

Service Manual

6D16 Diesel Engine

DP80

DP90

DP100

DP115

DP135

DP150

6D16

diesel engine

Shop Manual

FOREWORD

This Shop Manual is published for the information and guidance of personnel responsible for maintenance of 6D16 diesel engine, and includes procedures for adjustment and maintenance services.

We earnestly look forward to seeing that this manual is made full use of in order to perform correct service with no wastage.

For more details, please consult your nearest authorized Caterpillar® dealer or distributor.

Kindly note that the specifications and maintenance service figures are subject to change without prior notice in line with improvement which will be effected from time to time in the future.

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HOW TO READ THIS MANUAL

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HOW TO READ THIS MANUAL

How This Manual Is Compiled

- This manual is compiled by classifying various systems into certain groups.
- Each group contains specifications; troubleshooting; maintenance service standards;  tightening torque;  lubricant, fluid and sealant;  special tools; and service procedure.
- Page enumeration is independent by every group where first page is always 1.

Group No.	Group denomination	Contents
00	General	General specifications, engine No. and name plate, precautions for maintenance operations, table of standard tightening torques
11	Engine	Engine body
12	Lubrication	Lubrication system
13	Fuel and engine control	Fuel system
14	Cooling	Cooling system
15	Intake and exhaust	Intake and exhaust system, intercooler
54	Electrical system	Alternator, starter, preheating system, engine start system
61	Special equipment	Air compressor

General Explanation of This Manual

● Specifications

Particulars relative to maintenance service are made.

● Structure and operation

(1) Regarding conventional equipment, descriptions are made in brief.

(2) Regarding new equipment, descriptions of system and operating condition are made in detail.

● Troubleshooting

Symptoms of troubles and possible causes are described comparatively.

● Inspection and adjustment mounted in vehicle

Descriptions are made regarding inspection and adjustment of units mounted in vehicle.

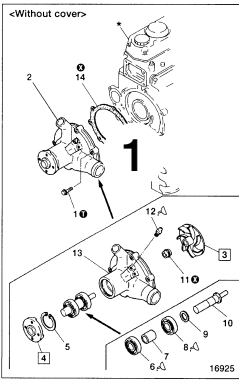
● Service procedure

In principle, an explanation is given at the spread title page so that the service procedure can be understood.

Servicing points are explained as a supplementary explanation.

Regarding the design of this manual

WATER PUMP



1a

- Disassembly sequence
 - 1 Bolt
 - 2 Water pump assembly
 - 3 Impeller
 - 4 Flange
 - 5 Snap ring
 - 6 Bearing
 - 7 Spacer
 - 8 Bearing
 - 9 Washer
 - 10 Water pump shaft
 - 11 Unit seal
 - 12 Grease nipple
 - 13 Water pump case
 - 14 Gasket
- Assembly sequence
 - 14 → 2 → 1

○: Cylinder head
●: Non-reusable part

● Inspection after assembly
□ P.14-16

Service standards Unit: mm (in.)

Location	Maintenance item	Standard value	Limit	Remedy
3, 10	Impeller-to- [Basic dia] shaft interference [Basic dia] (0.512 in.)	0.03 to 0.06 (0.00118 to 0.00236)	-	Reassembly allowed only twice
4, 10	Flange-to- [Basic dia] shaft interference [Basic dia] (1.02 in.)	0.05 to 0.08 (0.00197 to 0.00315)	-	Reassembly allowed only twice

Tightening torques Unit: N·m (kgf·m) [lbf·ft]

Location	Part	Tightening torque	Remarks
1	Bolt (water pump)	9.8 (1.0) [7.23]	Wet

14

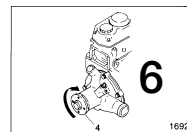
Lubricants and sealant

Location	Points of application	Kinds	Quantity
6, 8	Bearings	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
11	Unit seal outer p.	THREEBOND 1102	As required
12	Grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	60 g (2.12 oz)

Special tools

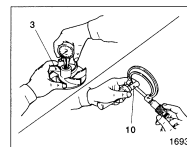
Unit: mm (in.)

Location	Tool name and shape	Part No.	Application
2	Imp	MH061417	Removing impeller



● Service procedure

- Inspection after assembly
- After assembly, rotate flange 4 by hand and check that it turns smoothly without hindrance.
- If the flange does not turn smoothly, disassemble and inspect the water pump again.



- 10 Impeller-to-water pump shaft interference
- If the measurement does not conform with the standard value, replace the defective part(s).

CAUTION ⚠
Even if the standard value is satisfied, reassembly must not be carried out more than twice.

- Illustration for disassembly and assembly or removal and installation: 3-D exploded view of component parts is displayed.
 - Names of parts show an example of the disassembly (removal) sequence.
 - When the assembly (installation) sequence differs from the disassembly (removal) sequence, an example of the assembly (installation) sequence is shown.
- Service standards are shown collectively, classified by location.
- Tightening torques are shown collectively, classified by location.
- Points of lubricant, fluid and sealant application are shown collectively, classified by location.
- Special tools to be used are shown collectively, classified by location.
- When it is considered hard to understand the service procedure, just by the foregoing description, a supplementary description of the service procedure is given.

HOW TO READ THIS MANUAL

1. Illustration for disassembly and assembly or removal and installation

This shows that the appropriate service procedure is described in the text.

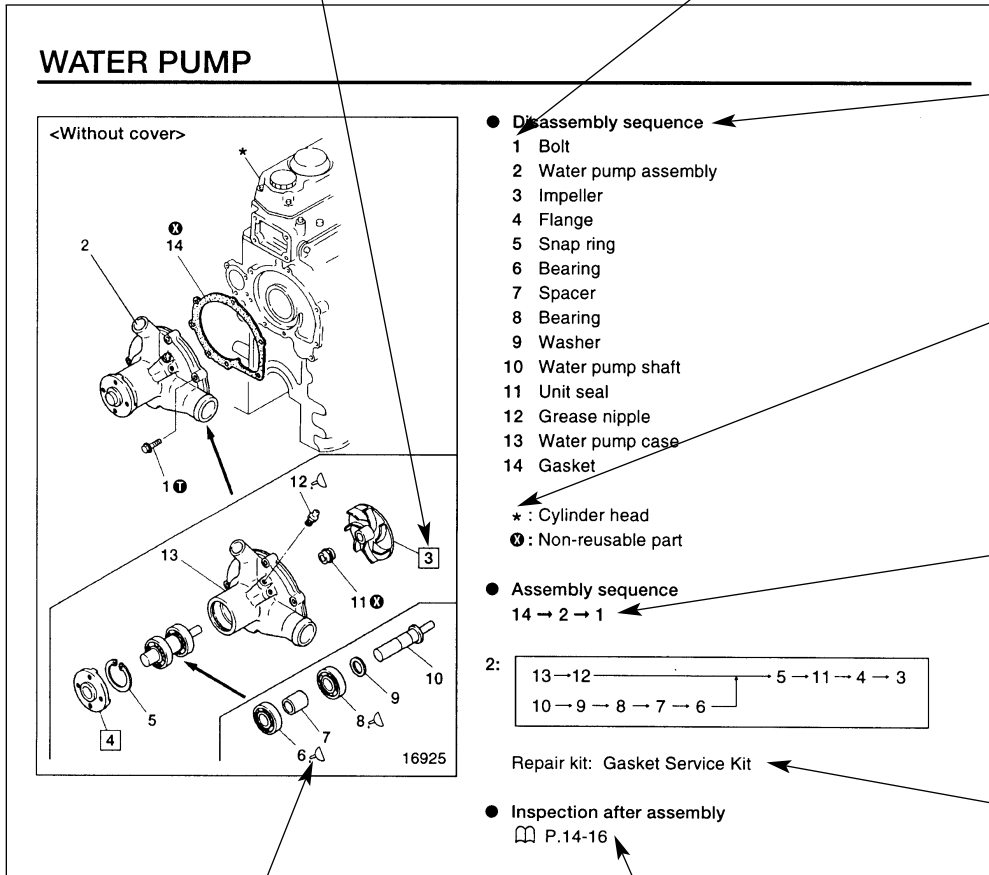
This shows the key No. of the part. In the text, this No. is referred to uniformly throughout.

This shows an example of the disassembly (removal) sequence.

No service procedure is referred to in this section, but the item can be an objective of various procedures.

This is shown when the assembly (installation) sequence is not the reverse of the disassembly (removal) sequence.

This shows that a repair kit is available.



Meaning of symbols

- ⓘ : shows that the tightening torque is specified.
- ⚡ : shows that application of lubricant, fluid or sealant is required.
- ⓧ : shows that the part should not be reused.

This shows that the service procedure is described in another section.

📖 P00-00

: shows reference page within the same group.

📖 Gr00

: shows reference group within the same book.

2. Service standards table

Only the relevant service standards are shown.



Service standards

Unit: mm (in.)

Location	Maintenance item	Standard value	Limit	Remedy
3, 10	Impeller-to-water pump shaft interference [Basic diameter: 13 mm (0.512 in.)]	0.03 to 0.06 (0.00118 to 0.00236)	–	Reassembly allowed only twice
4, 10	Flange-to-water pump shaft interference [Basic diameter: 26 mm (1.02 in.)]	0.05 to 0.08 (0.00197 to 0.00315)	–	Reassembly allowed only twice



This shows the key No. of the relevant part.

3. Tightening torque table

This shows specified tightening torque.



Tightening torques

Unit: N·m (kgf·m) [lbf·ft]

Location	Parts to be tightened	Tightening torque	Remarks
1	Bolt (water pump assembly mounting)	9.8 (1.0) [7.23]	Wet



This shows the key No. of the relevant part.



This shows that the item is to be tightened wet.

4. Lubricants and sealant table

Only the relevant lubricants and sealant are shown.



Lubricants and sealant

This shows the application point.

Location	Points of application	Kinds	Quantity
6, 8	Bearings	Wheel bearing grease [NLGI No. 2 (Li soap)]	As required
11	Unit seal outer periphery	THREEBOND 1102	As required
12	Grease nipple	Wheel bearing grease [NLGI No. 2 (Li soap)]	60 g (2.12 oz)



This shows the key No. of the relevant part.



This shows the specified brand.

HOW TO READ THIS MANUAL

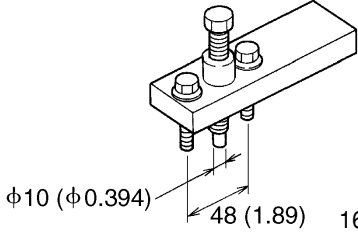
5. Special tools table

Only the relevant special tools are shown.

Purpose of special tools is shown.

Special tools

Unit: mm (in.)

Location	Tool name and shape	Part No.	Application
2	 <p>Impeller Puller</p>	MH061417	Removing impeller

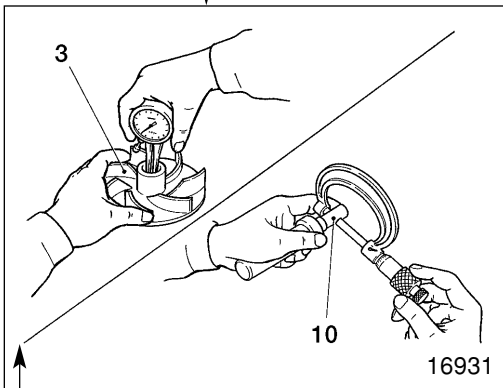
This shows the key No. of the relevant part.

Quote this number when placing an order for the part.

6. Service procedure

This indicates a special service tool.

This shows the key No. of the relevant part.



3 10 Impeller-to-water pump shaft interference

If the measurement does not conform with the standard value, replace the defective part(s).

CAUTION

Even if the standard value is satisfied, reassembly must not be carried out more than twice.


The key No. referred to in the text is always the same as the key No. shown in the illustration.


Servicing procedures of disassembly (removal), assembly (installation), inspection, adjustment, etc. are shown collectively.


Terms and Units

The terms and units in this manual are defined as follows.

- This service manual contains important cautionary instructions and supplementary information under the following four headings which identify the nature of the instructions and information:

DANGER  ————— Precautions that should be taken in handling potentially dangerous substances such as battery fluid and coolant additives.

WARNING  ————— Precautionary instructions, which, if not observed, could result in serious injury or death.

CAUTION  ————— Precautionary instructions, which, if not observed, could result in damage to or destruction of equipment or parts.

NOTE ————— Suggestions or supplementary information for more efficient use of equipment or a better understanding.

- **Front and rear**

The terms “front” is the fan side and “rear” the flywheels side of the engine.

- **Left and right**

The terms “right” and “left” shall be used to indicate the side as viewed from the flywheel side of the engine.

- **Terms of service standards**

(1) Standard value

Standard value dimensions in designs indicating: the design dimensions of individual parts, the standard clearance between two parts when assembled, and the standard value for an assembly part, as the case may be.

(2) Limit

When the value of a part exceeds this, it is no longer serviceable in respect of performance and strength and must be replaced or repaired.

- **Tightening torque**

Excessive or insufficient tightening torque has particular importance in respect of performance. Accordingly, tightening torque is specified in locations that are to be tightened.

Where there is no specified figure for tightening torque, follow the table covering standard tightening torques.

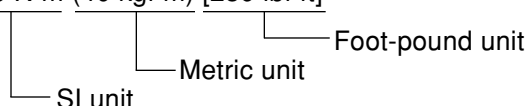
When the item is to be tightened in a wet state, wet is indicated. Where there is no indication, read it as dry, and tighten at specified torque.

- **Unit**

Length, weight, surface area and capacity are in SI units with foot-pound units are given in brackets.

Tightening torques and other parameters are given in SI units with metric and foot-pound units added in brackets () and [].

Example: 390 N·m (40 kgf·m) [289 lbf·ft]



Temperatures are given in degrees Celsius with degrees Fahrenheit given brackets.

For the conversion into the foot-pound system, refer to the following conversion table.

HOW TO READ THIS MANUAL

Unit	Sign of SI unit	Sign of foot-pound unit	Conversion rate
Mass quantity of matter	kg g	lb oz	1 kg = 2.2046 lb 1 g = 0.035274 oz
Dimension	m mm	ft. in.	1 m = 3.2808 ft. 1 mm = 0.03937 in.
Capacity	L cm ³ cm ³	gal. oz cu.in.	1 L = 0.2642 gal. (U.S.) 1 L = 0.220 gal. (Imp.) 1 cm ³ = 0.033814 oz (U.S.) 1 cm ³ = 0.035195 oz (Imp.) 1 cm ³ = 0.061023 cu.in.
Force	N (Newton)	lbf	1 N = 0.2248 lbf 1 N = 0.10197 kgf
Pressure	kPa (kilopascal) MPa (megapascal)	psi	1 kPa = 0.0102 kgf/cm ² 1 kPa = 0.145 psi 1 kPa = 0.2953 in. Hg 1 MPa = 10.197 kgf/cm ² 1 MPa = 145.0546 psi
Stress	N/cm ²	psi	1 N/cm ² = 1.45 psi
Moment of force	N·m	lbf.ft	1 N·m = 0.7375 lbf.ft 1 N·m = 0.10197 kgf·m
Output	kW (kilowatt)	HP	1 kW = 1.34 HP
Temperature	°C	°F	t°C = (1.8t°C + 32)°F

GROUP 00 GENERAL

GENERAL SPECIFICATIONS.....	2
ENGINE NUMBER AND NAME PLATE	3
PRECAUTIONS FOR MAINTENANCE OPERATION	4
TABLE OF STANDARD TIGHTENING TORQUES	12

GENERAL SPECIFICATIONS

Item	Specifications
Engine model	6D16
Type	6-cylinder in-line, water-cooled 4-cycle diesel
Combustion chamber type	Direct injection type
Valve mechanism	Overhead valve (OHV) type
Bore × Stroke	mm (in.) 118 × 115 (4.65 × 4.53)
Total displacement	cc (cu. in.) 7545 (460.4)
Compression ratio	17.5
Empty mass	kg (lb)* 500 (1.102)

* Empty mass as measured according to Mitsubishi Motors Corporation standard.

Engine Output

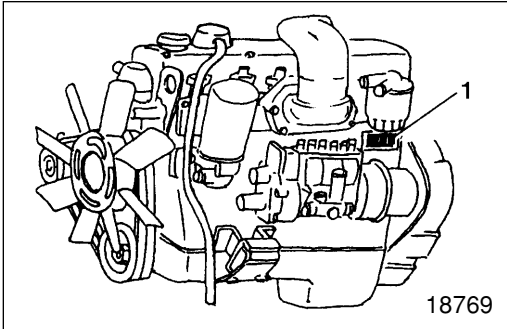
6D16	kW (HP)/rpm	98 (131)/2200
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NOTE

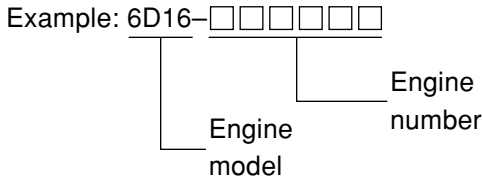
The output (SAE, gross) is corrected to standard ambient conditions based on SAE J1349.

The serial number for engine is assigned to the respective engine in manufacturing sequence: every engine has its own number. This number is required for incidental inspection of the engine. Please do not fail to mention this number to the dealers when ordering spare parts.

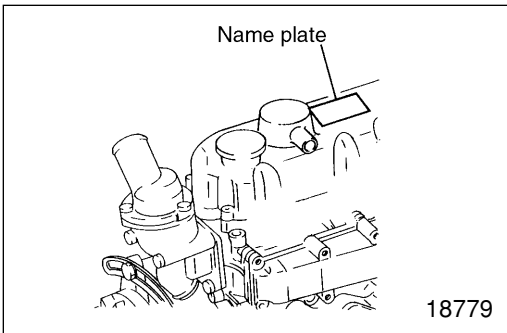
Engine Number



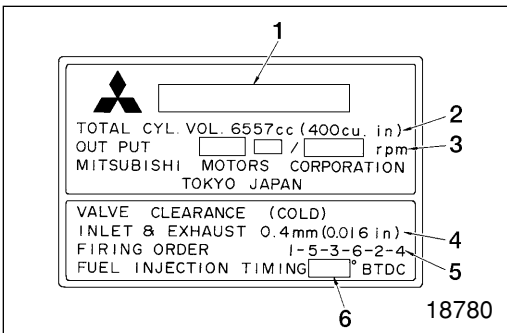
Engine number 1 is punch-marked on the left of the crankcase.



Name Plate



The name plate is attached to the portion shown in the illustration, and indicate the following items.



- 1 Engine model
- 2 Total displacement
- 3 Maximum output
- 4 Valve clearance
- 5 Firing order
- 6 Fuel injection timing

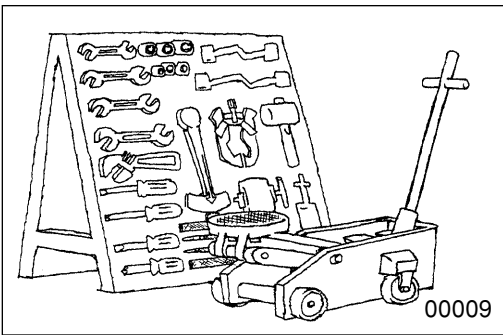
PRECAUTIONS FOR MAINTENANCE OPERATION

In order to determine the condition of the vehicle adequately, attend the vehicle beforehand to find and keep record of the accumulated hours, operating condition, what the customer's demand is, and other information that may be necessary.

Prepare the steps to be taken and perform efficient and wasteless maintenance procedure.



Determine where the fault exists and check for the cause to see whether removal or disassembly of the part is necessary. Then follow the procedure specified by this manual.



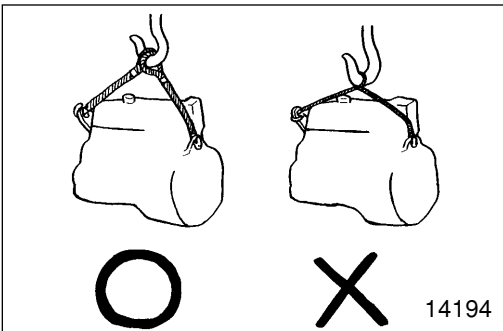
Perform maintenance work at a level area.

Prepare the following.

- Prepare general and special tools necessary for the maintenance work.

WARNING

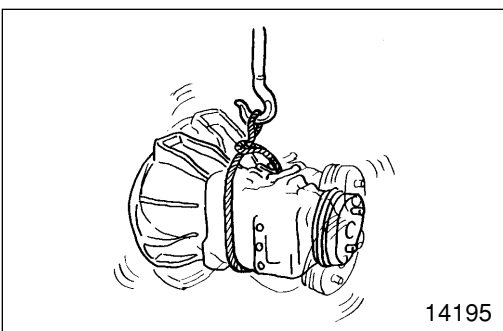
Do not attempt to use tools other than special tools where use of special tools is specified in this manual. This will avoid injury or damage.



Pay special attention to safety when removing or installing heavy items such as engines, transmissions.

When lifting up heavy items using cables, pay special attention to the following points:

- Check the mass of the item to be lifted and use a cable capable of lifting that mass.

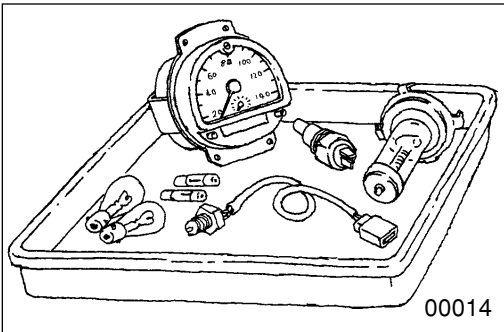


- If you do not have the specified lifting hanger, secure the item using cable taking the point-of-balance of the item into consideration.

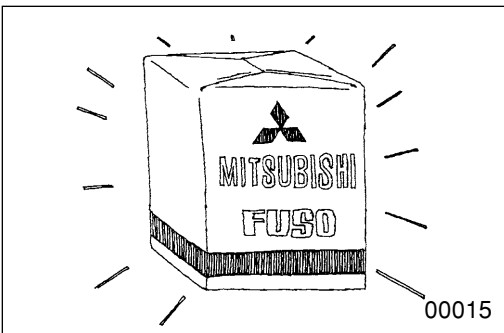
- You must work in a position where you will not be injured even if the cable comes undone and the lifted item falls.



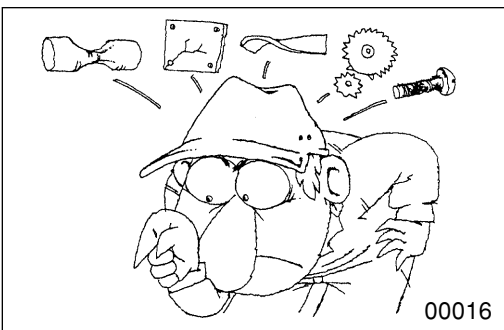
Be particularly careful not to work in shoes that have oily soles and are slippery. When working as a team of two or more, arrange signals in advance and keep confirming safety. Be careful not to accidentally bump switches or levers.



Check for oil leakage before cleaning the area having the fault otherwise you might miss detecting the leakage. Prepare replacement part(s) beforehand.

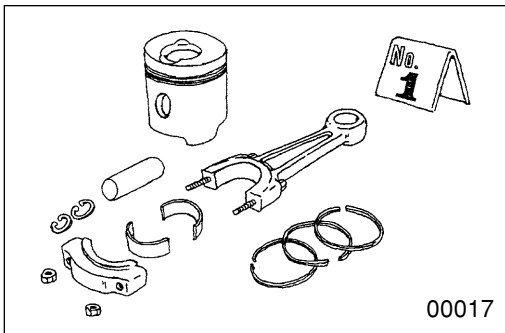


Replace oil seals, packing, O-rings and other rubber parts; gaskets and split pins with new parts whenever any of them has been removed. Use only genuine Caterpillar replacement parts.



On disassembly, visually inspect all parts for wear and tear, cracks, damage, deformation, degradation, rust, corrosion, smoothness in rotation, fatigue, clogging and any other possible defect.

PRECAUTIONS FOR MAINTENANCE OPERATION



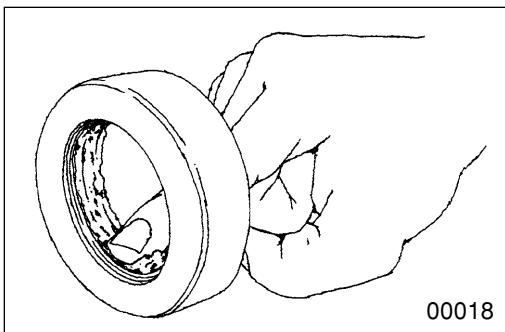
Put alignment marks on part combinations before disassembly and arrange the disassembled parts neatly. This will help avoid mismatching of the parts later.

Put the alignment marks, punch marks, etc. where performance and appearance will not be affected.

Cover the area left open after removal of parts to keep it free from dust.

CAUTION

- Take care to avoid mixing up numerous parts, similar parts, left and right, etc.
- Keep new parts for replacement and original (removed) parts separate.

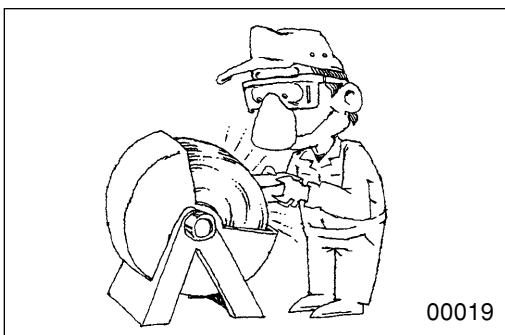


Apply the specified oil or grease to U-packings, oil seals, dust seals and bearings during assembly.

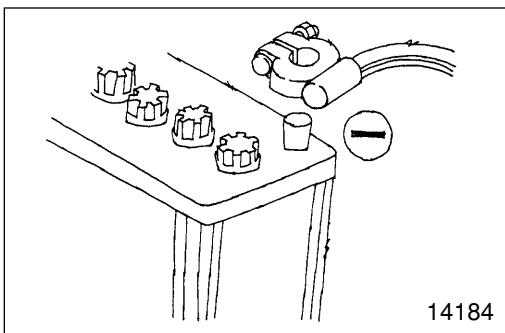
Use only the specified oil, grease, etc. for lubricant, remove the excess immediately after application with a piece of waste, etc.

CAUTION

When the specified lubricant, fluid and sealant is not available, you may use an equivalent.



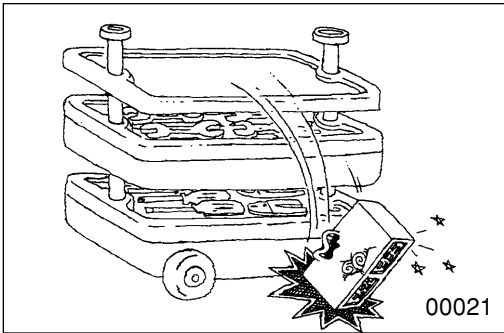
Wear goggles when using a grinder or welder. Pay full attention to safety by wearing gloves when necessary. Watch out for sharp edges, etc. that might injure your hands or fingers.



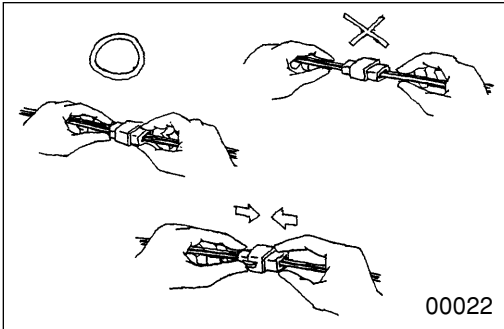
Before carrying out maintenance work on the electric system, disconnect the negative terminals of the batteries to prevent them from short-circuiting and burning-out.

CAUTION

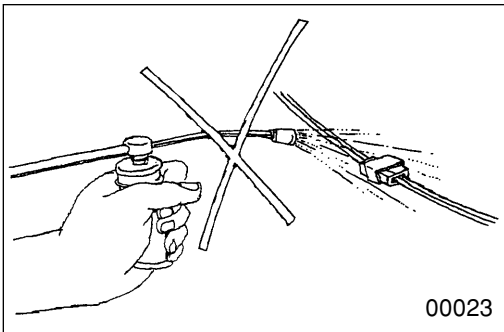
Be sure to turn starter and lighting switches, etc. off before disconnecting or connecting battery terminals, because the semiconductors can be damaged.



Take care when handling sensors, relays, etc. which are vulnerable to shock and heat. Do not attempt to remove the cover from, or apply paint to, the electronic control unit.



Pull the connector, and not the harness lead, to separate connectors. To separate a lock-type connector, first push toward arrow mark. To reconnect a lock-type connector, press the separated parts until they click together.

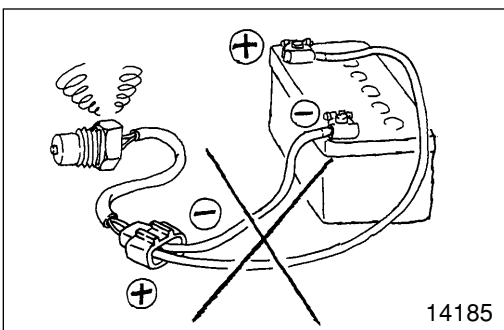


When washing the vehicle, cover the electric system parts and instruments with waterproof material beforehand (Cover with vinyl sheet or the like). Keep water away from harness wire connectors and sensors. If any of them should get wet, wipe them off immediately.

When using an electric welder, such electronic parts that are directly connected to the batteries might be damaged due to the flow of current from the welder that flows through the negative circuit. Parts that have switches might be subject to the same danger if the switches are left on.

Therefore, do not fail to observe the following.

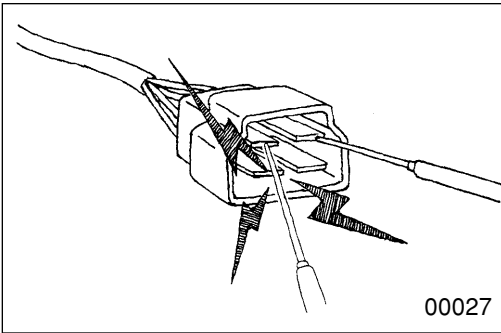
- Connect the negative terminal of the welder as near as possible to the area that is to be welded.
- Disconnect the negative terminals of batteries.



To apply voltage for testing, check that the positive and negative cables are connected properly, then increase voltage gradually from 0 volt. Do not apply voltage higher than the specified value.

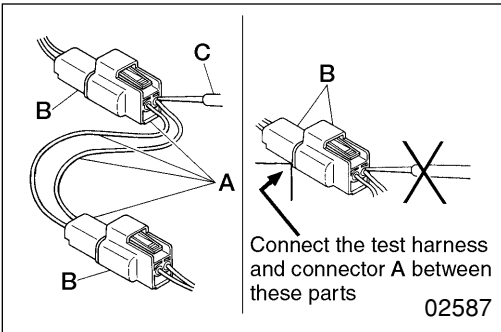
In particular, pay close attention to the electronic control unit and sensors, since they are not always fed the battery voltage.

PRECAUTIONS FOR MAINTENANCE OPERATION



When using testers or the like for continuity tests, be careful not to allow test probes to touch the wrong terminals.

Measurement Procedures Using Connectors

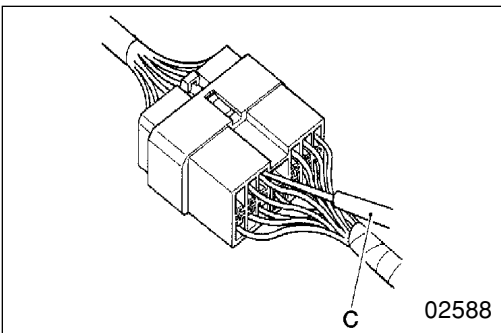


Test with connectors engaged (continuity through circuit obtained)

<Waterproof connector>

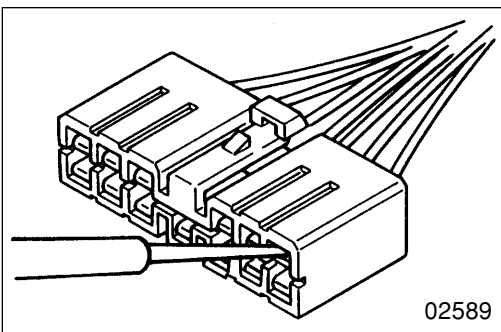
Prepare a test harness and connectors A, then connect it between the two parts of harness B that is to be tested. Check the circuit by touching test probe C to the test connector.

Never insert the test probe from the harness side of the waterproof connection, or waterproof performance might be diminished causing corrosion of the connector.



<Non-waterproof connector>

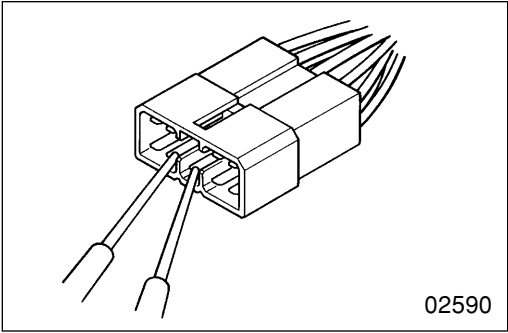
Insert test probe C from the harness side of the connector. Where control units, etc. have connectors that are too small to accept the test probe, do not force the test probe into them.



Test with connectors disengaged

Using female pins

Insert a test probe into a terminal. However, do not force the probe into the terminal, or it will cause a poor contact.

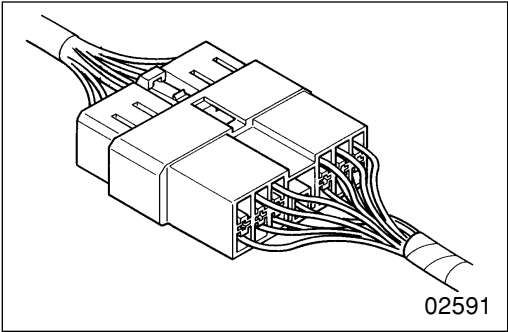


Using male pins
Touch the pins directly using test probes.

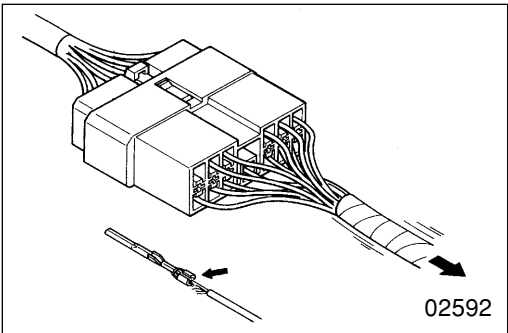
CAUTION ⚠

Be sure that you do not short circuit the connector pins when you use the test probe because this could damage the internal circuit of the electronic control unit.

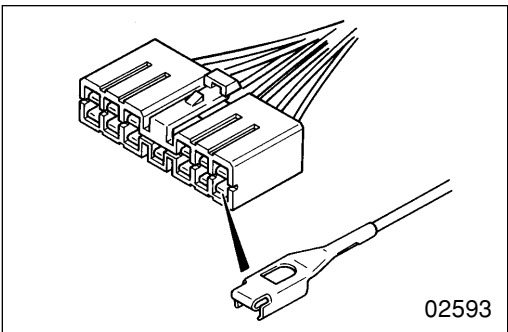
Connector Inspection Procedures



Visual inspection
Check for loose connection and poor engagement.



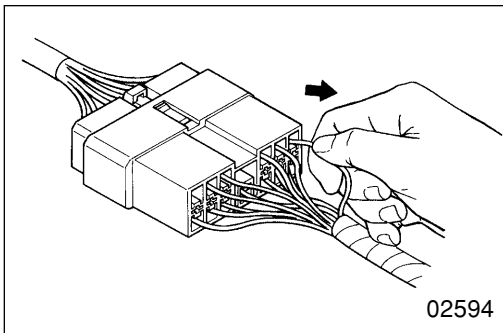
Check if harnesses are broken by pulling gently around the terminals.



Check for a decrease in contact pressure between the male and female terminals.

Check for poor contact caused by connector pins having fallen out, rusted terminals or foreign particles.

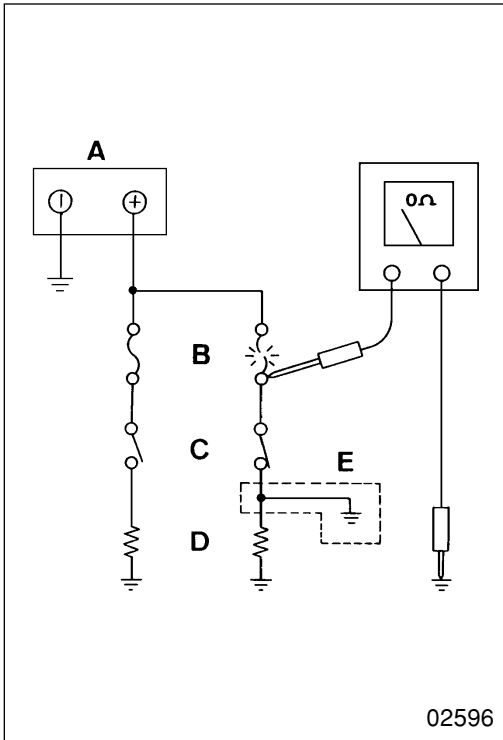
PRECAUTIONS FOR MAINTENANCE OPERATION



Connector pin fall out inspection

Damaged connector pin stoppers can cause poor engagement of the terminals (male and female pins) even if the connector body is secured, and might cause some pins to fall out. Check if the pins have fallen out from the connector by pulling each harness gently.

Inspection Procedures for Blown Fuses



Remove fuse B and measure resistance between the loaded side of the fuse and ground.

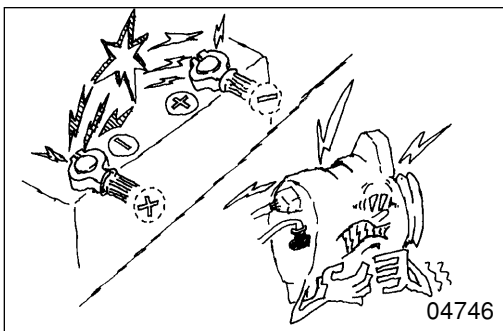
Turn on all circuit switches (connected to the fuse). If the resistance value reading is approximately 0, a short has occurred between the switch and the loaded point. A value of other than zero may indicate that the fuse was blown by a temporary short but the short is no longer present.

The major causes of a short circuit are as follows:

- Harness stuck onto the vehicle body.
- Harness sheath damaged by friction or heat.
- Water in connectors or circuits.
- Mistakes (accidental short circuits)

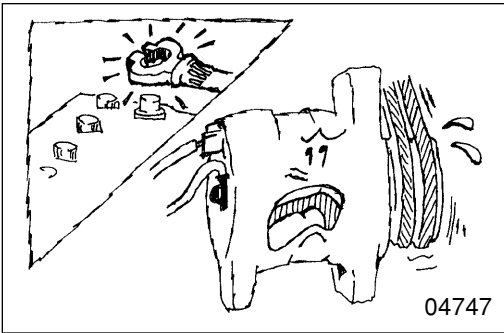
- A: Battery
- B: Fuse
- C: Loaded switch
- D: Load
- E: Short circuit

Precautions for Handling Alternator

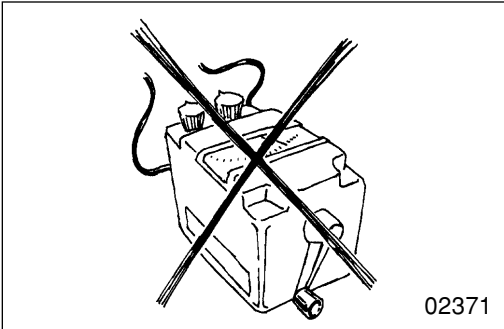


When servicing the alternator, pay attention to the following:

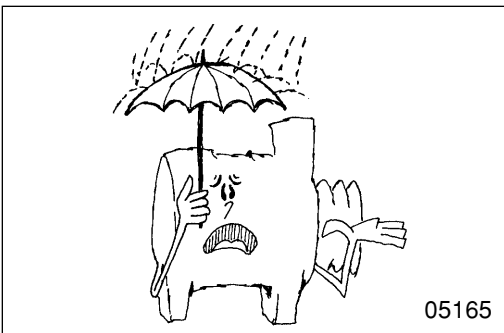
- Do not connect the alternator with battery polarities reversed. If the alternator is connected with reversed polarities, a large current flow from the battery to the alternator occurs, and the diode or regulator might be damaged.



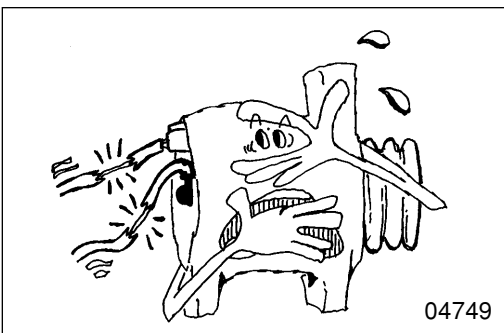
- While the engine is running, do not remove the battery terminals. If the battery terminals are removed at that time, a surge voltage is generated and the diode or regulator might be weakened.



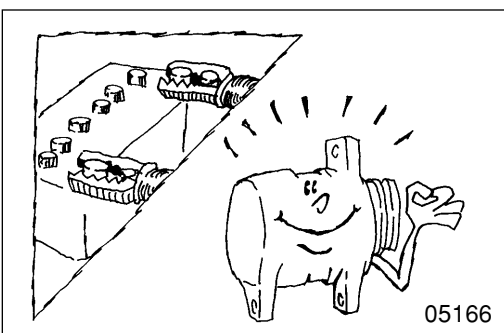
- Do not use a high-voltage tester such as a megger for inspection. If a high-voltage tester is used, the diode or regulator might be destroyed.



- Do not splash water over the alternator. If water is directly splashed over the alternator, individual components will be short-circuited and might be destroyed.



- Do not short-circuit terminal B and terminal L while running the alternator. If the terminals are short-circuited while the alternator is running, the diode trio might be destroyed.









- Disconnect the battery terminals before quick-charging the battery. Quick-charging without disconnecting the battery terminals might damage the diode or regulator.

TABLE OF STANDARD TIGHTENING TORQUES

- Use specified bolts and nuts and tighten them at specified torques according to the following table, unless otherwise specified.
- Threads and contact seats shall be dry.
- Where there is a difference in strength classification between the nut and bolt (or stud bolt), the torque specified for the bolt shall apply.

Hex-head Bolt and Stud Bolt

Unit: N·m (kgf·m) [lbf·ft]

Strength classification	4T		7T		8T	
Diameter symbol	Repre- sentation  (Stud)		Repre- sentation  (Stud)		Repre- sentation  (Stud)	 02154
M5	2 to 3 (0.2 to 0.3) [1.48 to 2.21]	–	4 to 6 (0.4 to 0.6) [2.95 to 4.43]	–	5 to 7 (0.5 to 0.7) [3.69 to 5.16]	–
M6	4 to 6 (0.4 to 0.6) [2.95 to 4.43]	–	7 to 11 (0.7 to 1.1) [5.16 to 8.11]	–	8 to 12 (0.8 to 1.2) [5.90 to 8.85]	–
M8	9 to 14 (0.9 to 1.4) [6.64 to 10.3]	–	17 to 26 (1.7 to 2.6) [12.5 to 19.2]	–	20 to 29 (2.0 to 3.0) [14.8 to 21.4]	–
M10	19 to 28 (1.9 to 2.8) [14.0 to 20.6]	18 to 26 (1.8 to 2.7) [13.3 to 19.2]	36 to 52 (3.5 to 5.5) [26.6 to 38.4]	33 to 49 (3.5 to 5.0) [24.3 to 36.1]	45 to 60 (4.5 to 6.0) [33.2 to 44.3]	41 to 59 (4.3 to 6.9) [30.2 to 43.5]
M12	35 to 50 (3.4 to 5.0) [25.8 to 36.9]	31 to 46 (3.1 to 4.7) [22.9 to 33.9]	70 to 95 (7.0 to 9.5) [51.6 to 70.1]	65 to 85 (6.5 to 8.5) [47.9 to 62.7]	85 to 110 (8.5 to 11) [62.7 to 81.1]	75 to 100 (7.5 to 10) [55.3 to 73.8]
M14	60 to 85 (6.0 to 8.5) [44.3 to 62.7]	55 to 75 (5.5 to 7.5) [40.6 to 55.3]	120 to 160 (12 to 16) [88.5 to 118]	110 to 140 (11 to 14) [81.1 to 103]	130 to 180 (13 to 18) [95.9 to 133]	120 to 160 (12 to 17) [88.5 to 118]
M16	90 to 130 (9.5 to 13) [66.4 to 95.9]	90 to 120 (9.0 to 12) [66.4 to 88.5]	180 to 240 (18 to 24) [133 to 177]	160 to 220 (16 to 22) [118 to 162]	200 to 270 (20 to 27) [148 to 199]	190 to 260 (19 to 26) [140 to 192]
M18	140 to 190 (14 to 19) [103 to 140]	120 to 160 (12 to 16) [88.5 to 118]	260 to 340 (25 to 35) [192 to 251]	220 to 290 (22 to 30) [162 to 214]	290 to 390 (30 to 40) [214 to 288]	260 to 340 (26 to 35) [192 to 251]
M20	190 to 260 (19 to 26) [140 to 192]	170 to 230 (17 to 23) [125 to 170]	350 to 470 (36 to 48) [251 to 347]	320 to 420 (32 to 43) [236 to 310]	410 to 550 (41 to 56) [302 to 406]	370 to 490 (37 to 50) [273 to 361]
M22	260 to 340 (26 to 35) [192 to 251]	230 to 300 (23 to 31) [170 to 221]	470 to 640 (48 to 65) [347 to 472]	430 to 570 (43 to 58) [317 to 420]	550 to 740 (56 to 75) [406 to 546]	490 to 670 (50 to 68) [361 to 494]
M24	340 to 450 (34 to 46) [251 to 332]	290 to 390 (29 to 40) [214 to 288]	630 to 840 (63 to 86) [465 to 620]	540 to 730 (55 to 74) [398 to 538]	730 to 980 (74 to 100) [538 to 723]	630 to 840 (64 to 86) [465 to 620]

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