ENGINE SECTION 3

This service manual has been prepared to provide SUBARU service personnel with the necessary information and data for the correct maintenance and repair of SUBARU vehicles.
This manual includes the procedures for maintenance, disassembling, reassembling, inspection and adjustment of components and diagnostics for guidance of experienced mechanics.
Please peruse and utilize this manual fully to ensure complete repair work for satisfying our customers by keeping their vehicle in optimum condition. When replacement of parts during repair work is needed, be sure to use SUBARU genuine parts.

All information, illustration and specifications contained in this manual are based on the latest product information available at the time of publication approval.

LUBRICATION

LU(H6DO)

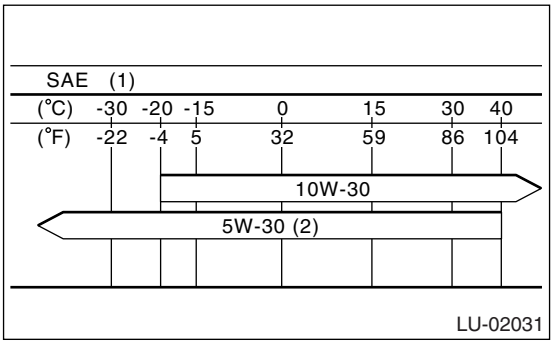
1. General Description

A: SPECIFICATION

Lubrication method				Forced lubrication
Oil pump	Pump type			Trochoid type
	Number of teeth	Inner rotor		7
		Outer rotor		8
	Outer rotor diameter × thickness		mm (in)	86 × 13 (3.39 × 0.51)
	Tip clearance between inner and outer rotors		mm (in)	0.04 — 0.14 (0.0016 — 0.0055)
	Side clearance between inner rotor and pump case		mm (in)	0.020 — 0.046 (0.0008 — 0.0018)
	Case clearance between outer rotor and pump case		mm (in)	0.110 — 0.175 (0.0043 — 0.0069)
Oil filter	Filter type			Full-flow filter type
	Filtration area		cm^2 (sq in)	1,300 (201.5)
	By-pass valve opening pressure		kPa (kg/cm^2, psi)	160 (1.63, 23.2)
	Outer diameter × width		mm (in)	80 × 75 (3.15 × 2.95)
	Installation screw specifications			M 20 × 1.5
Relief valve operation pressure			kPa (kg/cm^2, psi)	708 (7.2, 102.7)
Oil pressure switch	Type			Immersed contact point type
	Operating voltage — Power consumption			12 V — 3.4 W or less
	Warning light activation pressure		kPa (kg/cm^2, psi)	15 (0.15, 2.2)
	Proof pressure		kPa (kg/cm^2, psi)	980 (10.0, 142) or more
Oil capacity (at replacement)			ℓ (US qt, Imp qt)	5.5 (5.8, 4.8)

Recommended oil

For the API specification SL and SJ, use the logo mark with "Energy Conserving" (If the SL, SJ grade is not available, use SH grade).
ACEA specification A1, A2 or A3
CCMC specification G4 or G5
New API specification mark (Star burst mark) label is on the container.

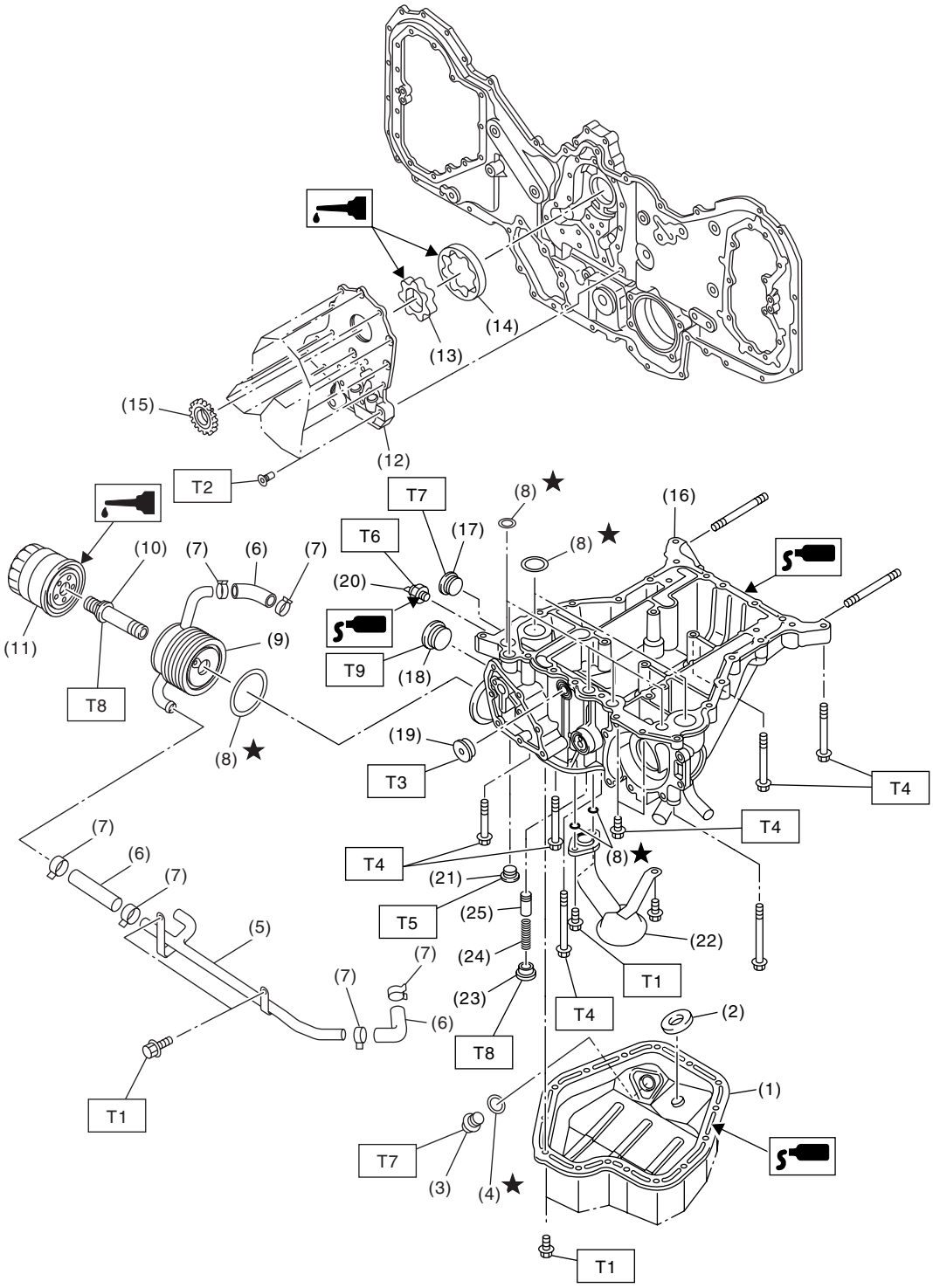


(1) SAE viscosity No. and applicable temperature
(2) Recommended

The proper viscosity helps the vehicle to get good cold and hot starting by reducing viscous friction and thus increasing cranking speed.

CAUTION:
When replenishing oil, it does not matter if the oil to be added is a different brand from that in the engine; however, use oil having the API classification and SAE viscosity No. designated by SUBARU.

B: COMPONENT


(1)
(2)
(3)
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(5)
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(25)
T1
T2
T3
T4
T5
T6
T7
T8
T9
LU-02010

(1) Oil pan lower
(2) Magnet
(3) Drain plug
(4) Gasket
(5) Oil cooler pipe
(6) Hose
(7) Clamp
(8) O-ring
(9) Oil cooler
(10) Connector
(11) Oil filter
(12) Oil pump cover
(13) Inner rotor
(14) Outer rotor
(15) Crank sprocket
(16) Oil pan upper
(17) Plug
(18) Plug
(19) Plug
(20) Oil pressure switch
(21) Plug
(22) Oil strainer
(23) Plug
(24) Relief valve spring
(25) Relief valve

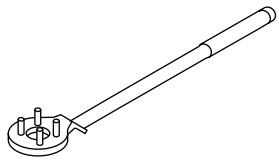
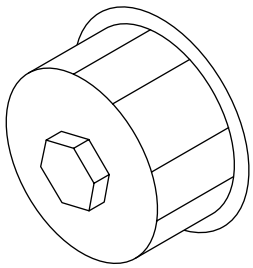
Tightening torque: N·m (kgf-m, ft-lb)
T1: 6.4 (0.65, 4.7)
T2: <Ref. to LU(H6DO)-8, INSTALLATION, Oil Pump.>
T3: 16 (1.6, 12)
T4: 18 (1.8, 13)
T5: 23 (2.3, 17)
T6: 25 (2.5, 18)
T7: 37 (3.8, 27)
T8: 44 (4.5, 33)
T9: 90 (9.2, 66)

C: CAUTION

• Wear work clothing, including a cap, protective goggles and protective shoes during operation.
• Remove contamination including dirt and corrosion before removal, installation or disassembly.
• Keep the disassembled parts in order and protect them from dust and dirt.
• Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly and replacement.
• Be careful not to burn yourself, because each part on the vehicle is hot after running.
• Be sure to tighten fasteners including bolts and nuts to the specified torque.
• Place shop jacks or rigid racks at the specified points.
• Before disconnecting electrical connectors of sensors or units, be sure to disconnect the ground cable from battery.

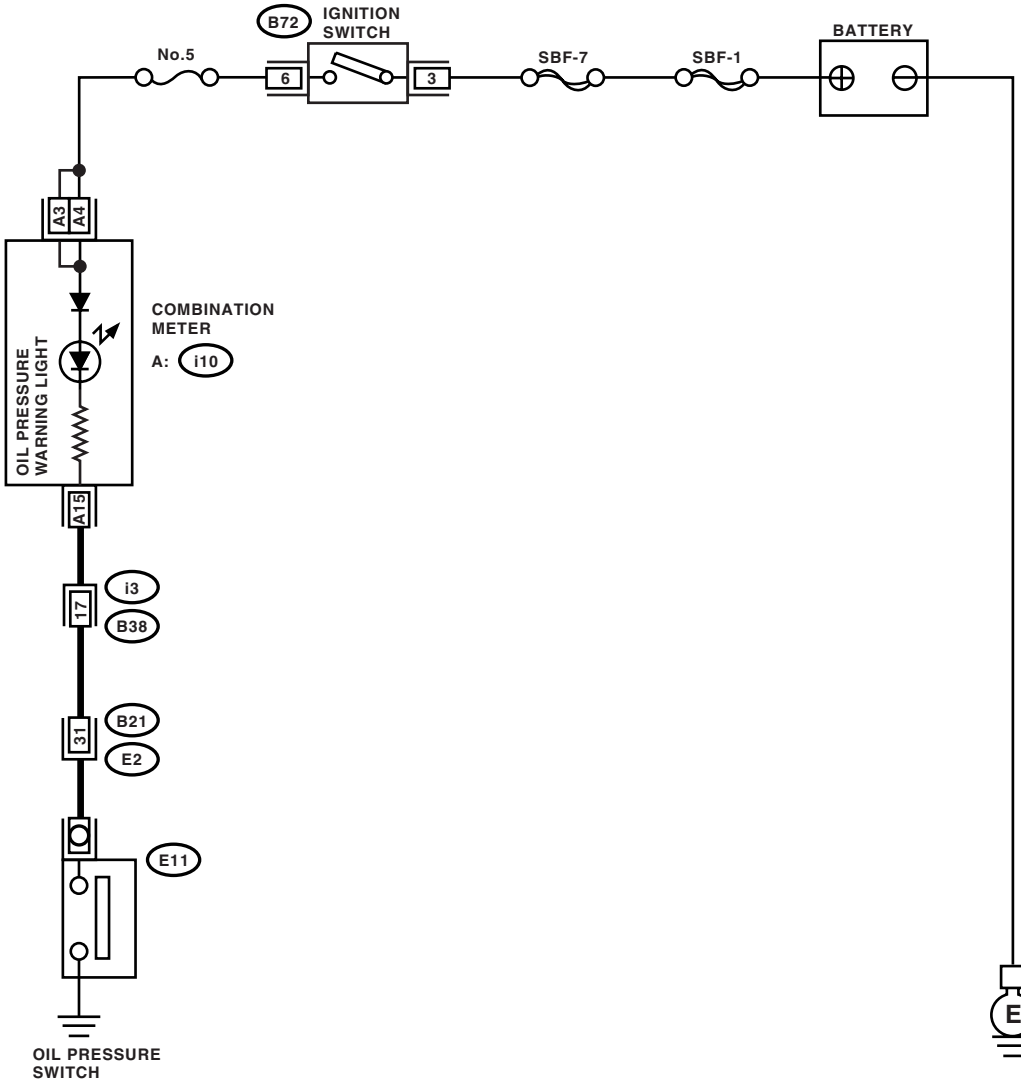
D: PREPARATION TOOL

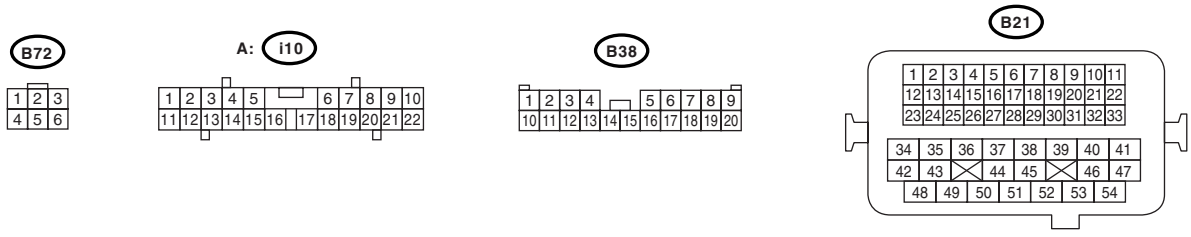
1. SPECIAL TOOL

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499977100	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when removing and tightening crank pulley bolt.
 ST-498547000	498547000	OIL FILTER WRENCH	Used for removing and installing oil filter.

2. Oil Pressure System

A: WIRING DIAGRAM





LU-00241

B: INSPECTION

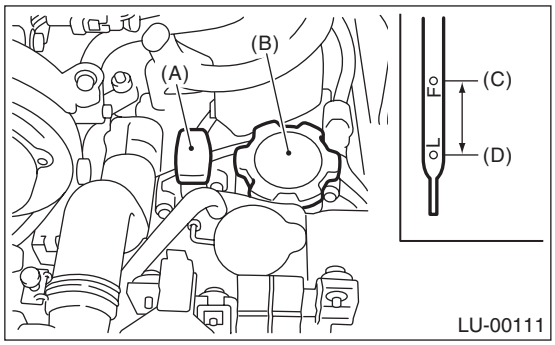
	Step	Check	Yes	No
1	**CHECK COMBINATION METER.** 1) Turn the ignition switch to ON. (engine OFF) 2) Check the warning light of combination meter.	Does the warning light illuminate?	Go to step **2.**	Repair or replace the combination meter. <Ref. to IDI-3, INSPECTION, Combination Meter System.>
2	**CHECK HARNESS CONNECTOR BETWEEN COMBINATION METER AND OIL PRESSURE SWITCH.** 1) Turn the ignition switch to OFF. 2) Disconnect the connector from oil pressure switch. 3) Turn the ignition switch to ON. 4) Measure the voltage of harness between combination meter connector and chassis ground. ***Connector & terminal*** ***(E11) No. 1 (+) — Chassis ground (−):***	Is the voltage more than 10 V?	Replace the oil pressure switch.	Go to step **3.**
3	**CHECK COMBINATION METER.** 1) Turn the ignition switch to OFF. 2) Remove the combination meter. 3) Measure the resistance of combination meter. ***Terminals*** ***No. 4 — No. 15:*** ***No. 3 — No. 15:***	Is the resistance less than 10 Ω?	Replace the harness connector between combination meter and oil pressure switch.	Repair or replace the combination meter. <Ref. to IDI-3, INSPECTION, Combination Meter System.>

3. Engine Oil

A: INSPECTION

1) Park the vehicle on a level surface.
2) Extract the oil level gauge and wipe it clean.
3) Reinsert the level gauge all the way. Be sure that the level gauge is correctly inserted and properly orientated.
4) Remove it again and check the reading. If the engine oil level is below “L” line, add oil to bring the level up to “F” line.
5) After turning off the engine, wait a few minutes for the oil to return to the oil pan before checking the level.
6) Just after driving or while the engine is warm, engine oil level show in the range between “F” line and the notch mark. This is caused by thermal expansion of the engine oil.

NOTE:
To prevent overfilling the engine oil, do not add oil above “F” line when the engine is cold.

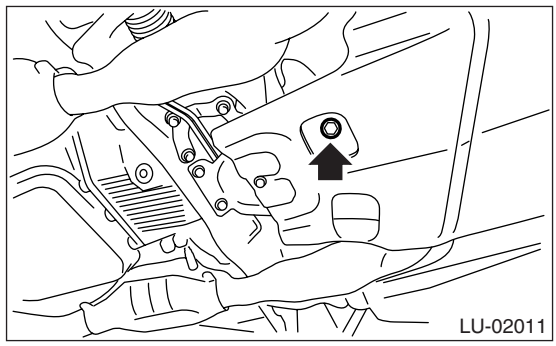


(A) Oil level gauge
(B) Engine oil filler cap
(C) Upper level
(D) Lower level

B: REPLACEMENT

1) Open the engine oil filler cap for quick draining of the engine oil.
2) Lift-up the vehicle.
3) Drain engine oil by loosening the engine oil drain plug.

NOTE:
Prepare a container for draining of engine oil.



4) Tighten the engine oil drain plug after draining engine oil.

NOTE:
Use a new drain plug gasket.

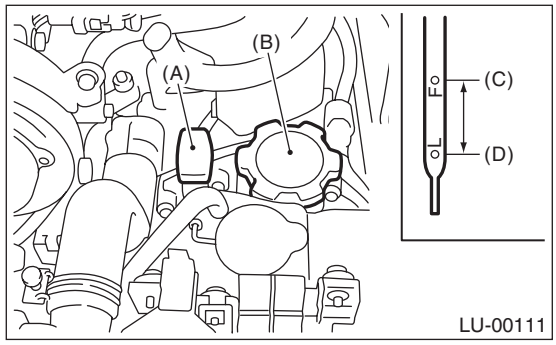
Tightening torque:
44 N·m (4.5 kgf-m, 32.5 ft-lb)

5) Use the engine oil of proper quality and viscosity, fill engine oil through the oil filler duct to upper point on level gauge. Make sure that the vehicle is parked on a level surface when checking oil level.

Recommended oil:
Refer to “SPECIFICATION” for the recommended oil. <Ref. to LU(H6DO)-2, SPECIFICATION, General Description.>

Engine oil capacity (when replacing engine oil):
5.5 ℓ (5.8 US qt, 4.8 Imp qt)

6) Close the engine oil filler cap.
7) Start the engine and warm it up for a time.
8) After the engine stops, recheck the oil level. If necessary, add engine oil up to the upper level on level gauge.

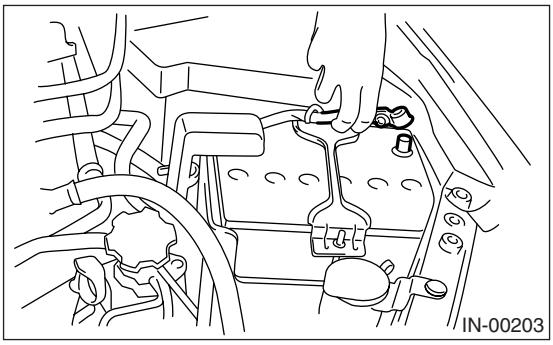


(A) Oil level gauge
(B) Engine oil filler cap
(C) Upper level
(D) Lower level

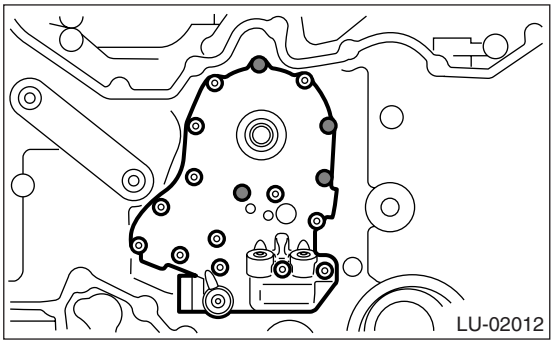
4. Oil Pump

A: REMOVAL

1) Remove the collector cover.
2) Disconnect the ground cable from battery.



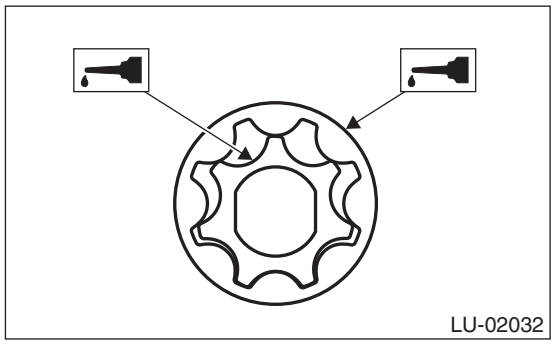
3) Lift-up the vehicle.
4) Remove the under cover.
5) Drain engine coolant. <Ref. to CO(H6DO)-9, DRAINING OF ENGINE COOLANT, REPLACEMENT, Engine Coolant.>
6) Lower the vehicle.
7) Remove the radiator. <Ref. to CO(H6DO)-13, REMOVAL, Radiator.>
8) Remove the V-belts. <Ref. to ME(H6DO)-33, REMOVAL, V-belt.>
9) Remove the front chain cover. <Ref. to ME(H6DO)-43, REMOVAL, Front Chain Cover.>
10) Remove the timing chain. <Ref. to ME(H6DO)-45, REMOVAL, Timing Chain Assembly.>
11) Remove the crank sprocket.
12) Remove the oil pump cover.



13) Remove the inner rotor and outer rotor.

B: INSTALLATION

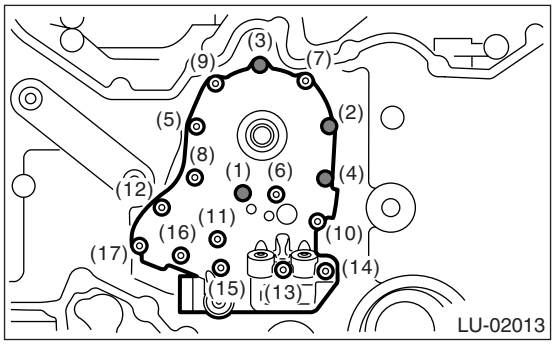
1) Apply a coat of engine oil to the whole area of inner rotor and outer rotor.



2) Set the inner rotor onto opening edge of crank shaft, and install the inner rotor, and then assemble the outer rotor.
3) Install the oil pump cover.
4) Tighten the bolts in the numerical order as shown in the figure.

CAUTION:
Ensure that the bolt is installed in correct position.

Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)



Bolt installing position	Bolt dimension
(1) and (3)	6 × 14 × 14
(2) and (4)	6 × 35 × 18
(5), (6), (7), (8), (9), (10) and (11)	6 × 35 × 15
(12), (15), (16) and (17)	6 × 16 × 16
(13) and (14)	6 × 26 × 15

5) Install the crank sprocket.
6) Install the timing chain. <Ref. to ME(H6DO)-46, INSTALLATION, Timing Chain Assembly.>
7) Install the front chain cover. <Ref. to ME(H6DO)-43, INSTALLATION, Front Chain Cover.>
8) Install the V-belts. <Ref. to ME(H6DO)-33, INSTALLATION, V-belt.>
9) Install the radiator. <Ref. to CO(H6DO)-14, INSTALLATION, Radiator.>
10) Install the under cover.

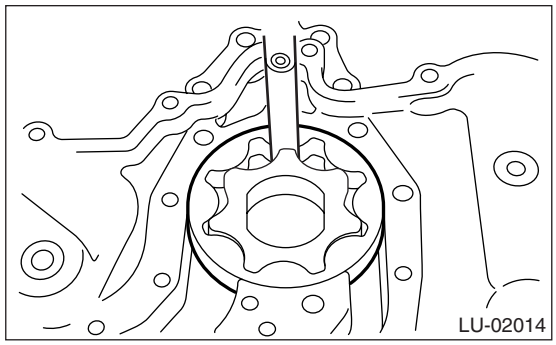
11) Fill engine coolant.
<Ref. to CO(H6DO)-9, FILLING OF ENGINE COOLANT, REPLACEMENT, Engine Coolant.>

C: INSPECTION

1. TIP CLEARANCE

Measure the tip clearance of rotors. If the clearance exceeds the limit, replace the rotors as a matched set.

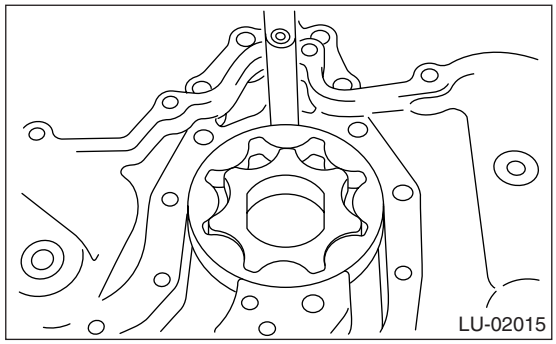
Tip clearance:
Standard value
0.04 — 0.14 mm (0.0016 — 0.0055 in)



2. CASE CLEARANCE

Measure the clearance between the outer rotor and rear chain cover rotor housing. If the clearance exceeds the limit, replace the outer rotor.

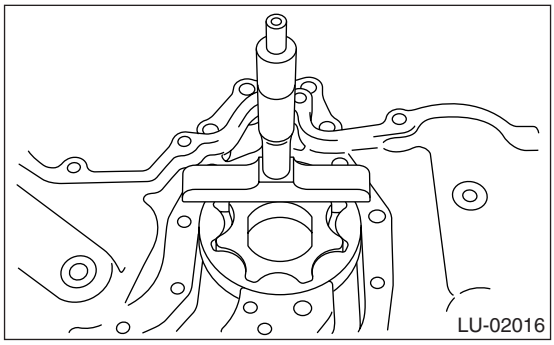
Case clearance:
Standard value
0.110 — 0.175 mm (0.0043 — 0.0069 in)



3. SIDE CLEARANCE

Measure the clearance between oil pump inner rotor and rear chain cover. If the clearance exceeds the limit, replace rotors as a matched set.

Side clearance:
Standard value
0.020 — 0.046 mm (0.0008 — 0.0018 in)



4. OIL PUMP CASE

Check the worn shaft hole, clogged oil passage, crank and other parts for faults.

5. Oil Pump Relief Valve

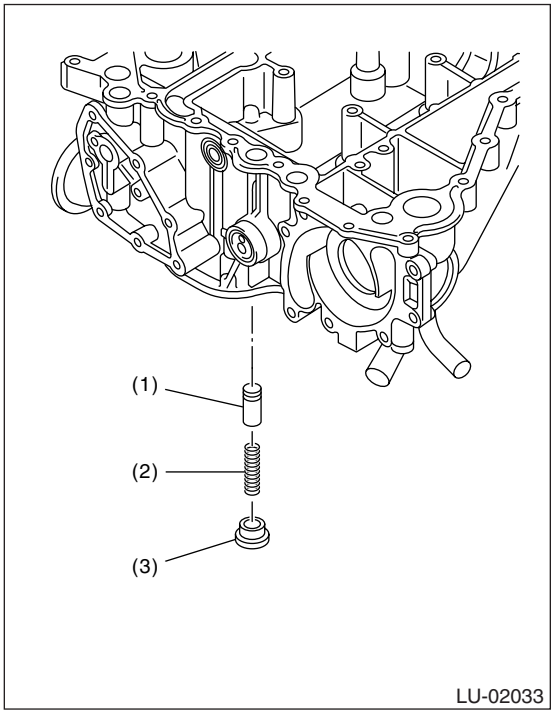
A: REMOVAL

1. REAR CHAIN COVER SIDE

Oil pump relief valve is integrated into oil pump cover as one unit; therefore, refer to “Oil Pump” for removal procedure. <Ref. to LU(H6DO)-8, REMOVAL, Oil Pump.>

2. OIL PAN UPPER SIDE

1) Remove the oil pan. <Ref. to LU(H6DO)-11, REMOVAL, Oil Pan and Strainer.>
2) Remove the plug, relief valve spring and relief valve.



(1) Relief valve
(2) Relief valve spring
(3) Plug

B: INSTALLATION

1. REAR CHAIN COVER SIDE

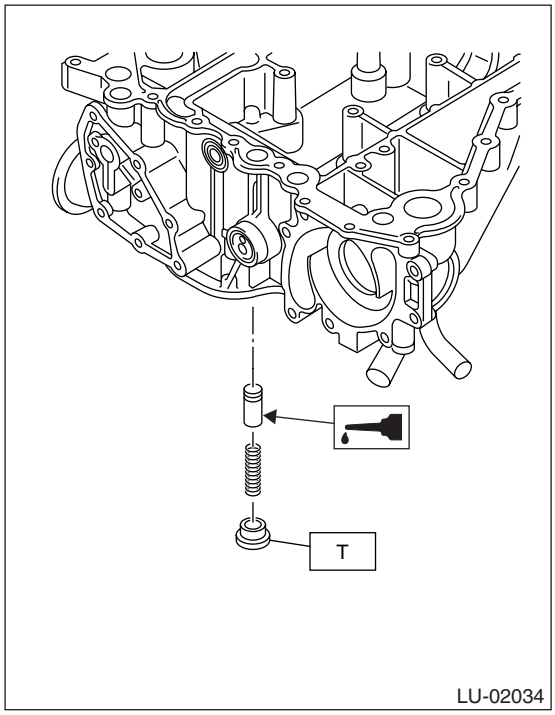
Oil pump relief valve is integrated into oil pump cover as one unit; therefore, refer to “Oil Pump” for installation procedure. <Ref. to LU(H6DO)-8, INSTALLATION, Oil Pump.>

2. OIL PAN UPPER SIDE

1) Install the relief valve, relief valve spring and plug.

NOTE:
Apply the engine oil to relief valve.

Tightening torque:
T: 44 N·m (4.5 kgf-m, 33 ft-lb)



2) Install the oil pan. <Ref. to LU(H6DO)-11, INSTALLATION, Oil Pan and Strainer.>

C: INSPECTION

Check the worn shaft hole of oil pump relief valve case, clogged oil passage, crank and other parts for faults.

6. Oil Pan and Strainer

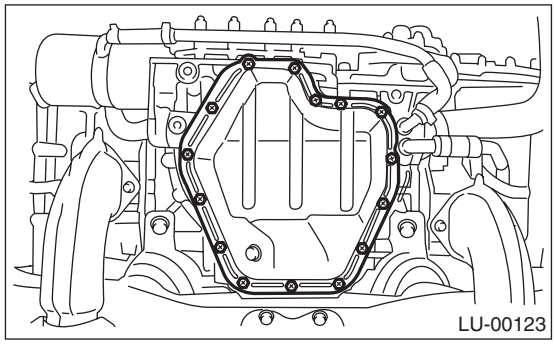
A: REMOVAL

NOTE:
Before removing the oil pan upper, remove the engine from vehicle. <Ref. to ME(H6DO)-34, REMOVAL, Engine Assembly.> <Ref. to ME(H6DO)-63, REMOVAL, Cylinder Block.>

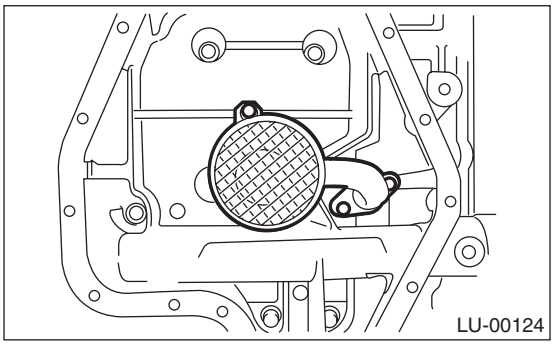
1) Set the vehicle on a lift.
2) Lift-up the vehicle.
3) Remove the under cover.
4) Drain the engine oil. <Ref. to LU(H6DO)-7, REPLACEMENT, Engine Oil.>
5) Insert the oil pan cutter blade between oil pan upper and oil pan lower.

CAUTION:
Do not use a screwdriver or similar tool in place of oil pan cutter.

6) Remove the oil pan lower.



7) Remove the oil strainer.



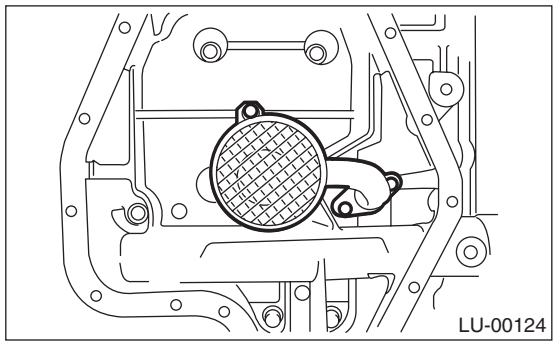
B: INSTALLATION

CAUTION:
Before installing the oil pan, wipe clean the mating surface of oil pan lower and oil pan upper.

1) Install the oil strainer to oil pan upper.

NOTE:
Replace O-ring with new one.

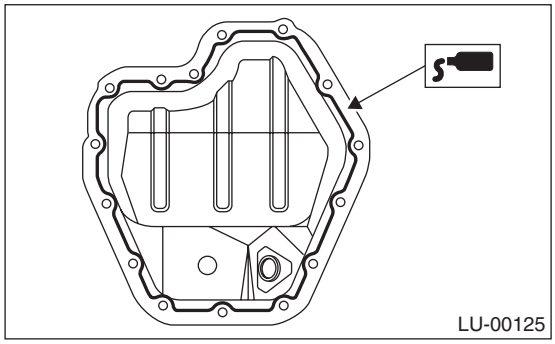
Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)



2) Apply liquid gasket to the mating surfaces and install the oil pan.

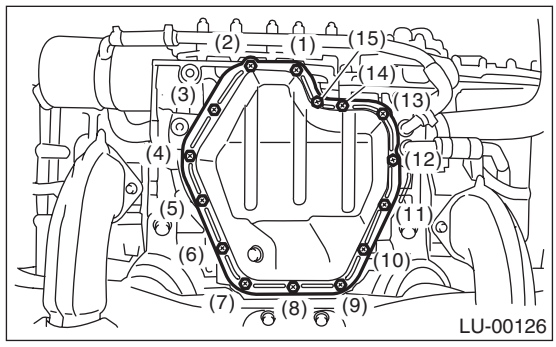
Liquid gasket
THREE BOND 1280B (Part No. K0877YA018)

Liquid gasket applying diameter
5.0±1.0 mm (0.197±0.039 in)



3) Tighten the oil pan lower installing bolts in the numerical order as shown in the figure.

Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)



4) Install the under cover.
5) Fill engine oil. <Ref. to LU(H6DO)-7, INSPECTION, ENGINE OIL.>

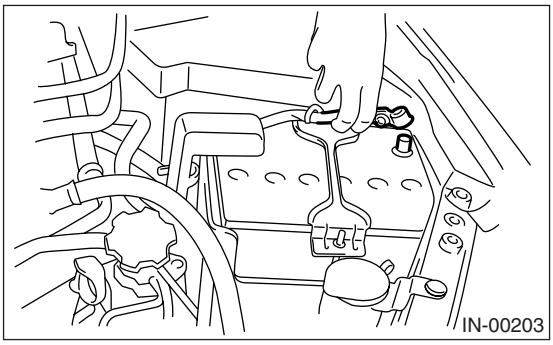
C: INSPECTION

Visually check that the oil pan, oil strainer and oil strainer stay are not damaged.

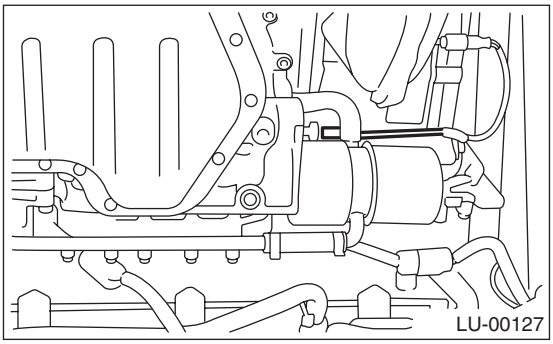
7. Oil Pressure Switch

A: REMOVAL

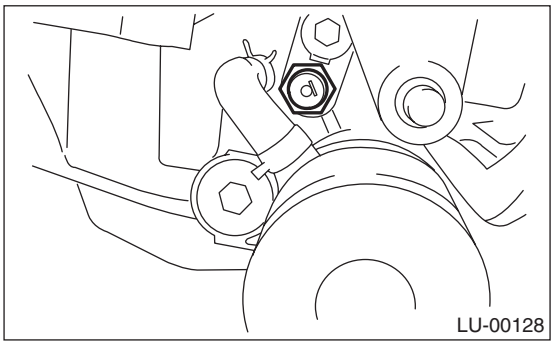
1) Set the vehicle on a lift.
2) Disconnect the ground cable from battery.



3) Lift-up the vehicle.
4) Remove the under cover.
5) Disconnect the terminal from oil pressure switch.



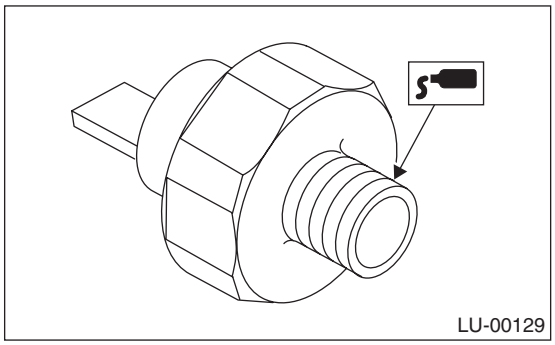
6) Remove the oil pressure switch.



B: INSTALLATION

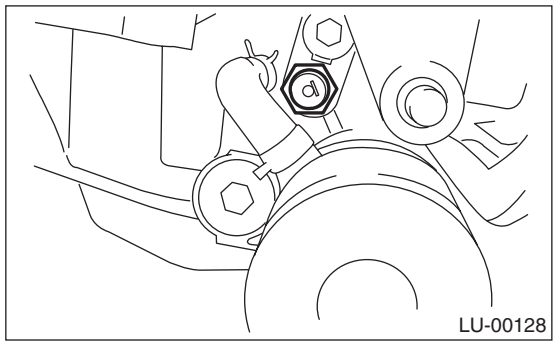
1) Apply liquid gasket to the oil pressure switch threads.

Liquid gasket
THREE BOND 1324 (Part No. 004403042) or equivalent

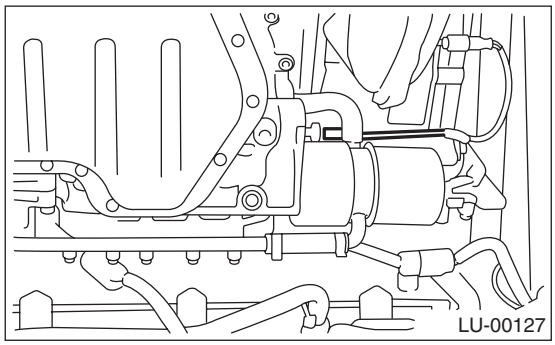


2) Install the oil pressure switch.

Tightening torque:
25 N·m (2.5 kgf-m, 18.1 ft-lb)



3) Connect the terminal of oil pressure switch.



4) Install the under cover.

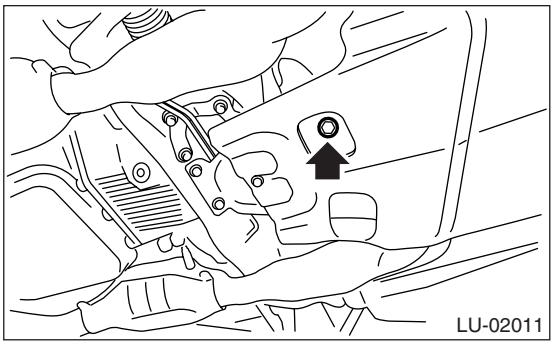
C: INSPECTION

Make sure oil does not leak or seep from where the oil pressure switch is installed.

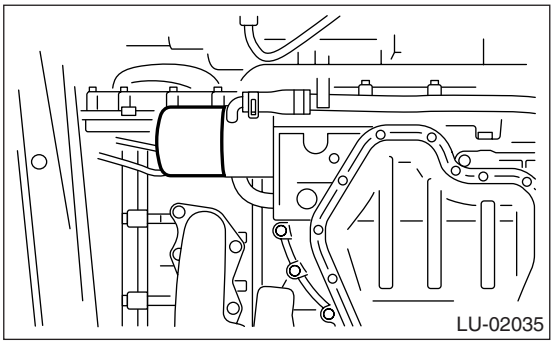
8. Engine Oil Filter

A: REMOVAL

1) Drain the engine oil by removing engine oil drain plug.



2) Remove the under cover.
3) Remove the oil filter using ST.
ST 4985447000 OIL FILTER WRENCH



B: INSTALLATION

1) Clean the oil filter installing surface of oil cooler.
2) Obtain a new oil filter and apply a thin coat of engine oil to the seal rubber.
3) Install the oil filter turning it by hand, being careful not to damage seal rubber.
4) Tighten more (approx. 3/4 turn) after the seal rubber contacts the oil cooler. Do not tighten excessively, or oil may leak.
5) Install the under cover.
6) Lower the vehicle.
7) Fill engine oil. <Ref. to LU(H6DO)-7, INSPECTION, ENGINE OIL.>

C: INSPECTION

1) After installing the oil filter, run engine and make sure that no oil is leaking around seal rubber.

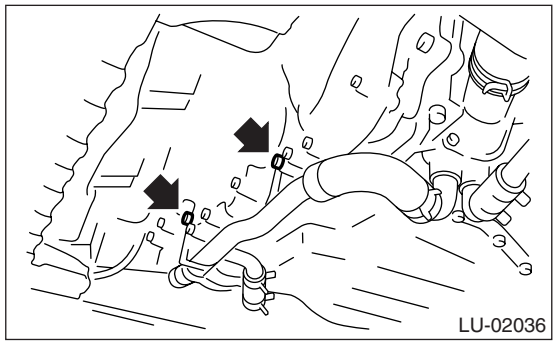
NOTE:
The filter element and filter case are permanently jointed; therefore, interior cleaning is not necessary.

2) Check the engine oil level. <Ref. to LU(H6DO)-7, INSPECTION, ENGINE OIL.>

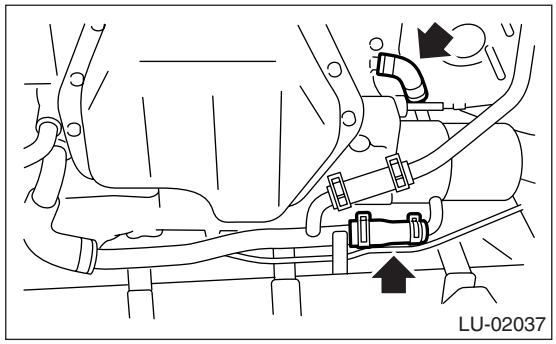
9. Oil Cooler

A: REMOVAL

1) Lift-up the vehicle.
2) Remove the under cover.
3) Drain the engine coolant.
<Ref. to CO(H6DO)-9, DRAINING OF ENGINE COOLANT, REPLACEMENT, Engine Coolant.>
4) Drain the engine oil. <Ref. to LU(H6DO)-7, REPLACEMENT, Engine Oil.>
5) Remove the bolts which hold the water pipe to engine.

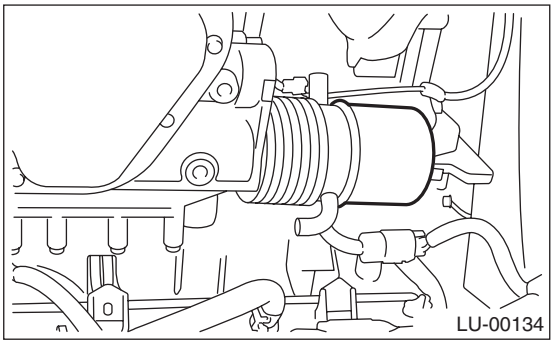


6) Disconnect the water hose from oil cooler.

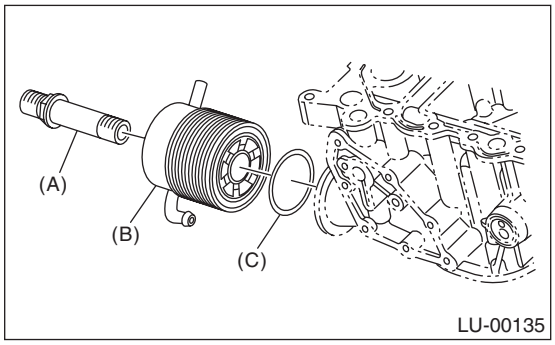


7) Remove the oil filter using ST. <Ref. to LU(H6DO)-13, REMOVAL, Engine Oil Filter.>
ST 498547000 OIL FILTER WRENCH

NOTE:
Set a container under the vehicle.



8) Remove the connector and remove oil cooler.



(A) Connector
(B) Oil cooler
(C) O-ring

B: INSPECTION

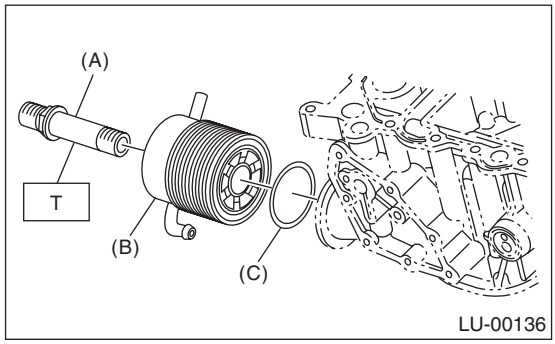
1) Check that engine coolant passages are not clogged using an compressed air.
2) Check that the oil pan upper and O-ring installing surface of oil filter are not damaged.

C: INSTALLATION

1) Install the oil cooler to oil pan upper with connector pipe.

Tightening torque:
T: 54 N·m (5.5 kgf-m, 39.8 ft-lb)

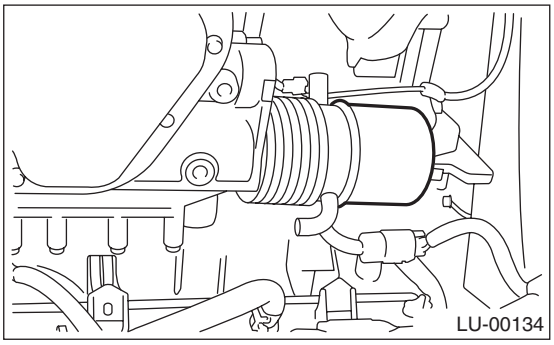
NOTE:
Use new O-rings.



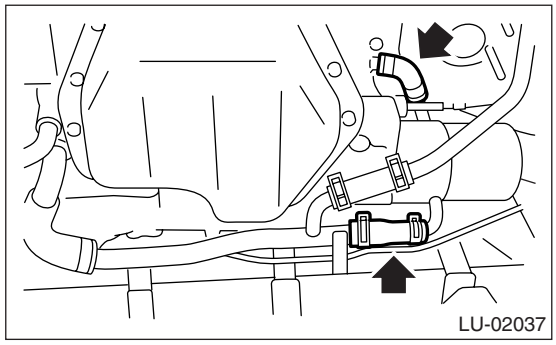
(A) Connector
(B) Oil cooler
(C) O-ring

2) Install the oil filter using ST. <Ref. to LU(H6DO)-13, INSTALLATION, ENGINE OIL FILTER.>

ST 498547000 OIL FILTER WRENCH

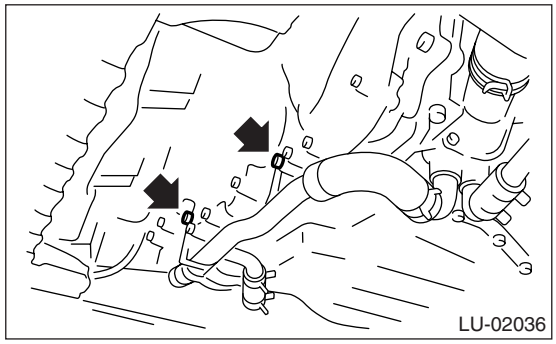


3) Connect the water hose.



4) Install the water pipe to engine.

Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)



5) Fill engine oil. <Ref. to LU(H6DO)-7, REPLACEMENT, Engine Oil.>
6) Fill engine coolant. <Ref. to CO(H6DO)-9, FILLING OF ENGINE COOLANT, REPLACEMENT, Engine Coolant.>
7) Check the engine oil level. <Ref. to LU(H6DO)-7, INSPECTION, ENGINE OIL.>

10.General Diagnostic Table

A: INSPECTION

Before performing diagnosis, make sure that the engine oil level is correct and no oil leakage exists.

Symptom	Possible cause		Corrective action
1. Warning light remains on.	1) Oil pressure switch failure	Cracked diaphragm or oil leakage within switch	Replace.
		Broken spring or seized contacts	Replace.
	2) Low oil pressure	Clogging of oil filter	Replace.
		Malfunction of oil by-pass valve in oil filter	Clean or replace.
		Malfunction of oil relief valve in oil pump	Clean or replace.
		Clogged oil passage	Clean.
		Excessive tip clearance and side clearance of oil pump rotor and gear	Replace.
		Clogged oil strainer or broken pipe	Clean or replace.
	3) No oil pressure	Insufficient engine oil	Replenish.
		Broken pipe of oil strainer	Replace.
		Stuck oil pump rotor	Replace.
2. Warning light does not come on.	1) Malfunction of combination meter		Replace.
	2) Poor contact of switch contact points		Replace.
	3) Disconnection of wiring		Repair.
3. Warning light flickers momentarily.	1) Poor contact at terminals		Repair.
	2) Defective wiring harness		Repair.
	3) Low oil pressure		Check for the same possible causes as listed in 1) — 2).