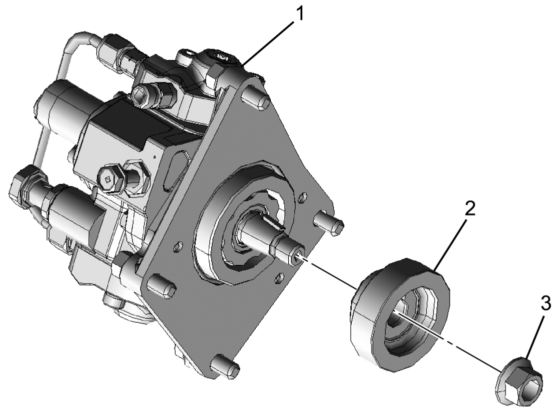
Note :

- Remove the tightening bolts, and remove together with the bracket.



PAWC1CSH000101

   3. Remove the supply pump gear from the fuel supply pump.



PAWC1CSH001401

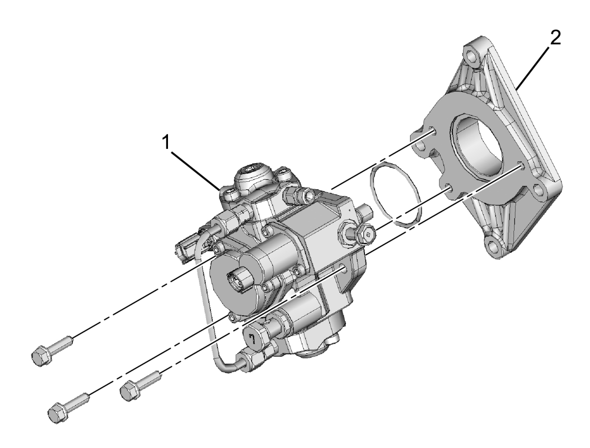
1. Fuel supply pump
2. Supply pump gear
3. Nut

   4. Remove the fuel supply pump from the supply pump bracket.

Caution :

- Do not hold the high pressure pipe of the pump when removing the fuel supply pump.

5. Remove the O-ring from the fuel supply pump.



PAWC1CSH000801

1. Fuel supply pump
2. Supply pump bracket

37. Idle gear A measurement

Caution :

- Before removing the idle gear, measure the end play of the gear.

1. Measure the backlash using a dial gauge.

Note :

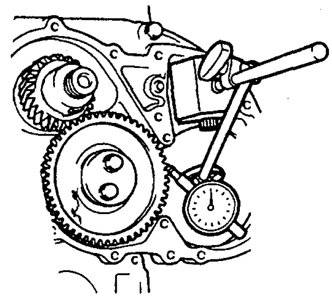
- Install the dial gauge as shown in the diagram, and measure by turning the gear left and right.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.04 mm { 0.0016 in } Crank gear, idle gear

limit : 0.2 mm { 0.008 in } Crank gear, idle gear

specified value : 0.03 mm { 0.0012 in } Camshaft gear, idle gear

limit : 0.2 mm { 0.008 in } Camshaft gear, idle gear



PAWC1BSH001401

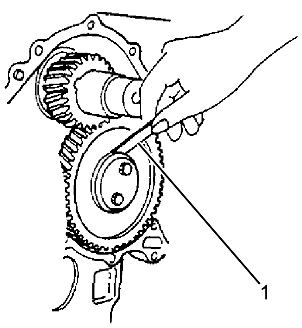
2. Measure the idle gear using a feeler gauge.

Note :

- Measure the gap between the idle gear and the thrust collar.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.058 to 0.115 mm { 0.0023 to 0.0045 in }

limit : 0.2 mm { 0.008 in }



PAWC1BSH001301

1. Feeler gauge

38. Idle gear B removal

1. Remove idle gear B from the idle gear shaft.

Note :

- Remove the idle gear B shaft and the thrust plate.

39. Idle gear A removal

1. Remove idle gear A from the idle gear shaft.

Note：

- Remove the idle gear A shaft and the thrust plate.

40. Camshaft gear removal

1. Remove the camshaft gear from the camshaft.

41. Oil level gauge guide tube removal

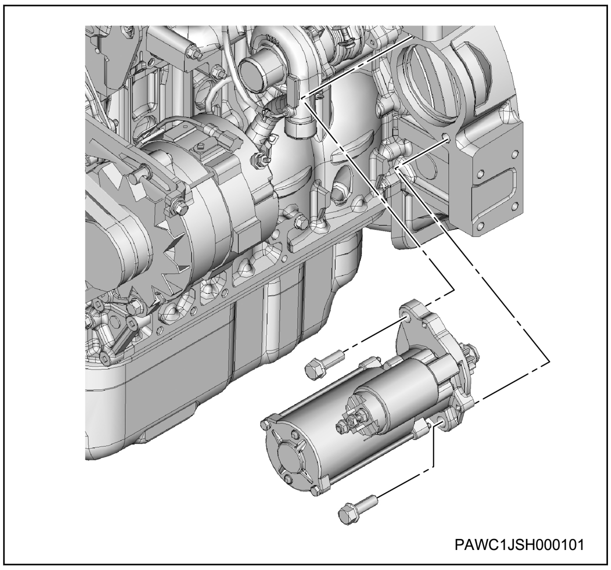
1. Remove the oil level gauge from the oil level gauge guide tube.
2. Remove the oil level gauge guide tube from the cylinder block.

42. Starter motor removal

1. Remove the ground cable from the starter motor.
2. Remove the starter motor from the flywheel housing.

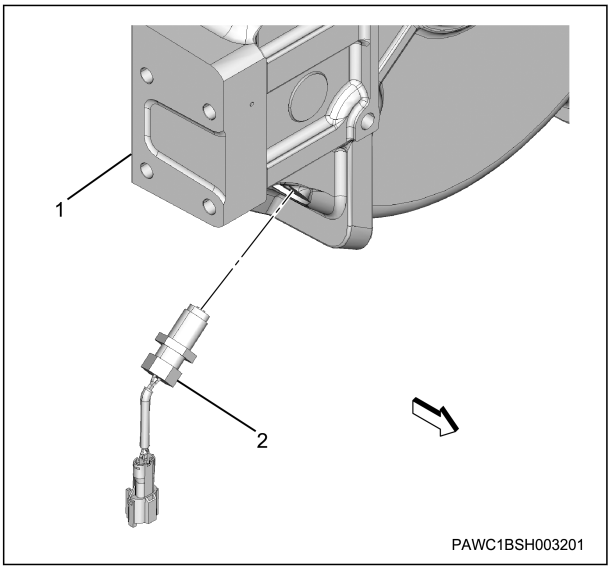
Note：

- The diagram shows the 24 V - 3.2 kW specification.



43. Engine speed sensor removal

1. Disconnect the harness connector from the engine speed sensor.
2. Remove the engine speed sensor from the flywheel housing.



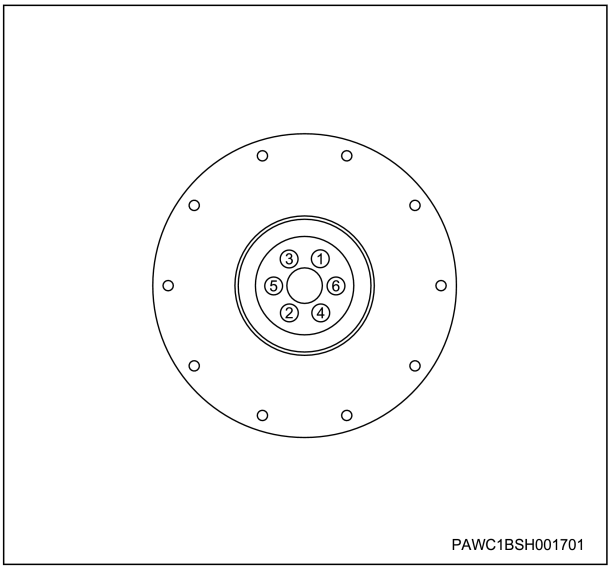
1. Flywheel housing
2. Engine speed sensor

44. Flywheel removal

1. Remove the flywheel from the crankshaft.

Note：

- Make an alignment mark before removing.
- Gradually loosen the flywheel mounting bolts in the order shown in the diagram while making sure that the flywheel does not rotate.



Note：

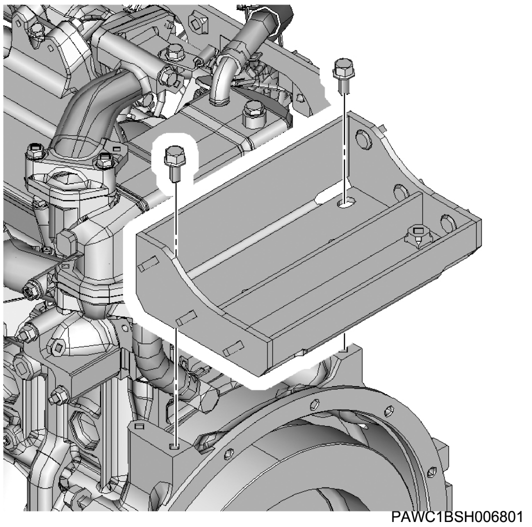
- Remove the flywheel while lightly tapping with a plastic hammer.

Caution：

- Do not damage the ring gear.

45. Flywheel housing removal

1. Remove the silencer bracket from the flywheel housing.

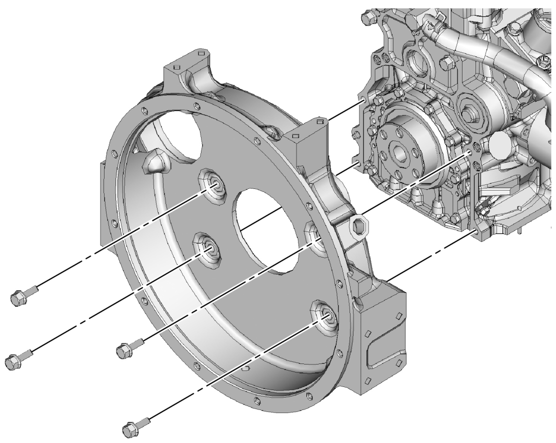


PAWC1BSH006801

2. Remove the flywheel housing from the cylinder block.

Note :

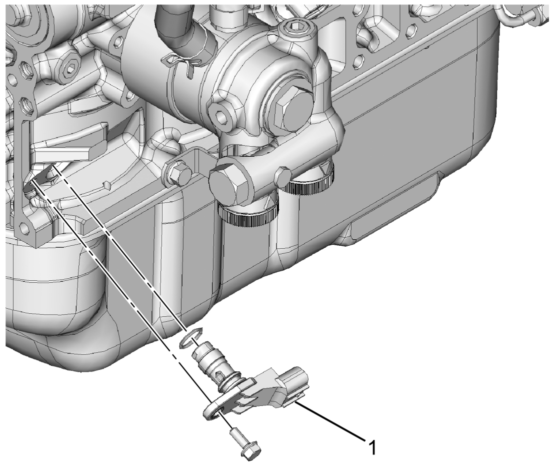
- Remove while lightly tapping the housing with a plastic hammer.



PAWC1BSH002401

46. CKP sensor removal

1. Disconnect the harness connector from the CKP sensor.
2. Remove the CKP sensor from the cylinder block.

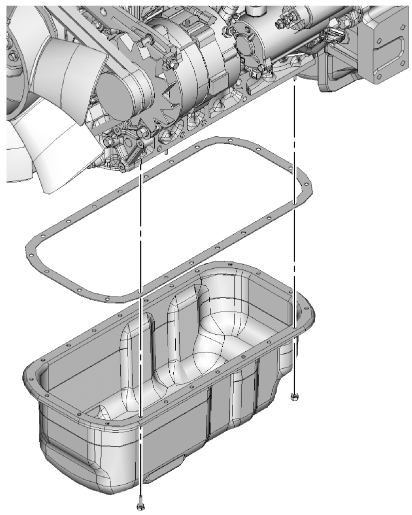


PAWC1BSH001901

1. CKP sensor

47. Oil pan removal

1. Remove the oil pan from the cylinder block.



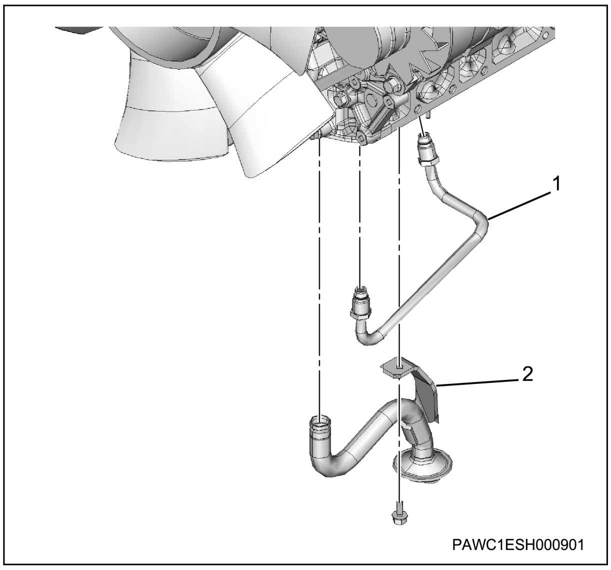
PAWC1ESH000801

48. Oil strainer removal

1. Remove the oil pipe from the front oil pump plate and the cylinder block.
2. Remove the oil strainer from the front oil pump plate and the cylinder block.

Note :

- Remove the O-ring.



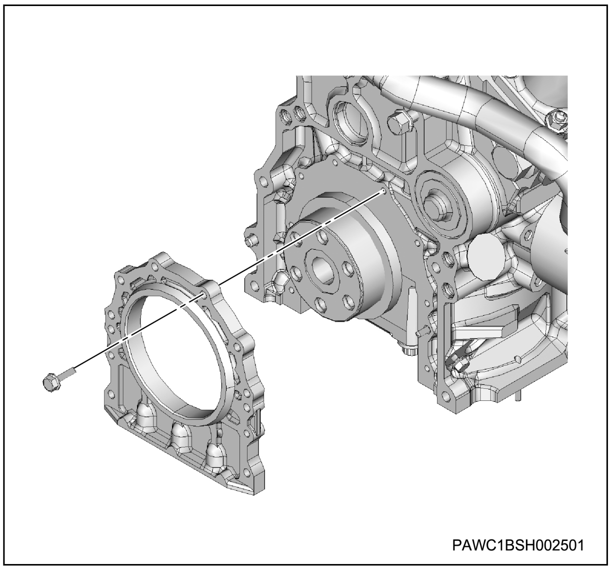
1. Oil pipe
2. Oil strainer

49. Oil seal retainer removal

1. Remove the oil seal retainer from the cylinder block.

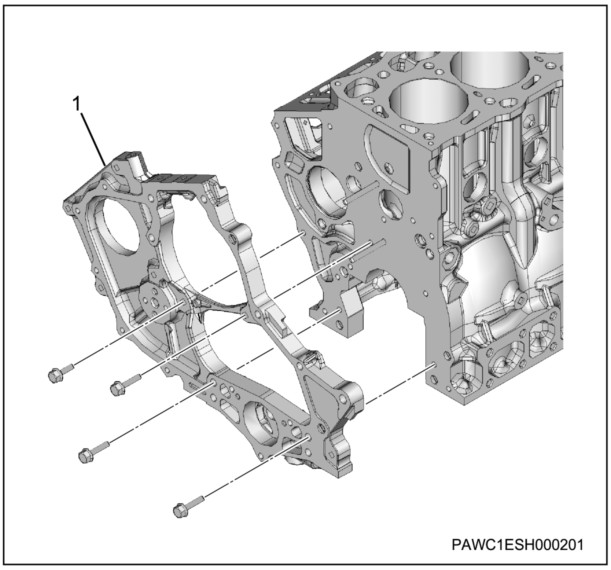
Caution :

- Be careful not to damage or deform when removing.



50. Front oil pump plate removal

1. Remove the front oil pump plate from the cylinder block.



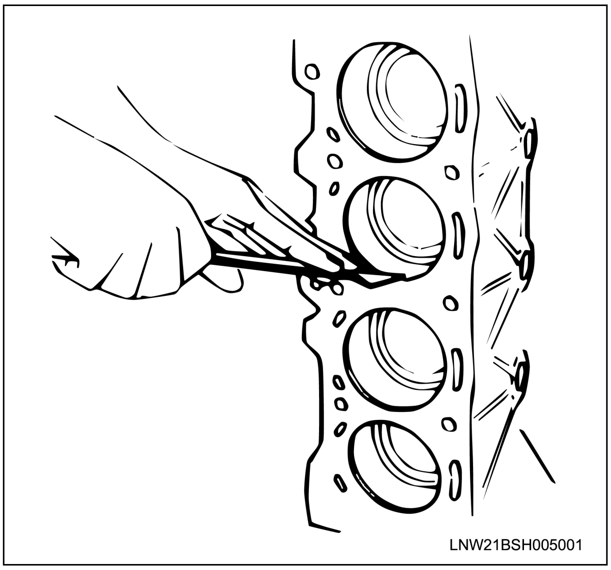
1. Front oil pump plate

51. Piston removal

1. Clean the cylinder block using a scraper.

Note :

- Remove carbon from the inside of the cylinder using a scraper.



2. Remove the connecting rod bearing cap from the connecting rod.

Note :

- Put the piston of the cylinder to be removed in the bottom dead center position.

3. Remove the connecting rod bearing from the connecting rod bearing cap.

Note :

- Organize the removed bearings according to the cylinders using tags, etc.

4. Remove the piston from the cylinder block.

Note：

- Pull the piston as a unit with the connecting rod out to the cylinder head side.

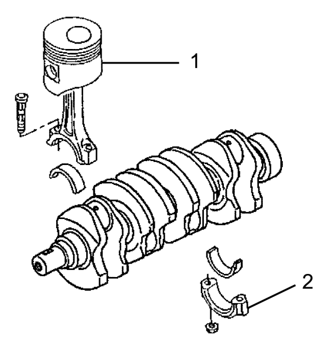
Caution：

- Be careful not to damage the inner wall of the cylinder.

5. Remove the connecting rod bearing from the connecting rod.

Note：

- Organize the removed bearings according to the cylinders using tags, etc.



1. Piston
2. Connecting rod bearing cap

52. Crankshaft removal

1. Measure the clearance using a feeler gauge.

Note：

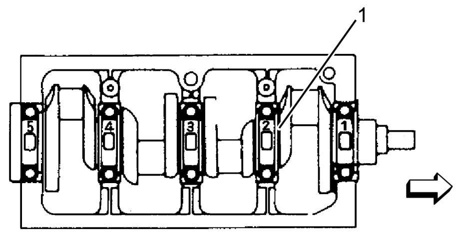
- Measure the end play of the crankshaft.
- Push the crankshaft toward the front, and insert a feeler gauge in the front side of the No. 2 journal section.

Caution：

- If the measured value exceeds the limit, replace the thrust bearing.

specified value： 0.058 to 0.208 mm { 0.0023 to 0.0082 in }

specified value： 0.3 mm { 0.012 in }

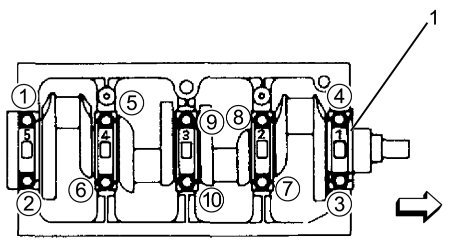


1. Measurement point

2. Remove the bearing cap from the cylinder block.

Note：

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.
- Lightly tap with a hammer and remove together with the bearing.



1. Arrow

3. Remove the crankshaft from the cylinder block.

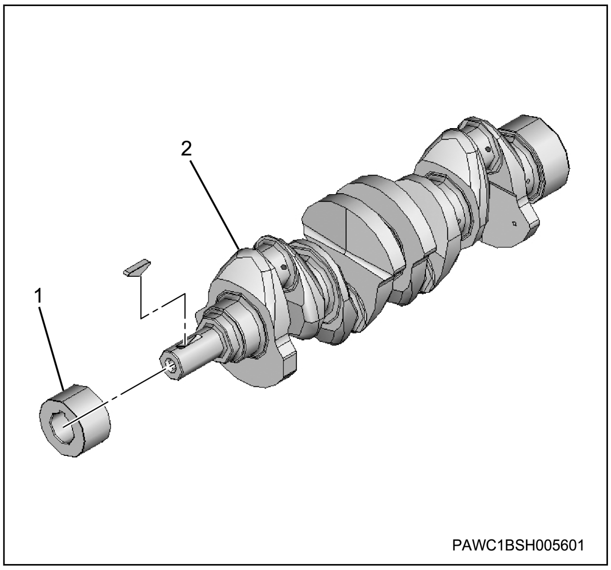
4. Remove the crankshaft bearing from the cylinder block.

Note：

- Organize the removed bearing caps and bearings according to the cylinders using tags, etc.

disassembly

1. Crankshaft gear removal
   1. Remove the crankshaft gear from the crankshaft.



1. Crankshaft gear
2. Crankshaft

inspection

1. Crankshaft measurement
   1. Measure the outer diameter using a micrometer.

Note :

- Measure the outer diameter of the journal section to measure the amount of wear.

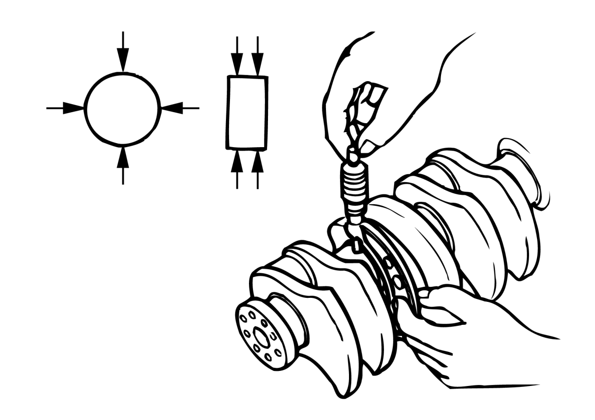
specified value : 60 mm { 2.362 in } Nominal dimension

limit : 0.14 mm { 0.0055 in } Amount of wear

Note :

- Calculate the difference between the maximum and minimum wear of the journal section.

limit : 0.05 mm { 0.002 in }



LNW21BSH024601

Caution :

- If the measured value exceeds the limit, replace the crankshaft.

Note :

- Measure the outer diameter of the crank pin section to measure the amount of wear.

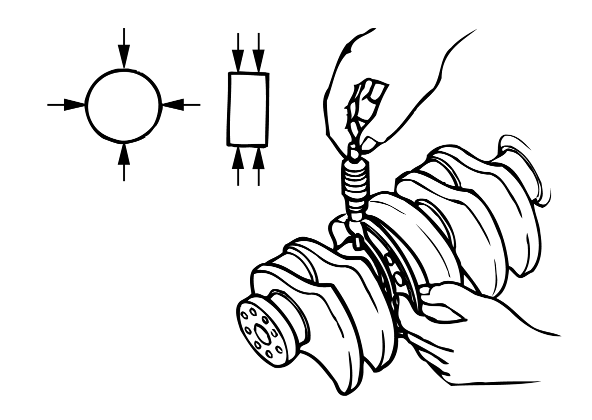
specified value : 46 mm { 1.811 in } Nominal dimension

limit : 0.13 mm { 0.005 in } Amount of wear

Note :

- Calculate the difference between the maximum and minimum wear of the crank pin.

limit : 0.05 mm { 0.002 in }



LNW21BSH024601

Caution :

- If the measured value exceeds the limit, replace the crankshaft.

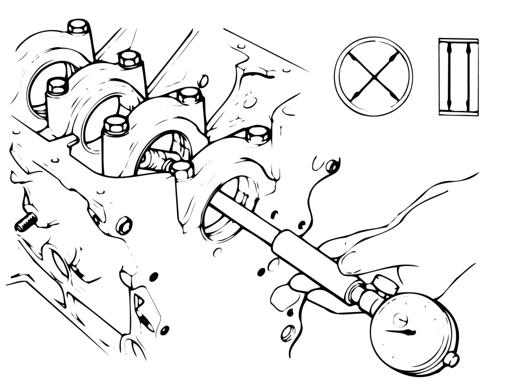
2. Install the crankshaft bearing to the cylinder block.
3. Install the bearing cap to the cylinder block.

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft }

4. Measure the inner diameter using a cylinder gauge.

Note :

- Measure the inner diameter of the journal section.



RTWC1BSH013701

5. Calculate the clearance from the measured value.

Note :

- Calculate the clearance between the outer diameter of the crank journal and the inner diameter of the bearing.

specified value : 0.029 to 0.072 mm { 0.0011 to 0.0028 in }

limit : 0.11 mm { 0.0043 in }

Caution :

- If the measured value exceeds the limit, replace the bearing.

6. Inspect the crankshaft bearing.

Note :

- Inspect the tension of the crankshaft bearing.

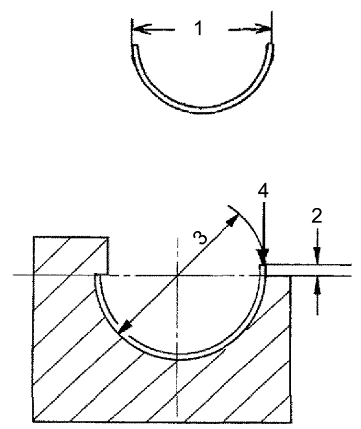
specified value : 64.5 to 65.5 mm { 2.539 to 2.579 in }

limit : 64.1 mm { 2.524 in }

Note :

- Inspect the bearing protrusion when a load of 4.9 kN {1101.6 lb} is applied to the bearing.

specified value : 0.02 to 0.06 mm { 0.00079 to 0.00236 in }



PAWC1BSH005401

1. Tension
2. Protrusion
3. 64 mm {2.520 in}
4. 4.9 kN {1101.6 lb}

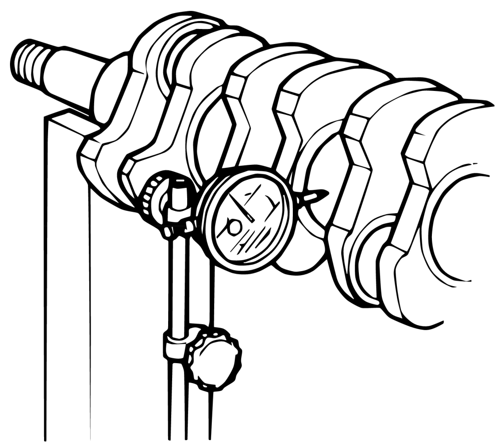
7. Measure the crankshaft using a dial gauge.

Note :

- Slowly rotate the crankshaft and measure the runout.
- Replace the crankshaft if the crankshaft runout exceeds the limit.

specified value : 0.025 mm { 0.00098 in } or less

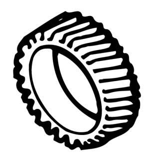
limit : 0.05 mm { 0.002 in }


LNW21BSH024501

2. Crankshaft gear inspection
   1. Inspect the crankshaft gear.

Note :

- Inspect the crankshaft gear for damage or pitching.
- Replace the crankshaft gear if there is excessive damage.

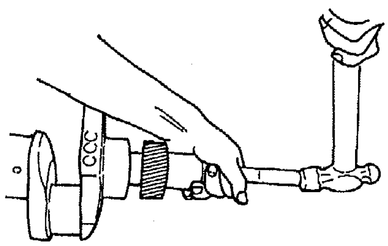

MFW41BSH019101

reassembly

1. Crankshaft gear installation
   1. Install the crankshaft gear to the crankshaft using a brass rod.

Note：

- Press the crankshaft gear using a brass rod and a hammer.



PAWC1BSH006101

installation

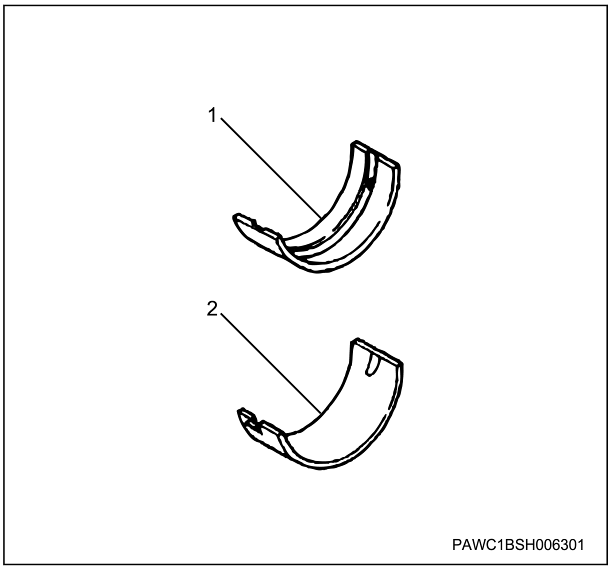
1. Crankshaft installation
   1. Clean the crankshaft bearing using a shop cloth.

      Note :
      - Verify that there is no foreign material on the back side of the crankshaft bearing and on crankshaft bearing housing of the cylinder block.
   2. Install the crankshaft bearing to the cylinder block.

      Note :
      - Install the crankshaft upper bearing to the cylinder block.
      - Securely fit the bearing claw to the notched section of the cylinder block and assemble.
   3. Apply engine oil to the crankshaft bearing.

      Note :
      - Sufficiently apply engine oil to the sliding surface of the crankshaft upper bearing.

      Caution :
      - Because the lower bearing does not have an oil hole or an oil groove, be careful when assembling.



1. Upper bearing
2. Lower bearing

   4. Install the crankshaft to the cylinder block.

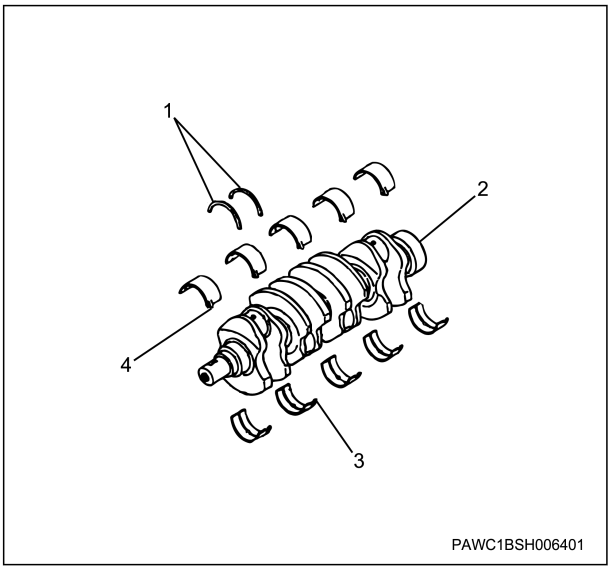
      Note :
      - Carefully install the crankshaft.
   5. Install the thrust bearing to the cylinder block.

      Note :
      - Assemble to the No. 2 journal section so that the oil groove faces the outside.
   6. Apply engine oil to the crankshaft bearing.

      Note :
      - Sufficiently apply engine oil to the sliding surface of the crankshaft lower bearing.
   7. Install the crankshaft bearing to the crankshaft.

      Note :
      - Install the crankshaft lower bearing to the crankshaft.

      Caution :
      - Verify that there is no foreign material on the installation section or the sliding surface of the bearing.
      - Verify that there is no oil adhering to the installation section of the bearing.



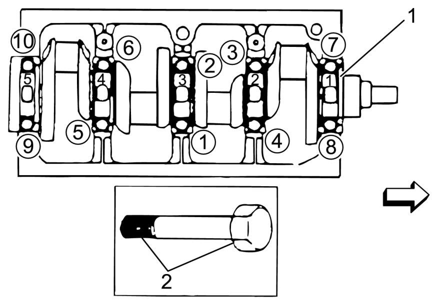
1. Thrust bearing
2. Crankshaft
3. Upper bearing claw section
4. Lower bearing claw section

   8. Install the bearing cap to the cylinder block.

      Note :
      - Align with the front mark of the crankshaft bearing cap, and install.
   9. Apply engine oil to the bolt.

      Note :
      - Apply engine oil to the threaded portion and the seat surface of the bearing cap bolt.
      - Gradually and uniformly tighten in the numerical order shown in the diagram.

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft }



PAWC1BSH006201

1. Arrow
2. Engine oil application area

Caution：

- Verify that the crankshaft rotates after installing.

2. Piston installation
   1. Apply engine oil to the piston.

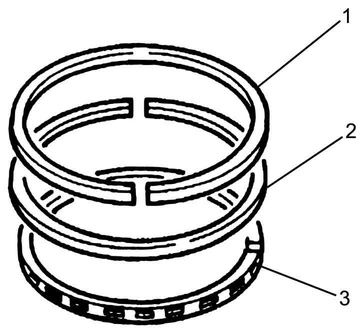
Note：

- Thoroughly apply to the piston side surface.

   2. Apply engine oil to the piston rings.

Note：

- Thoroughly apply to the piston rings and the ring grooves.
- Set the piston rings as shown in the diagram so that the joints are not perpendicular to the piston pin.



PAWC1BSH006701

1. Top ring
2. Second ring
3. Oil ring

3. Rotate the crankshaft gear.

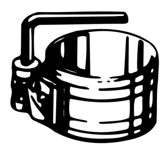
Note：

- Before installing the pistons, put every cylinder in the top dead center position.

4. Install the connecting rod bearing to the connecting rod.
5. Install the piston to the cylinder block using a special tool.

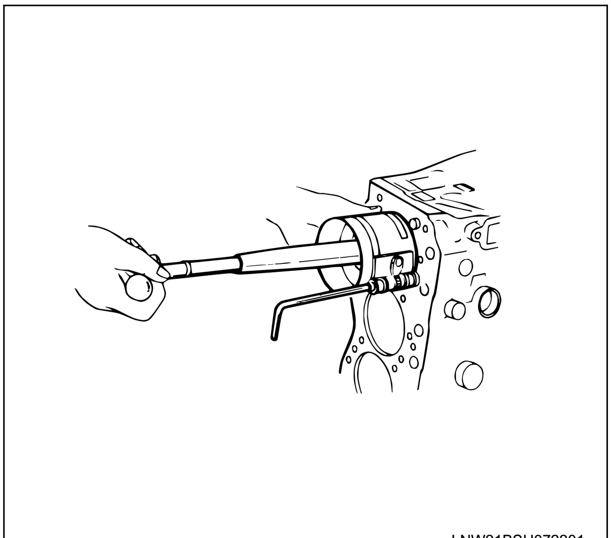
Note：

- Face the piston front mark toward the front, and insert the piston into the cylinder block.



5884090180

SST: 5-8840-9018-0 - piston setting tool


LNW21BSH072201

6. Rotate the crankshaft gear.

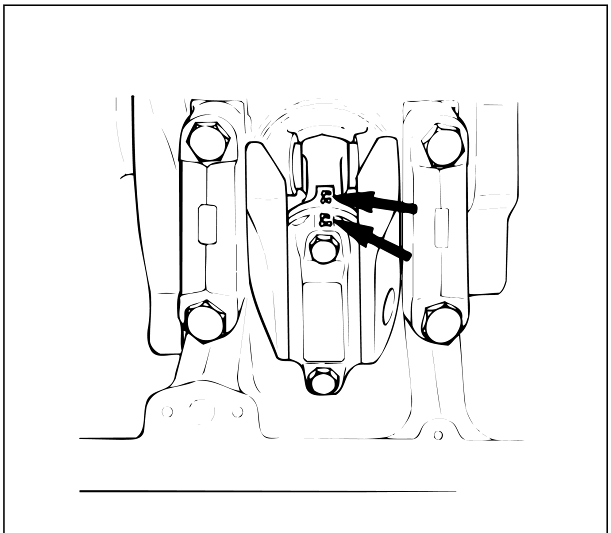
Note：

- Slowly rotate the crankshaft and put each cylinder at bottom dead center.

7. Apply engine oil to the connecting rod bearing.
8. Install the connecting rod bearing to the connecting rod bearing cap.
9. Install the connecting rod bearing cap to the connecting rod.

Note：

- Align the cap and the connecting rod number markings, and install the cap.


LNW61ASH004801

10. Apply engine oil to the bolt.

Note：

- Apply to the threaded portion and the seat surface of the tightening bolts.
- Check that the crankshaft turns smoothly after installing the connecting rod.

11. Tighten the bolts using a torque wrench.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft } 1st time

specified angle： 100 ° 2nd time

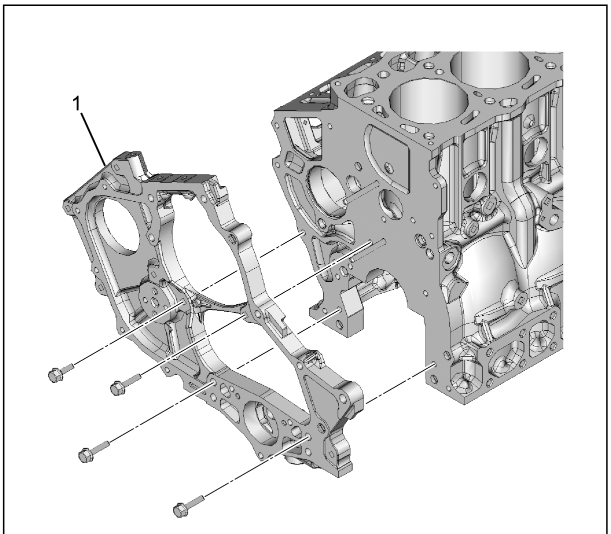
3. Front oil pump plate installation
   1. Apply liquid gasket to the front oil pump plate.

   Note：

   - Apply ThreeBond 1207B.

   2. Install the front oil pump plate to the cylinder block.

   tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }



PAWC1ESH000201

1. Front oil pump plate

4. Oil seal retainer installation
   1. Apply engine oil to the crankshaft rear oil seal.

   Note：

   - Thinly apply engine oil to the lip section of the rear oil seal.

   2. Apply liquid gasket to the oil seal retainer.

   Note：

   - Apply ThreeBond 1207B.

   Caution：

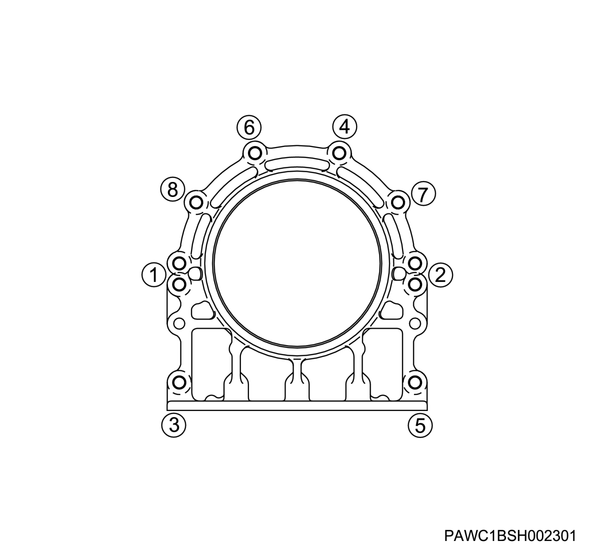
   - Verify that there is no dirt on the large end of the crankshaft.

   3. Install the oil seal retainer to the cylinder block.

   Note：

   - Tighten the bolts in the tightening order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH002301

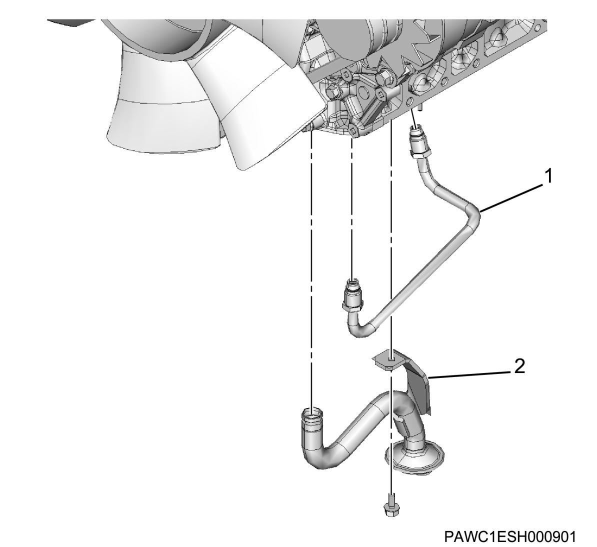
5. Oil strainer installation

1. Apply engine oil to the O-ring.
2. Install the oil strainer to the front oil pump plate and the cylinder block.

tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

3. Install the oil pipe to the front oil pump plate and the cylinder block.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }



PAWC1ESH000901

1. Oil pipe
2. Oil strainer

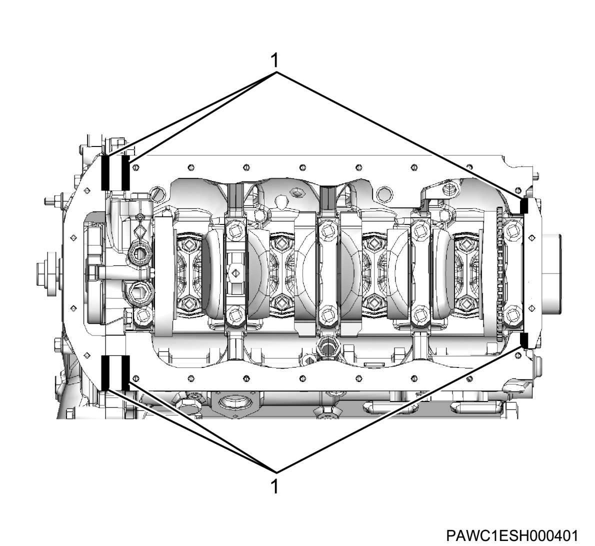
6. Oil pan installation

1. Apply liquid gasket to the cylinder block.

Note :

- Apply ThreeBond 1207B to the installation surface between the cylinder block and the front oil pump plate.

bead width : 3 mm { 0.12 in }



PAWC1ESH000401

1. Liquid gasket application area

2. Install the oil pan to the cylinder block.

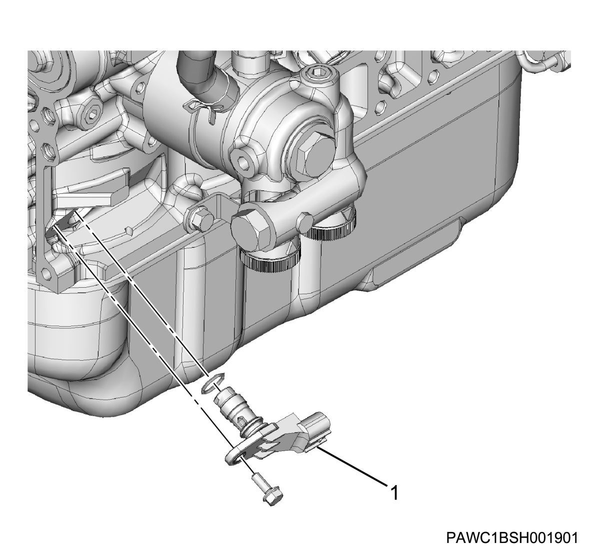
tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

7. CKP sensor installation

1. Install the CKP sensor to the cylinder block.

tightening torque : 5 N・m { 0.5 kgf・m / 44 lb・in }

2. Connect the harness connector to the CKP sensor.



PAWC1BSH001901

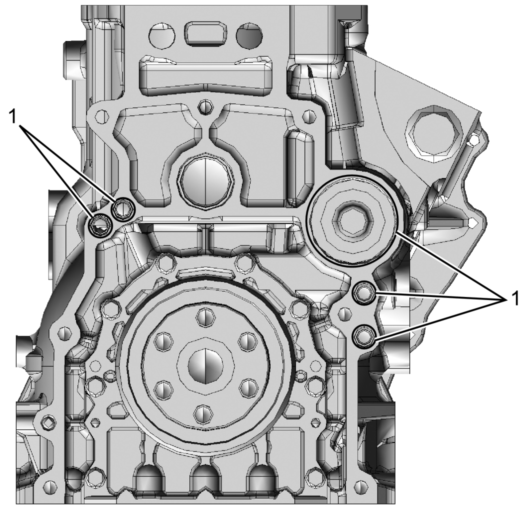
1. CKP sensor

8. Flywheel housing installation

1. Apply liquid gasket to the cylinder block.

Note :

- Apply ThreeBond 1207B to the 5 places indicated in the diagram.

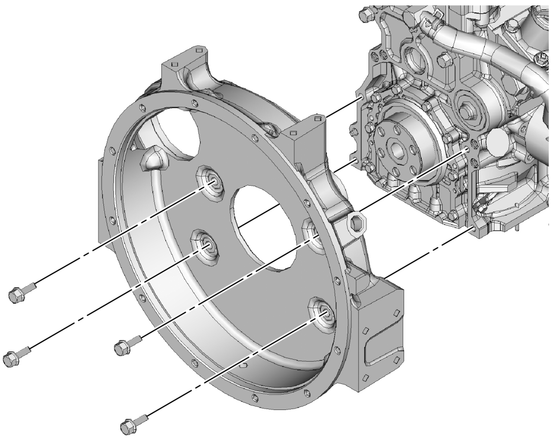


PAWC1BSH002601

1. Liquid gasket application area

2. Install the flywheel housing to the cylinder block.

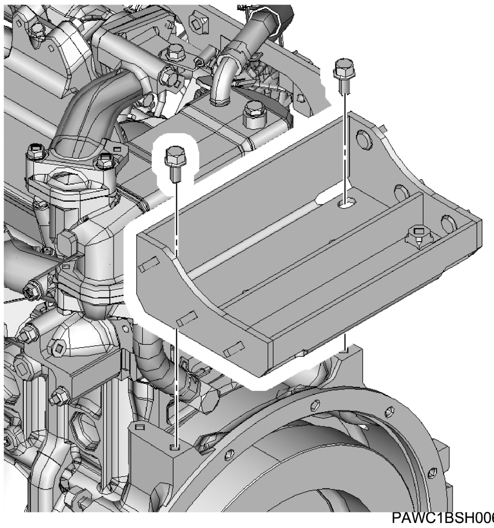
tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



PAWC1BSH002401

3. Install the silencer bracket to the flywheel housing.

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



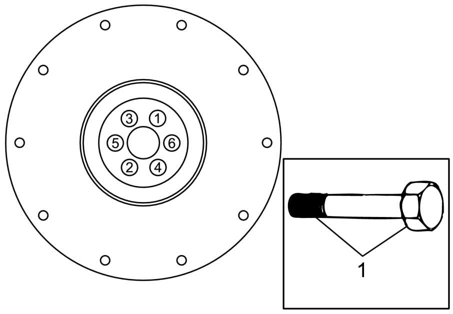
PAWC1BSH006801

9. Flywheel installation

1. Apply engine oil to the bolt.

Note :

- Apply to the seat surface and the threaded portion of the flywheel mounting bolts.



PAWC1BSH001801

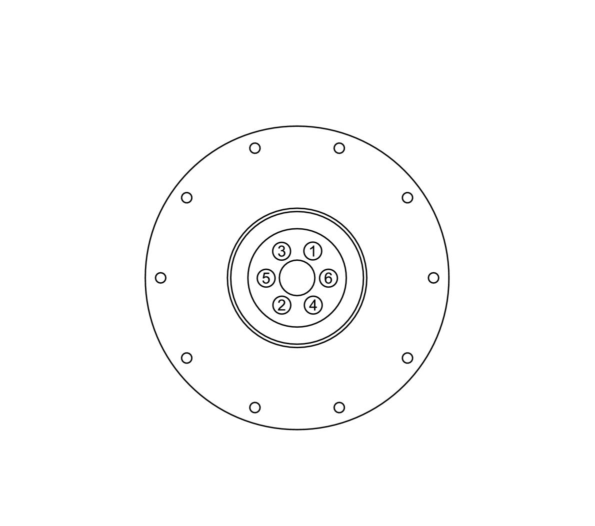
1. Engine oil application area

2. Install the flywheel to the crankshaft.

Note :

- Gradually tighten the mounting bolts in the order shown in the diagram.

tightening torque : 98 N・m { 10.0 kgf・m / 72 lb・ft }



PAWC1BSH001701

Caution：

- Install while verifying the installation position.

10. Engine speed sensor installation
    1. Install the engine speed sensor to the flywheel housing.

Note：

- Screw in the engine speed sensor until it reaches the end.

Caution：

- Be careful not to damage the sensor tip.

Note：

- Return the engine speed sensor 1 rotation, and secure with a nut.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

2. Inspect the engine speed sensor.

Note：

- Check the output voltage at maximum speed without load and low speed without load.

	Specified output voltage	
Engine speed	Voltage waveform	AC voltage
Maximum speed without load	： 20 to 72 V	： 7.1 to 25.5 V
Low speed without load	： 9 to 40 V	： 3.2 to 14.2 V

Note：

- If the measured value is outside the specified output voltage, adjust the engine speed sensor until it is within the specified output voltage.

11. Starter motor installation
    1. Install the starter motor to the flywheel housing.

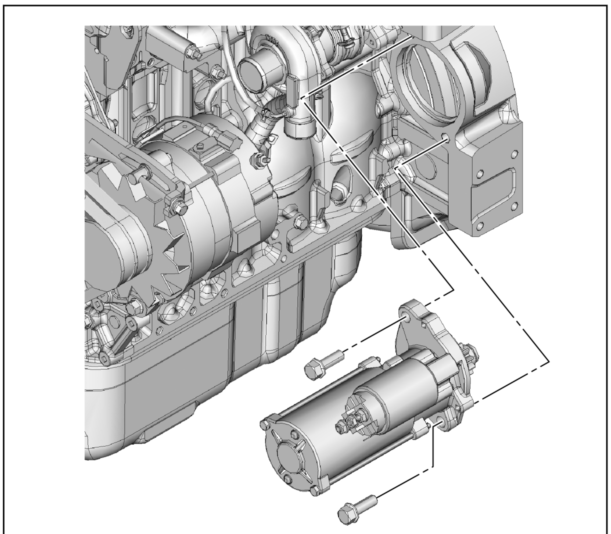
tightening torque： 103 N・m { 10.5 kgf・m / 76 lb・ft }

2. Install the ground cable to the starter motor.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

Note：

- The diagram shows the 24 V - 3.2 kW specification.



PAWC1JSH000101

12. Oil level gauge guide tube installation
    1. Install the oil level gauge guide tube to the cylinder block.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

2. Install the oil level gauge to the oil level gauge guide tube.

13. Idle gear A installation
    1. Align the No. 1 cylinder to compression top dead center.

Note：

- Rotate the crankshaft in the forward direction and align the No. 1 cylinder piston to compression top dead center.

2. Install the idle gear shaft to the cylinder block.
3. Apply engine oil to the idle gear.

Note：

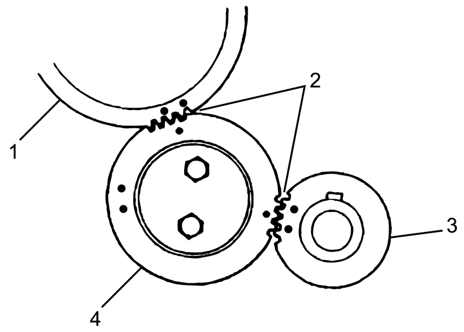
- Apply to idle gear A and the idle gear shaft.

4. Install idle gear A to the idle gear shaft.

Note：

- Install after meshing so that the alignment mark of the crankshaft gear is as shown in the diagram.

tightening torque： 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



PAWC1BSH001201

1. Camshaft gear
2. Timing point
3. Crank gear
4. Idle gear A

5. Apply engine oil to the idle gear.

Note：

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

6. Install the thrust collar to the idle gear.

Note：

- Install so that the chamfered side of the thrust collar faces the outside.

14. Camshaft gear installation

1. Install the camshaft gear to the camshaft.

Note：

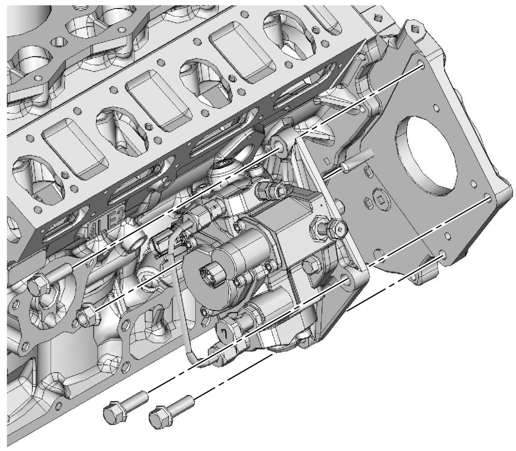
- Install after meshing so as to align the idle gear alignment marks.

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft }

15. Fuel supply pump installation

1. Install the fuel supply pump to the front oil pump plate.

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }



PAWC1CSH000101

2. Connect the harness connector to the fuel supply pump.

16. Idle gear B installation

1. Install the idle gear shaft to the cylinder block.
2. Apply engine oil to the idle gear.

Note：

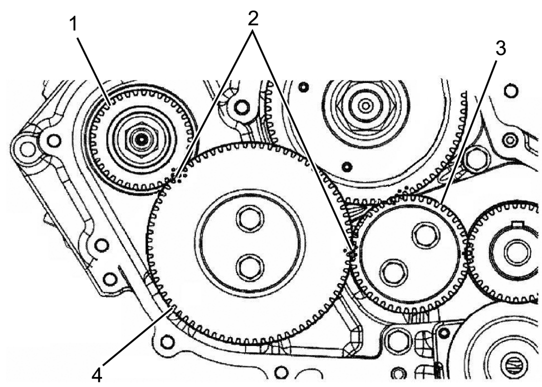
- Apply to idle gear B and the idle gear shaft.

3. Install idle gear B to the idle gear shaft.

Note：

- Install after meshing so as to align the idle gear B alignment marks with idle gear A and the supply pump gear.

tightening torque： 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



PAWC1BSH001501

1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

4. Apply engine oil to the idle gear.

Note：

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

5. Install the thrust collar to the idle gear.

Note：

- Install so that the chamfered side of the thrust collar faces the outside.

17. Fuel return pipe installation

1. Install the fuel return pipe to the fuel supply pump.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M10

tightening torque： 17 N・m { 1.7 kgf・m / 13 lb・ft } M14

18. Fuel pipe installation

1. Temporarily tighten the fuel pipe to the fuel supply pump.
2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

Caution：

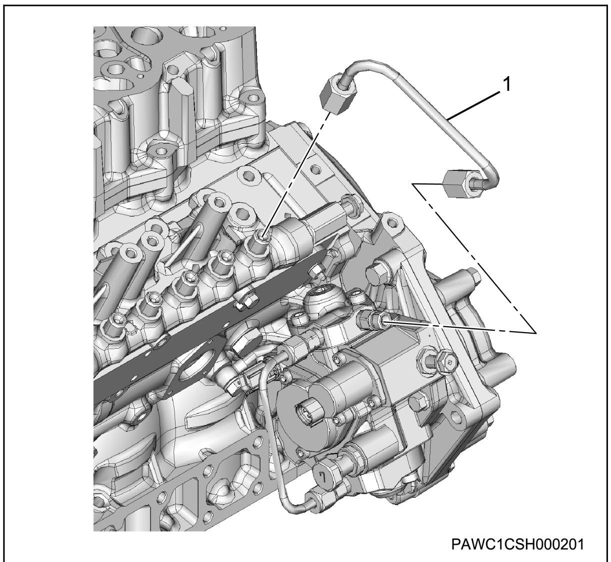
- Use a new fuel pipe.

Note：

- Verify that there is no dirt in the fuel pipe.

3. Securely tighten the fuel pipe to the fuel supply pump.
4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque： 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

19. Timing gear case installation

1. Apply liquid gasket to the front oil pump plate.

Note：

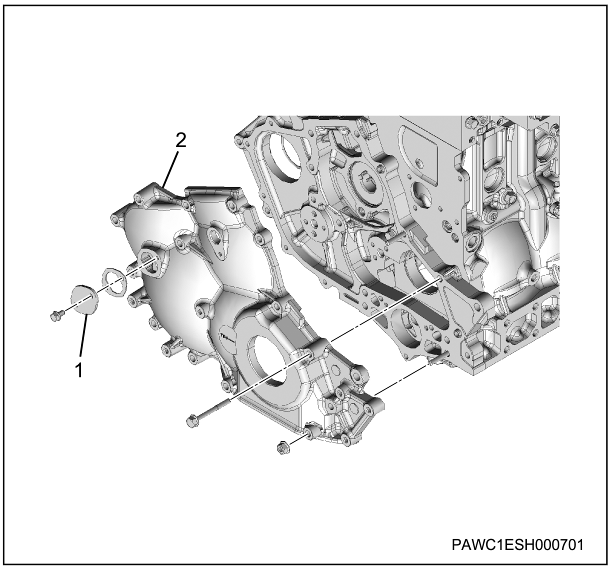
- Apply ThreeBond 1207B.

2. Install the timing gear case to the front oil pump plate.

tightening torque： 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

3. Install the idle gear cover to the timing gear case.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Idle gear cover
2. Timing gear case

20. CMP sensor installation

1. Apply engine oil to the O-ring.
2. Install the CMP sensor to the timing gear case.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

3. Connect the harness connector to the CMP sensor.

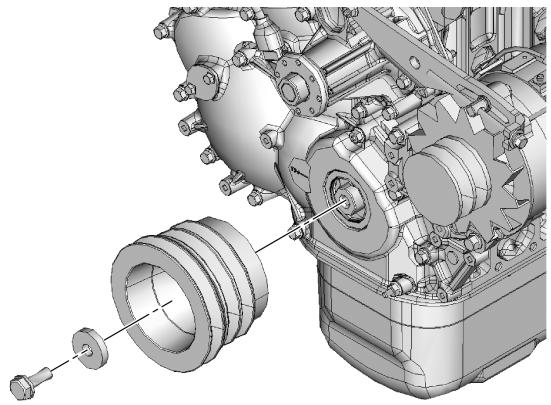
21. Crankshaft pulley installation

1. Install the crankshaft pulley to the crankshaft.

Caution：

- Do not reuse the bolt and the washer.

tightening torque： 177 N・m { 18.0 kgf・m / 131 lb・ft }



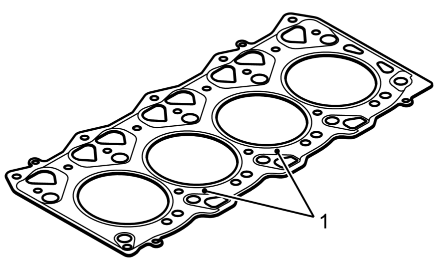
PAWC1BSH001601

22. Tappet installation
   1. Apply engine oil to the tappet.

   Note :
   - Apply to the bottom surface and the outer circumference of the tappet.

   2. Install the tappet to the cylinder block.
23. Cylinder head assembly installation
   1. Install the cylinder head gasket to the cylinder block.

   Note :
   - Install with the marked side facing upward.



PAWC1BSH003301

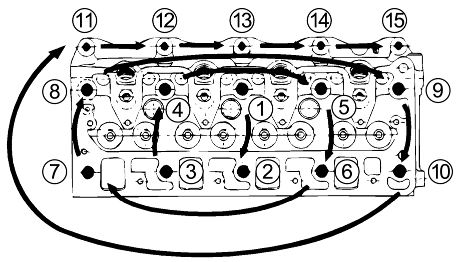
1. Mark

   2. Apply engine oil to the bolt.

   Note :
   - Apply engine oil to the threaded portion and the seat surface of the head bolt.

   3. Install the cylinder head assembly to the cylinder block.
   4. Tighten the head bolts using a torque wrench.

   Note :
   - Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



PAWC1BSH004001

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle : 60 ° 3rd time

Note :
- Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }

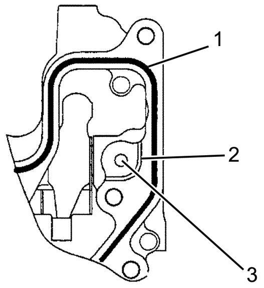
24. Push rod installation
   1. Install the push rod to the cylinder block.

   Note :
   - Pass it through the cylinder block and insert it into the tappet.

25. Rocker arm bracket installation
   1. Apply liquid gasket to the rocker arm bracket.

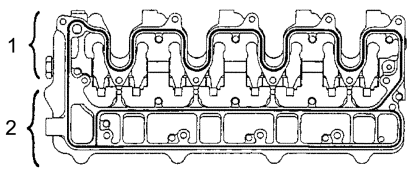
   Note :
   - Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

   Caution :
   - Do not apply liquid gasket to the groove around the oil gallery.



PAWC1BSH004201

1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



PAWC1BSH004301

1. Liquid gasket application area
2. Oil gallery groove

Note :

- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note :

- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.
4. Securely tighten the rocker arm bracket to the cylinder head.

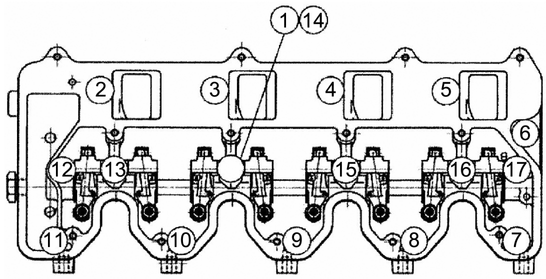
Note :

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution :

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



PAWC1BSH004101

26. Rocker arm shaft adjustment

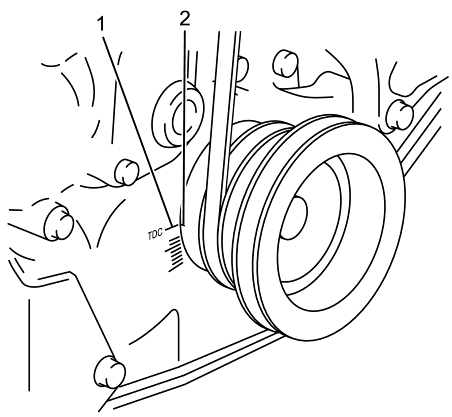
Note :

- Valve clearance adjustment

Caution :

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



PAWC1BSH004401

1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note :

- Insert the feeler gauge between the rocker arm and the bridge cap.

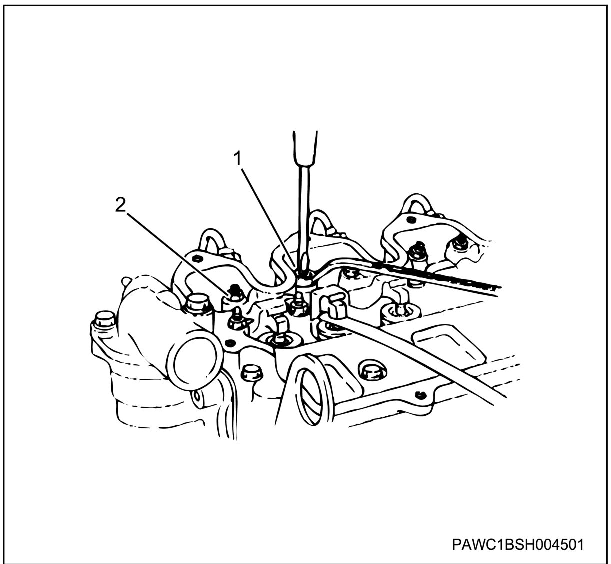
specified value :　0.40 mm { 0.016 in } Inlet valve

specified value :　0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note :

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



1. Adjust screw
2. Lock nut

tightening torque :　10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note :

- Rotate the crankshaft in the forward direction and measure the valve clearance.

Caution :

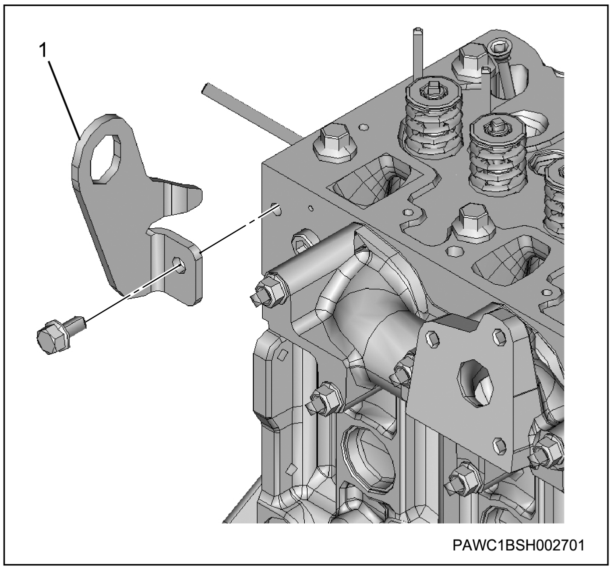
- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

27. Engine hanger installation

1. Install the engine hanger to the cylinder head.

tightening torque :　23 N・m { 2.3 kgf・m / 17 lb・ft }

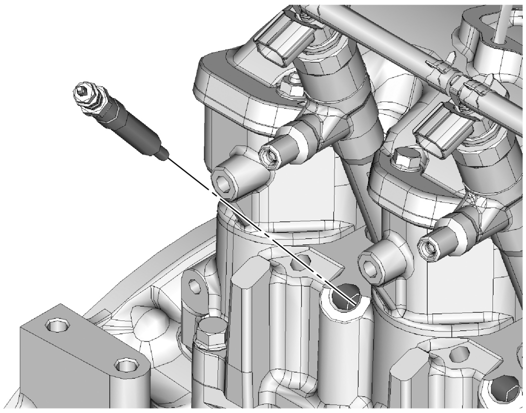


1. Engine hanger

28. Glow plug installation

1. Install the glow plug to the cylinder head.

tightening torque :　22.5 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1JSH000201

29. Glow plug connector installation
   1. Install the glow plug connector to the glow plug.

   tightening torque： 1.0 N・m { 0.1 kgf・m / 9 lb・in }

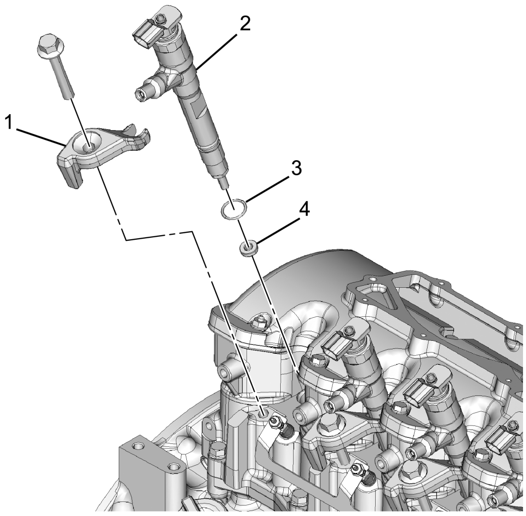
30. Injector installation

   Caution：
   - Do not change the installation position of the injectors when reusing the injectors.

   1. Install the O-ring to the injector.
   2. Install the injector gasket to the injector.

   Note：
   - Do not reuse the injector gasket or the O-ring.

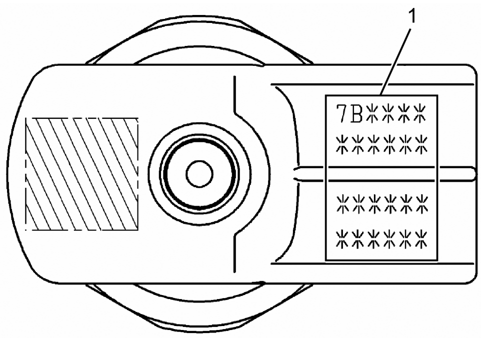
   3. Temporarily tighten the injector to the cylinder head assembly.



PAWC1CSH000601

1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Caution：
- If the injector has been replaced, record the injector ID code of the new injector.



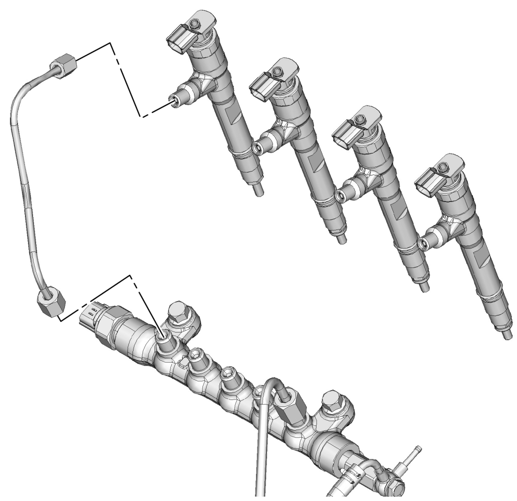
PAWC1CSH000701

1. Injector ID code

4. Connect the harness connector to the injector.

31. Injection pipe installation
   1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

   Note：
   - Do not reuse the injection pipe.



PAWC1CSH000501

   2. Securely tighten the injector to the cylinder head assembly.

   tightening torque： 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

・ Securely tighten the injector side.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

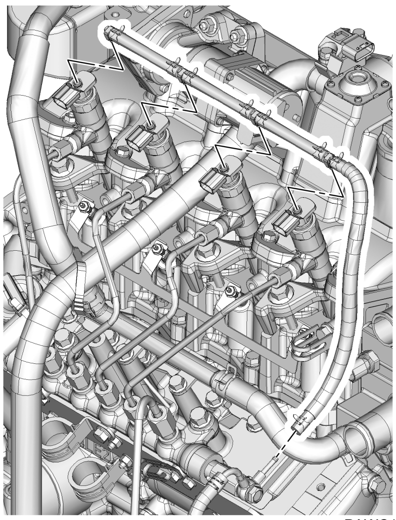
Note：

・ Securely tighten the common rail (fuel rail) side.

tightening torque： 30 N・m { 3.1 kgf・m / 22 lb・ft }

32. Fuel leak-off hose installation

1. Install the fuel leak-off hose to the injector.

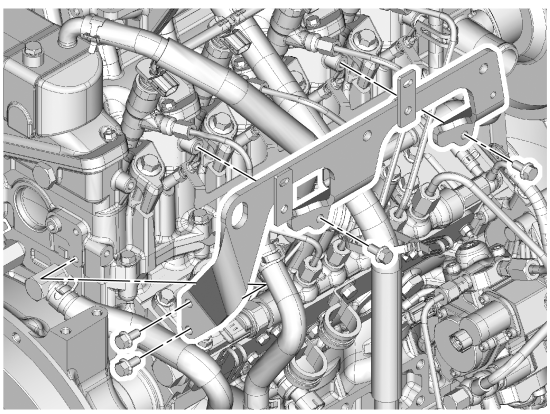


PAWC1CSH000401

33. Harness bracket installation

1. Install the harness bracket to the cylinder head.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }



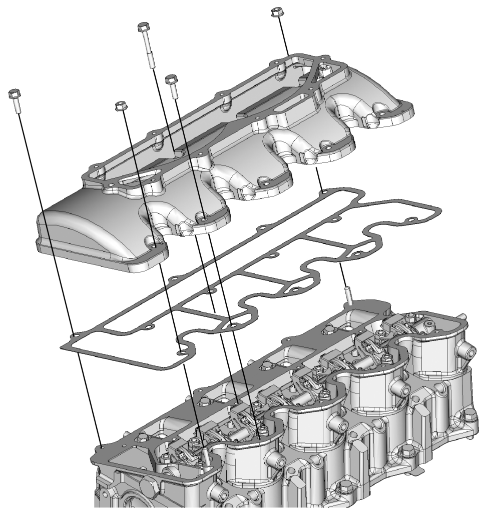
PAWC1CSH000301

2. Connect the engine harness to the harness bracket.

34. Cylinder head cover installation

1. Install the cylinder head cover to the rocker arm bracket.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

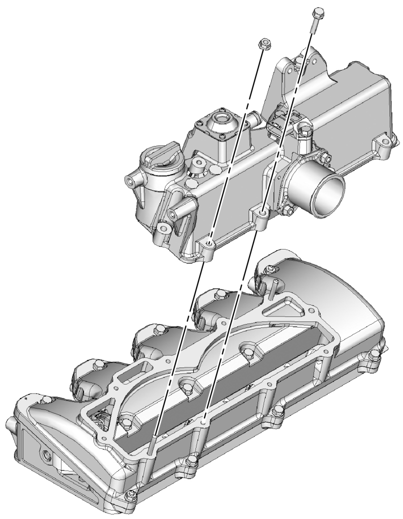


PAWC1BSH001001

35. Intake chamber installation

1. Install the intake chamber to the cylinder head cover.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

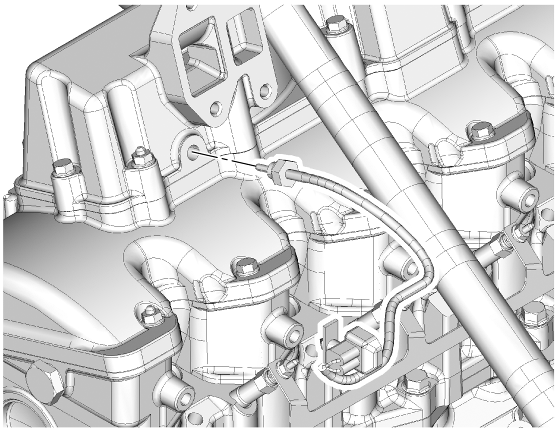


PAWC1BSH000701

36. IMT sensor installation

1. Install the IMT sensor to the intake chamber.

tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

2. Connect the harness connector to the IMT sensor.

37. PCV hose installation

1. Install the PCV hose to the intake chamber.

38. EGR valve installation

1. Temporarily tighten the EGR valve to the intake chamber.
2. Temporarily tighten the EGR pipe to the exhaust manifold.
3. Temporarily tighten the EGR pipe to the EGR valve.
4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

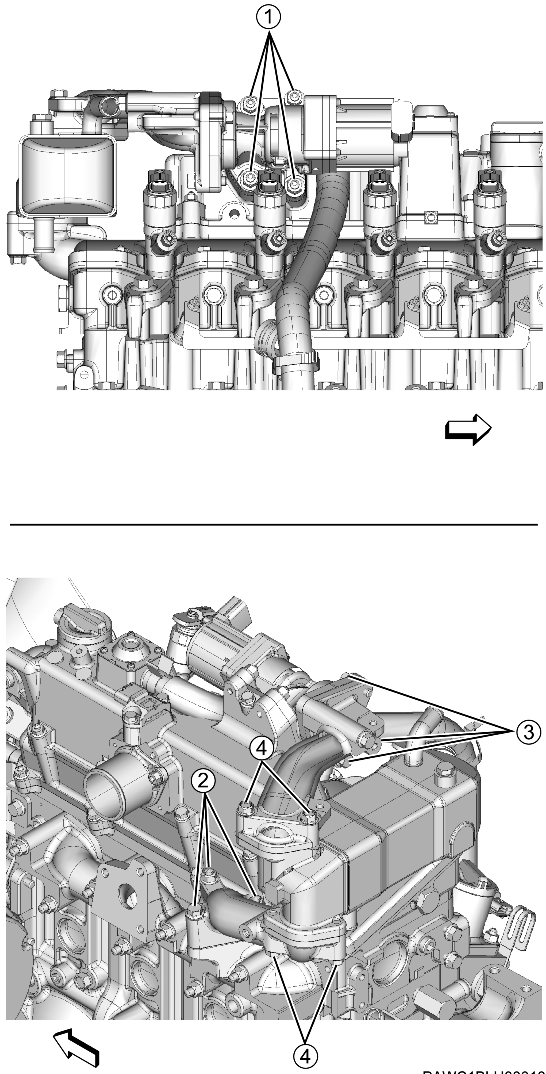
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



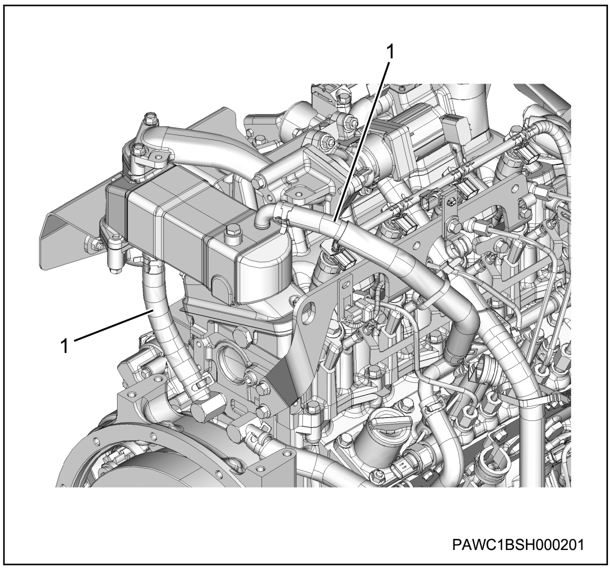
PAWC1BLH000101

Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

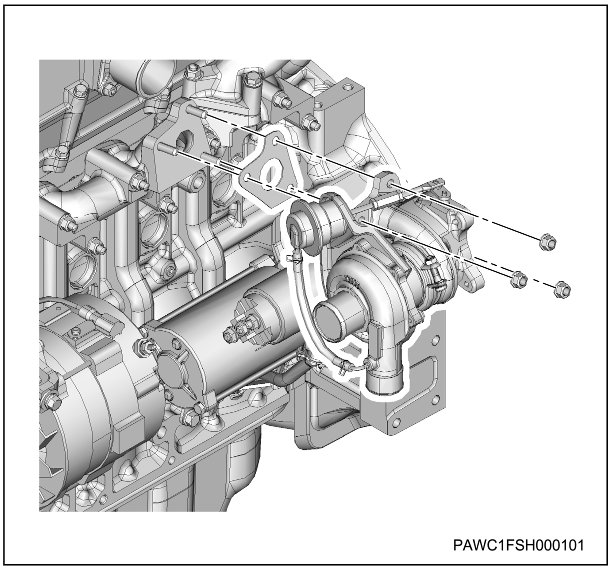
39. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note :

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



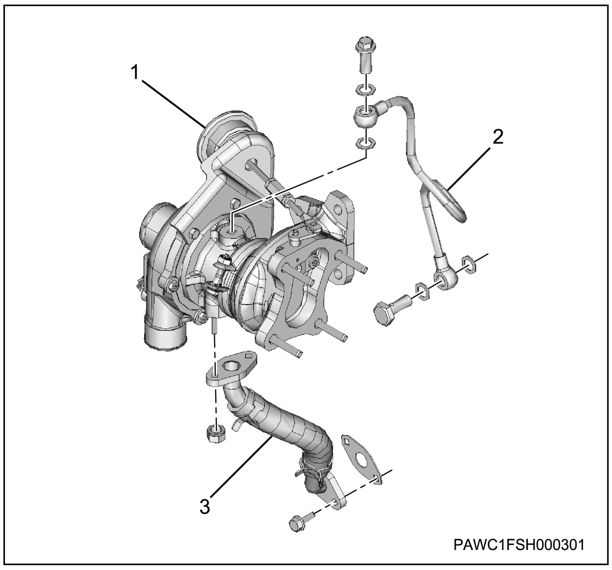
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }
Cylinder block side

tightening torque : 22 N・m { 2.2 kgf・m / 16 lb・ft }
Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

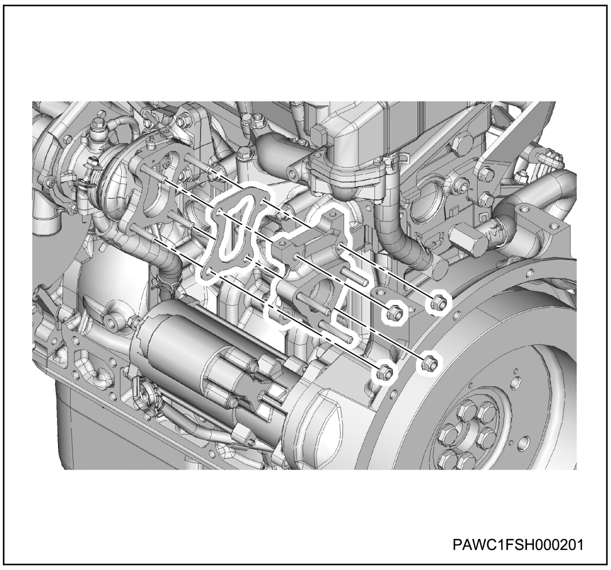
tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

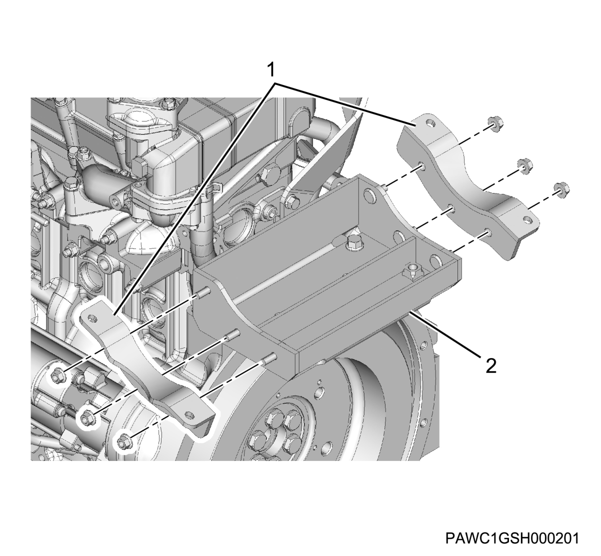
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



40. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

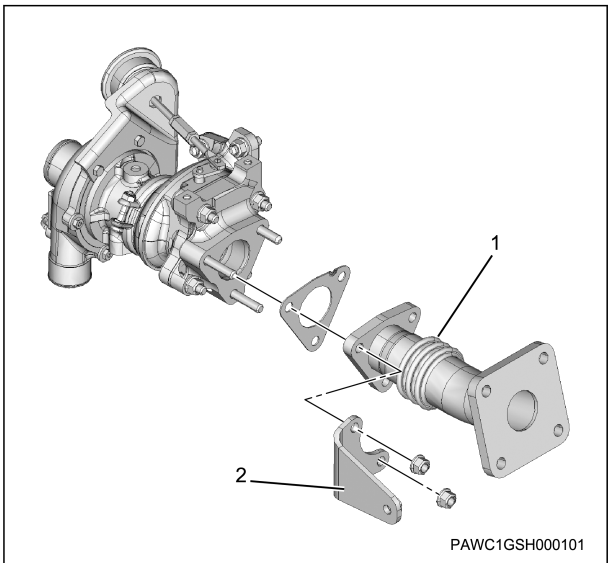


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note :

- Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

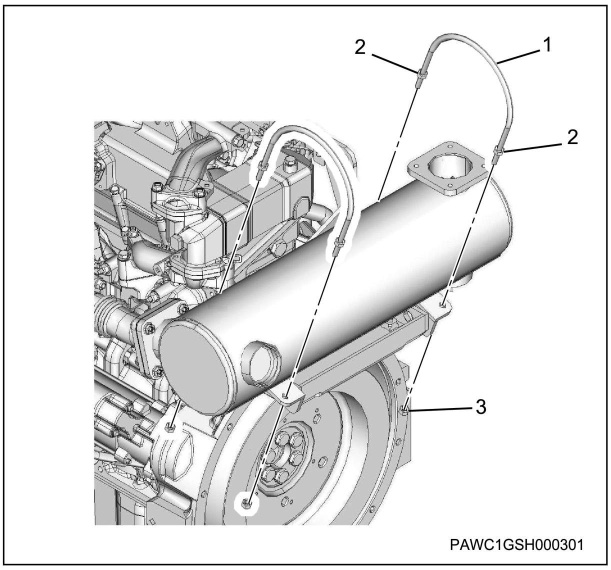
Note :

- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque : 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution :

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note :

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque : 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

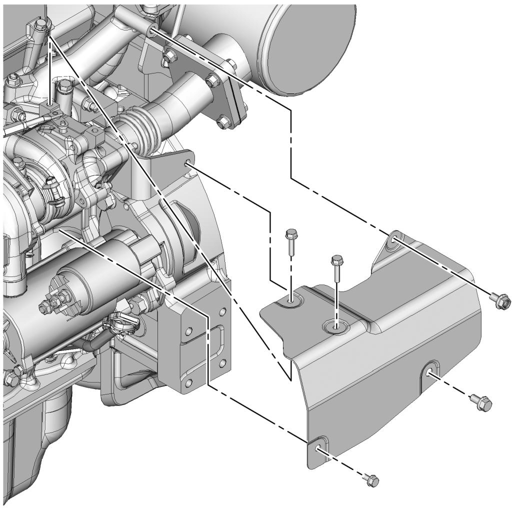
tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

41. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M6



PAWC1BSH001101

42. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note :

・ Install the harness clip.

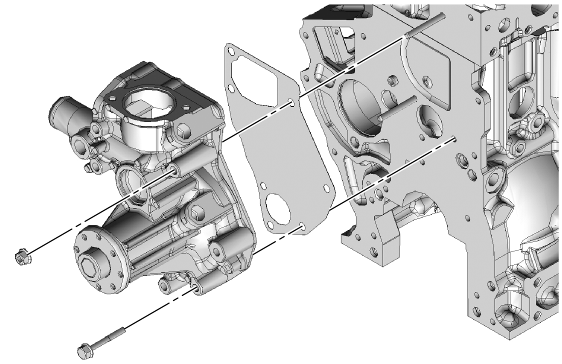
43. Water pump assembly installation

1. Install the water pump assembly to the cylinder block and the cylinder head.

Note :

・ Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1DSH000201

44. Water hose connect

1. Connect the water hose to the water pump assembly.

Note :

・ Install the hose clip.

45. Engine coolant temperature sensor connect

1. Connect the harness connector to the engine coolant temperature sensor.

46. Generator installation

1. Install the adjust plate to the water pump assembly.

tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

2. Temporarily tighten the generator to the generator bracket.

3. Temporarily tighten the generator to the adjust plate.

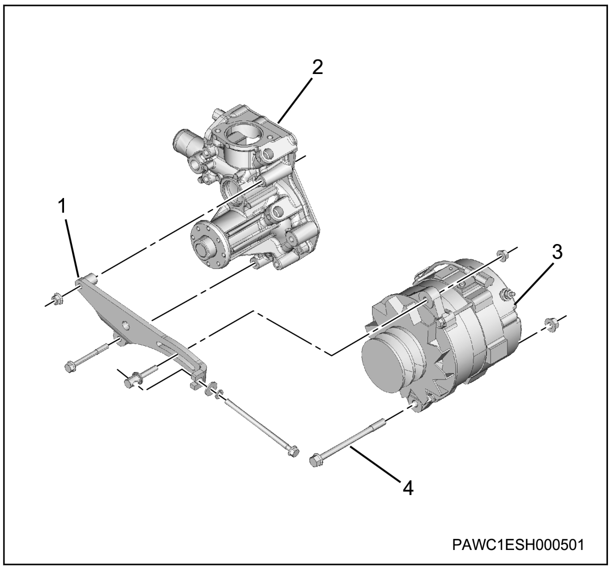
Note :

・ Securely tighten the bolt and the nut after adjusting the cooling fan belt.

4. Connect the harness connector to the generator.

Note :

・ The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

47. Fan pulley installation
   1. Install the fan pulley to the water pump assembly.

   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

48. Cooling fan belt installation
   1. Install the cooling fan belt to the pulley.

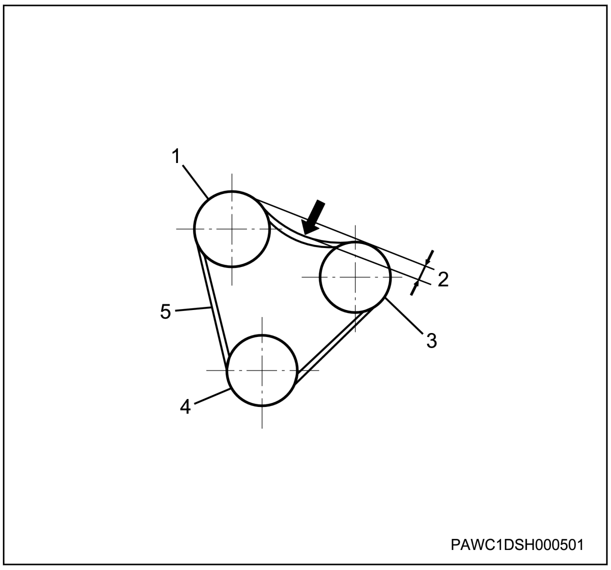
49. Cooling fan belt adjustment
   1. Check the tension of the cooling fan belt.

   Note：
   - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

   standard： 98 N { 10.0 kg / 22 lb }

   specified value： 7.7 to 8.7 mm { 0.303 to 0.343 in }
   New product

   specified value： 8.3 to 9.3 mm { 0.327 to 0.366 in }
   Reuse

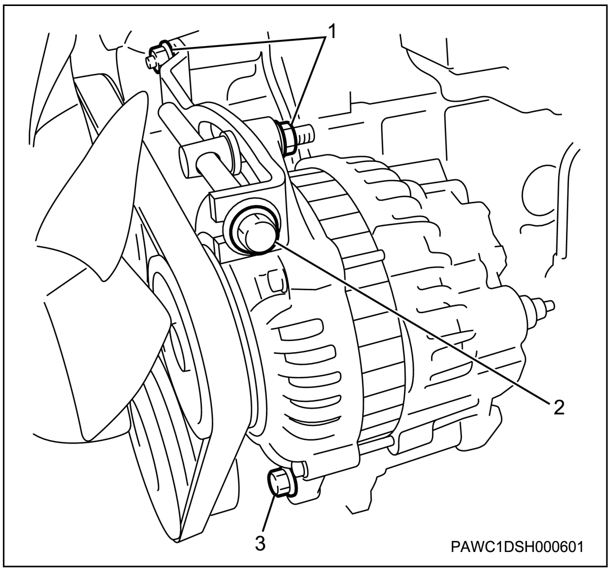


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

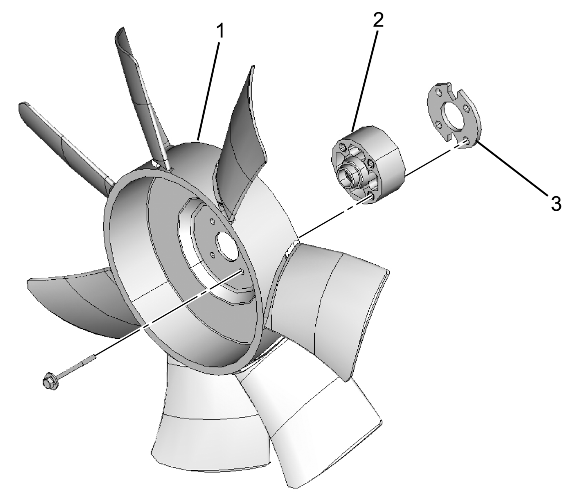
tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25



1. Nut
2. Adjust bolt
3. Mounting bolt

50. Cooling fan installation
   1. Install the cooling fan to the fan pulley.

   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1DSH000301

1. Cooling fan
2. Adapter
3. Spacer

51. Engine oil filling
   1. Refill the engine with engine oil.

   Note：
   - Check the tightening of the oil pan drain plug again.

52. Coolant filling
   1. Loosen the plug using a wrench.
   2. Replenish the radiator with coolant.

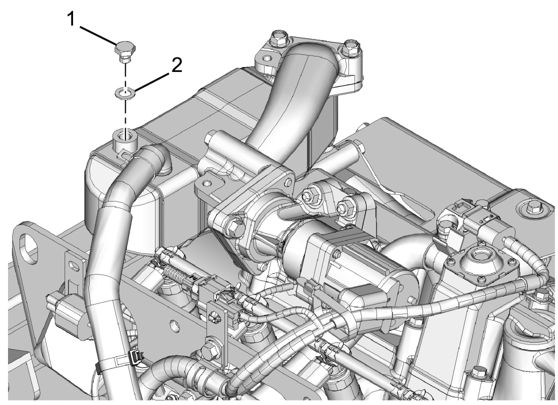
   Caution：
   - Take care to prevent overflow coolant from splashing on to the exhaust system parts.
   - Wipe off any coolant overflow.

   3. Tighten the plug using a wrench.

   Caution：
   - Use a new gasket.

   tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

   4. Replenish the radiator with coolant.



PAWC1BSH000101

1. Plug
2. Gasket

53. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Piston

removal

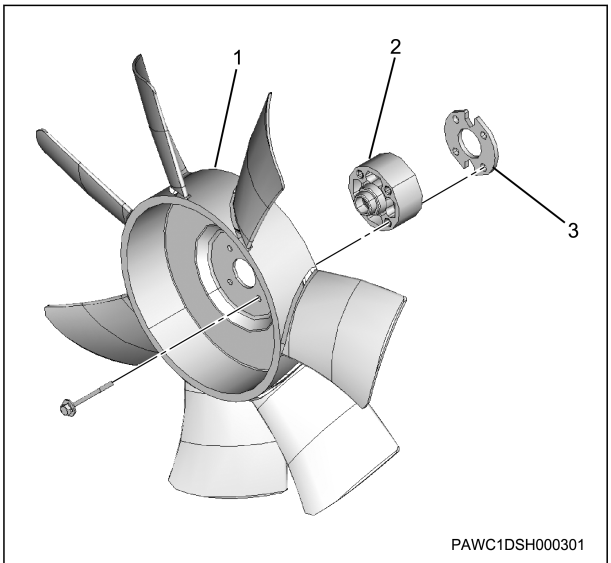
1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Engine oil drain
   1. Drain the engine oil from the oil pan.

   Note :
   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

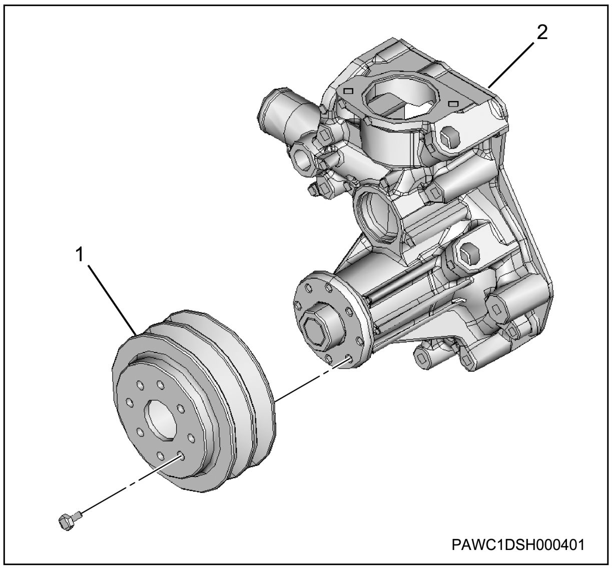
   Caution :
   - Do not forget to tighten the drain plug.
4. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



1. Cooling fan
2. Adapter
3. Spacer

5. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

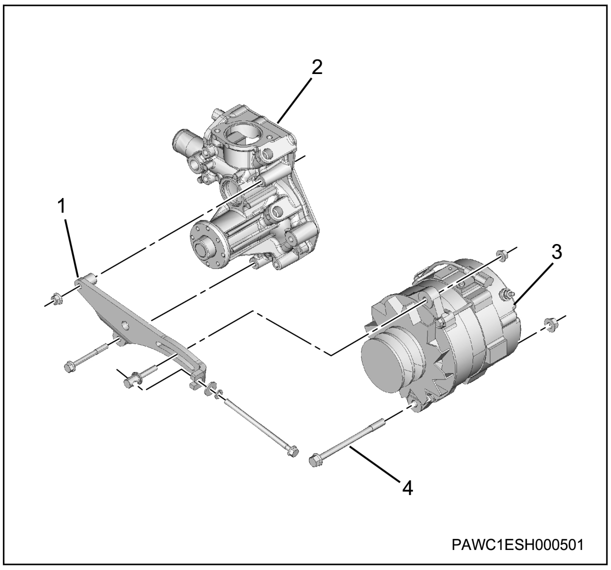
   Note :
   - Loosen the generator adjust bolt and remove the belt.
6. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.



1. Fan pulley
2. Water pump assembly

7. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :
   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate

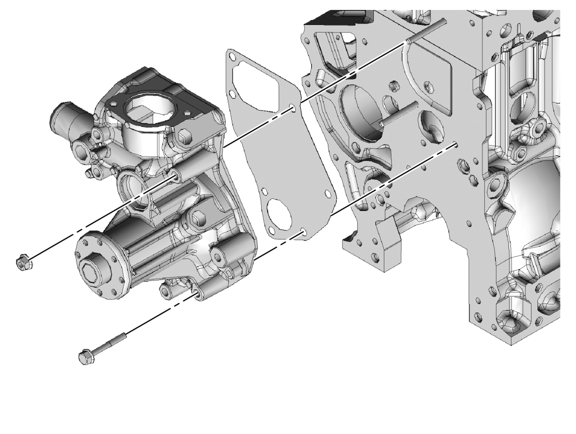
2. Water pump assembly
3. Generator
4. Bolt

8. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
9. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

Note :
- Remove the hose clip.

10. Water pump assembly removal
    1. Remove the water pump assembly from the cylinder block and the cylinder head.

Note :
- Remove the water pump assembly and the gasket.

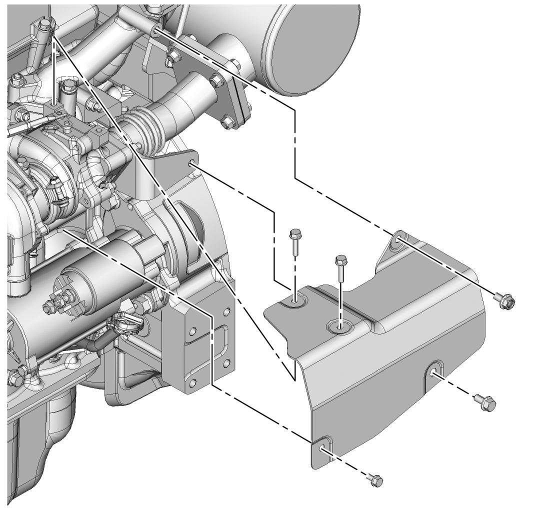


PAWC1DSH000201

11. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

Note :
- Remove the harness clip.

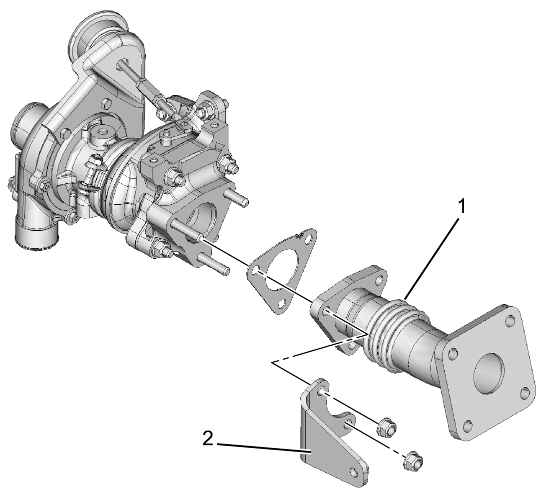
12. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.



PAWC1BSH001101

13. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

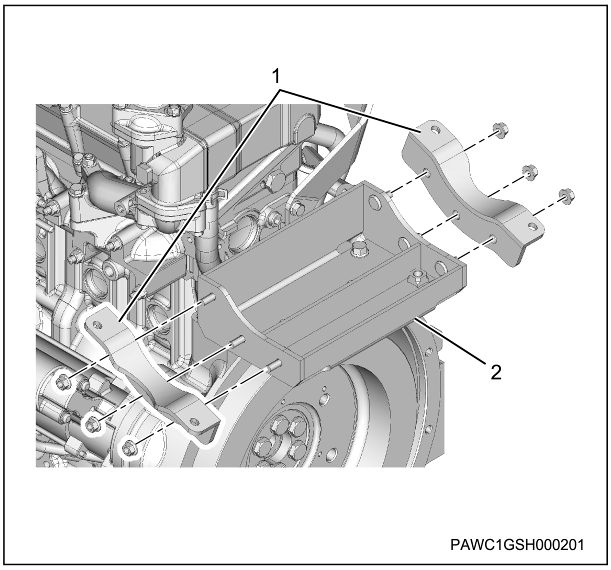
Note :
- Remove together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

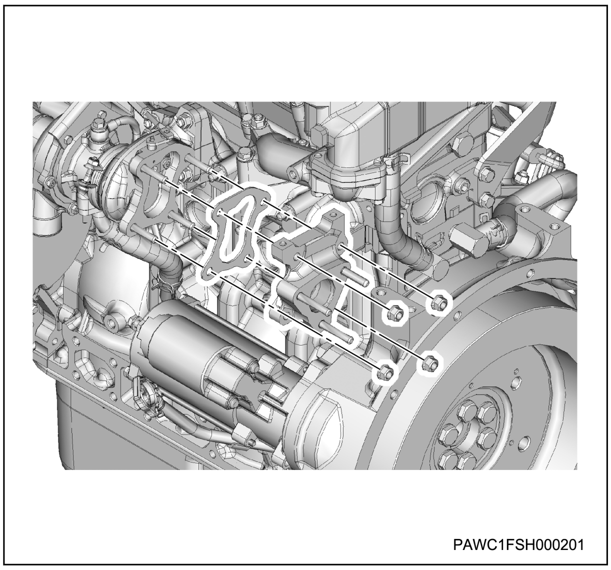
3. Remove the support bracket from the silencer bracket.



1. Support bracket
2. Silencer bracket

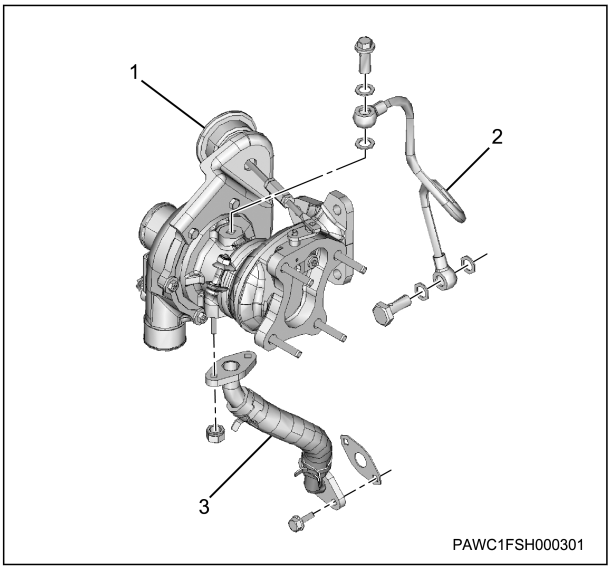
14. Turbocharger assembly removal

1. Remove the exhaust pipe adapter from the turbocharger assembly.



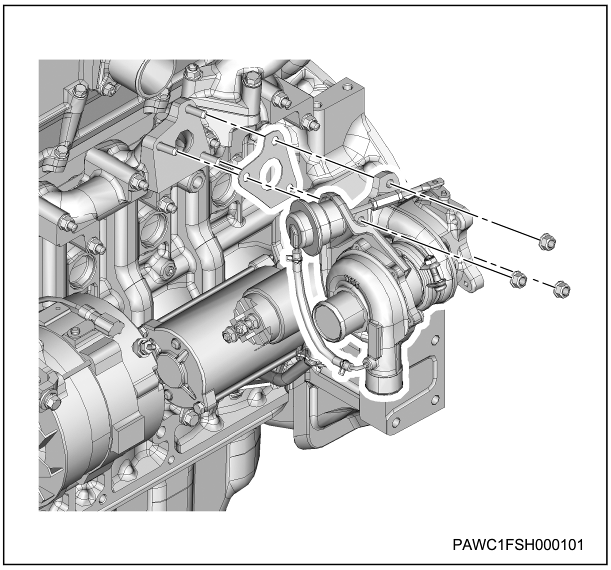
2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.

3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

4. Remove the turbocharger assembly from the exhaust manifold.

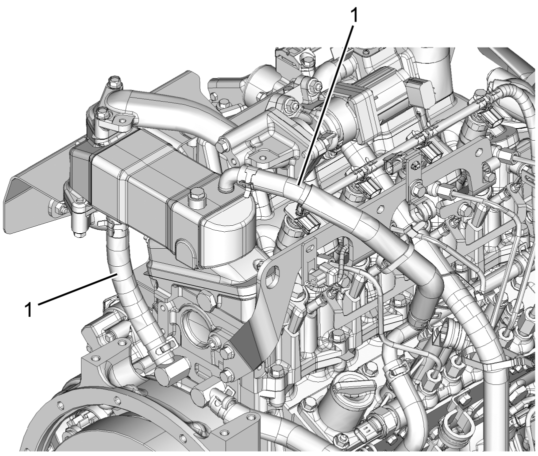


15. EGR valve removal

1. Disconnect the harness connector from the EGR valve.

2. Disconnect the harness clip from the EGR pipe.

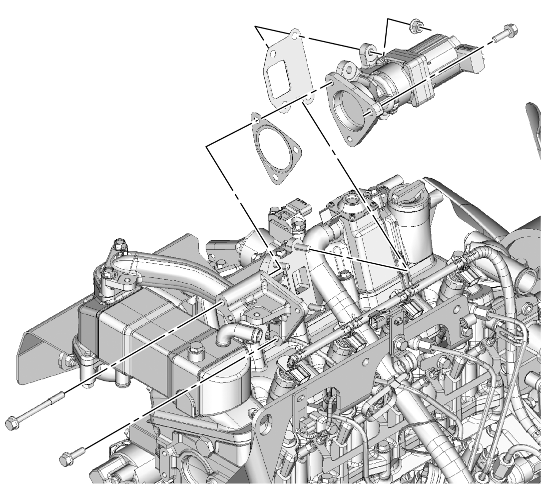
3. Disconnect the water rubber hose from the EGR cooler assembly.



PAWC1BSH000201

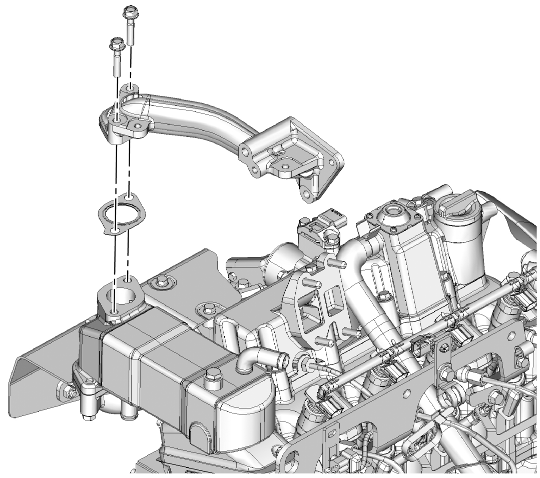
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.



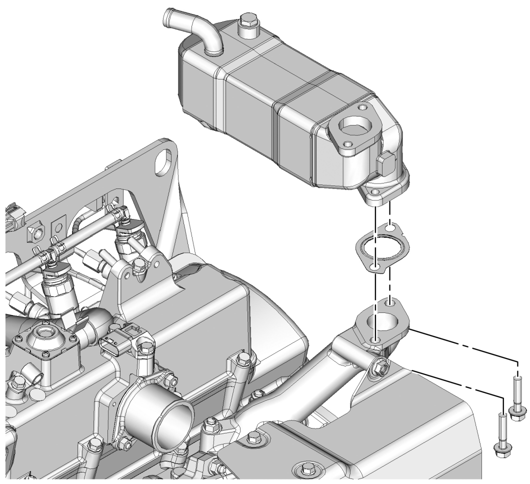
PAWC1BSH000301

5. Remove the EGR pipe from the EGR cooler.



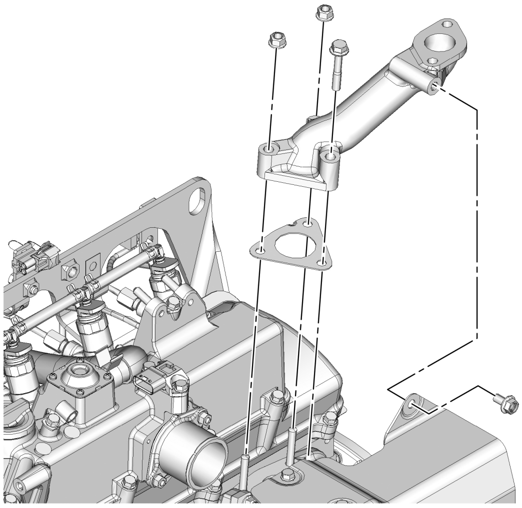
PAWC1BSH000401

6. Remove the EGR cooler from the EGR pipe.



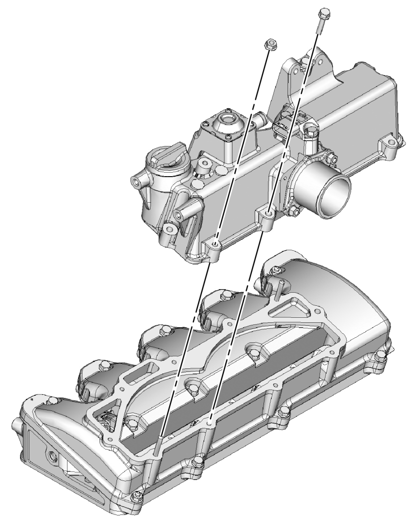
PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.



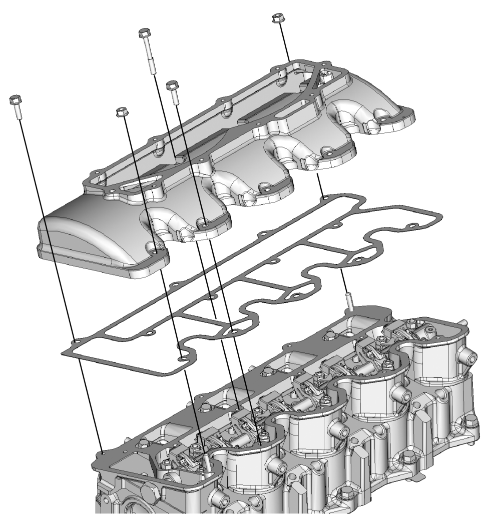
PAWC1BSH000601

16. PCV hose removal
    1. Remove the PCV hose from the intake chamber.
17. IMT sensor removal
    1. Disconnect the harness connector from the IMT sensor.
    2. Remove the IMT sensor from the intake chamber.
18. Intake chamber removal
    1. Remove the intake chamber from the cylinder head cover.



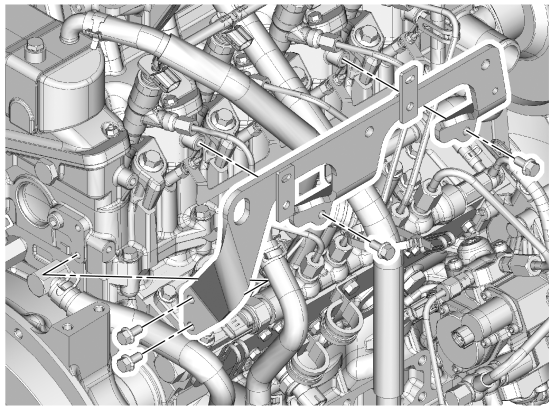
PAWC1BSH000701

19. Cylinder head cover removal
    1. Remove the cylinder head cover from the rocker arm bracket.



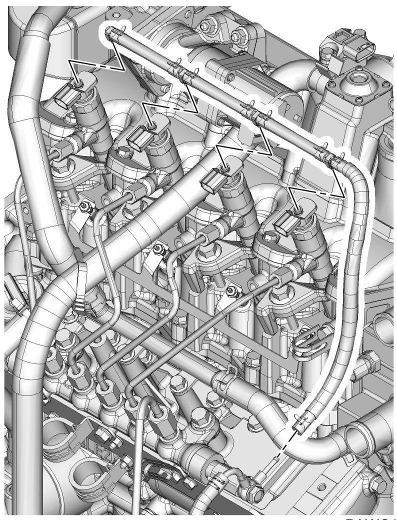
PAWC1BSH001001

20. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



PAWC1CSH000301

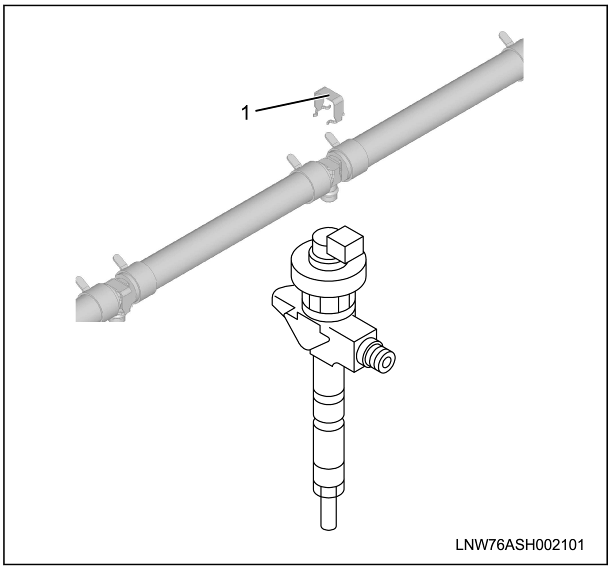
21. Fuel leak-off hose removal
    1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note：

- Do not reuse the leak-off pipe clip.



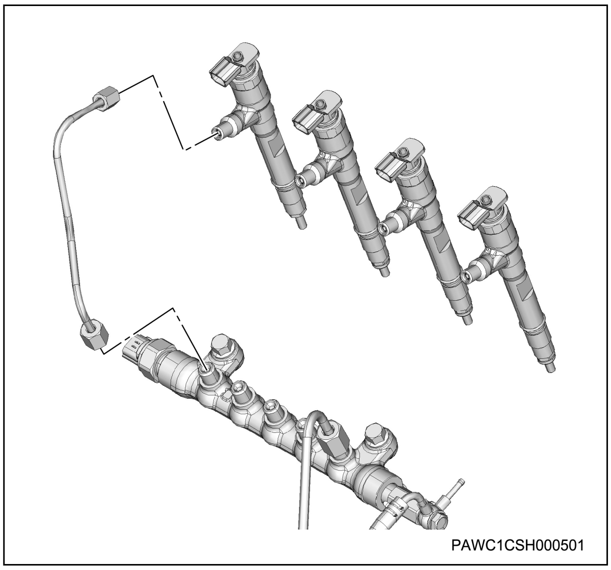
1. Clip

22. Injection pipe removal

    1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note：

- Do not reuse the injection pipe.

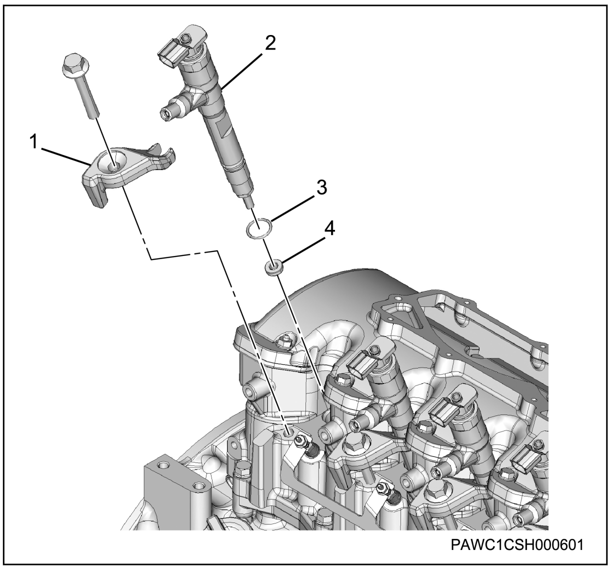


23. Injector removal

    1. Disconnect the harness connector from the injector.
    2. Remove the injector from the cylinder head assembly.
    3. Remove the injector gasket from the injector.
    4. Remove the O-ring from the injector.

Note：

- Do not reuse the injector gasket or the O-ring.



1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Note：

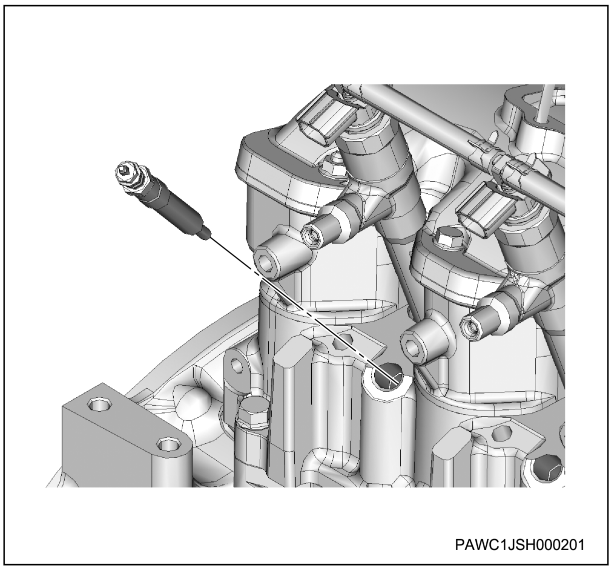
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

24. Glow plug connector removal

    1. Remove the glow plug connector from the glow plug.

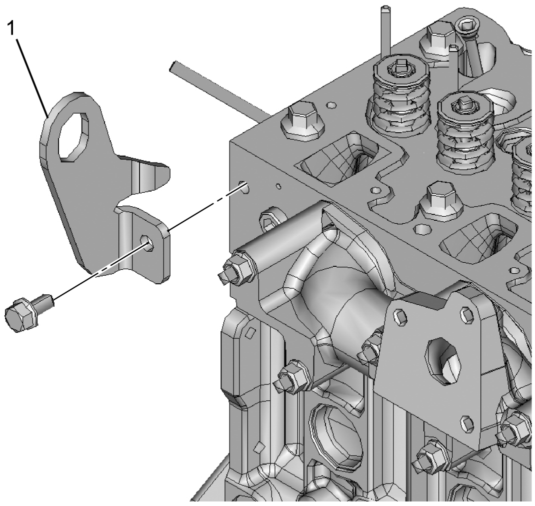
25. Glow plug removal

    1. Remove the glow plug from the cylinder head.



26. Engine hanger removal

    1. Remove the engine hanger from the cylinder head.



PAWC1BSH002701

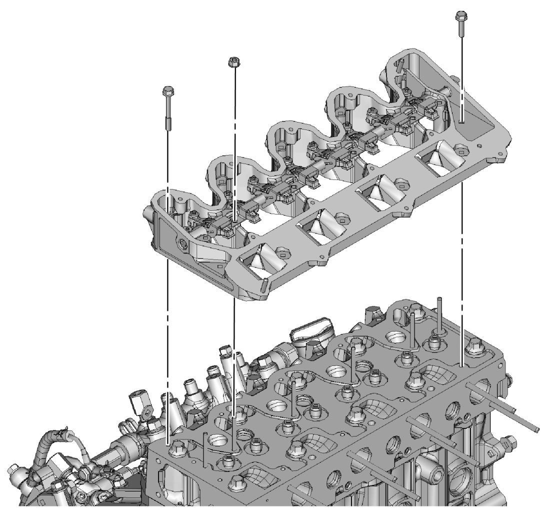
1. Engine hanger

27. Rocker arm bracket removal

1. Remove the rocker arm bracket from the cylinder head.

Caution :

- Be careful not to damage the rocker arm bracket when removing.



PAWC1BSH002901

28. Push rod removal

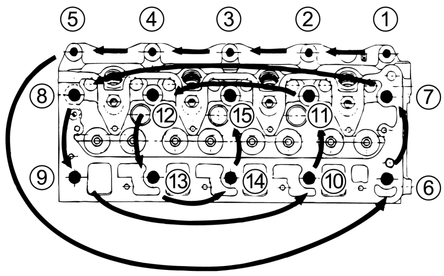
1. Remove the push rod from the cylinder block.

29. Cylinder head assembly removal

1. Remove the cylinder head assembly from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



PAWC1BSH002801

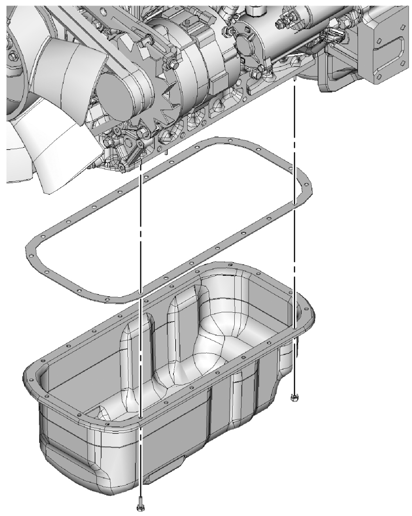
2. Remove the cylinder head gasket from the cylinder block.

30. Tappet removal

1. Remove the tappet from the cylinder block.

31. Oil pan removal

1. Remove the oil pan from the cylinder block.



PAWC1ESH000801

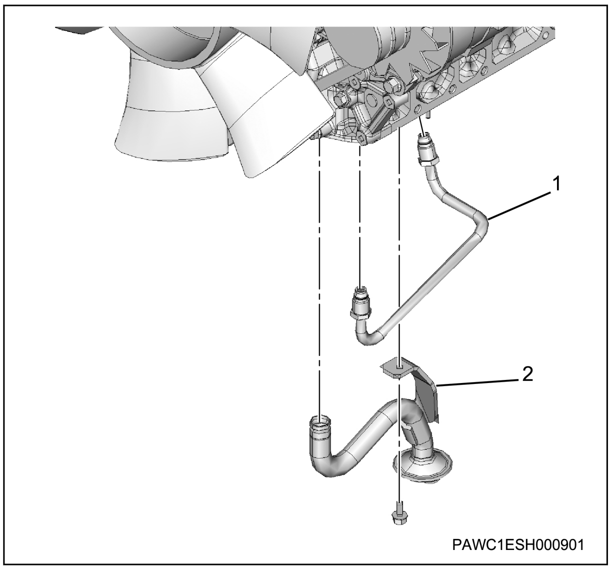
32. Oil strainer removal

1. Remove the oil pipe from the front oil pump plate and the cylinder block.

2. Remove the oil strainer from the front oil pump plate and the cylinder block.

Note :

- Remove the O-ring.



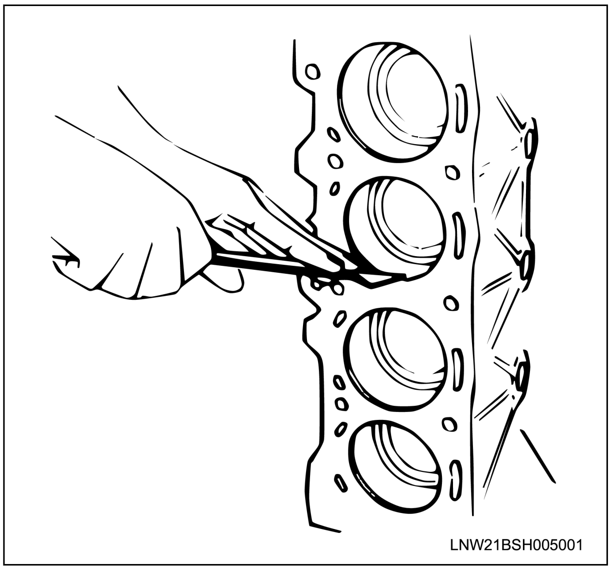
1. Oil pipe
2. Oil strainer

33. Piston removal

1. Clean the cylinder block using a scraper.

Note：

- Remove carbon from the inside of the cylinder using a scraper.



2. Remove the connecting rod bearing cap from the connecting rod.

Note：

- Put the piston of the cylinder to be removed in the bottom dead center position.

3. Remove the connecting rod bearing from the connecting rod bearing cap.

Note：

- Organize the removed bearings according to the cylinders using tags, etc.

4. Remove the piston from the cylinder block.

Note：

- Pull the piston as a unit with the connecting rod out to the cylinder head side.

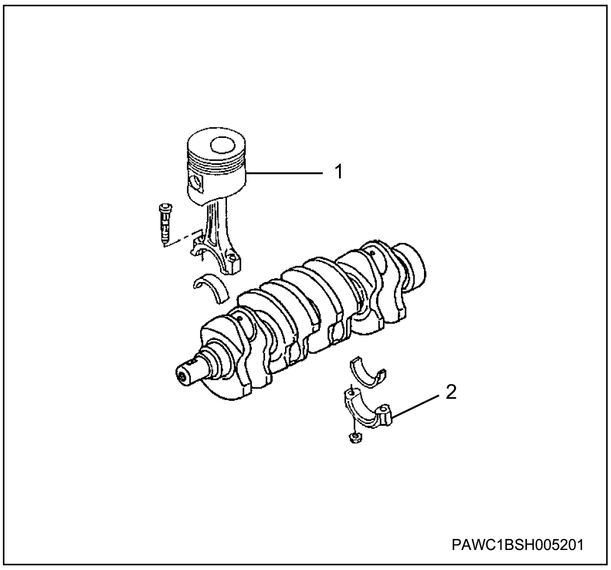
Caution：

- Be careful not to damage the inner wall of the cylinder.

5. Remove the connecting rod bearing from the connecting rod.

Note：

- Organize the removed bearings according to the cylinders using tags, etc.



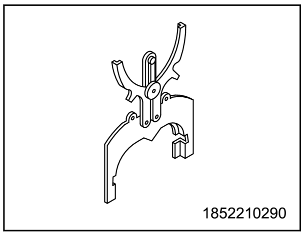
1. Piston
2. Connecting rod bearing cap

disassembly

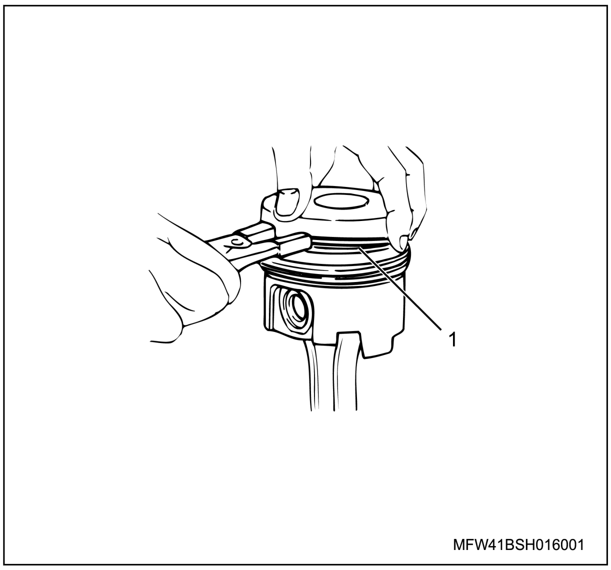
1. Piston ring removal
   1. Remove the piston rings from the piston using a special tool.

Caution :

- Be careful not to deform the piston rings.



SST: 1-8522-1029-0 - piston ring setting tool



1. Piston ring

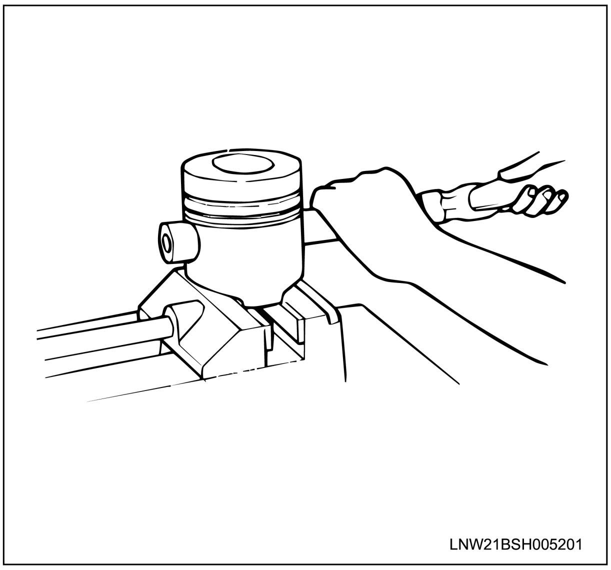
Note :

- Organize the removed piston rings according to the cylinders.

2. Connecting rod assembly removal
   1. Remove the snap ring from the piston.
   2. Remove the piston pin from the piston using a brass rod.

Note :

- Gently tap it out using a brass rod and a hammer.
- Organize the disassembled piston pins, pistons, and connecting rods according to the order of cylinders.



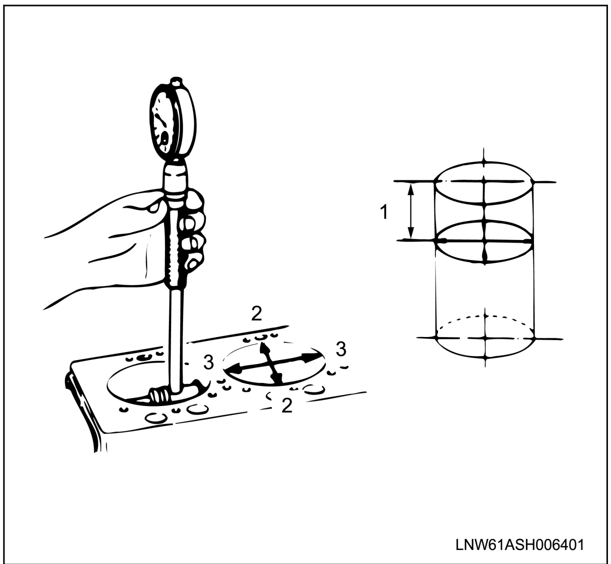
3. Remove the connecting rod assembly from the piston.

inspection

1. Piston measurement
   1. Measure the cylinder block using a cylinder gauge.

Note：

- Measure the inner diameter of the cylinder in the axis direction and the thrust direction 13 mm {0.512 in} from the top surface of the cylinder block.



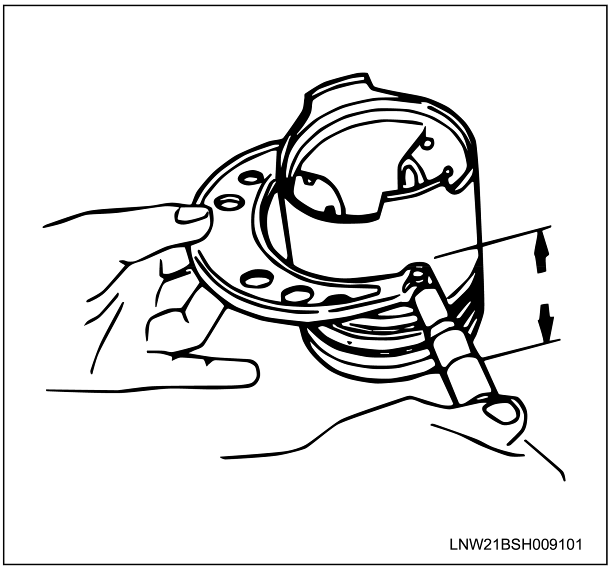
1. Measurement position
2. Axis direction
3. Thrust direction

2. Measure the piston using a micrometer.

Note：

- Measure the outer diameter at the specified position of the piston.

specified value： 54.85 mm { 2.159 in } From the top surface of the piston



1. Measurement position

specified value： 84.945 to 84.960 mm { 3.3443 to 3.3449 in } for service

specified value： 85.195 to 85.210 mm { 3.3541 to 3.3547 in } O/S 0.25

3. Calculate the clearance from the measured value.

Note：

- Calculate the clearance between the piston and the cylinder block inner diameter.

specified value： 0.040 to 0.085 mm { 0.0016 to 0.0033 in }

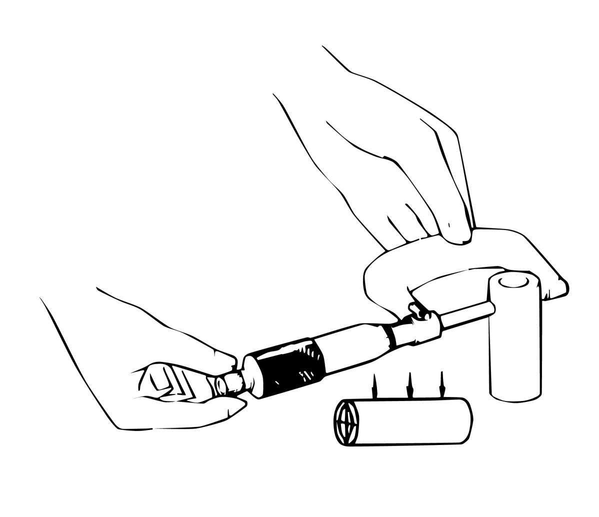
2. Piston pin inspection
   1. Measure the piston pin using a micrometer.

Note：

- Measure the outer diameter of the piston pin, and replace the piston pin if the measured value exceeds the limit.

specified value： 27 mm { 1.063 in }

limit： 26.97 mm { 1.062 in }



LNW21BSH009601

2. Calculate the clearance from the measured value.

Note :

- Measure the inner diameter of the piston pin hole, and calculate the clearance with the outer diameter of the piston pin.

specified value : 0.004 to 0.017 mm { 0.00016 to 0.00067 in }

3. Piston ring measurement

1. Inspect the piston rings.

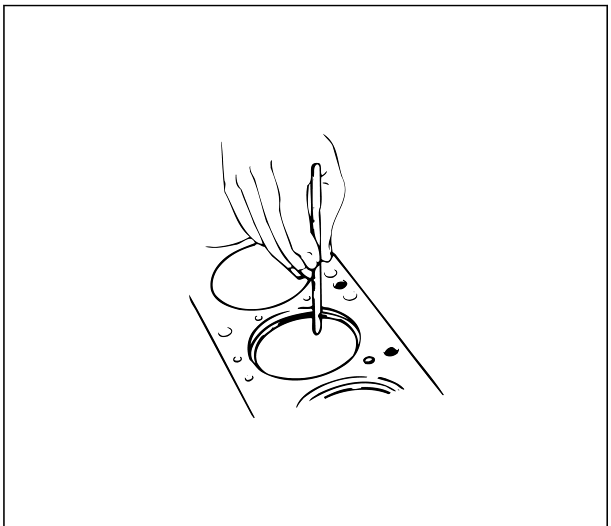
Note :

- Using the piston, press the ring into the cylinder perpendicularly to the cylinder wall.

2. Measure the piston rings using a feeler gauge.

Note :

- Measure the joint clearance of the piston.



MFW41BSH016201

	Specified value	Limit
Top ring	: 0.20 to 0.35 mm { 0.008 to 0.014 in }	: 1.5 mm { 0.059 in }
Second ring	: 0.20 to 0.40 mm { 0.008 to 0.016 in }	
Oil ring	: 0.20 to 0.40 mm { 0.008 to 0.016 in }	: 1.0 mm { 0.039 in }

Caution :

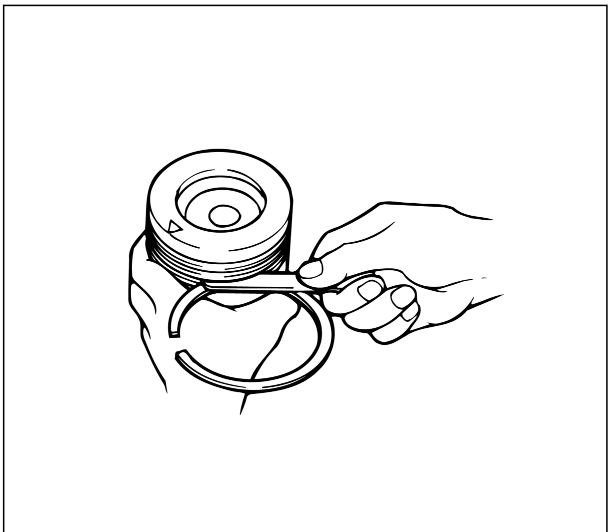
- If the measured value exceeds the limit, replace the piston rings.

3. Measure the piston rings using a feeler gauge.

Note :

- Measure the clearance between the piston ring grooves and the piston rings.
- Remove any carbon adhering to the piston ring grooves.

	Specified value	Limit
Top ring	Measurement impossible due to tapering	
Second ring	: 0.070 to 0.110 mm { 0.0028 to 0.0043 in }	: 0.15 mm { 0.006 in }
Oil ring	: 0.030 to 0.070 mm { 0.0012 to 0.0028 in }	



BLW61BSH000701

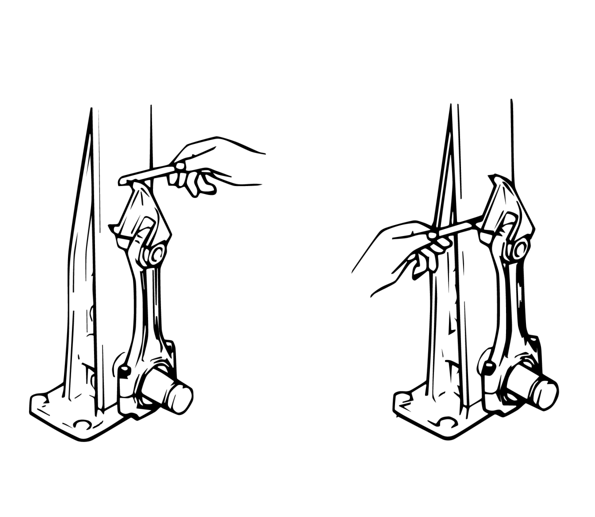
Caution :

- If the measured value exceeds the limit, replace the piston and the piston rings.

4. Connecting rod assembly measurement

1. Measure the connecting rod assembly using a connecting rod aligner.

	Specified value	Limit
Twisting, 24 mm {0.945 in}	: less than 0.05 mm { less than 0.002 in }	: 0.2 mm { 0.008 in }
Degree of parallelization, 100 mm {3.937 in}	: less than 0.075 mm { less than 0.003 in }	: 0.15 mm { 0.006 in }



LNW21BSH010401

Caution :

- If the measured value exceeds the limit, replace the connecting rod assembly.

2. Measure the connecting rod assembly using a cylinder gauge.

Note :

- Measure the inner diameter of the connecting rod small end.

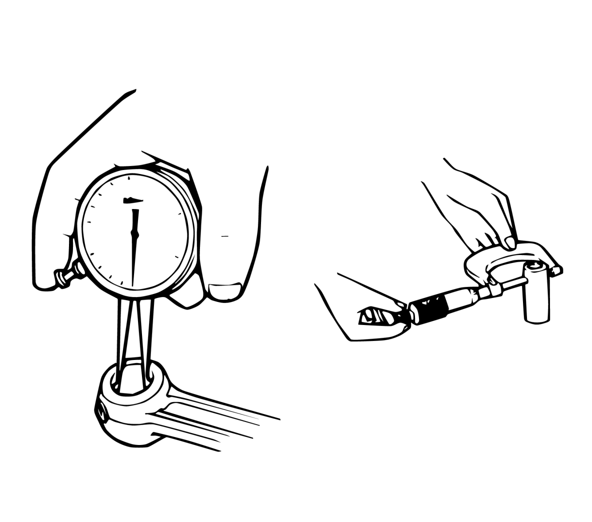
3. Calculate the clearance from the measured value.

Note :

- Calculate the clearance with the piston pin outer diameter.

specified value : 0.008 to 0.020 mm { 0.00031 to 0.00079 in }

limit : 0.05 mm { 0.002 in }

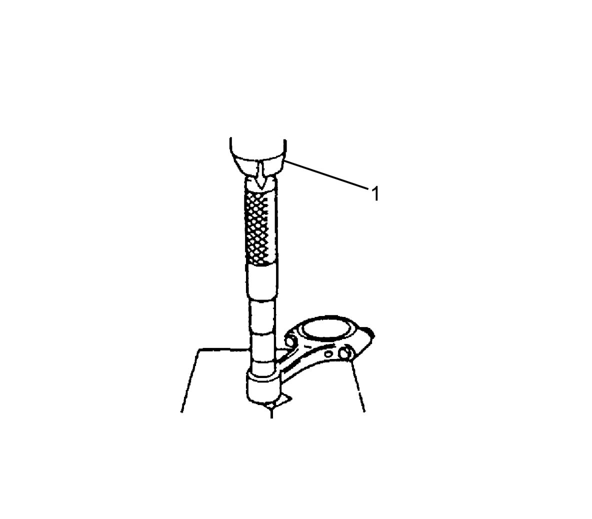


LNW21BSH009801

Note :

- Bushing replacement
- Install the bushing to the connecting rod using a press.
- Inner diameter after press-fitting the bushing

Inner diameter polishing dimension after press-fitting the bushing	
Specified value	: 27 mm { 1.063 in }
Tolerance	: 27.008 to 27.015 mm { 1.0633 to 1.0636 in }



PAWC1BSH005101

1. Press

4. Install the connecting rod bearing to the connecting rod.

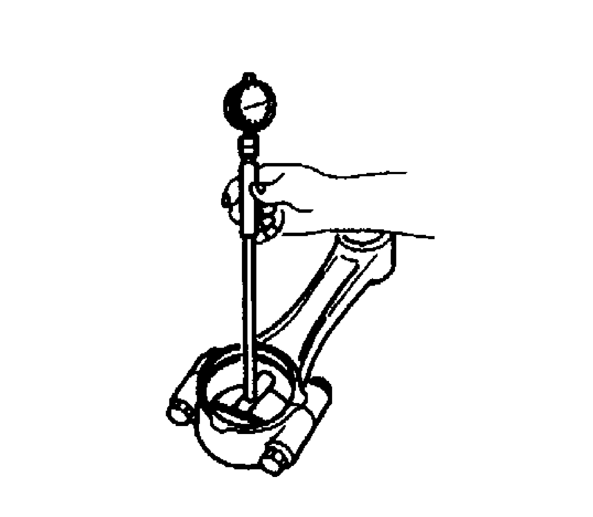
5. Install the connecting rod bearing cap to the connecting rod.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft } 1st time specified angle : 100 ° 2nd time

6. Measure the connecting rod assembly using a cylinder gauge.

Note :

- Measure the inner diameter of the connecting rod large end.



PAWC1BSH005501

7. Measure the crankshaft using a micrometer.

Note :

- Measure the outer diameter of the crank pin.

8. Calculate the clearance from the measured value.

specified value : 0.026 to 0.067 mm { 0.0010 to 0.0026 in }

limit : 0.1 mm { 0.0039 in }

5. Connecting rod bearing inspection

1. Inspect the connecting rod bearing.

Note :

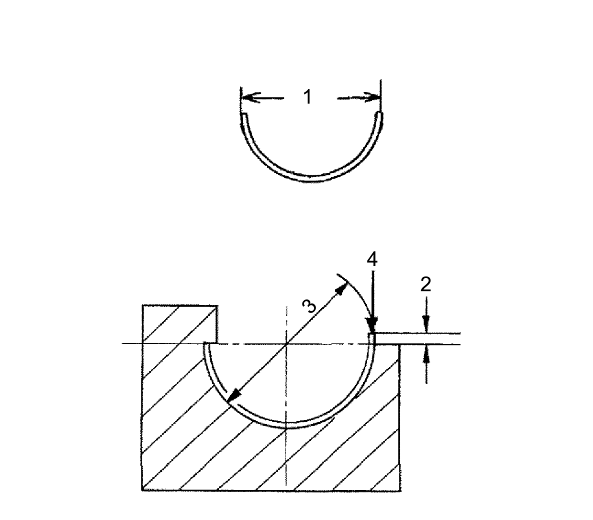
- Inspect the tension of the connecting rod bearing.

specified value : more than 49.5 mm { more than 1.949 in }

Note :

- Inspect bearing protrusion when a load of 3 kN {674 lb} is applied to the bearing.

specified value : 0.055 to 0.085 mm { 0.00217 to 0.00335 in }



PAWC1BSH005401

1. Tension
2. Protrusion
3. 49 mm {1.929 in}
4. 3 kN {674 lb}

reassembly

1. Connecting rod assembly installation
   1. Align the connecting rod assembly with the piston.

Note：

- When assembled in a factory, the pistons are sorted according to grades, but the standard pistons for service are not set by grade

Cylinder bore grade	Piston grade	
	At time of factory shipment	At time of service
A	A	None
B	B	
C	C	

Note：

- Heat the piston using a piston heater.

heating temperature： 100 ℃ { 212 °F }

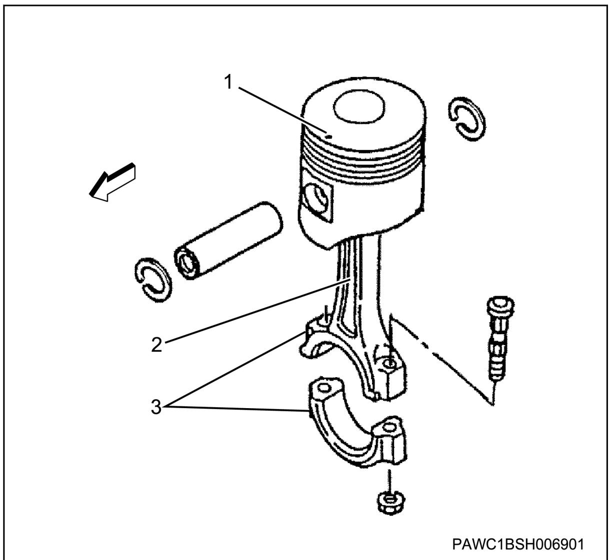
Note：

- It can be installed even when cool.

2. Apply engine oil to the piston pin.
3. Install the piston pin to the piston.

Note：

- Assemble so that the piston head front mark and the connecting rod protruding boss face the same direction.

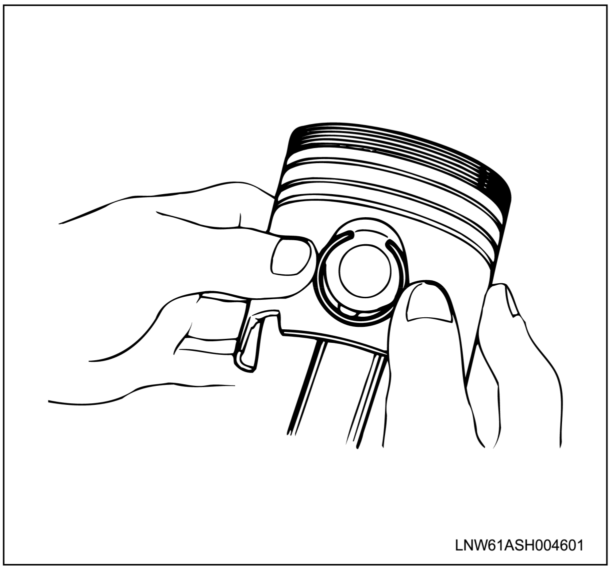


1. Front mark
2. Protruding boss
3. Cylinder number stamping side

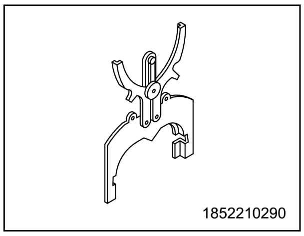
4. Install the snap ring to the piston.

Note：

- Insert the snap ring and stop the piston pin.
- Verify that the piston and the connecting rod move smoothly.



2. Piston ring installation
   1. Install the piston rings to the piston using a special tool.



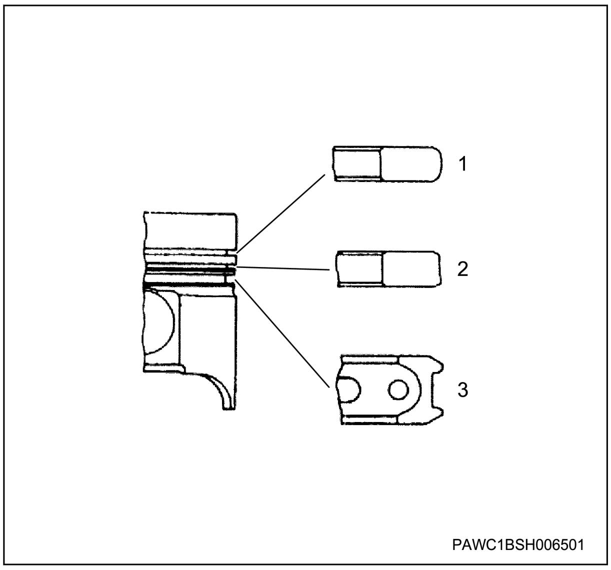
SST: 1-8522-1029-0 - piston ring setting tool

Note：

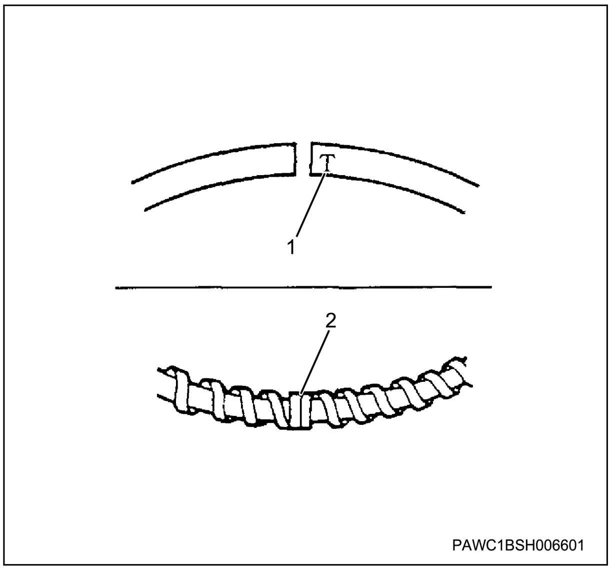
- Install the oil ring so that the ring and the coil expander joints are 180°in the opposite direction.
- Check the coil expander for gaps in the joint section.
- Face the T mark or the 1T or 2T mark side of the compression ring upward, and assemble in the order of the second ring, the top ring, and the compression ring.

Caution：

- Be careful as the shape of the top and second compression rings differ.



1. Top ring
2. Second ring
3. Oil ring



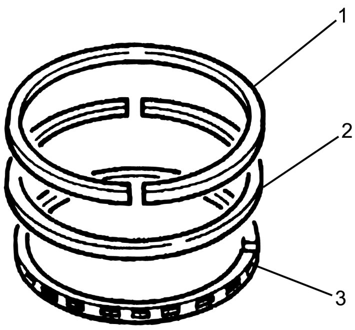
1. T mark (or 1T or 2T)
2. Joint section

installation

1. Piston installation
   1. Apply engine oil to the piston.

      Note :
      - Thoroughly apply to the piston side surface.
   2. Apply engine oil to the piston rings.

      Note :
      - Thoroughly apply to the piston rings and the ring grooves.
      - Set the piston rings as shown in the diagram so that the joints are not perpendicular to the piston pin.



PAWC1BSH006701

1. Top ring
2. Second ring
3. Oil ring

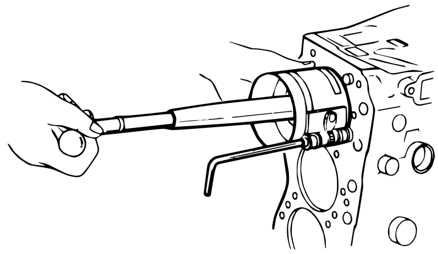
   3. Rotate the crankshaft gear.

      Note :
      - Before installing the pistons, put every cylinder in the top dead center position.
   4. Install the connecting rod bearing to the connecting rod.
   5. Install the piston to the cylinder block using a special tool.

      Note :
      - Face the piston front mark toward the front, and insert the piston into the cylinder block.


5884090180

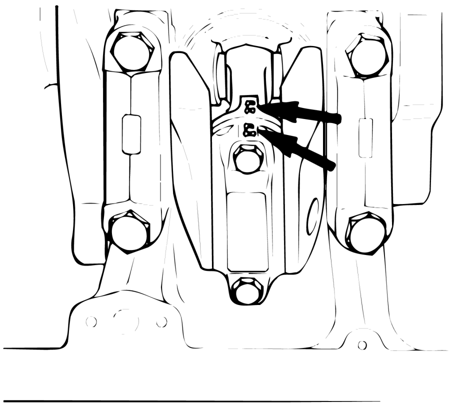
SST: 5-8840-9018-0 - piston setting tool


LNW21BSH072201

   6. Rotate the crankshaft gear.

      Note :
      - Slowly rotate the crankshaft and put each cylinder at bottom dead center.
   7. Apply engine oil to the connecting rod bearing.
   8. Install the connecting rod bearing to the connecting rod bearing cap.
   9. Install the connecting rod bearing cap to the connecting rod.

      Note :
      - Align the cap and the connecting rod number markings, and install the cap.


LNW61ASH004801

10. Apply engine oil to the bolt.

Note :

- Apply to the threaded portion and the seat surface of the tightening bolts.
- Check that the crankshaft turns smoothly after installing the connecting rod.

11. Tighten the bolts using a torque wrench.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft } 1st time

specified angle : 100 ° 2nd time

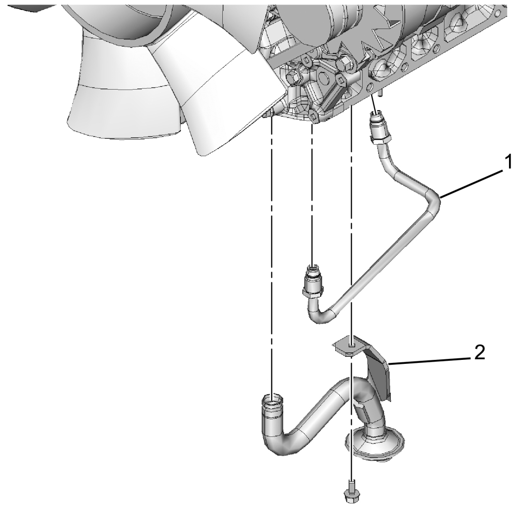
2. Oil strainer installation

1. Apply engine oil to the O-ring.
2. Install the oil strainer to the front oil pump plate and the cylinder block.

tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

3. Install the oil pipe to the front oil pump plate and the cylinder block.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }



PAWC1ESH000901

1. Oil pipe
2. Oil strainer

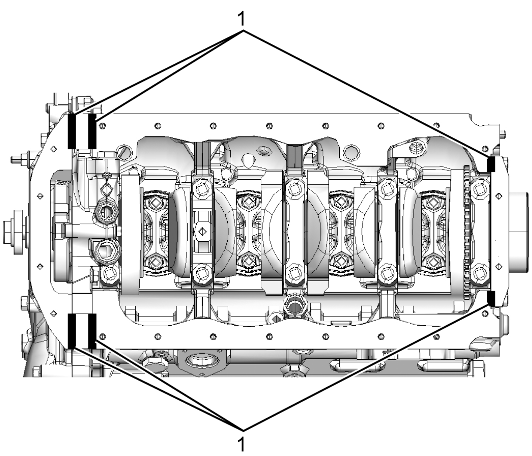
3. Oil pan installation

1. Apply liquid gasket to the cylinder block.

Note :

- Apply ThreeBond 1207B to the installation surface between the cylinder block and the front oil pump plate.

bead width : 3 mm { 0.12 in }



PAWC1ESH000401

1. Liquid gasket application area

2. Install the oil pan to the cylinder block.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

4. Tappet installation

1. Apply engine oil to the tappet.

Note：

- Apply to the bottom surface and the outer circumference of the tappet.

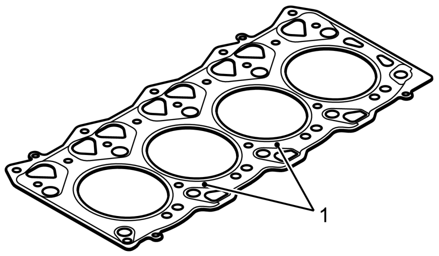
2. Install the tappet to the cylinder block.

5. Cylinder head assembly installation

1. Install the cylinder head gasket to the cylinder block.

Note：

- Install with the marked side facing upward.



PAWC1BSH003301

1. Mark

2. Apply engine oil to the bolt.

Note：

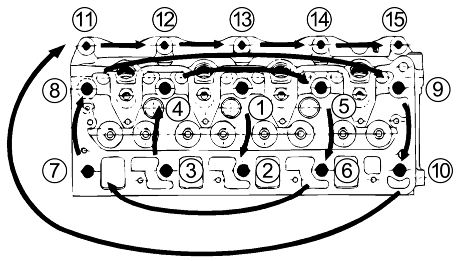
- Apply engine oil to the threaded portion and the seat surface of the head bolt.

3. Install the cylinder head assembly to the cylinder block.

4. Tighten the head bolts using a torque wrench.

Note：

- Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



PAWC1BSH004001

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle： 60 ° 3rd time

Note：

- Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

6. Push rod installation

1. Install the push rod to the cylinder block.

Note：

- Pass it through the cylinder block and insert it into the tappet.

7. Rocker arm bracket installation

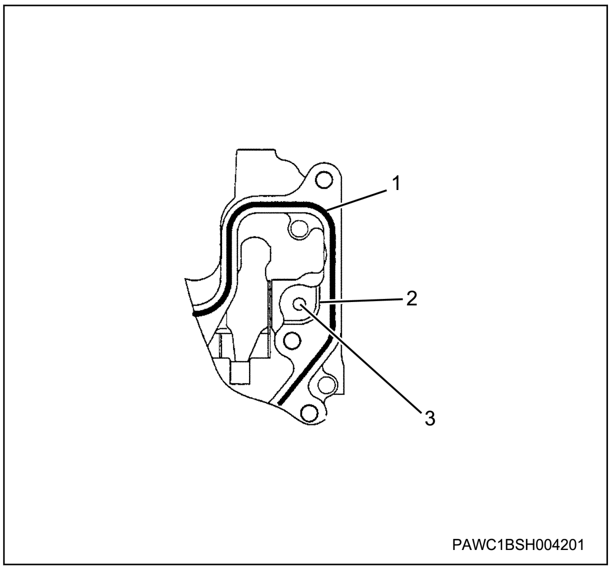
1. Apply liquid gasket to the rocker arm bracket.

Note：

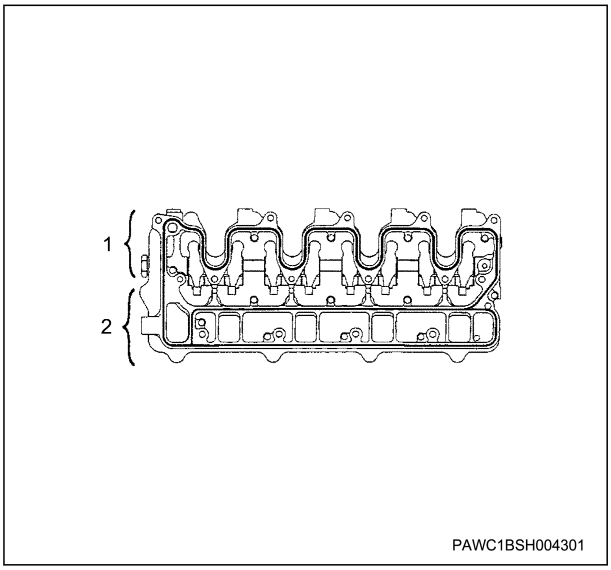
- Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

Caution：

- Do not apply liquid gasket to the groove around the oil gallery.



1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



1. Liquid gasket application area
2. Oil gallery groove

Note：

- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note：

- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.
4. Securely tighten the rocker arm bracket to the cylinder head.

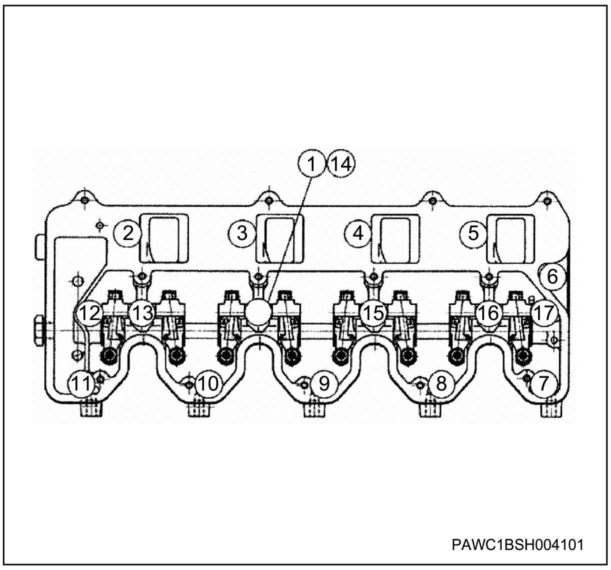
Note：

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution：

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



8. Rocker arm shaft adjustment

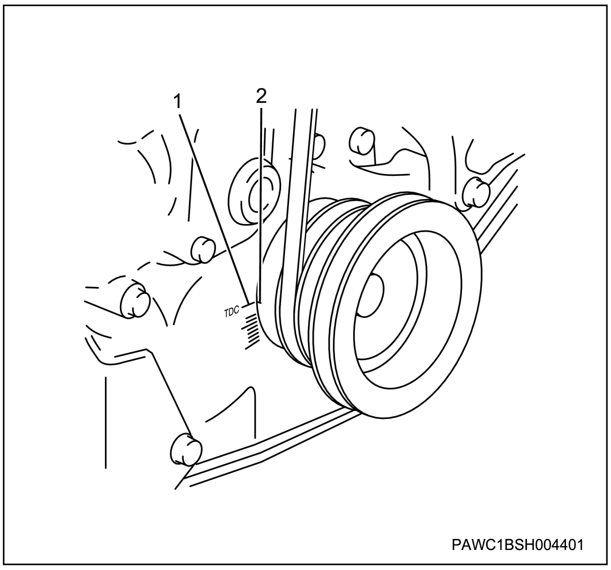
Note：

- Valve clearance adjustment

Caution：

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note：

- Insert the feeler gauge between the rocker arm and the bridge cap.

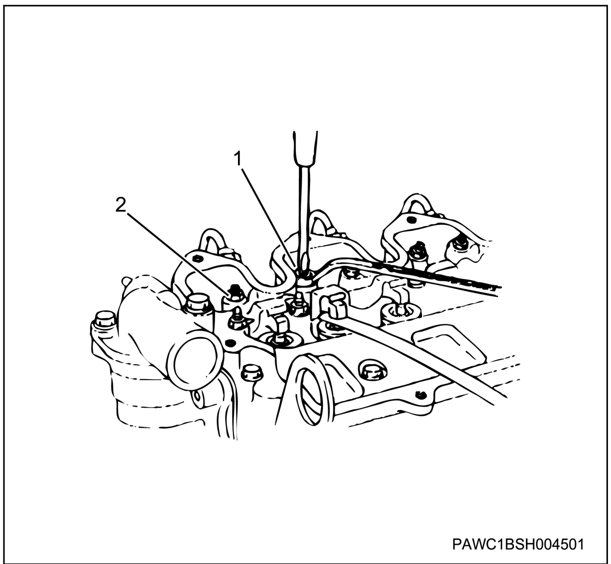
specified value： 0.40 mm { 0.016 in } Inlet valve

specified value： 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note：

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



1. Adjust screw
2. Lock nut

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note：

- Rotate the crankshaft in the forward direction and measure the valve clearance.

Caution：

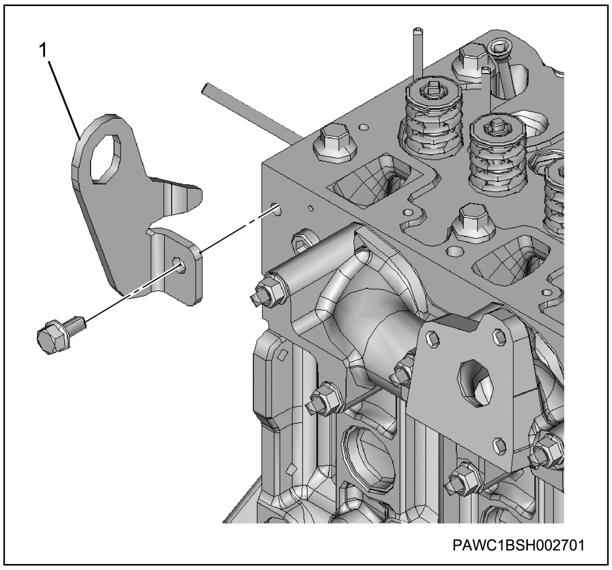
- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

9. Engine hanger installation

1. Install the engine hanger to the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }

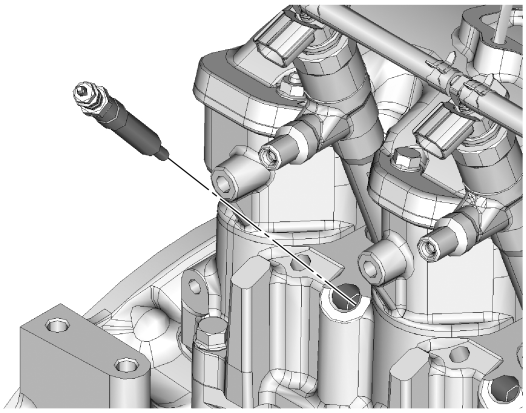


1. Engine hanger

10. Glow plug installation

1. Install the glow plug to the cylinder head.

tightening torque： 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1JSH000201

11. Glow plug connector installation

1. Install the glow plug connector to the glow plug.

tightening torque : 1.0 N・m { 0.1 kgf・m / 9 lb・in }

12. Injector installation

Caution :

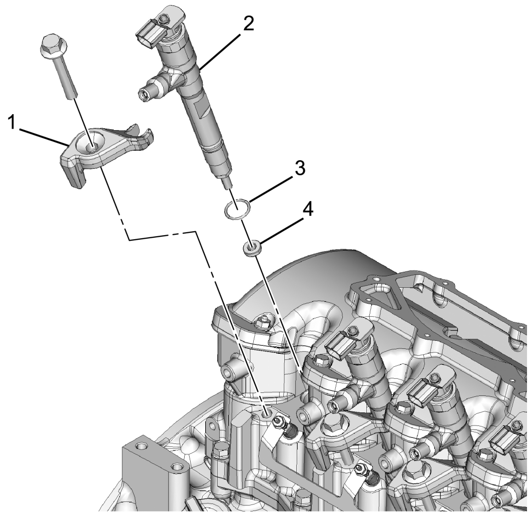
- Do not change the installation position of the injectors when reusing the injectors.

1. Install the O-ring to the injector.
2. Install the injector gasket to the injector.

Note :

- Do not reuse the injector gasket or the O-ring.

3. Temporarily tighten the injector to the cylinder head assembly.

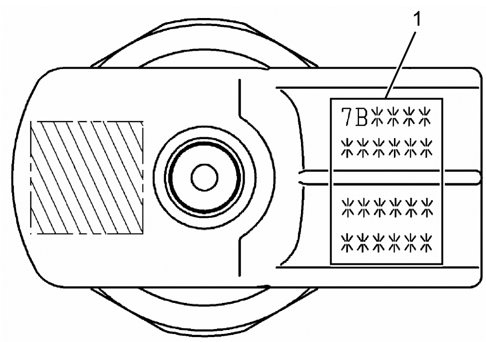


PAWC1CSH000601

1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Caution :

- If the injector has been replaced, record the injector ID code of the new injector.



PAWC1CSH000701

1. Injector ID code

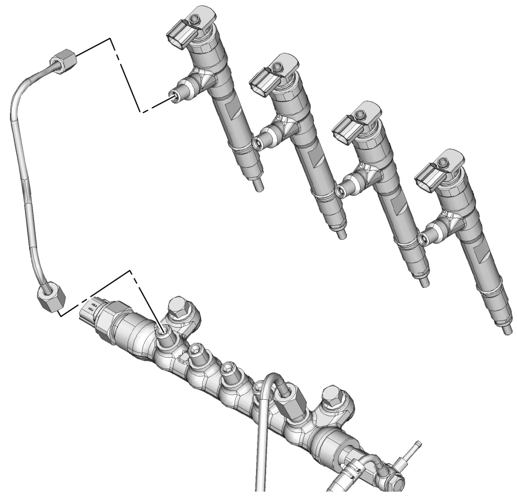
4. Connect the harness connector to the injector.

13. Injection pipe installation

1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note :

- Do not reuse the injection pipe.



PAWC1CSH000501

2. Securely tighten the injector to the cylinder head assembly.

tightening torque : 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

・ Securely tighten the injector side.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

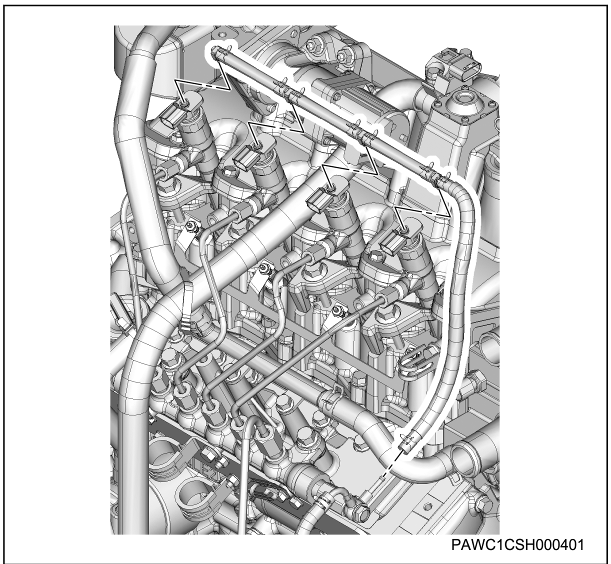
Note：

・ Securely tighten the common rail (fuel rail) side.

tightening torque： 30 N・m { 3.1 kgf・m / 22 lb・ft }

14. Fuel leak-off hose installation

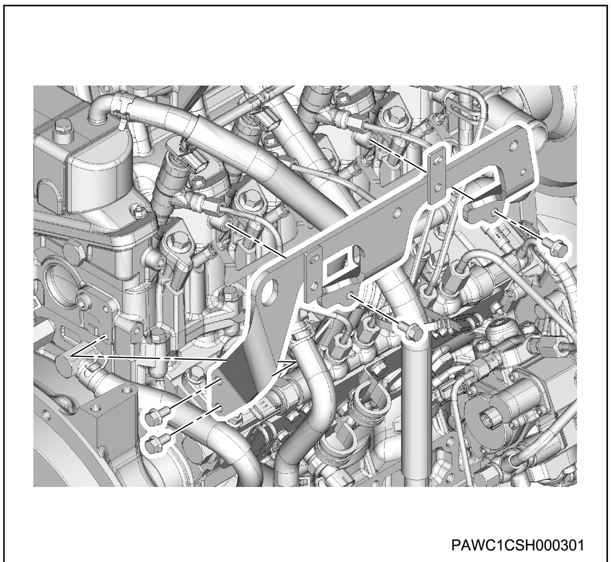
1. Install the fuel leak-off hose to the injector.



15. Harness bracket installation

1. Install the harness bracket to the cylinder head.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

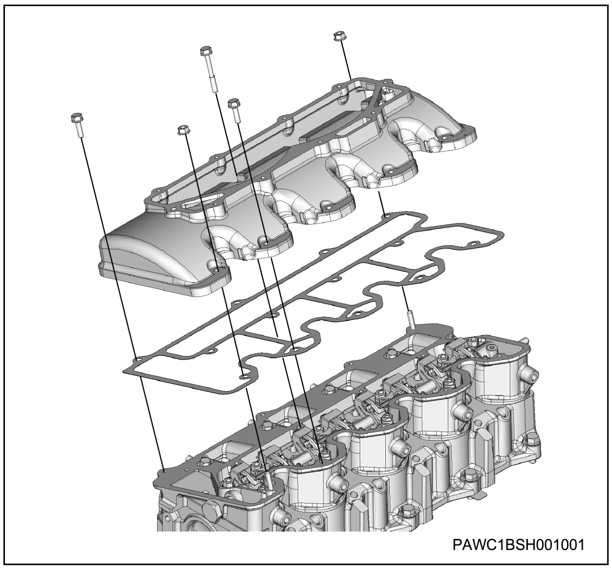


2. Connect the engine harness to the harness bracket.

16. Cylinder head cover installation

1. Install the cylinder head cover to the rocker arm bracket.

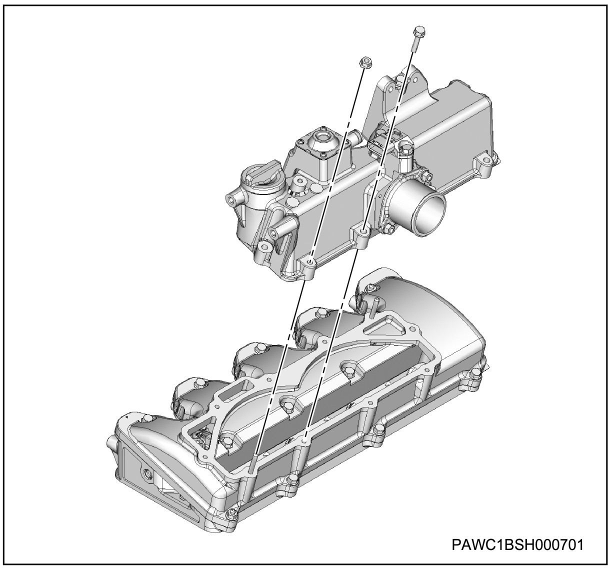
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



17. Intake chamber installation

1. Install the intake chamber to the cylinder head cover.

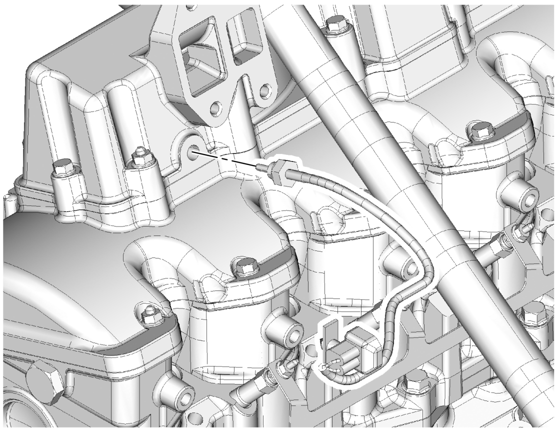
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



18. IMT sensor installation

1. Install the IMT sensor to the intake chamber.

tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



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2. Connect the harness connector to the IMT sensor.

19. PCV hose installation

1. Install the PCV hose to the intake chamber.

20. EGR valve installation

1. Temporarily tighten the EGR valve to the intake chamber.
2. Temporarily tighten the EGR pipe to the exhaust manifold.
3. Temporarily tighten the EGR pipe to the EGR valve.
4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

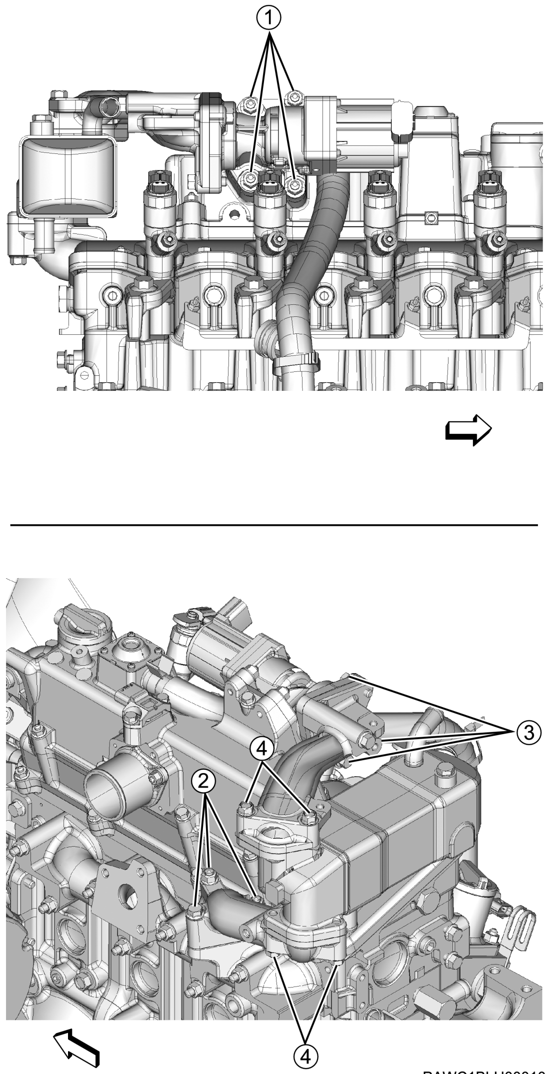
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



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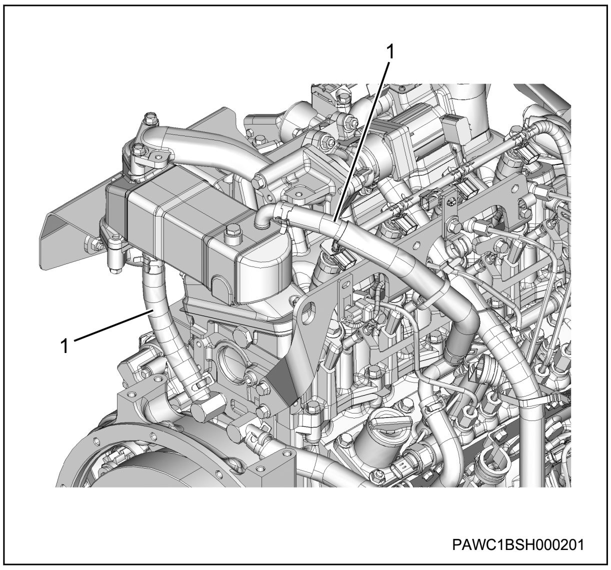
Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

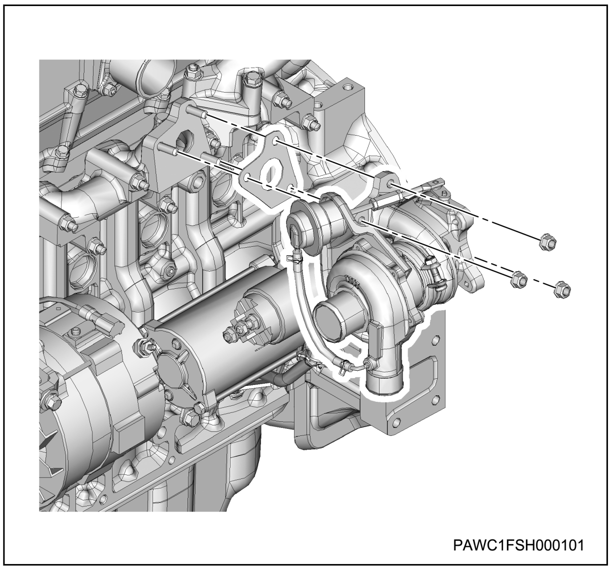
21. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note：

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



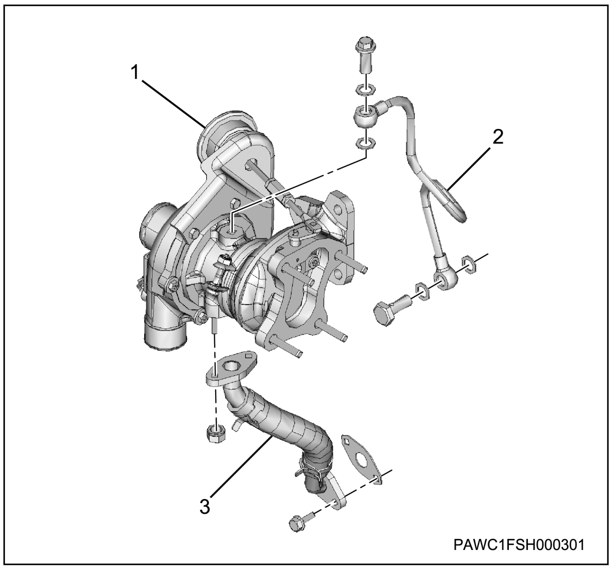
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }
Cylinder block side

tightening torque： 22 N・m { 2.2 kgf・m / 16 lb・ft }
Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

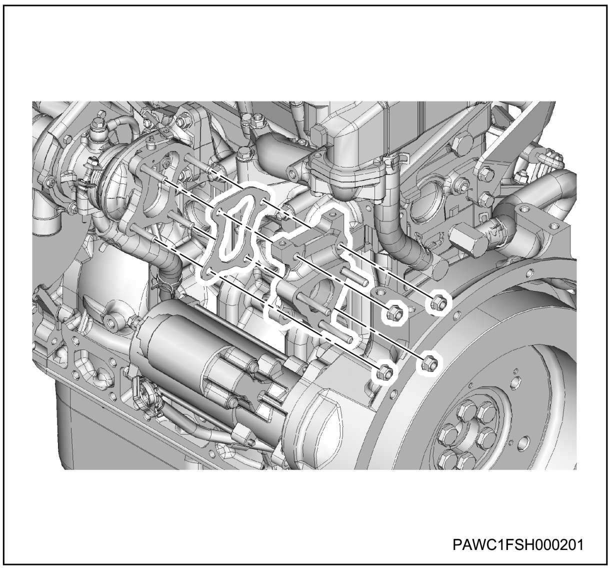
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

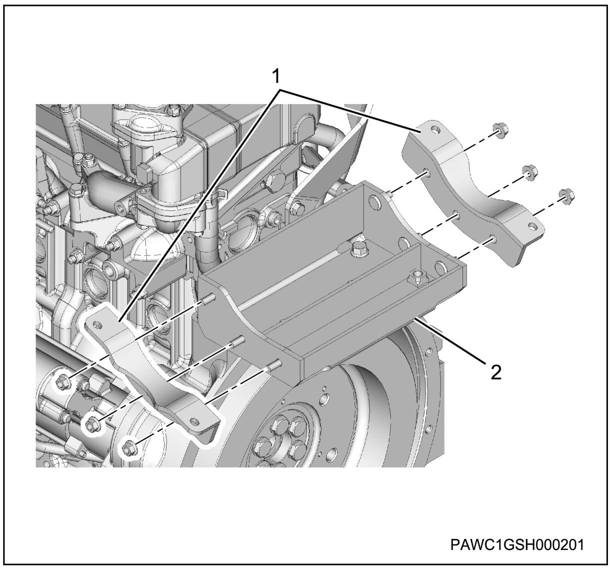
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



22. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

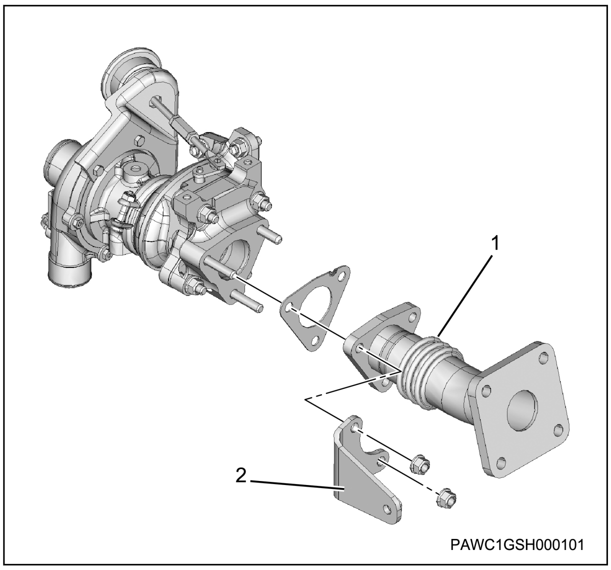


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note :

- Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

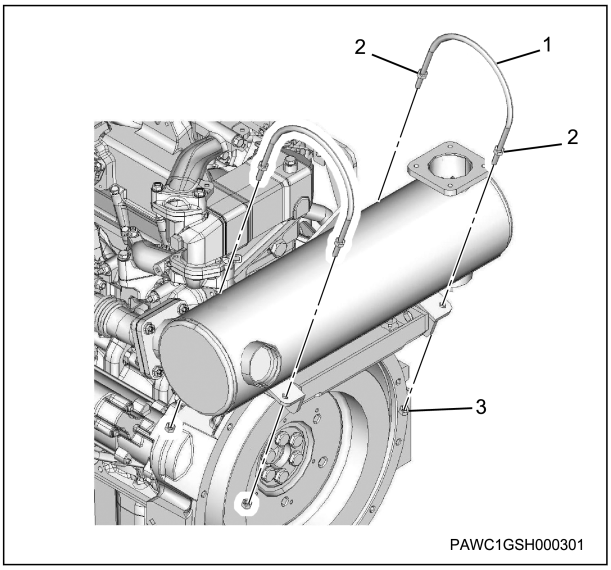
Note :

- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque : 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution :

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note :

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque : 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

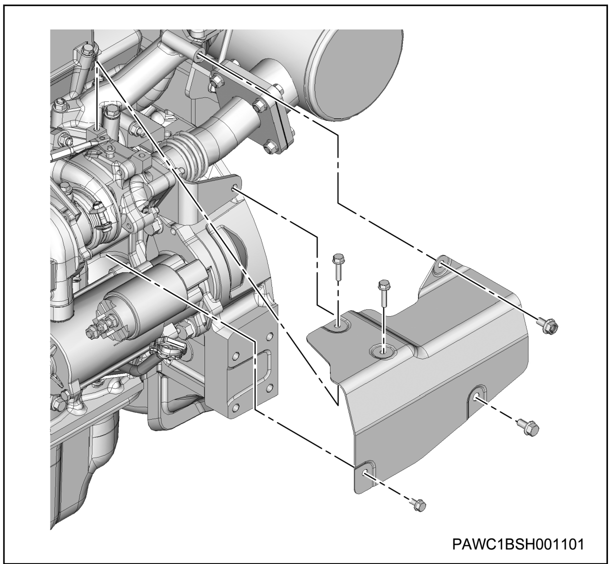
tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

23. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M6



24. Pressure sensor/boost temperature sensor connect
    1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

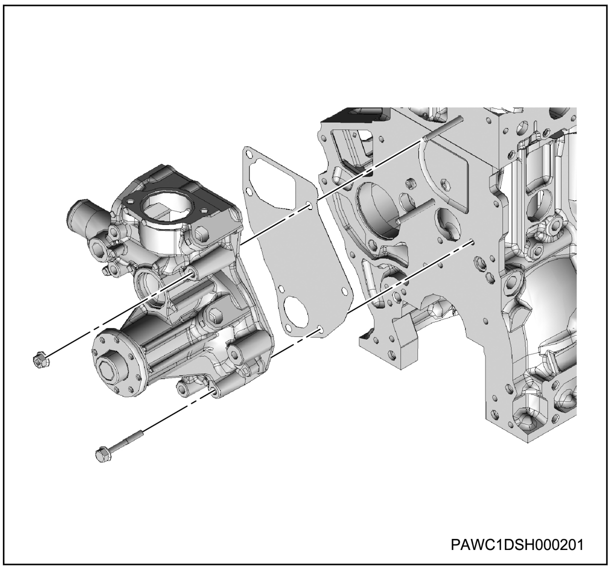
・ Install the harness clip.

25. Water pump assembly installation
    1. Install the water pump assembly to the cylinder block and the cylinder head.

Note：

・ Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }



26. Water hose connect
    1. Connect the water hose to the water pump assembly.

Note：

・ Install the hose clip.

27. Engine coolant temperature sensor connect
    1. Connect the harness connector to the engine coolant temperature sensor.
28. Generator installation
    1. Install the adjust plate to the water pump assembly.

tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

2. Temporarily tighten the generator to the generator bracket.
3. Temporarily tighten the generator to the adjust plate.

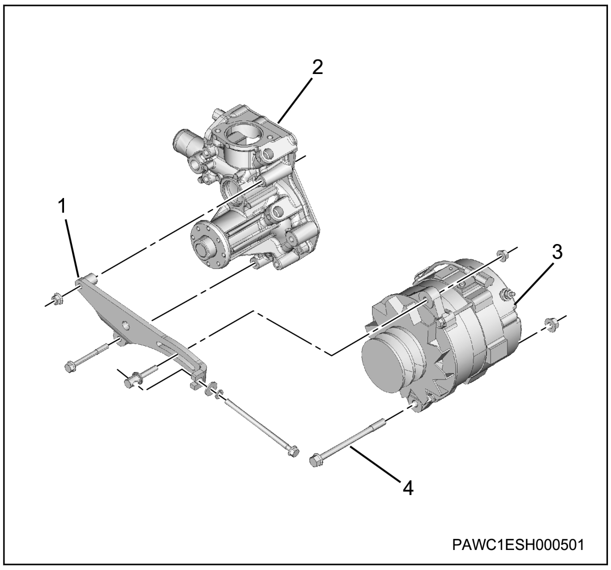
Note：

・ Securely tighten the bolt and the nut after adjusting the cooling fan belt.

4. Connect the harness connector to the generator.

Note：

・ The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

29. Fan pulley installation
   1. Install the fan pulley to the water pump assembly.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

30. Cooling fan belt installation
   1. Install the cooling fan belt to the pulley.

31. Cooling fan belt adjustment
   1. Check the tension of the cooling fan belt.

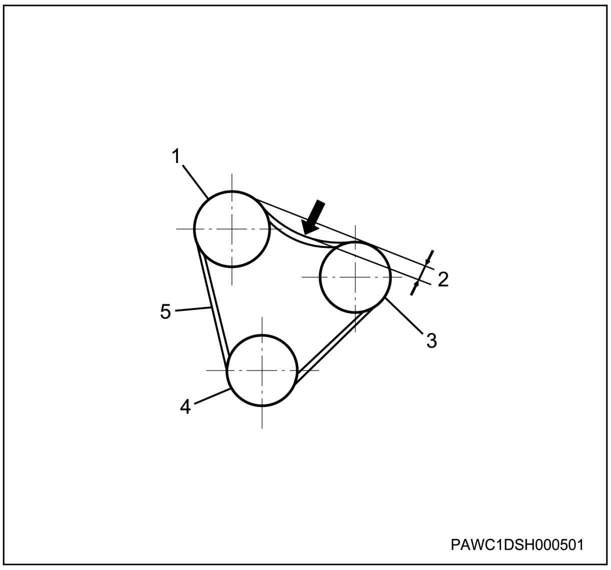
Note :

・ Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard : 98 N { 10.0 kg / 22 lb }

specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

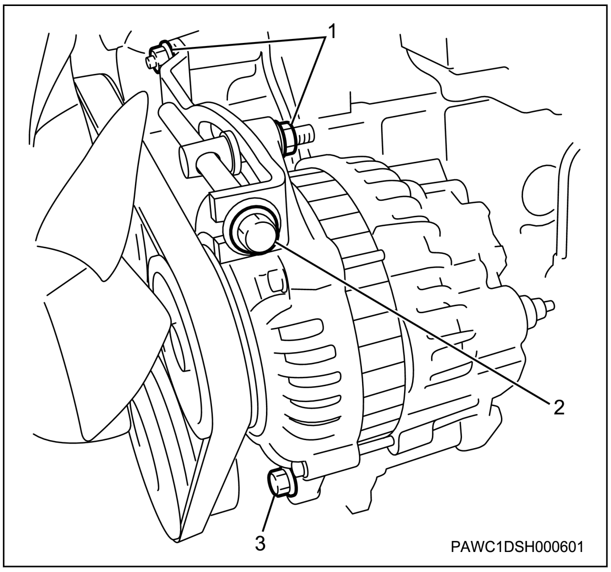


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

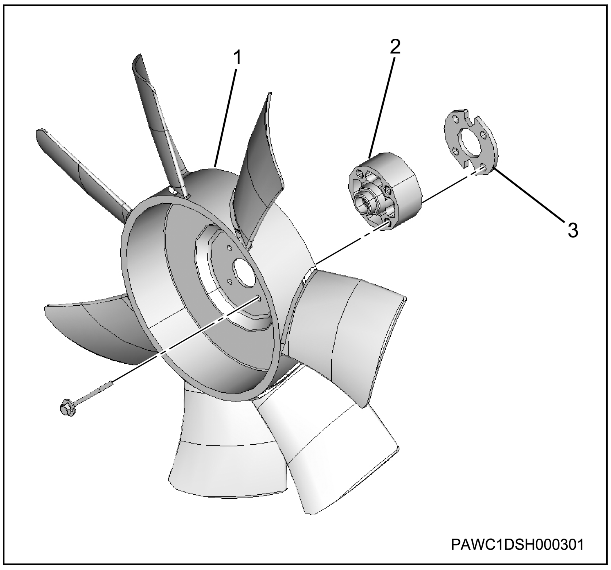
tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25



1. Nut
2. Adjust bolt
3. Mounting bolt

32. Cooling fan installation
   1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

33. Engine oil filling
    1. Refill the engine with engine oil.

Note :

- Check the tightening of the oil pan drain plug again.

34. Coolant filling
    1. Loosen the plug using a wrench.
    2. Replenish the radiator with coolant.

Caution :

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

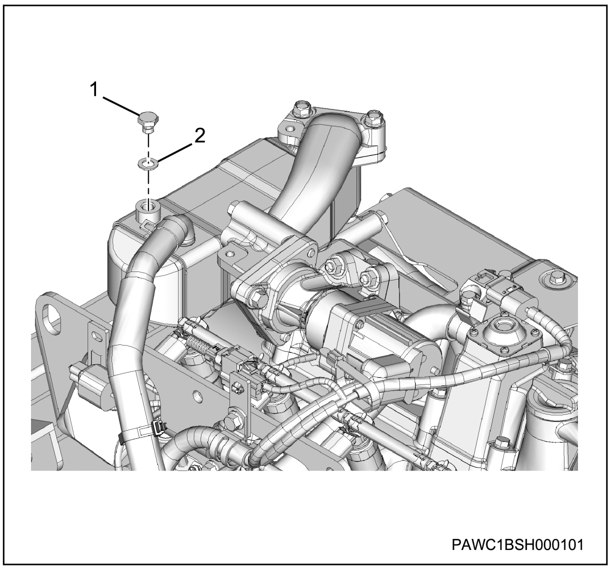
    3. Tighten the plug using a wrench.

Caution :

- Use a new gasket.

tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

    4. Replenish the radiator with coolant.



1. Plug
2. Gasket

35. Battery ground cable connect
    1. Connect the battery ground cable to the battery.

Camshaft

removal

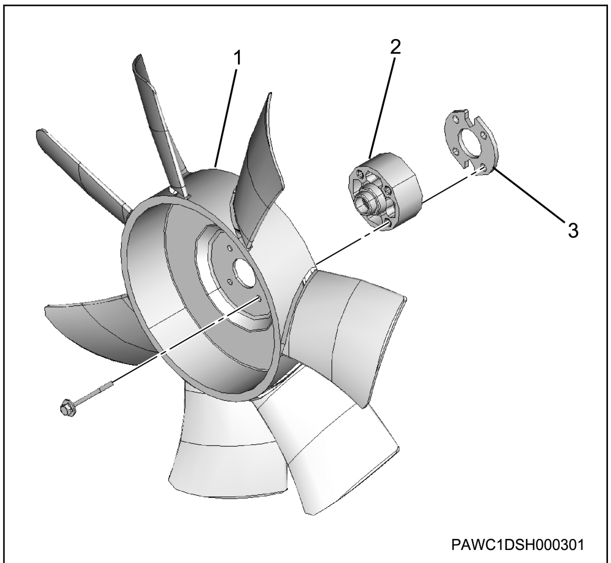
1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Engine oil drain
   1. Drain the engine oil from the oil pan.

   Note :
   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

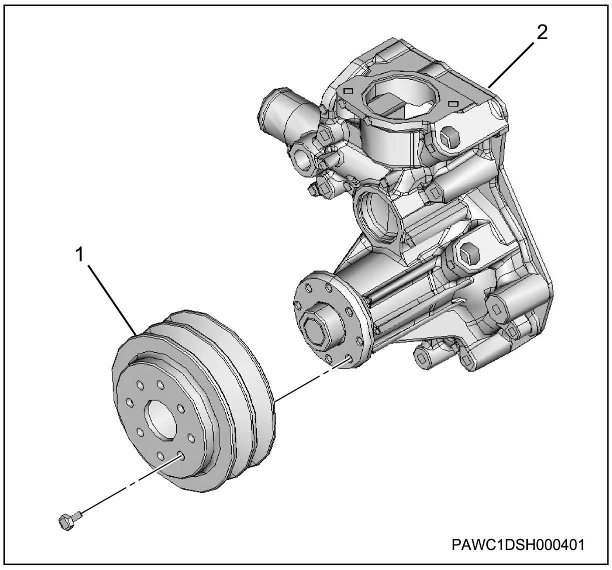
   Caution :
   - Do not forget to tighten the drain plug.
4. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



1. Cooling fan
2. Adapter
3. Spacer

5. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

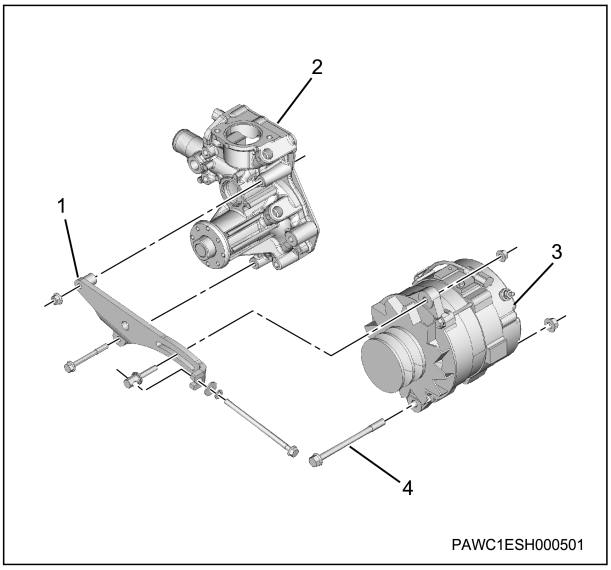
   Note :
   - Loosen the generator adjust bolt and remove the belt.
6. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.



1. Fan pulley
2. Water pump assembly

7. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :
   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate

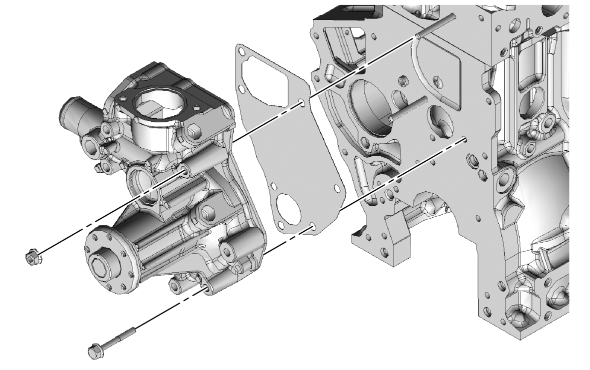
2. Water pump assembly
3. Generator
4. Bolt

8. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
9. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

Note:
- Remove the hose clip.

10. Water pump assembly removal
    1. Remove the water pump assembly from the cylinder block and the cylinder head.

Note:
- Remove the water pump assembly and the gasket.



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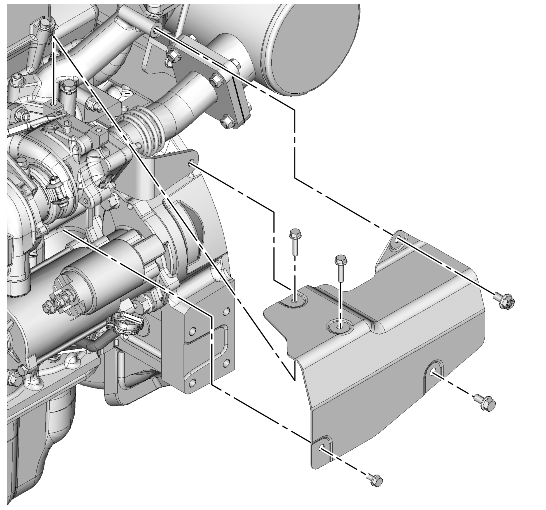
11. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

Note:
- Remove the harness clip.

12. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.



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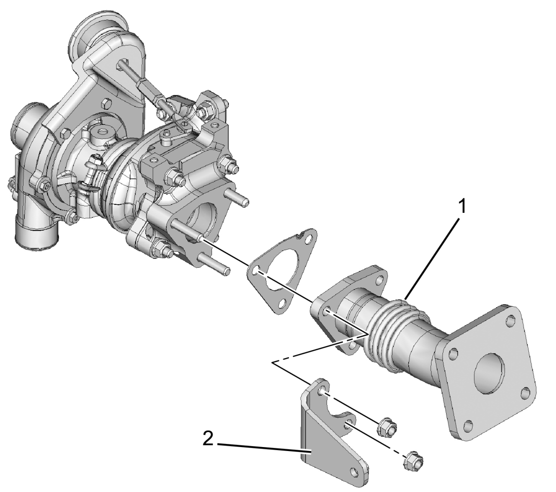
13. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

Note:
- Remove together with the bracket.



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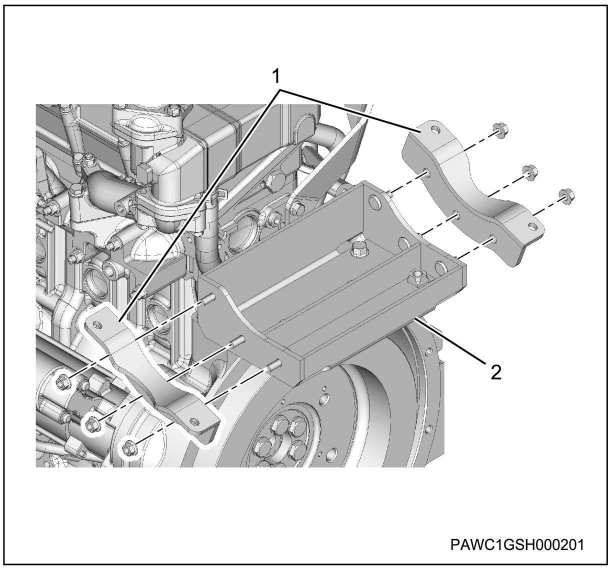
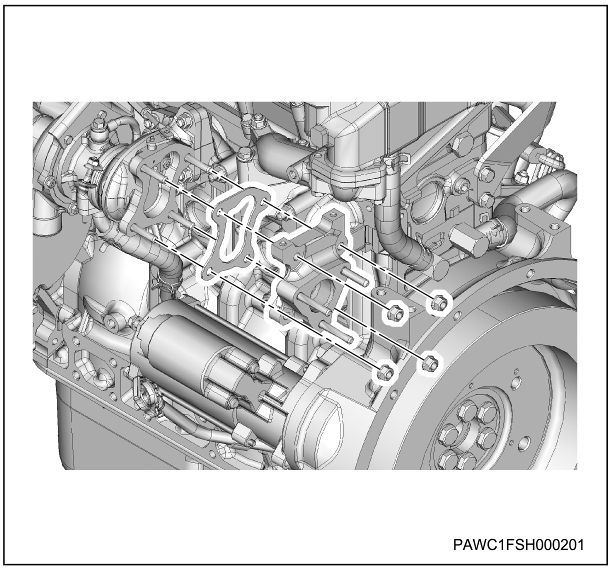
1. Exhaust pipe
2. Bracket

3. Remove the support bracket from the silencer bracket.

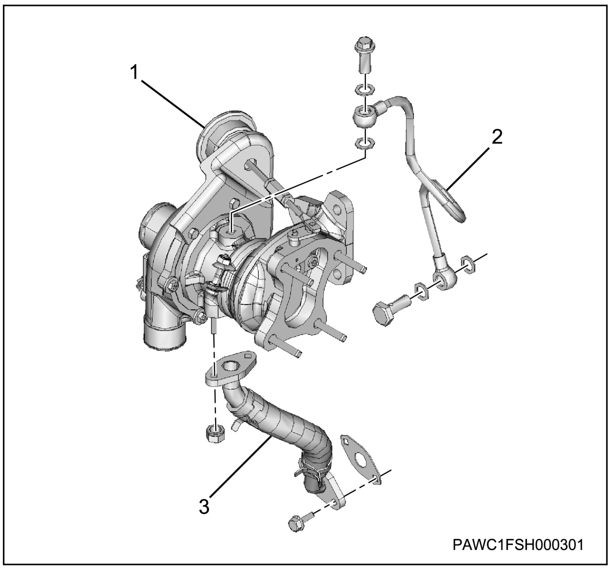


1. Support bracket
2. Silencer bracket

14. Turbocharger assembly removal
    1. Remove the exhaust pipe adapter from the turbocharger assembly.

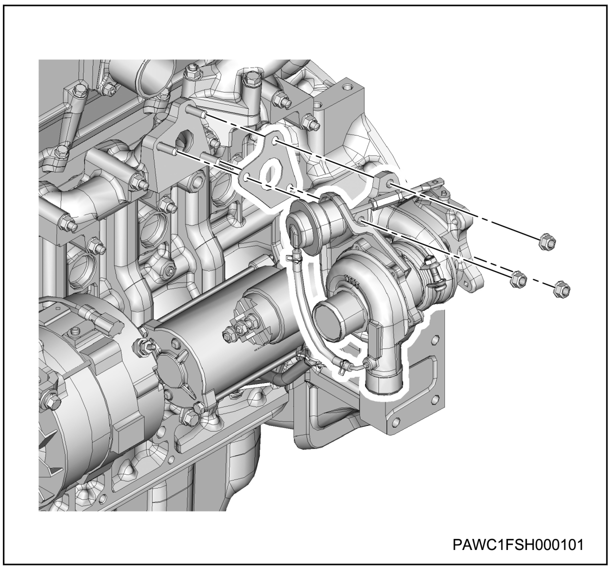


    2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
    3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.

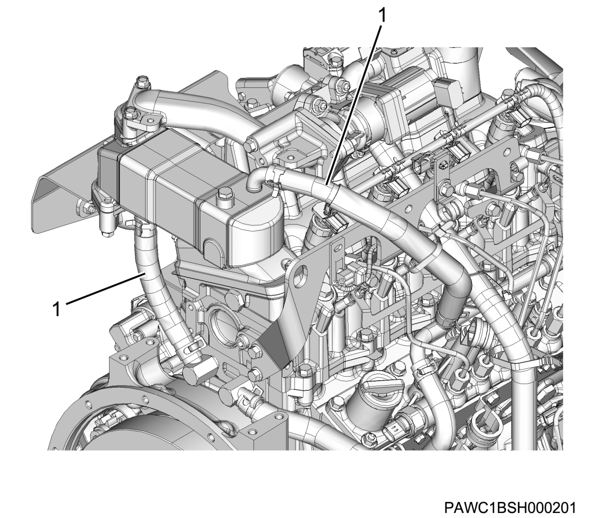


1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

    4. Remove the turbocharger assembly from the exhaust manifold.



15. EGR valve removal
    1. Disconnect the harness connector from the EGR valve.
    2. Disconnect the harness clip from the EGR pipe.
    3. Disconnect the water rubber hose from the EGR cooler assembly.



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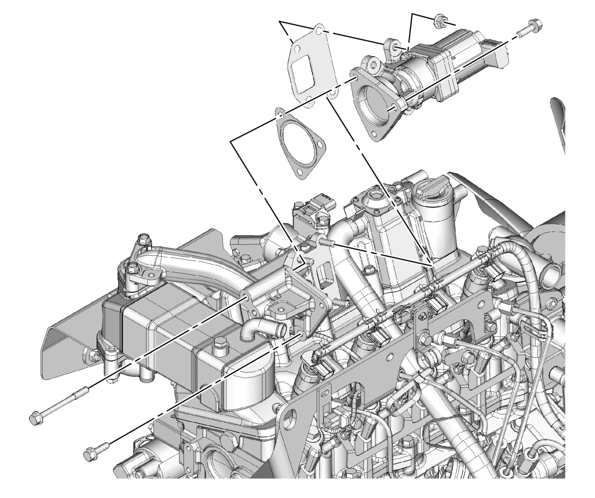
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.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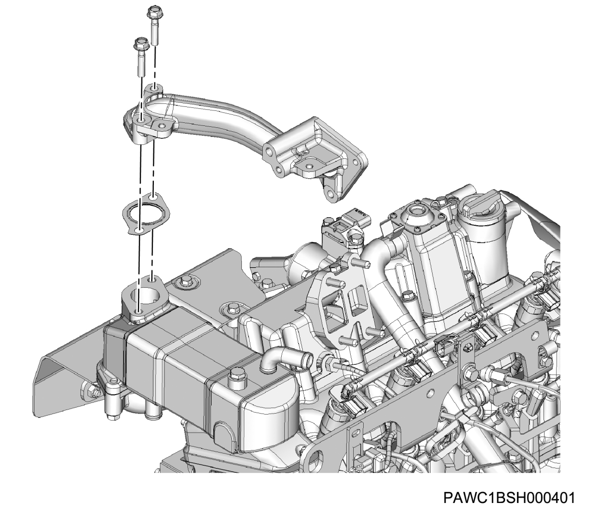
5. Remove the EGR pipe from the EGR cooler.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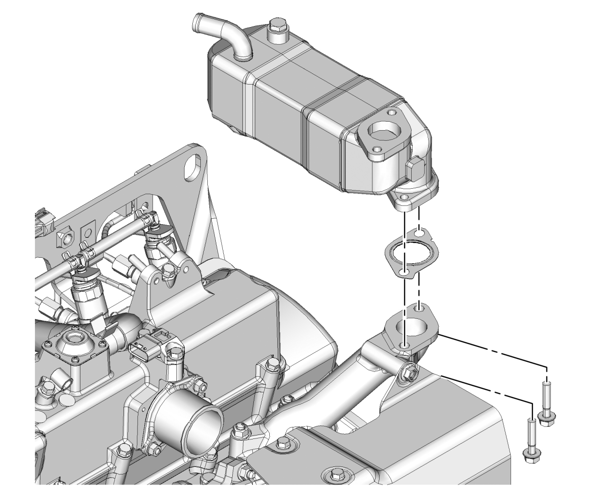
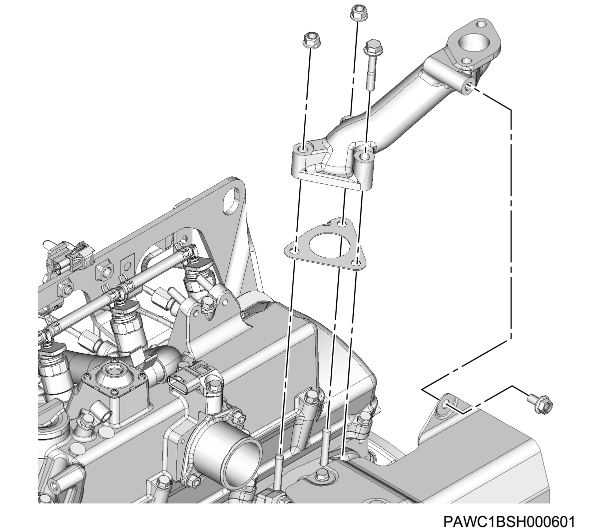
6. Remove the EGR cooler from the EGR pipe.


PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.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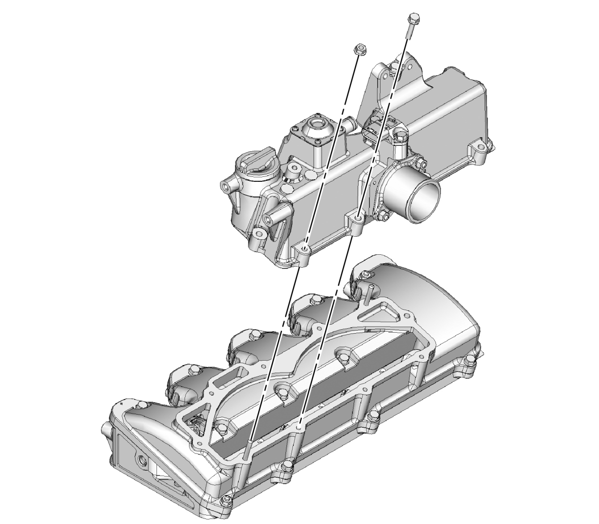
16. PCV hose removal
    1. Remove the PCV hose from the intake chamber.
17. IMT sensor removal
    1. Disconnect the harness connector from the IMT sensor.
    2. Remove the IMT sensor from the intake chamber.
18. Intake chamber removal
    1. Remove the intake chamber from the cylinder head cover.



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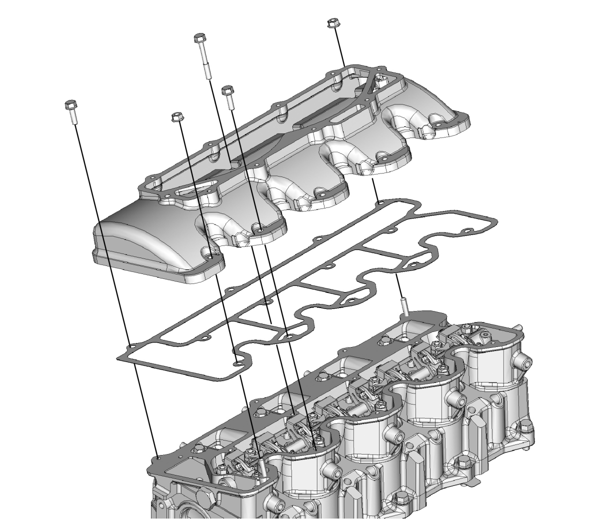
19. Cylinder head cover removal
    1. Remove the cylinder head cover from the rocker arm bracket.



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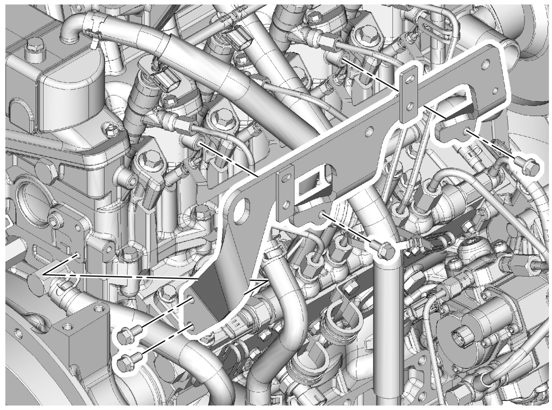
20. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



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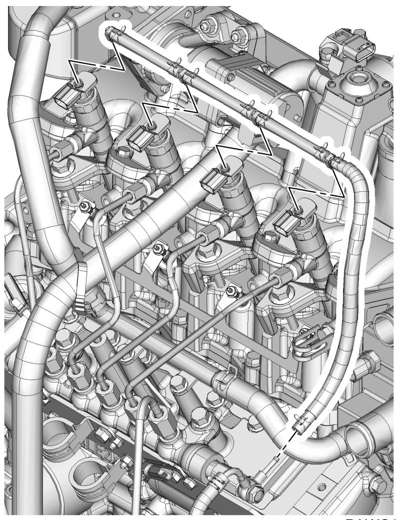
21. Fuel leak-off hose removal
    1. Remove the fuel leak-off hose from the injector.



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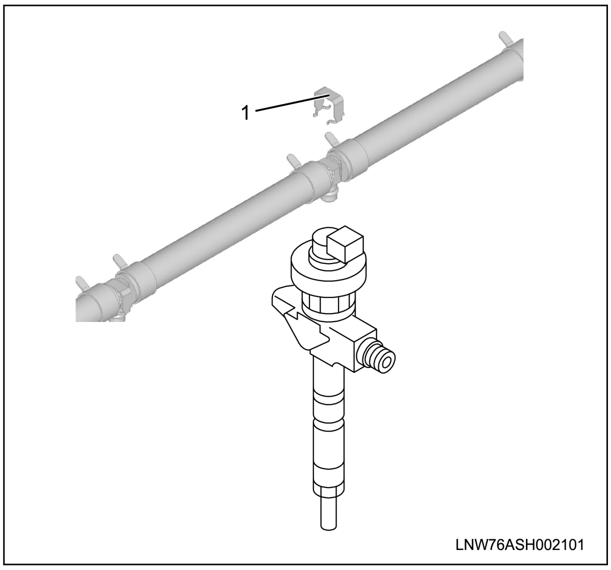
Note：

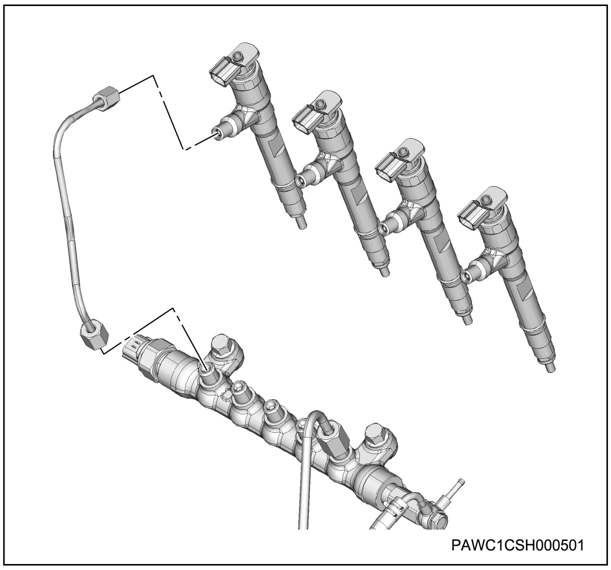
- Do not reuse the leak-off pipe clip.



1. Clip

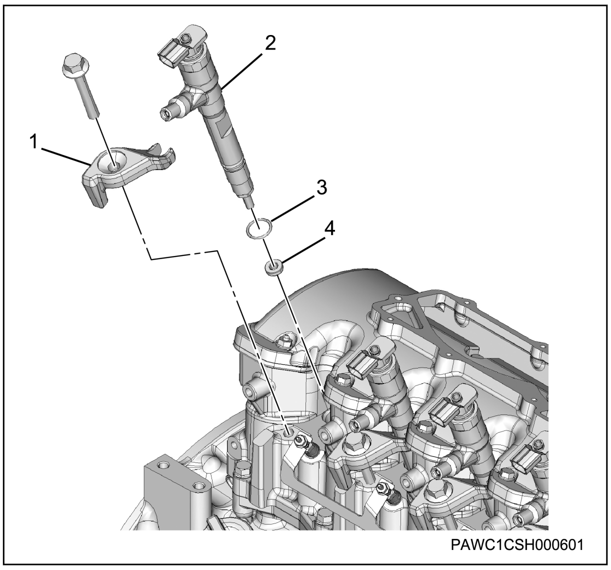
22. Injection pipe removal
    1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note :
- Do not reuse the injection pipe.



23. Injector removal
    1. Disconnect the harness connector from the injector.
    2. Remove the injector from the cylinder head assembly.
    3. Remove the injector gasket from the injector.
    4. Remove the O-ring from the injector.

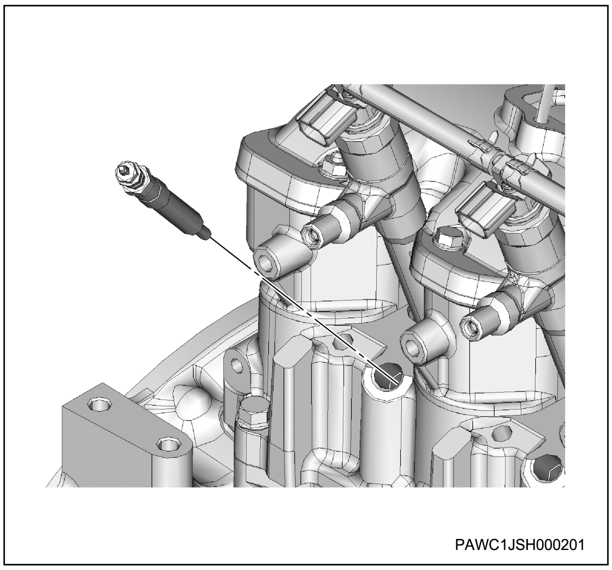
Note :
- Do not reuse the injector gasket or the O-ring.



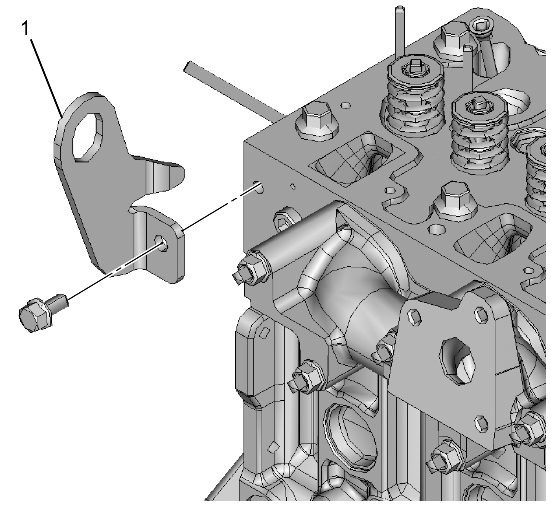
1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Note :
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

24. Glow plug connector removal
    1. Remove the glow plug connector from the glow plug.
25. Glow plug removal
    1. Remove the glow plug from the cylinder head.



26. Engine hanger removal
    1. Remove the engine hanger from the cylinder head.



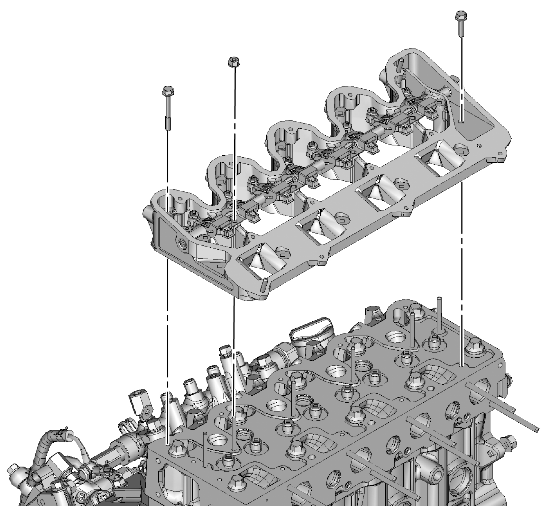
PAWC1BSH002701

1. Engine hanger

27. Rocker arm bracket removal
   1. Remove the rocker arm bracket from the cylinder head.

Caution :

- Be careful not to damage the rocker arm bracket when removing.

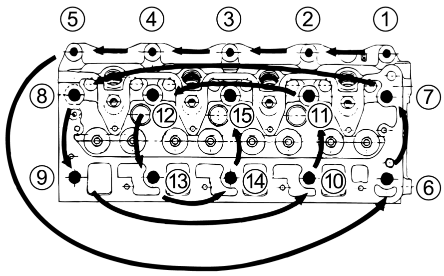


PAWC1BSH002901

28. Push rod removal
   1. Remove the push rod from the cylinder block.
29. Cylinder head assembly removal
   1. Remove the cylinder head assembly from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



PAWC1BSH002801

2. Remove the cylinder head gasket from the cylinder block.

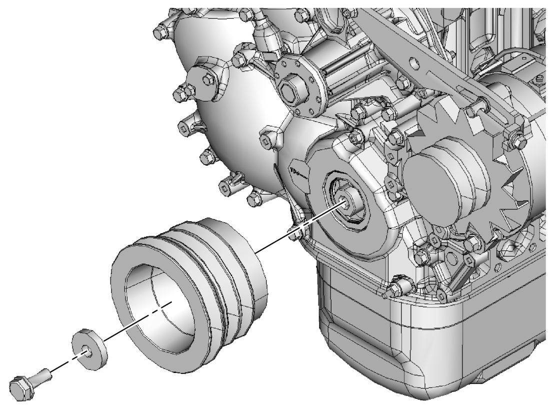
30. Tappet removal
   1. Remove the tappet from the cylinder block.
31. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

Note :

- Remove after stopping the crankshaft from turning.

Caution :

- Do not reuse the bolt and the washer.



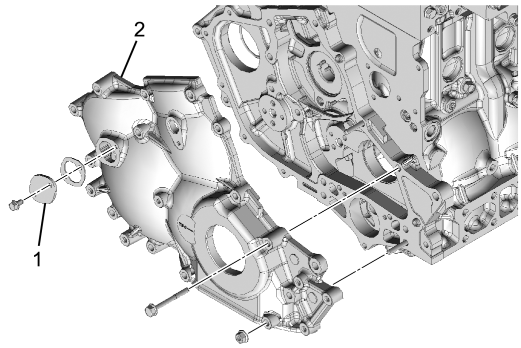
PAWC1BSH001601

32. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.

3. Remove the O-ring from the CMP sensor.

33. Timing gear case removal

1. Remove the idle gear cover from the timing gear case.
2. Remove the timing gear case from the front oil pump plate.

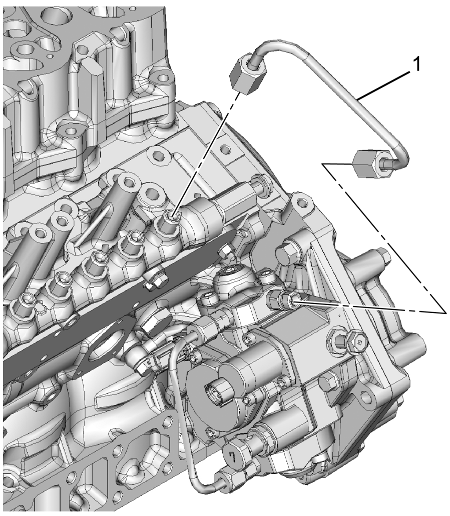


PAWC1ESH000701

1. Idle gear cover
2. Timing gear case

34. Fuel pipe removal

1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



PAWC1CSH000201

1. Fuel pipe

35. Fuel return pipe removal

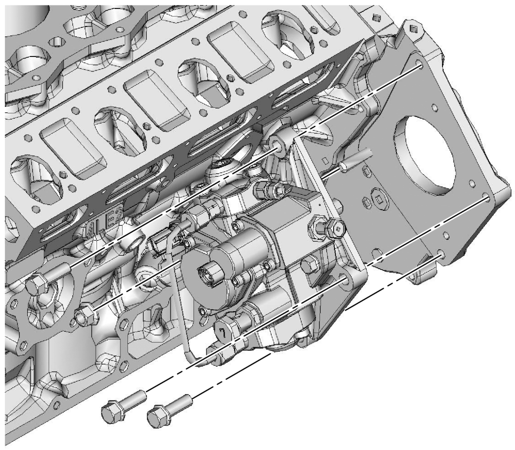
1. Remove the fuel return pipe from the fuel supply pump.

36. Fuel supply pump removal

1. Disconnect the harness connector from the fuel supply pump.
2. Remove the fuel supply pump from the front oil pump plate.

Note：

- Remove the tightening bolts, and remove together with the bracket.



PAWC1CSH000101

37. Idle gear A measurement

Caution：

- Before removing the idle gear, measure the end play of the gear.

1. Measure the backlash using a dial gauge.

Note：

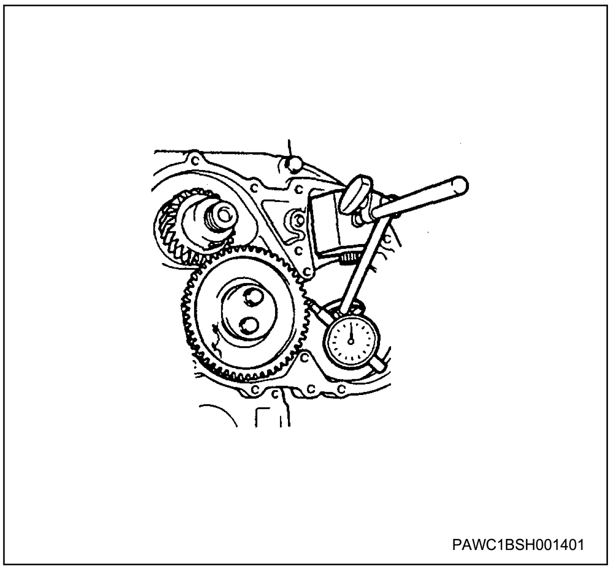
- Install the dial gauge as shown in the diagram, and measure by turning the gear left and right.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.04 mm { 0.0016 in } Crank gear, idle gear

limit： 0.2 mm { 0.008 in } Crank gear, idle gear

specified value： 0.03 mm { 0.0012 in } Camshaft gear, idle gear

limit： 0.2 mm { 0.008 in } Camshaft gear, idle gear



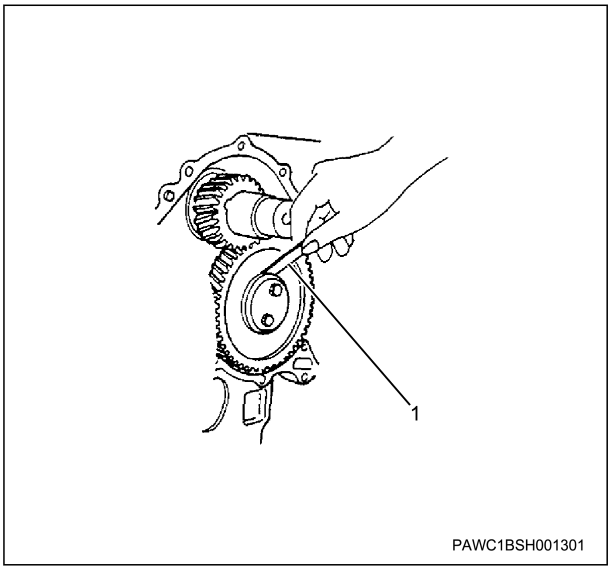
2. Measure the idle gear using a feeler gauge.

Note :

- Measure the gap between the idle gear and the thrust collar.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.058 to 0.115 mm { 0.0023 to 0.0045 in }

limit : 0.2 mm { 0.008 in }



1. Feeler gauge

38. Idle gear B removal

1. Remove idle gear B from the idle gear shaft.

Note :

- Remove the idle gear B shaft and the thrust plate.

39. Idle gear A removal

1. Remove idle gear A from the idle gear shaft.

Note :

- Remove the idle gear A shaft and the thrust plate.

40. Camshaft gear removal

1. Remove the camshaft gear from the camshaft.

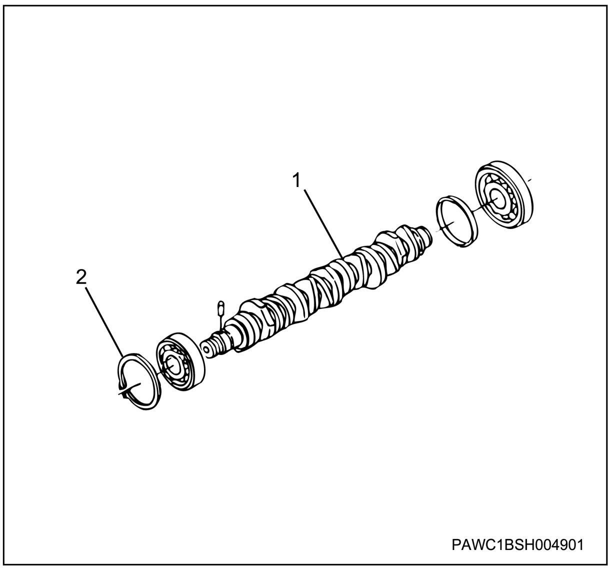
41. Camshaft removal

1. Remove the camshaft from the cylinder block.

Note :

- Remove the snap ring, and pull the camshaft from the cylinder block together with the bearing.

2. Remove the camshaft bearing from the camshaft.



1. Camshaft
2. Snap ring

inspection

1. Camshaft inspection
   1. Inspect the camshaft.

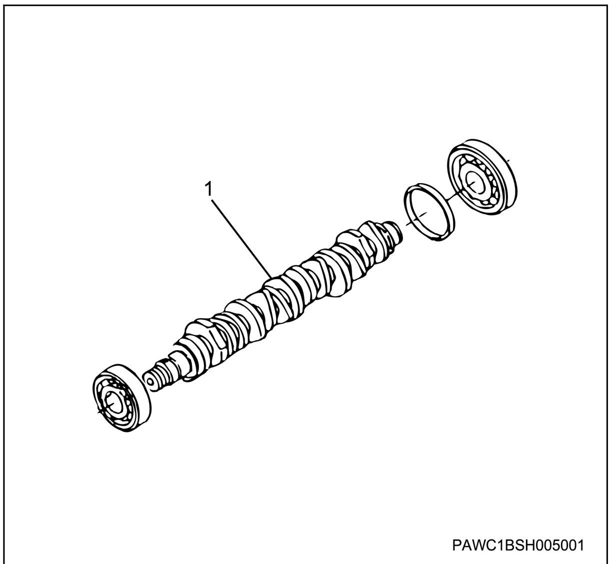
      Note：

      - Inspect the camshaft journal and cam sections for wear or damage.

   2. Inspect the camshaft bearing.

      Note：

      - Verify that the ball bearing and roller bearing of the camshaft rotates smoothly.



1. Camshaft

2. Camshaft measurement
   1. Measure the camshaft using a micrometer.

      Note：

      - Measure the cam height.
      - If the measured value exceeds the limit, replace the camshaft.

      specified value： 6.13 mm { 0.241 in } Inlet

      limit： 5.83 mm { 0.230 in } Inlet

      specified value： 6.43 mm { 0.253 in } Exhaust

      limit： 6.13 mm { 0.241 in } Exhaust

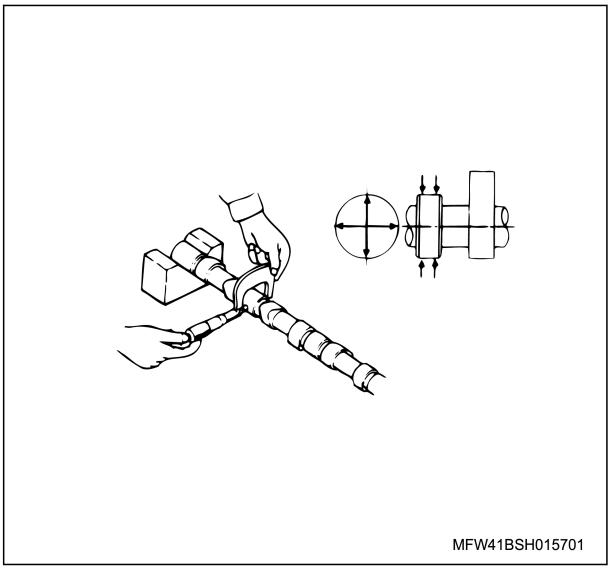
   2. Measure the camshaft journal using a micrometer.

      Note：

      - If the measured value exceeds the limit, replace the camshaft.

      specified value： 52 mm { 2.047 in }

      limit： 51.92 mm { 2.044 in }



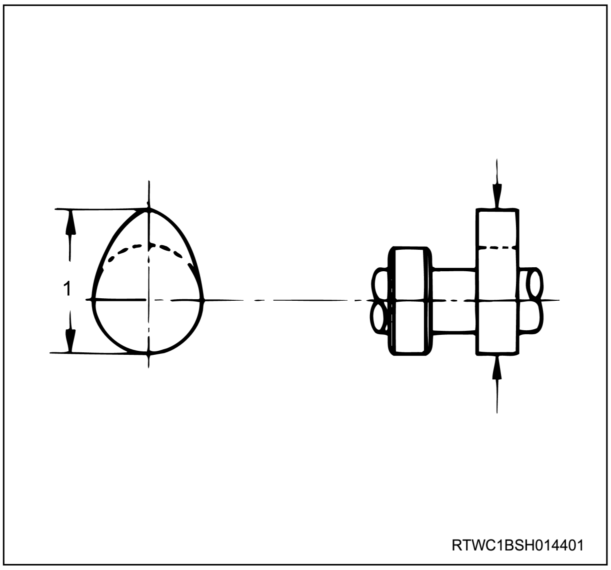
Note：

- Inspect the journal for uneven wear.
- Check the difference of the X axis and Y axis dimensions.

limit： 0.05 mm { 0.002 in }

Note：

- If the measured value exceeds the limit, replace the camshaft.



1. Cam lobe height

3. Put the camshaft on a V-block.
4. Measure the camshaft using a dial gauge.

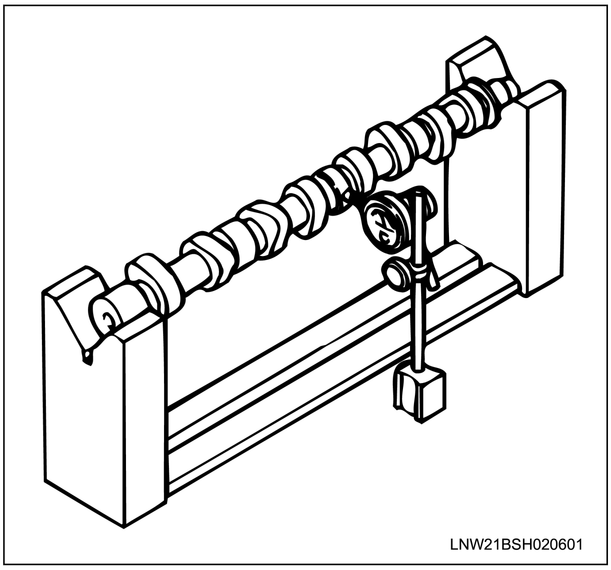
   Note：

   - With the dial gauge contacting the center journal section, gently rotate the camshaft one turn and measure the runout.

- If the measured value exceeds the limit, replace the camshaft.

specified value： less than 0.02 mm { less than 0.0008 in }

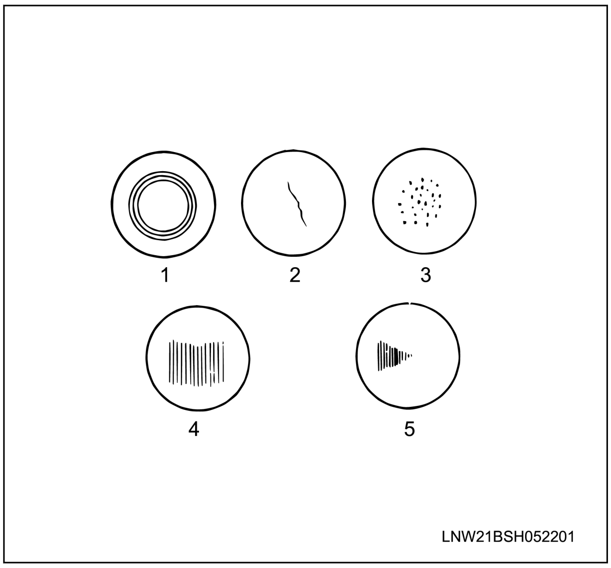
limit： 0.1 mm { 0.0039 in }



3. Tappet inspection
   1. Inspect the tappet.

Note：

- Visually inspect the contact status of the tappet and replace it when obvious damage or wear is found.



1. Normal contact
2. Cracking
3. Pitting
4. Uneven contact
5. Partial contact

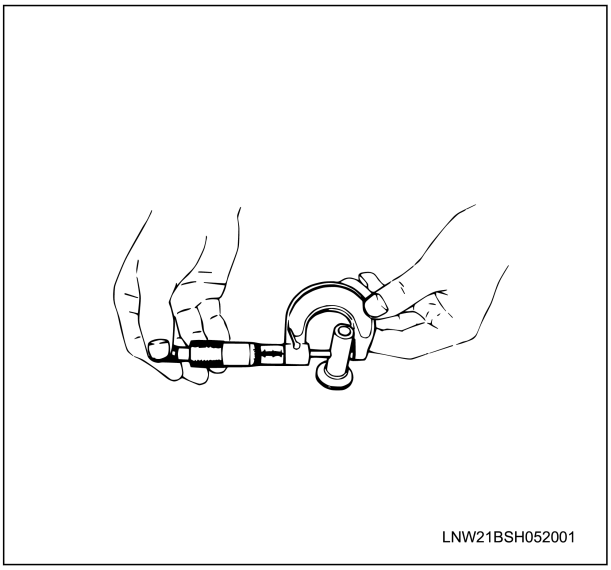
4. Tappet measurement
   1. Measure the outer diameter using a micrometer.

Note：

- If the tappet outer diameter is less than the limit, replace the tappet.

specified value： 20.97 to 20.98 mm { 0.8256 to 0.8260 in }

limit： 20.92 mm { 0.8236 in }

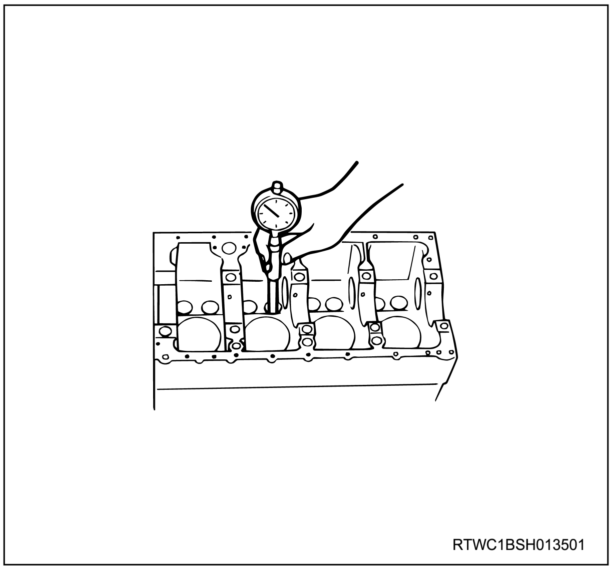


Note：

- Measure the clearance between the tappet and the cylinder block.

clearance： 0.020 to 0.054 mm { 0.0008 to 0.0021 in }

limit： 0.1 mm { 0.0039 in }



installation

1. Camshaft installation
   1. Apply engine oil to the camshaft.

      Note：
      - Apply to the camshaft journal section, the bearing, the cam surface, and the cylinder block bearing.
   2. Install the camshaft bearing to the camshaft.

      Caution：
      - Be careful not to damage the bearing.
   3. Install the camshaft to the cylinder block.

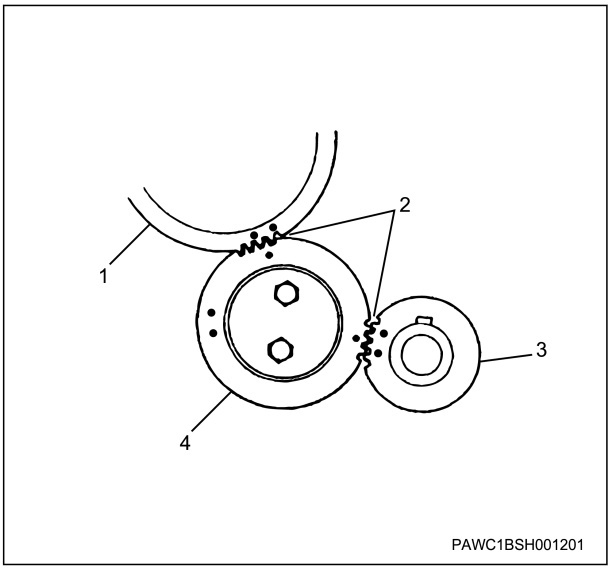
      Note：
      - Install the snap ring to the outside of the front bearing, and verify that the camshaft rotates smoothly.
2. Idle gear A installation
   1. Align the No. 1 cylinder to compression top dead center.

      Note：
      - Rotate the crankshaft in the forward direction and align the No. 1 cylinder piston to compression top dead center.
   2. Install the idle gear shaft to the cylinder block.
   3. Apply engine oil to the idle gear.

      Note：
      - Apply to idle gear A and the idle gear shaft.
   4. Install idle gear A to the idle gear shaft.

      Note：
      - Install after meshing so that the alignment mark of the crankshaft gear is as shown in the diagram.

      tightening torque： 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



1. Camshaft gear
2. Timing point
3. Crank gear
4. Idle gear A

   5. Apply engine oil to the idle gear.

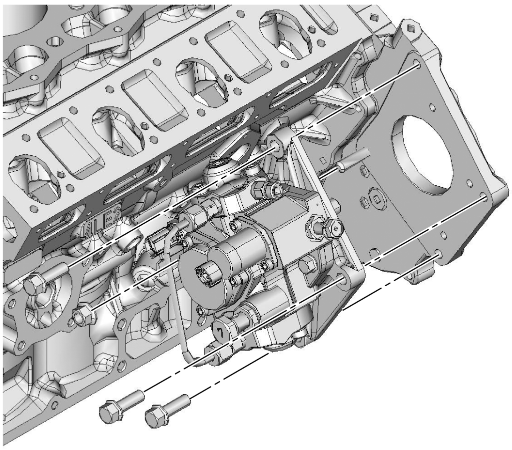
      Note：
      - Apply engine oil to the thrust collar, the bolt, and the threaded portion.
   6. Install the thrust collar to the idle gear.

      Note：
      - Install so that the chamfered side of the thrust collar faces the outside.
3. Camshaft gear installation
   1. Install the camshaft gear to the camshaft.

      Note：
      - Install after meshing so as to align the idle gear alignment marks.

      tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft }
4. Fuel supply pump installation
   1. Install the fuel supply pump to the front oil pump plate.

      tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }



PAWC1CSH000101

2. Connect the harness connector to the fuel supply pump.

5. Idle gear B installation

1. Install the idle gear shaft to the cylinder block.
2. Apply engine oil to the idle gear.

Note :

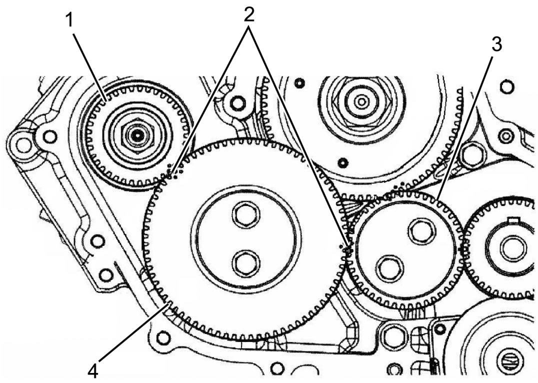
- Apply to idle gear B and the idle gear shaft.

3. Install idle gear B to the idle gear shaft.

Note :

- Install after meshing so as to align the idle gear B alignment marks with idle gear A and the supply pump gear.

tightening torque : 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



PAWC1BSH001501

1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

4. Apply engine oil to the idle gear.

Note :

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

5. Install the thrust collar to the idle gear.

Note :

- Install so that the chamfered side of the thrust collar faces the outside.

6. Fuel return pipe installation

1. Install the fuel return pipe to the fuel supply pump.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M10

tightening torque : 17 N・m { 1.7 kgf・m / 13 lb・ft } M14

7. Fuel pipe installation

1. Temporarily tighten the fuel pipe to the fuel supply pump.
2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

Caution :

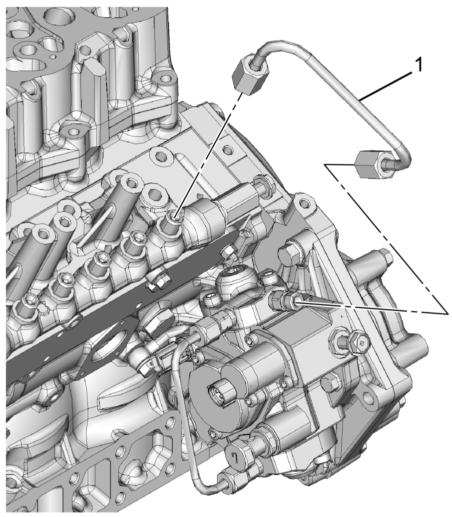
- Use a new fuel pipe.

Note :

- Verify that there is no dirt in the fuel pipe.

3. Securely tighten the fuel pipe to the fuel supply pump.
4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque : 44 N・m { 4.5 kgf・m / 32 lb・ft }



PAWC1CSH000201

1. Fuel pipe

8. Timing gear case installation
   1. Apply liquid gasket to the front oil pump plate.

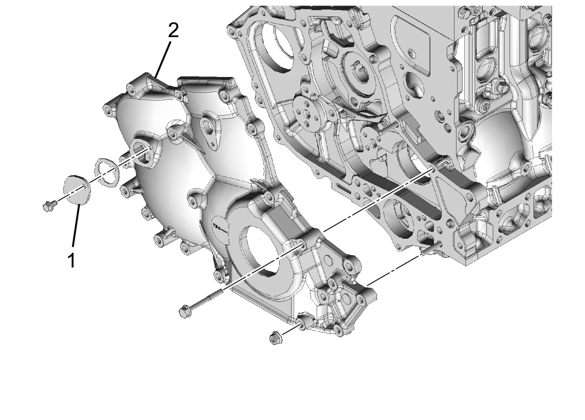
   Note :
   - Apply ThreeBond 1207B.

   2. Install the timing gear case to the front oil pump plate.

   tightening torque : 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

   3. Install the idle gear cover to the timing gear case.

   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1ESH000701

1. Idle gear cover
2. Timing gear case

9. CMP sensor installation
   1. Apply engine oil to the O-ring.
   2. Install the CMP sensor to the timing gear case.

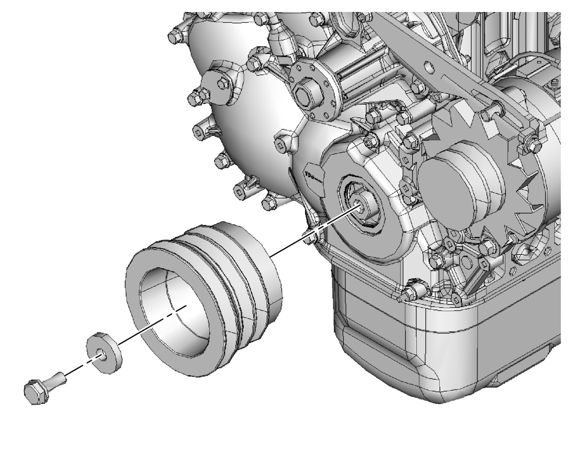
   tightening torque : 5 N・m { 0.5 kgf・m / 44 lb・in }

   3. Connect the harness connector to the CMP sensor.

10. Crankshaft pulley installation
    1. Install the crankshaft pulley to the crankshaft.

    Caution :
    - Do not reuse the bolt and the washer.

    tightening torque : 177 N・m { 18.0 kgf・m / 131 lb・ft }



PAWC1BSH001601

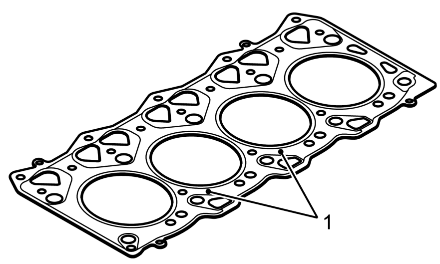
11. Tappet installation
    1. Apply engine oil to the tappet.

    Note :
    - Apply to the bottom surface and the outer circumference of the tappet.

    2. Install the tappet to the cylinder block.

12. Cylinder head assembly installation
    1. Install the cylinder head gasket to the cylinder block.

    Note :
    - Install with the marked side facing upward.



PAWC1BSH003301

1. Mark

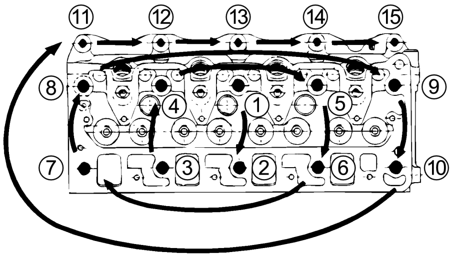
    2. Apply engine oil to the bolt.

    Note :
    - Apply engine oil to the threaded portion and the seat surface of the head bolt.

3. Install the cylinder head assembly to the cylinder block.
4. Tighten the head bolts using a torque wrench.

Note：

・ Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



PAWC1BSH004001

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle： 60 ° 3rd time

Note：

・ Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

13. Push rod installation
1. Install the push rod to the cylinder block.

Note：

・ Pass it through the cylinder block and insert it into the tappet.

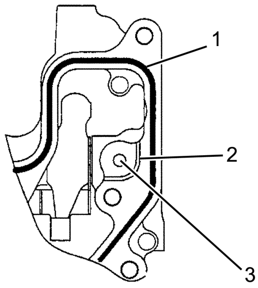
14. Rocker arm bracket installation
1. Apply liquid gasket to the rocker arm bracket.

Note：

・ Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

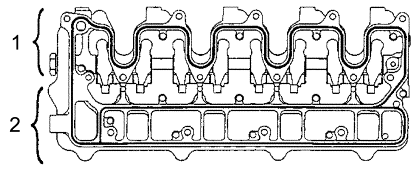
Caution：

・ Do not apply liquid gasket to the groove around the oil gallery.



PAWC1BSH004201

1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



PAWC1BSH004301

1. Liquid gasket application area
2. Oil gallery groove

Note：

・ Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note：

・ Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.
4. Securely tighten the rocker arm bracket to the cylinder head.

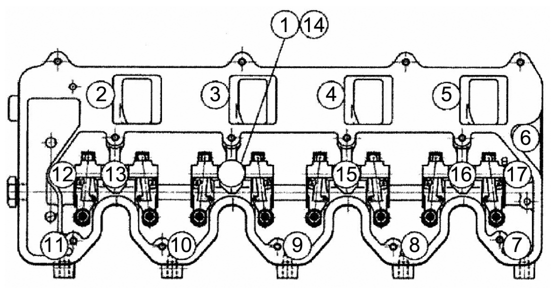
Note :

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution :

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



PAWC1BSH004101

15. Rocker arm shaft adjustment

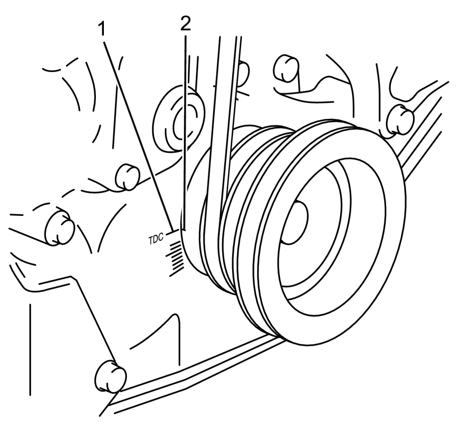
Note :

- Valve clearance adjustment

Caution :

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



PAWC1BSH004401

1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note :

- Insert the feeler gauge between the rocker arm and the bridge cap.

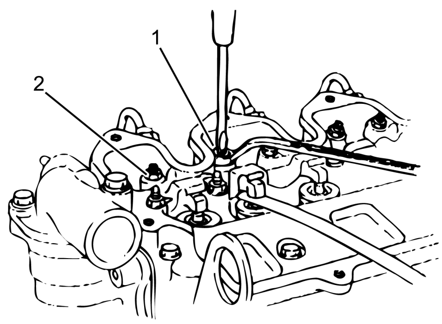
specified value : 0.40 mm { 0.016 in } Inlet valve

specified value : 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note :

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



PAWC1BSH004501

1. Adjust screw
2. Lock nut

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note :

- Rotate the crankshaft in the forward direction and measure the valve clearance.

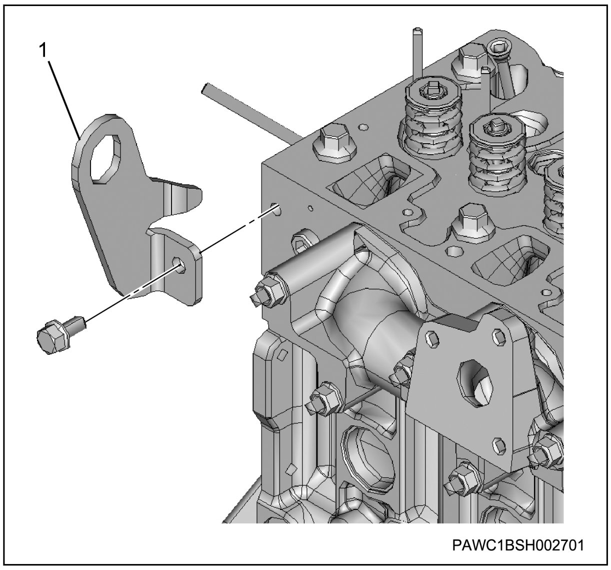
Caution :

- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

16. Engine hanger installation
   1. Install the engine hanger to the cylinder head.

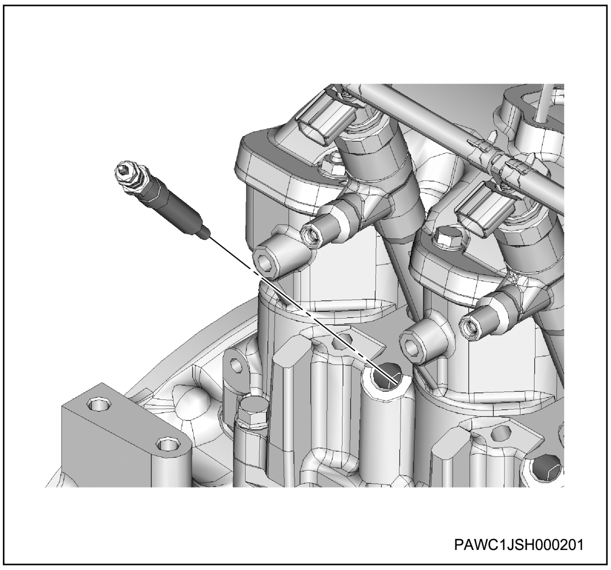
   tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }



1. Engine hanger

17. Glow plug installation
   1. Install the glow plug to the cylinder head.

   tightening torque : 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



18. Glow plug connector installation
   1. Install the glow plug connector to the glow plug.

   tightening torque : 1.0 N・m { 0.1 kgf・m / 9 lb・in }

19. Injector installation

   Caution :

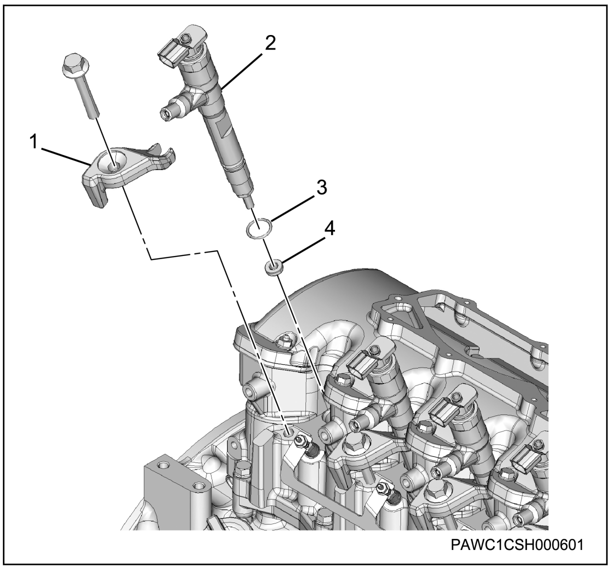
   - **Do not change the installation position of the injectors when reusing the injectors.**

   1. Install the O-ring to the injector.
   2. Install the injector gasket to the injector.

   Note :

   - Do not reuse the injector gasket or the O-ring.

   3. Temporarily tighten the injector to the cylinder head assembly.

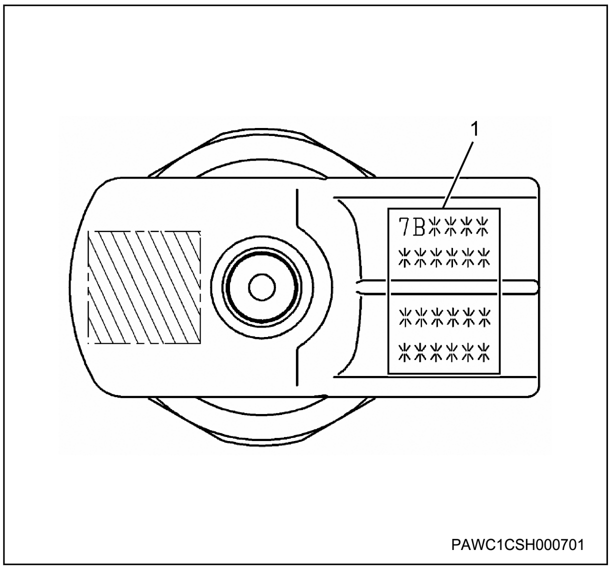


1. Injector clamp
2. Injector
3. O-ring

4. Injector gasket

Caution：

- If the injector has been replaced, record the injector ID code of the new injector.



PAWC1CSH000701

1. Injector ID code

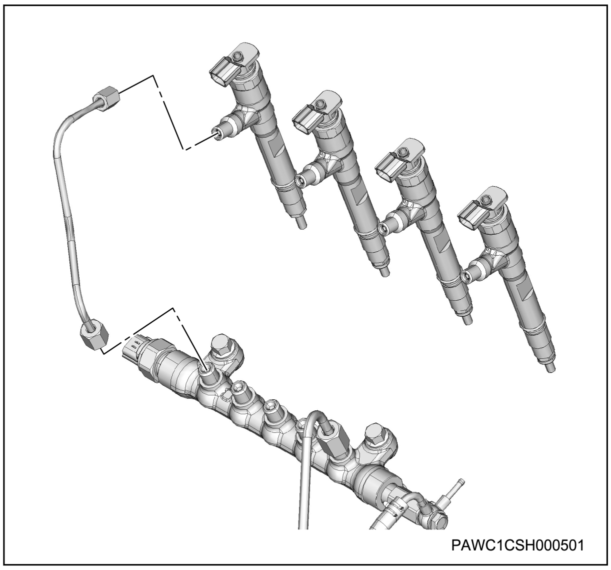
4. Connect the harness connector to the injector.

20. Injection pipe installation

1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

- Do not reuse the injection pipe.


PAWC1CSH000501

2. Securely tighten the injector to the cylinder head assembly.

tightening torque： 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

- Securely tighten the injector side.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

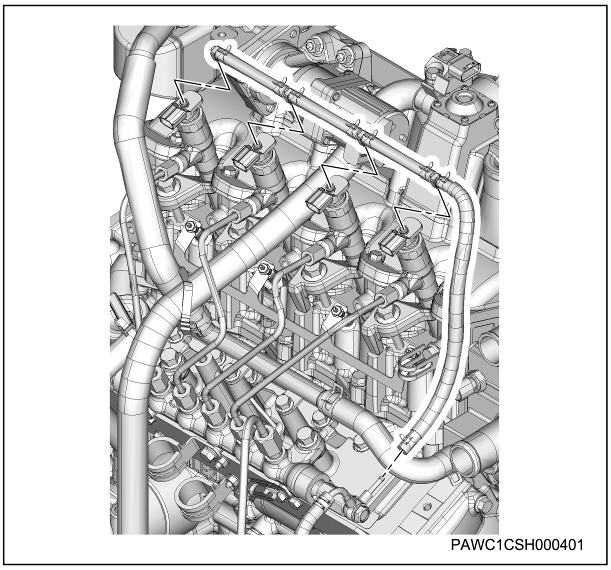
Note：

- Securely tighten the common rail (fuel rail) side.

tightening torque： 30 N・m { 3.1 kgf・m / 22 lb・ft }

21. Fuel leak-off hose installation

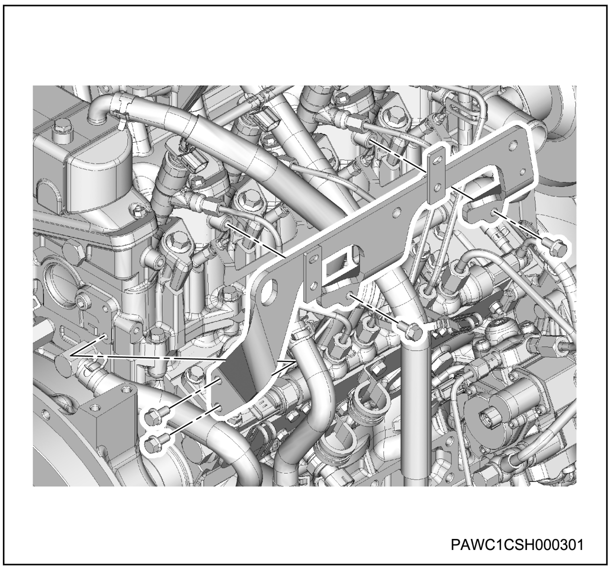
1. Install the fuel leak-off hose to the injector.


PAWC1CSH000401

22. Harness bracket installation

1. Install the harness bracket to the cylinder head.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

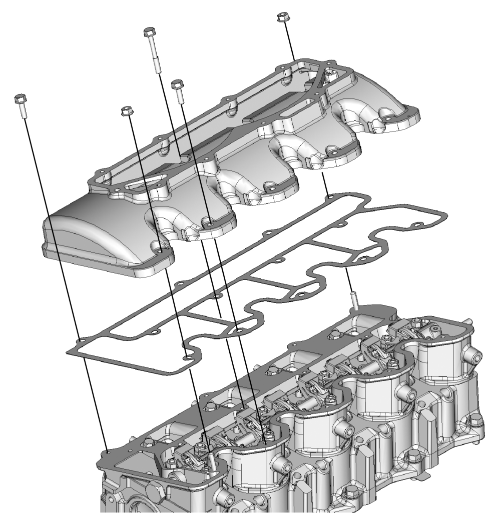

PAWC1CSH000301

2. Connect the engine harness to the harness bracket.

23. Cylinder head cover installation

1. Install the cylinder head cover to the rocker arm bracket.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

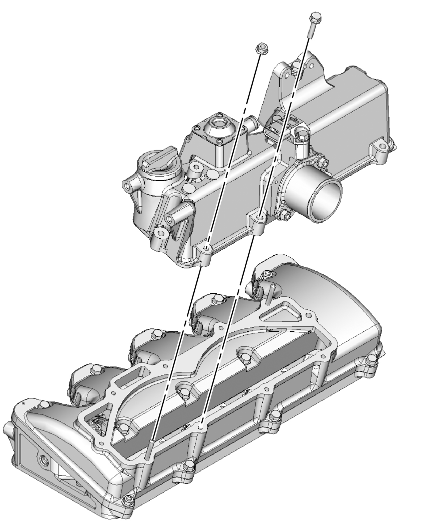


PAWC1BSH001001

24. Intake chamber installation

1. Install the intake chamber to the cylinder head cover.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

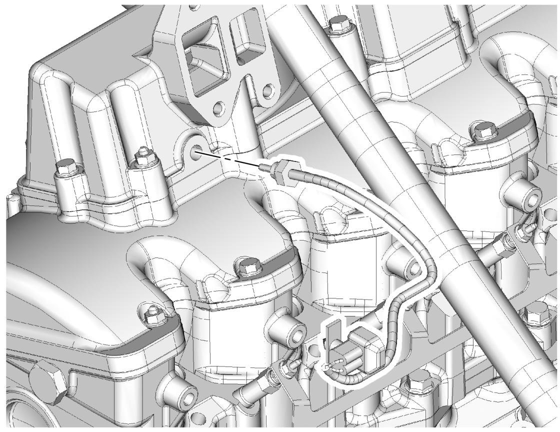


PAWC1BSH000701

25. IMT sensor installation

1. Install the IMT sensor to the intake chamber.

tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

2. Connect the harness connector to the IMT sensor.

26. PCV hose installation

1. Install the PCV hose to the intake chamber.

27. EGR valve installation

1. Temporarily tighten the EGR valve to the intake chamber.
2. Temporarily tighten the EGR pipe to the exhaust manifold.
3. Temporarily tighten the EGR pipe to the EGR valve.
4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

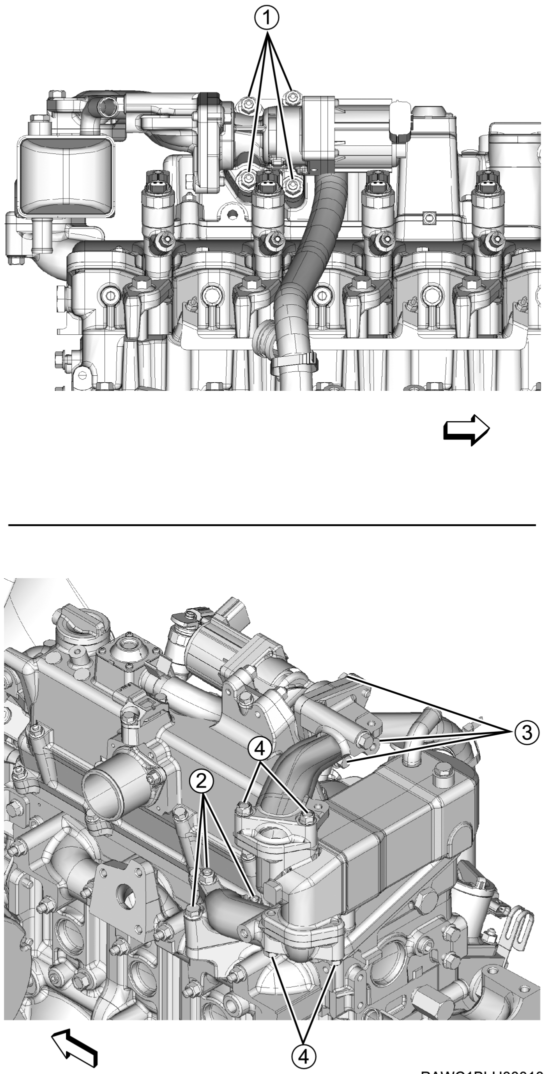
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



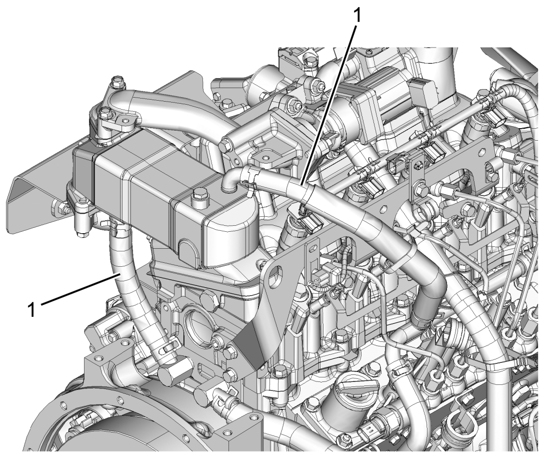
PAWC1BLH000101

Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



PAWC1BSH000201

1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

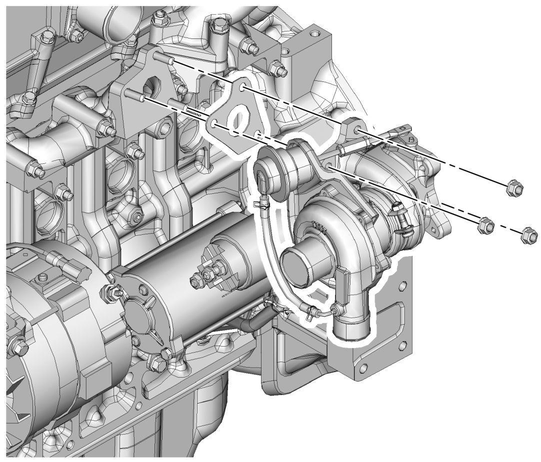
28. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note：

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



PAWC1FSH000101

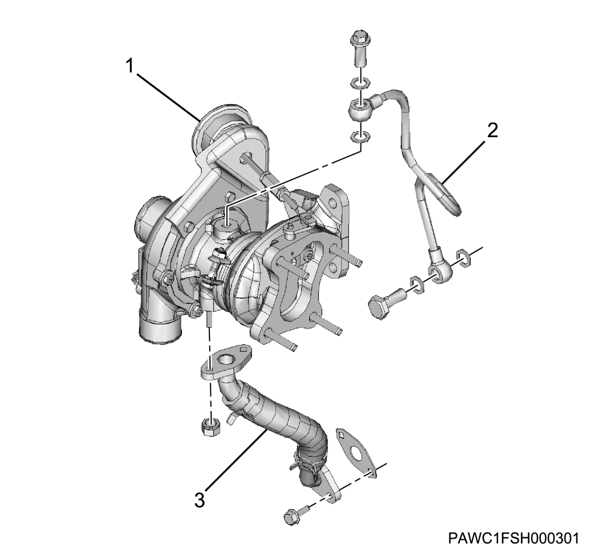
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }
Cylinder block side

tightening torque： 22 N・m { 2.2 kgf・m / 16 lb・ft }
Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

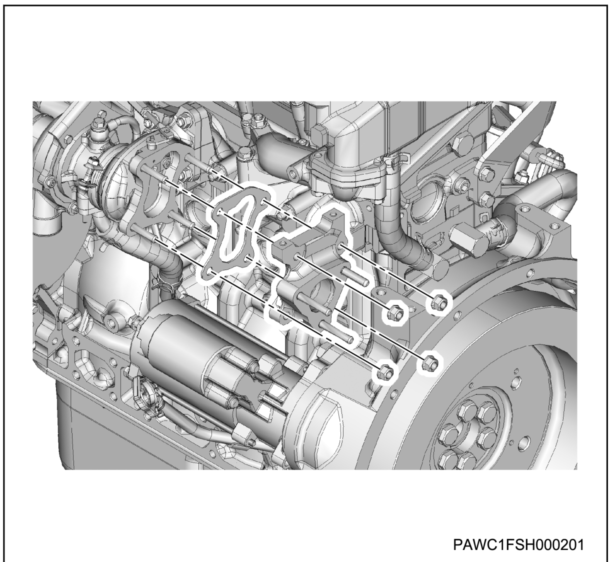
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

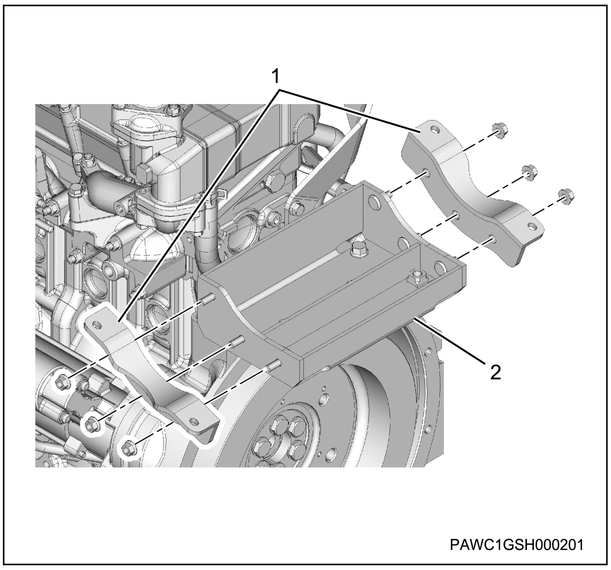
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



29. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

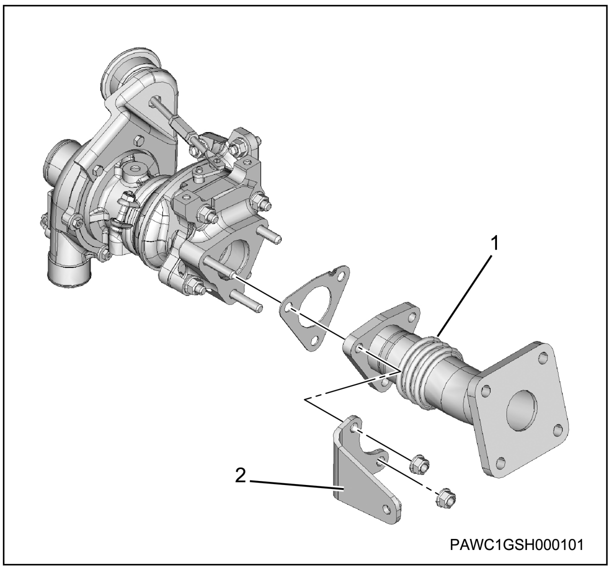


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

- Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.

4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

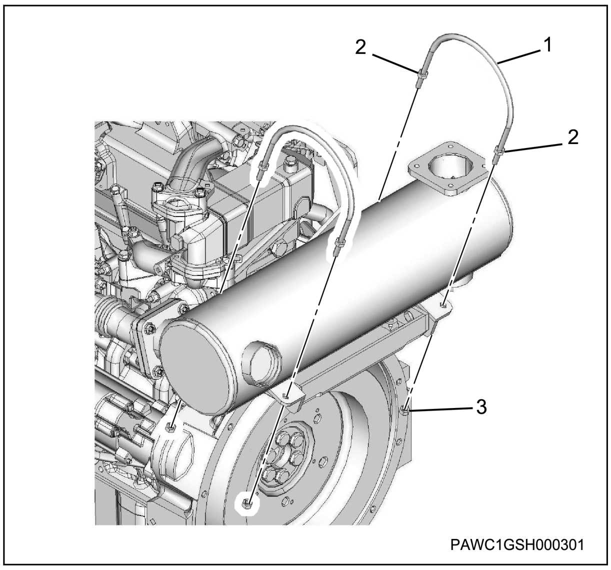
- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.

- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

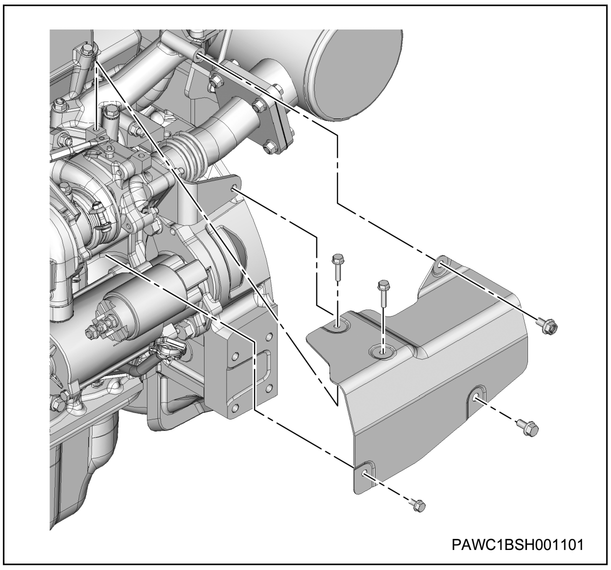
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

30. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M6



31. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

- Install the harness clip.

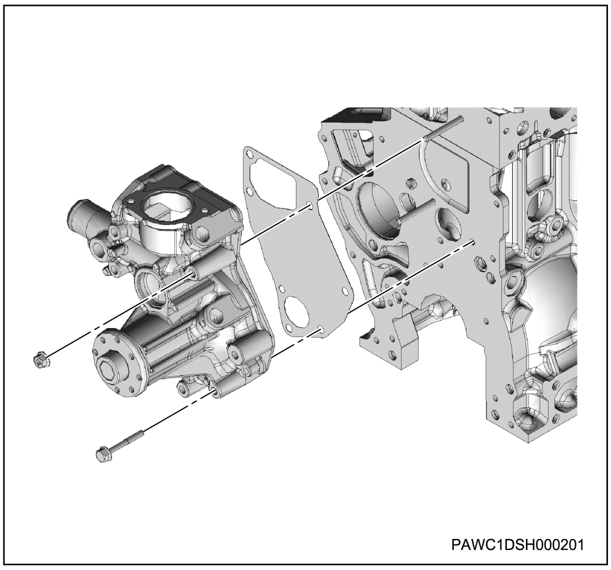
32. Water pump assembly installation

1. Install the water pump assembly to the cylinder block and the cylinder head.

Note：

- Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1DSH000201

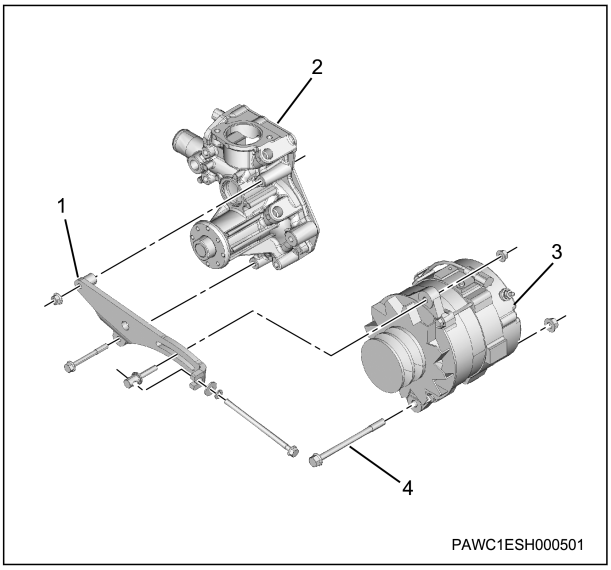
33. Water hose connect
   1. Connect the water hose to the water pump assembly.

   Note :
   - Install the hose clip.
34. Engine coolant temperature sensor connect
   1. Connect the harness connector to the engine coolant temperature sensor.
35. Generator installation
   1. Install the adjust plate to the water pump assembly.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }
   2. Temporarily tighten the generator to the generator bracket.
   3. Temporarily tighten the generator to the adjust plate.

   Note :
   - Securely tighten the bolt and the nut after adjusting the cooling fan belt.
   4. Connect the harness connector to the generator.

   Note :
   - The diagram shows the 24 V - 50 A specification.



PAWC1ESH000501

1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

36. Fan pulley installation
   1. Install the fan pulley to the water pump assembly.

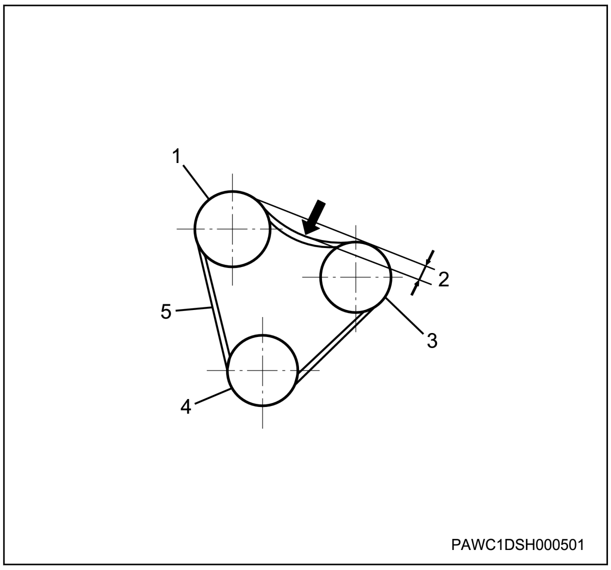
   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }
37. Cooling fan belt installation
   1. Install the cooling fan belt to the pulley.
38. Cooling fan belt adjustment
   1. Check the tension of the cooling fan belt.

   Note :
   - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

   standard : 98 N { 10.0 kg / 22 lb }

   specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in } New product

   specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in } Reuse

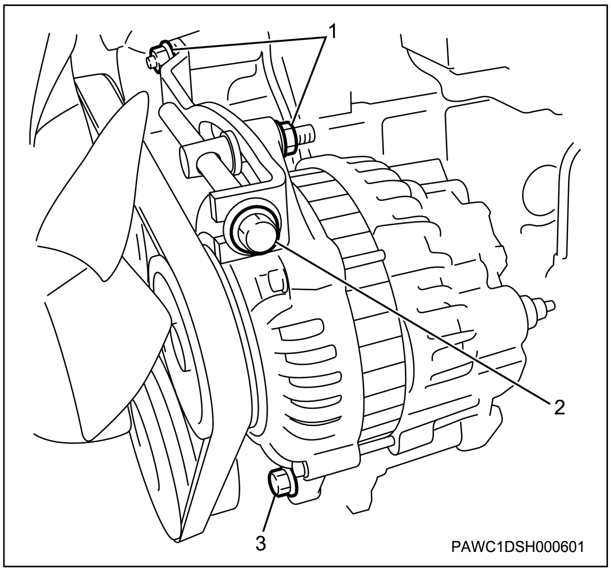


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

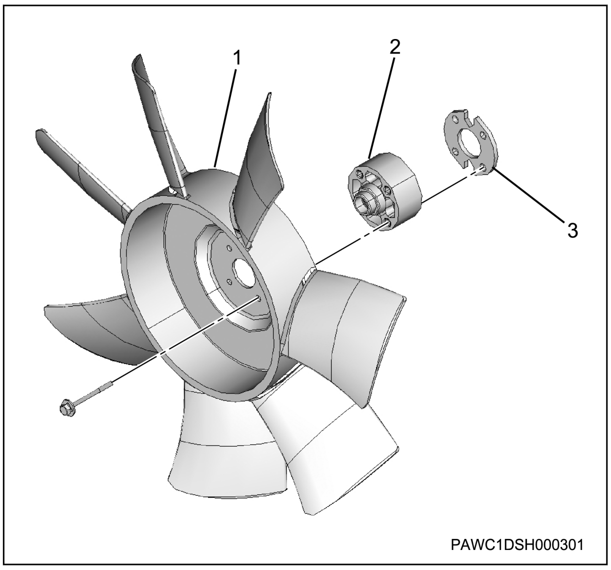


1. Nut
2. Adjust bolt
3. Mounting bolt

39. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

40. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution :

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

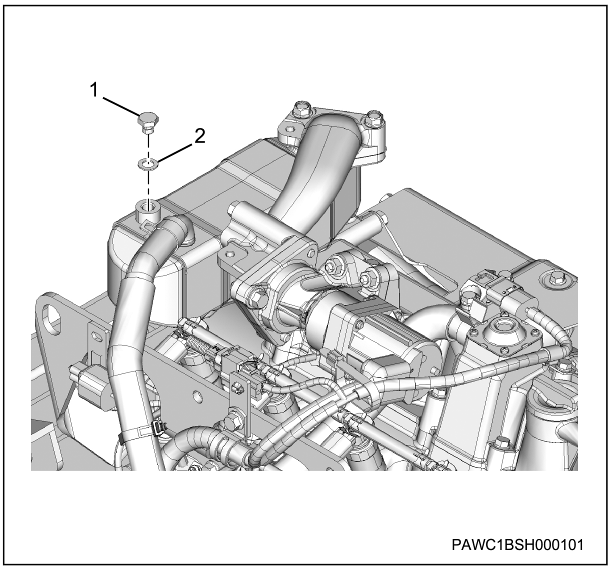
3. Tighten the plug using a wrench.

Caution :

- Use a new gasket.

tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug

2. Gasket

41. Battery ground cable connect

1. Connect the battery ground cable to the battery.

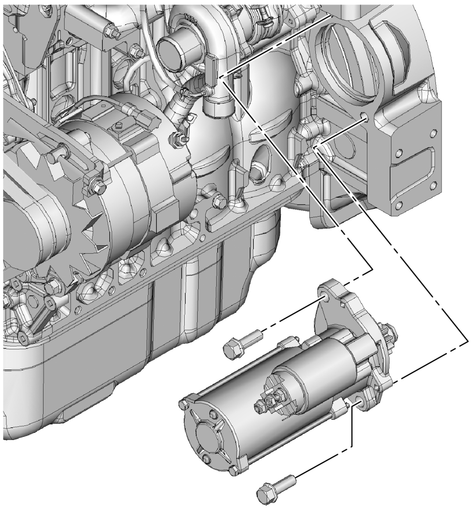
Flywheel

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Oil level gauge guide tube removal
   1. Remove the oil level gauge from the oil level gauge guide tube.
   2. Remove the oil level gauge guide tube from the cylinder block.
3. Starter motor removal
   1. Remove the ground cable from the starter motor.
   2. Remove the starter motor from the flywheel housing.

Note：

- The diagram shows the 24 V - 3.2 kW specification.



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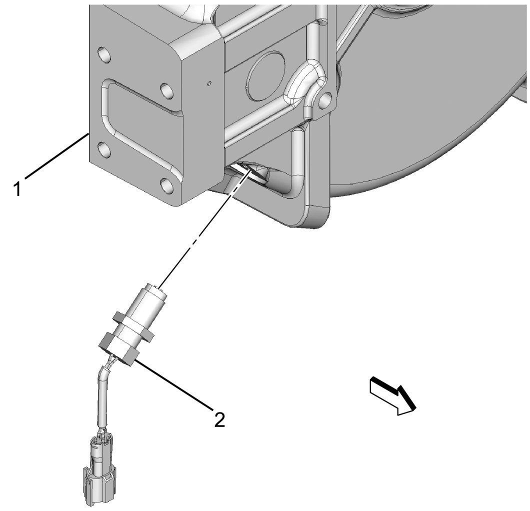
4. Engine speed sensor removal
   1. Disconnect the harness connector from the engine speed sensor.
   2. Remove the engine speed sensor from the flywheel housing.



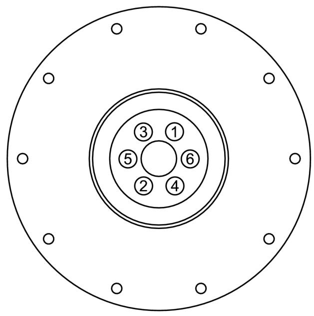
PAWC1BSH003201

1. Flywheel housing
2. Engine speed sensor

5. Flywheel removal
   1. Remove the flywheel from the crankshaft.

Note：

- Make an alignment mark before removing.
- Gradually loosen the flywheel mounting bolts in the order shown in the diagram while making sure that the flywheel does not rotate.



PAWC1BSH001701

Note：

- Remove the flywheel while lightly tapping with a plastic hammer.

Caution：

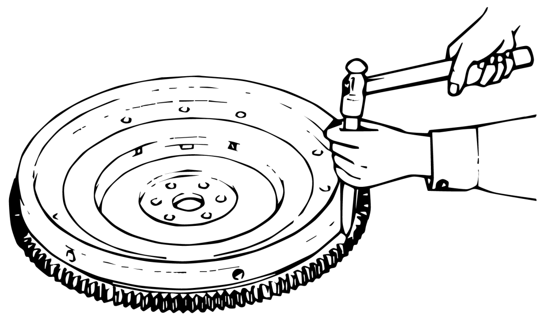
- Do not damage the ring gear.

6. Ring gear removal

   1. Remove the ring gear from the flywheel.

   Note :

   - Place a rod against the ring gear and remove it by tapping with a hammer.



LNW21BSH012001

inspection

1. Flywheel inspection
   1. Inspect the flywheel.

   Note :

   - Inspect the flywheel friction surface for cracking, wear, or damage.
   - Inspect the tooth surface of the ring gear and replace the ring gear if there is damage or excessive wear.
   - Inspect the flywheel mounting bolts and replace the bolts if there is damage.

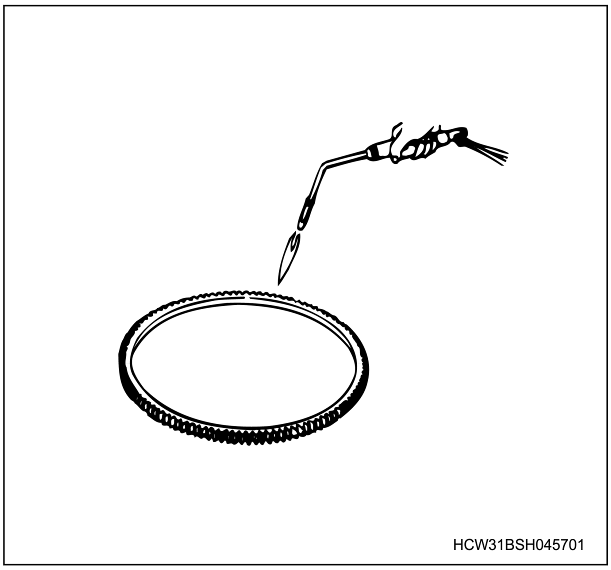
installation

1. Ring gear installation
   1. Heat the ring gear with a gas burner.

Note :

- Uniformly heat the inside of the ring gear.

heating temperature : 200 ℃ { 392 °F }



2. Install the ring gear to the flywheel.

Note :

- Install while tapping with a hammer.

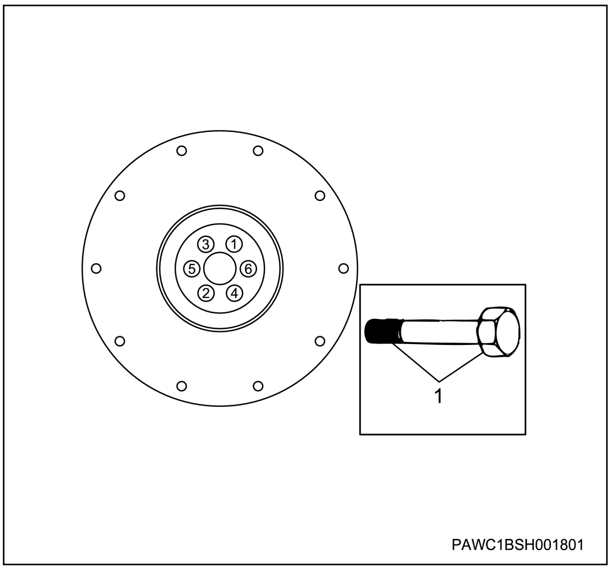
Caution :

- After shrink-fitting, verify that the ring gear is airtight against the flywheel.

2. Flywheel installation
   1. Apply engine oil to the bolt.

Note :

- Apply to the seat surface and the threaded portion of the flywheel mounting bolts.



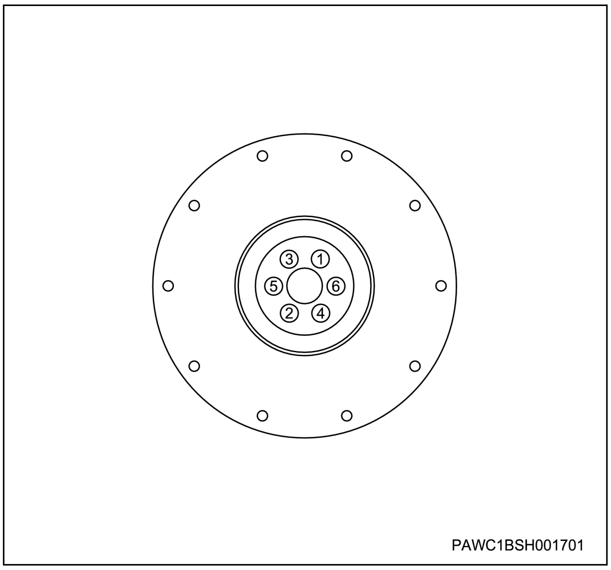
1. Engine oil application area

2. Install the flywheel to the crankshaft.

Note :

- Gradually tighten the mounting bolts in the order shown in the diagram.

tightening torque : 98 N・m { 10.0 kgf・m / 72 lb・ft }



Caution :

- Install while verifying the installation position.

3. Engine speed sensor installation
   1. Install the engine speed sensor to the flywheel housing.

Note :

- Screw in the engine speed sensor until it reaches the end.

Caution :

- Be careful not to damage the sensor tip.

Note：

- Return the engine speed sensor 1 rotation, and secure with a nut.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

2. Inspect the engine speed sensor.

Note：

- Check the output voltage at maximum speed without load and low speed without load.

	Specified output voltage	
Engine speed	Voltage waveform	AC voltage
Maximum speed without load	： 20 to 72 V	： 7.1 to 25.5 V
Low speed without load	： 9 to 40 V	： 3.2 to 14.2 V

Note：

- If the measured value is outside the specified output voltage, adjust the engine speed sensor until it is within the specified output voltage.

4. Starter motor installation

1. Install the starter motor to the flywheel housing.

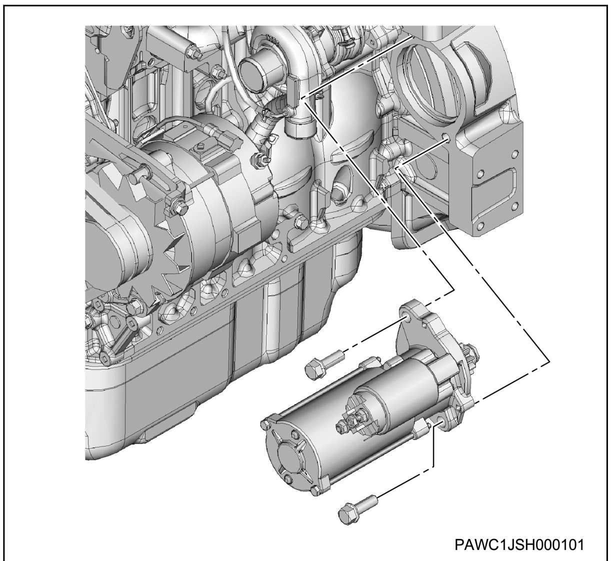
tightening torque： 103 N・m { 10.5 kgf・m / 76 lb・ft }

2. Install the ground cable to the starter motor.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

Note：

- The diagram shows the 24 V - 3.2 kW specification.



5. Oil level gauge guide tube installation

1. Install the oil level gauge guide tube to the cylinder block.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

2. Install the oil level gauge to the oil level gauge guide tube.

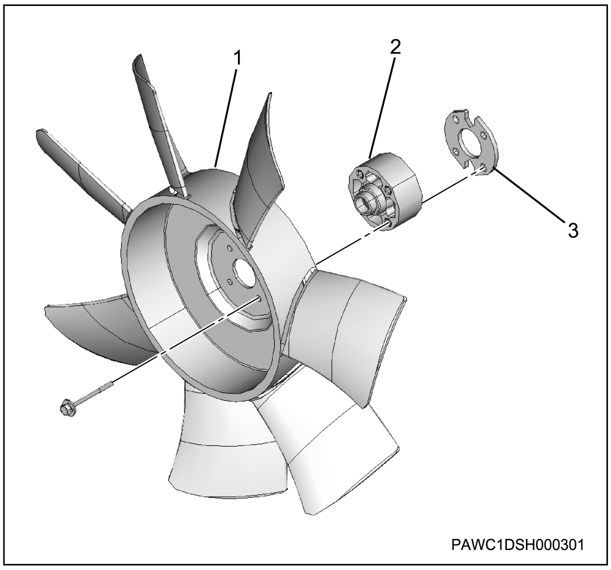
6. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Crankshaft front oil seal

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



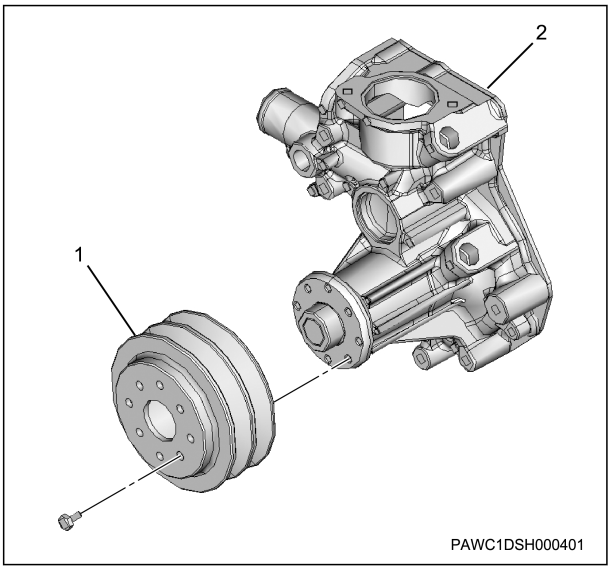
1. Cooling fan
2. Adapter
3. Spacer

3. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

Note :

- Loosen the generator adjust bolt and remove the belt.

4. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

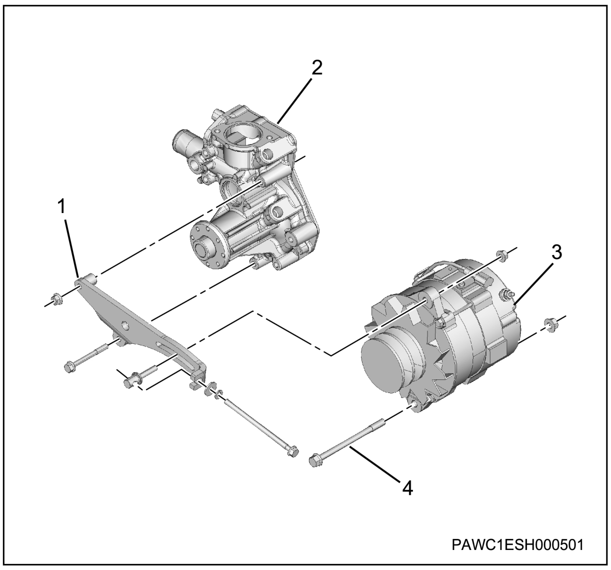


1. Fan pulley
2. Water pump assembly

5. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

Note :

- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

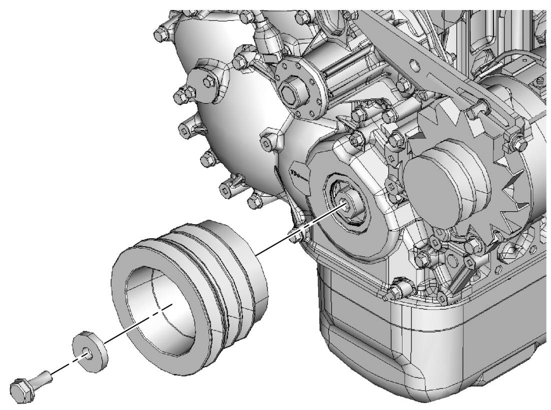
6. Generator bracket removal
   1. Remove the generator bracket from the cylinder block.
7. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.
   3. Remove the O-ring from the CMP sensor.
8. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

Note：

- Remove after stopping the crankshaft from turning.

Caution：

- Do not reuse the bolt and the washer.



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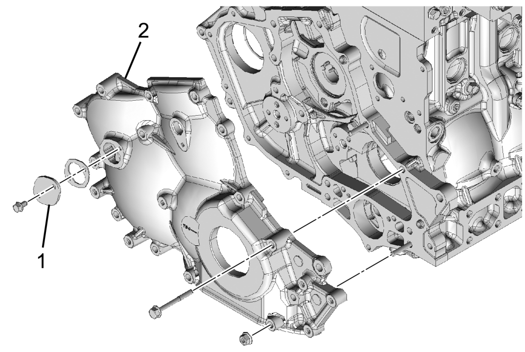
9. Timing gear case removal
   1. Remove the idle gear cover from the timing gear case.
   2. Remove the timing gear case from the front oil pump plate.



PAWC1ESH000701

1. Idle gear cover
2. Timing gear case

10. Crankshaft front oil seal removal
    1. Remove the crankshaft front oil seal from the timing gear case.

Note：

- Use a driver, etc., to pry the oil seal, and remove it.

Caution：

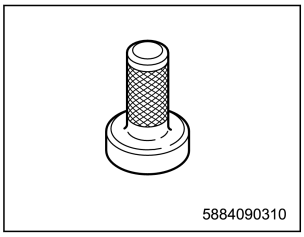
- Be careful not to damage the contact surface of the oil seal.

installation

1. Crankshaft front oil seal installation
   1. Apply engine oil to the crankshaft front oil seal.

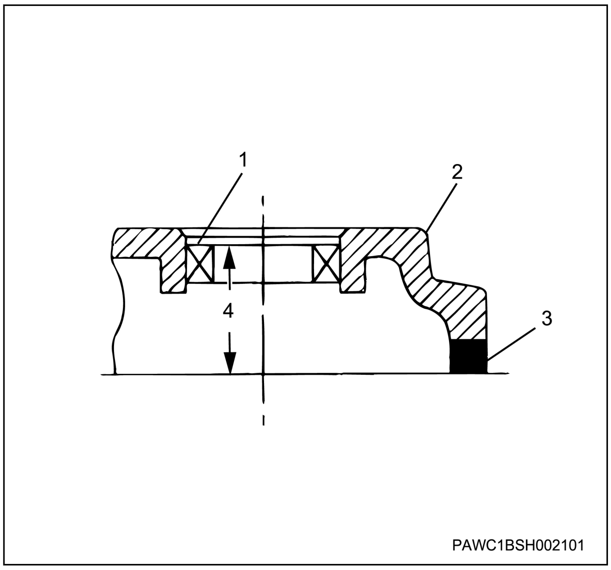
      Note :
      - Apply to the lip section of the oil seal.
   2. Install the crankshaft front oil seal to the timing gear case using a special tool.

      Note :
      - Use an oil seal installer to install.



SST: 5-8840-9031-0 - oil seal installer

Note :
- After installing the oil seal, verify the installation position of the oil seal.



1. Front oil seal
2. Timing gear case
3. Front oil plate
4. Specified value

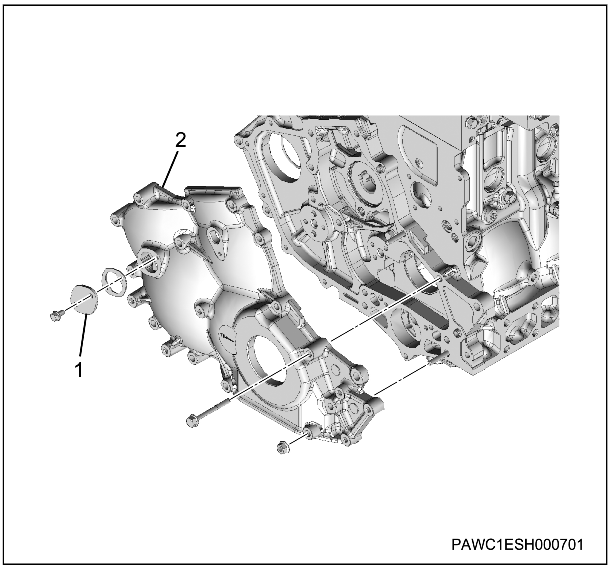
specified value : 60 mm { 2.4 in }

2. Timing gear case installation
   1. Apply liquid gasket to the front oil pump plate.

      Note :
      - Apply ThreeBond 1207B.
   2. Install the timing gear case to the front oil pump plate.

      tightening torque : 23.5 N・m { 2.40 kgf・m / 17 lb・ft }
   3. Install the idle gear cover to the timing gear case.

      tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

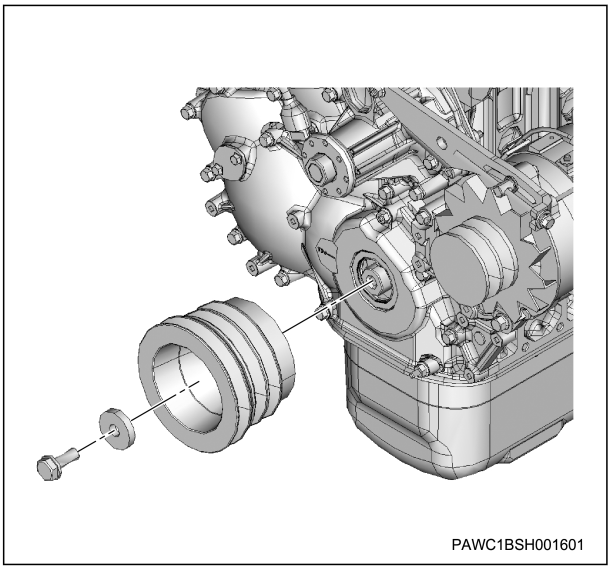


1. Idle gear cover
2. Timing gear case

3. Crankshaft pulley installation
   1. Install the crankshaft pulley to the crankshaft.

      Caution :
      - Do not reuse the bolt and the washer.

      tightening torque : 177 N・m { 18.0 kgf・m / 131 lb・ft }



4. CMP sensor installation

1. Apply engine oil to the O-ring.
2. Install the CMP sensor to the timing gear case.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

3. Connect the harness connector to the CMP sensor.

5. Generator bracket installation

1. Install the generator bracket to the cylinder block.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10

6. Generator installation

1. Install the adjust plate to the water pump assembly.

tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

2. Temporarily tighten the generator to the generator bracket.
3. Temporarily tighten the generator to the adjust plate.

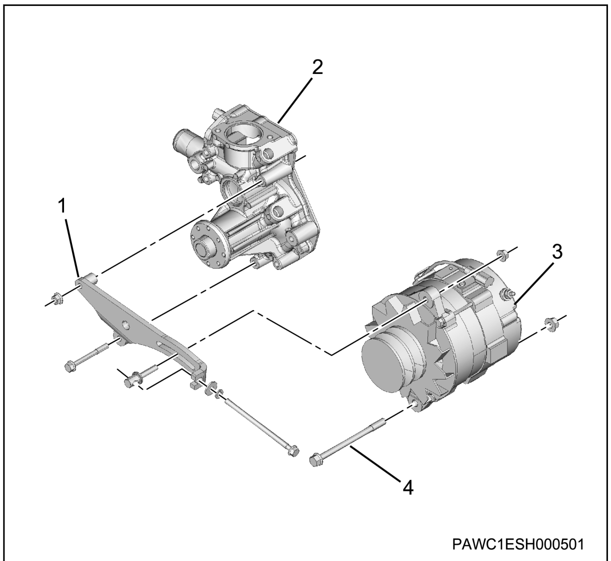
Note：

- Securely tighten the bolt and the nut after adjusting the cooling fan belt.

4. Connect the harness connector to the generator.

Note：

- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Fan pulley installation

1. Install the fan pulley to the water pump assembly.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

8. Cooling fan belt installation

1. Install the cooling fan belt to the pulley.

9. Cooling fan belt adjustment

1. Check the tension of the cooling fan belt.

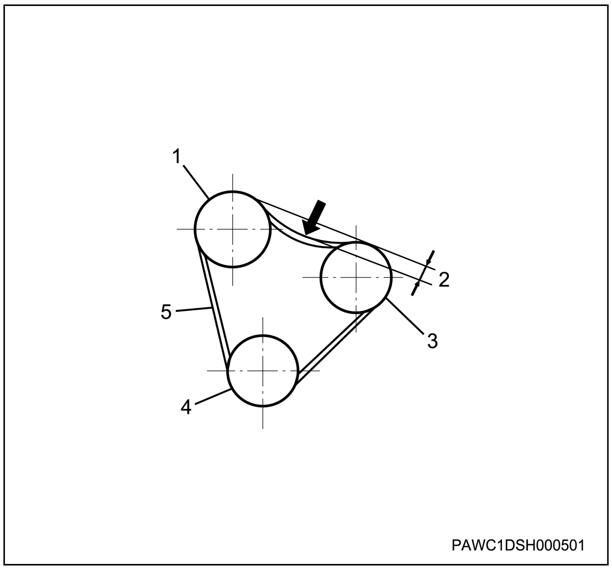
Note：

- Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard： 98 N { 10.0 kg / 22 lb }

specified value： 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value： 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

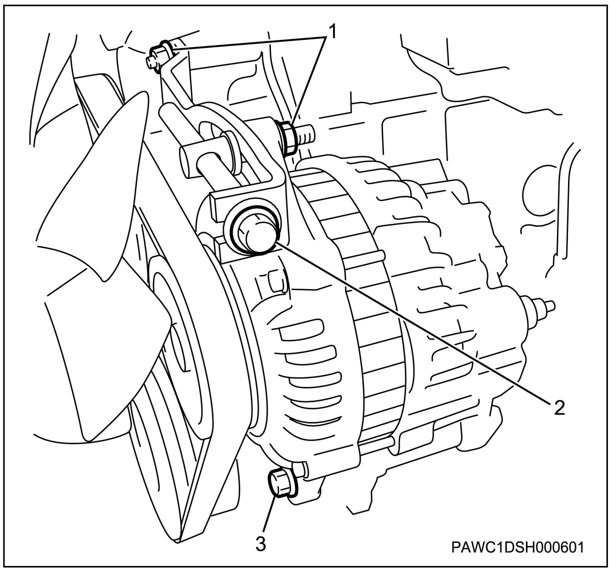


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25

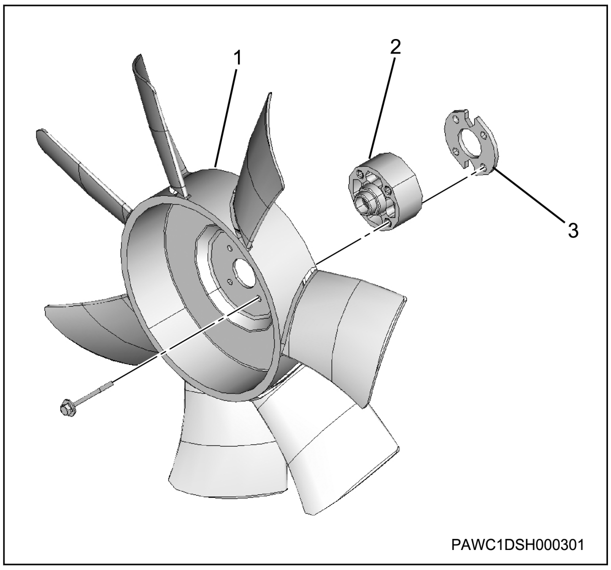


1. Nut
2. Adjust bolt
3. Mounting bolt

10. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

11. Battery ground cable connect

1. Connect the battery ground cable to the battery.

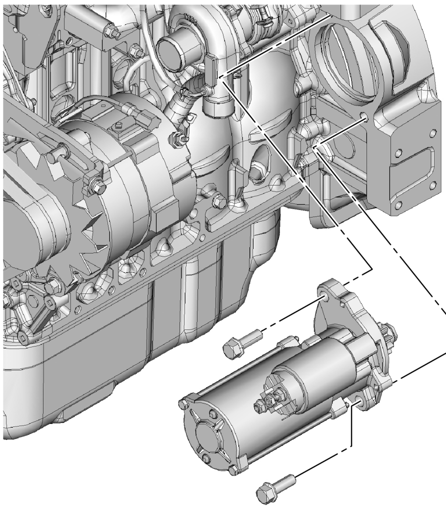
Crankshaft rear oil seal

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Oil level gauge guide tube removal
   1. Remove the oil level gauge from the oil level gauge guide tube.
   2. Remove the oil level gauge guide tube from the cylinder block.
3. Starter motor removal
   1. Remove the ground cable from the starter motor.
   2. Remove the starter motor from the flywheel housing.

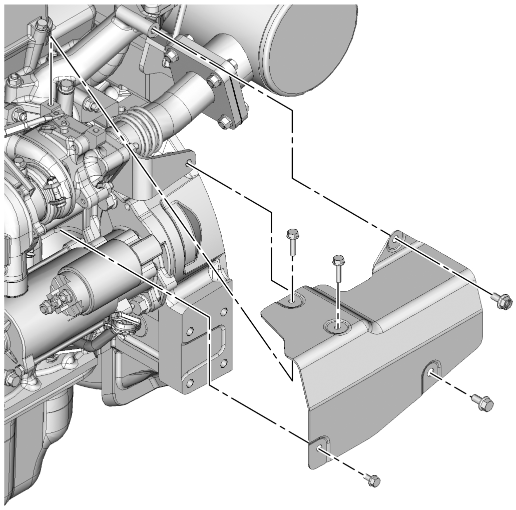
Note：

- The diagram shows the 24 V - 3.2 kW specification.



PAWC1JSH000101

4. Turbocharger heat protector removal
   1. Remove the turbocharger heat protector from the turbocharger.

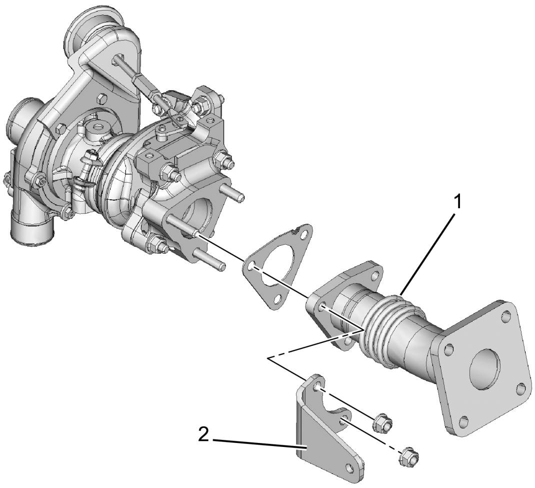


PAWC1BSH001101

5. Integrated oxidation catalyst silencer removal
   1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
   2. Remove the exhaust pipe from the turbocharger assembly.

Note：

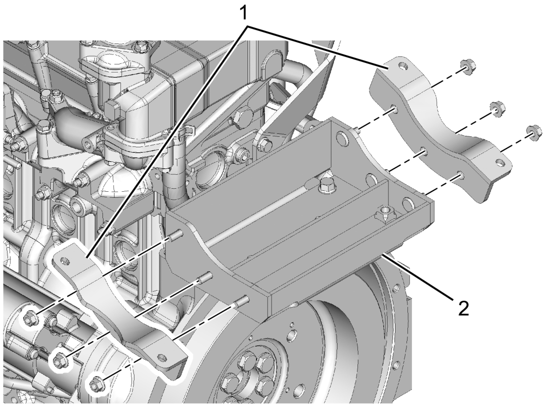
- Remove together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

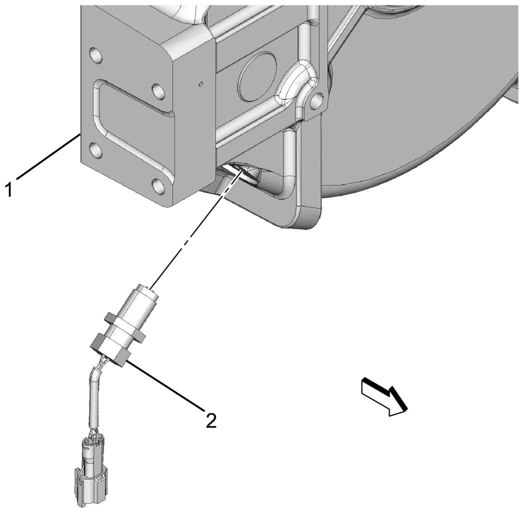
3. Remove the support bracket from the silencer bracket.



PAWC1GSH000201

1. Support bracket
2. Silencer bracket

6. Engine speed sensor removal
   1. Disconnect the harness connector from the engine speed sensor.
   2. Remove the engine speed sensor from the flywheel housing.



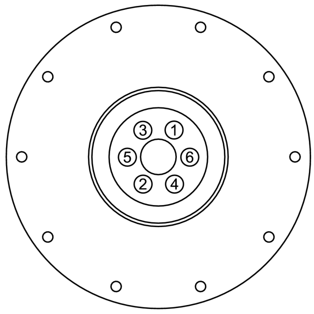
PAWC1BSH003201

1. Flywheel housing
2. Engine speed sensor

7. Flywheel removal
   1. Remove the flywheel from the crankshaft.

Note :

- Make an alignment mark before removing.
- Gradually loosen the flywheel mounting bolts in the order shown in the diagram while making sure that the flywheel does not rotate.



PAWC1BSH001701

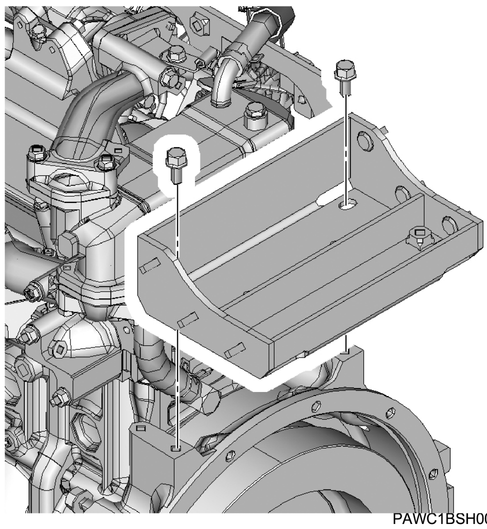
Note :

- Remove the flywheel while lightly tapping with a plastic hammer.

Caution :

- Do not damage the ring gear.

8. Flywheel housing removal
   1. Remove the silencer bracket from the flywheel housing.

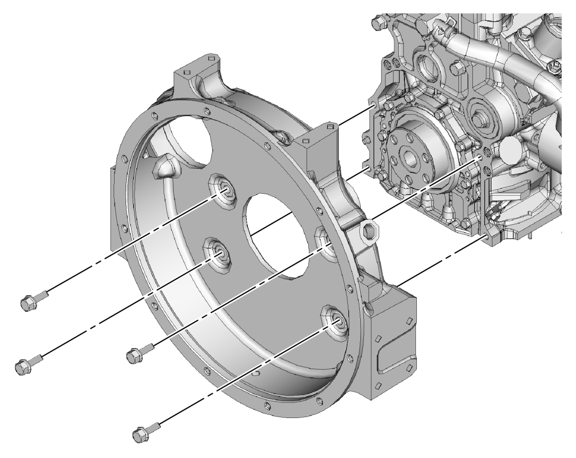


PAWC1BSH006801

   2. Remove the flywheel housing from the cylinder block.

Note :

- Remove while lightly tapping the housing with a plastic hammer.



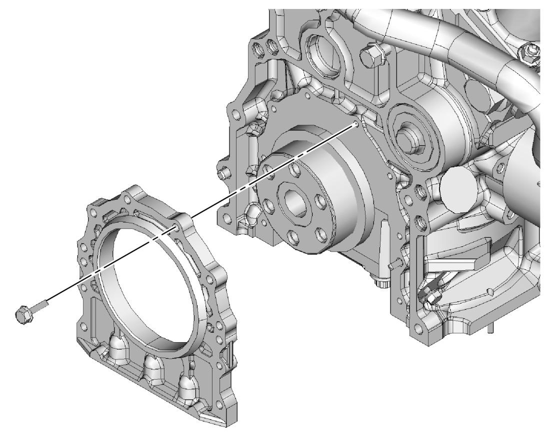
PAWC1BSH002401

9. Oil seal retainer removal

   1. Remove the oil seal retainer from the cylinder block.

   Caution :

   - Be careful not to damage or deform when removing.



PAWC1BSH002501

10. Crankshaft rear oil seal removal

    1. Remove the crankshaft rear oil seal from the oil seal retainer.

    Note :

    - Use a driver, etc., to pry the oil seal, and remove it.

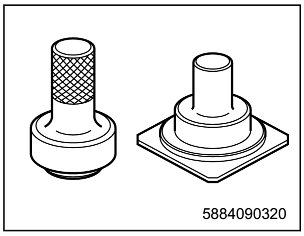
    Caution :

    - Be careful not to damage the oil seal contact surface of the retainer.

installation

1. Crankshaft rear oil seal installation
   1. Install the crankshaft rear oil seal to the oil seal retainer using a special tool.

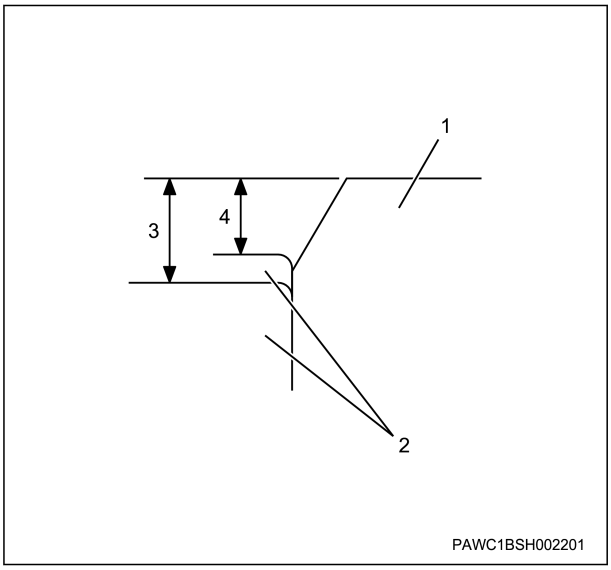
Note：
- Use an oil seal installer to install.



SST: 5-8840-9032-0 - oil seal installer

Note：
- Verify the oil seal installation position.

specified value： 0.0 to 0.5 mm { 0.00 to 0.02 in } From the end surface of the retainer



1. Retainer
2. Crankshaft rear oil seal
3. 0.5 mm
4. 0 mm

2. Oil seal retainer installation
   1. Apply engine oil to the crankshaft rear oil seal.

Note：
- Thinly apply engine oil to the lip section of the rear oil seal.

   2. Apply liquid gasket to the oil seal retainer.

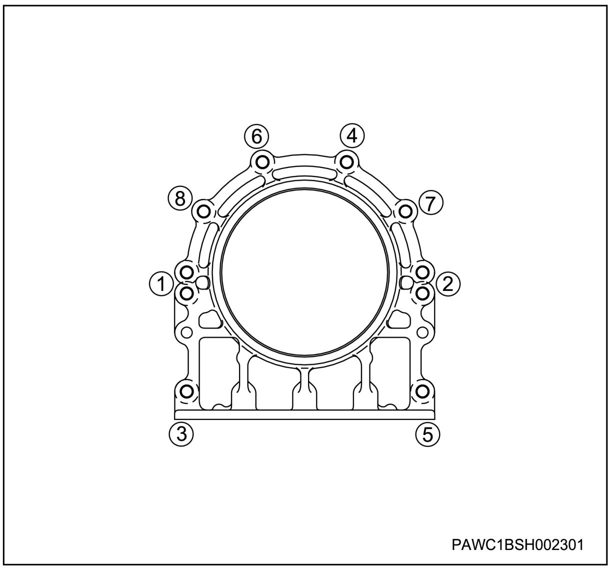
Note：
- Apply ThreeBond 1207B.

Caution：
- Verify that there is no dirt on the large end of the crankshaft.

   3. Install the oil seal retainer to the cylinder block.

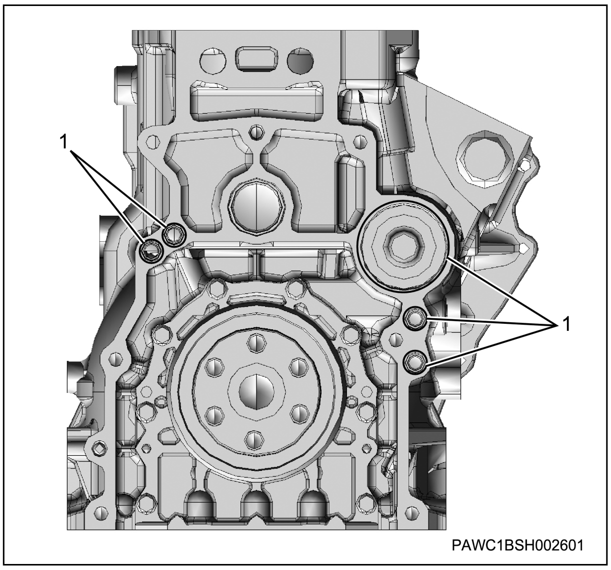
Note：
- Tighten the bolts in the tightening order shown in the diagram.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



3. Flywheel housing installation
   1. Apply liquid gasket to the cylinder block.

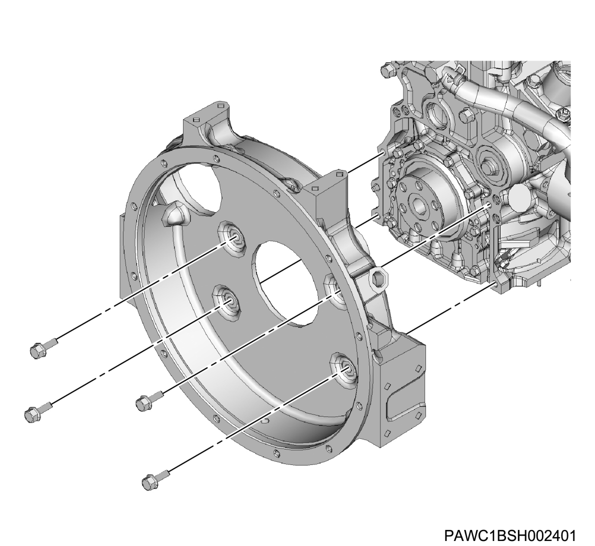
Note：
- Apply ThreeBond 1207B to the 5 places indicated in the diagram.



1. Liquid gasket application area

   2. Install the flywheel housing to the cylinder block.

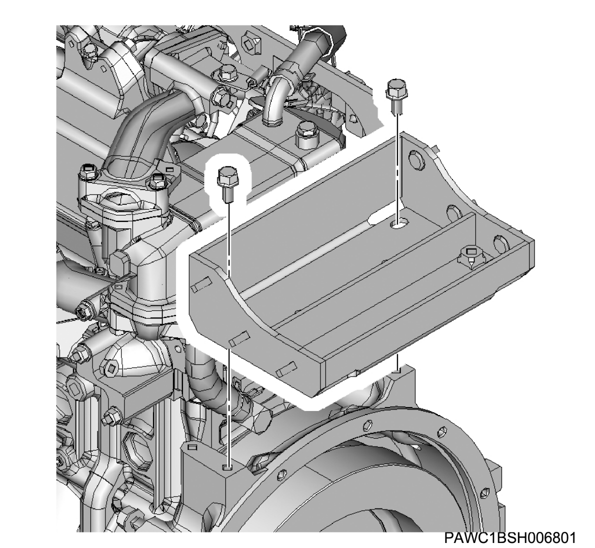
tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



PAWC1BSH002401

3. Install the silencer bracket to the flywheel housing.

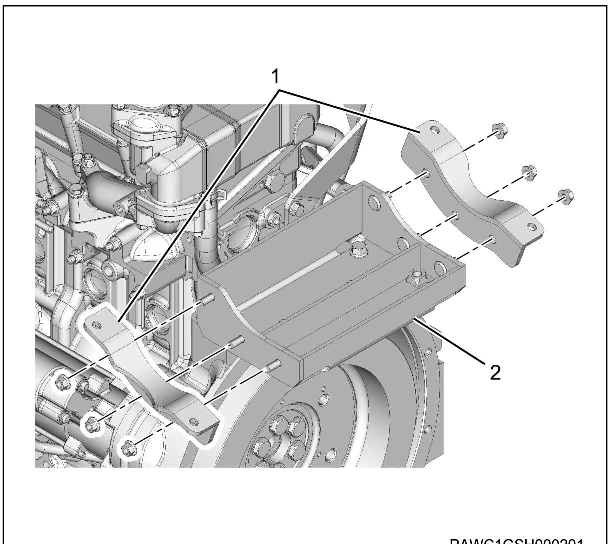
tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



PAWC1BSH006801

4. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.



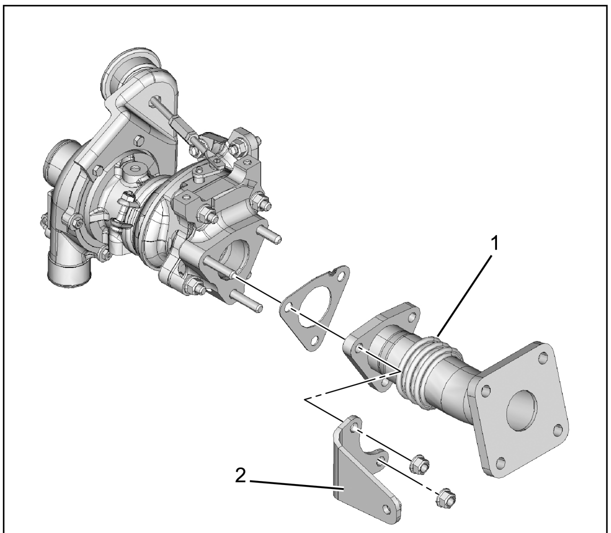
PAWC1GSH000201

1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note :

- Install together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.

4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

Note :

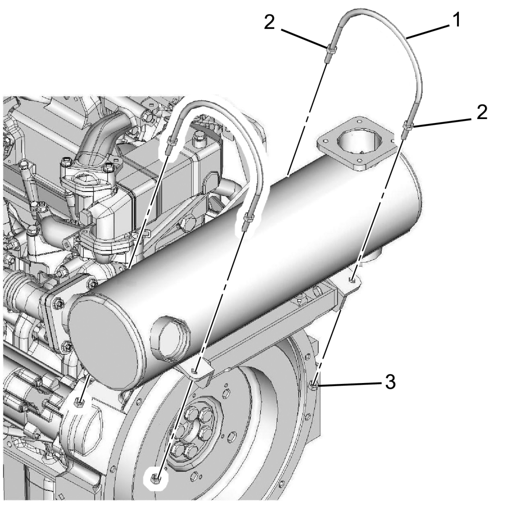
- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.

- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



PAWC1GSH000301

1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

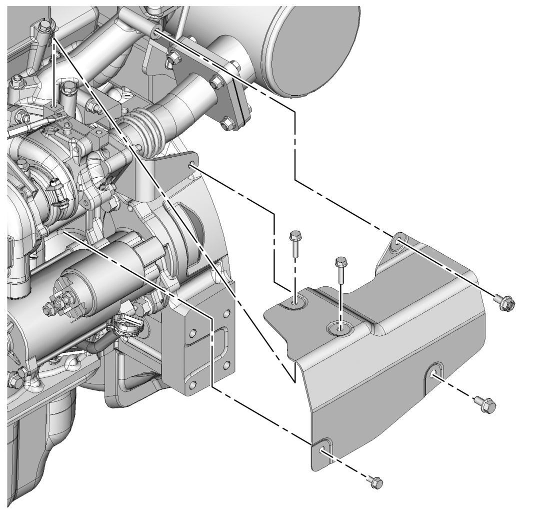
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

5. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }
M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }
M6

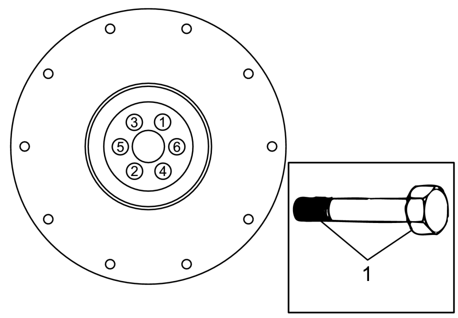

PAWC1BSH001101

6. Flywheel installation

1. Apply engine oil to the bolt.

Note：

- Apply to the seat surface and the threaded portion of the flywheel mounting bolts.



PAWC1BSH001801

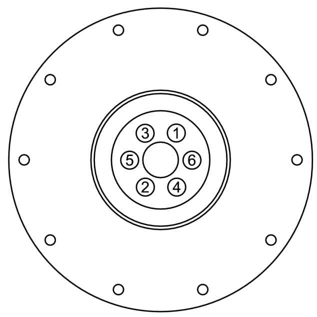
1. Engine oil application area

2. Install the flywheel to the crankshaft.

Note：

- Gradually tighten the mounting bolts in the order shown in the diagram.

tightening torque： 98 N・m { 10.0 kgf・m / 72 lb・ft }



PAWC1BSH001701

Caution：

- Install while verifying the installation position.

7. Engine speed sensor installation
   1. Install the engine speed sensor to the flywheel housing.

Note：

- Screw in the engine speed sensor until it reaches the end.

Caution：

- Be careful not to damage the sensor tip.

Note：

- Return the engine speed sensor 1 rotation, and secure with a nut.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

2. Inspect the engine speed sensor.

Note：

- Check the output voltage at maximum speed without load and low speed without load.

	Specified output voltage	
Engine speed	Voltage waveform	AC voltage
Maximum speed without load	： 20 to 72 V	： 7.1 to 25.5 V
Low speed without load	： 9 to 40 V	： 3.2 to 14.2 V

Note：

- If the measured value is outside the specified output voltage, adjust the engine speed sensor until it is within the specified output voltage.

8. Starter motor installation
   1. Install the starter motor to the flywheel housing.

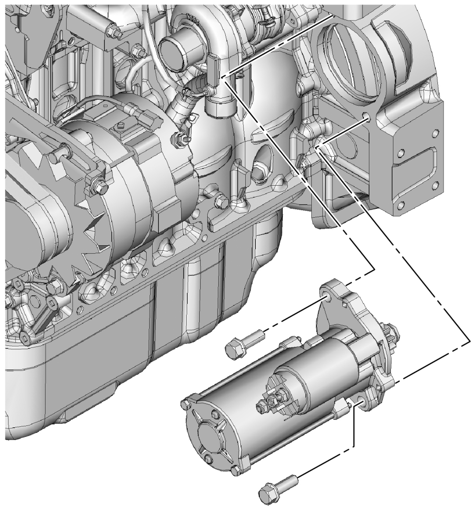
tightening torque： 103 N・m { 10.5 kgf・m / 76 lb・ft }

2. Install the ground cable to the starter motor.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

Note：

- The diagram shows the 24 V - 3.2 kW specification.



PAWC1JSH000101

9. Oil level gauge guide tube installation
   1. Install the oil level gauge guide tube to the cylinder block.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

2. Install the oil level gauge to the oil level gauge guide tube.

10. Battery ground cable connect
    1. Connect the battery ground cable to the battery.

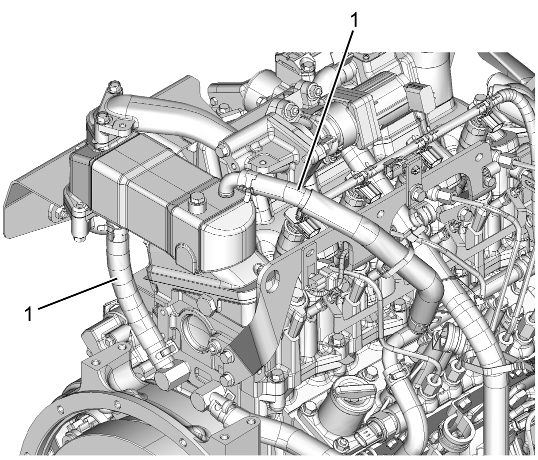
Rocker arm shaft

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution：
   - After draining the coolant, do not forget to tighten the drain plug.
3. Pressure sensor/boost temperature sensor disconnect
   1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

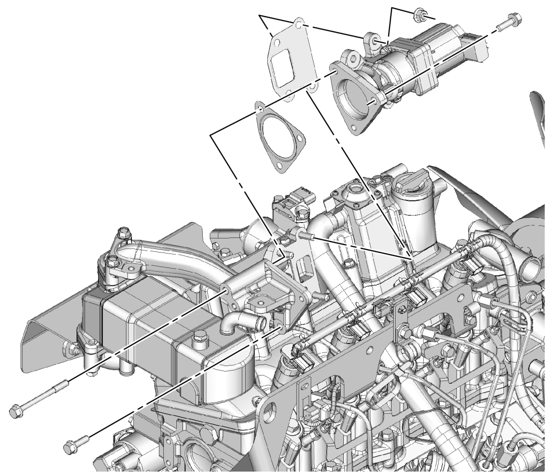
   Note：
   - Remove the harness clip.
4. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.



PAWC1BSH000201

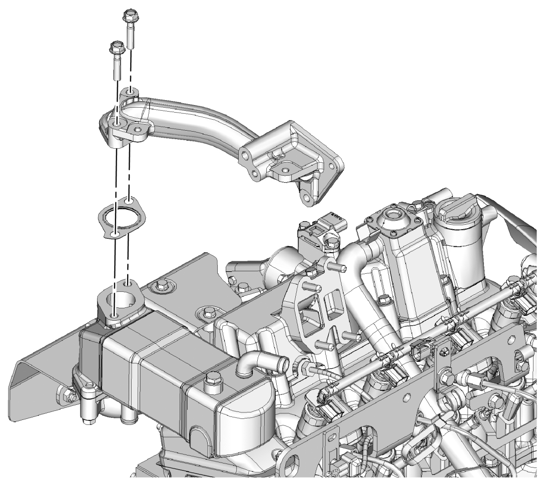
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.



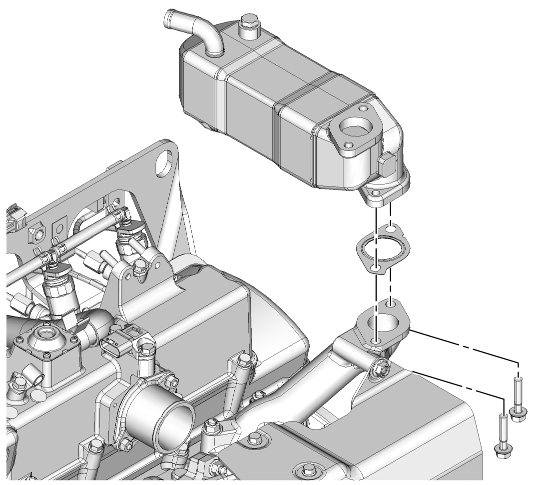
PAWC1BSH000301

5. Remove the EGR pipe from the EGR cooler.



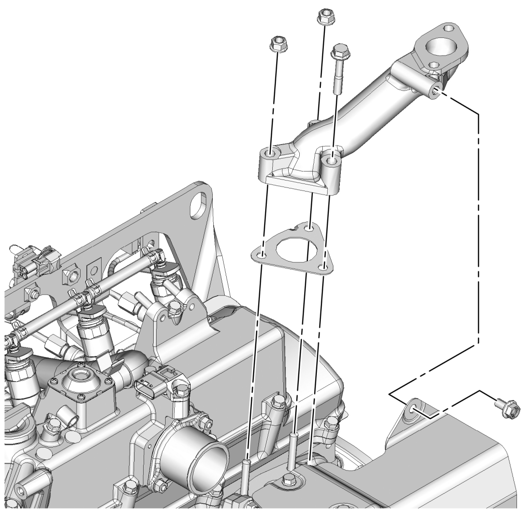
PAWC1BSH000401

6. Remove the EGR cooler from the EGR pipe.



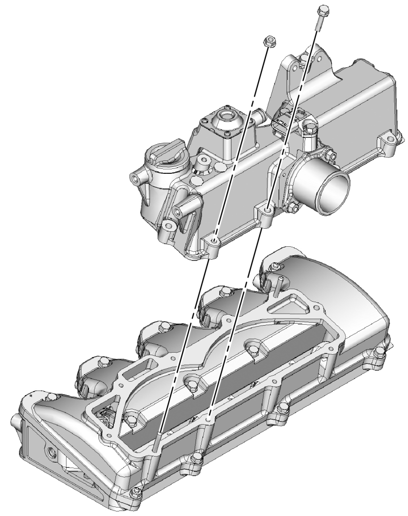
PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.



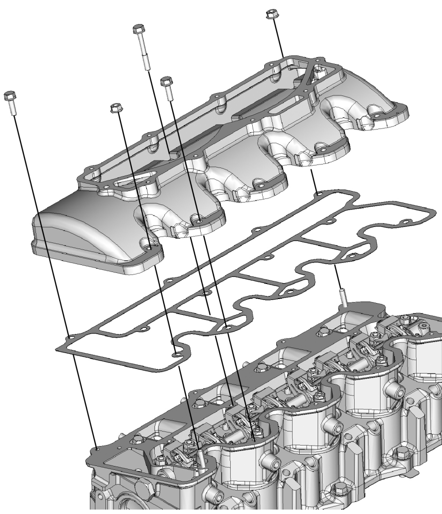
PAWC1BSH000601

5. PCV hose removal
   1. Remove the PCV hose from the intake chamber.
6. IMT sensor removal
   1. Disconnect the harness connector from the IMT sensor.
   2. Remove the IMT sensor from the intake chamber.
7. Intake chamber removal
   1. Remove the intake chamber from the cylinder head cover.



PAWC1BSH000701

8. Cylinder head cover removal
   1. Remove the cylinder head cover from the rocker arm bracket.

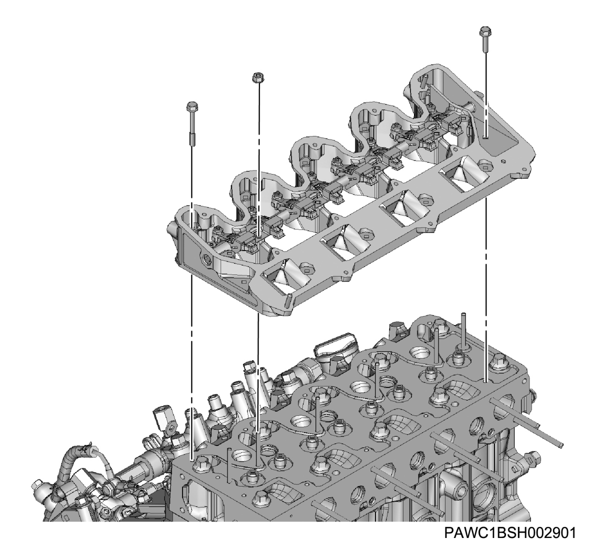


PAWC1BSH001001

9. Rocker arm bracket removal
   1. Remove the rocker arm bracket from the cylinder head.

Caution :

- Be careful not to damage the rocker arm bracket when removing.

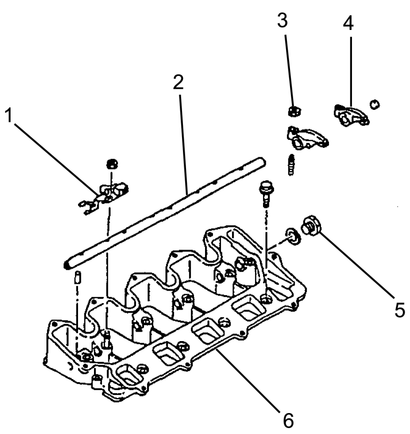

PAWC1BSH002901

10. Rocker arm shaft removal

1. Remove the rocker arm shaft from the rocker arm bracket.

Note :

- Remove the plug, and pull out the rocker arm shaft from the bracket.
- Organize the removed rocker arms according to the cylinders using tags, etc.



PAWC1BSH004601

1. Rocker arm spring
2. Rocker arm shaft
3. Lock nut
4. Rocker arm
5. Rocker arm shaft plug
6. Rocker arm bracket

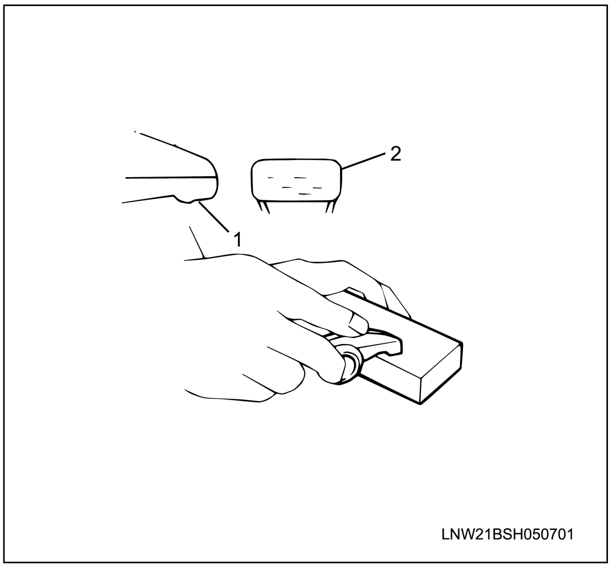
11. Push rod removal

1. Remove the push rod from the cylinder block.

inspection

1. Rocker arm inspection
   1. Inspect the rocker arm.

   Note：
   - Inspect the oil holes of the rocker arm for clogging, dirt, etc.
   - If there is clogging or dirt, clean using air.
   - Inspect the contact surface of the rocker arm valve stem.
   - If scratches or wear is found on the contact surface, repair using an abrasive wheel.
   - Replace the rocker arm if significant wear is found.



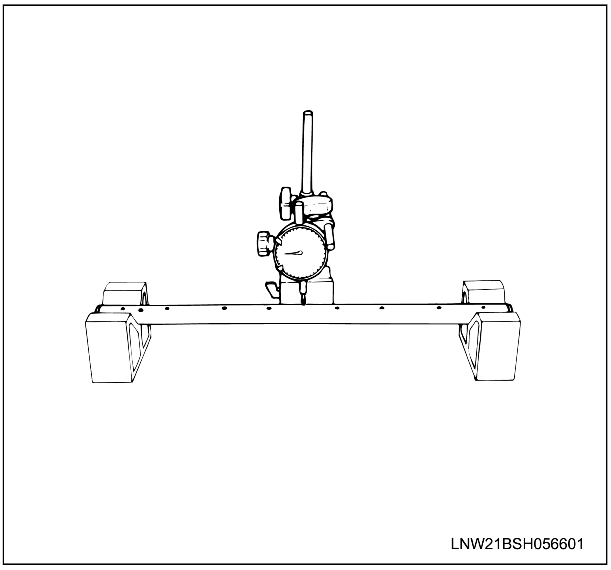
1. Wear
2. Damage

2. Rocker arm shaft inspection
   1. Put the rocker arm shaft on the V-block.
   2. Measure the fluctuation a using dial gauge.

   Note：
   - Slowly rotate the rocker arm shaft and measure fluctuation of the dial gauge at the center part of the rocker arm shaft.
   - If the measured value exceeds the limit, replace the rocker arm shaft.

   specified value： less than 0.2 mm { less than 0.008 in }

   limit： 0.3 mm { 0.012 in }

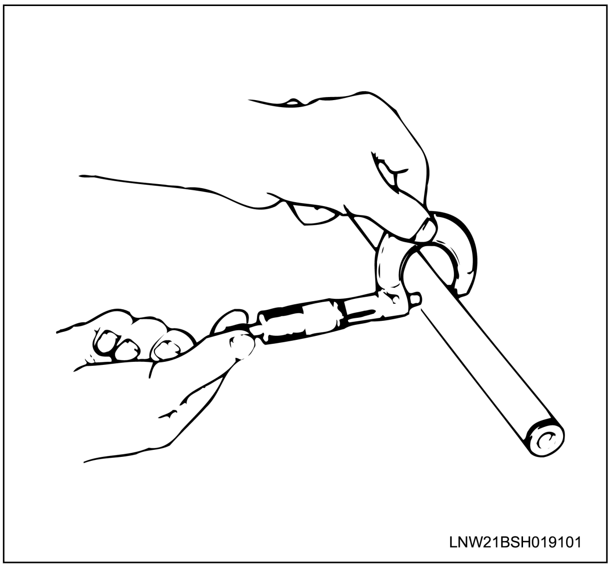


   3. Measure the outer diameter using a micrometer.

   Note：
   - Measure the outer diameter of the rocker arm shaft.
   - If the measured value is less than the limit, replace the rocker arm shaft.

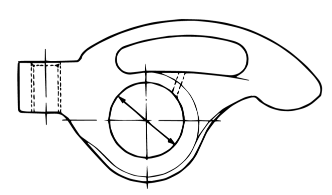
   specified value： 12.00 mm { 0.472 in }

   limit： 11.85 mm { 0.467 in }



   4. Measure the inner diameter using a vernier caliper.

   Note：
   - Use a vernier caliper or a cylinder gauge to measure the inner diameter of the rocker arm.



LNW21BSH050601

5. Calculate the clearance from the measured value.

specified value : 0.005 to 0.045 mm { 0.0002 to 0.0018 in }

limit : 0.2 mm { 0.008 in }

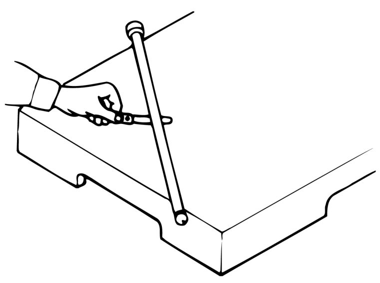
3. Push rod measurement

1. Measure the bend using a feeler gauge.

Note :

- Rotate the push rod on a level block and measure the bend of the push rod with a feeler gauge.
- If the measured value exceeds the limit, replace the push rod.

specified value : 0.3 mm { 0.012 in }



LNW21BSH049901

installation

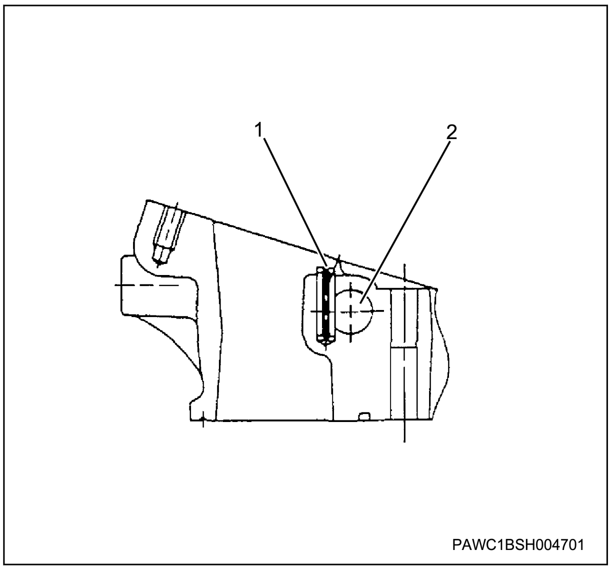
1. Push rod installation
   1. Install the push rod to the cylinder block.

   Note :
   - Pass it through the cylinder block and insert it into the tappet.
2. Rocker arm shaft installation
   1. Apply engine oil to the rocker arm shaft.

   Note :
   - Apply to the rocker arm and the rocker arm shaft.
   2. Install the rocker arm shaft to the rocker arm bracket.

   Note :
   - Align the notches of the rocker arm shaft to the rocker shaft pin and install.

   Caution :
   - Make sure to align the rocker arm in the original position and install.

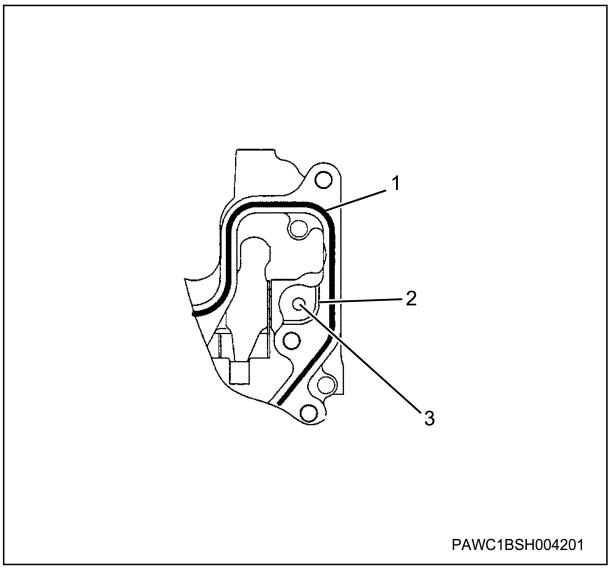


1. Pin
2. Rocker arm shaft

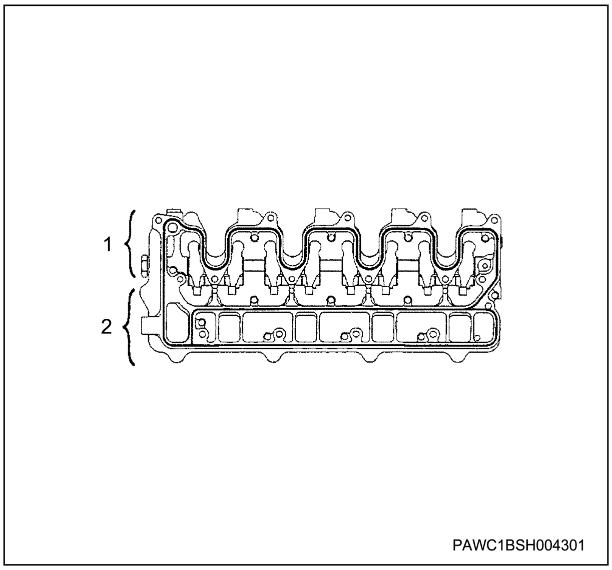
3. Rocker arm bracket installation
   1. Apply liquid gasket to the rocker arm bracket.

   Note :
   - Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

   Caution :
   - Do not apply liquid gasket to the groove around the oil gallery.



1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



1. Liquid gasket application area
2. Oil gallery groove

Note :
- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note :
- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.
4. Securely tighten the rocker arm bracket to the cylinder head.

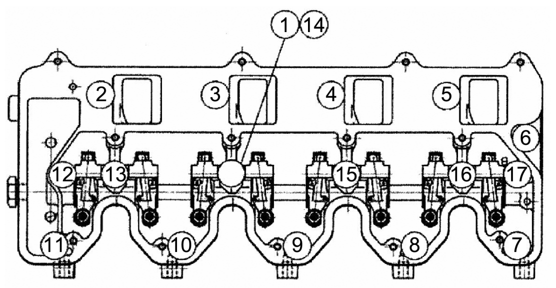
Note：

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution：

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



PAWC1BSH004101

4. Rocker arm shaft adjustment

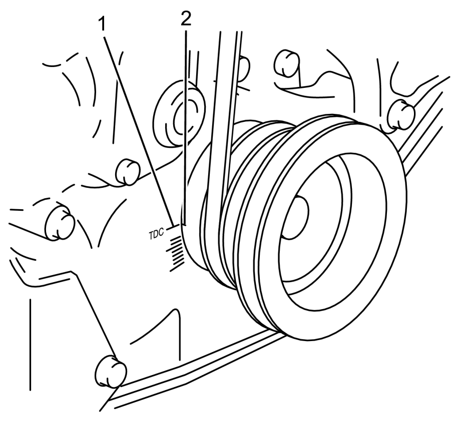
Note：

- Valve clearance adjustment

Caution：

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



PAWC1BSH004401

1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note：

- Insert the feeler gauge between the rocker arm and the bridge cap.

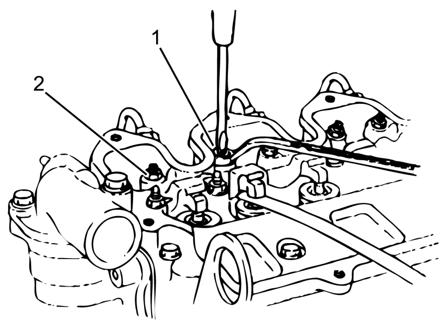
specified value： 0.40 mm { 0.016 in } Inlet valve

specified value： 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note：

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



PAWC1BSH004501

1. Adjust screw
2. Lock nut

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note：

- Rotate the crankshaft in the forward direction and measure the valve clearance.

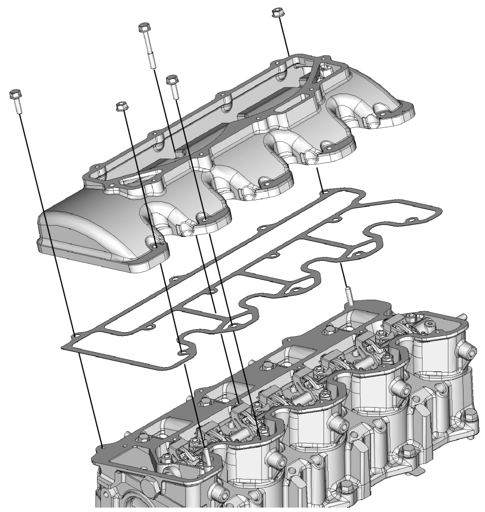
Caution：

- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

5. Cylinder head cover installation
   1. Install the cylinder head cover to the rocker arm bracket.

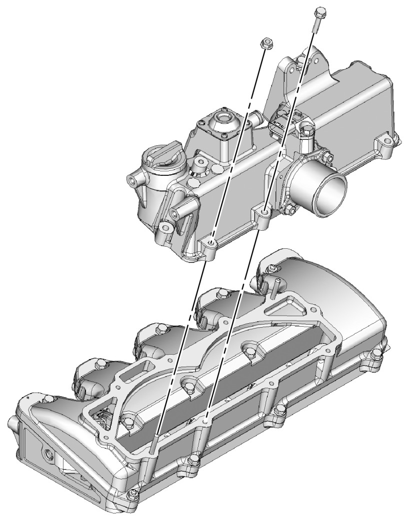
   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH001001

6. Intake chamber installation
   1. Install the intake chamber to the cylinder head cover.

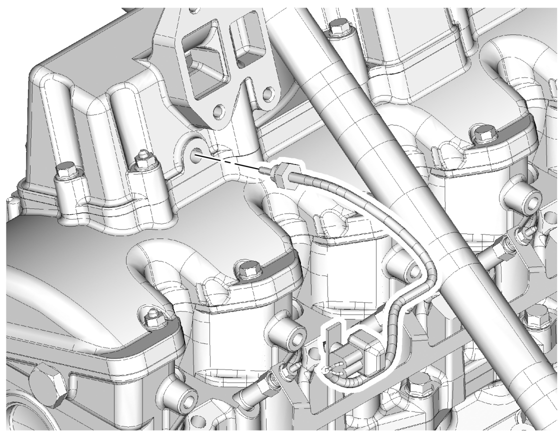
   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH000701

7. IMT sensor installation
   1. Install the IMT sensor to the intake chamber.

   tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

   2. Connect the harness connector to the IMT sensor.
8. PCV hose installation
   1. Install the PCV hose to the intake chamber.
9. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

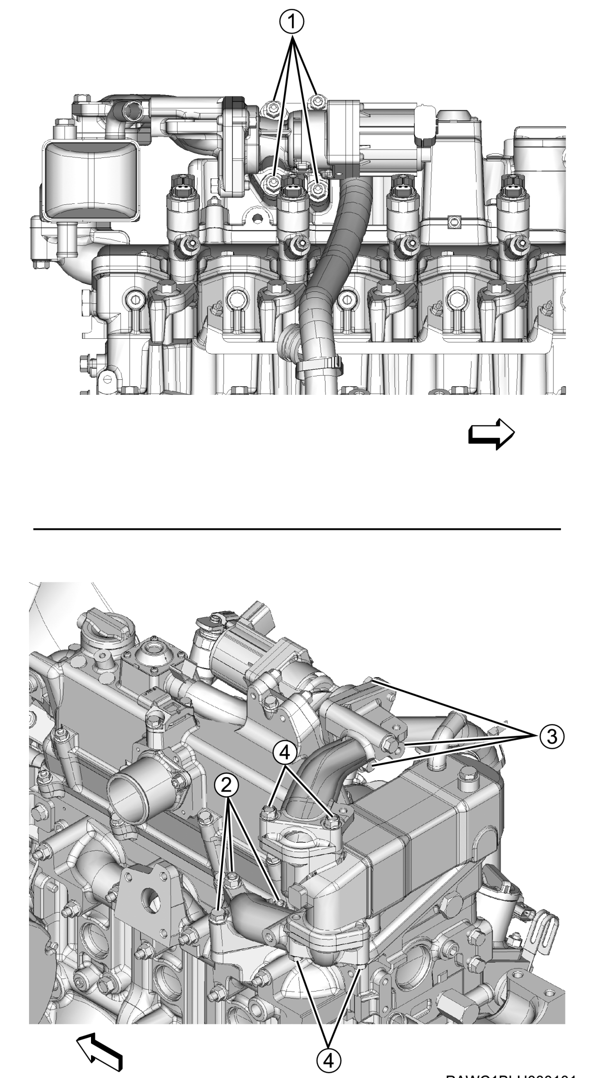
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

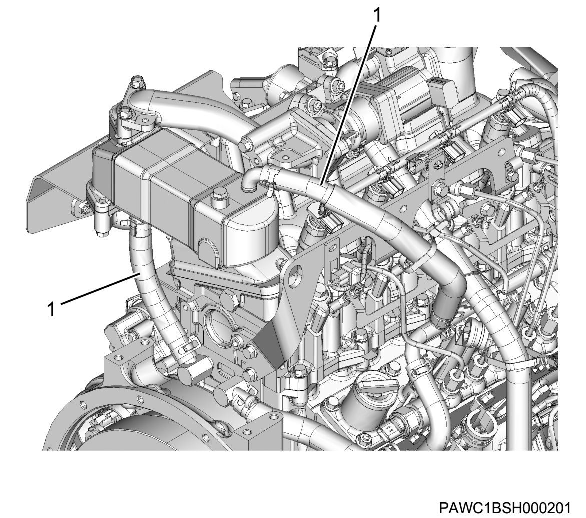


Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

10. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

- Install the harness clip.

11. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

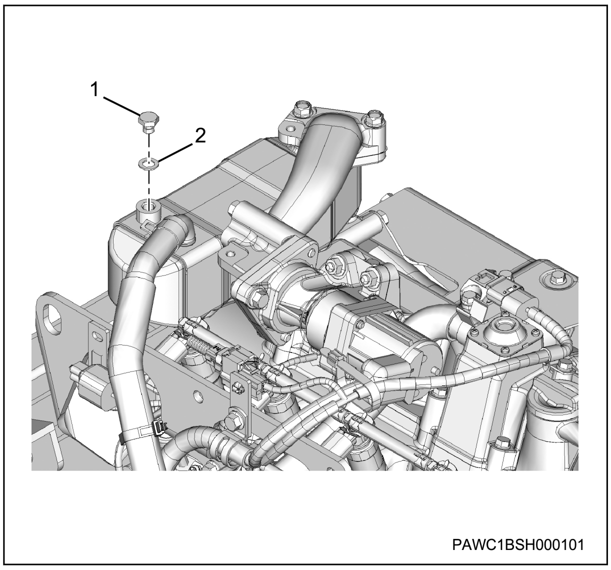
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug
2. Gasket

12. Battery ground cable connect

1. Connect the battery ground cable to the battery.

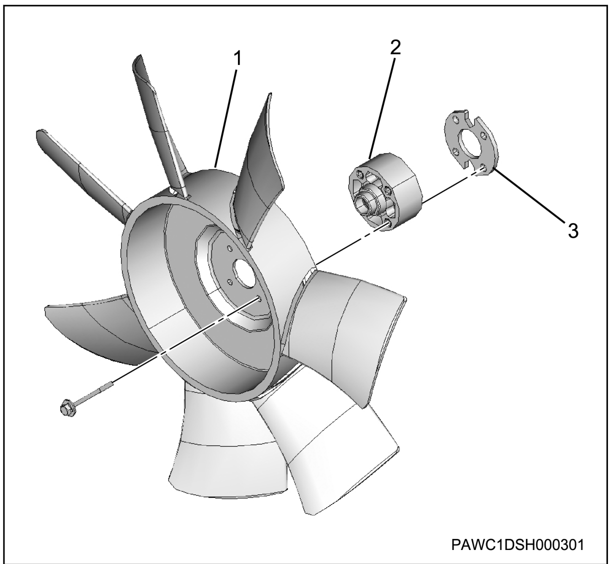
Valve spring

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.

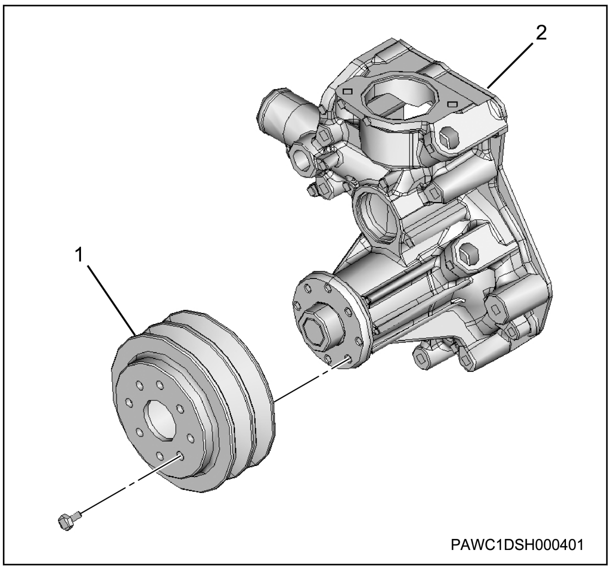


1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

   Note :

   - Loosen the generator adjust bolt and remove the belt.
5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

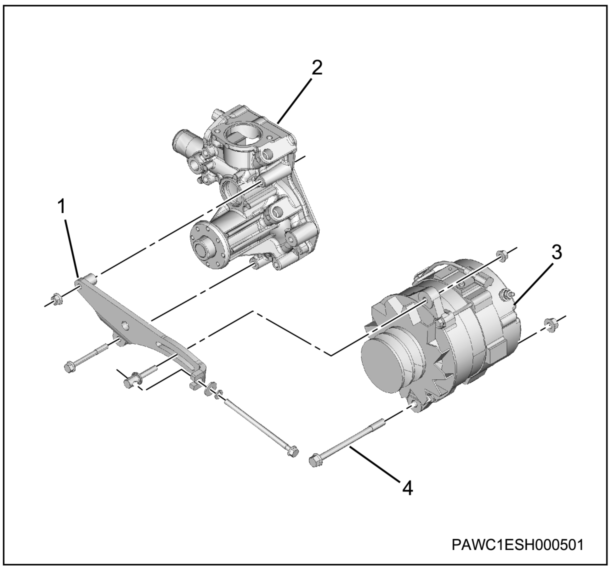


1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :

   - The diagram shows the 24 V - 50 A specification.

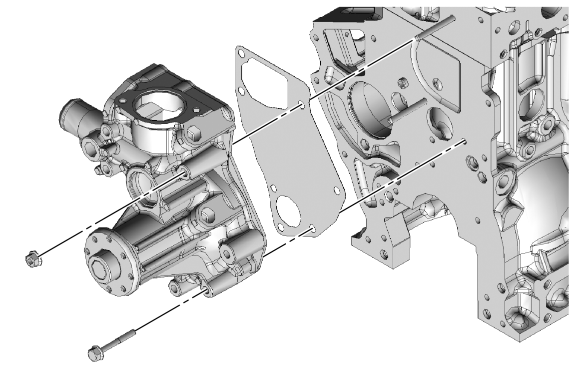


1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
8. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

   Note :
   - Remove the hose clip.
9. Water pump assembly removal
   1. Remove the water pump assembly from the cylinder block and the cylinder head.

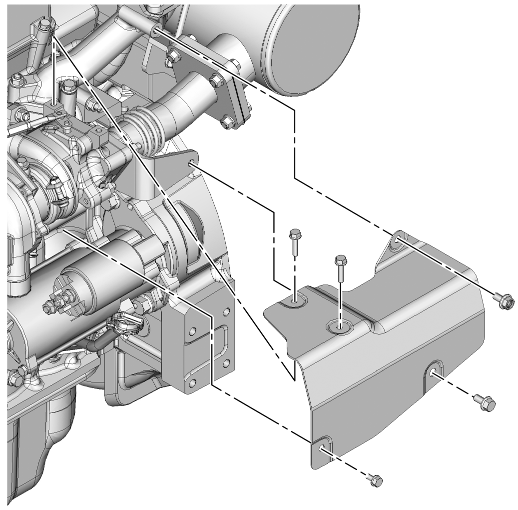
   Note :
   - Remove the water pump assembly and the gasket.



PAWC1DSH000201

10. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

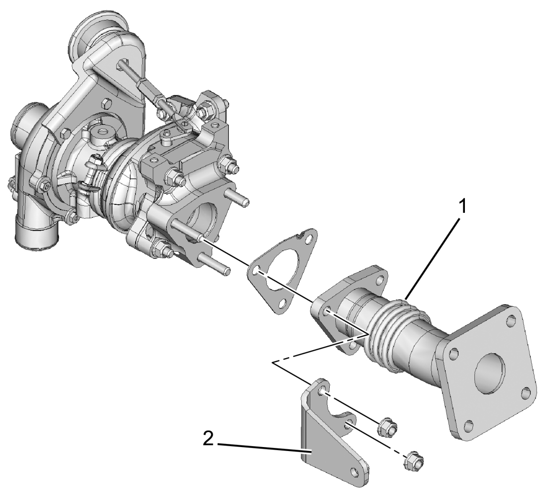
    Note :
    - Remove the harness clip.
11. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.



PAWC1BSH001101

12. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

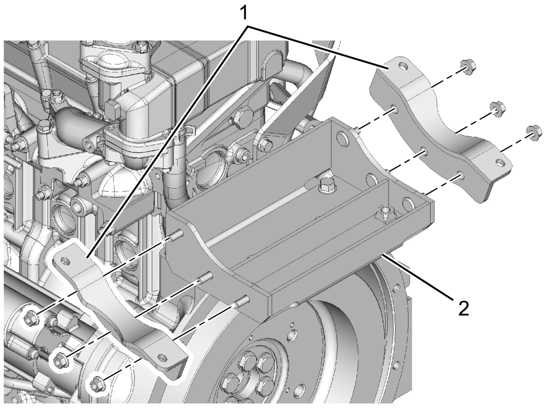
    Note :
    - Remove together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

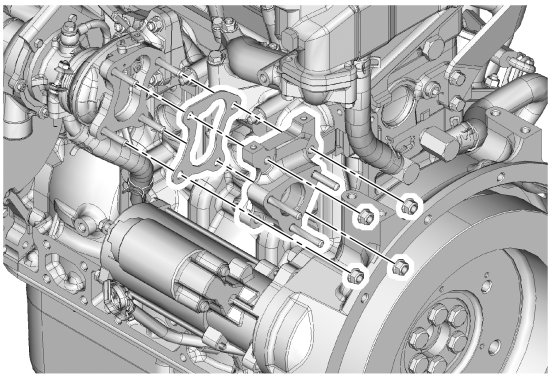
3. Remove the support bracket from the silencer bracket.



PAWC1GSH000201

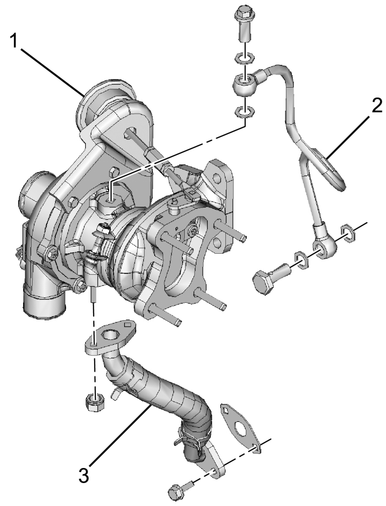
1. Support bracket
2. Silencer bracket

13. Turbocharger assembly removal
    1. Remove the exhaust pipe adapter from the turbocharger assembly.



PAWC1FSH000201

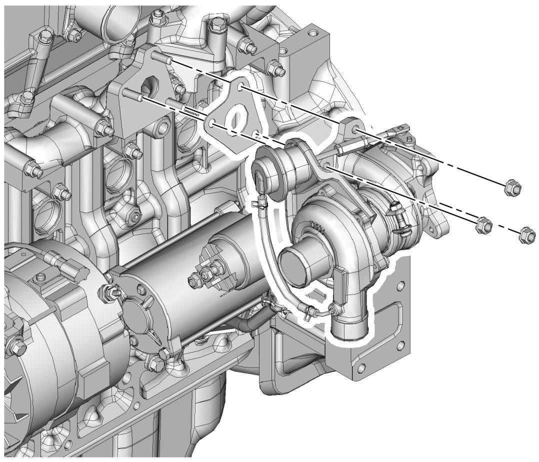
2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.



PAWC1FSH000301

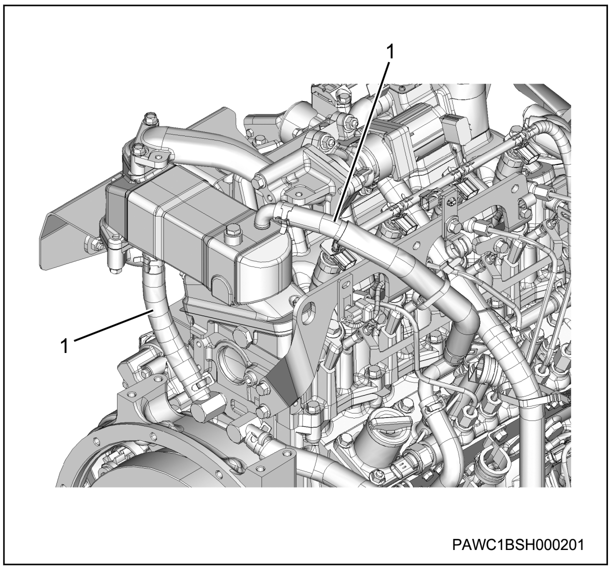
1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

4. Remove the turbocharger assembly from the exhaust manifold.



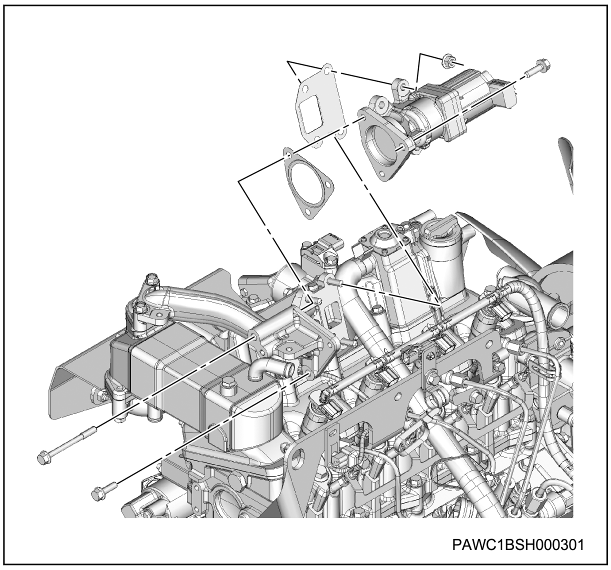
PAWC1FSH000101

14. EGR valve removal
    1. Disconnect the harness connector from the EGR valve.
    2. Disconnect the harness clip from the EGR pipe.
    3. Disconnect the water rubber hose from the EGR cooler assembly.

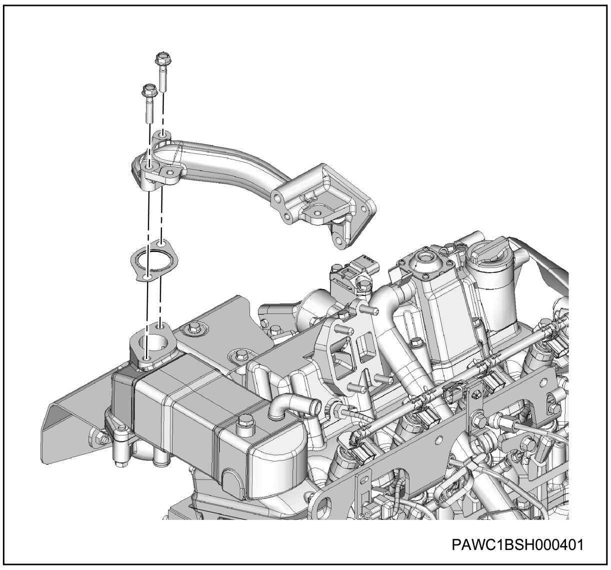


1. Water rubber hose

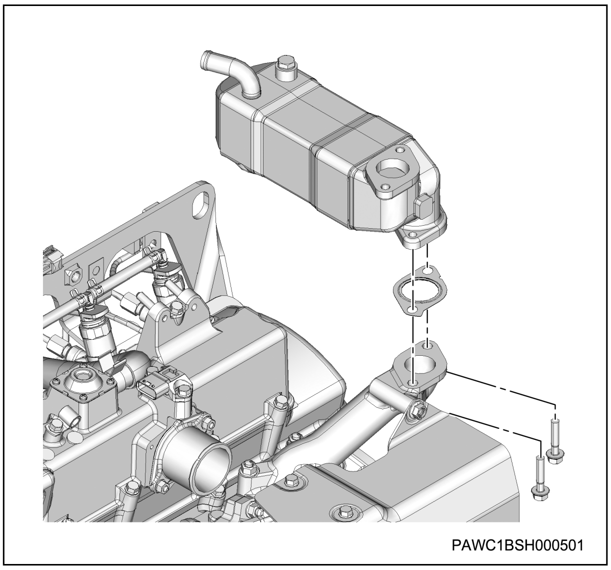
4. Remove the EGR valve from the intake chamber.



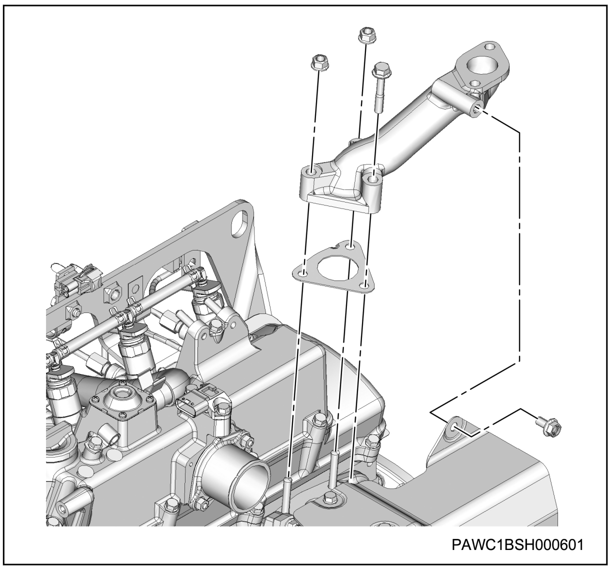
5. Remove the EGR pipe from the EGR cooler.



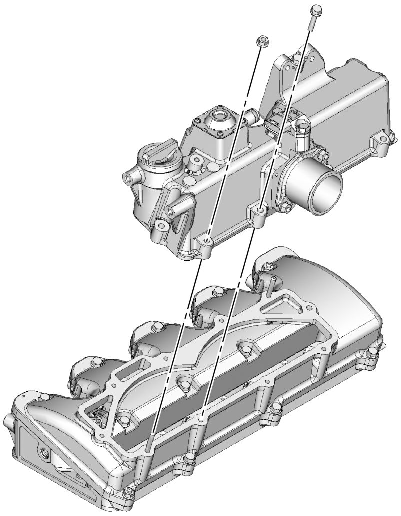
6. Remove the EGR cooler from the EGR pipe.



7. Remove the EGR pipe from the exhaust manifold.

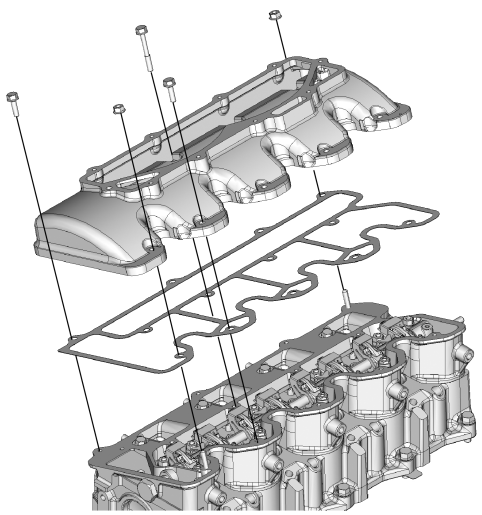


15. PCV hose removal
   1. Remove the PCV hose from the intake chamber.
16. IMT sensor removal
   1. Disconnect the harness connector from the IMT sensor.
   2. Remove the IMT sensor from the intake chamber.
17. Intake chamber removal
   1. Remove the intake chamber from the cylinder head cover.



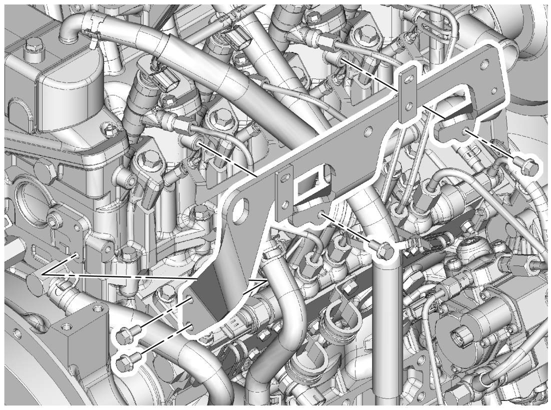
PAWC1BSH000701

18. Cylinder head cover removal
   1. Remove the cylinder head cover from the rocker arm bracket.



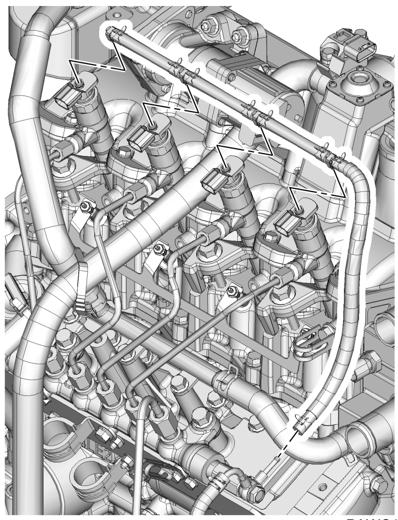
PAWC1BSH001001

19. Harness bracket removal
   1. Disconnect the engine harness from the harness bracket.
   2. Remove the harness bracket from the cylinder head.



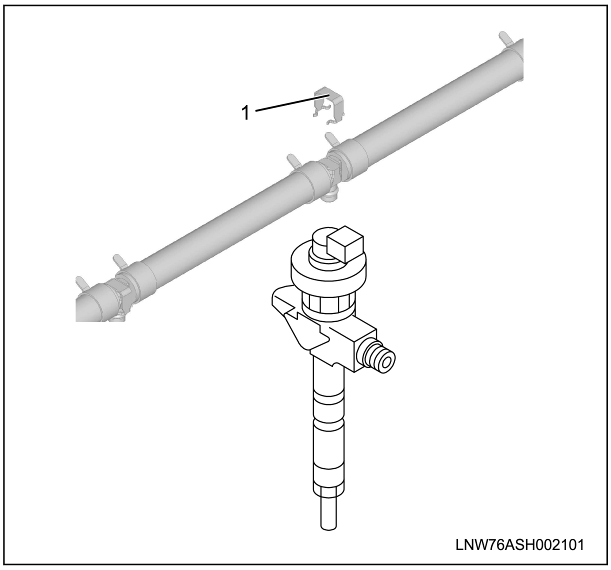
PAWC1CSH000301

20. Fuel leak-off hose removal
   1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note：
- Do not reuse the leak-off pipe clip.



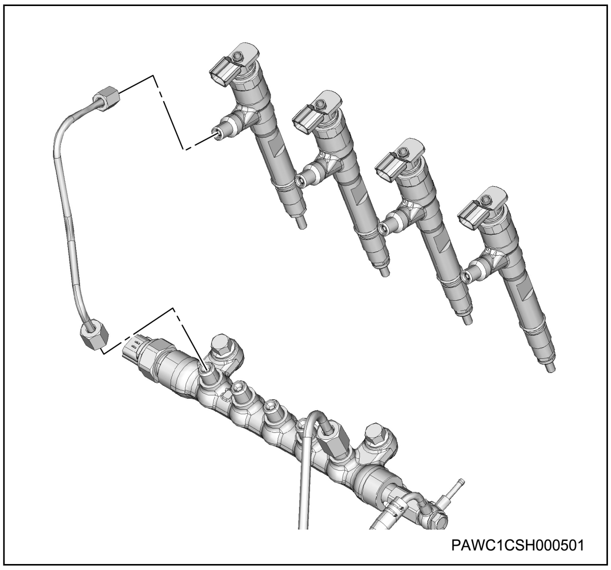
1. Clip

21. Injection pipe removal

1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note：

- Do not reuse the injection pipe.

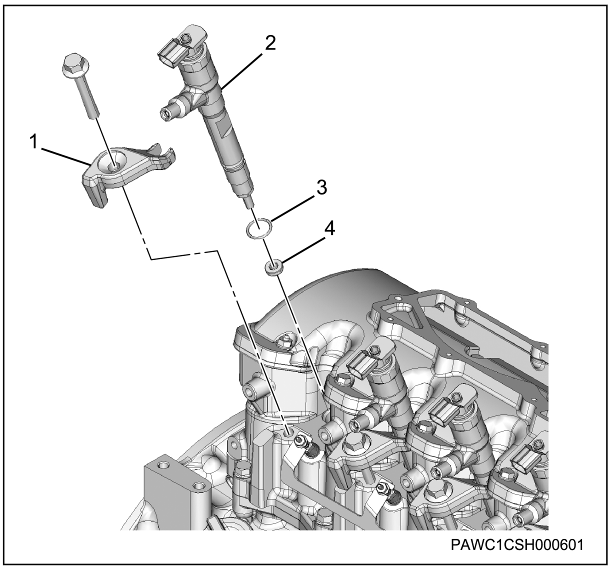


22. Injector removal

1. Disconnect the harness connector from the injector.
2. Remove the injector from the cylinder head assembly.
3. Remove the injector gasket from the injector.
4. Remove the O-ring from the injector.

Note：

- Do not reuse the injector gasket or the O-ring.



1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Note：

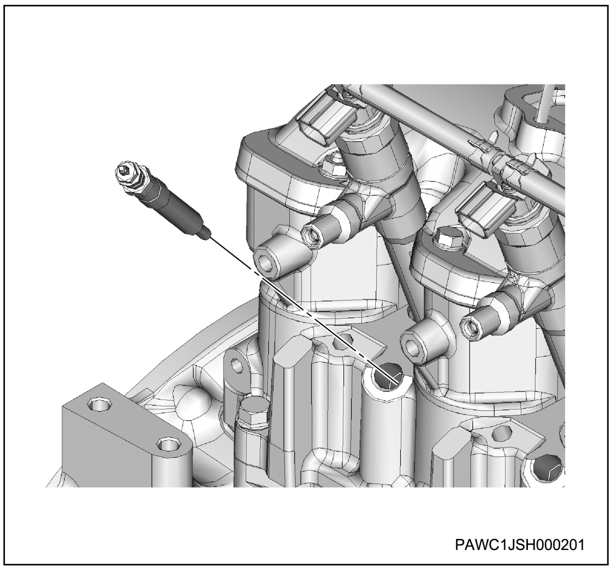
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

23. Glow plug connector removal

1. Remove the glow plug connector from the glow plug.

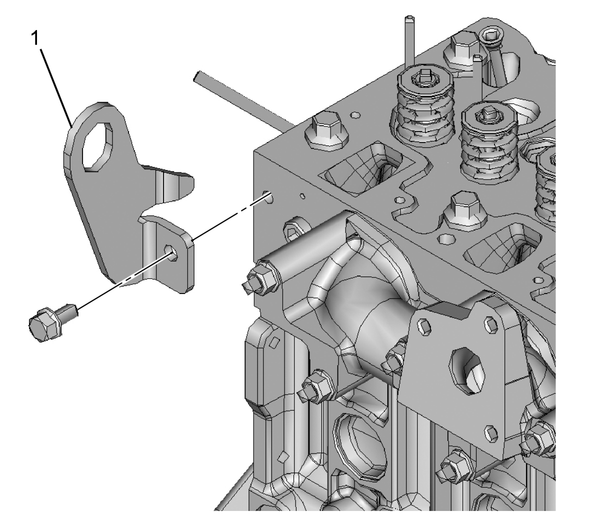
24. Glow plug removal

1. Remove the glow plug from the cylinder head.



25. Engine hanger removal

1. Remove the engine hanger from the cylinder head.

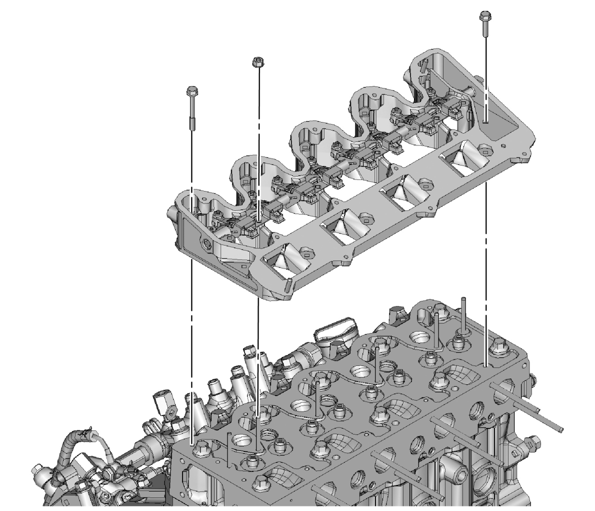


PAWC1BSH002701

1. Engine hanger

26. Rocker arm bracket removal
   1. Remove the rocker arm bracket from the cylinder head.

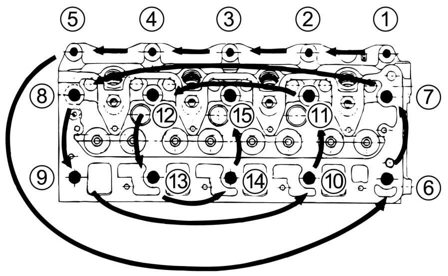
Caution :
- Be careful not to damage the rocker arm bracket when removing.



PAWC1BSH002901

27. Push rod removal
   1. Remove the push rod from the cylinder block.
28. Cylinder head assembly removal
   1. Remove the cylinder head assembly from the cylinder block.

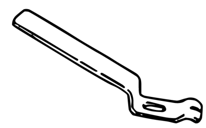
Note :
- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



PAWC1BSH002801

   2. Remove the cylinder head gasket from the cylinder block.
29. Split collar removal
   1. Remove the split collar from the valve using a special tool.

Note :
- Using a replacer, compress the valve spring and remove the split collar.



5884090300

SST: 5-8840-9030-0 - valve spring compressor

30. Spring seat removal
   1. Remove the spring seat from the valve.
31. Valve spring removal
   1. Remove the valve spring from the cylinder head.

inspection

1. Valve spring inspection
   1. Measure the free length using a vernier caliper.

      Note：

      - If the measured value is less than the limit, replace the valve spring.

      specified value： 42.1 mm { 1.657 in }

      limit： 40 mm { 1.575 in }

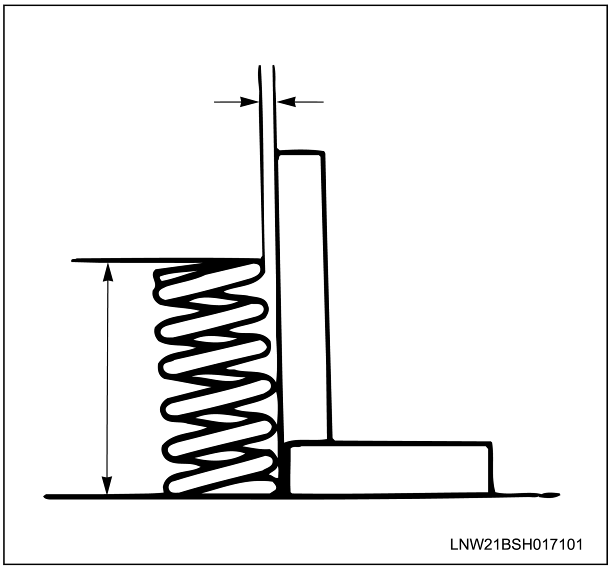
   2. Measure the perpendicularity using a simple straight ruler.

      Note：

      - If the measured value exceeds the limit, replace the valve spring.

      specified value： less than 1.8 mm { less than 0.071 in }

      limit： 2.5 mm { 0.098 in }



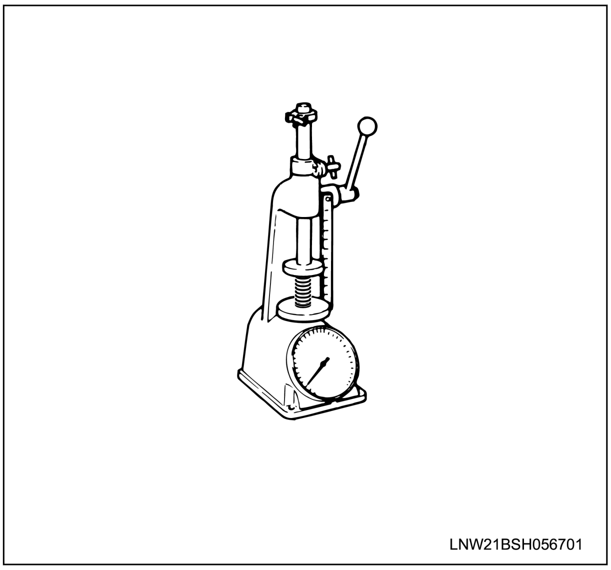
   3. Measure the tension using a spring tester.

      Note：

      - Compress the spring to the installation height.

      specified value： 29.9 mm { 1.177 in } Installation length

Valve spring tension	
Specified value	： 167 N { 17 kg / 38 lb }
Limit	： 147 N { 15 kg / 33 lb }

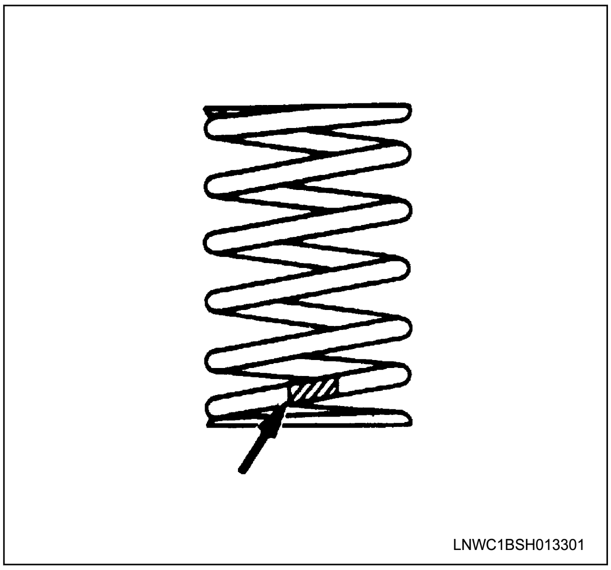


installation

1. Valve spring installation
   1. Install the valve spring to the cylinder head.

   Note :

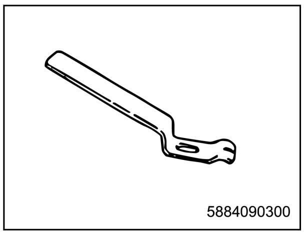
   - Install so that the painted side faces the cylinder head side.



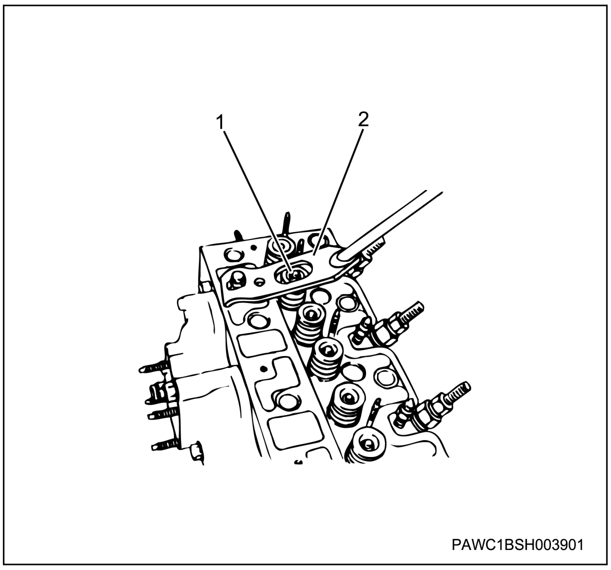
2. Spring seat installation
   1. Install the spring seat to the valve.
3. Split collar installation
   1. Install the split collar to the valve using a special tool.

   Note :

   - Using a replacer, compress the valve spring and install the split collar.



SST: 5-8840-9030-0 - valve spring compressor

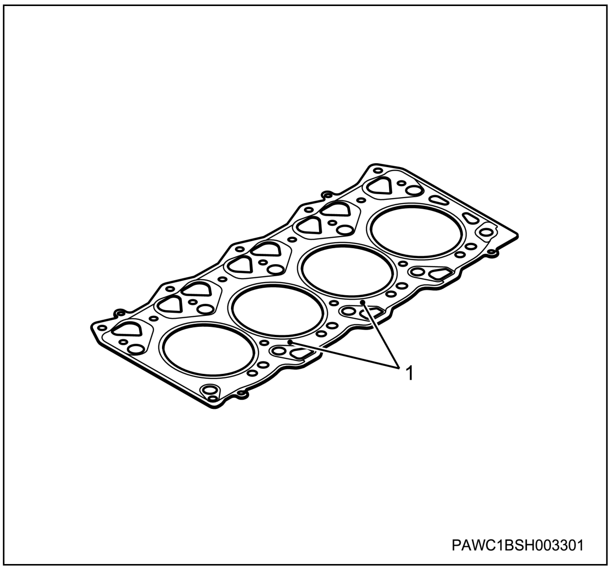


1. Split collar
2. Replacer

4. Cylinder head assembly installation
   1. Install the cylinder head gasket to the cylinder block.

   Note :

   - Install with the marked side facing upward.



1. Mark

   2. Apply engine oil to the bolt.

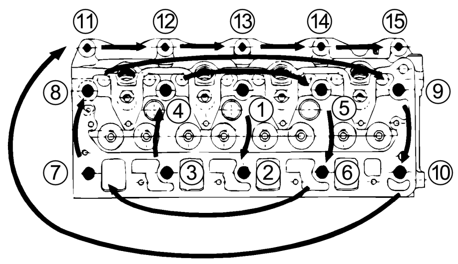
   Note :

   - Apply engine oil to the threaded portion and the seat surface of the head bolt.

   3. Install the cylinder head assembly to the cylinder block.
   4. Tighten the head bolts using a torque wrench.

Note：

- Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



PAWC1BSH004001

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle： 60 ° 3rd time

Note：

- Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque： 29 N・m { 3.0 kgf・m / 21 lb・ft }

5. Push rod installation

1. Install the push rod to the cylinder block.

Note：

- Pass it through the cylinder block and insert it into the tappet.

6. Rocker arm bracket installation

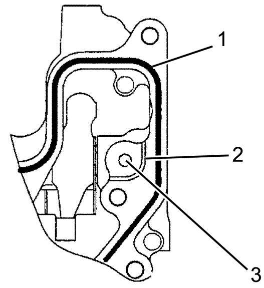
1. Apply liquid gasket to the rocker arm bracket.

Note：

- Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

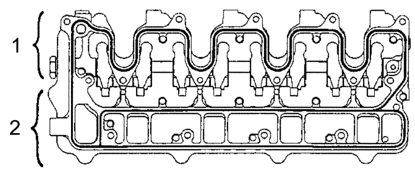
Caution：

- Do not apply liquid gasket to the groove around the oil gallery.



PAWC1BSH004201

1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



PAWC1BSH004301

1. Liquid gasket application area
2. Oil gallery groove

Note：

- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note：

- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.

4. Securely tighten the rocker arm bracket to the cylinder head.

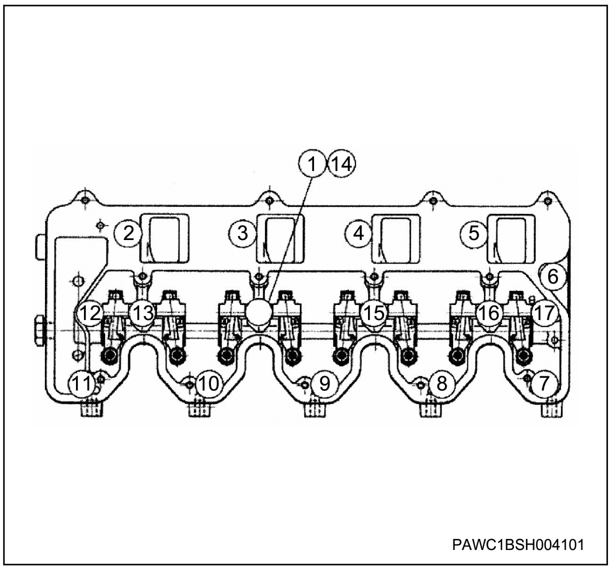
Note :

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution :

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



7. Rocker arm shaft adjustment

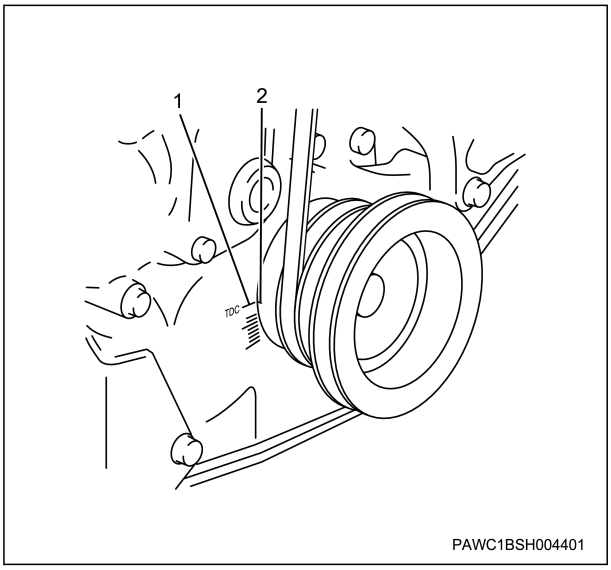
Note :

- Valve clearance adjustment

Caution :

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note :

- Insert the feeler gauge between the rocker arm and the bridge cap.

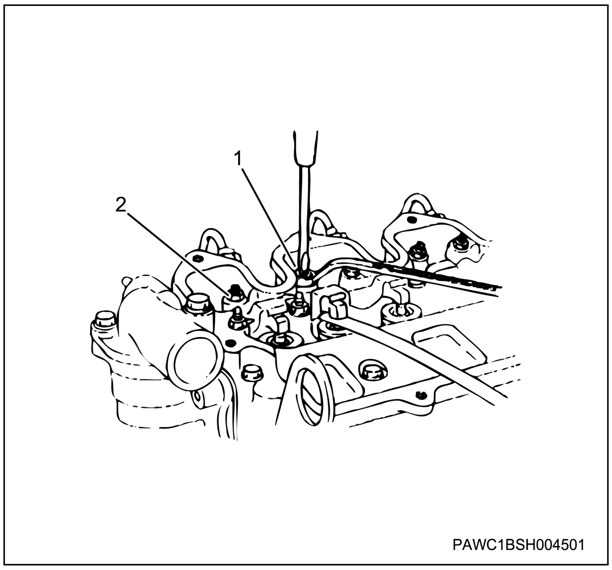
specified value : 0.40 mm { 0.016 in } Inlet valve

specified value : 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note :

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



1. Adjust screw
2. Lock nut

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note :

- Rotate the crankshaft in the forward direction and measure the valve clearance.

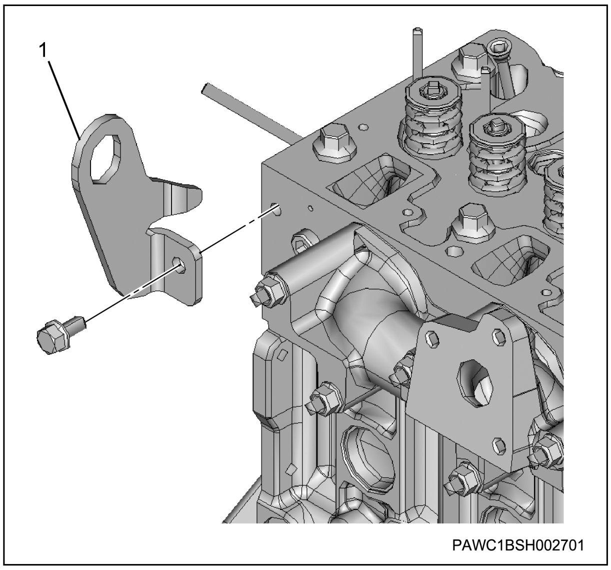
Caution :

- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

8. Engine hanger installation
   1. Install the engine hanger to the cylinder head.

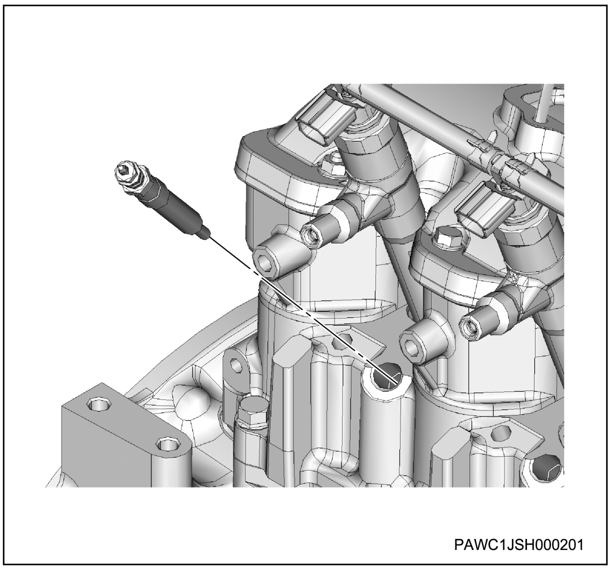
   tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }



1. Engine hanger

9. Glow plug installation
   1. Install the glow plug to the cylinder head.

   tightening torque： 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



10. Glow plug connector installation
    1. Install the glow plug connector to the glow plug.

    tightening torque： 1.0 N・m { 0.1 kgf・m / 9 lb・in }

11. Injector installation

    Caution：

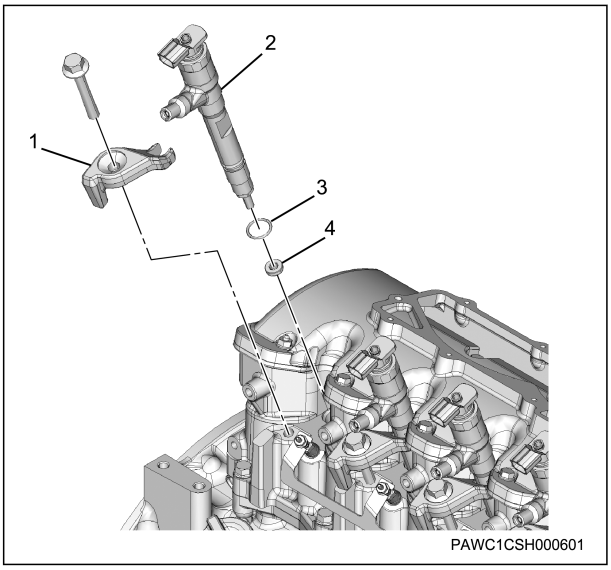
    ・ Do not change the installation position of the injectors when reusing the injectors.

    1. Install the O-ring to the injector.
    2. Install the injector gasket to the injector.

    Note：

    ・ Do not reuse the injector gasket or the O-ring.

    3. Temporarily tighten the injector to the cylinder head assembly.

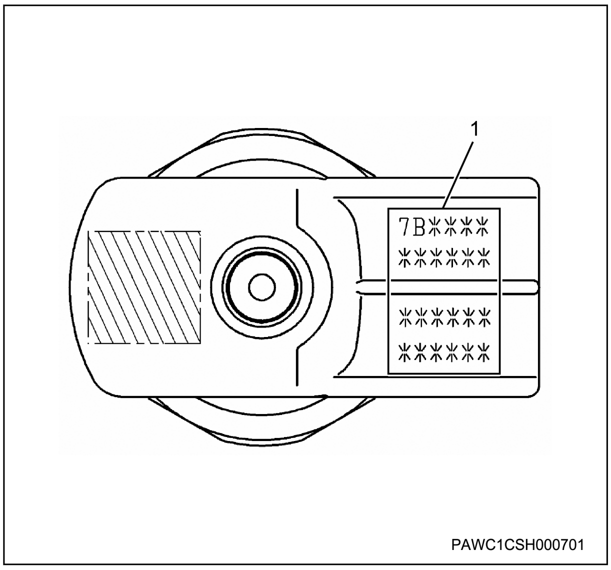


1. Injector clamp
2. Injector
3. O-ring

4. Injector gasket

Caution :

- If the injector has been replaced, record the injector ID code of the new injector.



PAWC1CSH000701

1. Injector ID code

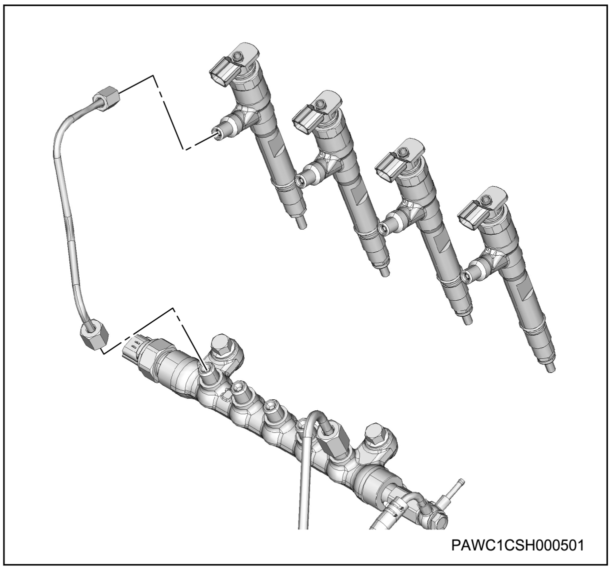
4. Connect the harness connector to the injector.

12. Injection pipe installation

1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note :

- Do not reuse the injection pipe.



PAWC1CSH000501

2. Securely tighten the injector to the cylinder head assembly.

tightening torque : 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note :

- Securely tighten the injector side.

tightening torque : 25 N・m { 2.5 kgf・m / 18 lb・ft }

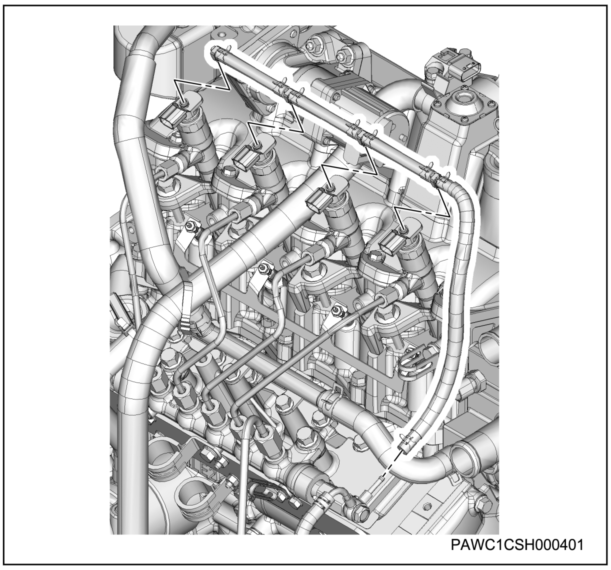
Note :

- Securely tighten the common rail (fuel rail) side.

tightening torque : 30 N・m { 3.1 kgf・m / 22 lb・ft }

13. Fuel leak-off hose installation

1. Install the fuel leak-off hose to the injector.

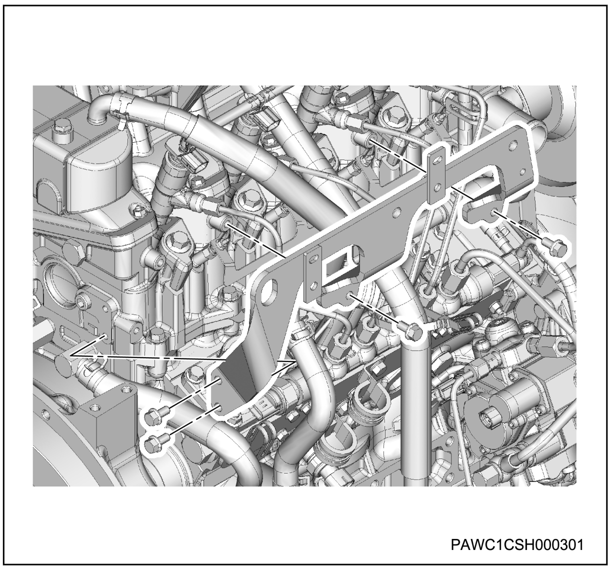


PAWC1CSH000401

14. Harness bracket installation

1. Install the harness bracket to the cylinder head.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

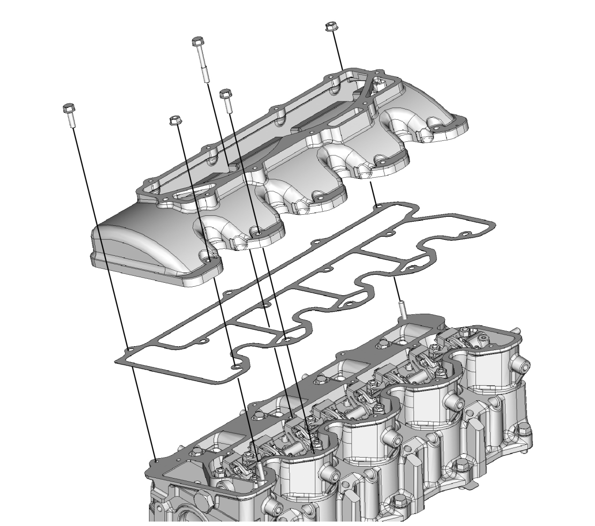


PAWC1CSH000301

2. Connect the engine harness to the harness bracket.

15. Cylinder head cover installation
    1. Install the cylinder head cover to the rocker arm bracket.

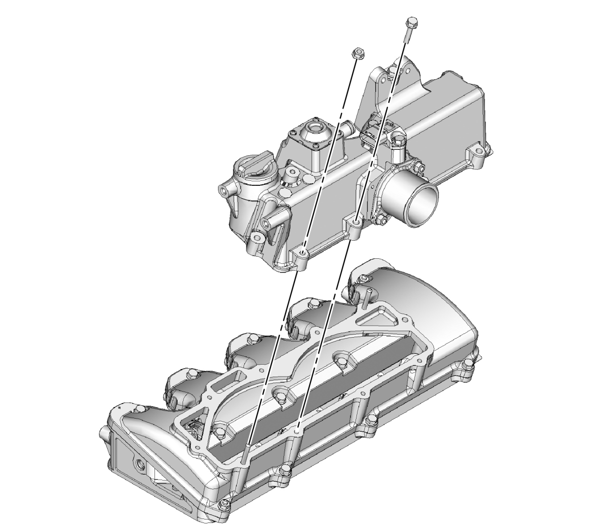
    tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH001001

16. Intake chamber installation
    1. Install the intake chamber to the cylinder head cover.

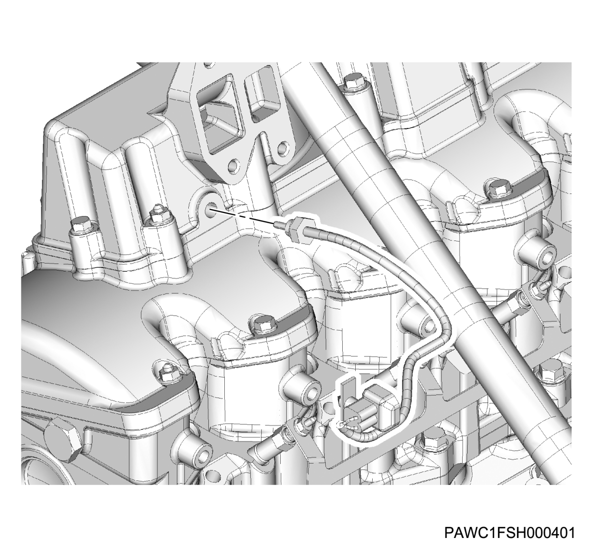
    tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH000701

17. IMT sensor installation
    1. Install the IMT sensor to the intake chamber.

    tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

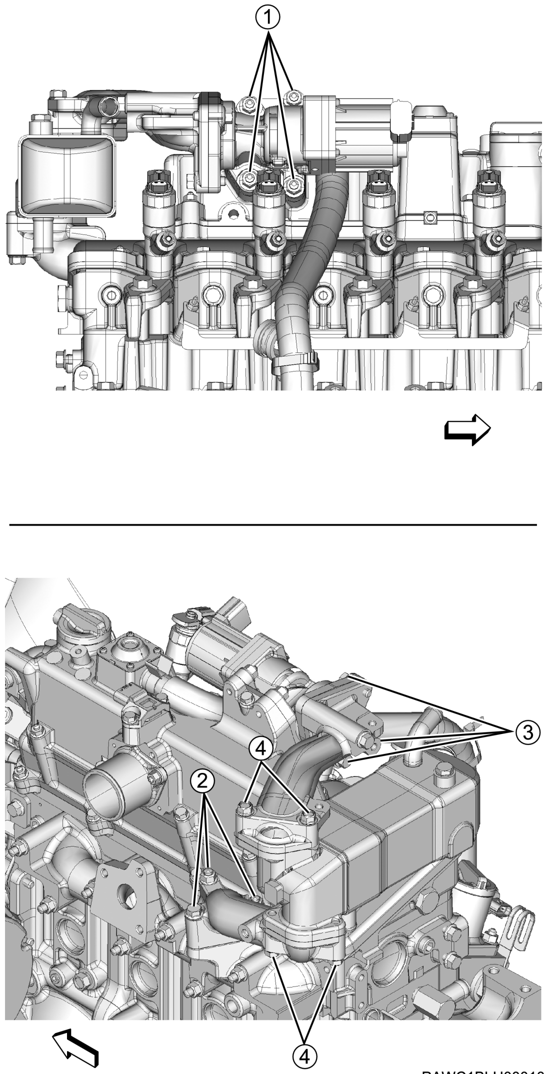
    2. Connect the harness connector to the IMT sensor.
18. PCV hose installation
    1. Install the PCV hose to the intake chamber.
19. EGR valve installation
    1. Temporarily tighten the EGR valve to the intake chamber.
    2. Temporarily tighten the EGR pipe to the exhaust manifold.
    3. Temporarily tighten the EGR pipe to the EGR valve.
    4. Temporarily tighten the EGR cooler to the EGR pipe.

    Note：
    - Temporarily tighten the entire component until seated.

    5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

    Note：
    - After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

    tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



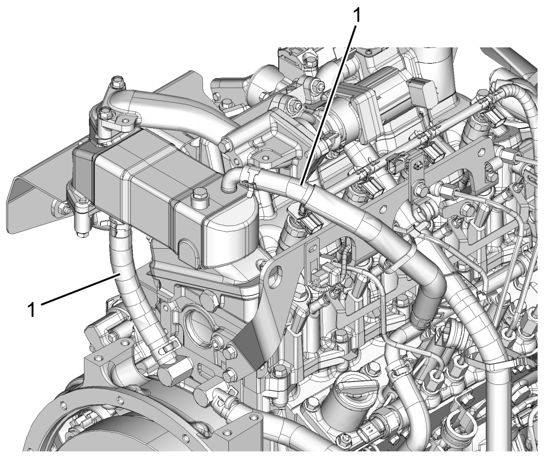
PAWC1BLH000101

Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



PAWC1BSH000201

1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

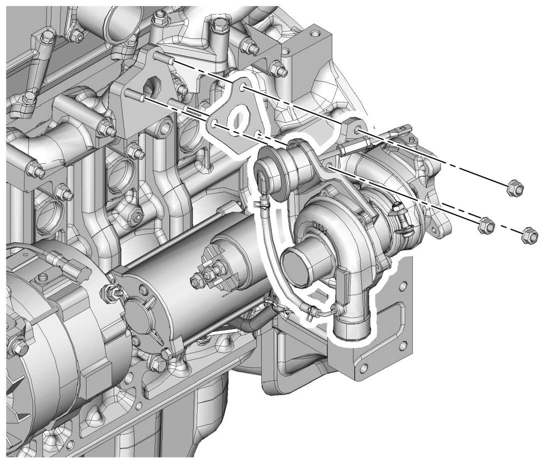
20. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note：

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }


PAWC1FSH000101

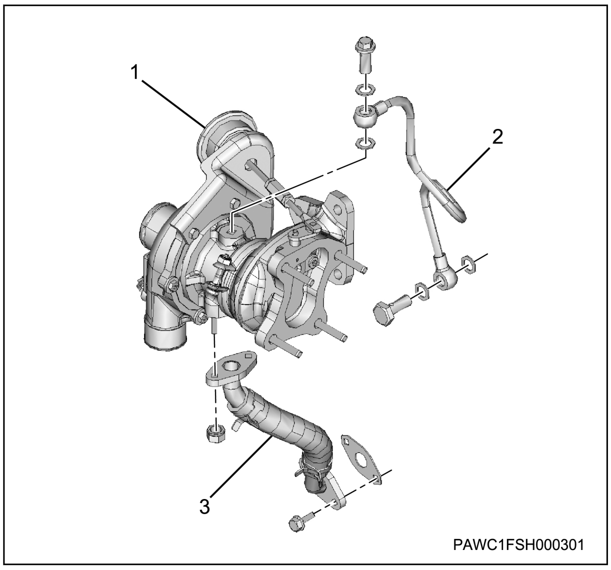
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft } Cylinder block side

tightening torque： 22 N・m { 2.2 kgf・m / 16 lb・ft }
Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

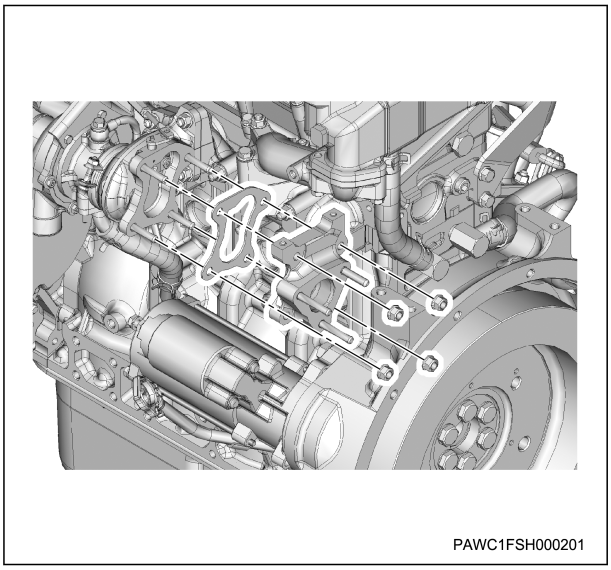
tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

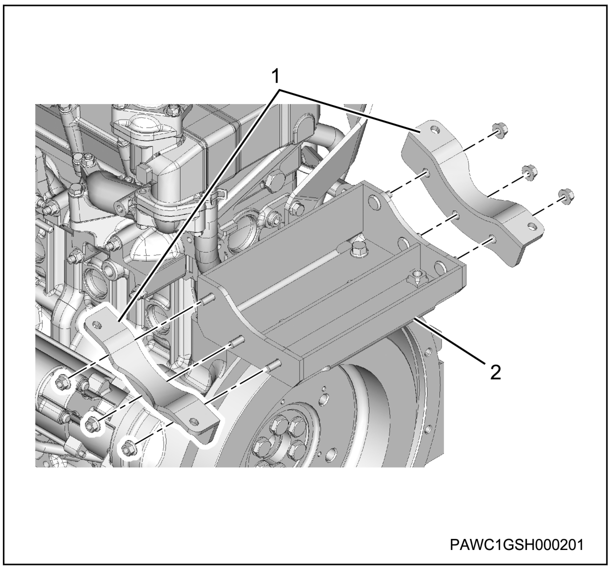
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



21. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

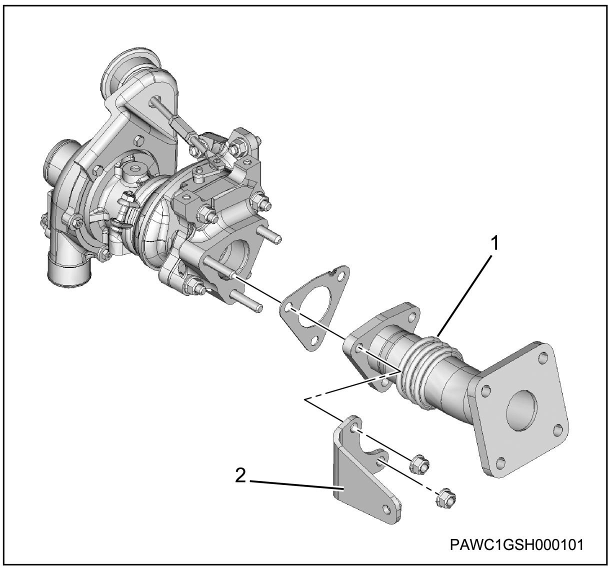


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

・ Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.

4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

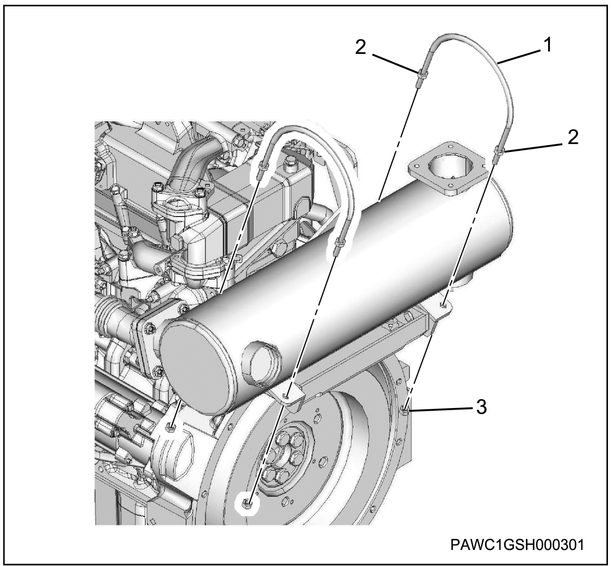
・ Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
・ With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.

- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

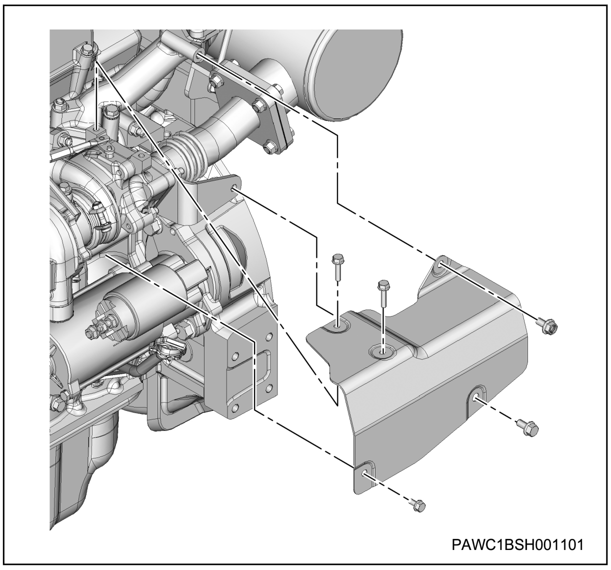
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

22. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M6



23. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

- Install the harness clip.

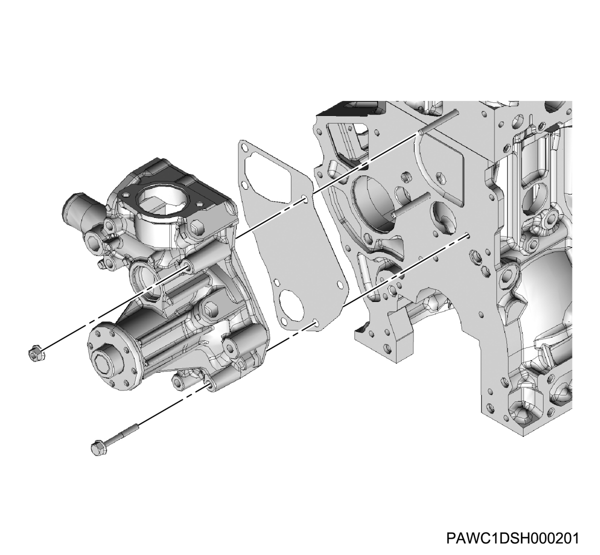
24. Water pump assembly installation

1. Install the water pump assembly to the cylinder block and the cylinder head.

Note：

- Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }



25. Water hose connect
    1. Connect the water hose to the water pump assembly.

    Note :
    - Install the hose clip.

26. Engine coolant temperature sensor connect
    1. Connect the harness connector to the engine coolant temperature sensor.

27. Generator installation
    1. Install the adjust plate to the water pump assembly.

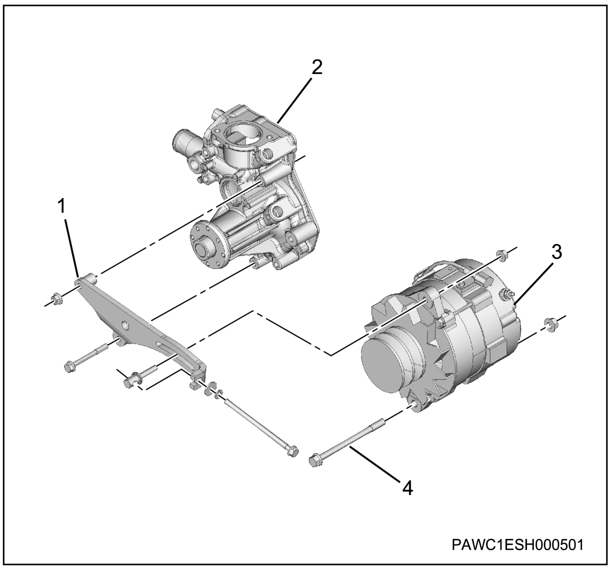
    tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

    2. Temporarily tighten the generator to the generator bracket.
    3. Temporarily tighten the generator to the adjust plate.

    Note :
    - Securely tighten the bolt and the nut after adjusting the cooling fan belt.

    4. Connect the harness connector to the generator.

    Note :
    - The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

28. Fan pulley installation
    1. Install the fan pulley to the water pump assembly.

    tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

29. Cooling fan belt installation
    1. Install the cooling fan belt to the pulley.

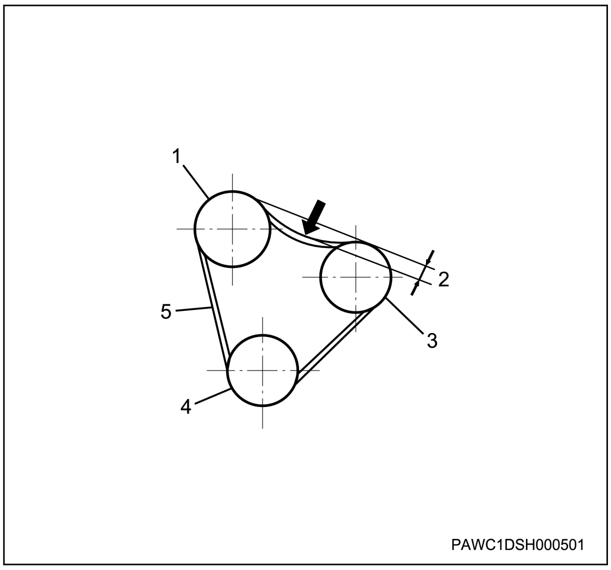
30. Cooling fan belt adjustment
    1. Check the tension of the cooling fan belt.

    Note :
    - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

    standard : 98 N { 10.0 kg / 22 lb }

    specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in }
    New product

    specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in }
    Reuse

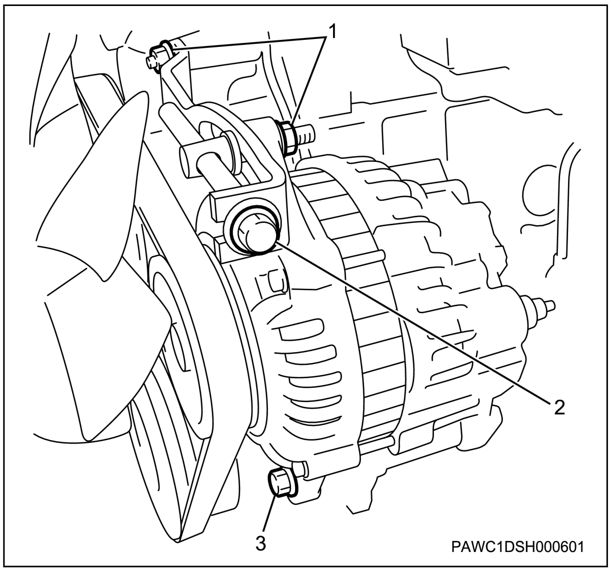


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

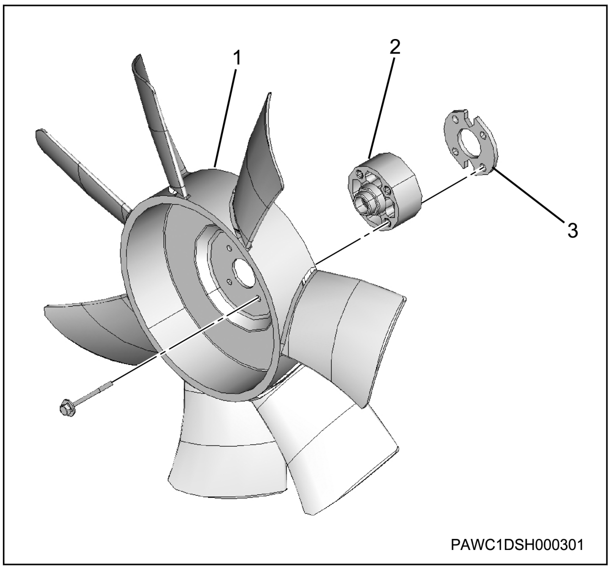


1. Nut
2. Adjust bolt
3. Mounting bolt

31. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

32. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution :

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

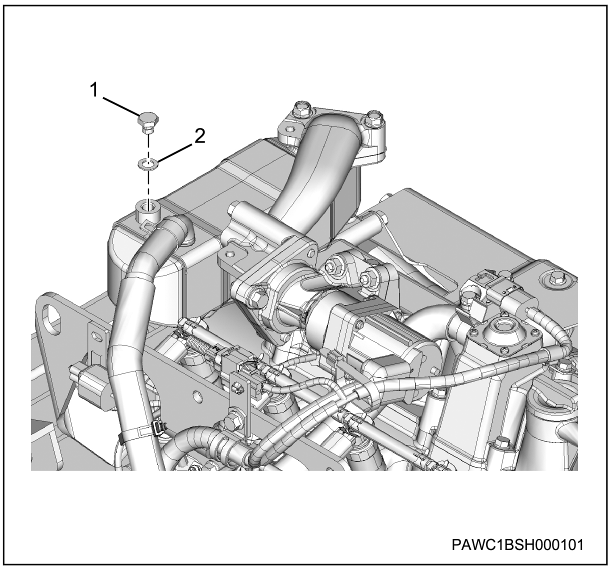
3. Tighten the plug using a wrench.

Caution :

- Use a new gasket.

tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug

2. Gasket

33. Battery ground cable connect
1. Connect the battery ground cable to the battery.

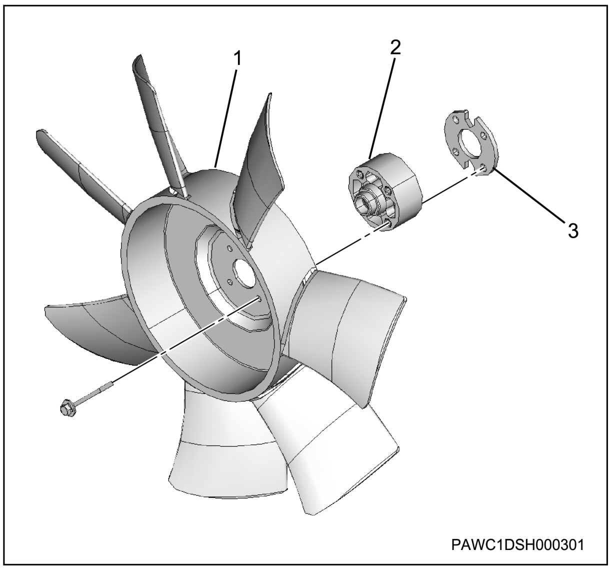
Valve stem oil seal

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.

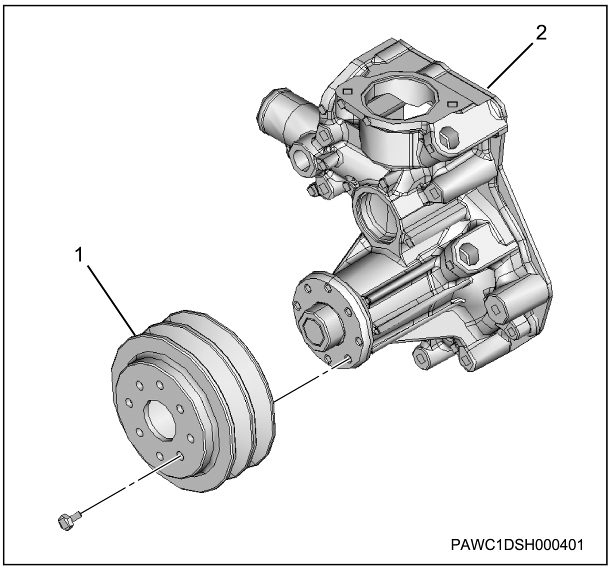


1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

   Note :

   - Loosen the generator adjust bolt and remove the belt.
5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

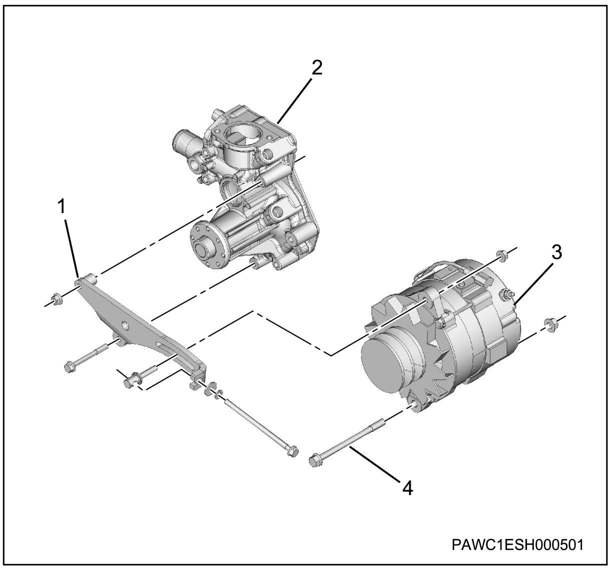


1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

   Note :

   - The diagram shows the 24 V - 50 A specification.



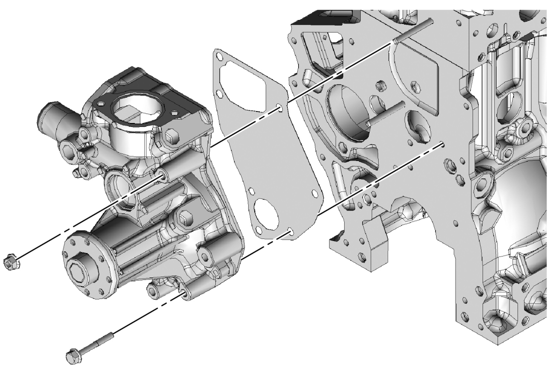
1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
8. Water hose disconnect
   1. Disconnect the water hose from the water pump assembly.

Note :
- Remove the hose clip.

9. Water pump assembly removal
   1. Remove the water pump assembly from the cylinder block and the cylinder head.

Note :
- Remove the water pump assembly and the gasket.

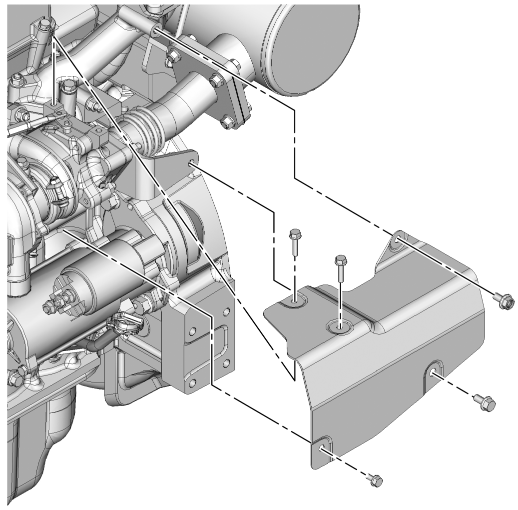


PAWC1DSH000201

10. Pressure sensor/boost temperature sensor disconnect
    1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

Note :
- Remove the harness clip.

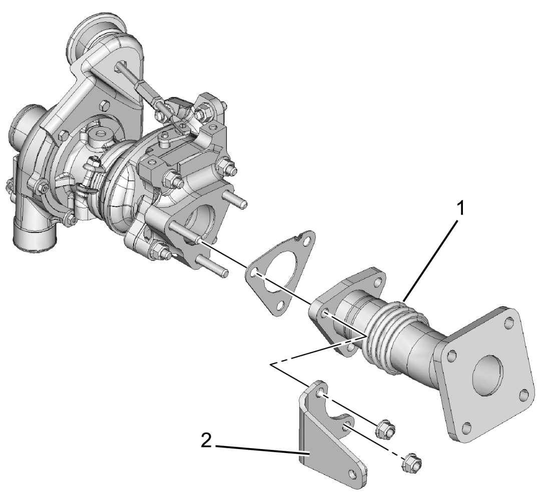
11. Turbocharger heat protector removal
    1. Remove the turbocharger heat protector from the turbocharger.



PAWC1BSH001101

12. Integrated oxidation catalyst silencer removal
    1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
    2. Remove the exhaust pipe from the turbocharger assembly.

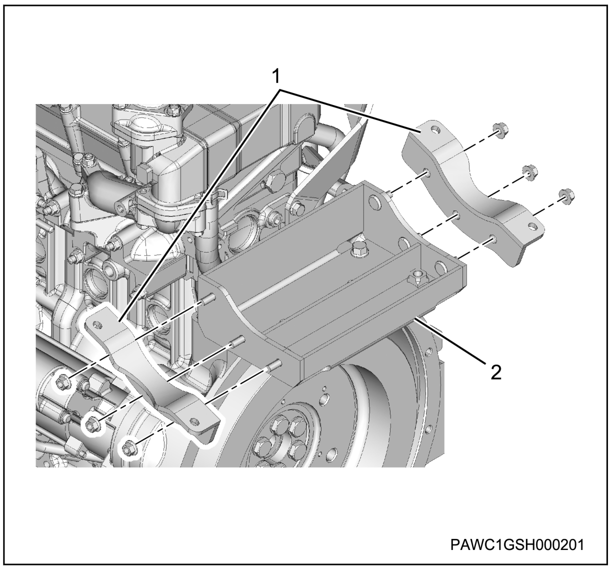
Note :
- Remove together with the bracket.



PAWC1GSH000101

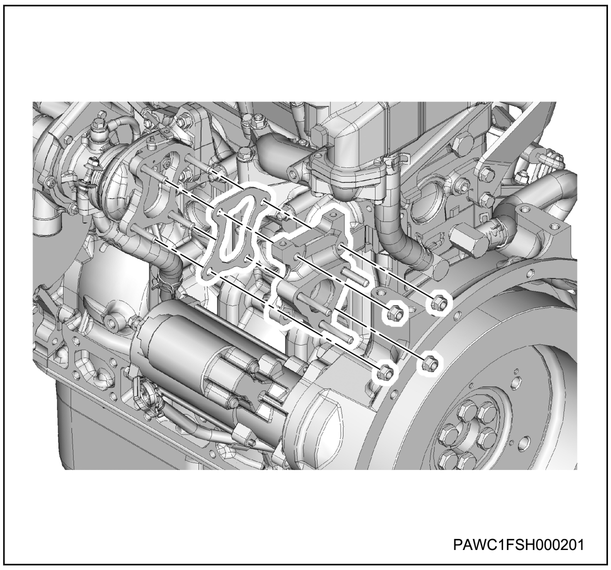
1. Exhaust pipe
2. Bracket

3. Remove the support bracket from the silencer bracket.

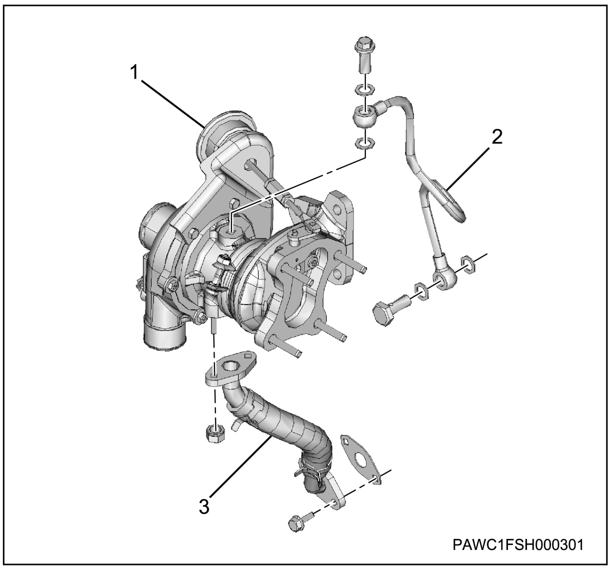


1. Support bracket
2. Silencer bracket

13. Turbocharger assembly removal
    1. Remove the exhaust pipe adapter from the turbocharger assembly.

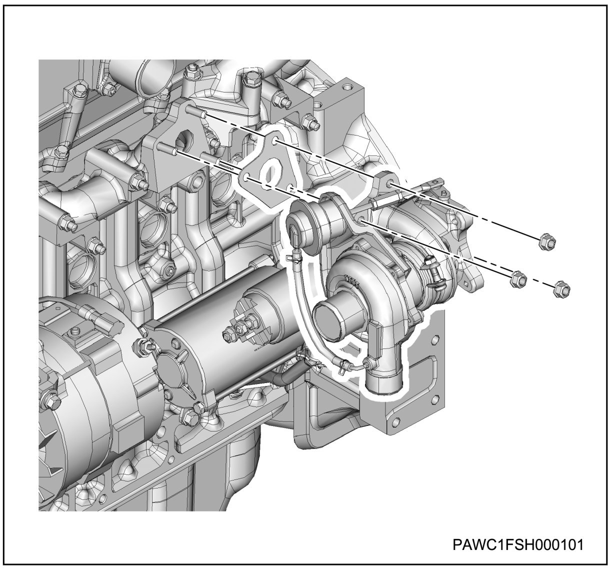


    2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
    3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.

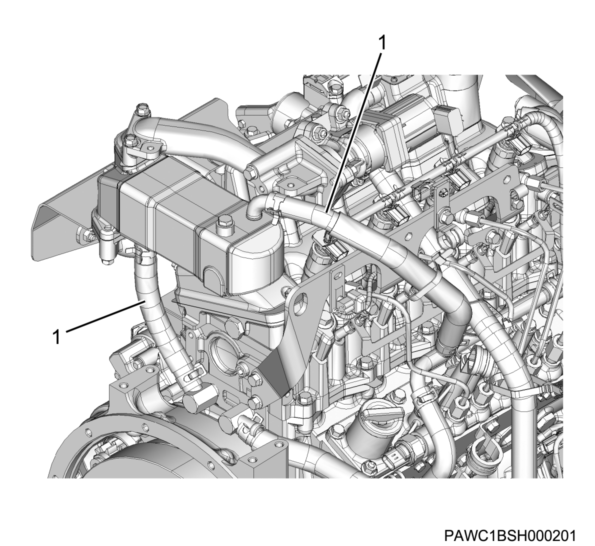


1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

    4. Remove the turbocharger assembly from the exhaust manifold.



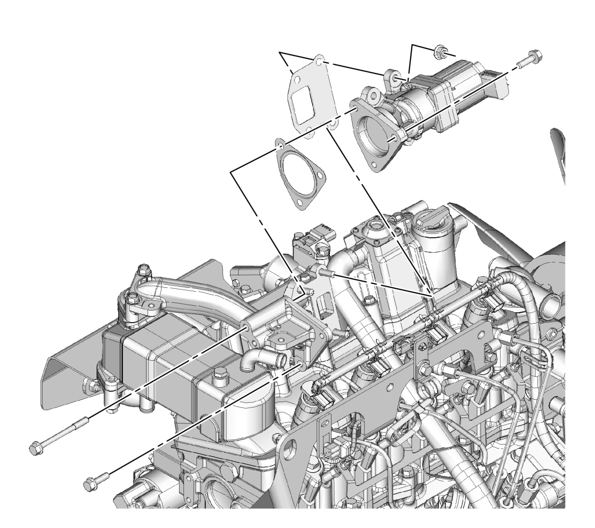
14. EGR valve removal
    1. Disconnect the harness connector from the EGR valve.
    2. Disconnect the harness clip from the EGR pipe.
    3. Disconnect the water rubber hose from the EGR cooler assembly.



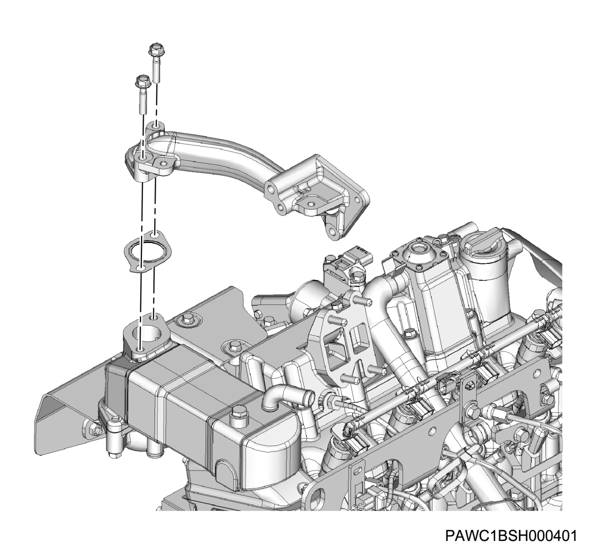
PAWC1BSH000201

1. Water rubber hose

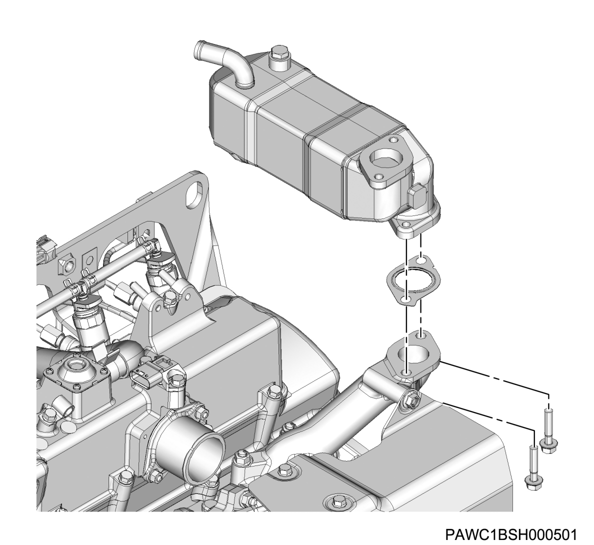
4. Remove the EGR valve from the intake chamber.


PAWC1BSH000301

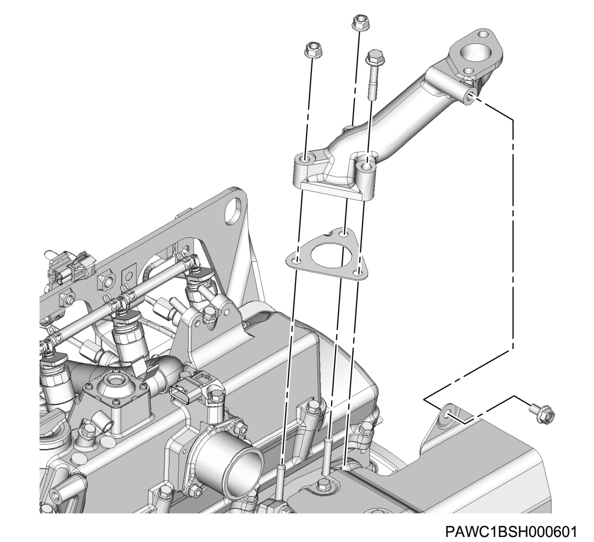
5. Remove the EGR pipe from the EGR cooler.


PAWC1BSH000401

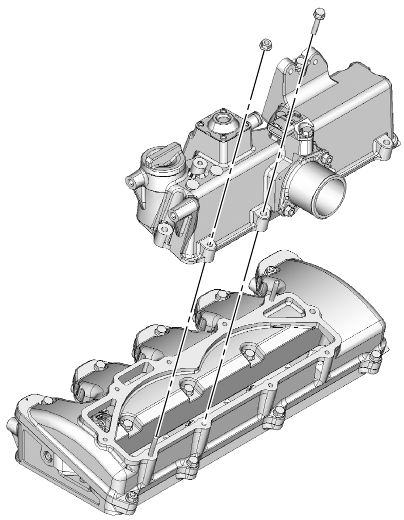
6. Remove the EGR cooler from the EGR pipe.


PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.

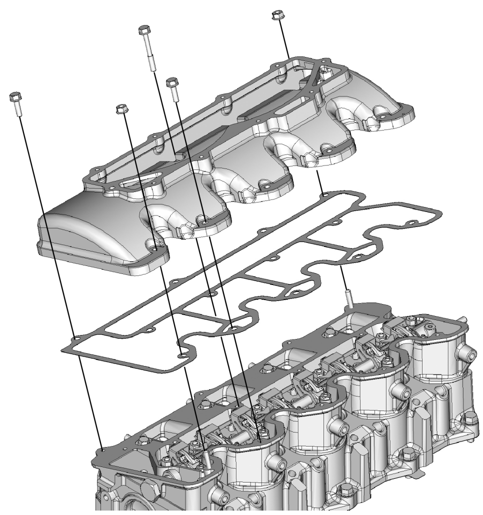

PAWC1BSH000601

15. PCV hose removal
    1. Remove the PCV hose from the intake chamber.
16. IMT sensor removal
    1. Disconnect the harness connector from the IMT sensor.
    2. Remove the IMT sensor from the intake chamber.
17. Intake chamber removal
    1. Remove the intake chamber from the cylinder head cover.



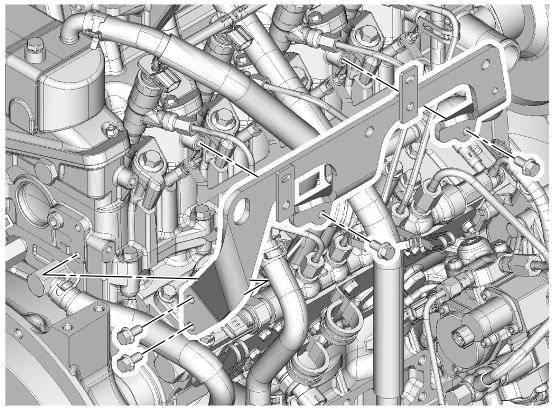
PAWC1BSH000701

18. Cylinder head cover removal
    1. Remove the cylinder head cover from the rocker arm bracket.



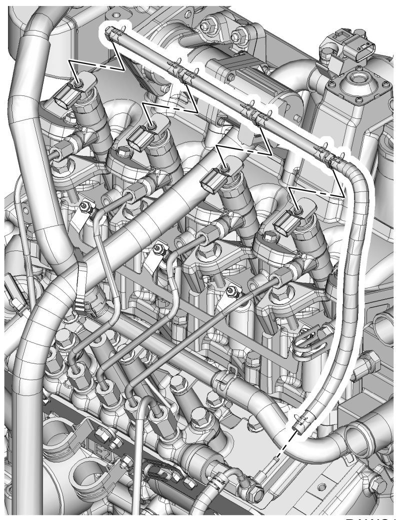
PAWC1BSH001001

19. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



PAWC1CSH000301

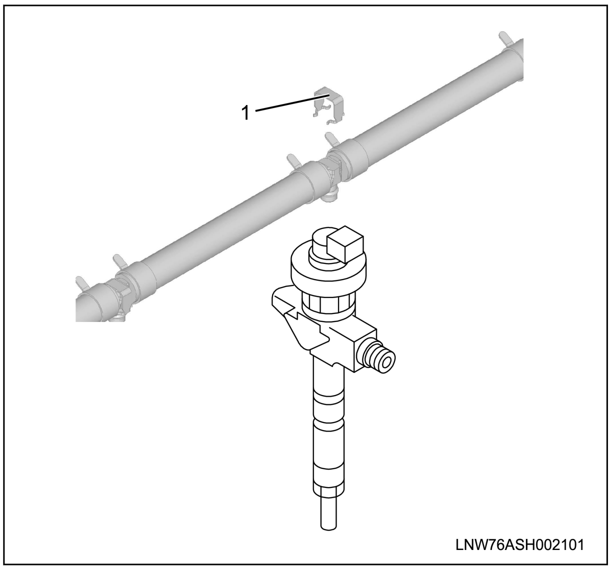
20. Fuel leak-off hose removal
    1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note：

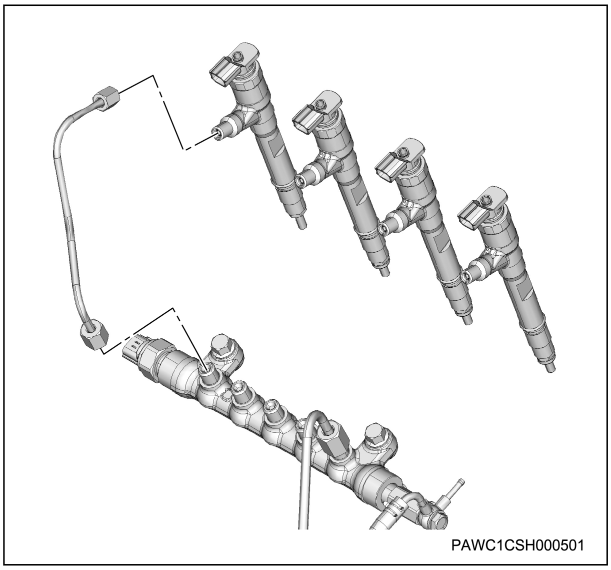
- Do not reuse the leak-off pipe clip.



1. Clip

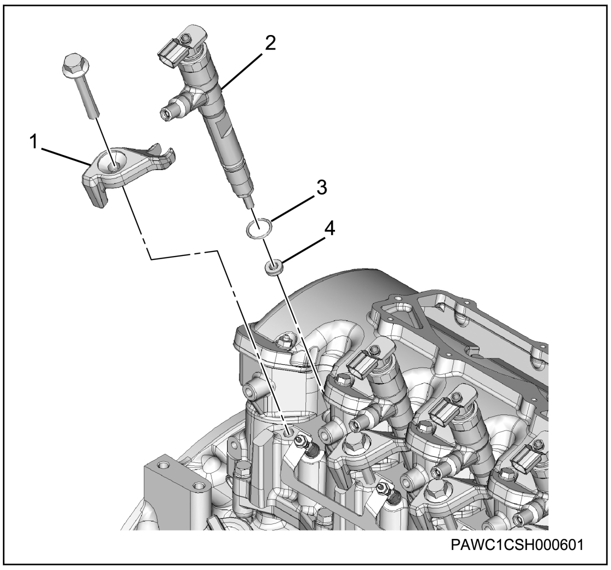
21. Injection pipe removal
    1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note :
- Do not reuse the injection pipe.



22. Injector removal
    1. Disconnect the harness connector from the injector.
    2. Remove the injector from the cylinder head assembly.
    3. Remove the injector gasket from the injector.
    4. Remove the O-ring from the injector.

Note :
- Do not reuse the injector gasket or the O-ring.

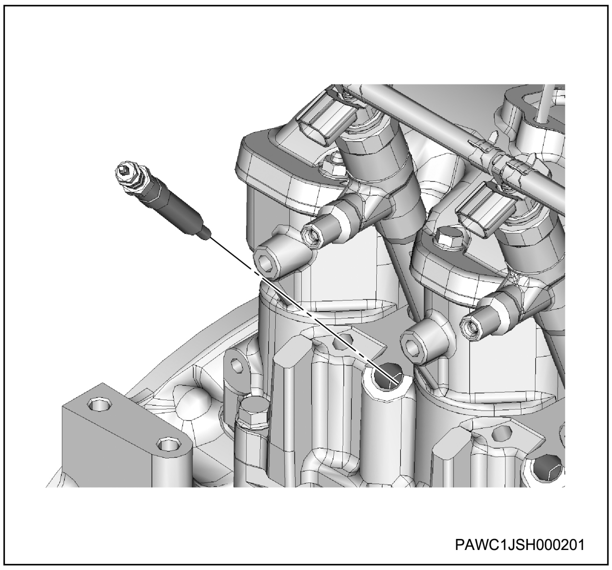


1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

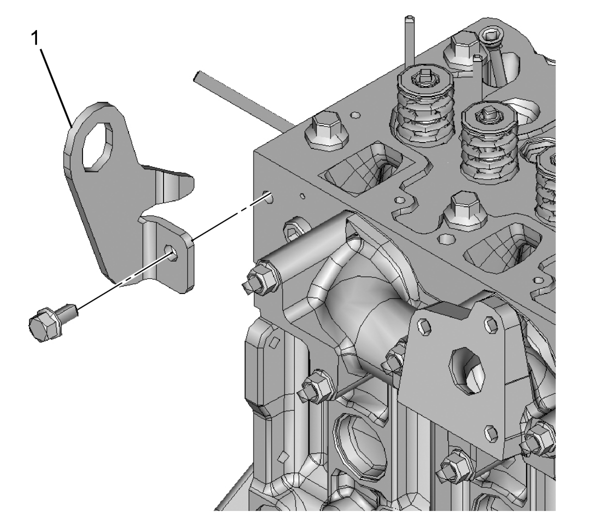
Note :
- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.
- Store the removed injector with the cylinder number on it.

23. Glow plug connector removal
    1. Remove the glow plug connector from the glow plug.

24. Glow plug removal
    1. Remove the glow plug from the cylinder head.



25. Engine hanger removal
    1. Remove the engine hanger from the cylinder head.



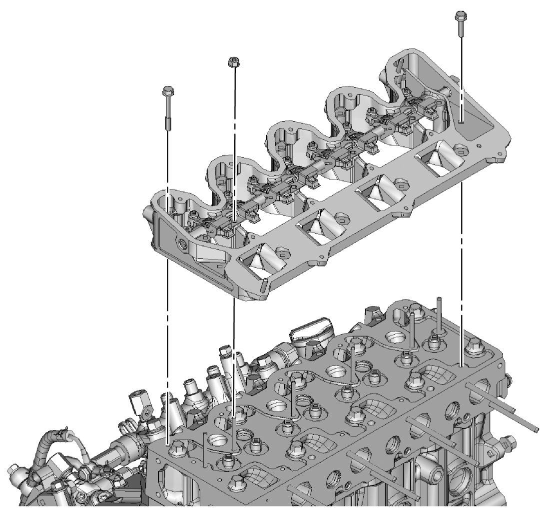
PAWC1BSH002701

1. Engine hanger

26. Rocker arm bracket removal
   1. Remove the rocker arm bracket from the cylinder head.

Caution :

- Be careful not to damage the rocker arm bracket when removing.

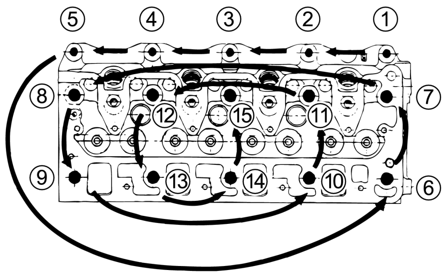


PAWC1BSH002901

27. Push rod removal
   1. Remove the push rod from the cylinder block.
28. Cylinder head assembly removal
   1. Remove the cylinder head assembly from the cylinder block.

Note :

- Gradually loosen the bolts in the numerical order shown in the diagram and remove.



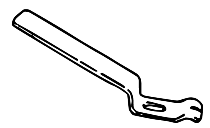
PAWC1BSH002801

2. Remove the cylinder head gasket from the cylinder block.

29. Split collar removal
   1. Remove the split collar from the valve using a special tool.

Note :

- Using a replacer, compress the valve spring and remove the split collar.



5884090300

SST: 5-8840-9030-0 - valve spring compressor

30. Spring seat removal
   1. Remove the spring seat from the valve.
31. Valve spring removal
   1. Remove the valve spring from the cylinder head.
32. Inlet valve removal
   1. Remove the inlet valve from the cylinder head.

Note :

- Organize the removed valves according to the cylinders using tags, etc.

33. Exhaust valve removal
   1. Remove the exhaust valve from the cylinder head.

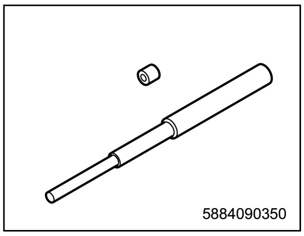
Note :

- Organize the removed valves according to the cylinders using tags, etc.

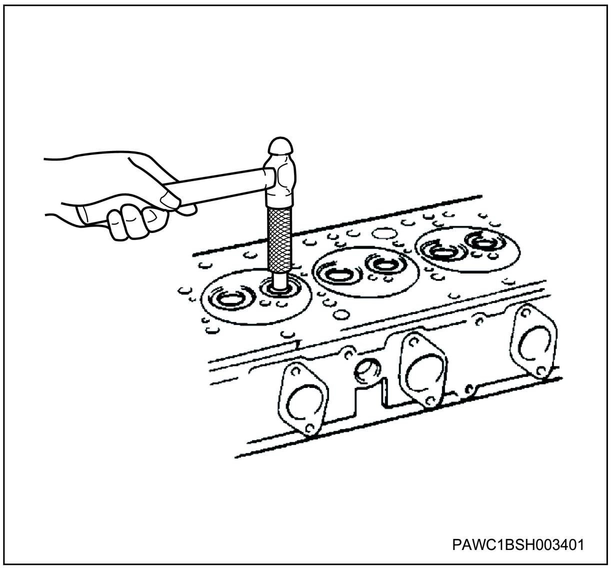
34. Valve stem oil seal removal
    1. Remove the valve stem oil seal from the cylinder head using pliers.
35. Valve guide removal
    1. Remove the valve guide from the cylinder head using a special tool.

Note :

- Using a valve guide remover, tap out the valve guide from the lower surface side of the cylinder head.



SST: 5-8840-9035-0 - valve guide replacer

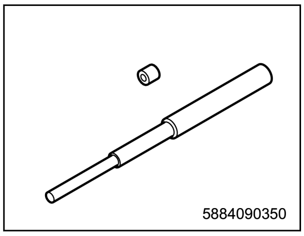


installation

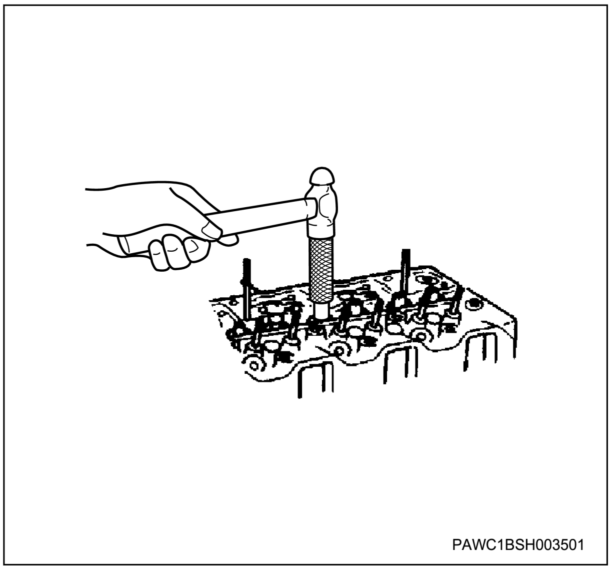
1. Valve guide installation
   1. Install the valve guide to the cylinder head using a special tool.

Note :

- Using a valve guide installer, tap in the valve guide from the upper surface side of the cylinder head.



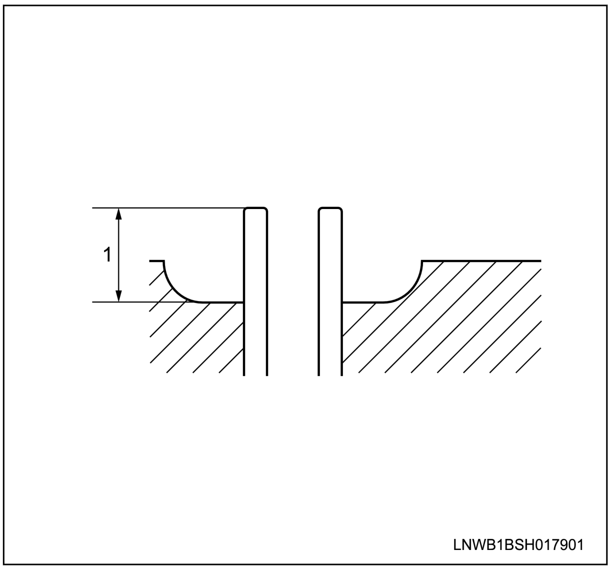
SST: 5-8840-9035-0 - valve guide replacer



valve stem height : 9.5 mm { 0.374 in }

Caution :

- When replacing the valve guide, replace with the valve as a set.



1. Height from the upper surface of the cylinder head to the end surface of the valve guide

2. Valve stem oil seal installation
   1. Apply engine oil to the valve guide.

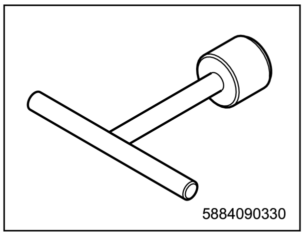
Note :

- Apply engine oil to the outer circumference of the valve guide.

   2. Install the valve stem oil seal to the cylinder head using a special tool.

Note :

- Using a valve stem seal installer, tap until the protruding section of the oil seal is securely fixed in the valve guide groove.



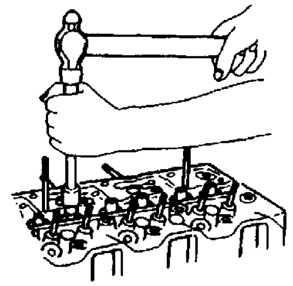
SST: 5-8840-9033-0 - valve stem seal installer

Note :

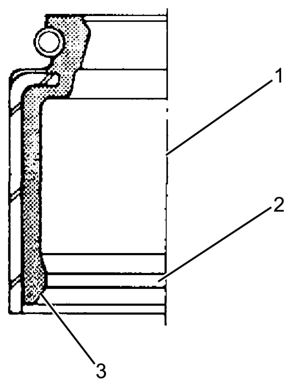
- Verify that the spring has not come off.

Caution :

- Be careful not to damage the lip section of the seal.



PAWC1BSH003601



PAWC1BSH003701

1. Valve guide
2. Groove
3. Protruding section

3. Exhaust valve installation
   1. Apply engine oil to the exhaust valve.

   Note :
   - Apply engine oil to the valve stem section.

   2. Install the exhaust valve to the cylinder head.

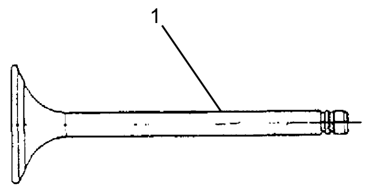
   Caution :
   - Be careful not to allow the installed valve to fall down from the cylinder head.

4. Inlet valve installation
   1. Apply engine oil to the inlet valve.

   Note :
   - Apply engine oil to the valve stem section.

   2. Install the inlet valve to the cylinder head.

   Caution :
   - Be careful not to allow the installed valve to fall down from the cylinder head.

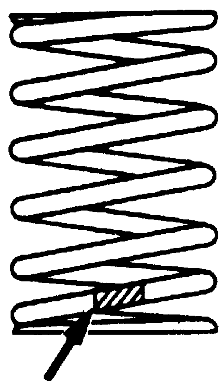


PAWC1BSH003801

1. Valve stem

5. Valve spring installation
   1. Install the valve spring to the cylinder head.

   Note :
   - Install so that the painted side faces the cylinder head side.

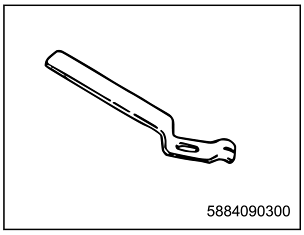


LNWC1BSH013301

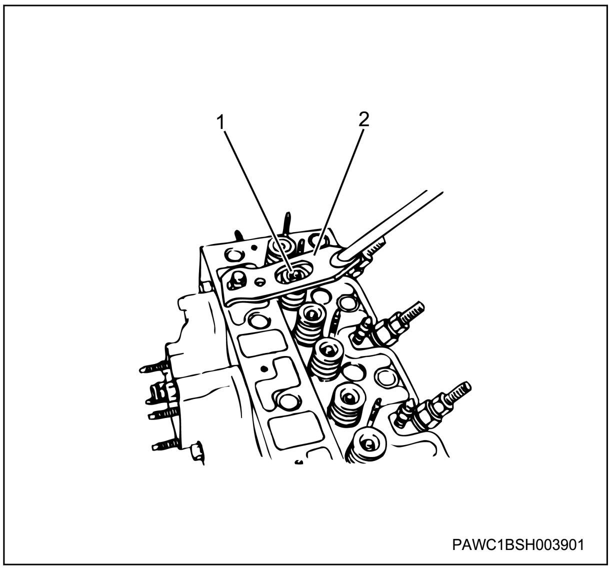
6. Spring seat installation
   1. Install the spring seat to the valve.
7. Split collar installation
   1. Install the split collar to the valve using a special tool.

Note :

- Using a replacer, compress the valve spring and install the split collar.



SST: 5-8840-9030-0 - valve spring compressor



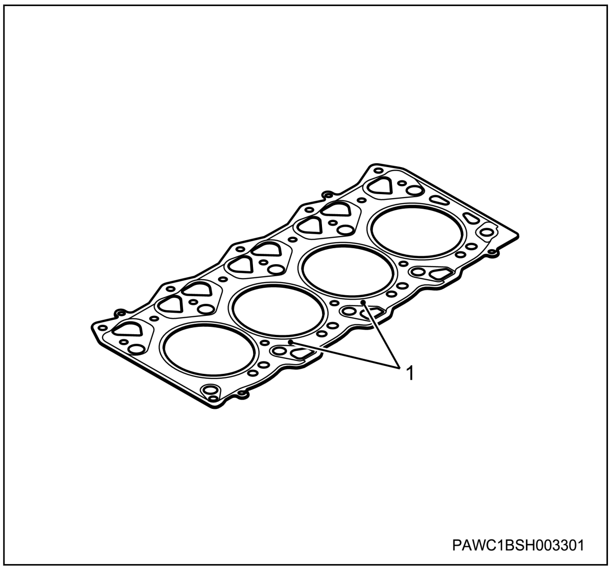
1. Split collar
2. Replacer

8. Cylinder head assembly installation

1. Install the cylinder head gasket to the cylinder block.

Note :

- Install with the marked side facing upward.



1. Mark

2. Apply engine oil to the bolt.

Note :

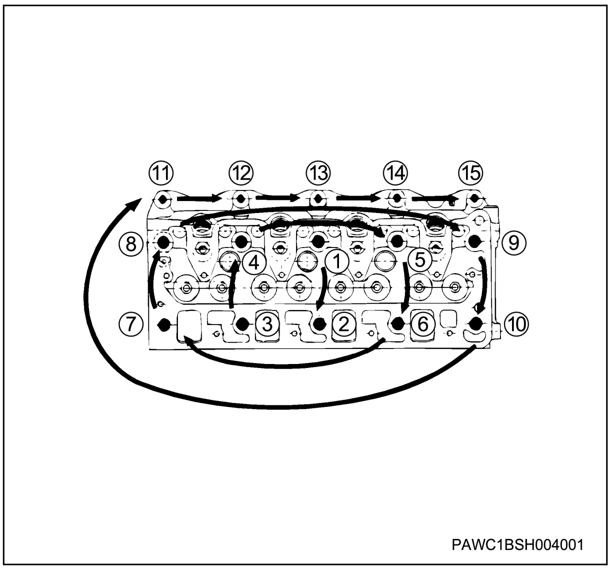
- Apply engine oil to the threaded portion and the seat surface of the head bolt.

3. Install the cylinder head assembly to the cylinder block.

4. Tighten the head bolts using a torque wrench.

Note :

- Tighten M12 head bolts 1 to 10 in the numerical order shown in the diagram.



tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft } 1st time

tightening torque : 88 N・m { 9.0 kgf・m / 65 lb・ft } 2nd time

tightening angle : 60 ° 3rd time

Note :

- Tighten M8 head bolts 11 to 15 in the numerical order shown in the diagram.

tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }

9. Push rod installation

1. Install the push rod to the cylinder block.

Note :

- Pass it through the cylinder block and insert it into the tappet.

10. Rocker arm bracket installation

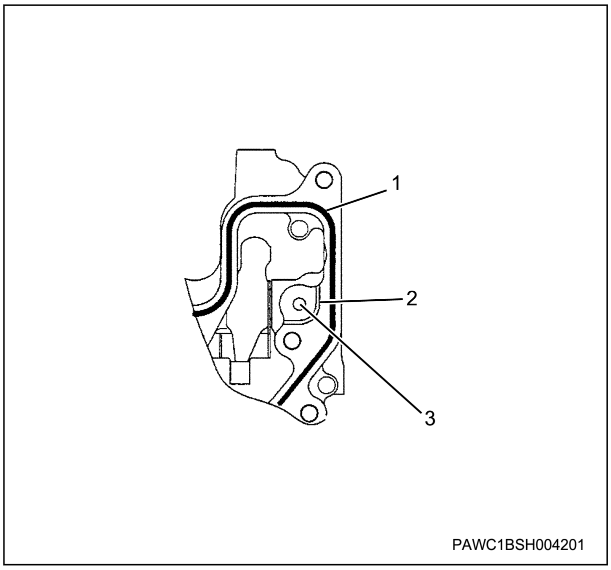
1. Apply liquid gasket to the rocker arm bracket.

Note :

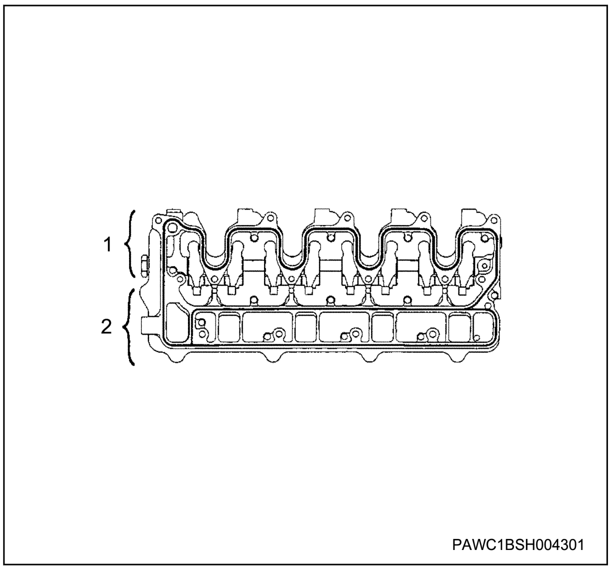
- Apply ThreeBond 1207B after cleaning the rocker arm bracket and the cylinder head.

Caution :

- Do not apply liquid gasket to the groove around the oil gallery.



1. Liquid gasket application area
2. Oil gallery groove
3. Oil gallery



1. Liquid gasket application area
2. Oil gallery groove

Note :

- Push the rocker arm against the rocker spring.

2. Rotate the crankshaft gear.

Note :

- Put the No. 1 cylinder at exhaust top dead center.

3. Temporarily tighten the rocker arm bracket to the cylinder head.

4. Securely tighten the rocker arm bracket to the cylinder head.

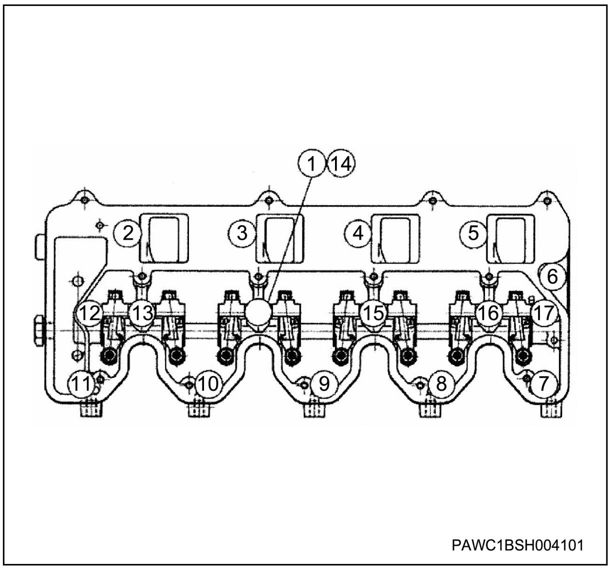
Note :

- Securely tighten the bolts and nuts in the order shown in the diagram.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

Caution :

- After applying liquid gasket, install within 5 minutes.
- Align the tray section of the push rod and the position of the rocker arm adjust screw.



11. Rocker arm shaft adjustment

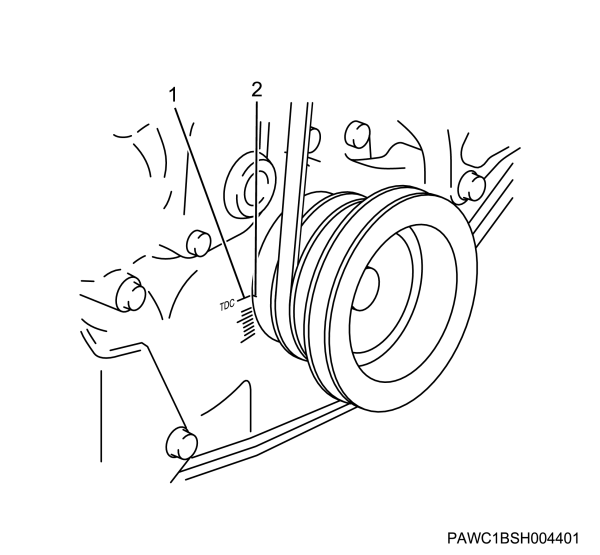
Note :

- Valve clearance adjustment

Caution :

- Adjust the valve clearance when cool.

1. Align the No. 1 cylinder to compression top dead center.



1. TDC mark
2. Mark groove

2. Measure the valve clearance using a feeler gauge.

Note：

- Insert the feeler gauge between the rocker arm and the bridge cap.

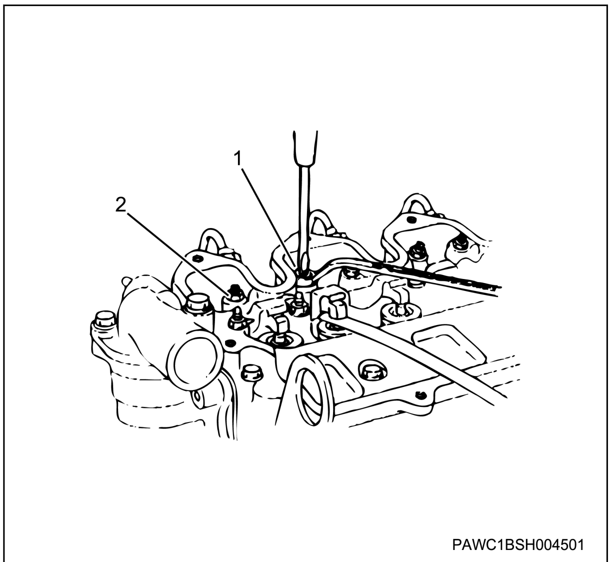
specified value： 0.40 mm { 0.016 in } Inlet valve

specified value： 0.40 mm { 0.016 in } Exhaust valve

3. Adjust the valve clearance to the specified value.

Note：

- Lightly tighten the bridge adjust screw with the feeler gauge inserted.
- When the movement of the feeler gauge becomes stiff, fasten the adjust screw nut of the rocker arm.



1. Adjust screw
2. Lock nut

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } Lock nut

4. Rotate the crankshaft gear.

Note：

- Rotate the crankshaft in the forward direction and measure the valve clearance.

Caution：

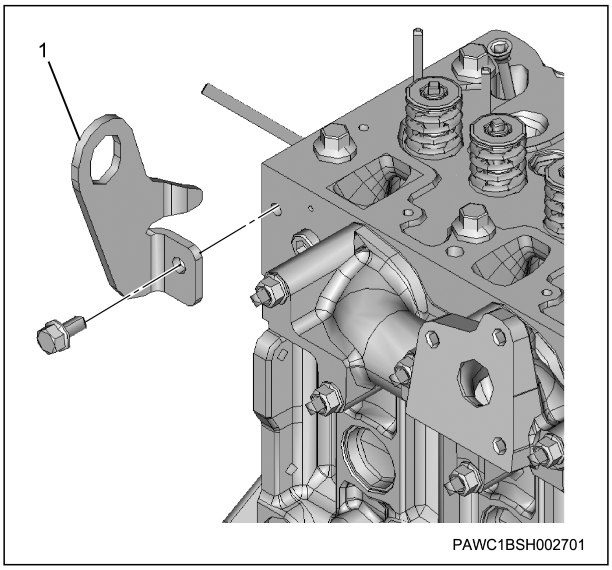
- Be careful not to over-tighten when tightening the adjust screw.
- Be careful not to press the spring down when measuring and adjusting the clearance.

Cylinder No.	1		2		3		4	
Valve parallelism	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder at compression top dead center	○	○	○			○		
No. 1 cylinder at exhaust top dead center				×	×		×	×

12. Engine hanger installation

1. Install the engine hanger to the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }

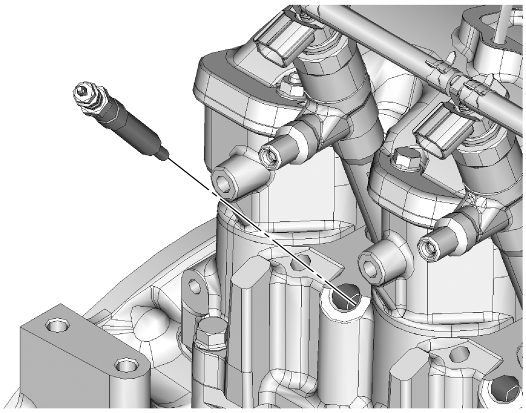


1. Engine hanger

13. Glow plug installation

1. Install the glow plug to the cylinder head.

tightening torque： 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1JSH000201

14. Glow plug connector installation
    1. Install the glow plug connector to the glow plug.

    tightening torque： 1.0 N・m { 0.1 kgf・m / 9 lb・in }

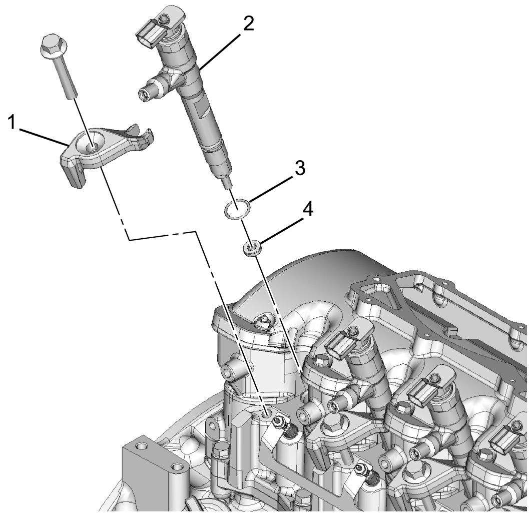
15. Injector installation

    Caution：
    - Do not change the installation position of the injectors when reusing the injectors.

    1. Install the O-ring to the injector.
    2. Install the injector gasket to the injector.

    Note：
    - Do not reuse the injector gasket or the O-ring.

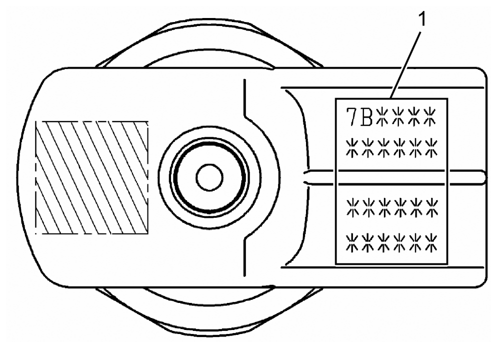
    3. Temporarily tighten the injector to the cylinder head assembly.



PAWC1CSH000601

1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Caution：
- If the injector has been replaced, record the injector ID code of the new injector.



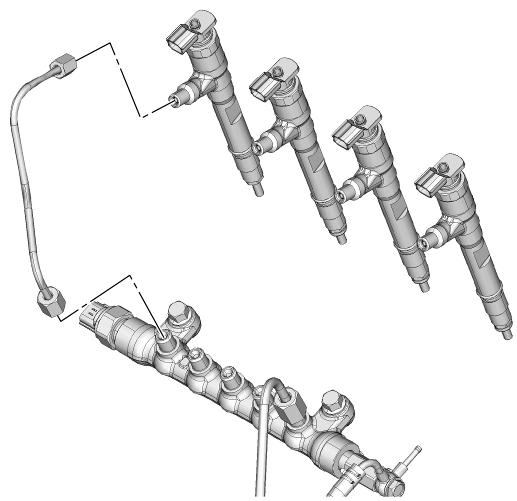
PAWC1CSH000701

1. Injector ID code

4. Connect the harness connector to the injector.

16. Injection pipe installation
    1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

    Note：
    - Do not reuse the injection pipe.



PAWC1CSH000501

2. Securely tighten the injector to the cylinder head assembly.

tightening torque： 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note :

- Securely tighten the injector side.

tightening torque : 25 N・m { 2.5 kgf・m / 18 lb・ft }

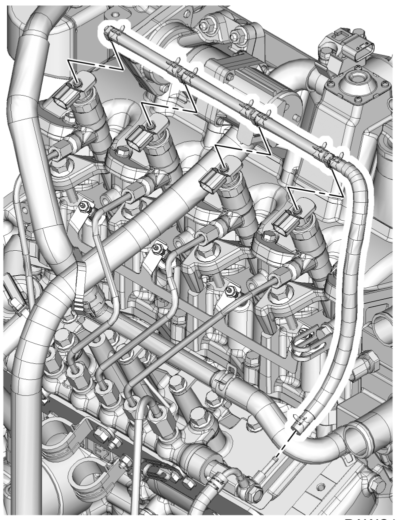
Note :

- Securely tighten the common rail (fuel rail) side.

tightening torque : 30 N・m { 3.1 kgf・m / 22 lb・ft }

17. Fuel leak-off hose installation

1. Install the fuel leak-off hose to the injector.

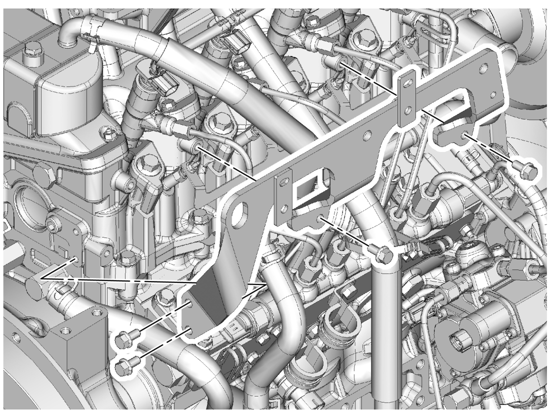


PAWC1CSH000401

18. Harness bracket installation

1. Install the harness bracket to the cylinder head.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }



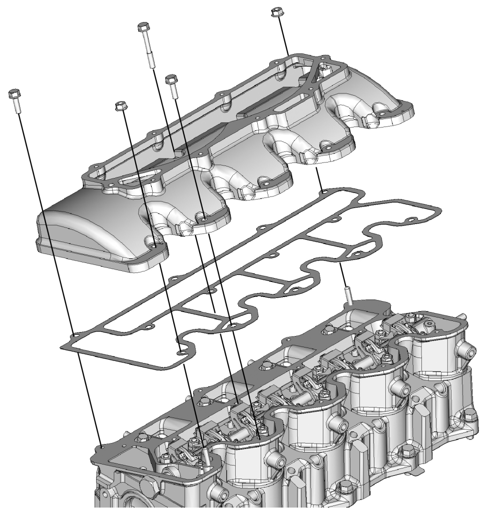
PAWC1CSH000301

2. Connect the engine harness to the harness bracket.

19. Cylinder head cover installation

1. Install the cylinder head cover to the rocker arm bracket.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

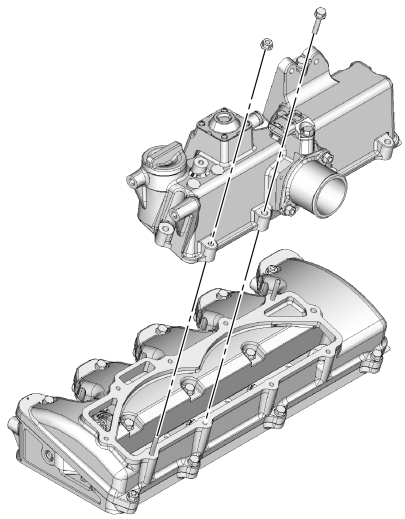


PAWC1BSH001001

20. Intake chamber installation

1. Install the intake chamber to the cylinder head cover.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

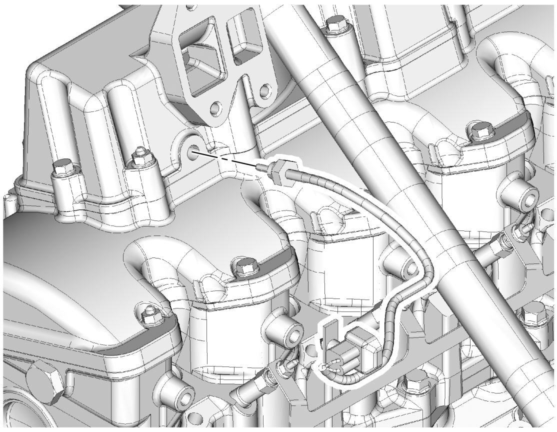


PAWC1BSH000701

21. IMT sensor installation

1. Install the IMT sensor to the intake chamber.

tightening torque : 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

2. Connect the harness connector to the IMT sensor.

22. PCV hose installation

1. Install the PCV hose to the intake chamber.

23. EGR valve installation

1. Temporarily tighten the EGR valve to the intake chamber.
2. Temporarily tighten the EGR pipe to the exhaust manifold.
3. Temporarily tighten the EGR pipe to the EGR valve.
4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

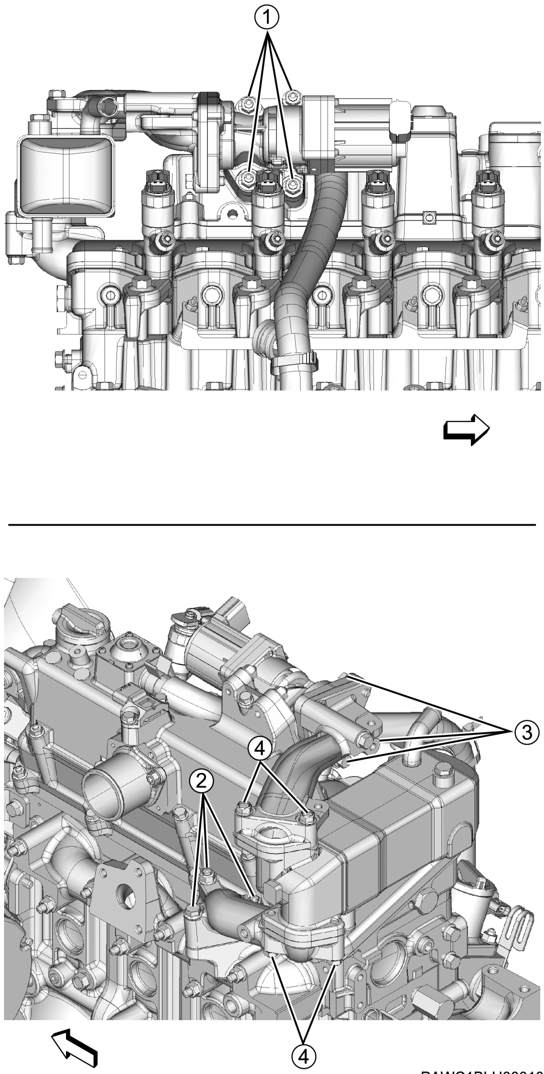
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



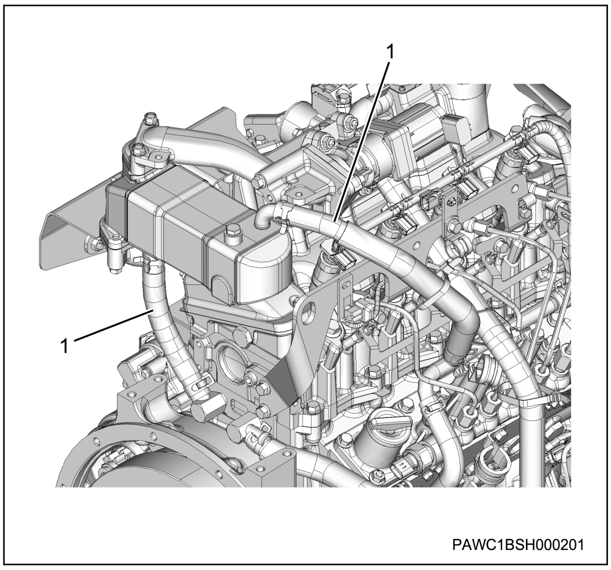
PAWC1BLH000101

Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

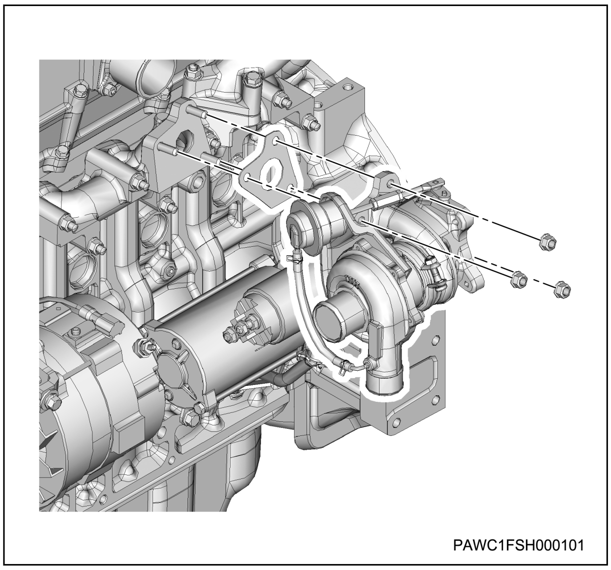
24. Turbocharger assembly installation

1. Install the turbocharger assembly to the exhaust manifold.

Note :

- Fill with 5 - 10 cc of engine oil from the oil feed port.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



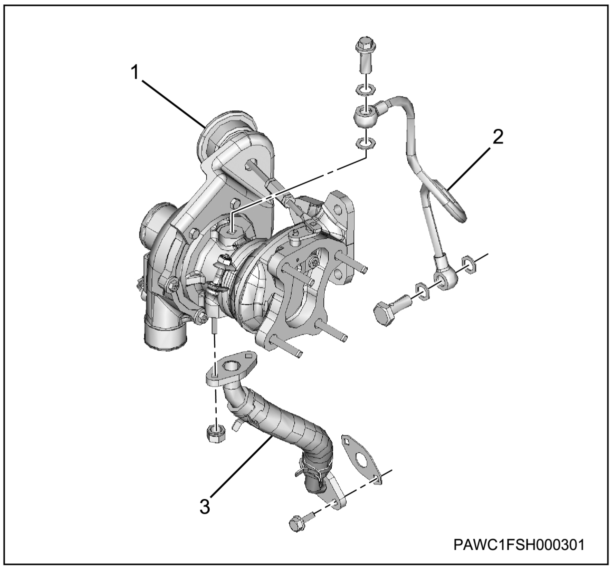
2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }
Cylinder block side

tightening torque : 22 N・m { 2.2 kgf・m / 16 lb・ft }
Turbocharger side

3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

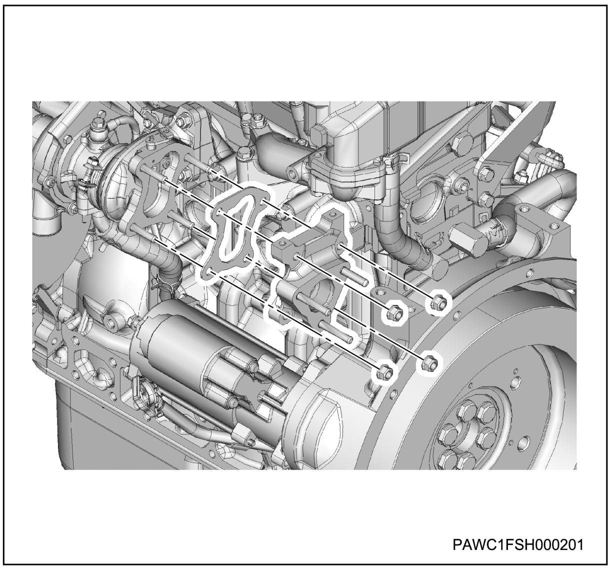
tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

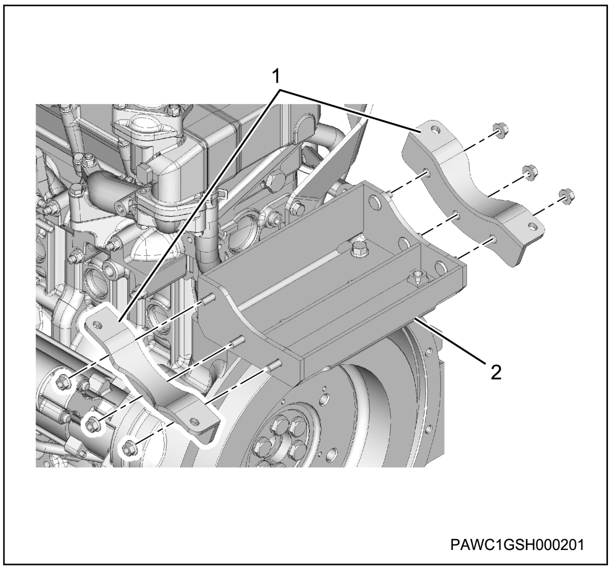
4. Install the exhaust pipe adapter to the turbocharger assembly.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



25. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

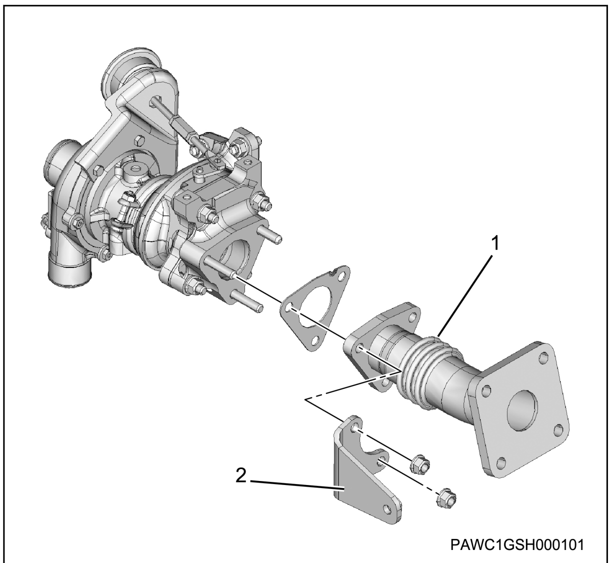


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

・ Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

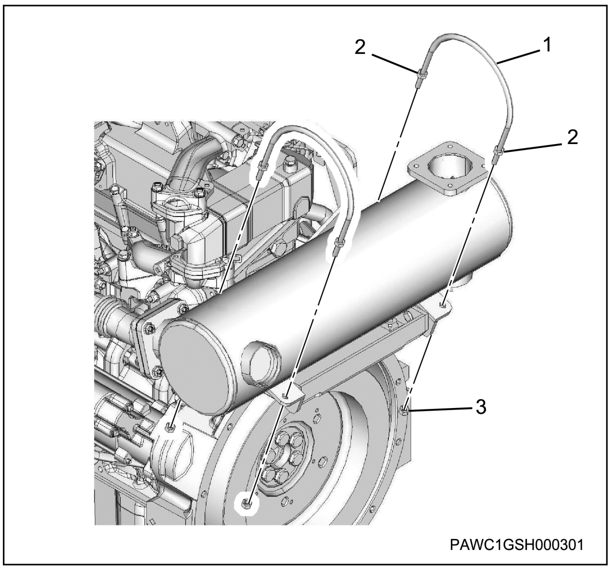
Note：

・ Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
・ With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
・ Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

・ Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
・ Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

・ Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
・ Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

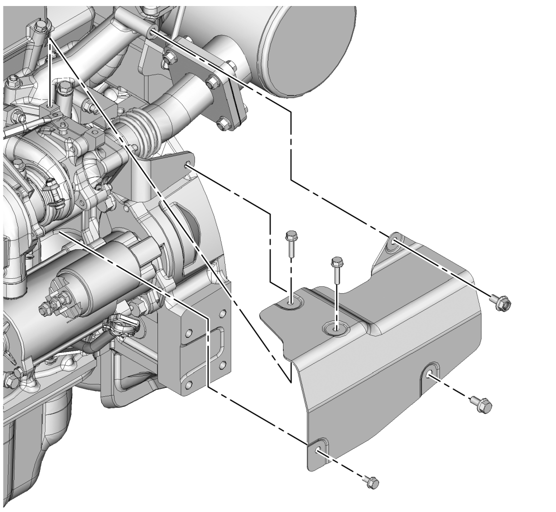
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

26. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M6



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27. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

・ Install the harness clip.

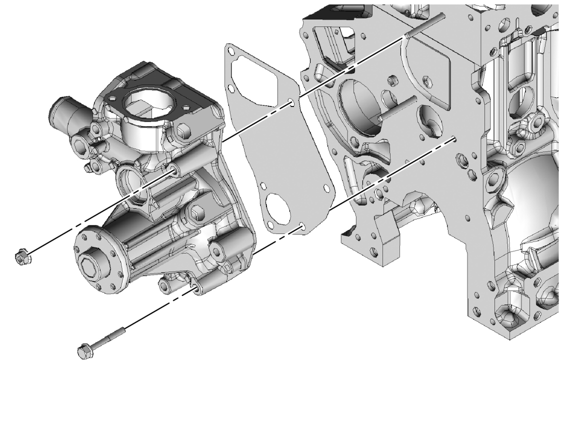
28. Water pump assembly installation

1. Install the water pump assembly to the cylinder block and the cylinder head.

Note：

・ Install the water pump assembly to the cylinder block and the cylinder head.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }



PAWC1DSH000201

29. Water hose connect

1. Connect the water hose to the water pump assembly.

Note：

・ Install the hose clip.

30. Engine coolant temperature sensor connect

1. Connect the harness connector to the engine coolant temperature sensor.

31. Generator installation

1. Install the adjust plate to the water pump assembly.

tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

2. Temporarily tighten the generator to the generator bracket.

3. Temporarily tighten the generator to the adjust plate.

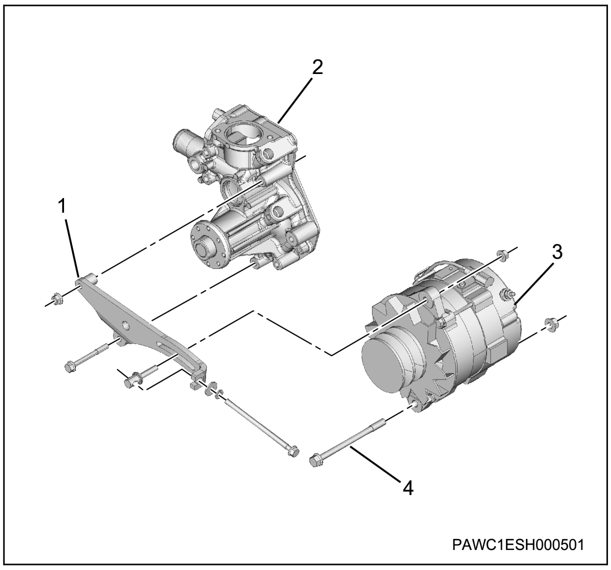
Note：

・ Securely tighten the bolt and the nut after adjusting the cooling fan belt.

4. Connect the harness connector to the generator.

Note：

・ The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

32. Fan pulley installation

1. Install the fan pulley to the water pump assembly.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

33. Cooling fan belt installation

1. Install the cooling fan belt to the pulley.

34. Cooling fan belt adjustment

1. Check the tension of the cooling fan belt.

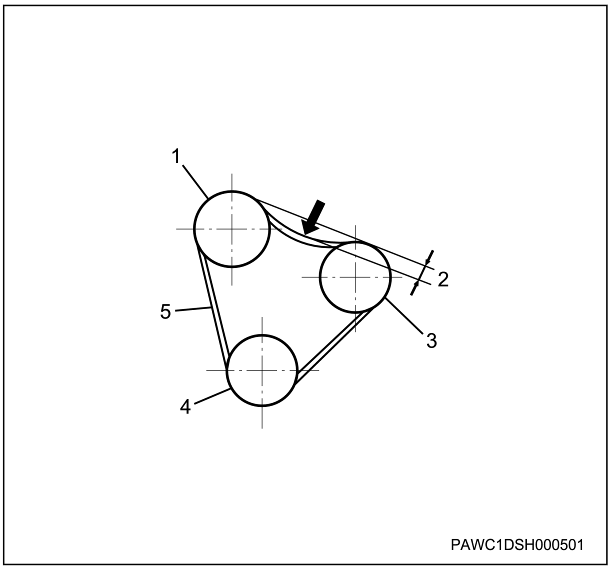
Note：

- Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard： 98 N { 10.0 kg / 22 lb }

specified value： 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value： 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

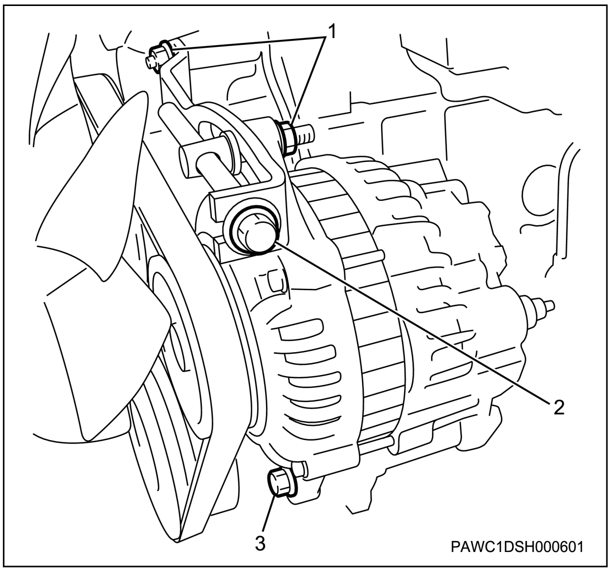


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25

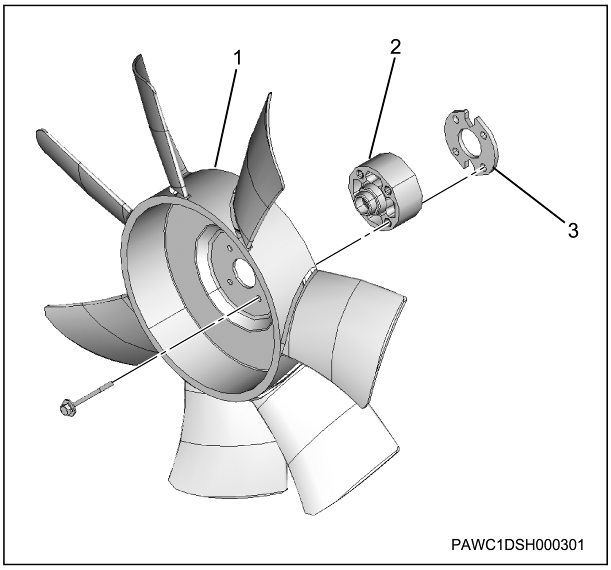


1. Nut
2. Adjust bolt
3. Mounting bolt

35. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

36. Coolant filling
   1. Loosen the plug using a wrench.
   2. Replenish the radiator with coolant.

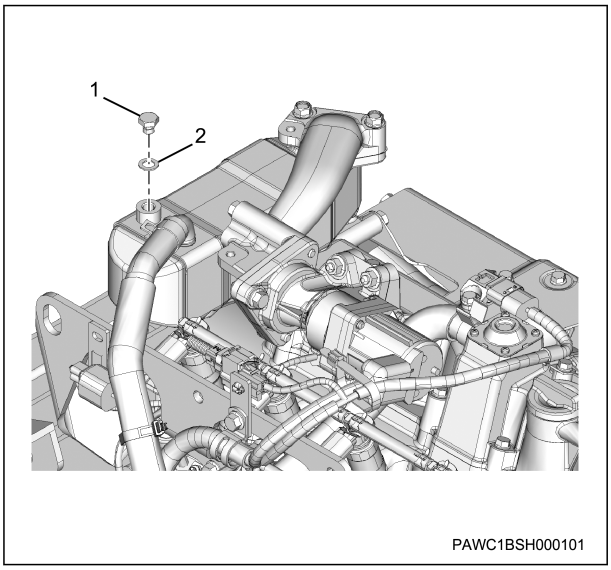
   Caution :
   - Take care to prevent overflow coolant from splashing on to the exhaust system parts.
   - Wipe off any coolant overflow.

   3. Tighten the plug using a wrench.

   Caution :
   - Use a new gasket.

   tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

   4. Replenish the radiator with coolant.



1. Plug
2. Gasket

37. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

CMP sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.
   3. Remove the O-ring from the CMP sensor.

inspection

1. CMP sensor inspection

   1. Inspect the CMP sensor.

      Note：

      - Inspect whether the CMP sensor is securely installed.
      - Inspect the sensor and connector sections for damage or dirt.

installation

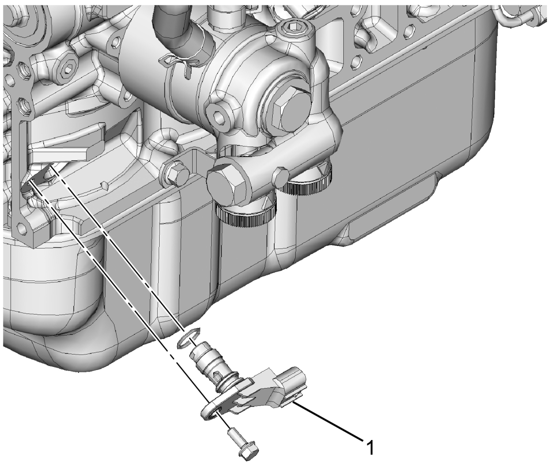
1. CMP sensor installation
   1. Apply engine oil to the O-ring.
   2. Install the CMP sensor to the timing gear case.

   tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }
   3. Connect the harness connector to the CMP sensor.
2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

CKP sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. CKP sensor removal
   1. Disconnect the harness connector from the CKP sensor.
   2. Remove the CKP sensor from the cylinder block.



1. CKP sensor

inspection

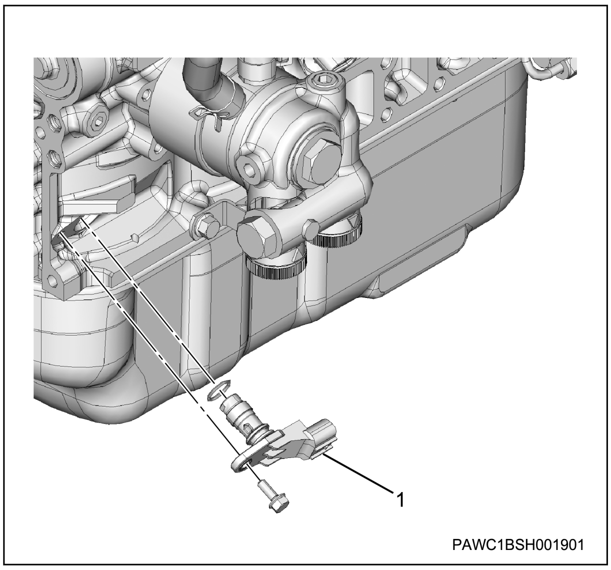
1. CKP sensor inspection
   1. Inspect the CKP sensor.

   Note：
   - Inspect whether the CKP sensor is securely installed.
   - Inspect the sensor and connector sections for damage or dirt.

installation

1. CKP sensor installation
   1. Install the CKP sensor to the cylinder block.

      tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }
   2. Connect the harness connector to the CKP sensor.



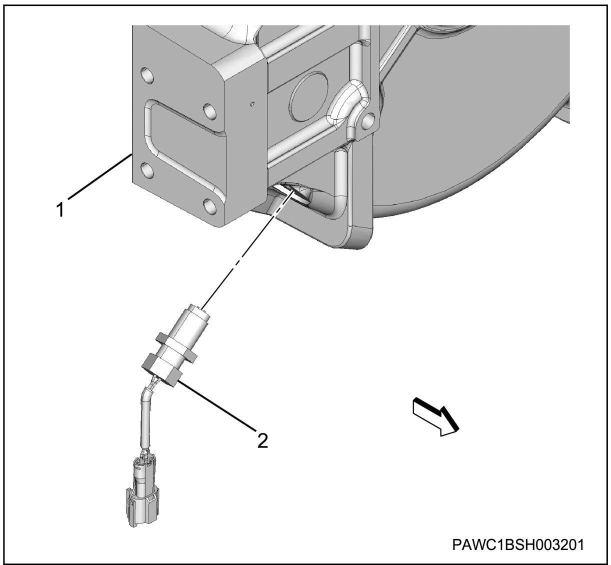
1. CKP sensor

2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Engine speed sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Engine speed sensor removal
   1. Disconnect the harness connector from the engine speed sensor.
   2. Remove the engine speed sensor from the flywheel housing.



1. Flywheel housing
2. Engine speed sensor

inspection

1. Engine speed sensor inspection
   1. Inspect the engine speed sensor.

   Note :

   - Inspect whether the engine speed sensor is securely installed.
   - Inspect the sensor and connector sections for damage or dirt.

installation

1. Engine speed sensor installation
   1. Install the engine speed sensor to the flywheel housing.

      Note :

      - Screw in the engine speed sensor until it reaches the end.

      Caution :

      - Be careful not to damage the sensor tip.

      Note :

      - Return the engine speed sensor 1 rotation, and secure with a nut.

      tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }
   2. Inspect the engine speed sensor.

      Note :

      - Check the output voltage at maximum speed without load and low speed without load.

	Specified output voltage	
Engine speed	Voltage waveform	AC voltage
Maximum speed without load	: 20 to 72 V	: 7.1 to 25.5 V
Low speed without load	: 9 to 40 V	: 3.2 to 14.2 V

      Note :

      - If the measured value is outside the specified output voltage, adjust the engine speed sensor until it is within the specified output voltage.
2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Intake chamber

removal

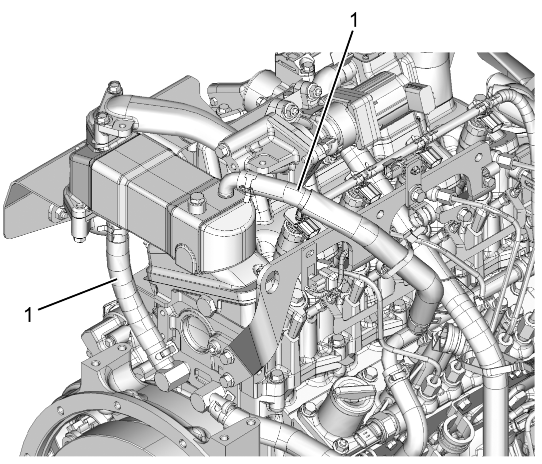
1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. Pressure sensor/boost temperature sensor disconnect
   1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

   Note :

   - Remove the harness clip.
4. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.



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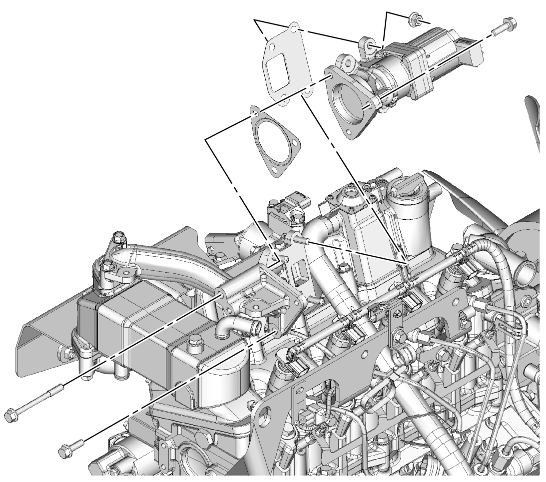
1. Water rubber hose

   4. Remove the EGR valve from the intake chamber.



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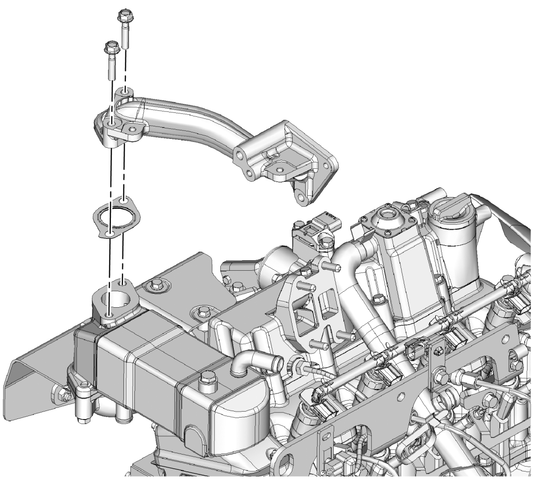
   5. Remove the EGR pipe from the EGR cooler.



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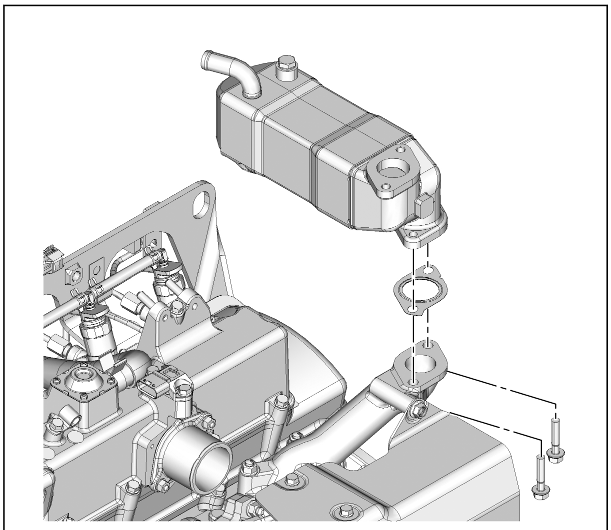
   6. Remove the EGR cooler from the EGR pipe.



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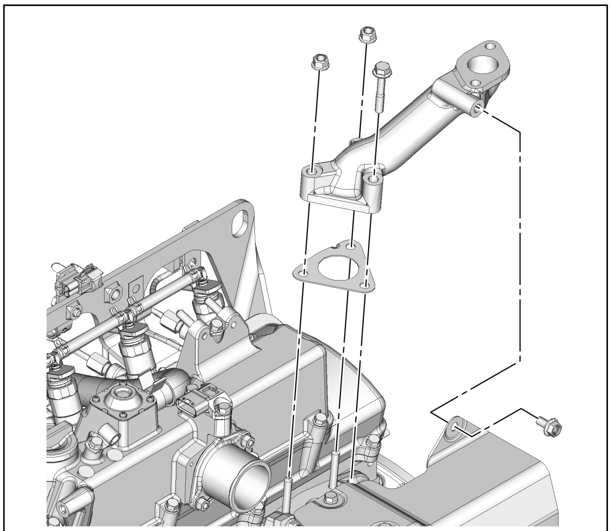
7. Remove the EGR pipe from the exhaust manifold.



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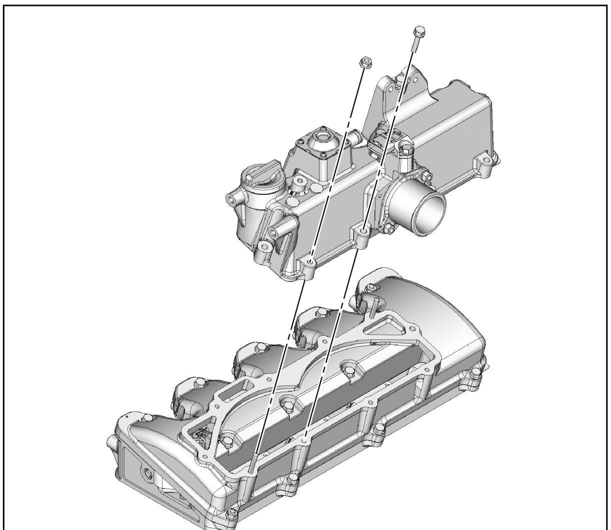
5. PCV hose removal
   1. Remove the PCV hose from the intake chamber.
6. IMT sensor   removal
   1. Disconnect the harness connector from the IMT sensor.
   2. Remove the IMT sensor from the intake chamber.
7. Intake chamber removal
   1. Remove the intake chamber from the cylinder head cover.



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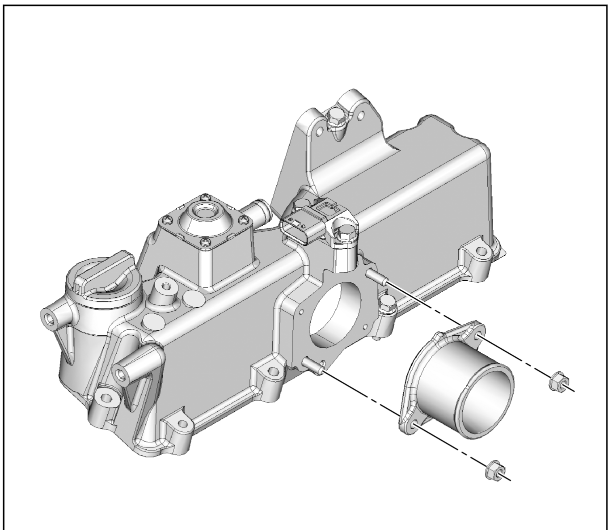
8. Air pipe removal
   1. Remove the air pipe from the intake chamber.



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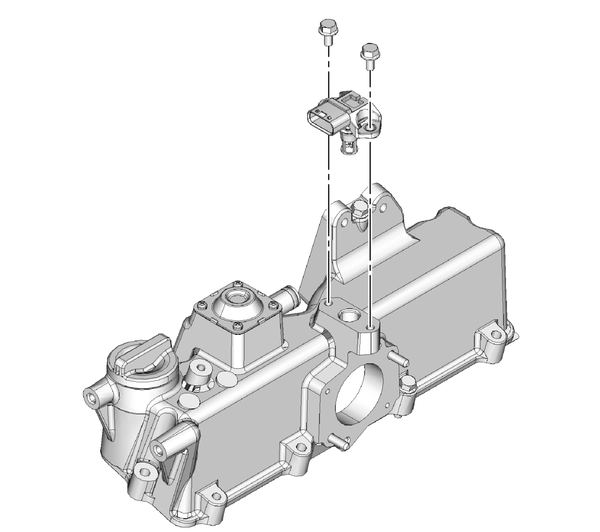
9. Pressure sensor/boost temperature sensor removal
   1. Remove the boost pressure sensor/boost temperature sensor from the intake chamber.


PAWC1BSH000901

installation

1. Pressure sensor/boost temperature sensor installation
   1. Install the boost pressure sensor/boost temperature sensor to the intake chamber.

   tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

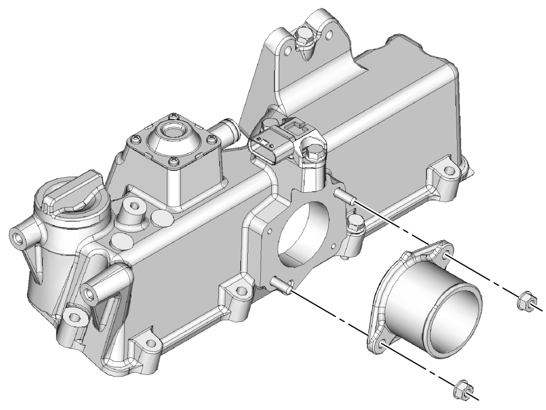
2. Air pipe installation
   1. Apply liquid gasket to the air pipe.

   Note：
   - Apply ThreeBond 1207C to the groove section.
   - The application amount is 2 mm {0.08 in} wide and 2 mm {0.08 in} high.

   Caution：
   - Wipe away any excess gasket on the inside.

   2. Install the air pipe to the intake chamber.

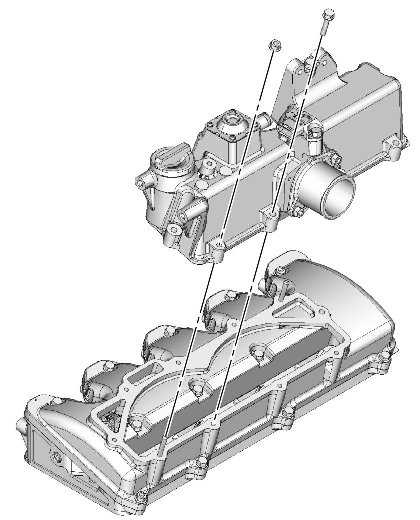
   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH000801

3. Intake chamber installation
   1. Install the intake chamber to the cylinder head cover.

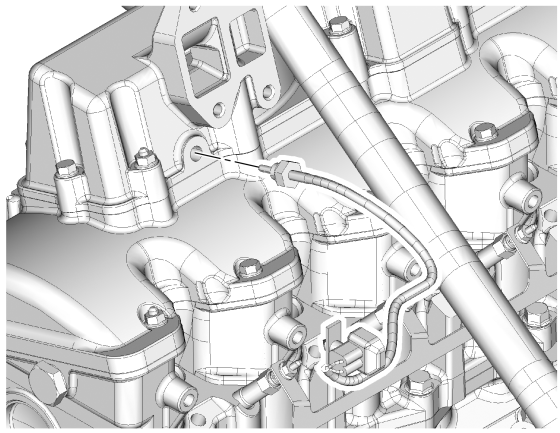
   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



PAWC1BSH000701

4. IMT sensor installation
   1. Install the IMT sensor to the intake chamber.

   tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



PAWC1FSH000401

   2. Connect the harness connector to the IMT sensor.

5. PCV hose installation
   1. Install the PCV hose to the intake chamber.

6. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

Note：

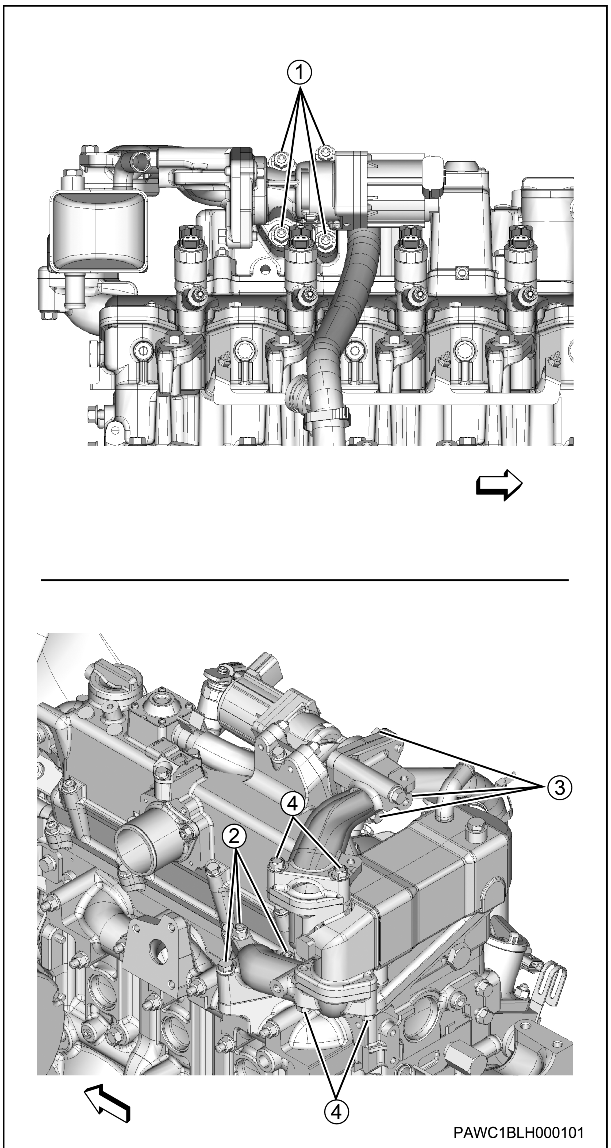
- Temporarily tighten the entire component until seated.

5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

Note：

- After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

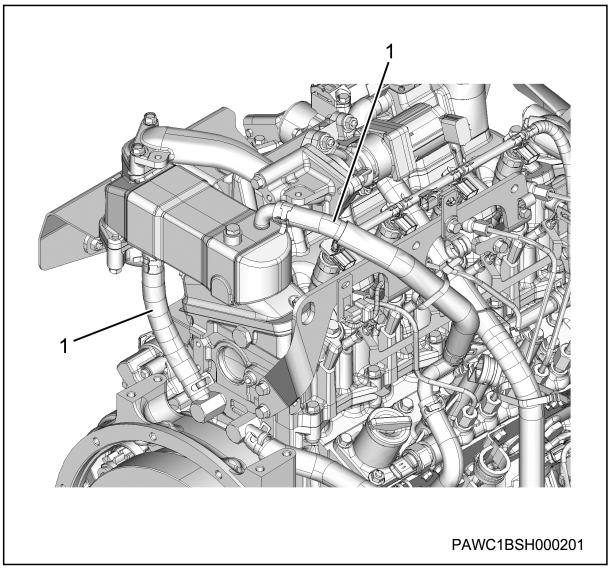


Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

7. Pressure sensor/boost temperature sensor connect

1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

Note：

- Install the harness clip.

8. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

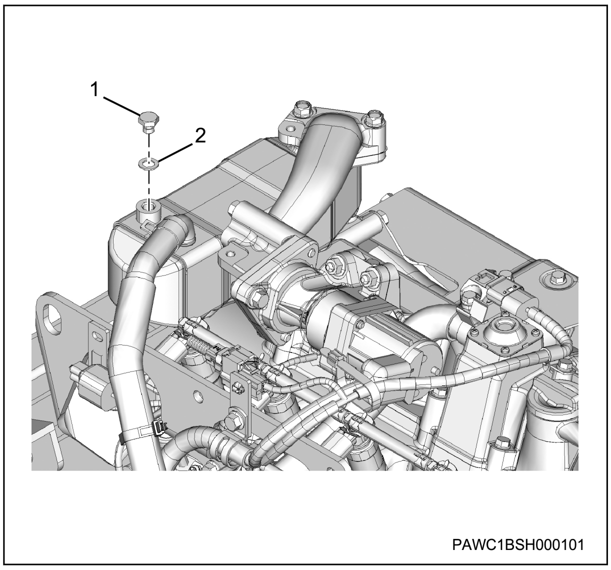
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug
2. Gasket

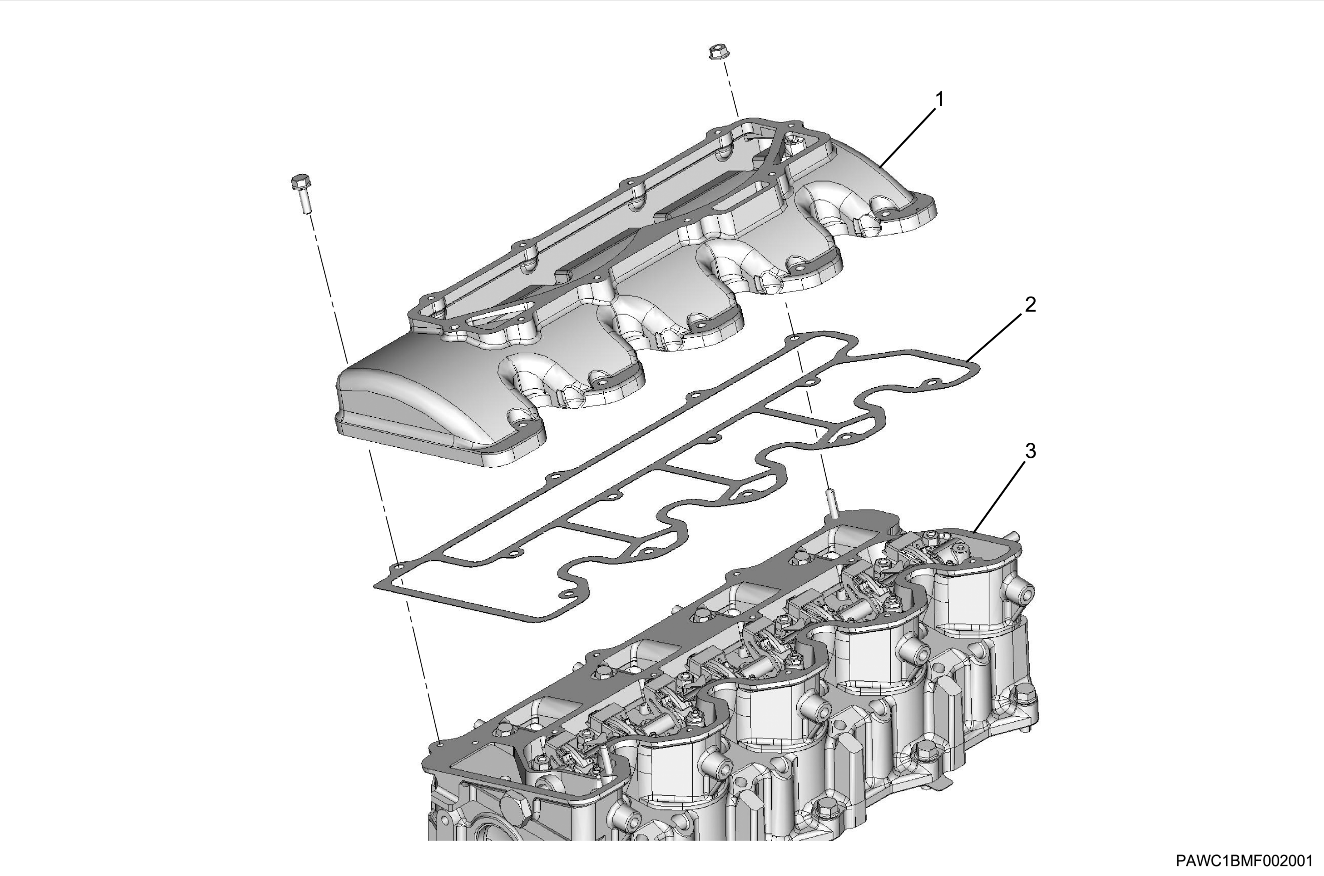
9. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Supplementary Information

1. Component Views

Note：

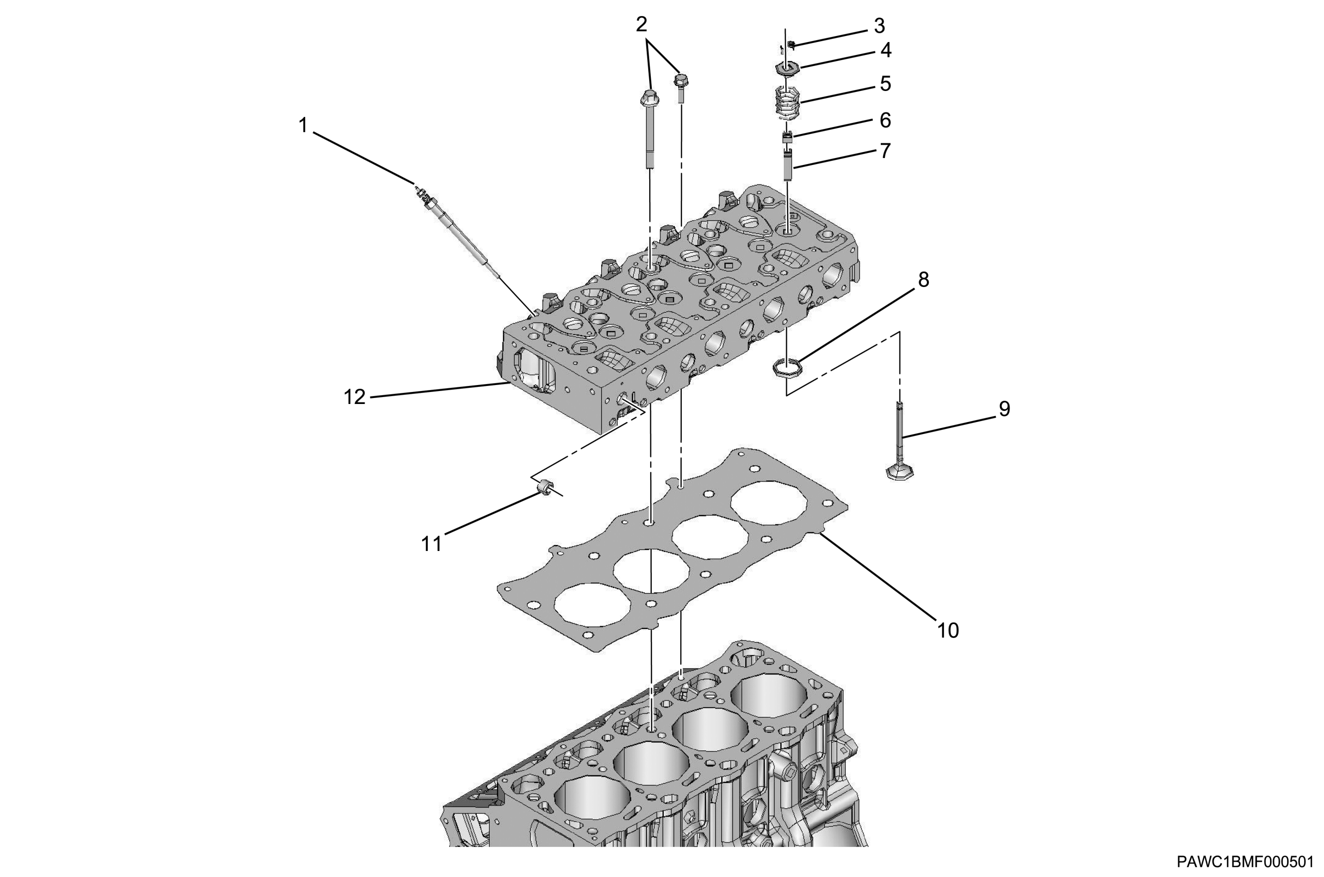
- Cylinder head cover



1. Cylinder head cover
2. Gasket
3. Rocker arm bracket

Note：

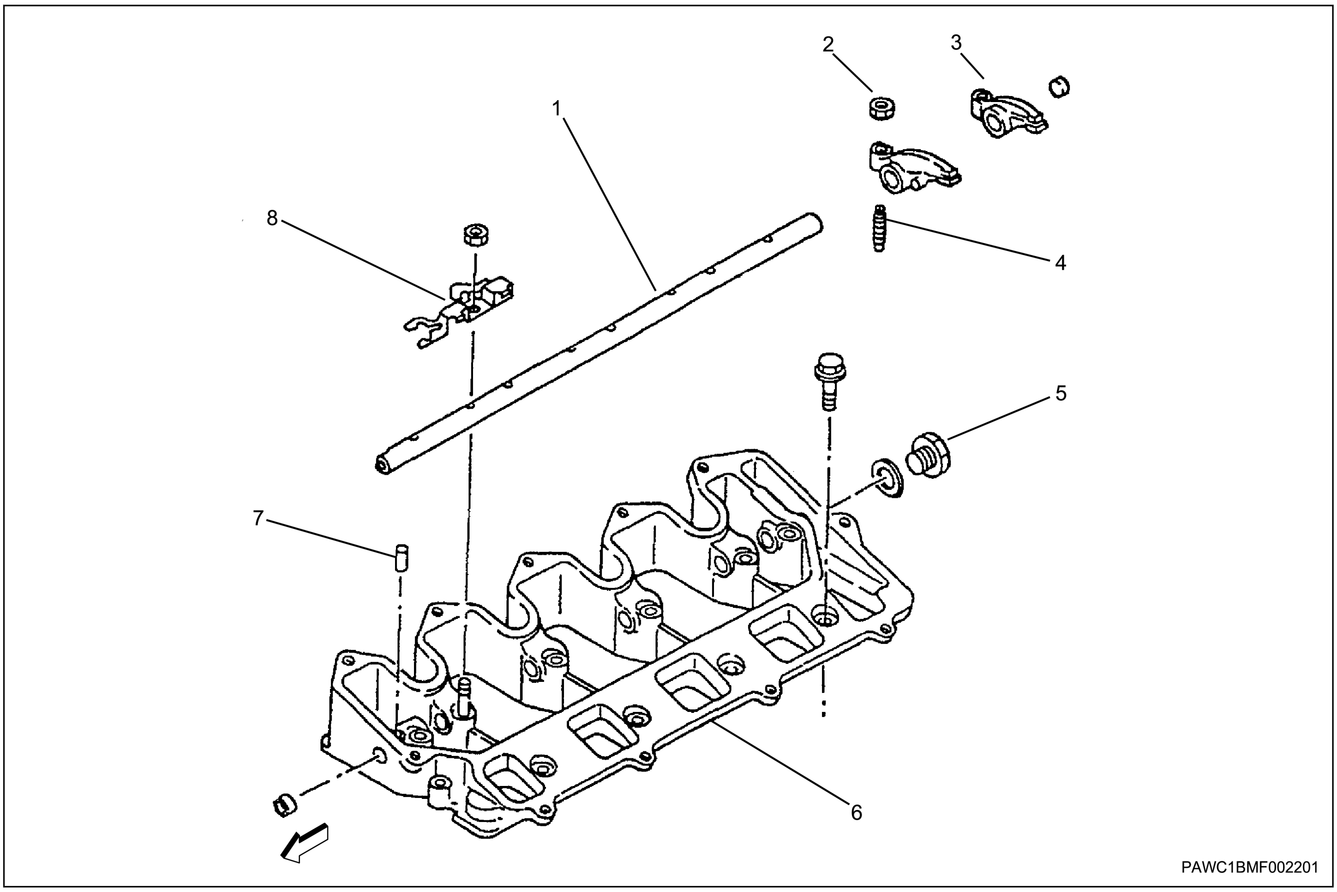
- Cylinder head assembly



1. Glow plug
2. Head bolt
3. Split collar
4. Spring seat
5. Valve spring
6. Valve stem oil seal
7. Valve guide
8. Valve seat insert
9. Valve
10. Gasket
11. Hot plug
12. Cylinder head assembly

Note：

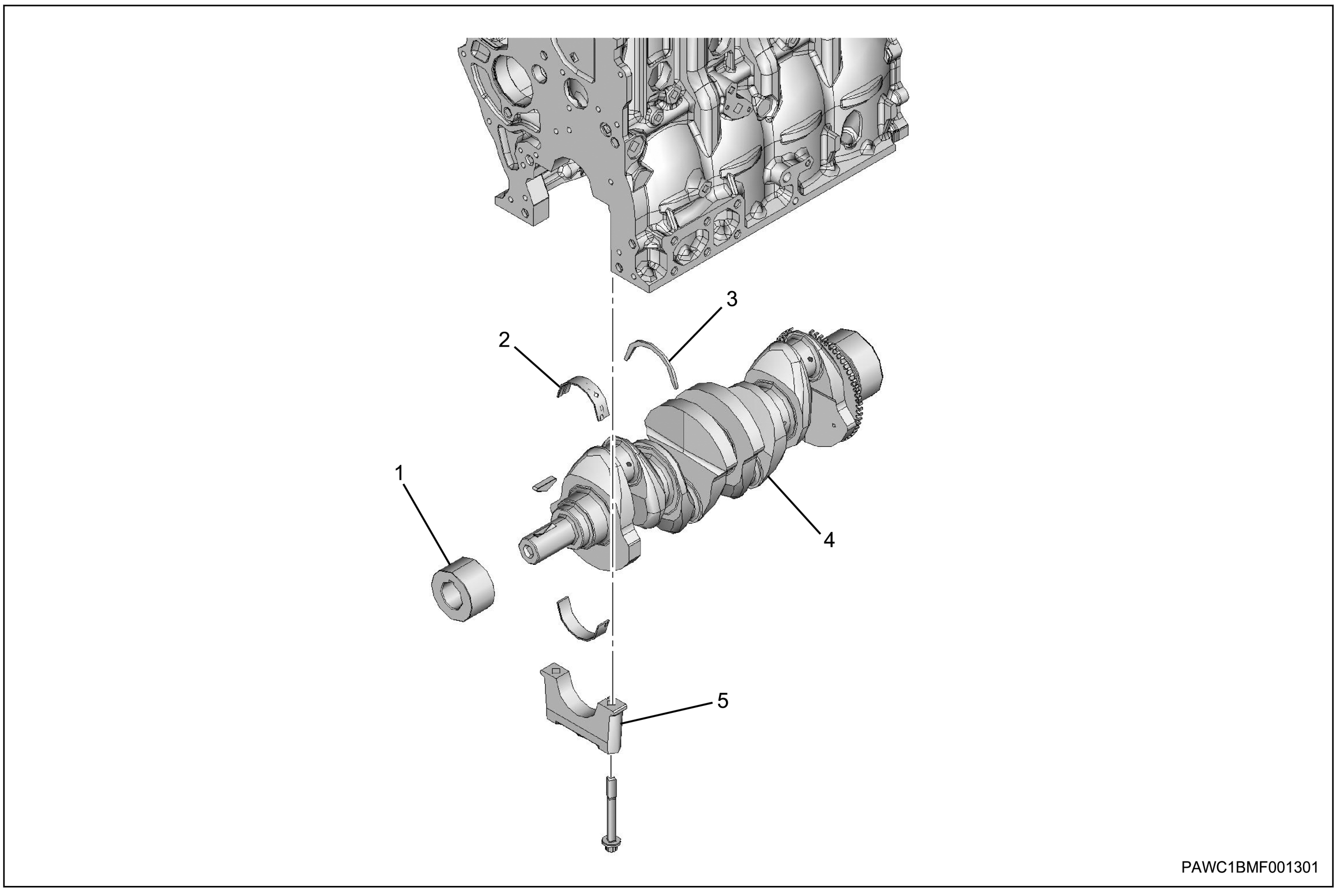
・ Rocker arm shaft



1. Rocker arm shaft
2. Lock nut
3. Rocker arm
4. Adjust screw
5. Rocker arm shaft plug
6. Rocker arm bracket
7. Rocker arm shaft pin
8. Rocker arm spring

Note：

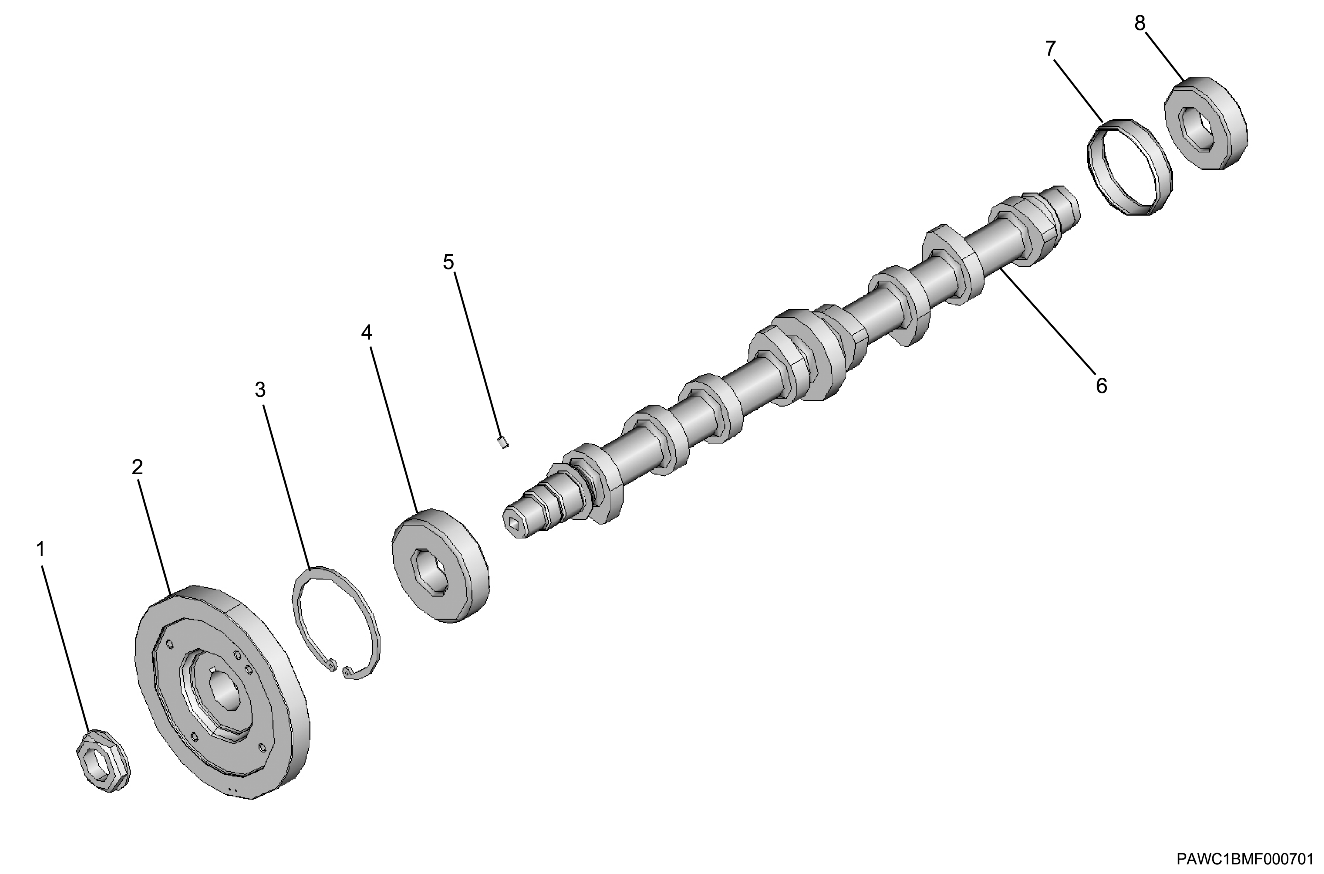
・ Crankshaft



1. Crank gear
2. Upper bearing
3. Thrust bearing
4. Crankshaft
5. Bearing cap
6. Lower bearing

Note：

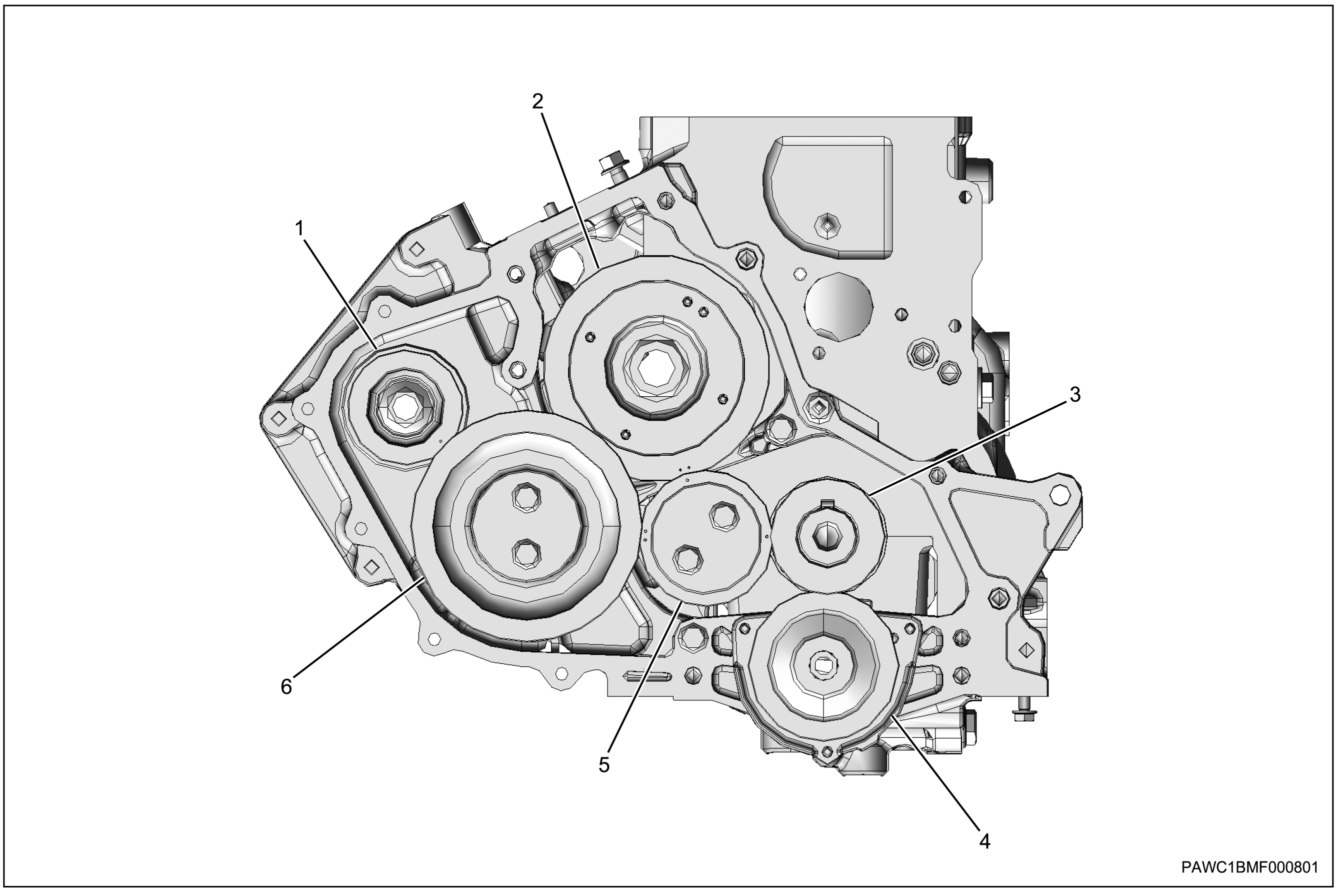
- Camshaft



1. Lock nut
2. Camshaft gear
3. Snap ring
4. Ball bearing
5. Pin
6. Camshaft
7. Roller bearing
8. Ball bearing

Note：

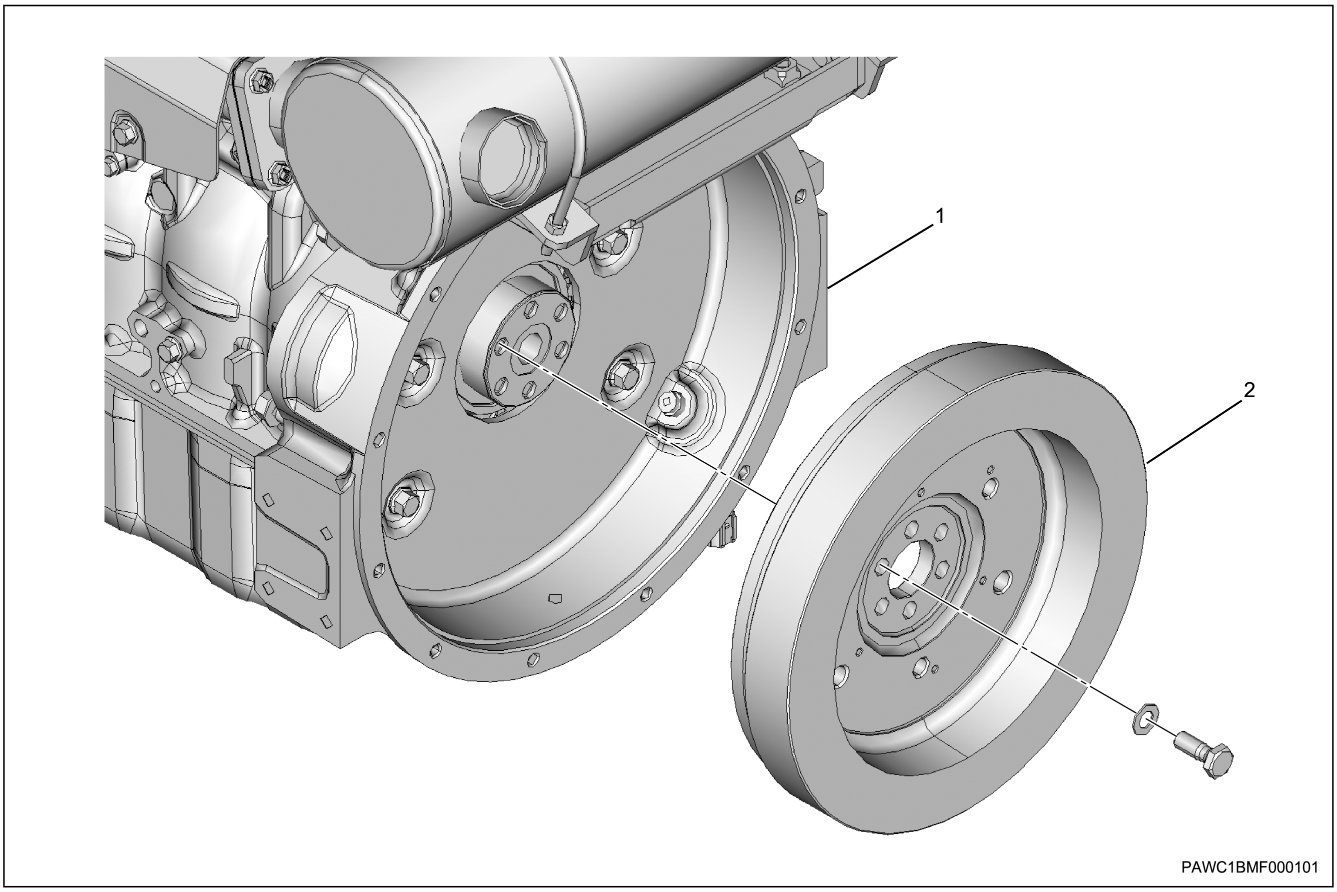
- Idle gear



1. Supply pump gear
2. Camshaft gear
3. Crankshaft gear
4. Oil pump gear
5. Idle gear A
6. Idle gear B

Note：

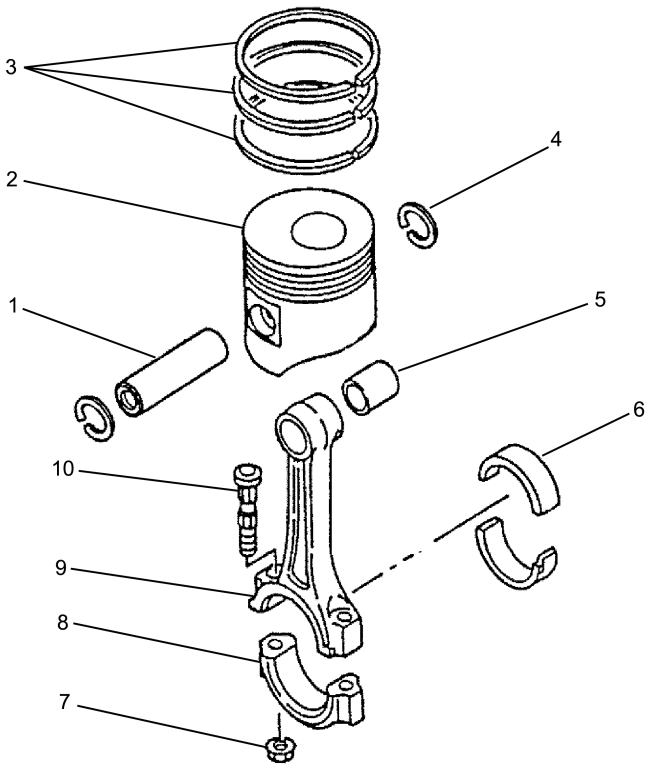
- Flywheel



1. Flywheel housing
2. Flywheel

Note：

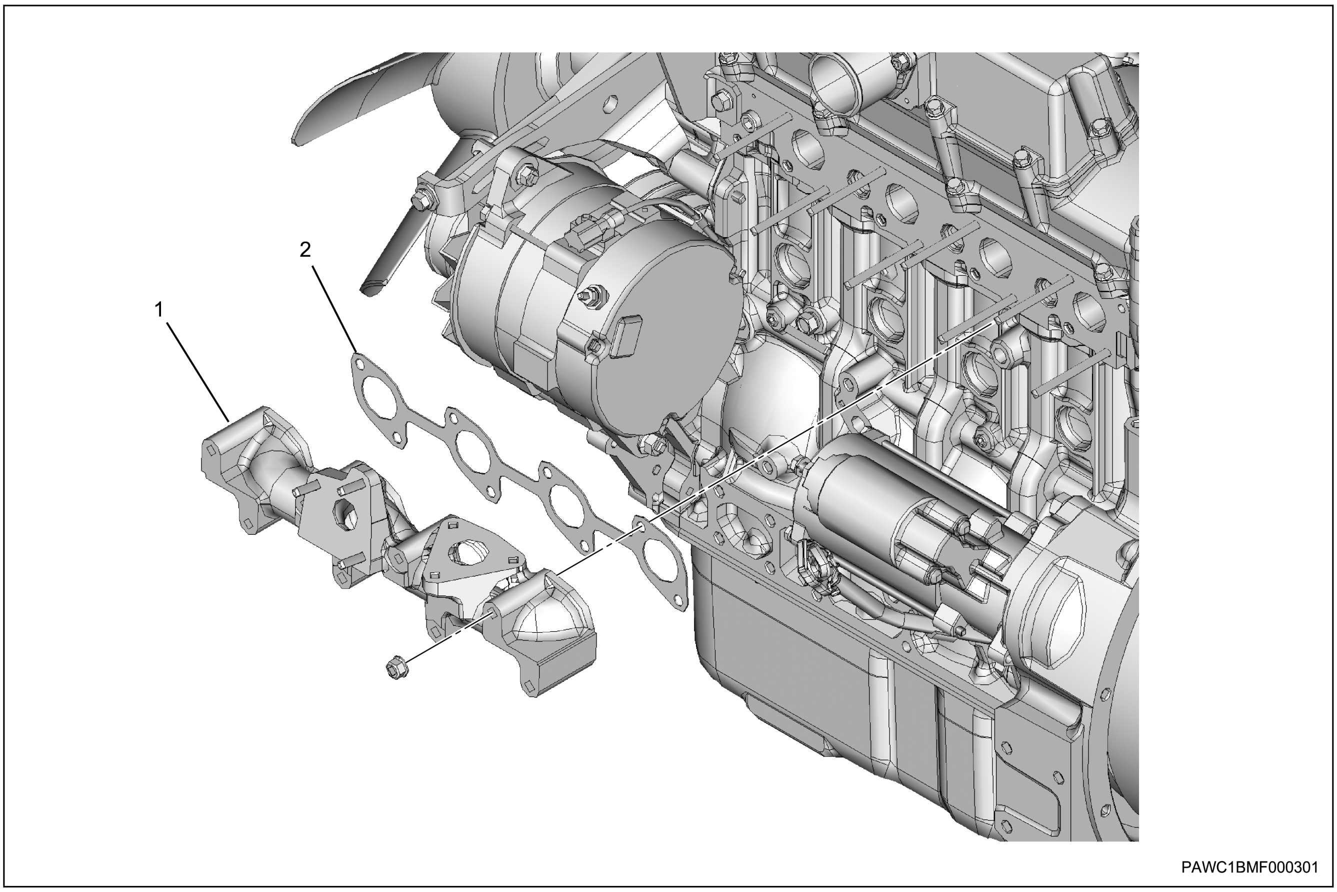
- Piston



1. Piston pin
2. Piston
3. Piston ring
4. Snap ring
5. Bushing
6. Bearing
7. Cap nut
8. Cap
9. Connecting rod
10. Connecting rod bolt

Note：

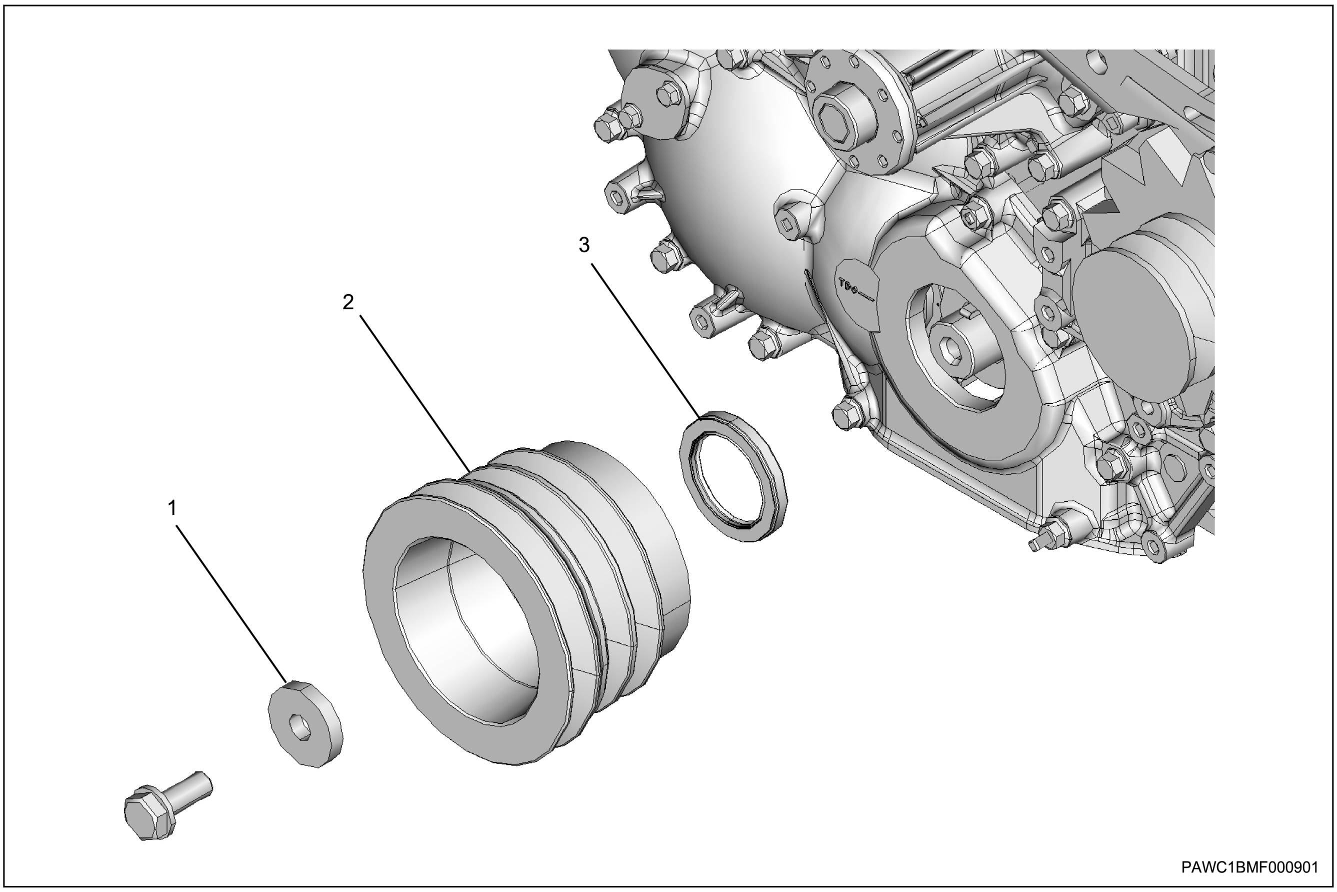
- Exhaust manifold



1. Exhaust manifold
2. Gasket

Note：

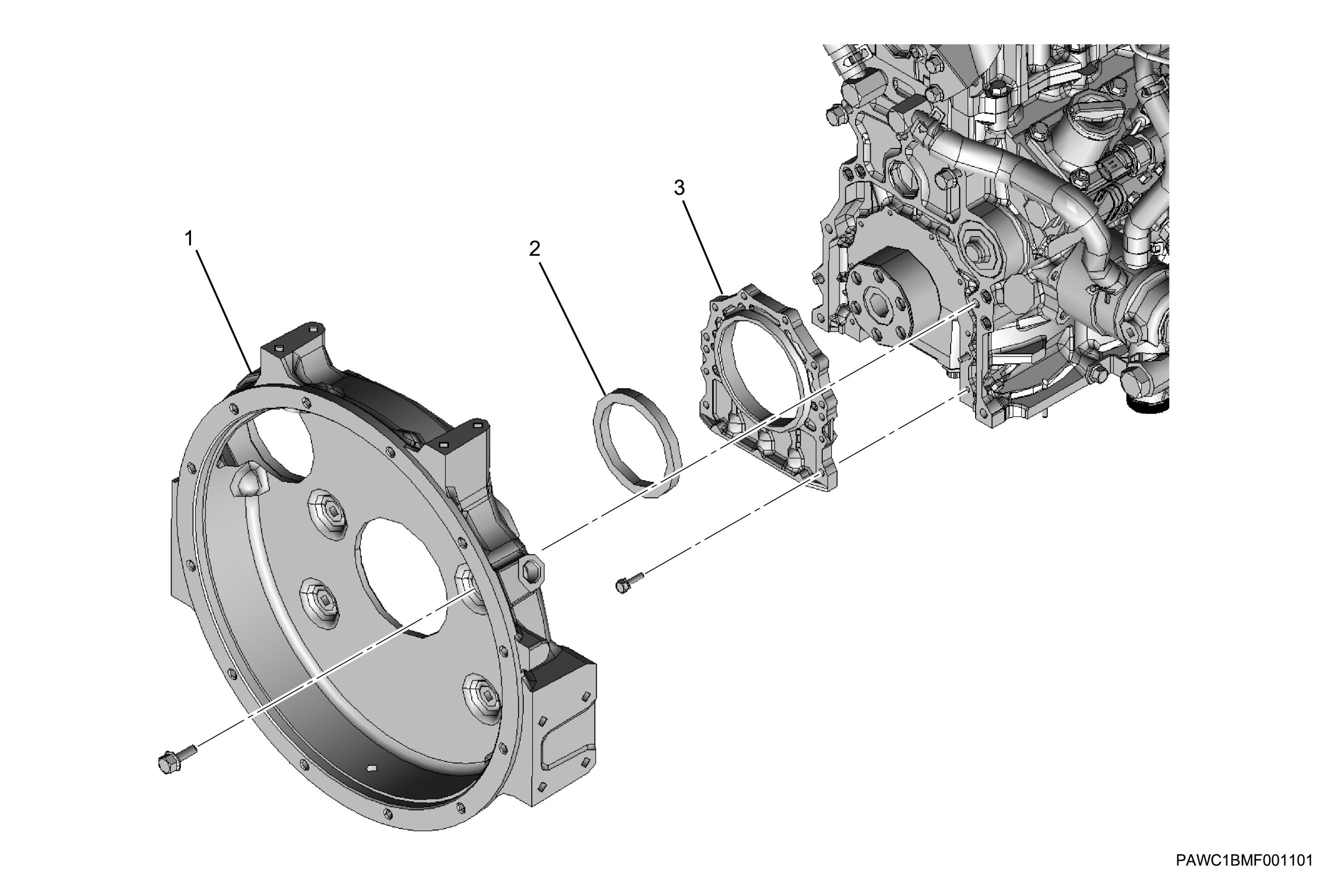
- Crankshaft front oil seal



1. Washer
2. Crankshaft pulley
3. Crankshaft front oil seal

Note：

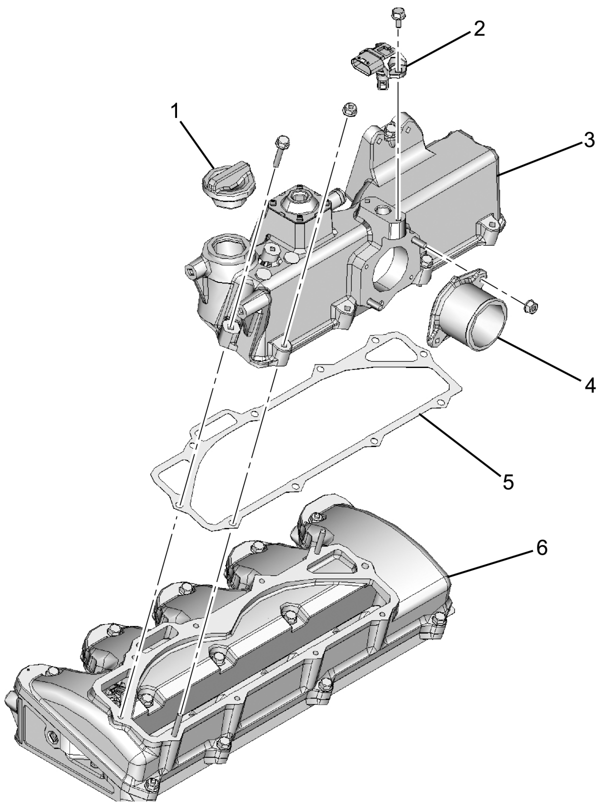
- Crankshaft rear oil seal



1. Flywheel housing
2. Crankshaft rear oil seal
3. Oil seal retainer

Note：

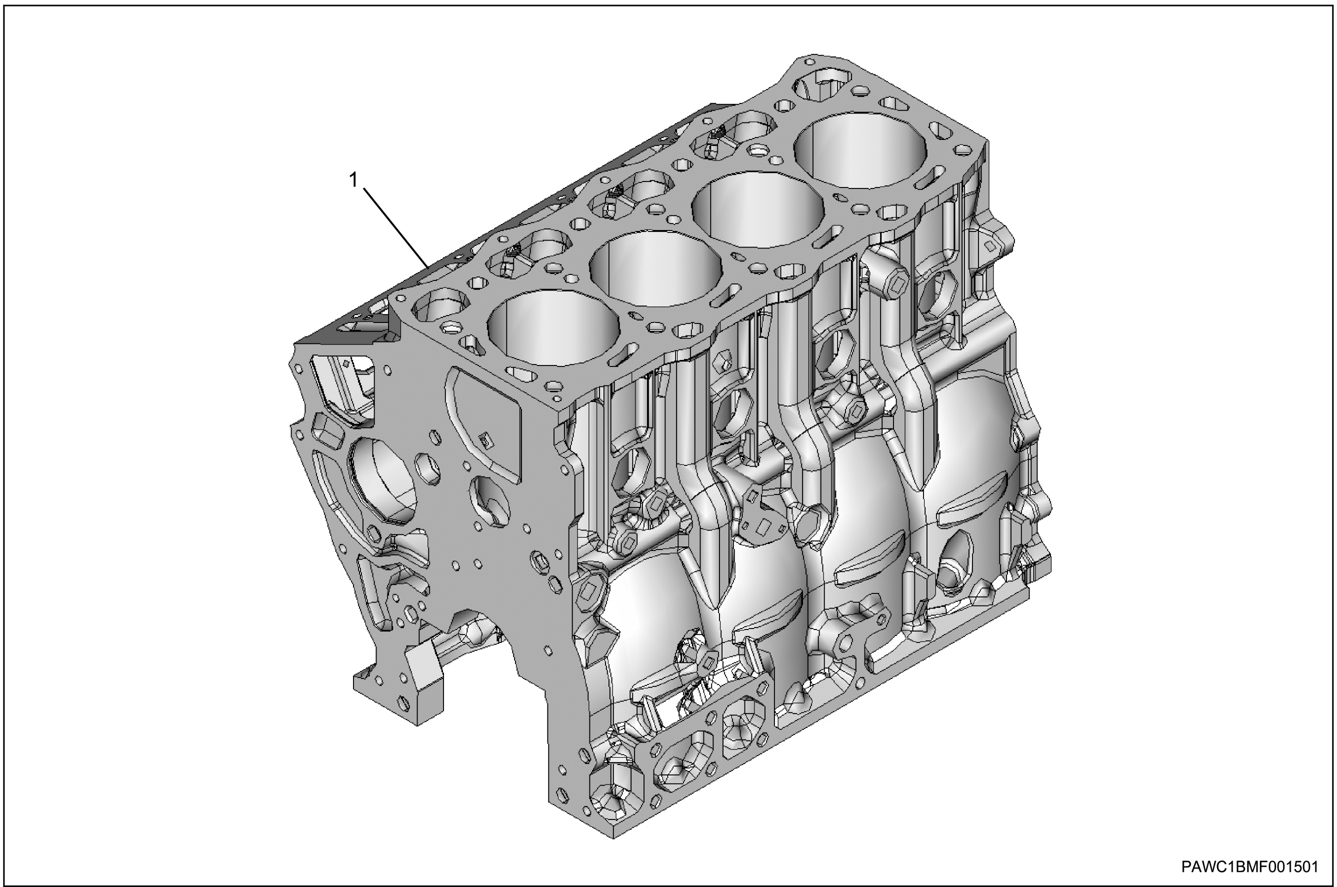
- Intake chamber



1. Fuel filler cap
2. MAP sensor
3. Intake chamber
4. Air pipe
5. Gasket
6. Cylinder head cover

Note：

- Cylinder block

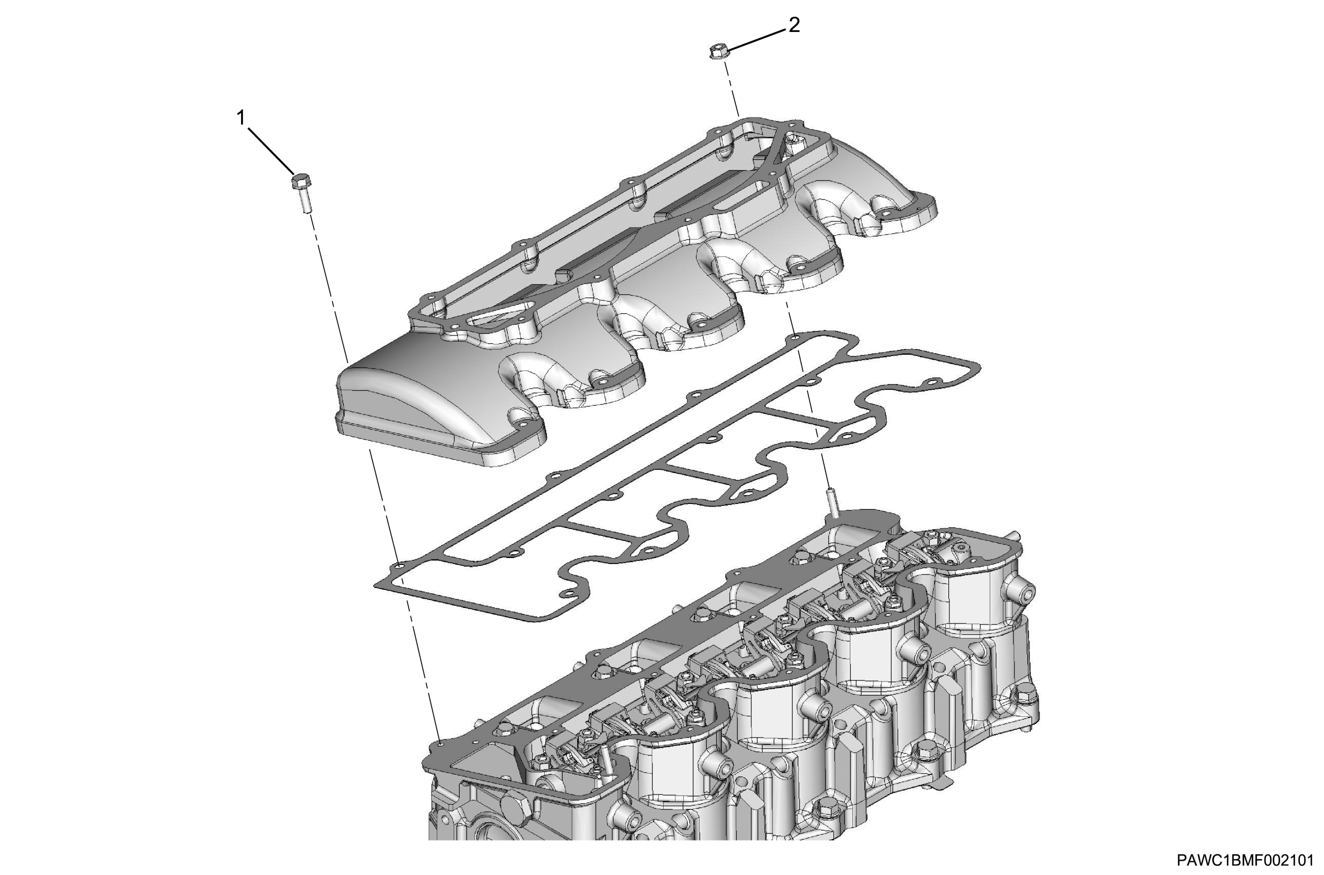


1. Cylinder block

2. Tightening Torque Views

Note :

- Cylinder head cover

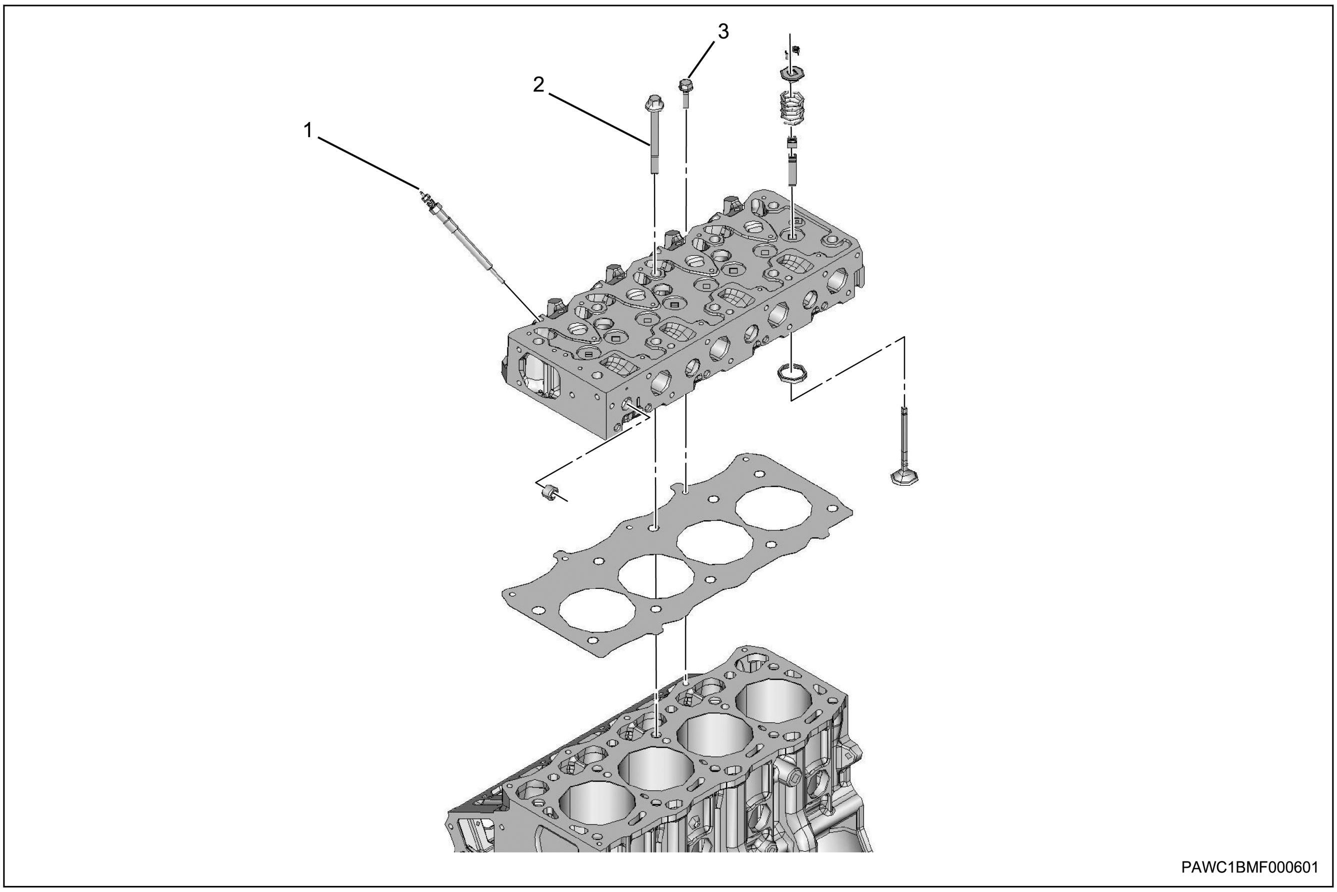


1 : 10 N・m { 1.0 kgf・m / 89 lb・in }

2 : 10 N・m { 1.0 kgf・m / 89 lb・in }

Note :

- Cylinder head assembly



1 : 22 N・m { 2.2 kgf・m / 16 lb・ft }

2-1 : 88 N・m { 9.0 kgf・m / 65 lb・ft }

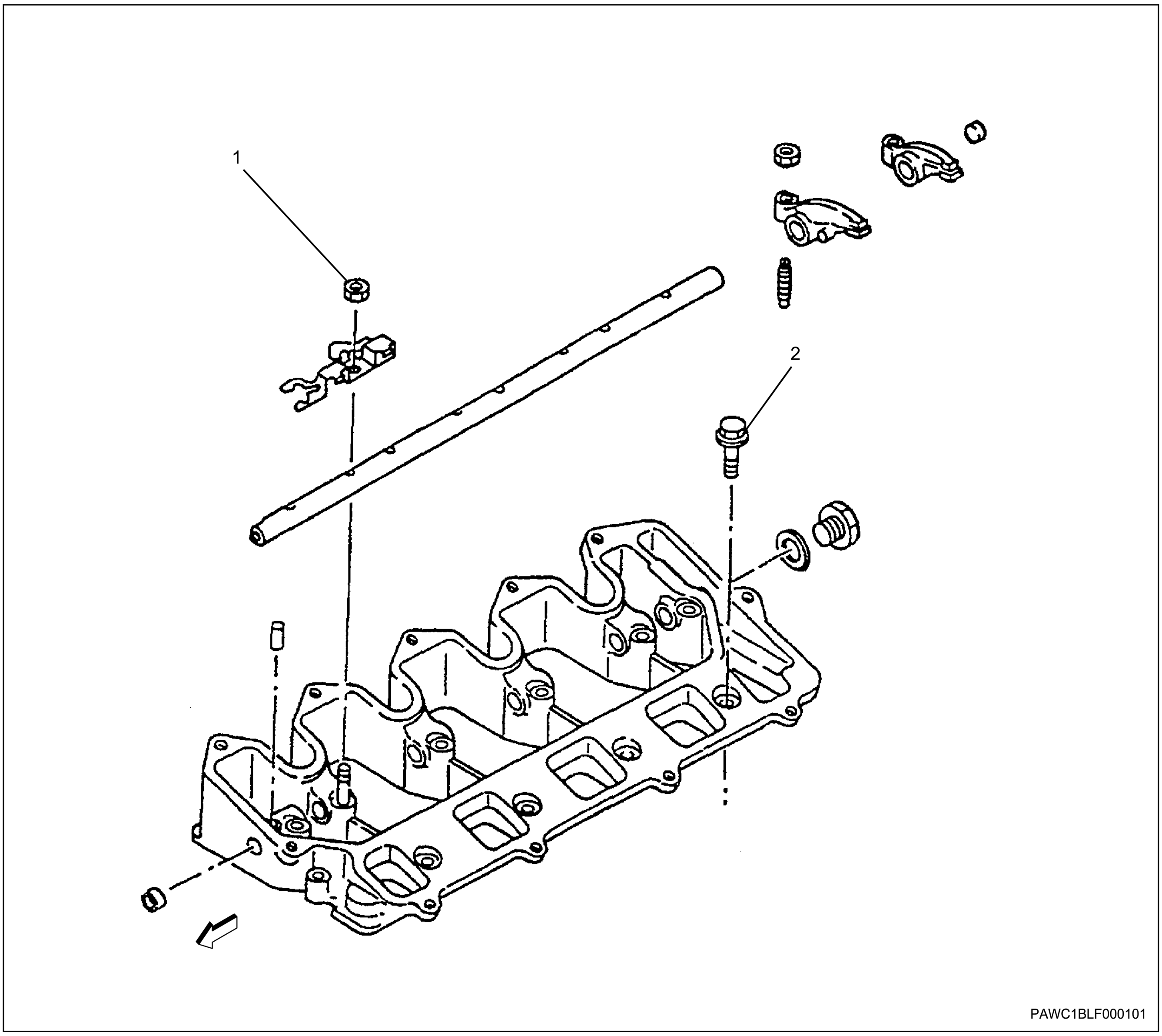
2-2 : 88 N・m { 9.0 kgf・m / 65 lb・ft }

2-3 : 60 °

3 : 29 N・m { 3.0 kgf・m / 21 lb・ft }

Note :

- Rocker arm shaft

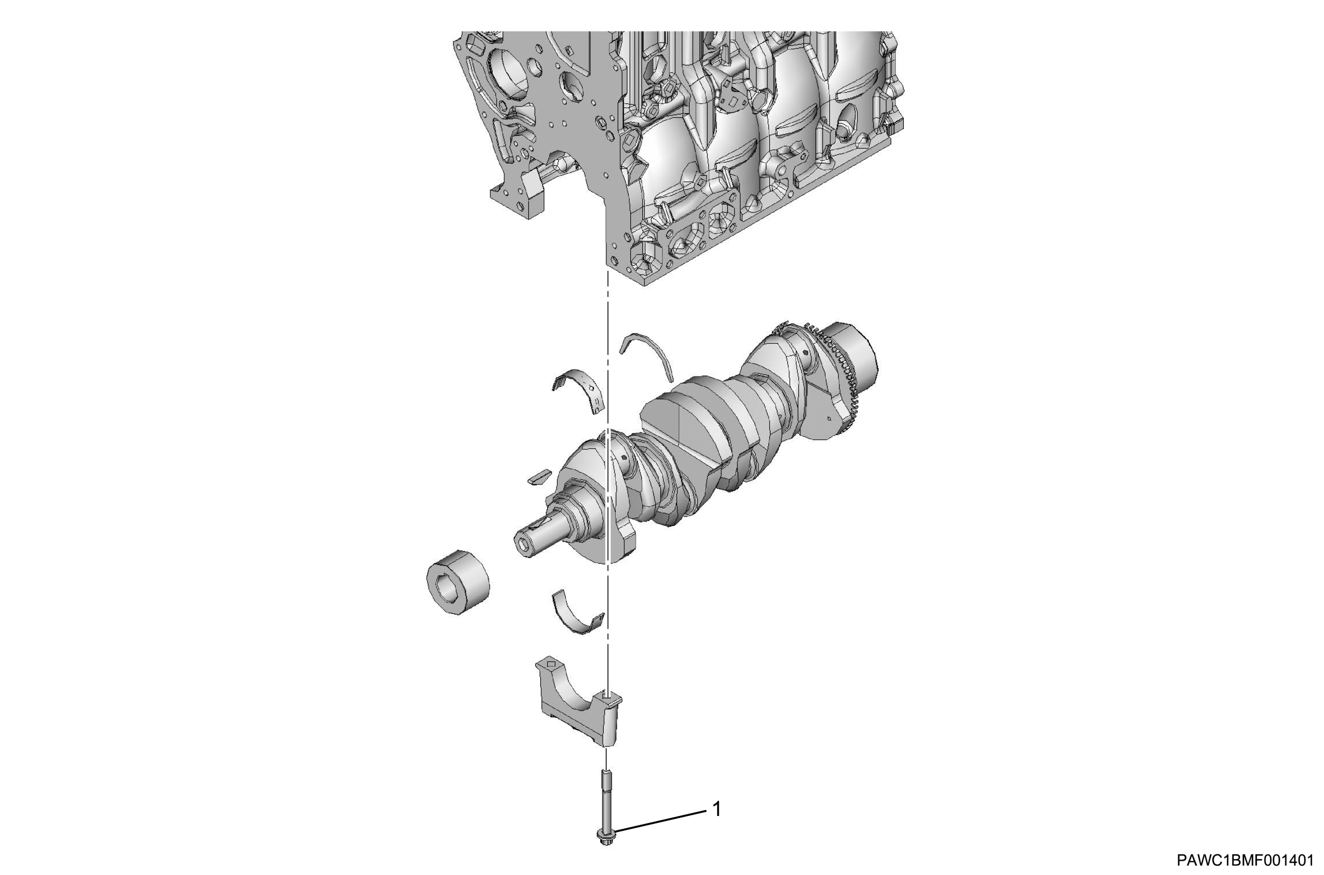


1 : 10 N・m { 1.0 kgf・m / 89 lb・in }

2 : 10 N・m { 1.0 kgf・m / 89 lb・in }

Note :

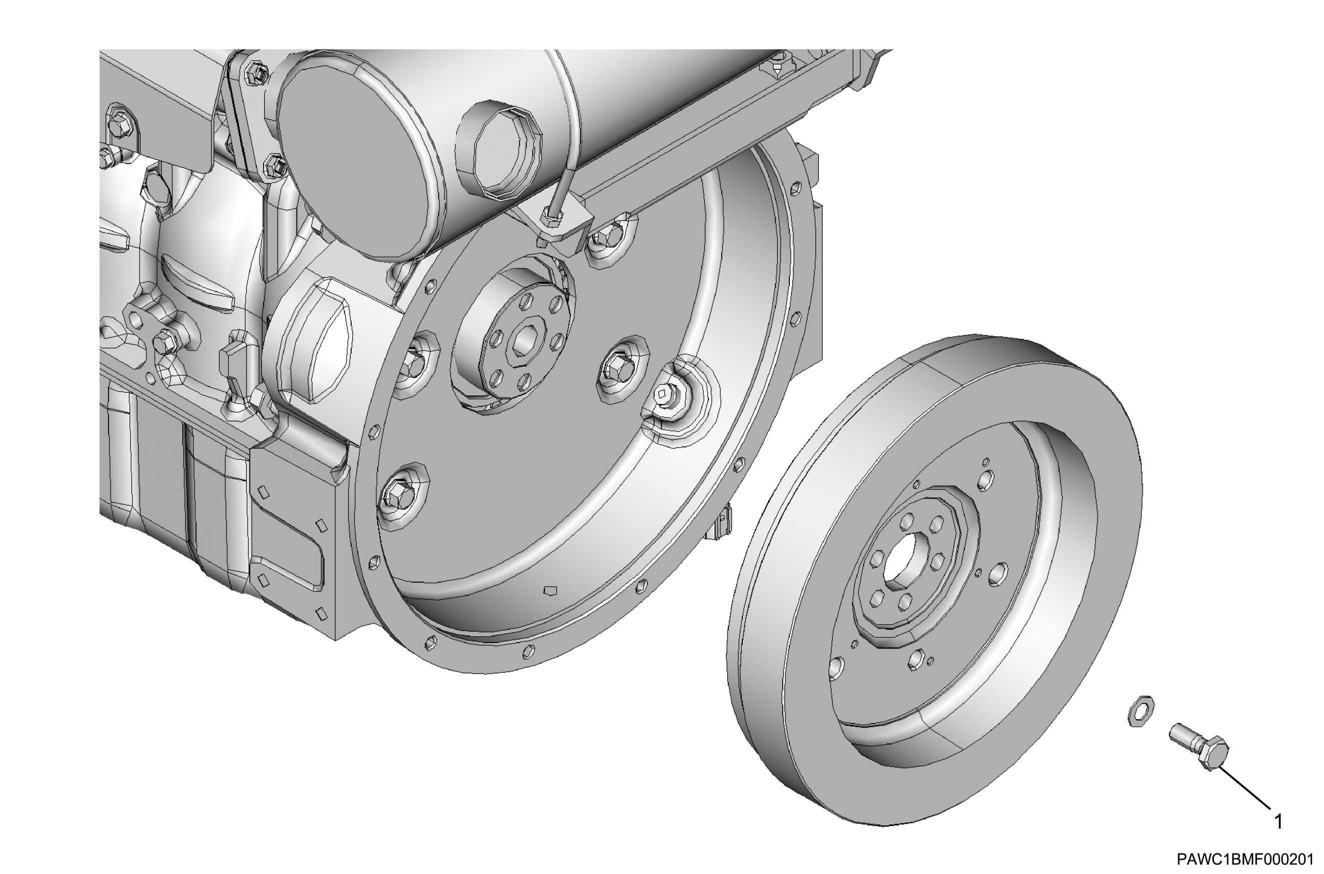
- Crankshaft



1 : 88 N・m { 9.0 kgf・m / 65 lb・ft }

Note :

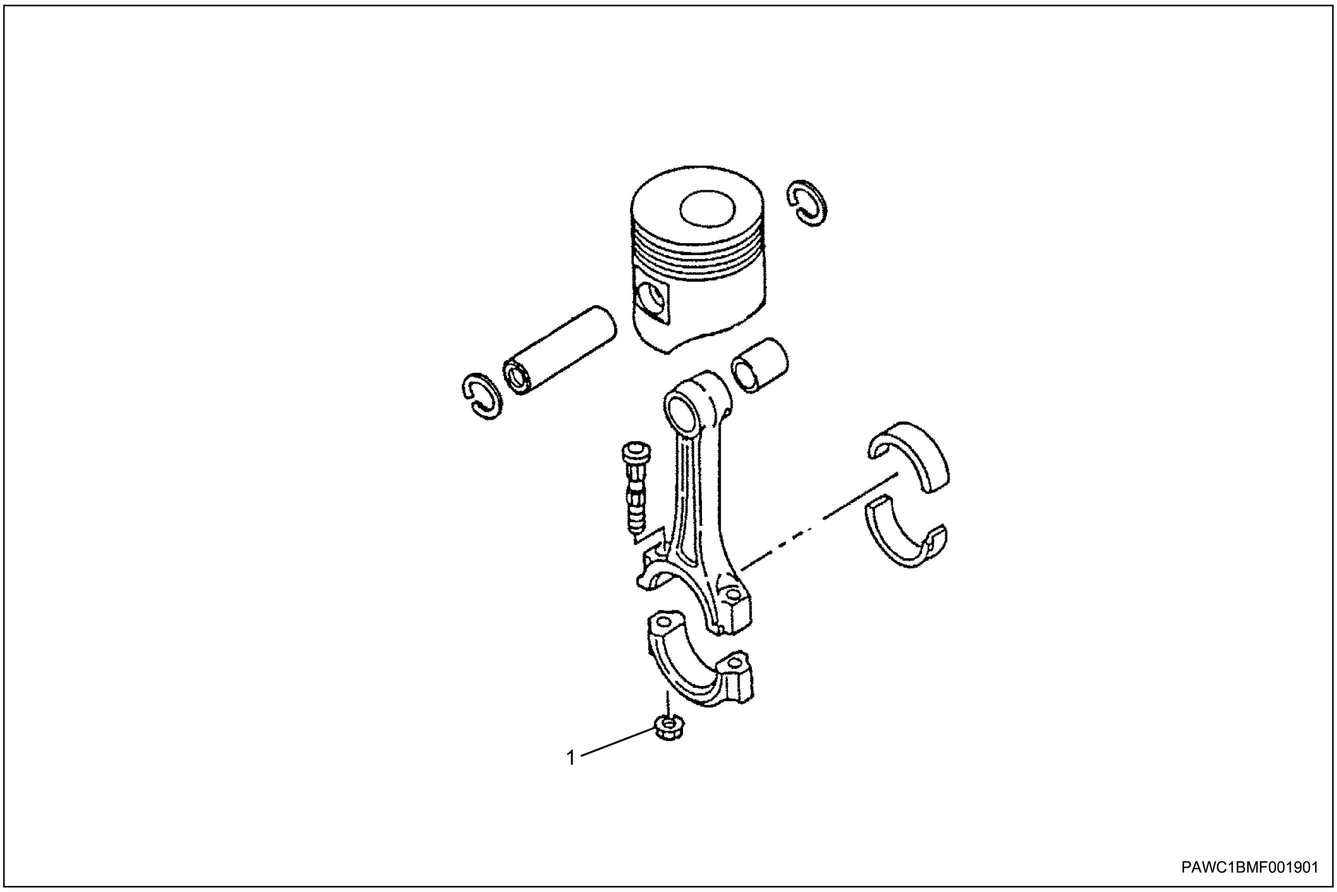
・ Flywheel



1： 98 N・m { 10.0 kgf・m / 72 lb・ft }

Note：

・ Piston

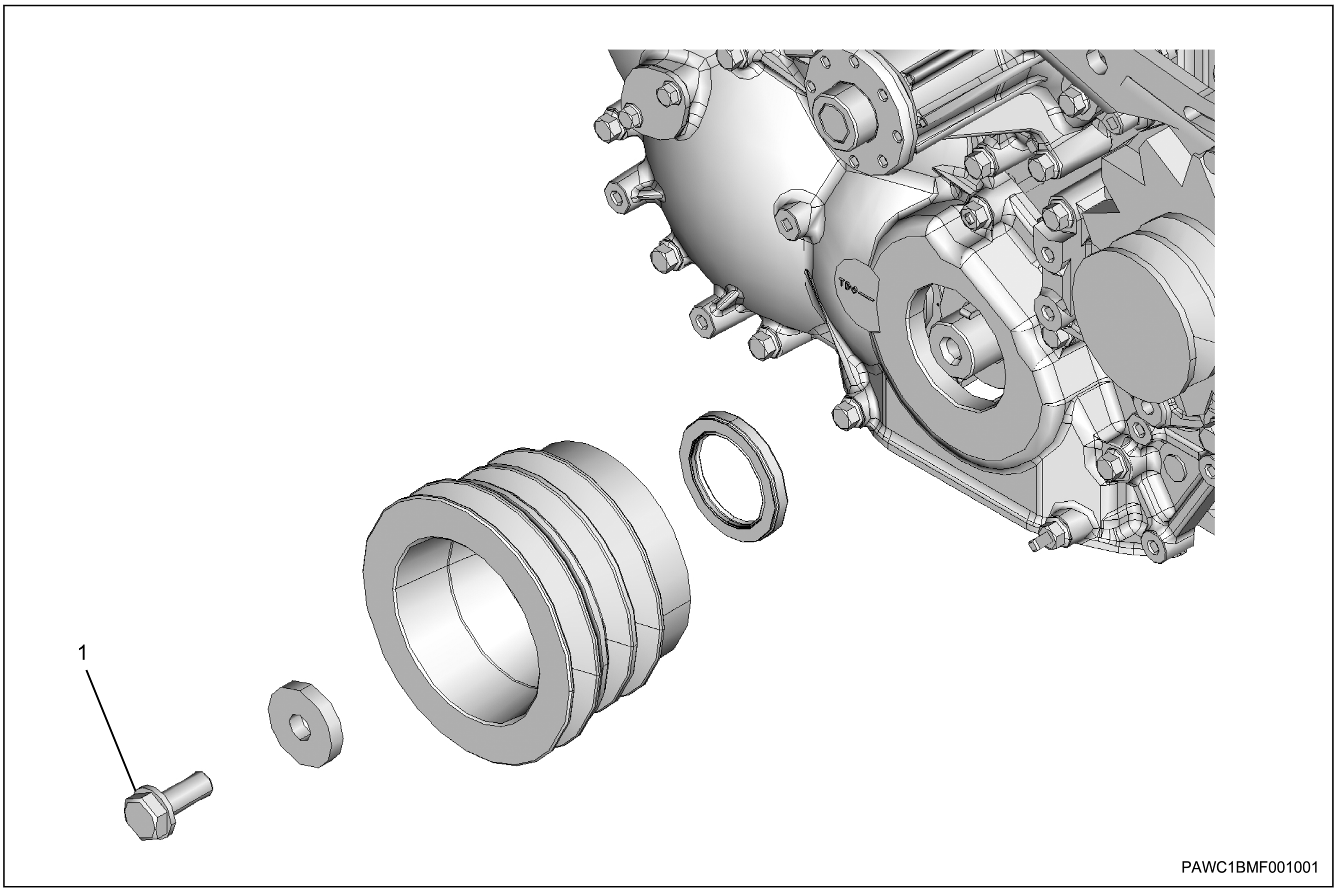


1-1 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

1-2 : 100 °

Note :

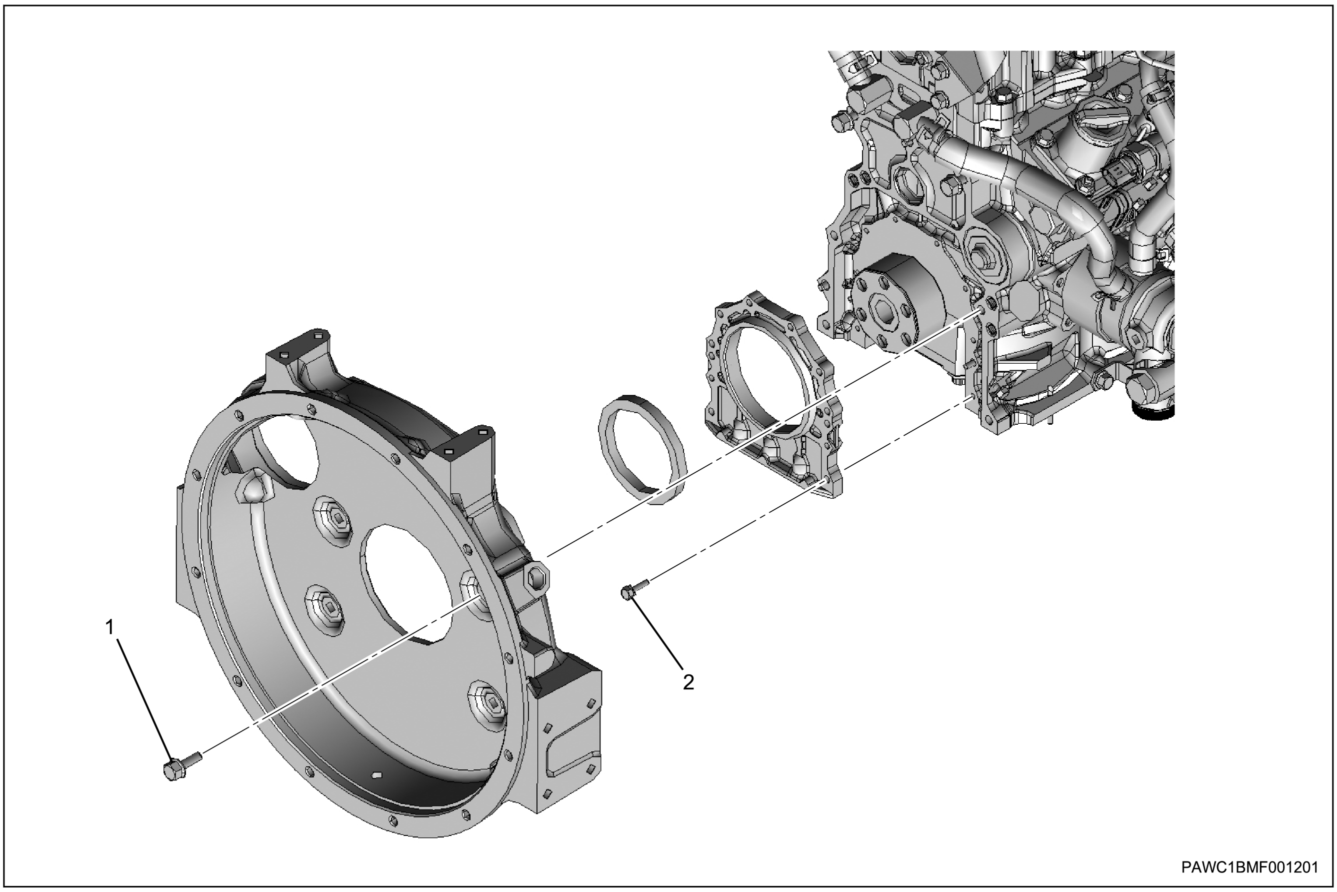
- Crankshaft front oil seal



1 : 177 N・m { 18.0 kgf・m / 131 lb・ft }

Note :

- Crankshaft rear oil seal

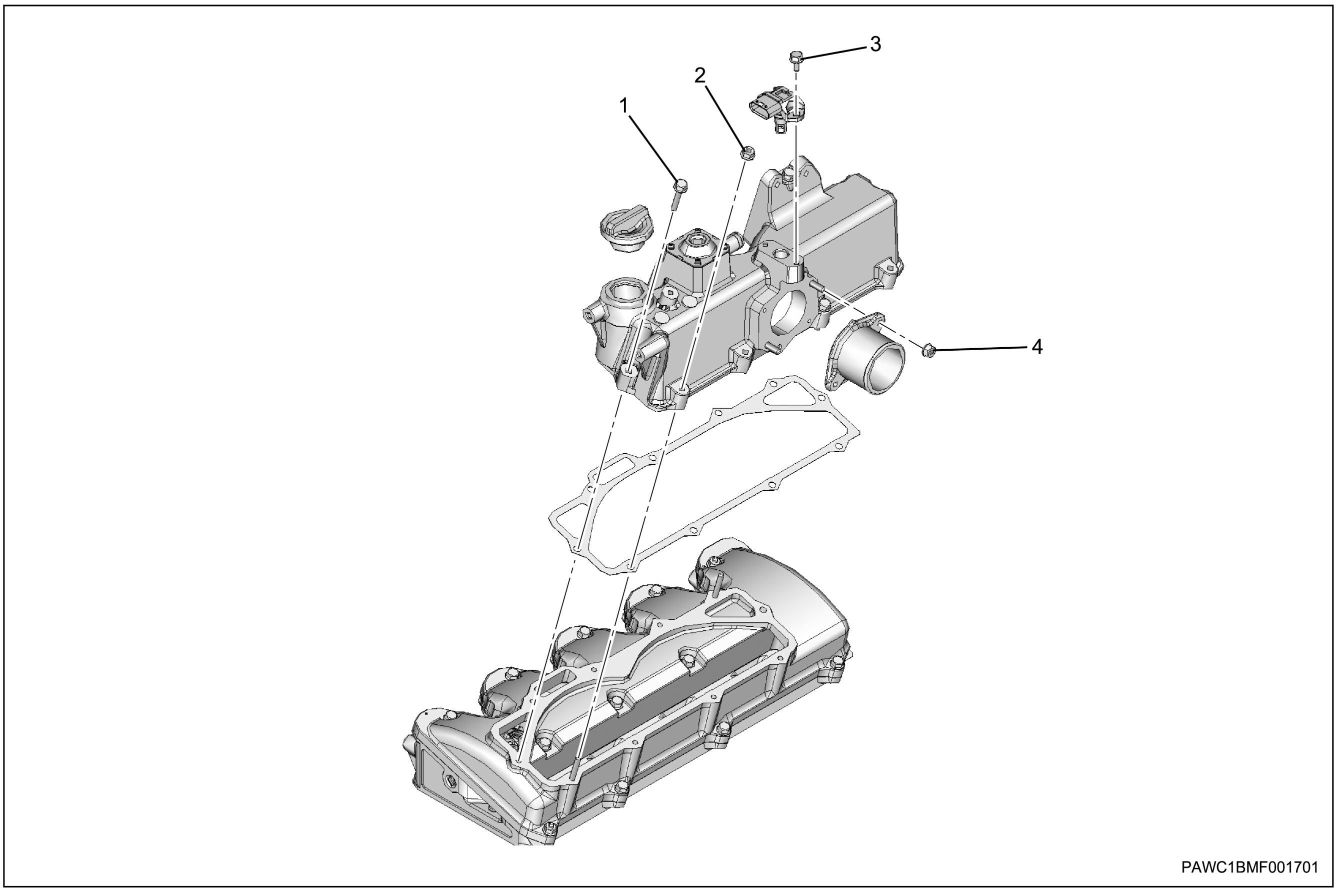


1 : 48 N・m { 4.9 kgf・m / 35 lb・ft }

2 : 10 N・m { 1.0 kgf・m / 89 lb・in }

Note :

- Intake chamber



1 : 10 N・m { 1.0 kgf・m / 89 lb・in }

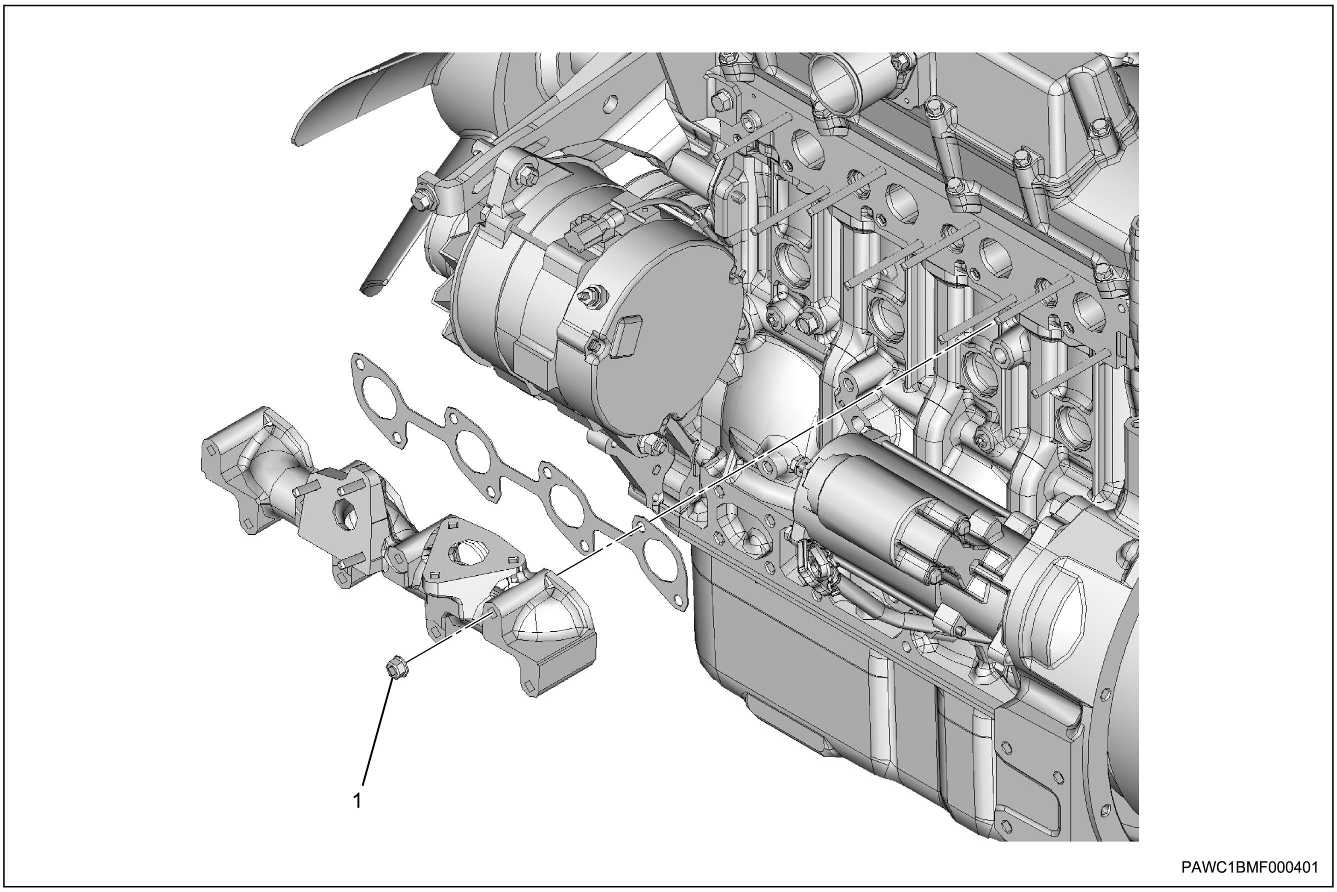
2 : 10 N・m { 1.0 kgf・m / 89 lb・in }

3 : 18 N・m { 1.8 kgf・m / 13 lb・ft }

4 : 10 N・m { 1.0 kgf・m / 89 lb・in }

Note :

- Exhaust manifold



1 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

Engine

Fuel System

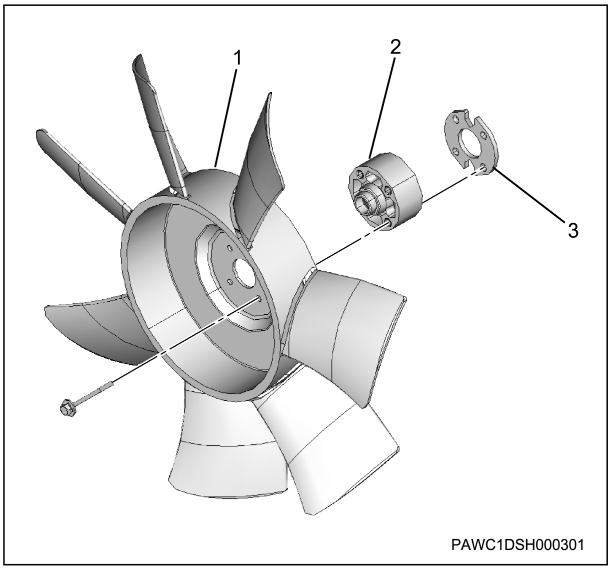
(4LE2)

Table of Contents

Fuel supply pump

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



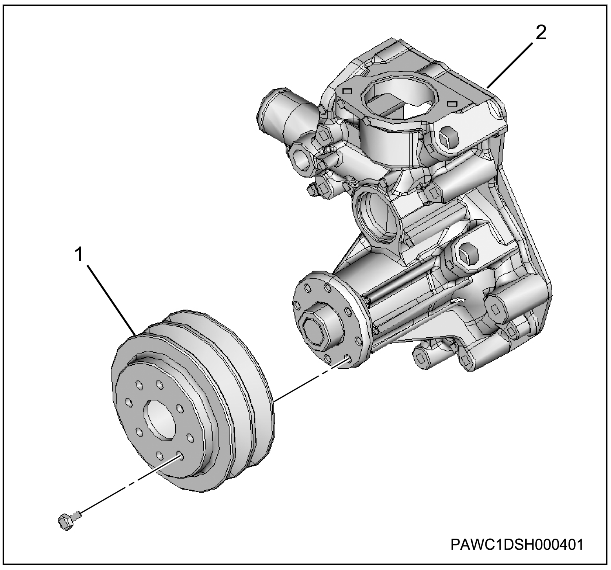
1. Cooling fan
2. Adapter
3. Spacer

3. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

Note :

- Loosen the generator adjust bolt and remove the belt.

4. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

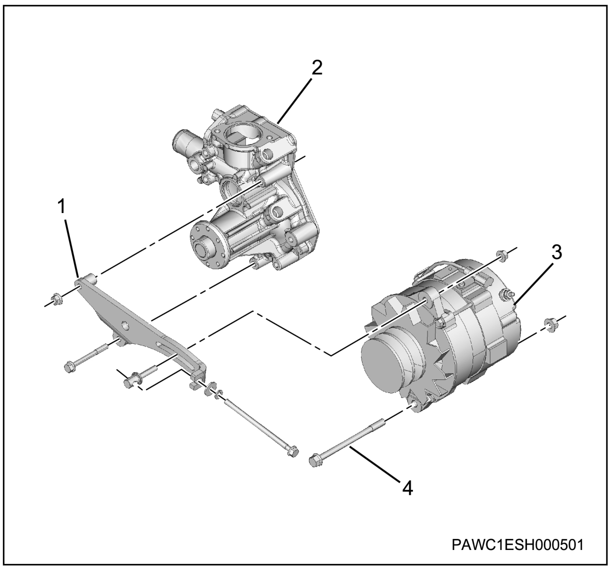


1. Fan pulley
2. Water pump assembly

5. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

Note :

- The diagram shows the 24 V - 50 A specification.

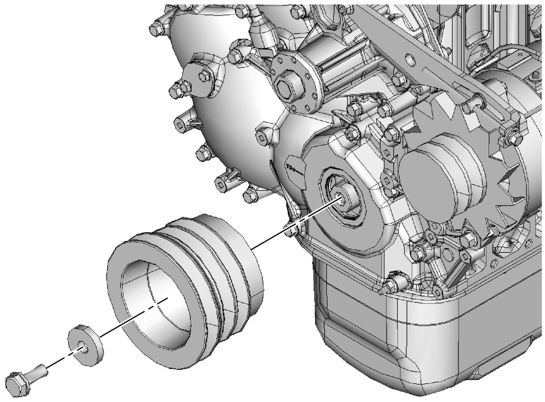


1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

6. Generator bracket removal
   1. Remove the generator bracket from the cylinder block.
7. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

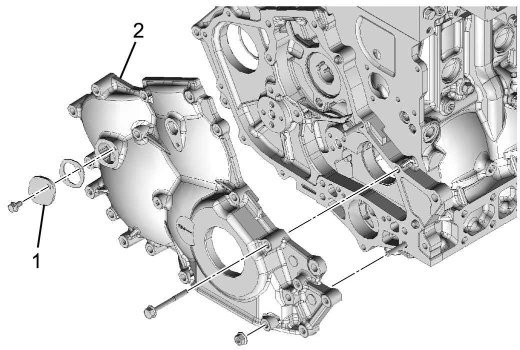
Note :
- Remove after stopping the crankshaft from turning.

Caution :
- Do not reuse the bolt and the washer.



PAWC1BSH001601

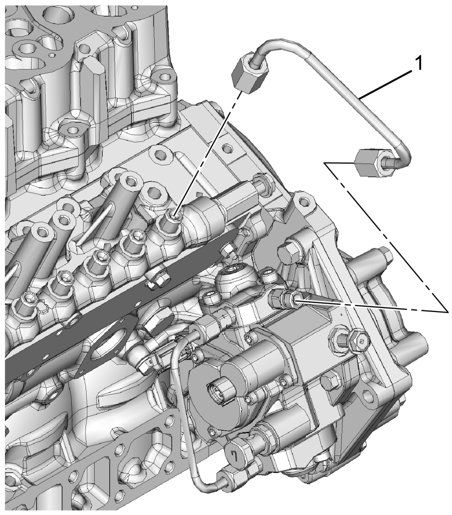
8. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.
   3. Remove the O-ring from the CMP sensor.
9. Timing gear case removal
   1. Remove the idle gear cover from the timing gear case.
   2. Remove the timing gear case from the front oil pump plate.



PAWC1ESH000701

1. Idle gear cover
2. Timing gear case

10. Fuel pipe removal
    1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



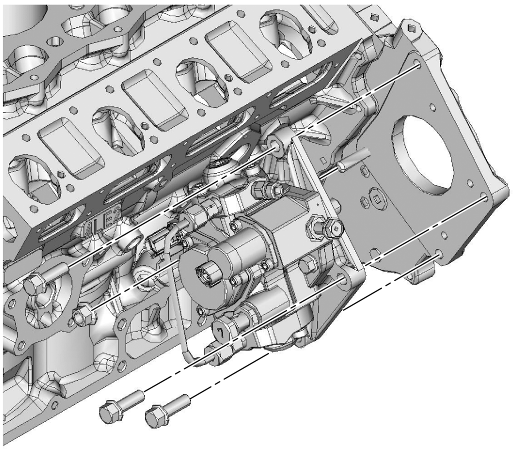
PAWC1CSH000201

1. Fuel pipe

11. Fuel return pipe removal
    1. Remove the fuel return pipe from the fuel supply pump.
12. Fuel supply pump removal
    1. Disconnect the harness connector from the fuel supply pump.
    2. Remove the fuel supply pump from the front oil pump plate.

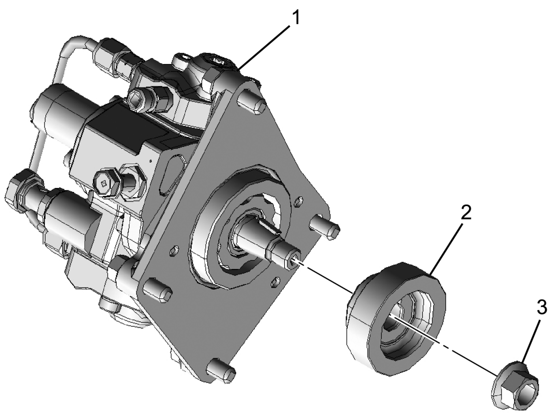
Note：

- Remove the tightening bolts, and remove together with the bracket.



PAWC1CSH000101

3. Remove the supply pump gear from the fuel supply pump.



PAWC1CSH001401

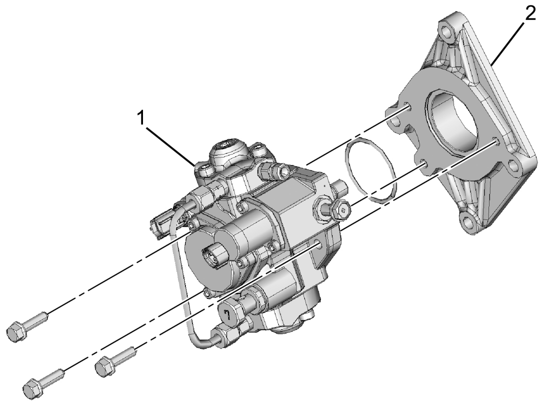
1. Fuel supply pump
2. Supply pump gear
3. Nut

4. Remove the fuel supply pump from the supply pump bracket.

Caution：

- Do not hold the high pressure pipe of the pump when removing the fuel supply pump.

5. Remove the O-ring from the fuel supply pump.



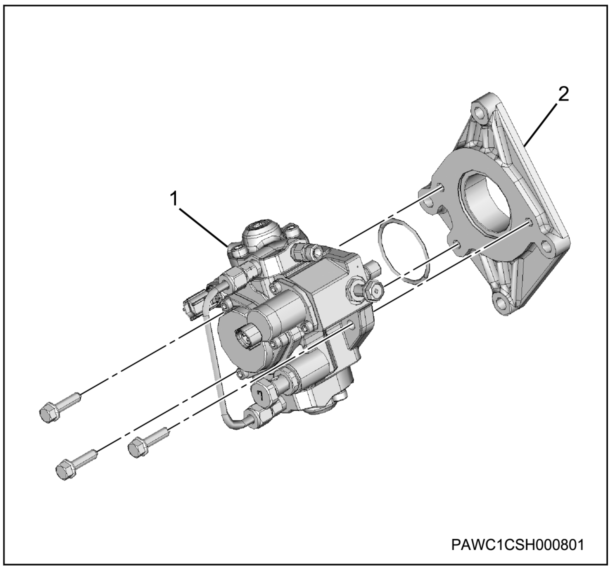
PAWC1CSH000801

1. Fuel supply pump
2. Supply pump bracket

installation

1. Fuel supply pump installation
   1. Install the O-ring to the fuel supply pump.
   2. Install the fuel supply pump to the supply pump bracket.

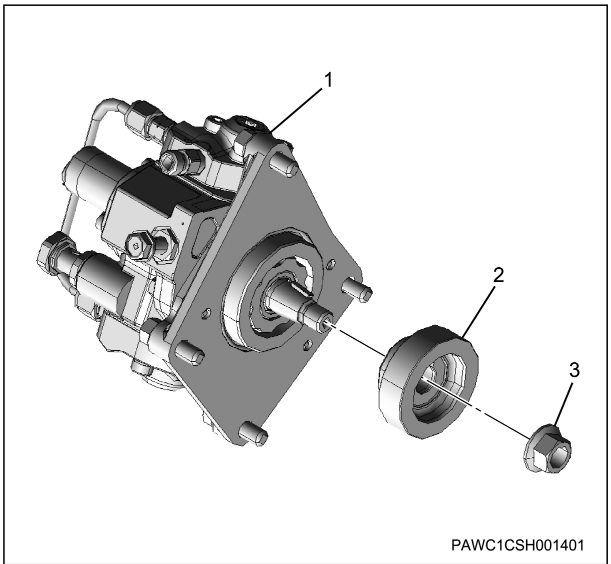
   tightening torque : 19 N・m { 1.9 kgf・m / 14 lb・ft }



1. Fuel supply pump
2. Supply pump bracket

   3. Install the supply pump gear to the fuel supply pump.

   tightening torque : 64 N・m { 6.5 kgf・m / 47 lb・ft }



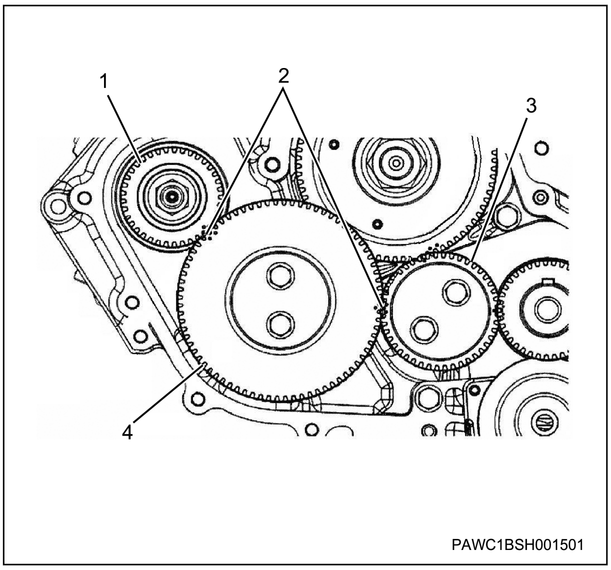
1. Fuel supply pump
2. Supply pump gear
3. Nut

   4. Align the No.1 cylinder to compression top dead center.
   5. Install the O-ring to the fuel supply pump.
   6. Install the fuel supply pump to the front oil pump plate.

   Note :

   ・ Align the alignment marks on the supply pump gear and idle gear B, and install.

   tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

   7. Connect the harness connector to the fuel supply pump.

2. Fuel return pipe installation
   1. Install the fuel return pipe to the fuel supply pump.

   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }
   M10

   tightening torque : 17 N・m { 1.7 kgf・m / 13 lb・ft }
   M14

3. Fuel pipe installation
   1. Temporarily tighten the fuel pipe to the fuel supply pump.
   2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

   Caution :

   ・ Use a new fuel pipe.

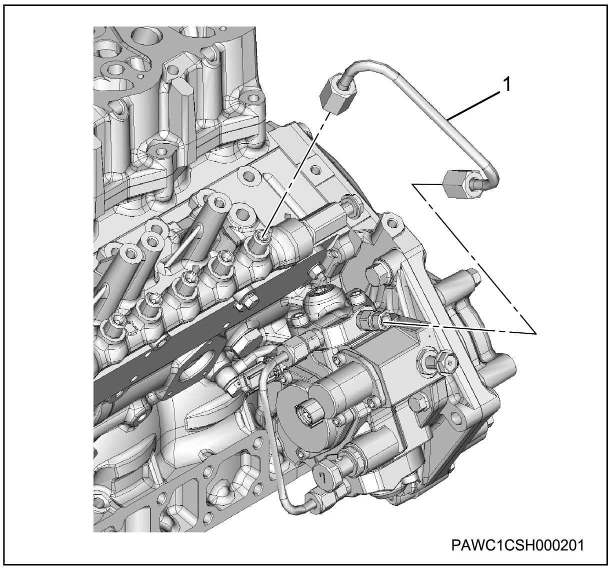
   Note :

   ・ Verify that there is no dirt in the fuel pipe.

   3. Securely tighten the fuel pipe to the fuel supply pump.

4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque： 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

4. Timing gear case installation
   1. Apply liquid gasket to the front oil pump plate.

Note：

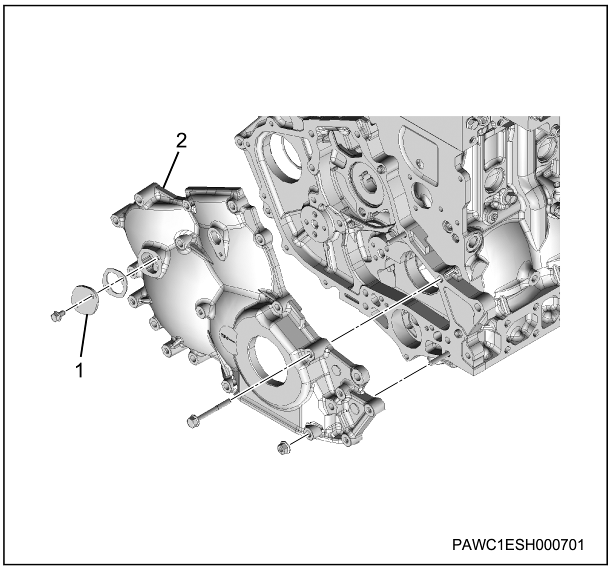
・ Apply ThreeBond 1207B.

   2. Install the timing gear case to the front oil pump plate.

tightening torque： 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

   3. Install the idle gear cover to the timing gear case.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Idle gear cover
2. Timing gear case

5. CMP sensor installation
   1. Apply engine oil to the O-ring.
   2. Install the CMP sensor to the timing gear case.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

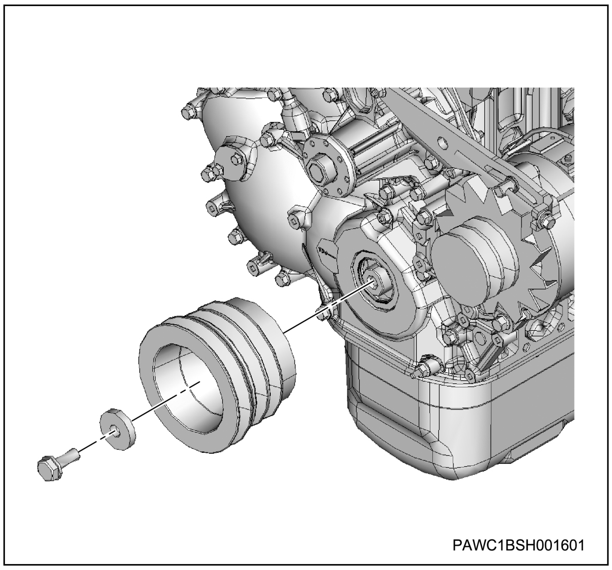
   3. Connect the harness connector to the CMP sensor.

6. Crankshaft pulley installation
   1. Install the crankshaft pulley to the crankshaft.

Caution：

・ Do not reuse the bolt and the washer.

tightening torque： 177 N・m { 18.0 kgf・m / 131 lb・ft }



7. Generator bracket installation
   1. Install the generator bracket to the cylinder block.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft } M8

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft } M10

8. Generator installation
   1. Install the adjust plate to the water pump assembly.

tightening torque： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

   2. Temporarily tighten the generator to the generator bracket.
   3. Temporarily tighten the generator to the adjust plate.

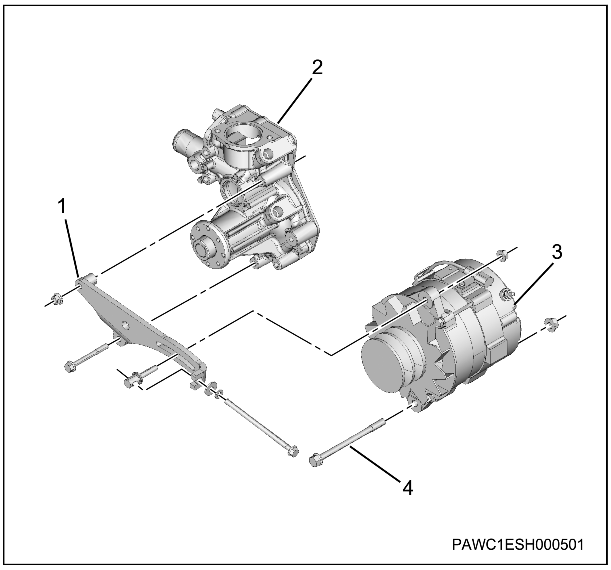
Note：

・ Securely tighten the bolt and the nut after adjusting the cooling fan belt.

   4. Connect the harness connector to the generator.

Note :

- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

9. Fan pulley installation

 1. Install the fan pulley to the water pump assembly.

 tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

10. Cooling fan belt installation

 1. Install the cooling fan belt to the pulley.

11. Cooling fan belt adjustment

 1. Check the tension of the cooling fan belt.

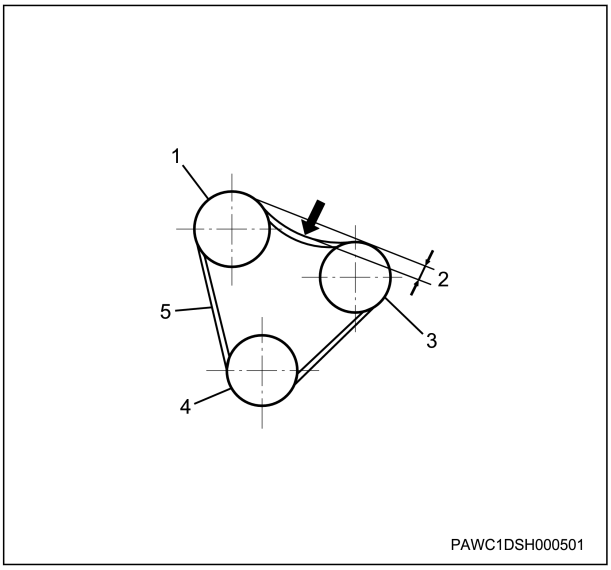
 Note :

 - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

 standard : 98 N { 10.0 kg / 22 lb }

 specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in } New product

 specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in } Reuse

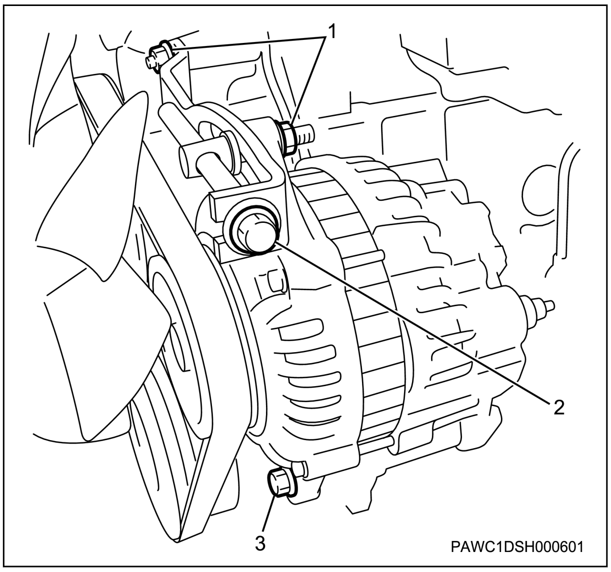


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

 2. Adjust the cooling fan belt to the specified value using the adjust bolt.

 tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

 tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

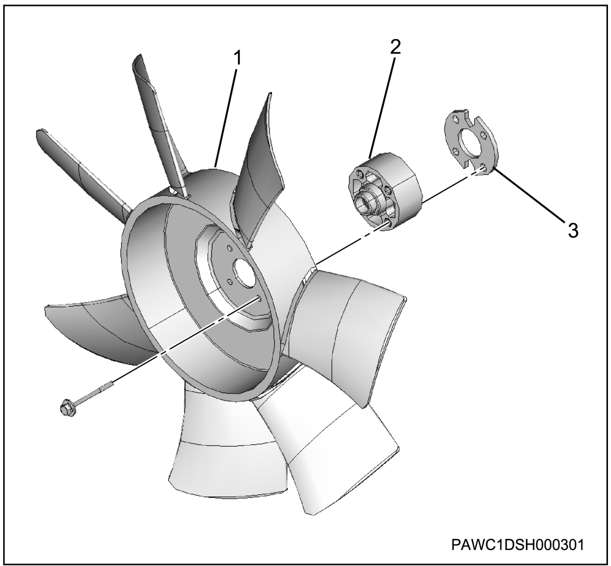


1. Nut
2. Adjust bolt
3. Mounting bolt

12. Cooling fan installation

 1. Install the cooling fan to the fan pulley.

 tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

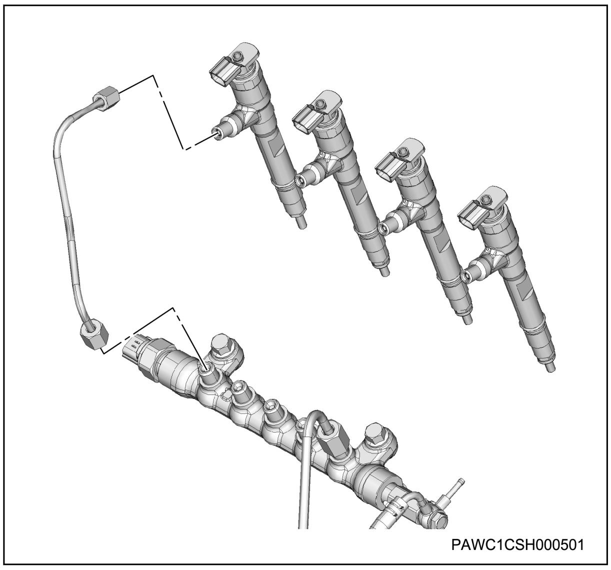
13. Battery ground cable connect
    1. Connect the battery ground cable to the battery.

Common rail assembly

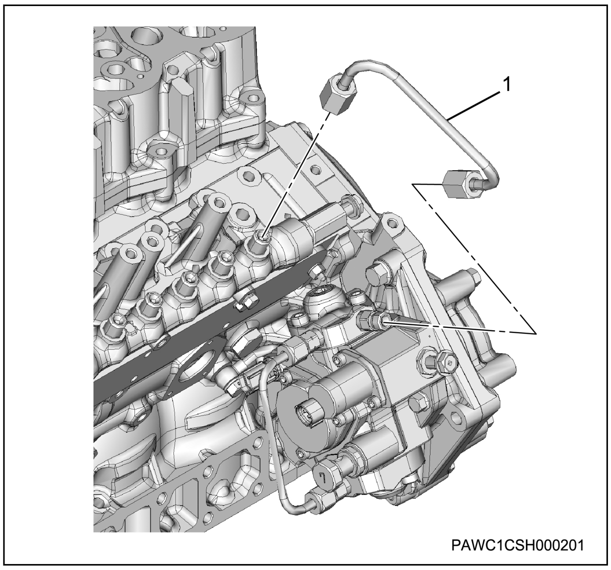
removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Injection pipe removal
   1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

   Note：
   - Do not reuse the injection pipe.

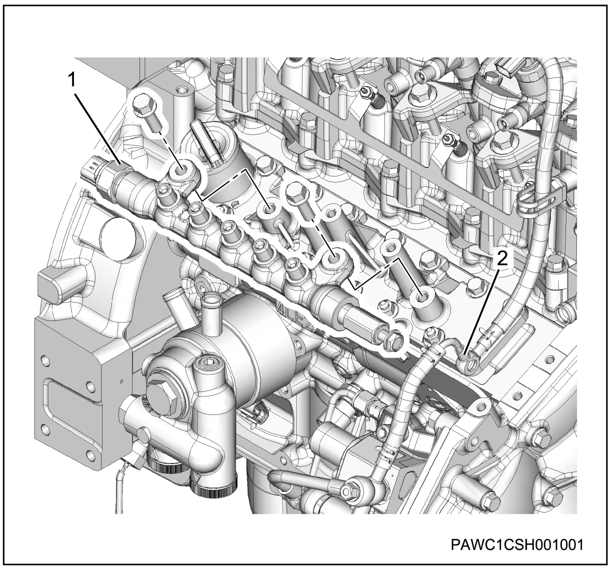


3. Fuel pipe removal
   1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



1. Fuel pipe

4. Common rail assembly removal
   1. Disconnect the harness connector from the common rail (fuel rail) assembly.
   2. Remove the fuel leak-off pipe from the common rail (fuel rail) assembly.
   3. Remove the common rail (fuel rail) assembly from the common rail (fuel rail) bracket.



1. Common rail (fuel rail) assembly
2. Fuel leak-off pipe

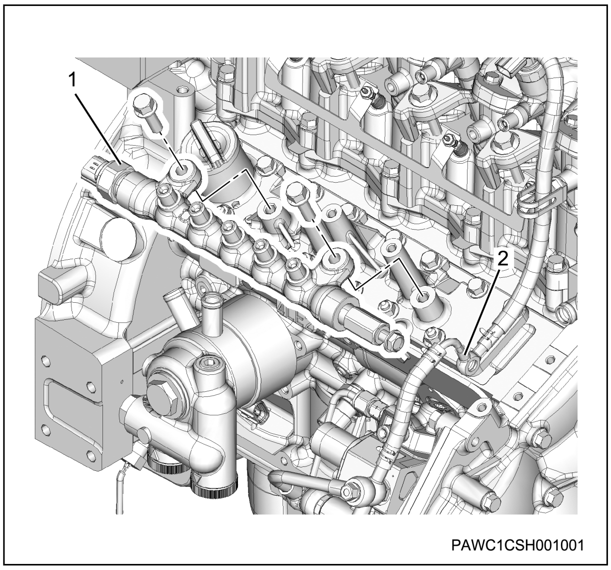
installation

1. Common rail assembly installation
   1. Install the common rail (fuel rail) assembly to the common rail (fuel rail) bracket.

   tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }

   2. Install the fuel leak-off pipe to the common rail (fuel rail) assembly.

   tightening torque : 20 N・m { 2.0 kgf・m / 15 lb・ft }



1. Common rail (fuel rail) assembly
2. Fuel leak-off pipe

   3. Install the harness connector to the common rail (fuel rail) assembly.

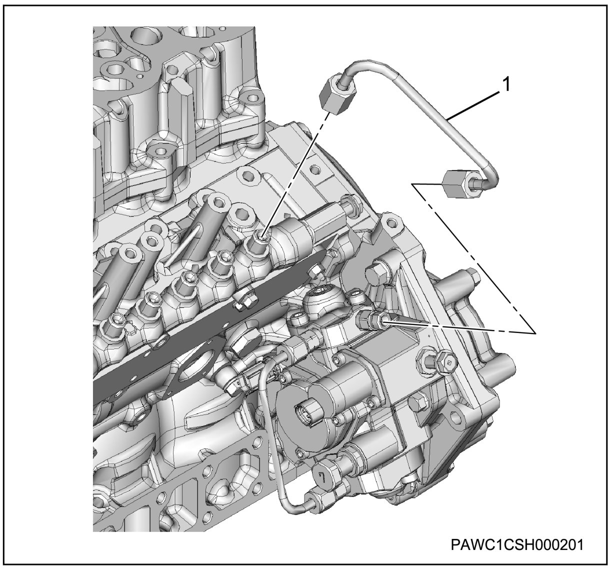
2. Fuel pipe installation
   1. Temporarily tighten the fuel pipe to the fuel supply pump.
   2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

   Caution :
   - Use a new fuel pipe.

   Note :
   - Verify that there is no dirt in the fuel pipe.

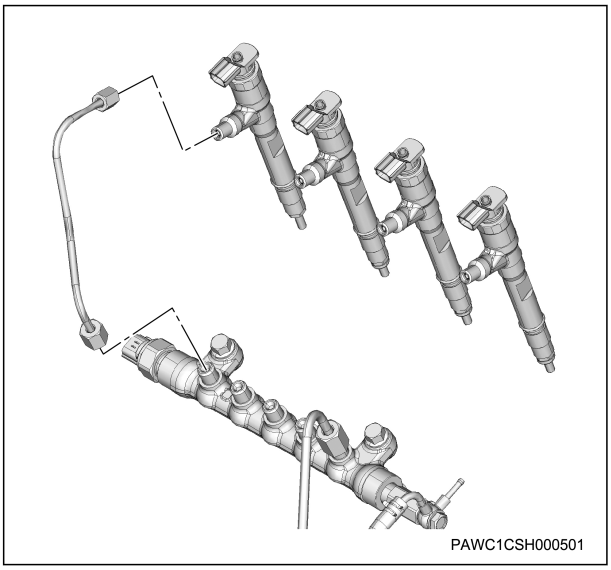
   3. Securely tighten the fuel pipe to the fuel supply pump.
   4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

   tightening torque : 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

3. Injection pipe installation
   1. Install the injection pipe to the injector and the common rail (fuel rail) assembly.



tightening torque : 25 N・m { 2.5 kgf・m / 18 lb・ft }
Injector side

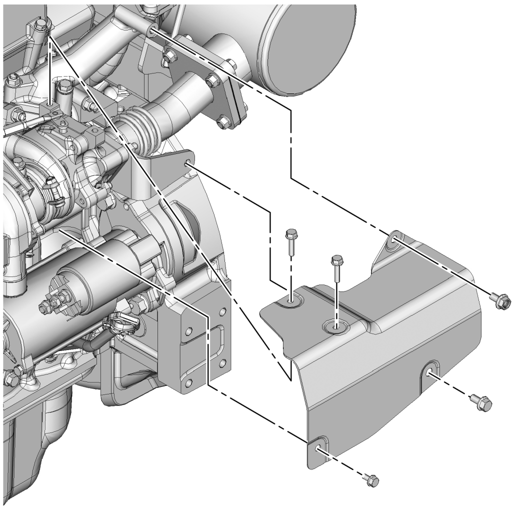
tightening torque : 30 N・m { 3.1 kgf・m / 22 lb・ft }
Common rail (fuel rail) side

4. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Injector

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Turbocharger heat protector removal
   1. Remove the turbocharger heat protector from the turbocharger.

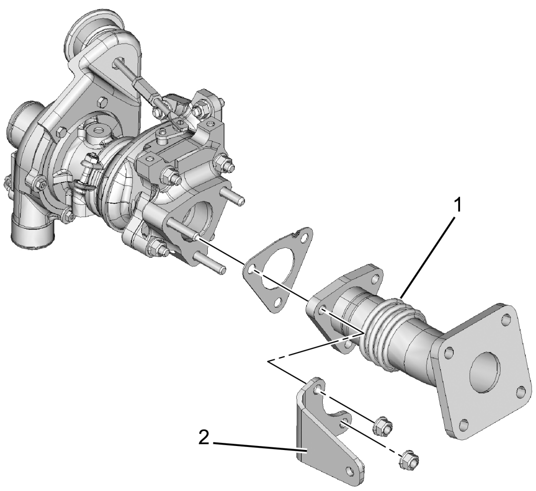


PAWC1BSH001101

3. Integrated oxidation catalyst silencer removal
   1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
   2. Remove the exhaust pipe from the turbocharger assembly.

Note :

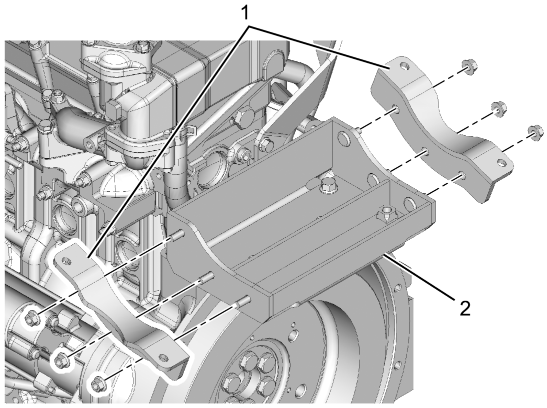
- Remove together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

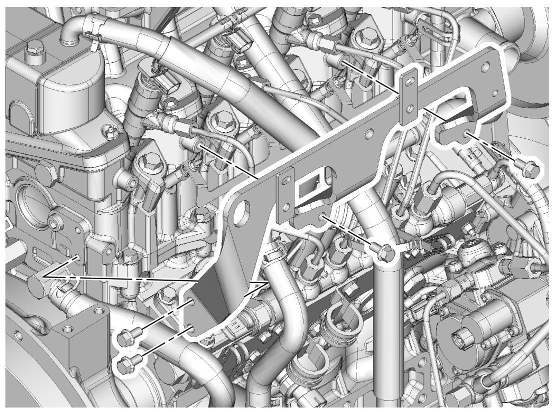
3. Remove the support bracket from the silencer bracket.



PAWC1GSH000201

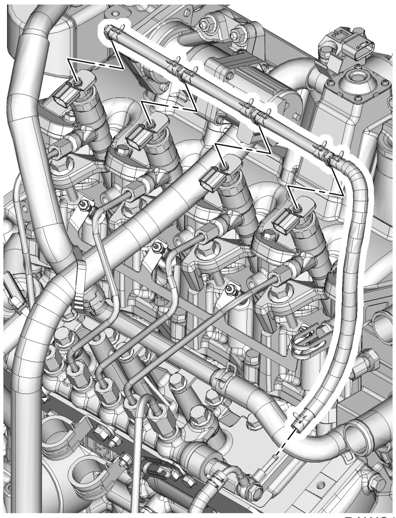
1. Support bracket
2. Silencer bracket

4. Harness bracket removal
   1. Disconnect the engine harness from the harness bracket.
   2. Remove the harness bracket from the cylinder head.



PAWC1CSH000301

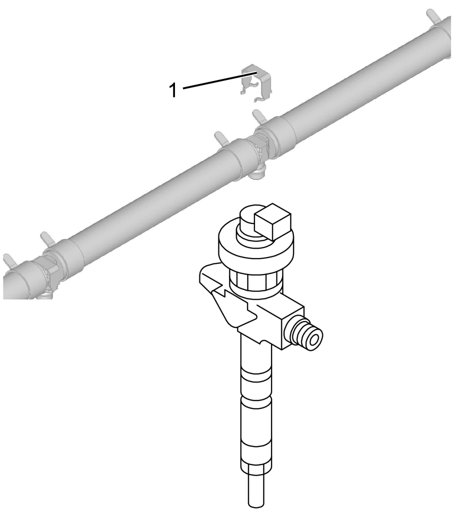
5. Fuel leak-off hose removal
   1. Remove the fuel leak-off hose from the injector.



PAWC1CSH000401

Note：

- Do not reuse the leak-off pipe clip.



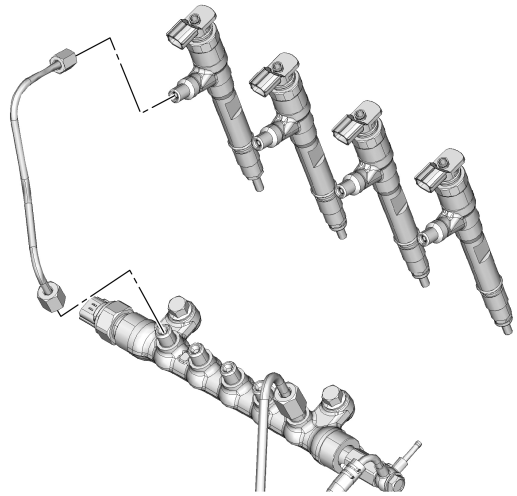
LNW76ASH002101

1. Clip

6. Injection pipe removal
   1. Remove the injection pipe from the injector and the common rail (fuel rail) assembly.

Note：

- Do not reuse the injection pipe.

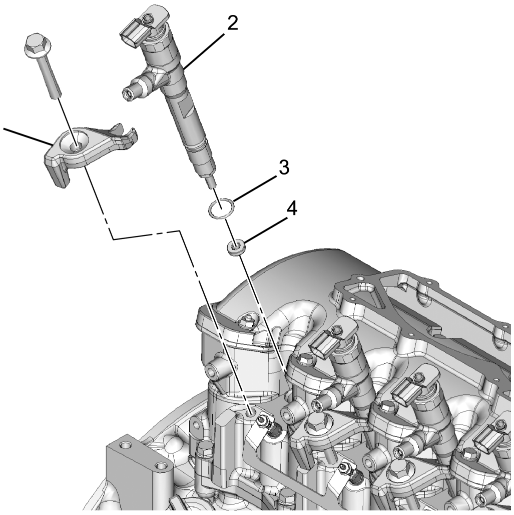


PAWC1CSH000501

7. Injector removal
   1. Disconnect the harness connector from the injector.
   2. Remove the injector from the cylinder head assembly.
   3. Remove the injector gasket from the injector.
   4. Remove the O-ring from the injector.

Note：

- Do not reuse the injector gasket or the O-ring.



PAWC1CSH000601

1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Note：

- Absolutely never touch the injector solenoid because doing so can hinder performance or cause damage.

- Store the removed injector with the cylinder number on it.

installation

1. Injector installation

Caution：

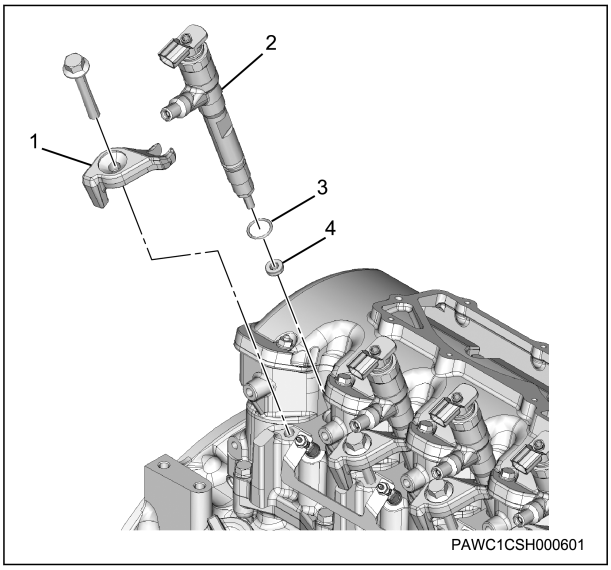
- Do not change the installation position of the injectors when reusing the injectors.

1. Install the O-ring to the injector.
2. Install the injector gasket to the injector.

Note：

- Do not reuse the injector gasket or the O-ring.

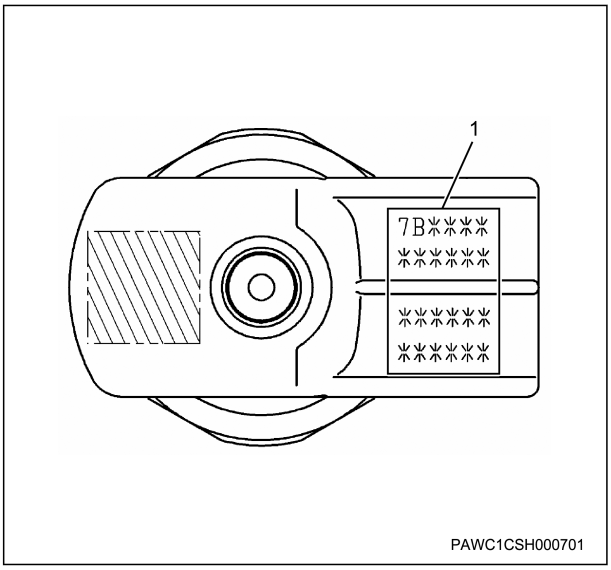
3. Temporarily tighten the injector to the cylinder head assembly.



1. Injector clamp
2. Injector
3. O-ring
4. Injector gasket

Caution：

- If the injector has been replaced, record the injector ID code of the new injector.



1. Injector ID code

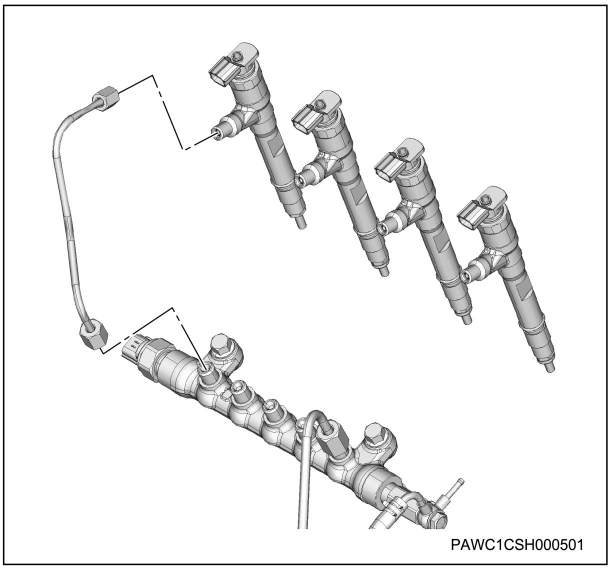
4. Connect the harness connector to the injector.

2. Injection pipe installation

1. Temporarily tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

- Do not reuse the injection pipe.



2. Securely tighten the injector to the cylinder head assembly.

tightening torque： 37 N・m { 3.8 kgf・m / 27 lb・ft }

3. Securely tighten the injection pipe to the injector and the common rail (fuel rail) assembly.

Note：

- Securely tighten the injector side.

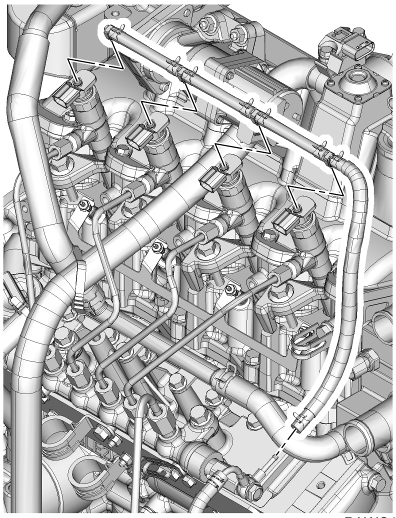
tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

Note：

- Securely tighten the common rail (fuel rail) side.

tightening torque： 30 N・m { 3.1 kgf・m / 22 lb・ft }

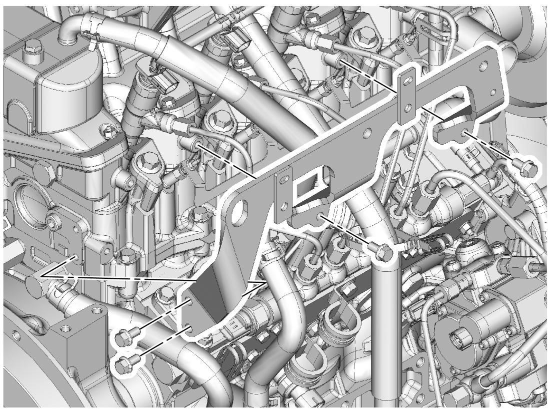
3. Fuel leak-off hose installation
   1. Install the fuel leak-off hose to the injector.



PAWC1CSH000401

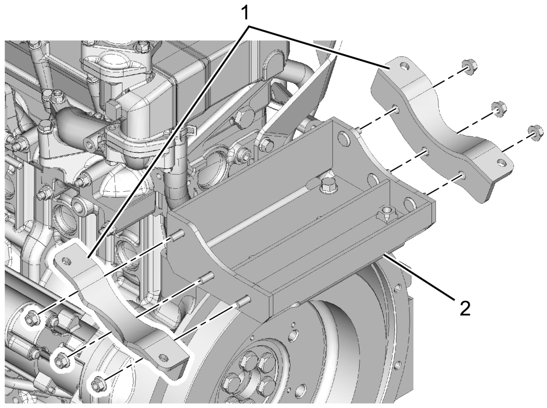
4. Harness bracket installation
   1. Install the harness bracket to the cylinder head.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }



PAWC1CSH000301

   2. Connect the engine harness to the harness bracket.
5. Integrated oxidation catalyst silencer installation
   1. Temporarily tighten the support bracket to the silencer bracket.



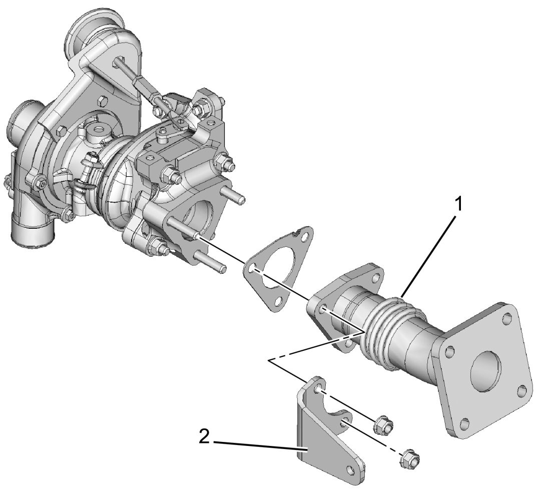
PAWC1GSH000201

1. Support bracket
2. Silencer bracket

   2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

- Install together with the bracket.



PAWC1GSH000101

1. Exhaust pipe
2. Bracket

   3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
   4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

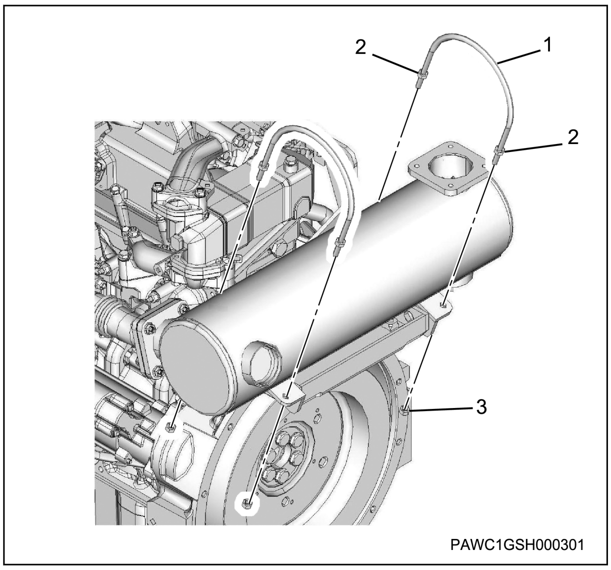
- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.

- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

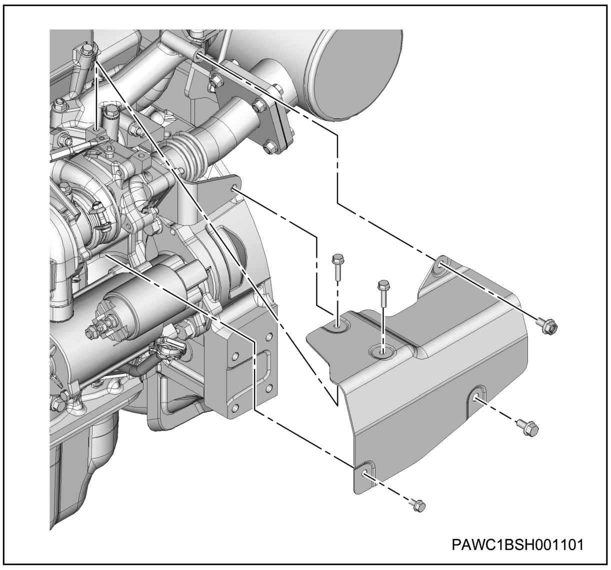
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

6. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M6



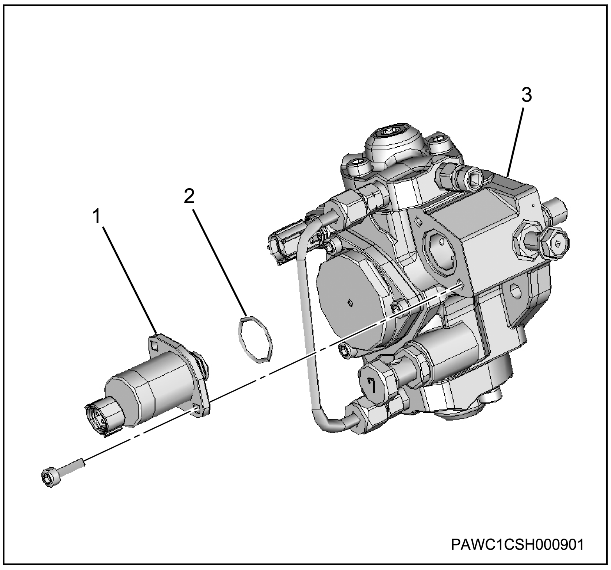
7. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Suction control valve

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Suction control valve removal
   1. Disconnect the harness connector from the suction control valve.
   2. Remove the suction control valve from the fuel supply pump.
   3. Remove the O-ring from the fuel supply pump.



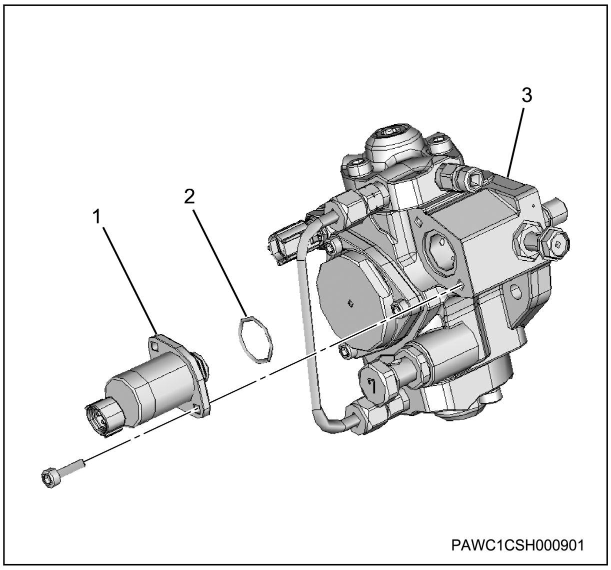
1. Suction control valve
2. O-ring
3. Fuel supply pump

installation

1. Suction control valve installation
   1. Install the O-ring to the fuel supply pump.
   2. Install the suction control valve to the fuel supply pump.

   tightening torque : 9 N・m { 0.9 kgf・m / 80 lb・in }

   3. Connect the harness connector to the suction control valve.



1. Suction control valve
2. O-ring
3. Fuel supply pump

2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

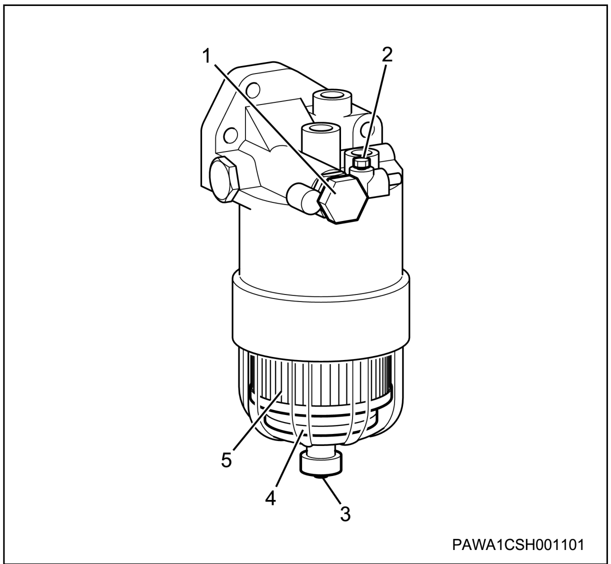
Fuel filter

removal

1. Fuel filter removal
   1. Disconnect the harness connector from the fuel sedimenter switch.
   2. Remove the fuel feed hose from the fuel filter.

      Caution：
      - To prevent fuel outflow, be sure to plug the disconnected hose.
   3. Remove the fuel return hose from the fuel filter.

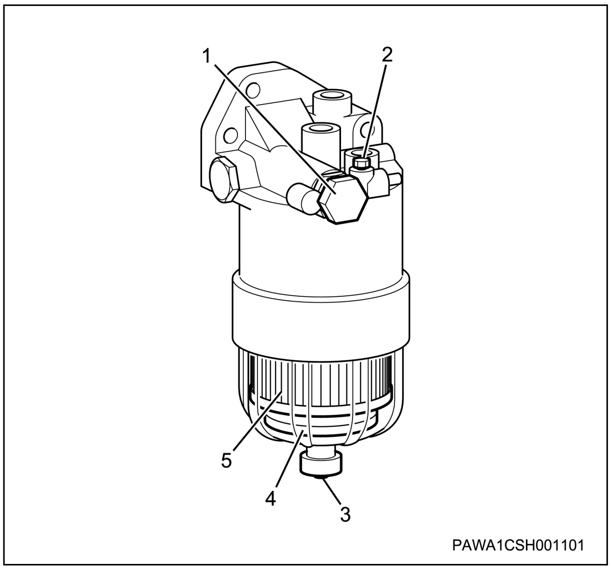
      Caution：
      - To prevent fuel outflow, be sure to plug the disconnected hose.
   4. Remove the fuel filter from the engine.



1. Priming pump
2. Plug
3. Drain plug
4. Case
5. Fuel filter element

installation

1. Fuel filter installation
   1. Install the fuel filter to the engine.
   2. Install the fuel return hose to the fuel filter.
   3. Install the fuel feed hose to the fuel filter.
   4. Connect the harness connector to the fuel sedimenter switch.



1. Priming pump
2. Plug
3. Drain plug
4. Case
5. Fuel filter element

2. Fuel filter air bleed
   1. Loosen the plug using a wrench.
   2. Operate the priming pump.

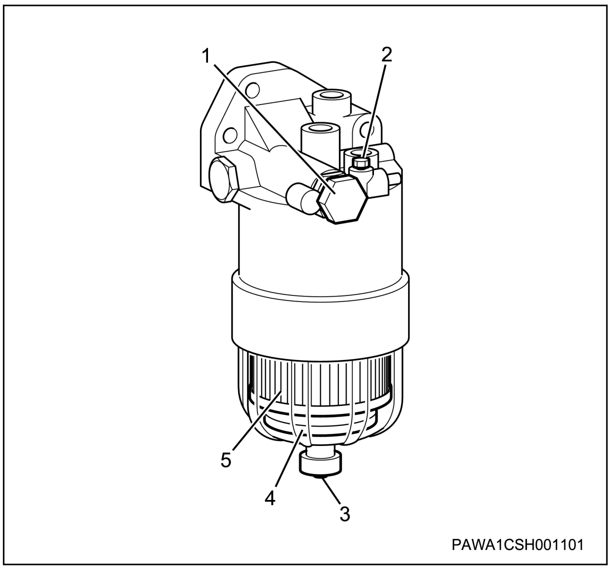
   Note：
   - Press the priming pump until it becomes hard.

   3. Tighten the plug using a wrench.

   tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

   4. Operate the priming pump.

   Note：
   - Operate until the opening sound of the overflow valve is heard.



1. Priming pump
2. Plug
3. Drain plug
4. Case
5. Fuel filter element

Fuel temperature sensor

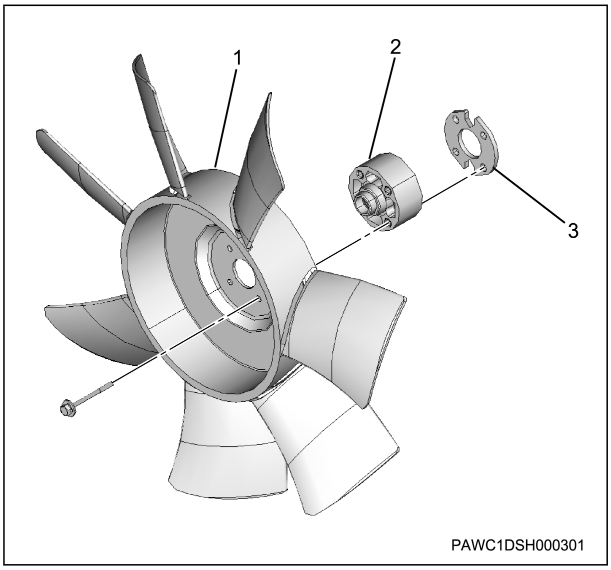
removal

1. Fuel temperature sensor safety information

Caution :

- Add a cleaning agent to the steam cleaner and thoroughly clean the sensor and the supply pump areas.
- Completely remove moisture with an air blower.
- Start work after checking that all foreign material has been removed.
- After starting the engine, verify that there is no fuel leakage.
- After replacing, verify that the trouble code is cleared and that the operations are normal with a scan tool.

2. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



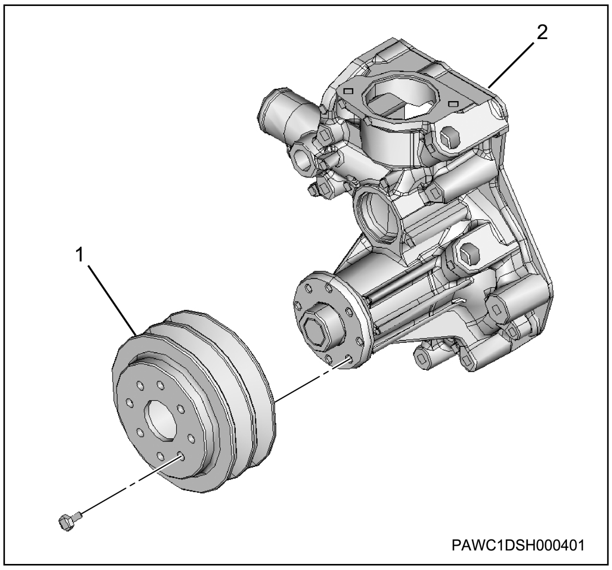
1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

Note :

- Loosen the generator adjust bolt and remove the belt.

5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

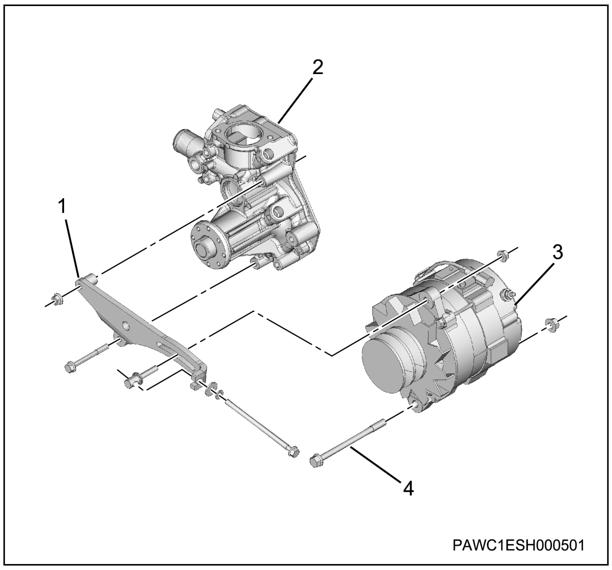


1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

Note :

- The diagram shows the 24 V - 50 A specification.



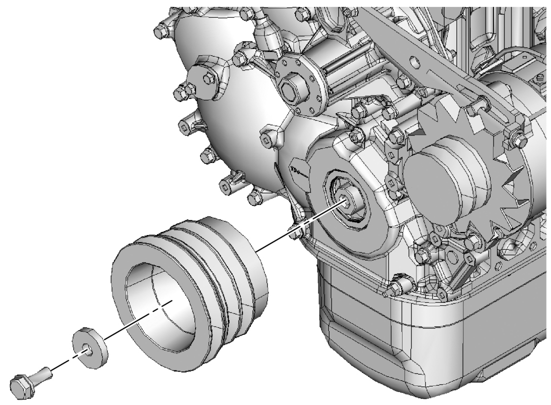
1. Adjust plate
2. Water pump assembly
3. Generator

4. Bolt

7. Generator bracket removal
   1. Remove the generator bracket from the cylinder block.
8. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

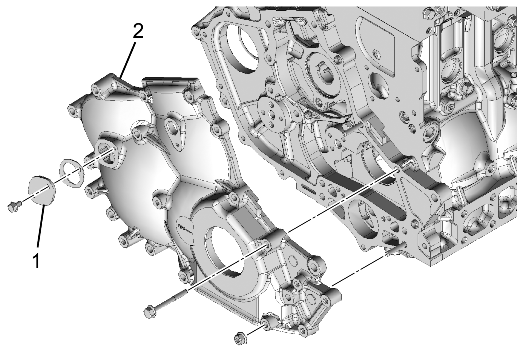
Note :
- Remove after stopping the crankshaft from turning.

Caution :
- Do not reuse the bolt and the washer.



PAWC1BSH001601

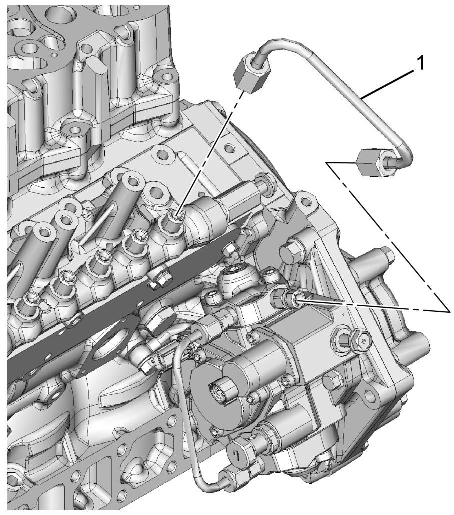
9. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.
   3. Remove the O-ring from the CMP sensor.
10. Timing gear case removal
    1. Remove the idle gear cover from the timing gear case.
    2. Remove the timing gear case from the front oil pump plate.



PAWC1ESH000701

1. Idle gear cover
2. Timing gear case

11. Fuel pipe removal
    1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.



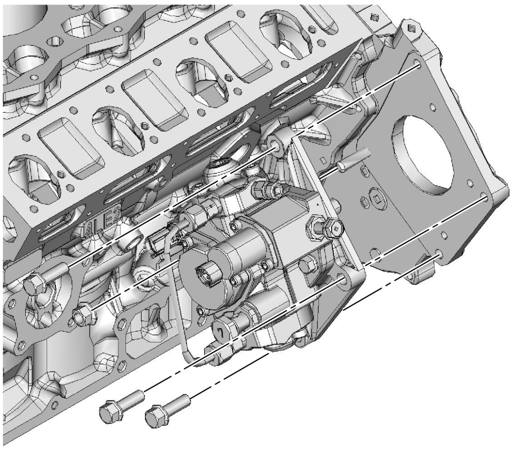
PAWC1CSH000201

1. Fuel pipe

12. Fuel return pipe removal
    1. Remove the fuel return pipe from the fuel supply pump.
13. Fuel supply pump removal
    1. Disconnect the harness connector from the fuel supply pump.
    2. Remove the fuel supply pump from the front oil pump plate.

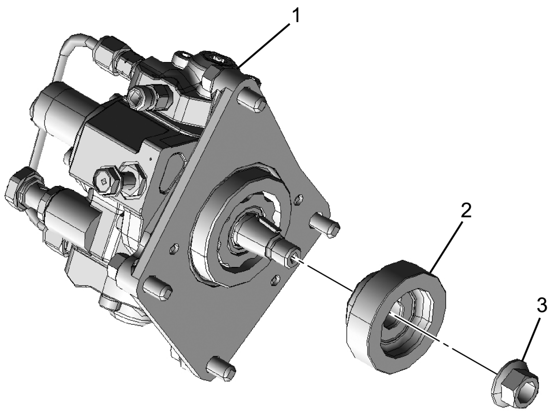
Note：

- Remove the tightening bolts, and remove together with the bracket.



PAWC1CSH000101

3. Remove the supply pump gear from the fuel supply pump.



PAWC1CSH001401

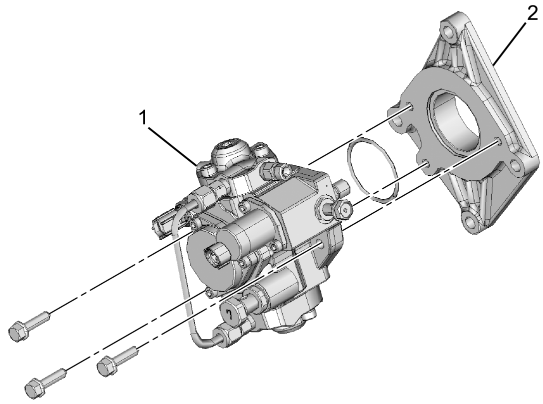
1. Fuel supply pump
2. Supply pump gear
3. Nut

4. Remove the fuel supply pump from the supply pump bracket.

Caution：

- Do not hold the high pressure pipe of the pump when removing the fuel supply pump.

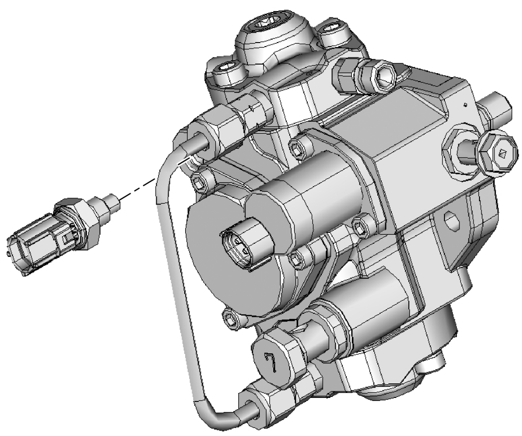
5. Remove the O-ring from the fuel supply pump.



PAWC1CSH000801

1. Fuel supply pump
2. Supply pump bracket

14. Fuel temperature sensor removal
    1. Disconnect the harness connector from the fuel temperature sensor.
    2. Remove the fuel temperature sensor from the fuel supply pump.

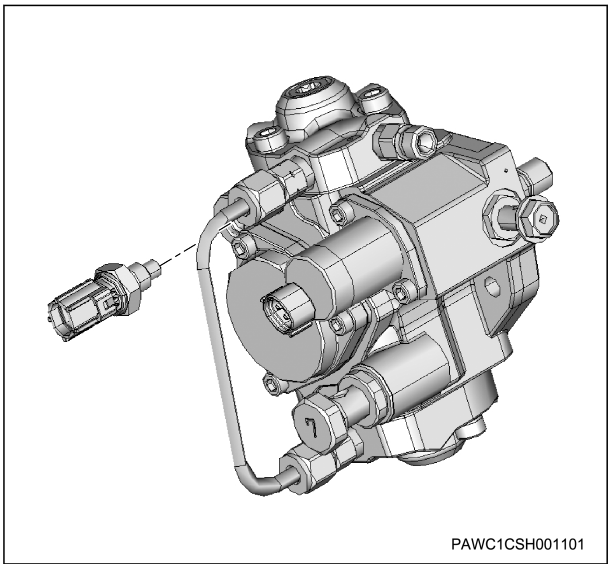


PAWC1CSH001101

installation

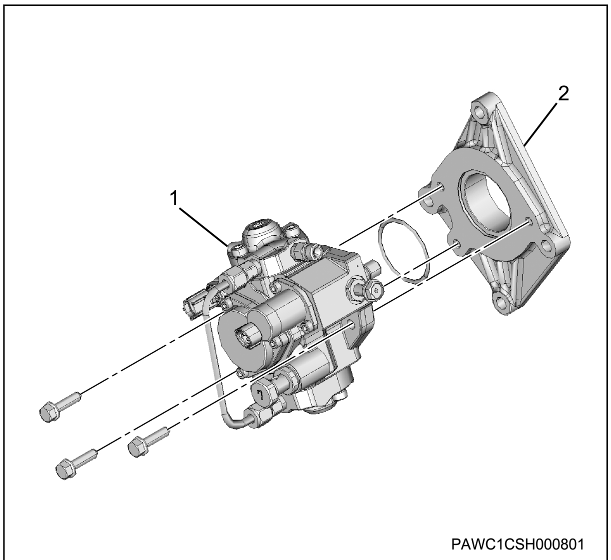
1. Fuel temperature sensor installation
   1. Install the fuel temperature sensor to the fuel supply pump.

   tightening torque : 22 N・m { 2.2 kgf・m / 16 lb・ft }



   2. Connect the harness connector to the fuel temperature sensor.
2. Fuel supply pump installation
   1. Install the O-ring to the fuel supply pump.
   2. Install the fuel supply pump to the supply pump bracket.

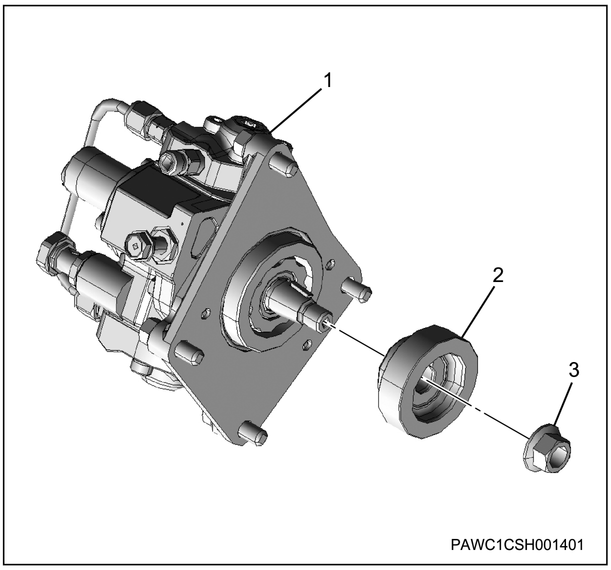
   tightening torque : 19 N・m { 1.9 kgf・m / 14 lb・ft }



   1. Fuel supply pump
   2. Supply pump bracket

   3. Install the supply pump gear to the fuel supply pump.

   tightening torque : 64 N・m { 6.5 kgf・m / 47 lb・ft }



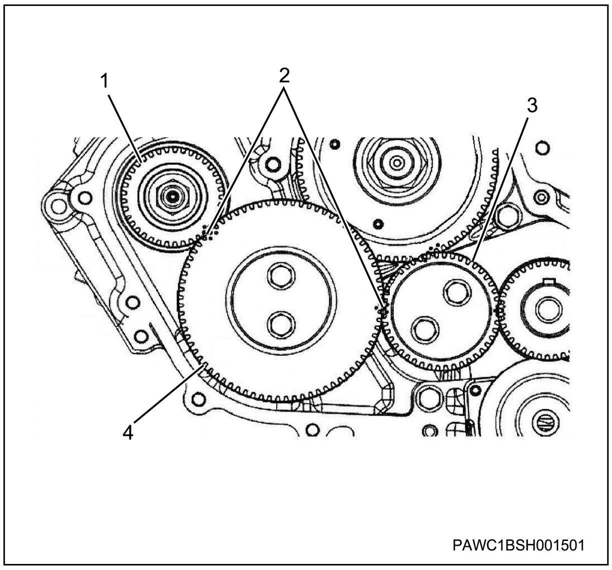
   1. Fuel supply pump
   2. Supply pump gear
   3. Nut

   4. Align the No.1 cylinder to compression top dead center.
   5. Install the O-ring to the fuel supply pump.
   6. Install the fuel supply pump to the front oil pump plate.

Note :

・ Align the alignment marks on the supply pump gear and idle gear B, and install.

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

7. Connect the harness connector to the fuel supply pump.

3. Fuel return pipe installation

1. Install the fuel return pipe to the fuel supply pump.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in } M10

tightening torque： 17 N・m { 1.7 kgf・m / 13 lb・ft } M14

4. Fuel pipe installation

1. Temporarily tighten the fuel pipe to the fuel supply pump.

2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

Caution：

・ Use a new fuel pipe.

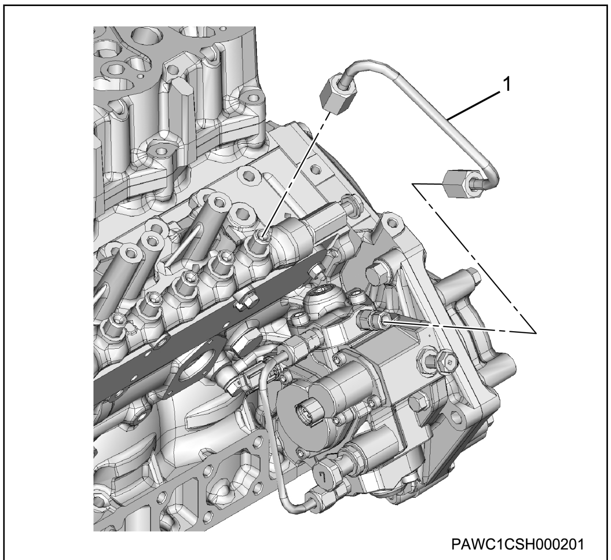
Note：

・ Verify that there is no dirt in the fuel pipe.

3. Securely tighten the fuel pipe to the fuel supply pump.

4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque： 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

5. Timing gear case installation

1. Apply liquid gasket to the front oil pump plate.

Note：

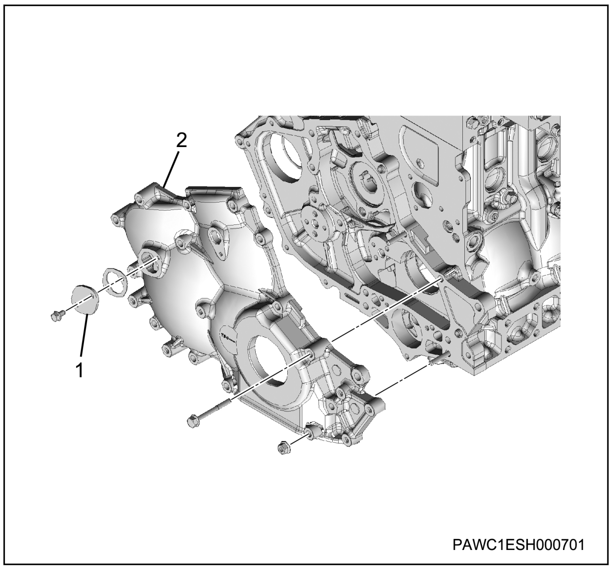
・ Apply ThreeBond 1207B.

2. Install the timing gear case to the front oil pump plate.

tightening torque： 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

3. Install the idle gear cover to the timing gear case.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Idle gear cover
2. Timing gear case

6. CMP sensor installation

1. Apply engine oil to the O-ring.

2. Install the CMP sensor to the timing gear case.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

3. Connect the harness connector to the CMP sensor.

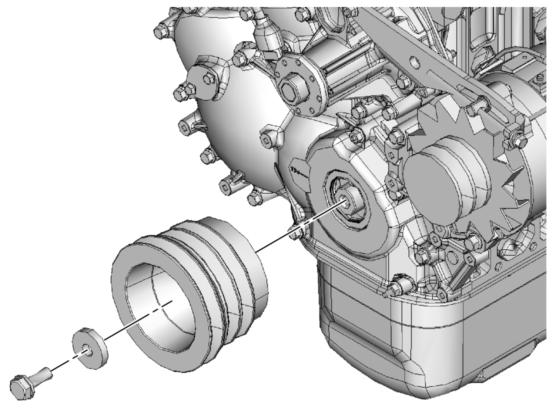
7. Crankshaft pulley installation

1. Install the crankshaft pulley to the crankshaft.

Caution：

・ Do not reuse the bolt and the washer.

tightening torque： 177 N・m { 18.0 kgf・m / 131 lb・ft }



PAWC1BSH001601

8. Generator bracket installation
   1. Install the generator bracket to the cylinder block.

   tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8

   tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10

9. Generator installation
   1. Install the adjust plate to the water pump assembly.

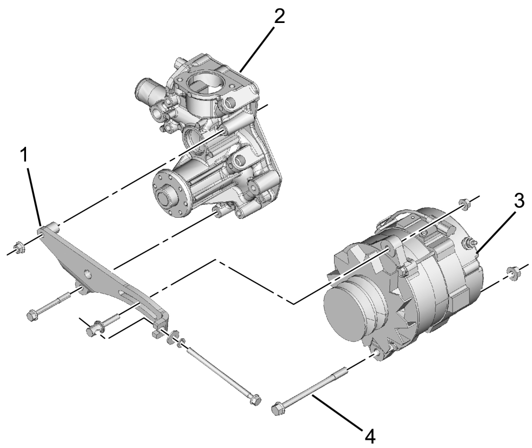
   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

   2. Temporarily tighten the generator to the generator bracket.
   3. Temporarily tighten the generator to the adjust plate.

   Note :
   - Securely tighten the bolt and the nut after adjusting the cooling fan belt.

   4. Connect the harness connector to the generator.

   Note :
   - The diagram shows the 24 V - 50 A specification.



PAWC1ESH000501

1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

---

10. Fan pulley installation
    1. Install the fan pulley to the water pump assembly.

    tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

11. Cooling fan belt installation
    1. Install the cooling fan belt to the pulley.

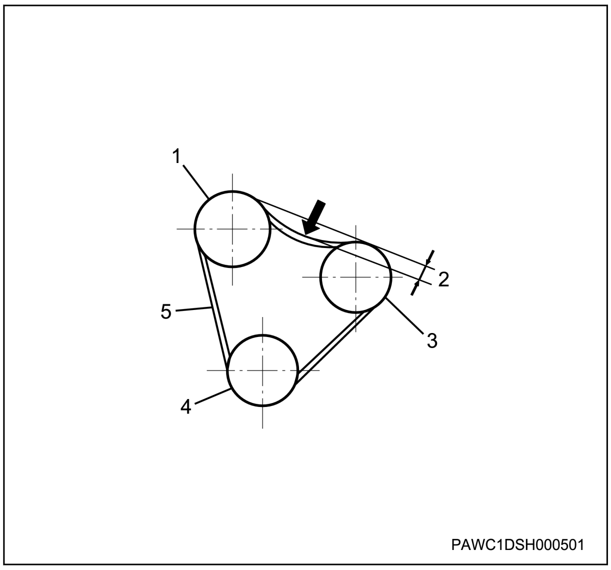
12. Cooling fan belt adjustment
    1. Check the tension of the cooling fan belt.

    Note :
    - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

    standard : 98 N { 10.0 kg / 22 lb }

    specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in } New product

    specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in } Reuse

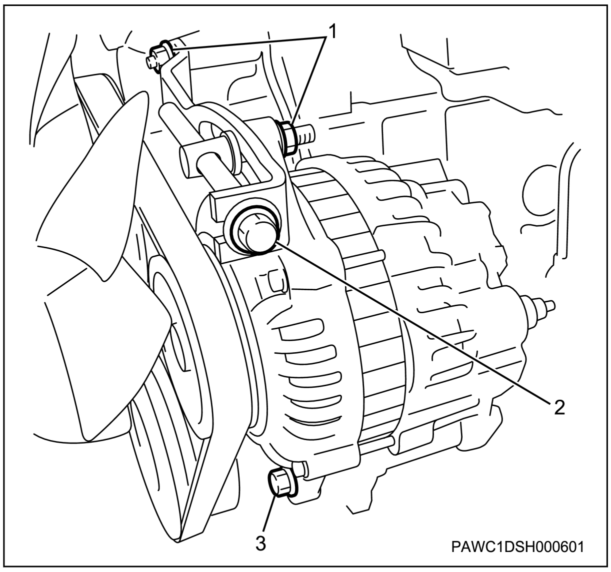


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

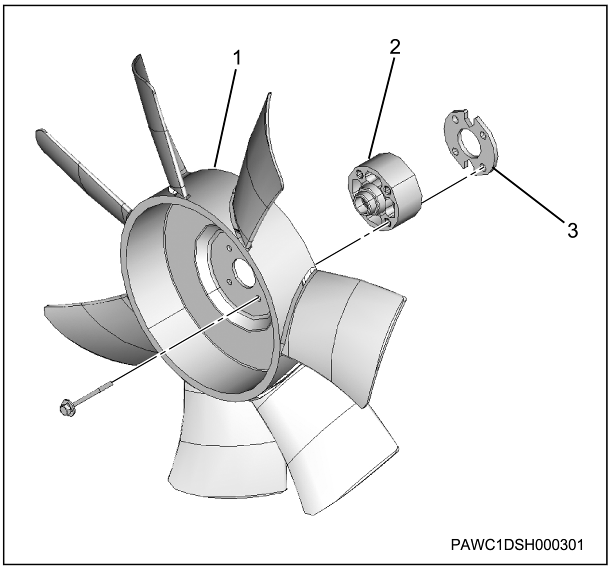


1. Nut
2. Adjust bolt
3. Mounting bolt

13. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

14. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Pressure limiter

removal

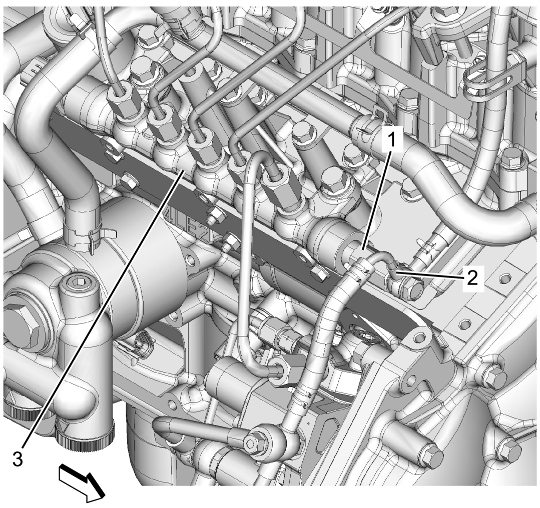
1. Pressure limiter safety information

   Caution :

   - Add a cleaning agent to the steam cleaner and thoroughly clean the pressure limiter and the common rail (fuel rail) assembly areas.
   - Completely remove moisture with an air blower.
   - Start work after checking that all foreign material has been removed.
   - After starting the engine, verify that there is no fuel leakage.

2. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.

3. Pressure limiter removal
   1. Remove the fuel leak-off pipe from the common rail (fuel rail) assembly.
   2. Remove the pressure limiter from the common rail (fuel rail) assembly.



1. Pressure limiter
2. Fuel leak-off pipe
3. Common rail (fuel rail) assembly

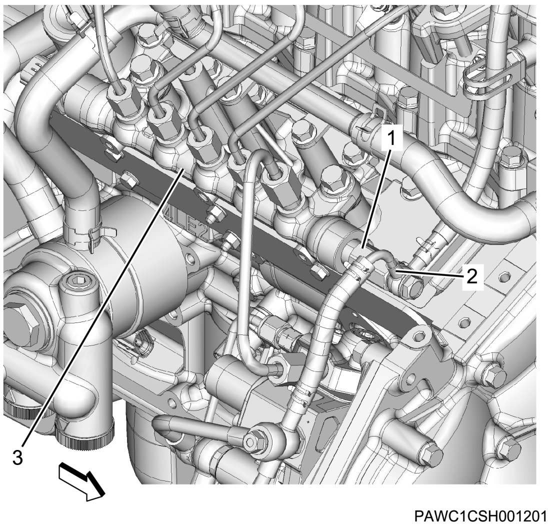
installation

1. Pressure limiter installation
   1. Install the pressure limiter to the common rail (fuel rail) assembly.

   tightening torque : 172 N・m { 17.5 kgf・m / 127 lb・ft }

   2. Install the fuel leak-off pipe to the common rail (fuel rail) assembly.

   tightening torque : 20 N・m { 2.0 kgf・m / 15 lb・ft }



1. Pressure limiter
2. Fuel leak-off pipe
3. Common rail (fuel rail) assembly

2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Fuel pressure sensor

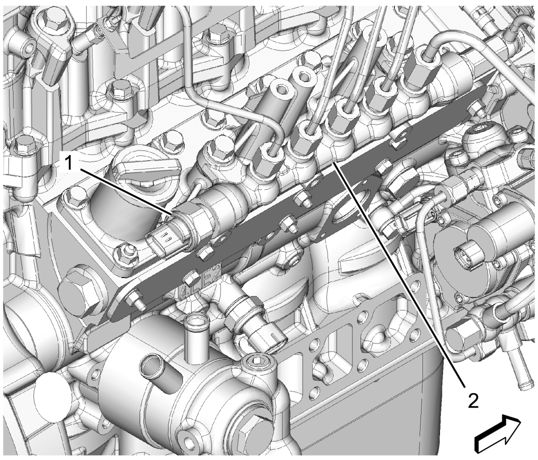
removal

1. Fuel pressure sensor safety information

Caution :

- Add a cleaning agent to the steam cleaner and thoroughly clean the sensor and common rail (fuel rail) assembly areas.
- Completely remove moisture with an air blower.
- Start work after checking that all foreign material has been removed.
- After starting the engine, verify that there is no fuel leakage.
- After replacing, verify that the trouble code is cleared and that the operations are normal with a scan tool.

2. Battery ground cable disconnect
    1. Disconnect the battery ground cable from the battery.
3. Fuel pressure sensor removal
    1. Disconnect the harness connector from the FRP sensor.
    2. Remove the FRP sensor from the common rail (fuel rail) assembly.



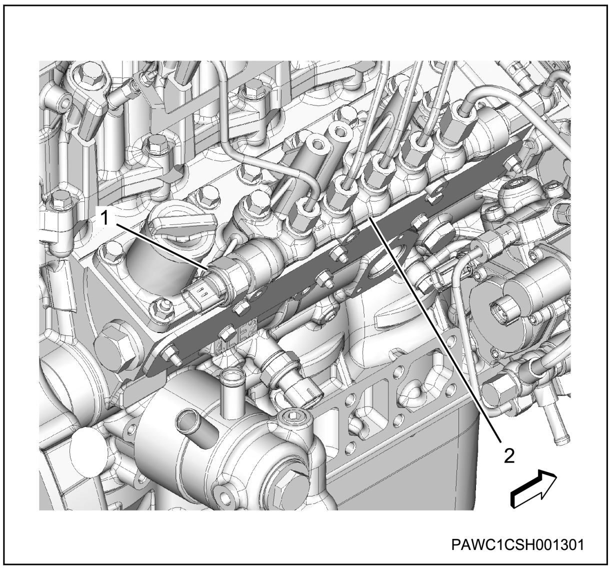
PAWC1CSH001301

1. FRP sensor
2. Common rail (fuel rail) assembly

installation

1. Fuel pressure sensor installation
   1. Install the FRP sensor to the common rail (fuel rail) assembly.

   tightening torque : 98 N・m { 10.0 kgf・m / 72 lb・ft }



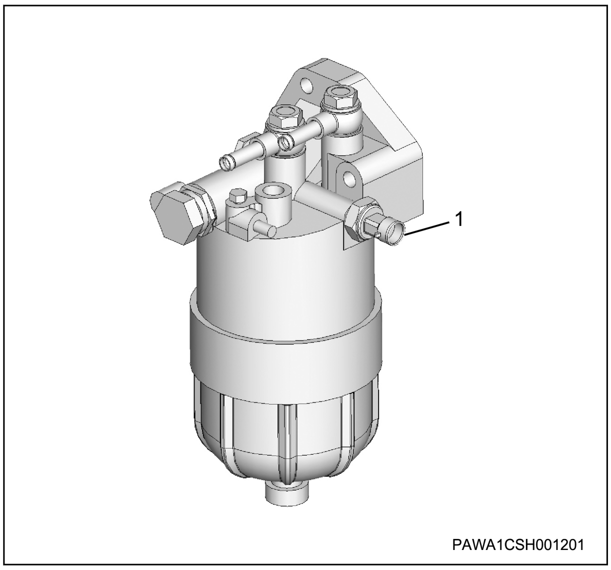
1. FRP sensor
2. Common rail (fuel rail) assembly

   2. Connect the harness connector to the FRP sensor.
2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Fuel filter pressure sensor

removal

1. Fuel filter pressure sensor removal
   1. Disconnect the harness connector from the FRP sensor.
   2. Remove the fuel filter pressure sensor from the fuel filter.

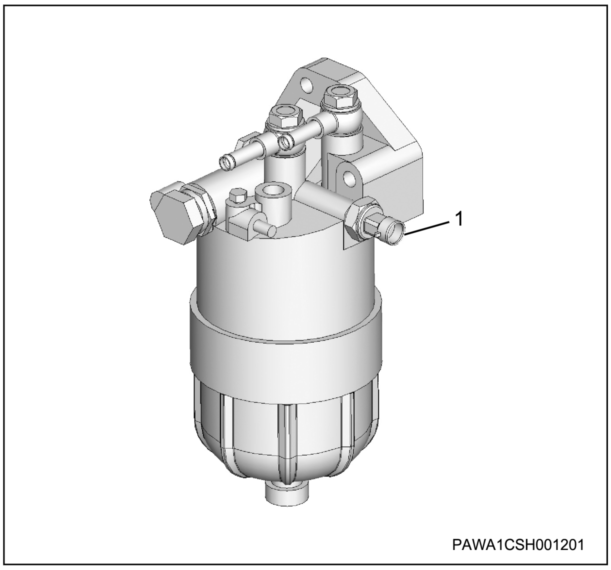


1. Fuel filter pressure sensor

installation

1. Fuel filter pressure sensor installation
   1. Install the fuel filter pressure sensor to the fuel filter.

   tightening torque : 12 N・m { 1.2 kgf・m / 106 lb・in }



1. Fuel filter pressure sensor

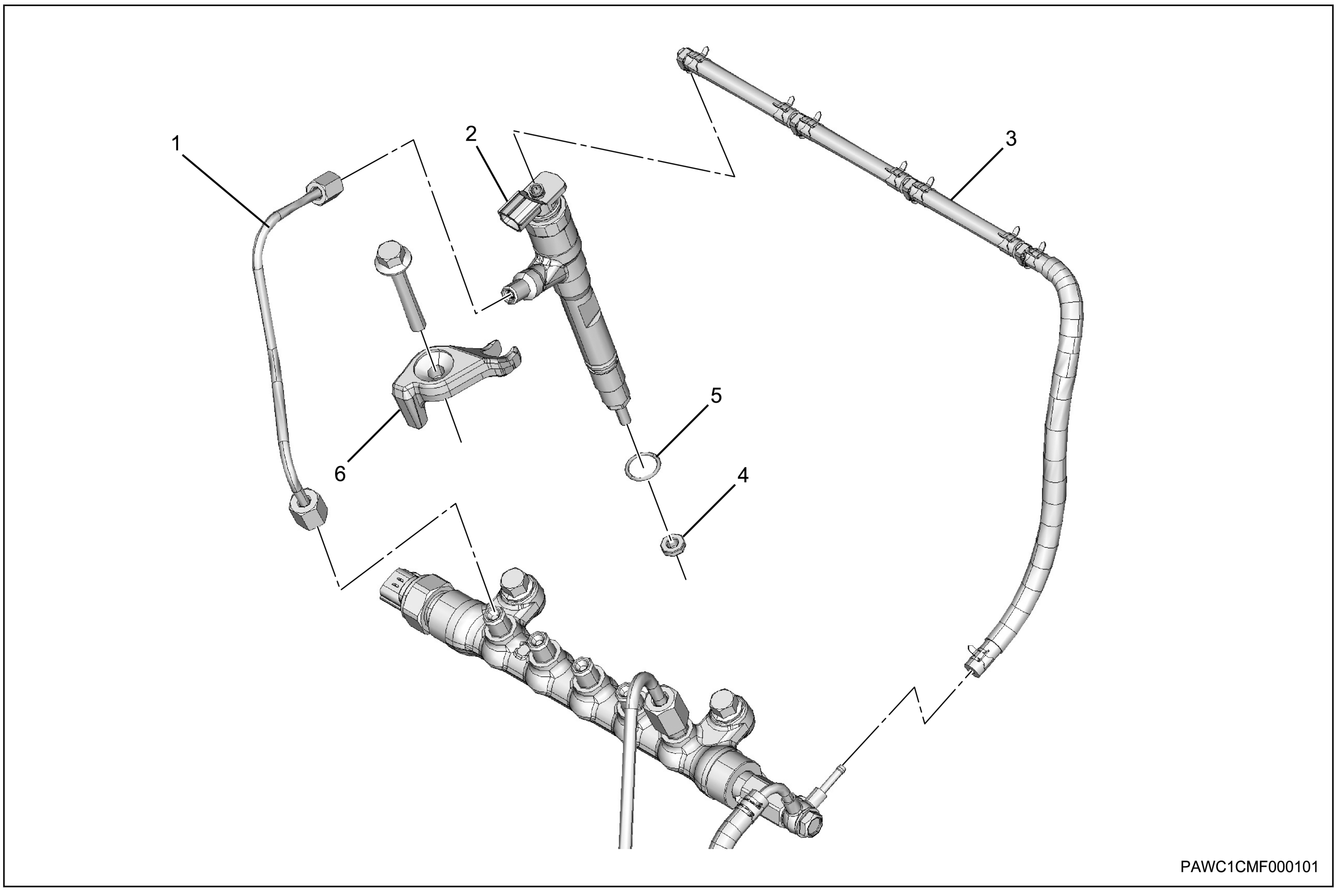
   2. Connect the harness connector to the FRP sensor.

Supplementary Information

1. Component Views

Note：

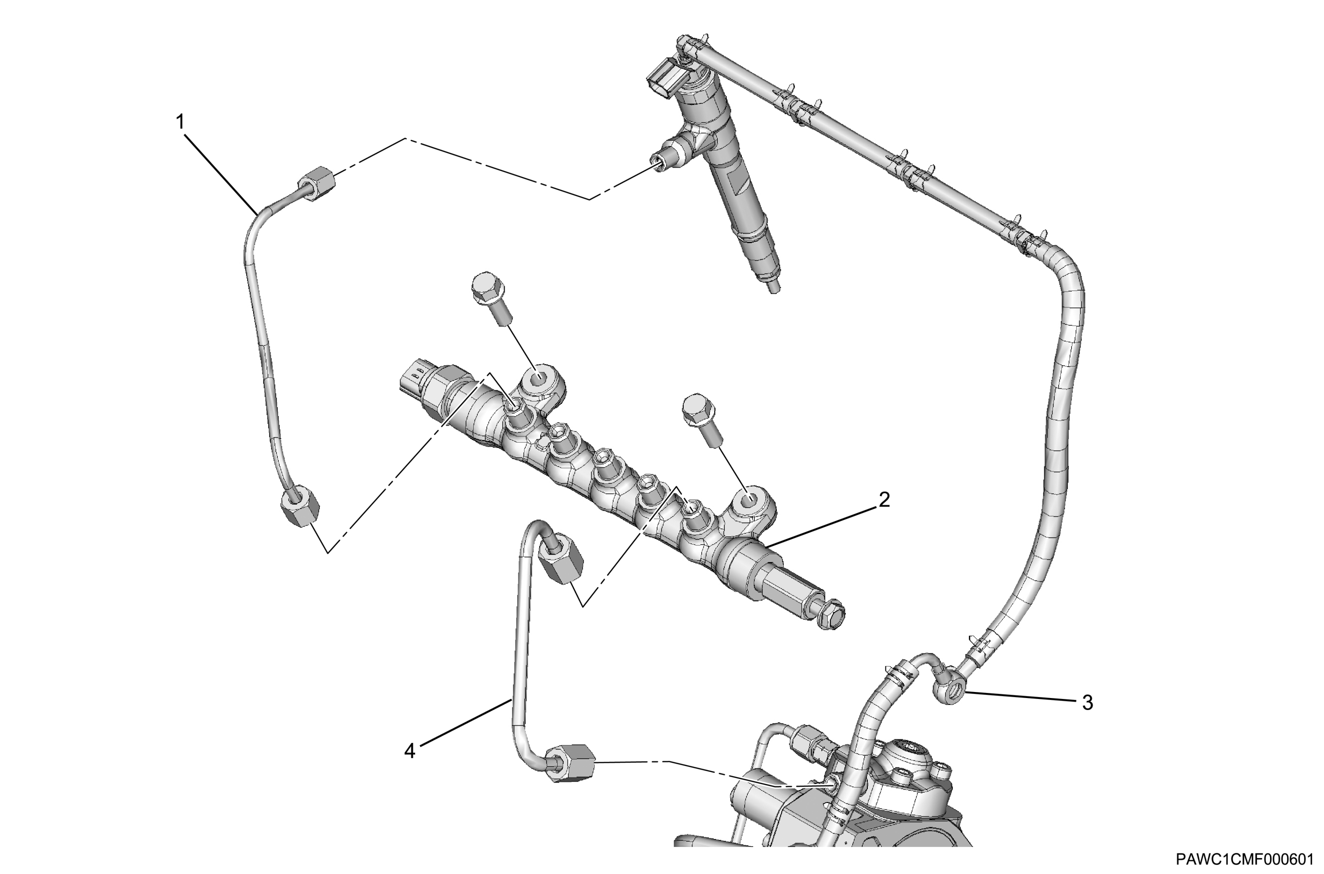
- Injector



1. Injection pipe
2. Injector
3. Fuel leak-off hose
4. Injector gasket
5. O-ring
6. Injector clamp

Note：

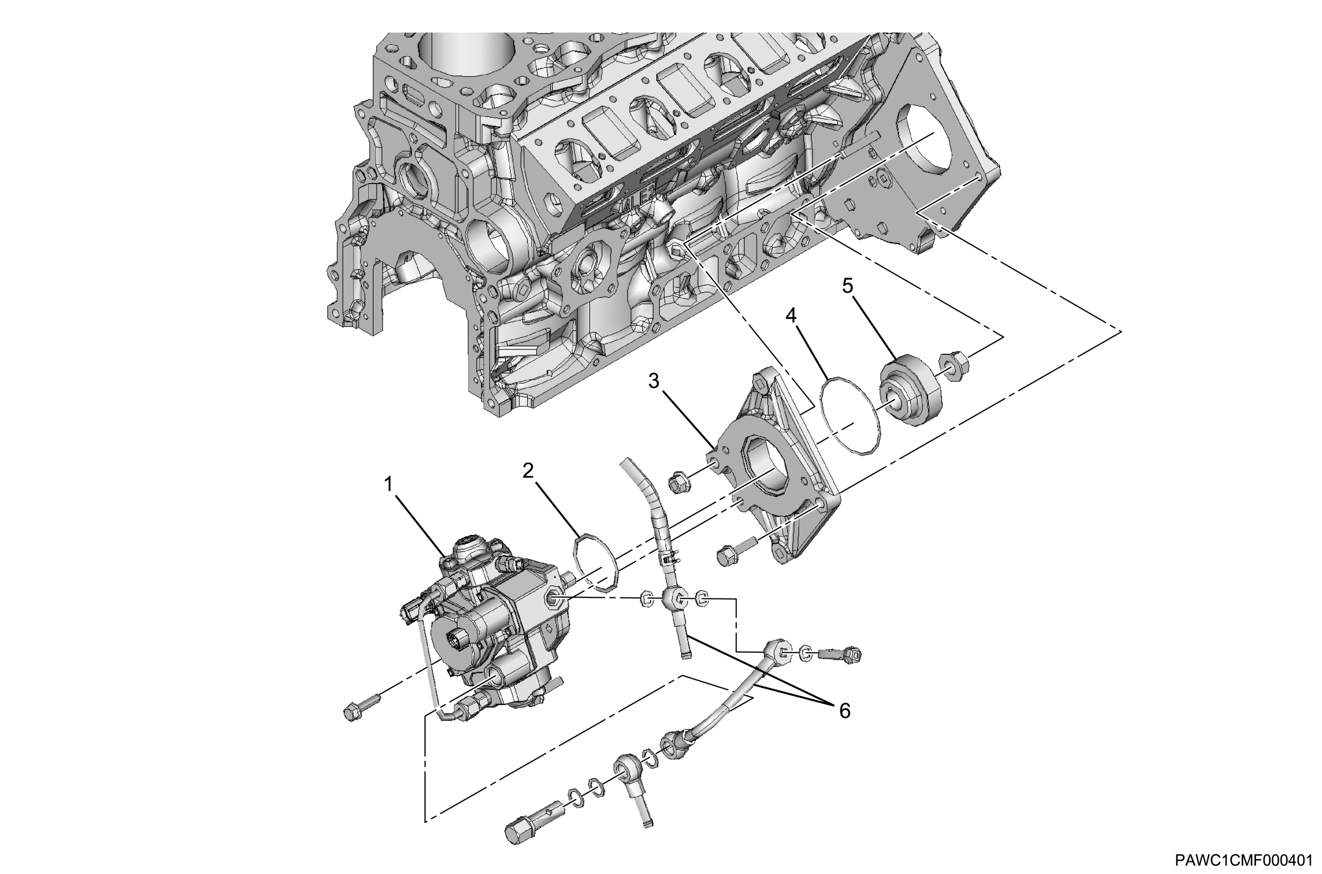
- Common rail (fuel rail) assembly



1. Injection pipe
2. Common rail (fuel rail) assembly
3. Fuel leak-off pipe
4. Fuel pipe

Note：

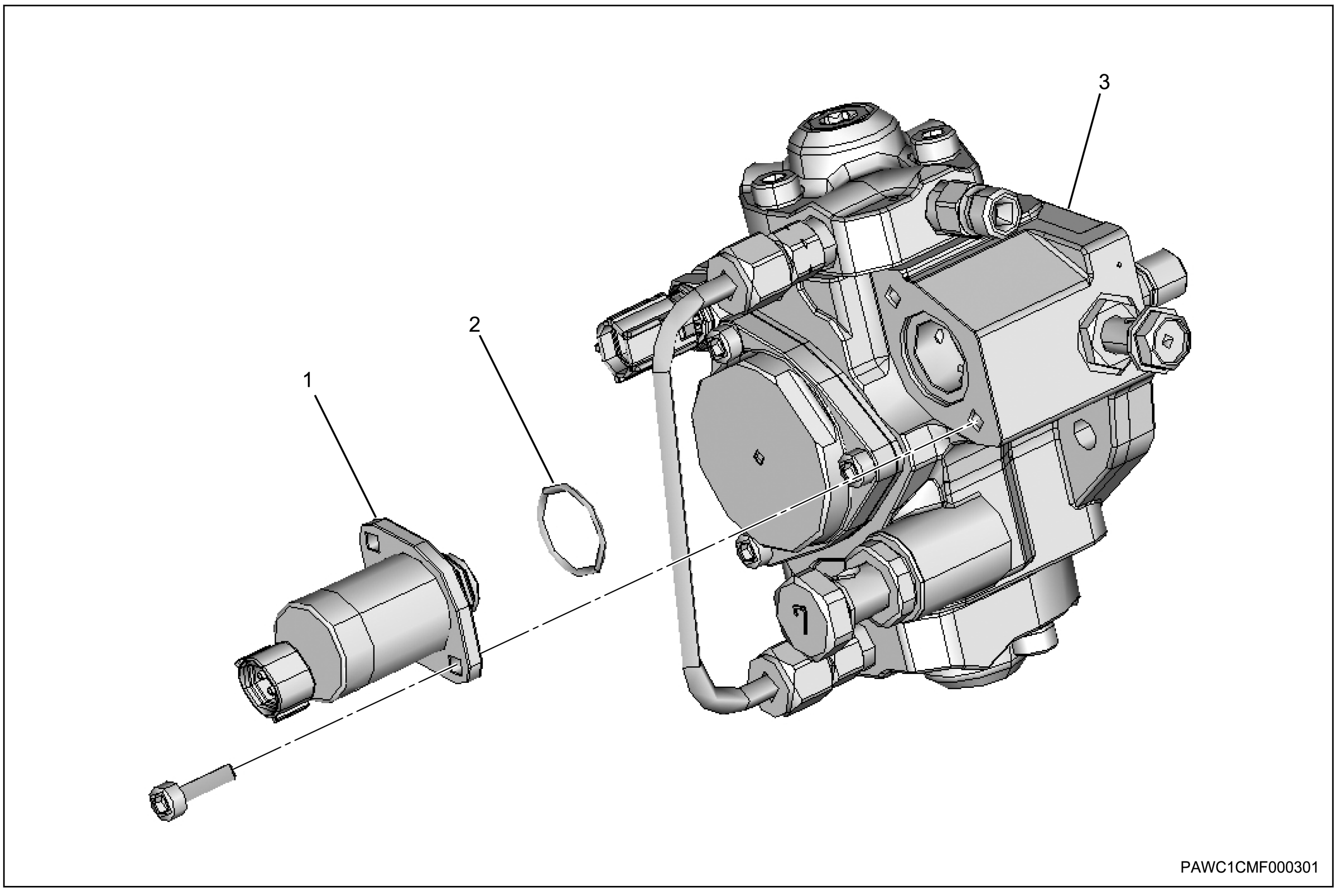
- Fuel supply pump



1. Fuel supply pump
2. O-ring
3. Supply pump bracket
4. O-ring
5. Supply pump gear
6. Fuel return pipe

Note :

- Suction control valve

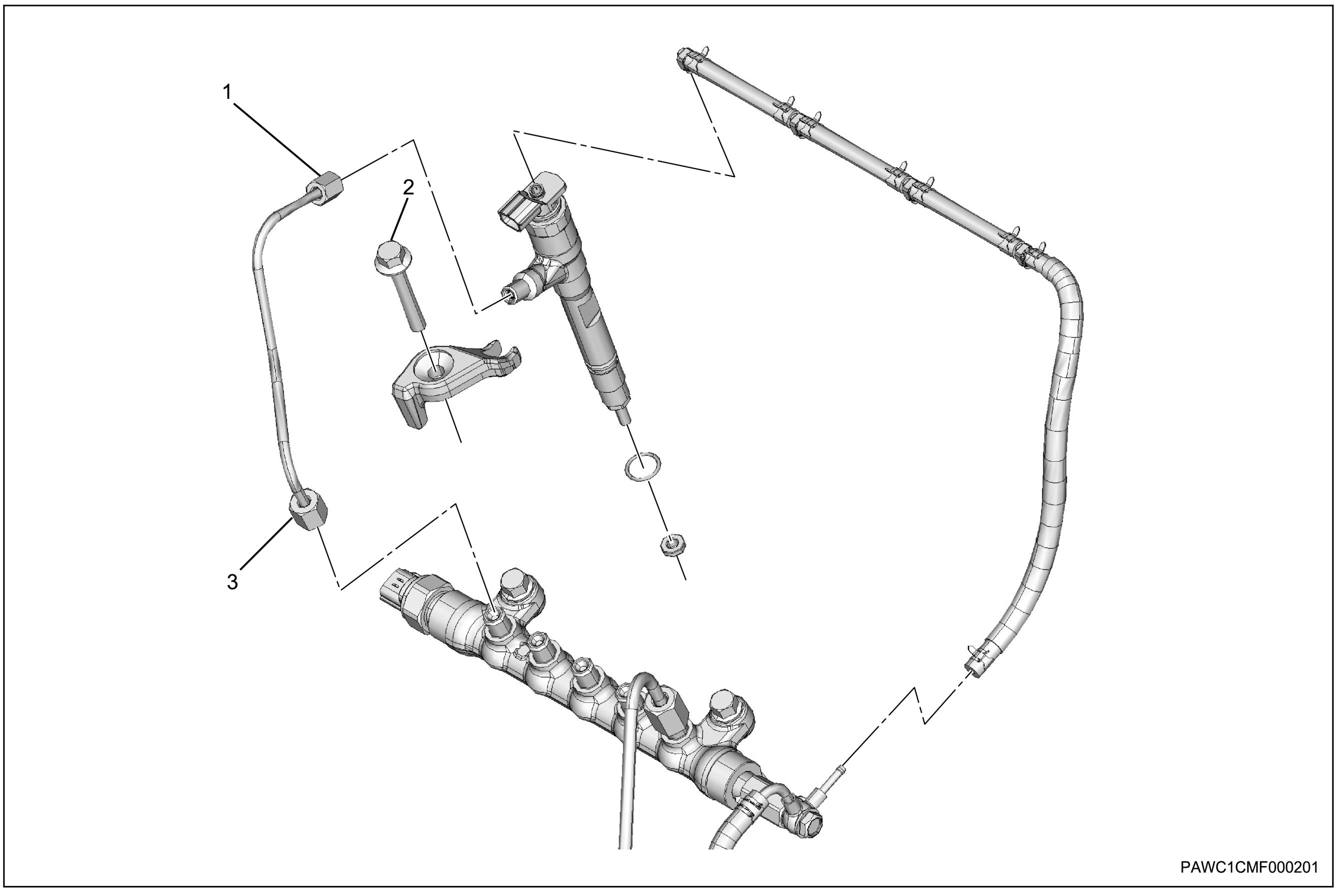


1. Suction control valve
2. O-ring
3. Fuel supply pump

2. Tightening Torque Views

Note :

- Injector



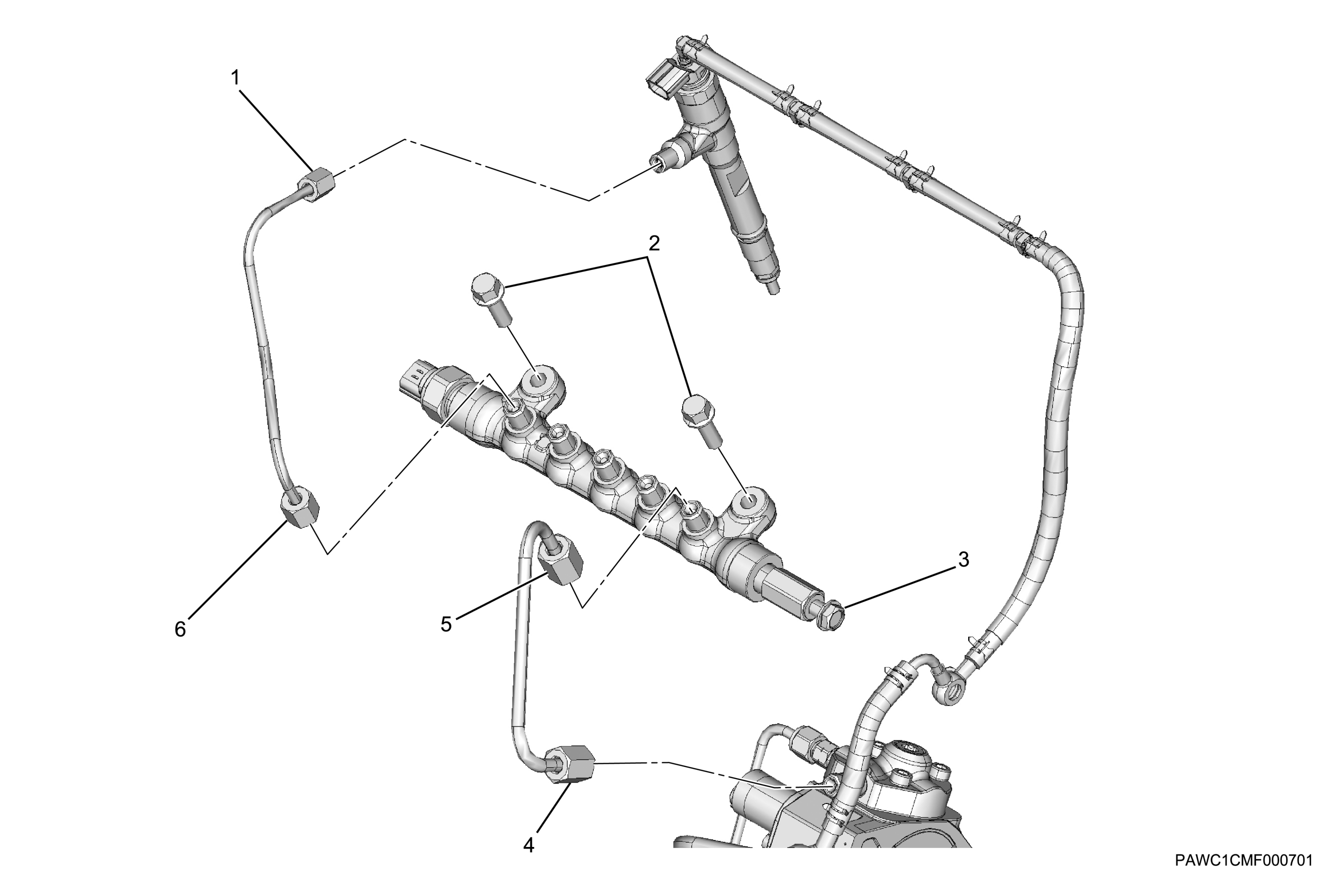
1 : 25 N・m { 2.5 kgf・m / 18 lb・ft }

2 : 37 N・m { 3.8 kgf・m / 27 lb・ft }

3 : 30 N・m { 3.1 kgf・m / 22 lb・ft }

Note :

- Common rail (fuel rail) assembly



1 : 25 N・m { 2.5 kgf・m / 18 lb・ft }

2 : 48 N・m { 4.9 kgf・m / 35 lb・ft }

3 : 20 N・m { 2.0 kgf・m / 15 lb・ft }

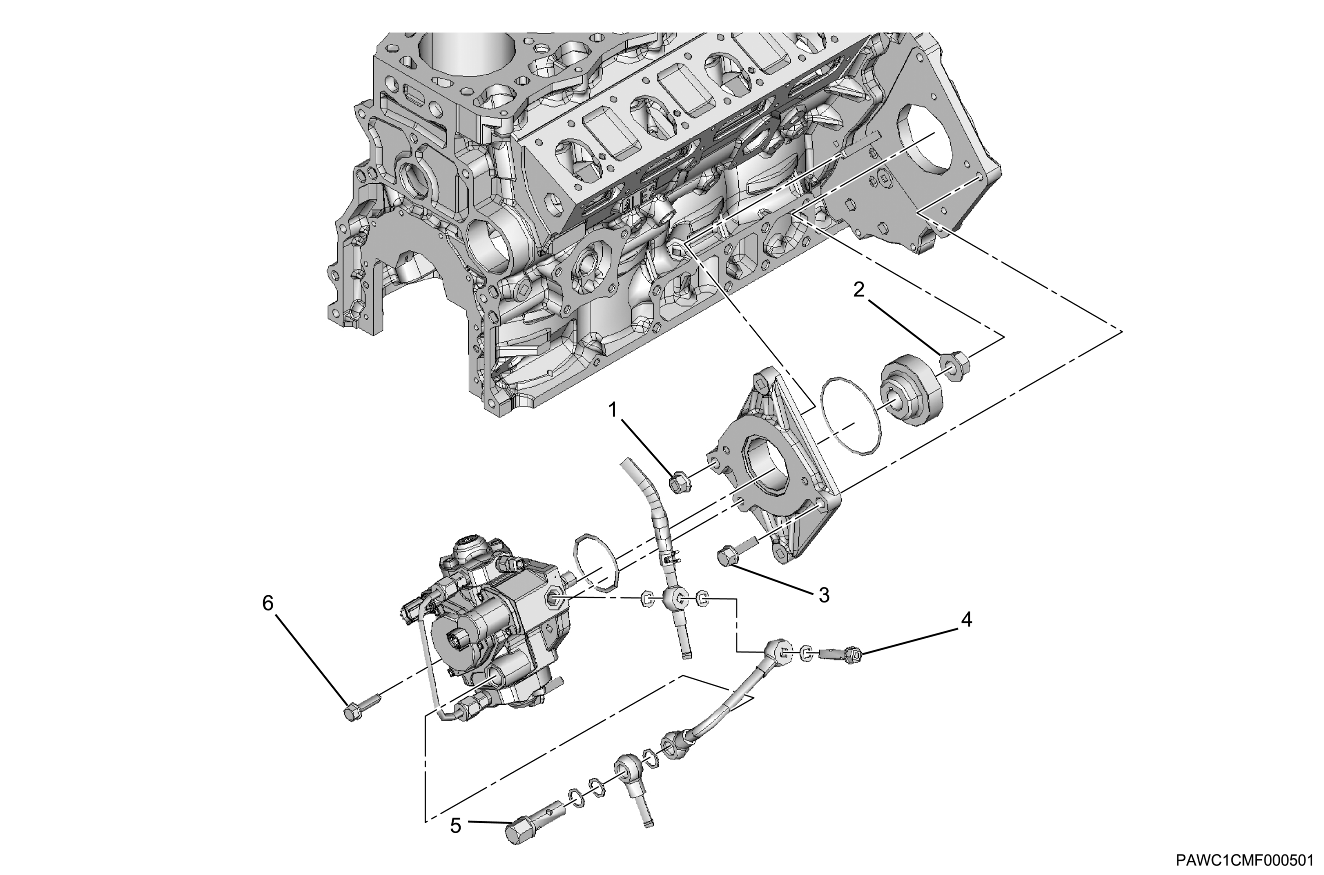
4 : 44 N・m { 4.5 kgf・m / 32 lb・ft }

5 : 44 N・m { 4.5 kgf・m / 32 lb・ft }

6 : 30 N・m { 3.1 kgf・m / 22 lb・ft }

Note :

- Fuel supply pump



1 : 48 N・m { 4.9 kgf・m / 35 lb・ft }

2 : 64 N・m { 6.5 kgf・m / 47 lb・ft }

3 : 48 N・m { 4.9 kgf・m / 35 lb・ft }

4 : 10 N・m { 1.0 kgf・m / 89 lb・in }

5 : 17 N・m { 1.7 kgf・m / 13 lb・ft }

6 : 19 N・m { 1.9 kgf・m / 14 lb・ft }

Engine

Cooling

(4LE2)

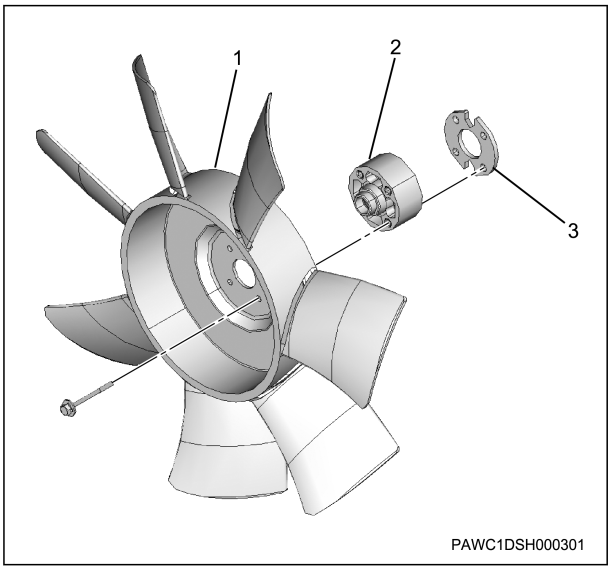
Table of Contents

Water pump assembly

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

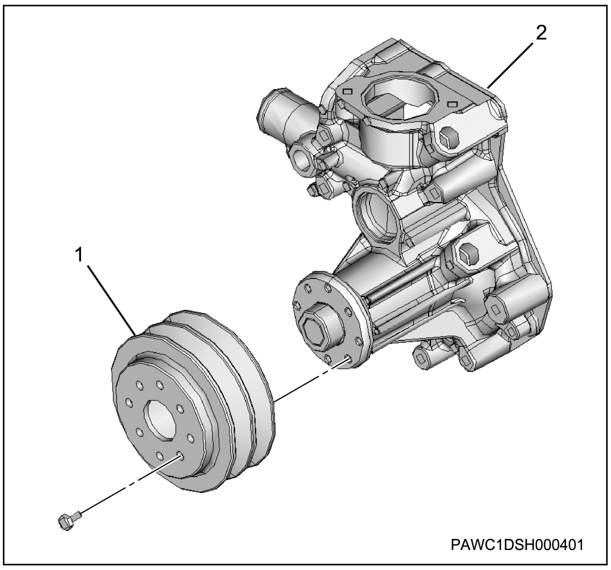
   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

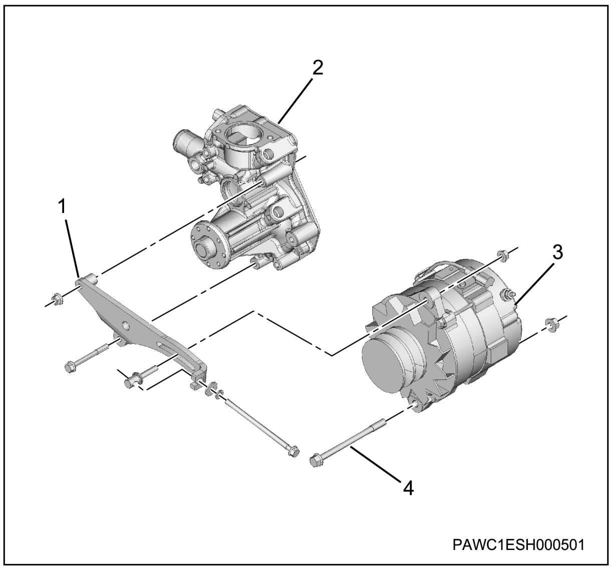
   Note :
   - Loosen the generator adjust bolt and remove the belt.
5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.



1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

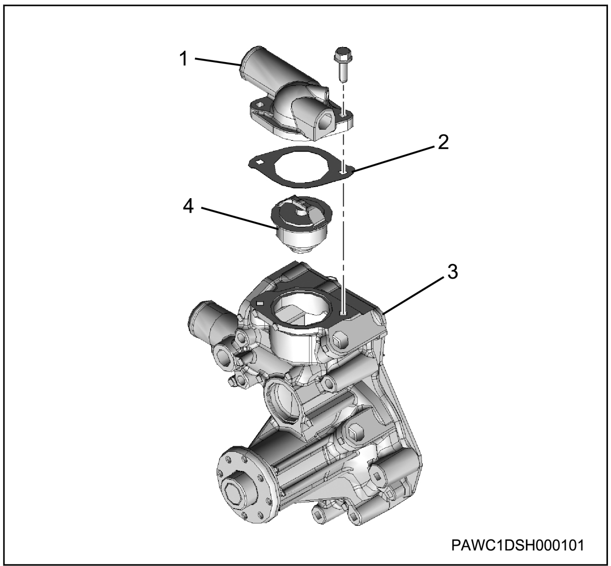
   Note :
   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Water outlet pipe removal
   1. Remove the water outlet pipe from the water pump assembly.

   Note :
   - Remove the gasket.

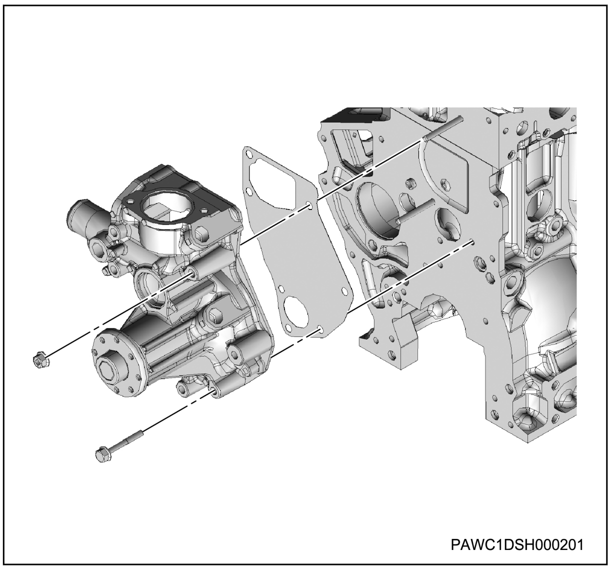


1. Water outlet pipe
2. Gasket
3. Water pump assembly
4. Thermostat

8. Thermostat removal
   1. Remove the thermostat from the water pump assembly.
9. Engine coolant temperature sensor removal
   1. Remove the engine coolant temperature sensor from the water pump assembly.
10. Water hose disconnect
    1. Disconnect the water hose from the water pump assembly.

    Note :
    - Remove the hose clip.
11. Water pump assembly removal
    1. Remove the water pump assembly from the cylinder block and the cylinder head.

    Note :
    - Remove the water pump assembly and the gasket.



inspection

1. Water pump assembly inspection

    1. Inspect the water pump assembly.

    Note：

    - The water pump assembly cannot be disassembled.
    - Replace the water pump assembly if excessive wear or damage is found.
    - Replace the water pump assembly if cracks are found on the water pump body.
    - Replace the water pump assembly if coolant leakage from the seal unit is found.
    - Replace the water pump assembly if excessive radial play of the fan center or abnormal sounds are found during manual rotation.
    - Replace the water pump assembly if cracks or corrosion is found on the impeller.
    - Replace the water pump assembly if excessive end play of the fan center is found.

    specified value： 0.008 to 0.010 mm { 0.00031 to 0.00039 in }

    limit： 0.2 mm { 0.008 in }

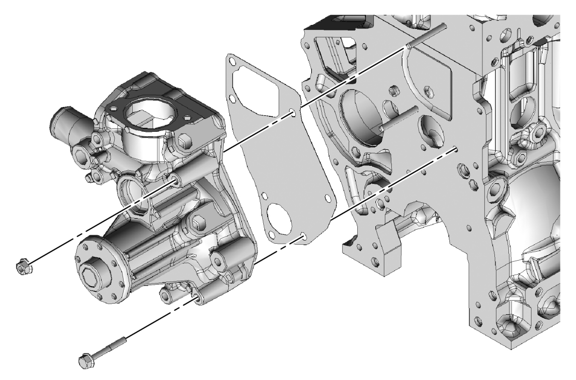
installation

1. Water pump assembly installation
   1. Install the water pump assembly to the cylinder block and the cylinder head.

   Note :

   - Install the water pump assembly to the cylinder block and the cylinder head.

   tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }



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2. Water hose connect
   1. Connect the water hose to the water pump assembly.

   Note :

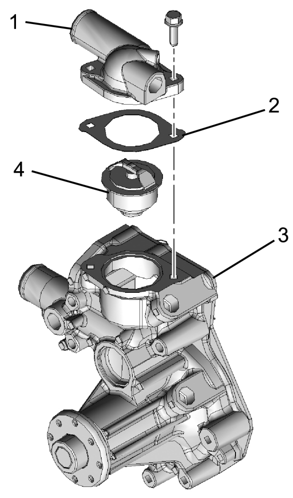
   - Install the hose clip.
3. Engine coolant temperature sensor installation
   1. Install the engine coolant temperature sensor to the water pump assembly.

   tightening torque : 20 N・m { 2.0 kgf・m / 15 lb・ft }
4. Thermostat installation
   1. Install the thermostat to the water pump assembly.
5. Water outlet pipe installation
   1. Install the water outlet pipe to the water pump assembly.

   Note :

   - Tighten together with the gasket.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }



PAWC1DSH000101

1. Water outlet pipe
2. Gasket
3. Water pump assembly
4. Thermostat

6. Generator installation
   1. Install the adjust plate to the water pump assembly.

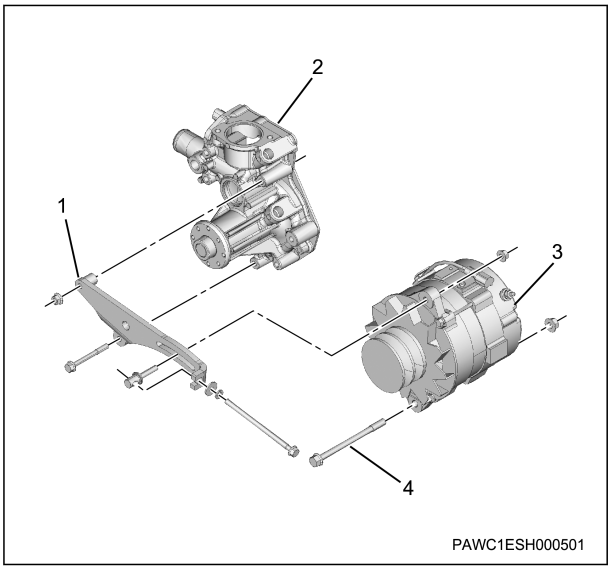
   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }
   2. Temporarily tighten the generator to the generator bracket.
   3. Temporarily tighten the generator to the adjust plate.

   Note :

   - Securely tighten the bolt and the nut after adjusting the cooling fan belt.
   4. Connect the harness connector to the generator.

   Note :

   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

7. Fan pulley installation
    1. Install the fan pulley to the water pump assembly.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

8. Cooling fan belt installation
    1. Install the cooling fan belt to the pulley.
9. Cooling fan belt adjustment
    1. Check the tension of the cooling fan belt.

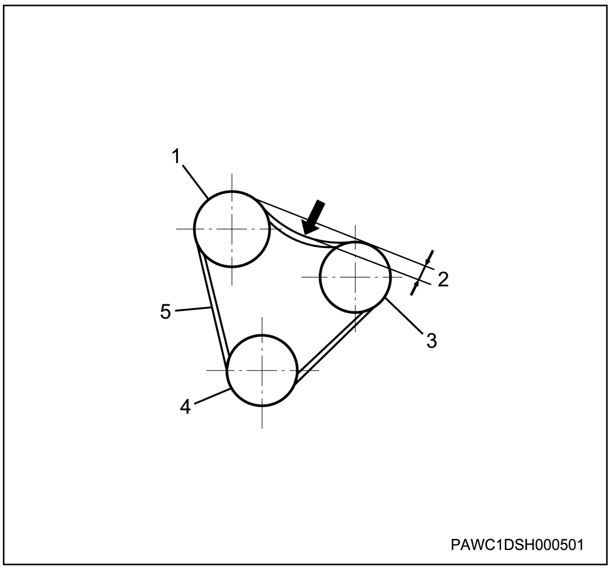
Note :

- Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard : 98 N { 10.0 kg / 22 lb }

specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

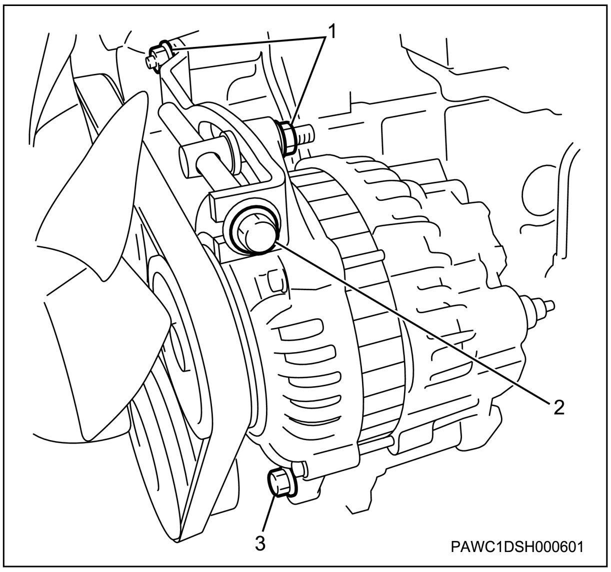


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

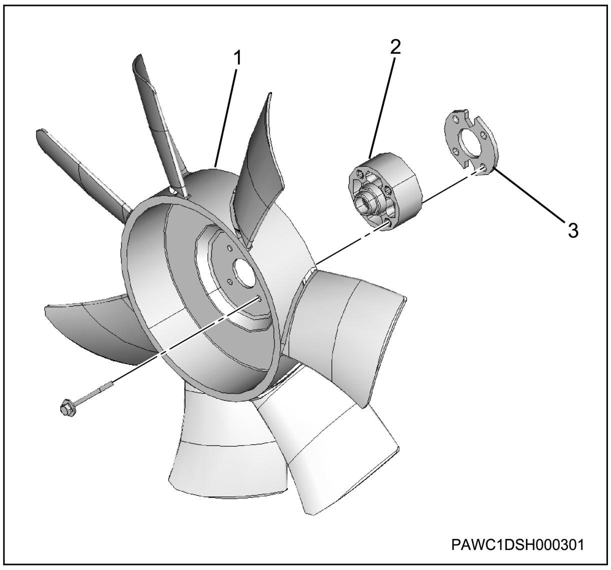
tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25



1. Nut
2. Adjust bolt
3. Mounting bolt

10. Cooling fan installation
    1. Install the cooling fan to the fan pulley.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

11. Coolant filling
    1. Loosen the plug using a wrench.
    2. Replenish the radiator with coolant.

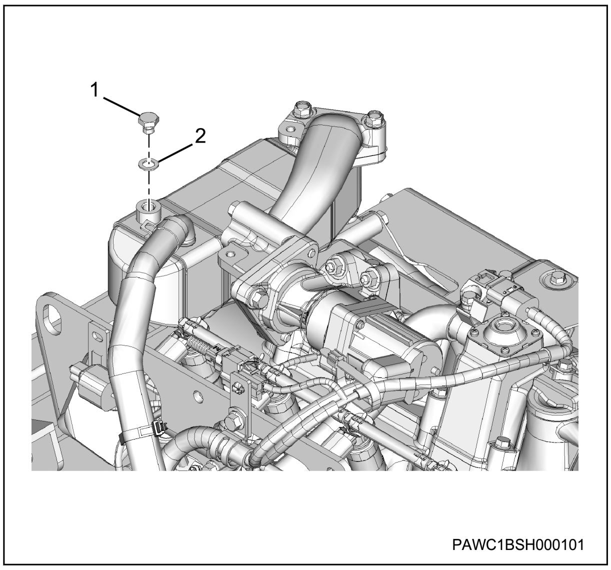
    Caution :
    - Take care to prevent overflow coolant from splashing on to the exhaust system parts.
    - Wipe off any coolant overflow.

    3. Tighten the plug using a wrench.

    Caution :
    - Use a new gasket.

    tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

    4. Replenish the radiator with coolant.



1. Plug
2. Gasket

12. Battery ground cable connect
    1. Connect the battery ground cable to the battery.

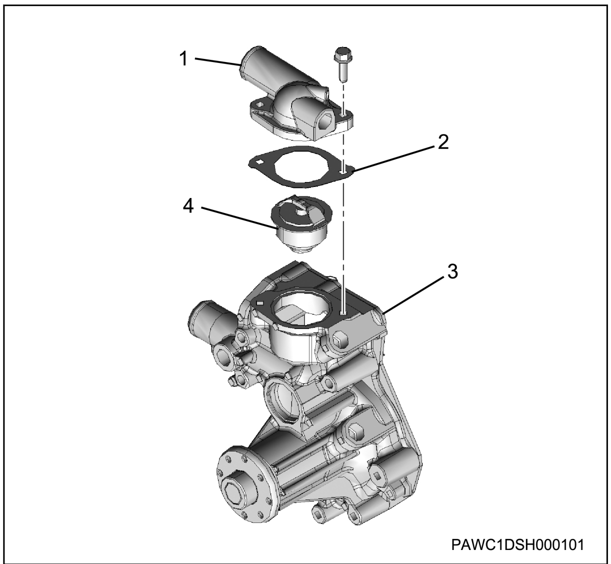
Thermostat

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Water outlet pipe removal
   1. Remove the water outlet pipe from the water pump assembly.

   Note :
   - Remove the gasket.



1. Water outlet pipe
2. Gasket
3. Water pump assembly
4. Thermostat

4. Thermostat removal
   1. Remove the thermostat from the water pump assembly.

inspection

1. Thermostat inspection
   1. Inspect the thermostat.

      Note :
      - Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is found.
   2. Prepare a container.

      Note :
      - Put water and the thermostat in a heatable container.
   3. Increase the water temperature.

      Note :
      - Stir sufficiently so that the water temperature inside the container increases uniformly.

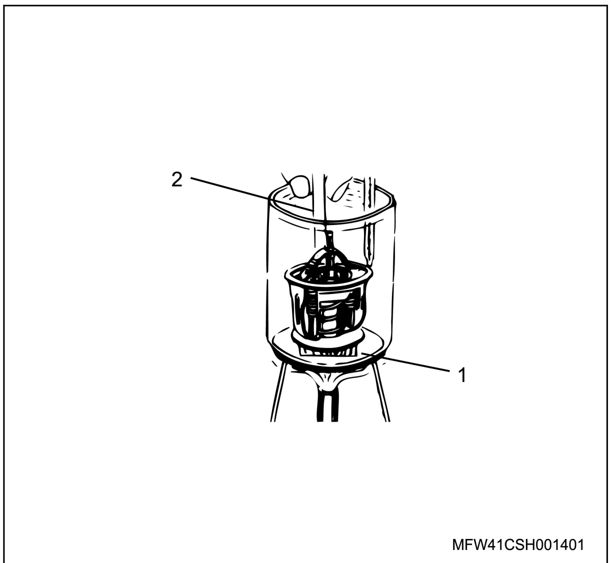
      Caution :
      - Do not directly heat the thermostat.
   4. Measure the water temperature using a thermometer.

      Note :
      - Measure the thermostat open valve temperature.

      valve opening temperature : 82 ℃ { 180 °F }

      temperature when fully open : 95 ℃ { 203 °F }

      lift amount : more than 8.0 mm { more than 0.3150 in }



1. Piece of wood
2. Stirring rod

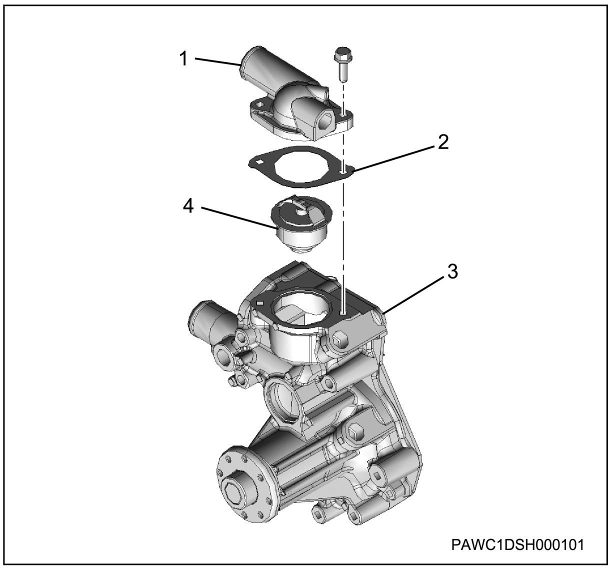
installation

1. Thermostat installation
   1. Install the thermostat to the water pump assembly.
2. Water outlet pipe installation
   1. Install the water outlet pipe to the water pump assembly.

   Note :

   - Tighten together with the gasket.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }



1. Water outlet pipe
2. Gasket
3. Water pump assembly
4. Thermostat

3. Coolant filling
   1. Loosen the plug using a wrench.
   2. Replenish the radiator with coolant.

   Caution :

   - Take care to prevent overflow coolant from splashing on to the exhaust system parts.
   - Wipe off any coolant overflow.

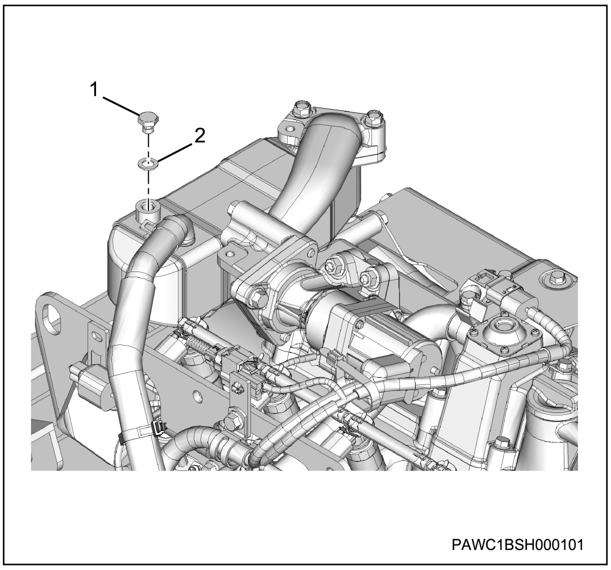
   3. Tighten the plug using a wrench.

   Caution :

   - Use a new gasket.

   tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

   4. Replenish the radiator with coolant.



1. Plug
2. Gasket

4. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Cooling fan belt

inspection

1. Cooling fan belt inspection
   1. Inspect the cooling fan belt.

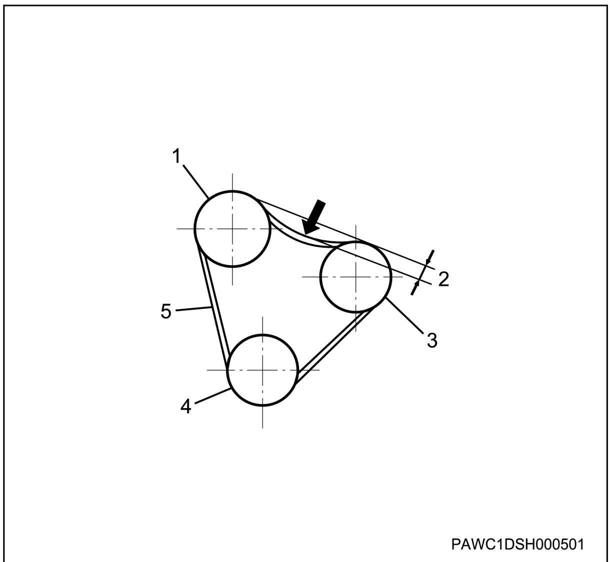
   Note :
   - Inspect for wear or damage.
2. Cooling fan belt adjustment
   1. Check the tension of the cooling fan belt.

   Note :
   - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

standard : 98 N { 10.0 kg / 22 lb }

specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in }
New product

specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in }
Reuse

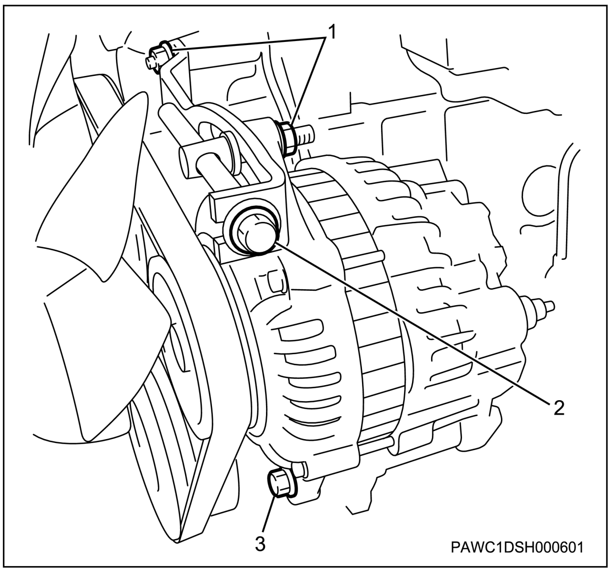


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft }
M8 x 1.25

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }
M10 x 1.25



1. Nut
2. Adjust bolt
3. Mounting bolt

Radiator

inspection

1. Radiator inspection
   1. Inspect the radiator.

Note :

- Inspect for collapsing of the radiator fins.
- Remove dirt or other foreign material.
- Repair the radiator fins if they are deformed as this can lead to a decrease in the heat dissipation effect, causing overheating.

Caution :

- When repairing the fins, be careful not to damage the base.

2. Radiator cleaning

Caution :

- Before cleaning, seal the hose connecting sections using caps, cloth tape, etc.

1. Clean the radiator using tap water.

Note :

- Thoroughly wash off fouling that can be removed by splashing tap water.

Caution :

- At this time, do not use a high pressure washing machine or brush.

2. Apply detergent to radiator.

Note :

- Apply a type of mild detergent that contains approx. 8% surface acting agent, and leave for 10 minutes.

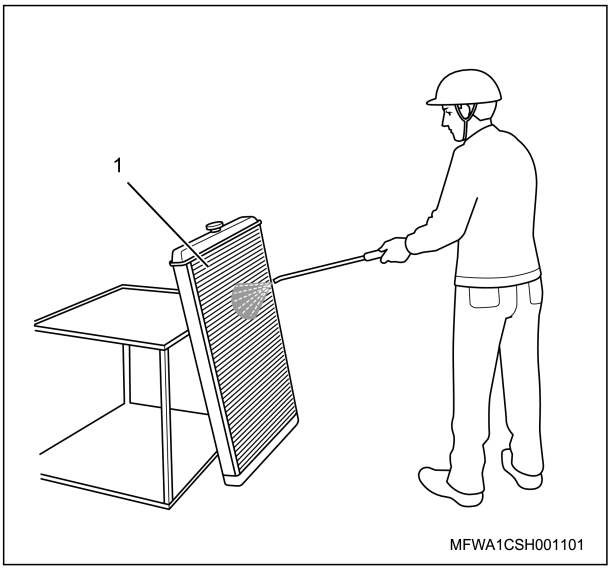
Caution :

- Do not use material other than mild detergent because it may cause corrosion.

3. Clean the radiator using a high pressure washing machine.

Caution :

- High pressure water should be applied perpendicular to the fins from the engine side of the radiator.



1. Radiator

Note :

- When dirt is not washed off sufficiently, repeat the cleaning work.

4. Clean the radiator using tap water.

Caution :

- Sufficiently rinse off the detergent ingredient to prevent it from remaining on the core and the resin portions.

5. Clean the connecting section using tap water.

Note :

- Remove the seal, and clean the hose connecting section.

6. Clean the radiator using tap water.

Note :

- Wash the coolant path inside the radiator with water, and remove all scales and rust.

Engine coolant temperature sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

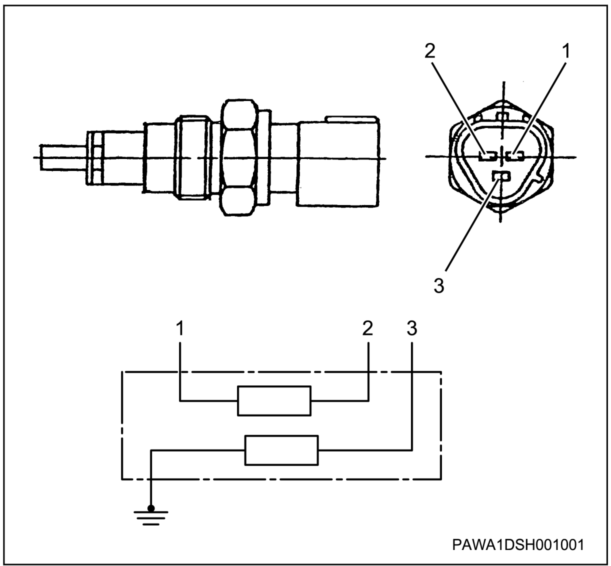
   Caution：
   - After draining the coolant, do not forget to tighten the drain plug.
3. Engine coolant temperature sensor disconnect
   1. Disconnect the harness connector from the engine coolant temperature sensor.
4. Engine coolant temperature sensor removal
   1. Remove the engine coolant temperature sensor from the water pump assembly.

inspection

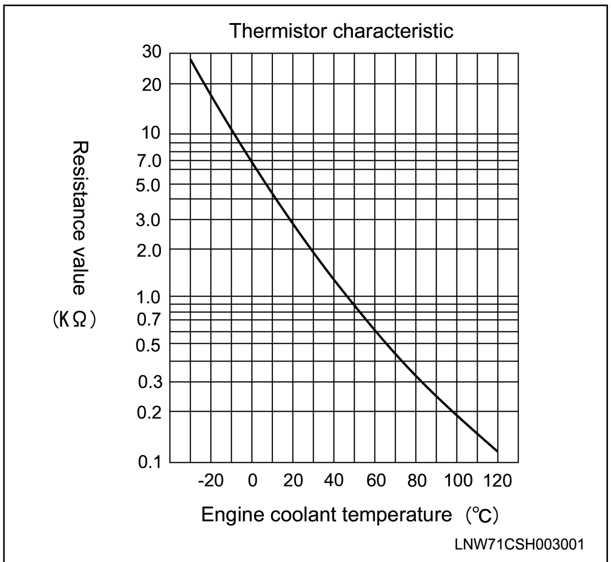
1. Engine coolant temperature sensor inspection
   1. Inspect the coolant sensor using a circuit tester.

Note :

- Verify that the resistance for each coolant temperature and the thermistor characteristics are consistent.



1. GND terminal for engine control
2. Signal terminal for engine control
3. Signal terminal for meter



installation

1. Engine coolant temperature sensor installation
   1. Install the engine coolant temperature sensor to the water pump assembly.

   tightening torque : 20 N・m { 2.0 kgf・m / 15 lb・ft }
2. Engine coolant temperature sensor connect
   1. Connect the harness connector to the engine coolant temperature sensor.
3. Coolant filling
   1. Loosen the plug using a wrench.
   2. Replenish the radiator with coolant.

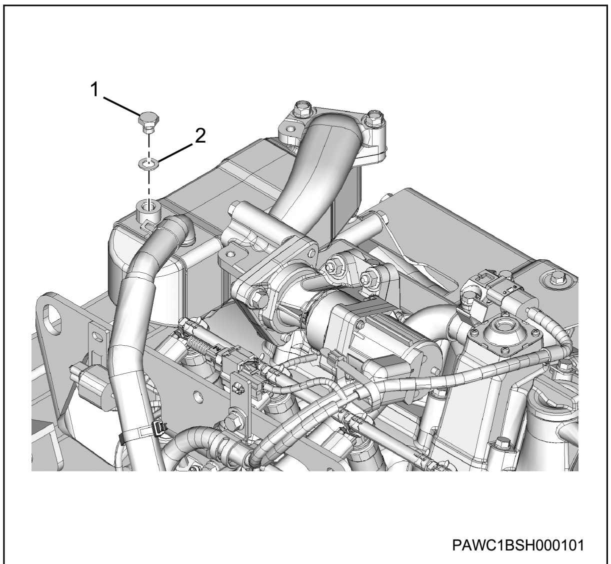
   Caution :
   - Take care to prevent overflow coolant from splashing on to the exhaust system parts.
   - Wipe off any coolant overflow.

   3. Tighten the plug using a wrench.

   Caution :
   - Use a new gasket.

   tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }

   4. Replenish the radiator with coolant.



1. Plug
2. Gasket

4. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Coolant

inspection

1. Coolant inspection

Warning :

- Do not inspect the coolant if the coolant temperature is high.
- Be careful because the coolant may burst out if the cap is removed while the coolant temperature is still high.

Caution :

- For a long life coolant, make sure to use the products specified or recommended by Isuzu.
- If used with a concentration other than specified, the anti-freezing performance may decrease, causing freezing to occur.
- Make sure to use a coolant with a concentration that is appropriate to the usage environment.
- Dilute the specified long life coolant with soft tap water to the specified concentration for use.

Area of use	LLC concentration
General area, areas where the lowest temperature is -12°C {10.4°F}	: 30 %
Cold area, areas where the lowest temperature is -30°C {-22°F}	: 50 %
Areas where the temperature is equal to or less than -30°C {-22°F}	: 55 %

1. Inspect the radiator reserve tank.

Note :

- If the coolant amount is at or below MIN, add coolant until MAX.

Caution :

- If refilling the coolant, make sure to use a concentration that is appropriate to the usage environment.

volume of coolant : 4.3 L { 1.14 US gal / 0.95 Imp.gal }
4LE2X engine only

volume of coolant : 2.8 L { 0.74 US gal / 0.62 Imp.gal }
4LE2N engine only

2. Inspect for water leakage using a radiator cap tester.

Note :

- Apply the pressure specified below, and check for leakage.

inspection pressure : 200 kPa { 29 psi / 2 kgf/cm2 }

Note :

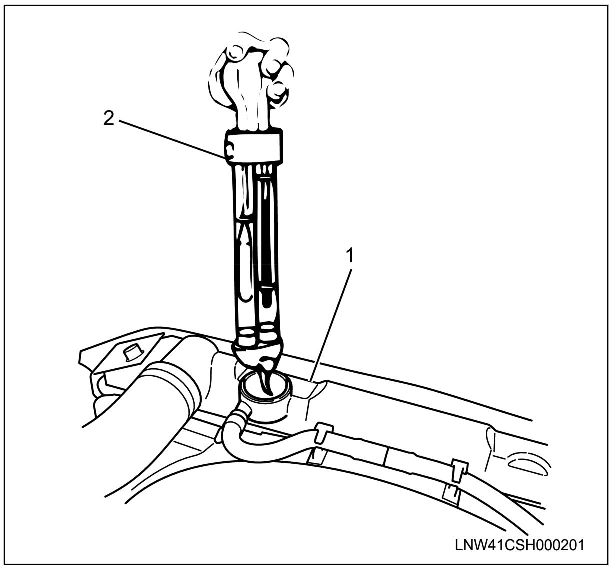
- Inspection locations
- Radiator assembly
- Water pump assembly
- Radiator hose
- Heater hose
- Verify that the radiator hoses, the heater hoses, or the hose clamps are not damaged.

3. Measure the specific gravity using a hydrometer.

engine coolant temperature : 0 to 50 ℃ { 32 to 122 °F }
When inspecting

Note :

- Use a container that is deeper than the length of the hydrometer.

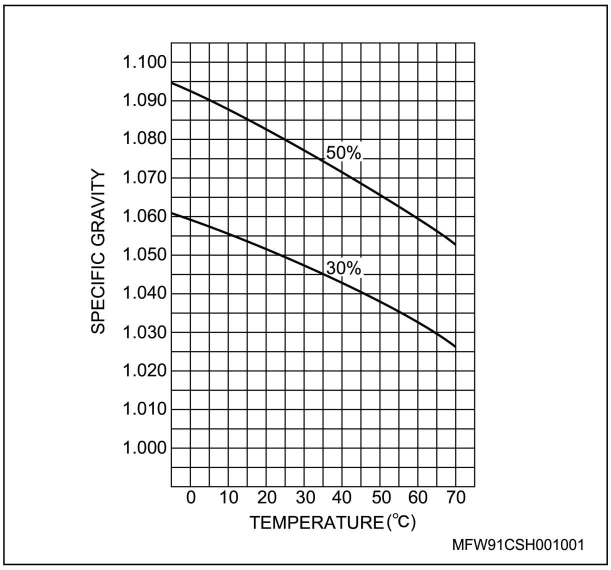


1. Radiator
2. Hydrometer

4. Measure the temperature using a thermometer.

engine coolant temperature : 0 to 50 ℃ { 32 to 122 °F }
When inspecting

5. Calculate the concentration from the measured value.



Note :

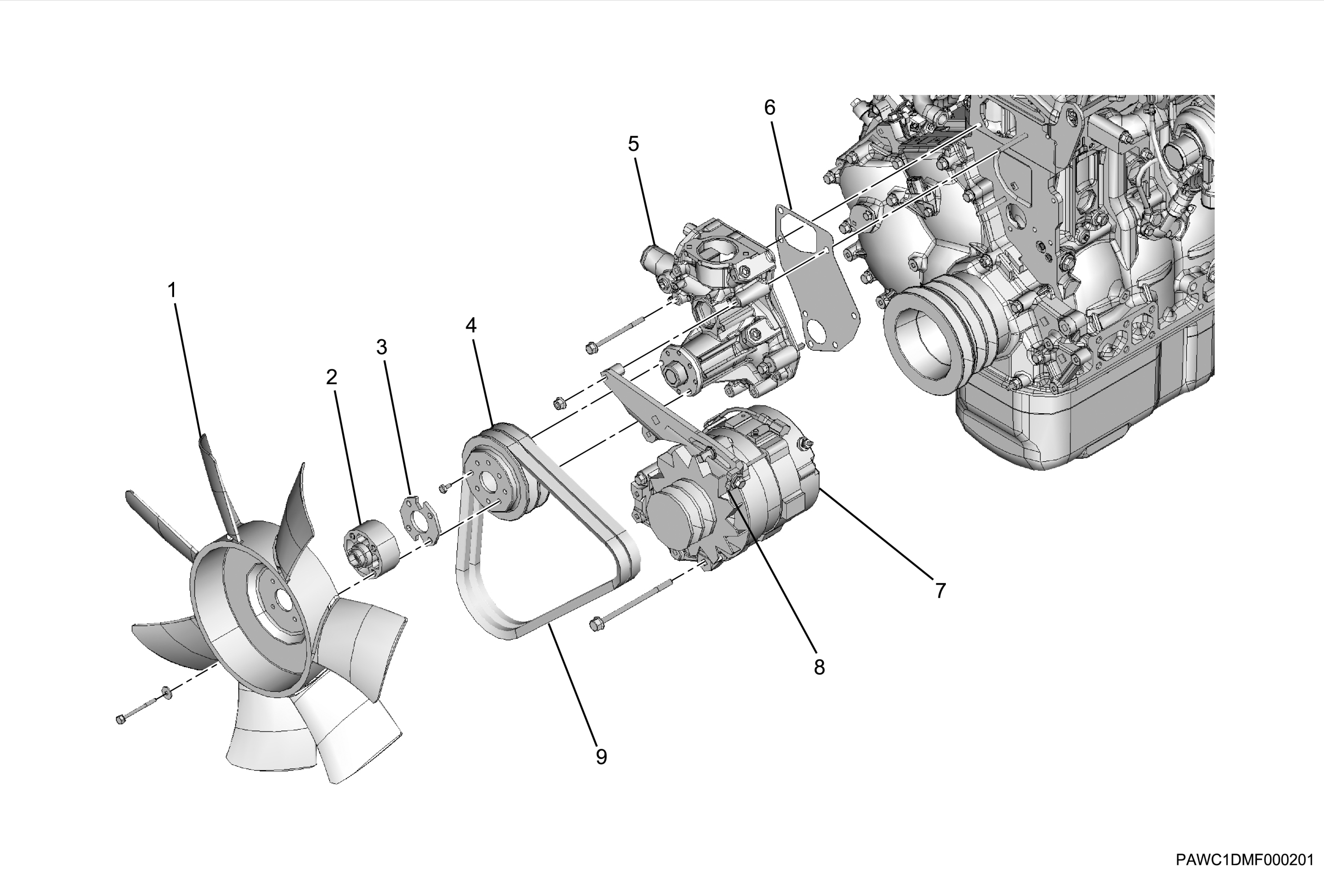
- The coolant concentration can be measured using a coolant scope.

Supplementary Information

1. Component Views

Note：

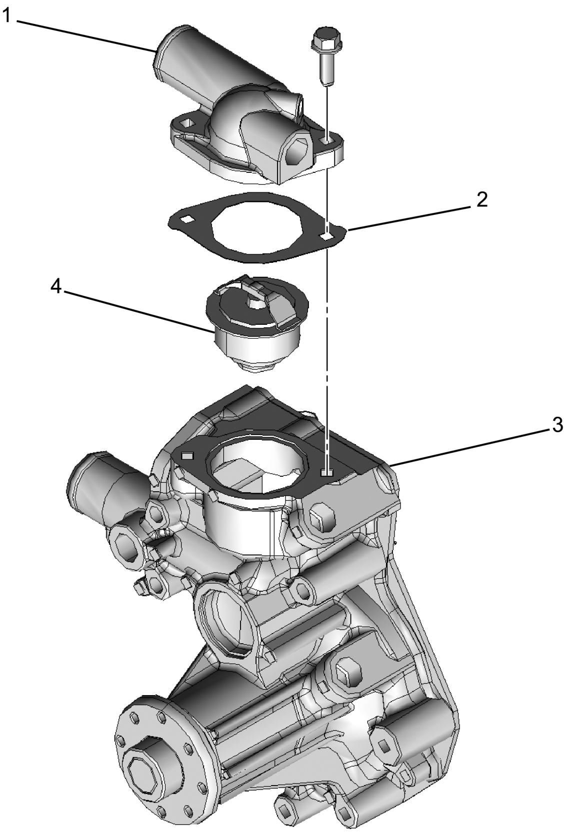
- Water pump assembly



1. Cooling fan
2. Adapter
3. Spacer
4. Fan pulley
5. Water pump assembly
6. Gasket
7. Generator
8. Adjust plate
9. Cooling fan belt

Note：

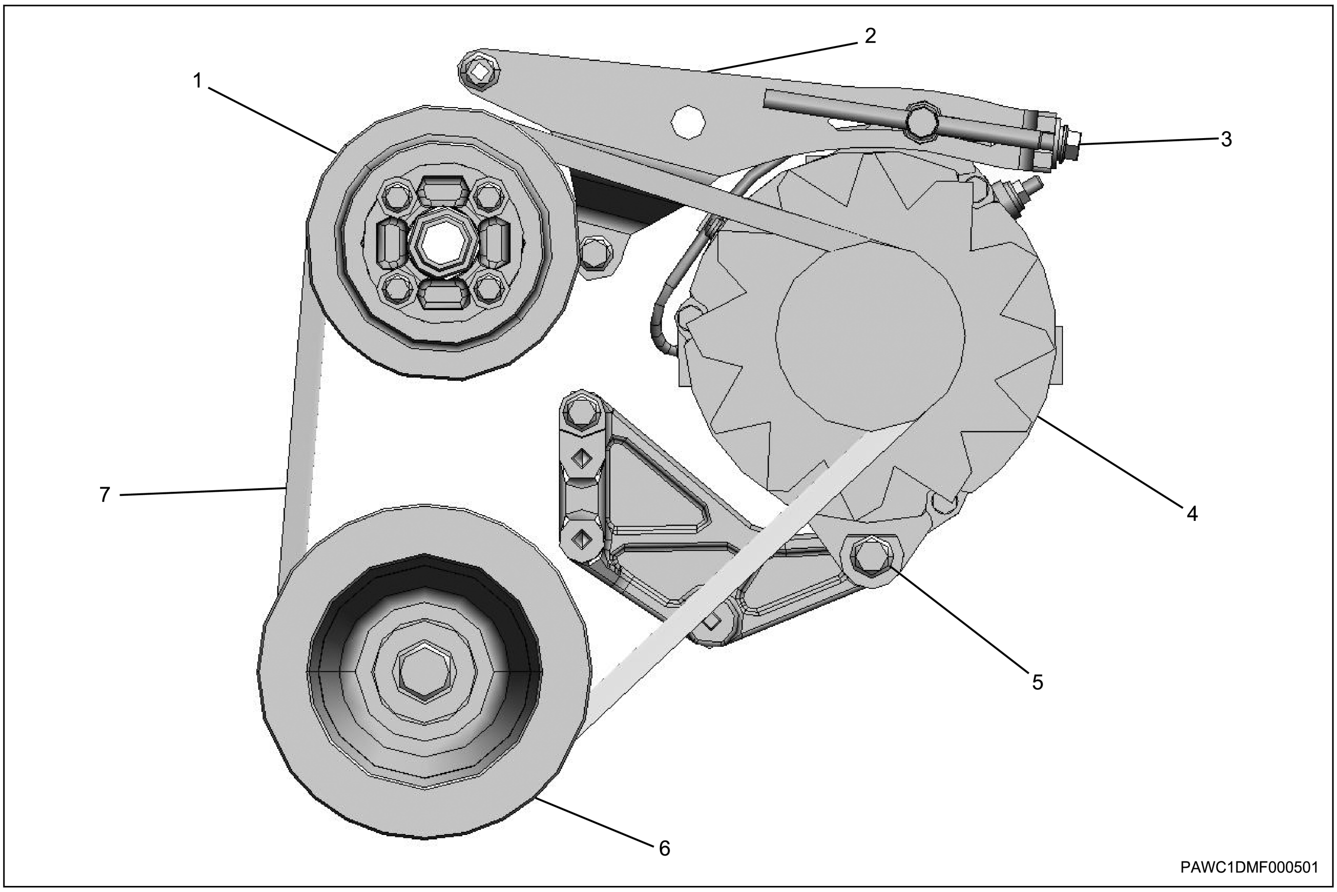
- Thermostat



1. Water outlet pipe
2. Gasket
3. Water pump assembly
4. Thermostat

Note：

- Cooling fan belt

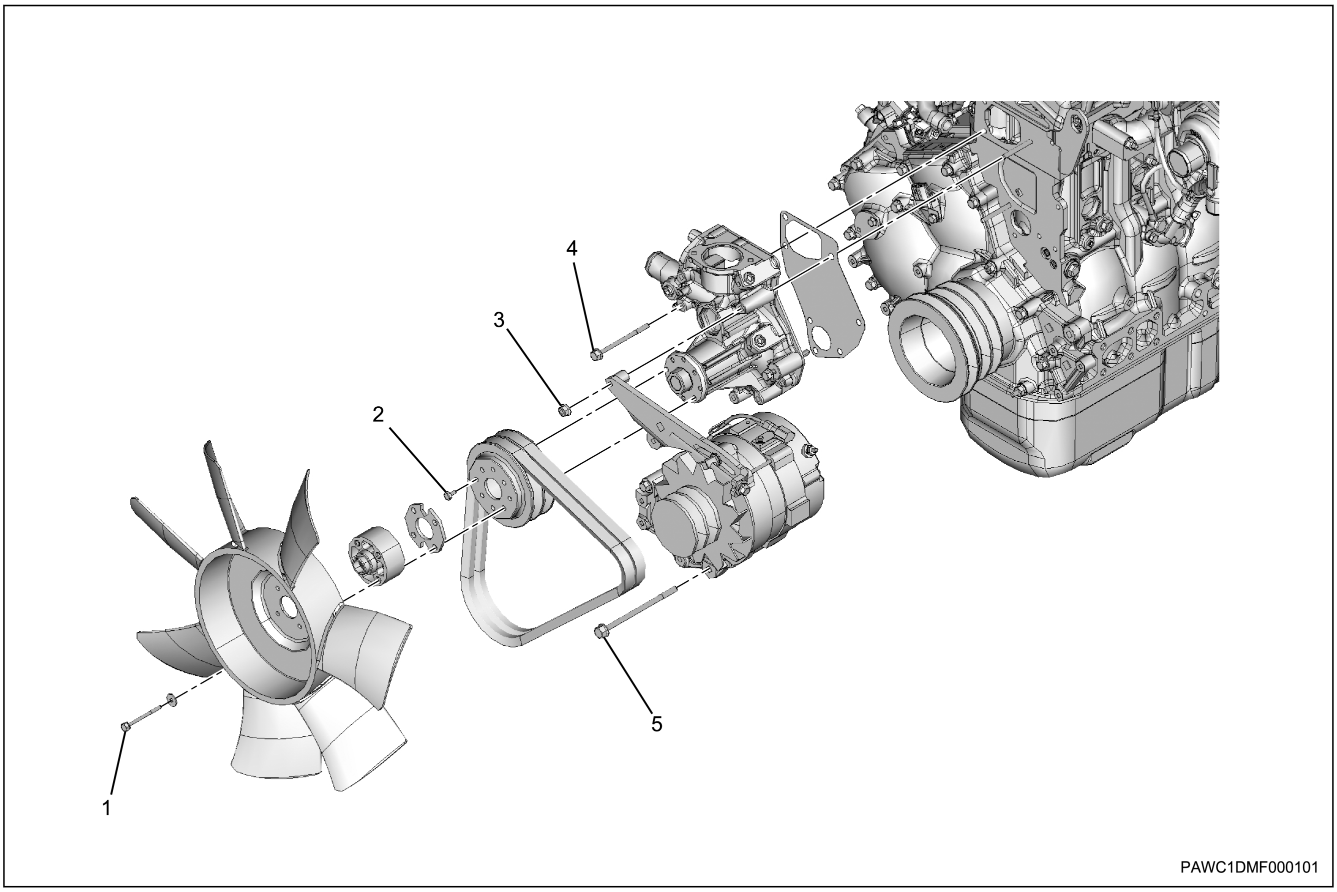


1. Fan pulley
2. Adjust plate
3. Adjust bolt
4. Generator
5. Bolt
6. Crank pulley
7. Cooling fan belt

2. Tightening Torque Views

Note：

・ Water pump assembly



1： 10 N・m { 1.0 kgf・m / 89 lb・in }

2： 10 N・m { 1.0 kgf・m / 89 lb・in }

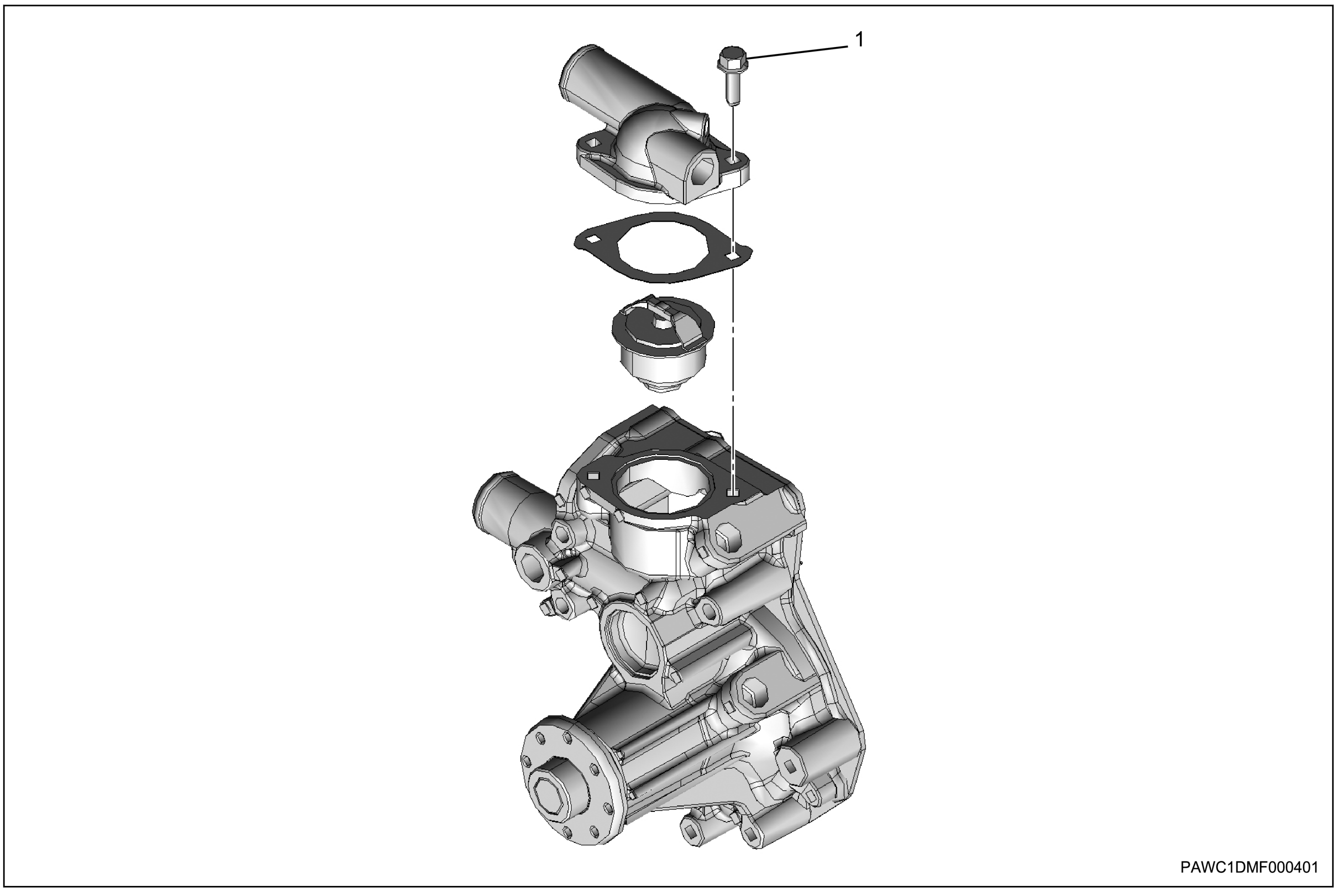
3： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

4： 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

5： 48 N・m { 4.9 kgf・m / 35 lb・ft }

Note：

・ Thermostat



1 : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

Engine

Lubrication

(4LE2)

Table of Contents

Oil pan

removal

1. Engine oil drain
   1. Drain the engine oil from the oil pan.

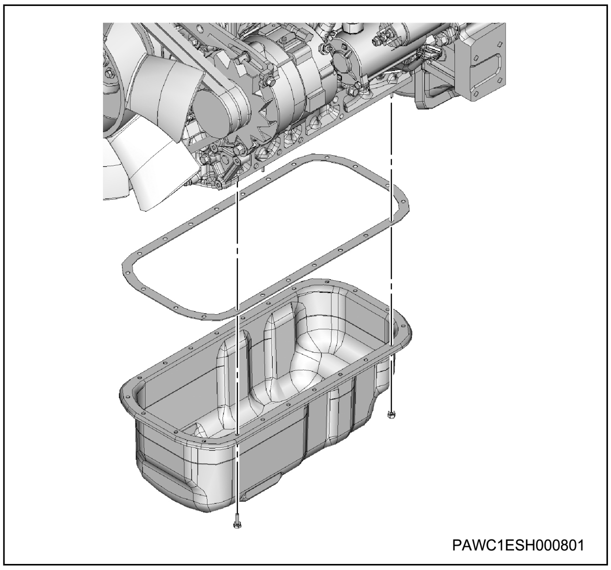
   Note :

   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

   Caution :

   - Do not forget to tighten the drain plug.
2. Oil pan removal
   1. Remove the oil pan from the cylinder block.



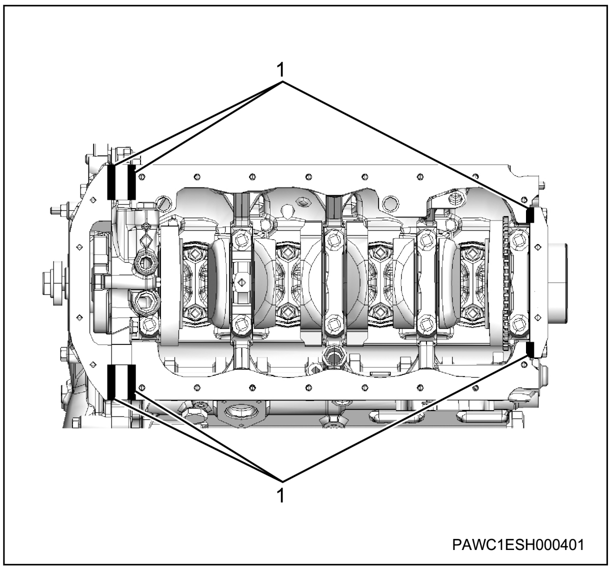
installation

1. Oil pan installation
   1. Apply liquid gasket to the cylinder block.

   Note :

   - Apply ThreeBond 1207B to the installation surface between the cylinder block and the front oil pump plate.

   bead width : 3 mm { 0.12 in }



1. Liquid gasket application area

   2. Install the oil pan to the cylinder block.

   tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

2. Engine oil filling
   1. Refill the engine with engine oil.

   Note :

   - Check the tightening of the oil pan drain plug again.

Oil pump assembly

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Engine oil drain
   1. Drain the engine oil from the oil pan.

Note :

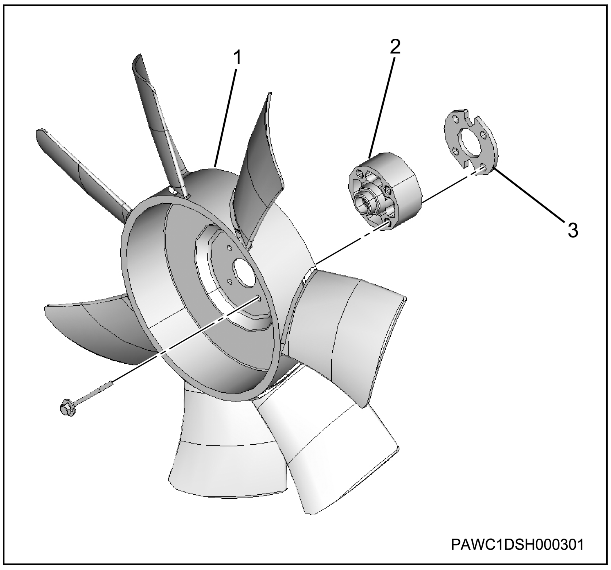
- After draining the oil, tighten the drain plug to the specified torque.

tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

Caution :

- Do not forget to tighten the drain plug.

3. Cooling fan removal
   1. Remove the cooling fan from the fan pulley.



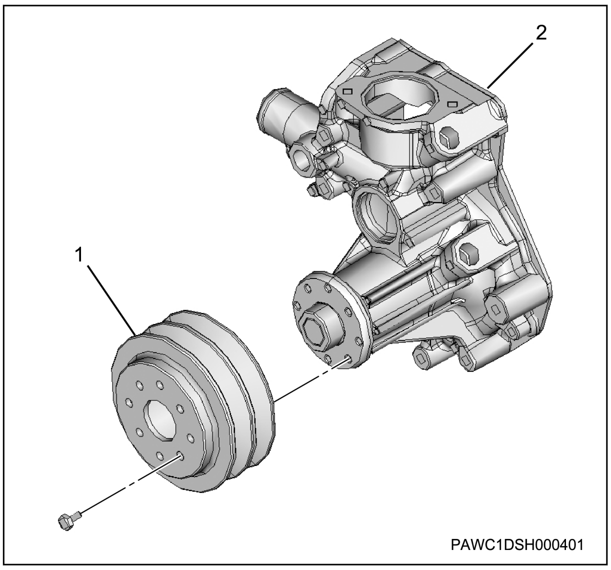
1. Cooling fan
2. Adapter
3. Spacer

4. Cooling fan belt removal
   1. Remove the cooling fan belt from the pulley.

Note :

- Loosen the generator adjust bolt and remove the belt.

5. Fan pulley removal
   1. Remove the fan pulley from the water pump assembly.

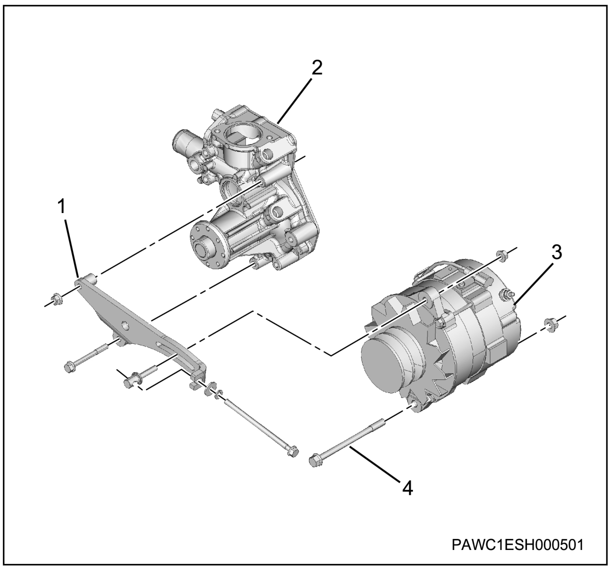


1. Fan pulley
2. Water pump assembly

6. Generator removal
   1. Disconnect the harness connector from the generator.
   2. Remove the generator from the generator bracket.
   3. Remove the adjust plate from the water pump assembly.

Note :

- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

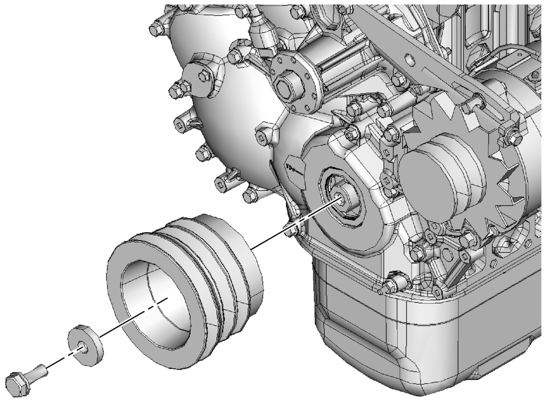
7. Generator bracket removal
   1. Remove the generator bracket from the cylinder block.
8. Crankshaft pulley removal
   1. Remove the crankshaft pulley from the crankshaft.

Note :

- Remove after stopping the crankshaft from turning.

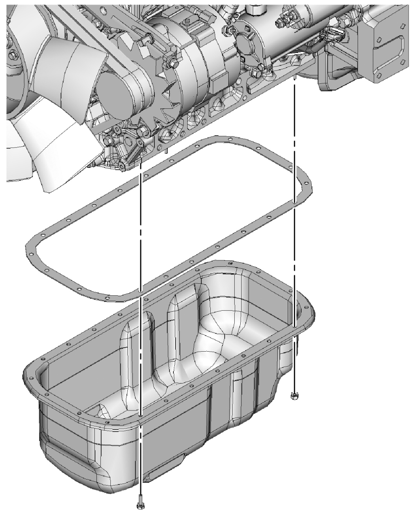
Caution :

- Do not reuse the bolt and the washer.



PAWC1BSH001601

9. CMP sensor removal
   1. Disconnect the harness connector from the CMP sensor.
   2. Remove the CMP sensor from the timing gear case.
   3. Remove the O-ring from the CMP sensor.
10. Oil pan removal
    1. Remove the oil pan from the cylinder block.



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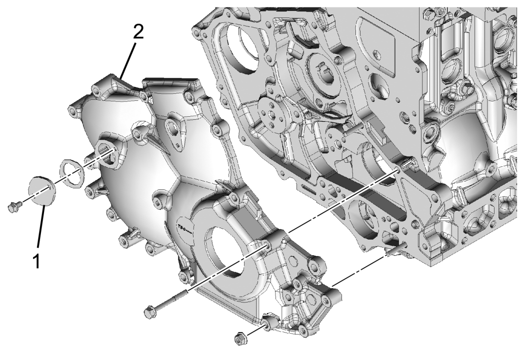
11. Timing gear case removal
    1. Remove the idle gear cover from the timing gear case.
    2. Remove the timing gear case from the front oil pump plate.



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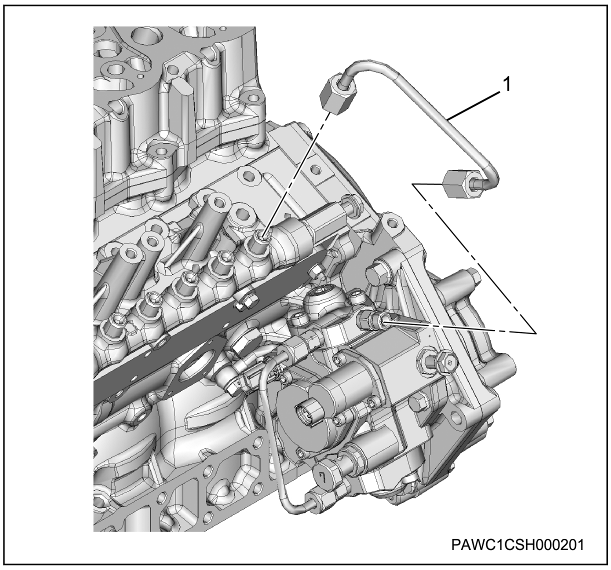
1. Idle gear cover
2. Timing gear case

12. Fuel pipe removal
    1. Remove the fuel pipe from the fuel supply pump and the common rail (fuel rail) assembly.

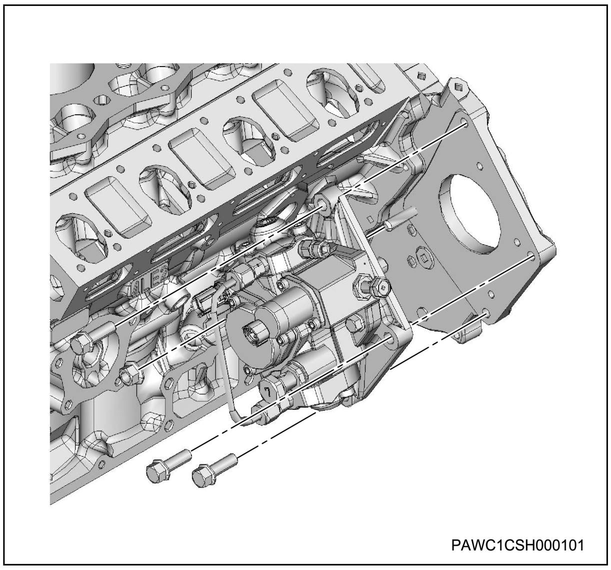


1. Fuel pipe

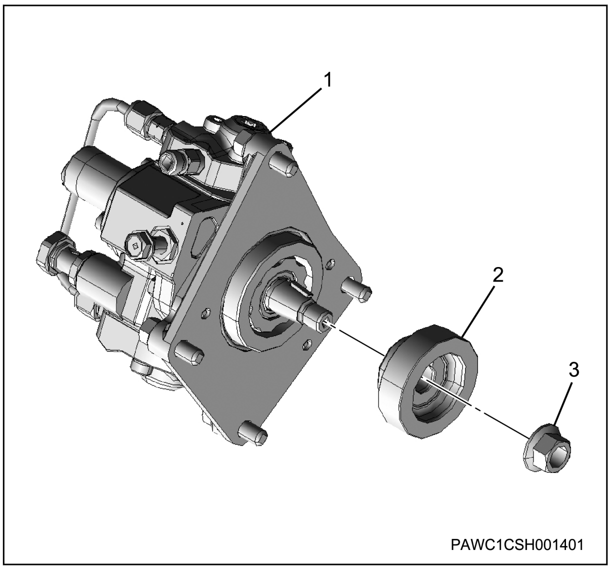
13. Fuel return pipe removal
    1. Remove the fuel return pipe from the fuel supply pump.
14. Fuel supply pump removal
    1. Disconnect the harness connector from the fuel supply pump.
    2. Remove the fuel supply pump from the front oil pump plate.

Note :

- Remove the tightening bolts, and remove together with the bracket.



3. Remove the supply pump gear from the fuel supply pump.



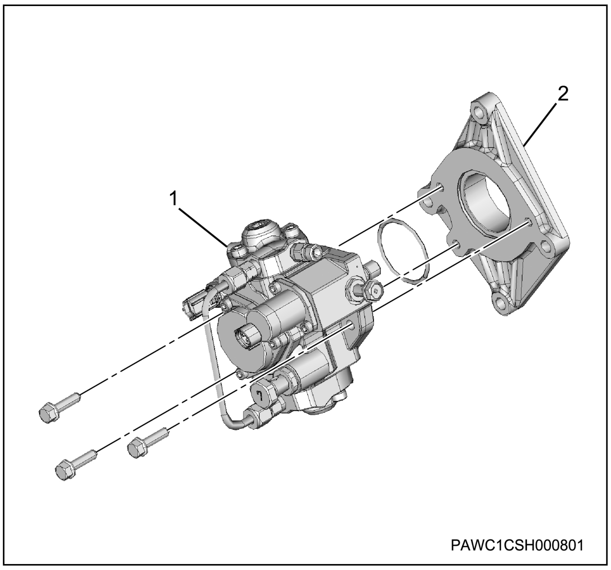
1. Fuel supply pump
2. Supply pump gear
3. Nut

4. Remove the fuel supply pump from the supply pump bracket.

Caution :

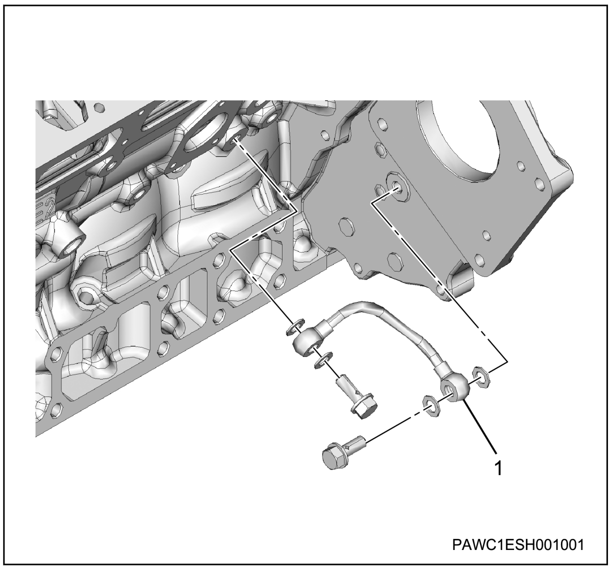
- Do not hold the high pressure pipe of the pump when removing the fuel supply pump.

5. Remove the O-ring from the fuel supply pump.



1. Fuel supply pump
2. Supply pump bracket

15. Oil feed pipe removal
    1. Remove the oil feed pipe from the front oil pump plate and the cylinder block.



1. Oil feed pipe

16. Idle gear A measurement

Caution：

- Before removing the idle gear, measure the end play of the gear.

1. Measure the backlash using a dial gauge.

Note：

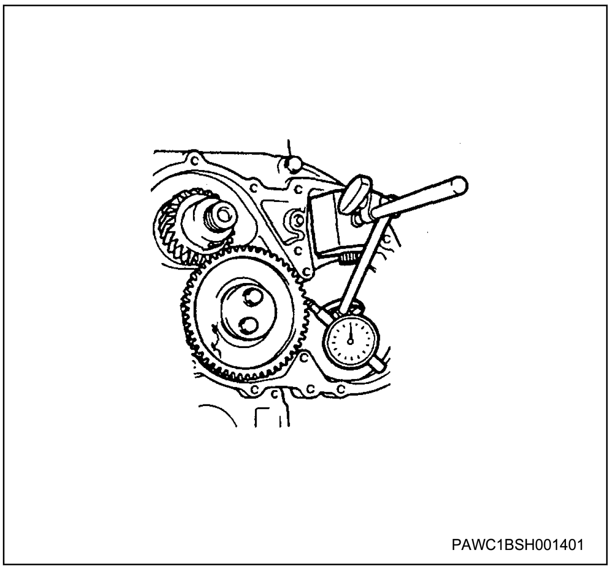
- Install the dial gauge as shown in the diagram, and measure by turning the gear left and right.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value : 0.04 mm { 0.0016 in } Crank gear, idle gear

limit： 0.2 mm { 0.008 in } Crank gear, idle gear

specified value： 0.03 mm { 0.0012 in } Camshaft gear, idle gear

limit： 0.2 mm { 0.008 in } Camshaft gear, idle gear



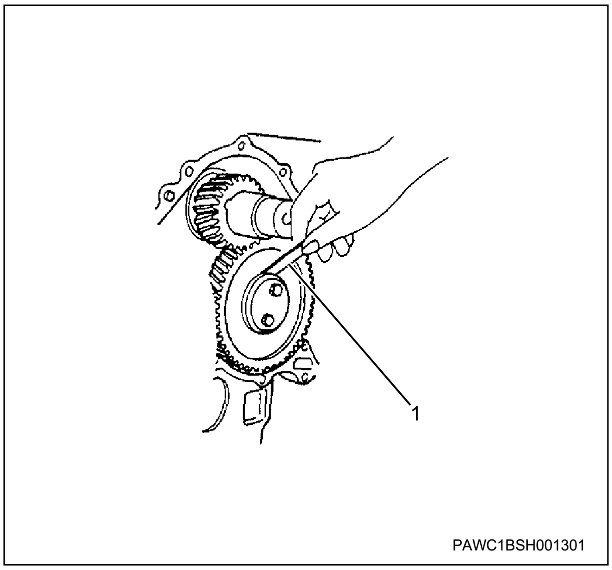
2. Measure the idle gear using a feeler gauge.

Note：

- Measure the gap between the idle gear and the thrust collar.
- If the measured value exceeds the limit, replace the thrust collar or the idle gear.

specified value： 0.058 to 0.115 mm { 0.0023 to 0.0045 in }

limit： 0.2 mm { 0.008 in }



1. Feeler gauge

17. Idle gear B removal

1. Remove idle gear B from the idle gear shaft.

Note：

- Remove the idle gear B shaft and the thrust plate.

18. Idle gear A removal

1. Remove idle gear A from the idle gear shaft.

Note：

- Remove the idle gear A shaft and the thrust plate.

19. Camshaft gear removal

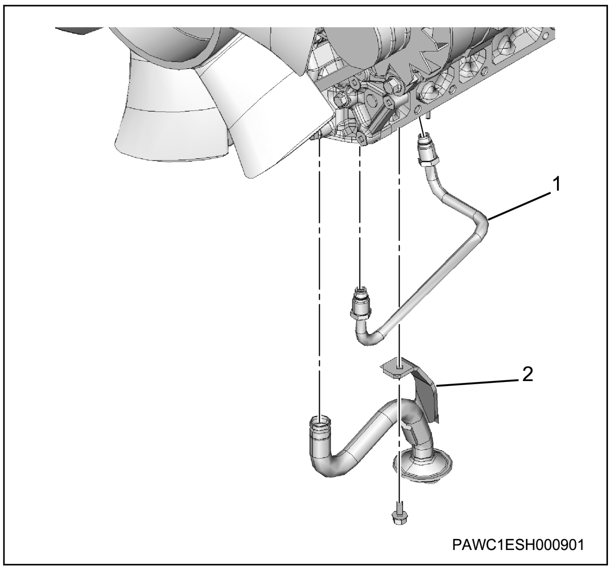
1. Remove the camshaft gear from the camshaft.

20. Oil strainer removal

1. Remove the oil pipe from the front oil pump plate and the cylinder block.
2. Remove the oil strainer from the front oil pump plate and the cylinder block.

Note：

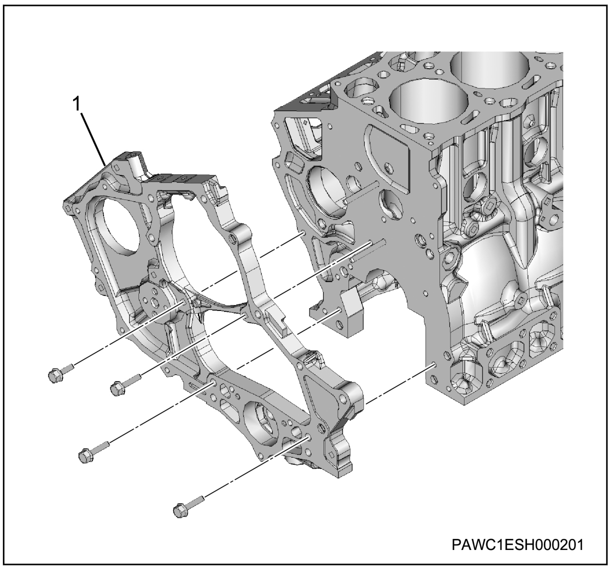
- Remove the O-ring.



1. Oil pipe
2. Oil strainer

21. Front oil pump plate removal

1. Remove the front oil pump plate from the cylinder block.



1. Front oil pump plate

22. Oil pump assembly removal

1. Remove the oil pump assembly from the front oil pump plate.
2. Remove the plug from the front oil pump plate.

Note：

- Remove the spring and the relief valve.

installation

1. Oil pump assembly installation
   1. Install the plug to the front oil pump plate.

   Note :

   - Install the relief valve and the spring.

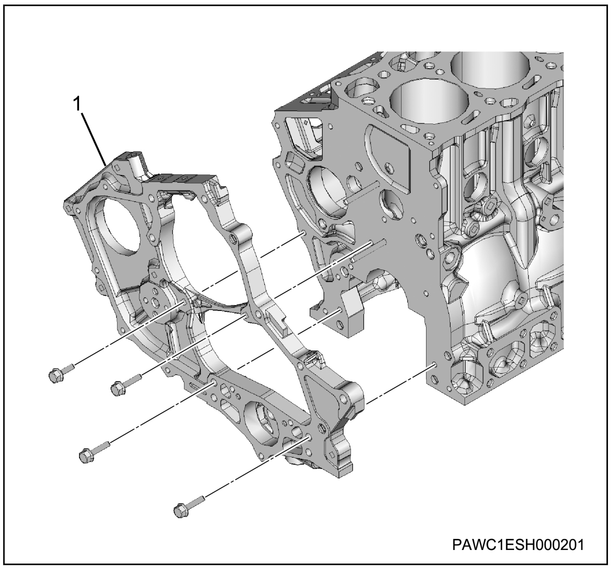
   2. Install the oil pump assembly to the front oil pump plate.
2. Front oil pump plate installation
   1. Apply liquid gasket to the front oil pump plate.

   Note :

   - Apply ThreeBond 1207B.

   2. Install the front oil pump plate to the cylinder block.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }



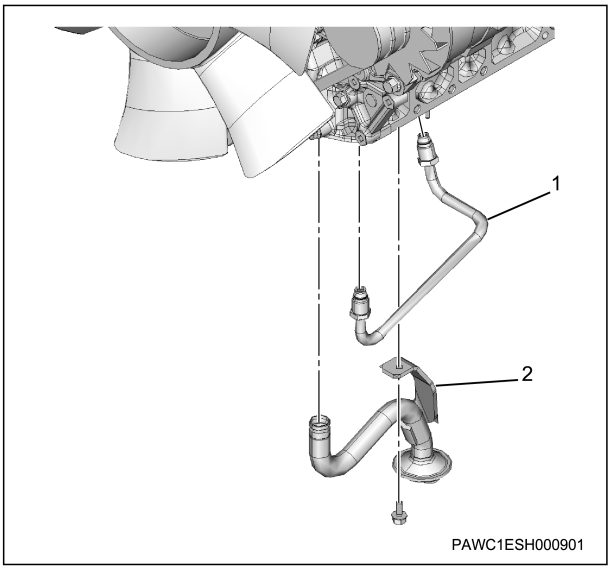
1. Front oil pump plate

3. Oil strainer installation
   1. Apply engine oil to the O-ring.
   2. Install the oil strainer to the front oil pump plate and the cylinder block.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

   3. Install the oil pipe to the front oil pump plate and the cylinder block.

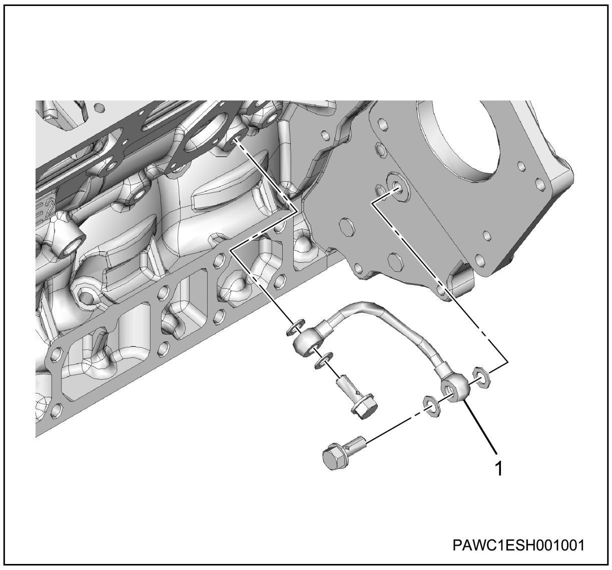
   tightening torque : 29 N・m { 3.0 kgf・m / 21 lb・ft }



1. Oil pipe
2. Oil strainer

4. Oil feed pipe installation
   1. Install the oil feed pipe to the front oil pump plate and the cylinder block.

   tightening torque : 15 N・m { 1.5 kgf・m / 11 lb・ft }



1. Oil feed pipe

5. Idle gear A installation
   1. Align the No. 1 cylinder to compression top dead center.

   Note :

   - Rotate the crankshaft in the forward direction and align the No. 1 cylinder piston to compression top dead center.

   2. Install the idle gear shaft to the cylinder block.
   3. Apply engine oil to the idle gear.

Note：

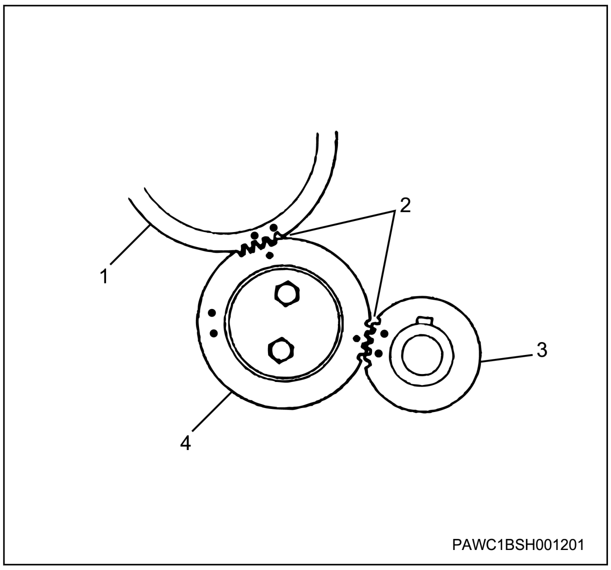
- Apply to idle gear A and the idle gear shaft.

4. Install idle gear A to the idle gear shaft.

Note：

- Install after meshing so that the alignment mark of the crankshaft gear is as shown in the diagram.

tightening torque： 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



1. Camshaft gear
2. Timing point
3. Crank gear
4. Idle gear A

5. Apply engine oil to the idle gear.

Note：

- Apply engine oil to the thrust collar, the bolt, and the threaded portion.

6. Install the thrust collar to the idle gear.

Note：

- Install so that the chamfered side of the thrust collar faces the outside.

6. Camshaft gear installation

1. Install the camshaft gear to the camshaft.

Note：

- Install after meshing so as to align the idle gear alignment marks.

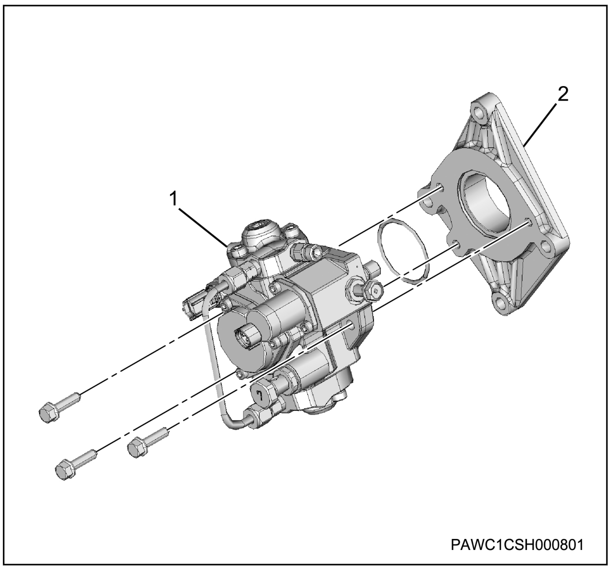
tightening torque： 88 N・m { 9.0 kgf・m / 65 lb・ft }

7. Fuel supply pump installation

1. Install the O-ring to the fuel supply pump.

2. Install the fuel supply pump to the supply pump bracket.

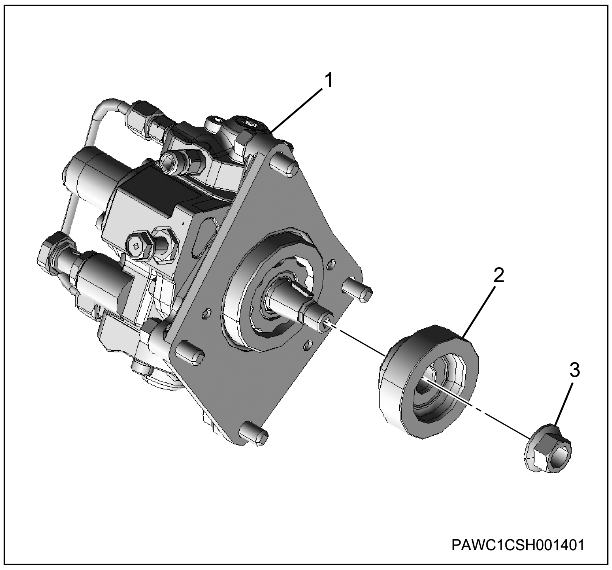
tightening torque： 19 N・m { 1.9 kgf・m / 14 lb・ft }



1. Fuel supply pump
2. Supply pump bracket

3. Install the supply pump gear to the fuel supply pump.

tightening torque： 64 N・m { 6.5 kgf・m / 47 lb・ft }



1. Fuel supply pump
2. Supply pump gear
3. Nut

4. Align the No.1 cylinder to compression top dead center.

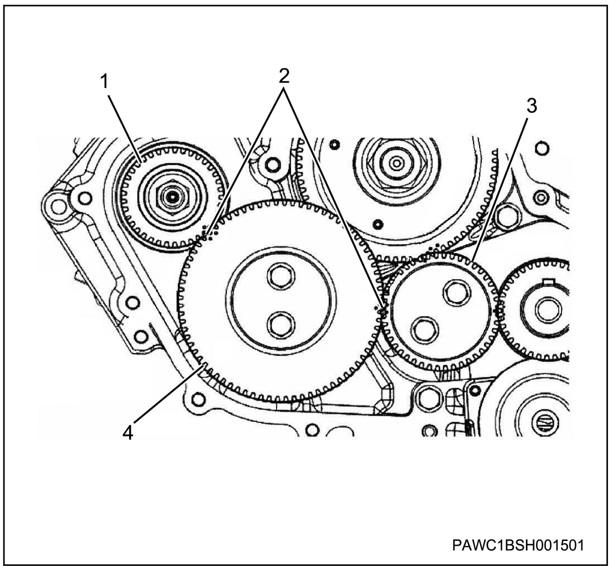
5. Install the O-ring to the fuel supply pump.

6. Install the fuel supply pump to the front oil pump plate.

Note：

- Align the alignment marks on the supply pump gear and idle gear B, and install.

tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft }



1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

7. Connect the harness connector to the fuel supply pump.

8. Idle gear B installation

1. Install the idle gear shaft to the cylinder block.
2. Apply engine oil to the idle gear.

Note :

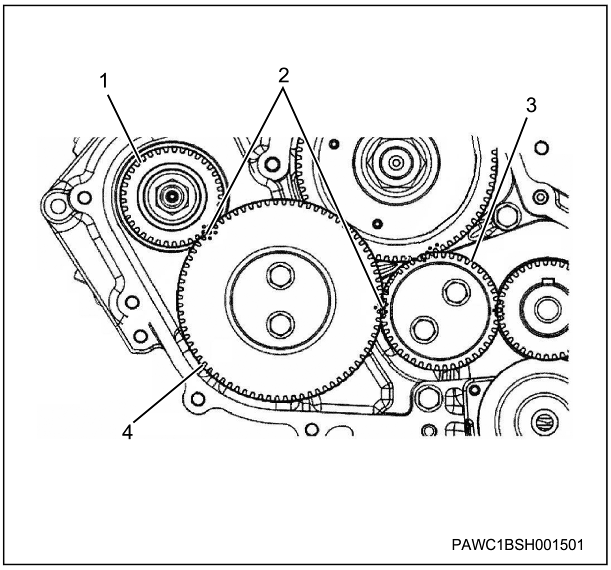
・ Apply to idle gear B and the idle gear shaft.

3. Install idle gear B to the idle gear shaft.

Note :

・ Install after meshing so as to align the idle gear B alignment marks with idle gear A and the supply pump gear.

tightening torque : 25.5 N・m { 2.6 kgf・m / 19 lb・ft }



1. Supply pump gear
2. Timing point
3. Idle gear A
4. Idle gear B

4. Apply engine oil to the idle gear.

Note :

・ Apply engine oil to the thrust collar, the bolt, and the threaded portion.

5. Install the thrust collar to the idle gear.

Note :

・ Install so that the chamfered side of the thrust collar faces the outside.

9. Fuel return pipe installation

1. Install the fuel return pipe to the fuel supply pump.

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M10

tightening torque : 17 N・m { 1.7 kgf・m / 13 lb・ft } M14

10. Fuel pipe installation

1. Temporarily tighten the fuel pipe to the fuel supply pump.
2. Temporarily tighten the fuel pipe to the common rail (fuel rail) assembly.

Caution :

・ Use a new fuel pipe.

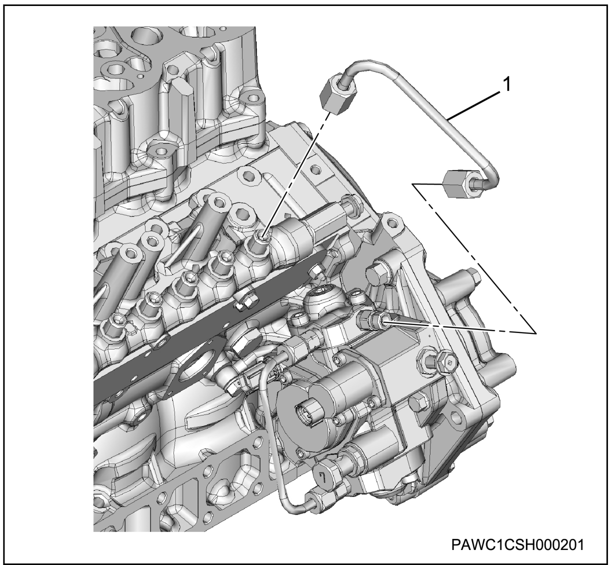
Note :

・ Verify that there is no dirt in the fuel pipe.

3. Securely tighten the fuel pipe to the fuel supply pump.

4. Securely tighten the fuel pipe to the common rail (fuel rail) assembly.

tightening torque： 44 N・m { 4.5 kgf・m / 32 lb・ft }



1. Fuel pipe

11. Timing gear case installation

1. Apply liquid gasket to the front oil pump plate.

Note：

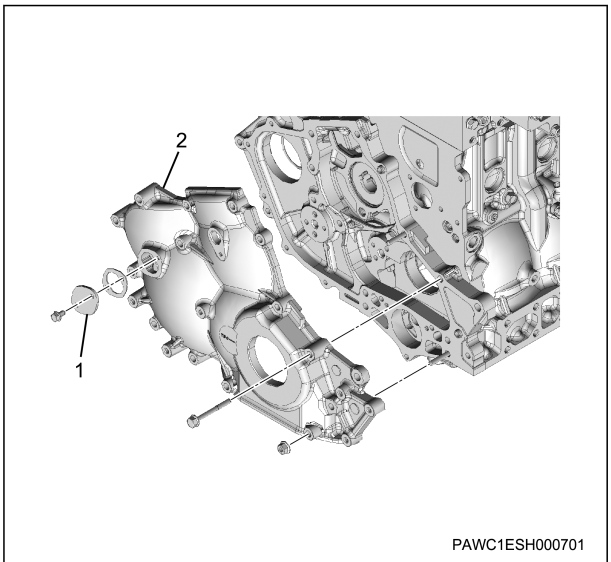
- Apply ThreeBond 1207B.

2. Install the timing gear case to the front oil pump plate.

tightening torque： 23.5 N・m { 2.40 kgf・m / 17 lb・ft }

3. Install the idle gear cover to the timing gear case.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Idle gear cover
2. Timing gear case

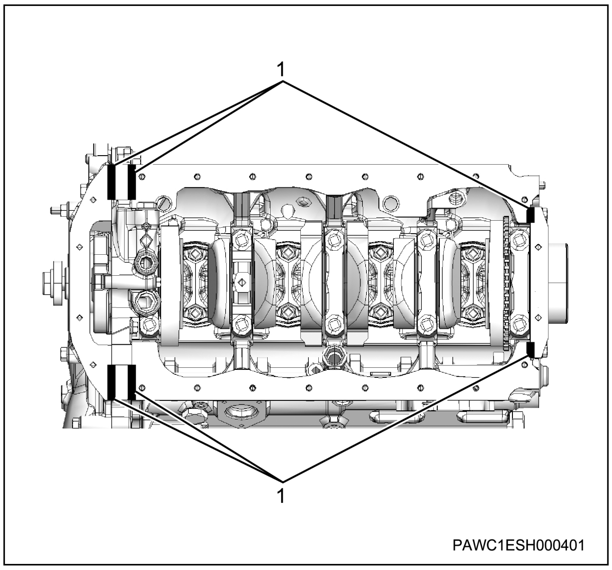
12. Oil pan installation

1. Apply liquid gasket to the cylinder block.

Note：

- Apply ThreeBond 1207B to the installation surface between the cylinder block and the front oil pump plate.

bead width： 3 mm { 0.12 in }



1. Liquid gasket application area

2. Install the oil pan to the cylinder block.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }

13. CMP sensor installation

1. Apply engine oil to the O-ring.
2. Install the CMP sensor to the timing gear case.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

3. Connect the harness connector to the CMP sensor.

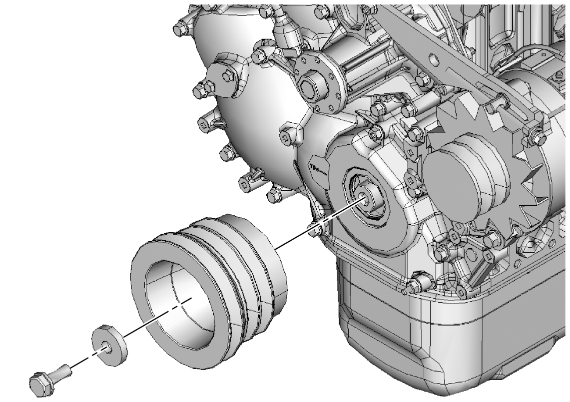
14. Crankshaft pulley installation

1. Install the crankshaft pulley to the crankshaft.

Caution：

- Do not reuse the bolt and the washer.

tightening torque： 177 N・m { 18.0 kgf・m / 131 lb・ft }



PAWC1BSH001601

15. Generator bracket installation
    1. Install the generator bracket to the cylinder block.

    tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8

    tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10

16. Generator installation
    1. Install the adjust plate to the water pump assembly.

    tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

    2. Temporarily tighten the generator to the generator bracket.
    3. Temporarily tighten the generator to the adjust plate.

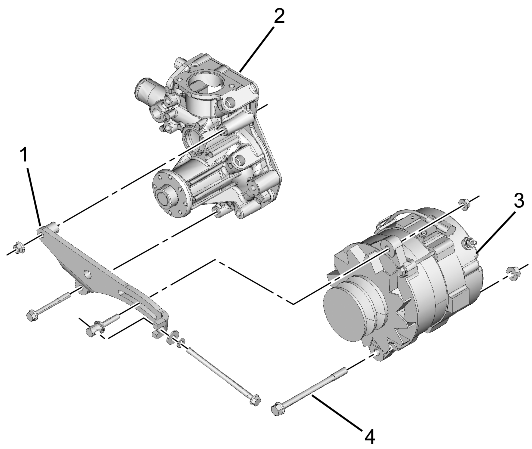
    Note :

    - Securely tighten the bolt and the nut after adjusting the cooling fan belt.

    4. Connect the harness connector to the generator.

    Note :

    - The diagram shows the 24 V - 50 A specification.



PAWC1ESH000501

1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

17. Fan pulley installation
    1. Install the fan pulley to the water pump assembly.

    tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }

18. Cooling fan belt installation
    1. Install the cooling fan belt to the pulley.

19. Cooling fan belt adjustment
    1. Check the tension of the cooling fan belt.

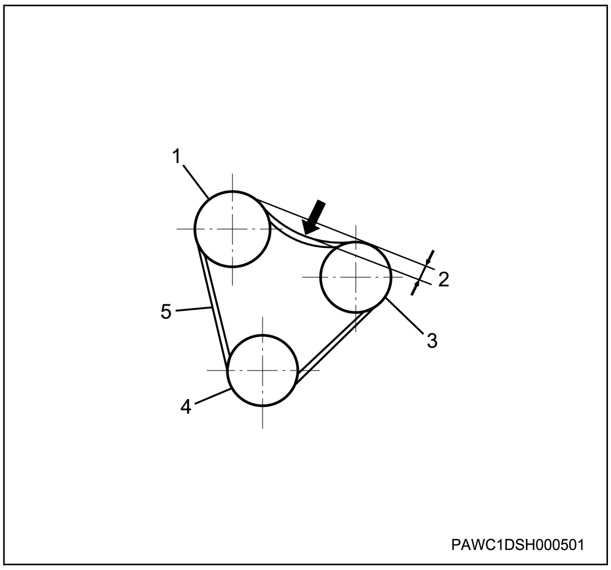
    Note :

    - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

    standard : 98 N { 10.0 kg / 22 lb }

    specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in } New product

    specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in } Reuse

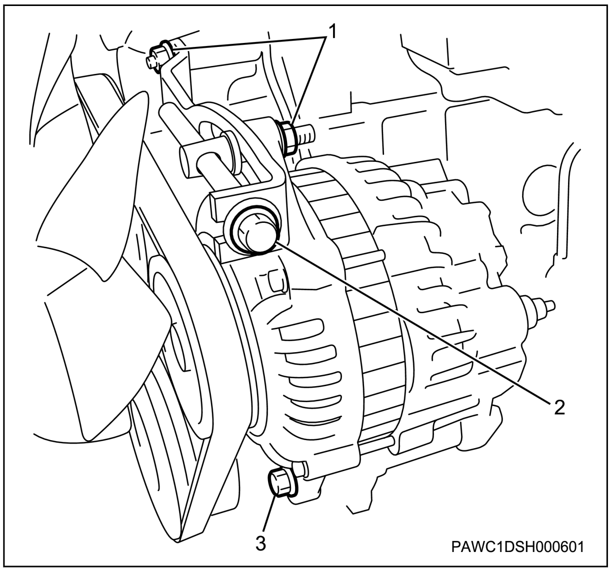


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

2. Adjust the cooling fan belt to the specified value using the adjust bolt.

tightening torque： 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

tightening torque： 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

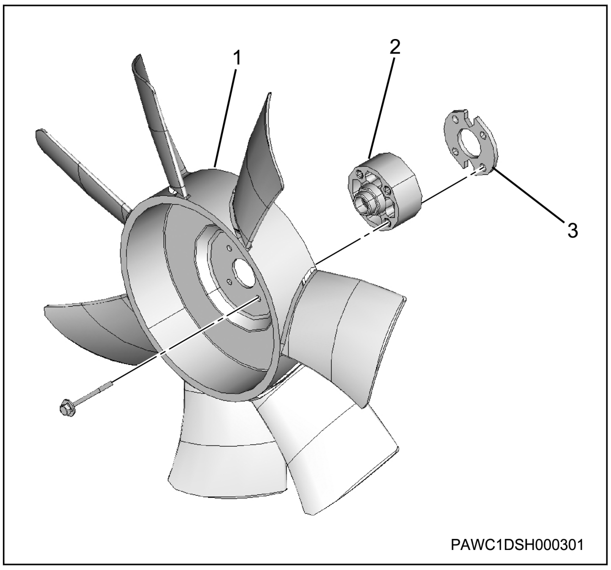


1. Nut
2. Adjust bolt
3. Mounting bolt

20. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

21. Engine oil filling

1. Refill the engine with engine oil.

Note：

- Check the tightening of the oil pan drain plug again.

22. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Oil cooler assembly

removal

1. Engine oil drain
   1. Drain the engine oil from the oil pan.

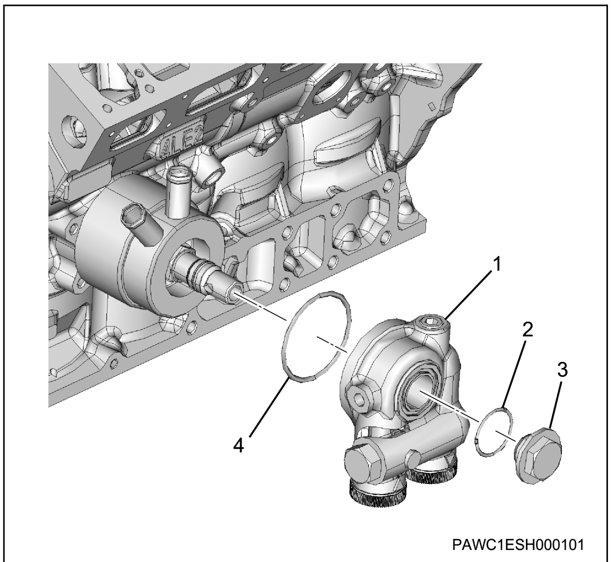
   Note :
   - After draining the oil, tighten the drain plug to the specified torque.

   tightening torque : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

   Caution :
   - Do not forget to tighten the drain plug.
2. Coolant drain
   1. Drain coolant from the radiator.

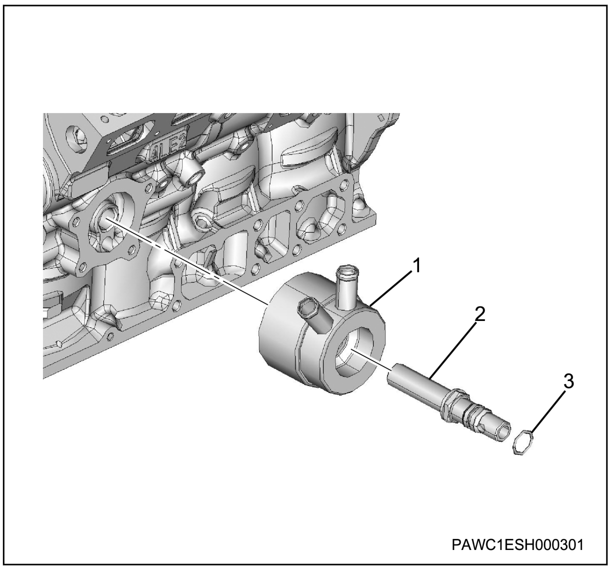
   Caution :
   - After draining the coolant, do not forget to tighten the drain plug.
3. Water outlet hose removal
   1. Remove the water outlet hose from the oil cooler assembly and the water pipe.
4. Water inlet hose removal
   1. Remove the water inlet hose from the oil cooler assembly and the cylinder block.
5. Oil cooler assembly removal
   1. Remove the oil cooler cover from the oil cooler assembly.

   Note :
   - Remove the plug, and remove the oil cooler cover and the O-ring.



1. Oil cooler
2. O-ring
3. Plug
4. O-ring

2. Remove the center bolt from the oil cooler assembly.
3. Remove the oil cooler assembly from the cylinder block.



1. Oil cooler
2. Center bolt
3. O-ring

installation

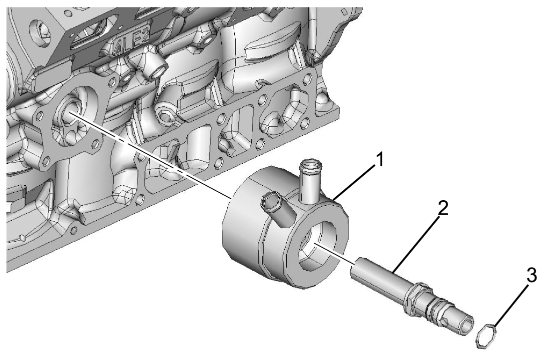
1. Oil cooler assembly installation
   1. Apply engine oil to the O-ring.

      Note :
      - Apply oil to the entire O-ring of the center bolt.
   2. Install the oil cooler assembly to the cylinder block.

      Note :
      - Apply LOCTITE 262 or equivalent to the center bolt.
   3. Install the center bolt to the oil cooler assembly.

      Caution :
      - Be careful not to twist the O-ring.

      tightening torque : 29.4 N・m { 3.0 kgf・m / 22 lb・ft }

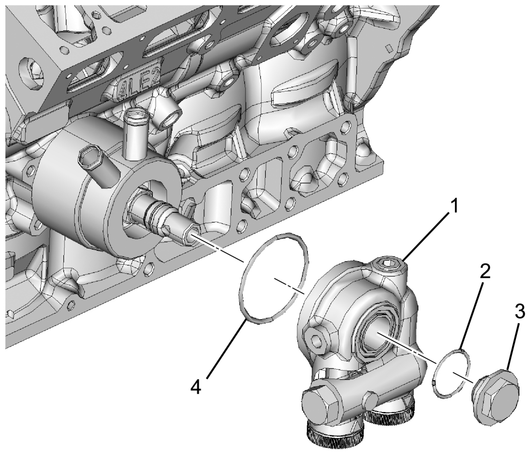


PAWC1ESH000301

1. Oil cooler
2. Center bolt
3. O-ring

   4. Install the oil cooler cover to the oil cooler assembly.

      tightening torque : 29.4 N・m { 3.0 kgf・m / 22 lb・ft }



PAWC1ESH000101

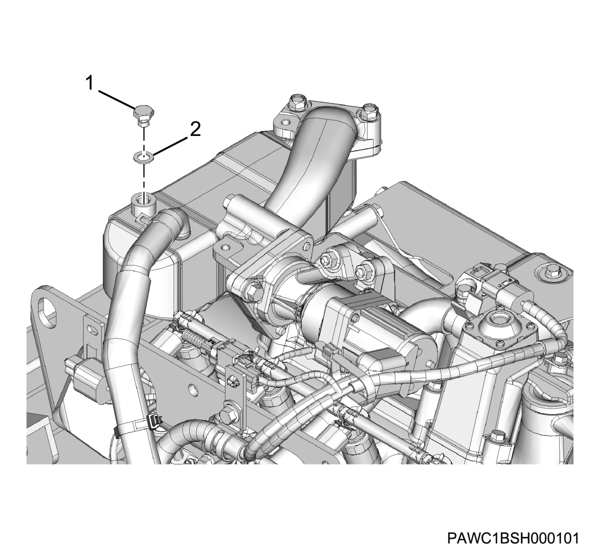
1. Oil cooler cover
2. O-ring
3. Plug
4. O-ring

2. Water inlet hose installation
   1. Install the water inlet hose to the oil cooler assembly and the cylinder block.
3. Water outlet hose installation
   1. Install the water outlet hose to the oil cooler assembly and the water pipe.
4. Coolant filling
   1. Loosen the plug using a wrench.
   2. Replenish the radiator with coolant.

      Caution :
      - Take care to prevent overflow coolant from splashing on to the exhaust system parts.
      - Wipe off any coolant overflow.
   3. Tighten the plug using a wrench.

      Caution :
      - Use a new gasket.

      tightening torque : 28 N・m { 2.9 kgf・m / 21 lb・ft }
   4. Replenish the radiator with coolant.



1. Plug
2. Gasket

5. Engine oil filling
   1. Refill the engine with engine oil.

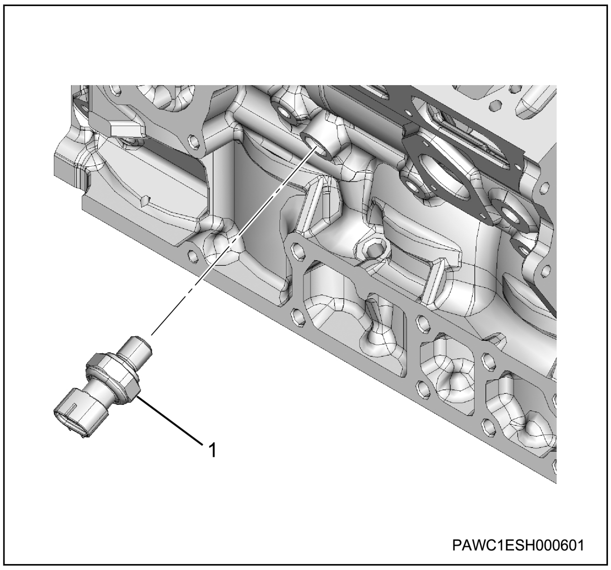
Note :

- Check the tightening of the oil pan drain plug again.

Oil pressure sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Oil pressure sensor removal
   1. Disconnect the harness connector from the oil pressure switch.
   2. Remove the oil pressure sensor from the cylinder block.

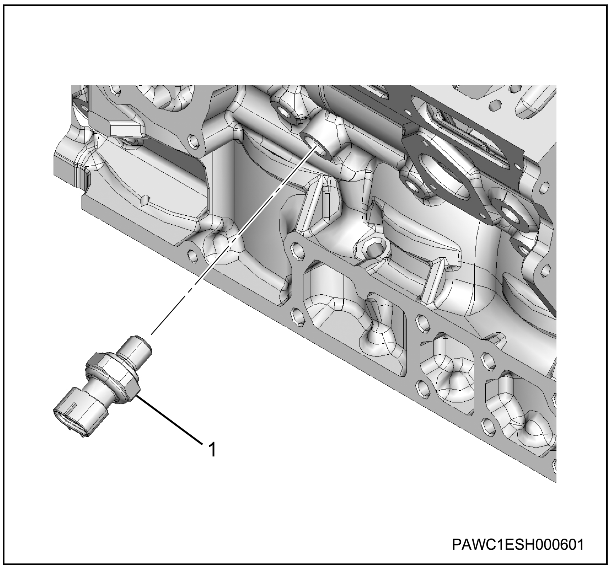


1. Oil pressure sensor

installation

1. Oil pressure sensor installation
   1. Install the oil pressure sensor to the cylinder block.

   tightening torque： 41 N・m { 4.2 kgf・m / 30 lb・ft }



1. Oil pressure sensor

   2. Connect the harness connector to the oil pressure sensor.
2. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Engine oil

inspection

1. Engine oil inspection

Caution :

- Make sure that the engine is in a level condition.
- Make sure that at least 5 minutes have passed after stopping the engine or before starting the engine.

1. Remove the oil level gauge from the oil level gauge guide tube.

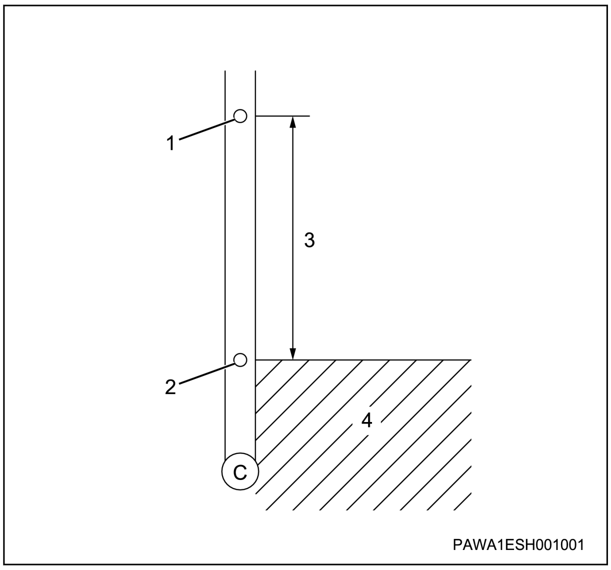
Note :

- Wipe off the engine oil attached to the oil level gauge.

2. Install the oil level gauge to the oil level gauge guide tube.
3. Remove the oil level gauge from the oil level gauge guide tube.
4. Inspect the engine oil.

Note :

- Check the engine oil attached to the oil level gauge, and inspect the engine oil level.

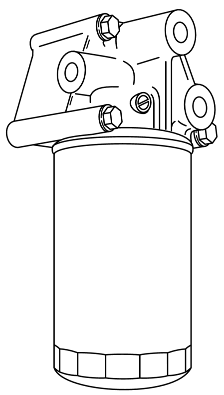


1. MAX
2. MIN
3. Acceptable oil amount
4. Requires replenishment

Oil filter element

removal

1. Oil filter element removal
   1. Remove the oil filter element from the oil filter body.

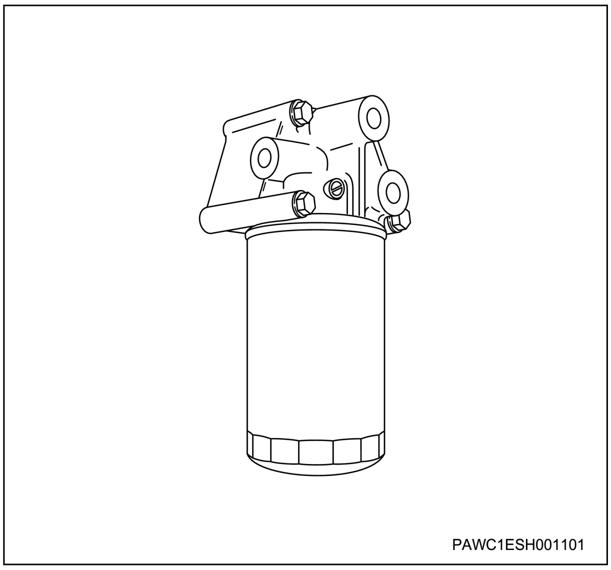


PAWC1ESH001101

installation

1. Oil filter element installation
   1. Install the oil filter element to the oil filter body.

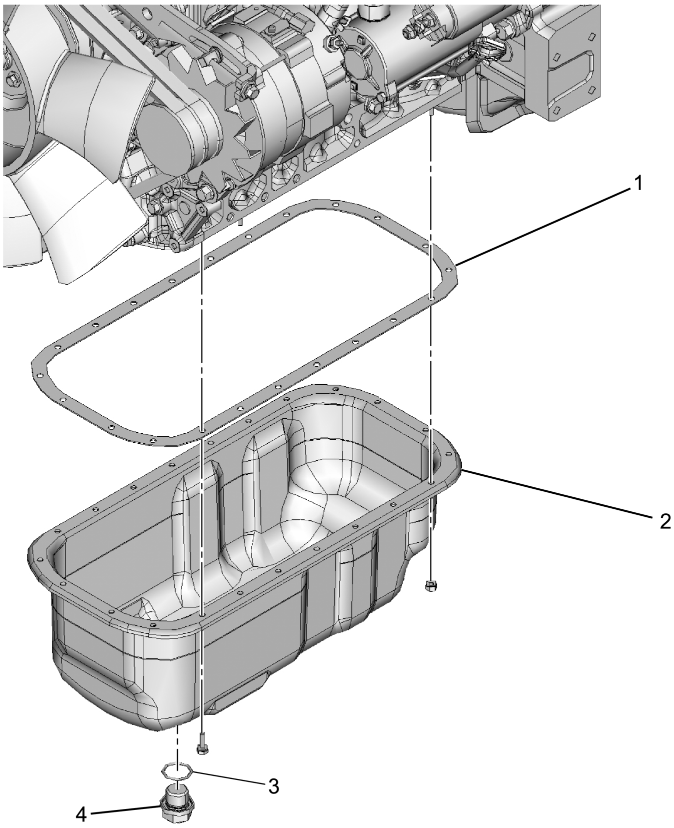
   tightening torque : 15 N・m { 1.5 kgf・m / 11 lb・ft }



Supplementary Information

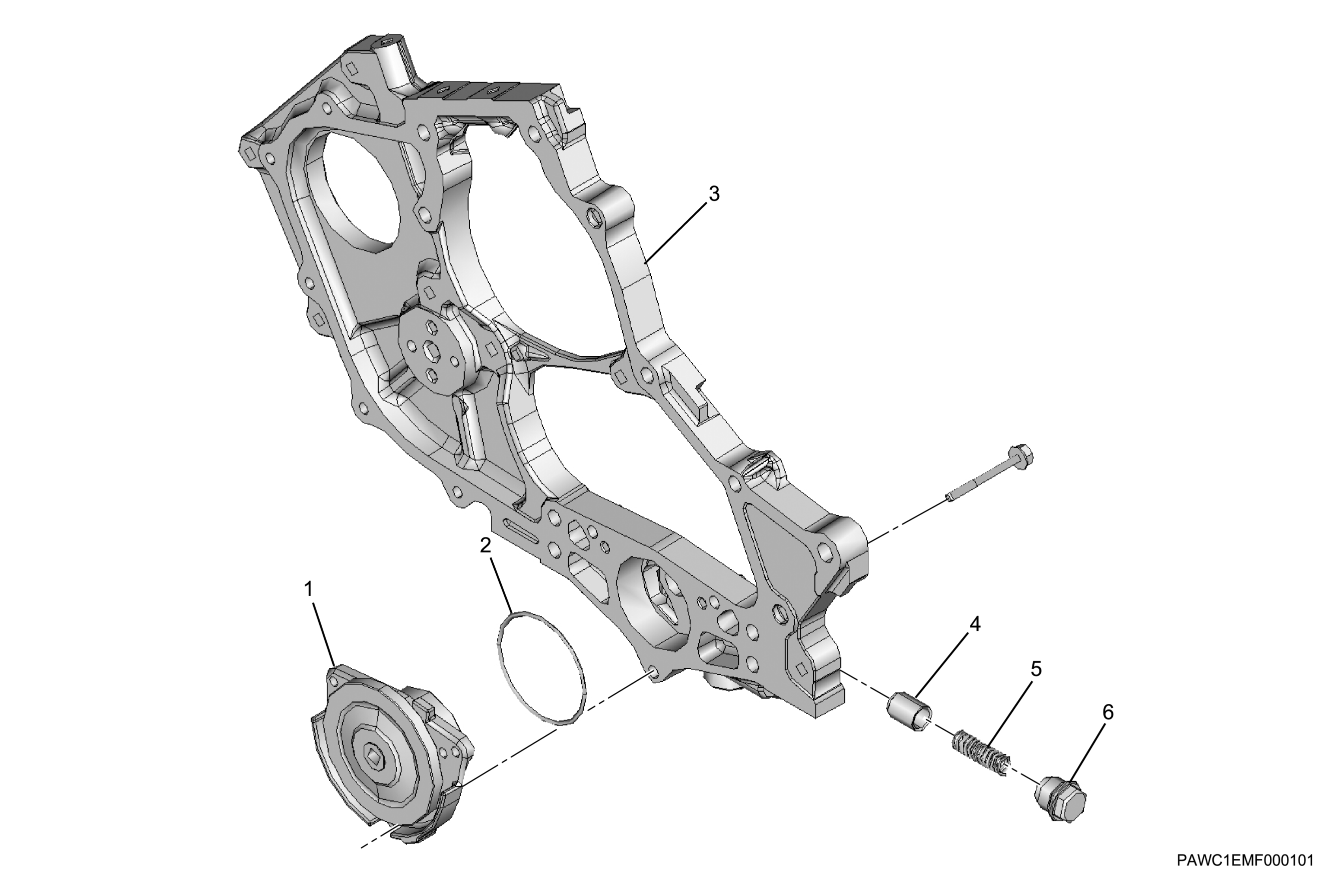
1. Component Views

Note：
- Oil pan



1. Gasket
2. Oil pan
3. Gasket
4. Drain plug

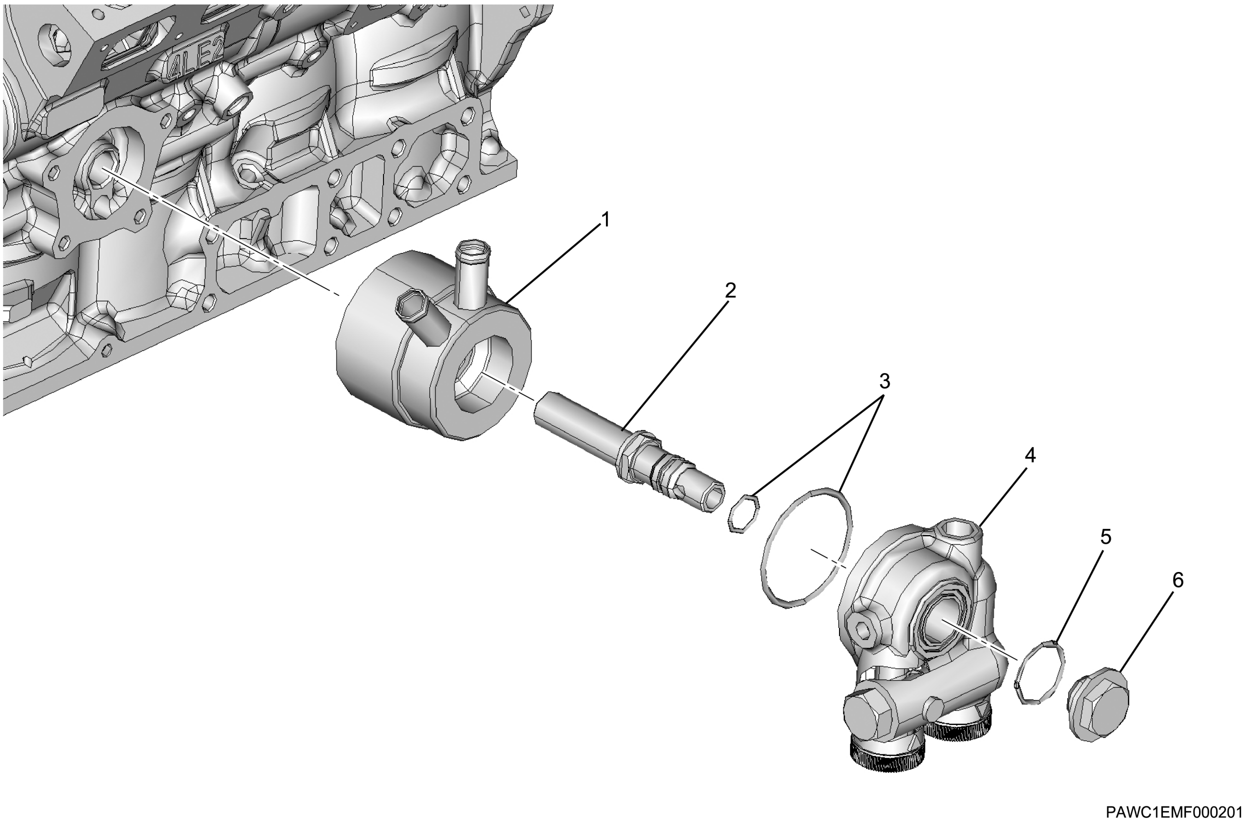
Note：
- Oil pump assembly



1. Oil pump assembly
2. O-ring
3. Front oil plate
4. Relief valve
5. Spring
6. Plug

Note：

- Oil cooler assembly

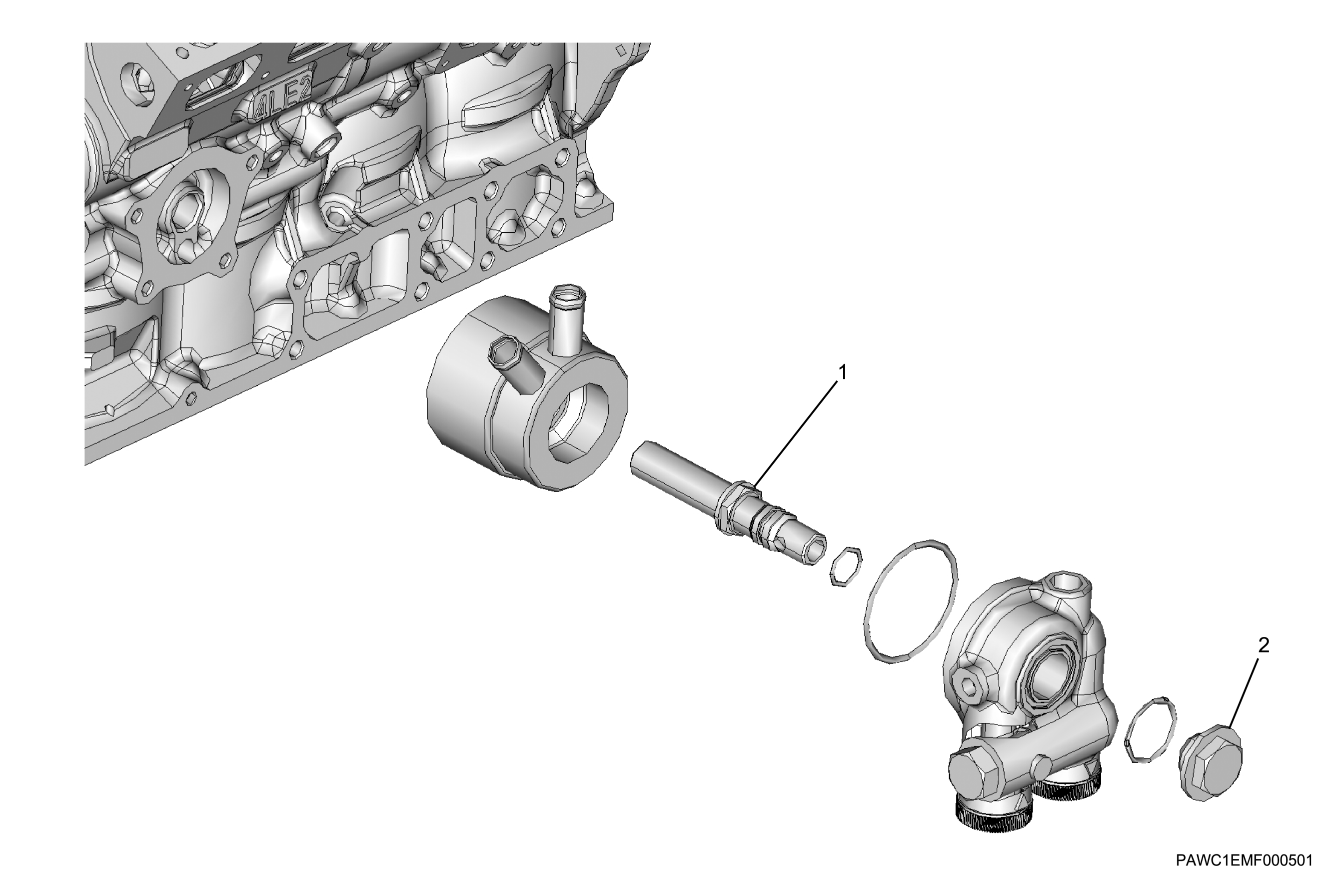


1. Oil cooler
2. Center bolt
3. O-ring
4. Oil cooler cover
5. O-ring
6. Plug

2. Tightening Torque Views

Note：

・ Oil cooler assembly

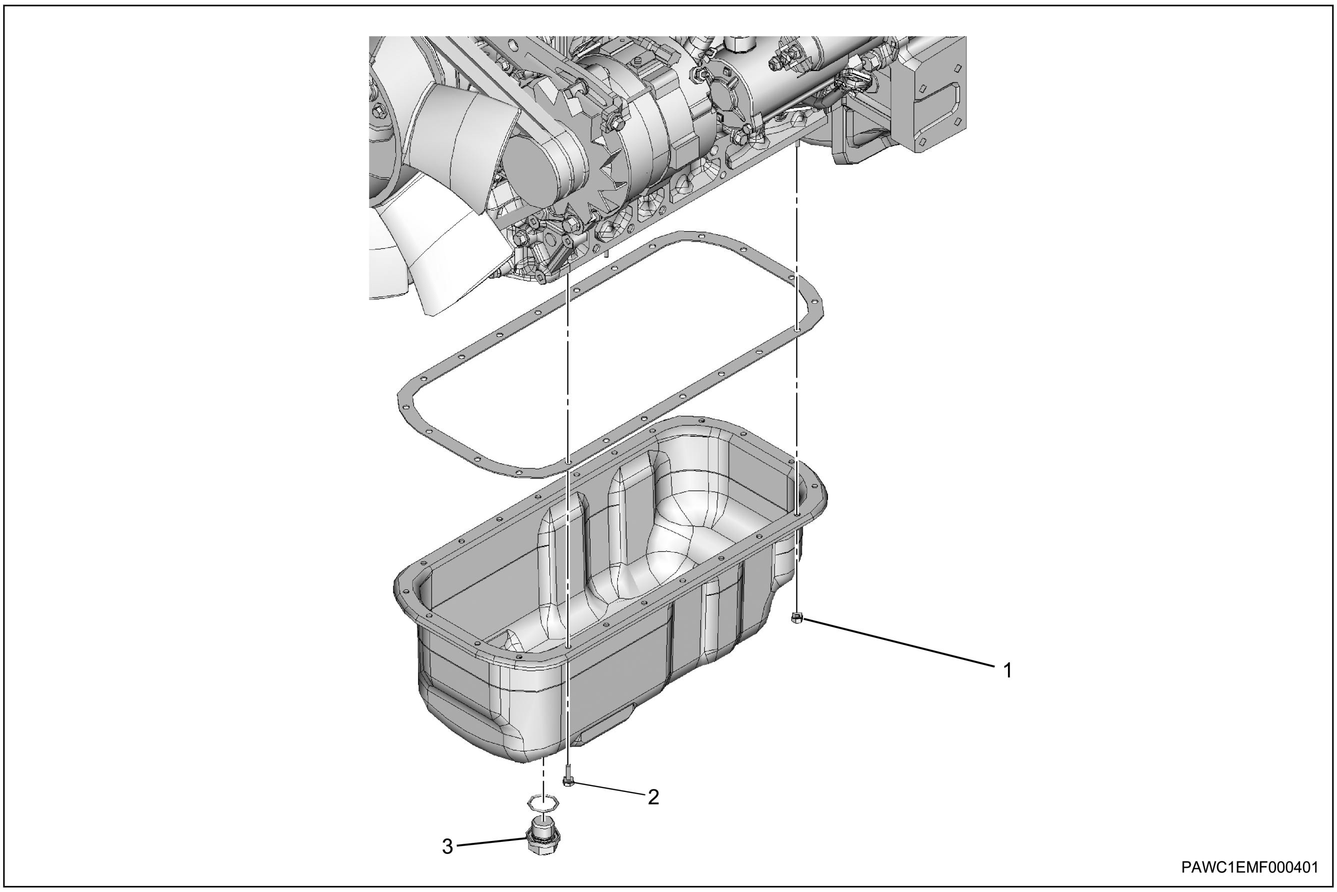


1 : 29.4 N・m { 3.0 kgf・m / 22 lb・ft }

2 : 29.4 N・m { 3.0 kgf・m / 22 lb・ft }

Note :

・ Oil pan



1 : 10 N・m { 1.0 kgf・m / 89 lb・in }

2 : 10 N・m { 1.0 kgf・m / 89 lb・in }

3 : 78.5 N・m { 8.0 kgf・m / 58 lb・ft }

Engine

Induction

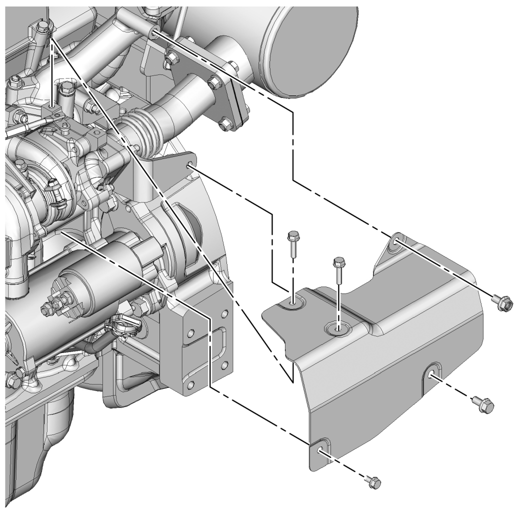
(4LE2)

Table of Contents

Turbocharger assembly

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Turbocharger heat protector removal
   1. Remove the turbocharger heat protector from the turbocharger.



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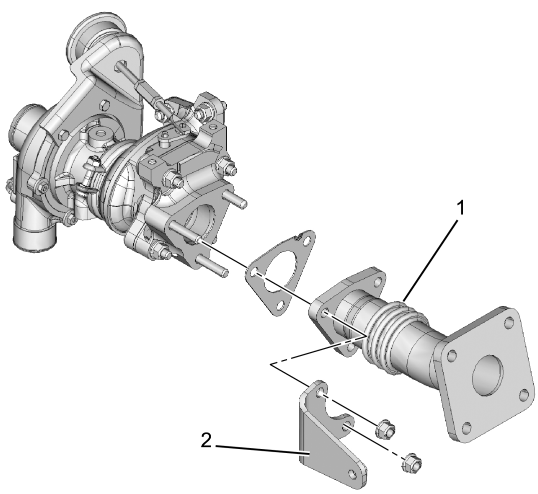
3. Integrated oxidation catalyst silencer removal
   1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
   2. Remove the exhaust pipe from the turbocharger assembly.

Note :

- Remove together with the bracket.



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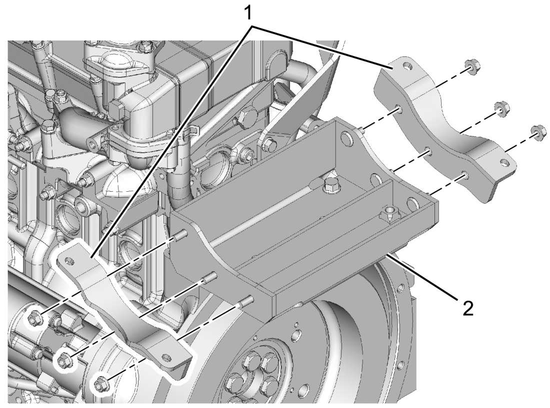
1. Exhaust pipe
2. Bracket

3. Remove the support bracket from the silencer bracket.



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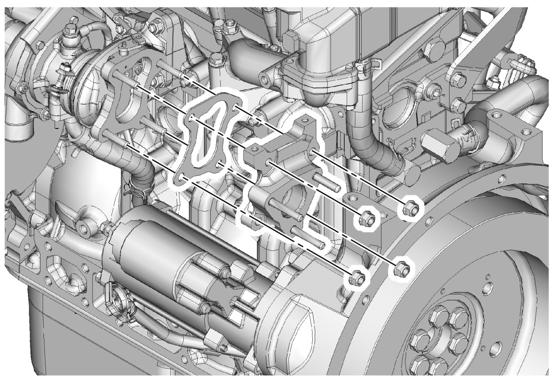
1. Support bracket
2. Silencer bracket

4. Turbocharger assembly removal
   1. Remove the exhaust pipe adapter from the turbocharger assembly.



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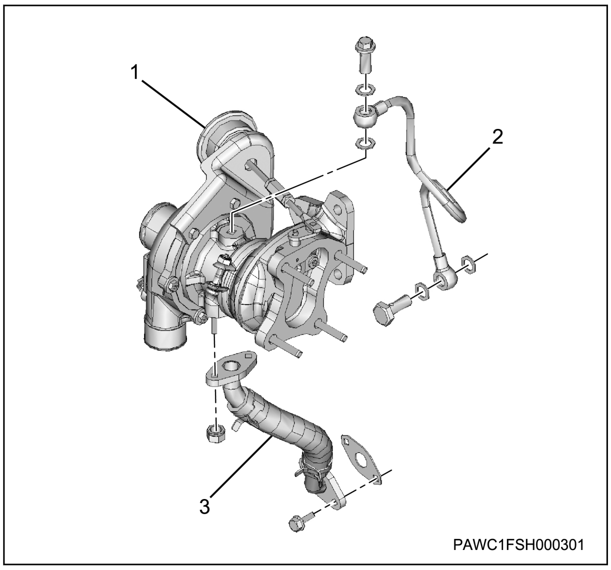
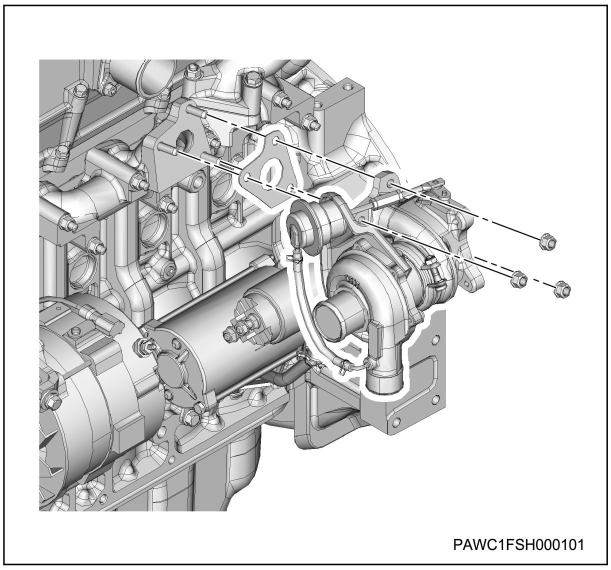
   2. Remove the oil feed pipe from the turbocharger assembly and the cylinder block.
   3. Remove the oil return pipe from the turbocharger assembly and the cylinder block.



1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

4. Remove the turbocharger assembly from the exhaust manifold.

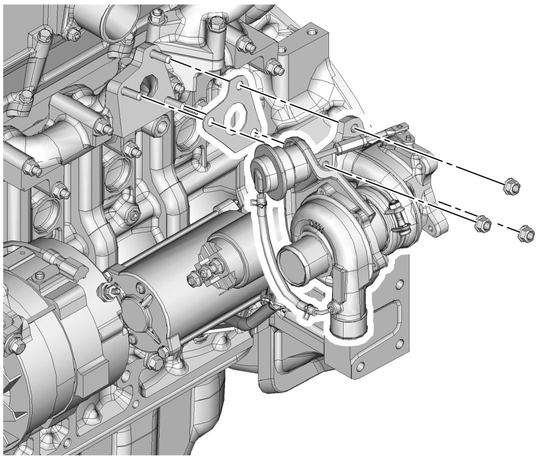


installation

1. Turbocharger assembly installation
   1. Install the turbocharger assembly to the exhaust manifold.

      Note：
      - Fill with 5 - 10 cc of engine oil from the oil feed port.

      tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



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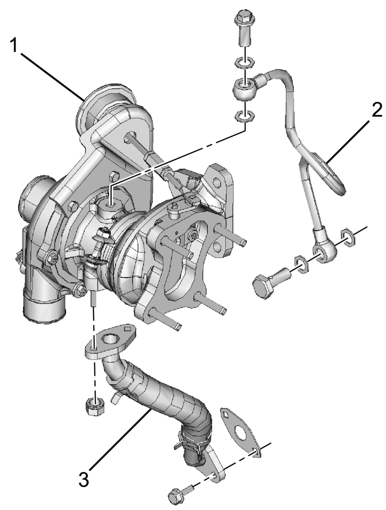
   2. Install the oil feed pipe to the cylinder block and the turbocharger assembly.

      tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft } Cylinder block side

      tightening torque： 22 N・m { 2.2 kgf・m / 16 lb・ft } Turbocharger side

   3. Install the oil return pipe to the cylinder block and the turbocharger assembly.

      tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



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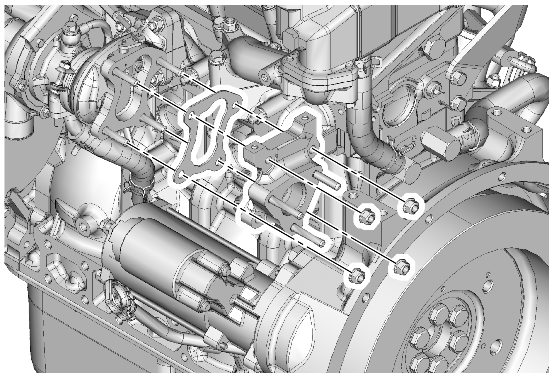
1. Turbocharger assembly
2. Oil feed pipe
3. Oil return pipe

   4. Install the exhaust pipe adapter to the turbocharger assembly.

      tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



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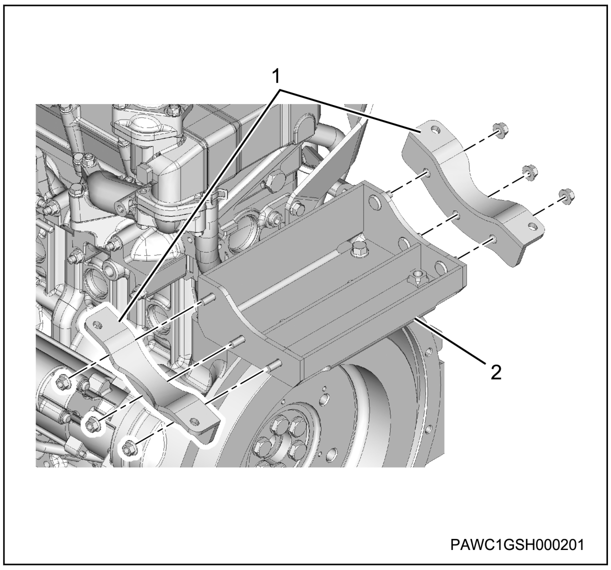
2. Integrated oxidation catalyst silencer installation
   1. Temporarily tighten the support bracket to the silencer bracket.

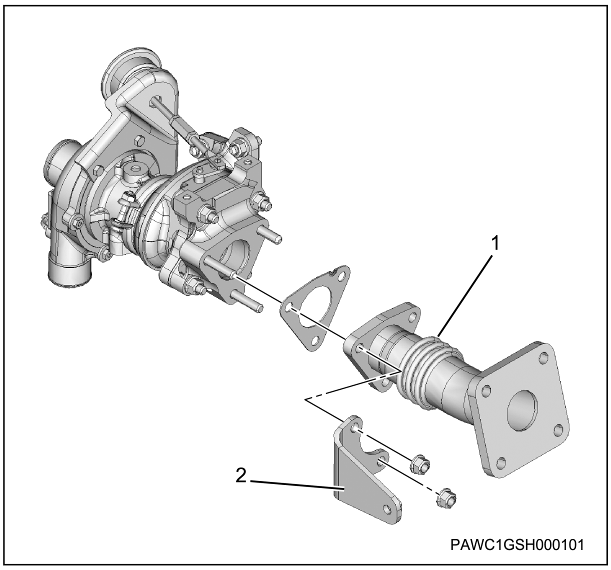


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

- Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.
4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

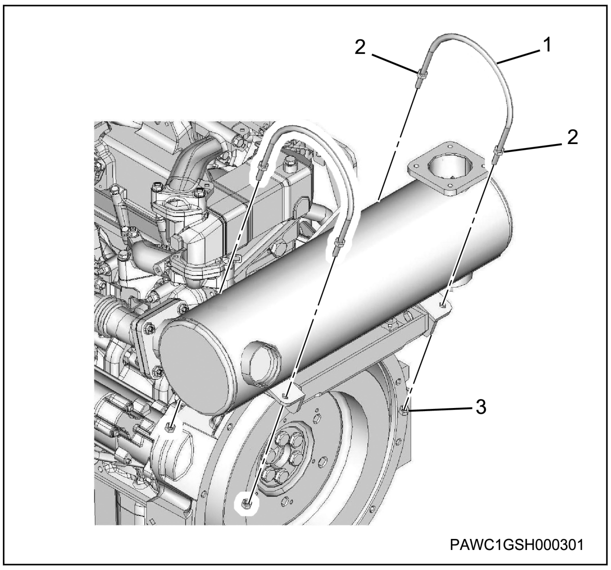
Note：

- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

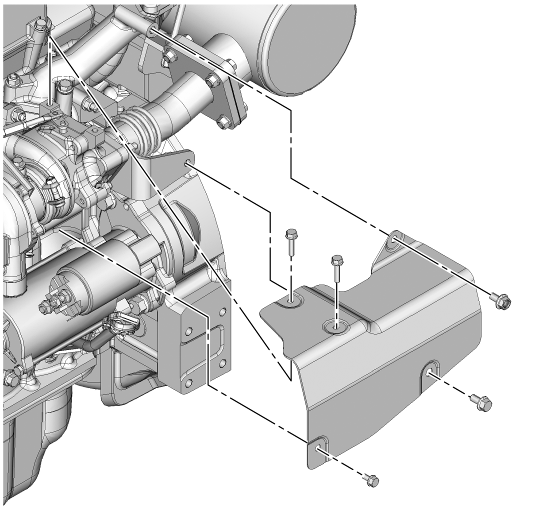
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

3. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft } M8

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in } M6



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4. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Intercooler

inspection

1. Intercooler inspection
   1. Inspect the intercooler.

   Note :
   - Inspect the fins for collapsing.
   - Remove dirt or other foreign material.

   Caution :
   - When repairing the fins, be careful not to damage the base of the fins.
   - Inspect the inside of the intercooler for filth, and if it is significantly dirty, clean it.
   - If the fins are clogged, clean them.
2. Intercooler cleaning

   Caution :
   - Before cleaning, seal the hose connecting sections using caps, cloth tapes, etc.

   1. Clean the intercooler using tap water.

   Note :
   - Thoroughly wash off fouling that can be removed by splashing tap water.

   Caution :
   - At this time, do not use a high-pressure washing machine or brush.

   2. Apply detergent to the intercooler.

   Note :
   - Apply a type of mild detergent that contains approx. 8% surface acting agent, and leave for 10 minutes.

   Caution :
   - Do not use material other than mild detergent, because it may cause corrosion.

   3. Clean the intercooler using a high-pressure washing machine.

   Caution :
   - High-pressure water should be applied perpendicular to the fins from the engine side of the intercooler.

   Note :
   - If dirt is not washed off sufficiently, repeat the cleaning.

   4. Clean the intercooler using tap water.

   Caution :
   - Sufficiently rinse off the detergent ingredient to prevent it from remaining on the core and the resin portions.

   5. Clean the connecting section using tap water.

   Note :
   - Remove the seals, and clean the hose connecting sections.

Air cleaner element

inspection

1. Air cleaner element inspection
   1. Inspect the air cleaner element.

   Note :

   - Inspect the air cleaner element for damage or thinned portion.

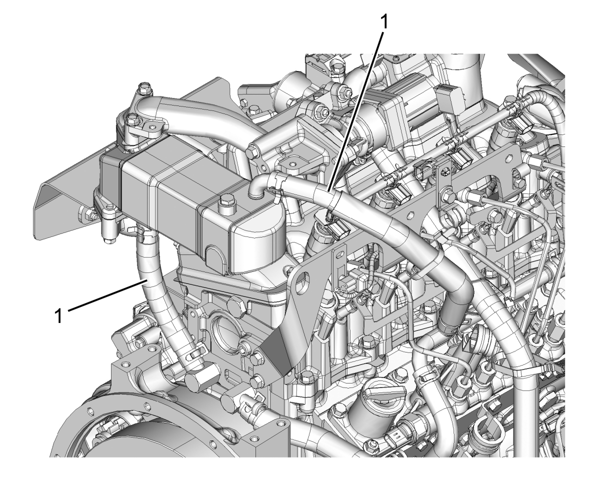
IMT sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.



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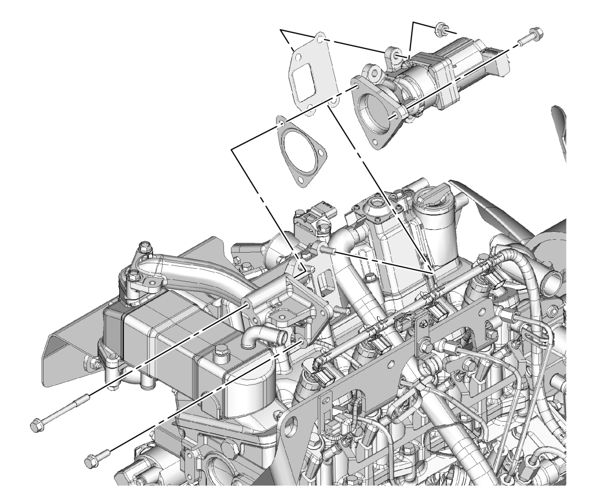
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.



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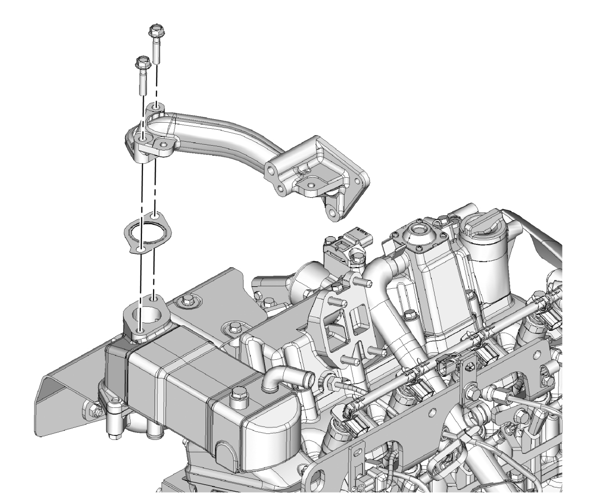
5. Remove the EGR pipe from the EGR cooler.



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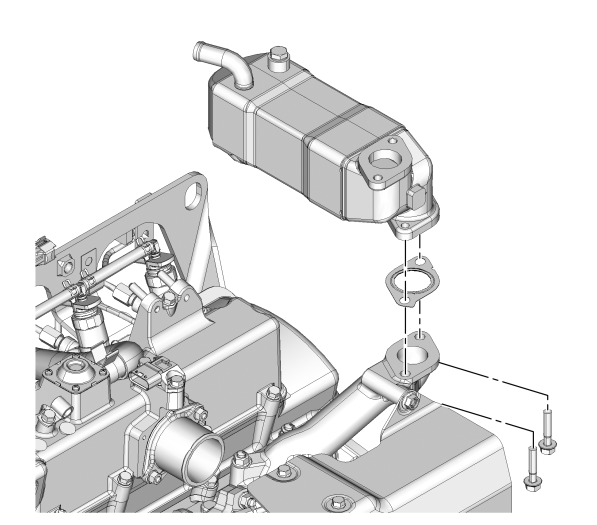
6. Remove the EGR cooler from the EGR pipe.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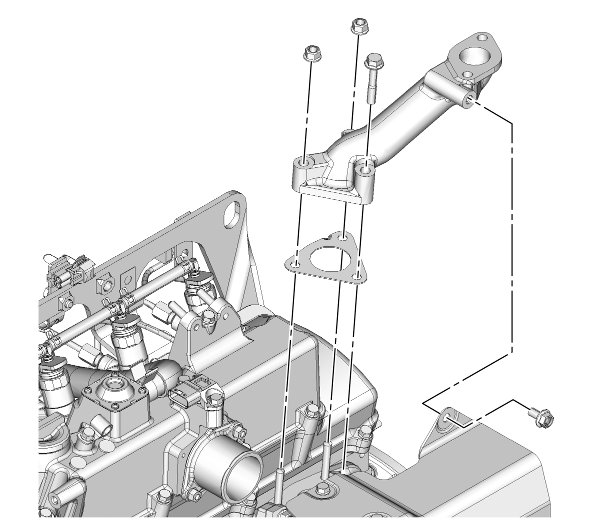
7. Remove the EGR pipe from the exhaust manifold.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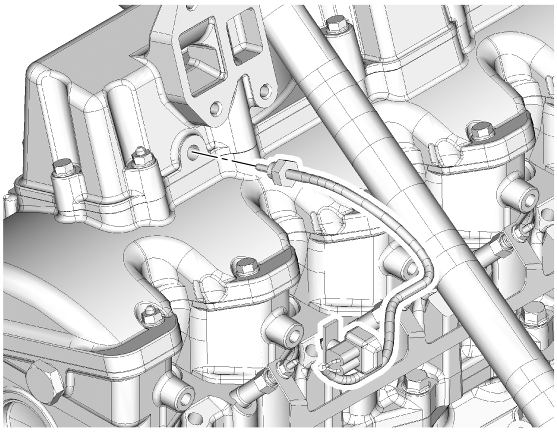
4. IMT sensor removal
   1. Disconnect the harness connector from the IMT sensor.
   2. Remove the IMT sensor from the intake chamber.

installation

1. IMT sensor installation
   1. Install the IMT sensor to the intake chamber.

   tightening torque： 20 N・m { 2.0 kgf・m / 15 lb・ft }



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   2. Connect the harness connector to the IMT sensor.
2. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

   Note：

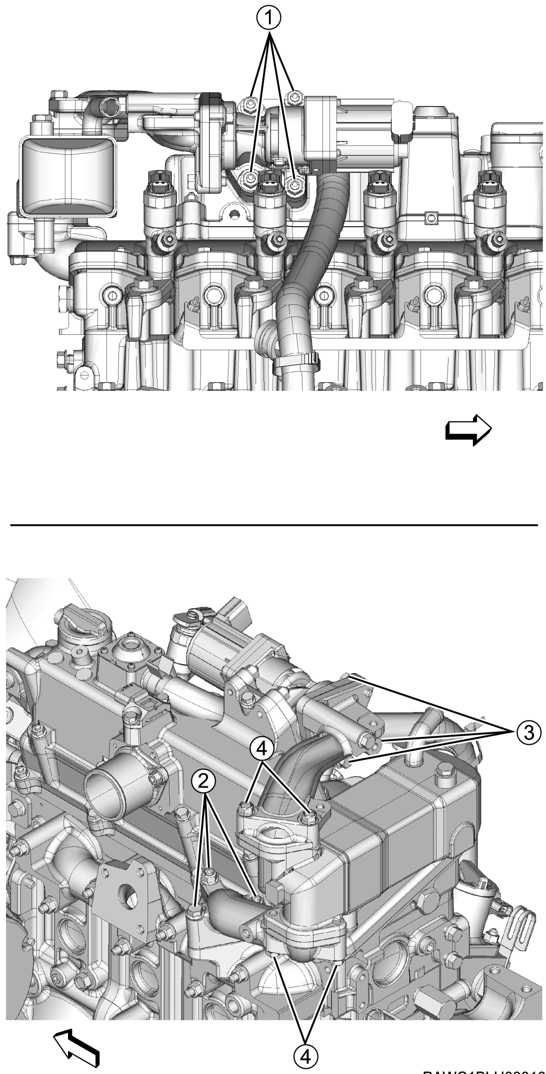
   - Temporarily tighten the entire component until seated.

   5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

   Note：

   - After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

   tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }



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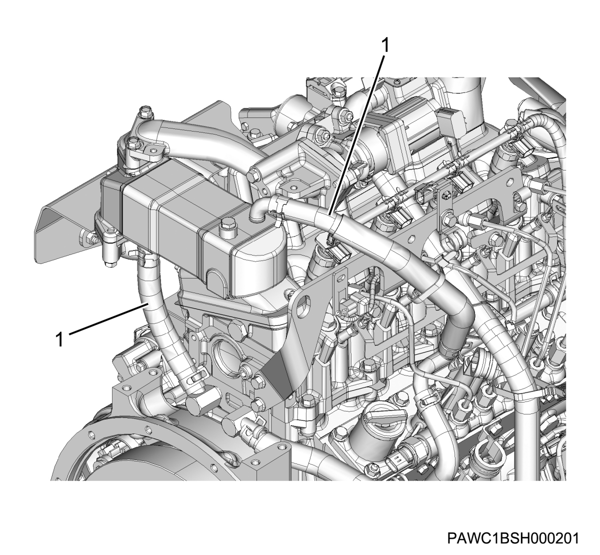
   Note：

   - Tighten the heat protector tightening bolts.

   tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

   6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

3. Coolant filling

1. Loosen the plug using a wrench.

2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

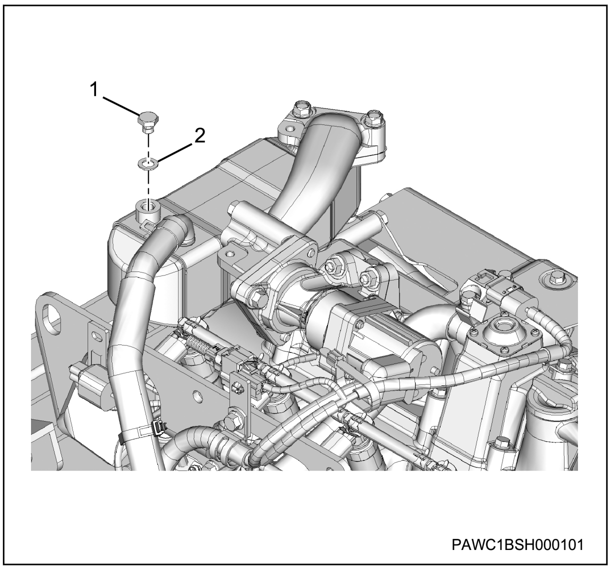
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug
2. Gasket

4. Battery ground cable connect

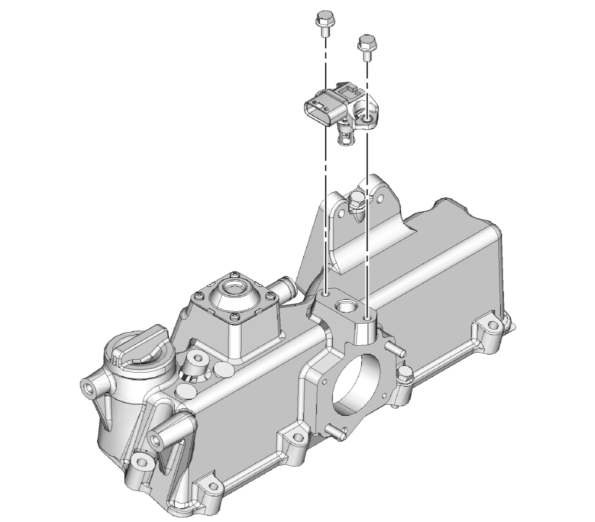
1. Connect the battery ground cable to the battery.

Pressure sensor/boost temperature sensor

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Pressure sensor/boost temperature sensor disconnect
   1. Disconnect the harness connector from the boost pressure sensor/boost temperature sensor.

   Note :
   - Remove the harness clip.
3. Pressure sensor/boost temperature sensor removal
   1. Remove the boost pressure sensor/boost temperature sensor from the intake chamber.



PAWC1BSH000901

inspection

1. Pressure sensor/boost temperature sensor inspection
   1. Inspect the boost pressure sensor/boost temperature sensor.

   Note：
   - Body fouling
   - Body damage
   - Terminal malfunction

   Caution：
   - The sensor body must not be cleaned because doing so may damage the sensor internally.

installation

1. Pressure sensor/boost temperature sensor installation
   1. Install the boost pressure sensor/boost temperature sensor to the intake chamber.

   tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }
2. Pressure sensor/boost temperature sensor connect
   1. Connect the harness connector to the boost pressure sensor/boost temperature sensor.

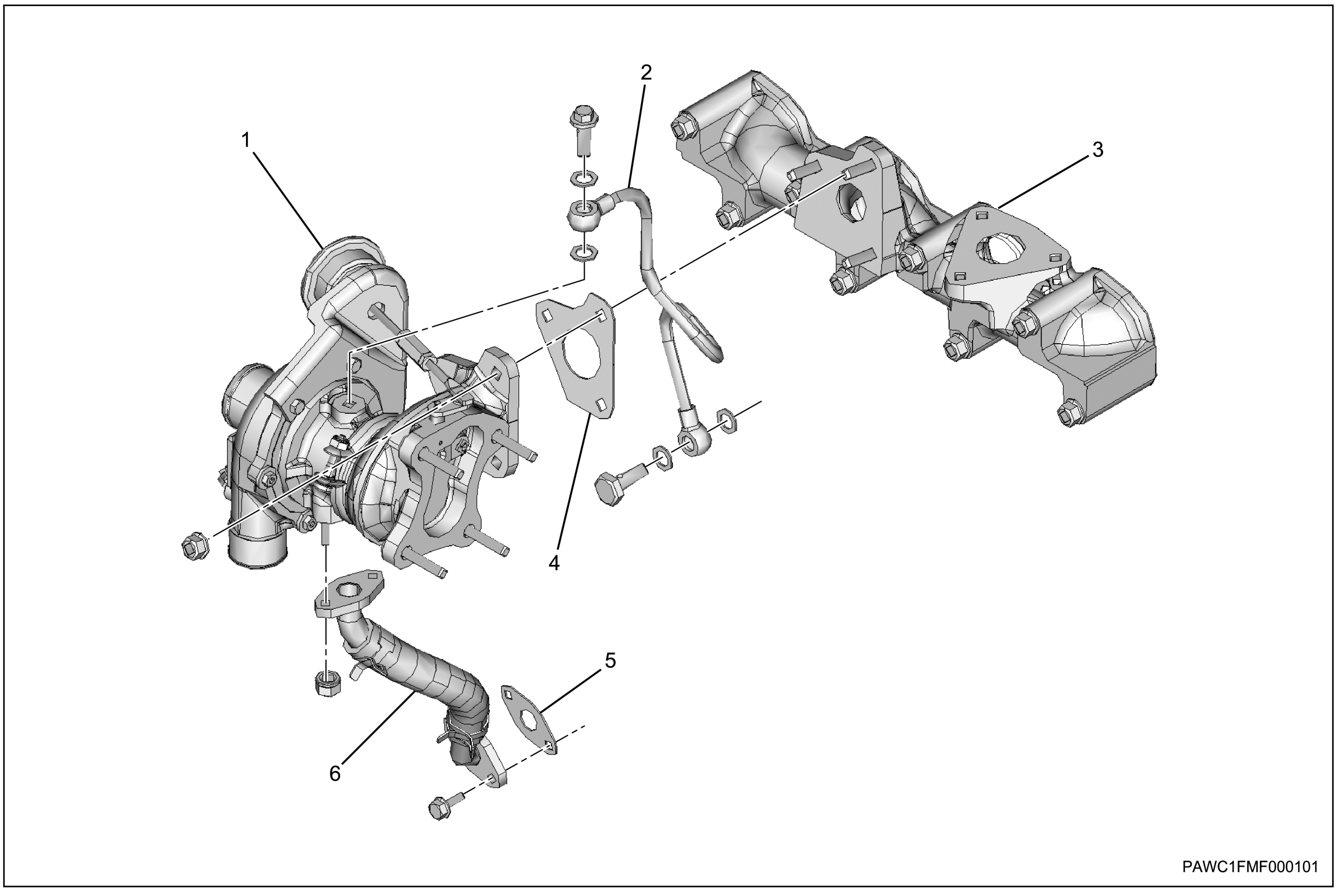
   Note：
   - Install the harness clip.
3. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Supplementary Information

1. Component Views

Note：

- Turbocharger assembly

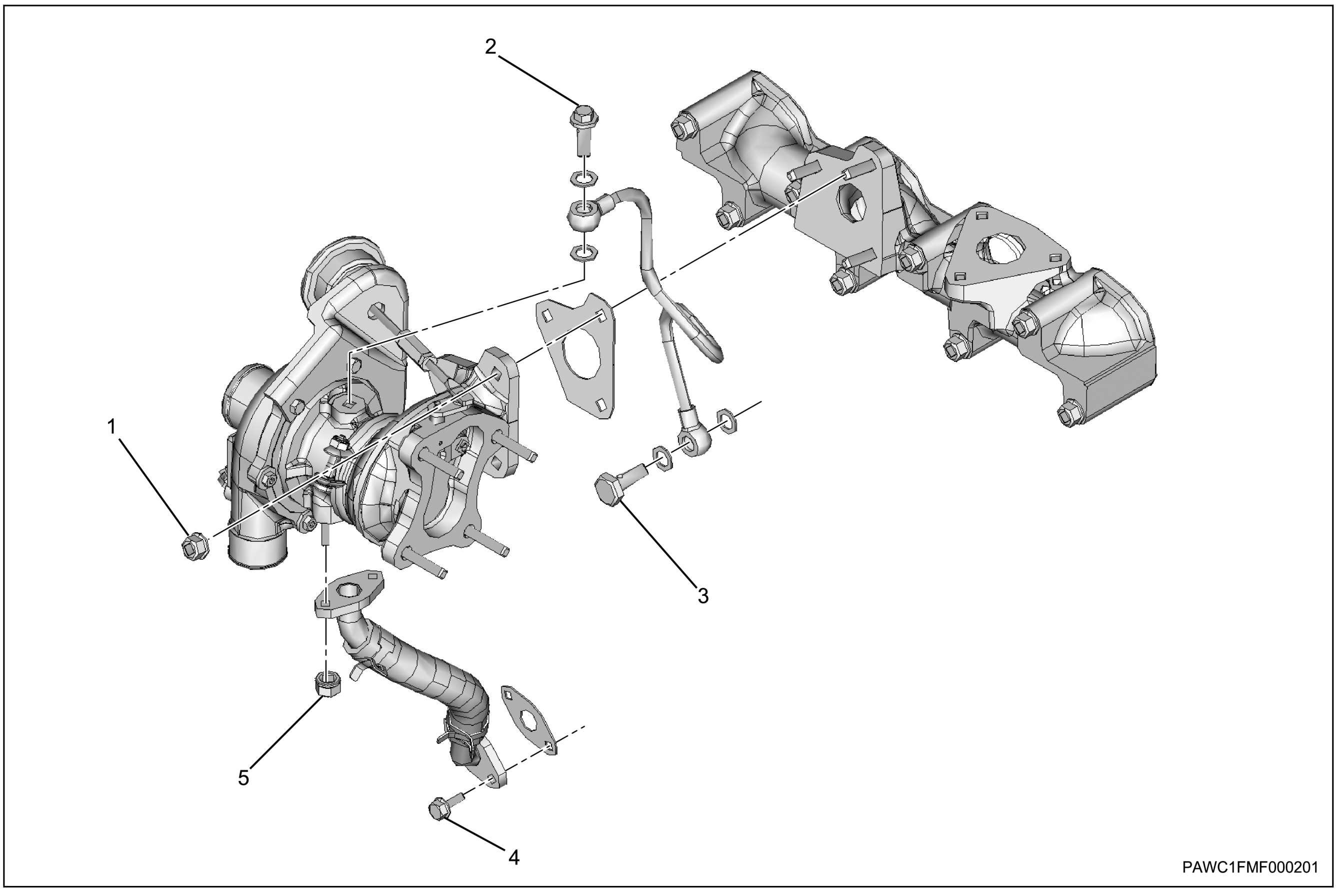


1. Turbocharger assembly
2. Oil feed pipe
3. Exhaust manifold
4. Gasket
5. Gasket
6. Oil return pipe

2. Tightening Torque Views

Note：

- Turbocharger assembly



1 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

2 : 22 N・m { 2.2 kgf・m / 16 lb・ft }

3 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

4 : 10 N・m { 1.0 kgf・m / 89 lb・in }

5 : 10 N・m { 1.0 kgf・m / 89 lb・in }

Engine

Exhaust

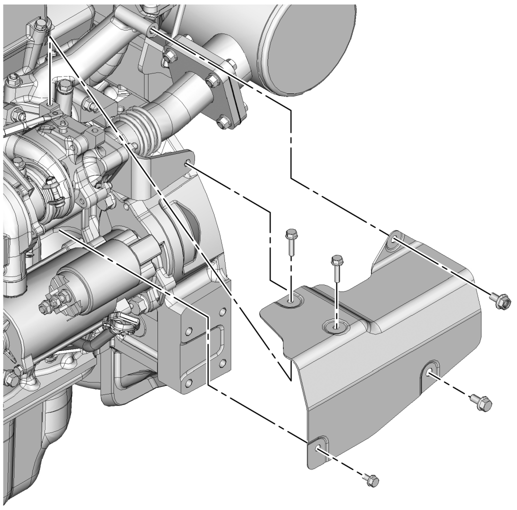
(4LE2)

Table of Contents

Integrated oxidation catalyst silencer

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Turbocharger heat protector removal
   1. Remove the turbocharger heat protector from the turbocharger.



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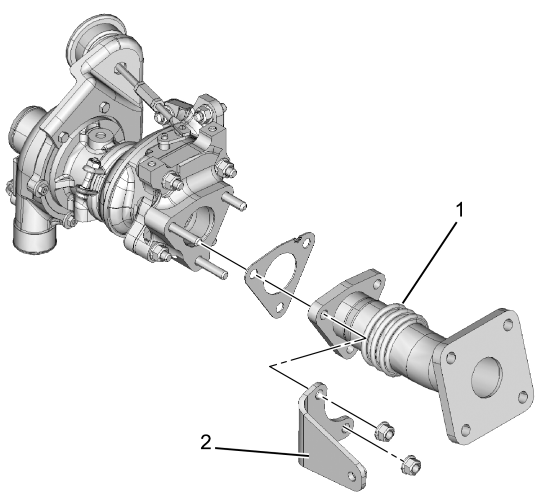
3. Integrated oxidation catalyst silencer removal
   1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
   2. Remove the exhaust pipe from the turbocharger assembly.

Note：

- Remove together with the bracket.



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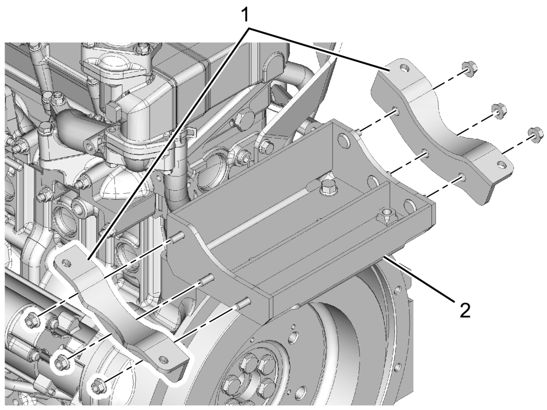
1. Exhaust pipe
2. Bracket

3. Remove the support bracket from the silencer bracket.



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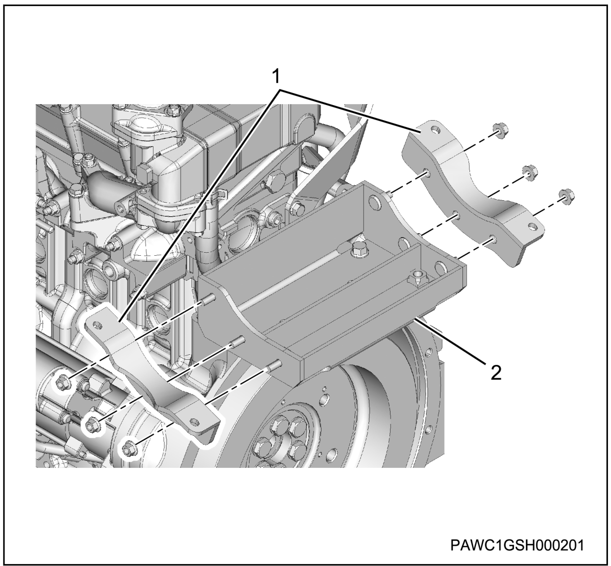
1. Support bracket
2. Silencer bracket

installation

1. Integrated oxidation catalyst silencer installation

   1. Temporarily tighten the support bracket to the silencer bracket.

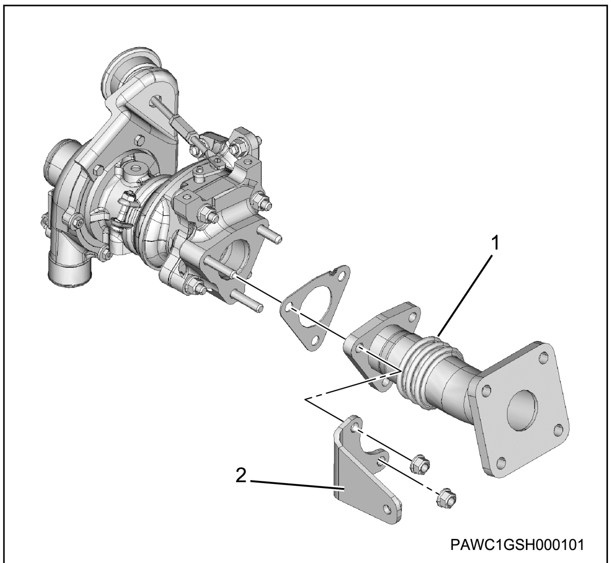


1. Support bracket
2. Silencer bracket

   2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

・ Install together with the bracket.



1. Exhaust pipe
2. Bracket

   3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.

   4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

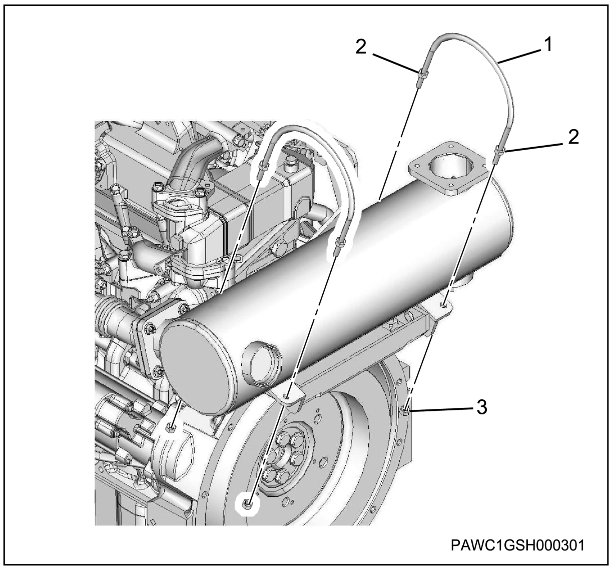
Note：

・ Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
・ With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
・ Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

・ Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
・ Install so that the U-bolts are not tilted.



1. U-bolt
2. Nut A
3. Nut B

   5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

・ Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
・ Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

   6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

   7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

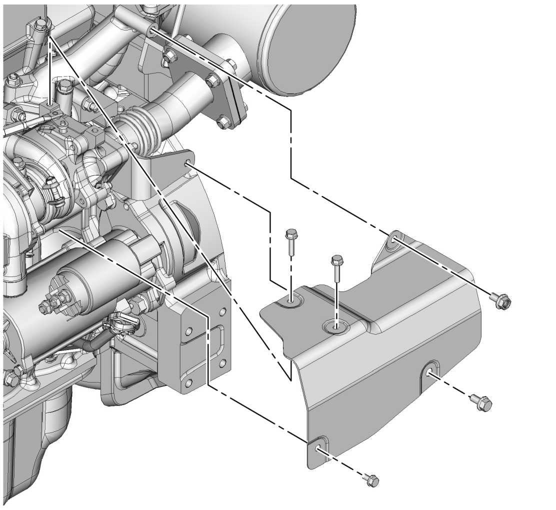
tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }

2. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }
M8

tightening torque : 10 N・m { 1.0 kgf・m / 89 lb・in }
M6



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3. Battery ground cable connect

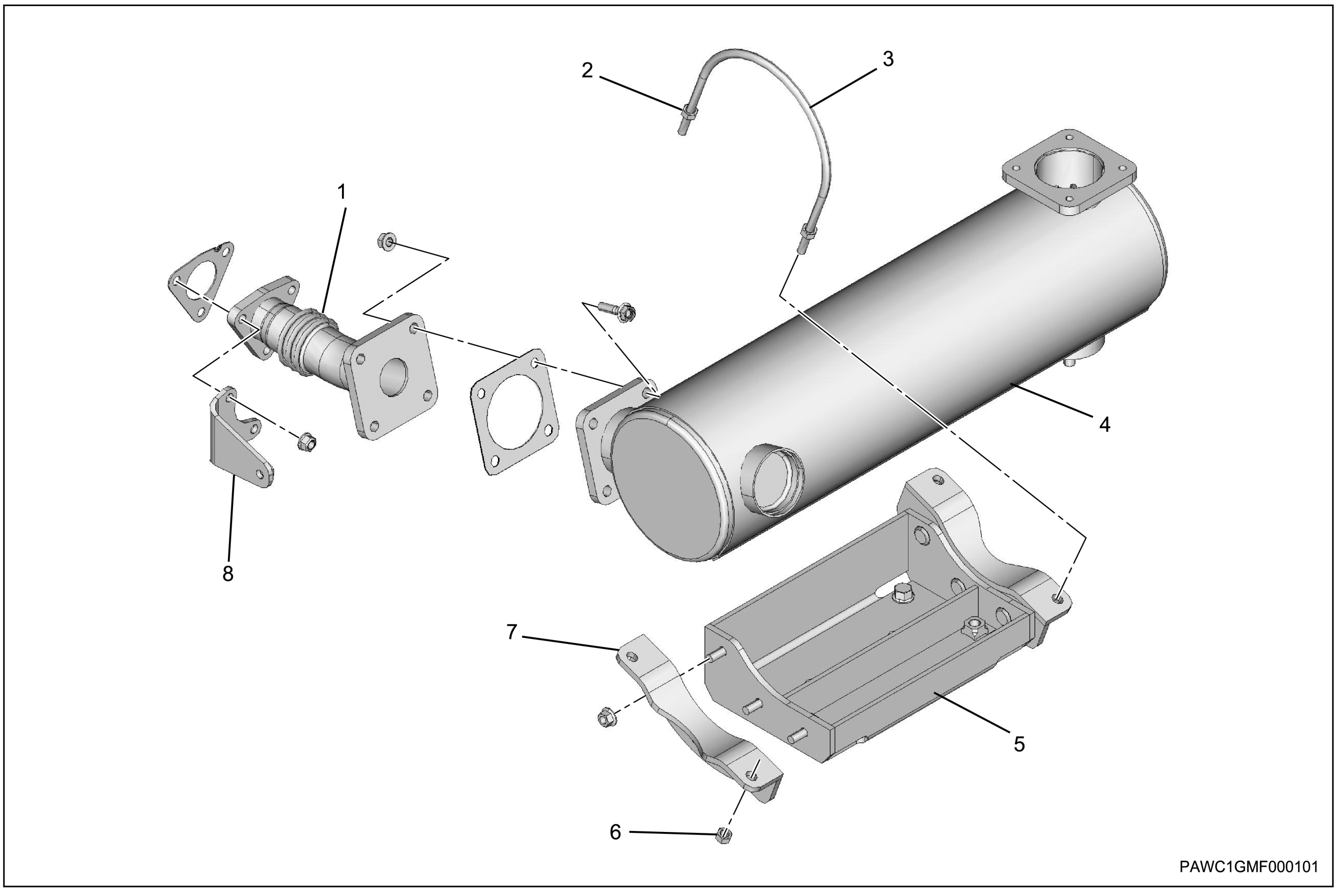
1. Connect the battery ground cable to the battery.

Supplementary Information

1. Component Views

Note：

・ Integrated oxidation catalyst silencer

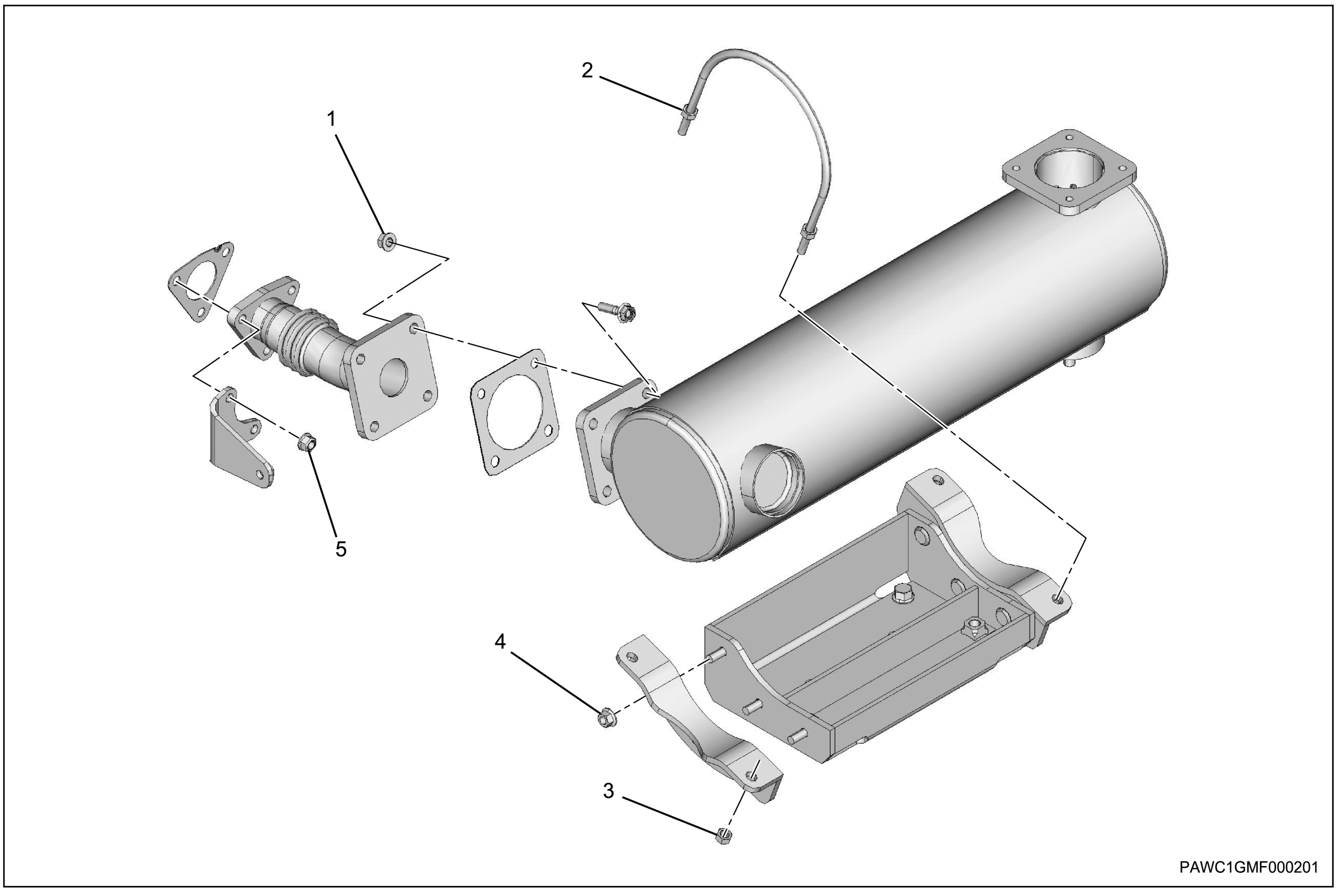


1. Exhaust pipe
2. Nut A
3. U-bolt
4. Integrated oxidation catalyst silencer
5. Silencer bracket
6. Nut B
7. Support bracket
8. Bracket

2. Tightening Torque Views

Note：

・ Integrated oxidation catalyst silencer



1 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

2 : 25 N・m { 2.5 kgf・m / 18 lb・ft }

3 : 5 N・m { 0.5 kgf・m / 44 lb・in }

4 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

5 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

Engine

Aux. Emission Control Devices

(4LE2)

Table of Contents

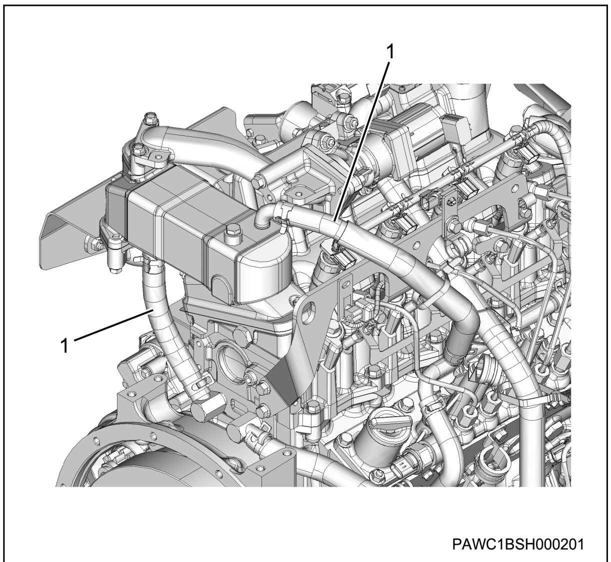
EGR valve

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

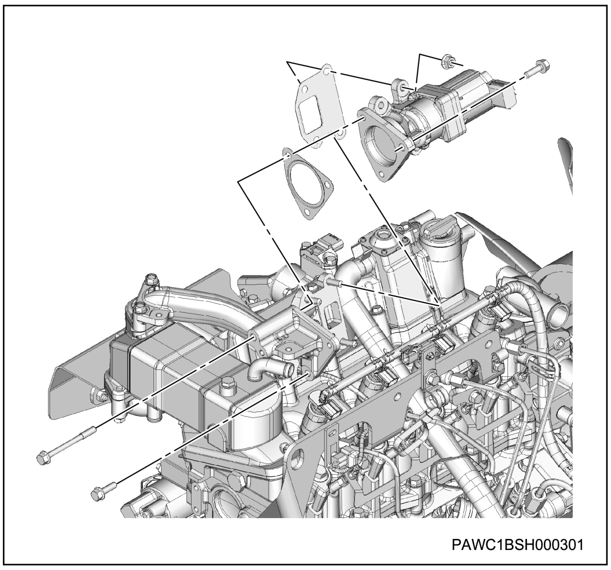
   Caution :

   - After draining the coolant, do not forget to tighten the drain plug.
3. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.

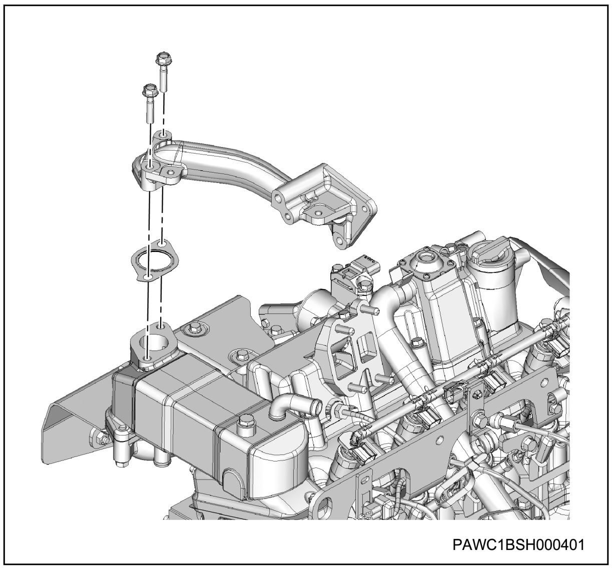


1. Water rubber hose

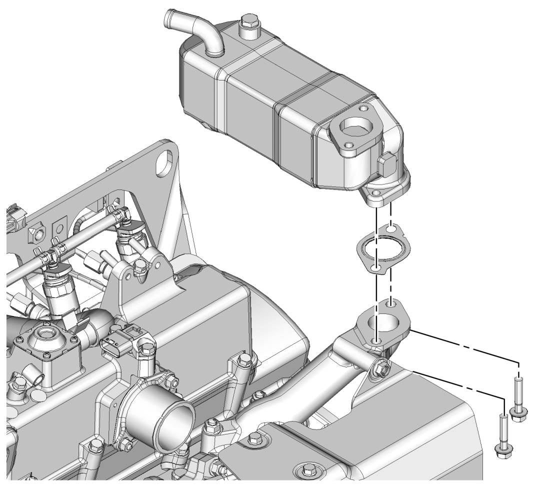
   4. Remove the EGR valve from the intake chamber.



   5. Remove the EGR pipe from the EGR cooler.

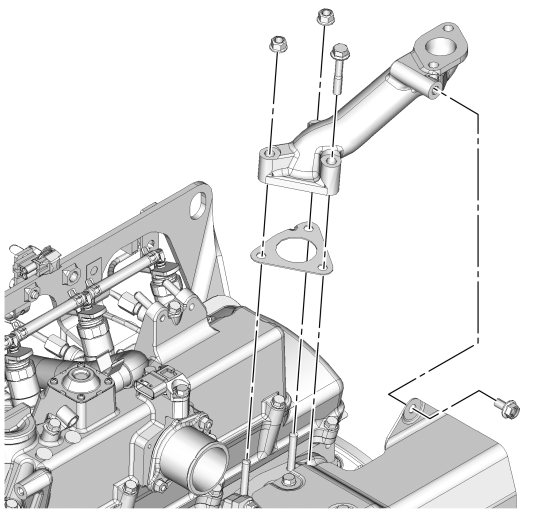


   6. Remove the EGR cooler from the EGR pipe.



PAWC1BSH000501

7. Remove the EGR pipe from the exhaust manifold.



PAWC1BSH000601

inspection

1. EGR valve inspection
   1. Inspect the EGR valve.

   Note：
   - Inspect at the following specified time [every].

   specified time： 3000 h

   Note：
   - Clean if there are carbon deposits.
   - Replace the EGR valve if it is damaged.
2. EGR cooler inspection
   1. Inspect the EGR cooler.

   Note：
   - Inspect at the following specified time [every].

   specified time： 1500 h

   Note：
   - Inspect the inside of the EGR cooler, and clean it if there are carbon deposits.
   - Inspect the inside of the EGR cooler, and replace the EGR cooler if damage is found.
3. EGR cooler cleaning
   1. Prepare cleaning fluid.

   Note：
   - Use Oil-Clean for the cleaning fluid.

   2. Prepare the container.

   Note：
   - Pour the Oil-Clean into the container.

   3. Clean the EGR cooler using the cleaning fluid.

   Note：
   - Soak the EGR cooler in Oil-Clean and wait for the specified time.

   specified time： 30 min

   Note：
   - Rinse off the Oil-Clean from the EGR cooler using a cleaner after the specified time has passed.

   Caution：
   - Before installing the EGR cooler, dry it completely.

installation

1. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

   Note：

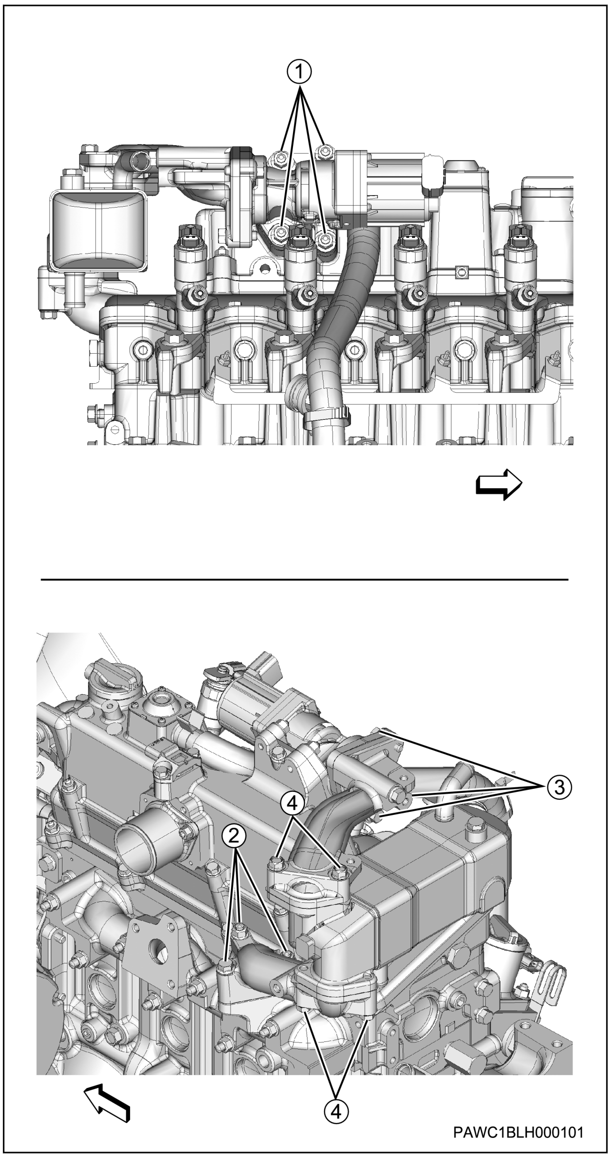
   ・ Temporarily tighten the entire component until seated.

   5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

   Note：

   ・ After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

   tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

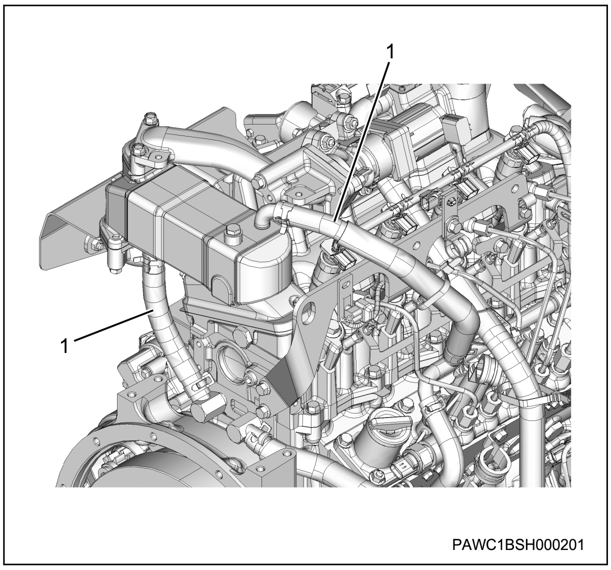


   Note：

   ・ Tighten the heat protector tightening bolts.

   tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

   6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

2. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

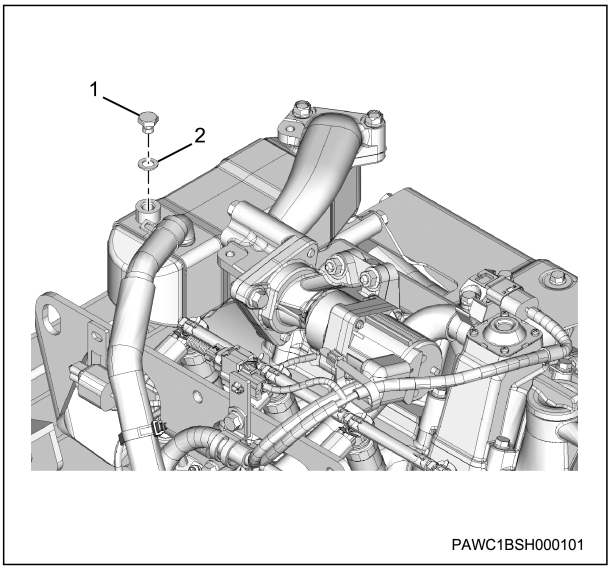
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



1. Plug
2. Gasket

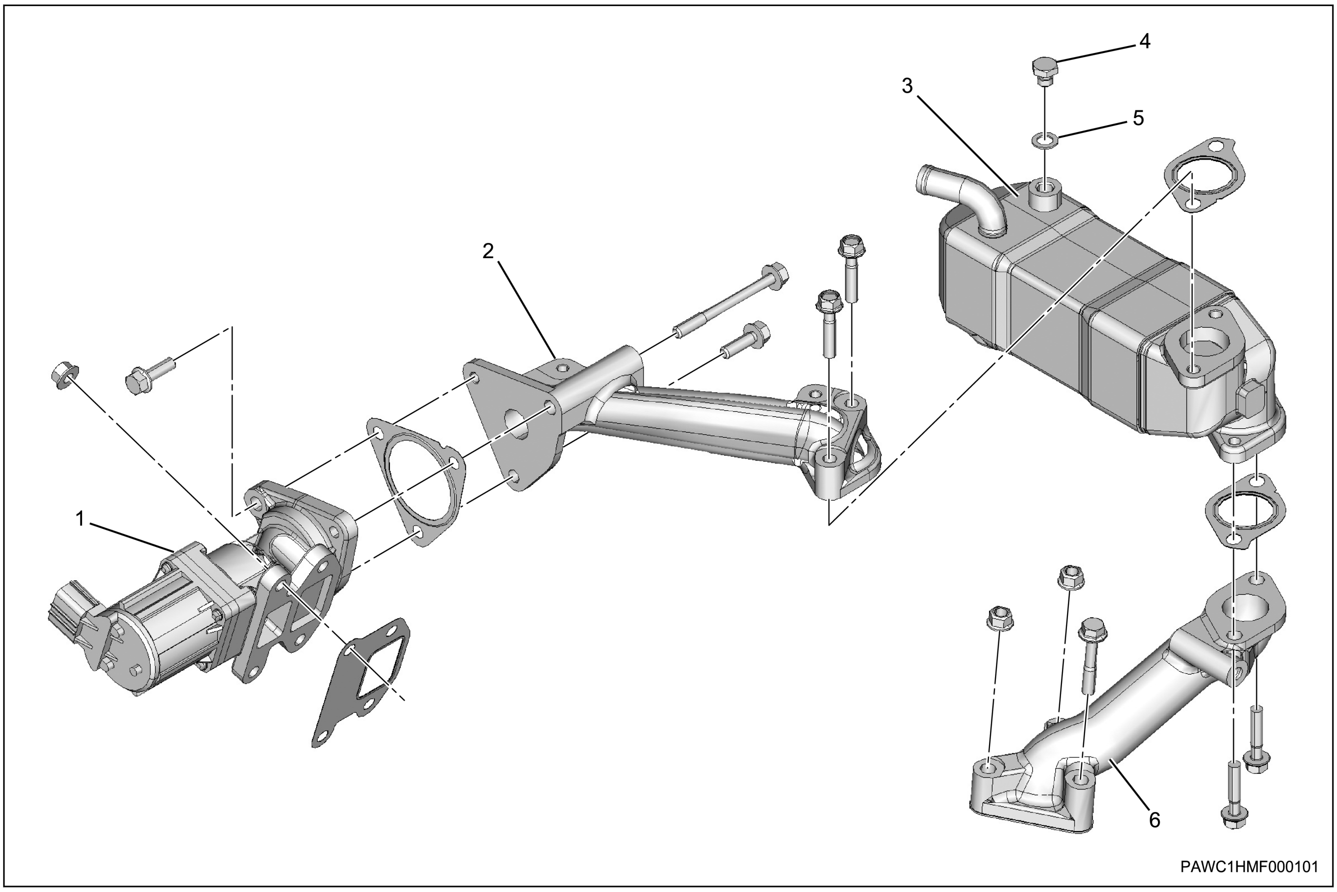
3. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Supplementary Information

1. Component Views

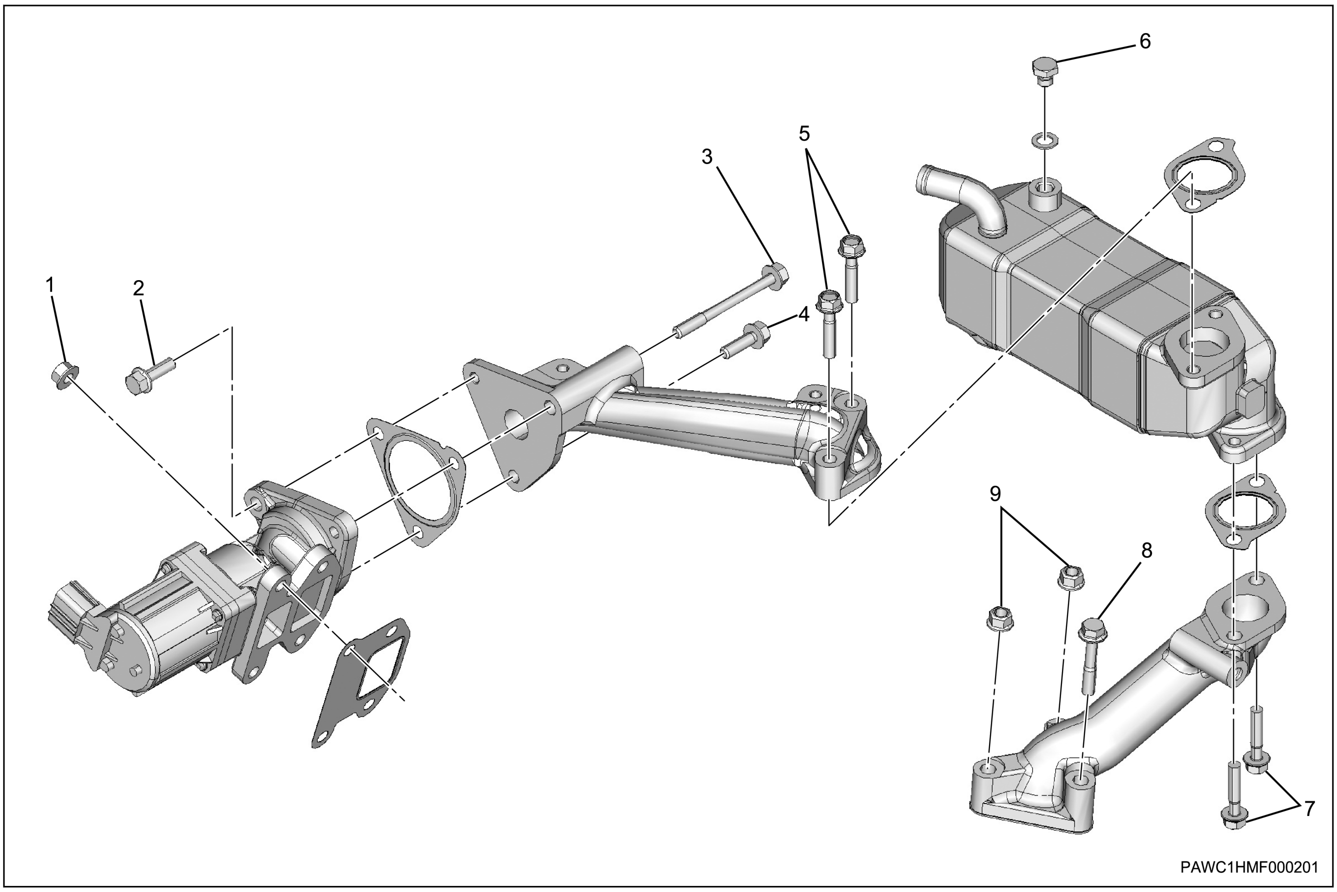
Note：
- EGR valve



1. EGR valve
2. EGR pipe
3. EGR cooler
4. Plug
5. Gasket
6. EGR pipe

2. Tightening Torque Views

Note：
- EGR valve



1 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

2 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

3 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

4 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

5 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

6 : 28 N・m { 2.9 kgf・m / 21 lb・ft }

7 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

8 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

9 : 27 N・m { 2.8 kgf・m / 20 lb・ft }

Engine

Electrical

(4LE2)

Table of Contents

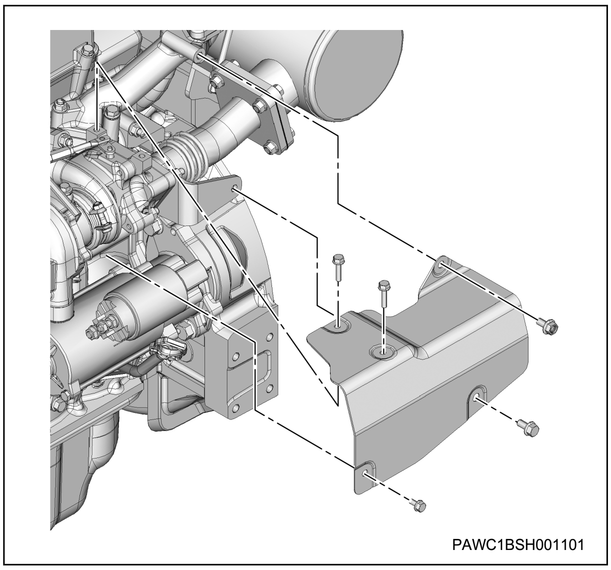
Glow plug

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. Coolant drain
   1. Drain coolant from the radiator.

   Caution :

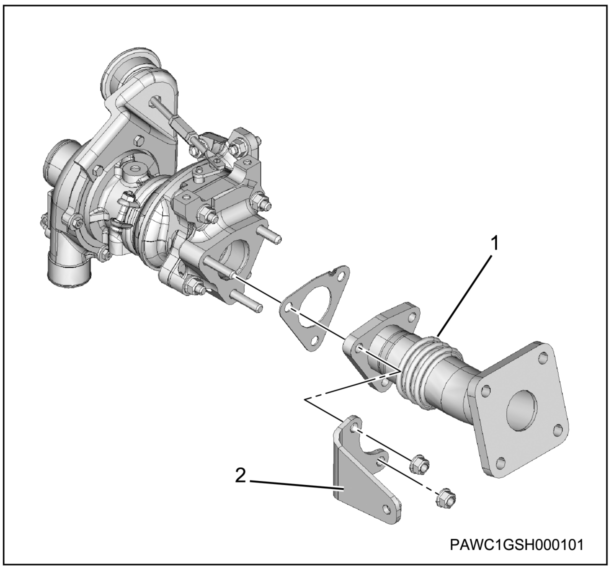
   - After draining the coolant, do not forget to tighten the drain plug.
3. Turbocharger heat protector removal
   1. Remove the turbocharger heat protector from the turbocharger.



4. Integrated oxidation catalyst silencer removal
   1. Remove the integrated oxidation catalyst silencer from the exhaust pipe.
   2. Remove the exhaust pipe from the turbocharger assembly.

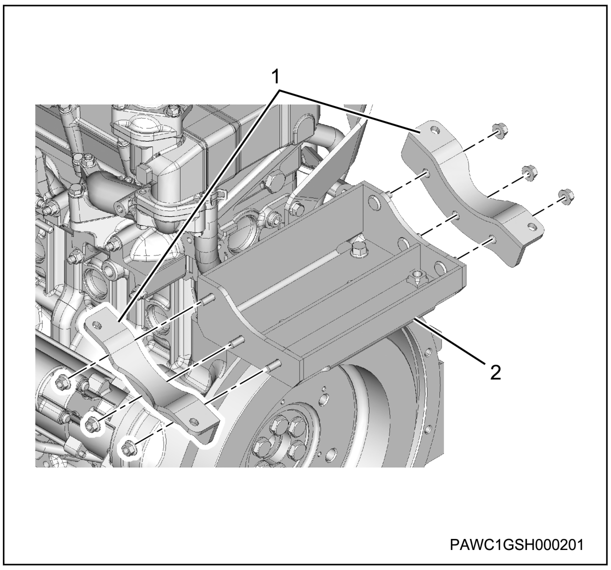
   Note :

   - Remove together with the bracket.



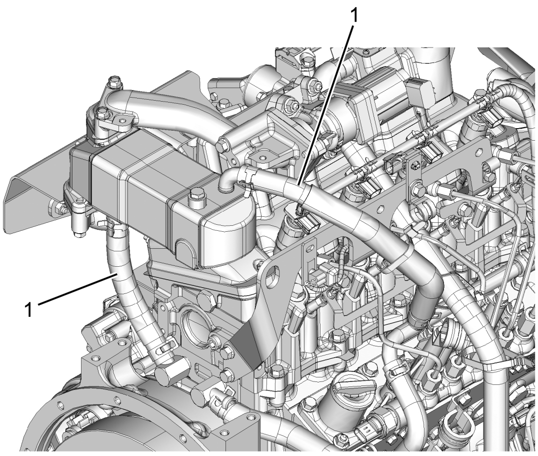
1. Exhaust pipe
2. Bracket

3. Remove the support bracket from the silencer bracket.



1. Support bracket
2. Silencer bracket

5. EGR valve removal
   1. Disconnect the harness connector from the EGR valve.
   2. Disconnect the harness clip from the EGR pipe.
   3. Disconnect the water rubber hose from the EGR cooler assembly.



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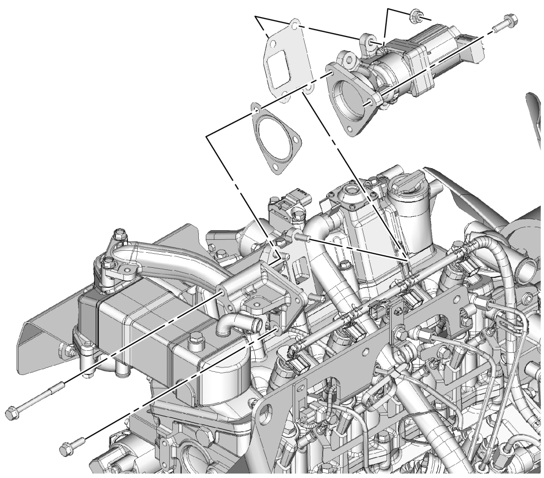
1. Water rubber hose

4. Remove the EGR valve from the intake chamber.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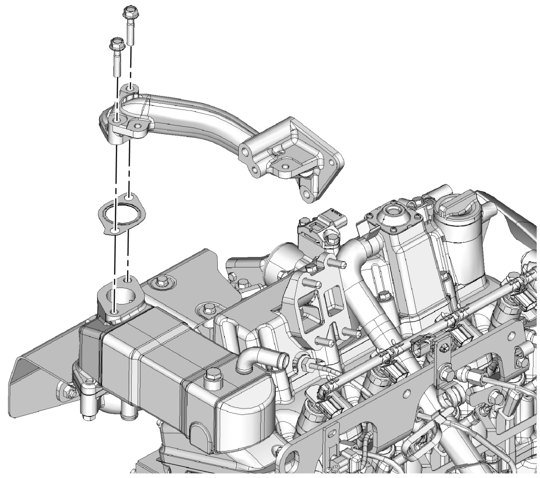
5. Remove the EGR pipe from the EGR cooler.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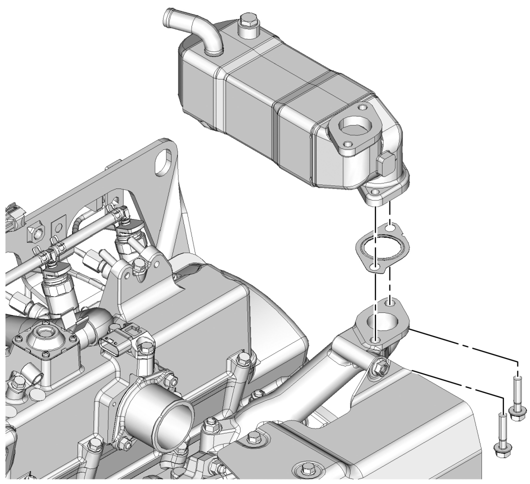
6. Remove the EGR cooler from the EGR pipe.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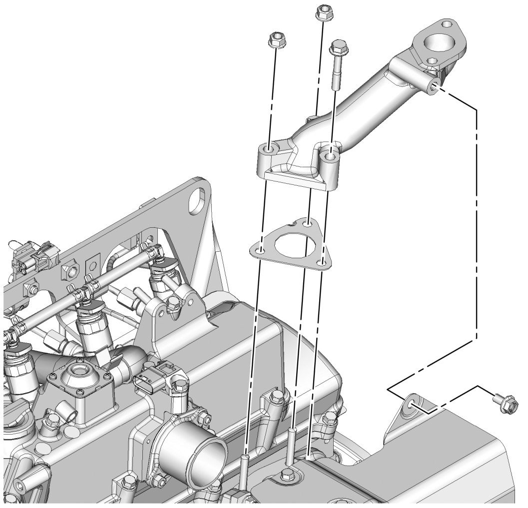
7. Remove the EGR pipe from the exhaust manifold.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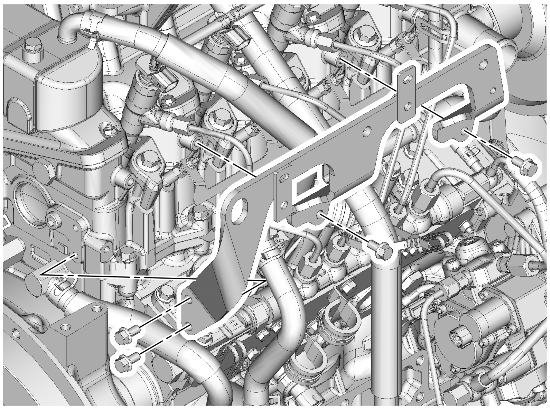
6. Harness bracket removal
    1. Disconnect the engine harness from the harness bracket.
    2. Remove the harness bracket from the cylinder head.



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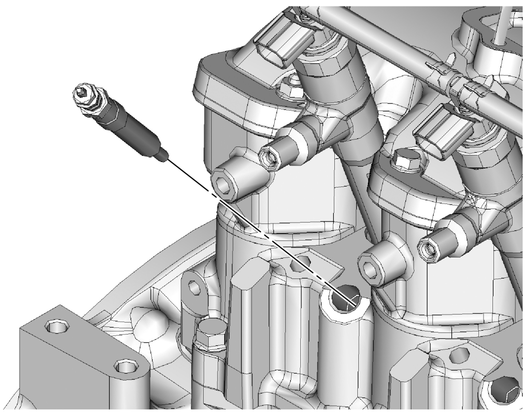
7. Glow plug connector removal
    1. Remove the glow plug connector from the glow plug.
8. Glow plug removal
    1. Remove the glow plug from the cylinder head.



PAWC1JSH000201

inspection

1. Glow plug inspection
   1. Inspect the glow plug using a circuit tester.

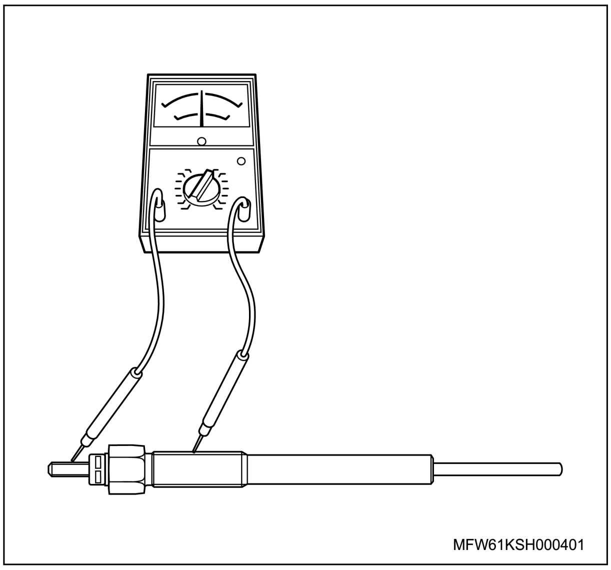
Note :

- Measure the resistance of the glow plug.
- Replace the glow plug if the measurements reveal that the resistance is not the specified value.

resistance : 3 Ω Room temperature

Caution :

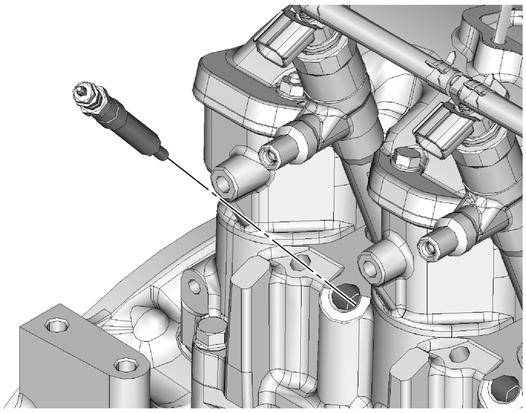
- When replacing the glow plug, use a set of 4 glow plugs made by the same manufacturer.



installation

1. Glow plug installation
   1. Install the glow plug to the cylinder head.

   tightening torque : 22.5 N・m { 2.3 kgf・m / 17 lb・ft }



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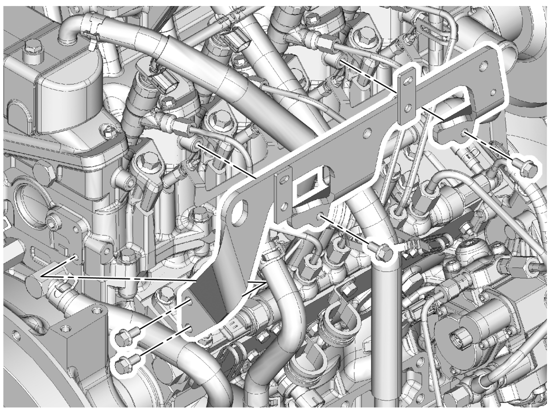
2. Glow plug connector installation
   1. Install the glow plug connector to the glow plug.

   tightening torque : 1.0 N・m { 0.1 kgf・m / 9 lb・in }
3. Harness bracket installation
   1. Install the harness bracket to the cylinder head.

   tightening torque : 24 N・m { 2.4 kgf・m / 18 lb・ft }



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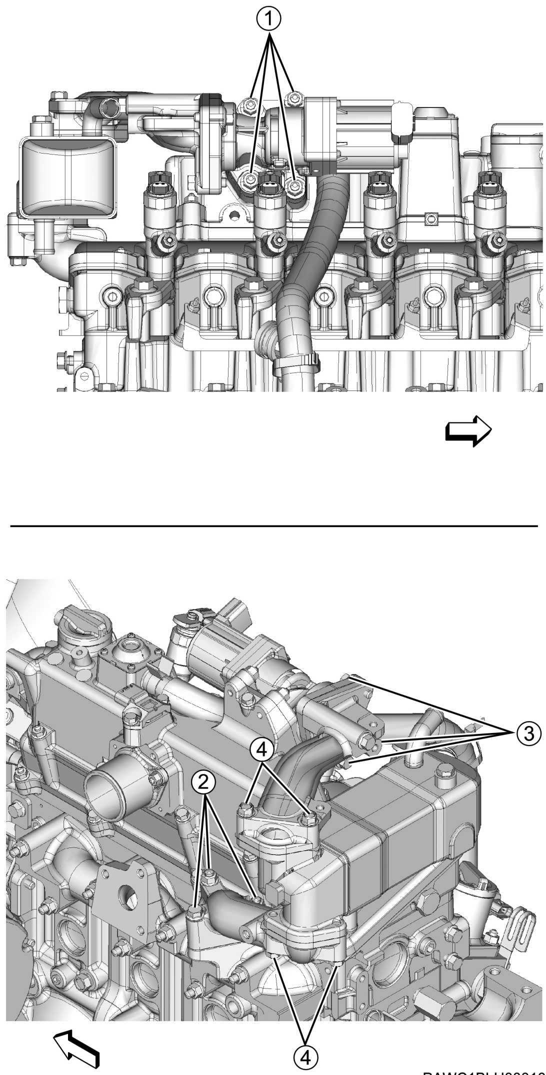
   2. Connect the engine harness to the harness bracket.
4. EGR valve installation
   1. Temporarily tighten the EGR valve to the intake chamber.
   2. Temporarily tighten the EGR pipe to the exhaust manifold.
   3. Temporarily tighten the EGR pipe to the EGR valve.
   4. Temporarily tighten the EGR cooler to the EGR pipe.

   Note :
   - Temporarily tighten the entire component until seated.

   5. Securely tighten the EGR cooler assembly to the intake chamber and the exhaust manifold.

   Note :
   - After temporarily tightening all the components, securely tighten in the numerical order shown in the diagram.

   tightening torque : 27 N・m { 2.8 kgf・m / 20 lb・ft }



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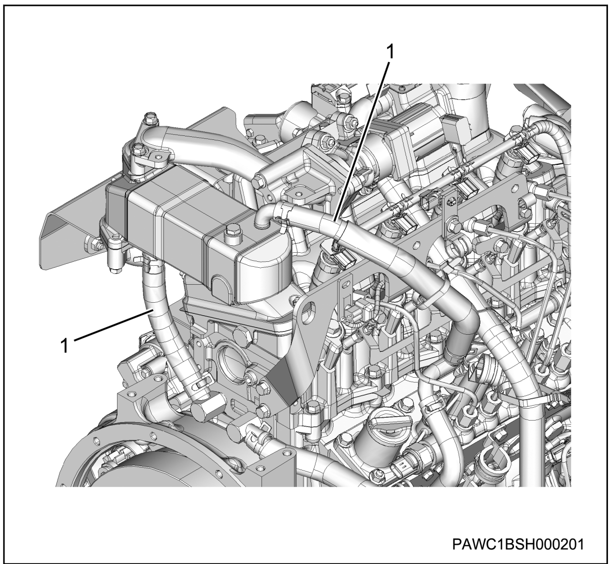
Note：

- Tighten the heat protector tightening bolts.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

6. Connect the water rubber hose to the EGR cooler assembly.



1. Water rubber hose

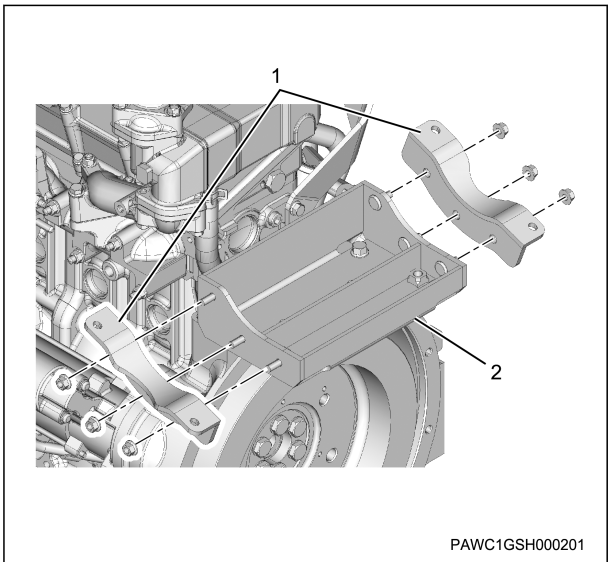
7. Connect the harness clip to the EGR pipe.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }

8. Connect the harness connector to the EGR valve.

5. Integrated oxidation catalyst silencer installation

1. Temporarily tighten the support bracket to the silencer bracket.

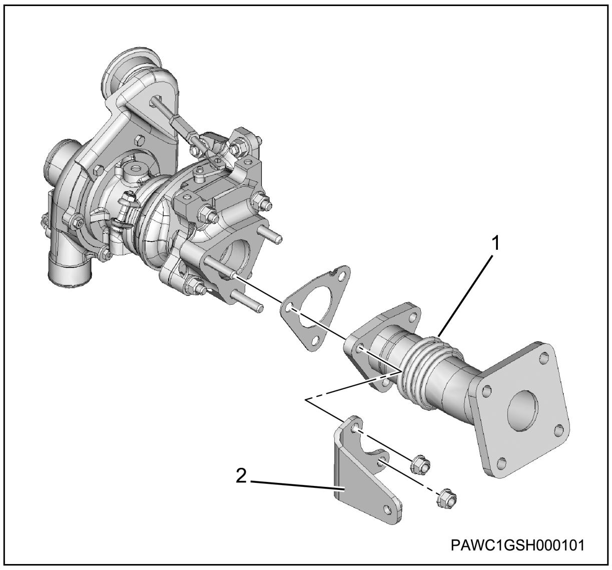


1. Support bracket
2. Silencer bracket

2. Temporarily tighten the exhaust pipe to the turbocharger assembly.

Note：

- Install together with the bracket.



1. Exhaust pipe
2. Bracket

3. Temporarily tighten the integrated oxidation catalyst silencer to the exhaust pipe.

4. Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer.

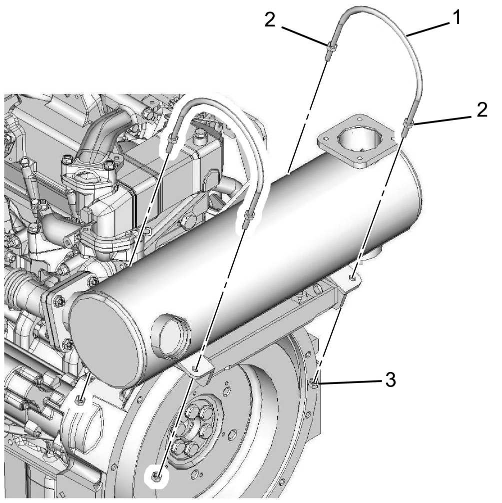
Note：

- Temporarily tighten nut A until the end of the threaded portion of the U-bolt.
- With nut A tightened, temporarily tighten the integrated oxidation catalyst silencer.
- Temporarily tighten the U-bolts to the integrated oxidation catalyst silencer with nut B.

tightening torque： 5 N・m { 0.5 kgf・m / 44 lb・in }

Caution：

- Temporarily tighten so that the U-bolt protrusion amounts are even in the front and rear of the integrated oxidation catalyst silencer.
- Install so that the U-bolts are not tilted.



PAWC1GSH000301

1. U-bolt
2. Nut A
3. Nut B

5. Securely tighten the U-bolts to the integrated oxidation catalyst silencer.

Note：

- Securely tighten the U-bolts after settling the entire integrated oxidation catalyst silencer.
- Tighten nut A and securely tighten.

tightening torque： 25 N・m { 2.5 kgf・m / 18 lb・ft }

6. Securely tighten the exhaust pipe to the turbocharger assembly.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

7. Securely tighten the integrated oxidation catalyst silencer to the exhaust pipe.

tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

8. Securely tighten the support bracket to the silencer bracket.

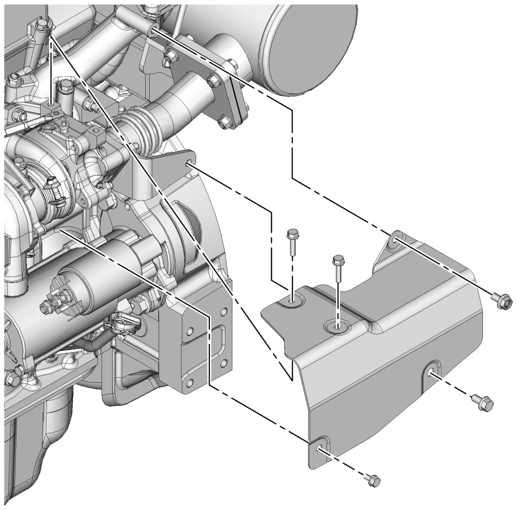
tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

6. Turbocharger heat protector installation

1. Install the turbocharger heat protector to the turbocharger.

tightening torque： 27 N・m { 2.8 kgf・m / 20 lb・ft }
M8

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }
M6



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7. Coolant filling

1. Loosen the plug using a wrench.
2. Replenish the radiator with coolant.

Caution：

- Take care to prevent overflow coolant from splashing on to the exhaust system parts.
- Wipe off any coolant overflow.

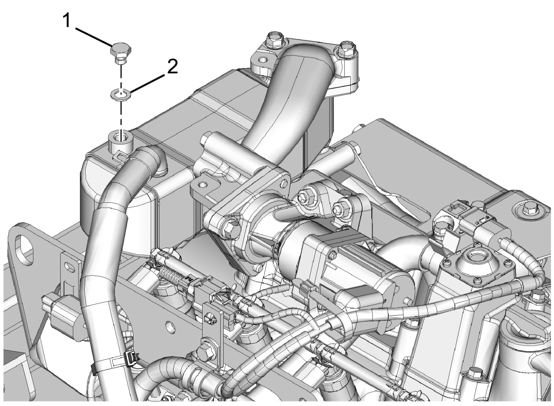
3. Tighten the plug using a wrench.

Caution：

- Use a new gasket.

tightening torque： 28 N・m { 2.9 kgf・m / 21 lb・ft }

4. Replenish the radiator with coolant.



PAWC1BSH000101

1. Plug
2. Gasket

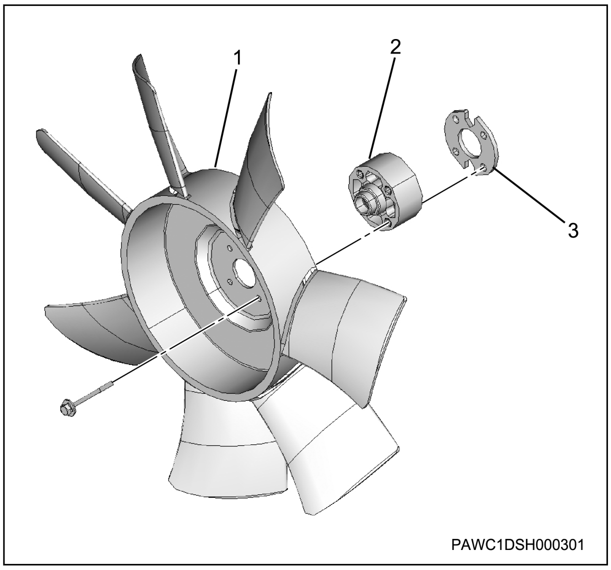
8. Battery ground cable connect

1. Connect the battery ground cable to the battery.

Generator

removal

1. Battery ground cable disconnect
    1. Disconnect the battery ground cable from the battery.
2. Cooling fan removal
    1. Remove the cooling fan from the fan pulley.



1. Cooling fan
2. Adapter
3. Spacer

3. Cooling fan belt removal
    1. Remove the cooling fan belt from the pulley.

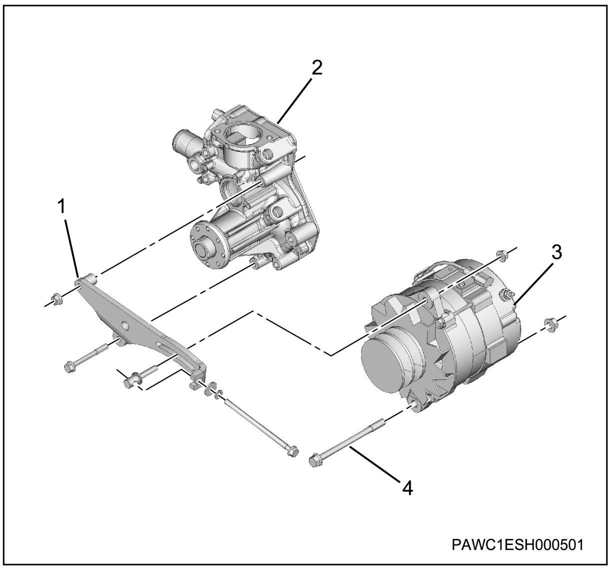
Note :

- Loosen the generator adjust bolt and remove the belt.

4. Generator removal
    1. Disconnect the harness connector from the generator.
    2. Remove the generator from the generator bracket.
    3. Remove the adjust plate from the water pump assembly.

Note :

- The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

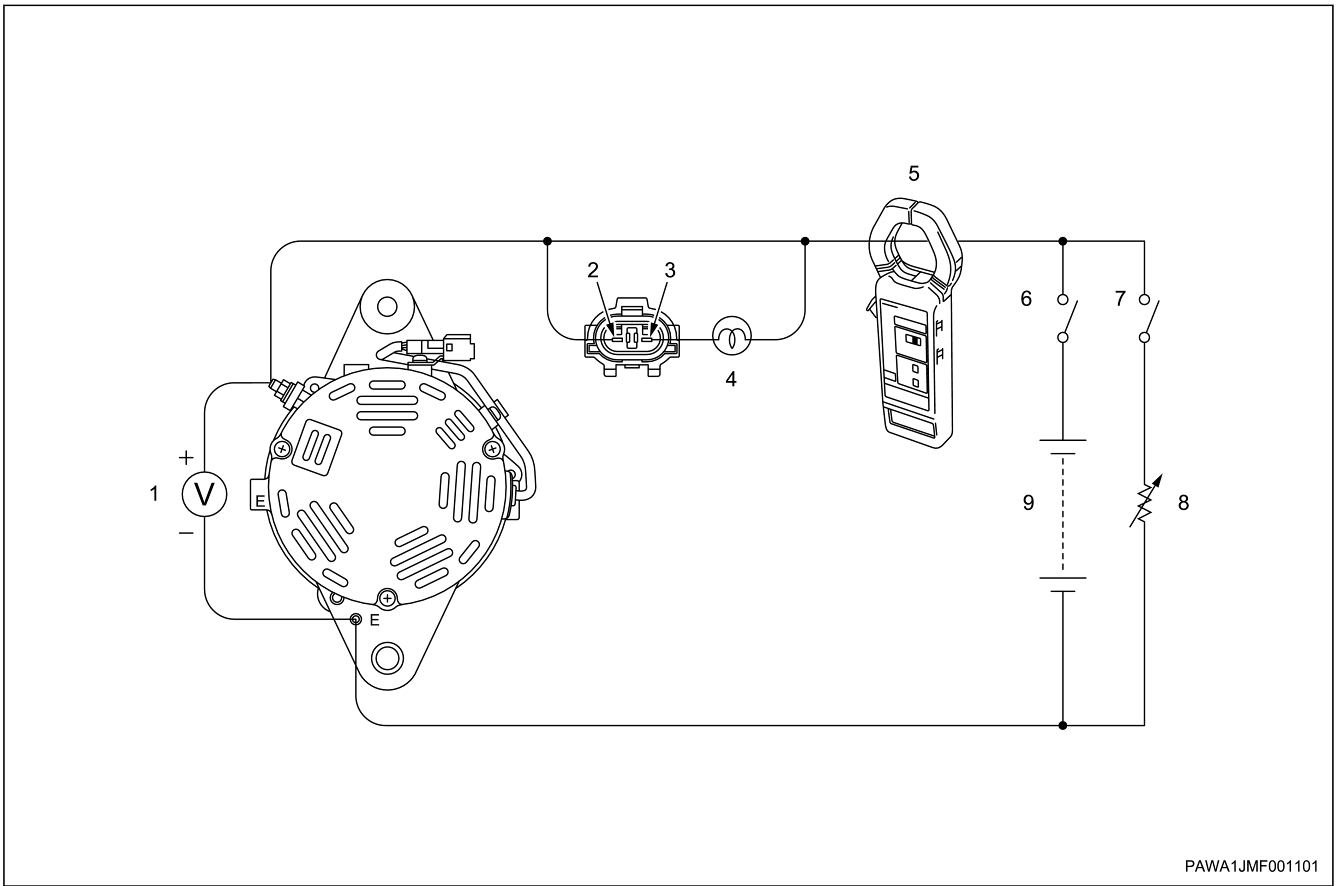
inspection

1. Generator safety information

Caution：

- Take caution because disassembly and maintenance at the market is not covered as a product liability.
- The inspection method after disassembly stated here is for reference purposes only.

2. Generator inspection



1. Voltage meter
2. R-terminal
3. L-terminal
4. Charge light (24 V, 3 W)
5. Current meter
6. Switch 1
7. Switch 2
8. Variable resistor
9. Battery (24 V)

Caution：

- Never turn OFF the battery circuit while the generator is rotating.
- Do not wire the L terminal when the charge light is not used.
- Never connect the L-terminal and the B circuit because doing so will damage the excitation diode.
- Make sure to maintain a maximum continuous load of 1.0 A or less from the L-terminal.

1. Close the switch.

Note：

- Close switch 1.

2. Inspect the current using a tester.

Note：

- Increase the generator rotation speed, and observe the current display when the rotation speed is at approx. 3000 - 4000 r/min.
- If the current meter reading is 6 A or more, continue charging for a little while, or replace the battery with a fully charged one.

3. Measure the voltage using a tester.

values： 27.5 to 29.5 V Regulator adjustment voltage

Note：

- Verify that the current is equal to or less than 2 - 6 A when the generator rotation speed is approx. 1500 r/min.
- Increase the generator rotation speed, and observe the voltage display when the rotation speed is at approx. 3000 - 4000 r/min.

Caution：

- If the regulator adjustment voltage is outside the specified value range, replace the regulator assembly.

4. Stop the generator.
5. Close the switch.

Note：

- Close switch 1 and switch 2.

6. Increase the rotation speed.

Note：

- Increase the generator rotation speed to approx. 5000 r/min, and retain the reading of the voltage meter at 27 V.

7. Adjust the current to the maximum value using a resistance.

Note：

- Adjust the load resistance so that the output current will be maximized while retaining the generator rotation speed at approx. 5000 r/min.

8. Measure the current using a tester.

Generator Rotation speed	Specified value
: 5000 r/min	: more than 50.00 A

Caution：

- Inspect the generator if the measured value is equal to or less than the specified value.

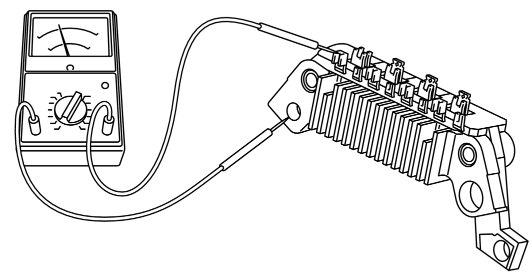
3. Rectifier inspection
   1. Inspect the rectifier using a circuit tester.

Note：

- Inspect the continuity between the positive diode and the 4 diode terminals using a circuit tester.
- If the diode is normal, a low resistance will be indicated, and a high resistance will be indicated in the reverse direction.

Caution：

- For anything other than the above, replace the rectifier.



PAWA1JSH001401

4. Condenser inspection
   1. Charge the condenser.

Note：

- Charge the condenser using a tester.

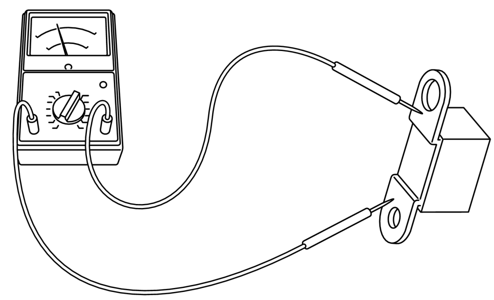
   2. Inspect the condenser using a tester.

Note：

- Verify that the meter needle swings back a little and returns to the original position if a tester lead is connected reversely.

Caution：

- For anything other than the above, replace the condenser.



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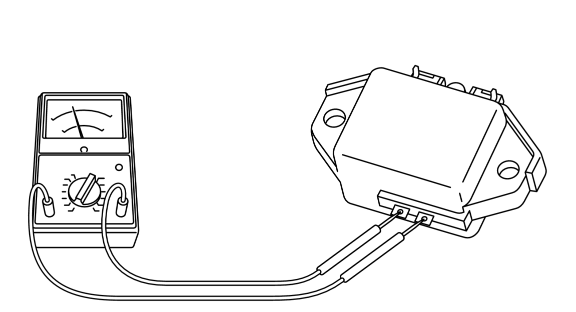
5. Regulator assembly inspection
   1. Inspect the regulator assembly using a circuit tester.

Note：
- Inspect the continuity between connector terminals R and L.
- If the diode and the resistor are normal, a low resistance will be indicated, and a high resistance will be indicated in the reverse direction.

Caution：
- For anything other than the above, replace the regulator assembly.



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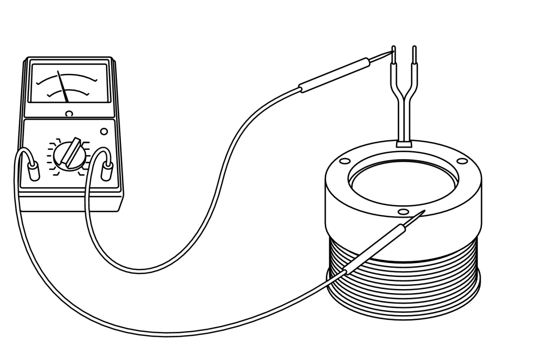
6. Field coil inspection
   1. Inspect the field coil using a circuit tester.

Note：
- Measure the continuity between the field coil lead portion and the core using a tester.



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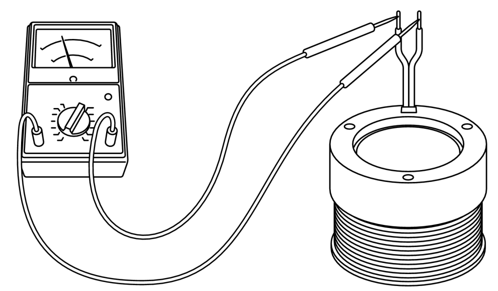
Caution：
- If there is continuity, replace the field coil.

Note：
- Measure the resistance between both ends of the field coil terminal section using a circuit tester.

field coil resistance： 6.7 Ω 20°C {68°F}



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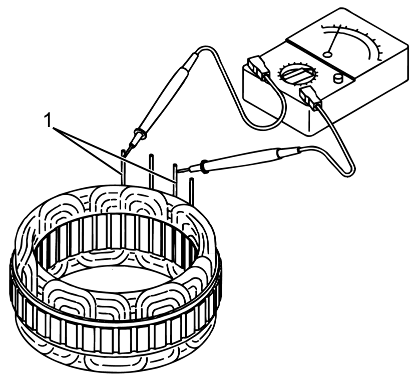
Caution：
- Replace the field coil if the measured value is outside the specified value range.

7. Stator inspection
   1. Inspect the stator using a circuit tester.

Note：
- Inspect the continuity between the 2 stator coil lead wires using a circuit tester.



HCW31ESH004301

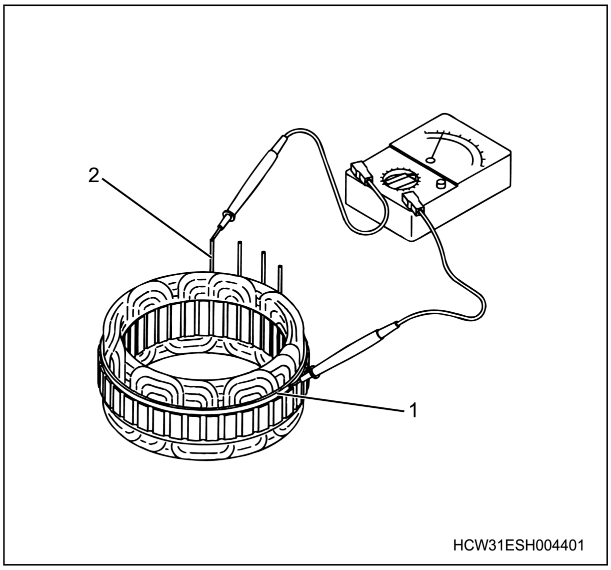
1. Stator coil lead wire

Caution：
- If there is no continuity, replace the stator.

2. Inspect the stator using a circuit tester.

Note :

- Inspect the continuity between the stator coil lead wire and the core using a circuit tester.



1. Core
2. Stator coil lead wire

Caution :

- If there is continuity, replace the stator.

8. Bearing inspection

1. Inspect the bearing.

Note :

- Rotate the bearing by hand, and inspect for abnormalities such as noise or looseness.

installation

1. Generator installation
   1. Install the adjust plate to the water pump assembly.

   tightening torque : 23.5 N・m { 2.4 kgf・m / 17 lb・ft }

   2. Temporarily tighten the generator to the generator bracket.
   3. Temporarily tighten the generator to the adjust plate.

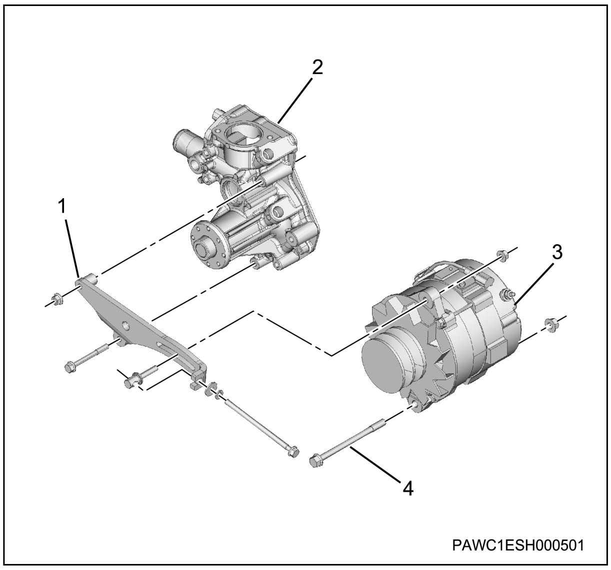
   Note :

   - Securely tighten the bolt and the nut after adjusting the cooling fan belt.

   4. Connect the harness connector to the generator.

   Note :

   - The diagram shows the 24 V - 50 A specification.



1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt

2. Cooling fan belt installation
   1. Install the cooling fan belt to the pulley.
3. Cooling fan belt adjustment
   1. Check the tension of the cooling fan belt.

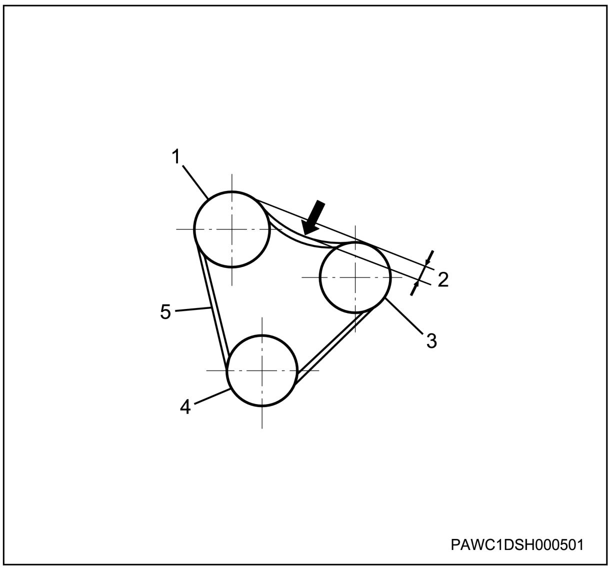
   Note :

   - Measure the amount of flex in the cooling fan belt when pushing with the specified force on the section indicated by the arrow in the diagram.

   standard : 98 N { 10.0 kg / 22 lb }

   specified value : 7.7 to 8.7 mm { 0.303 to 0.343 in } New product

   specified value : 8.3 to 9.3 mm { 0.327 to 0.366 in } Reuse

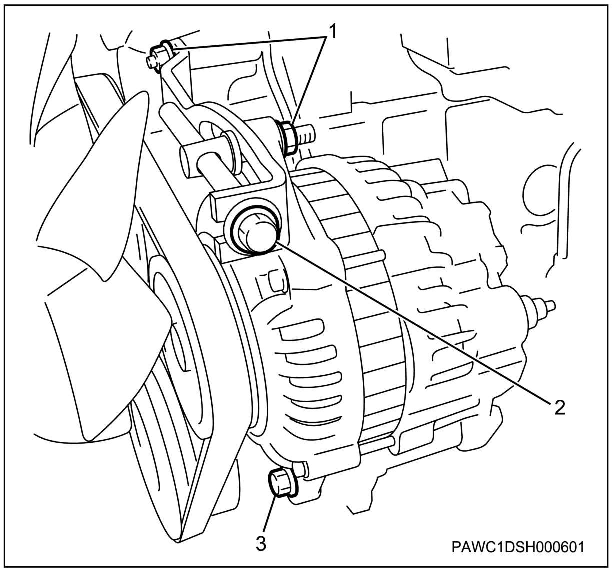


1. Fan pulley
2. Amount of flex
3. Generator pulley
4. Crank pulley
5. Fan belt

   2. Adjust the cooling fan belt to the specified value using the adjust bolt.

   tightening torque : 23 N・m { 2.3 kgf・m / 17 lb・ft } M8 x 1.25

   tightening torque : 48 N・m { 4.9 kgf・m / 35 lb・ft } M10 x 1.25

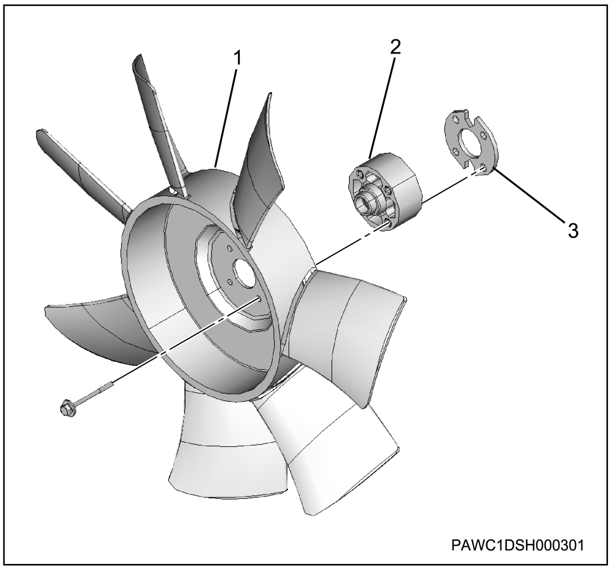


1. Nut
2. Adjust bolt
3. Mounting bolt

4. Cooling fan installation

1. Install the cooling fan to the fan pulley.

tightening torque： 10 N・m { 1.0 kgf・m / 89 lb・in }



1. Cooling fan
2. Adapter
3. Spacer

5. Battery ground cable connect

1. Connect the battery ground cable to the battery.

ECM

removal

1. Battery ground cable disconnect
   1. Disconnect the battery ground cable from the battery.
2. ECM removal
   1. Turn OFF the ignition switch.
   2. Disconnect the harness connector from the ECM.
   3. Remove the ECM from the machine.

   Caution：

   - Refer to the manual of the machine because the installation method and the position may vary depending on the machine.

installation

1. ECM installation

   Caution :

   - Refer to the manual of the machine because the installation method and the position may vary depending on the machine.

   1. Install the ECM to the machine.
   2. Connect the harness connector to the ECM.

2. Battery ground cable connect

   1. Connect the battery ground cable to the battery.

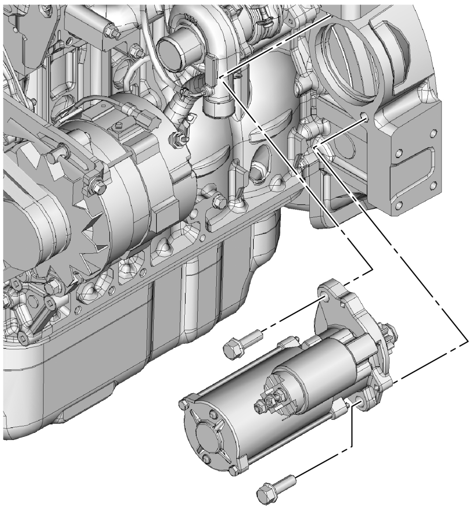
Starter motor

removal

1. Battery ground cable disconnect
    1. Disconnect the battery ground cable from the battery.
2. Oil level gauge guide tube removal
    1. Remove the oil level gauge from the oil level gauge guide tube.
    2. Remove the oil level gauge guide tube from the cylinder block.
3. Starter motor removal
    1. Remove the ground cable from the starter motor.
    2. Remove the starter motor from the flywheel housing.

Note :

- The diagram shows the 24 V - 3.2 kW specification.



PAWC1JSH000101

inspection

1. Starter motor inspection

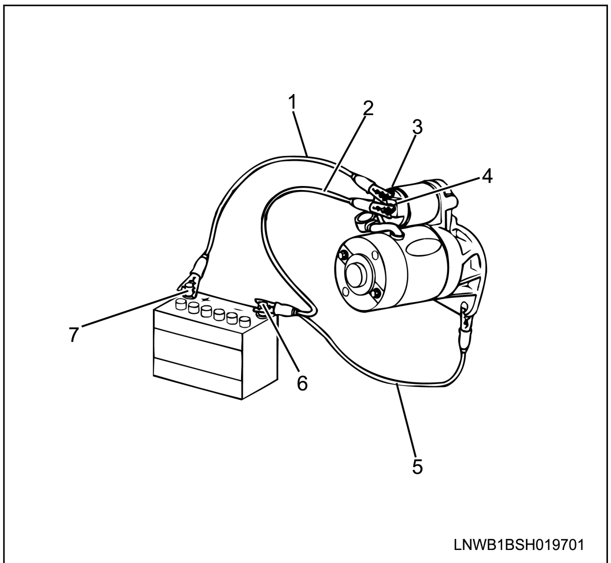
Caution：

- Make sure to conduct a pull-in test and a hold-in test within 5 seconds respectively.

1. Inspect the magnetic switch.

Note：

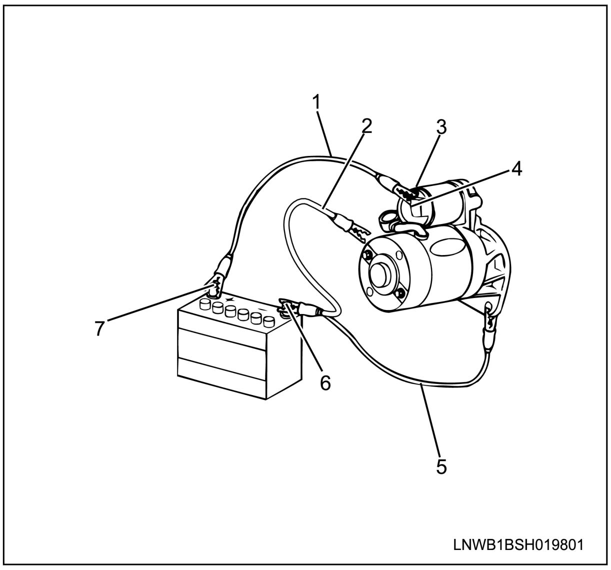
- Pull-in test
- Disconnect the M-terminal lead wire of the magnetic switch, and connect a negative cable to the M-terminal and the body.
- Check if the pinion jumps out when the positive cable is connected to the S-terminal.
- Go to Hold-in test immediately after verification.



1. Positive cable
2. Negative cable
3. S-terminal
4. M-terminal
5. Negative cable
6. Negative terminal
7. Positive terminal

Note：

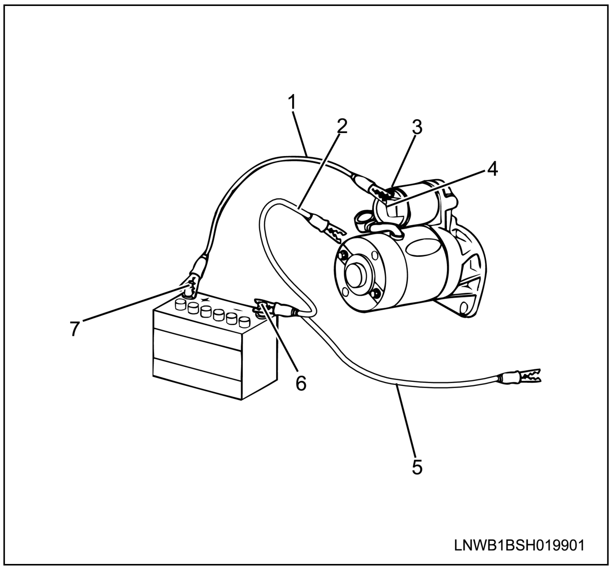
- Hold-in test
- After completing the pull-in test, remove the negative cable of the M-terminal.
- Verify that the pinion stays in the jumped out position.



1. Positive cable
2. Negative cable
3. S-terminal
4. M-terminal
5. Negative cable
6. Negative terminal
7. Positive terminal

Note：

- Return test
- After completing the hold-in test, disconnect the body negative cable with the negative cable disconnected.
- Verify that the pinion returns to the original position immediately.



1. Positive cable
2. Negative cable
3. S-terminal
4. M-terminal
5. Negative cable

6. Negative terminal
7. Positive terminal

installation

1. Starter motor installation
   1. Install the starter motor to the flywheel housing.

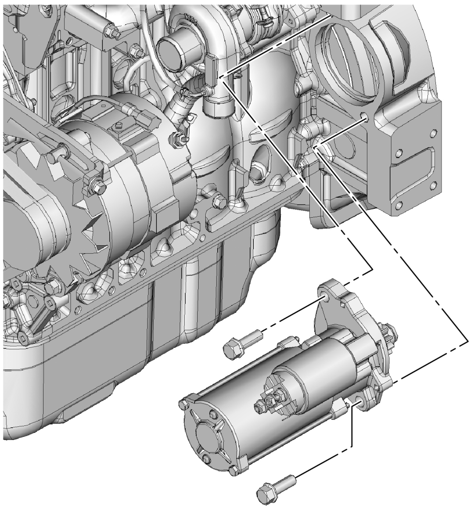
   tightening torque： 103 N・m { 10.5 kgf・m / 76 lb・ft }

   2. Install the ground cable to the starter motor.

   tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

   Note：

   - The diagram shows the 24 V - 3.2 kW specification.



PAWC1JSH000101

2. Oil level gauge guide tube installation
   1. Install the oil level gauge guide tube to the cylinder block.

   tightening torque： 24 N・m { 2.4 kgf・m / 18 lb・ft }

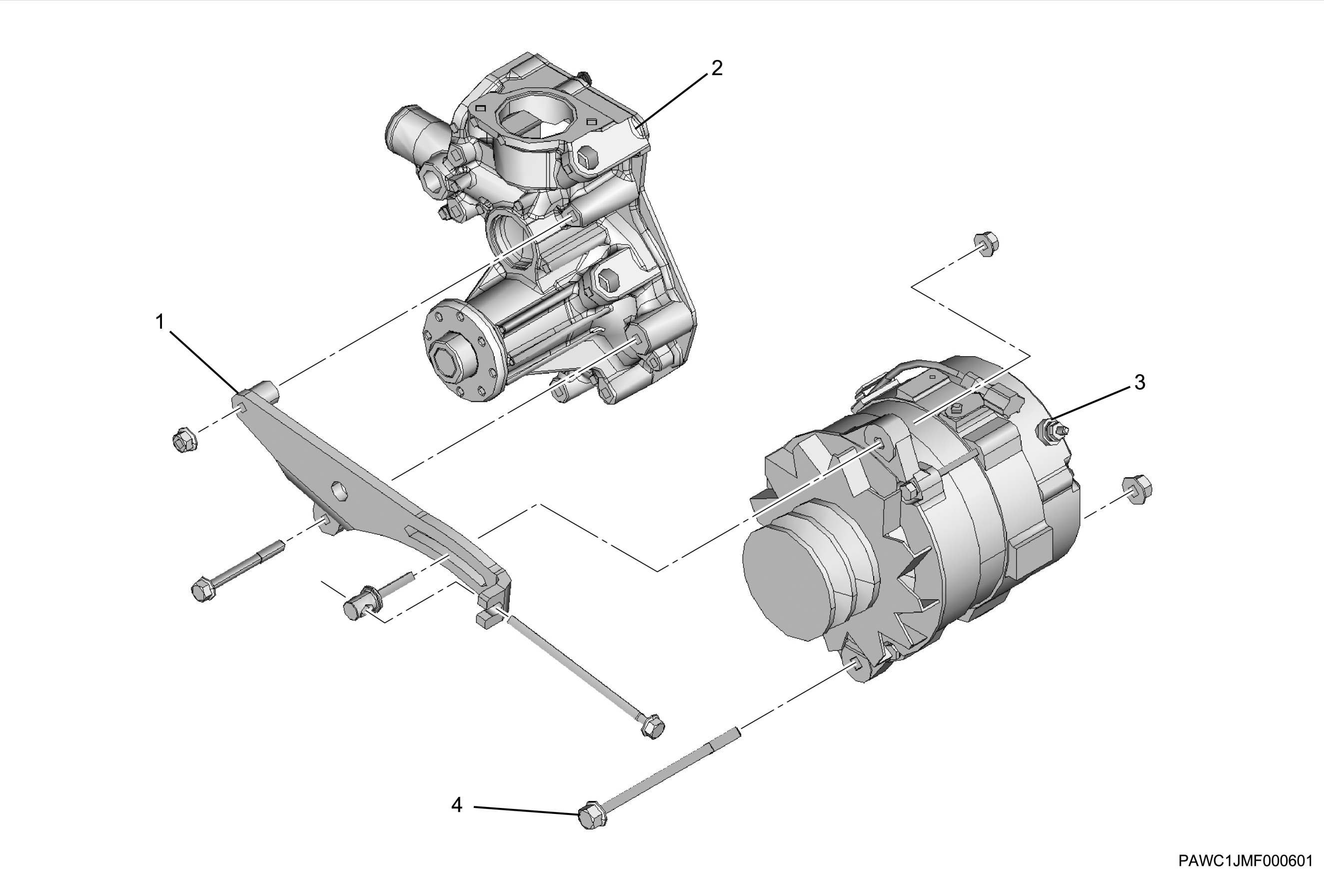
   2. Install the oil level gauge to the oil level gauge guide tube.
3. Battery ground cable connect
   1. Connect the battery ground cable to the battery.

Supplementary Information

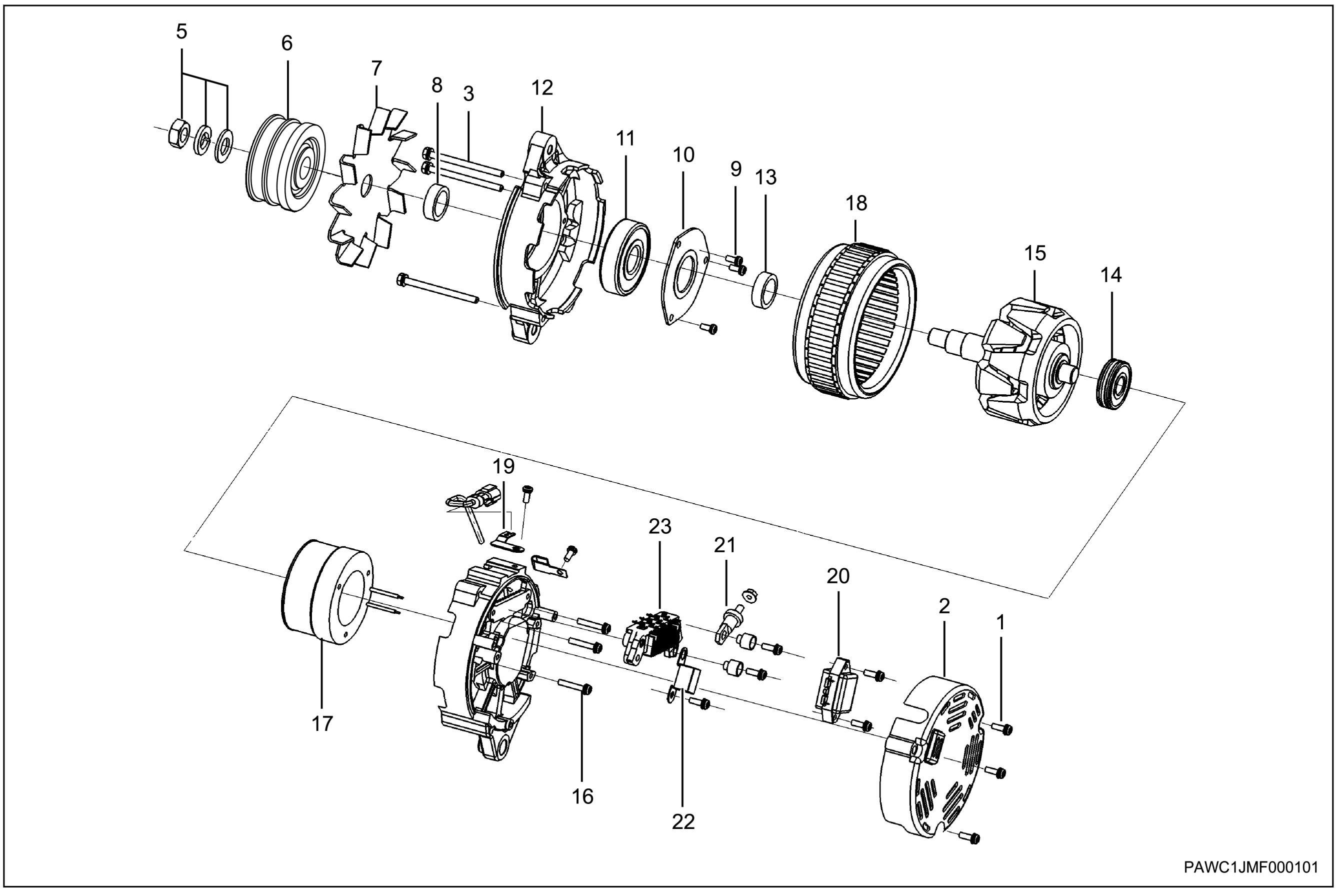
1. Component Views

Note：

- Generator (24 V - 50 A specification)



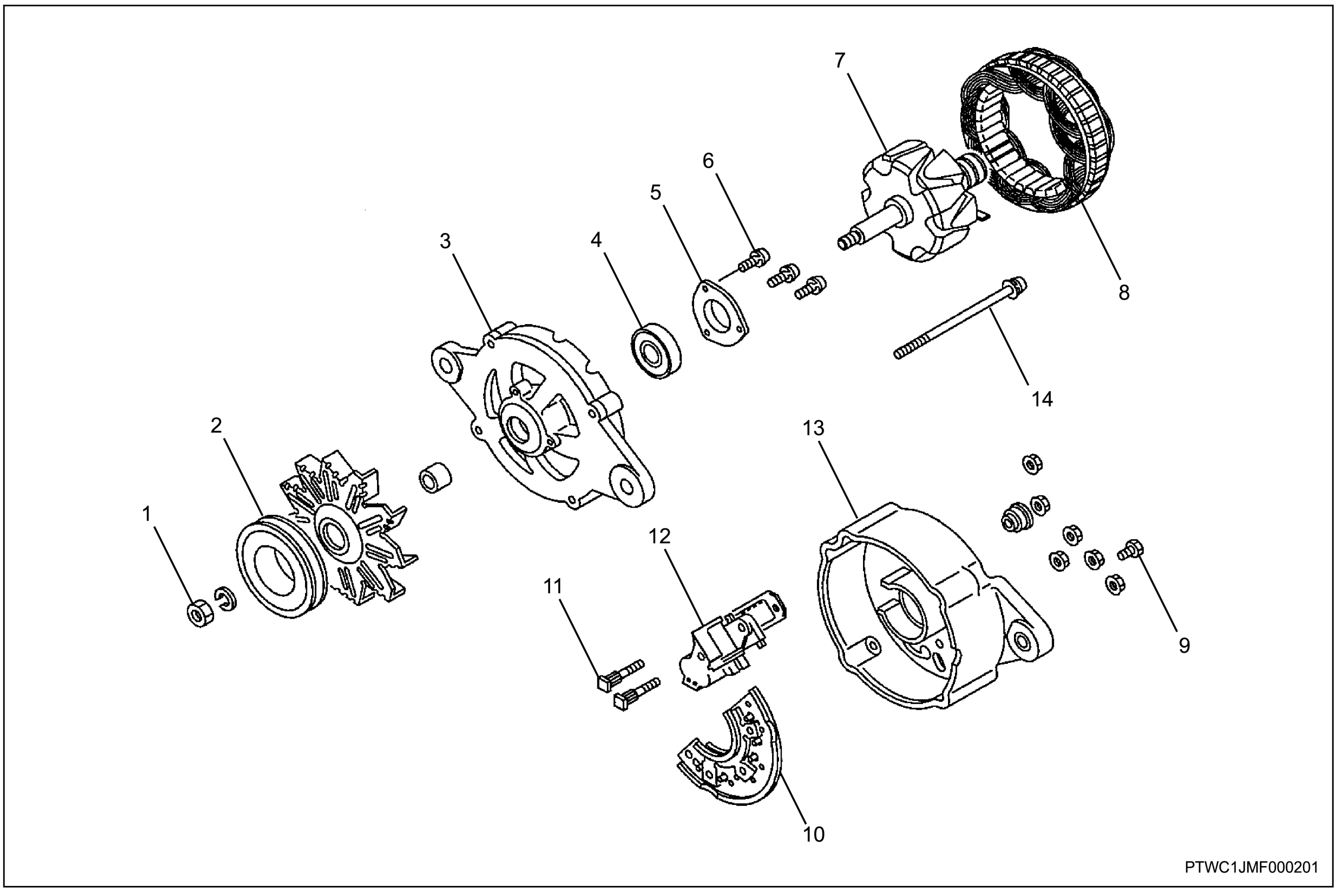
1. Adjust plate
2. Water pump assembly
3. Generator
4. Bolt



1. Screw
2. Cover
3. Through bolt
4. Rotor, front bracket assembly
5. Nut, washer
6. Pulley
7. Fan
8. Collar
9. Screw
10. Retainer
11. Ball bearing
12. Front bracket
13. Collar
14. Ball bearing
15. Rotor assembly
16. Screw
17. Field coil assembly
18. Stator assembly
19. Holder
20. Regulator assembly
21. B-terminal bolt
22. Condenser
23. Rectifier

Note :

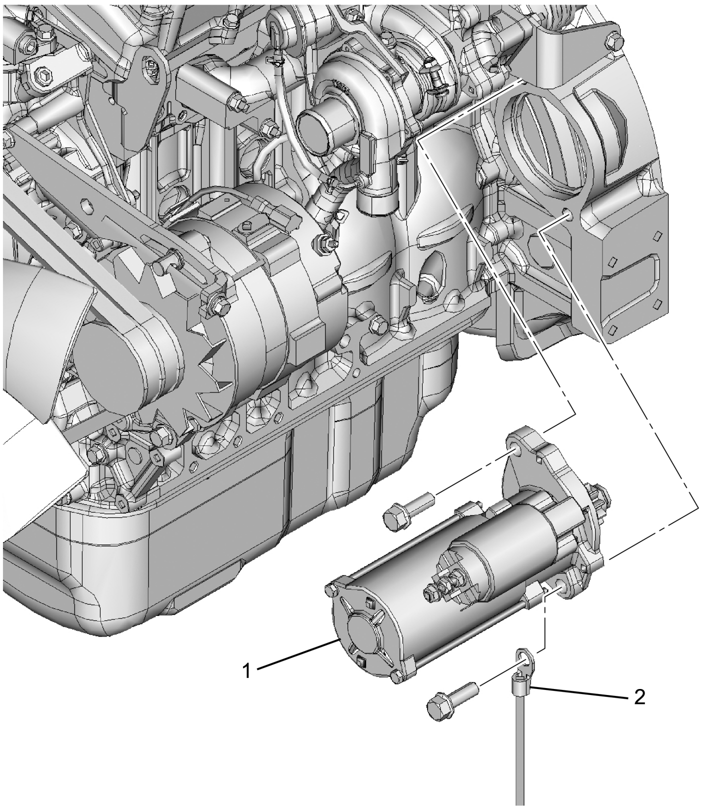
- Generator (12 V - 35 A specification)



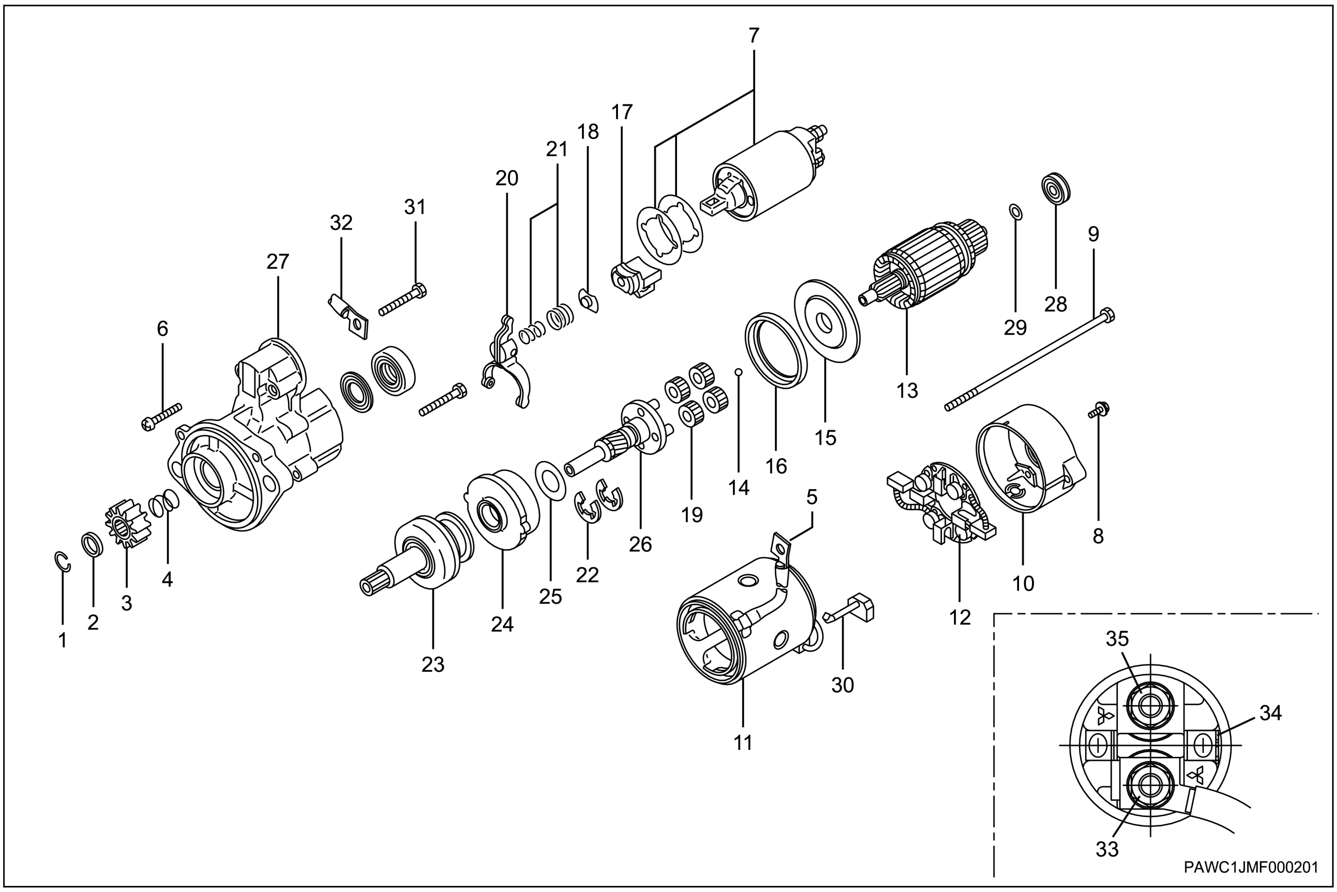
1. Pulley nut
2. Pulley
3. Front cover
4. Bearing
5. Retainer
6. Screw
7. Rotor assembly
8. Stator
9. Screw
10. Diode
11. Terminal bolt
12. Brush holder
13. Rear cover
14. Penetration bolt

Note：

- Starter motor (24 V - 3.2 kW specification)



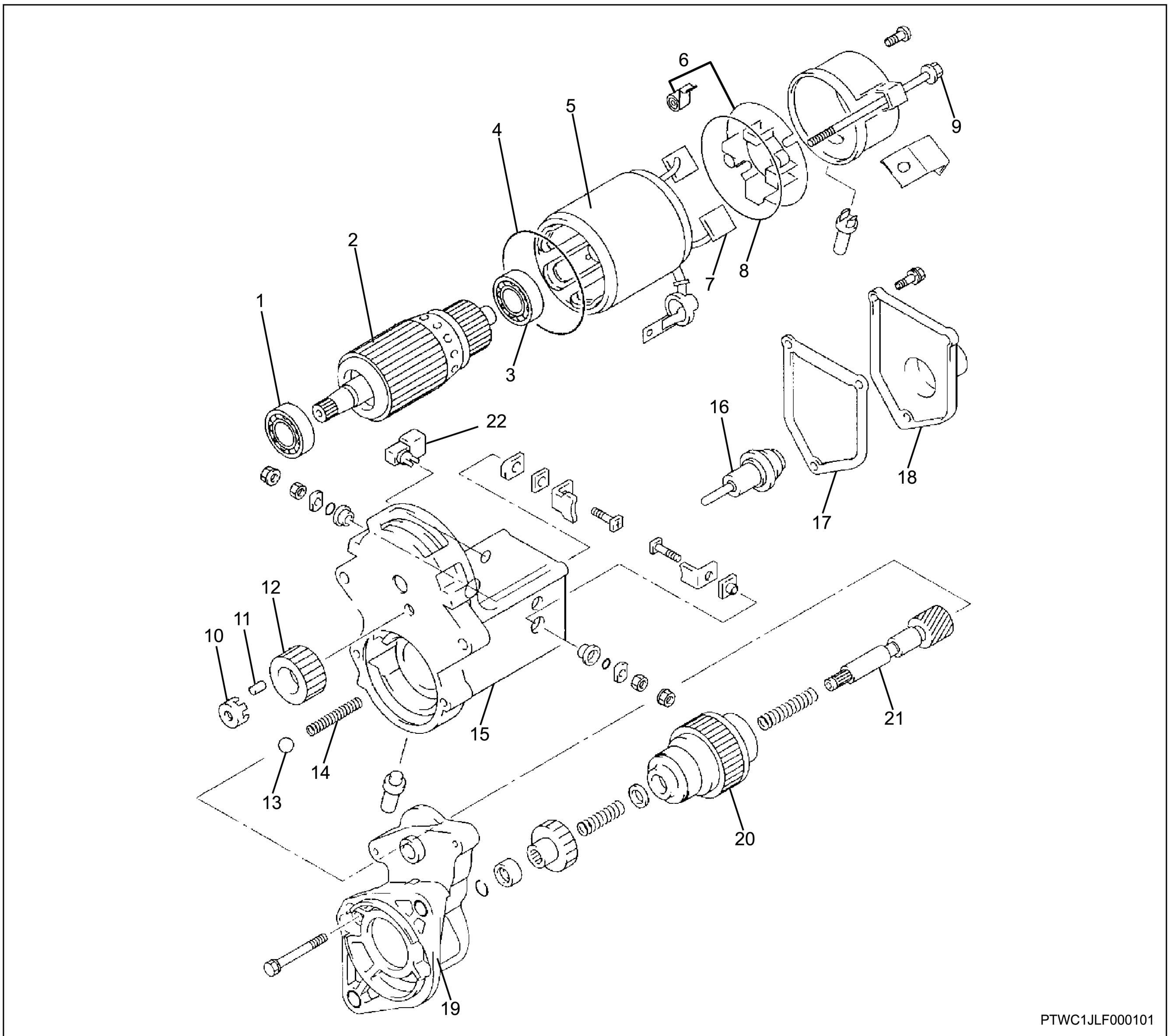
1. Starter motor
2. Ground cable



1. Snap ring
2. Stop ring
3. Pinion
4. Pinion spring
5. Lead wire with terminals
6. Screw
7. Magnet switch
8. Screw
9. Penetration bolt
10. Rear bracket
11. Yoke assembly
12. Brush holder
13. Armature
14. Ball
15. Plate
16. Packing
17. Packing
18. Plate
19. Planetary gear
20. Lever
21. Lever spring
22. E-shaped retaining ring
23. Overrunning clutch
24. Internal gear
25. Washer
26. Gear shaft
27. Front bracket
28. Bearing
29. Washer
30. Brush
31. Ground cable bolt
32. Ground cable
33. M-terminal
34. S-terminal
35. B-terminal

Note :

- Starter motor (12 V - 2.0 kW specification)

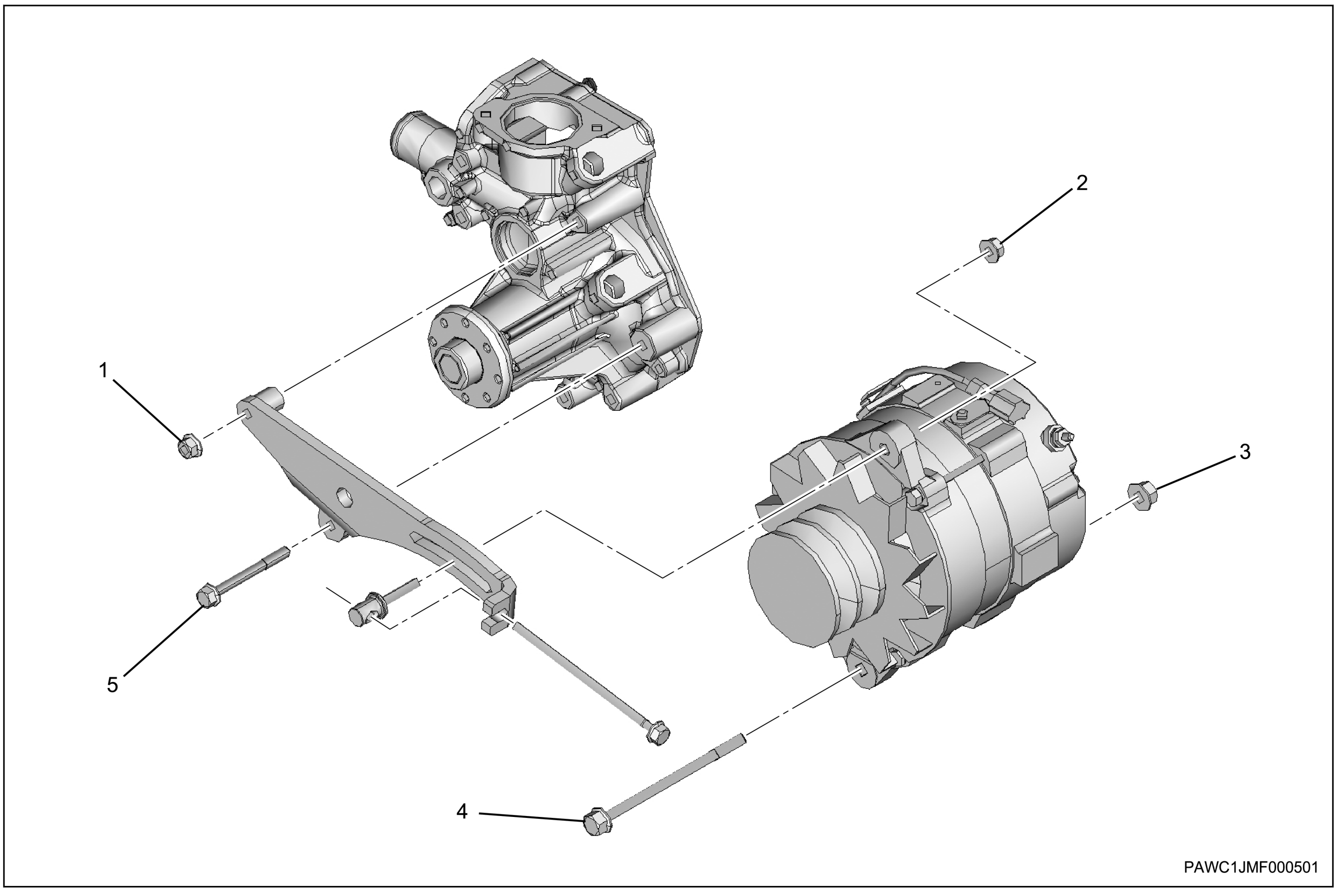


1. Front bearing
2. Armature
3. Rear bearing
4. O-ring
5. Yoke
6. Brush holder
7. Brush
8. O-ring
9. Through bolt
10. Retainer
11. Roller
12. Idle gear
13. Steam ball
14. Coil spring
15. Magnet switch
16. Plunger
17. Rubber cover
18. Drive housing
19. Clutch
20. Clutch shaft
21. C terminal

2. Tightening Torque Views

Note：

・ Generator (24 V - 50 A specification)



1 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

2 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

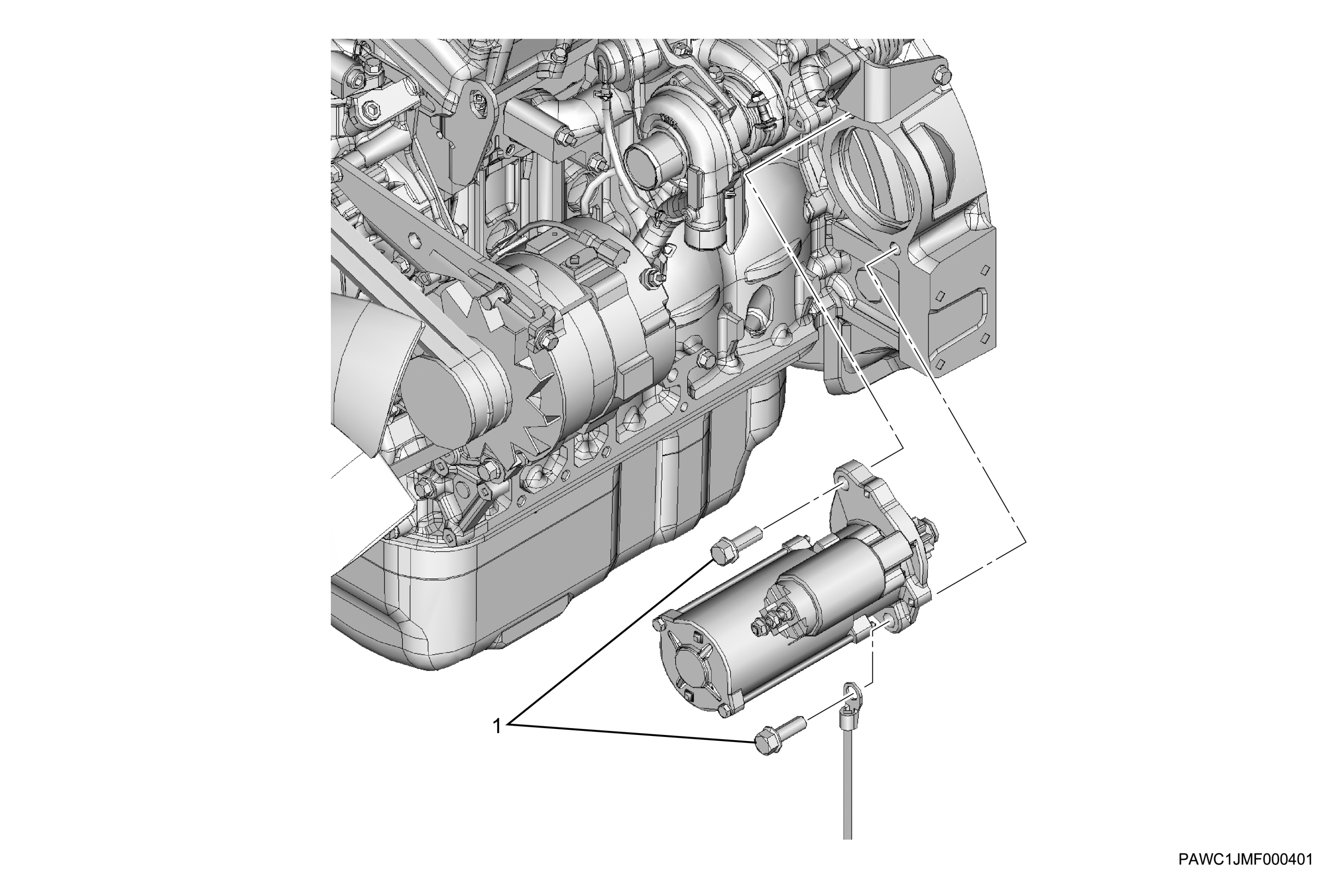
3 : 48 N・m { 4.9 kgf・m / 35 lb・ft }

4 : 48 N・m { 4.9 kgf・m / 35 lb・ft }

5 : 24 N・m { 2.4 kgf・m / 18 lb・ft }

Note :

- Starter motor (24 V - 3.2 kW specification)



1： 24 N・m { 2.4 kgf・m / 18 lb・ft }

Wiring Diagram

Table of Contents

Using the Wiring Diagram

Using the Wiring Diagram

Structure and Content of This Document

1. Wiring Diagram……………………………Includes from the parts installed on the engine to the connectors used for inputting and outputting control signals.

2. Location Diagram………………………Includes the positions of connectors used at each part of the engine.

3. Connector Information…………………The connector information includes connector shape, terminal position and connector color, if it is other than milky white color.

4. Terminal Name ………………………… Includes the circuits that correlate to each terminal of the parts.

5. Circuit Symbols

6. Abbreviations

1. Wiring Diagram

(1) Wiring information

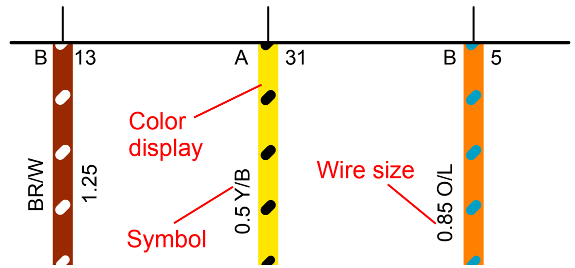
The wire size and wiring colors are described.
The wiring colors are described using color indications and color symbols.

Symbol	Color	Symbol	Color
B	Black	BR	Brown
W	White	LG	Light green
R	Red	GY	Gray
G	Green	P	Pink
Y	Yellow	SB	Sky blue
L	Blue	V	Violet
O	Orange	T	Tan

Wire Size Table

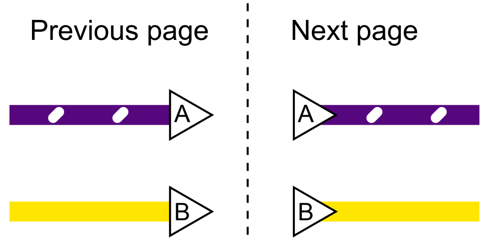
Nominal size	Calculated area (mm^2)	Outside diameter (mm)
0.3	0.372	1.8
0.5	0.563	2.0
0.85	0.885	2.2
1.25	1.287	2.5
2	2.091	2.9
3	3.296	3.6
5	5.227	4.4
8	7.952	5.5
15	13.36	7.0
20	20.61	8.2

Example:
When 2 colors such as "Y/B" are indicated,
it means wiring of yellow base with black line.



(2) Connection symbols between pages

The symbols indicate that the wiring with the same symbol is connecting from the previous page to the next page.



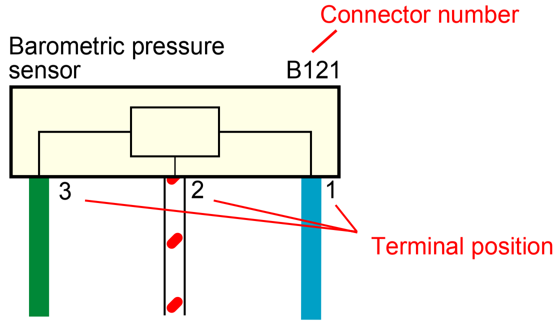
(3) Connection symbols within a page

The symbol indicates that it is connecting to the same symbol within the page.

(4) Connector

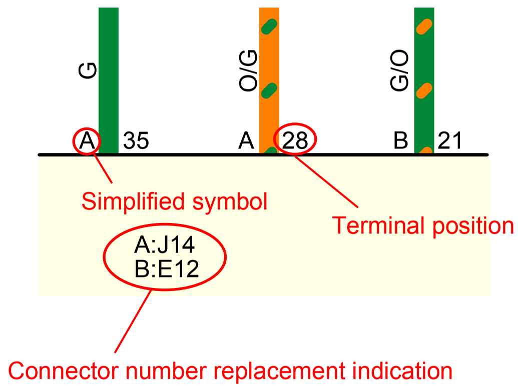
(a) Connector number

When multiple wires which are connected to equipment (a component) exist within the same connector, the connector number is indicated either inside or outside the equipment, and the corresponding terminal position is indicated next to each wire.



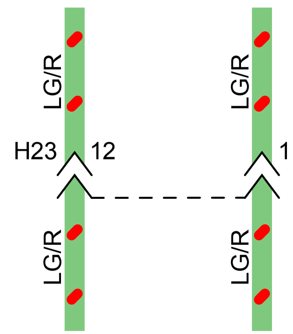
When multiple connectors are connected to a component, each connector number is expressed on the wiring diagram with a replacing simplified symbol.

Example:
"A: J14" means that J14 connector is described using the simplified symbol of "A".



(b) Inline connector

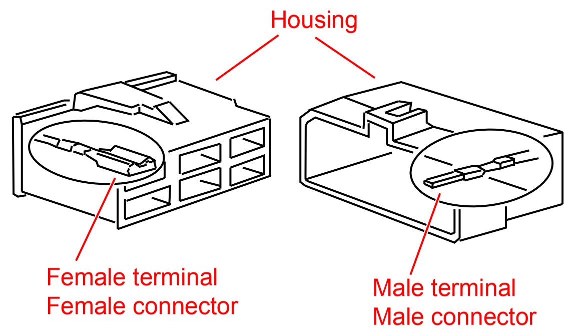
Connectors that are connecting wires are indicated.
" " indicates the female connector, and " " indicates the male connector.
On the wiring diagram, when connectors are linked with a dashed line (-----), it means that they are the same connector.



(c) Connector shape and terminal shape

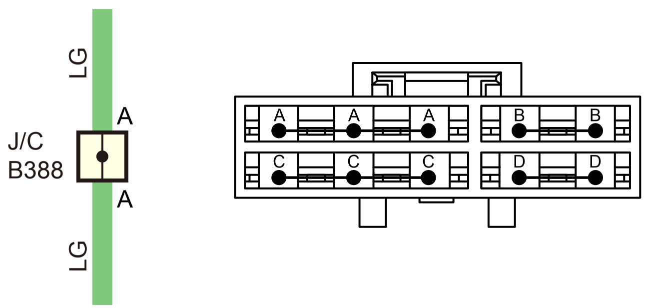
• Female connector
…indicates that the terminals are female.

• Male connector
…indicates that the terminals are male.



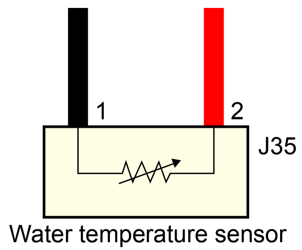
(d) Joint connector

A connector in which multiple terminals are collectively connected using joint terminals is indicated.
Alphabets indicate jointed groups (collectively connected terminals).



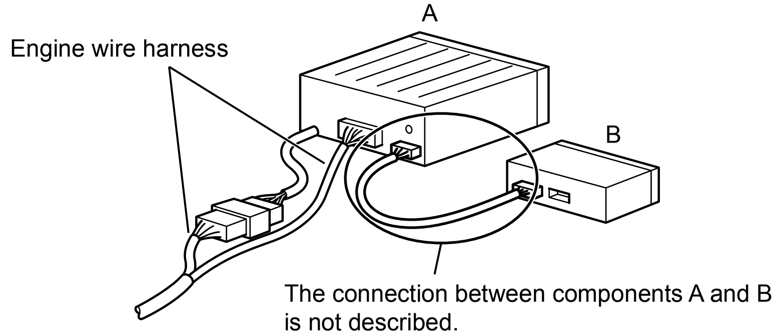
(5) Component

A component is represented as a frame (yellow inside), and the name of component is indicated either inside or outside the frame.



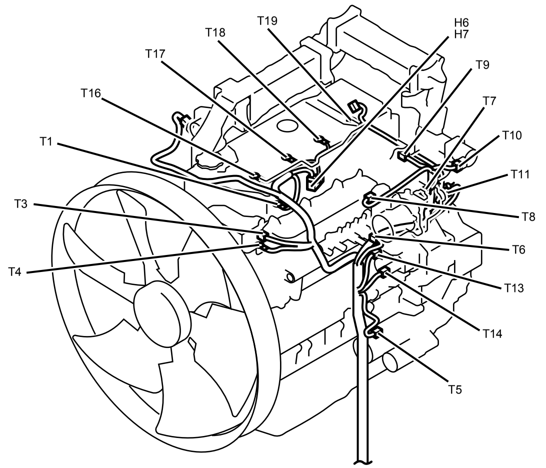
(6) Wiring not described

This document describes connections between engine wire harness and each component.
Therefore, connections made between components without mediating the engine wire harness are not described.



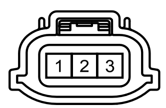
2. Location Diagram

The positional information of connectors is displayed.



3. Connector Information

The information for connector shape, terminal position
and connector color (except for milky white color) is displayed.



4. Terminal Name

Includes the circuits that correlate to each terminal of the parts.

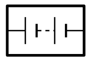
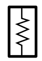
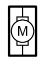
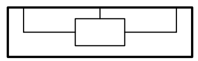
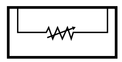
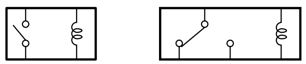
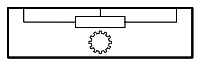
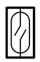
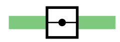
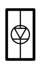
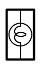
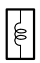
T3

Pin No.	Pin name
1	Engine coolant temperature sensor GND
2	Engine coolant temperature sensor signal
3	Engine coolant temperature sensor OEM meter

T5

Pin No.	Pin name
1	Oil pressure sensor GND
2	Oil pressure sensor signal
3	Oil pressure sensor power source

5. Circuit Symbols

Meaning of symbol	Symbol	Meaning of symbol	Symbol	Meaning of symbol	Symbol
Battery		Resistor		Shield	
Fuse		Buzzer		Ground	
Slow blow fuse		Motor		Connection between pages	
Fusible link (wire)		Pressure sensor, etc.		Connection within a page	
Circuit breaker		Temperature sensor			
Relay		Pulse sensor			
Switch		Other sensors, etc.			
Reed switch		Inline connector			
Diode		Joint connector junction block			
Light emitting diode		Joint			
Single filament bulb		Pair			
Solenoid valve, Magnetic valve, etc.		Twisted pair			

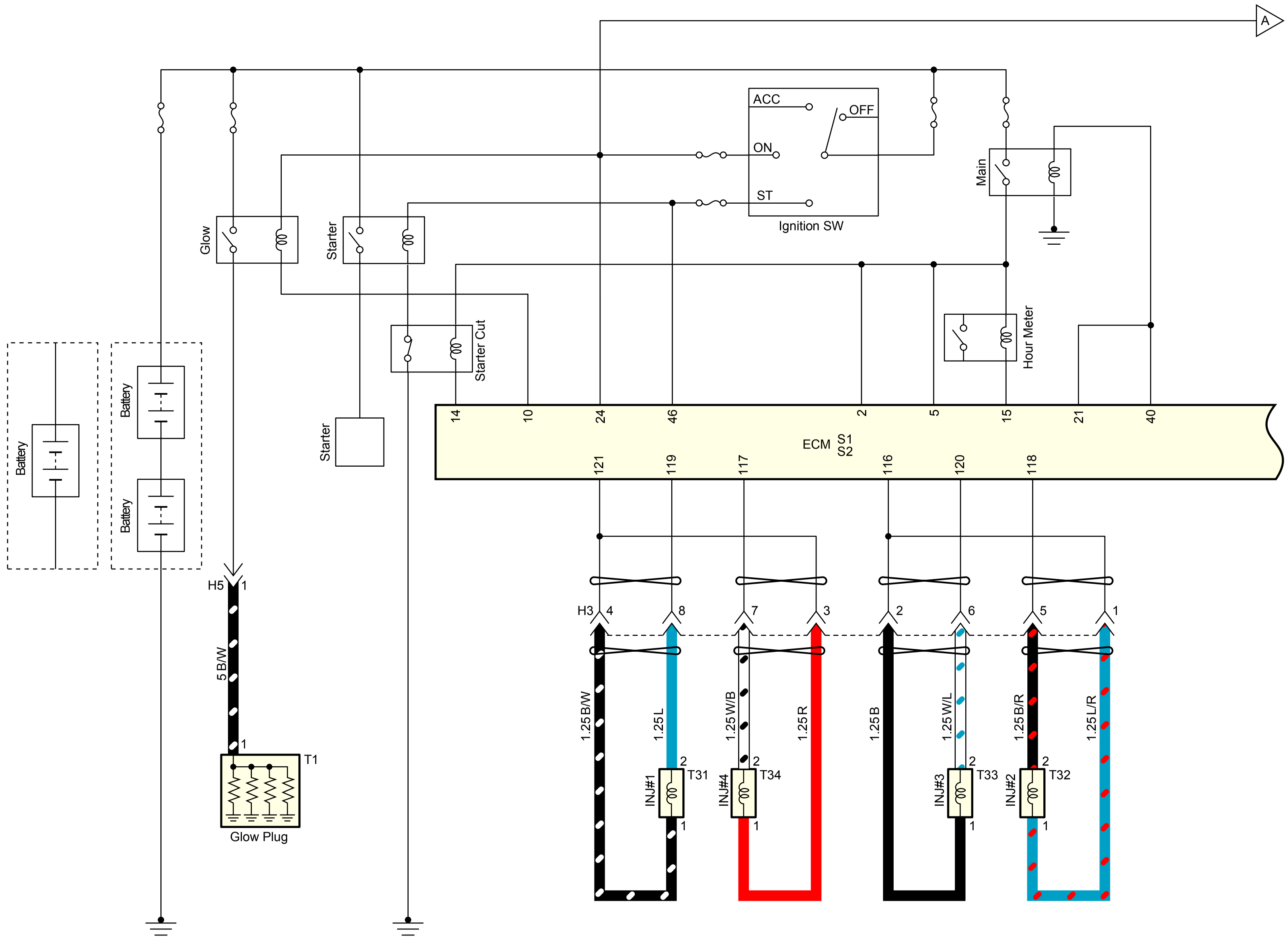
6. Abbreviations

The following abbreviations are used in this wiring diagram.

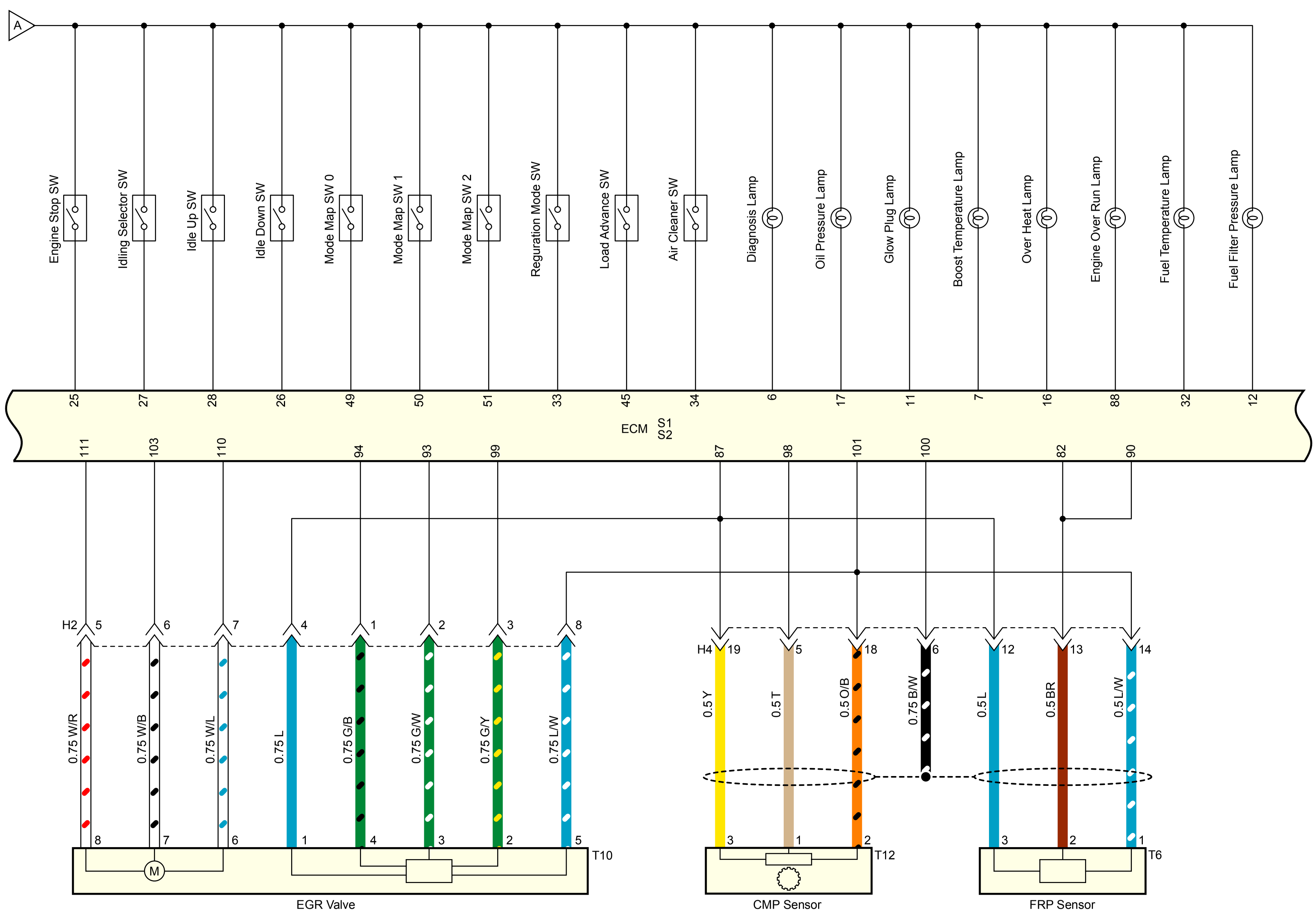
Abbreviations	Explanation
#	Cylinder or number indication
C/B	Circuit Breaker
Fr	Front
INJ	Injector
J/C	Joint Connector
L/H	Left Hand
R/H	Right Hand
Rr	Rear
SW	Switch
VSV	Vacuum Switching Valve

Engine

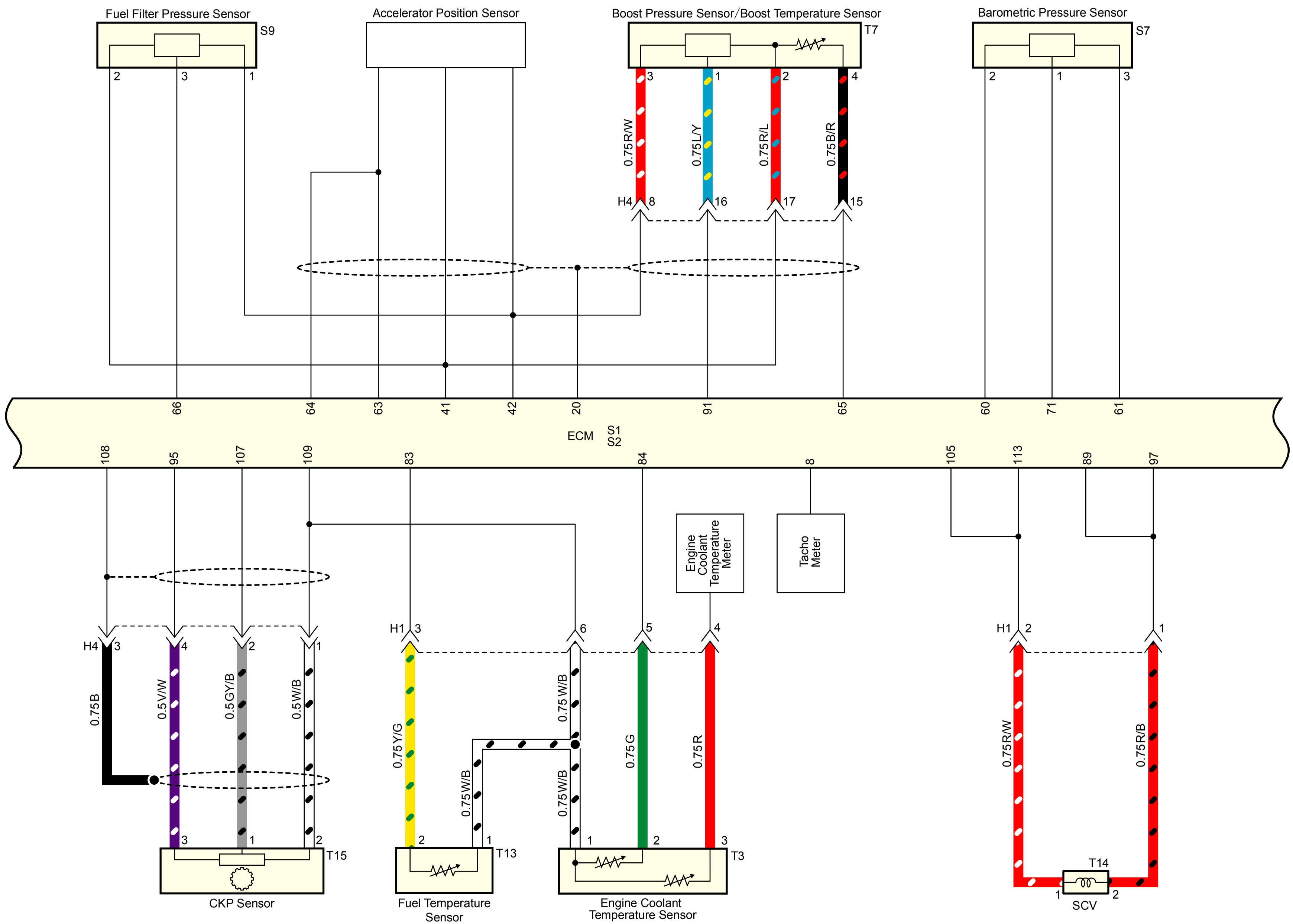
(Specifications vary depending on each machine. Refer to the machine's manual.)



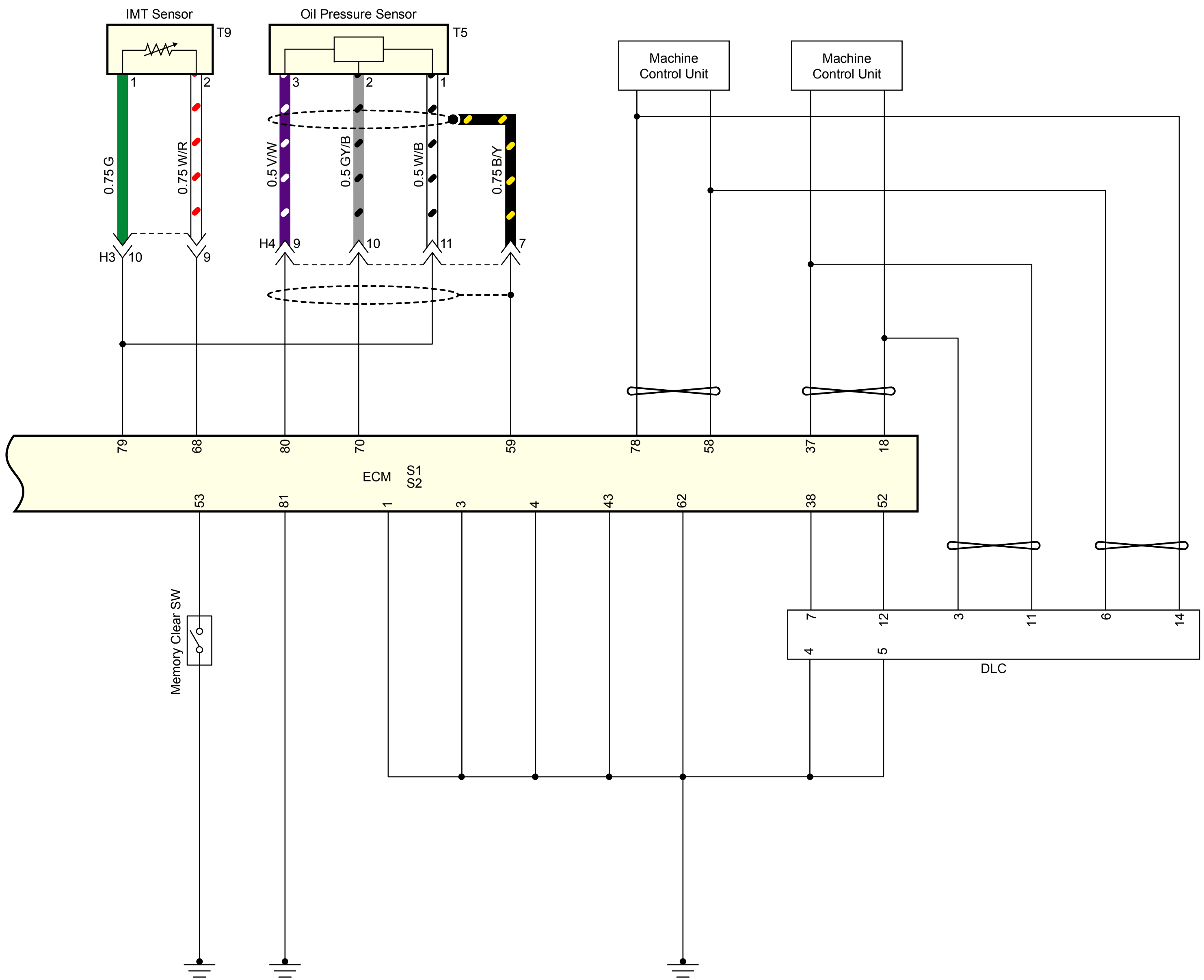
(Specifications vary depending on each machine. Refer to the machine's manual.)



(Specifications vary depending on each machine. Refer to the machine's manual.)

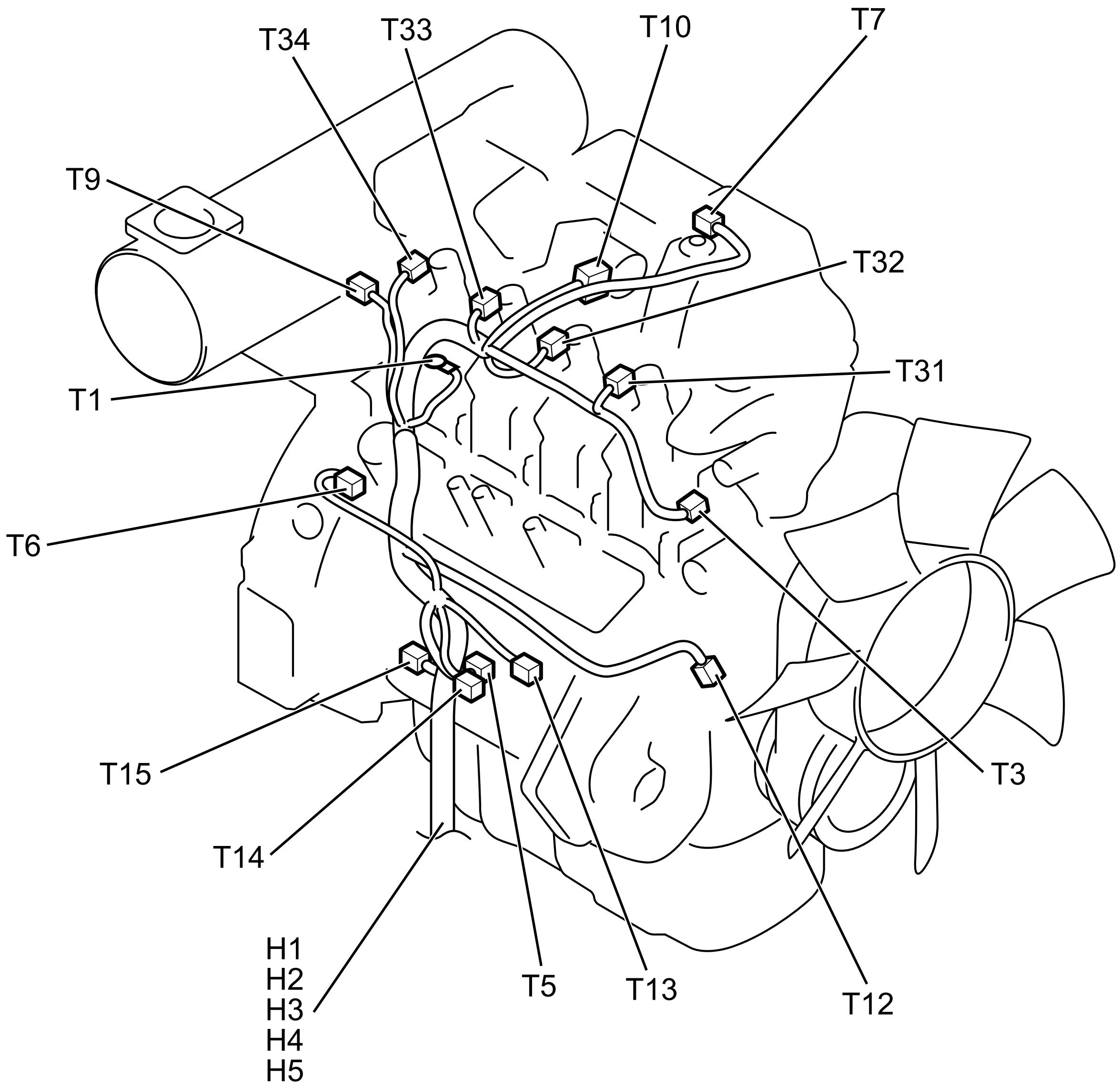


(Specifications vary depending on each machine. Refer to the machine's manual.)



Location Diagram

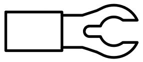
4LE2



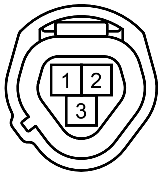
Connector List

T··· (Connector List)

T1

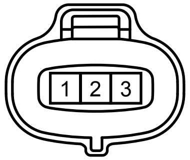


T3



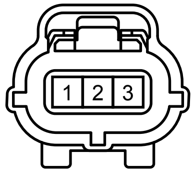
Gray

T5



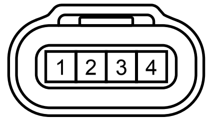
Black

T6



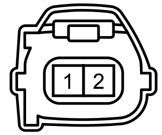
Black

T7



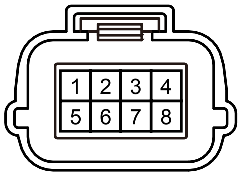
Black

T9



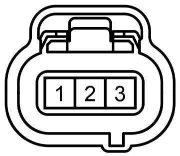
Dark Gray

T10



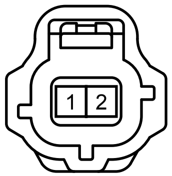
Dark Brown

T12



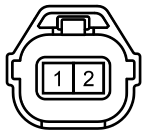
Light Gray

T13



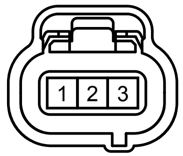
Dark Green

T14



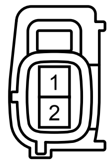
Gray

T15



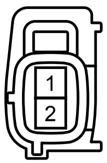
Light Gray

T31



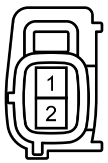
Gray

T32



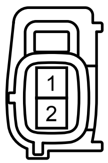
Gray

T33



Brown

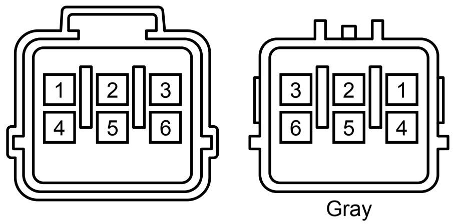
T34



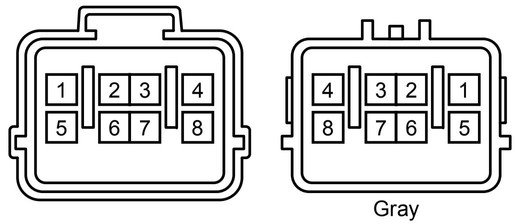
Gray

H… (Connector List)

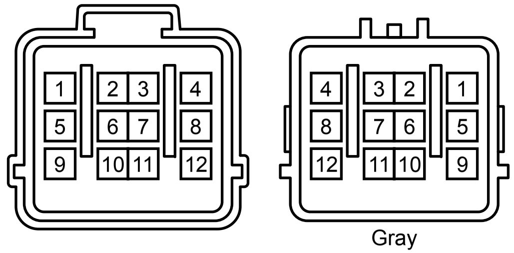
H1



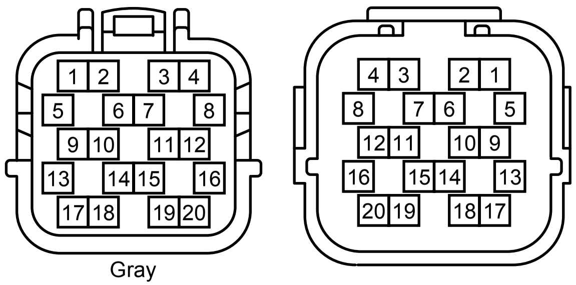
H2



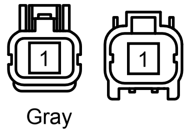
H3



H4

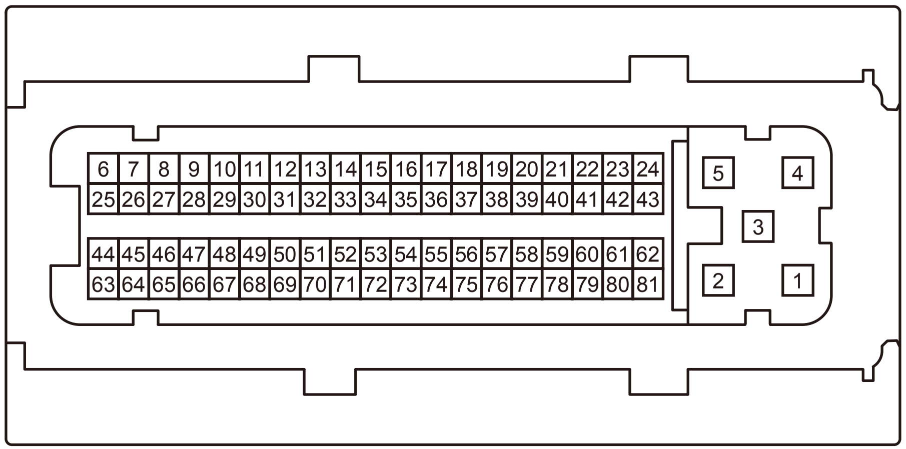


H5



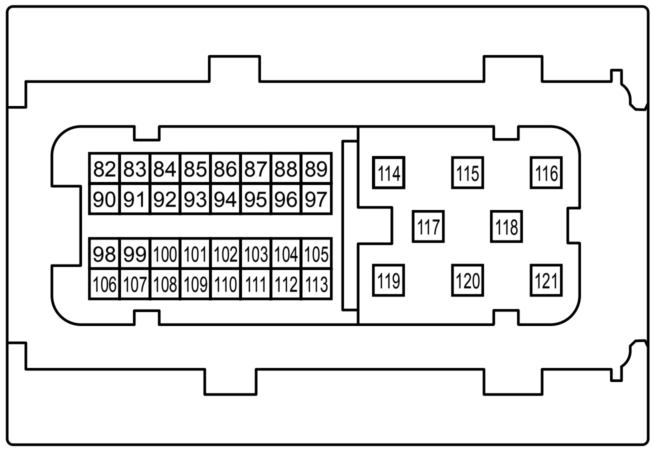
S… (Connector List)

S1



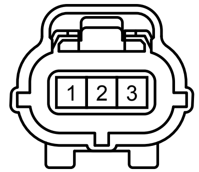
Black

S2

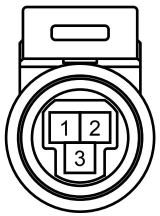


Black

S7



S9



Black

Terminal Name

(Specifications vary depending on each machine. Refer to the machine's manual.)

T1

1	Glow plug power source

T3

1	Engine coolant temperature sensor GND
2	Engine coolant temperature sensor signal
3	Engine coolant temperature sensor OEM meter

T5

1	Oil pressure sensor GND
2	Oil pressure sensor signal
3	Oil pressure sensor power source

T6

1	FRP sensor GND
2	FRP sensor signal
3	FRP sensor power source

T7

1	Boost pressure sensor signal
2	Boost pressure sensor GND
3	Boost pressure sensor power source
4	Boost temperature sensor signal

T9

1	IMT sensor GND
2	IMT sensor signal

T10

1	EGR position sensor power source
2	EGR position sensor signal W
3	EGR position sensor signal V
4	EGR position sensor signal U
5	EGR position sensor GND
6	EGR valve DC servo motor drive W
7	EGR valve DC servo motor drive V
8	EGR valve DC servo motor drive U

T12

1	CMP sensor signal
2	CMP sensor GND
3	CMP sensor power source

T13

1	Fuel temperature sensor signal
2	Fuel temperature sensor GND

T14

1	SCV-HI drive
2	SCV-LO drive

T15

1	CKP sensor signal
2	CKP sensor GND
3	CKP sensor power source

T31

1	Injector power source 1 No. 1 cylinder, No. 4 cylinder
2	Injector 1 control, No.1 cylinder

T32

1	Injector 4 control, No.2 cylinder
2	Injector power source 2 No. 2 cylinder, No. 3 cylinder

T33

1	Injector power source 2 No. 2 cylinder, No. 3 cylinder
2	Injector 2 control, No.3 cylinder

T34

1	Injector 3 control, No.4 cylinder
2	Injector power source 1 No. 1 cylinder, No. 4 cylinder

(Specifications vary depending on each machine. Refer to the machine's manual.)

S1

Pin No.	Connection
1	ECM power source GND
2	Battery power source
3	ECM power source GND
4	ECM power source GND
5	Battery power source
6	Diagnosis light
7	Boost temperature sensor pilot light
8	Tachometer
9	–
10	Glow relay
11	Glow light
12	Fuel filter clogging light
13	–
14	Starter cut relay
15	Hour meter relay
16	Overheat light
17	Engine hydraulic light
18	CAN-High
19	–
20	Accelerator position sensor, boost pressure shield
21	ECM main relay control
22	–
23	–
24	Ignition switch ON signal
25	Engine stop switch signal
26	Idling control switch Down signal
27	Idling control change switch signal
28	Idling control switch Up signal
29	–
30	–
31	–
32	Fuel temperature light
33	Regulation mode switch signal
34	Air cleaner switch signal
35	–
36	–
37	CAN-Low
38	Data link connector
39	–
40	ECM main relay control
41	Accelerator position sensor, boost pressure sensor, fuel filter pressure sensor GND

Pin No.	Connection
42	Accelerator position sensor, Boost pressure sensor, fuel filter pressure sensor power source
43	Signal GND
44	–
45	Load advance switch signal
46	Ignition switch start signal
47	–
48	–
49	Mode map switch 0 signal
50	Mode map switch 1 signal
51	Mode map switch 2 signal
52	Diagnostic switch signal
53	Memory clear switch
54	–
55	–
56	–
57	–
58	ISO CAN-High
59	Oil pressure shield
60	Barometric pressure sensor GND
61	Barometric pressure sensor power source
62	Signal GND
63	Accelerator position sensor 1 signal
64	Accelerator position sensor 2 signal
65	Boost temperature sensor signal
66	Fuel filter pressure sensor signal
67	–
68	IMT sensor signal
69	–
70	Oil pressure sensor signal
71	Barometric pressure sensor signal circuit
72	–
73	–
74	–
75	–
76	–
77	–
78	ISO CAN-Low
79	IMT sensor Oil pressure sensor GND
80	Oil pressure sensor power source
81	ECM case GND

S2

Pin No.	Connection
82	FRP sensor signal
83	Fuel temperature sensor signal
84	Engine coolant temperature sensor signal
85	–
86	–
87	CMP sensor, FRP sensor, EGR position sensor power source
88	Engine overrun light
89	SCV-LO drive
90	FRP sensor signal
91	Boost pressure sensor signal
92	–
93	EGR position sensor signal V
94	EGR position sensor signal U
95	CKP sensor power source
96	–
97	SCV-LO drive
98	CMP sensor signal
99	EGR position sensor signal W
100	CMP sensor, FRP sensor shield
101	CMP sensor, FRP sensor, EGR position sensor GND
102	–
103	EGR valve DC servo motor drive V
104	–
105	SCV-HI drive
106	–
107	CKP sensor signal
108	CKP sensor shield
109	CKP sensor, fuel temperature sensor, engine coolant temperature sensor GND
110	EGR valve DC servo motor drive W
111	EGR valve DC servo motor drive U
112	–
113	SCV-HI drive
114	–
115	–
116	Injector power source 2 No. 2 cylinder, No. 3 cylinder
117	Injector 3 control, No.4 cylinder
118	Injector 4 control, No.2 cylinder
119	Injector 1 control, No.1 cylinder
120	Injector 2 control, No.3 cylinder
121	Injector power source 1 No. 1 cylinder, No. 4 cylinder

Terminal Name···Terminal Name

(Specifications vary depending on each machine. Refer to the machine's manual.)

S7

1	Barometric pressure sensor signal circuit
2	Barometric pressure sensor GND
3	Barometric pressure sensor power source

S9

1	Fuel filter pressure sensor power source
2	Fuel filter pressure sensor GND
3	Fuel filter pressure sensor signal

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ISUZU

DIESEL ENGINE 4LE2

TIER 4/STAGE Ⅲ B

EXHAUST EMISSION STANDARDS

WORKSHOP MANUAL

ENGINE

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