

SECTION 6

ENGINE GENERAL INFORMATION
AND DIAGNOSIS**WARNING:**

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Precautions” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.
- Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).

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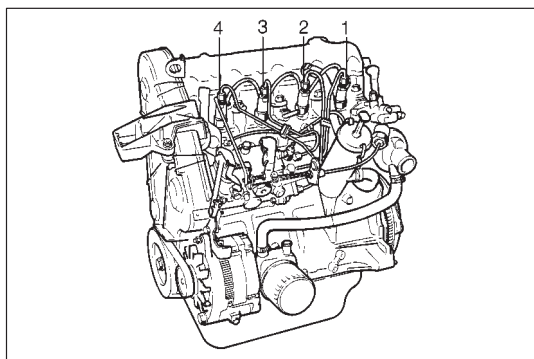
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GENERAL INFORMATION

STATEMENT ON CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the thousands of an millimeter (ten thousands of inch). Accordingly, when any internal engine parts are serviced, care and cleanliness are important. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

- A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces on initial operation.
- Whenever valve train components, pistons, piston rings, connecting rods, rod bearings, and crankshaft journal bearings are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.
- Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

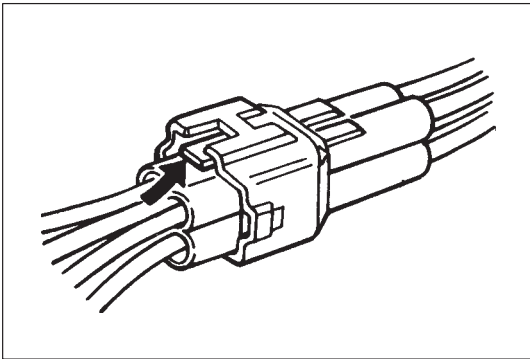


- Throughout this manual, the four cylinders of the engine are identified by numbers No.1, No.2, No.3 and No.4 as counted from flywheel side to crankshaft pulley side.

GENERAL INFORMATION ON ENGINE SERVICE

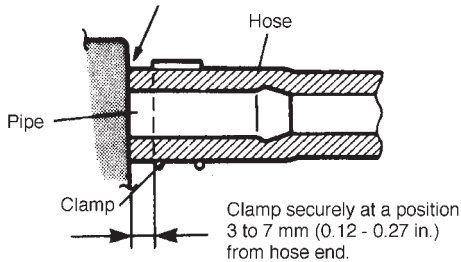
THE FOLLOWING INFORMATION ON ENGINE SERVICE SHOULD BE NOTED CAREFULLY, AS IT IS IMPORTANT IN PREVENTING DAMAGE, AND IN CONTRIBUTING TO RELIABLE ENGINE PERFORMANCE.

- When raising or supporting engine for any reason, do not use a jack under oil pan. Due to small clearance between oil pan and oil pump strainer, jacking against oil pan may cause it to be bent against strainer resulting in damaged oil pick-up unit.
- It should be kept in mind, while working on engine, that 12-volt electrical system is capable of violent and damaging short circuits.
When performing any work where electrical terminals could possibly be grounded, ground cable of the battery should be disconnected at battery.
- Any time the air cleaner, air intake hose, turbo charger or intake manifold is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material which could follow intake passage into cylinder and cause extensive damage when engine is started.

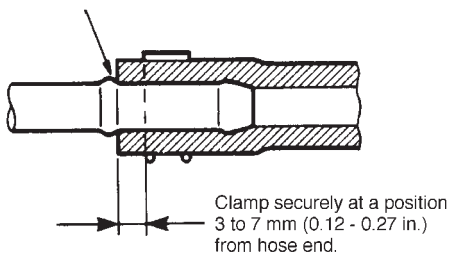


- When disconnecting couplers, don't pull wire harness but make sure to hold coupler itself. With lock type coupler, be sure to unlock before disconnection. Attempt to disconnect coupler without unlocking may result in damage to coupler. When connecting lock type coupler, insert it till clicking sound is heard and connect it securely.

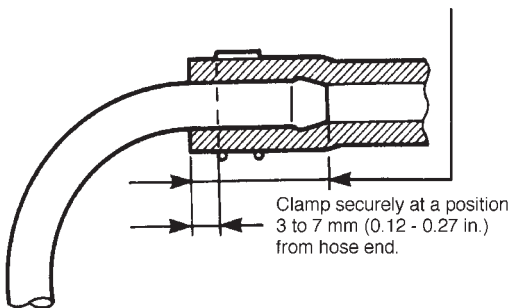
With short pipe, fit hose as far as it reaches pipe joint as shown.



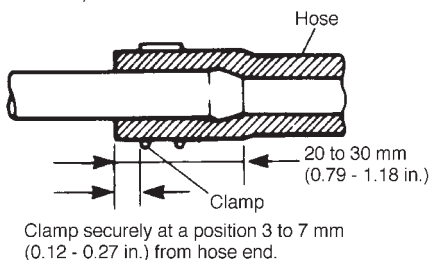
With following type pipe, fit hose as far as its peripheral projection as shown.



With bent pipe, fit hose as far as its bent part as shown or till pipe is about 20 - 30 mm (0.79 - 1.18 in.) into the hose.

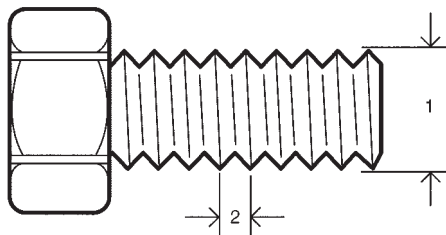


With straight pipe, fit hose till pipe is about 20 to 30 mm (0.79 - 1.18 in.) into the hose.



PRECAUTION ON FUEL SYSTEM SERVICE

- Work must be done with no smoking, in a well-ventilated area and away from any open flames.
- As fuel feed line (between fuel injection pump and fuel pipe) is still under high fuel pressure even after engine was stopped, loosening or disconnecting fuel feed line directly may cause dangerous spout of fuel to occur where loosened or disconnected.
A small amount of fuel may be released after fuel line is disconnected.
In order to reduce the chance of personal injury, cover fitting to be disconnected with a shop cloth. Put that cloth in an approved container when disconnection is completed.
- Fuel hose connection varies with each type of pipe. When reconnecting fuel hose, be sure to connect and clamp each hose correctly referring to figure "Hose Connection".
After connecting, make sure that it has no twist or kink.
- When installing fuel filter union bolt or plug bolt on union bolt, always use new gasket and tighten it to specified torque.



- 1. Diameter
- 2. Pitch

METRIC INFORMATION

METRIC FASTENERS

Most of the fasteners used for this vehicle are metric. When replacing any fasteners, it is most important that replacement fasteners be the correct diameter, thread pitch and strength.

CAUTION:

Note that both ISO and JIS type bolts and nuts are used for the engine assembly and related parts. Even when the diameter of the thread is the same, its pitch may vary between these two types. Installing a mismatched bolt or nut will cause damage to the thread. As the first step, make sure to tighten it by hand temporarily and if it feels tight, check the thread pitch for correct matching.

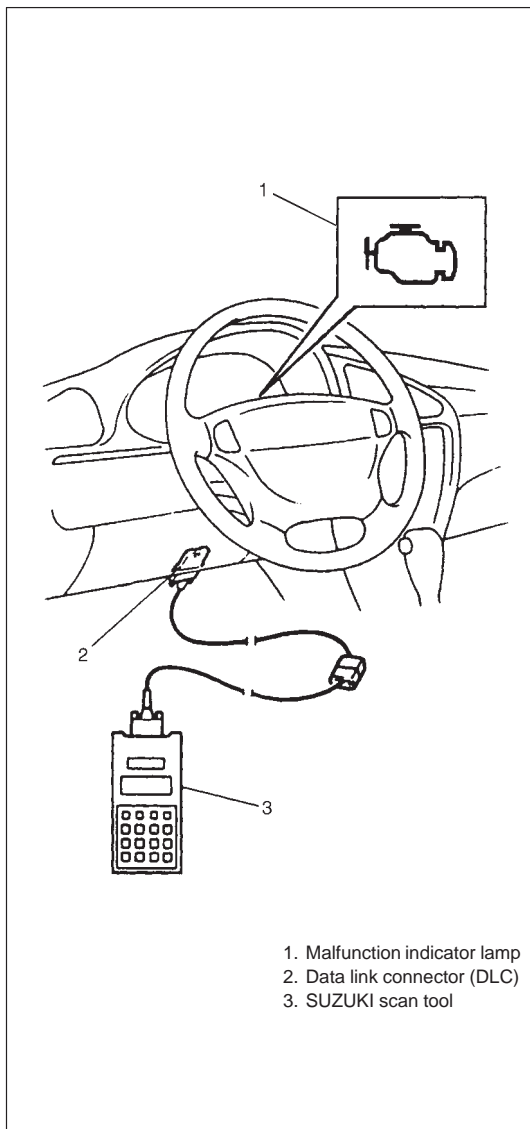
ENGINE DIAGNOSIS

GENERAL DESCRIPTION

This vehicle is equipped with an engine and emission control system which are under control of ECM.

The engine and emission control system in this vehicle are controlled by ECM. ECM has an On-Board Diagnostic system which detects a malfunction in this system and abnormality of those parts that influence the engine exhaust emission. When diagnosing engine troubles, be sure to have full understanding of the outline of “On-Board Diagnostic System” and each item in “Precaution in Diagnosing Trouble” and execute diagnosis according to “ENGINE DIAGNOSTIC FLOW TABLE”.

There is a close relationship between the engine mechanical, engine cooling system, immobilizer system, exhaust system, etc. and the engine and emission control system in their structure and operation. In case of an engine trouble, even when the malfunction indicator lamp (MIL) doesn't turn ON, it should be diagnosed according to this flow table.



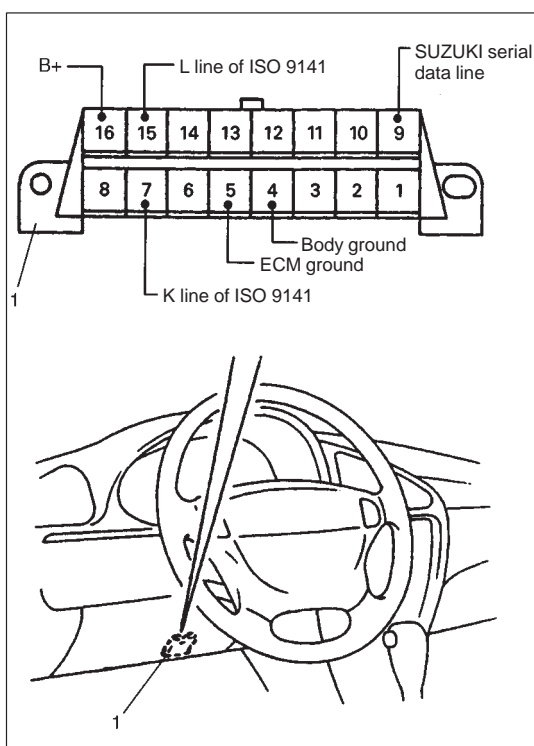
ON-BOARD DIAGNOSTIC SYSTEM

ECM diagnosis troubles which may occur in the area including the following parts when the ignition switch is ON and the engine is running, and indicates the result by turning on malfunction indicator lamp (1) for marked # following items.

- ☐ Injection timing actuator #
- ☐ Glow plug relay #
- ☐ CKP sensor
- ☐ ECT sensor
- ☐ TP sensor
- ☐ Barometric pressure sensor
- ☐ Injector needle sensor
- ☐ Power supply
- ☐ EGR No.1 solenoid valve
- ☐ EGR No.2 solenoid valve
- ☐ MIL
- ☐ CPU (Central Processing Unit) of ECM

ECM and malfunction indicator lamp (1) operate as follows.

- ☐ Malfunction indicator lamp (1) lights for 2 to 3 seconds when the ignition switch is turned ON (but the engine at stop). This is only to check the malfunction indicator lamp (1) bulb and its circuit.
- ☐ If the above areas of Engine and Emission Control system is free from any trouble, malfunction indicator lamp (1) turns OFF after 2 to 3 seconds from ignition switch turn ON.
- ☐ When ECM detects a trouble which has occurred in the above areas with marked #, it makes malfunction indicator lamp (1) stay ON after 2 to 3 seconds from ignition switch turn ON including while the engine is running to warn the driver of such occurrence of trouble and at the same time it stores the trouble area in ECM back-up memory. (The memory is kept as it is even if the trouble was only temporary and disappeared immediately.)



Data Link Connector (DLC)

DLC (1) is in compliance with SAEJ1962 in its installation position, the shape of connector and pin assignment.

Serial data line (K line and L line of ISO 9141) is used for SUZUKI scan tool (Tech-1) to communicate with ECM, Air Bag SDM and ABS control module.

SUZUKI serial data line is used for SUZUKI scan tool to communicate with immobilizer control module.

PRECAUTION IN DIAGNOSING TROUBLE

- Don't disconnect couplers from ECM, battery cable at battery, ECM ground wire harness from engine or main fuse before confirming diagnostic information (DTC, etc.) stored in ECM memory. Such disconnection will erase memorized information in ECM memory.
- Diagnostic information stored in ECM memory can be cleared as well as checked by using SUZUKI scan tool. Before using scan tool, read its Operator's (Instruction) Manual carefully to have good understanding as to what functions are available and how to use it.
- Priorities for diagnosing troubles.
If multiple diagnostic trouble codes (DTCs) are stored.
Troubleshoot diagnostic trouble codes according to the following priorities.
 1. DTC No.16/No.32/No.34 and DTC No.127
 2. Diagnostic trouble codes (DTCs) other than DTC No.16/No.32/No.34 and DTC No.127
- Be sure to read "Precautions for Electrical Circuit Service" in Section 0A before inspection and observe what is written there.
- ECM Replacement
When substituting a known-good ECM, check for following conditions. Neglecting this check may cause damage to a known-good ECM.
 - Resistance value of all relays, actuators is as specified respectively.

ENGINE DIAGNOSTIC FLOW TABLE

Refer to the following pages for the details of each step.

STEP	ACTION	YES	NO
1	Customer Complaint Analysis 1) Perform customer complaint analysis referring to the next page. Was customer complaint analysis performed?	Go to Step 2.	Perform customer complaint analysis.
2	Diagnostic Trouble Code (DTC) Check, Record and Clearance 1) Check for DTC referring to the next page. Is there any DTC(s)?	1) Print DTC or write them down and clear them by referring to "DTC Clearance" section. 2) Go to Step 3.	Go to Step 4.
3	Visual Inspection 1) Perform visual inspection referring to the next page. Is there any faulty condition?	1) Repair or replace malfunction part. 2) Go to Step 11.	Go to Step 5.
4	Visual Inspection 1) Perform visual inspection referring to the next page. Is there any faulty condition?		Go to Step 8.
5	Trouble Symptom Confirmation 1) Confirm trouble symptom referring to the next page. Is trouble symptom identified?	Go to Step 6.	Go to Step 7.
6	Rechecking and Record of DTC 1) Recheck for DTC referring to "DTC Check" section. Is there any DTC(s)?	Go to Step 9.	Go to Step 8.
7	Rechecking and Record of DTC 1) Recheck for DTC referring to "DTC Check" section. Is there any DTC(s)?		Go to Step 10.
8	Engine Basic Inspection, Diagnosis in Terms of Symptom and Engine Diagnosis Table 1) Check and repair according to "Engine Basic Check", "Diagnosis in Terms of Symptom" and "Engine Diagnosis Table" section. Are check and repair complete?	Go to Step 11.	1) Check and repair malfunction part(s). 2) Go to Step 11.
9	Trouble shooting for DTC 1) Check and repair according to applicable DTC diag. flow table. Are check and repair complete?		
10	Check for Intermittent Problems 1) Check for intermittent problems referring to the next page. Is there any faulty condition?	1) Repair or replace malfunction part(s). 2) Go to Step 11.	Go to Step 11.
11	Final Confirmation Test 1) Clear DTC if any. 2) Perform final confirmation test referring to the next page. Is there any problem symptom, DTC or abnormal condition?	Go to Step 6.	End.

1. CUSTOMER COMPLAINT ANALYSIS

Record details of the problem (failure, complaint) and how it occurred as described by the customer. For this purpose, use of such an inspection form will facilitate collecting information to the point required for proper analysis and diagnosis.

2. DIAGNOSTIC TROUBLE CODE (DTC) CHECK, RECORD AND CLEARANCE

First, check DTC, referring to “DTC check” section. If DTC is indicated, print it or write them down and then clear them by referring to “DTC clearance” section. DTC indicates malfunction that occurred in the system but does not indicate whether it exists now or it occurred in the past and the normal condition has been restored now. To check which case applies, check the symptom in question according to Step 4 and recheck DTC according to Step 5.

Attempt to diagnose a trouble based on DTC in this step only or failure to clear the DTC in this step will lead to incorrect diagnosis, trouble diagnosis of a normal circuit or difficulty in troubleshooting.

3. and 4. VISUAL INSPECTION

As a preliminary step, be sure to perform visual check of the items that support proper function of the engine referring to “Visual Inspection” section.

5. TROUBLE SYMPTOM CONFIRMATION

Based on information obtained in Step 1 Customer complaint analysis and Step 2 DTC check, confirm trouble symptoms. Also, reconfirm DTC according to “DTC Confirmation Procedure” described in each DTC Diagnosis section.

6. and 7. RECHECKING AND RECORD OF DTC

Refer to “DTC check” section for checking procedure.

8. ENGINE BASIC INSPECTION, DIAGNOSIS IN TERMS OF SYMPTOM AND ENGINE DIAGNOSIS TABLE

Perform basic engine check according to the “Engine Basic Inspection Flow Table” first. When the end of the flow table has been reached, check the parts of the system suspected as a possible cause referring to ENGINE DIAGNOSIS TABLE, DIAGNOSIS IN TERMS OF SYMPTOM and based on symptoms appearing on the vehicle (symptoms obtained through steps of customer complaint analysis, trouble symptom confirmation and/or basic engine check) and repair or replace faulty parts, if any.

9. TROUBLESHOOTING FOR DTC (See each DTC Diag. Flow Table)

Based on the DTC indicated in Step 5 and referring to the applicable DTC diag. flow table in this section, locate the cause of the trouble, namely in a sensor, switch, wire harness, connector, actuator, ECM or other part and repair or replace faulty parts.

10. CHECK FOR INTERMITTENT PROBLEM

Check parts where an intermittent trouble is easy to occur (e.g., wire harness, connector, etc.), referring to “INTERMITTENT AND POOR CONNECTION” in Section 0A and related circuit of DTC recorded in Step 2.

11. FINAL CONFIRMATION TEST

Confirm that the problem symptom has gone and the engine is free from any abnormal conditions. If what has been repaired is related to the DTC, clear the DTC once, perform DTC confirmation procedure and confirm that no DTC is indicated.

CUSTOMER PROBLEM INSPECTION FORM (EXAMPLE)

User name:	Model:	VIN:	
Date of issue:	Date Reg.	Date of problem:	Mileage:

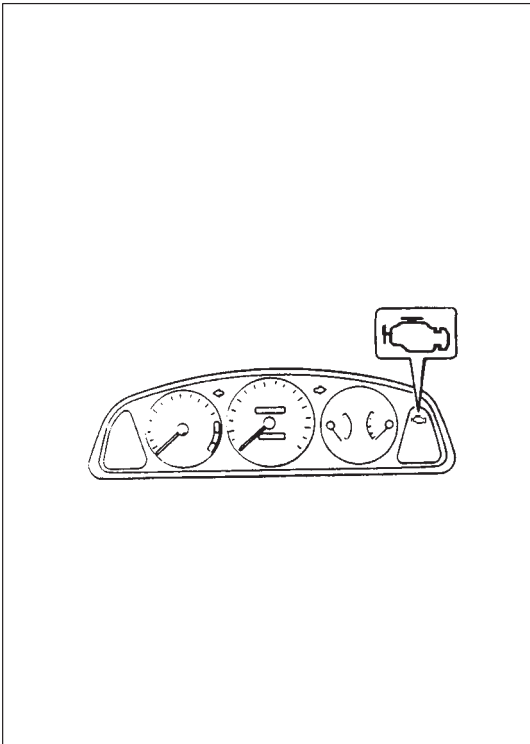
PROBLEM SYMPTOMS	
<input type="checkbox"/> Difficult Starting <input type="checkbox"/> No cranking <input type="checkbox"/> No initial combustion <input type="checkbox"/> No combustion <input type="checkbox"/> Poor starting at (<input type="checkbox"/> cold <input type="checkbox"/> warm <input type="checkbox"/> always) <input type="checkbox"/> Other _____	<input type="checkbox"/> Poor Driveability <input type="checkbox"/> Hesitation on acceleration <input type="checkbox"/> Back fire/ <input type="checkbox"/> After fire <input type="checkbox"/> Lack of power <input type="checkbox"/> Surging <input type="checkbox"/> abnormal knocking <input type="checkbox"/> Other _____
<input type="checkbox"/> Poor Idling <input type="checkbox"/> Poor fast idle <input type="checkbox"/> Abnormal idling speed (<input type="checkbox"/> High <input type="checkbox"/> Low) (r/min.) <input type="checkbox"/> Unstable <input type="checkbox"/> Hunting (r/min. to r/min.) <input type="checkbox"/> Other _____	<input type="checkbox"/> Engine Stall when <input type="checkbox"/> Immediately after start <input type="checkbox"/> Accel. pedal is depressed <input type="checkbox"/> Accel. pedal is released <input type="checkbox"/> Load is applied <input type="checkbox"/> A/C <input type="checkbox"/> Electric load <input type="checkbox"/> P/S <input type="checkbox"/> Other _____ <input type="checkbox"/> Other _____
<input type="checkbox"/> OTHERS:	

VEHICLE/ENVIRONMENTAL CONDITION WHEN PROBLEM OCCURS	
Environmental Condition	
Weather	<input type="checkbox"/> Fair <input type="checkbox"/> Cloudy <input type="checkbox"/> Rain <input type="checkbox"/> Snow <input type="checkbox"/> Always <input type="checkbox"/> Other _____
Temperature	<input type="checkbox"/> Hot <input type="checkbox"/> Warm <input type="checkbox"/> Cool <input type="checkbox"/> Cold (°F/ °C) <input type="checkbox"/> Always
Frequency	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes (times/ day, month) <input type="checkbox"/> Only once <input type="checkbox"/> Under certain condition
Road	<input type="checkbox"/> Urban <input type="checkbox"/> Suburb <input type="checkbox"/> Highway <input type="checkbox"/> Mountainous (<input type="checkbox"/> Uphill <input type="checkbox"/> Downhill) <input type="checkbox"/> Tarmacadam <input type="checkbox"/> Gravel <input type="checkbox"/> Other _____
Vehicle Condition	
Engine condition	<input type="checkbox"/> Cold <input type="checkbox"/> Warming up phase <input type="checkbox"/> Warmed up <input type="checkbox"/> Always <input type="checkbox"/> Other at starting <input type="checkbox"/> Immediately after start <input type="checkbox"/> Racing without load <input type="checkbox"/> Engine speed (r/min)
Vehicle condition	During driving: <input type="checkbox"/> Constant speed <input type="checkbox"/> Accelerating <input type="checkbox"/> Decelerating <input type="checkbox"/> Right hand corner <input type="checkbox"/> Left hand corner <input type="checkbox"/> When shifting (Lever position) <input type="checkbox"/> At stop <input type="checkbox"/> Vehicle speed when problem occurs (km/h, Mile/h) <input type="checkbox"/> Other _____

Malfunction indicator lamp condition	<input type="checkbox"/> Always ON <input type="checkbox"/> Sometimes ON <input type="checkbox"/> Always OFF <input type="checkbox"/> Good condition
Diagnostic trouble code	First check: <input type="checkbox"/> No code <input type="checkbox"/> Malfunction code () Second check: <input type="checkbox"/> No code <input type="checkbox"/> Malfunction code ()

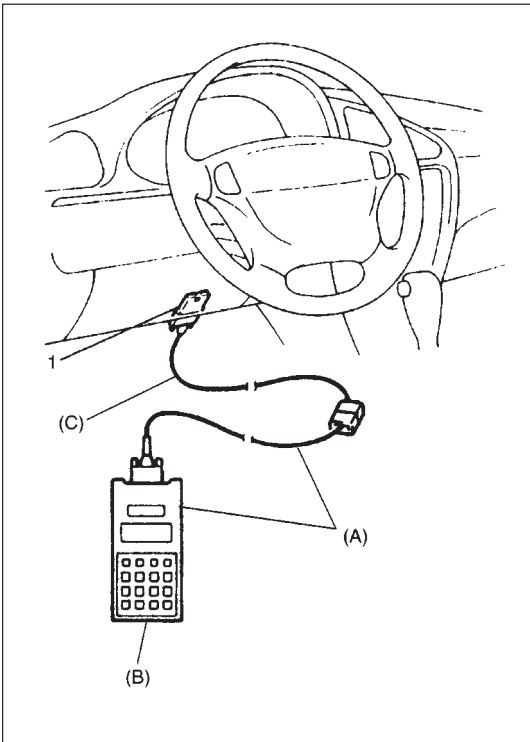
NOTE:

The above form is a standard sample. It should be modified according to conditions characteristic of each market.



MALFUNCTION INDICATOR LAMP (MIL) CHECK

- 1) Turn ON ignition switch (but the engine at stop) and check that MIL lights for 2 – 3 sec. and then goes out.
If MIL does not light up (or MIL dims), go to “Diagnostic Flow Table A-1” for troubleshooting.
- 2) If MIL remains ON and no DTC is stored in ECM, go to “Diagnostic Flow Table A-2” for troubleshooting.



DIAGNOSTIC TROUBLE CODE (DTC) CHECK

- 1) Prepare SUZUKI scan tool (Tech-1).
- 2) With ignition switch OFF, connect it to data link connector (DLC) (1) located on underside of instrument panel at driver's seat side.

Special Tool:

- (A): SUZUKI scan tool
- (B): Mass storage cartridge
- (C): 16/14 pin DLC cable

- 3) Turn ignition switch ON and confirm that MIL lights.
- 4) Read DTC according to instructions displayed on scan tool and print it or write it down.

Refer to scan tool operator's manual for further details.

If communication between scan tool and ECM is not possible, check if scan tool is communicable by connecting it to ECM in another vehicle. If communication is possible in this case, scan tool is in good condition. Then check data link connector and serial data line (circuit) in the vehicle with which communication was not possible.

- 5) After completing the check, turn ignition switch off and disconnect scan tool from data link connector.

DIAGNOSTIC TROUBLE CODE (DTC) CLEARANCE

- 1) Connect SUZUKI scan tool (Tech-1) to data link connector in the same manner as when making this connection for DTC check.
- 2) Turn ignition switch ON.
- 3) Erase DTC according to instructions displayed on scan tool.
Refer to scan tool operator's manual for further details.
- 4) After completing the clearance, turn ignition switch off and disconnect scan tool from data link connector.

DIAGNOSTIC TROUBLE CODE (DTC) TABLE

DTC NO.	DETECTING ITEM	DETECTING CONDITION (DTC will set when detecting)	MIL
1	CKP sensor circuit malfunction	Implausible signal during engine running	No lights
3	Engine coolant temperature sensor circuit malfunction	Sensor circuit voltage low input Sensor circuit voltage high input	No lights
4	Throttle position sensor circuit malfunction	Sensor circuit voltage low input Sensor circuit voltage high input	No lights
13	Barometric pressure sensor malfunction	Sensor circuit in ECM voltage low Sensor circuit in ECM voltage high	No lights
14	Injector needle sensor circuit malfunction	Implausible signal during engine running Sensor circuit is open Sensor circuit is short to ground or battery voltage line	No lights
16	Injection timing actuator control malfunction	Implausible injection timing during engine running	Lights
17	Power supply circuit malfunction	Battery voltage is low Battery voltage is high	Lights (when undervoltage)
22	Glow plug relay diagnostic feedback malfunction	Low input when should be turn ON glow plug	Lights
23	Glow plug relay control circuit malfunction	Relay circuit is open Relay circuit is short to ground or battery voltage line	No lights
32	Glow plug relay diagnostic feedback malfunction	High input when should be turn OFF glow plug	Lights
33	EGR No.1 solenoid valve circuit malfunction	Solenoid valve circuit is open Solenoid valve circuit is short to ground or battery voltage line	No lights
34	Injection timing actuator circuit malfunction	Actuator circuit is open Actuator circuit is short to ground or battery voltage line	Lights
36	EGR No.2 solenoid valve circuit malfunction	Solenoid valve circuit is open Solenoid valve circuit is short to ground or battery voltage line	No lights
37	A/C cut off control circuit malfunction	Control circuit is open Control circuit is short to ground or battery voltage line	No lights
38	MIL circuit malfunction	MIL circuit is open MIL circuit is short to ground or battery voltage line	No lights
39	Glow plug indicator lamp malfunction	Lamp circuit is open Lamp circuit is short to ground or battery voltage line	No lights
127	Internal control module memory check sum error	Data write error (or check sum error) when written into ECM	Lights

VISUAL INSPECTION

Visually check following parts and systems.

INSPECTION ITEM	REFERRING SECTION
○ Engine oil ——— level, leakage	Section 0B
○ Engine coolant ——— level, leakage	Section 0B
○ Fuel ——— level, leakage	Section 0B
○ Air cleaner element ——— dirt, clogging	Section 0B
○ Battery ——— fluid level, corrosion of terminal	
○ Water pump belt ——— tension, damage	Section 0B
○ Throttle cable ——— play, installation	Section 6E
○ Vacuum hoses ——— disconnection, looseness, deterioration, bend	
○ Connectors of electric wire harness ——— disconnection, friction	
○ Fuses ——— burning	Section 8
○ Parts ——— installation, bolt ——— looseness	
○ Parts ——— deformation	
○ Other parts that can be checked visually	
Also check following items at engine start, if possible	
○ Malfunction indicator lamp	Section 6
○ Charge warning lamp	Section 6H
○ Engine oil pressure warning lamp	Section 8 (section 6A4 for pressure check)
○ Engine coolant temp. meter	Section 8
○ Fuel level meter	Section 8
○ Tachometer	
○ Abnormal air being inhaled from air intake system	
○ Exhaust system ——— leakage of exhaust gas, noise	
○ Other parts that can be checked visually	

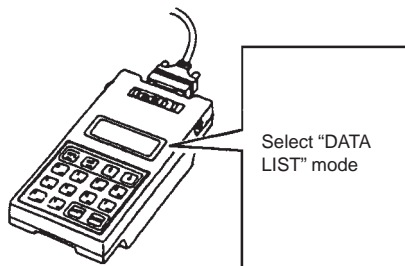
ENGINE BASIC INSPECTION

This check is very important for troubleshooting when ECM has detected no DTC and no abnormality has been found in visual inspection.

Follow the flow table carefully.

STEP	ACTION	YES	NO
1	Was "ENGINE DIAG. FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAG. FLOW TABLE".
2	Check battery voltage. Is it 11 V or more?	Go to Step 3.	Charge or replace battery.
3	Is engine cranked?	Go to Step 4.	Go to "DIAGNOSIS" in Section 6G.
4	Does engine start?	Go to Step 5.	Go to Step 7.
5	Check idle speed as follows: 1) Warm up engine to normal operating temp. 2) Shift transmission to neutral position. 3) All of electrical loads are switched off. 4) Check engine idle speed with scan tool. See Fig. 1. Is it 845 – 895 r/min?	Go to Step 6.	Go to "IDLE SPEED INSPECTION AND ADJUSTMENT" in Section 6E3.
6	Check ignition pump static timing referring to "FUEL INJECTION PUMP STATIC TIMING ADJUSTMENT AND CHECKING" in Section 6E3. Is injection pump static timing correct?	Go to "DIAGNOSIS IN TERMS OF SYMPTOM".	Adjust injection pump static timing referring to Section 6E3.
7	Check immobilizer DTC with scan tool referring to Section 8G. Is it indicated the trouble code?	Go to "DIAGNOSIS" in Section 8G.	Go to Step 8.
8	Perform air evacuation in the fuel circuit as follows: 1) Pump the priming pump on fuel filter over 30 times. 2) Carry out cranking the engine over 3 times for 5 seconds. Does engine start?	Go to "ENGINE DIAGNOSTIC FLOW TABLE".	Go to "DIAGNOSIS IN TERMS OF SYMPTOM".

Fig. 1 for Step 5



ENGINE DIAGNOSIS TABLE

Perform troubleshooting referring to following table when ECM has no DTC and no abnormality found in visual inspection and engine basic inspection previously.

Condition	Possible Cause	Referring Item
Hard Starting (Engine cranks OK)	Injection system out of order <input type="radio"/> Faulty fuel injection pump static timing <input type="radio"/> Clogged fuel filter or lines <input type="radio"/> Faulty fuel injection pump <input type="radio"/> Faulty ignitor	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Immobilizer control system out of order	Immobilizer control system in Section 8G
	Engine and emission control system out of order <input type="radio"/> Faulty CKP sensing rotor <input type="radio"/> Faulty CKP sensor, injector needle sensor, ECT sensor and TP sensor <input type="radio"/> Faulty fuel injection timing control actuator <input type="radio"/> Faulty ECM <input type="radio"/> Faulty glow plug control relay	CKP sensing rotor in Section 6E3 CKP sensor, injector needle sensor, ECT sensor and TP sensor in Section 6E3 Fuel injection timing control actuator in section 6E3 Inspection of ECM and its circuit. Glow plug control relay in Section 6E3
	Low compression <input type="radio"/> Improper valve lash <input type="radio"/> Improper valve timing <input type="radio"/> Compression leak from valve seat <input type="radio"/> Sticky valve stem <input type="radio"/> Weak or damaged valve spring <input type="radio"/> Compression leak at cylinder head gasket <input type="radio"/> Sticking or damaged ring <input type="radio"/> Worn piston, ring or cylinder	Compression check in section 6A4 Valve clearance in section 6A4 Valve timing in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Valve seats in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Valves in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Valve spring in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed in FOREWORD of this manual Piston and Connecting Rod in section 6A4 Piston and Connecting Rod in section 6A4

Condition	Possible Cause	Reference Item
Engine has no power	Engine overheating	Refer to "Overheating" of this table.
	Injection system out of order <ul style="list-style-type: none"> ○ Faulty fuel injection pump static timing ○ Clogged fuel filter or lines ○ Faulty fuel injection pump ○ Faulty injector 	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine and emission control system out of order <ul style="list-style-type: none"> ○ Faulty CKP sensing rotor ○ Faulty CKP sensor, injector needle sensor, ECT sensor and TP sensor ○ Faulty fuel injection timing control actuator ○ Faulty ECM ○ Malfunctioning EGR valve ○ Maladjusted accelerator cable play 	CKP sensing rotor in Section 6E3 CKP sensor, injector needle sensor, ECT sensor and TP sensor in section 6E3 Fuel injection timing control actuator in section 6E3 Inspection of ECM and its circuit EGR system inspection in section 6E3 Adjustment injection pump in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Low compression	Previously outlined.
	Others <ul style="list-style-type: none"> ○ Dragging brakes ○ Slipping clutch 	Diagnosis in Section 5. Diagnosis in Section 7C.

Condition	Possible Cause	Reference Item
Improper engine idling or engine fails to idle	Injection system out of order <input type="radio"/> Faulty fuel injection pump static timing <input type="radio"/> Clogged fuel filter or lines <input type="radio"/> Faulty fuel injection pump <input type="radio"/> Faulty injector	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine overheating	Refer to "Overheating" of this table.
	Engine and emission control system out of order <input type="radio"/> Faulty CKP sensing rotor <input type="radio"/> Faulty CKP sensor, injector needle sensor, ECT sensor and TP sensor <input type="radio"/> Faulty fuel injection timing control actuator <input type="radio"/> Faulty ECM <input type="radio"/> Malfunctioning EGR valve <input type="radio"/> Maladjusted accelerator cable play	CKP sensing rotor in Section 6E3 CKP sensor, injector needle sensor, ECT sensor and TP sensor in section 6E3 Fuel injection timing control actuator in Section 6E3 Inspection of ECM and its circuit EGR system inspection in section 6E3 Adjustment injection pump in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Low compression	Previously outlined.

Condition	Possible Cause	Reference Item
Engine hesitates (Momentary lack of response as the accelerator is depressed. Can occur at all vehicle speeds. Usually most severe when first trying to make the vehicle move, as from a stop sign.)	Injection system out of order <ul style="list-style-type: none"> ○ Faulty fuel injection pump static timing ○ Clogged fuel filter or lines ○ Faulty fuel injection pump ○ Faulty injector 	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine overheating	Refer to "Overheating" of this table.
	Engine and emission control system out of order <ul style="list-style-type: none"> ○ Faulty CKP sensing rotor ○ Faulty CKP sensor, injector needle sensor, ECT sensor and TP sensor ○ Faulty fuel injection timing control actuator ○ Faulty ECM ○ Malfunctioning EGR valve ○ Maladjusted accelerator cable play 	CKP sensing rotor in Section 6E3 CKP sensor, injector needle sensor, ECT sensor and TP sensor in section 6E3 Fuel injection timing control actuator in section 6E3 Inspection of ECM and its circuit EGR system inspection in section 6E3 Adjustment injection pump in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Low compression	Previously outlined.
Surges (Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and down with no change in the accelerator pedal.)	Injection system out of order <ul style="list-style-type: none"> ○ Faulty fuel injection pump static timing ○ Clogged fuel filter or lines ○ Faulty fuel injection pump ○ Faulty injector 	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine and emission control system out of order <ul style="list-style-type: none"> ○ Faulty ECM ○ Faulty fuel injection timing control actuator ○ Malfunctioning EGR valve 	Inspection of ECM and its circuit Fuel injection timing control actuator in section 6E3 EGR system inspection in section 6E3

Condition	Possible Cause	Reference Item
Excessive detonation (The engine makes sharp metallic knocks that change with throttle opening. Sounds like pop corn popping.)	Injection system out of order <input type="radio"/> Faulty fuel injection pump static timing <input type="radio"/> Clogged fuel filter or lines <input type="radio"/> Faulty fuel injection pump <input type="radio"/> Faulty injector	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine overheating	Refer to "Overheating" of this table.
	Engine and emission control system out of order <input type="radio"/> Faulty ECM <input type="radio"/> Faulty fuel injection timing control actuator <input type="radio"/> Malfunctioning EGR valve	Inspection of ECM and its circuit Fuel injection timing control actuator in Section 6E3 EGR system inspection in Section 6E3
	Others <input type="radio"/> Excessive combustion chamber deposits	Piston and cylinder head in Section 6A4
Overheating	<input type="radio"/> Inoperative thermostat <input type="radio"/> Faulty radiator fan motor or its circuit <input type="radio"/> Poor water pump performance <input type="radio"/> Clogged or leaky radiator <input type="radio"/> Improper engine oil grade <input type="radio"/> Clogged oil filter or oil strainer <input type="radio"/> Poor oil pump performance <input type="radio"/> Dragging brakes <input type="radio"/> Slipping clutch <input type="radio"/> Blown cylinder head gasket	Thermostat in Section 6B Radiator fan control system in Section 6B Water pump in Section 6B Radiator in Section 6B ITEM 1-3 Engine oil and oil filter change in Section 0B Oil pressure check in Section 6A4 Oil pressure check in Section 6A4 Diagnosis in Section 5. Diagnosis in Section 7C. Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual

Condition	Possible Cause	Reference Item
Poor fuel mileage	Injection system out of order <ul style="list-style-type: none"> ○ Faulty fuel injection pump static timing ○ Clogged fuel filter or lines ○ Faulty fuel injection pump ○ Faulty injector 	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine and emission control system out of order <ul style="list-style-type: none"> ○ Air cleaner element clogged ○ Faulty ECT sensor and TP sensor ○ Faulty fuel injection timing control actuator ○ Faulty ECM ○ Malfunctioning EGR valve 	ITEM 3-1 Air cleaner element inspection in Section 0B ECT sensor and TP sensor in Section 6E3 Fuel injection timing control actuator in Section 6E3 Inspection of ECM and its circuit EGR system inspection in Section 6E3
	Low compression	Previously outlined.
	Others <ul style="list-style-type: none"> ○ Dragging brakes ○ Slipping clutch ○ Thermostat out of order ○ Improper tire pressure 	Diagnosis in Section 5. Diagnosis in Section 7C. Thermostat in Section 6B. Refer to Section 3F.

Condition	Possible Cause	Reference Item
Excessive engine oil consumption	Oil entering combustion chamber <ul style="list-style-type: none"> ○ Sticky piston ring ○ Worn piston and cylinder ○ Worn piston ring groove and ring ○ Improper location of piston ring gap ○ Worn or damaged valve stem seal ○ Worn valve stem 	<p>Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p>
Low oil pressure	<ul style="list-style-type: none"> ○ Improper oil viscosity ○ Malfunctioning oil pressure switch ○ Clogged oil strainer ○ Functional deterioration of oil pump ○ Worn oil pump relief valve ○ Excessive clearance in various sliding parts 	<p>ITEM 1-3 Engine oil and oil filter change in Section 0B</p> <p>Oil pressure switch in Section 8</p> <p>Oil pan and oil pump strainer in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Oil pump in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Oil pump in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p> <p>Refer to Section 6A4 and "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual</p>

Condition	Possible Cause	Reference Item
Engine noise Note: Before checking the mechanical noise, make sure that: <input type="radio"/> Ignition timing is proper. <input type="radio"/> Specified fuel is used.	Valve noise <input type="radio"/> Improper valve lash <input type="radio"/> Worn valve stem and guide <input type="radio"/> Weak or broken valve spring <input type="radio"/> Warped or bent valve <input type="radio"/> Loose camshaft housing bolts	Valve clearance in Section 6A4 Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Valve spring in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Camshaft in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual
	Piston, ring and cylinder noise <input type="radio"/> Worn piston, ring and cylinder bore	Valves and cylinder head in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual
	Connecting rod noise <input type="radio"/> Worn crankpin bearing <input type="radio"/> Worn crankpin <input type="radio"/> Loose connecting rod nuts <input type="radio"/> Low oil pressure	Crankpin and connecting rod in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Crankpin and connecting rod in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Connecting rod in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Previously outlined.
	Crankshaft noise <input type="radio"/> Low oil pressure <input type="radio"/> Worn crankshaft journal bearing <input type="radio"/> Worn crankshaft journal <input type="radio"/> Loose lower crankcase (bearing cap) bolts <input type="radio"/> Excessive crankshaft thrust play	Previously outlined. Crank shaft and bearing in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Crank shaft and bearing in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Crankshaft in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual Crankshaft in "OVERHAUL CHECKING TUNING MANUAL" listed below in FOREWORD of this manual

Condition	Possible Cause	Referring Item
Excessive hydrocarbon (HC) emission or excessive carbon monoxide (CO) emission	Injection system out of order <input type="radio"/> Faulty fuel injection pump static timing <input type="radio"/> Clogged fuel filter or lines <input type="radio"/> Faulty fuel injection pump <input type="radio"/> Faulty injector	Static timing in "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel filter in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injection pump in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual Fuel injector in Section 6E3 and "ALL MODEL DIESEL DIAGNOSIS MANUAL" listed in FOREWORD of this manual
	Engine and Emission control system out of order <input type="radio"/> Air cleaner element clogged <input type="radio"/> Faulty ECT sensor and TP sensor <input type="radio"/> Faulty fuel injection timing control actuator <input type="radio"/> Faulty ECM <input type="radio"/> Malfunctioning EGR valve	ITEM 3-1 Air cleaner element inspection in Section 0B ECT sensor and TP sensor in Section 6E3 Fuel injection timing control actuator in Section 6E3 Inspection of ECM and its circuit EGR system inspection in Section 6E3
	Low compression	Previously outlined.
Excessive nitrogen oxides (NOx) emission	Engine and emission control system out of order <input type="radio"/> Air cleaner element clogged <input type="radio"/> Faulty ECT sensor and TP sensor <input type="radio"/> Faulty fuel injection timing control actuator <input type="radio"/> Faulty ECM <input type="radio"/> Malfunctioning EGR valve	ITEM 3-1 Air cleaner element inspection in Section 0B ECT sensor and TP sensor in Section 6E3 Fuel injection timing control actuator in Section 6E3 Inspection of ECM and its circuit EGR system inspection in Section 6E3

SCAN TOOL DATA

As the data values given below are standard values estimated on the basis of values obtained from the normally operating vehicles by using a scan tool, use them as reference values. Even when the vehicle is in good condition, there may be cases where the checked value does not fall within each specified data range. Therefore, judgment as abnormal should not be made by checking with these data alone.

Also, conditions in the below table that can be checked by the scan tool are those detected by ECM and output from ECM as commands and there may be cases where the engine or actuator is not operating (in the condition) as indicated by the scan tool.

NOTE:

- When checking the data with the engine running at idle or racing, be sure to shift M/T gear to the neutral gear position and pull the parking brake fully. Also, if nothing or “no load” is indicated, turn OFF A/C, all electric loads, P/S and all the other necessary switches.

SCAN TOOL DATA	CONDITION	REFERENCE VALUES
CALC LOAD (CALCULATED ENGINE LOAD VALUE)	At specified idle speed with no load after warming up	4 – 5 mg/str
	At 2000 r/min with no load after warming up	6 – 7 mg/str
COOLANT TEMP. SENSOR VOLTAGE (ENGINE COOLANT TEMPERATURE SENSOR)	At specified idle speed after warming up	0.1 V (80 – 100°C, 176 – 212°F)
ENGINE SPEED	At idling with no load after warming up	Desired idle speed ± 50 r/min
INJECTION TIMING	At specified idle speed with no load after warming up	3 – 4 deg
	At 2000 r/min with no load after warming up	6 – 7 deg
THROTTLE POS SENSOR VOLTAGE (THROTTLE POSITION SENSOR)	Throttle valve fully closed	0.6 – 1.0 V
	Throttle valve fully open	2.4 – 2.8 V
BATTERY VOLTAGE	Ignition switch ON/engine stop	12 – 15 V
BAROMETRIC PRESSURE VOLTAGE	Ignition switch ON	Display the barometric pressure voltage
INJECTOR NEEDLE SENSOR VOLTAGE	At specified idle speed with no load after warming up	0.8 – 1.2 V

SCAN TOOL DATA DEFINITIONS

CALC LOAD (CALCULATED LOAD VALUE, mg/str)

Engine load value calculated from throttle position and engine speed. Load is referred to in terms of fuel quantity per stroke.

COOLANT TEMP. VOLTAGE (ENGINE COOLANT TEMPERATURE VOLTAGE, V)

It is detected by engine coolant temp. sensor.

ENGINE SPEED (rpm)

It is computed by reference pulses from crankshaft position sensor.

INJECTION TIMING (START OF INJECTION, °)

Start of injection control is performed by calculating an optimal desired start of injection and closing the loop on it. ECM controls the injection start timing.

THROTTLE POSITION SENSOR VOLTAGE (TP SENSOR VOLT, V)

The Throttle Position Sensor reading provides throttle valve opening information in the form of voltage. This information is used for correction, such as enrichment correction during acceleration.

The voltage reading should increase as the throttle is opened. 0 V indicates a broken or shorted sensor.

BATTERY VOLTAGE (V)

This parameter indicates battery positive voltage inputted from main relay to ECM.

NEEDLE SENSOR VOLTAGE (V)

The ECM detects the start of needle movement by triggering on the rising edge of the needle movement sensor signal.

BAROMETRIC SENSOR VOLTAGE (V)

This parameter represents a measurement of barometric air pressure and is used for altitude correction of the fuel injection quantity.

INSPECTION OF ECM AND ITS CIRCUITS

ECM and its circuits can be checked at ECM wiring connectors by measuring voltage and resistance.

CAUTION:

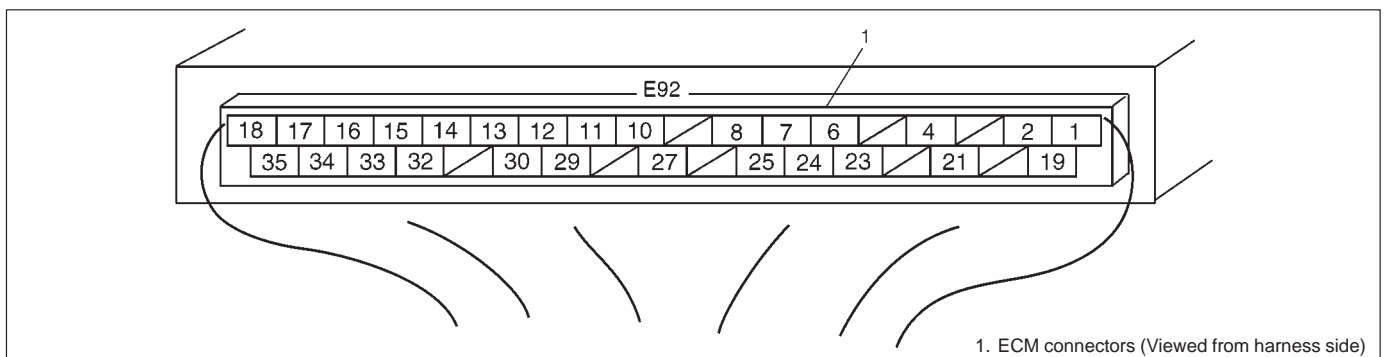
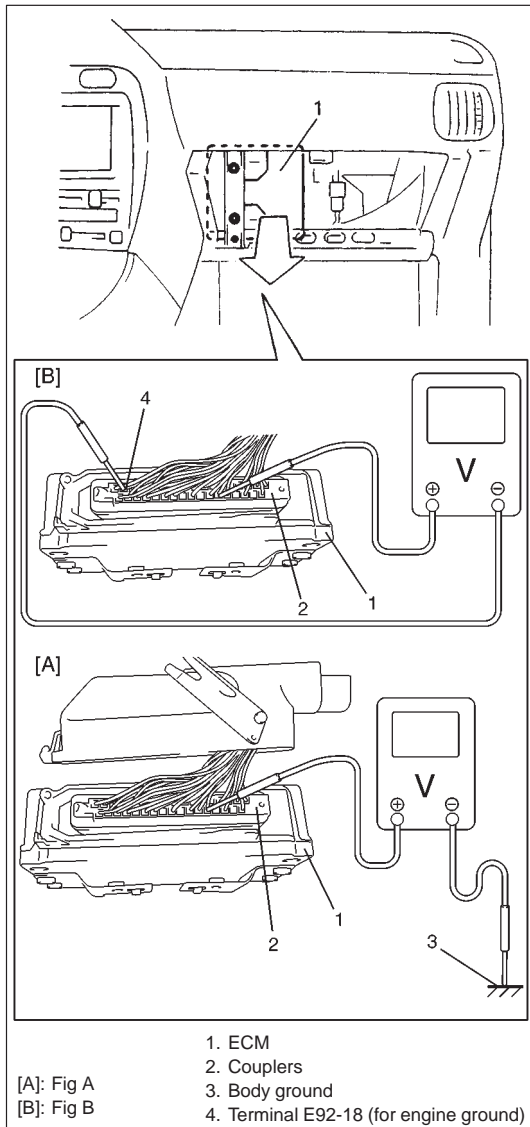
ECM cannot be checked by itself. It is strictly prohibited to connect voltmeter or ohmmeter to ECM with connector disconnected from it.

VOLTAGE CHECK

- 1) Remove ECM from body referring to Section 6E.
- 2) Check voltage at each terminal of connectors connected.

NOTE:

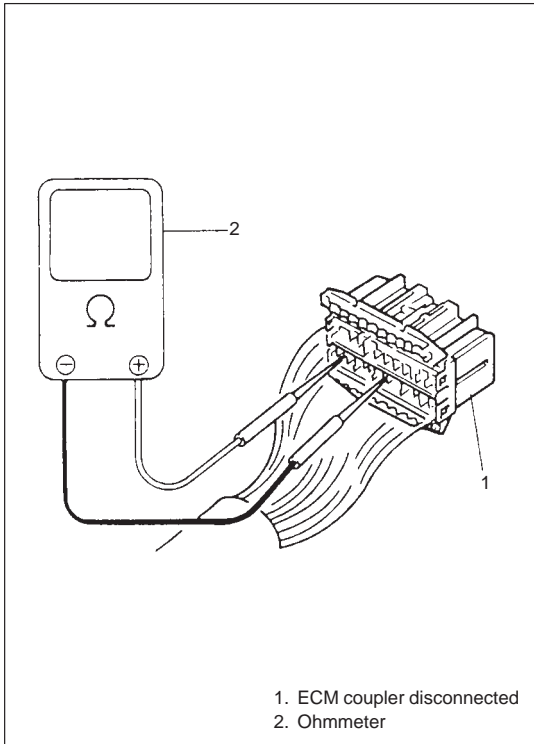
As each terminal voltage is affected by the battery voltage, confirm that it is 11 V or more when ignition switch is ON.



ECM VOLTAGE VALUES TABLE

Terminal	Wire	Circuit	Measurement ground	Normal value	Condition
E92-01	Bl/R	TP sensor power supply output	Ground to engine (Fig B)	4 – 6 volts	Ignition switch ON position
E92-02	Bl/B	TP sensor input	Ground to engine (Fig B)	0.6 – 1.0 volts	Ignition switch ON position and throttle lever at idle position.
				2.4 – 2.8 volts	Ignition switch ON position and throttle lever at fully open position.
E92-04	Br	ECT sensor signal input	Ground to engine (Fig B)	0.25 – 0.28 volt	Ignition switch ON position at engine coolant temp. 60°C (140°F)
				0.1 – 0.12 volt	Ignition switch ON position at engine coolant temp. 90°C (194°F)
E92-06	Bl	Glow plug control relay feed back signal	Ground to engine (Fig B)	8 – 12 volts	While turn ON ignition switch for several seconds
				– 0.5 – 0.5 volt	Engine running
E92-07	B	Injector needle sensor positive input	Ground to engine (Fig B)	3 – 4.5 volts	Ignition switch ON position
E92-08	R	CKP sensor positive input	Ground to engine (Fig B)	2 – 3 volts	Ignition switch ON position
E92-10	P/G	Data link connector (K-line)	Ground to engine (Fig B)	2 – 3 volts	Ignition switch ON position
E92-11	Br	Engine speed signal output	Ground to engine (Fig B)	4 – 6 volts	Ignition switch ON position
E92-12	Bl	Glow plug indicator lamp output	Ground to engine (Fig B)	8 – 12 volts	While turn ON ignition switch for several seconds
				0 – 1 volt	Engine running
E92-13	P	A/C CUT signal output	Ground to engine (Fig B)	10 – 14 volts	Engine running
E92-14	Bl/W	EGR valve No.2 output	Ground to engine (Fig B)	10 – 14 volts	Ignition switch ON position
				0 – 1 volt	Engine running
E92-15	G/R	Injection timing control actuator output	Ground to engine (Fig B)	10 – 14 volts	Ignition switch ON position
E92-16	G/W	ECM power source	Ground to engine (Fig B)	10 – 14 volts	Ignition switch ON position
E92-17	B	ECM ground	Ground to engine (Fig A)	– 0.5 – 0.5 volt	Ignition switch ON position
E92-18	B/Or	ECM ground	Ground to engine (Fig A)	– 0.5 – 0.5 volt	Ignition switch ON position
E92-19	Bl/Or	TP sensor ground	Ground to engine (Fig B)	– 0.5 – 0.5 volt	Ignition switch ON position
E92-21	Br/W	ECT sensor ground	Ground to engine (Fig B)	– 0.5 – 0.5 volt	Ignition switch ON position
E92-23	B/Bl	Sealed wire ground	Ground to engine (Fig B)	– 0.5 – 0.5 volt	Ignition switch ON position
E92-24	W	Injector needle sensor negative input	Ground to engine (Fig B)	– 0.5 – 0.5 volt	Ignition switch ON position
E92-25	G	CKP sensor negative input	Ground to engine (Fig B)	2 – 3 volts	Ignition switch ON position

Terminal	Wire	Circuit	Measurement ground	Normal value	Condition
E92-27	Br/Y	Data link connector (L-line)	Ground to engine (Fig B)	- 0.5 – 0.5 volt	Ignition switch ON position
E92-29	B/R	Glow plug control relay output	Ground to engine (Fig B)	0 – 1 volt	While turn ON ignition switch for several seconds
				10 – 14 volts	Engine running
E92-30	V	Malfunction indicator lamp output	Ground to engine (Fig B)	0 – 1 volt	While turn ON ignition switch for several seconds
				10 – 14 volts	Engine running
E92-32	R/Y	EGR valve No.1 output	Ground to engine (Fig B)	10 – 14 volts	Ignition switch ON position
				0 – 1 volt	Engine running
E92-33	G/Y	ECM power source	Ground to engine (Fig B)	10 – 14 volts	Ignition switch ON position
E92-34	B/Or	ECM ground	Ground to engine (Fig A)	- 0.5 – 0.5 volt	Ignition switch ON position
E92-35	B/Or	ECM ground	Ground to engine (Fig A)	- 0.5 – 0.5 volt	Ignition switch ON position



RESISTANCE CHECK

1) Disconnect ECM couplers from ECM with ignition switch OFF.

CAUTION:
Never touch terminals of ECM itself or connect volt-meter or ohmmeter.

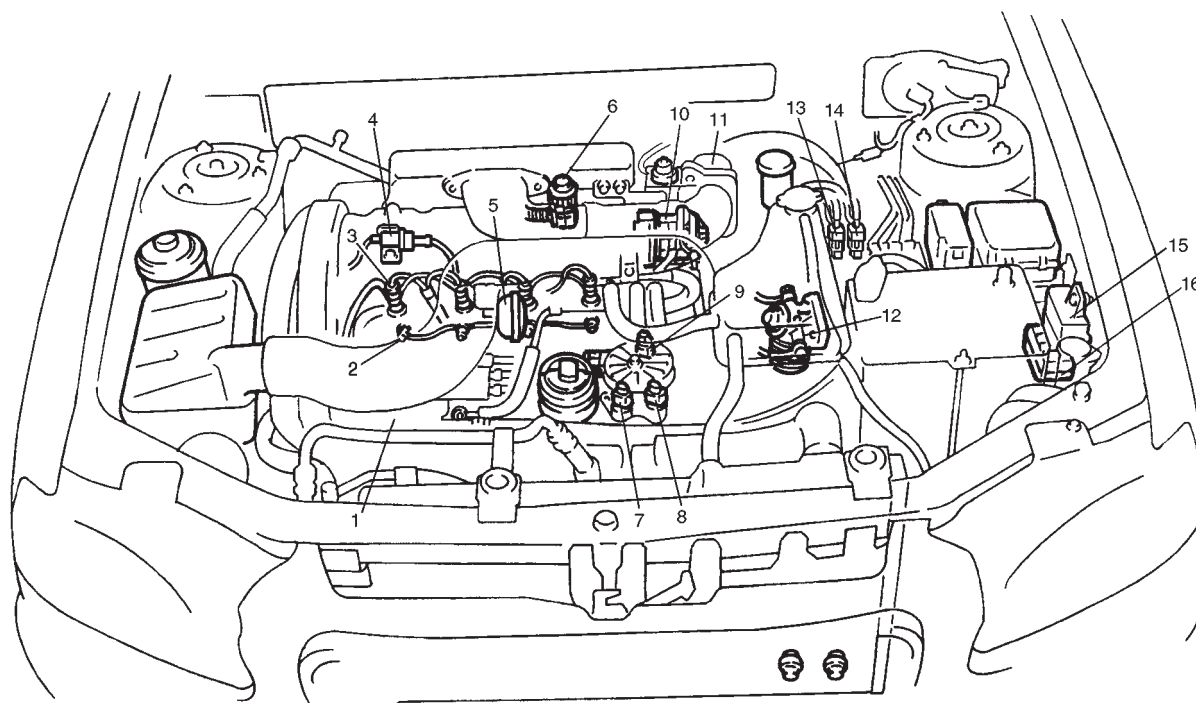
2) Check resistance between each terminal of couplers disconnected.

CAUTION:

- Be sure to connect ohmmeter probe from wire harness side of coupler.
- Be sure to turn OFF ignition switch for this check.
- Resistance in table below represents that when parts temperature is 20°C (68°F).

TERMINALS	CIRCUIT	STANDARD RESISTANCE
E92-7 to E92-24	Injector needle sensor	85 I – 130 I
E92-8 to E92-25	CKP sensor	330 I – 480 I
E92-4 to E92-24	ECT sensor	530 I – 590 I at 60°C, 140°F
		220 I – 240 I at 90°C, 194°F
E92-1 to E92-19	TP sensor	1.4 KI – 2.1 KI
E92-2 to E92-19		950 I – 1.5 KI
E92-12 to E92-18	Glow plug indicator	8 I – 14 I
E92-17 to E92-18	Ground	Continuity
E92-34 to E92-18	Ground	Continuity
E92-35 to E92-18	Ground	Continuity

COMPONENT LOCATION



1. Fuel injection pump
2. Glow plug
3. Fuel injector
4. Injection needle sensor
5. Regulator
6. EGR No.1 valve
7. Coolant temp. gauge
8. Coolant temp. switch

9. ECT sensor
10. Vacuum pump
11. EGR No.2 valve
12. Fuel filter
13. EGR No.1 solenoid valve
14. EGR No.2 solenoid valve
15. Double relay
16. Glow plug control relay

TABLE A-1 MALFUNCTION INDICATOR LAMP CIRCUIT CHECK – LAMP DOES NOT COME “ON” AT IGNITION SWITCH ON (BUT ENGINE AT STOP)

TABLE A-2 MALFUNCTION INDICATOR LAMP CIRCUIT CHECK – LAMP REMAINS “ON” WITH IGNITION SWITCH ON

WIRING DIAGRAM/CIRCUIT DESCRIPTION – Refer to table A-1.

INSPECTION

STEP	ACTION	YES	NO
1	Diagnostic Trouble Code (DTC) check 1) Check DTC referring to DTC CHECK section. Is there any DTC(s)?	Go to Step 2 of ENGINE DIAG. FLOW TABLE.	Go to Step 2.
2	DTC check Start engine and recheck DTC while engine running. Is there any DTC(s)?		Go to Step 3.
3	MIL Circuit check 1) Turn OFF ignition switch. 2) Disconnect connectors from ECM. Does MIL turn ON at ignition switch ON?	“V” wire circuit shorted to ground.	Substitute a known-good ECM and recheck.

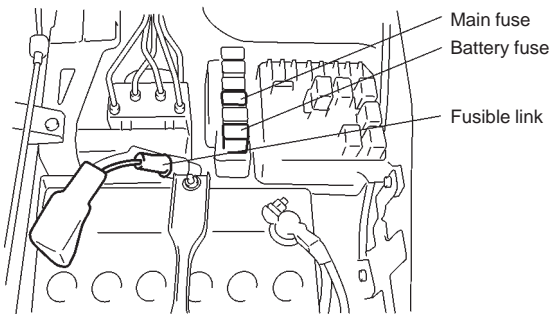
1. Main fuse
2. Ignition switch
3. Double relay
4. Malfunction indicator lamp in combination meter
5. Fusible link
6. "IG" fuse
7. "IG METER" fuse
8. Generator
9. ECM

INSPECTION

STEP	ACTION	YES	NO
1	Double Relay Operating Sound Check Is operating sound of double relay heard at ignition switch ON?	Go to Step 3.	Go to Step 2.
2	Double Relay Check Refer to DOUBLE RELAY in Section 6E3. Is double relay in good condition?	Go to Step 3.	Replace double relay.
3	Fuse Check Is "Fusible link" and "IG METER" fuse in good condition? See Fig. 1.	Go to Step 4.	Check for short in circuits connected to this fuse.
4	Double Relay Power Circuit Check 1) Turn ignition switch OFF, and disconnect coupler from double relay. 2) Turn ignition switch ON, measure voltage between "B/W" terminal in double relay coupler and body ground, and "P" terminal in double relay coupler and body ground. Is each terminal voltage 10 to 14 V?	Go to Step 5.	"B/W" or "P" circuit in glow plug relay coupler open or shorted to ground.

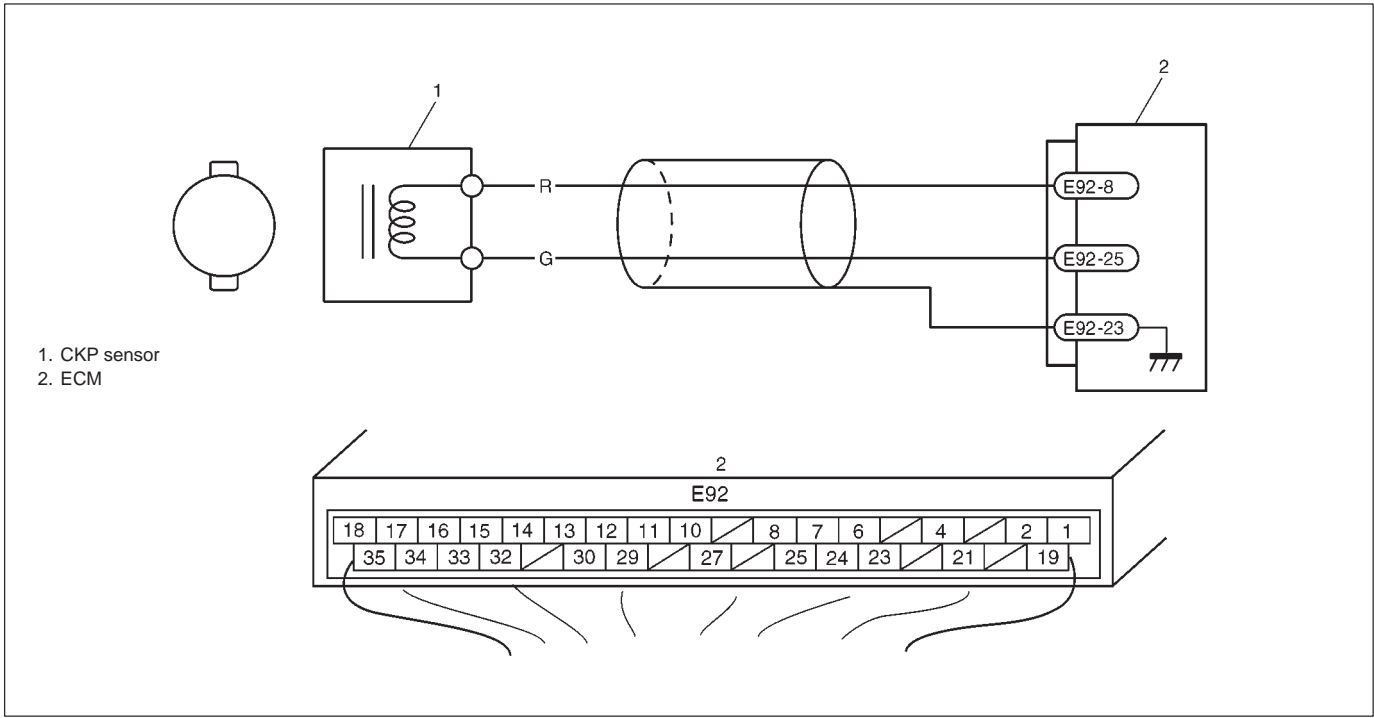
STEP	ACTION	YES	NO
5	Double Relay Ground Circuit Check 1) Turn ignition switch OFF. 2) Check continuity between “B/Or” terminal in double relay coupler and body ground. Is it continuity?	Go to Step 6.	“B/Or” circuit in glow plug relay coupler open.
6	1) Turn ignition switch ON. 2) Measure voltage between “G/Y”, “G/W” terminals in double relay coupler with connect it coupler. Is it 10 to 14 V?	Go to Step 7.	Double relay malfunction.
7	ECM Power Circuit Check 1) Turn OFF ignition switch, disconnect connectors from ECM and install double relay. 2) Check for proper connection to ECM at terminals E92-16 and E92-33. 3) If OK, then measure voltage between terminal E92-16 and ground, E92-33 and ground with ignition switch ON. Is each voltage 10 – 14 V?	Substitute a known-good ECM and recheck.	“G/Y” or “G/W” circuit open.

Fig. 1 for Step 3



DTC No.1 CRANKSHAFT POSITION (CKP) SENSOR CIRCUIT MALFUNCTION

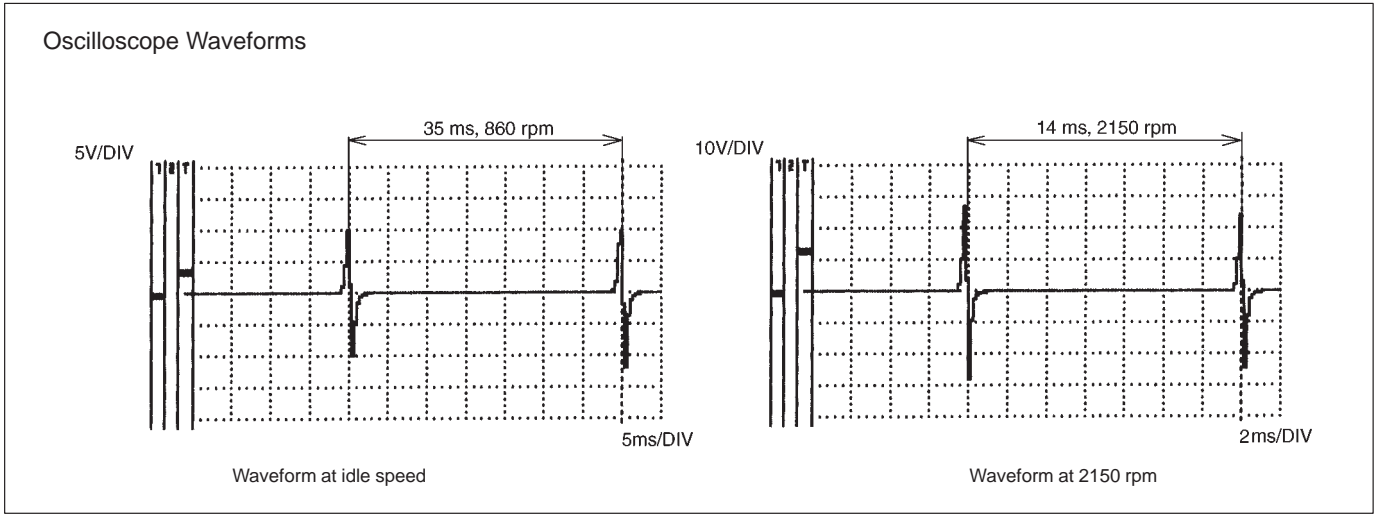
CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
<ul style="list-style-type: none">○ No CKP sensor signal for 2 seconds at engine cranking.	<ul style="list-style-type: none">○ CKP sensor circuit open or short.○ Signal teeth damaged.○ CKP sensor malfunction, foreign material being attached or improper installation.○ ECM malfunction.

Reference

Connect oscilloscope between terminals E92-8 and E92-25 of ECM connector connected to ECM and body ground, then check CKP sensor signal.



DTC CONFIRMATION PROCEDURE

- 1) Clear DTC and crank engine for 2 sec.
- 2) Select “DTC” mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check CKP sensor and connector for proper installation. Is CKP sensor installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check CKP sensor resistance as follows. 1) Disconnect CKP sensor connector with ignition switch OFF. 2) Measure resistance between sensor terminals. Refer to CKP SENSOR in Section 6E3. Is measured resistance value as specified?	Go to Step 4.	Replace CKP sensor.
4	Check ECM terminals voltage as follows. 1) Turn ignition switch OFF. 2) Disconnect ECM connector. 3) Check for proper connection to ECM at each sensor terminals. 4) If check is OK, then turn ignition switch ON and measure voltage between sensor terminal E92-8, E92-25 of ECM and body ground. See Fig. 1. Is it 0 V?	Go to Step 5.	CKP sensor circuit shorted to power.
5	Check continuity of CKP sensor circuit as follows. 1) Turn ignition switch OFF. 2) Connect CKP sensor coupler. 3) Measure resistance between the following points. ○ Both ECM connector terminals of the CKP sensor circuit: continuity ○ Either terminal of CKP sensor coupler and body ground: no-continuity Are both check results satisfactory?	Go to Step 6.	Circuit open or shorted to ground.
6	Check CKP sensor damage as follows. 1) Remove CKP sensor. 2) Check sensor for damage or foreign material attached. Is it in good condition?	Go to Step 7.	Clean, repair or replace.
7	Check CKP sensor voltage waveform as follows. 1) Install CKP sensor. 2) Check for voltage waveform as shown in reference of previous page. Is specified voltage and waveform obtained?	Substitute a known-good ECM and recheck.	Go to Step 8.
8	Check sensor rotor with flywheel for the following. ○ Rotor teeth neither missing nor damaged. See Fig. 2. ○ No foreign material being attached. ○ Rotor being eccentric. Are they in good condition?	Replace CKP sensor.	Clean, repair or replace sensor rotor.

Fig. 1 for Step 4

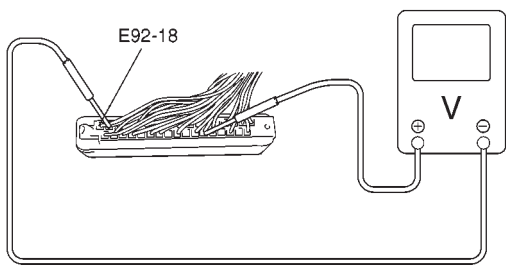
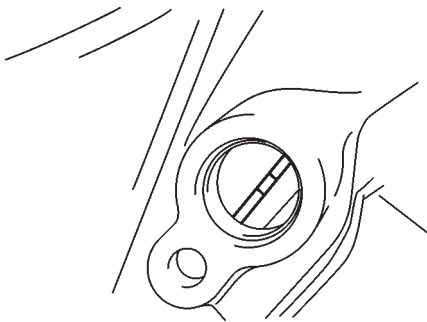
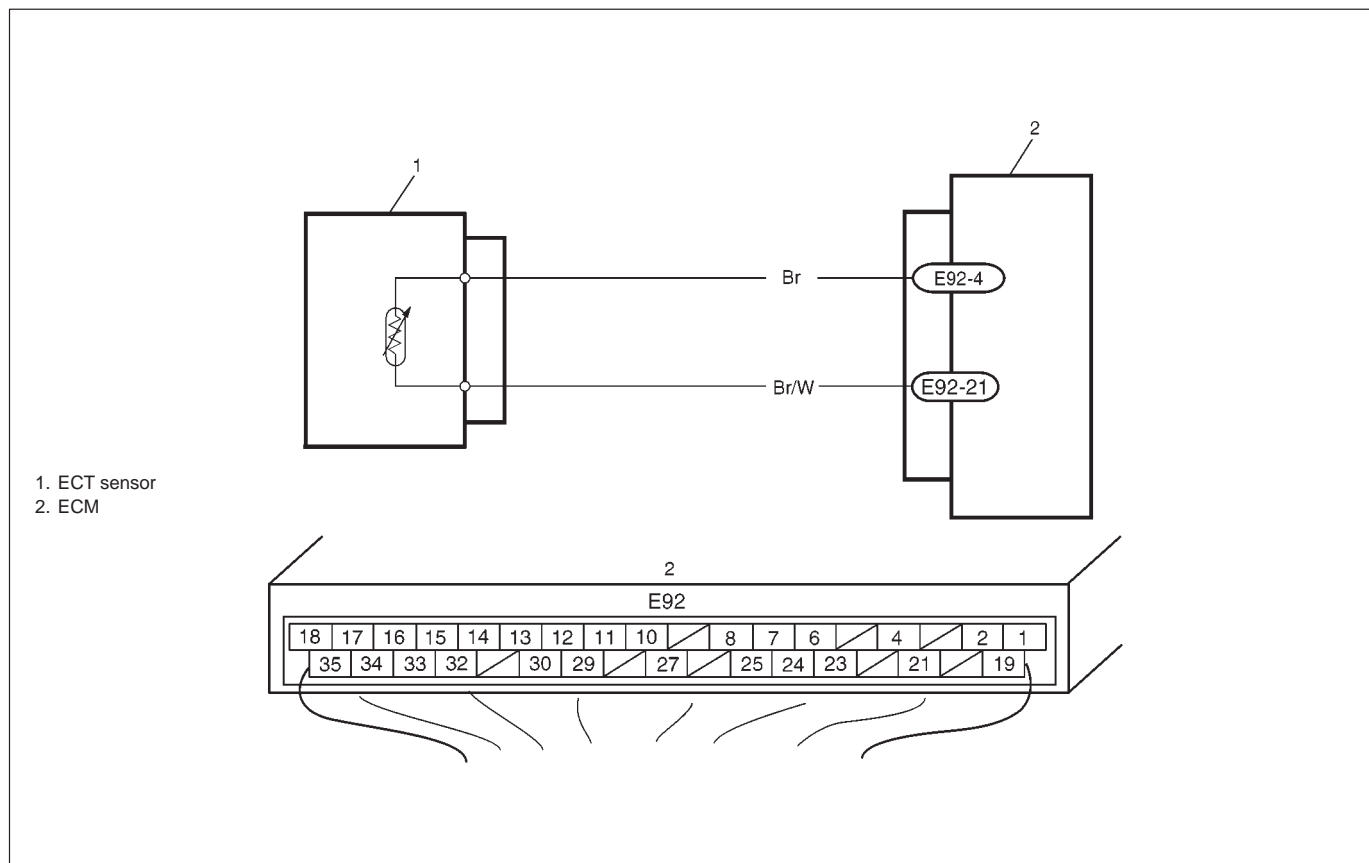


Fig. 2 for Step 8



DTC No.3 ENGINE COOLANT TEMPERATURE (ECT) CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
<input type="radio"/> Low engine coolant temperature (High voltage-High resistance) <input type="radio"/> High engine coolant temperature (Low voltage-Low resistance)	<input type="radio"/> "Br" circuit open or shorted to power <input type="radio"/> "Br/W" circuit open <input type="radio"/> ECT sensor malfunction <input type="radio"/> ECM malfunction

NOTE:

- ☐ Before inspecting, be sure to check that coolant temp. meter in combination meter indicates normal operating temperature (Engine is not overheating).

DTC CONFIRMATION PROCEDURE

- 1) Clear DTC, start engine and keep it at idle for 1 min.
- 2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAG. FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAG. FLOW TABLE".
2	Check ECT Sensor and Its Circuit. 1) Connect scan tool with ignition switch OFF. 2) Turn ignition switch ON. 3) Check engine coolant temp. displayed on scan tool. See Fig. 1. Is -40°C (-40°F) or 130°C (266°F) indicated?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0 A.
3	Check Wire Harness. 1) Disconnect ECT sensor connector. 2) Check engine coolant temp. displayed on scan tool. Is -40°C (-40°F) indicated?	Replace ECT sensor.	"Br" wire shorted to ground. If wire is OK, substitute a known-good ECM and recheck.
4	Does scan tool indicate -40°C (-40°F) at Step 2.	Go to Step 6.	Go to Step 5.
5	Check Wire Harness. 1) Disconnect ECT sensor connector with ignition switch OFF. 2) Check for proper connection to ECT sensor at "Br/W" and "Br" wire terminals. 3) If OK, then with ignition switch ON, is voltage applied to "Br" wire terminal about 4 – 6 V? See Fig. 2.	Go to Step 4.	"Br" wire open or shorted to power, or poor E92-4 connection. If wire and connection are OK, substitute a known-good ECM and recheck.
6	Check Wire Harness. 1) Using service wire, connect ECT sensor connector terminals. See Fig. 3. 2) Turn ignition switch ON and check engine coolant temp. displayed on scan tool. Is 130°C (266°F) indicated?	Replace ECT sensor.	"Br/W" wire open or poor E92-21 connection. If wire and connection are OK, substitute a known-good ECM and recheck.

Fig. 1 for Step 2

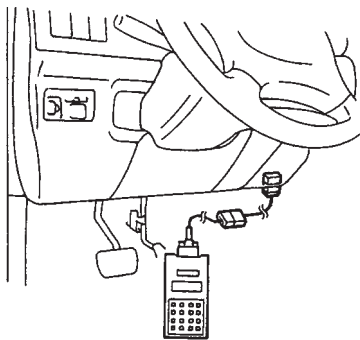


Fig. 2 for Step 5

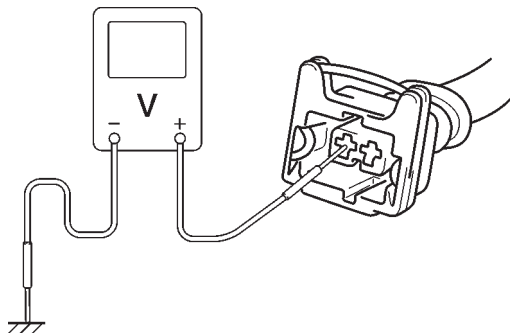
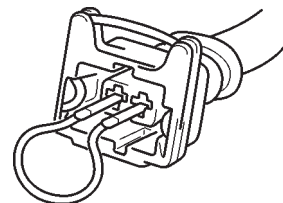
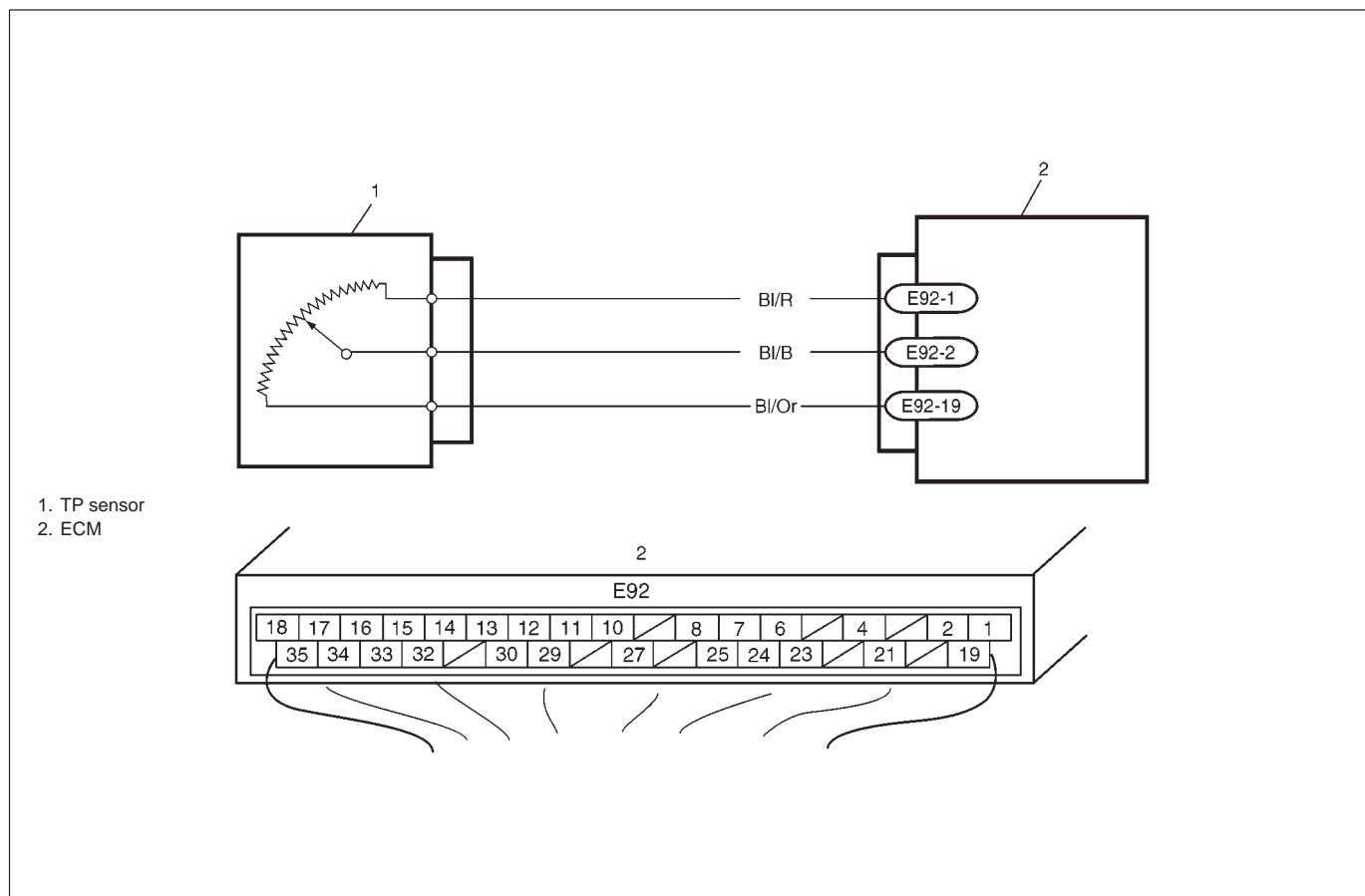


Fig. 3 for Step 6



DTC No.4 THROTTLE POSITION CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
<ul style="list-style-type: none"> ○Signal voltage high ○Signal voltage low 	<ul style="list-style-type: none"> ○“BI/Or” circuit open or shorted to power ○“BI/B” circuit open or shorted to ground ○“BI/R” circuit open or shorted to power or ground ○TP sensor malfunction ○ECM malfunction

DTC CONFIRMATION PROCEDURE

- 1) Clear DTC, start engine and keep it at idle for 1 min.
- 2) Select “DTC” mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAG. FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAG. FLOW TABLE".
2	Check TP Sensor and Its Circuit. 1) Connect scan tool to DLC with ignition switch OFF and then turn ignition switch ON. 2) Check throttle valve opening percentage displayed on scan tool. See Fig. 1. Is it displayed 0% or 100%?	Go to Step 3.	Intermittent trouble. Check for intermittent referring to "Intermittent and Poor Connection" in Section 0 A.
3	Check Wire Harness. 1) Disconnect connector from TP sensor with ignition switch OFF. 2) Check for proper connection to TP sensor at "BI/R", "BI/B" and "BI/Or" wire terminal. 3) If OK, then with ignition switch ON, check voltage at each of "BI/R" and "BI/B" wire terminals and body ground. See Fig. 2. Is voltage about 4 – 6 V at each terminal?	Go to Step 4.	"BI/R" wire open, "BI/R" wire shorted to ground circuit or power circuit or "BI/Or" wire, "BI/B" wire open or shorted to ground circuit or poor E92-1 or E92-2 connection. If wire and connection are OK, substitute a known-good ECM and recheck.
4	Check TP Sensor. Refer to TP SENSOR in Section 6E3. Is it in good condition?	"BI/Or" wire open or poor E92-19 connection. If wire and connection are OK, substitute a known-good ECM and recheck.	Replace TP sensor.

Fig. 1 for Step 2

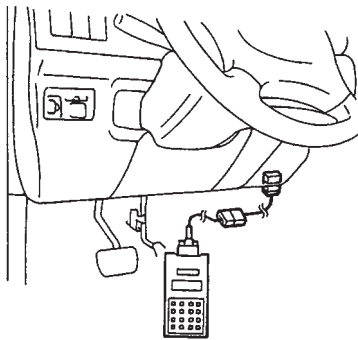
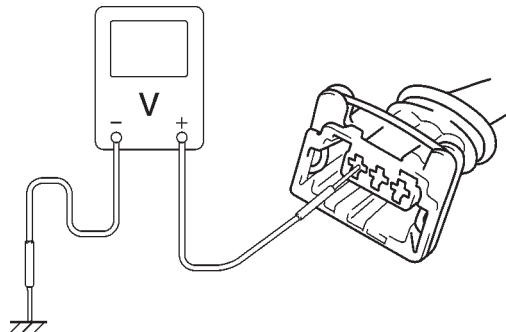


Fig. 2 for Step 3



DTC NO.13 BAROMETRIC PRESSURE SENSOR LOW/HIGH INPUT

WIRING DIAGRAM/CIRCUIT DESCRIPTION

Barometric pressure sensor is installed in ECM.

DTC DETECTING CONDITION	POSSIBLE CAUSE
○Barometric pressure sensor voltage is too high or too low	○ECM (barometric pressure sensor) malfunction

DTC CONFIRMATION PROCEDURE

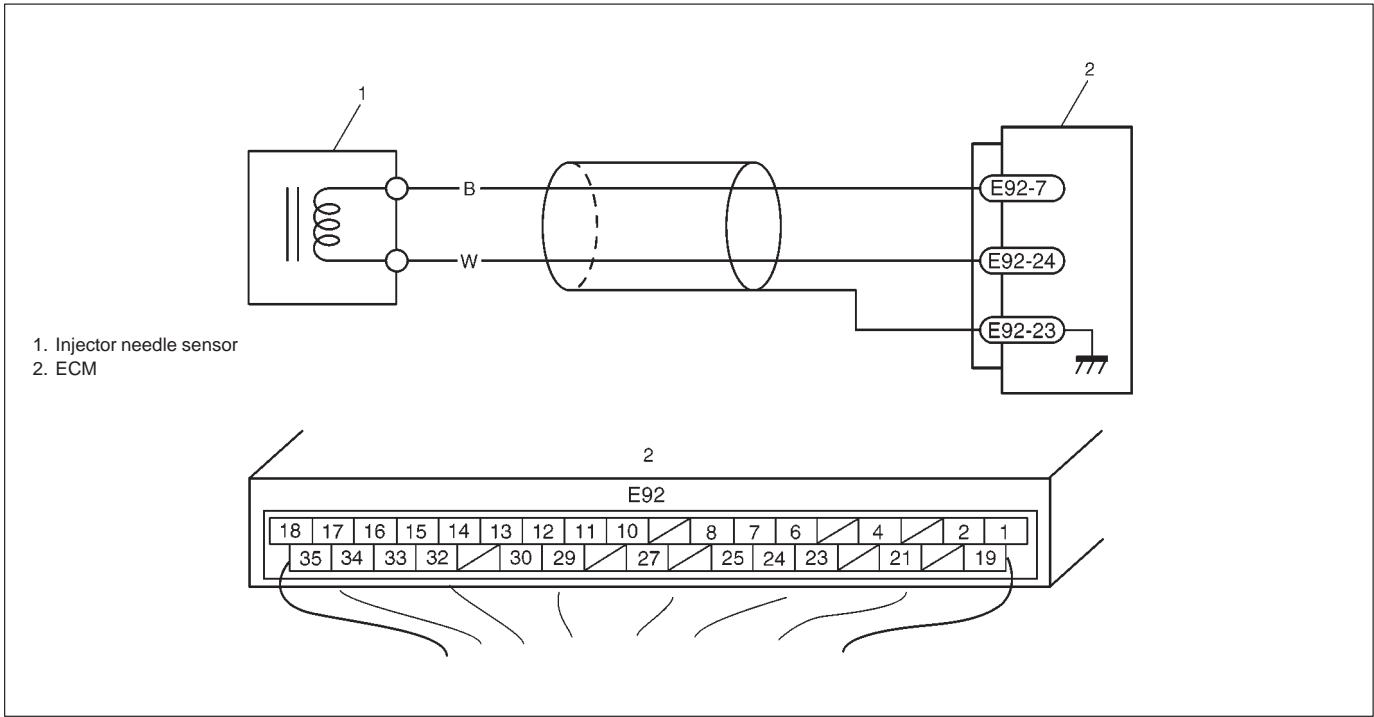
- 1) Turn ignition switch OFF.
- 2) Clear DTC with ignition switch ON.
- 3) Turn ignition switch ON for 2 sec., crank engine for 2 sec. and run it at idle for 1 min.
- 4) Check DTC in "DTC" mode.

INSPECTION

Substitute a known-good ECM and recheck.

DTC No.14 INJECTOR NEEDLE SENSOR CIRCUIT MALFUNCTION

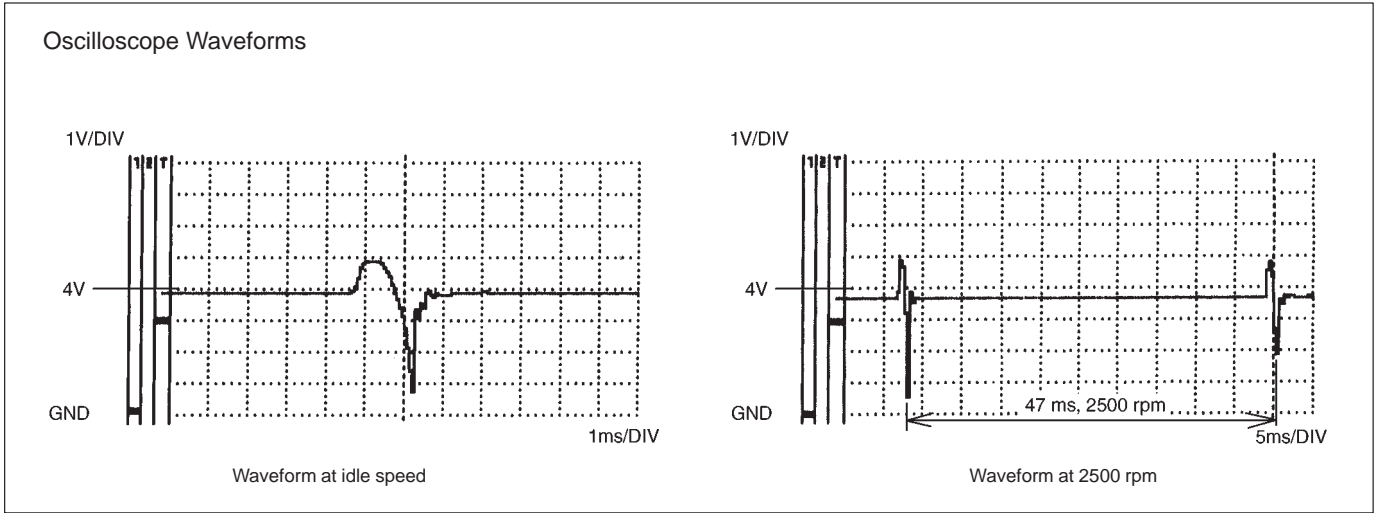
CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
○ No injector needle sensor signal for 2 seconds at engine cranking.	○Injector needle sensor circuit open or short. ○Injector damaged. ○Injector needle sensor malfunction. ○ECM malfunction.

Reference

Connect oscilloscope between terminals E92-7, E92-24 of ECM connector connected to ECM and check CKP sensor signal.



DTC CONFIRMATION PROCEDURE

- 1) Clear DTC and crank engine for 2 sec.
- 2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check injector needle sensor and connector for proper installation. Is injector needle sensor installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check injector needle sensor resistance as follows. 1) Disconnect injector needle sensor connector with ignition switch OFF. 2) Measure resistance between sensor terminals. Refer to INJECTOR NEEDLE SENSOR in Section 6E3. Is measured resistance value as specified?	Go to Step 4.	Replace injector needle sensor.
4	Check ECM terminal voltage as follows. 1) Turn ignition switch OFF. 2) Disconnect ECM connector. 3) Check for proper connection to ECM at each sensor terminals. 4) If check is OK, then turn ignition switch ON and measure voltage between sensor terminal of ECM and body ground. Is it 0 V?	Go to Step 5.	Injector needle sensor circuit shorted to power.
5	Check continuity of injector needle sensor circuit as follows. 1) Turn ignition switch OFF. 2) Connect injector needle sensor coupler. 3) Measure resistance between the following points. ○ Both ECM connector terminals of the injector needle sensor: continuity ○ Either terminal of injector needle sensor coupler and body ground: no-continuity Are both check results satisfactory?	Go to Step 6.	Circuit open or shorted to ground.
6	Check injector damage as follows. 1) Remove needle sensor with injector. 2) Check injector for damage, pollution and clogs. Refer to INJECTOR in Section 6A4. Is it in good condition?	Go to Step 7.	Clean, repair or replace.
7	Check voltage waveform for injector needle sensor as follows. 1) Install needle sensor with injector. 2) Check for voltage waveform as shown in reference of previous page. Is specified voltage and/or waveform obtained?	Substitute a known-good ECM and recheck.	Replace injector.

[illegible]

ITEM	DTC DETECTING CONDITION	POSSIBLE CAUSE
DTC No.16	Injection timing actuator improper operative	<ul style="list-style-type: none"> ○Injection pump static timing is displacement ○Injection pump malfunction ○ECM malfunction
DTC No.34	Injection timing actuator circuit is opened or shorted	<ul style="list-style-type: none"> ○“G” circuit open or short ○“G/R” circuit open or short ○Injection timing actuator malfunction

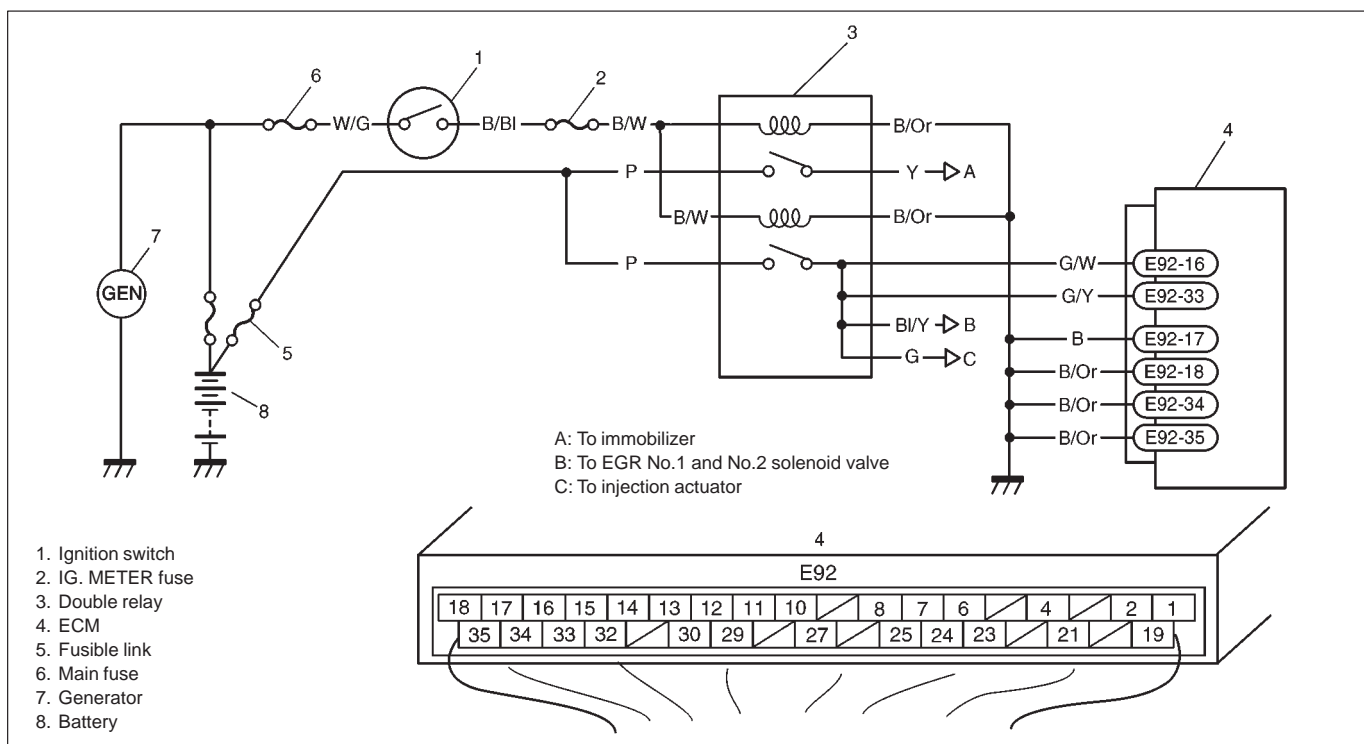
- 1) Clear DTC with ignition switch ON.
- 2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check injection timing actuator connector for proper installation. Is injection timing actuator connector connected securely?	Go to Step 3.	Correct.
3	Check injection timing actuator operation as follows. 1) With ignition switch OFF, disconnect coupler from injection timing actuator. 2) Check injection timing actuator resistance. Refer to INJECTOR TIMING ACTUATOR in Section 6E3. Is it as specified?	Go to Step 4.	Remove the injection pump and have it checked by BOSCH dealer. (Refer to FUEL INJECTION PUMP in Section 6E3.)
4	Check ECM terminal voltage as follows. 1) Disconnect ECM coupler. 2) Connect injection timing actuator coupler. 3) Turn ignition switch ON. 4) Measure voltage between E92-15 terminal in ECM coupler and body ground. Is it over 10 V?	Go to Step 5.	"G" and "G/R" circuits open or shorted to ground.
5	Check injection timing actuator circuit voltage as follows. 1) Disconnect injection timing actuator coupler. 2) Turn ignition switch ON. 3) Measure voltage between E92-15 terminal in ECM coupler and body ground. Is it 0 V?	Go to Step 6.	"G/R" circuit shorted to power supply.
6	Check injection pump static timing. Refer to FUEL INJECTION PUMP in Section 6E3. Is it as specified?	Go to Step 7.	Adjust injection pump static timing. (Refer to FUEL INJECTION PUMP in Section 6E3.)
7	Substitute a known-good ECM and recheck. Is DTC detected?	Remove the injection pump and have it checked by BOSCH dealer. (Refer to FUEL INJECTION PUMP in Section 6E3.)	Faulty ECM.

DTC No.17 ECM POWER SUPPLY CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
<ul style="list-style-type: none"> ○ ECM power supply circuit is 6 V or lower ○ ECM power supply circuit is 16 V or higher 	<ul style="list-style-type: none"> ○ Poor charge battery. ○ Fuse blown. ○ "G/Y" and "G/W" circuit open or shorted to ground. ○ "B/W" and "P" circuit open or shorted to ground. ○ Double relay ground open or shorted to power supply. ○ Generator malfunction. ○ Double relay malfunction.

DTC CONFIRMATION PROCEDURE

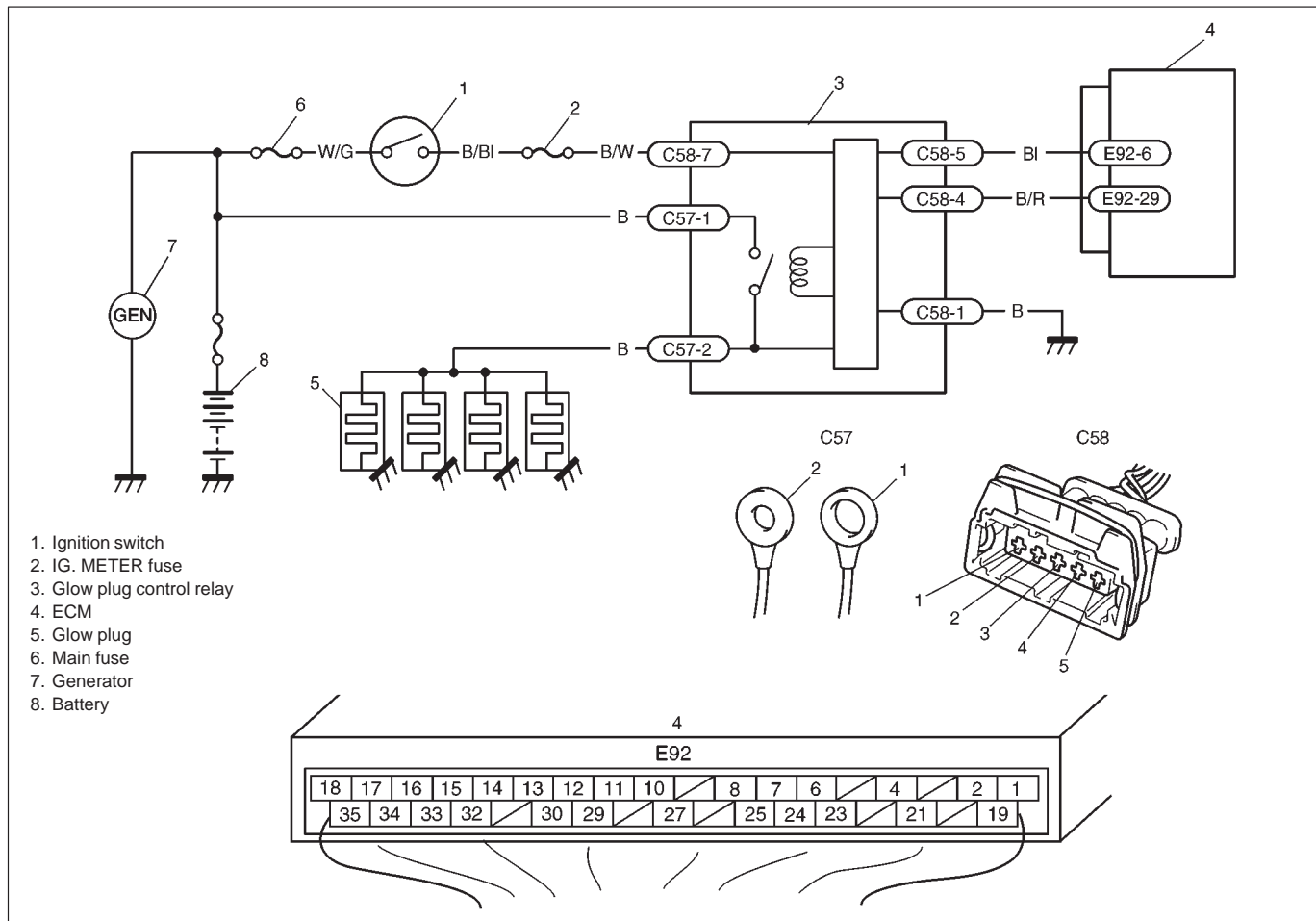
- 1) Clear "DTC".
- 2) Start engine and run it at 3000 r/min.
- 3) Select "DTC" mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check battery voltage. Is it over 12 V?	Go to Step 3.	Battery poor charge or malfunction.
3	Check ECM power circuit. Go to TABLE A-2 ECM POWER AND GROUND CIRCUIT CHECK. Is check results OK?	Go to Step 4.	ECM power circuit malfunction.
4	Check generator voltage as follows. 1) Run engine at 3000 rpm. 2) Measure battery voltage. Is it 12 to 16 V?	Substitute a known-good ECM and recheck.	Generator malfunction.

DTC No.22 GLOW PLUG RELAY CONTROL MALFUNCTION (FEEDBACK LOW VOLTAGE)
DTC No.23 GLOW PLUG RELAY CONTROL CIRCUIT MALFUNCTION
DTC No.32 GLOW PLUG RELAY CONTROL MALFUNCTION (FEEDBACK HIGH VOLTAGE)

CIRCUIT DESCRIPTION



ITEM	DTC DETECTING CONDITION	POSSIBLE CAUSE
DTC No.22	Glow plug relay control malfunction. (Glow plug relay feedback voltage is low when E92-29 terminal on ECM output voltage is low.)	<ul style="list-style-type: none"> ○“BI” circuit short to ground. ○Glow plug relay malfunction. ○Glow plug relay C57-1, C58-3 terminal circuit open or short to ground. ○Glow plug relay C57-2 terminal circuit short to ground.
DTC No.23	Glow plug relay control circuit open or short	<ul style="list-style-type: none"> ○“B/R” circuit open or short to ground.
DTC No.32	Glow plug relay control malfunction. (Glow plug relay feedback voltage is high when E92-29 terminal on ECM output voltage is high.)	<ul style="list-style-type: none"> ○“BI” circuit short to power supply. ○Glow plug relay malfunction. ○Glow plug relay C57-2 terminal circuit short to power supply.

DTC CONFIRMATION PROCEDURE

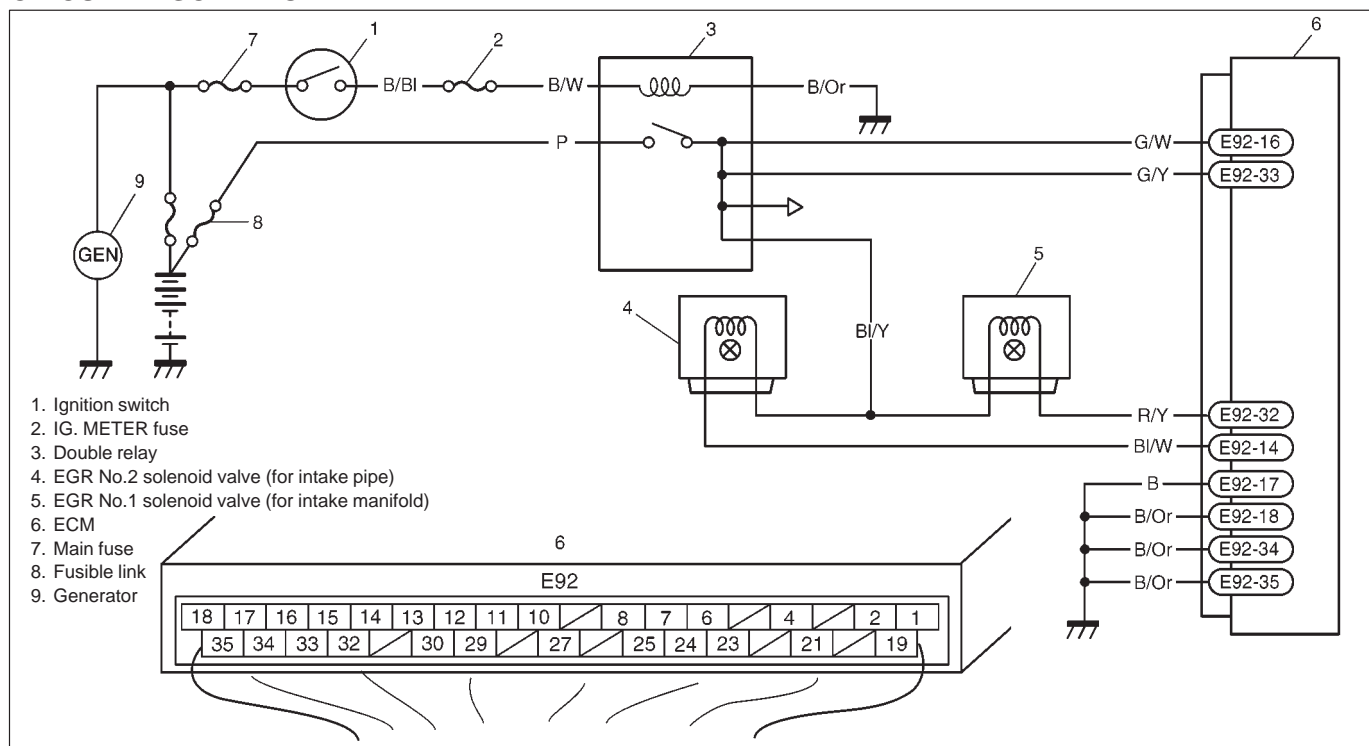
- 1) Clear DTC, start engine and keep it at idle for 1 min.
- 2) Select “DTC” mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check glow plug relay and connector for proper installation. Is glow plug relay installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check glow plug relay operation as follows. 1) Disconnect negative cable terminal at battery. 2) Disconnect coupler and terminals from glow plug relay and remove it. 3) Check glow plug relay. Refer to GLOW PLUG RELAY in Section 6E3. Is check results as specified?	Go to Step 4.	Glow plug relay malfunction.
4	Check glow plug relay power supply circuit as follows. 1) Insulate C57-1 and C57-2 terminals in glow plug harness. 2) Connect negative cable to battery terminal. 3) Turn ignition switch ON. 4) Measure voltage between C57-1 terminal in glow plug harness terminal and ground, C57-2 terminal in glow plug harness terminal and ground. Is voltage at each terminal over 10 V?	Go to Step 5.	C57-1 and C57-2 circuits open or shorted to ground.
5	Check glow plug relay circuit continuity as follows. 1) Turn ignition switch OFF. 2) Check continuity between C58-1 terminal in glow plug relay coupler and body ground. Is it continuity?	Go to Step 6.	C58-1 circuit open.
6	Check glow plug relay circuit insulation as follows. 1) Disconnect coupler from ECM. 2) Check continuity between C57-2 terminal in glow plug harness and body ground. Is it continuity?	Go to Step 7.	C57-2 circuit open or glow plug malfunction.
7	Check terminal E92-29 circuit voltage as follows. 1) Connect coupler and terminal to glow plug relay. 2) Disconnect coupler from ECM. 3) Turn ignition switch ON. 4) Measure voltage between E92-29 terminal in ECM coupler and body ground. Is voltage over 10 V?	Go to Step 8.	E92-29 circuit open or shorted to ground.
8	Check terminal E92-29 circuit voltage as follows. 1) Disconnect coupler from glow plug relay. 2) Measure voltage between E92-29 terminal in ECM coupler and body ground with ignition switch ON. Is it 0 V?	Go to Step 9.	E92-29 circuit shorted to power supply.
9	Check terminal E92-6 circuit voltage as follows. 1) Connect shorting harness between E92-29 terminal in ECM coupler and body ground. 2) Measure voltage between E92-6 terminal in ECM coupler and body ground with ignition switch ON. Is it over 6 V?	Go to Step 10.	E92-6 circuit open or shorted to ground.
10	1) Disconnect shorting harness in Step 7. 2) Measure voltage E92-6 terminal in ECM coupler and body ground with ignition switch ON. Is it over 0 V?	Substitute a known-good ECM and recheck.	E92-6 circuit shorted to power supply.

DTC NO.33 EGR NO.1 CONTROL VALVE CIRCUIT MALFUNCTION
DTC NO.36 EGR NO.2 CONTROL VALVE CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
EGR No.1 or No.2 solenoid valve circuit is opened or shorted.	<ul style="list-style-type: none"> ○“R/Y”, “BI/W” circuit open or short ○“BI/Y” circuit open or short ○EGR solenoid valve malfunction

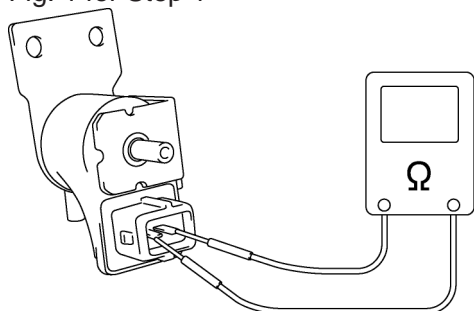
DTC CONFIRMATION PROCEDURE

- 1) Clear DTC with ignition switch ON.
- 2) Select "DTC" mode on scan tool and check DTC.

INSPECTION

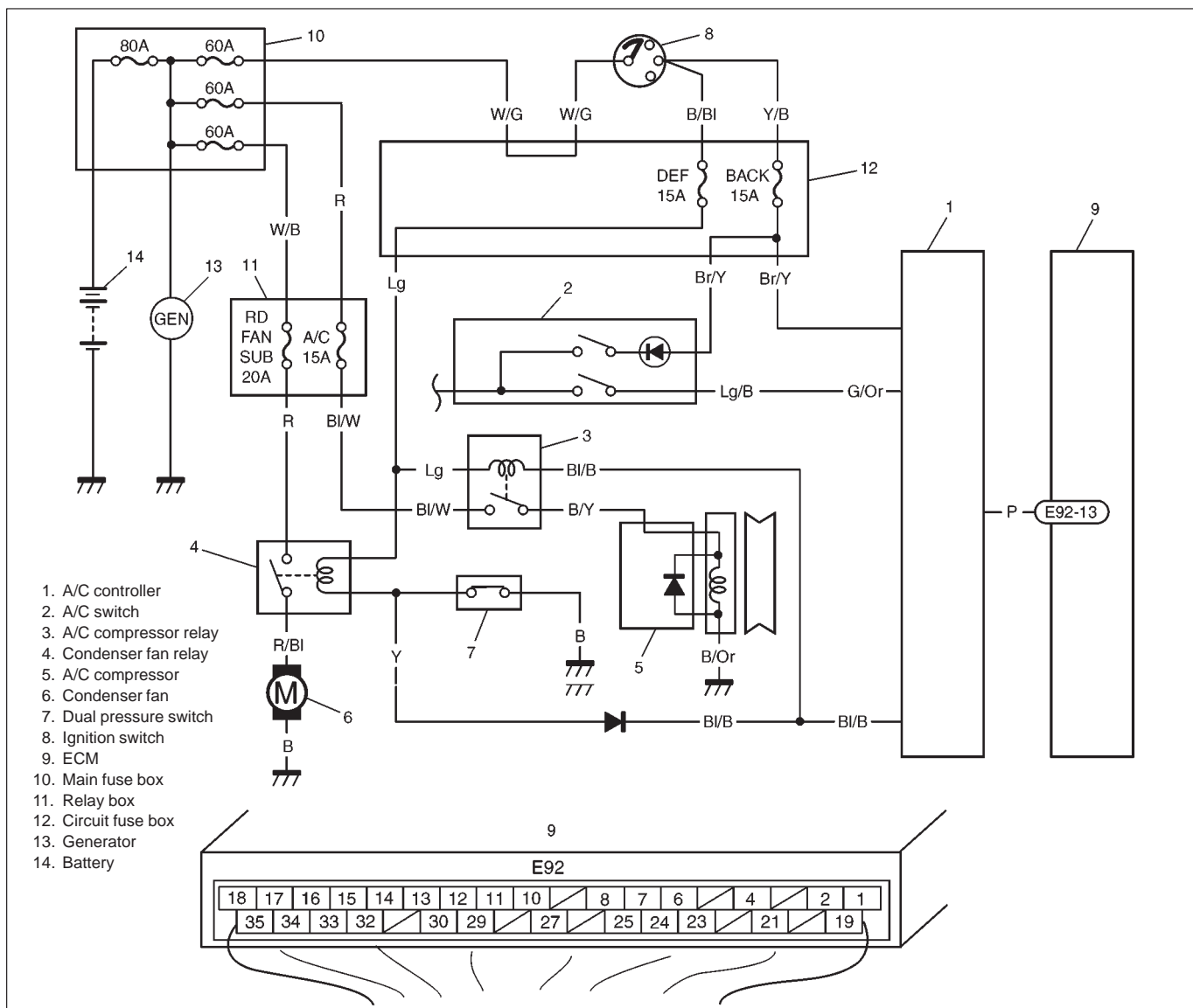
STEP	ACTION	YES	NO
1	<p>Check EGR No.1, No.2 solenoid valve for resistance.</p> <p>1) With ignition switch OFF, disconnect coupler from canister purge valve.</p> <p>2) Check resistance of EGR No.1, No.2 solenoid valve.</p> <p>Resistance between two terminals. See Fig.1. : 23 – 40 I at 20°C (68°F)</p> <p>Resistance between terminal and body : 1M I or higher</p> <p>Is it as specified?</p>	“R/Y”, “BI/Y” circuit open or short.	Replace EGR No.1 or No.2 solenoid valve.

Fig. 1 for Step 1



DTC NO.37 A/C CUT OFF CONTROL CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
<input type="radio"/> Low voltage at terminal E92-13 when ECM doesn't output A/C ON signal to A/C amplifier or when engine coolant temp. is not 110°C (230°F) or more.	<input type="radio"/> "P" circuit open or short <input type="radio"/> Each engine emission control sensor faulty <input type="radio"/> ECM malfunction

DTC CONFIRMATION PROCEDURE

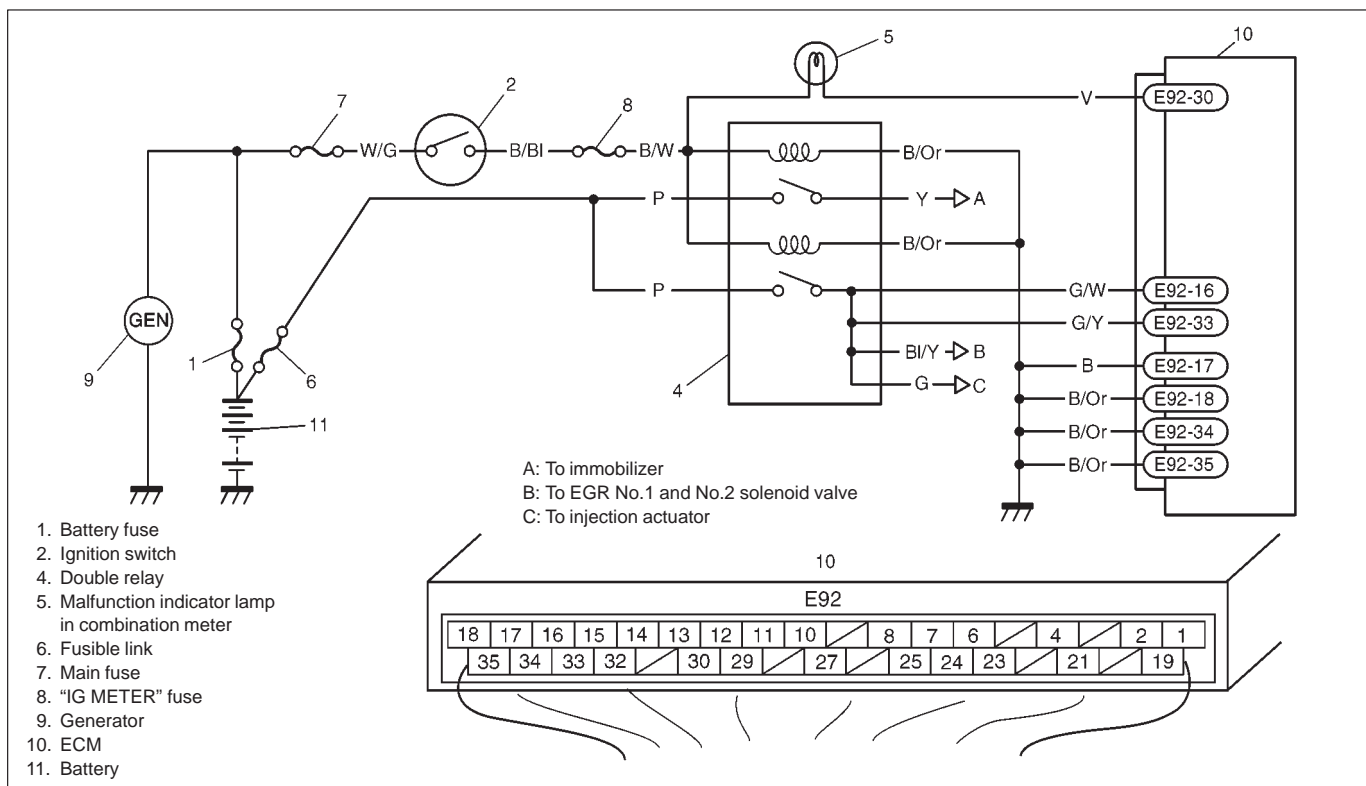
- 1) Clear DTC with ignition switch ON.
- 2) Select "DTC" mode on scan tool and check DTC.

DTC NO.37**INSPECTION**

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check A/C Cut Signal Circuit. 1) Check voltage at terminal E92-13 A/C cut signal specification: While engine running: 0 – 1.5 V Ignition switch turn ON or while cranking engine: 10 – 14 V Are check results as specified?	Substitute a known-good ECM and recheck.	"P" circuit open or short.

DTC NO.38 MALFUNCTION INDICATOR LAMP (MIL) CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
○ MIL open circuit.	○ E92-30 circuit opened.
○ MIL short circuit.	○ E92-30 shorted to ground or power supply.

DTC CONFIRMATION PROCEDURE

- 1) Clear DTC.
- 2) Start engine and run it at idle speed.
- 3) Select "DTC" mode on scan tool and check DTC.

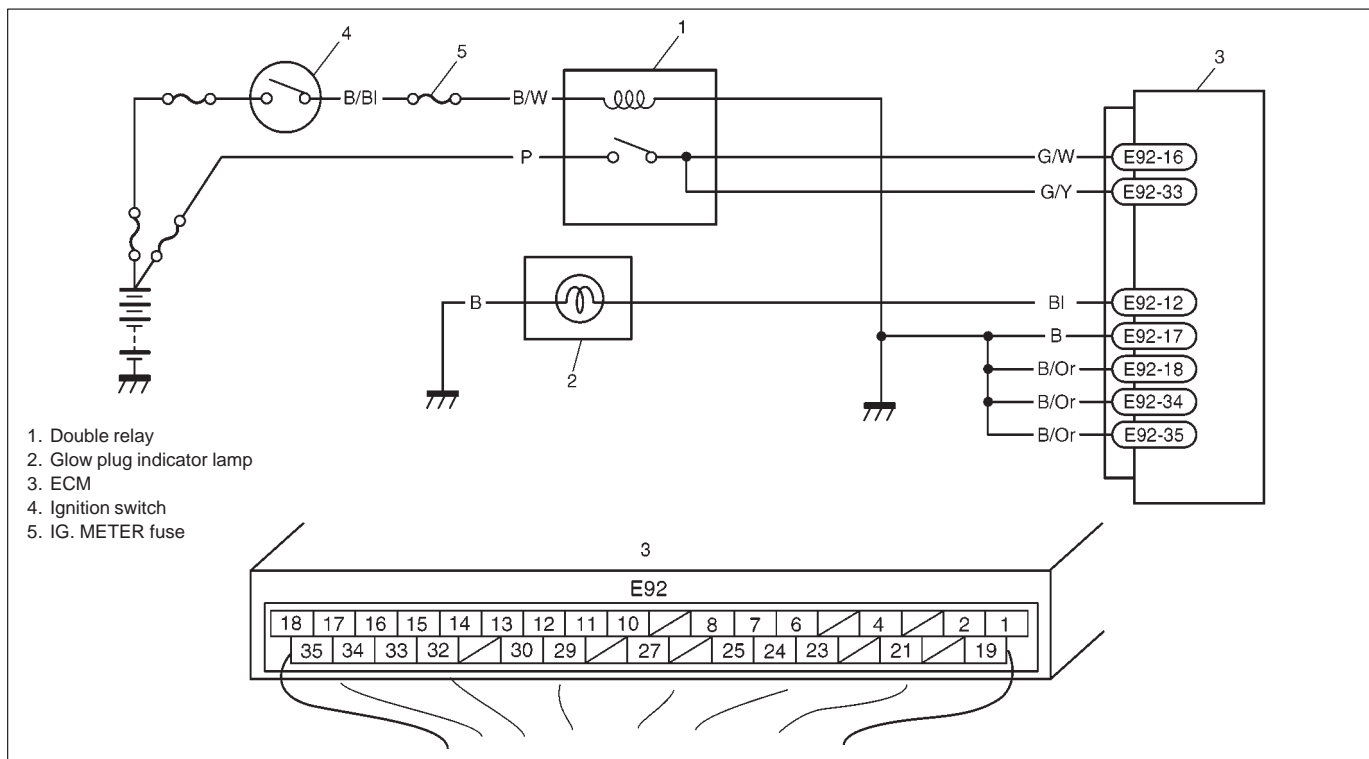
INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check ECM and connector for proper installation. Is ECM installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check terminal E92-30 voltage as follows. 1) Turn ignition switch OFF, disconnect coupler from ECM. 2) Measure voltage between E92-30 terminal in ECM coupler and body ground with ignition switch ON. Is it 12 to 16 V?	Go to Step 6.	Go to Step 4.

STEP	ACTION	YES	NO
4	MIL bulb check 1) Remove combination meter. 2) Remove MIL bulb, and then check that there is no burned out for bulb. Is it OK?	Go to Step 5.	Glow plug indicator lamp burned out.
5	Check MIL power supply as follows. 1) Measure voltage between "B/W" terminal in combination meter coupler and body ground with ignition switch ON. Is it 12 to 16 V?	E92-30 circuit opened or shorted to ground.	"B/W" circuit in combination meter circuit opened or shorted to ground.
6	Check terminal E92-30 voltage as follows. 1) Turn ignition switch OFF, disconnect coupler from combination meter. 2) Measure voltage between E92-30 terminal in ECM coupler and body ground with ignition switch ON. Is it 0 V?	Go to Step 7.	E92-30 circuit shorted to power supply line.
7	Check terminal E92-30 circuit as follows. 1) Check for continuity between E92-30 terminal in ECM coupler and body ground. Is continuity indicated?	E92-30 circuit shorted to ground.	Substitute a known-good ECM and recheck.

DTC No.39 GLOW PLUG INDICATOR LAMP CIRCUIT MALFUNCTION

CIRCUIT DESCRIPTION



DTC DETECTING CONDITION	POSSIBLE CAUSE
<input type="radio"/> Glow plug indicator lamp open circuit. <input type="radio"/> Glow plug indicator lamp short circuit.	<input type="radio"/> E92-12 circuit open. <input type="radio"/> E92-12 shorted to ground or power supply.

DTC CONFIRMATION PROCEDURE

- 1) Clear DTC.
- 2) Start engine and run it at idle speed.
- 3) Select "DTC" mode on scan tool and check DTC.

INSPECTION

STEP	ACTION	YES	NO
1	Was "ENGINE DIAGNOSIS FLOW TABLE" performed?	Go to Step 2.	Go to "ENGINE DIAGNOSIS FLOW TABLE".
2	Check ECM and connector for proper installation. Is ECM installed properly and connector connected securely?	Go to Step 3.	Correct.
3	Check terminal E92-12 voltage as follows. 1) Turn ignition switch OFF, disconnect coupler from ECM. 2) Measure voltage between E92-12 terminal in ECM coupler and body ground with ignition switch ON. Is it 0 V?	Go to Step 4.	E92-12 circuit shorted to power supply.
4	Check glow plug indicator as follows. 1) Remove combination meter. 2) Remove glow plug indicator bulb, and then check that there is no burned out for bulb. Is it OK?	Go to Step 5.	Glow plug indicator lamp burned out.

STEP	ACTION	YES	NO
5	Check terminal E92-12 no-continuity as follows. 1) Check for no-continuity between E92-12 terminal in ECM coupler and body ground with disconnected bulb from ECM. Is no-continuity indicated?	Go to Step 6.	E92-12 circuit shorted to ground.
6	Check terminal E92-12 circuit as follows. 1) Install glow plug indicator bulb. 2) Check for continuity between E92-12 terminal in ECM coupler and body ground. Is continuity indicated?	Substitute a known-good ECM and recheck.	E92-12 circuit opened.

DTC NO.127 INTERNAL CONTROL MODULE MEMORY CHECK SUM ERROR

DTC DETECTING CONDITION	POSSIBLE CAUSE
Data write error (or check sum error) when written into ECM	ECM

DTC CONFIRMATION PROCEDURE

- 1) Turn ignition switch OFF.
- 2) Clear DTC with ignition switch ON and then turn ignition switch OFF.
- 3) Start engine and run it at idle if possible.
- 4) Check DTC in “DTC” mode.

INSPECTION

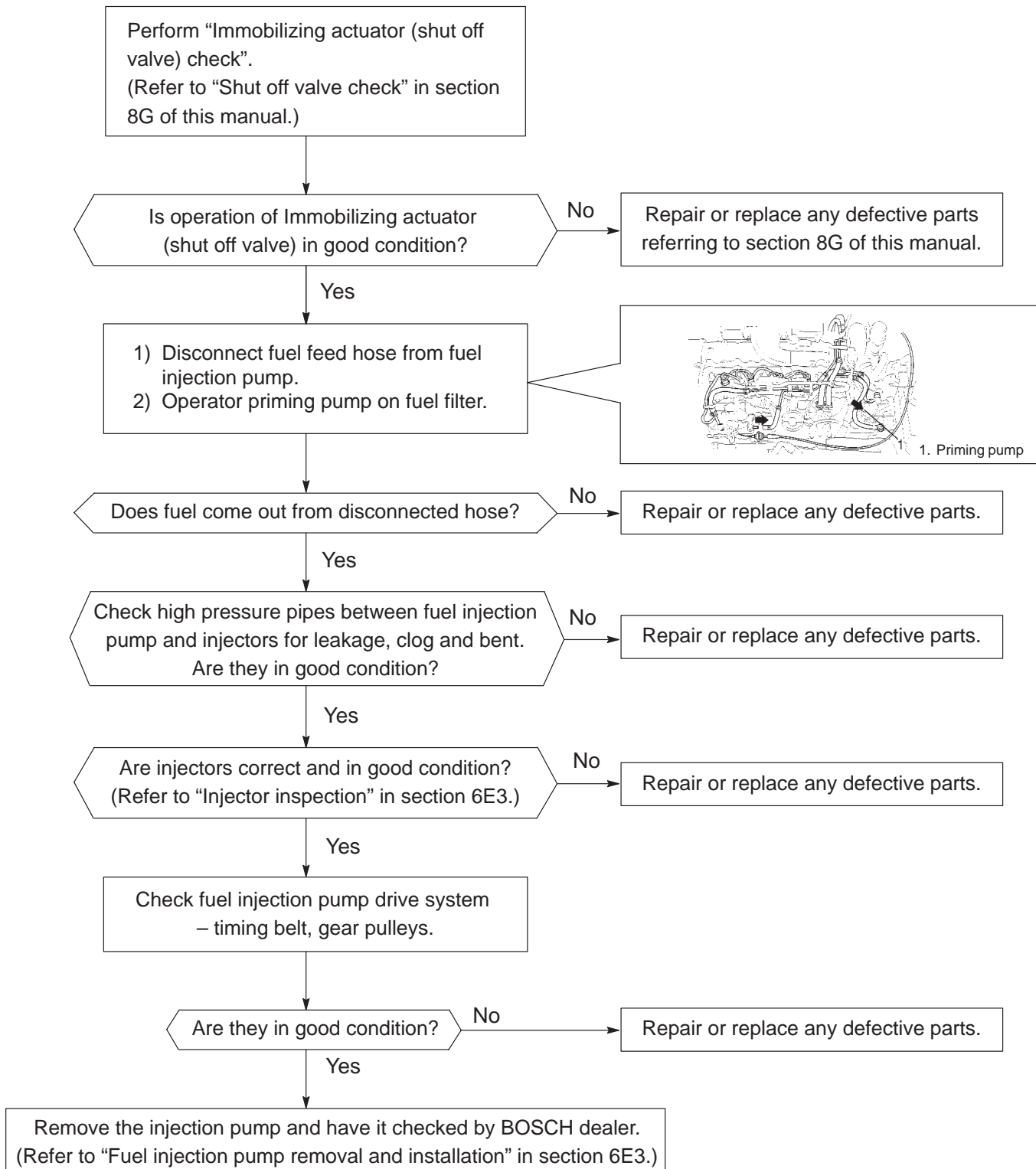
Substitute a known-good ECM and recheck.

DIAGNOSIS IN TERMS OF SYMPTOM

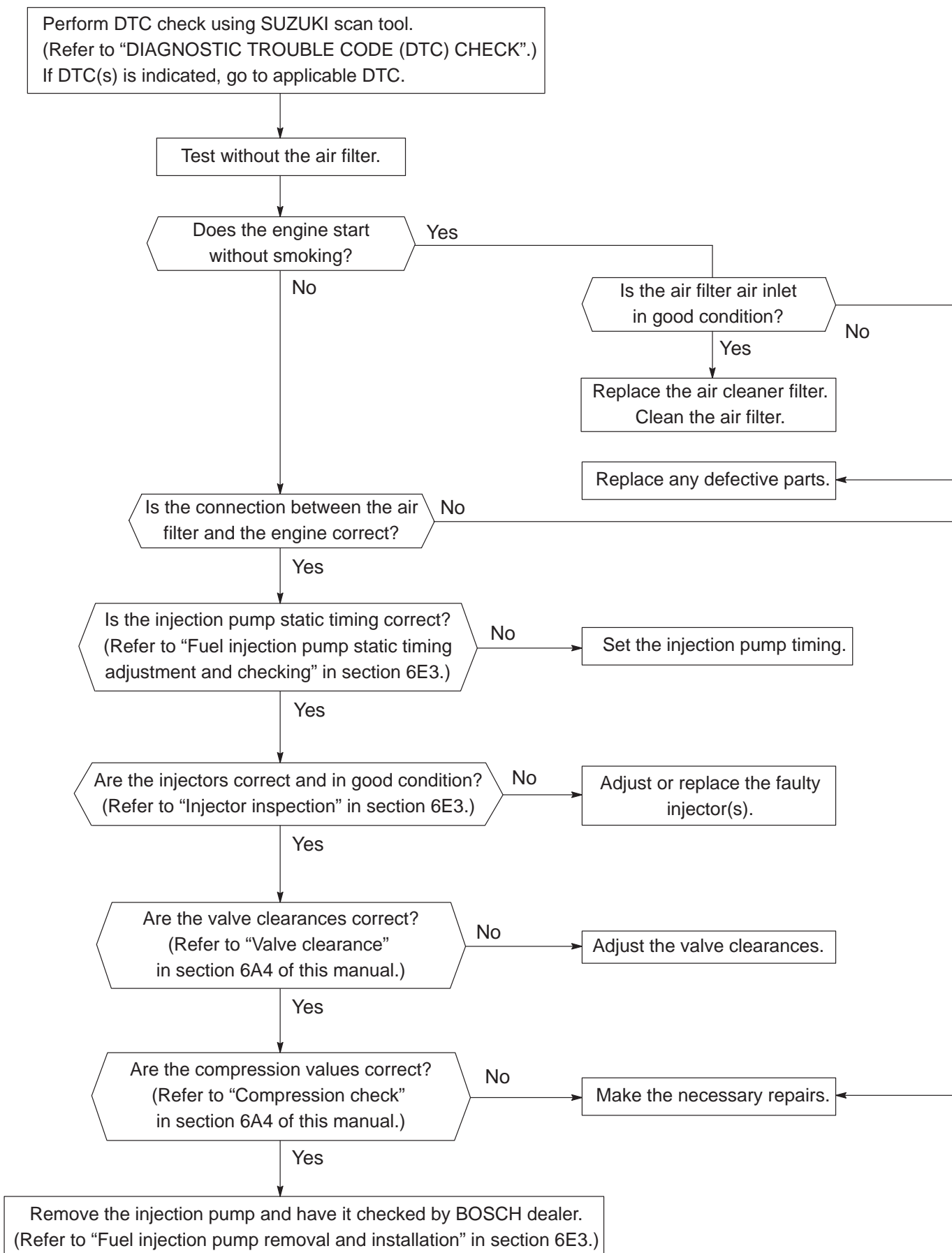
Retrieve Table

Item	Corresponding procedure
The engine will not start with no emission of smoke (engine warm and cold)	Procedure 1
The engine will not start with emission of black smoke (engine warm and cold)	Procedure 2
The engine will not start with emission of clear smoke (engine cold)	Procedure 3
The engine is difficult to start when cold (with emission of black smoke)	Procedure 4
The engine starts then stops	Procedure 5
Unstable idling	Procedure 6
Vibration at idle	Procedure 7
Unwanted acceleration	Procedure 8
The engine stalls/on overrun (slow return to idle)	Procedure 9
Engine miss-fire; irregular operation	Procedure 10
The engine starts with difficulty (engine hot)	Procedure 11
Vehicle lacks of power (with or without emission of smoke)	Procedure 12
Excessive diesel consumption	Procedure 13
Engine knocking	Procedure 14
Hesitation at steady speed	Procedure 15
Hesitation on re-acceleration	Procedure 16
With emission of black smoke (at idle) after starting	Procedure 17
Emission of blue smoke (at idle; on overrun; at low load)	Procedure 18
With emission of black smoke (at load)	Procedure 19
No re-acceleration/no liveliness (with or without emission of smoke)	Procedure 20
The vehicle moves off with difficulty (with or without emission of smoke)	Procedure 21

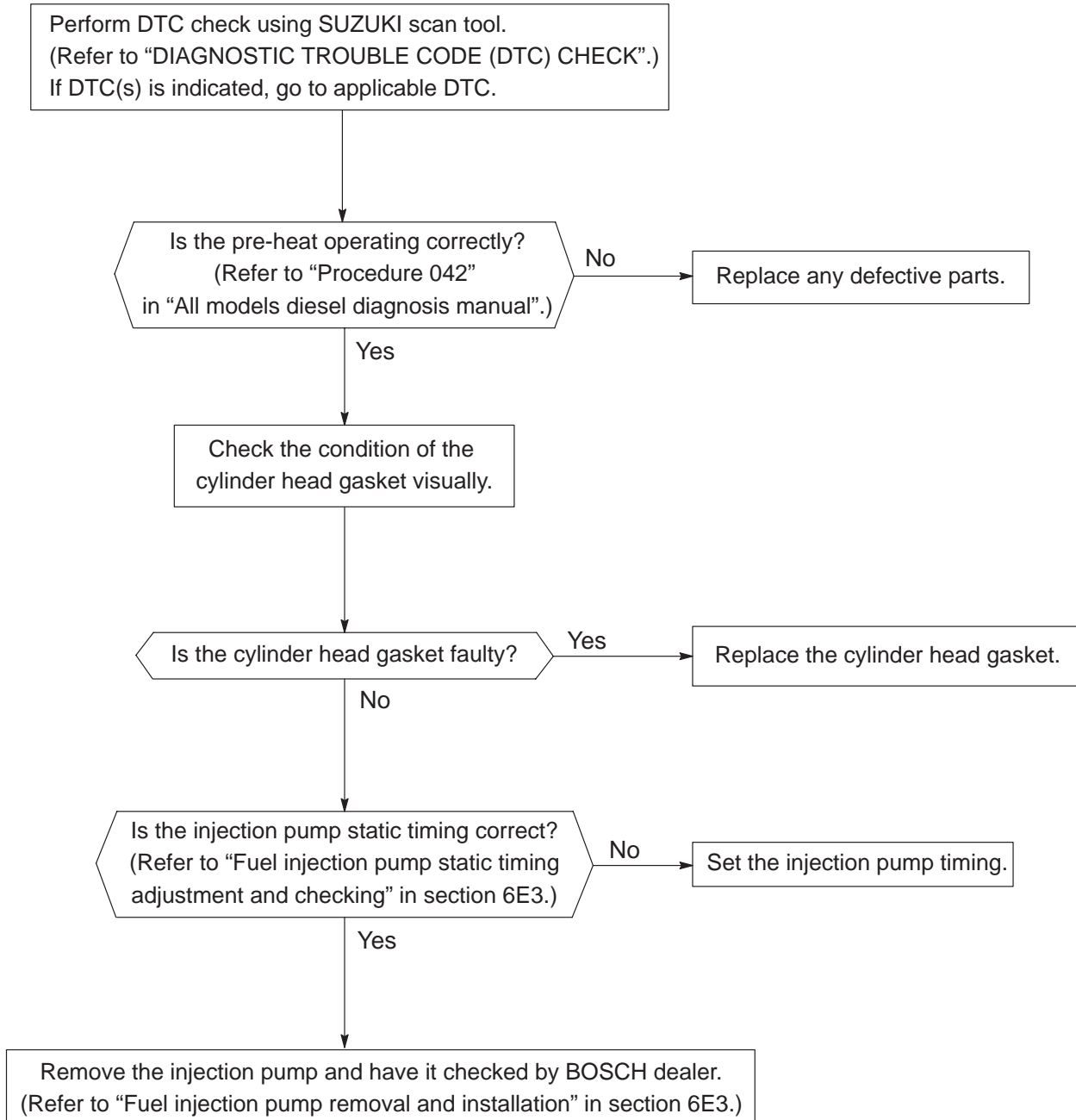
PROCEDURE 001

The engine will not start with no emission of smoke – engine warm and cold

PROCEDURE 002

The engine will not start with emission of black smoke – engine warm or cold.

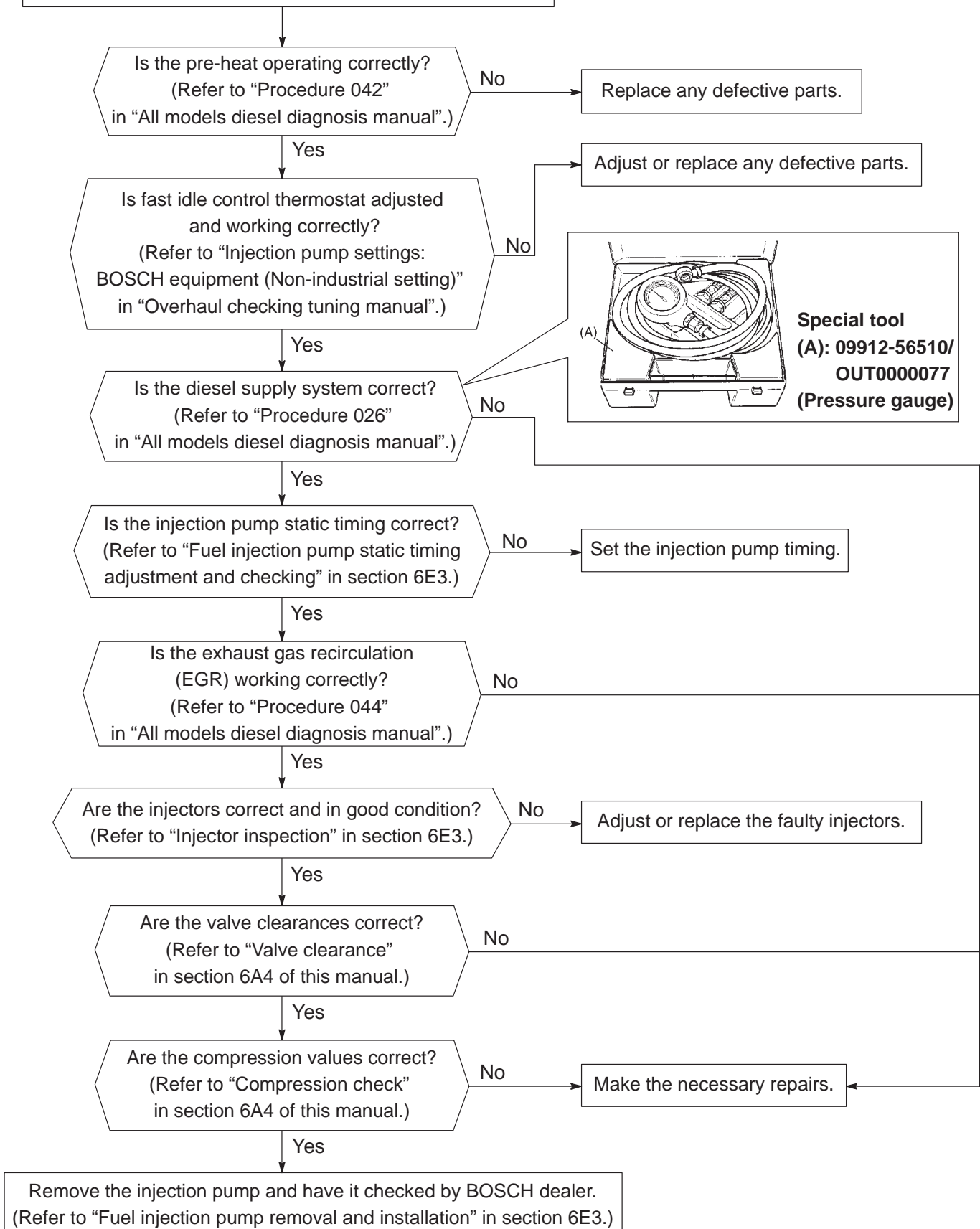
PROCEDURE 003

The engine will not start with emission of clear smoke – engine cold

PROCEDURE 004

The engine is difficult to start when cold – with emission of black smoke

Perform DTC check using SUZUKI scan tool.
(Refer to “DIAGNOSTIC TROUBLE CODE (DTC) CHECK”.)
If DTC(s) is indicated, go to applicable DTC.



PROCEDURE 005

The engine starts then stops

Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.

Accelerate slightly.
Start the engine.

Does the engine still
stop after starting?

No

Engine hot: adjust the idle speed
(Refer to "Idle speed inspection
and adjustment" in section 6E3.)
Engine cold: check the operation of the fast
idle system and adjust it.
(Refer to "Injection pump set-
tings: BOSCH equipment (Non-
industrial setting)" in "Overhaul
checking turning manual".)

Yes

Is the engine oil too thick when cold?

Yes

Change the engine oil.

No

Remove the fuel filler cap.

Does the engine still stop after starting?

No

Check the fuel tank breather.

Yes

Is the diesel supply system correct?

No

Make the necessary repairs.

Yes

Is the post-heat device working correctly?
(Refer to "Procedure 042"
in "All models diesel diagnosis manual".)

No

Check the post-heat device.

Yes

Test without the air filter.

Does the engine still stop after starting?

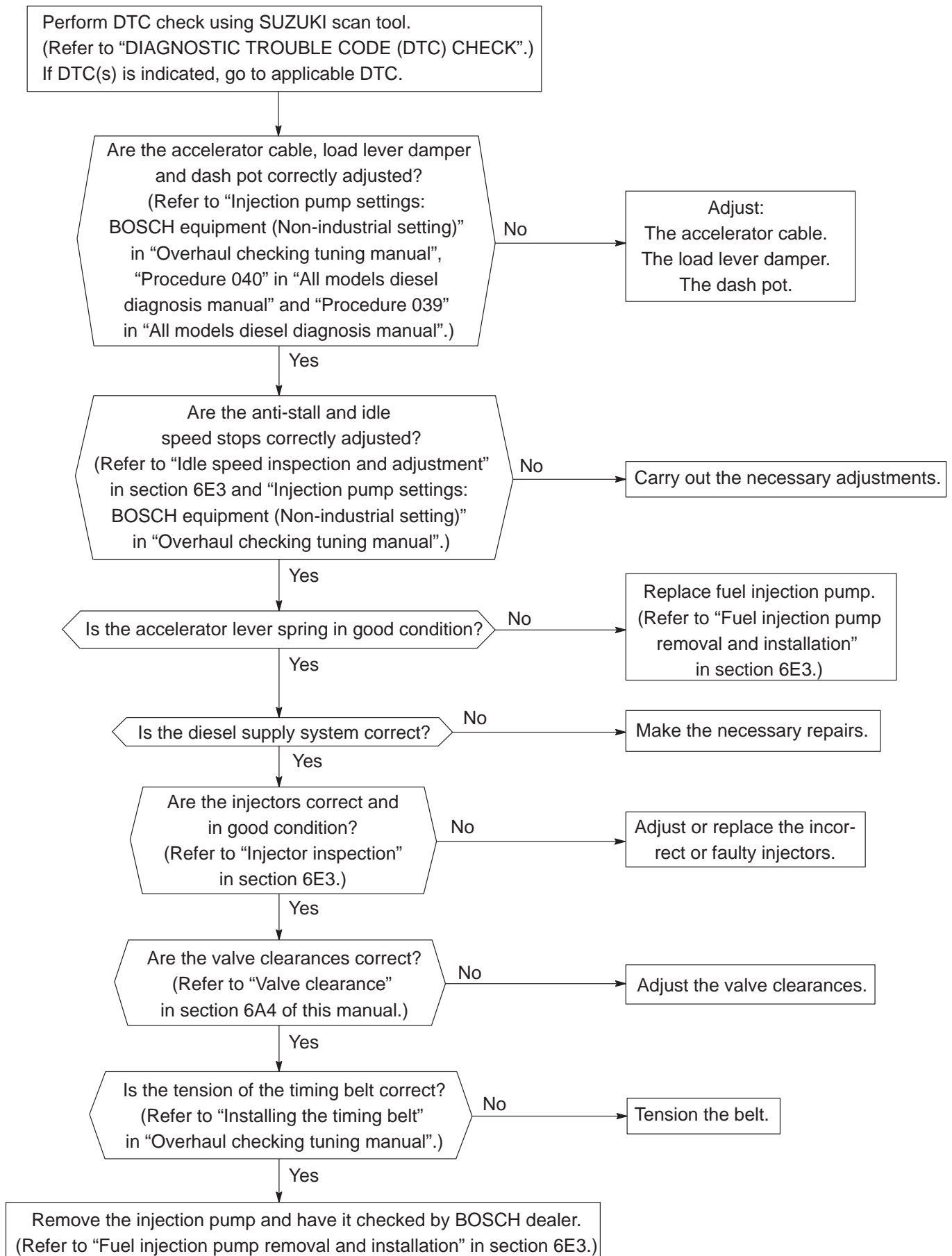
No

Clean the air filter or replace the filter.

Yes

Remove the injection pump and have it checked by BOSCH dealer.
(Refer to "Fuel injection pump removal and installation" in section 6E3.)

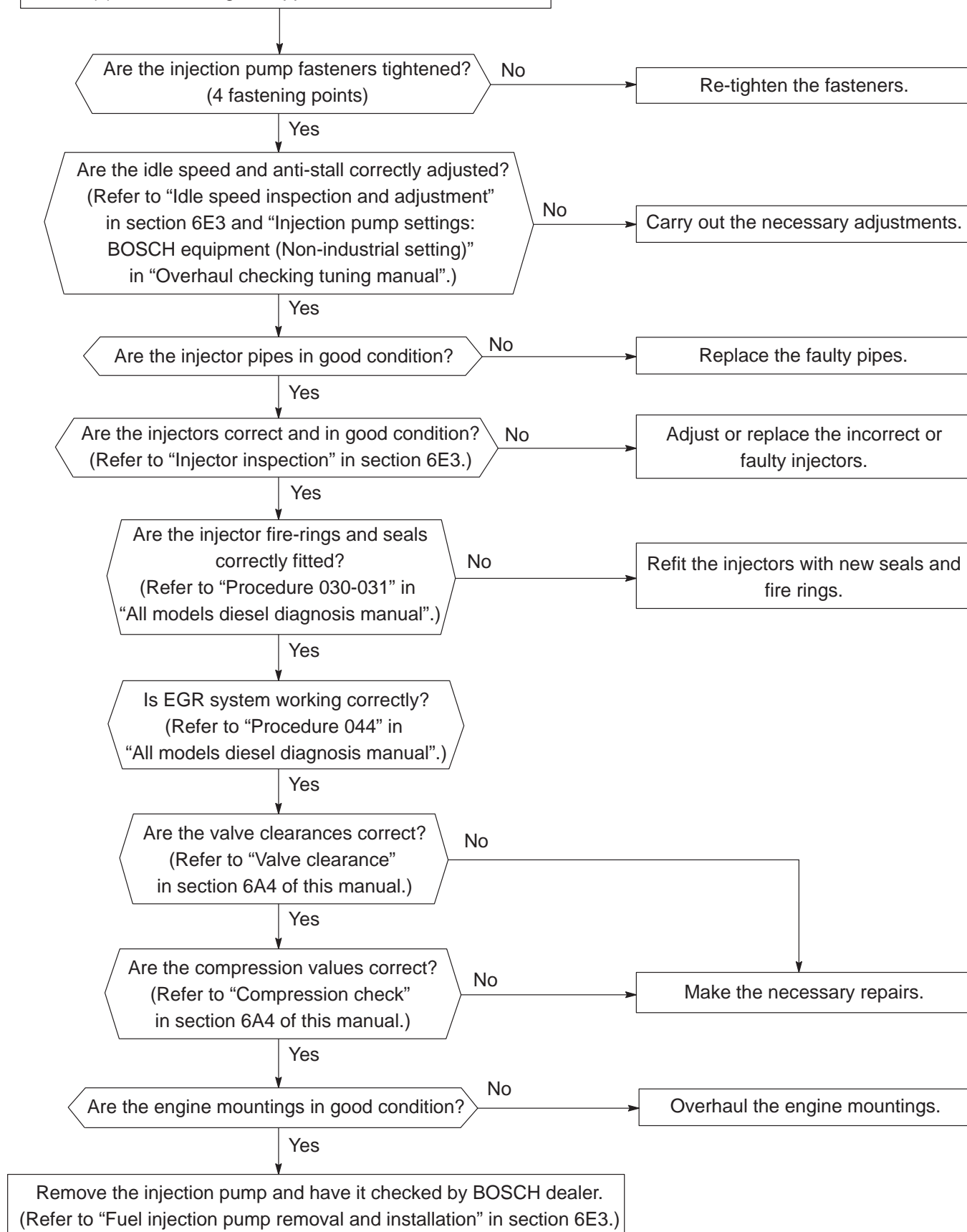
PROCEDURE 006

Unstable idling

PROCEDURE 007

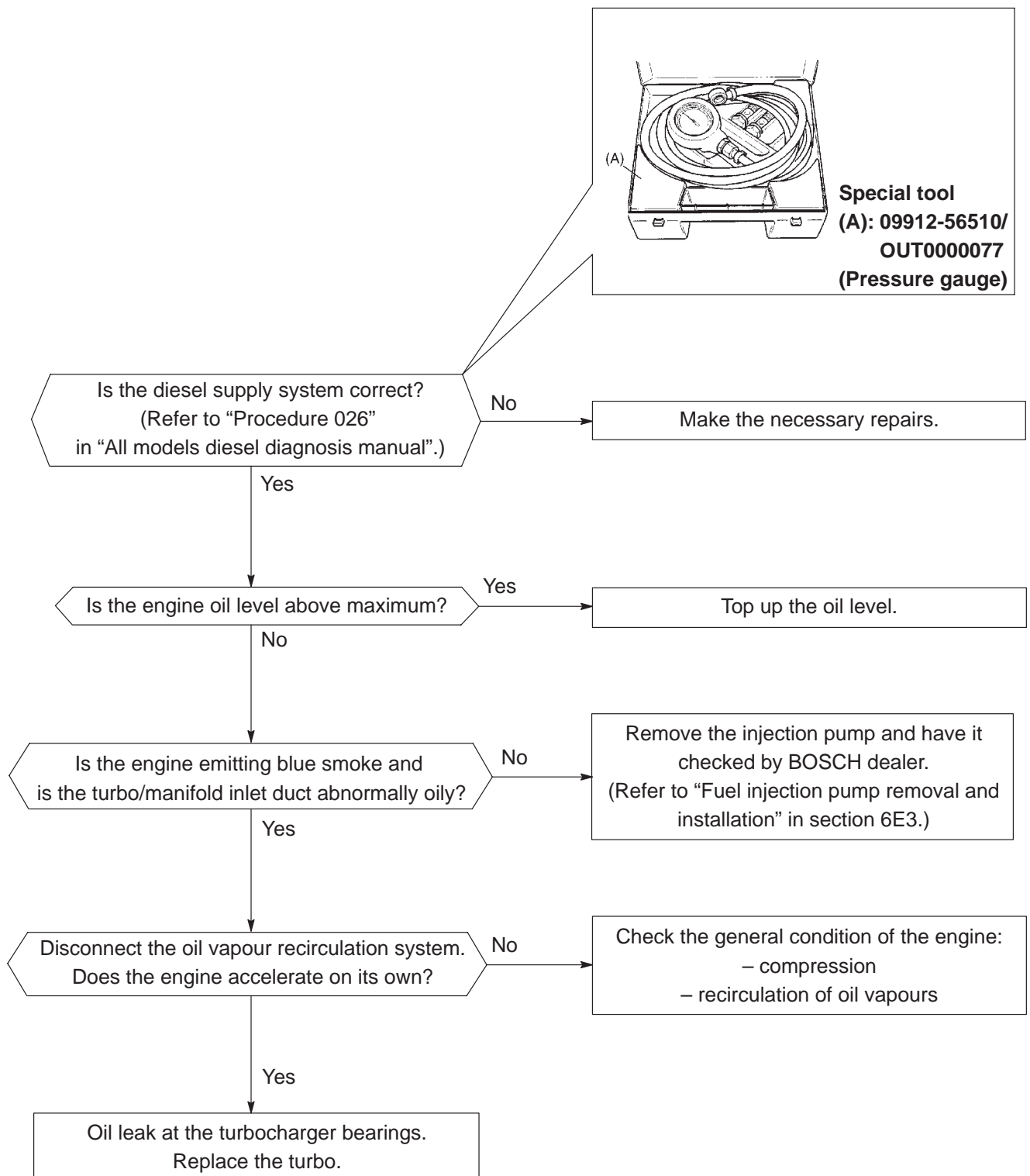
Vibration at idle

Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.

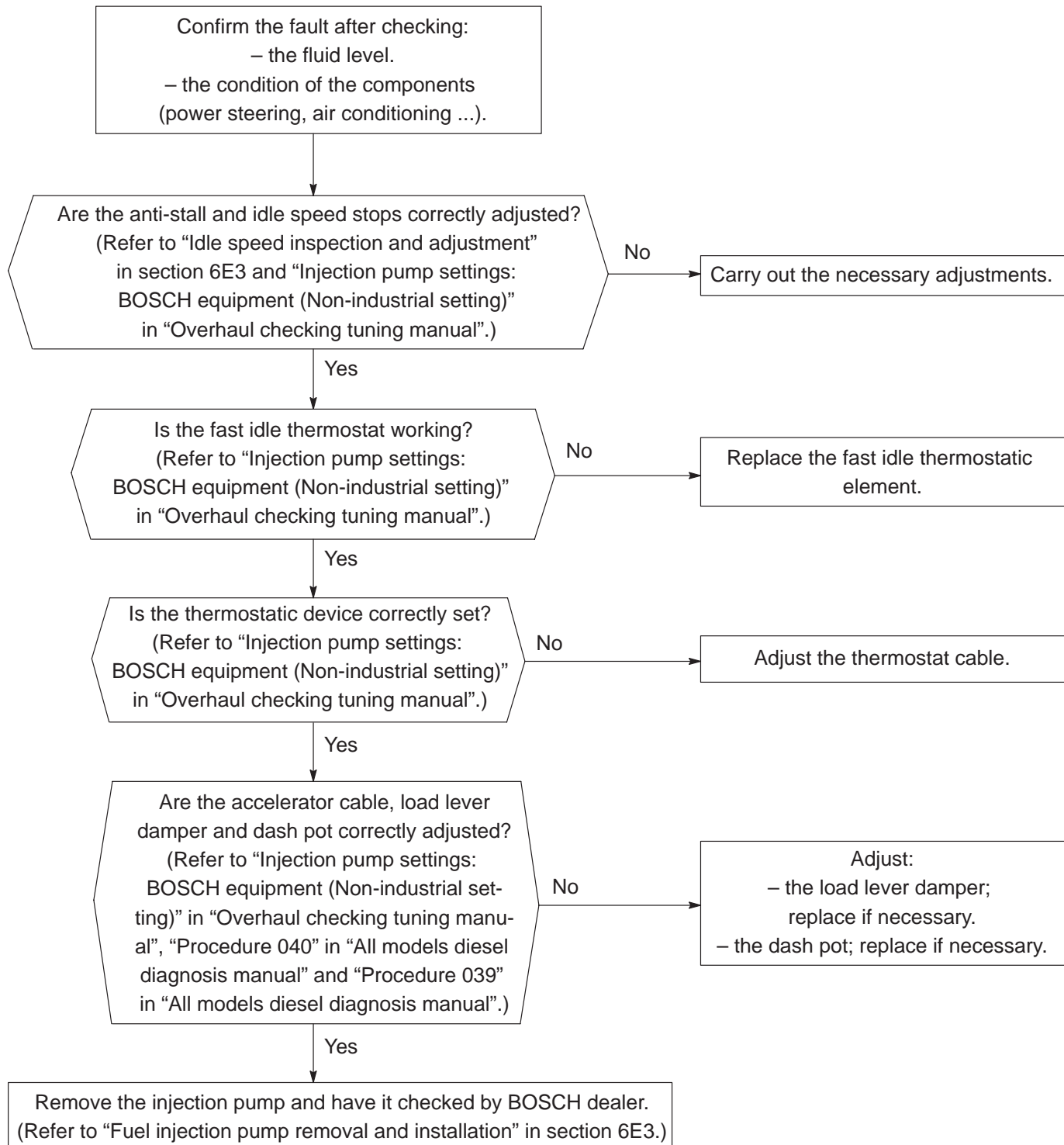


PROCEDURE 008

Unwanted acceleration



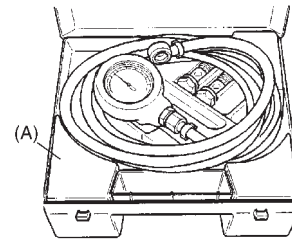
PROCEDURE 009

The engine stalls (on overrun) – slow return to idle

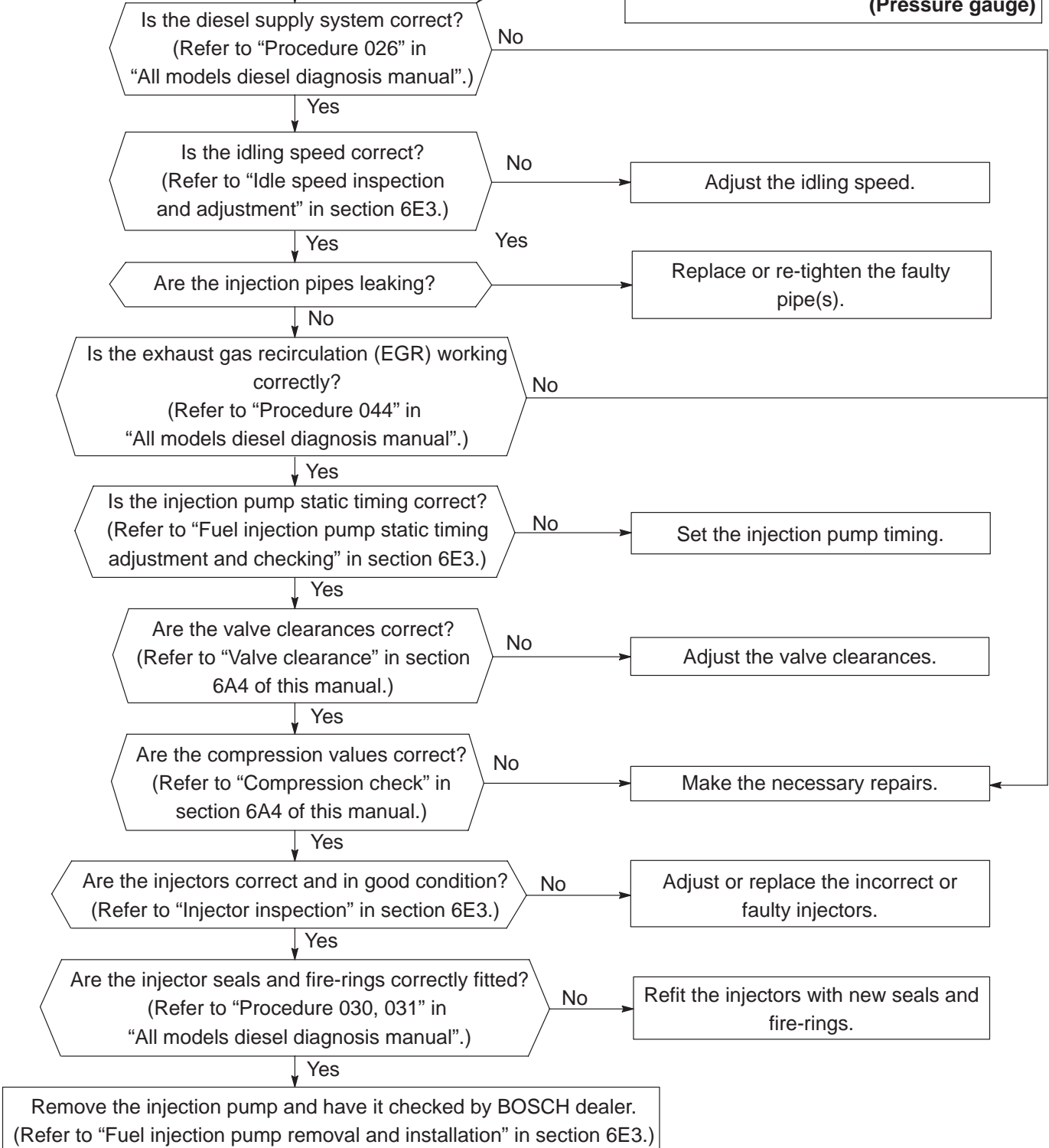
PROCEDURE 010

Engine mis-fires; irregular operation

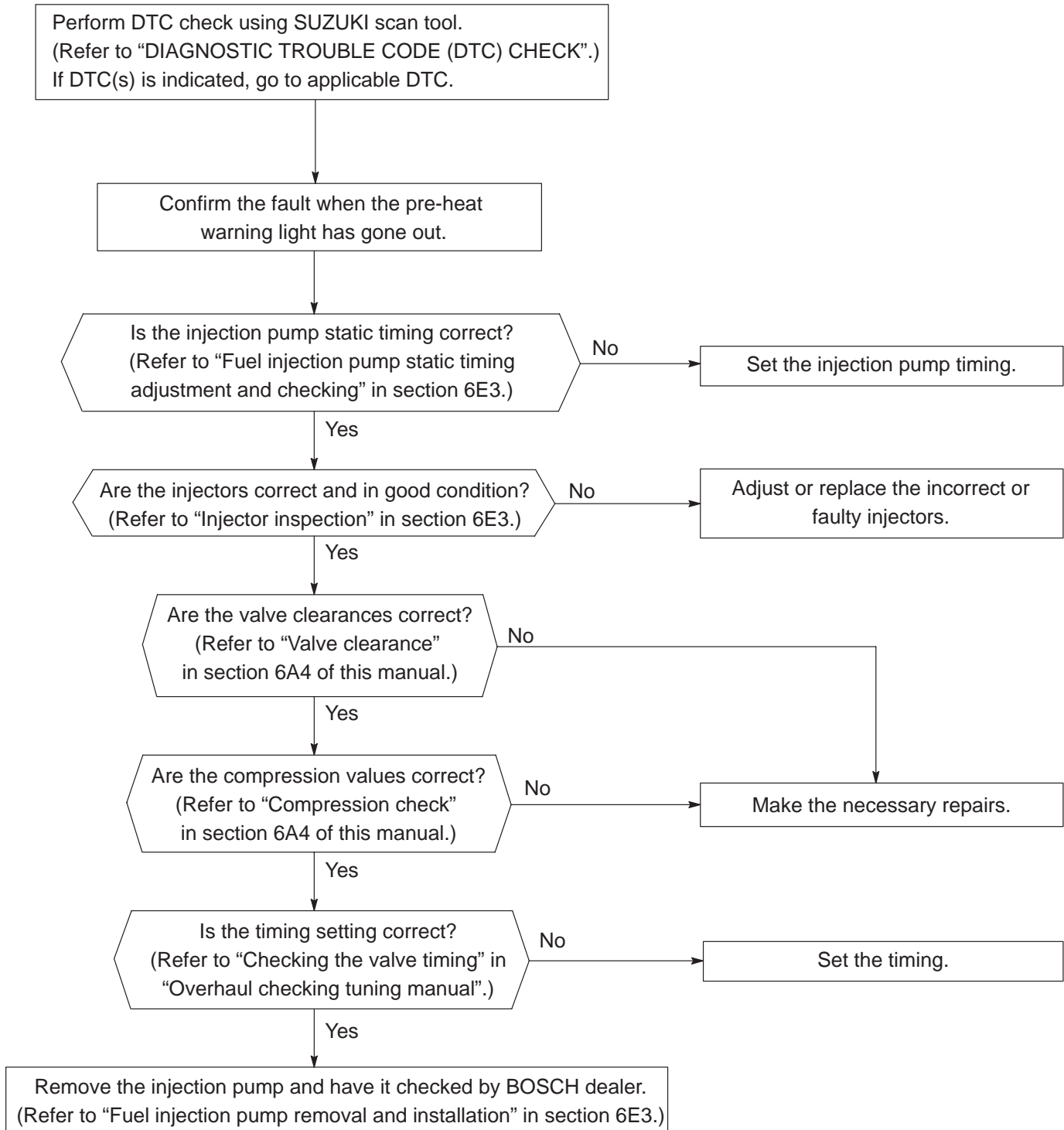
Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.



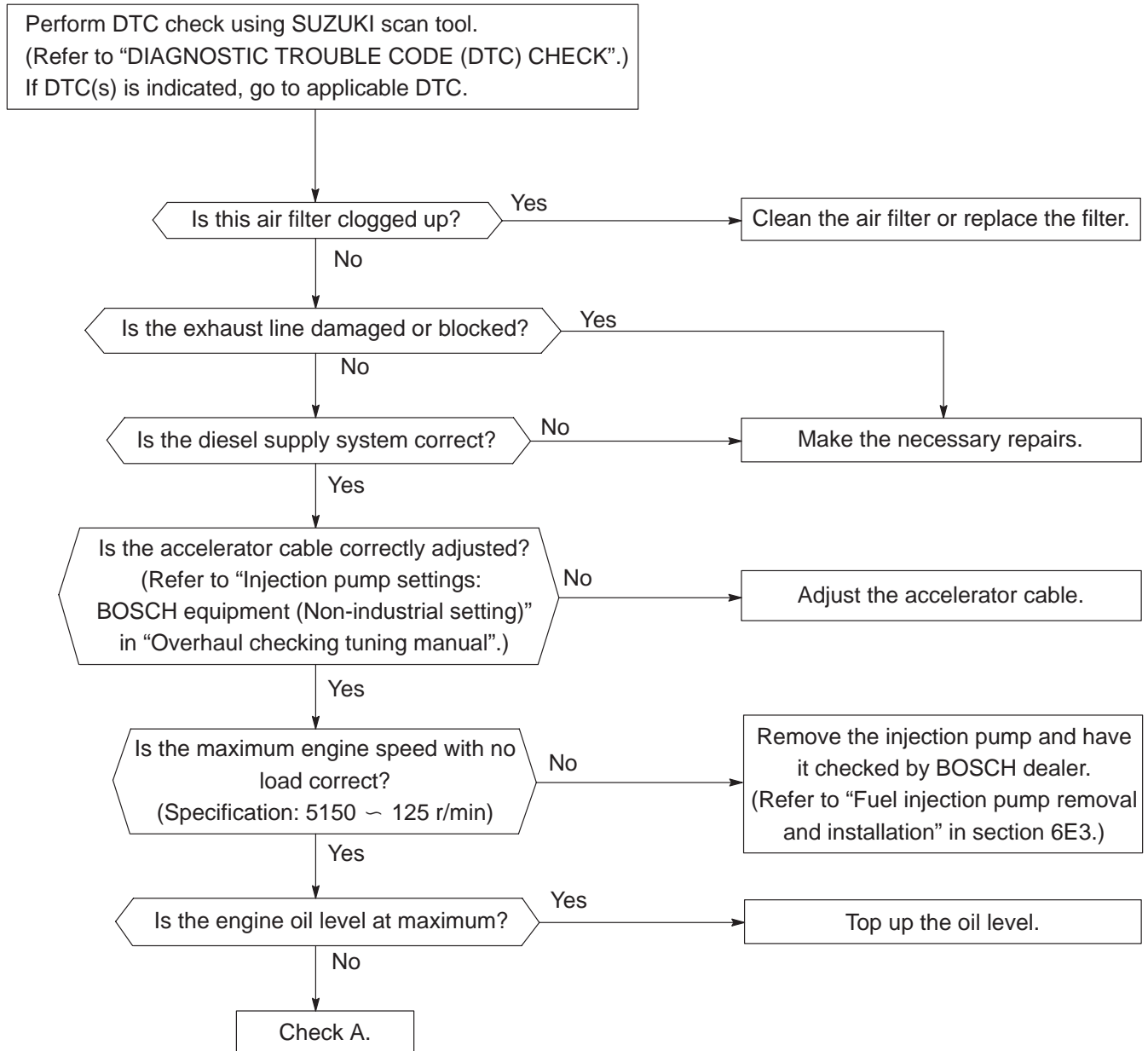
Special tool
(A): 09912-56510/
OUT0000077
(Pressure gauge)

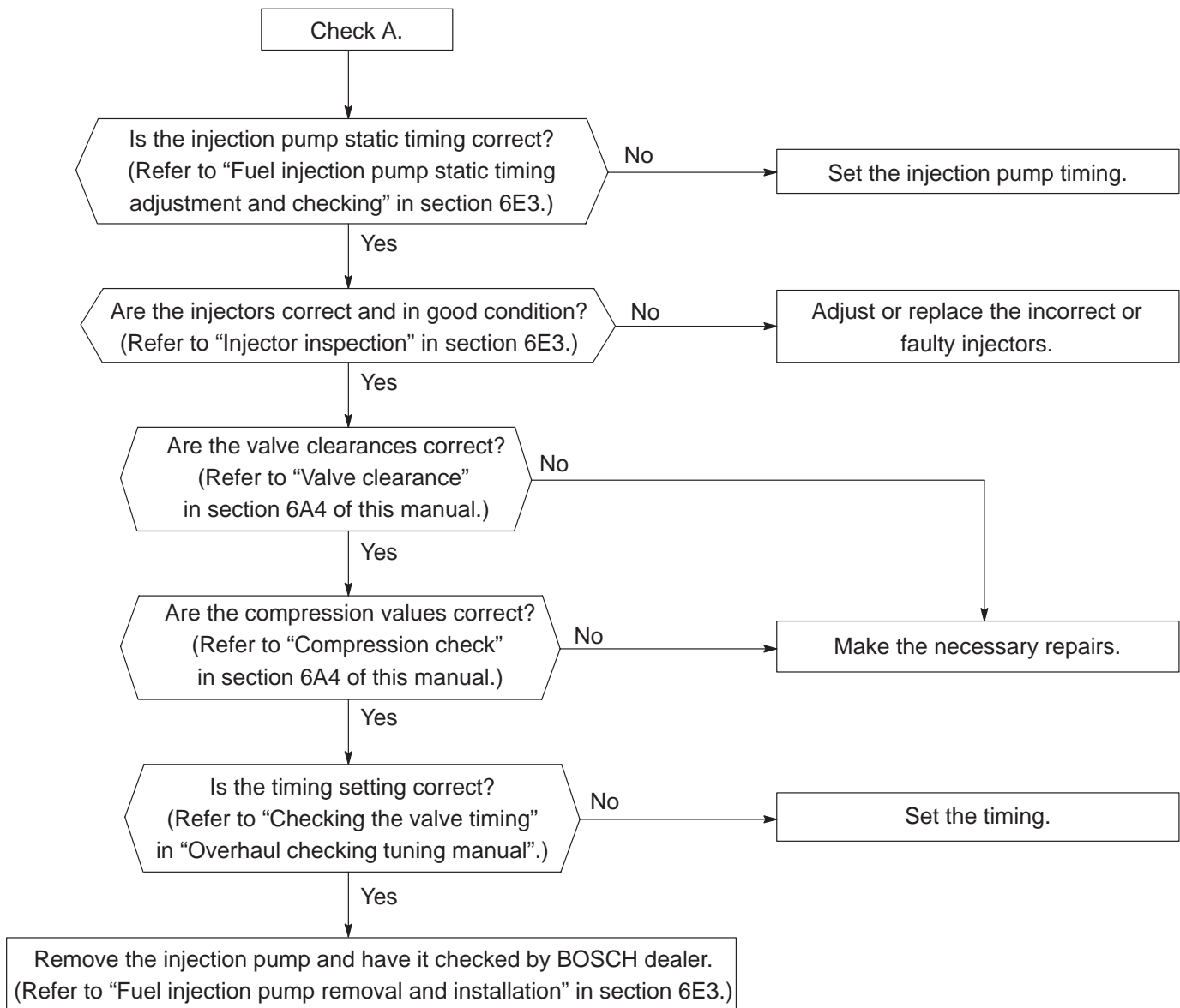


PROCEDURE 011

The engine starts with difficulty (engine hot)

PROCEDURE 012

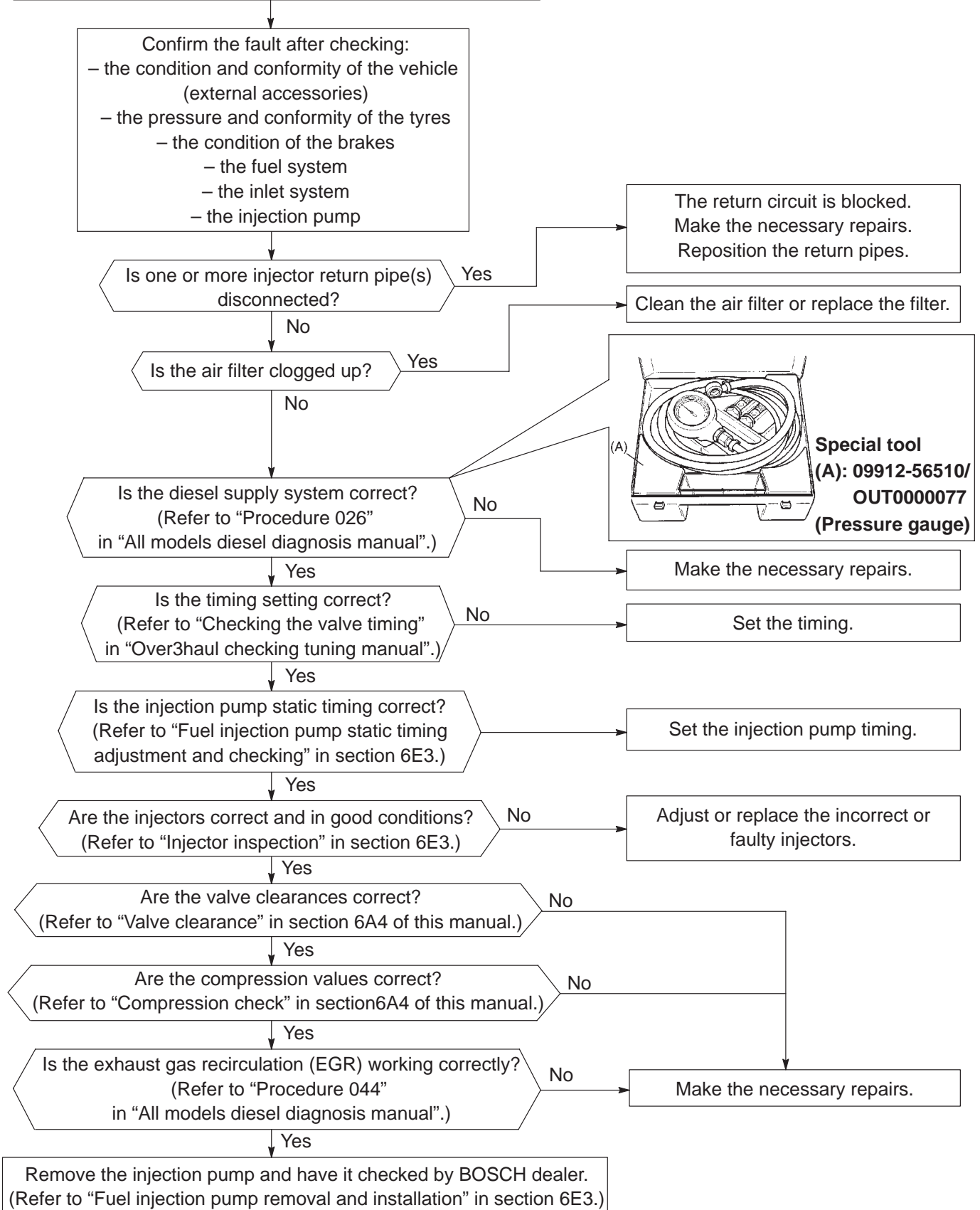
Vehicle lacks of power (with or without emission of smoke)



PROCEDURE 013

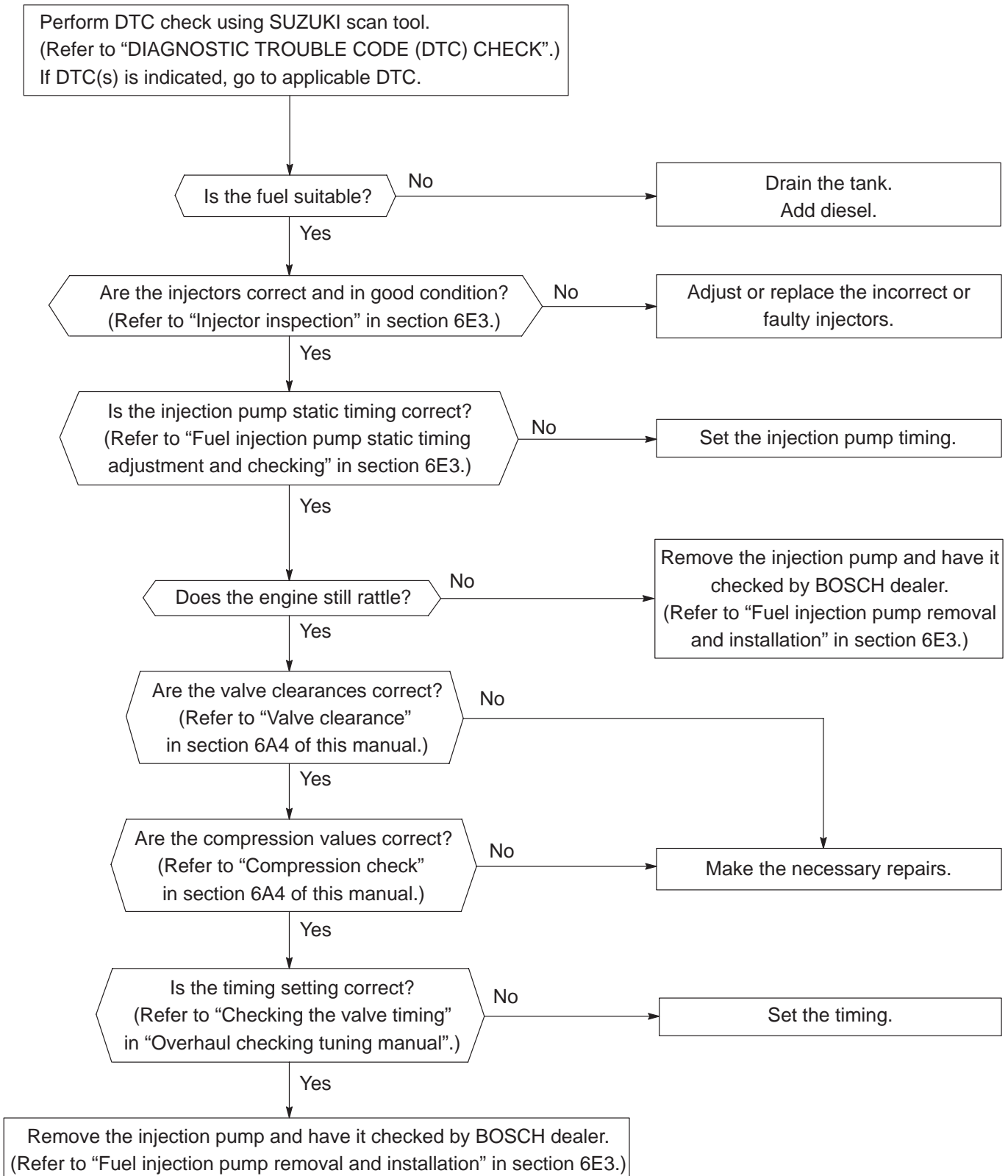
Excessive diesel consumption

Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.

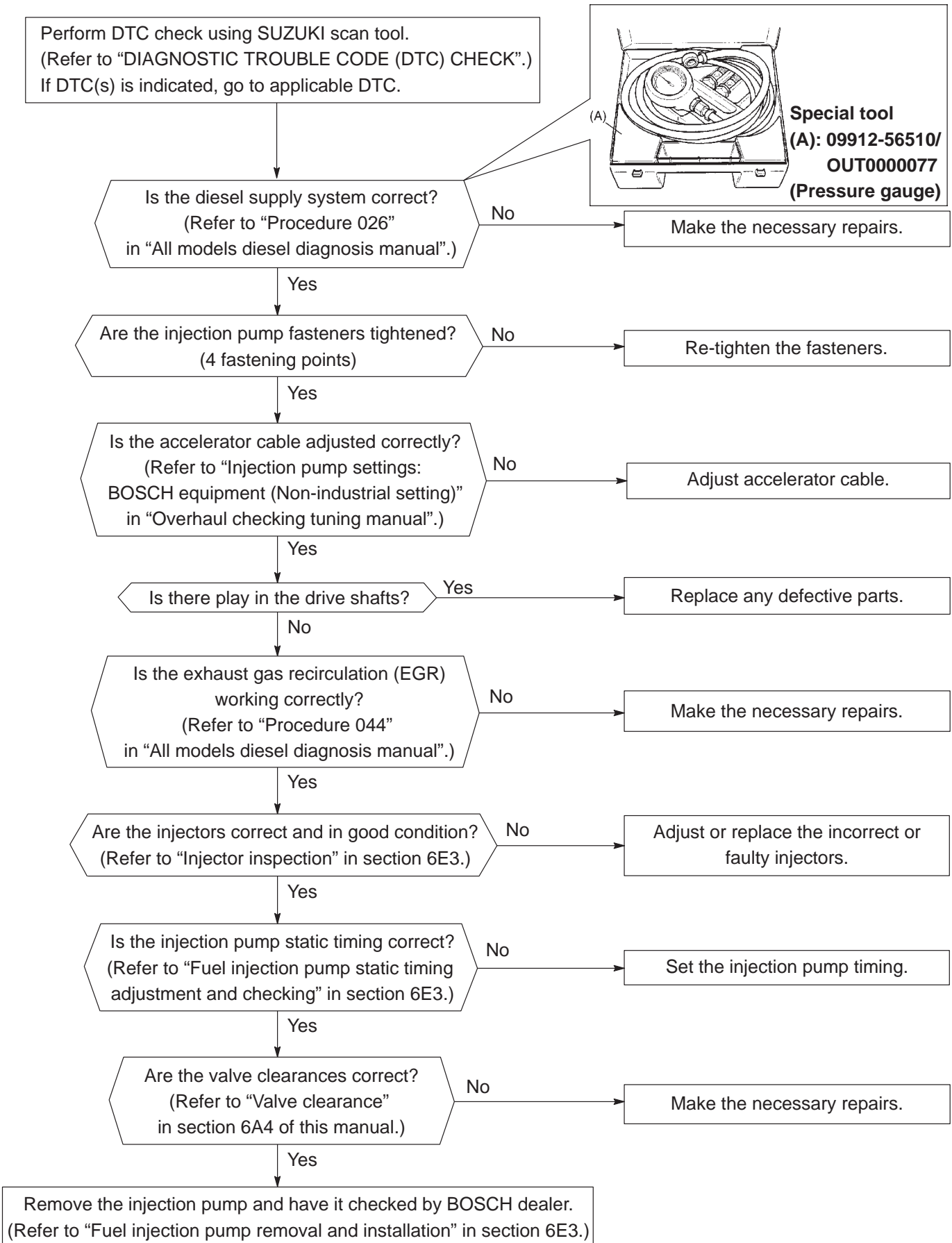


PROCEDURE 014

Engine knocking



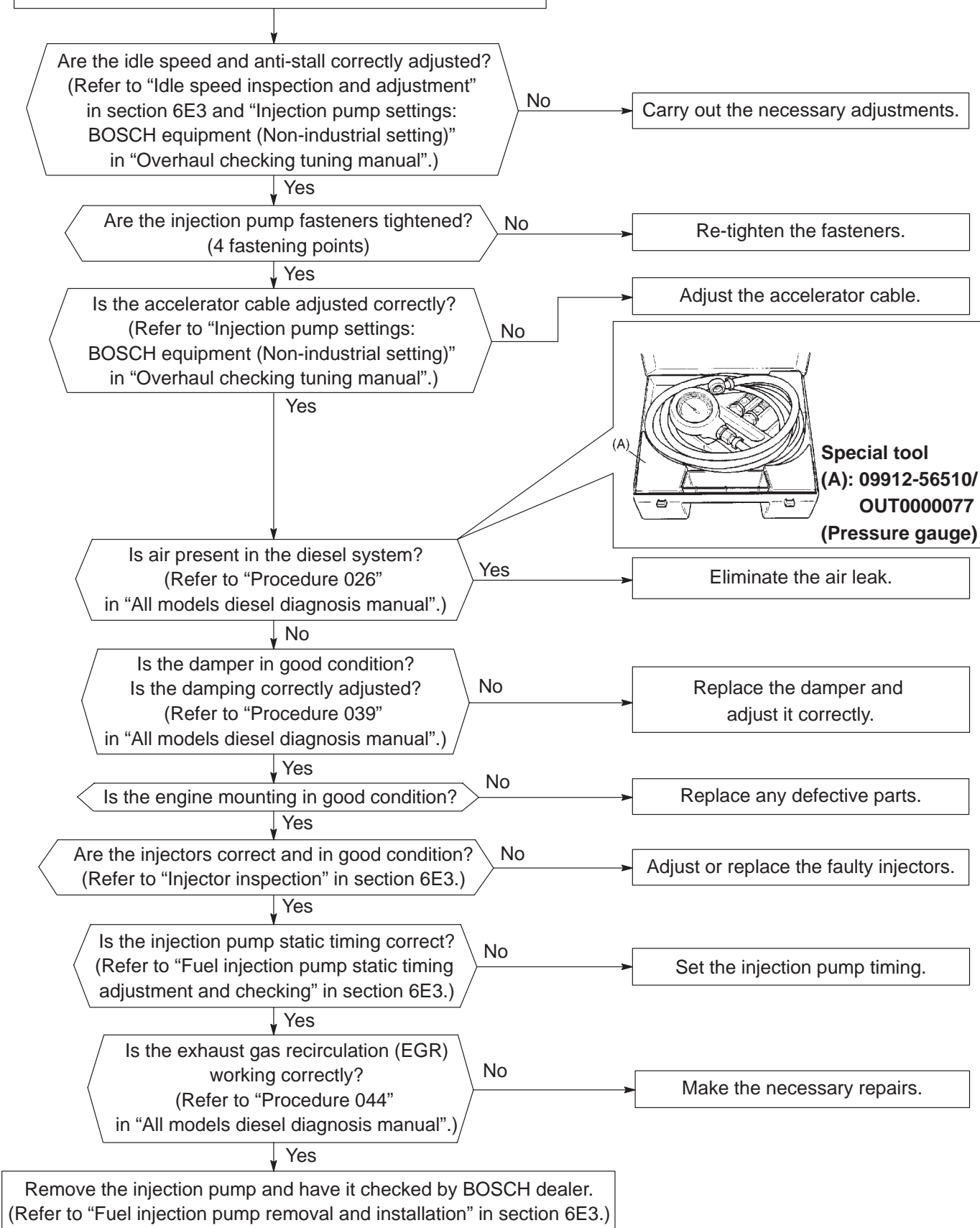
PROCEDURE 015

Hesitation at steady speed

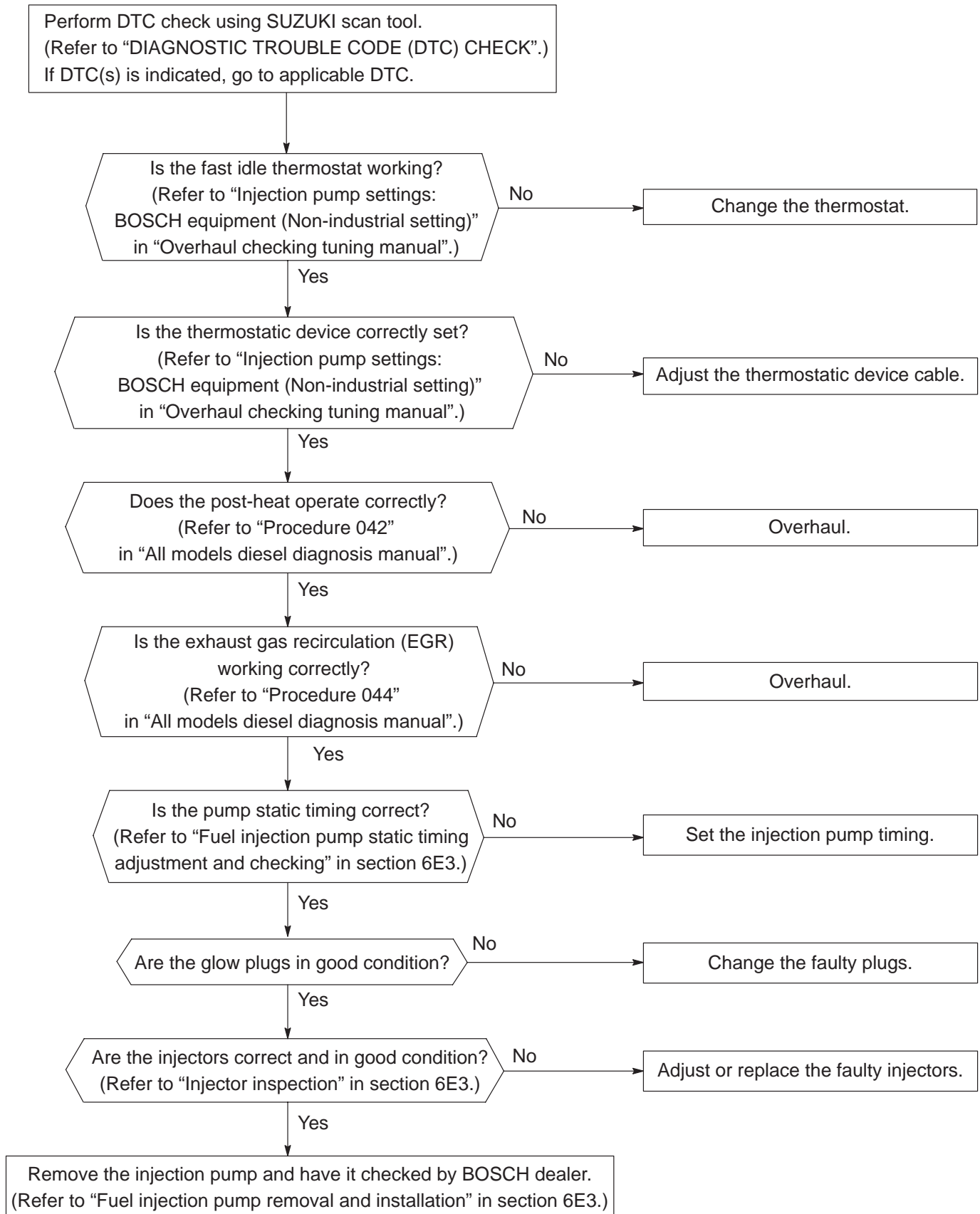
PROCEDURE 016

Hesitation on re-acceleration

Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.



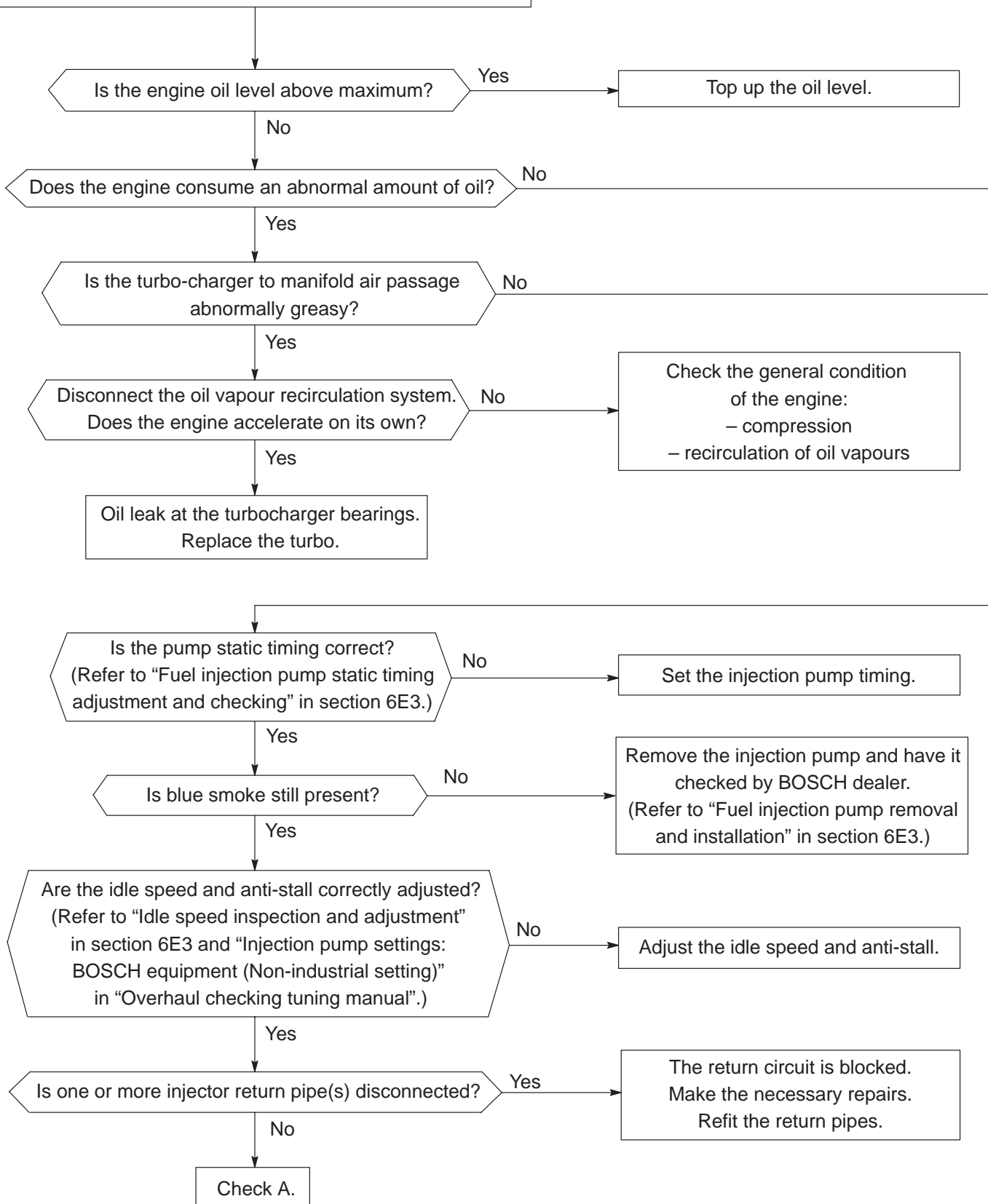
PROCEDURE 017

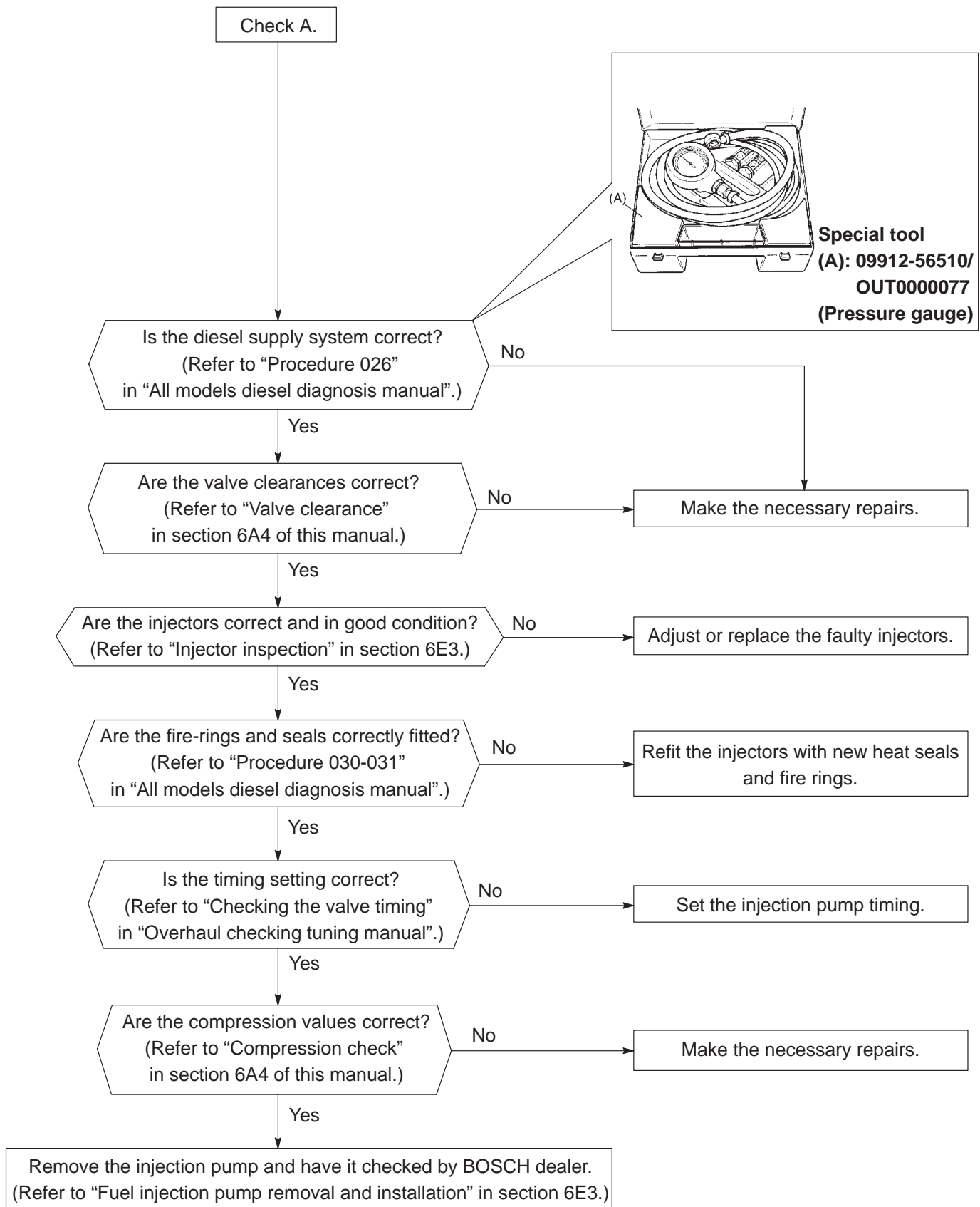
With emission of black smoke (at idle) after starting

PROCEDURE 018

Emission of blue smoke (at idle; on overrun; at low load)

Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.

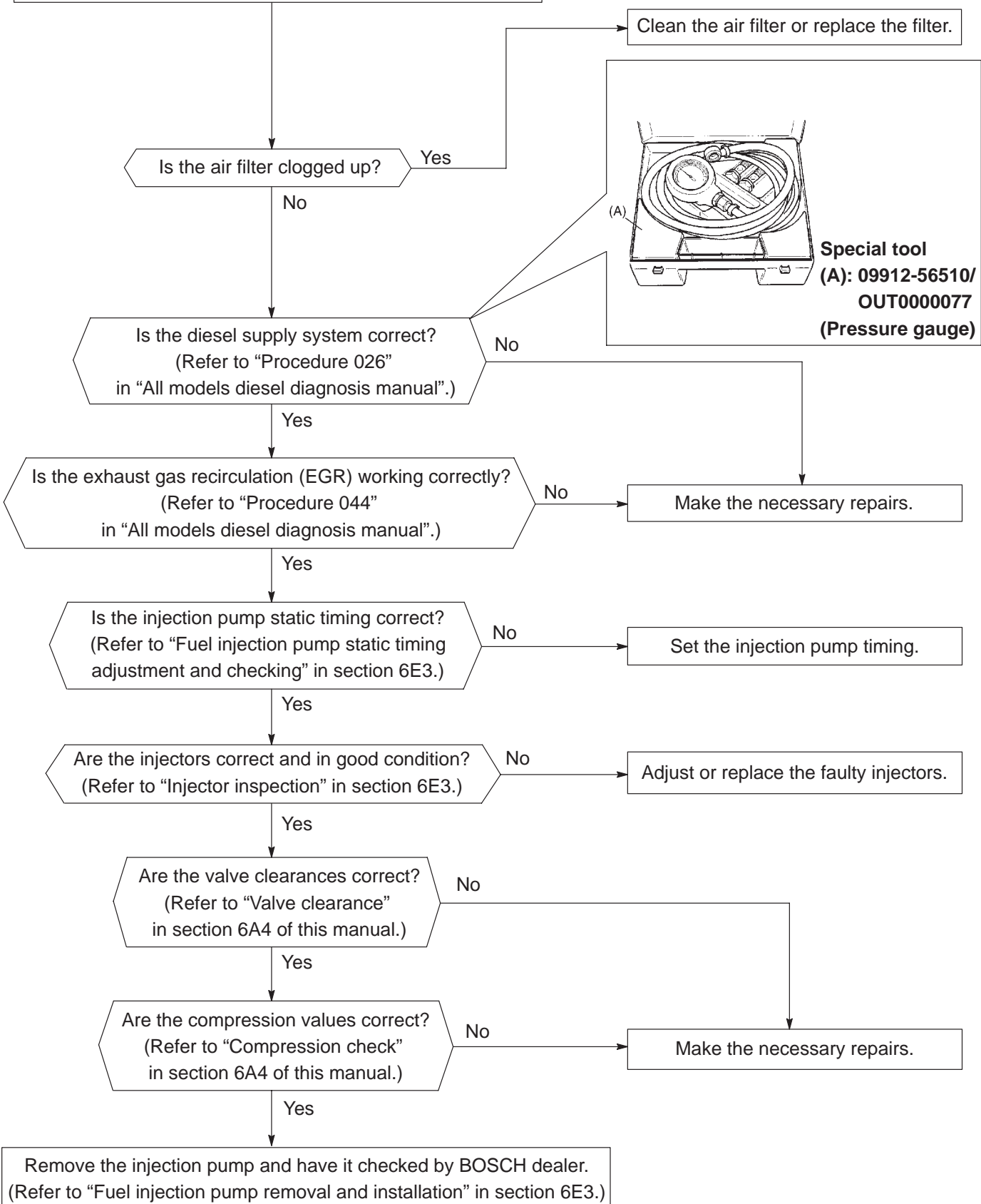




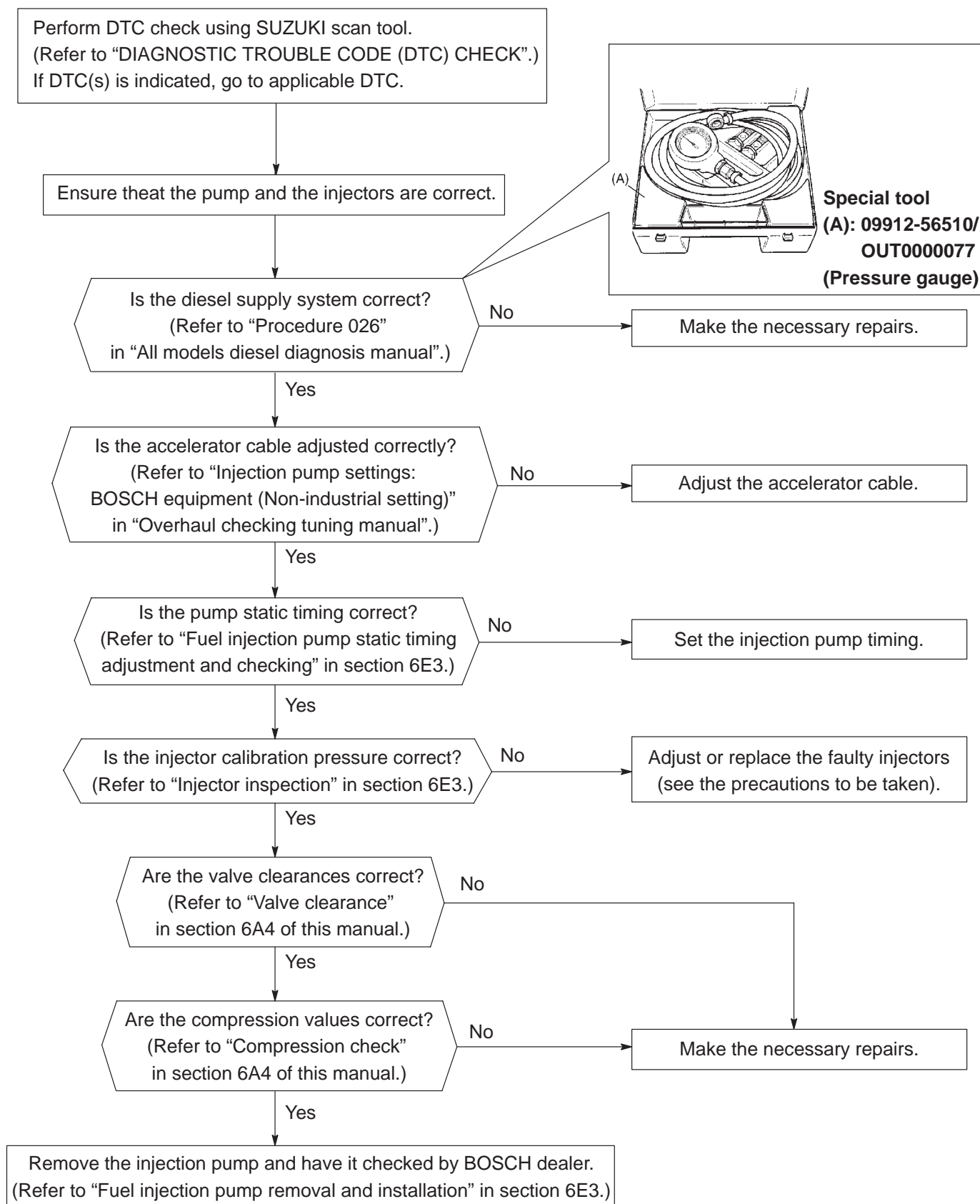
PROCEDURE 019

With emission of black smoke (at load)

Perform DTC check using SUZUKI scan tool.
(Refer to "DIAGNOSTIC TROUBLE CODE (DTC) CHECK".)
If DTC(s) is indicated, go to applicable DTC.

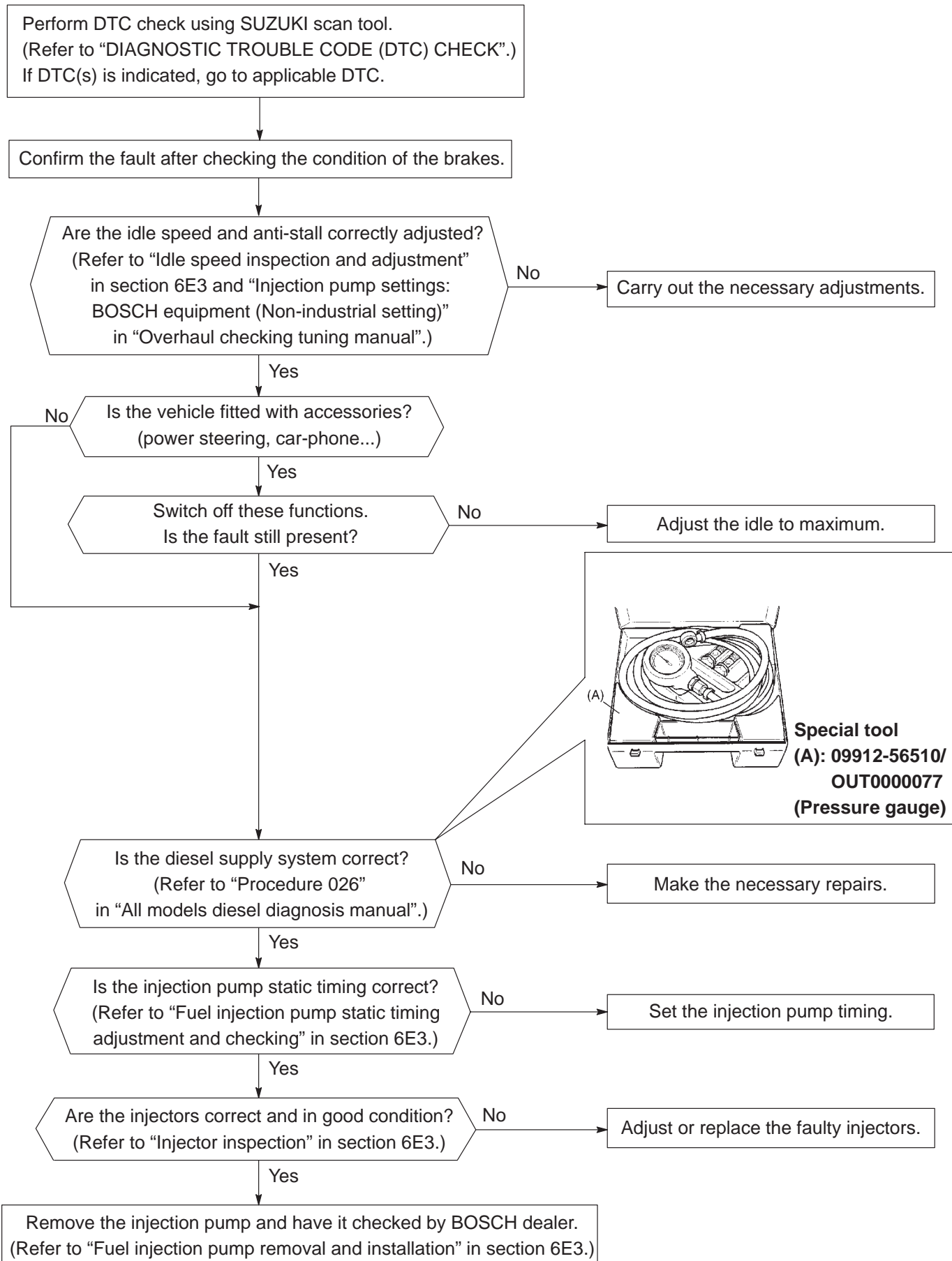


PROCEDURE 020

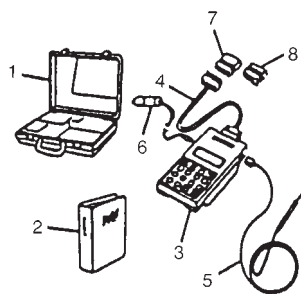
No re-acceleration/no liveliness (with or without emission of smoke)

NOTE: If the fault persists after checking the pump, check the conformity of the thickness of the cylinder head gasket.

PROCEDURE 021

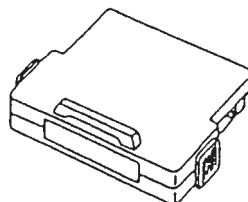
The vehicle moves off with difficulty (with or without emission of smoke)

SPECIAL TOOLS

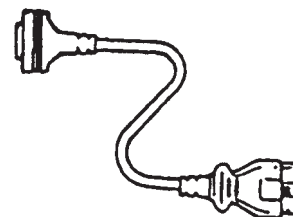


1. Storage case
2. Operator's manual
3. Scan tool
4. DLC cable (14/26 pin, 09931-76040)
5. Test lead/probe
6. Power source cable
7. DLC cable adaptor
8. Self-test adaptor

09931-76011
SUZUKI scan tool (Tech 1 A) kit



Mass storage cartridge



09931-76030
16/14 pin DLC cable

SECTION 6A4

ENGINE MECHANICAL
(XUD9BSD ENGINE)

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Precautions” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.
- Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).

NOTE:

Please refer to description of XUD9 SD/BSD engine in “OVERHAUL CHECKING TUNING MANUAL” listed as one of related manuals in FOREWORD as well. In principle, on-vehicle repair and maintenance, disassembly and assembly are described in this section while disassembly and assembly of the parts removed from the vehicle are described in “OVERHAUL CHECKING TUNING MANUAL”.

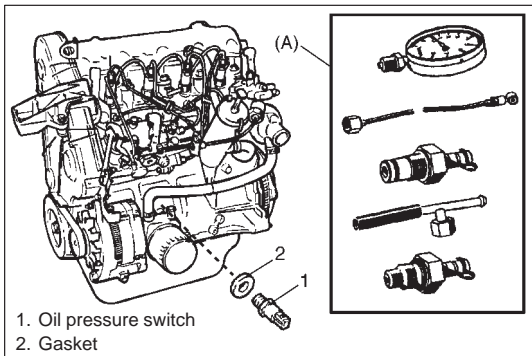
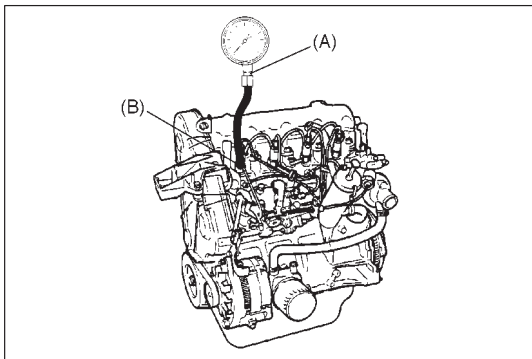
6A4

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ON-VEHICLE SERVICE	6A4- 2	Intake Manifold, Exhaust Manifold and	
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NOTE:

For what each abbreviation stands for (i.e., full term), refer to SECTION 0A.



ON-VEHICLE SERVICE

COMPRESSION CHECK

Check compression pressure referring to "Procedure 024" in "All models diesel diagnosis manual".

Special tool

(A): 09912-57820

(B): 09912-57830

OIL PRESSURE CHECK

Check engine oil pressure. Refer to "Checking oil pressure" in "Overhaul checking turning manual".

Special tool

(A): 09915-76530/OUT0000057

When installing oil pressure switch, use a new gasket.

VALVE CLEARANCE

Check or adjust valve clearance. Refer to "Adjusting valve clearance" in "Overhaul checking tuning manual".

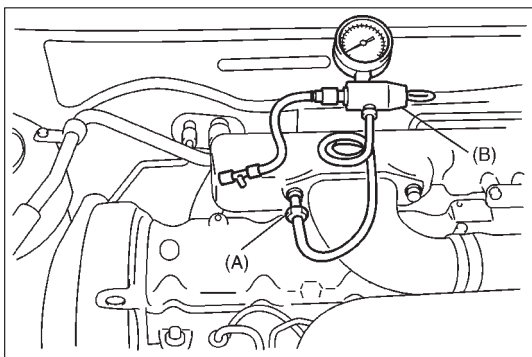
Valve clearance specification (when cold)

INTAKE	0.15 ~ 0.04 mm
EXHAUST	0.30 ~ 0.04 mm

TURBOCHARGER PRESSURE CHECK

WARNING:

- When carrying out road tests, select a safe place where no man or no running vehicle is seen so as to prevent any accident.
- Road test, should be carried out with 2 persons, a driver and tester, on a level road.



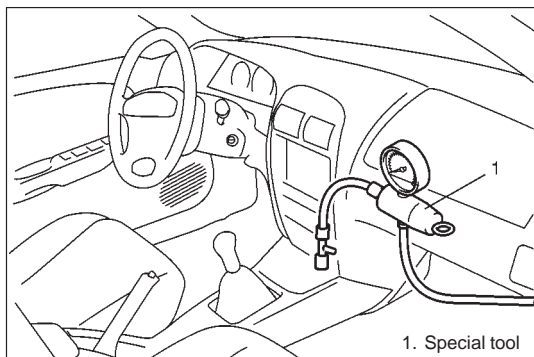
- 1) Replace right side bolt of air inlet pipe to special tool (A).
- 2) Connect special tool (B) of which port (1) is plugged with bending hose as shown.

Special tool

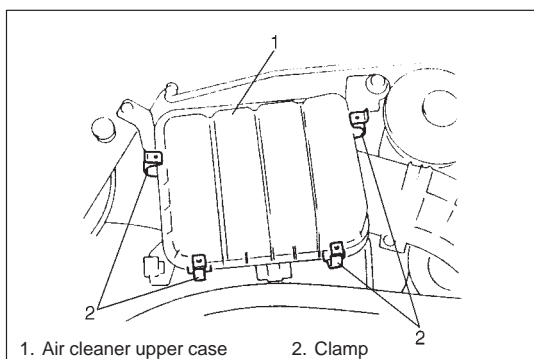
(A): 09915-78220

(B): 09918-18111

- 3) Open valve in special tool (B) by turning counterclockwise it.
- 4) Start engine and warm it up to normal operating temperature.
- 5) Drive with 3rd gear at idle speed.



- 6) Depress the accelerator pedal fully.
- 7) During the acceleration, measure turbocharger pressure when the engine speed reaches 2000 – 3000 RPM.
Turbocharger pressure should be 20 to 55 kPa.
If turbocharger pressure is not within specified value, check air intake system and exhaust system for leakage and clog.
If there is no leakage and clog, replace turbocharger.

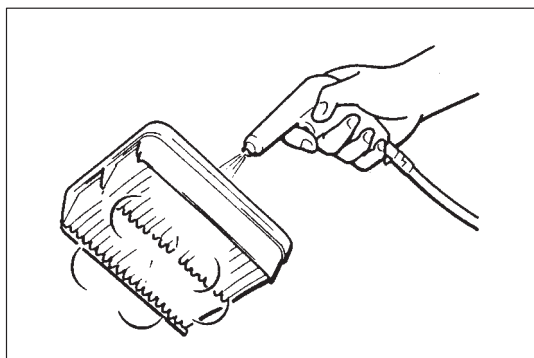


AIR CLEANER ELEMENT

This air cleaner element is of dry type. Clean it according to the following procedure.

REMOVAL

- 1) Remove air cleaner upper case from lower case after unhooking clamps from upper case.
- 2) Remove air cleaner element.

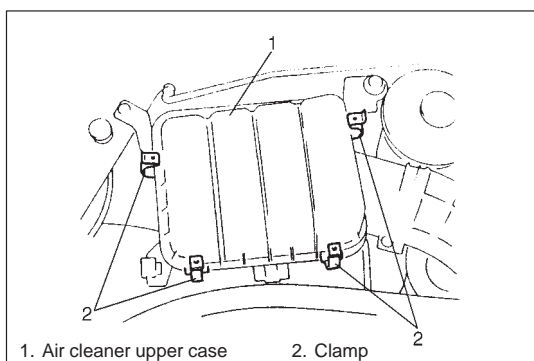


INSPECTION

Inspect air cleaner filter. Clean or replace if necessary.

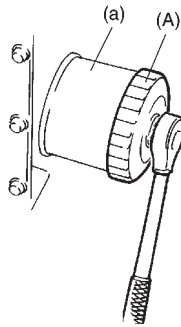
CLEANING

Clean element with compressed air from inside of element.



INSTALLATION

- 1) Install air cleaner element to its lower case.
- 2) Install air cleaner upper case.
Hook clamps securely.



OIL FILTER

REMOVAL

- 1) Remove oil filter using special tool (oil filter wrench).

Special tool

(A): 09915-46510

INSTALLATION

- 1) Apply engine oil to new oil filter O-ring.
- 2) Install oil filter and tighten it to specified torque by using special tool (A).

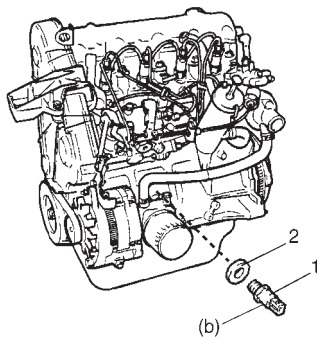
Special tool

(A): 09915-46510

Tightening torque

(a): 14 N·m (1.4 kg-m)

- 3) Check engine oil level referring to section 0B.
- 4) Start engine and check oil filter for oil leakage.



1. Oil pressure switch
2. Gasket

OIL PRESSURE SWITCH

REMOVAL

- 1) Disconnect oil pressure switch connector.
- 2) Remove oil pressure switch.

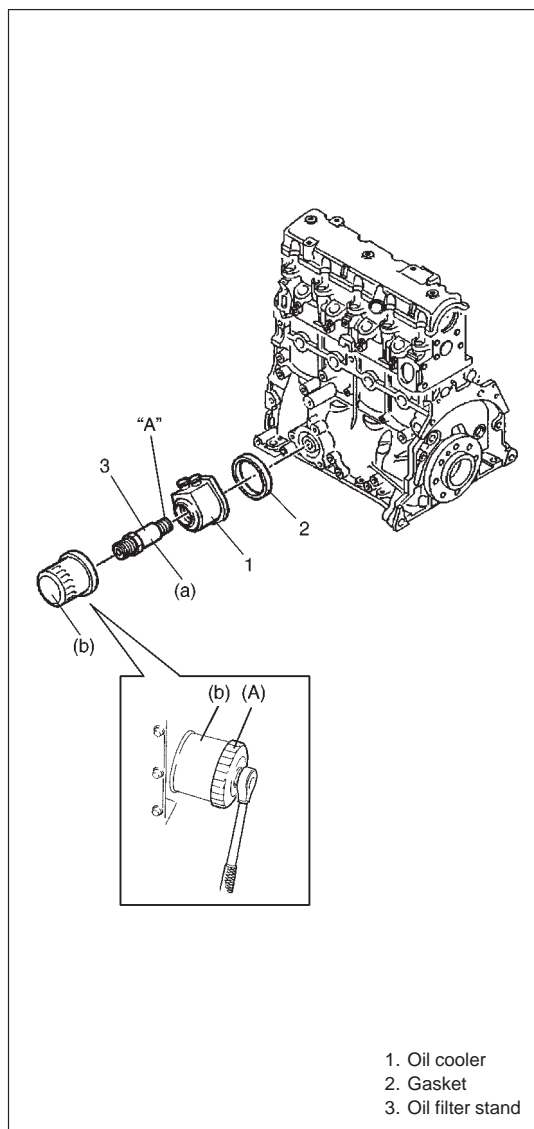
INSTALLATION

- 1) Install oil pressure switch with new gasket.
- 2) Tighten oil pressure switch.

Tightening torque

(b): 30 N·m (3.0 kg-m)

- 3) Connect connector.
- 4) Start engine and check for oil leakage.



OIL COOLER

REMOVAL

- 1) Drain engine coolant.
- 2) Remove oil filter.
- 3) Disconnect hoses and remove oil cooler.

INSTALLATION

- 1) Install oil cooler with new gasket.
- 2) Tighten cooler stud stand to specified torque.

Tightening torque:

(a): 57.5 N·m (5.8 kg-m)

Sealant:

“A” : LOCTITE 572

- 3) Connect hoses and tighten oil filter to specified torque by using special tool (A).

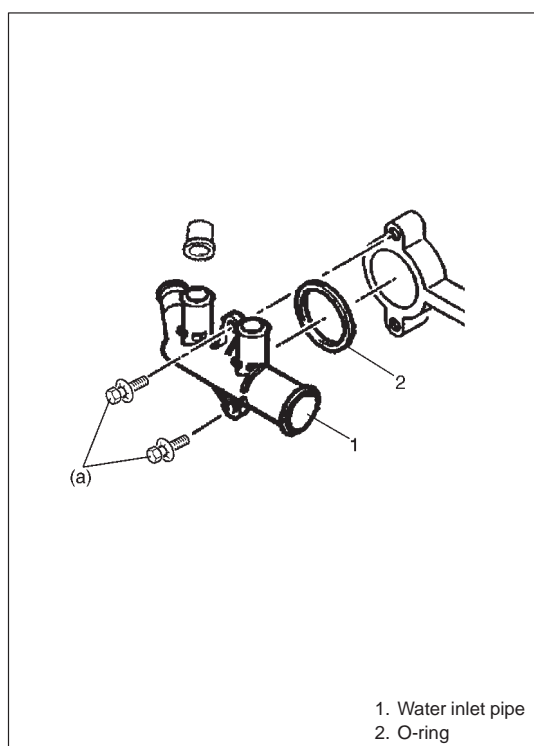
Special tool

(A): 09915-46510

Tightening torque:

(b): 14 N·m (1.4 kg-m)

- 4) Fill engine coolant.
- 5) Check engine oil level. Refer to section 0B.
- 6) Check for oil leakage.



WATER INLET BOX

REMOVAL

- 1) Drain engine coolant.
- 2) Disconnect hoses and remove water inlet pipe.

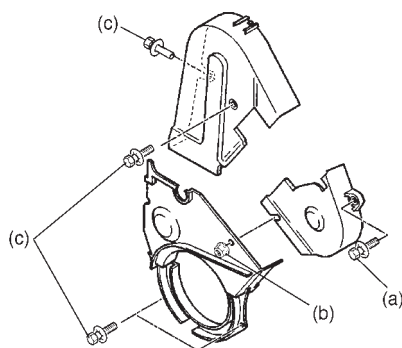
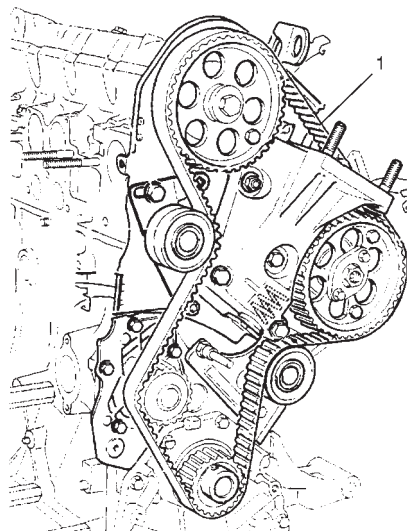
INSTALLATION

- 1) Install water inlet pipe with new O-ring.
- 2) Tighten water inlet pipe bolts.

Tightening torque:

(a): 20 N·m (2.0 kg-m)

- 3) Fill engine coolant.



TIMING BELT

REMOVAL

- 1) Drain engine coolant.
- 2) Remove the following parts.
 - Front-right wheel.
 - Engine under cover right side.
 - Radiator outlet pipe.
 - Accessory drive belt.
 - Air cleaner suction pipe No.1 and air cleaner case.
 - Power steering pump with hoses connected.
- 3) Support engine.
- 4) Remove engine mounting right side.
- 5) Remove timing belt cover.
- 6) Remove timing belt (1). Refer to "Dismantling the engine" in "Overhaul checking tuning manual".

INSTALLATION

- 1) Reverse removal procedure for installation.
Refer to "INSTALLING THE TIMING BELT" in "Overhaul checking tuning manual".
- 2) Tighten bolts and nuts to specified torque.

Tightening torque:

- (a): 10 N·m (1.0 kg-m, 7.5 lb-ft)
- (b): 5 N·m (0.5 kg-m, 4.0 lb-ft)
- (c): 15 N·m (1.5 kg-m, 11.0 lb-ft)

TURBOCHARGER

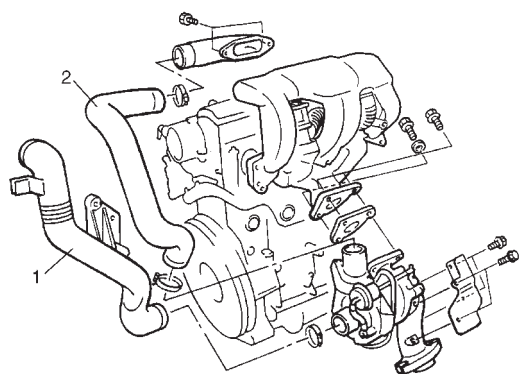
REMOVAL

- 1) Drain transmission oil and engine coolant.
- 2) Remove the following items.

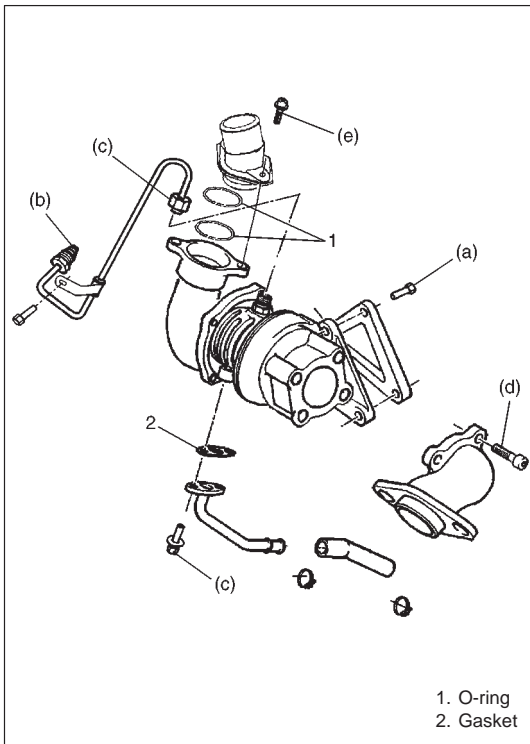
NOTE:

The inlet and outlet orifices of the turbocharger must be blanked off.

- Air intake pipe.
 - Air outlet hose from turbocharger.
 - Exhaust pipe No.1.
 - Center shaft. Refer to section 4 of this manual.
 - Oil feed pipe and oil return hose from engine.
- 3) Remove turbocharger from exhaust manifold.



1. Air intake pipe
2. Air outlet hose



INSTALLATION

- 1) Make sure that there are no foreign material in air intake circuit and exhaust manifold.
- 2) Reverse removal procedure.

NOTE:

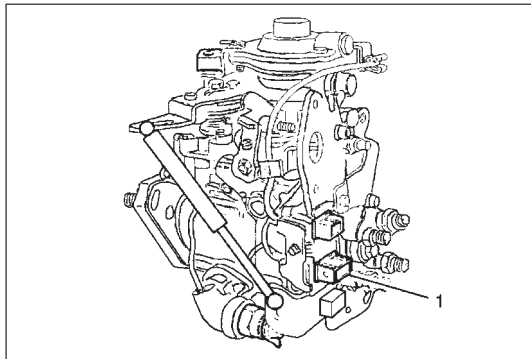
Use new gasket.

- 3) Tighten bolts and nuts to specified torque.

Tightening torque:

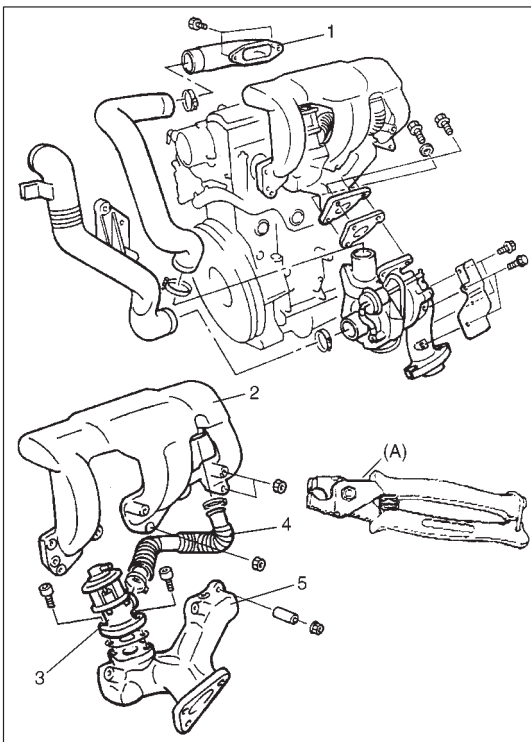
- (a): 50 N·m (5.0 kg-m, 36.5 lb-ft)
- (b): 30 N·m (3.0 kg-m, 22.0 lb-ft)
- (c): 20 N·m (2.0 kg-m, 14.5 lb-ft)
- (d): 22 N·m (2.2 kg-m, 16.0 lb-ft)
- (e): 11 N·m (1.1 kg-m, 8.0 lb-ft)

- 4) Before starting engine, perform "PRECAUTIONS TO BE TAKEN BEFORE STARTING THE ENGINE" as explained below.



PRECAUTIONS TO BE TAKEN BEFORE STARTING THE ENGINE

- 1) Disconnect connector of immobilizer actuator (1).
- 2) Crank engine until the oil pressure light is turned off.
- 3) Reconnect connector of immobilizer actuator (1).
- 4) Start engine and let it run at idle speed for approximately 30 seconds.
- 5) Check there are no leaks on any of the hose connections.



INTAKE MANIFOLD, EXHAUST MANIFOLD AND EGR VALVE

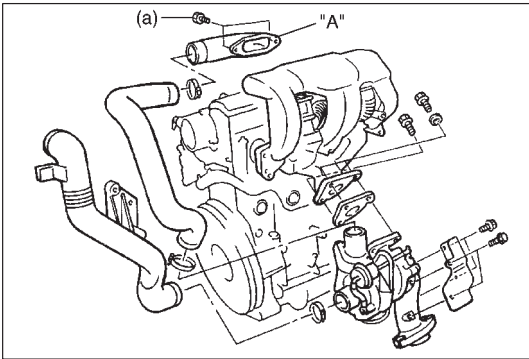
REMOVAL AND DISASSEMBLING

- 1) Remove the following parts.
 - Turbocharger
 - Air inlet pipe (1) from intake manifold (2)
- 2) Remove intake manifold (2), exhaust manifold (5) and EGR valve (3) assembly from cylinder head. (They are connected by EGR pipe (4).)
- 3) Remove EGR pipe (4) using special tool then intake manifold (2) can be separated from exhaust manifold (5).

Special tool:

(A): 09919-46510/OUT0000110

- 4) Remove EGR valve from exhaust manifold.



INSTALLATION

- 1) Reverse removal procedure when installation.

NOTE:

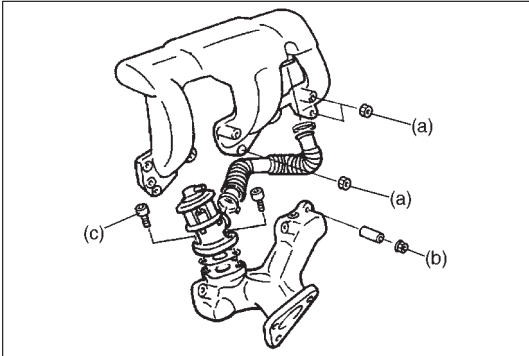
Use new gasket.

Apply sealant between air inlet pipe and intake manifold.

“A” Sealant: LOCTITE 518

Tightening torque:

(a): 9 N·m (0.9 kg-m, 6.5 lb-ft)



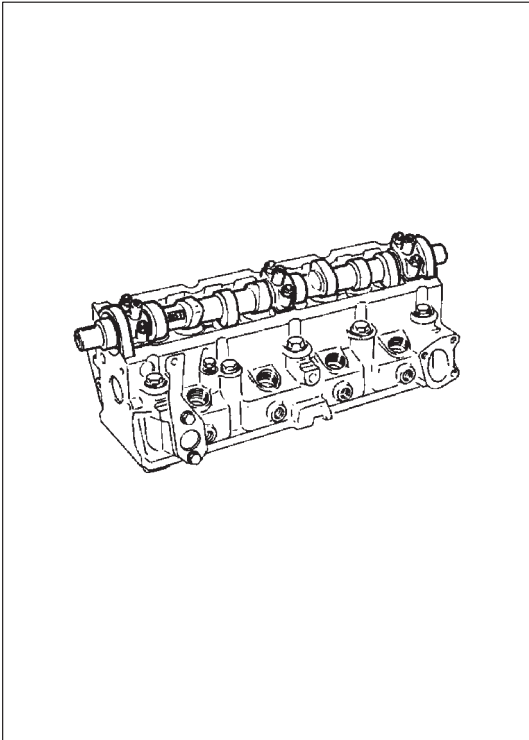
- 2) Tighten bolts and nuts to specified torque.

Tightening torque:

(a): 20 N·m (2.0kg-m, 14.5 lb-ft)

(b): 30 N·m (3.0 kg-m, 22.0 lb-ft)

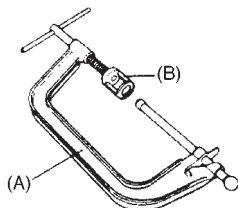
(c): 15 N·m (1.5 kg-m, 11.0 lb-ft)



CYLINDER HEAD

REMOVAL

- 1) Remove intake manifold, exhaust manifold and EGR valve assembly.
- 2) Remove cylinder head. Refer to the following items in “Overhaul checking tuning manual”.
 - “Stripping the engine”
 - “Dismantling the engine”
 - “Removing cylinder head”
 - (Specified tool; 0.0149 is not needed)
 - “Tightening the cylinder head”



DISASSEMBLING, INSPECTION AND REASSEMBLING

- 1) Disassemble, inspect and reassembling cylinder head. Refer to the following items in "Overhaul checking tuning manual". Use special tool when removing and installing valve.

Special tool:

(A): 09916-14510

(B): 09916-14910

"Cylinder head"

"Valves"

"Valve springs"

"Valve guides"

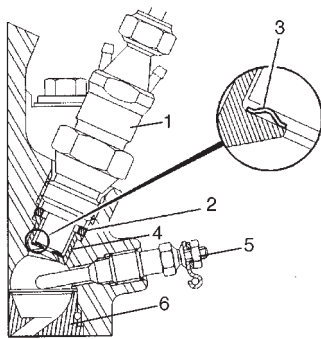
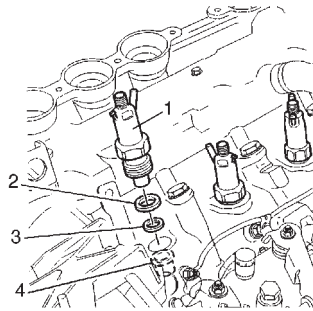
"Valve seats"

"Swirl chambers"

"Reconditioning the cylinder head"

INSTALLATION

- 1) Install cylinder head. Refer to the following items in "Overhaul checking tuning manual".
 - "Cylinder head gasket identification"
 - "Selecting the cylinder head gasket"
 - "Installing the cylinder head"
 - "Identification of various builds for cylinder head bolts"
 - "Reuse of the cylinder head bolts, type III"
 - "Tightening the cylinder head"
 - "Installing the camshaft"



1. Fuel injector
2. Copper washer
3. Flame ring
4. Injector shield
5. Glow plug
6. Swirl chamber

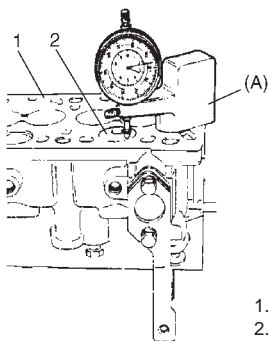
INJECTOR SHIELD

REMOVAL

- 1) Remove injector and then remove injector shield with finger.
If injector shield can not be removed, tap injector shield out using suitable brass drift from swirl chamber side as follows.
 - i) Remove fuel injectors and glow plugs.
 - ii) Remove cylinder head.
 - iii) Remove swirl chamber.
 - iv) Use a suitable brass drift, tap injector shield out.

INSTALLATION

- 1) Position old copper washer on its outer diameter and tap it into cylinder head using a suitable drift against copper washer.
- 2) Final positioning of injector shield can be left until it is pushed into place when fitting injector.



1. Cylinder head
2. Swirl chamber

SWIRL CHAMBER

INSPECTION

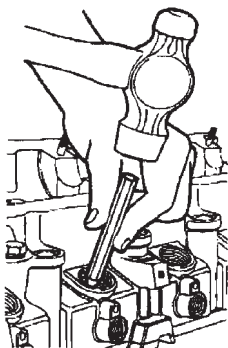
- 1) Remove injectors and glow plugs.
- 2) Remove cylinder head.
- 3) Check protrusion of swirl chamber. Refer to "Reconditioning the cylinder head" and "Swirl chambers" in "Overhaul checking tuning manual".

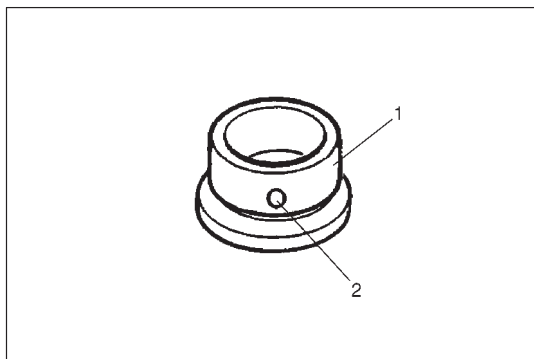
Special tool:

(A): 09910-26510/OUT 0000005

REMOVAL

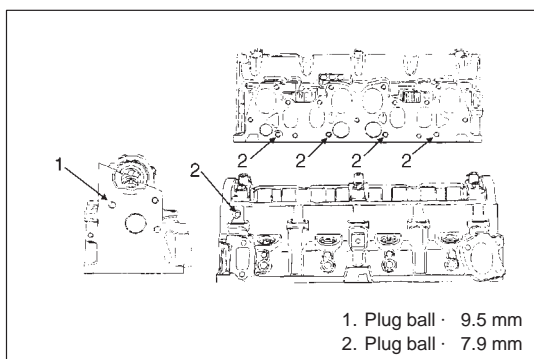
- 1) Identify each swirl chamber with its original location.
- 2) Use a suitable brass drift, tap the swirl chamber out.





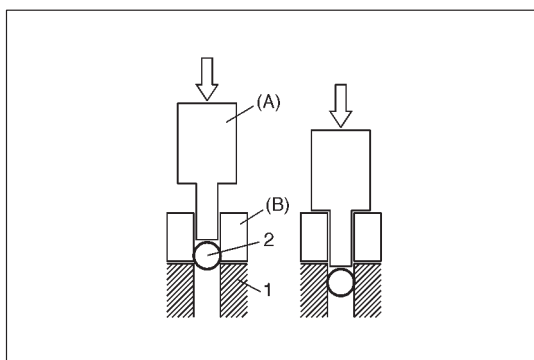
INSTALLATION

- 1) Install swirl chambers (1), so that swirl chamber protrusion (2) engages cylinder head recess.
- 2) Reverse removal procedure.



PLUG BALL

There are 6 plug balls in cylinder head.
Their locations are indicated in left figure.

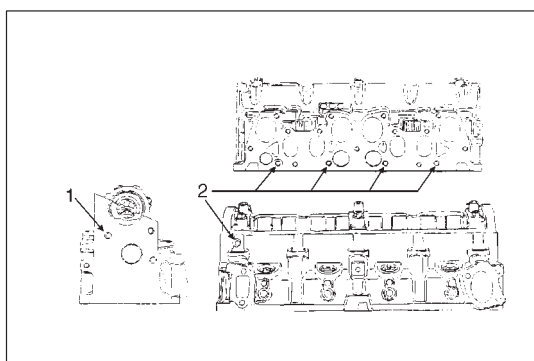


INSTALLATION

- 1) Apply "LOCTITE 243" on the plug ball.
- 2) Push the plug ball (2) into the cylinder head (1) with special tools (A) and (B) until tool (A) bottoms out.

Special tool

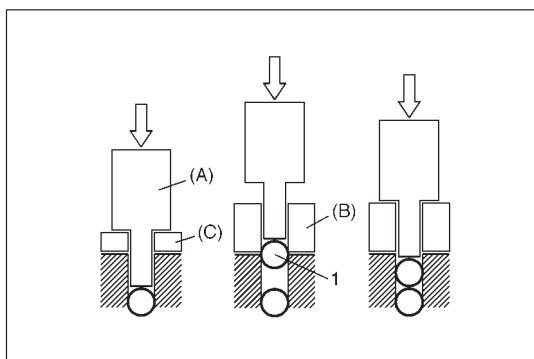
(A) and (B): 09918-96510/OUT0000136



SECOND PLUG BALL

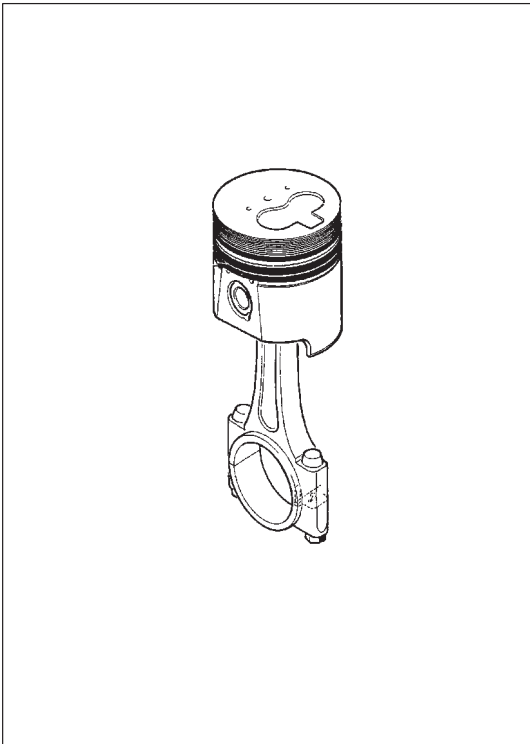
If oil leaks from plug ball · 9.5 mm (1), insert a second plug ball over original ball.

If oil leaks from plug balls · 7.9 mm (2), replace cylinder head with new one because no second ball is not available.



INSTALLATION

- 1) Push plug ball into cylinder head with special tools (A) and (C) until tool (A) bottoms out.
- 2) Apply "LOCTITE 243" on the second plug ball (1).
- 3) Push the second plug ball into the cylinder head with special tool (A) and (B) until (A) bottoms out.



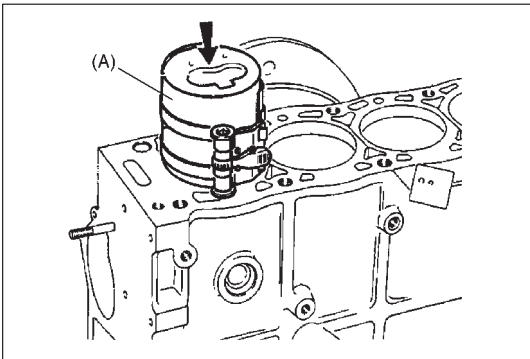
PISTON AND CONNECTING ROD

REMOVAL

- 1) Remove piston and connecting rod. Refer to “Removing the crankshaft and piston assembly” in “Overhaul checking tuning manual”.

INSPECTION

- 1) Inspect piston and connecting rod. Refer to the following items in “Overhaul checking tuning manual”.
 - “Cylinder/piston matching”
 - “Crankshaft”
 - “Crankshaft pins and journals”



INSTALLATION

- 1) Install piston and connecting rod. Refer to the following items in “Overhaul checking tuning manual”.
 - “Fitting pistons and connecting rods”
 - “Installing pistons and connecting rods”

Special tool:

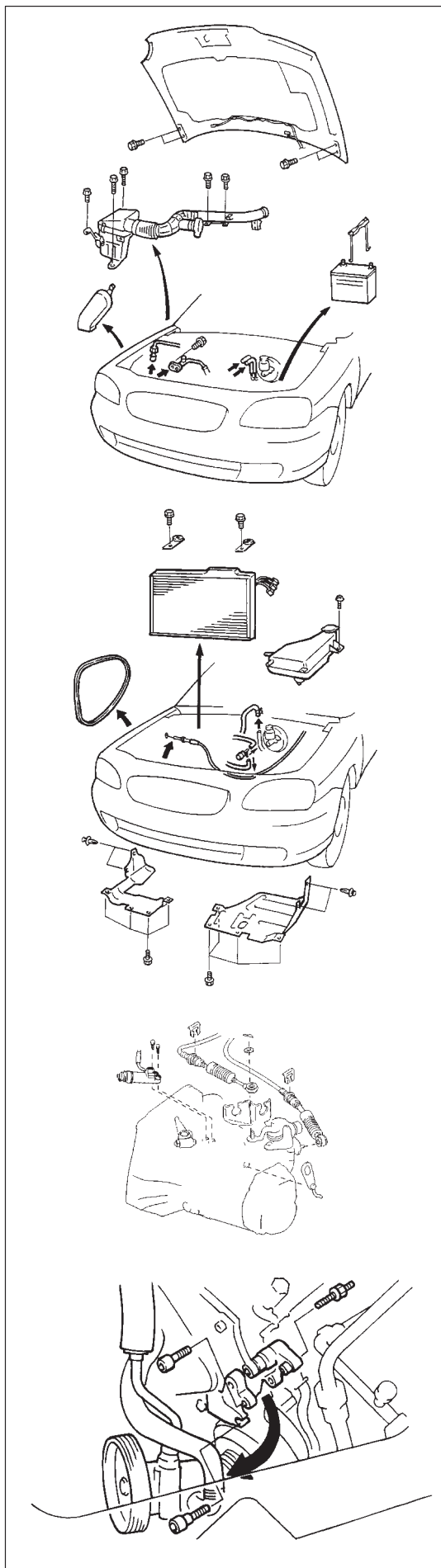
(A): 09916-77310

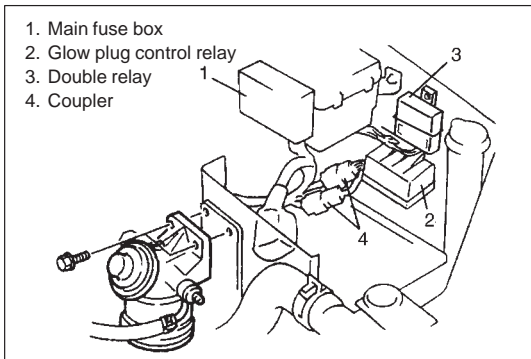
UNIT REPAIR OVERHAUL

ENGINE ASSEMBLY

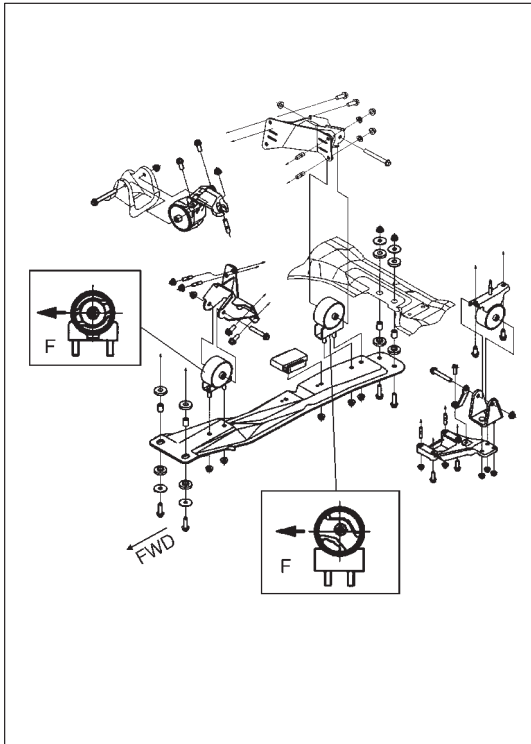
REMOVAL

- 1) Drain transmission oil and engine coolant.
- 2) Remove the following parts.
 - ☐ Fuel filler cap
 - ☐ Battery
 - ☐ Engine hood after disconnecting windshield washer hose
 - ☐ Air cleaner outlet hose No. 1
 - ☐ Air cleaner suction pipe No. 1
 - ☐ Air cleaner case assembly
 - ☐ Air cleaner outlet pipe
 - ☐ Engine coolant degassing tank and its bracket
 - ☐ Engine under covers
 - ☐ Radiator
 - ☐ Throttle cable
 - ☐ Shift cables from transmission
 - ☐ Clutch cylinder from transmission with hose still attached
 - ☐ Air conditioner compressor pipes referring to section 1B
 - ☐ Accessory drive belt
 - ☐ Power steering pump from its bracket with hoses still attached
 - ☐ Drive shafts
 - ☐ Exhaust pipe No. 1
 - ☐ Engine ground cable from transmission
- 3) Disconnect the following parts.
 - ☐ Vacuum hoses from EGR solenoid valve No.1, No.2 and brake booster
 - ☐ Fuel feed hose and return hose
 - ☐ Heater inlet hose and outlet hose
 - ☐ Water inlet hose

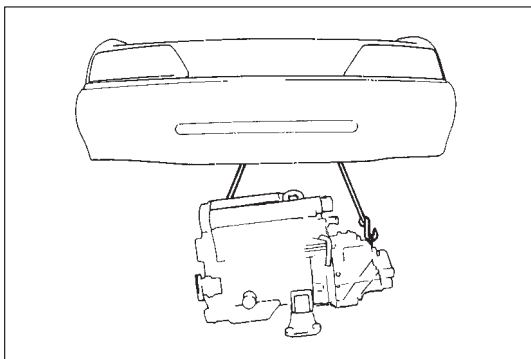




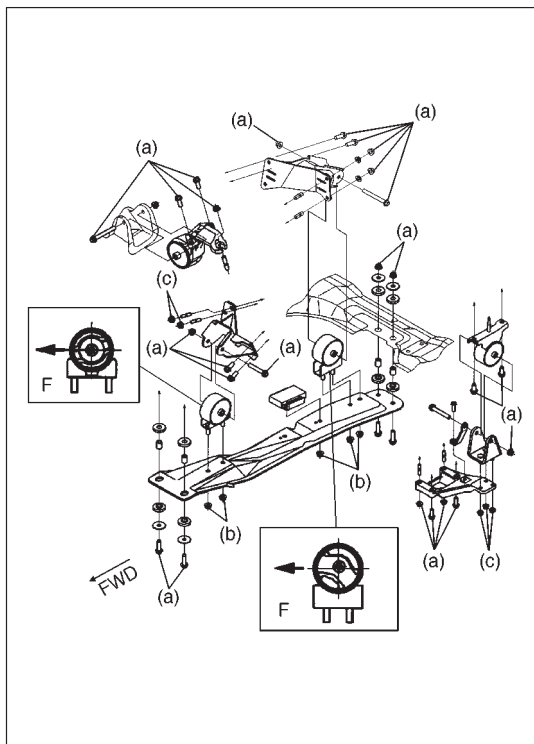
- 4) Remove double relay, glow-plug control relay and main fuse box.
- 5) Disconnect 2 couplers from main harness.
- 6) Remove fuel filter assembly from bracket with hoses still connected. Lower engine assembly with harness.



- 7) Install lifting device.
- 8) Remove rear mounting.
- 9) Remove 2 bolts that fix mounting member and suspension frame.
- 10) Remove bolt from engine front torque bush.
- 11) Remove 2 bolts that fix mounting member and front member. Then remove mounting member.
- 12) Remove left mounting from body. (2 bolts)
- 13) Remove engine right mounting from engine right bracket. (2 bolts and 1 nut)
- 14) Remove engine right mounting from body. (1 bolt)
- 15) Before removing engine with transmission, ensure that all hoses, electric wires and cables are disconnected from engine and transmission.



- 16) Lower engine with transmission from body.



INSTALLATION

For installation, reverse the removal procedure. However, pay attention to the following points.

- Be sure to clamp hoses securely.
- For adjustment of throttle cable, refer to "Injection pump setting: BOSCH equipment" in "Overhaul checking tuning manual".
- Connect engine ground cable properly and securely.
- Tighten bolts and nuts shown in the figure.

Tightening torque:

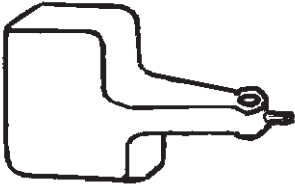

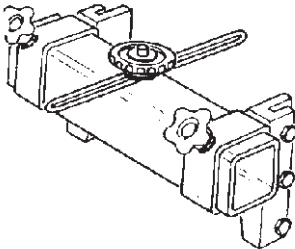
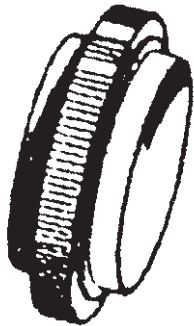


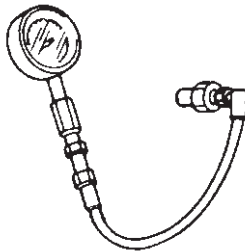
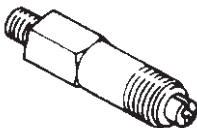
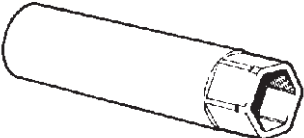
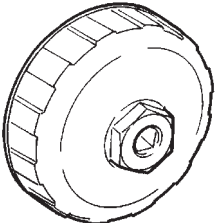
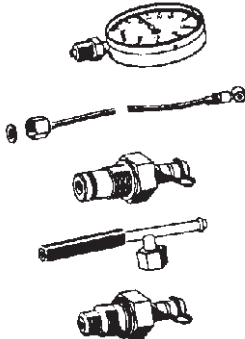
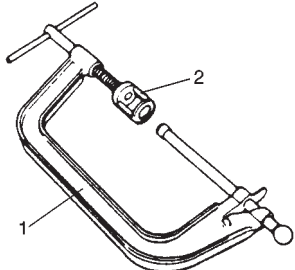
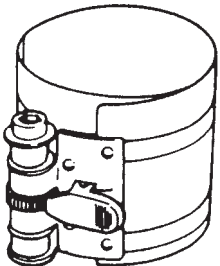
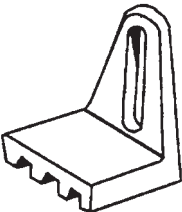


(a): 55 N·m (5.5 kg-m, 40.0 lb-ft)

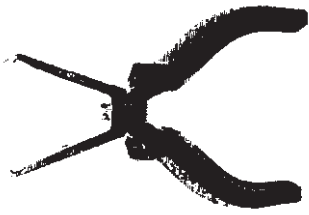
(b): 45 N·m (4.5 kg-m, 32.5 lb-ft)

(c): 25 N·m (2.5 kg-m, 18.0 lb-ft)

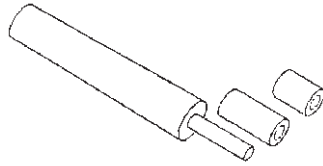
- For installing engine hood, refer to "Hood" in Section 9. And perform "hood latch operation check" as indicated below.
Pull primary hood latch release handle inside vehicle. Secondary latch should keep hood from operating all the way when primary latch is released. Make sure engine hood closes firmly.
- Check that there is no leakage of intake air, exhaust gas, engine coolant and oil.

SPECIAL TOOL

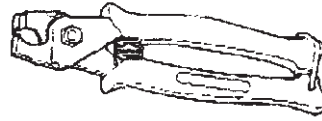
 <p>09910-26510 (OUT0000005) Dial gauge support</p>	 <p>09910-26520 (OUT0000015) TDC rod positioner</p>	 <p>09911-16510 (OUT0000002) Rear oil seal installer</p>	 <p>09911-16520 (OUT0000011) Rear main seal installer</p>
 <p>09911-16530 (OUT0000013) Front seal installer</p>	 <p>09918-18111 Air pressure regulator</p>	 <p>09912-57820 Compression gauge</p>	 <p>09912-57830 Compression gauge attachment</p>
 <p>09915-26510 (OUT0000001) Injector socket</p>	 <p>09915-46510 Oil filter wrench</p>	 <p>09915-76530 (OUT0000057) Oil pressure gauge kit</p>	 <p>1. 09916-14510 Valve lifter 2. 09916-14910 Valve lifter attachment</p>
 <p>09916-77310 Piston ring compressor</p>	 <p>09916-96510 (OUT0000049) Flywheel lock</p>	 <p>09917-66510 (OUT0000014) Camshaft oil seal installer</p>	 <p>09917-96510 (OUT0000019) Stem seal installer</p>



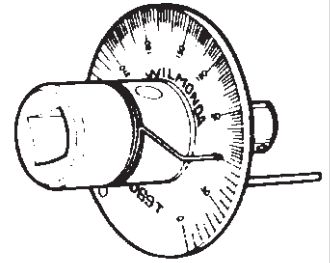
09917-96520
(OUT0000021)
Stem seal remover



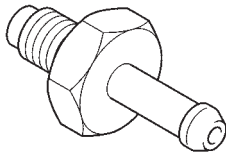
09918-96510
(OUT0000136)
Plug ball installer kit



09919-46510
(OUT0000110)
Clamp pliers



09919-56510
(OUT0000062)
Tightening angle gauge



09915-78220
Pressure gage attachment

TIGHTENING TORQUE SPECIFICATIONS

FASTENING PARTS	TIGHTENING TORQUE		
	N·m	kg-m	lb-ft
Cylinder block oil gallery plug (oil filter side)	20.0	2.0	14.7
Cylinder block oil gallery plug (flywheel side)	38.0	3.8	28.0
Cylinder block plug plate bolt (flywheel side)	8.5	0.9	6.3
Cylinder block water drain plug (intake manifold side)	38.0	3.8	28.0
Cylinder block oil gallery plug bolt (intake manifold side)	25.0	2.5	18.4
Crankshaft housing bolt	70.0	7.1	51.6
Cylinder head cover bolt	8.0	0.8	5.9
Camshaft housing bolt	16.0	1.6	11.8
Cylinder head bolt	See "Tightening the cylinder head, TYPE III" in "Overhaul checking tuning manual".		
Cylinder head coolant outlet plate bolt	11.0	1.1	8.1
Timing belt cover bolt	10.0	1.0	7.5
	15.0	1.5	11.0
Timing belt cover nut	5.0	0.5	4.0
Turbocharger oil feed pipe flare nut	20.0	2.0	14.5
Turbocharger oil feed pipe union nut	30.0	3.0	22.0
Turbocharger exhaust inlet flange bolt	50.0	5.0	36.5
Turbocharger exhaust outlet flange bolt	22.0	2.2	16.0
Turbocharger oil return pipe	20.0	2.0	14.5
Turbocharger air outlet pipe bolt	11.0	1.1	8.0
Flywheel bolt	50.0	5.1	36.9
Damper pulley bolt	See "Installing the damper pulley" in "Overhaul checking tuning manual"		
Crankshaft oil seal carrier (damper pulley side) bolt	15.0	1.5	11.1
Connecting rod	See "Installing pistons and connecting rods" in "Overhaul checking tuning manual".		
Camshaft pulley bolt	40.0	4.1	29.5
Timing belt tensioner bolt	18.0	1.8	13.3
Timing belt idler bolt	17.5	1.8	12.9
Oil pump bolt	20.0	2.0	14.7
Oil pump plug bolt	10.0	1.0	7.4
Oil strainer bolt	9.0	0.9	6.6
Oil pressure switch	30.0	3.1	22.1
Oil cooler	57.5	5.9	42.4
Oil filter	14.0	1.4	10.3
Oil pan bolt	18.0	1.8	13.3
Oil drain plug bolt	34.0	3.4	25.1
Oil jet bolt	10.0	1.0	7.4
Water pump bolt	15.0	1.5	11.1

FASTENING PARTS	TIGHTENING TORQUE		
	N·m	kg-m	lb-ft
Water inlet pipe bolt	20.0	2.0	14.7
Water bypass pipe bolt	17.5	1.8	12.9
Thermostat case bolt	8.0	0.8	5.9
Water outlet box bolt	16.0	1.6	11.8
Thermo switch (on water outlet box)	17.5	1.8	12.9
Thermo sensor (on water outlet box)	17.5	1.8	12.9
Fuel heater case bolt	15.0	1.5	11.1
Intake manifold bolt	15.0	1.5	11.1
Intake manifold nut	20.0	2.0	14.5
Air inlet pipe bolt	9.0	0.9	6.6
Fuel injection pump bracket bolt	20.0	2.0	14.7
Fuel injection pump bolt and nut	20.0	2.0	14.8
Fuel injection pump pulley nut	50.0	5.1	36.9
Fuel injector pipe nut	25.0	2.5	18.4
Fuel injector assembly	130.0	13.3	95.9
Fuel injector	95.0	9.5	70.1
Fast idle thermo device	27.0	2.7	19.9
Fuel feed pipe bolt (on fuel injection pump)	25.0	2.5	18.4
Fuel return pipe bolt (on fuel injection pump)	25.0	2.5	18.4
Fuel feed pipe bolt breeding screw (on fuel injection pump)	4.5	0.5	3.3
Fast idle control cable fix bolt	4.0	0.4	3.0
Fast idle control cable adjusting nut	6.0	0.6	4.4
EGR valve bolt	15.0	1.5	11.0
Exhaust manifold nut	30.0	3.0	22.0
Exhaust pipe No.1 bolt	19.0	1.9	14.0
Lifting bracket bolt No.4 cylinder side (diameter: 7 mm)	10.0	1.0	7.4
Lifting bracket bolt No.4 cylinder side (diameter: 8 mm)	20.0	2.0	14.8
Engine bracket (timing belt side)	20.0	2.0	14.7
Lifting bracket bolt (No.1 cylinder side)	17.0	1.7	12.5
Glow plug	22.0	2.2	16.2
Glow plug wiring nut	4.0	0.4	2.9
Vacuum pump bolt and nut	25.0	2.5	18.4
Accessory drive belt tensioner spring bolt	21.0	2.1	15.5
Accessory bracket bolt	20.0	2.0	14.7
Accessory drive belt idler bolt	22.0	2.2	16.2
Fuel filter outlet pipe bolt	39.5	4.0	29.1
Fuel filter inlet pipe bolt	39.5	4.0	29.1
Fuel filter inlet pipe bolt breeding screw	5.0	0.5	3.7
Fuel filter element bolt	9.0	0.9	6.6
Fuel filter water bleeding screw	3.5	0.4	2.6
Engine right mounting bolt and nut	55.0	5.5	40.0

FASTENING PARTS	TIGHTENING TORQUE		
	N·m	kg-m	lb-ft
Engine left mounting bolt	55.0	5.5	40.0
Engine left mounting bracket bolt and nut	55.0	5.5	40.0
Engine left mounting bracket No.1 & No.2 nut	25.0	2.5	18.0
Engine front mounting nut	45.0	4.5	32.5
Engine rear mounting nut	45.0	4.5	32.5
Engine rear mounting bracket bolt and nut	55.0	5.5	40.0
Engine front bush bracket bolt	55.0	5.5	40.0
Engine front bush bracket nut	25.0	2.5	18.0
Mounting member bolt and nut	55.0	5.5	40.0
Dynamic damper nut	55.0	5.5	40.0

SECTION 6B

ENGINE COOLING

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Precautions” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.
- Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).

NOTE:

For the description (items) not found in this section of this manual, refer to the same section of Service Manual mentioned in FOREWORD of this manual.

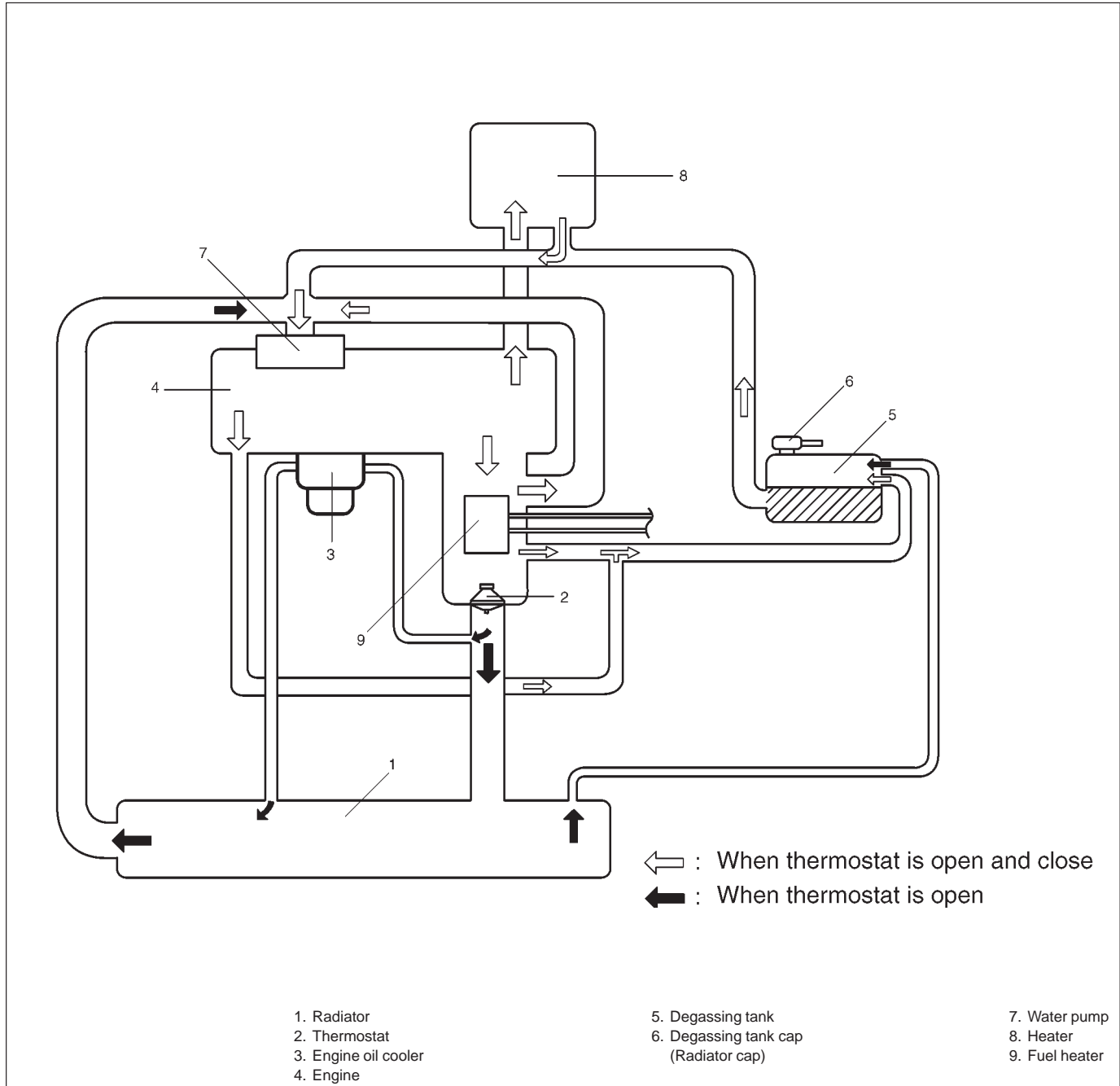
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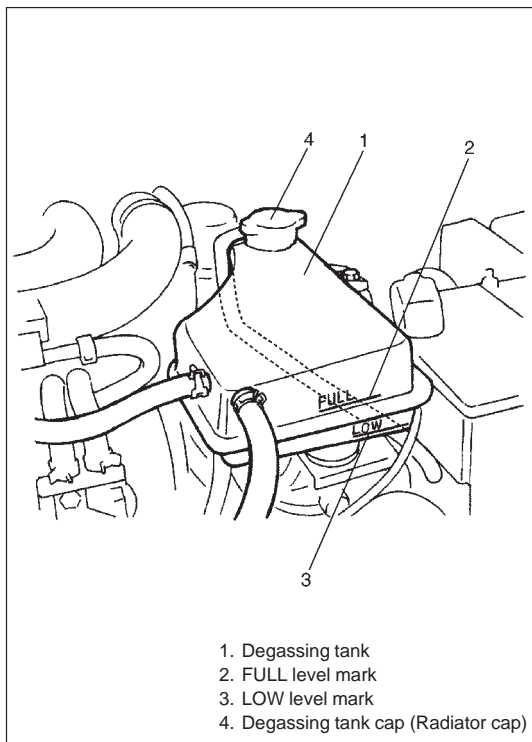
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GENERAL DESCRIPTION

The cooling system consists of the degassing tank cap, radiator, degassing tank, hoses, water pump, cooling fan, thermostat. The radiator is of tube-and-fin type.

COOLING SYSTEM CIRCULATION





COOLANT DEGASSING TANK

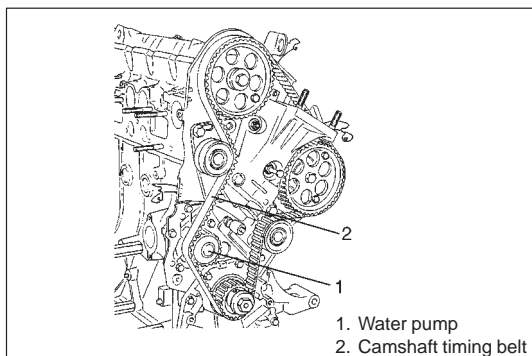
The degassing tank consists of a “see-through” plastic tank, a hose and a radiator cap.

During operation, the coolant circulates inside of the degassing tank constantly. As the coolant warms up and expands, the coolant level in the degassing tank rises. On the other hand, it lowers as the coolant cools down and contracts. When the pressure applied to the inside of the degassing tank constantly exceeds the specified value, the pressure is relieved through the degassing tank cap (radiator cap).

Thus, the radiator is kept filled with coolant to the desired level at all times, resulting in increased cooling efficiency.

Coolant level should be between “FULL” and “LOW” marks on the degassing tank.

Coolant should be added only to the degassing tank as necessary.



WATER PUMP

The water pump is driven by camshaft timing belt.

The water pump can not be disassembled.



THERMOSTAT

A wax pellet type thermostat is used in the coolant outlet passage to control the flow of engine coolant, to provide fast engine warm up and to regulate coolant temperatures.

A wax pellet element is hermetically contained in a metal case, and expands when heated and contracts when cooled.

When the pellet is heated and expands, the metal case pushed down the valve to open it.

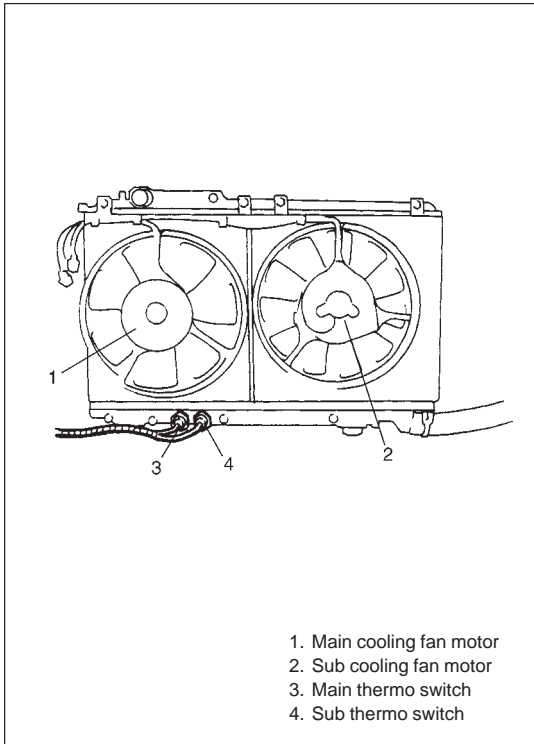
As the pellet is cooled, the contraction allows the spring to close the valve.

Thus, the valve remains closed while the coolant is cold, preventing circulation of coolant through the radiator.

At this point, coolant is allowed to circulate only throughout the engine to warm it quickly and evenly.

As the engine warms, the pellet expands and the thermostat valve opens, permitting coolant to flow through the radiator.

Thermostat functional spec. ~ 1.5·C (2.7·F)	
Temp. at which valve begins to open	83·C (181·F)



COOLING FAN

The cooling fan is driven by electric motor, and the motor is activated by two thermo switches (main and sub).

	Main thermo switch	Sub thermo switch
Temp. at switch "ON"	88· C (190· F)	93· C (199· F)
Temp. at switch "OFF"	82· C (180· F)	87· C (189· F)

WARNING:

Keep hands, tools, and clothing away from engine cooling fan to help prevent personal injury. This fan is electric and can come on whether or not the engine is running. The fan can start automatically in response to the thermo switch with the ignition switch in the "ON" position.

ANTI-FREEZE PROPORTIONING CHART			
Freezing temperature	· C	−16	−36
	· F	3	−33
Antifreeze/ Anticorrosion coolant concentration	%	30	50
Ratio of compound to cooling water	ltr.	2.4/5.6	4.0/4.0
	US pt.	5.1/11.8	8.5/8.5
	Imp. pt.	4.2/9.9	7.1/7.1

COOLANT CAPACITY	
Engine, radiator, heater and de-gassing tank etc.	8.0 liters (16.9/14.1 US/Imp.p.)

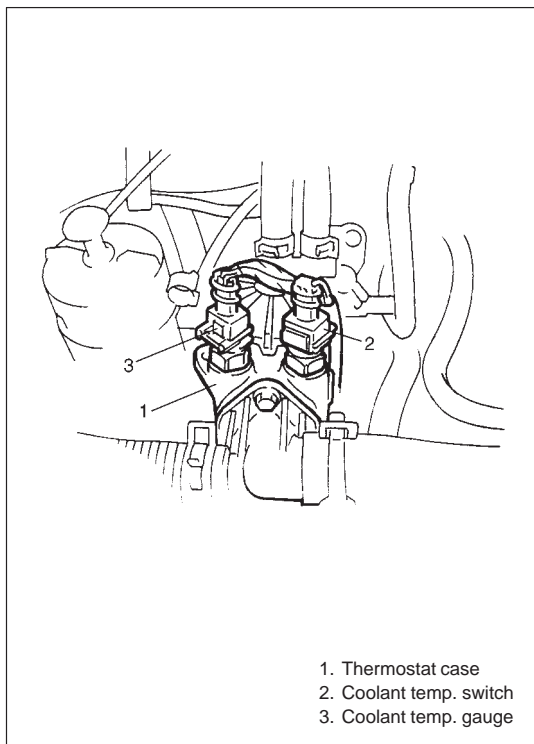
COOLANT

The cooling system has been filled at the factory with a quality coolant that is a 50/50 mixture of water and ethylene glycol antifreeze.

This 50/50 mixture coolant solution provides freezing protection to −36· C (−33· F).

- Maintain cooling system freeze protection at −36· C (−33· F) to ensure protection against corrosion and loss of coolant from boiling.
This should be done even if freezing temperatures are not expected.
- Add ethylene glycol base coolant when coolant has to be added because of coolant loss or to provide added protection against freezing at temperature lower than −36· C (−33· F).

- NOTE:**
- Alcohol or methanol base coolant or plain water alone should not be used in cooling system at any time as damage to cooling system could occur.
 - Even in a market where no freezing temperature is anticipated, mixture 70% water and 30% ethylene glycol antifreeze (Antifreeze/Anticorrosion coolant) should be used for the purpose of corrosion protection and lubrication.
 - "Hard water", if used, will foul up the cooling circuit by scale formation. Tap water available from city water supply is the best available water, in a practical sense, for the cooling system. Distilled water is ideal but is a luxury in most cases.

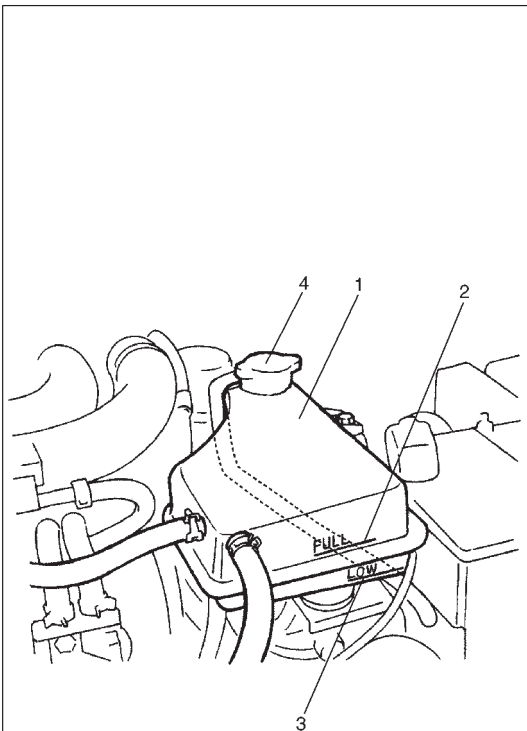


COOLANT (WATER) TEMP. GAUGE AND SWITCH

Coolant (water) temp. gauge and switch are installed to thermostat case. This gauge activates a temp. meter gauge in the instrument cluster and the switch activates a warning lamp in the instrument cluster.

DIAGNOSIS

Condition	Possible cause	Correction
Engine overheats	<ul style="list-style-type: none"> <input type="radio"/> Not enough coolant <input type="radio"/> Faulty thermostat <input type="radio"/> Faulty water pump <input type="radio"/> Dirty or bent radiator fins <input type="radio"/> Coolant leakage on cooling system <input type="radio"/> Defective cooling fan motor <input type="radio"/> Faulty thermo switch or its circuit <input type="radio"/> Plugged radiator <input type="radio"/> Faulty degassing tank cap <input type="radio"/> Dragging brakes <input type="radio"/> Slipping clutch 	<p>Check coolant level and add as necessary.</p> <p>Replace.</p> <p>Replace.</p> <p>Clean or remedy.</p> <p>Repair.</p> <p>Check and replace as necessary.</p> <p>Repair or replace</p> <p>Check and replace radiator as necessary.</p> <p>Replace.</p> <p>Adjust brake.</p> <p>Adjust or replace.</p>



1. Degassing tank
2. Full level mark
3. LOW level mark
4. Degassing tank cap (Radiator cap)

MAINTENANCE

COOLANT LEVEL

To check level, lift hood and look at “see-through” degassing tank. It is not necessary to remove radiator cap to check coolant level.

WARNING:

To help avoid danger of being burned:

- Do not remove degassing tank cap while coolant is “boiling”, and engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if either cap is taken off too soon.

When engine is cool, check coolant level in degassing tank. A normal coolant level should be between “FULL” and “LOW” marks on degassing tank.

If coolant level is below “LOW” mark, remove reservoir tank cap and add proper coolant to tank to bring coolant level up to “FULL” mark. Then, reinstall cap and align match marks on tank and cap.

NOTE:

If proper quality antifreeze is used, there is no need to add extra inhibitors or additives that claim to improve system. They may be harmful to proper operation of system, and are unnecessary expense.

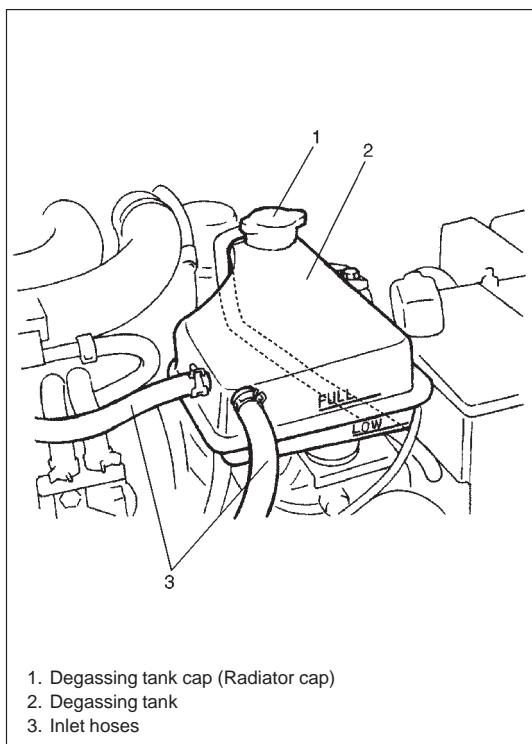
COOLING SYSTEM SERVICE

WARNING:

To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.

Cooling system should be serviced as follows.

- 1) Check cooling system for leakage or damage.
- 2) Wash radiator cap and filled neck with clean water by removing radiator cap when engine is cold.
- 3) Check coolant for proper level and freeze protection.



- 4) Using a pressure tester, check system and degassing tank cap for proper pressure holding capacity 110 kpa (1.1 kg/cm², 15.6 psi). If replacement of cap is required, use proper cap specified torque for this car.

NOTE:

After installing degassing tank cap to degassing tank, make sure that it is closed certainly as shown in figure. If not, turn cap more as shown figure.

- 5) Tighten hose clamps and inspect all hoses. Replace hoses whenever cracked, swollen or otherwise deteriorated.
- 6) Clean frontal area of radiator core.

COOLING SYSTEM FLUSH AND REFILL

- 1) Remove degassing tank cap (radiator cap) when engine is cool: Turn cap counterclockwise slowly until it reaches a "stop". (Do not press down while turning it.) Wait until pressure is relieved (indicated by a hissing sound) then press down on cap and continue to turn it counterclockwise.

WARNING:

To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.

- 2) With degassing tank cap (radiator cap) removed, run engine until upper radiator hose is hot (this shows that thermostat is open and coolant is flowing through system).
- 3) Stop engine and drain coolant.
- 4) Close drain plug. Add water until system is filled and run engine until upper radiator hose is hot again.
- 5) Repeat steps 3) and 4) several times until drained liquid is nearly colorless.
- 6) Drain system and then close radiator drain plug tightly.
- 7) Pour coolant (50/50 mixture of good quality ethylene glycol anti-freeze and water) up to "FULL" level mark of degassing tank.
- 8) Fill degassing tank up to "FULL" level mark on degassing tank. Reinstall degassing tank cap aligning match marks on degassing tank and cap.
- 9) Start engine and run it at idle speed and under 2,000 r/min. until radiator inlet (upper) hose is hot.

- 10) Run engine at 2,000 r/min. for 2 minutes to purge air in cooling system, with degassing tank cap removed.
- 11) Stop engine.
- 12) Replenish coolant up to "FULL" level mark of degassing tank and reinstall degassing tank cap.

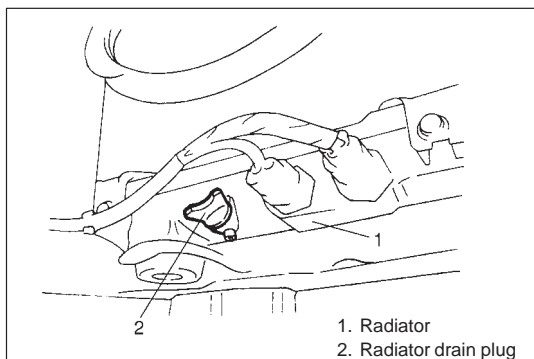
WATER PUMP BELT TENSION

Refer to OVERHAUL CHECKING TUNING MANUAL.

ON-VEHICLE SERVICE

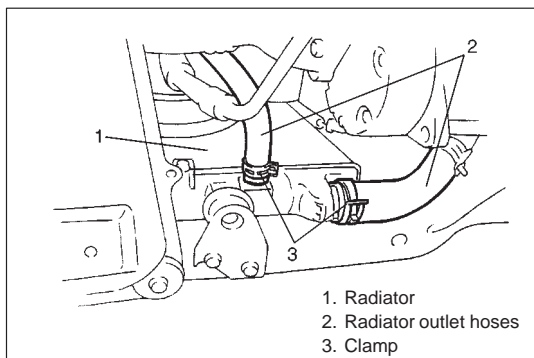
WARNING:

- Check to make sure that engine coolant temperature is cold before removing any part of cooling system.
- Also be sure to disconnect negative cord from battery terminal before removing any part.



COOLING SYSTEM DRAINING

- 1) Remove degassing tank cap.
- 2) Loosen drain plug on radiator to drain coolant.
- 3) After draining coolant, be sure to tighten drain plug securely.
- 4) Fill cooling system. (Refer to Item COOLANT of MAINTENANCE.)



COOLING WATER PIPES OR HOSES

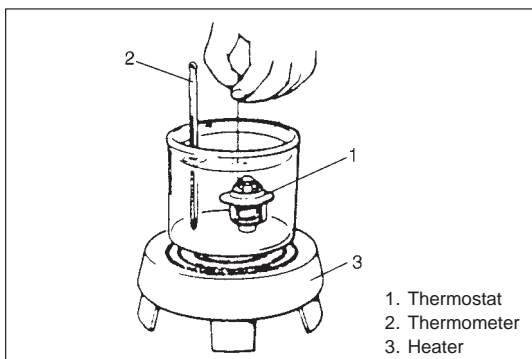
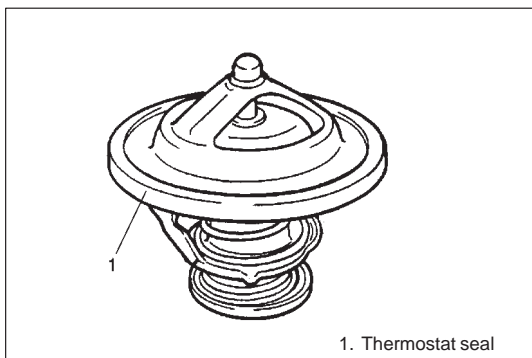
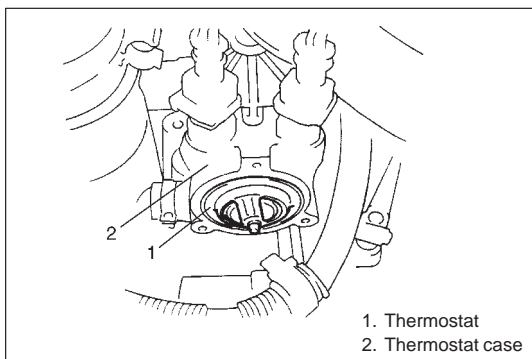
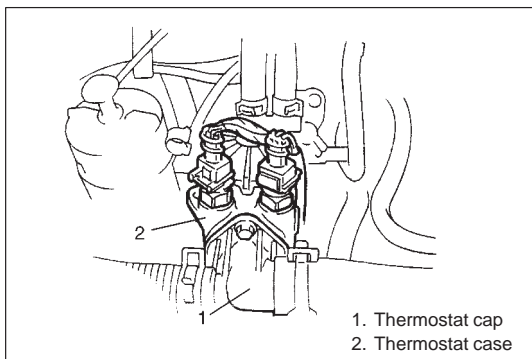
REMOVAL

- 1) Drain cooling system.
- 2) To remove these pipes or hoses, loosen clamp on each hose and pull hose end off.

INSTALLATION

Install removed parts in reverse order of removal procedure, noting the following.

- Tighten each clamp securely.
- Refill cooling system with proper coolant, referring to description on COOLANT of MAINTENANCE.



THERMOSTAT

REMOVAL

- 1) Disconnect negative cable at battery.
- 2) Drain cooling system and tighten drain plug.
- 3) Disconnect thermostat cap from thermostat case.

- 4) Remove thermostat.

INSPECTION

- 1) Check to make sure that valve seat is free from foreign matters which would prevent valve from seating tight.
- 2) Check thermostat seal for breakage, deterioration or any other damage.

- 3) Check thermostatic movement of wax pellet as follows:
 - a) Immerse thermostat in water, and heat water gradually.
 - b) Check that valve starts to open at specific temperature.
 - c) If valve starts to open at a temperature substantially below or above specific temperature, thermostat unit should be replaced with a new one. Such a unit, if reused, will bring about overcooling or overheating tendency.

INSTALLATION

Reverse removal procedures.

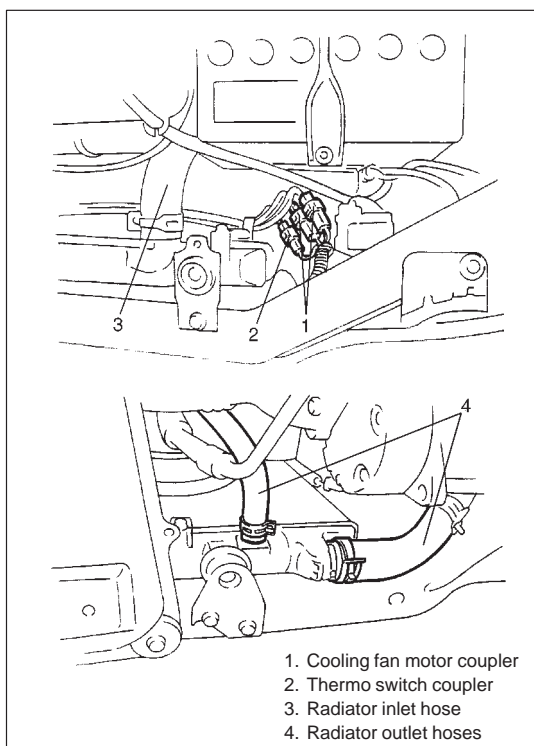
WATER PUMP BELT

Refer to "GENERATOR" under "ON-VEHICLE SERVICE" in Section 6H.

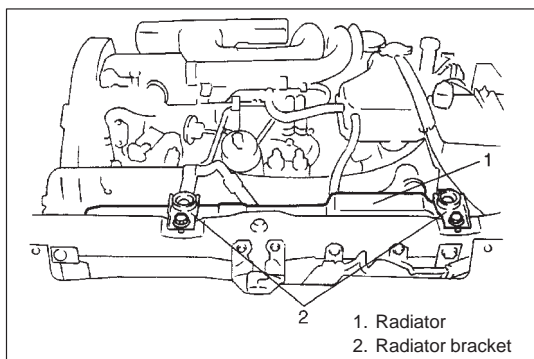
RADIATOR

REMOVAL

- 1) Disconnect negative cable at battery.
- 2) Drain cooling system by loosening drain plug of radiator.
- 3) Disconnect couplers of cooling fan motor and thermo switches.
- 4) Disconnect radiator inlet and outlet hoses and degassing tank hose from radiator.



- 5) Remove radiator brackets and radiator.



INSPECTION

Check radiator for leakage or damage. Straighten bent fins, if any.

CLEANING

Clean frontal area of radiator cores.

INSTALLATION

Reverse removal procedures.

NOTE:

- Refill cooling system with proper coolant referring to COOLANT item of MAINTENANCE.
- After installation, check each joint for leakage.

WATER PUMP

Refer to “DISMANTLING THE ENGINE” and “INSTALLING THE TIMING BELT” of “OVER HAUL CHECKING TUNING MANUAL”.

REQUIRED SERVICE MATERIALS

MATERIALS	USE
Ethylene glycol base coolant (Anti-freeze/Anti-corrosion coolant)	Additive to engine cooling system for improving cooling efficiency and for protection against rusting.

SECTION 6E3

ENGINE AND EMISSION CONTROL SYSTEM (XUD9BSD ENGINE)

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Precautions” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.
- Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).

NOTE:

Please refer to description of XUD9 SD/BSO engine in “OVERHAUL CHECKING TUNING MANUAL” and “ALL MODELS DIESEL DIAGNOSIS MANUAL” listed as related manuals in FOREWORD as well. This section describes DIAGNOSIS, removal, installation and inspection of parts and gives an instruction to refer to “OVERHAUL CHECKING TUNING MANUAL” or “ALL MODELS DIESEL DIAGNOSIS MANUAL” as necessary.

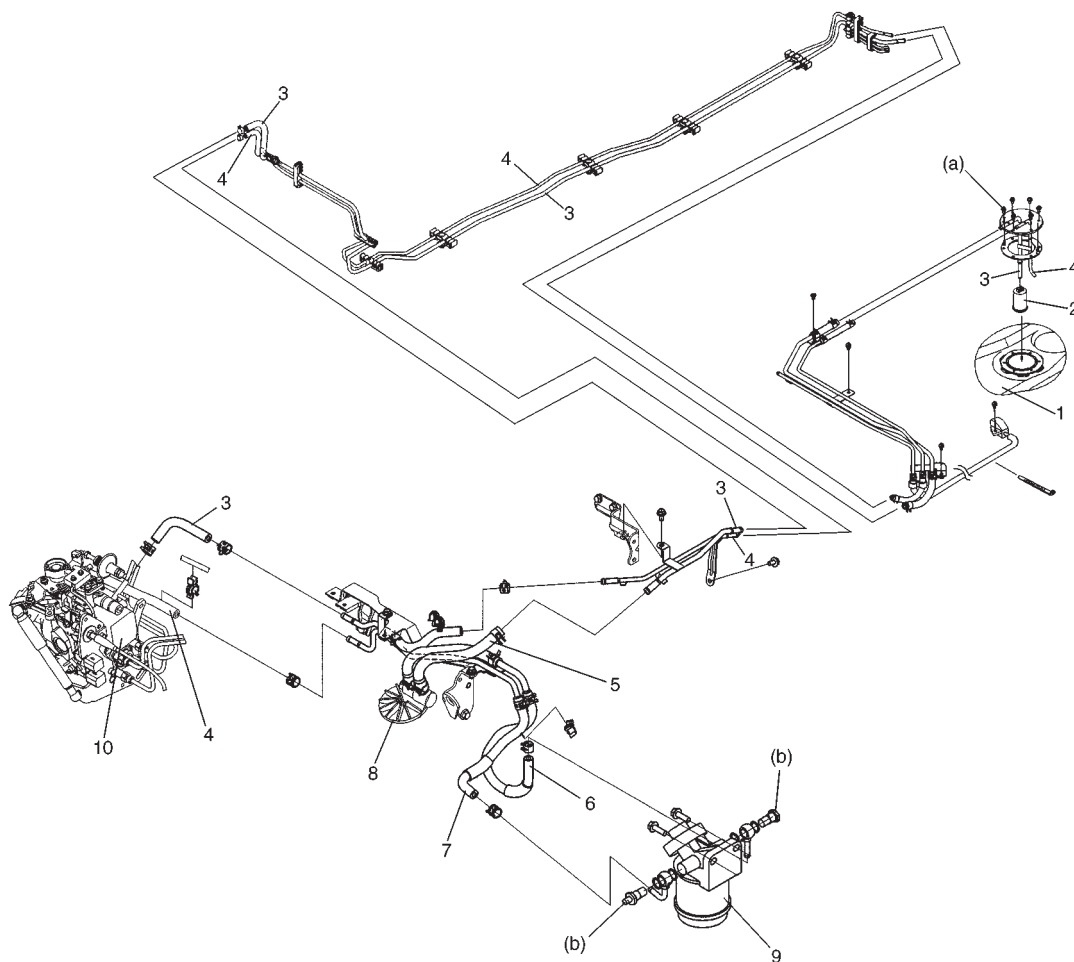
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Electric Control System	6E3- 4	Injector Needle Sensor	6E3-14
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Vacuum Pump	6E3-11		

GENERAL DESCRIPTION

FUEL DELIVERY SYSTEM

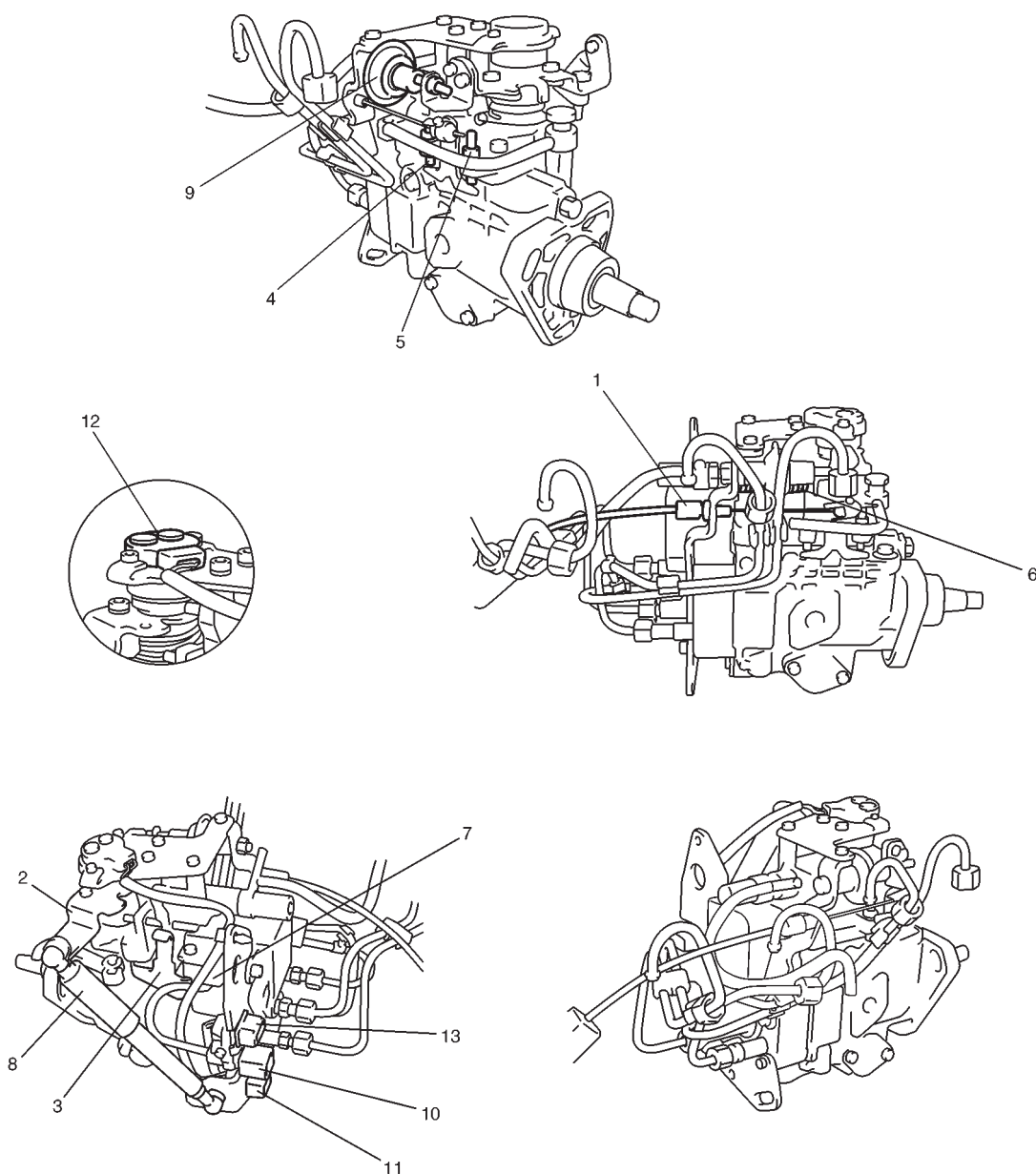


- 1. Fuel tank
- 2. Fuel net filter
- 3. Fuel feed line
- 4. Fuel return line
- 5. Fuel hose (to fuel heater)

- 6. Fuel hose (to fuel filter)
- 7. Fuel hose (to fuel injection pump)
- 8. Fuel heater
- 9. Fuel filter
- 10. Fuel injection pump

Tightening torque
(a) : 1.6 N·m (0.2 kg-m)
(b) : 40.0 N·m (4.0 kg-m)

FUEL INJECTION PUMP

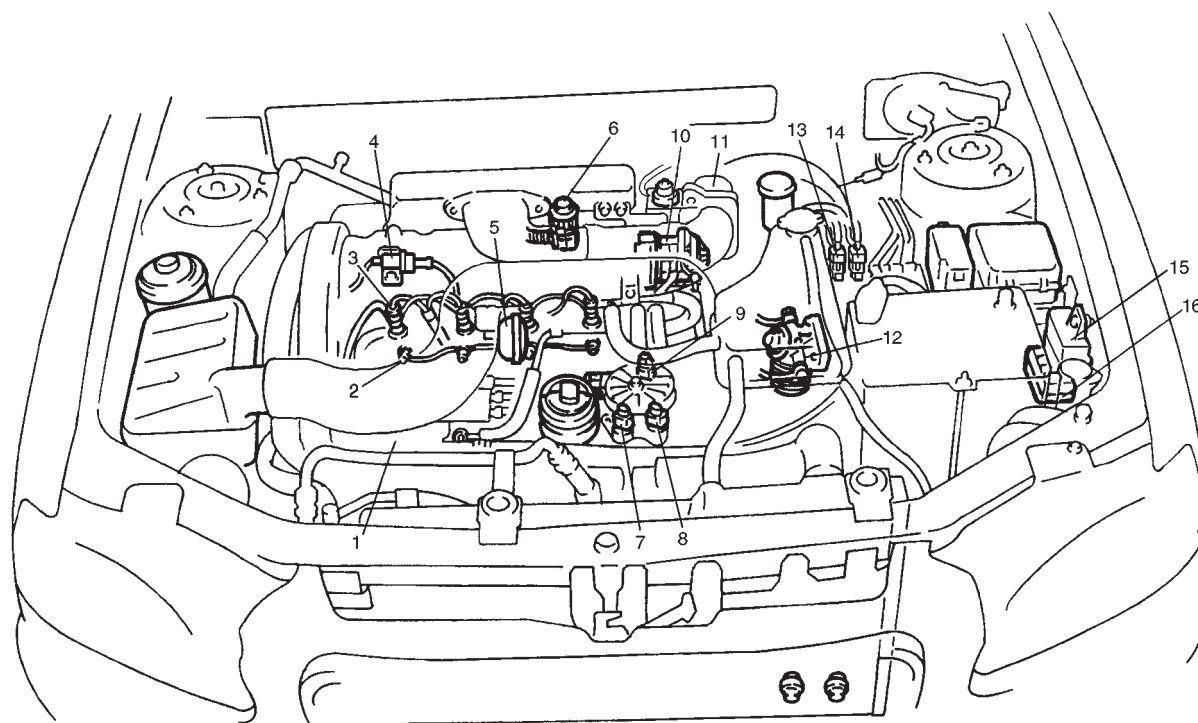


- 1. First idle thermostatic component
- 2. Load lever
- 3. Manual engine stop lever
- 4. Idle adjustment screw
- 5. Fast idle adjustment screw

- 6. Residual flow adjustment screw
- 7. Stop solenoid valve
- 8. Load lever damper
- 9. Dash pot

- 10. Immobilizing actuator
- 11. Throttle position sensor
- 12. Load lever position copy potentiometer
- 13. Injection timing control actuator

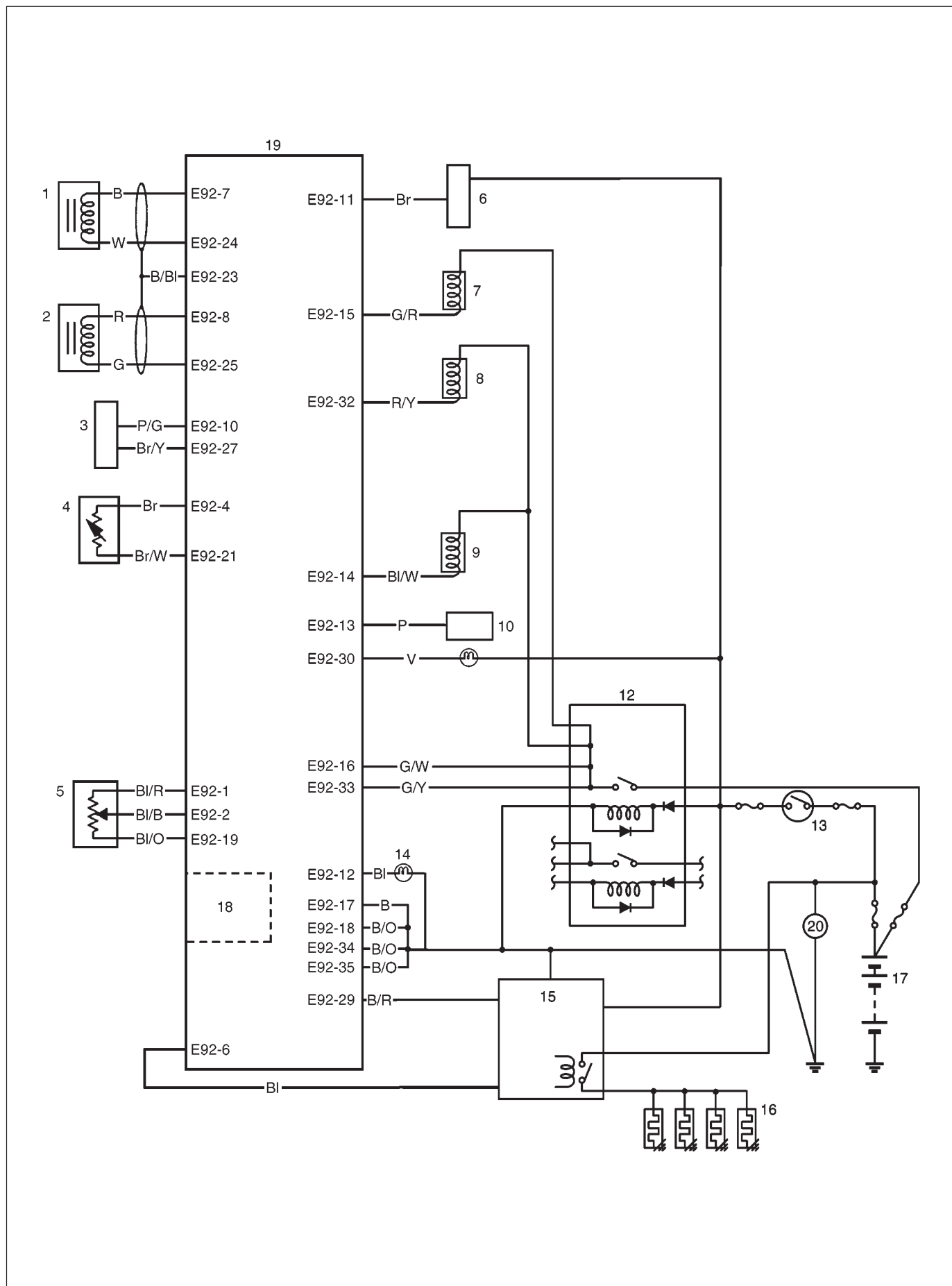
ELECTRIC CONTROL SYSTEM



1. Fuel injection pump
2. Glow plug
3. Fuel injector
4. Injector needle sensor
5. Regulator
6. EGR No.1 valve
7. Coolant temp. gauge
8. Coolant temp. switch

9. ECT sensor
10. Vacuum pump
11. EGR No.2 valve
12. Fuel filter
13. EGR No.1 solenoid valve
14. EGR No.2 solenoid valve
15. Double relay
16. Glow plug control relay

SYSTEM DIAGRAM



TERMINAL ARRANGEMENT OF ECM COUPLER (VIEWED FROM HARNESS SIDE)

E92

18	17	16	15	14	13	12	11	10		8	7	6		4		2	1
35	34	33	32		30	29		27		25	24	23		21		19	

TERMINAL	CIRCUIT
1	Power supply for sensor
2	Throttle position sensor (+)
3	–
4	Coolant temp. sensor (+)
5	–
6	Glow plug signal
7	Injector needle sensor (+)
8	Crankshaft position (CKP) sensor (+)
9	–
10	Data link connector
11	Tachometer signal
12	Glow plug lamp
13	A/C controller (if equipped)
14	EGR No.1 solenoid valve signal
15	Injection timing control actuator signal
16	Power source (from battery)
17	Ground
18	Ground

TERMINAL	CIRCUIT
19	Throttle position sensor (–)
20	–
21	Coolant temp. sensor (–)
22	–
23	Ground for sensor shield wire
24	Injector needle sensor (–)
25	Crankshaft position (CKP) sensor (–)
26	–
27	Data link connector
28	–
29	Glow plug control relay
30	Warning lamp
31	–
32	EGR No.2 solenoid valve signal
33	Power source (from battery)
34	Ground
35	Ground

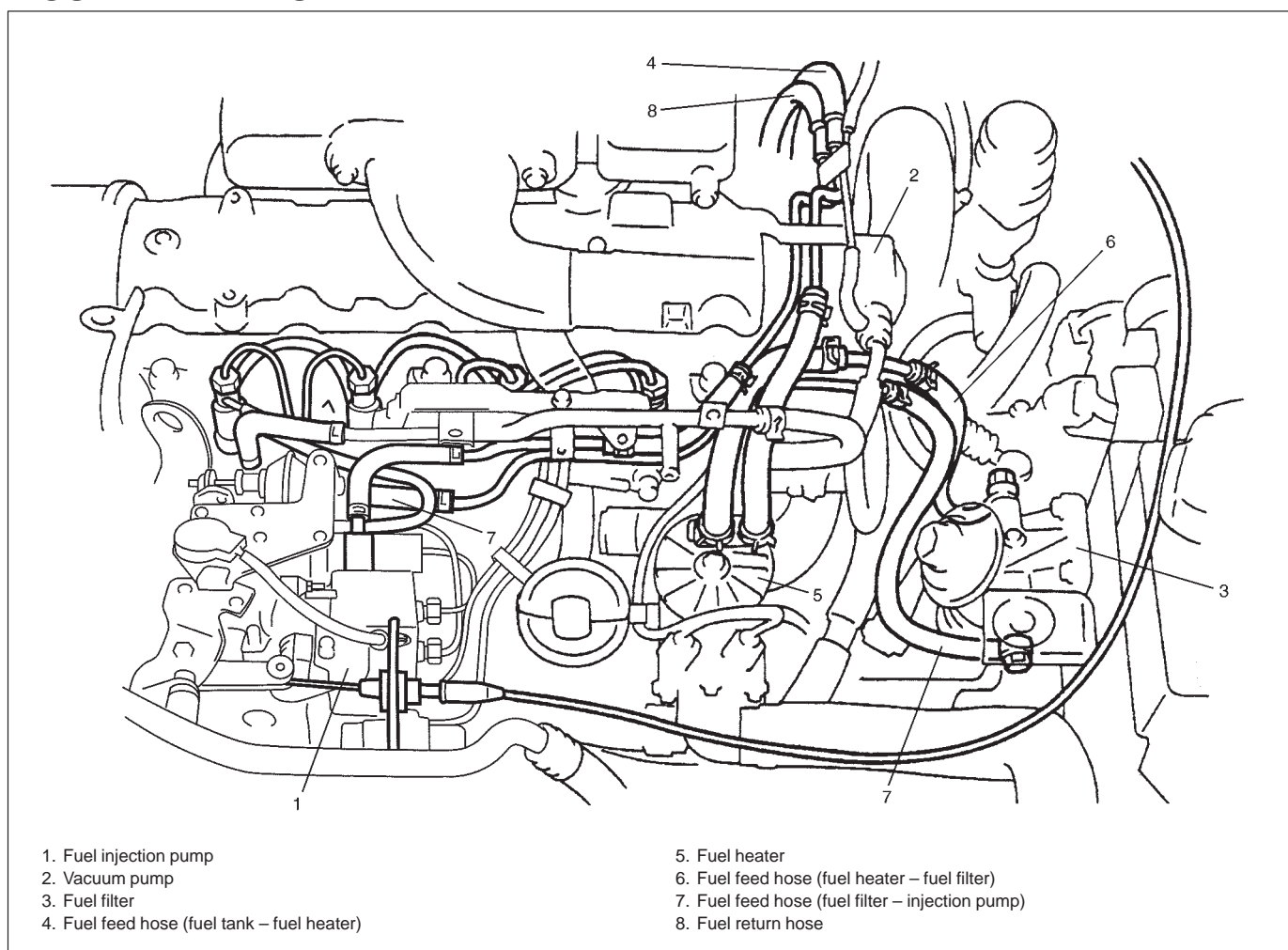
- 1.Injector needle sensor
- 2.Crankshaft position (CKP) sensor
- 3.DLC
- 4.Coolant temp. sensor
- 5.Throttle position sensor
- 6.Tachometer
- 7.Injection timing control actuator
- 8.EGR No.2 solenoid valve
- 9.EGR No.1 solenoid valve
- 10.A/C controller
- 11.Warning lamp
- 12.Double relay
- 13.Ignition switch
- 14.Glow plug indicator lamp
- 15.Glow plug control relay
- 16.Glow plug
- 17.Battery
- 18.Barometric pressure sensor
- 19.ECM
- 20.Generator

Wire color

- B : Black
 B/Bl : Black/Blue
 B/O : Black/Orange
 B/R : Black/Red
 Bl : Blue
 Bl/B : Blue/Black
 Bl/O : Blue/Orange
 Bl/R : Blue/Red
 Bl/W : Blue/White
 Br : Brown
 Br/W : Brown/White
 Br/Y : Brown/Yellow
 G : Green
 G/R : Green/Red
 G/W : Green/White
 G/Y : Green/Yellow
 P : Pink
 P/G : Pink/Green
 R : Red
 R/Y : Red/Yellow
 V : Violet
 W : White

ON-VEHICLE SERVICE

HOSE AND PIPES



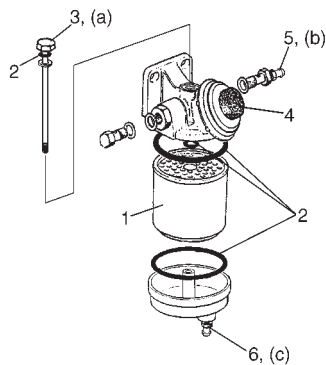
GENERAL

When hoses are disconnected and system components are removed for service, reinstall components properly, and route and connect hoses correctly after service. Refer to above figure for proper routing of hoses.

IDLE SPEED INSPECTION AND ADJUSTMENT

For adjustment of idle speed, refer to “Injection pump setting: BOSCH equipment” in “Overhaul checking tuning manual” for procedure. And the table below for specific idle speed value.

Idle speed [RPM]	Vehicle
870 ~ 25	Not equipped with A/C
	Equipped with A/C



1. Fuel filter
2. O-ring
3. Fuel filter bolt
4. Priming pump
5. Fuel filter bleeding screw
6. Water bleeding screw

FUEL FILTER

REPLACEMENT

WARNING:

This work must be performed in a well ventilated area and away from any open flames.

- 1) Remove fuel filter bolt.
- 2) Replace fuel filter (1) and O-rings.
- 3) Tighten fuel filter bolt.

Tightening torque

(a): 9 N·m (0.9 kg·m, 6.5 lb·ft)

- 4) Loose fuel filter bleeding screw.
- 5) Bleed fuel filter by working priming pump until there is no more air in the circuit.
- 6) Tighten fuel filter bleeding screw.

Tightening torque

(b): 5 N·m (0.5 kg·m, 4.0 lb·ft)

- 7) Check for fuel leakage.

WATER DRAINING

- 1) Loose water bleeding screw.
- 2) When water stops, tighten water bleeding screw to specified torque.

Tightening torque

(c): 3.5 N·m (0.4 kg·m, 2.5 lb·ft)

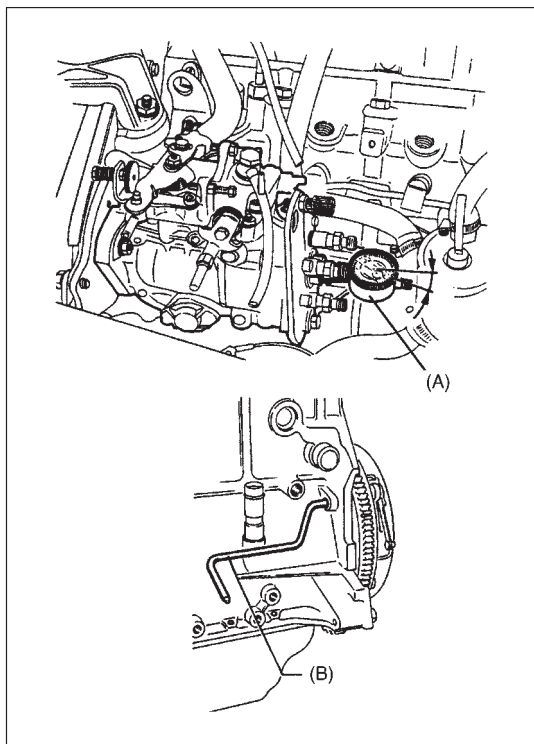
- 3) Check for fuel leakage.

FUEL INJECTION PUMP

NOTE:

Overhaul of injection pump requires use of special tools and testers, and therefore, pump is sealed to prevent unauthorized service.

Remove injection pump from engine referring to "Dismantling the engine" in "Overhaul checking tuning manual".



FUEL INJECTION PUMP STATIC TIMING ADJUSTMENT AND CHECKING

Adjust and check fuel injection static timing. Refer to the following items in "Overhaul checking tuning manual".

"Timing the injection pump (method 2: Timing at TDC, preparing the injection BOSCH pump)"

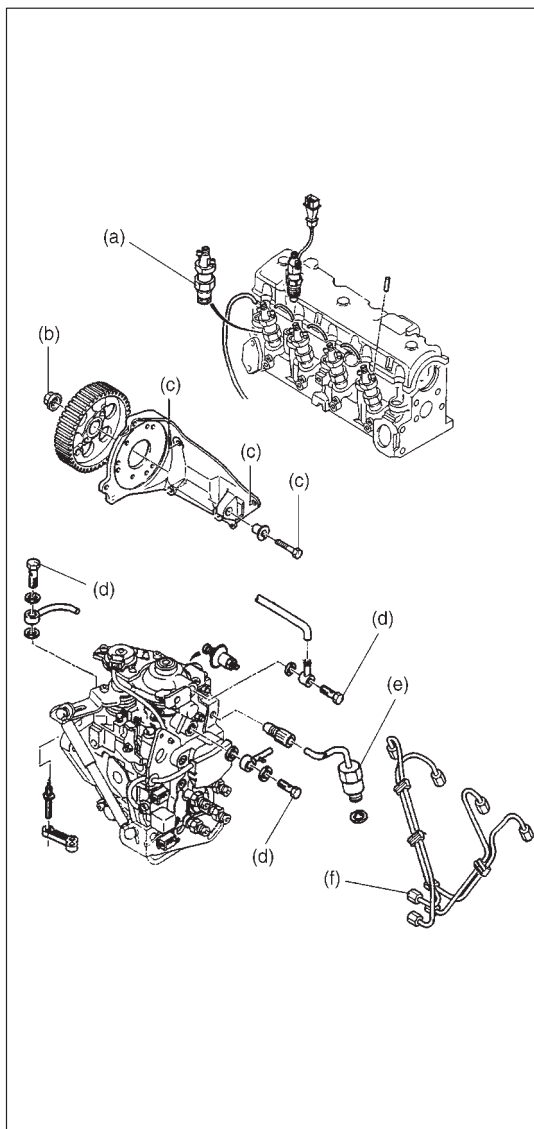
"Injection pump settings: BOSCH equipment"

"Checking the injection pump timing (method 2: BOSCH pump)"

Special tool

(A): 09900-20606

(B): 09910-26520 / OUT0000015



REMOVAL AND INSTALLATION

1) Refer to the following items in "Overhaul checking tuning manual".

"Dismantling the engine"

"Installing the timing belt"

Tightening torque

(a): 90 N·m (9.0 kg-m, 65.0 lb-ft)

(b): 50 N·m (5.0 kg-m, 36.5 lb-ft)

(c): 20 N·m (2.0 kg-m, 14.5 lb-ft)

(d): 25 N·m (2.5 kg-m, 18.0 lb-ft)

(e): 30 N·m (3.0 kg-m, 22.0 lb-ft)

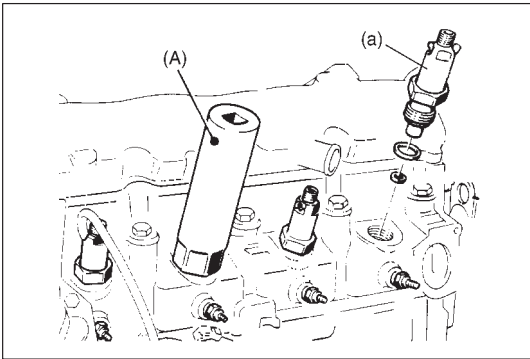
(f): 25 N·m (2.5 kg-m, 18.0 lb-ft)

"A" Sealant: Rhone Poulenc CAF 33 black

2) Perform "Fuel injection pump static timing adjustment and checking" in this section.

CAUTION:

After replacing fuel pump assembly, be sure to register each fuel pump/immobilizer control module code in immobilizer control module and fuel pump by performing procedure described in "Procedure After Fuel Pump Assembly Replacement" (in section 8G of this manual). Otherwise immobilizer control system can not operate.



FUEL INJECTOR

REMOVAL AND INSTALLATION

Remove and install injector. Refer to the following items in "Overhaul checking tuning manual".

"Removing the injectors"

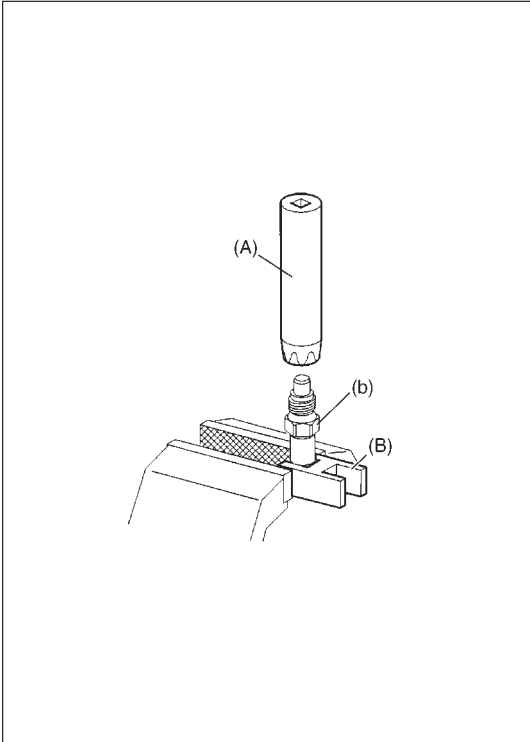
"Reinstalling the injectors"

Special tool

(A): 09915-26510 / OUT0000001

Tightening torque

(a): 90 N·m (9.0 kg-m, 65.0 lb-ft)



DISASSEMBLY AND REASSEMBLY

Disassemble and reassemble injector. Refer to the following items in "Overhaul checking tuning manual".

"Injector overhaul"

"Reassembling the injectors"

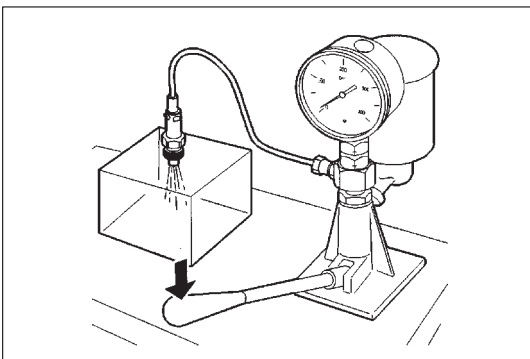
Special tool

(A): 09915-26510 / OUT0000001

(B): 09913-16520 / OUT0000073

Tightening torque

(b): 75 N·m (7.5 kg-m, 54.5 lb-ft)



INSPECTION AND ADJUSTMENT

Inspect and adjust injector. Refer to the following items in "Overhaul checking tuning manual".

"Checking and setting injector timing"

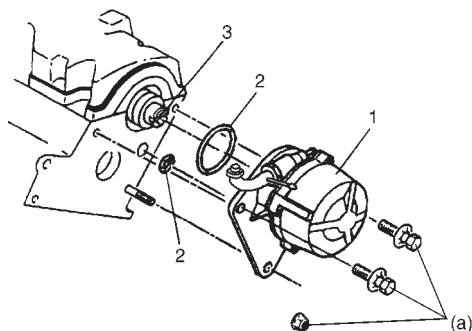
"Checking injector seals"

"Checking injector pressure setting"

"Adjusting injector pressure"

Injector opening pressure

13000 ~ 50 kPa (130 ~ 5 kg/cm²)



- 1. Vacuum pump
- 2. O-ring
- 3. Camshaft

VACUUM PUMP

REMOVAL

- 1) Disconnect hoses attached vacuum pump.
- 2) Remove vacuum pump from cylinder head.

INSTALLATION

- 1) Fit the dogs of vacuum pump coupling into the slot of camshaft.

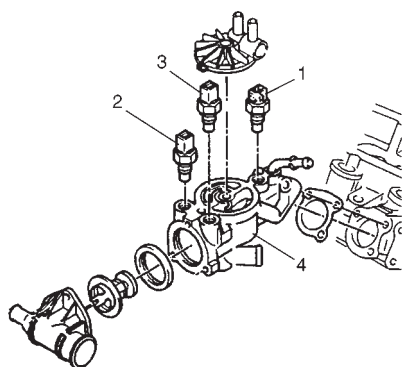
NOTE:

Use new O-rings.

- 2) Install vacuum pump and tighten bolts and nut to specified torque.

Tightening torque

(a): 25 N·m (2.5 kg-m, 18.0 lb-ft)



- 1. ECT gauge (for combination meter)
- 2. ECT switch (for combination meter)
- 3. Water outlet box

ENGINE COOLANT TEMPERATURE SENSOR (ECT SENSOR)

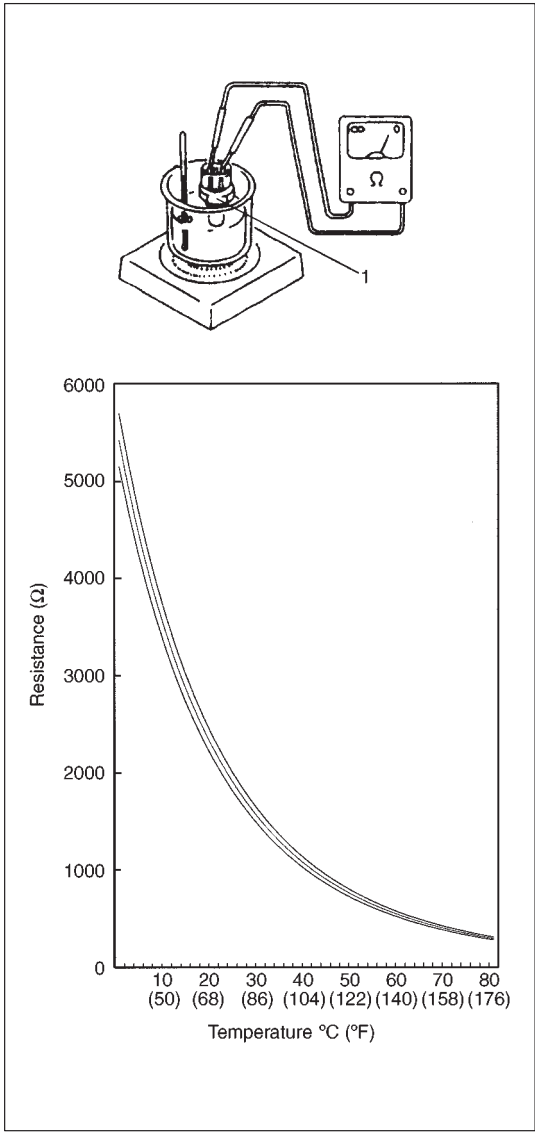
REMOVAL

- 1) Disconnect battery negative cable at battery.
- 2) Drain coolant referring to Section 6B.

WARNING:

To help avoid danger of being burned, do not remove radiator cap while engine and radiator are still hot. Scalding fluid and steam can be blown out under pressure if cap is taken off too soon.

- 3) Disconnect connector from ECT sensor.
- 4) Remove ECT sensor (1) from water outlet box.

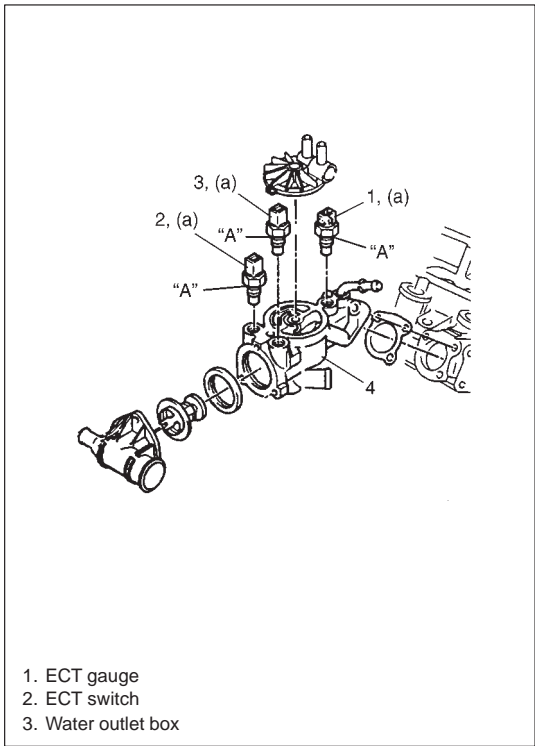


INSPECTION

Immerse temperature sensing part of ECT sensor (1) in water (or ice) and measure resistance between terminal while heating water gradually.

If measured resistance doesn't show such characteristic as shown below, replace ECT sensor (1).

Temperature (·C (·F))	Resistance (I)
20 (68)	2426 – 2592
40 (104)	1103 – 1211
80 (176)	271 – 347



INSTALLATION

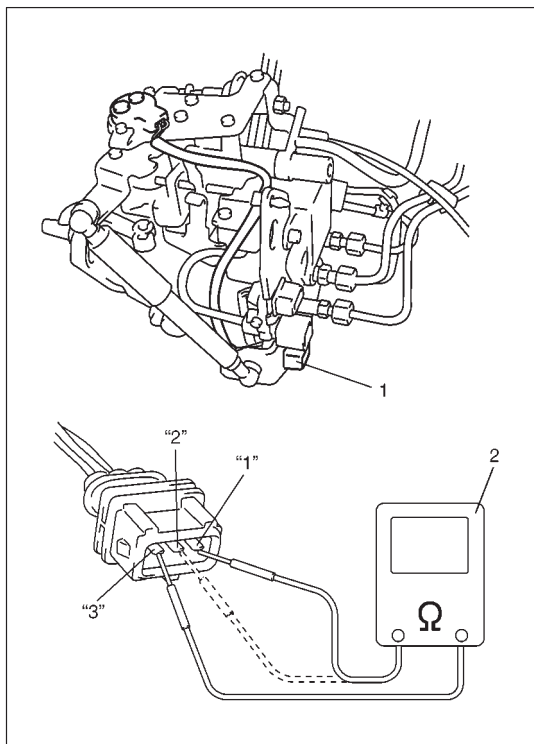
Reverse removal procedure noting the following:

- Clean mating surfaces of ECT sensor (1) and water outlet box.
- Tighten ECT sensor (1) that is applied with sealant "A" to specified torque.

Sealant "A":
LOCTITE 572

Tightening Torque
(a): 18 N·m (1.8 kg·m, 13.0 lb·ft)

- Connect connector to ECT sensor (1) securely.
- Refill coolant referring to Section 6B.



THROTTLE POSITION SENSOR (TP SENSOR)

INSPECTION

- 1) Disconnect negative cable at battery and disconnect throttle position sensor (1) connector.
- 2) Using an ohmmeter (2), check potentiometer resistance between terminals under each condition given in table below.
If check result is not satisfactory, replace injection pump assembly.

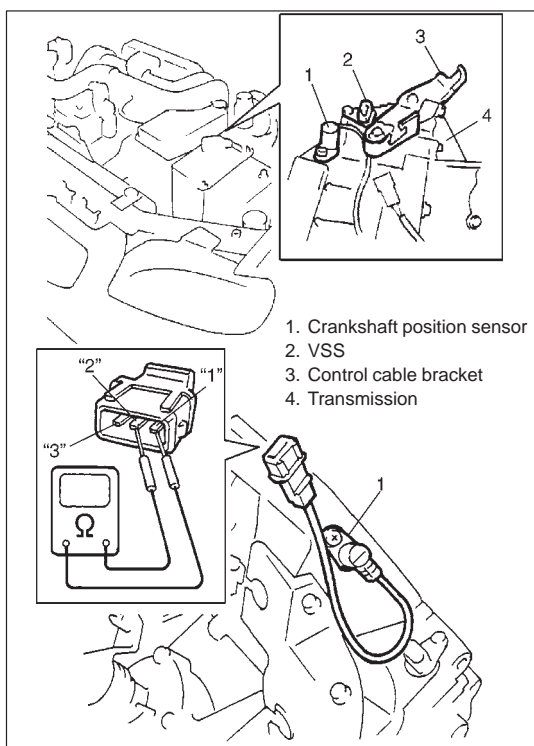
TP sensor potentiometer resistance

TERMINALS	RESISTANCE
Between "1" and "3" terminals	1700 Ω ~ 100 Ω
Between "2" and "3" terminals	1200 Ω ~ 60 Ω - 1800 Ω ~ 90 Ω varying according to throttle valve opening

NOTE:

There should be more than 600 Ω resistance difference between when throttle valve is at idle position and when it is fully open.

- 3) Connect throttle position sensor (1) connector.
- 4) Connect negative cable to battery.



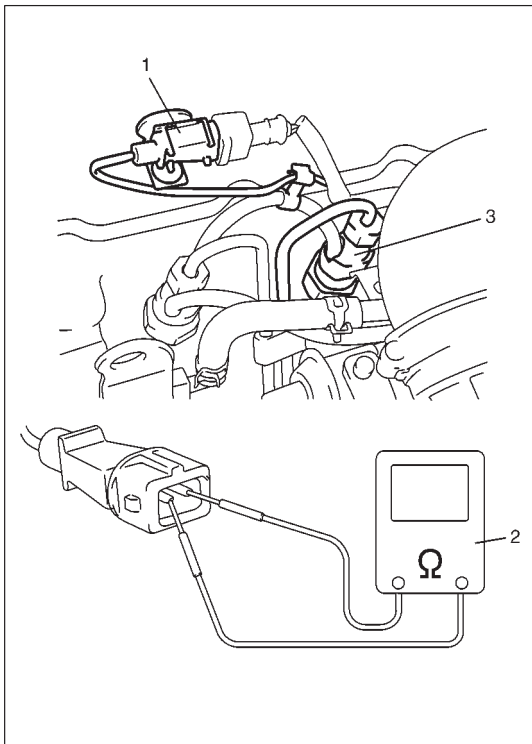
CRANKSHAFT POSITION SENSOR

INSPECTION

- 1) Disconnect negative cable at battery.
- 2) Disconnect engine position sensor coupler.
- 3) Using an ohmmeter, check sensor coil resistance between terminal "1" and terminal "2".
If check result is not satisfactory, replace crankshaft position sensor.

Engine position sensor coil resistance: 315 – 405 Ω

- 4) Connect crankshaft position sensor coupler.
- 5) Connect negative cable to battery.



INJECTOR NEEDLE SENSOR

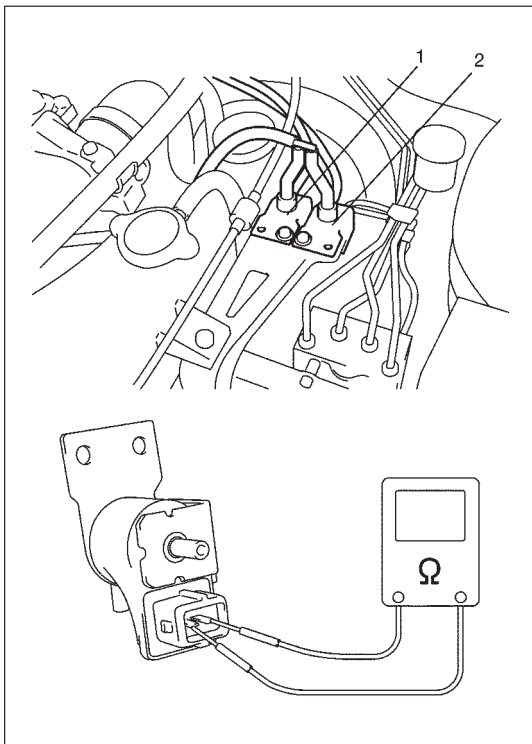
INSPECTION

- 1) Disconnect negative cable at battery.
- 2) Disconnect injector needle sensor (1) at coupler.
- 3) Using an ohmmeter (2), check sensor coil resistance between terminals.

If check result is not satisfactory, replace injector (3) with needle sensor.

Injector needle sensor coil resistance: 66 – 153 Ω

- 4) Connect injector needle sensor coupler.
- 5) Connect negative cable to battery.



EGR NO.1 AND NO.2 SOLENOID VALVE

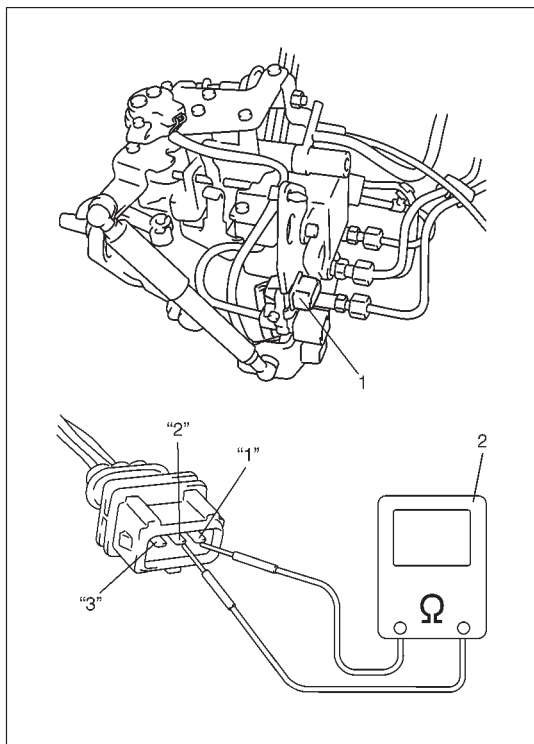
INSPECTION

- 1) Disconnect negative cable at battery.
- 2) Disconnect EGR No.1 (1), or No.2 (2) solenoid valve coupler.
- 3) Remove EGR No.1 (1) or No.2 (2) solenoid valve.
- 4) Using an ohmmeter, check solenoid valve coil resistance between terminals.

If check result is not satisfactory, replace EGR solenoid valve.

EGR solenoid valve coil resistance: 23 – 40 Ω

- 5) Install EGR solenoid valve.
- 6) Connect EGR solenoid valve connector.
- 7) Connect negative cable to battery.



INJECTION TIMING CONTROL ACTUATOR

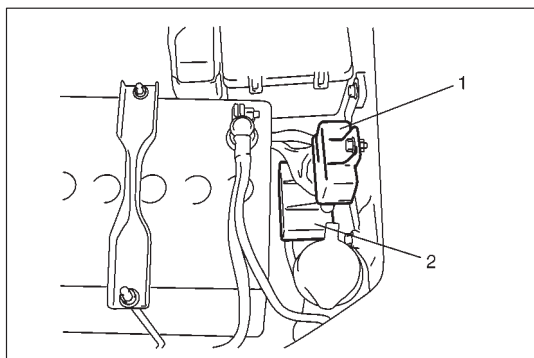
INSPECTION

- 1) Disconnect negative cable at battery.
- 2) Disconnect injection timing control actuator (1) at connector.
- 3) Using an ohmmeter (2), check injection timing control actuator coil resistance between terminals.

If check result is not satisfactory, replace injection pump assembly.

Injection timing control actuator coil resistance: 10 – 23 Ω

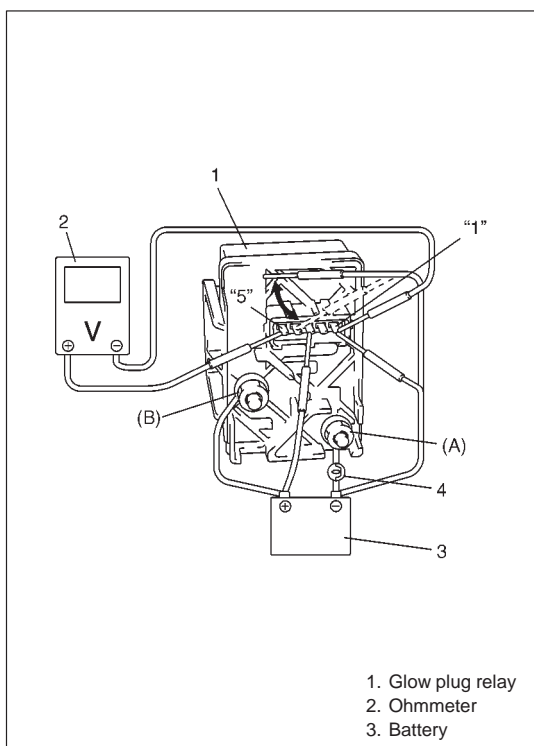
- 4) Connect injection timing control actuator connector.
- 5) Connect negative control at battery.



GLOW PLUG RELAY

INSPECTION

- 1) Disconnect negative cable at battery.
- 2) Remove double relay (1).
- 3) Remove glow plug relay (2).

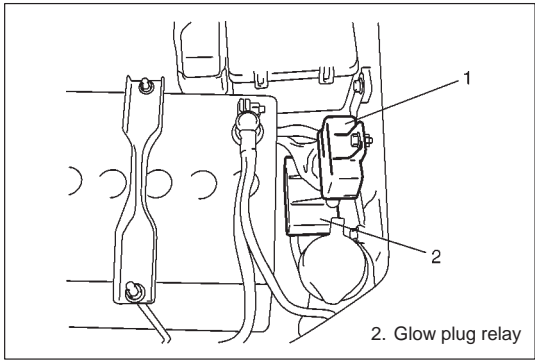


- 4) Connect test bulb (4) between terminal (A) and negative battery terminal as shown.
- 5) Connect negative battery terminal to terminal "1" and positive battery terminal to terminal "3" of relay.
- 6) Check voltage between terminal "1" and terminal "5" of relay and check bulb lights.

If measured voltage is less than 3 V and bulb doesn't light up, relay is in good condition. If not replace relay.

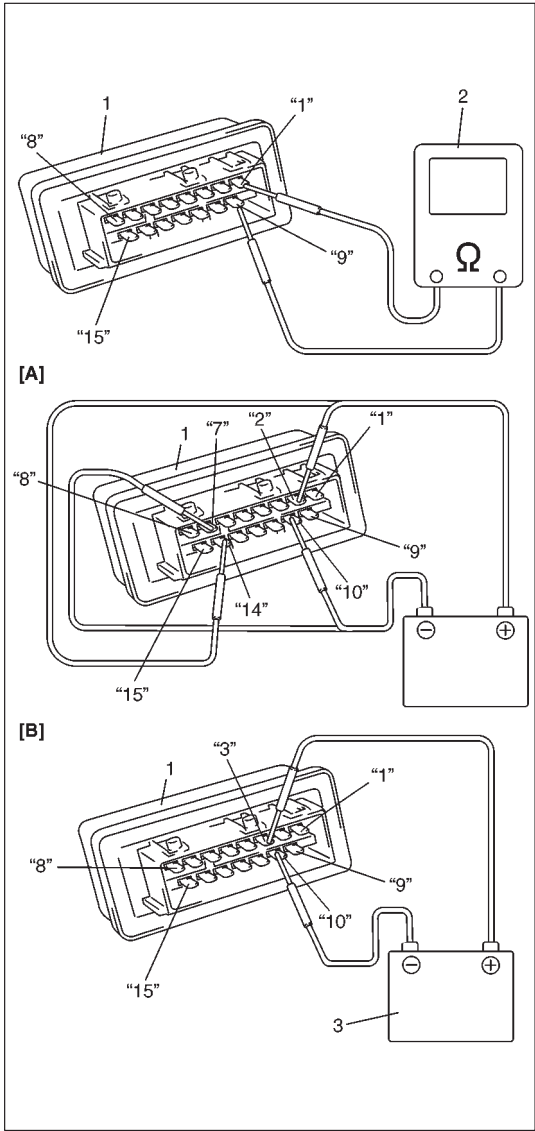
- 7) Connect negative battery to terminal "4" of relay.
- 8) Check voltage between terminal "1" and terminal "5" of relay and check bulb lights.

If measured voltage is more than 3 V and bulb lights up, relay is in good condition. If not, replace relay.



DOUBLE RELAY

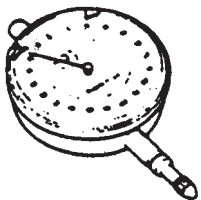

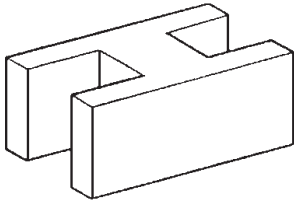
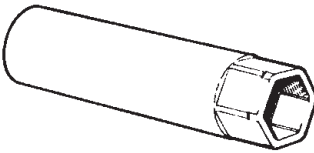
- 1) Disconnect negative cable at battery.
- 2) Remove double relay (1).



- 3) Using an ohmmeter, check continuity between each terminals under each condition given in table below.
If check result is not satisfactory, replace main relay.

Condition	Terminals														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Not connect battery terminal to terminal "2" and "14", and "7" and "10"				○	○	○							○		○
Connect positive battery terminal to terminal "2" and "14", and negative battery terminal to terminal "7" and "10" (fig.[A])				○	○	○		○					○	○	
Connect positive battery terminal to terminal "3" and negative battery terminal to terminal "10" (fig.[B])	○								○	○					

SPECIAL TOOLS

 <p>09900-20606 Dial gauge</p>	 <p>09910-26520 (OUT0000015) TDC rod positioner</p>	 <p>09913-16520 (OUT0000073) Injector flange</p>	 <p>09915-26510 (OUT0000001) Injector socket</p>
---------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------

TIGHTENING TORQUE SPECIFICATIONS

FASTENING PARTS	TIGHTENING TORQUE		
	N·m	kg-m	lb-ft
Coolant temp. switch (on water outlet box)	18.0	1.8	13.0
Fuel injection pump nut, bolt	20.0	2.0	14.5
Fuel injection pump pulley nut	50.0	5.0	36.5
Fuel injector pipe nut	25.0	2.5	18.0
Fuel injector assembly	75.0	7.5	54.5
Fuel injector	90.0	9.0	65.0
Fast idle thermo device	30.0	3.0	22.0
Fuel feed pipe bolt (on fuel injection pump)	25.0	2.5	18.0
Fuel return pipe bolt (on fuel injection pump)	25.0	2.5	18.0
Fuel feed pipe bolt bleeding screw (on fuel injection pump)	4.5	0.5	3.5
Fast idle control cable fix bolt	4.0	0.4	3.0
Fast idle control cable adjusting nut	6.0	0.6	4.5
Glow plug	22.0	2.2	16.0
Glow plug wiring nut	4.0	0.4	3.0
Vacuum pump bolt and nut	25.0	2.5	18.0
Fuel filter outlet pipe bolt	40.0	4.0	29.0
Fuel filter inlet pipe bolt	40.0	4.0	29.0
Fuel filter inlet pipe bolt bleeding screw	5.0	0.5	4.0
Fuel filter element bolt	9.0	0.9	6.5
Fuel filter water bleeding screw	3.5	0.4	2.5

SECTION 6G4

CRANKING SYSTEM

(1.7kW Reduction Type)

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Precautions” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.
- Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).

NOTE:

For descriptions (items) not found in this section, refer to the same section of the Service Manual mentioned in FOREWORD of this manual.

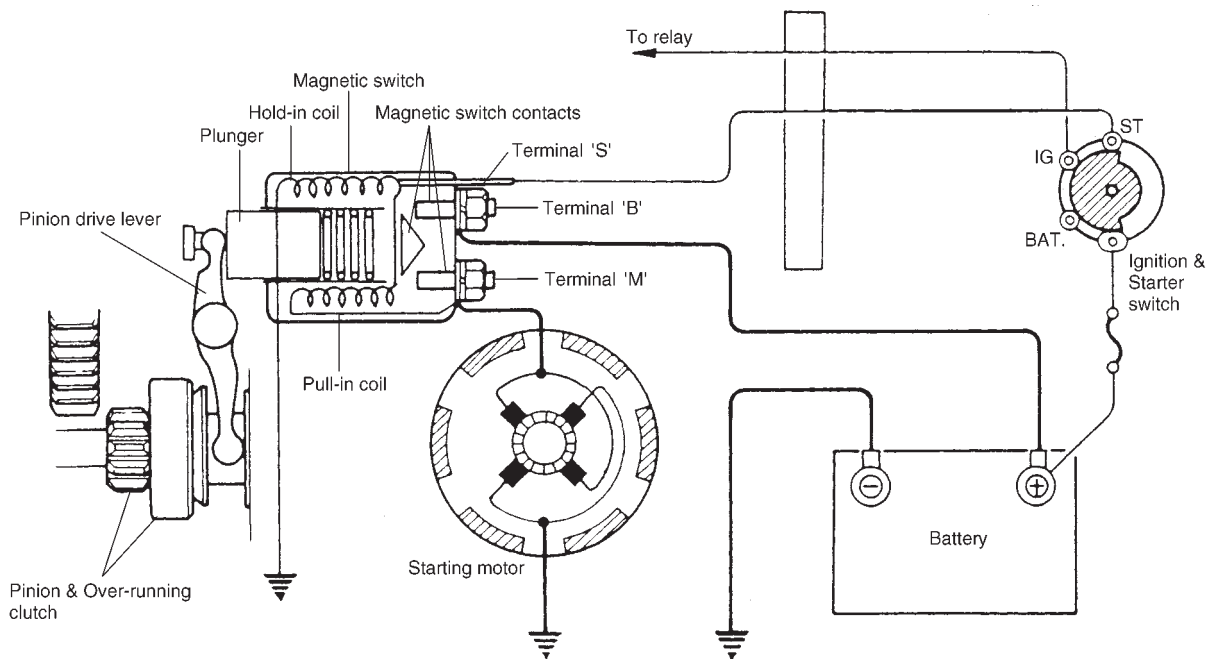
CONTENTS

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GENERAL DESCRIPTION

STARTING MOTOR CIRCUIT

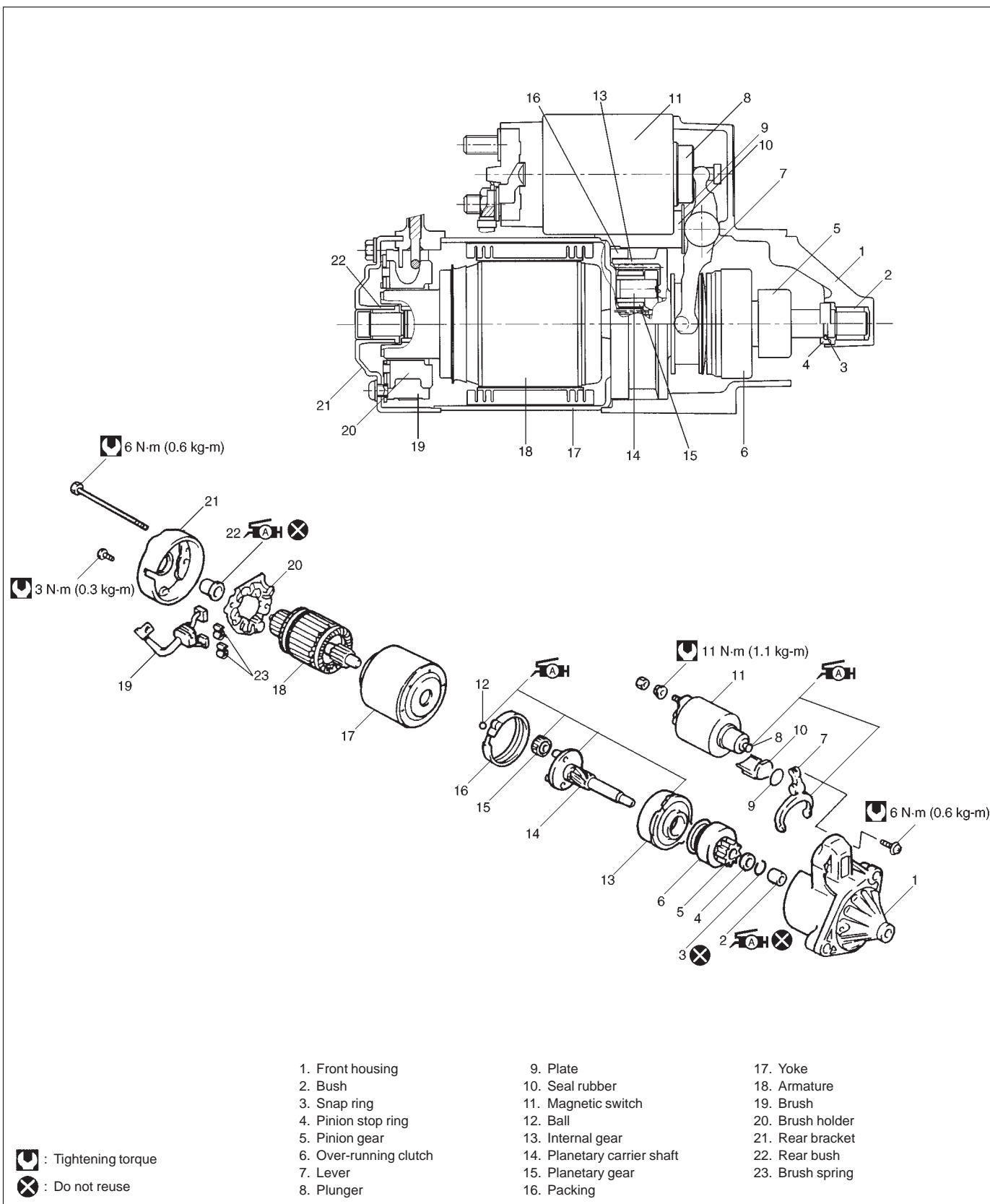
- The magnetic switch coils are magnetized when the ignition switch is closed.
- The resulting plunger and pinion drive lever movement causes the pinion to engage the engine flywheel gear and the magnetic switch main contacts to close, and cranking takes place.
- When the engine starts, the pinion over-running clutch protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage.

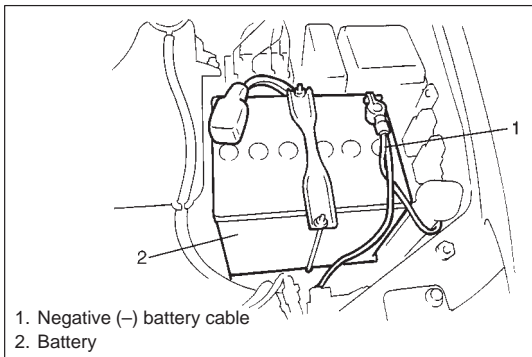


STARTING MOTOR

The starting motor consists of parts shown below and has permanent magnets mounted in starting motor yoke (frame).

The magnetic switch assembly and parts in the starting motor are enclosed in the housings so that they will be protected against possible dirt and water splash.

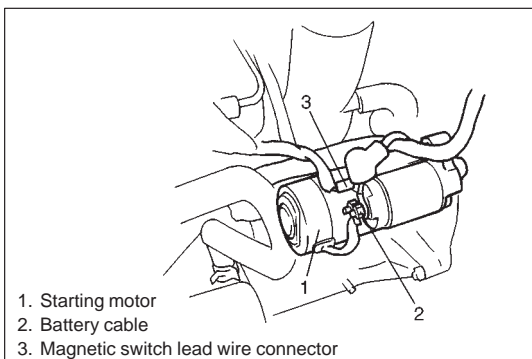




UNIT REPAIR OVERHAUL

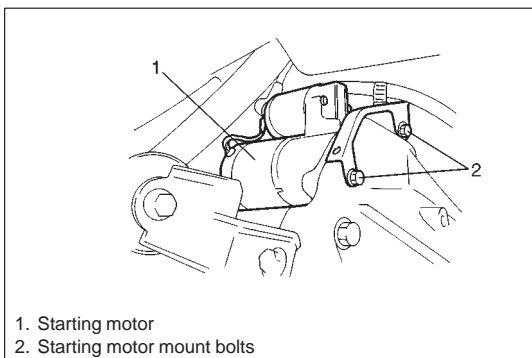
DISMOUNTING

1) Disconnect negative (-) battery cable at battery.



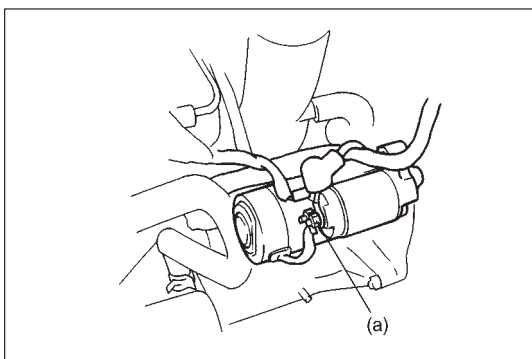
2) Disconnect magnetic switch lead wire and battery cable from starting motor terminals.

3) Remove left side engine under cover.



4) Remove 2 starting motor mount bolts.

5) Dismount starting motor.

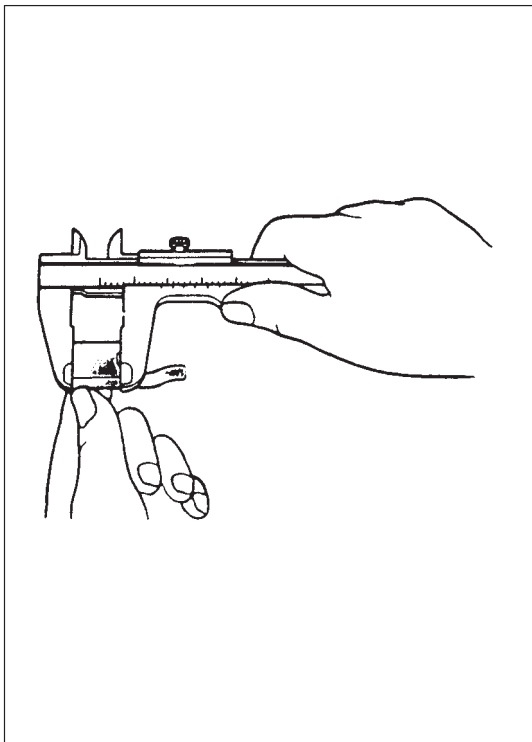


REMOUNTING

Reverse the dismounting procedure.

Tightening Torque

(a): 10 N·m (1.0 kg-m, 7.5 lb-ft)



INSPECTION

BRUSH

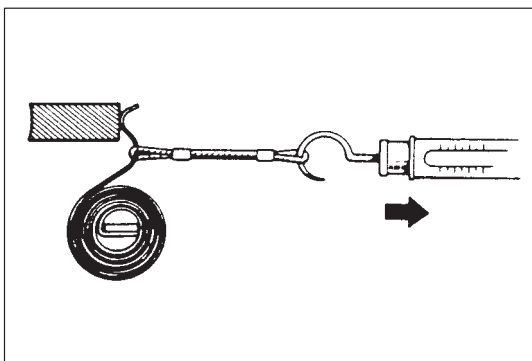
- Check brushes for wear.

Measure length of brushes and if below limit, replace brush assembly.

Brush length

	Length
Standard	17.5 mm (0.69 in.)
Limit	12 mm (0.47 in.)

- Check for smooth movement with the brushes installed to each brush holder.



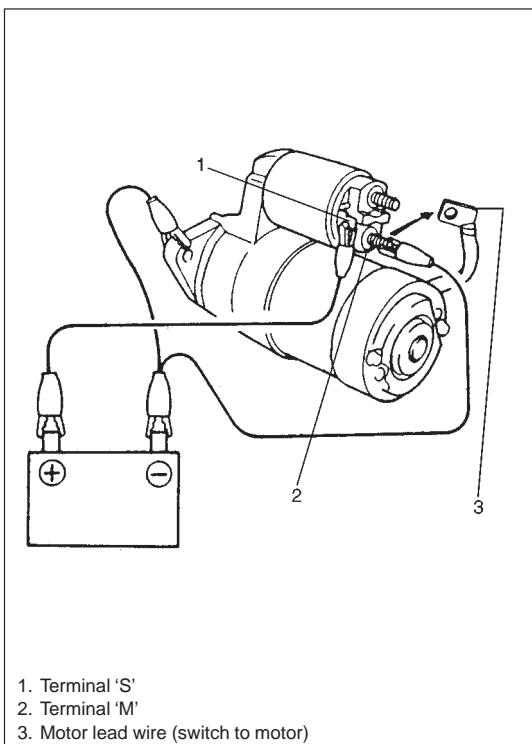
SPRING

Inspect brush springs for wear, damage or other abnormal conditions. Replace brush assembly if necessary.

Brush spring tension

Standard : 23.4 – 31.6 N (2.34 – 3.16 kg, 5.15 – 7.0 lb)

Limit : 10.0 N (1.0 kg, 2.2 lb)



PERFORMANCE TEST

CAUTION:

Each test must be performed within 3 – 5 seconds to avoid coil from burning.

1) Pull-In Test

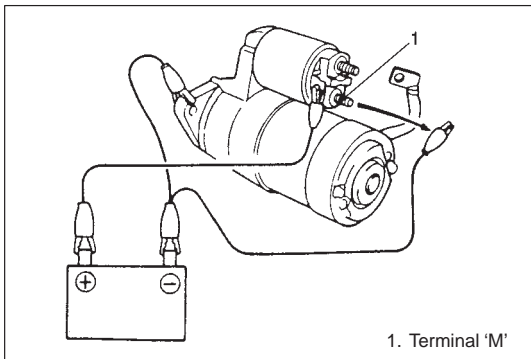
NOTE:

Before testing, disconnect motor lead wire from terminal 'M'.

Connect battery to magnetic switch as shown.

Check that plunger and pinion (over-running clutch) move outward.

If plunger and pinion (over-running clutch) don't move, replace magnetic switch.

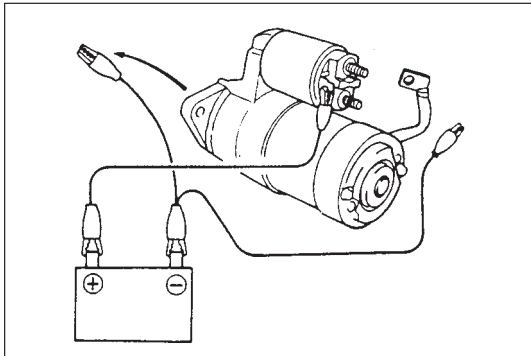


2) Hold-in Coil Test

While connected as above with plunger out, disconnect negative lead from terminal 'M'.

Check that plunger and pinion remain out.

If plunger and pinion return to inward, replace magnetic switch.

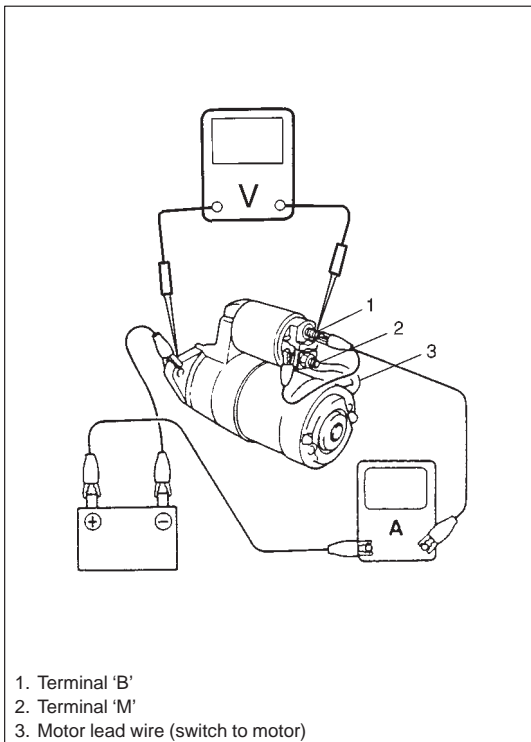


3) Plunger and Pinion Return Test

Disconnect negative lead from starting motor body.

Check that plunger and pinion return inward.

If plunger and pinion don't return, replace magnetic switch.



4) No-Load Performance Test

a) Connect motor lead wire (switch to motor) to terminal 'M'.

b) Connect battery and ammeter to starter as shown.

NOTE:

Use wires as thick as possible (The wire which is as thick as a negative battery cable.) and tighten each terminal.

c) Check that starter rotates smoothly and steadily with pinion moving out. Check that ammeter indicates specified current.

Specified current: 110 A MAX. at 11 V (between terminal 'B' and starter body)

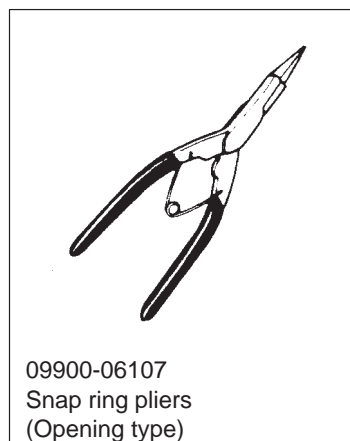
SPECIFICATION

Voltage		12 volts	
Output		1.7 kW	
Rating		30 seconds	
Direction of rotation		Clockwise as viewed from pinion side	
Brush length		17.5 mm (0.69 in.)	
Number of pinion teeth		11	
Performance		Condition	Guarantee
Around at 20·C (68·F)	No load characteristic	11.0 V	110 A maximum 2400 rpm minimum
	Load characteristic	7.7 V 400 A	16.0 N·m (1.6 kg-m, 11.6 lb-ft) minimum 740 rpm minimum
	Locked characteristic	3.5 V	940 A maximum 28.9 N·m (2.9 kg-m, 20.1 lb-ft) minimum
	Magnetic switch operating voltage		8 volts maximum

REQUIRED SERVICE MATERIALS

MATERIALS	RECOMMENDED SUZUKI PRODUCTS	USE
Lithium grease	SUZUKI SUPER GREASE A (99000-25010)	<input type="radio"/> Front and rear bush. <input type="radio"/> Plunger. <input type="radio"/> Pinion drive lever. <input type="radio"/> Internal gear. <input type="radio"/> Planetary carrier shaft. <input type="radio"/> Planetary gear <input type="radio"/> Ball

SPECIAL TOOL



SECTION 6H

CHARGING SYSTEM

WARNING:

For vehicles equipped with Supplemental Restraint (Air Bag) System:

- Service on and around the air bag system components or wiring must be performed only by an authorized SUZUKI dealer. Refer to “System Components and Wiring Location View” under “General Description” in air bag system section in order to confirm whether you are performing service on or near the air bag system components or wiring. Please observe all WARNINGS and “Precautions” in air bag system section before performing service on or around the air bag system components or wiring. Failure to follow WARNINGS could result in unintentional activation of the system or could render the system inoperative. Either of these two conditions may result in severe injury.
- Technical service work must be started at least 90 seconds after the ignition switch is turned to the “LOCK” position and the negative cable is disconnected from the battery. Otherwise, the system may be activated by reserve energy in the Sensing and Diagnostic Module (SDM).

NOTE:

For the descriptions (items) not found in this section, refer to the same section of the Service Manual mentioned in FOREWORD of this manual.

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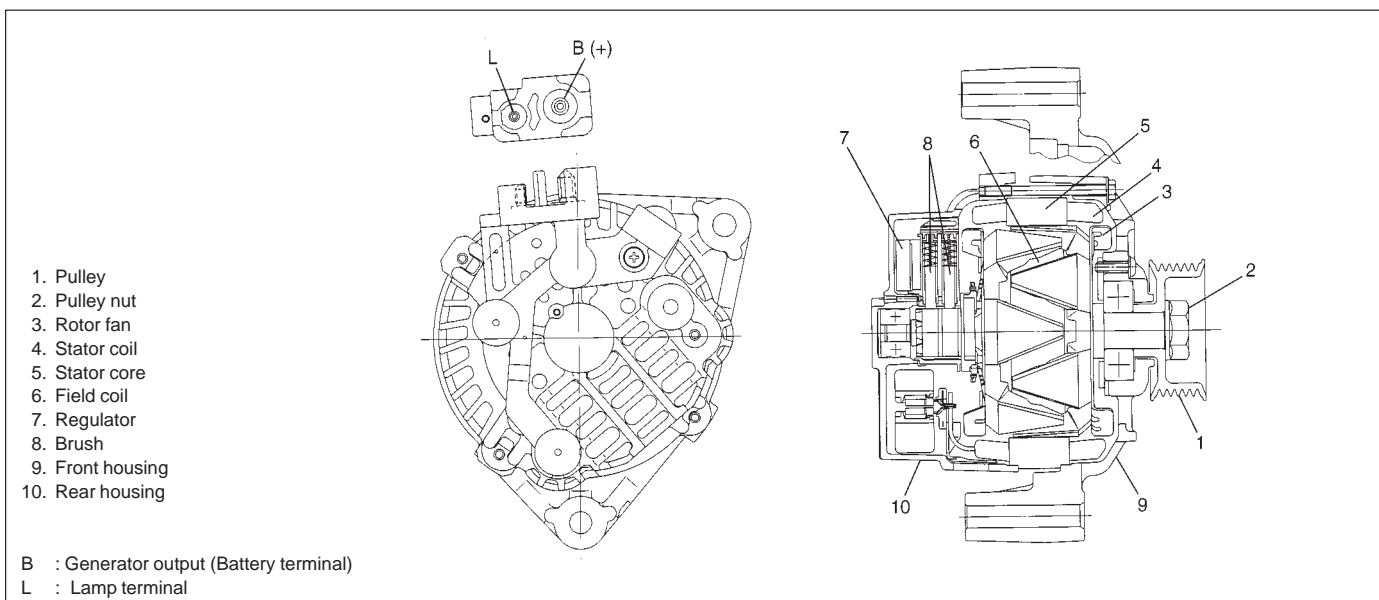
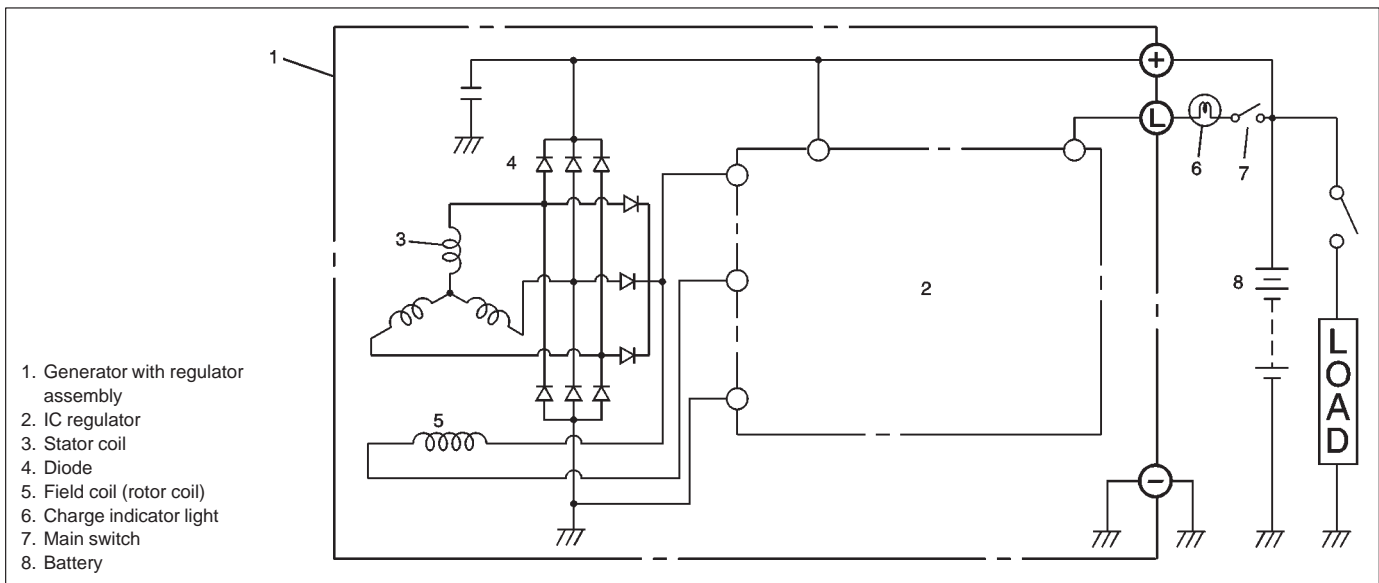
GENERAL DESCRIPTION

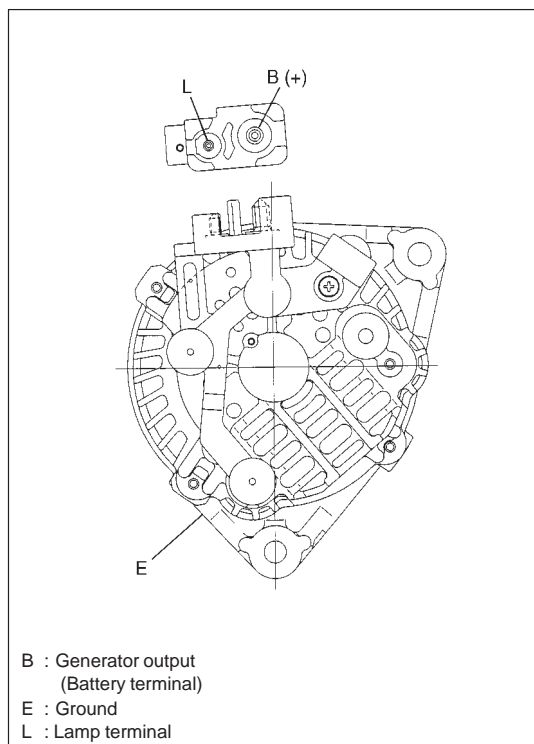
GENERATOR

The generator is a small and high performance type with an IC regulator incorporated. The internal components are connected electrically as shown below figure.

The generator features are as follows:

- Solid state regulator is mounted inside the generator.
- All regulator components are enclosed into a solid mold.
- The regulator along with the brush holder assembly are installed into the rear housing.
- The IC regulator uses integrated circuits and controls the voltage produced by the generator, and the voltage setting can not be adjusted.
- The generator rotor bearings contain enough grease to eliminate the need for periodic lubrication. Two brushes carry current through the two slip rings to the field coil mounted on the rotor, and under normal conditions will provide long period of maintenance-free service.
- The stator windings are assembled on the inside of a laminated core that forms part of the generator frame.
- A condenser mounted in the rear housing suppresses radio noise.





DIAGNOSIS GENERATOR

CAUTION:

- Do not mistake polarities of B (+) terminal and L terminal.
- Do not create a short circuit between B (+) and L terminals. Always connect these terminals through a lamp.
- Do not connect any load between L and E.
- When connecting a charger or a booster battery to vehicle battery, refer to this section describing battery charging.

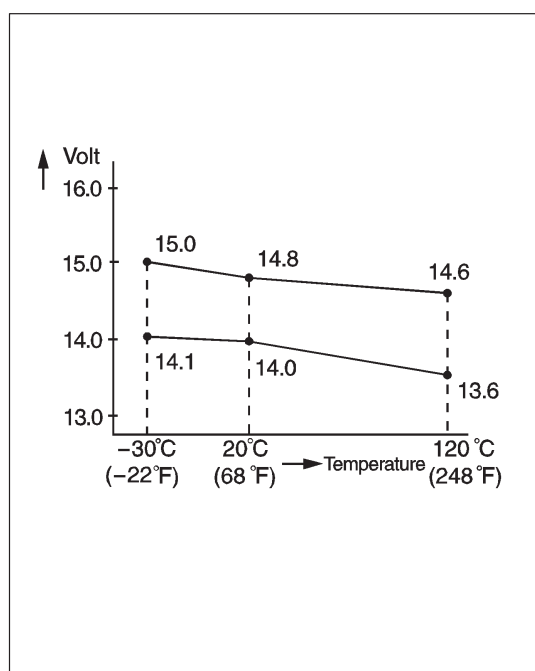
Trouble in charging system will show up as one or more of following conditions:

- 1) Charge warning light operation.
- 2) An undercharged battery as evidenced by slow cranking or indicator dark.
- 3) An overcharged battery as evidenced by excessive spewing of electrolyte from vents.

Noise from generator may be caused by a loose drive pulley, loose mounting bolts, worn or dirty bearings, defective diode, or defective stator.

FAULTY INDICATOR LAMP OPERATION

PROBLEM	POSSIBLE CAUSE	CORRECTION
Charge warning light does not light with ignition ON and engine off	<ul style="list-style-type: none"> ○ Fuse blown ○ Light burned out ○ Wiring connection loose ○ IC regulator or field coil faulty ○ Poor contact between brush and slip ring 	Check fuse. Replace light. Tighten loose connection. Check generator Repair or replace.
Charge warning light does not go out with engine running (battery requires frequent recharging)	<ul style="list-style-type: none"> ○ Drive belt loose or worn ○ IC regulator or generator faulty ○ Wiring faulty 	Adjust or replace drive belt. Check charging system. Repair wiring.



No-load Check

- 1) Run engine from idling up to 2,000 rpm and read meters.

NOTE:

Turn off switches of all accessories (wiper, heater etc.).

Standard current: 10 A maximum

Standard voltage: 14.0 – 14.8 V (at 20°C, 68°F)

NOTE:

Consideration should be taken that voltage will differ somewhat with regulator case temperature as shown in left figure.

Higher Voltage

If voltage is higher than standard value, check ground of brushes. If brushes are not grounded, replace IC regulator.

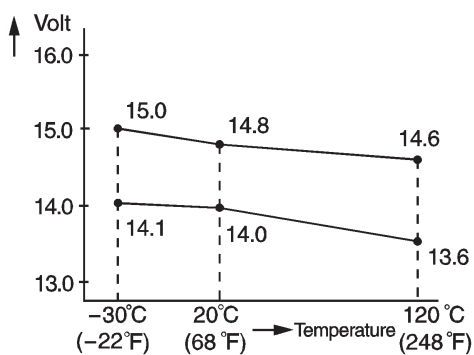
Lower Voltage

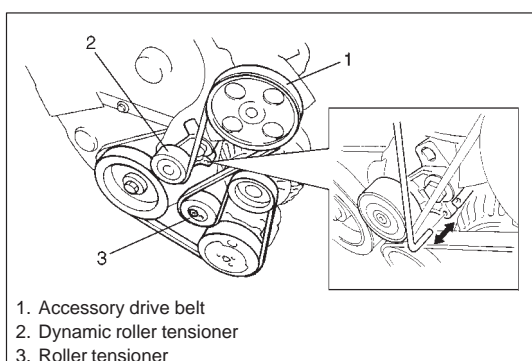
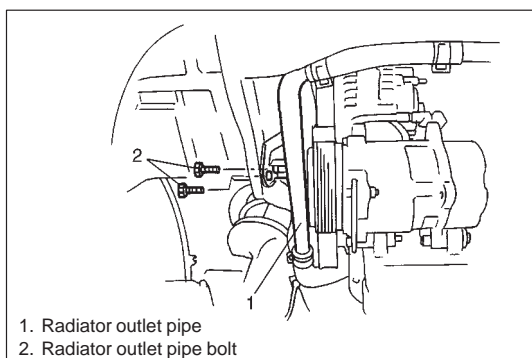
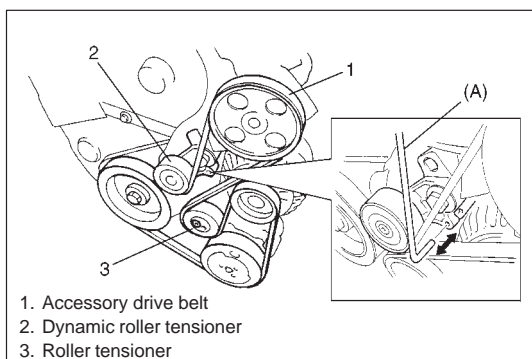
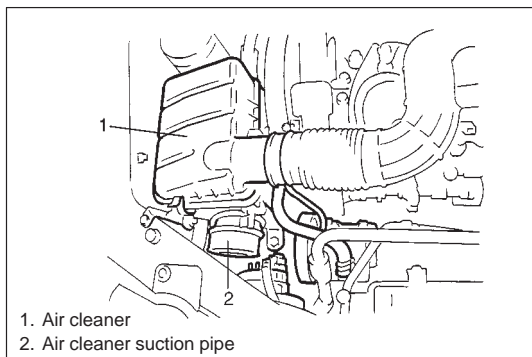
If voltage is below or in standard value, turn on head light and heater motor and increase engine speed up to 2000 – 2500 rpm soon after starting engine, and read maximum value on ammeter immediately.

If current is less than 56 A, repair or replace generator.

OVERCHARGED BATTERY

- 1) To determine battery condition, refer to BATTERY section.
- 2) If obvious overcharge condition exists as evidenced by excessive spewing of electrolyte, measure generator B (+) terminal voltage at engine 2000 rpm.
- 3) If measured voltage is higher than upper limit value, proceed to disassembly section of generator service.
- 4) Check ground of brushes. If brushes are not grounded, replace IC regulator. Then check field coil for grounds and shorts, referring to "INSPECTION" section.





ON-VEHICLE SERVICE

GENERATOR

ACCESSORY DRIVE BELT INSPECTION

1) Remove air cleaner and air cleaner suction pipe.

2) Inspect belt for cracks, cuts, deformation, wear and cleanliness. If any of above conditions are found replace accessory drive belt.

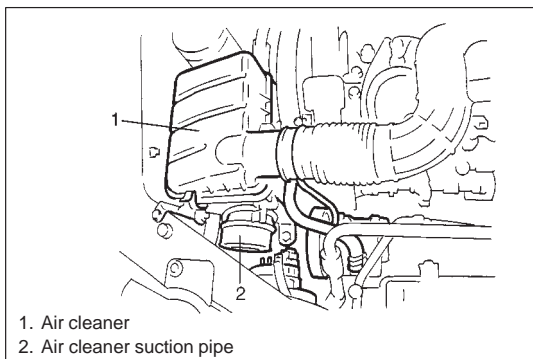
3) Using special tool (A), check that dynamic roller tensioner hole and generator mount bracket hole are aligned. If they are not aligned, perform following items.

Special Tool

(A): 09919-56520/OUT0000075

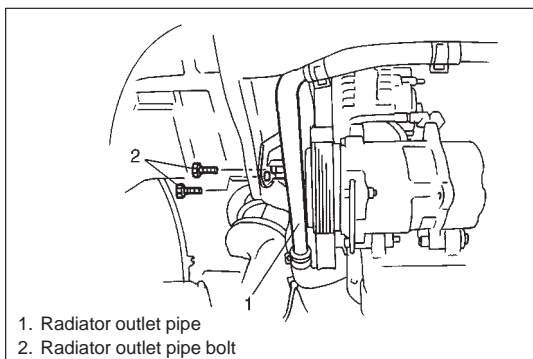
- i) Remove engine under cover (right side).
- ii) Remove radiator outlet pipe tightening bolts.

iii) Adjust belt tension by referring to step 3) to 7) of ACCESSORY DRIVE BELT INSTALLATION in this section. If belt tension can not be adjusted within specified value, replace the accessory drive belt.



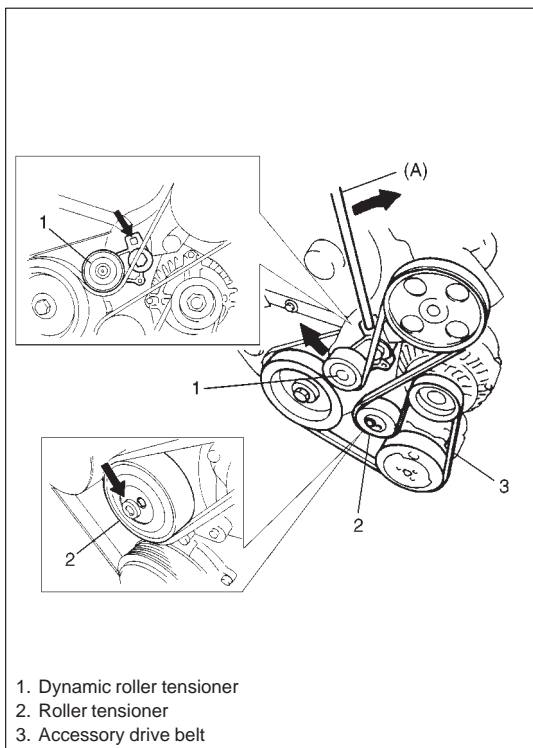
REMOVAL

1) Remove air cleaner and air cleaner suction pipe.



2) Remove engine under cover (right side).

3) Remove radiator outlet pipe tightening bolts.



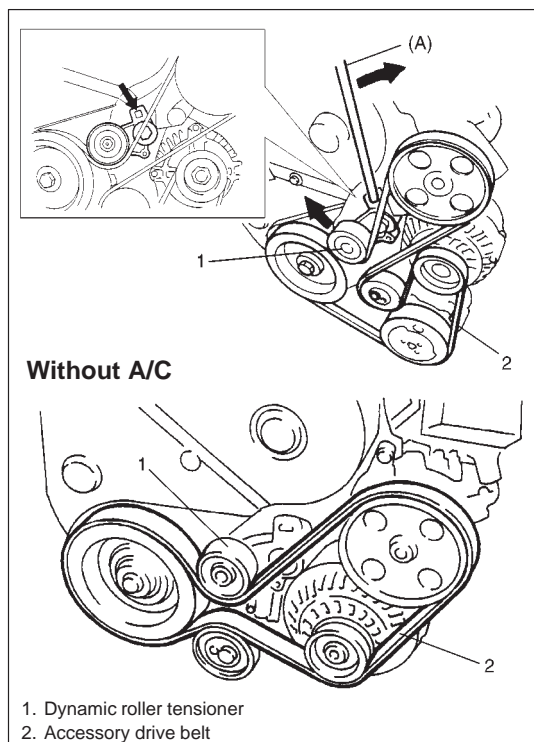
4) Loosen roller tensioner tightening bolt.

5) Using special tool (A) for dynamic roller tensioner, turn dynamic roller tensioner clockwise to loosen it.

Special Tool

(A): 09919-56540

6) While holding the tensioner, remove accessory drive belt.



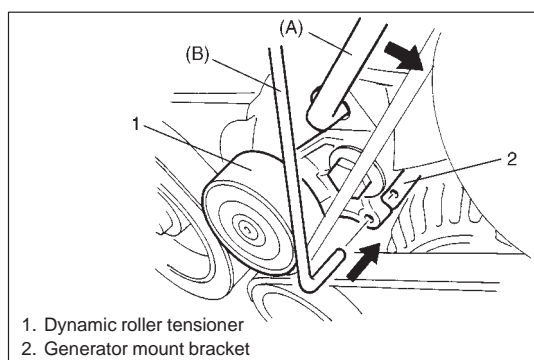
INSTALLATION

- 1) Using special tool (A) for dynamic roller tensioner, turn dynamic roller tensioner to loosen it.

Special Tool

(A): 09919-56540

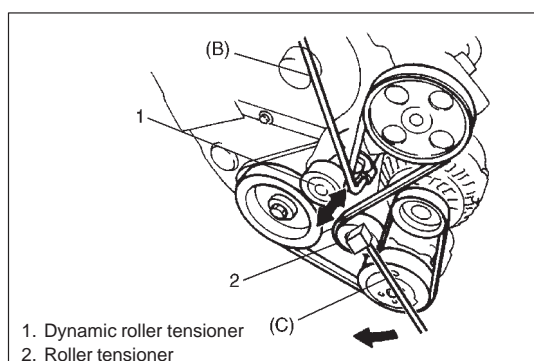
- 2) While holding dynamic roller tensioner, install accessory drive belt.



- 3) With tensioner hole and the generator mount bracket hole aligned by turning dynamic roller tensioner, insert special tool (B) into them.
- 4) Remove special tool (A) and lock dynamic roller tensioner by using special tool (B).

Special Tool

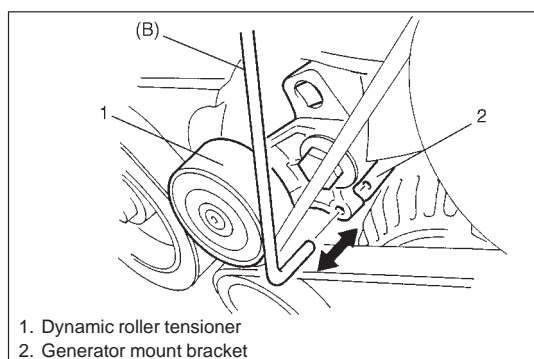
(B): 09919-56520/OUT0000075



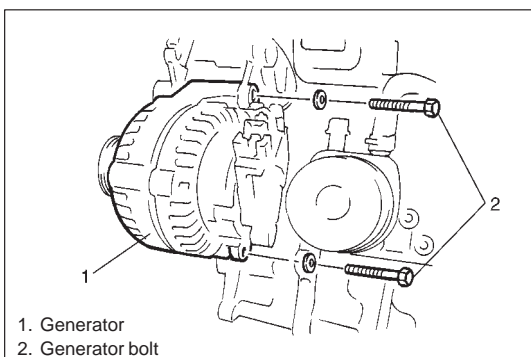
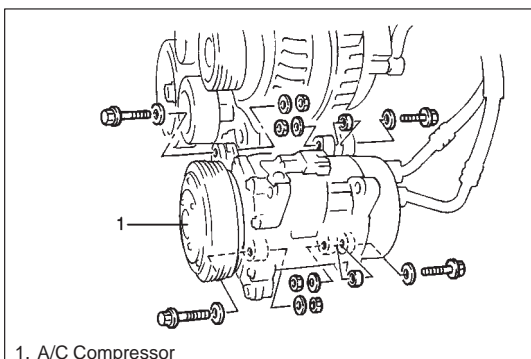
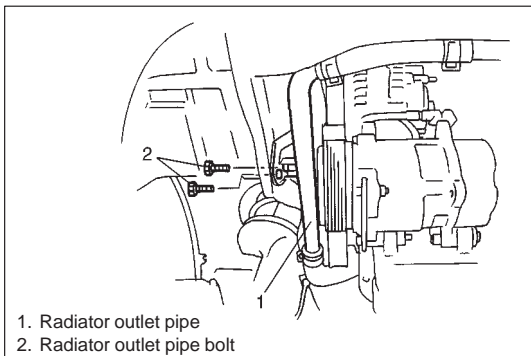
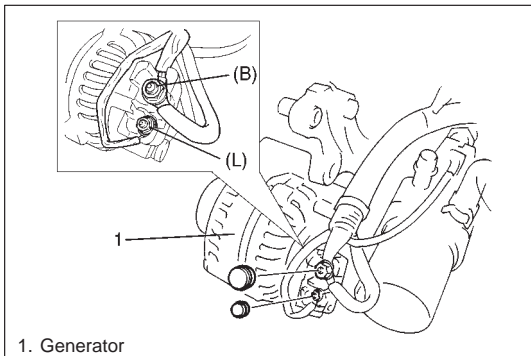
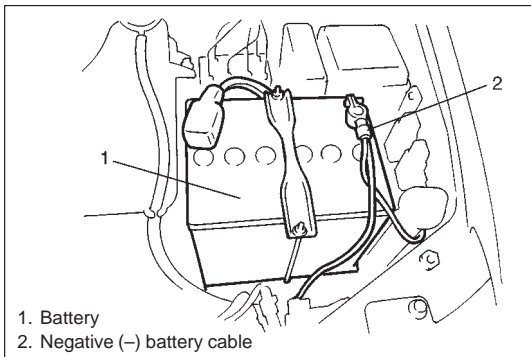
- 5) Using special tool (C), turn roller tensioner clockwise to until special tool (B) becomes free. With dynamic roller tensioner kept in that state, fix it by tightening its bolt to specified torque.
- 6) Turn crankshaft pulley 4 revolutions.

Special Tool

(C): 09919-56530/OUT0000115



- 7) Using special tool (C), check that dynamic roller tensioner hole and generator mount bracket hole are aligned. If they are not aligned, repeat step 3) to 5).
- 8) Install radiator outlet pipe tightening bolt.
- 9) Install engine under cover.
- 10) Install air cleaner and air cleaner suction pipe.



UNIT REPAIR OVERHAUL

GENERATOR

DISMOUNTING

1) Disconnect negative (-) cable at battery.

2) Disconnect (B) and (L) terminal wire from generator.

3) Remove engine under cover (right side) and remove radiator outlet pipe bolt (2 pcs.).

4) Remove accessory drive belt. Refer to "ACCESSORY DRIVE BELT" in this section.

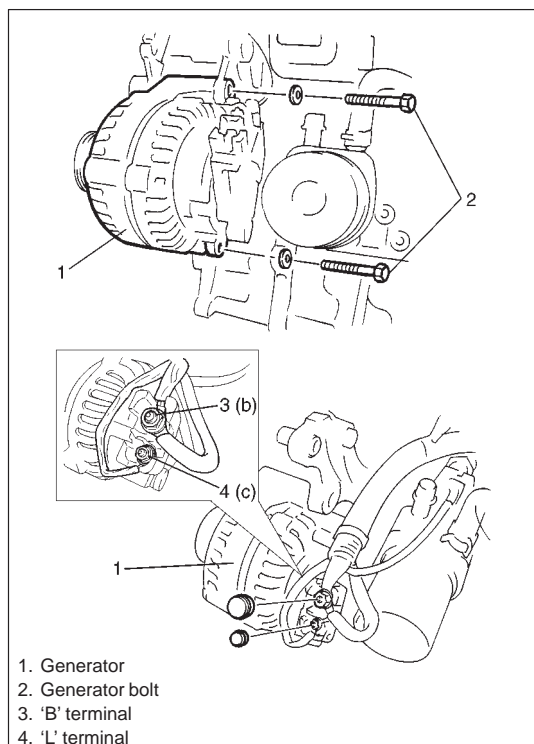
5) Disconnect A/C Compressor Coupler (if equipped).

6) Loosen A/C Compressor mounting bolt (4 pcs) and remove A/C Compressor. Refer to section 1B "AIR CONDITIONING" section. (if equipped)

NOTE:

Hang removed A/C Compressor with wire hook or the like so as to prevent A/C hose from bending and twisting excessively or being pulled.

7) Remove generator.



REMOUNTING

Reverse removal procedure for installation noting the followings.

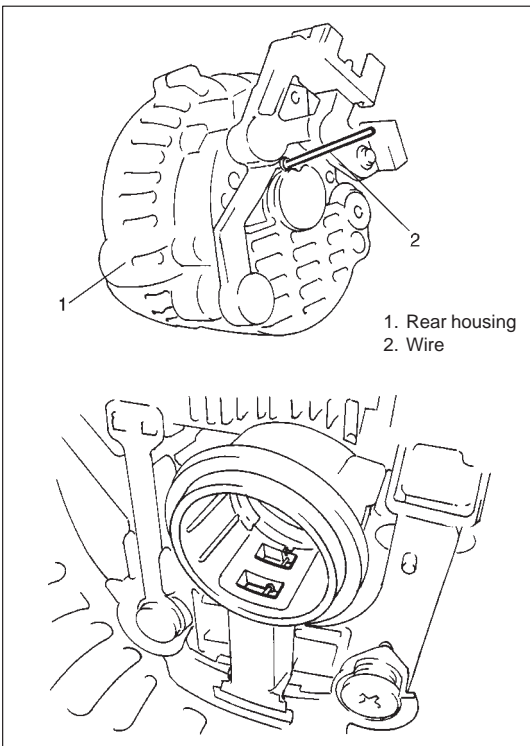
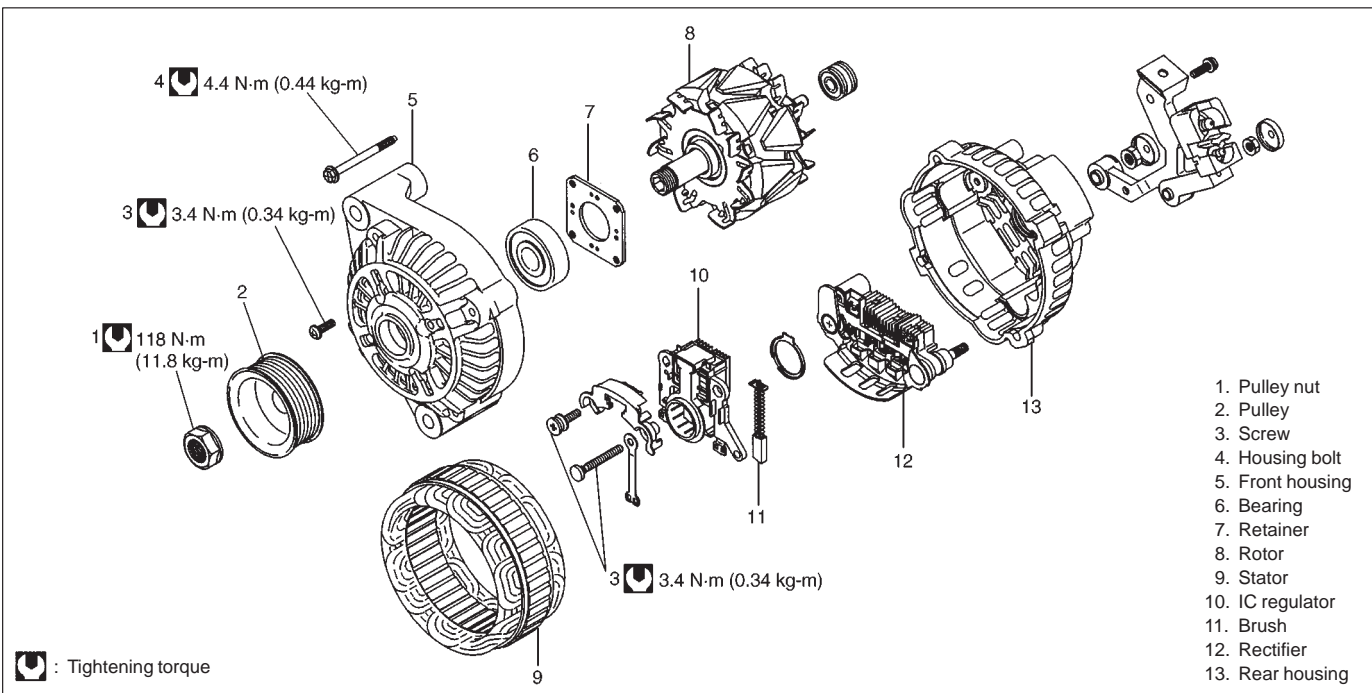
- Tighten generator bolts and its terminal as follows.

Tightening Torque

- (a): 50 N·m (5.0 kg-m, 36.2 lb-ft)
- (b): 10.0 N·m (1.0 kg-m, 7.2 lb-ft)
- (c): 4.0 N·m (0.4 kg-m, 2.9 lb-ft)

- Adjust accessory drive belt tension, referring to “ACCESSORY DRIVE BELT INSTALLATION” in this section.

DISASSEMBLY AND REASSEMBLY

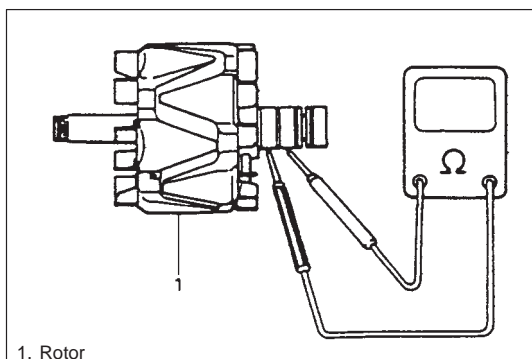


Assemble noting the following.

- Push brushes into brush holder, then support brushes by inserting appropriate wire from hole of rear housing.

NOTE:

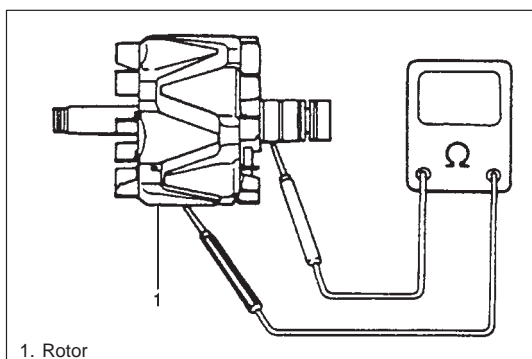
- After installing rotor, remove wire.
- Check to make sure that match marks on front and rear housing are aligned.
- Do not apply grease to rear (rotor) bearing. Remove oil completely if found in bearing box of rear housing.
- After assembling generator, make sure that rotor turns smoothly.



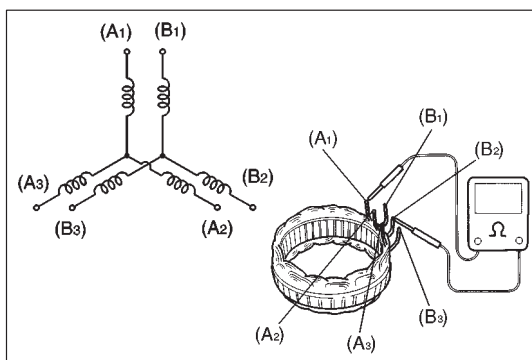
INSPECTION

Rotor

- 1) Using ohmmeter, check for continuity between slip rings of rotor. If there is no continuity, replace rotor.

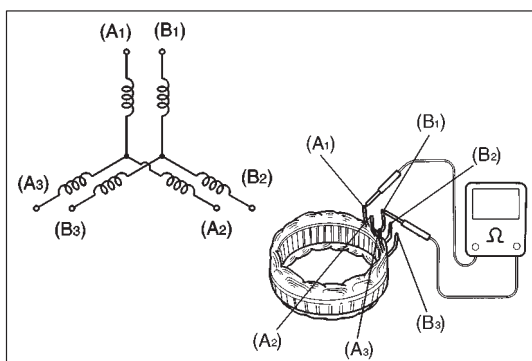


- 2) Using ohmmeter, check that there is no continuity between slip ring and rotor core. If there is continuity, replace rotor.
- 3) Check slip rings for roughness or scoring. If rough or scored, replace rotor.

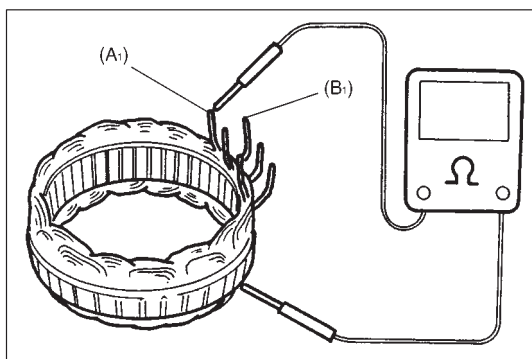


Stator

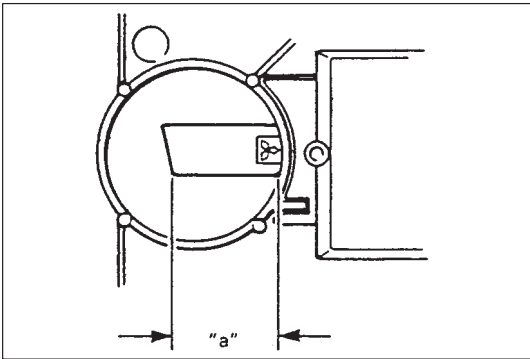
- 1) Using ohmmeter, check continuity between all stator leads so that two sets of connected coils can be identified as shown below. If not, replace stator.



- 2) Check that there is no continuity between (A₁) lead and (B₁) lead as shown. If there is continuity, replace stator.



- 3) Check that there is no continuity between (A₁), (B₁) lead and stator core. If there is continuity, replace stator.



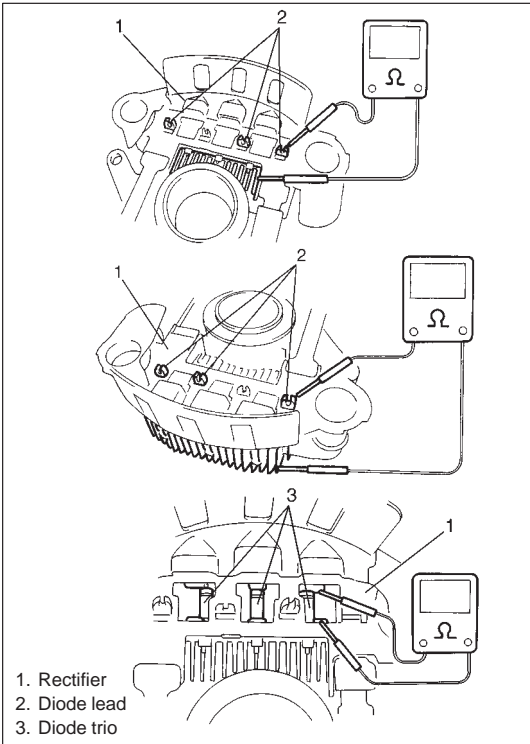
Brush and brush holder

Check each brush for wear by measuring its length.
If brush is found worn down below service limit, replace brush.

Brush length "a"

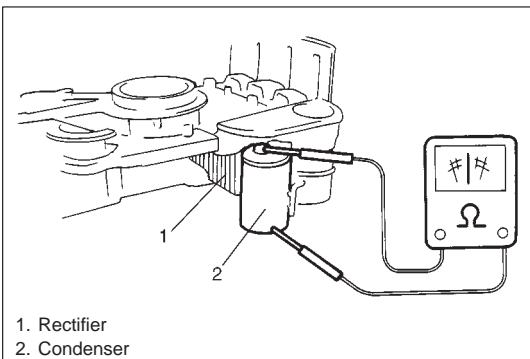
Standard: 11 mm (0.43 in.)

Service limit: 2 mm (0.08 in.)



Rectifier

- 1) Using an ohmmeter, check continuity between each of upper and lower rectifier bodies and each diode lead. Check both directions by reversing probes of ohmmeter and there should be only one-way continuity in each case. If check result is not satisfactory, replace rectifier.
- 2) In the same manner as described in above step 1), check that there is only one-way continuity between both leads of diode trio.



Condenser

Using an ohmmeter, check no continuity happening as soon as continuity happened in a moment.

If not, replace rectifier.

Reference condenser capacity : Approx. 2.2 I F

SPECIFICATIONS

BATTERY

Battery type	75D23L
Rated capacity	AH/5HR, 12 Volts
Electrolyte	L (US/Imp. pt)
Electrolyte S.G.	1.28 when fully charged at 20°C (68°F)


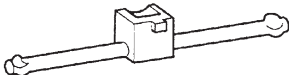

GENERATOR

Type	80 A type
Rated voltage	12 V
Nominal output	80 A
Permissible max. speed	18000 r/min.
No-load speed	1200 r/min (rpm)
Setting voltage	14.0 to 14.8 V
Permissible ambient temperature	−30 to 90° C (−22 to 194° F)
Polarity	Negative ground
Rotation	Clockwise viewed from pulley side

TIGHTENING TORQUE SPECIFICATIONS

Fastening	Tightening torque		
	N·m	kg·m	lb·ft
Body ground bolt	8	0.8	6.0
Generator mounting bolts and nut	23	2.3	16.5
“B” terminal nut	10	1.0	7.2
“L” terminal nut	4	0.4	2.9
Pulley nut	118	11.8	85.5
Terminal screw	3.4	0.34	2.5
Drive end bearing plate screws	3.4	0.34	2.5
Rectifier screws	3.4	0.34	2.5
Regulator and brush holder screws			
Housing bolts	4.4	0.44	3.2

SPECIAL TOOLS

 <p>09919-56520/OUT0000075 ROLLER PIN</p>	 <p>09919-56530/OUT0000115 TENSION LEVER</p>	 <p>09919-56540 TENSION LEVER</p>
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