

DIESEL FUEL

<4M4>

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GENERAL INFORMATION

The electronically-controlled fuel injection system consists of sensors which detect the condition of the diesel engine, an engine-ECU which controls the system based on signals from these sensors, and actuators which operate according to control commands from the engine-ECU.

The engine-ECU carries out operations such as fuel injection rate control, fuel injection timing control and idle up control. In addition, the engine-ECU is equipped with several self-diagnosis functions which make troubleshooting easier in the event that a problem develops.

FUEL INJECTION RATE CONTROL

The fuel injection completion timing is controlled by means of a solenoid-type spill valve to ensure that the optimum amount of fuel is supplied to the engine in accordance with gradual changes in the engine running condition.

Before fuel injection starts, the solenoid-type spill valve is on (energized), so that the valve is closed. As the plunger turns and rises, fuel is sent out under pressure, and when the fuel flow rate reaches the target value for fuel injection, the solenoid-type spill valve turns off. When the solenoid-type spill valve turns off, the fuel under high pressure inside the plunger is leaked out into the pump chamber and fuel injection is completed.

FUEL INJECTION TIMING CONTROL

The position of the injection pump timer piston is controlled so that fuel injection is carried out at the optimum timing in accordance with the engine running condition.

The timer piston position is determined by duty control of the timing control solenoid valve which is located in the line between the high-pressure chamber and the low-pressure chamber of the timer piston.

The fuel injection timing is advanced by increasing the control duty of the timing control solenoid valve.

IDLE SPEED CONTROL

Controlling the fuel injection rate in accordance with the engine running condition maintains the idle speed at the optimum condition.

SELF-DIAGNOSIS FUNCTION

- When an abnormality is detected in any of the sensors or actuators, the engine warning lamp illuminates to warn the driver.
- When an abnormality is detected in any of the sensors or actuators, a diagnosis code number corresponding to the problem which occurred is output.
- The RAM data relating to the sensors and actuators which is stored in the engine-ECU can be read using the MUT-II. In addition, the actuators can be force-driven under certain conditions.

OTHER CONTROL FUNCTIONS

1. Power Supply Control
When the ignition switch is turned to ON, the relay turns on and power is supplied to components such as the timing control solenoid valve.
2. Intake Air Throttle Control
When the engine is idling after having warmed up, the throttle valve is half opened to restrict the amount of intake air in order to reduce vibration and noise.
3. A/C Relay Control
Turns the compressor clutch of the A/C ON and OFF
4. Fan motor relay control
The radiator fan and condenser fan operating speeds are controlled in accordance with the engine coolant temperature and the vehicle speed.
5. Glow Control
Refer to GROUP 16.
6. EGR Control
Refer to GROUP 17.

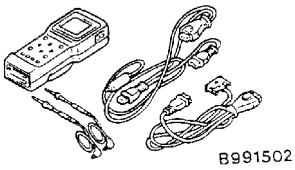
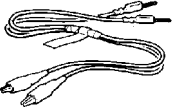
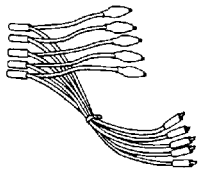
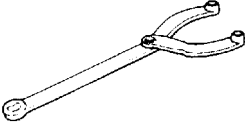
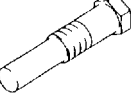
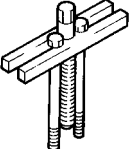
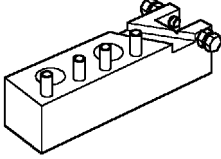
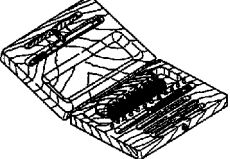
SERVICE SPECIFICATIONS

Item	Standard value	
Accelerator pedal position sensor reference voltage V	0.985 - 1.085	
Accelerator pedal position sensor resistance kΩ	3.5 - 6.5	
Boost air temperature sensor (Intake air temperature sensor) resistance kΩ	When the temperature is 20°C	2.3 - 2.9
	When the temperature is 80°C	0.30 - 0.39
Engine coolant temperature sensor resistance kΩ	When the temperature is 20°C	2.3 - 2.6
	When the temperature is 80°C	0.30 - 0.34
Fuel cut solenoid valve resistance Ω	6.8 - 9.2	
Timing control valve resistance Ω	10.8 - 11.2	
Timer piston position sensor resistance Ω	Connector terminals No.1 - No.2	160 - 168
	Connector terminals No.1 - No.3	80 - 84
	Connector terminals No.2 - No.3	80 - 84
Control sleeve position sensor resistance Ω	Connector terminals No.4 - No.12	11.2 - 12.4
	Connector terminals No.4 - No.8	5.6 - 6.2
	Connector terminals No.8 - No.12	5.6 - 6.2
GE actuator (electronic governor) resistance Ω	Connector terminals No.6 - No.10	0.64 - 0.72
Fuel temperature sensor resistance kΩ	Connector terminals No.7 - No.11	1.4 - 2.6
Engine speed sensor resistance kΩ		2.15
Main/sub throttle solenoid valve resistance Ω		36 - 44

SEALANT

Item	Specified sealant
Engine coolant temperature sensor	3M Nut Locking Part No.4171 or equivalent

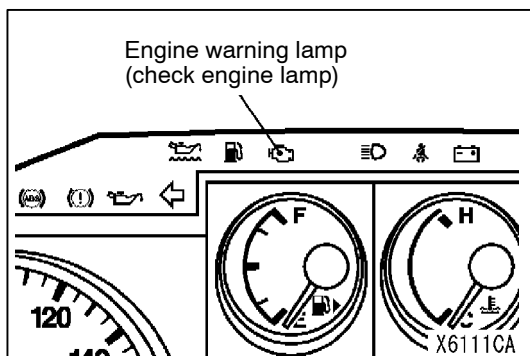
SPECIAL TOOLS

Tools	Number	Name	Application
 B991502	MB991502	MUT-II sub assembly	Electronically controlled fuel injection system check
	MB991529	Diagnosis code check harness	Diagnosis code reading
	MB991348, MB991658	Test harness set	<ul style="list-style-type: none"> Boost pressure sensor check <MB991348> APS adjustment <MB991658>
	MB990767	End yoke holder	Holding the crankshaft pulley
	MB998754	Crankshaft pulley holder pin	
 B990803	MH062567	Gear puller	Injection pump gear assembly removal
	157992-2820 (zexcel)	Plate	Retaining nut removal and installation
	105789-0010 (zexcel)	Nozzle cleaning tool	Cleaning of nozzle and needle valve

TROUBLESHOOTING

STANDARD FLOW OF DIAGNOSTIC TROUBLESHOOTING

Refer to GROUP 00 - How to Use Troubleshooting/Inspection Service Points.



DIAGNOSIS FUNCTION

ENGINE WARNING LAMP (CHECK ENGINE LAMP)

Engine warning lamp is lit when any abnormality takes place in the item related to electronically controlled fuel injection system shown in the following table.

If the malfunction indicator lamp has been on and/or is lit when the engine is in operation, check the diagnosis output.

Engine warning lamp check items

Accelerator pedal position sensor (main)
Accelerator pedal position sensor (sub)
Boost pressure sensor (Boost sensor)
Engine speed sensor
Control sleeve position sensor
Timer piston position sensor
Main throttle solenoid valve
GE actuator
Idle switch (built-in)
Engine-ECU

METHOD OF ERASING AND ERASING DIAGNOSIS CODES

Refer to GROUP 00 - How to Use Troubleshooting/Inspection Service Points.

INSPECTION USING MUT-II DATA LIST AND ACTUATOR TESTING

1. Carry out inspection by means of the data list and the actuator test function.
If there is an abnormality, check and repair the chassis harnesses and components.
2. After repairing, re-check using MUT-II and check that the abnormal input and output have returned to normal as a result of the repairs.
3. Erase the diagnosis code memory.
4. Remove the MUT-II.
5. Start the engine again and carry out a road test to confirm that the problem has disappeared.

FAIL-SAFE, BACKUP FUNCTIONS

When abnormalities in the major sensors are detected by diagnosis functions, pre-set control logic operates to maintain a safe driving condition for the vehicle.

Diagnosis item	Control features in malfunction
Accelerator pedal position sensor	<ul style="list-style-type: none"> ● Accelerator pedal released (idle switch ON) Acceleration opening degree = 0% ● Accelerator pedal applied (idle switch OFF) Engine controlled at low speed Acceleration opening degree = 20% fixed
Idle switch	<ul style="list-style-type: none"> ● Void idling speed control. ● Void cruise control.
Engine speed sensor	<ul style="list-style-type: none"> ● Engine controlled at low speed ● Void cruise control.
Boost air temperature sensor	Maintain the intake air temperature at 50 °C.
Vehicle speed sensor	<ul style="list-style-type: none"> ● Void idling speed control. ● Void cruise control.
Engine coolant temperature sensor	Maintain the engine coolant temperature at 80 °C.
Control sleeve position sensor	<ul style="list-style-type: none"> ● Engine controlled at low speed ● Void cruise control.
Timer piston position sensor	<ul style="list-style-type: none"> ● Injection timing stabilizing control ● Void cruise control.
Barometric pressure sensor (ECU built-in)	Keep the barometric pressure at 101 kPa.
Fuel temperature sensor	Maintain the fuel temperature at 50 °C.
Boost pressure sensor	Keep the boost pressure as barometric pressure (101 kPa).
Injection correction ROM	Void correction.
GE actuator	<ul style="list-style-type: none"> ● Engine controlled at low speed ● Void cruise control.
Over boost	Void cruise control.
Timing control valve	<ul style="list-style-type: none"> ● Injection timing stabilizing control ● Void cruise control.

INSPECTION CHART FOR DIAGNOSIS CODES

Code No.	Diagnosis item	Reference page
11	Accelerator pedal position sensor (main) system	13C-8
12*	Boost pressure sensor system	13C-9
13	Barometric pressure sensor (ECU built-in) system	13C-10
14	Fuel temperature sensor system	13C-10
15	Engine coolant temperature sensor system	13C-11
16	Boost air temperature sensor system	13C-11
17	Vehicle speed sensor system	13C-12
18	Engine speed sensor (backup) system	13C-13
21	Engine speed sensor system	13C-14
23	Idle switch (accelerator pedal position sensor built-in) system	13C-15
25*	Timer piston position sensor system	13C-16
26*	Control sleeve position sensor system	13C-17
27	Accelerator pedal position sensor (sub) system	13C-18
41*	Main throttle solenoid valve system	13C-19
43	Timing control valve system	13C-20
46	Injection correction ROM system	13C-21
48*	GE actuator (in the middle of control sleeve position sensor inoperative) system	13C-21
49*	Over boost (turbocharger waste gate malfunction)	13C-22
54	Immobilizer system	13C-22

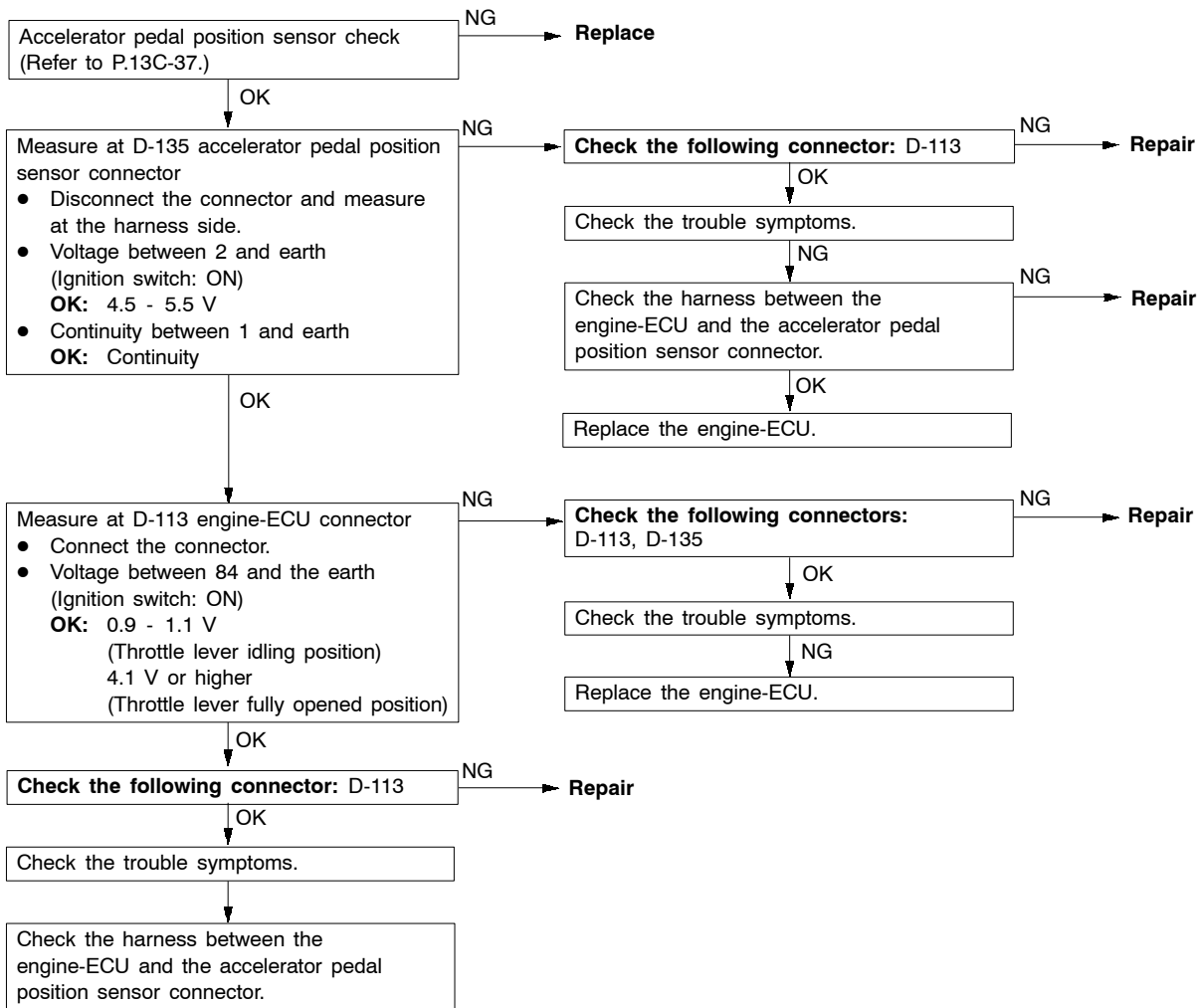
Caution

If the the above-mentioned diagnosis code number with the asterisks can be displayed along with another code number in parentheses simultaneously, check the other code number before replacing the engine-ECU.

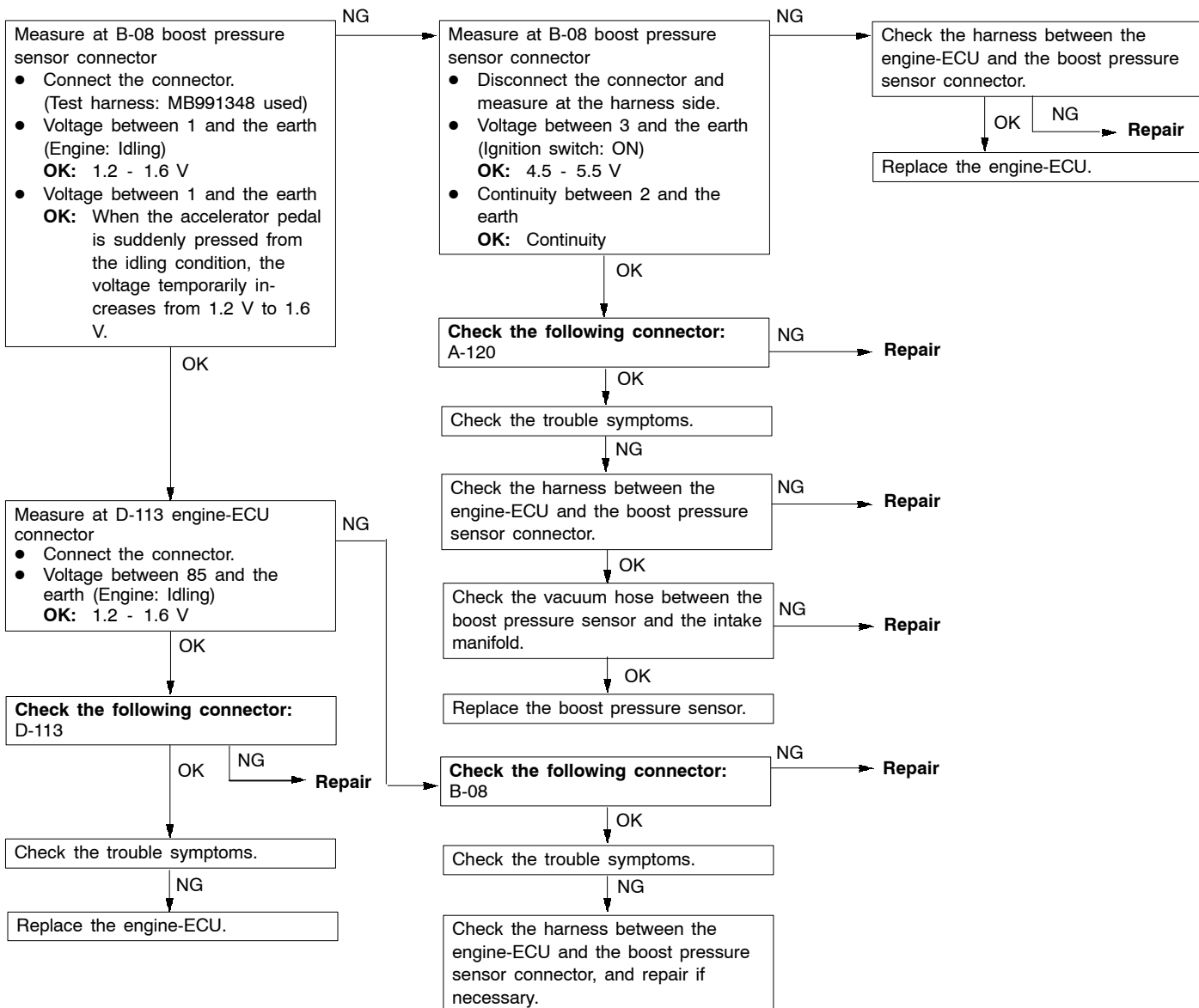
12 (41, 49), 26 (48), 25 (43), 41 (12, 49), 48 (26), 49 (12, 41)

INSPECTION PROCEDURE FOR DIAGNOSIS CODE

Code No. 11 Accelerator pedal position sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, accelerator pedal position sensor (sub) operative, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Output voltage of accelerator pedal position sensor (sub) for one second is 0.2 V or higher and lower than 2.5V. Output voltage of accelerator pedal position sensor (main) for one second is 4.5V or higher, or lower than 0.2V. <p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch:ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The output voltage of accelerator pedal position sensor (main and sub) for 0.2 second is 0.2V or higher, or lower than 4.5V and the difference in sensor output voltage between the main and sub is 1V or higher, or idle switch:ON, and sensor main output voltage is 1.875V or higher. 	<ul style="list-style-type: none"> Accelerator pedal position sensor inoperative Accelerator pedal position sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



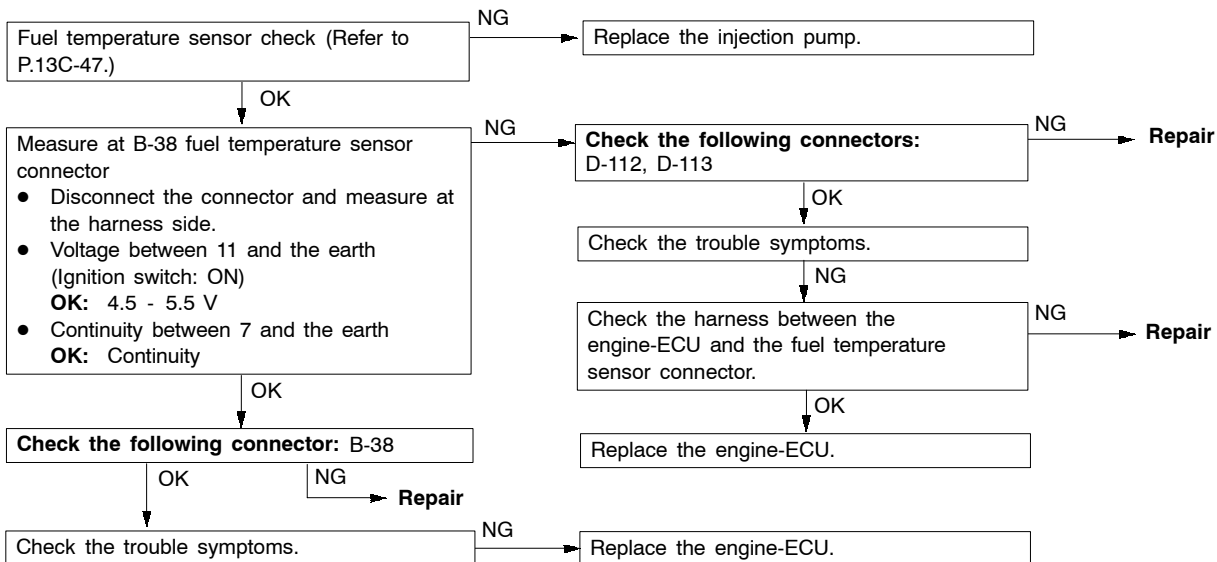
Code No. 12 Boost pressure sensor (boost sensor) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Sensor output voltage for one second is 4.5 V or higher (boost pressure is approximately 306.7kPa). <p>or</p> <ul style="list-style-type: none"> Sensor output voltage for one second is 0.2 V or lower (boost pressure is approximately 20kPa or lower) <p>Range of Check</p> <ul style="list-style-type: none"> Engine speed is 1600 r/min or higher and the acceleration opening degree is 60% or more. <p>Set Conditions</p> <ul style="list-style-type: none"> Boost pressure is lower than the barometric pressure + 13 kPa for two seconds. 	<ul style="list-style-type: none"> Boost pressure sensor inoperative Boost pressure sensor open circuit, short circuit, or connector contact inoperative Boost pressure sensor hose disconnected Engine-ECU inoperative



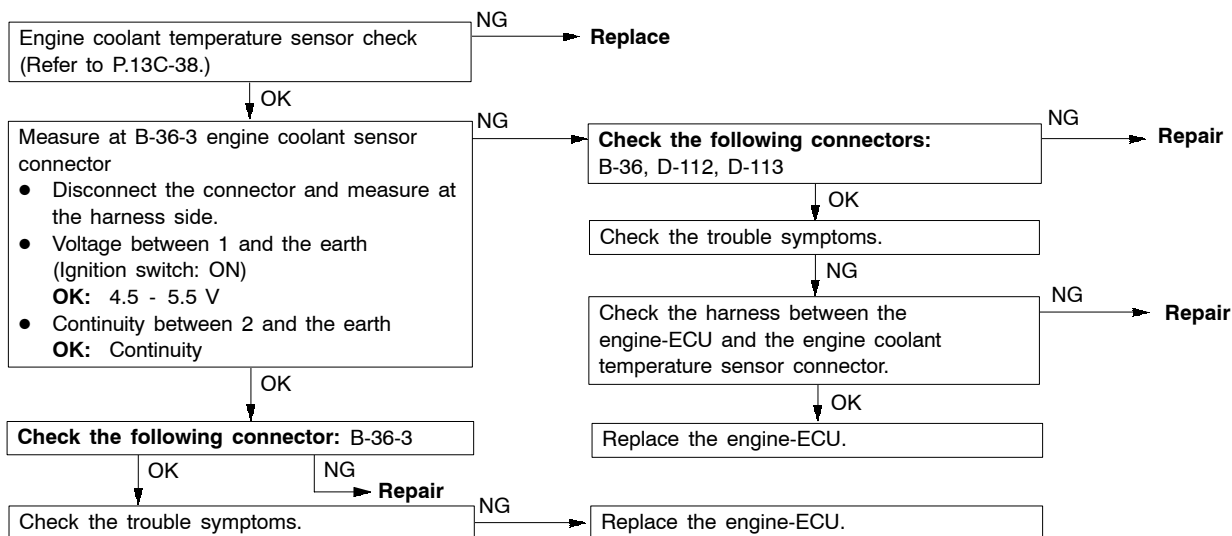
Code No. 13 Barometric pressure sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage is for 3 seconds is 4.5V or higher (the barometric pressure is approximately 120 kPa or over). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage is for 3 seconds is 1.5V or lower (the barometric pressure is approximately 33 kPa or under). 	Engine-ECU inoperative



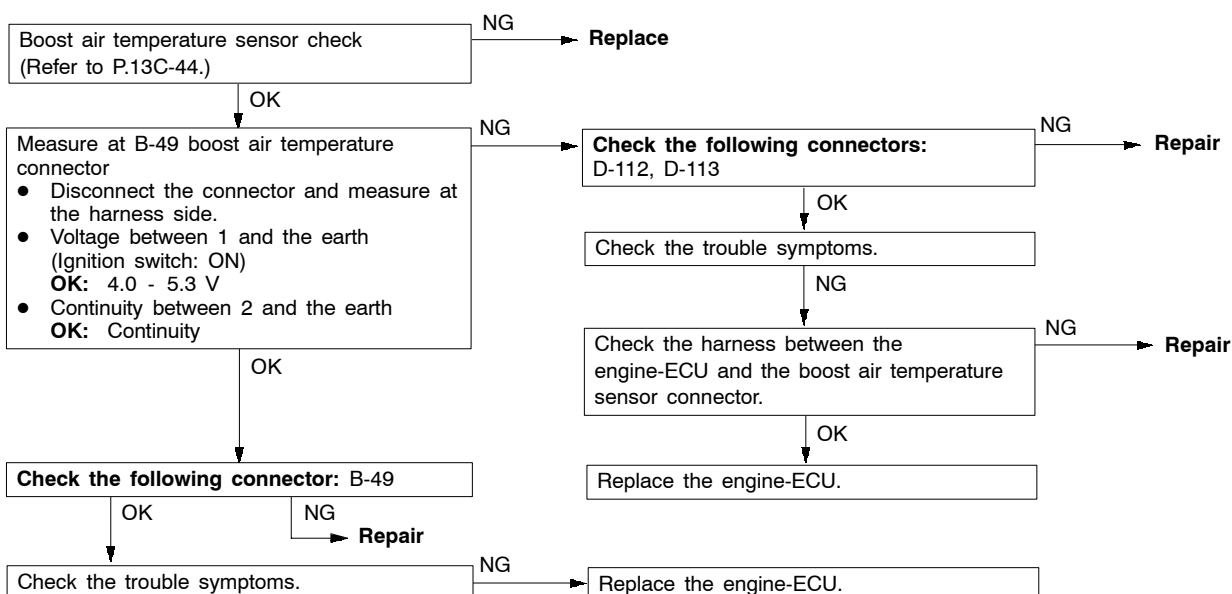
Code No. 14 Fuel temperature sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 0.2V or higher (the fuel temperature is approximately 120°C or higher). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 4.6V or lower (the fuel temperature is approximately 50°C or lower). 	<ul style="list-style-type: none"> Fuel temperature sensor inoperative Fuel temperature sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



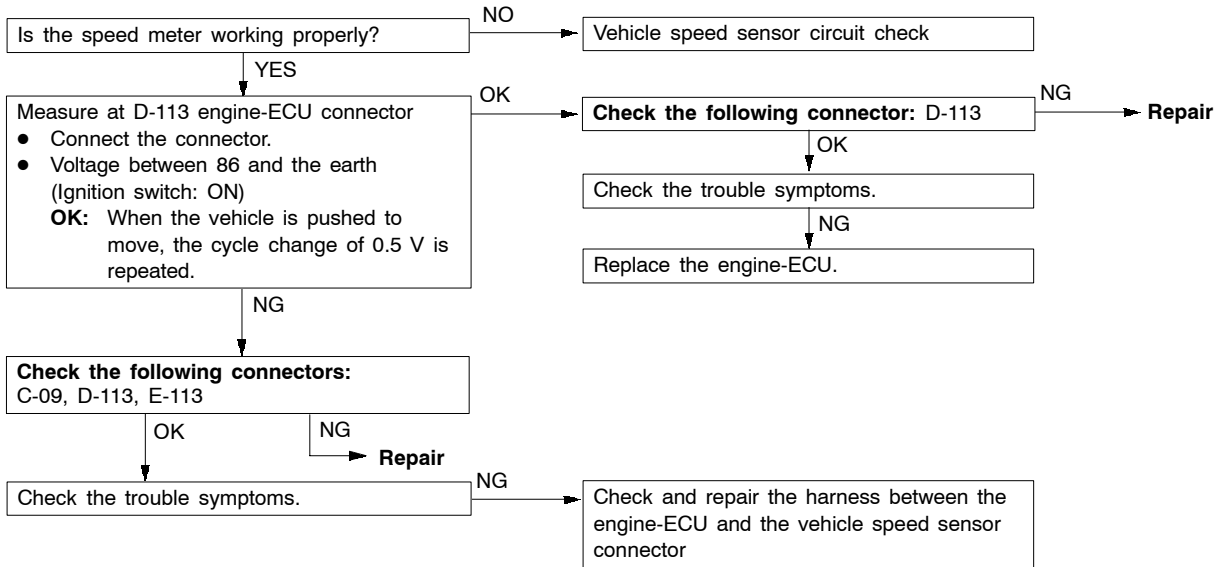
Code No. 15 Engine coolant temperature sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 4.9V or higher (the coolant temperature is approximately -45 °C or lower). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 0.2V or lower (the coolant temperature is approximately 140 °C or higher). 	<ul style="list-style-type: none"> Engine coolant temperature sensor inoperative Engine coolant temperature sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



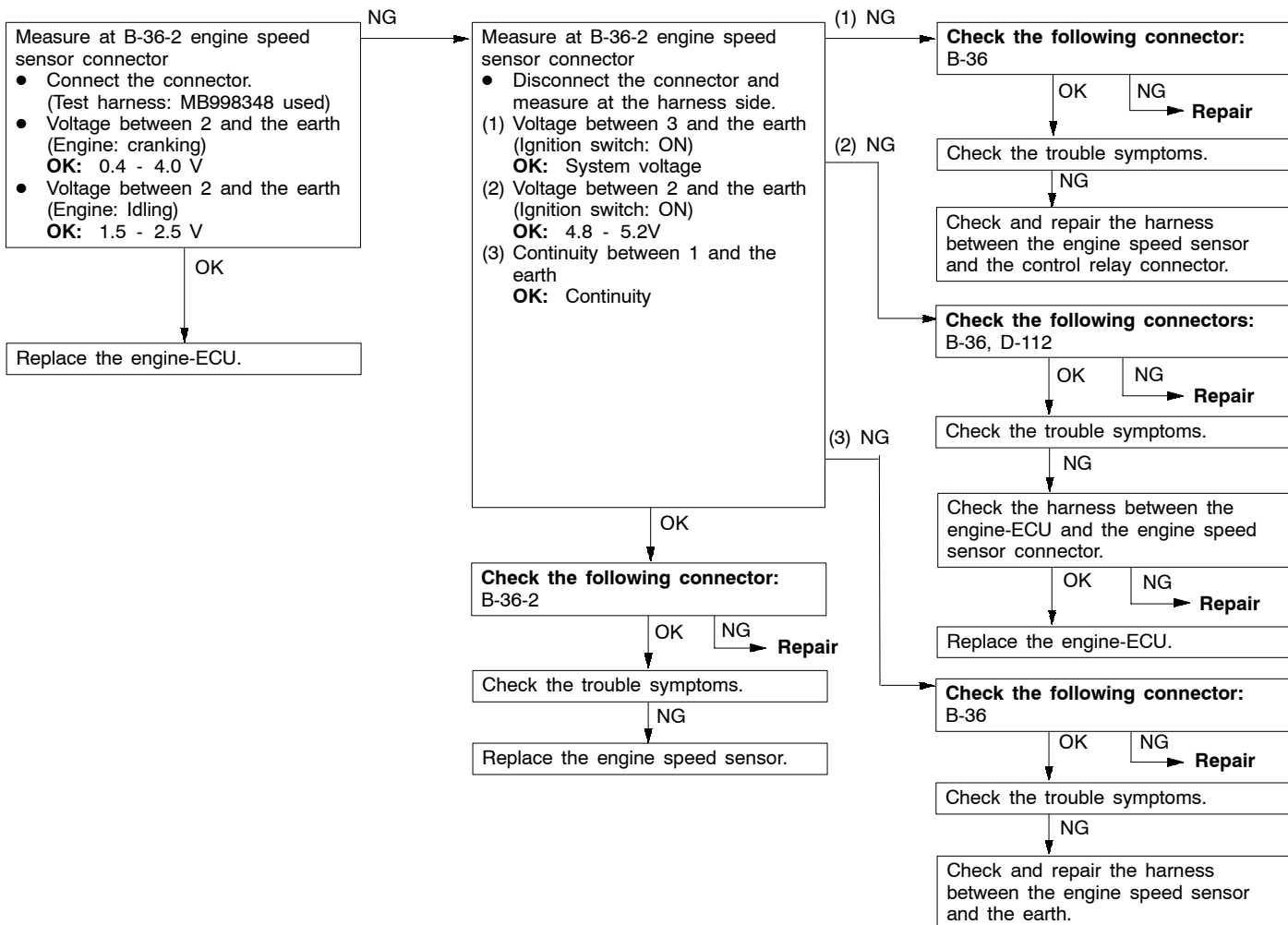
Code No. 16 Boost air temperature sensor (intake air sensor) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 4.6V or higher (the coolant temperature is approximately 45 °C or lower). <p>or</p> <ul style="list-style-type: none"> The sensor output voltage for 3 seconds is 0.3V or lower (the coolant temperature is approximately 110 °C or higher). 	<ul style="list-style-type: none"> Boost air temperature sensor inoperative Boost air temperature sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



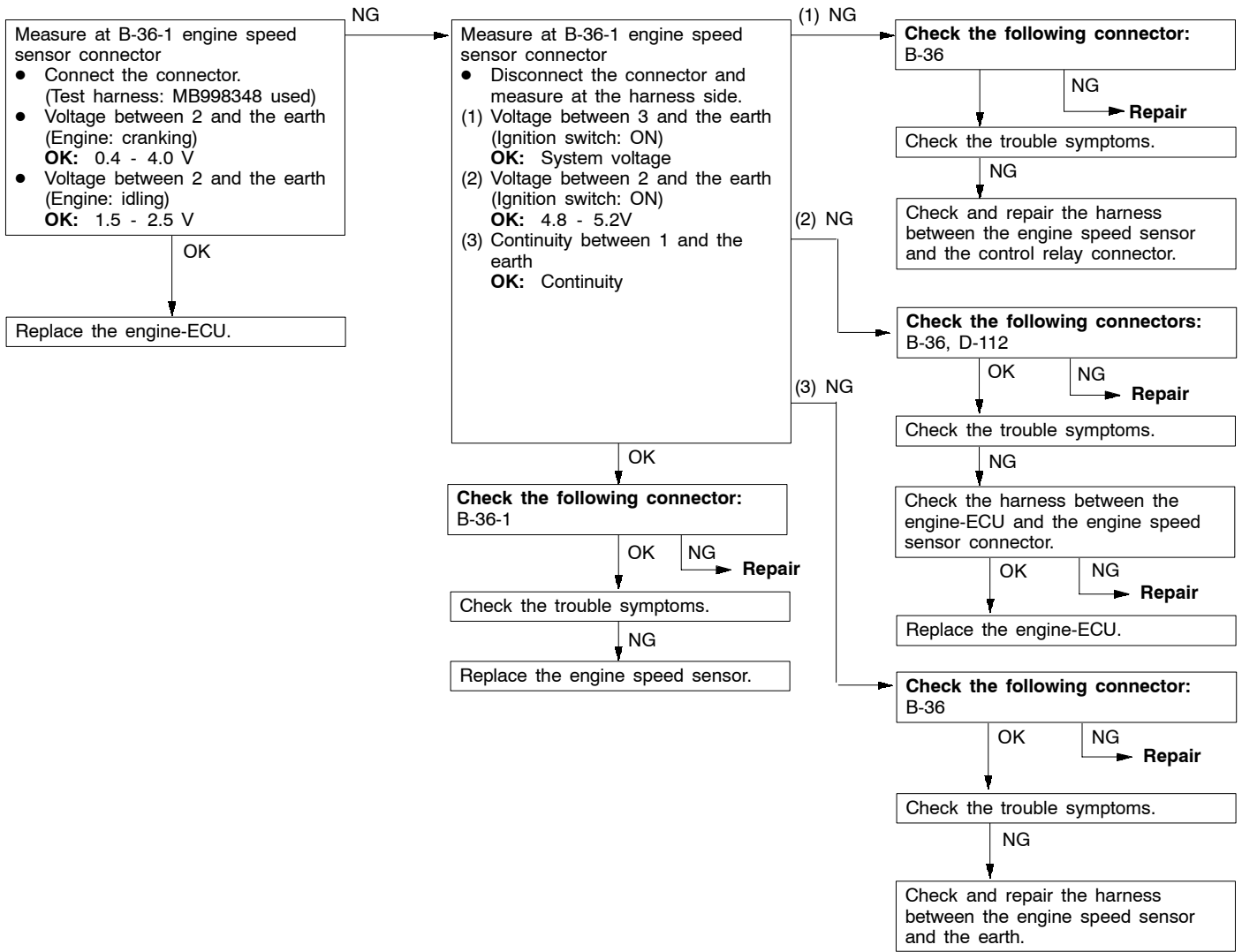
Code No. 17 Vehicle speed sensor system	Probable cause
Range of Check <ul style="list-style-type: none"> ● Ignition switch: ON ● Engine speed: 2800 r/min or higher ● Driving with heavy load Set Conditions <ul style="list-style-type: none"> ● Slower than vehicle speed of 3 km/h 	<ul style="list-style-type: none"> ● Vehicle speed sensor inoperative ● Vehicle speed sensor open circuit, short circuit, or connector contact inoperative ● Engine-ECU inoperative



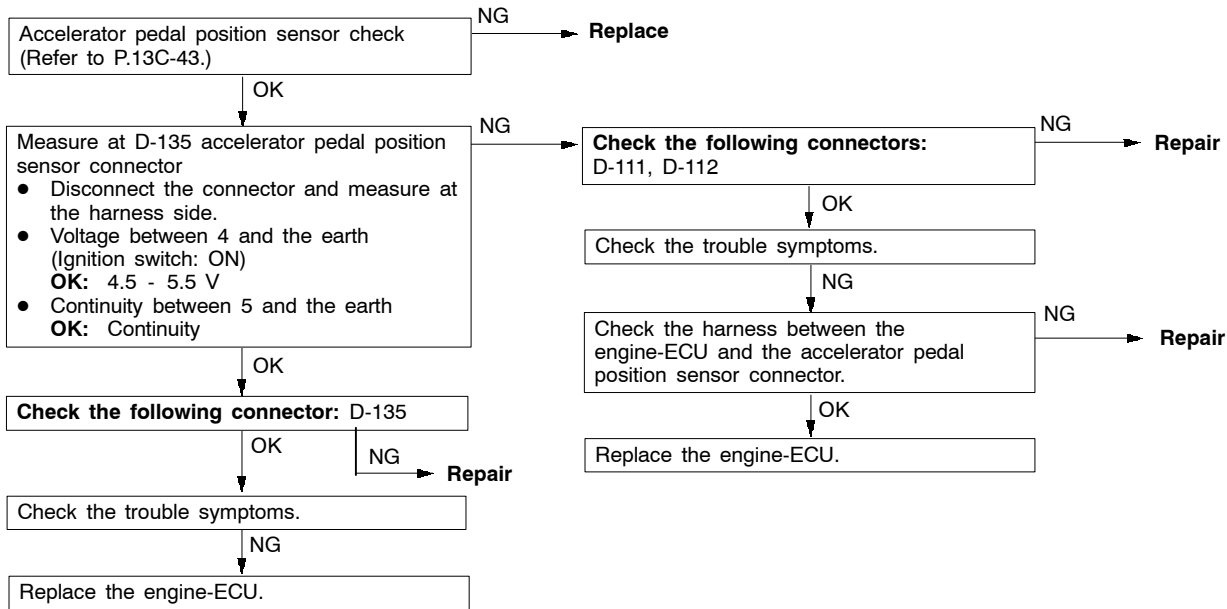
Code No. 18 Engine speed sensor (backup) system	Probable cause
Range of Check • Except for during engine running and cranking Set Conditions • The difference in the engine speed sensor output for 4 seconds: 325 r/min or more	<ul style="list-style-type: none"> • Engine speed sensor inoperative • Engine speed sensor open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative



Code No. 21 Engine speed sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> • During engine cranking <p>Or</p> <ul style="list-style-type: none"> • Except for during engine running and cranking <p>Set Conditions</p> <ul style="list-style-type: none"> • No change in the sensor output voltage for 3 seconds (no pulse signal has been input). <p>Or</p> <ul style="list-style-type: none"> • No change in the engine speed sensor output for 0.06 seconds (for backup), or in the sensor output for 0.3 seconds 	<ul style="list-style-type: none"> • Engine speed sensor inoperative • Engine speed sensor open circuit, short circuit, or connector contact inoperative • Engine-ECU inoperative



Code No. 23 Idle switch (accelerator pedal position sensor built-in) system	Probable cause
<p>Range of Check Ignition switch: ON, accelerator pedal position sensor (main, sub) operative, except for during engine cranking</p> <p>Set Conditions</p> <ul style="list-style-type: none"> For 1 minute idle switch (built-in): ON, accelerator pedal position sensor (main, sub) output voltage 1.875V or higher or 10 minutes Idle switch (built-in): OFF, accelerator pedal position sensor (main, sub) opening degrees less than 1% 	<ul style="list-style-type: none"> Accelerator pedal position sensor inoperative Accelerator pedal position sensor open circuit, short circuit, or connector contact inoperative Idle switch "ON" inoperative Idle switch signal line short circuit Engine-ECU inoperative

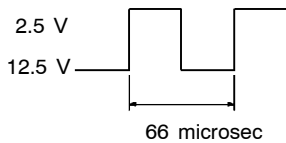


Code No. 25 Timer piston position sensor system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> ● Ignition switch: OK ● Not during the engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> ● The sensor output voltage for 1 second is 4.9V*1 or more or ● The sensor output voltage for 1 second is 0.25V*1 or less 	<ul style="list-style-type: none"> ● Timer piston position sensor inoperative ● Timer piston position sensor open circuit, short circuit, or connector contact inoperative ● Engine-ECU inoperative

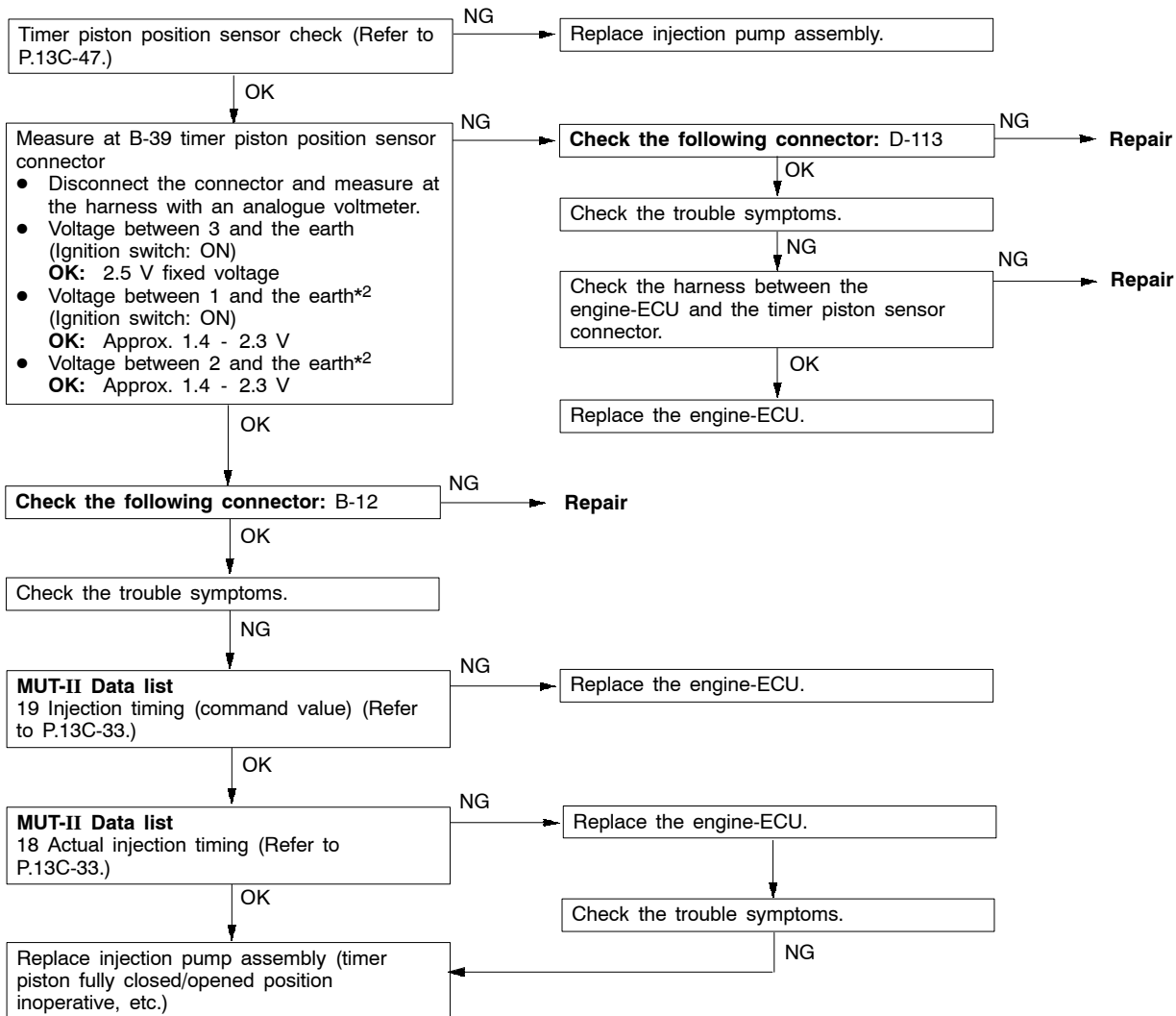
NOTE:

*1: This voltage is derived from the input pulse signal converted in the engine-ECU and cannot be measured.

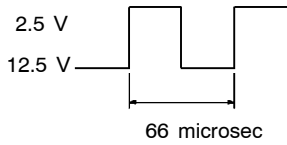
*2: This voltage is shown as a square wave with a cycle of 66 microsec (High: 2.5V, Low: 1.25V).



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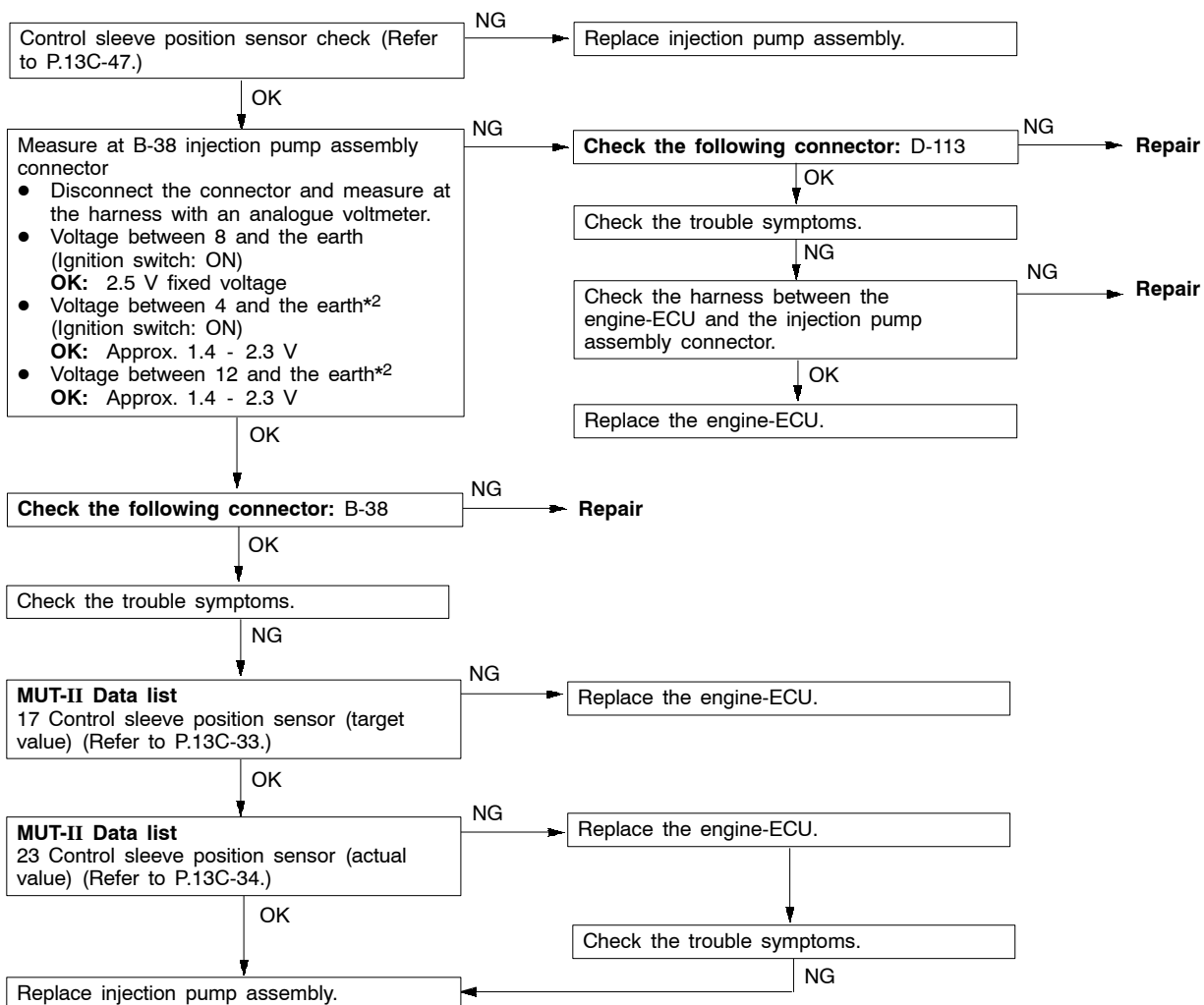
Code No. 26 Control sleeve position sensor system	Probable cause
Range of Check ● Ignition switch: ON Set Conditions ● The sensor output voltage for 1 second is 4.7V*1 or more or ● The sensor output voltage for 1 second is 0.25V*1 or less	● Control sleeve position sensor inoperative ● Control sleeve position sensor open circuit, short circuit, or connector contact inoperative ● Engine-ECU inoperative



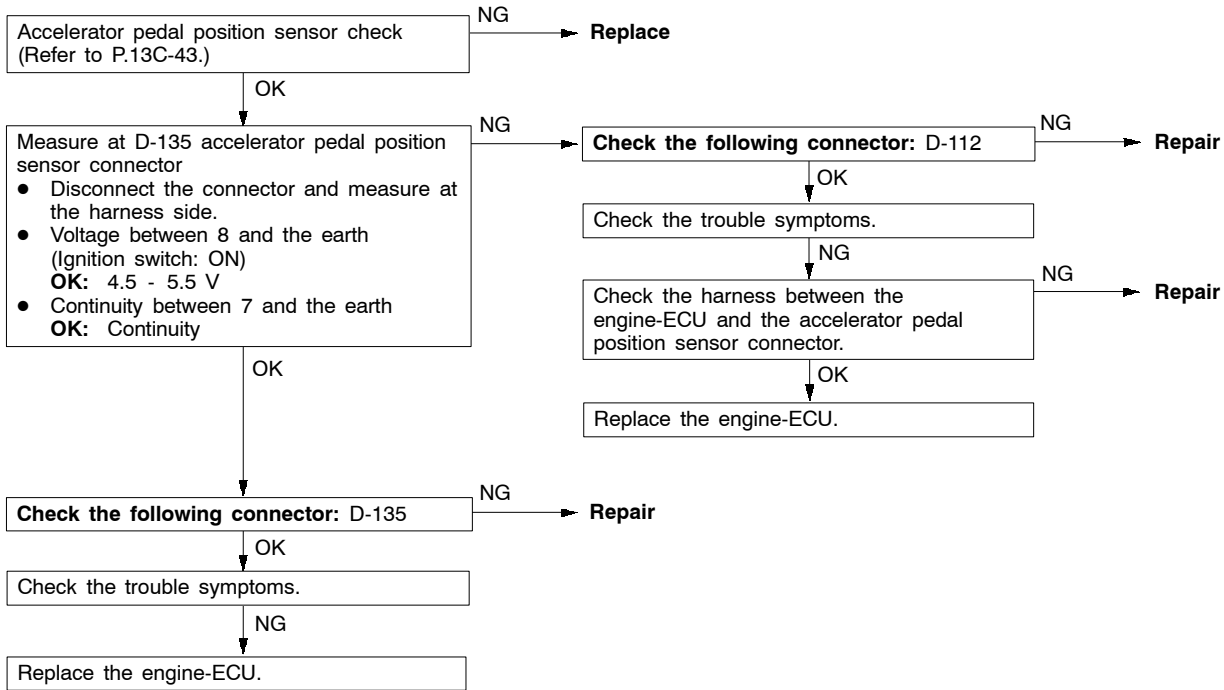
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NOTE:

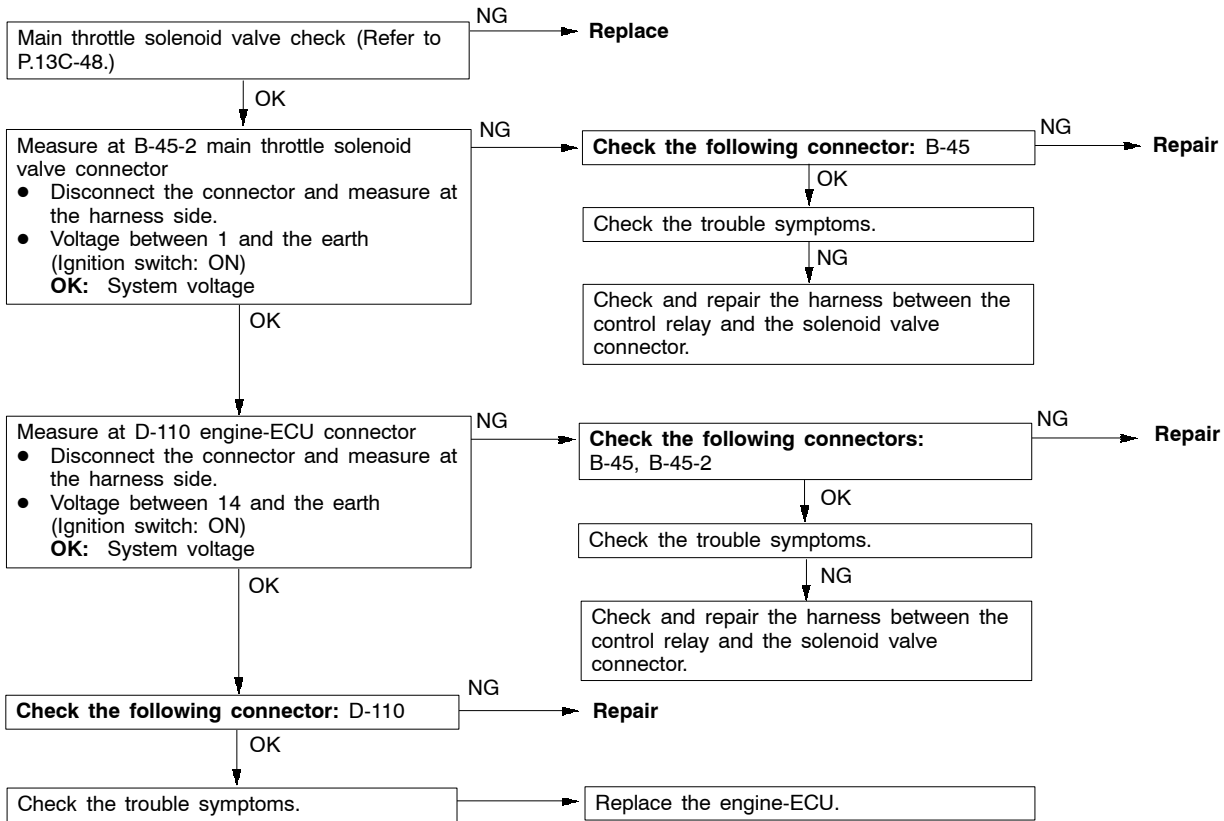
- *1: This voltage is derived from the input pulse signal converted in the engine-ECU and cannot be measured.
- *2: This voltage is shown as a square wave with a cycle of 16.7 microsec (High: 2.5V, Low: 1.25V).



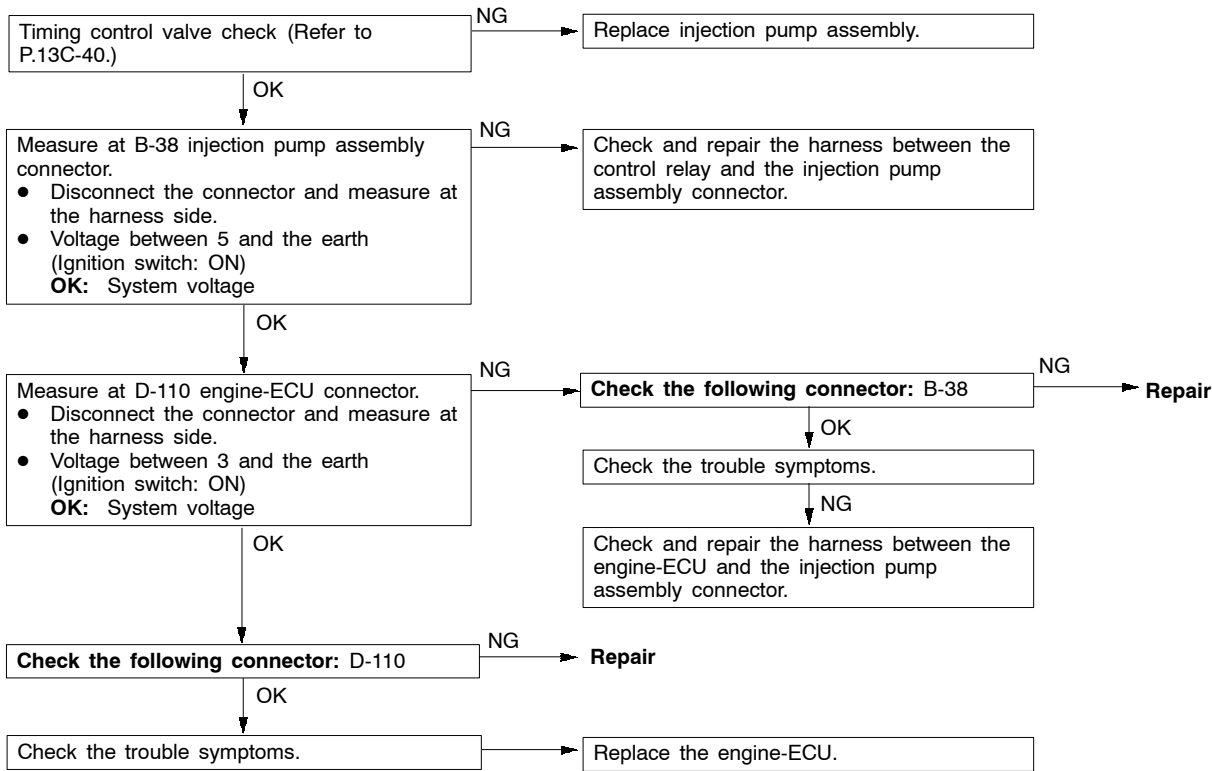
Code No. 27 Accelerator pedal position sensor (sub) system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, accelerator pedal position sensor (main) operative, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Output voltage of accelerator pedal position sensor (main) for 1 second is 0.2V or higher and lower than 2.5V. Output voltage of accelerator pedal position sensor (sub) for 1 second is 4.5V or higher, or lower than 0.2V. <p>Range of Check</p> <ul style="list-style-type: none"> Ignition switch: ON, except for during engine cranking <p>Set Conditions</p> <ul style="list-style-type: none"> Output voltage of accelerator pedal position sensor (main, sub) for 1 second is 0.2 V or higher or lower than 4.5V. The difference in the output sensor voltage between the main and the sub sensor is 1V or higher, or the idle switch ON, and sensor main output voltage is 1.875V or higher. 	<ul style="list-style-type: none"> Accelerator pedal position sensor inoperative Accelerator pedal position sensor open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



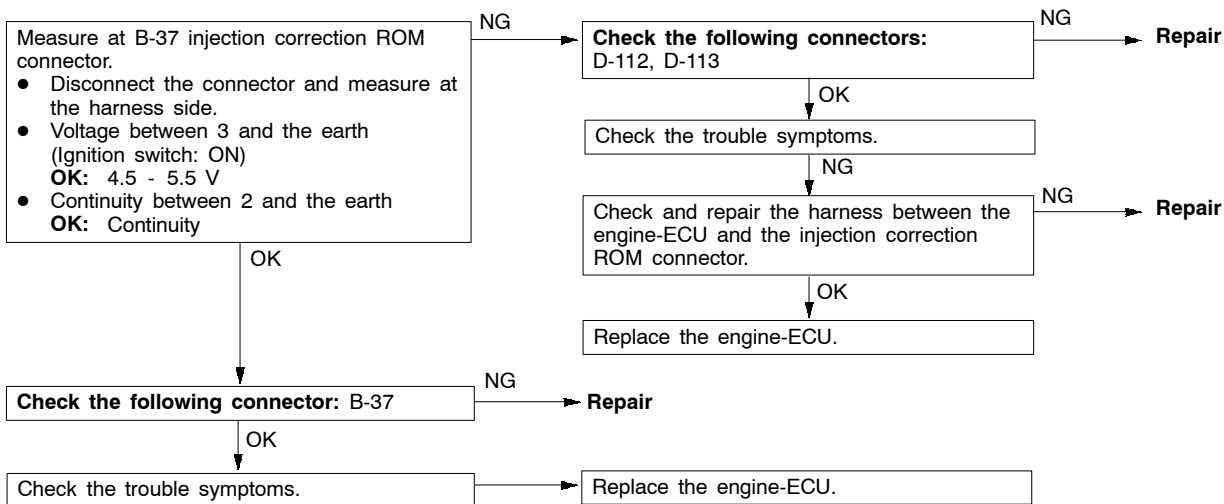
Code No. 41 Main throttle solenoid valve system	Probable cause
<p>Range of Check</p> <ul style="list-style-type: none"> Engine speed is 1600 r/min or higher and the acceleration opening degree is 60% or more. <p>Set Conditions</p> <ul style="list-style-type: none"> Boost pressure is lower than barometric pressure + 30 kPa for two seconds. <p>Range of Check</p> <ul style="list-style-type: none"> With the idling speed controlled, the engine warmed up, and no failure found <p>Set Conditions</p> <ul style="list-style-type: none"> Boost pressure is higher than barometric pressure - 2.7 kPa for 3 seconds. 	<ul style="list-style-type: none"> Main throttle solenoid valve inoperative Main throttle solenoid valve open circuit, short circuit, or connector contact inoperative Engine-ECU inoperative



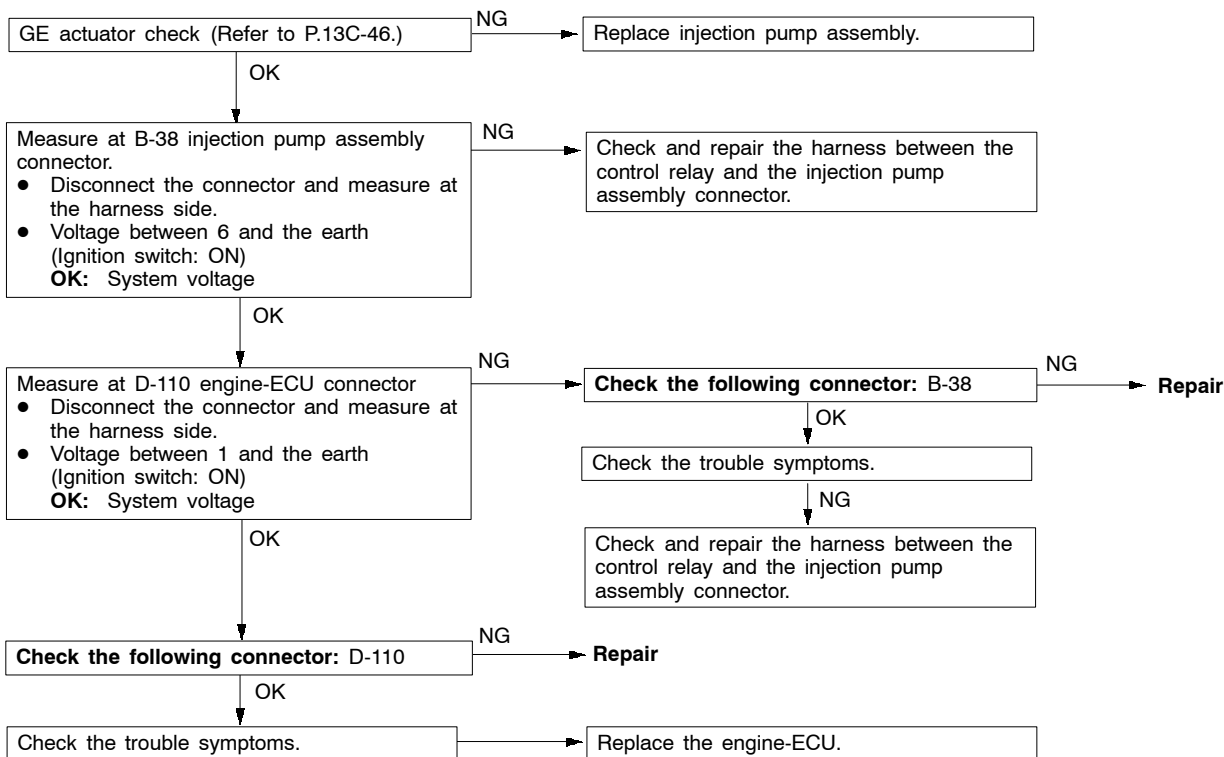
Code No. 43 Timing control valve system	Probable cause
Range of Check ● Engine coolant temperature 80 °C or higher and the engine running Set Conditions ● Target value minus actual value is 1 V or more.	● Timing control valve inoperative ● Timing control valve open circuit, short circuit, or connector contact inoperative ● Engine-ECU inoperative



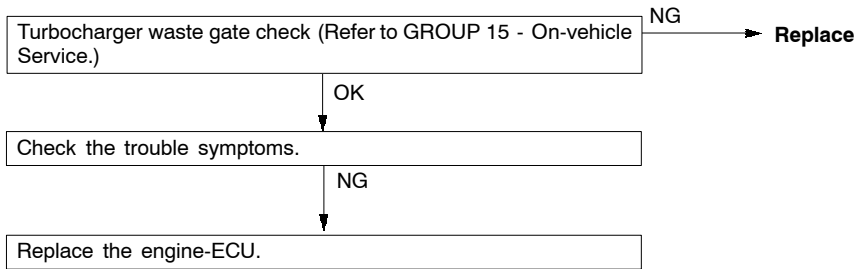
Code No. 46 Injection correction ROM system	Probable cause
Range of Check ● Ignition switch: ON Set Conditions ● When communication fails	● Injection correction ROM inoperative ● Engine-ECU inoperative



Code No. 48 GE actuator (in the middle of control sleeve position sensor inoperative) system	Probable cause
Range of Check ● Ignition switch: ON Set Conditions ● Target value minus actual value is 1 V or more.	● Control sleeve position sensor inoperative ● GE actuator inoperative ● Control sleeve position sensor open circuit, short circuit, or connector contact inoperative ● Engine-ECU inoperative



Code No. 49 Over boost	Probable cause
Range of Check • Ignition switch: ON, except during engine cranking Set Conditions • Boost pressure is higher than 305 kPa for 1 second.	• Malfunction of the turbocharger waste gate • Engine-ECU inoperative

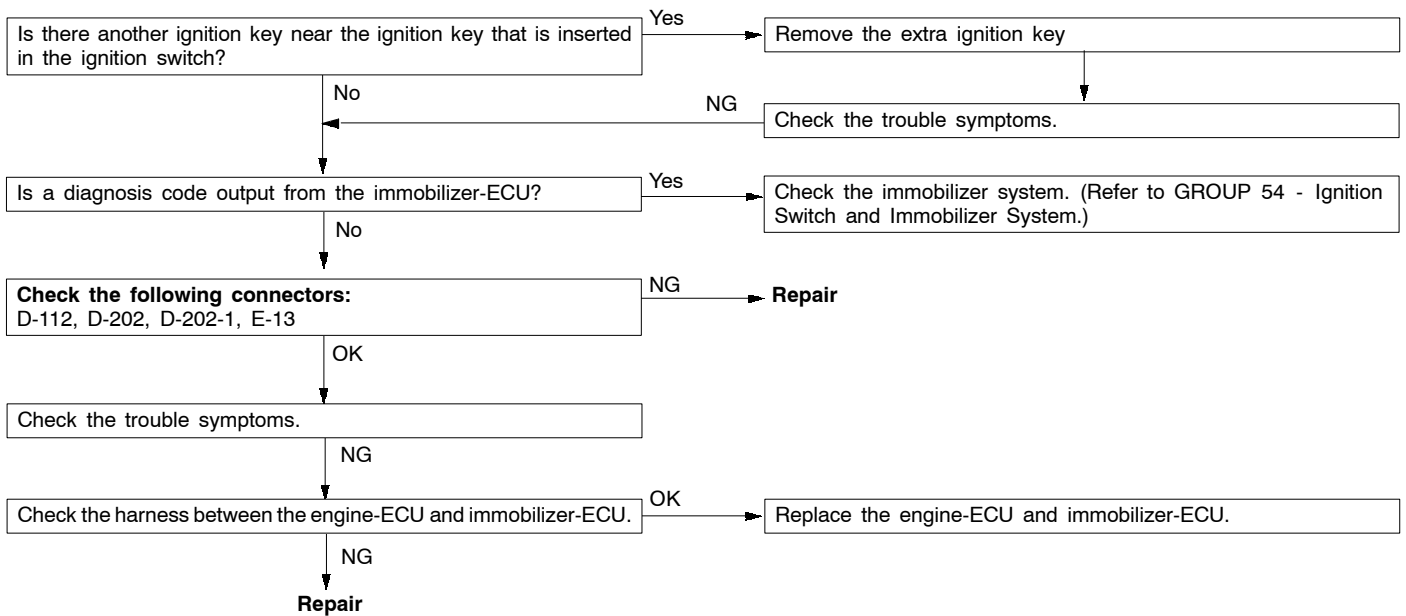


Code No. 54 Immobilizer system	Probable cause
Range of Check • Ignition switch: ON Set Conditions • Improper communication between the engine-ECU and immobilizer-ECU	• Radio interference of encrypted codes • Incorrect encrypted code • Malfunction of harness or connector • Malfunction of immobilizer-ECU • Engine-ECU inoperative

NOTE

(1) If the ignition switches are close each other when starting the engine, radio interference may cause this code to be displayed.

(2) This code may be displayed when registering the key encrypted code.



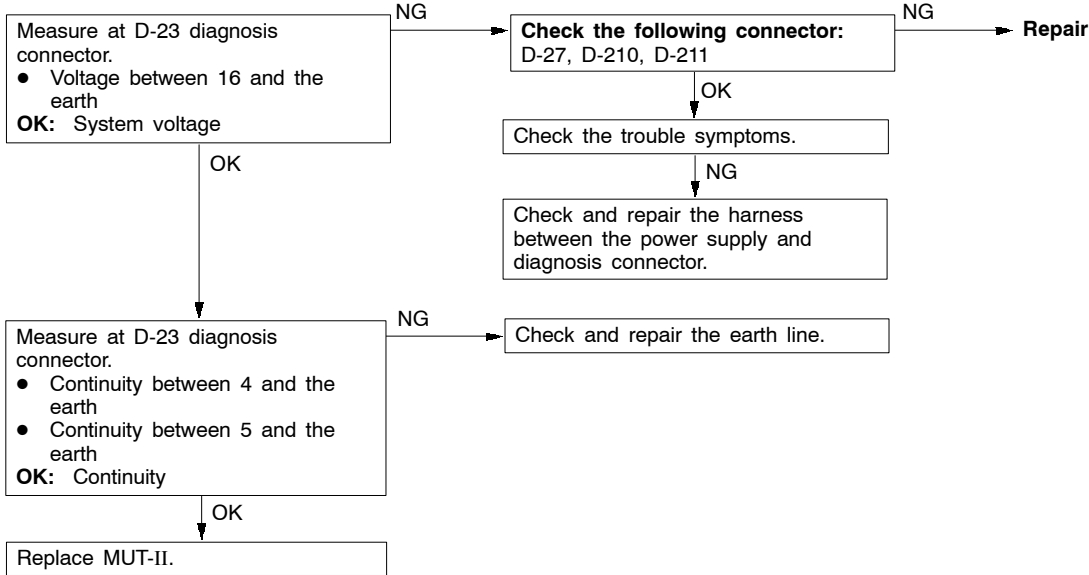
INSPECTION CHART FOR TROUBLE SYMPTOMS

Trouble Symptom		Inspection procedure No.	Reference page
No communication can be established between MUT-II and the engine-ECU.	No communication can be established with all systems.	1	13C-24
	No communication can be established only with the engine-ECU.	2	13C-24
Engine warning lamp related	Immediately after the ignition switch is "ON", the engine warning lamp does not turn on.	3	13C-25
	The engine warning lamp keeps on and does not turn off.	4	13C-25
Starting performance	No initial combustion (unable to start)	5	13C-26
	Starting performance is bad when the engine is cold (difficult to start)	6	13C-26
	Starting performance is bad regardless of when the engine is hot or cold (difficult to start)	7	13C-26
Idling stability (idling inoperative)	Low idling speed when the engine is cold (improper idling speed)	8	13C-27
	High idling speed (improper idling speed)	9	13C-27
	Low idling speed (improper idling speed)	10	13C-27
	Idling instable (rough idling, hunting)	11	13C-28
Idling stability (idling sustainment inoperative)	The engine halts after running for a while.	12	13C-28
	The engine halts during idling.	13	13C-29
Driveability	Lack of output power	14	13C-29
	Occurrence of abnormal knocking	15	13C-29
	Abnormal black smoke	16	13C-30
	Abnormal white smoke	17	13C-30
	Hunting during driving	18	13C-31

INSPECTION PROCEDURES FOR TROUBLE SYMPTOMS

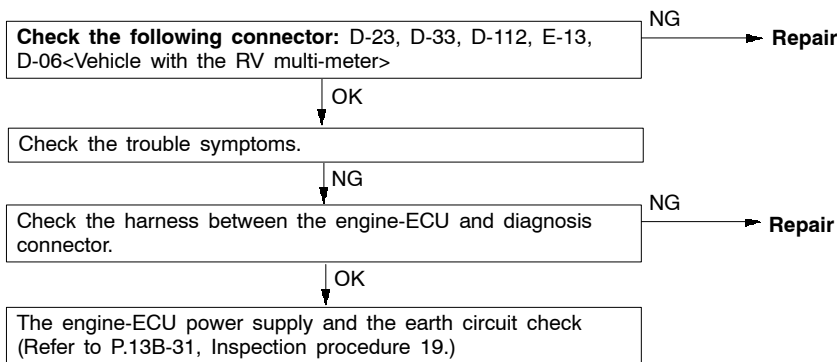
Inspection procedure 1

No communication can be established between MUT-II and all systems.	Probable cause
Probable cause can be found in troubles with the power supply circuit and the earth circuit to the diagnosis connector.	<ul style="list-style-type: none"> • Diagnosis connector inoperative • Harness inoperative



Inspection procedure 2

No communication can be established between MUT-II and the engine-ECU.	Probable cause
Probable causes are shown in the following: <ul style="list-style-type: none"> • The power is not supplied to the engine-ECU. • The earth circuit of the engine-ECU inoperative • The engine-ECU inoperative • Communication between the engine-ECU and MUT-II inoperative 	<ul style="list-style-type: none"> • The power supply circuit of the engine-ECU inoperative • Engine-ECU inoperative • Open circuit at the harness between the engine-ECU and the diagnosis connector

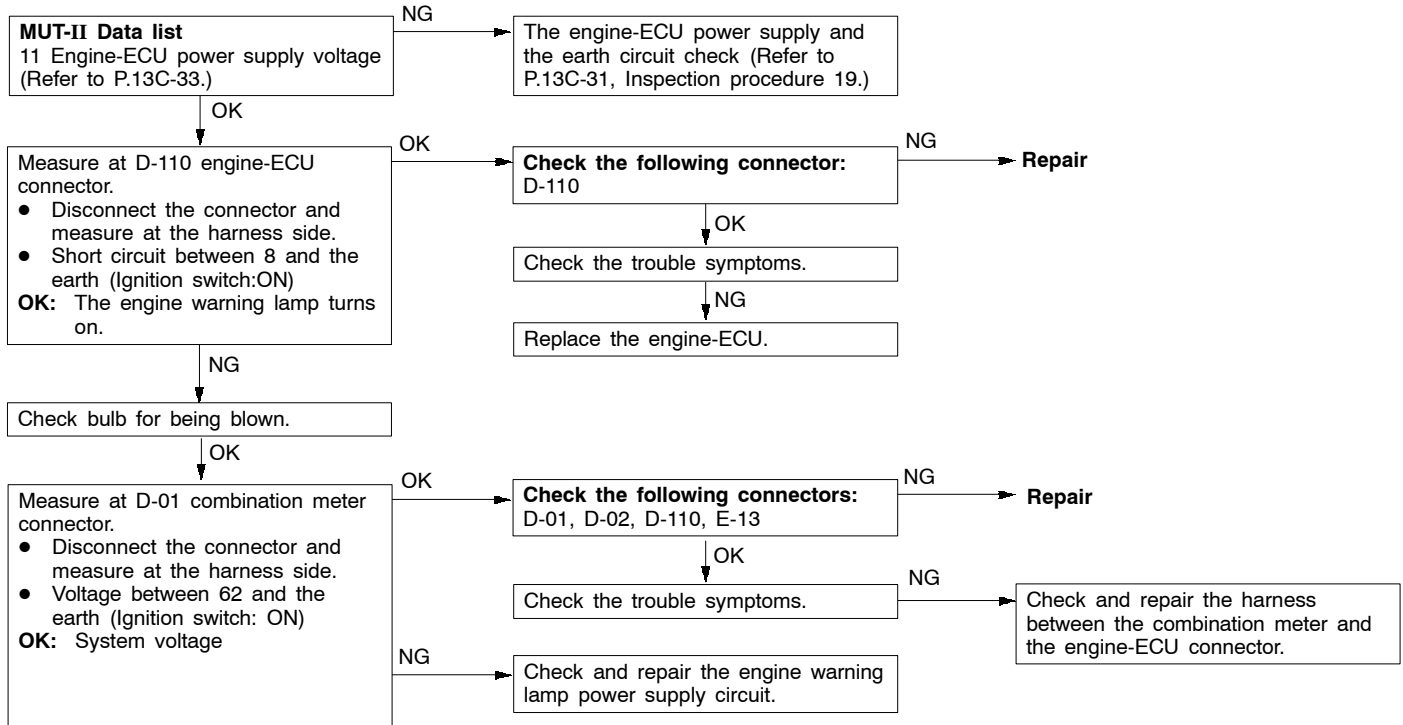


NOTE

If the trouble symptoms persist even after implementing the above-mentioned inspection procedure to the vehicle with center display, check the center display and replace it if necessary. (Refer to GROUP 54A - Clock or Center display.)

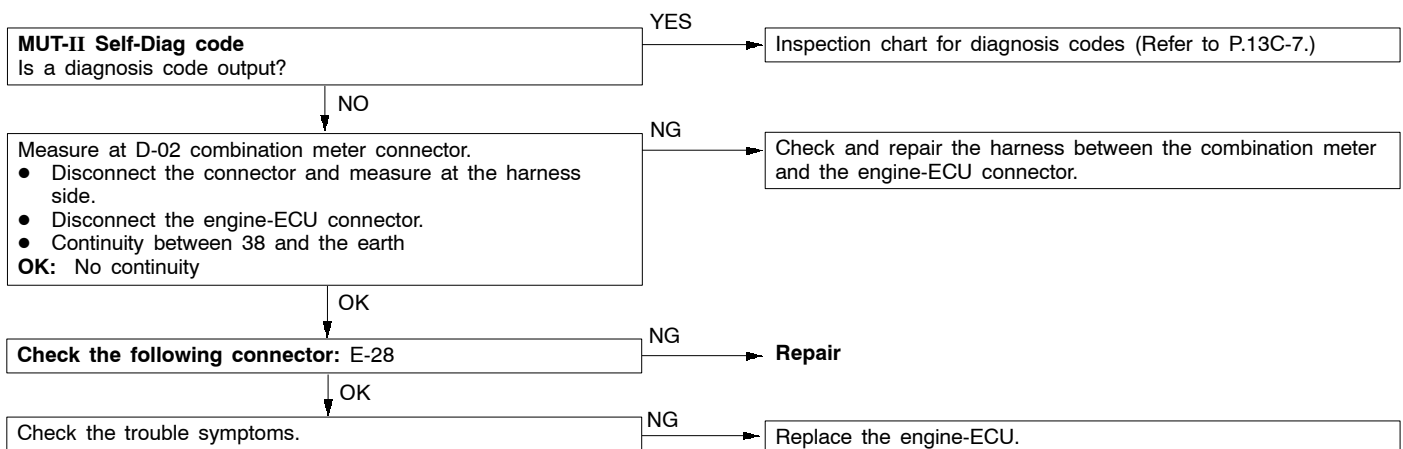
Inspection procedure 3

Immediately after the ignition switch is "ON", the engine warning lamp does not turn on.	Probable cause
The engine-ECU turns on the engine warning lamp for 5 seconds immediately after turning on the ignition switch to check the bulb for being blown. If the engine warning lamp does not turn on immediately after turning the ignition switch ON, problems shown in the right could exist.	<ul style="list-style-type: none"> • The engine warning lamp blown • The engine warning lamp circuit inoperative • Engine-ECU inoperative



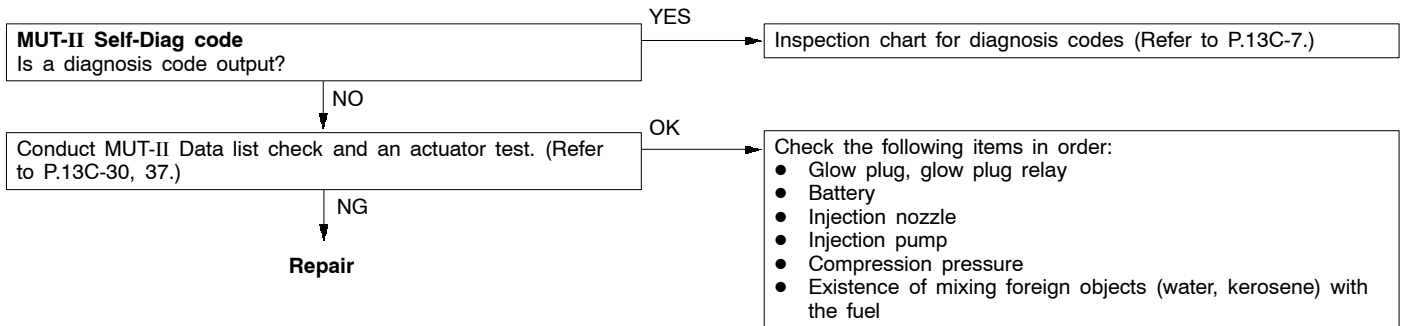
Inspection procedure 4

The engine warning lamp keeps on and does not turn off.	Probable cause
The probable causes can be found in either the engine-ECU detecting the malfunction in the sensor and/or the actuator, or the problem shown in the right takes place.	<ul style="list-style-type: none"> • Short circuit at the harness between the engine warning lamp and the engine-ECU • Engine-ECU inoperative



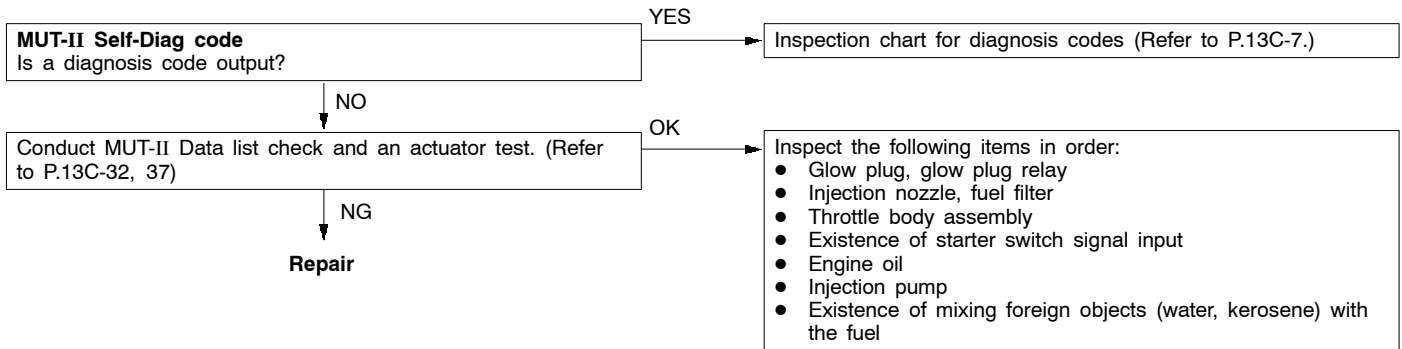
Inspection procedure 5

No initial combustion (unable to start)	Probable cause
Probable causes can be found in troubles with control system, injection pump, glow system, and power supply system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Glow system inoperative ● Engine-ECU inoperative



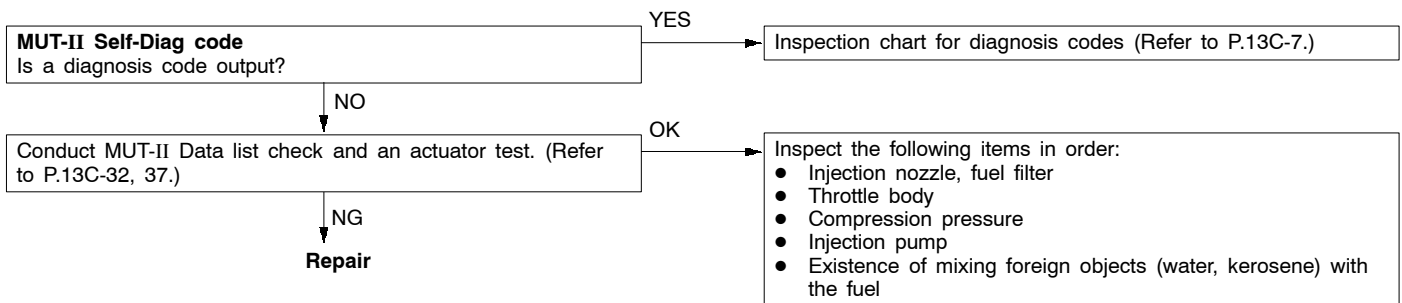
Inspection procedure 6

Starting performance is bad when the engine is cold (unable to start)	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, and glow system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Glow system inoperative ● Engine-ECU inoperative



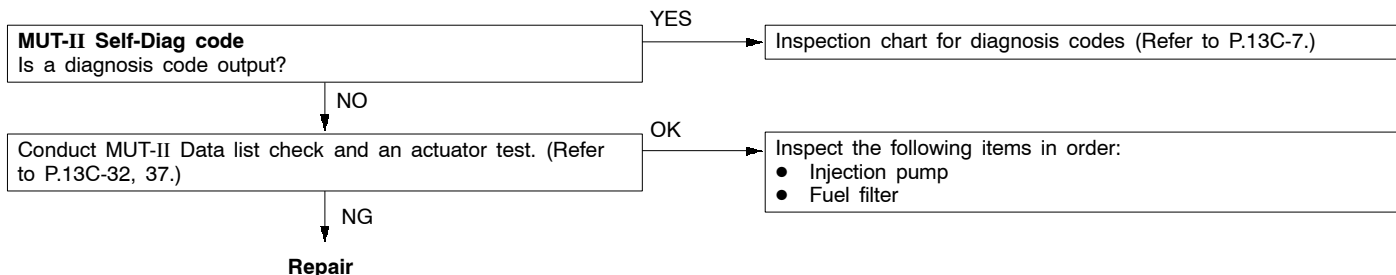
Inspection procedure 7

Starting performance is bad regardless of whether the engine is hot or cold (unable to start)	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, and intake system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Engine-ECU inoperative



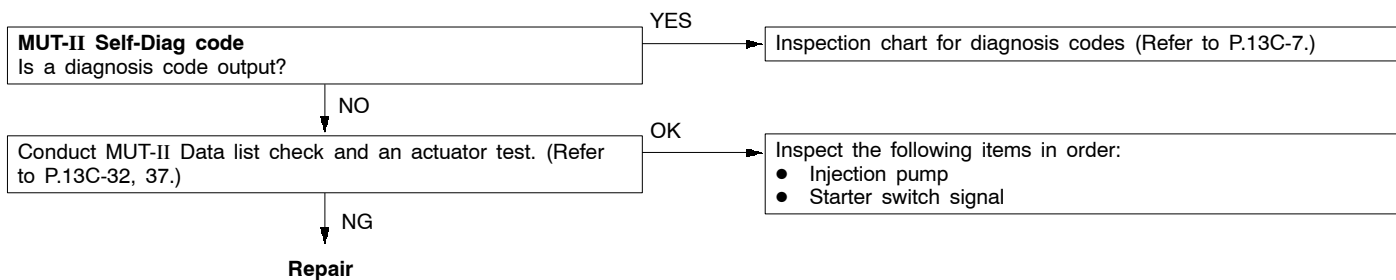
Inspection procedure 8

Low idling speed when the engine is cold (improper idling speed)	Probable cause
Probable causes can be found in troubles with control system, injection pump, and fuel system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Engine-ECU inoperative



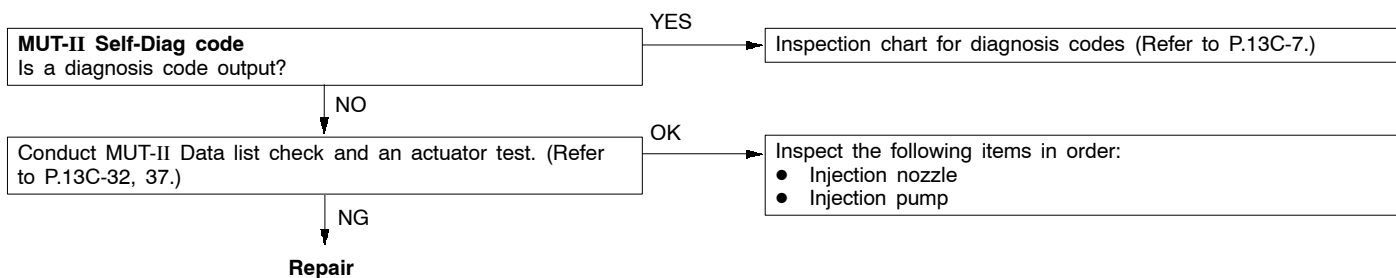
Inspection procedure 9

High idling speed (improper idling speed)	Probable cause
Probable causes can be found in troubles with control system and injection pump.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Engine-ECU inoperative



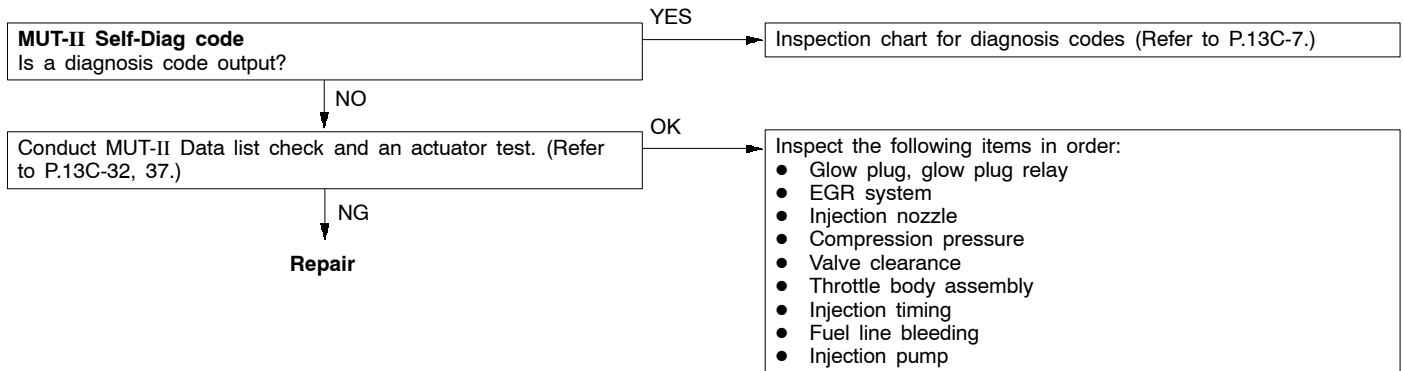
Inspection procedure 10

Low idling speed (improper idling speed)	Probable cause
Probable causes can be found in troubles with control system, injection pump, and fuel.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Engine-ECU inoperative



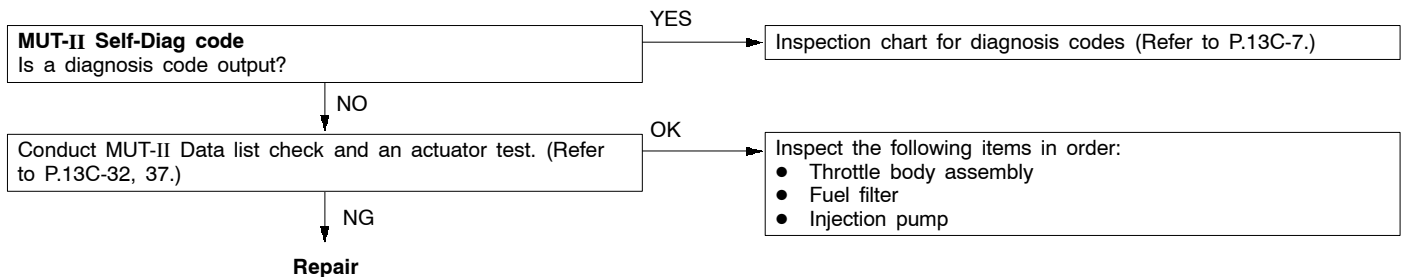
Inspection procedure 11

Idling instable (rough idling, hunting)	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, glow system, intake system, and EGR system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Glow system inoperative ● EGR system inoperative ● Engine-ECU inoperative



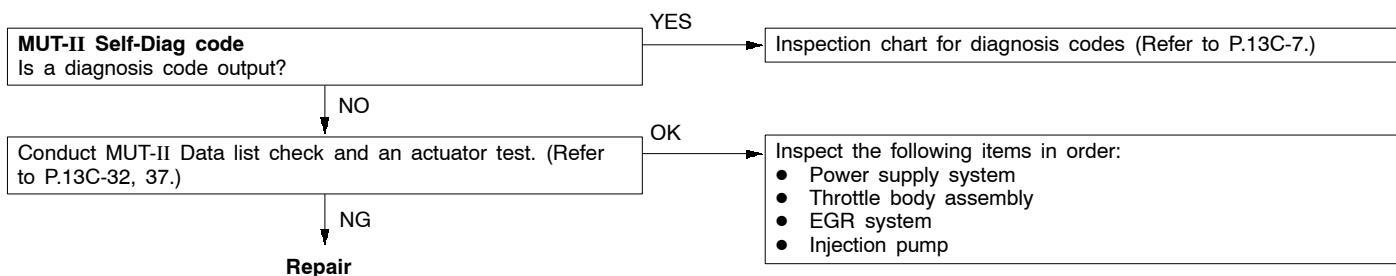
Inspection procedure 12

The engine stalls after running for a while.	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, and intake system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● Engine-ECU inoperative



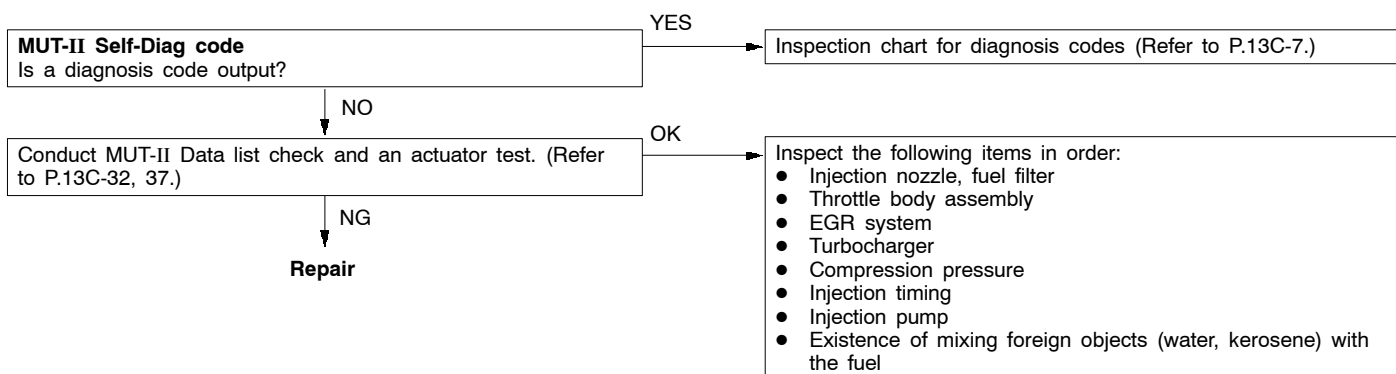
Inspection procedure 13

The engine stalls during idling.	Probable cause
Probable causes can be found in troubles with control system, injection pump, intake system, EGR system, and power supply.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● EGR system inoperative ● Engine-ECU inoperative



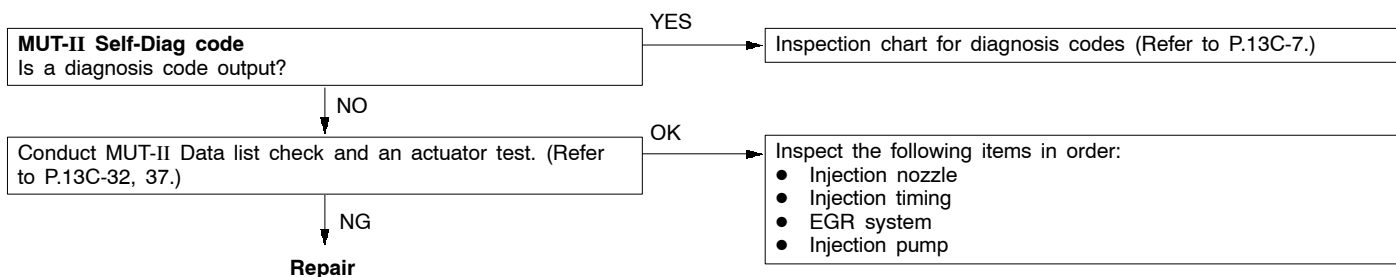
Inspection procedure 14

Lack of output power	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, and EGR system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● EGR system inoperative ● Engine-ECU inoperative



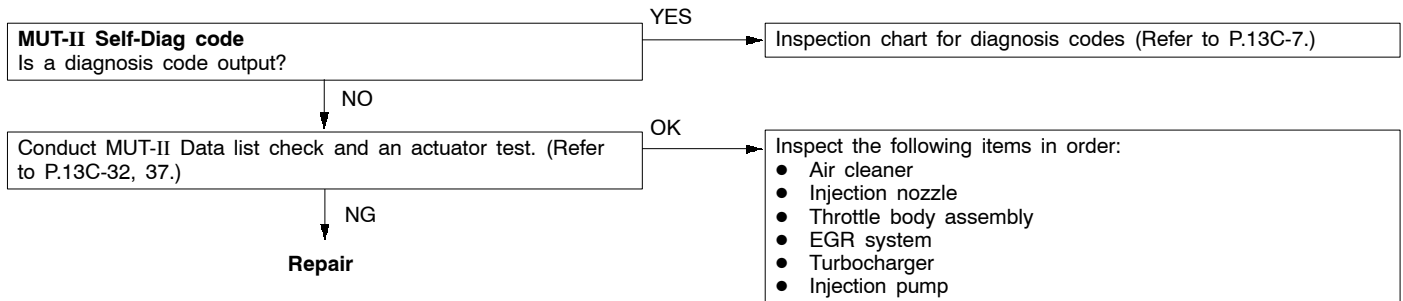
Inspection procedure 15

Occurrence of abnormal knocking	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, and EGR system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● EGR system inoperative ● Engine-ECU inoperative



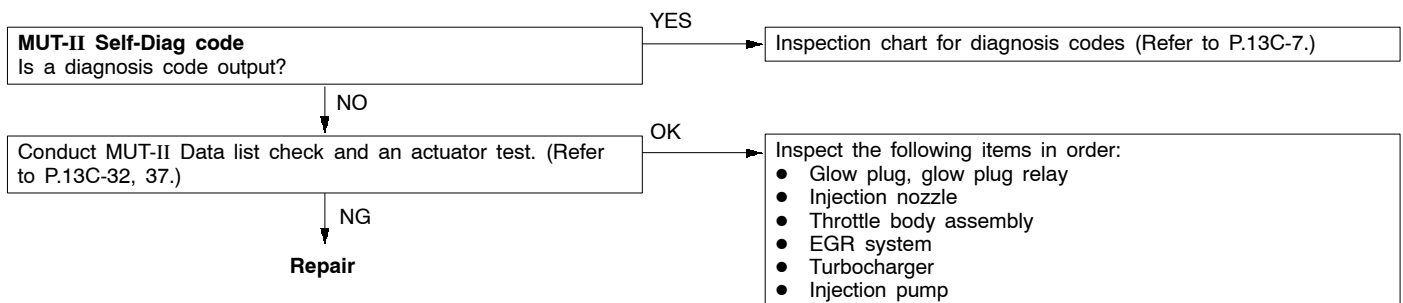
Inspection procedure 16

Abnormal black smoke	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, and EGR system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● EGR system inoperative ● Engine-ECU inoperative



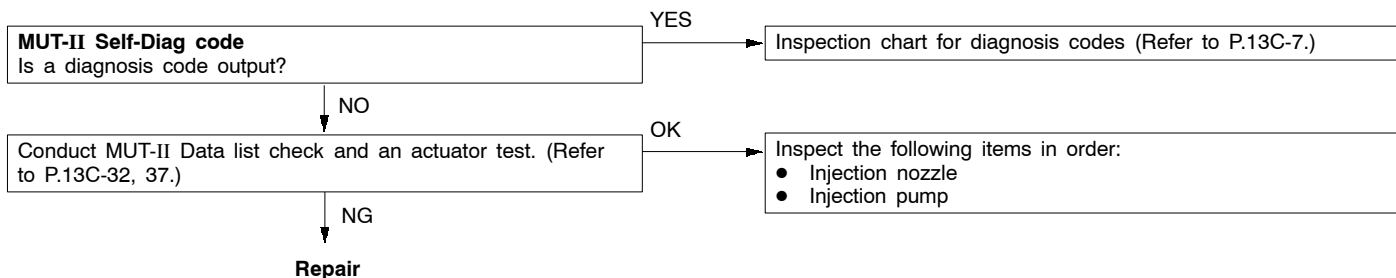
Inspection procedure 17

Abnormal white smoke	Probable cause
Probable causes can be found in troubles with control system, injection pump, fuel system, intake system, EGR system, and glow system.	<ul style="list-style-type: none"> ● Control system inoperative ● Injection pump inoperative ● Fuel system inoperative ● Intake system inoperative ● EGR system inoperative ● Glow system inoperative ● Engine-ECU inoperative



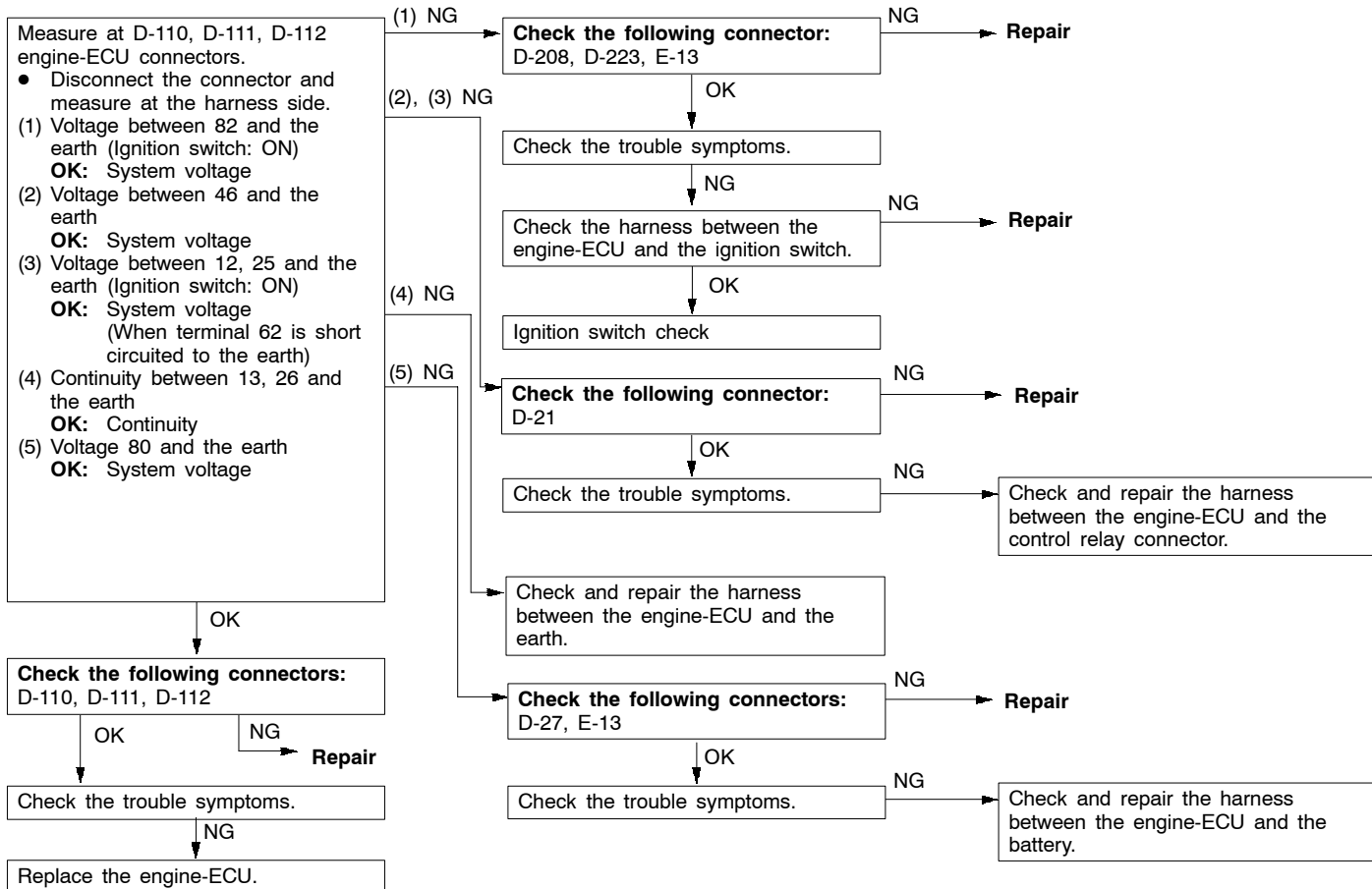
Inspection procedure 18

Hunting during driving	Probable cause
Probable causes can be found in troubles with control system, injection pump, and fuel system.	<ul style="list-style-type: none"> • Control system inoperative • Injection pump inoperative • Fuel system inoperative • Engine-ECU inoperative



Inspection procedure 19

Engine-ECU power supply and earth circuit check



DATA LIST REFERENCE TABLE

Item No.	Check item	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page	
01	Boost air temperature sensor	Ignition switch: ON or the engine running	When the intake air temperature is -20°C	-20°C	Code No. 16	13C-11
			When the intake air temperature is 0°C	0°C		
			When the intake air temperature is 20°C	20°C		
			When the intake air temperature is 40°C	40°C		
			When the intake air temperature is 80°C	80°C		
02	Engine coolant temperature sensor	Ignition switch: ON or the engine running	When the engine coolant temperature is -20°C	-20°C	Code No. 15	13C-11
			When the engine coolant temperature is 0°C	0°C		
			When the engine coolant temperature is 20°C	20°C		
			When the engine coolant temperature is 40°C	40°C		
			When the engine coolant temperature is 80°C	80°C		
03	Barometric pressure sensor	Ignition switch: ON	Altitude 0 m	101 kPa	Code No. 13	13C-10
			Altitude 600 m	95 kPa		
			Altitude 1,200 m	88 kPa		
			Altitude 1,800 m	81 kPa		
04	Boost pressure sensor	<ul style="list-style-type: none"> ● Engine coolant temperature: 80 - 95 °C ● Lamps, electrical cooling fan, and accessories: OFF ● Transmission: P range ● Ignition switch: ON 	Altitude 0 m	101 kPa	Code No. 12	13C-9
			Altitude 600 m	95 kPa		
			Altitude 1,200 m	88 kPa		
			Altitude 1,800 m	81 kPa		
			Idling	81 - 109 kPa		
When sudden racing is done	Increased					
05	Fuel temperature sensor	Ignition switch: ON or the engine running	When the fuel temperature is -20°C	-20°C	Code No. 14	13C-10
			When the fuel temperature is 0°C	0°C		
			When the fuel temperature is 20°C	20°C		
			When the fuel temperature is 40°C	40°C		
			When the fuel temperature is 80°C	80°C		

Item No.	Check item	Inspection conditions		Value to be determined as normal	Code No. or inspection procedure No.	Reference page
06	Vehicle speed sensor	When driving	Compare the engine speed displayed in the speed meter with that in MUT-II	Matched	Code No. 17	13C-12
07	Engine speed sensor (backup)	Engine: Cranking	Compare the engine speed displayed in the tachometer with that in MUT-II	Matched	Code No. 18	13C-13
		Engine: Idling				
08	Engine speed sensor	Engine: Cranking	Compare the engine speed displayed in the tachometer with that in MUT-II	Matched	Code No. 21	13C-14
		Engine: Idling				
09	Accelerator pedal position sensor (main)	Ignition switch: ON	Accelerator pedal: Idling position	0.9 - 1.1V	Code No. 11	13C-8
			Accelerator pedal: Fully opened position	4.1 V or higher		
10	Idle switch	Ignition switch: ON	Release the foot from the accelerator pedal.	0 - 1V	Code No. 23	13C-15
			Step on the accelerator pedal slightly	4V or higher		
11	System voltage	Ignition switch: ON		System voltage	Procedure No. 19	13C-31
13	Timing control valve*1	Engine: After warming up the engine	Idling	0%*1	Code No. 25 or No. 43	13C-16 13C-20
			2,500 r/min	35 - 45%*1		
			High idling	20 - 30%*1		
14	EGR command value	Engine: Idling		0 - 100%*2	-	-
		Engine: After warming up the engine				
17	Control sleeve position (target value)	Engine: After warming up the engine	Idling	1.535 - 1.735 V	Code No. 26	13C-17
			2,500 r/min	Slightly decreased.		
			High idling	1.884 - 2.084 V		
18	Actual injection timing	Engine: After warming up the engine	Idling	0.65 - 0.85 V	-	-
			2,500 r/min	2.325 - 2.525 V		
			High idling	3.814 - 4.014 V		
19	Injection timing command value	Engine: After warming up the engine	Idling	0.3 - 0.5 V	-	-
			2,500 r/min	2.325 - 2.525 V		
			High idling	3.814 - 4.014 V		

Item No.	Check item	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page	
21	GE actuator	Engine: After warming up the engine	Idling	20 - 30%	Code No. 26 or No. 48	13C-17 13C-21
			2,500 r/min	20 - 30%		
			High idling	20 - 29%		
22	EGR duty value	Engine: Idling	0 - 100%*2	-	-	
		Engine: After warming up the engine				
23	Control sleeve position (actual value)	Engine: After warming up the engine	Idling	1.535 - 1.735 V	Code No. 26	13C-17
			2, 500 r/min	Slightly decreased.		
			High idling	1.884 - 2.084 V		
24	Accelerator pedal position sensor (sub)	Ignition switch: ON	Accelerator pedal: Idling position	0.9 - 1.1 V	Code No. 27	13C-18
			Accelerator pedal: Fully opened position	4.1V or higher		
25	Accelerator pedal position sensor (sub)	Ignition switch: ON	Accelerator pedal: Idling position	0%	Code No. 27	13C-18
			Accelerator pedal: Fully opened position	99 - 100%		

NOTE

*1: The opening degree of the timing control valve is converted into percentage. (0%: timer non-advanced angle, 100%: timer maximum advanced angle)

*2: The opening degree of the EGR solenoid valve is converted into percentage.

Item No.	Check item	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page	
41	Idle switch	Ignition switch: ON (check by repeated accelerator operation)	Release the foot from the accelerator pedal.	ON	-	-
			Step on the accelerator pedal slightly.	OFF		
43	A/C switch	Engine: Idling (The A/C compressor should be in operation when the A/C switch is "ON")	A/C switch: ON	ON	-	-
			A/C switch: OFF	OFF		
44	Ignition switch-ST	Ignition switch: ON	Engine: Stop	OFF	-	-
			Engine: Cranking	ON		
45	Ignition switch-IG	Ignition switch: ON	ON	-	-	
46	Control relay	Ignition switch: ON	ON	-	-	
47	A/C relay	Engine: Idling after warming up the engine	A/C switch: OFF	OFF (A/C compressor clutch not in operation)	-	-
			A/C switch: ON	ON (A/C compressor clutch in operation)		

Item No.	Check item	Inspection conditions		Value to be determined as normal	Code No. or inspection procedure No.	Reference page
50	Condenser fan relay	Ignition switch: ON	A/C switch: OFF (engine coolant temperature at 109°C or higher)	ON	-	-
			A/C switch: ON (engine coolant temperature at 109°C or higher or no higher than 109°C and the vehicle speed at 60 km/h or slower)			
52	Glow plug relay	Ignition switch: OFF → ON	A/C switch: OFF (engine coolant temperature at 109°C or lower)	OFF	-	-
			A/C switch: ON (engine coolant temperature at 109°C or lower or no higher than 109°C and the vehicle speed at 60 km/h or faster)			
53	Main throttle solenoid valve	Ignition switch: ON (Engine stops)	Engine coolant temperature at 60°C or lower	ON	-	-
			Engine coolant temperature at 60°C or higher	OFF		
54	Sub throttle solenoid valve	Engine: Idling after warming up the engine	OFF	-	-	
		Engine: Idling → Stop (within 3 seconds)	ON			
55	Engine warning lamp	Ignition switch: OFF → ON	ON (For 5 seconds)	Procedure No. 3	13C-25	
56	Glow lamp	Ignition switch: OFF → ON	The engine coolant temperature at 60°C or lower	ON	-	-
			The engine coolant temperature at 60°C or higher	OFF		

Item No.	Check item	Inspection conditions	Value to be determined as normal	Code No. or inspection procedure No.	Reference page
58	Neutral switch	Ignition switch: ON	N, P range	N, P	-
			None of the above	D, R	
60	Fuel cut relay	Ignition switch: ON → OFF afterwards for a certain period of time	ON	-	-
		None of the above	OFF		
61	EGR control solenoid valve No. 2	Turning off EGR quickly	ON	-	-
		None of the above	OFF		
62	AT/MT switch	Ignition switch: ON	Vehicles with A/T	A/T	-
			Vehicles with M/T	M/T	
68	A/C switch 2	A/C: Under high load or low load	ON	-	-
		A/C: OFF or under medium load	OFF		
69	Warm up switch	<ul style="list-style-type: none"> ● Warm up switch: ON ● Heater temperature setting: Maximum ● Engine coolant temperature: 90°C or lower ● Blower fan: ON 	ON	-	-
		None of the above	OFF		
70	PTC heater	<ul style="list-style-type: none"> ● Warm up switch: ON ● Heater temperature setting: Maximum ● Engine coolant temperature: 65°C to 75°C or lower ● Blower fan: ON 	ON	-	-
		None of the above	OFF		
71	Power steering switch	Power steering switch: ON	ON	-	-
		Power steering switch: OFF	OFF		

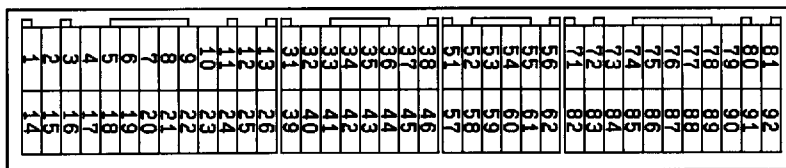
ACTUATOR TEST TABLE

Item No.	Check item	Drive Con- tents	Inspection conditions	Value to be determined as normal	Code No. or inspec- tion proce- dure No.	Reference page
02	Glow plug relay	Turning the relay from OFF to ON or from ON to OFF	Ignition switch: ON	Battery charge is energized to the glow plug when the glow plug relay is ON.	—	—
03	A/C compressor relay	Turning the relay from OFF to ON or from ON to OFF	Ignition switch: ON	The A/C compressor clutch makes an audible sound.	—	—
11	Timing control valve	Turn the timing control valve to ON	<ul style="list-style-type: none"> ● Ignition switch: ON ● Engine: Idling ● Timer piston position sensor: Normal 	Makes an audible sound	Code No.43	13C-20
12		Turn the timing control valve to OFF				
15	Glow lamp	Turn the glow lamp on or off	Ignition switch: ON	The glow lamp turns on	—	—
16	Warning lamp	Turn the warning lamp on or off	Ignition switch: ON	The warning lamp turns on	Procedure No.3, 4	13C-25
22	Condenser fan relay	Turning the relay from OFF to ON or from ON to OFF	Ignition switch: ON	The condenser fan rotates.	—	—
23	Main throttle solenoid valve	Turn the solenoid valve from OFF to ON or from ON to OFF	<ul style="list-style-type: none"> ● Ignition switch: ON ● Vehicle speed: 0 km/h ● Engine speed: 1,000 r/min or lower 	Makes an audible sound	Code No.41	13C-19
24	Sub throttle solenoid valve	Turn the solenoid valve from OFF to ON or from ON to OFF	<ul style="list-style-type: none"> ● Ignition switch: ON ● Vehicle speed: 0 km/h ● Engine speed: 1,000 r/min or lower 	Makes an audible sound	—	—

Item No.	Check item	Drive Con- tents	Inspection conditions	Value to be determined as normal	Code No. or inspec- tion proce- dure No.	Reference page
25	GE actuator	Turn the GE actuator to ON	<ul style="list-style-type: none"> ● Ignition switch: ON ● Engine speed: 0 r/min or lower ● Control sleeve posi- tion sensor: Normal 	Makes an audible sound	Code No.48	13C-21
26		Turn the GE actuator to OFF				
27	Fuel cut solenoid valve	Turn the solenoid valve to ON	<ul style="list-style-type: none"> ● Ignition switch: ON ● Vehicle speed: 0 km/h 	Makes an audible sound	—	—
28	EGR solenoid valve No.1	Turn the solenoid valve to ON	<ul style="list-style-type: none"> ● Ignition switch: ON ● Vehicle speed: 0 km/h 	Makes an audible sound	—	—
29		Turn the solenoid valve to ON				
30	EGR solenoid valve No.2	Turn the solenoid valve from OFF to ON or from ON to OFF	<ul style="list-style-type: none"> ● Ignition switch: ON ● Vehicle speed: 0 km/h 	Makes an audible sound	—	—
33	PTC heater	Switch the PTC heater relay ON/ OFF.	<ul style="list-style-type: none"> ● Ignition switch: ON 	Voltage on the ECU terminal No.9: 0-1V	—	—
34	Middle position of GE actuator	Hold the injection governor in its middle position.	<ul style="list-style-type: none"> ● Ignition switch: ON 	When the crankshaft is turned clockwise during the adjustment of the injection timing, the injection pipes spray out fuel.	Code No.48	13C-21

ENGINE-ECU CHECK

TERMINAL VOLTAGE TABLE



W6106AQ

Terminal No.	Check item	Inspection conditions (engine status)	Normal condition:
1	GE actuator	Ignition switch: ON (Engine stops)	9 V or higher
2	Fuel cut solenoid valve	Ignition switch: OFF → ST	0 - 1 V
		Engine: Idling → Stop (in about 1 second)	System voltage
3	Timing control valve	Ignition switch: ON (Engine stops)	11 V or higher
4	Glow lamp	<ul style="list-style-type: none"> Engine coolant temperature: 40°C or lower Ignition switch: OFF → ON 	0 - 1 V (In about 1 second: at 20°C) → System voltage
5	EGR control solenoid valve No. 2	Ignition switch: OFF → ON	System voltage
		Engine: After warming up the engine, conduct sudden racing from idling.	Decreased momentarily
7	Condenser fan relay	Condenser fan in operation	0 - 1 V
8	Engine warning lamp	Ignition switch: OFF → ON	0 - 1 V (In few seconds) → System voltage
9	PTC heater relay	Heating switch: ON, outside temperature at 10°C or lower, and the engine coolant temperature at 65°C or lower	0 - 1 V
14	Main throttle solenoid valve	Ignition switch: ON (Engine stops)	System voltage
		Engine: After warming up the engine, conduct sudden racing from idling.	0 - 1 V
16	Glow plug relay	<ul style="list-style-type: none"> Engine coolant temperature: 40°C or lower Ignition switch: OFF → ON 	System voltage (In about 8 seconds: at 20°C) → 0 - 1 V
18	Sub throttle solenoid valve	Engine: Idling	System voltage
		Engine: Idling → Stop (within approx. 3 seconds)	0 - 1 V
21	A/C relay	A/C switch: ON	0 - 1 V
31	Idle switch	Ignition switch: ON	0 - 1 V
		Release the foot from the accelerator pedal. Step on the accelerator pedal slightly	4 V or higher
32	A/C switch	A/C in operation (compressor in operation)	System voltage
35	Power steering fluid pressure switch	Engine: Idling after warming up the engine	When turning steering wheel 0 - 1 V

Terminal No.	Check item	Inspection conditions (engine status)		Normal condition:
36	Selector switch between A/T and M/T	Ignition switch: ON		0 - 1 V
37	Inhibitor switch	Ignition switch: ON (Engine stops)	Set the selector lever to P or N	0 - 1 V
			Set the selector lever to D, 2, L, or R	System voltage
39	Stop lamp switch	Depress the brake pedal		System voltage
40	Brake switch	Depress the brake pedal		0 - 1 V
46	Control relay	Ignition switch: ON		0 - 1 V
		Ignition switch: ON → OFF (in about 8 seconds)		System voltage
51	Engine speed sensor (backup)	Engine: Idling		1.5 - 2.5 V
55	Accelerator pedal position sensor (sub)	Ignition switch: ON	Accelerator pedal: Idling position	0.9 - 1.1 V
			Accelerator pedal: Fully opened position	4.1 V or higher
71	Ignition switch-ST	Engine: Cranking		8 V or higher
74	Control sleeve position sensor	Ignition switch: ON (Engine stops)		2.2 - 2.7 V
73				2.0 - 4.0 V
75				2.0 - 4.0 V
76	Timer piston position sensor	Ignition switch: ON (Engine stops)		2.2 - 2.7 V
77				2.0 - 4.0 V
78				2.0 - 4.0 V
80	Back-up power supply	Ignition switch: OFF		System voltage
82	Ignition switch-IG	Ignition switch: ON		System voltage
83	Engine coolant temperature sensor	Ignition switch: ON	Engine coolant temperature: 0°C	3.4 - 4.5 V
			Engine coolant temperature: 20°C	2.6 - 3.6 V
			Engine coolant temperature: 40°C	1.8 - 2.5 V
			Engine coolant temperature: 80°C	0.7 - 1.1 V
84	Accelerator pedal position sensor (main)	Ignition switch: ON	Accelerator pedal: Idling position	0.9 - 1.1 V
			Accelerator pedal: Fully opened position	4.1 V or higher
85	Boost pressure sensor	Ignition switch: ON (760 mmHg)		1.2 - 1.6 V
86	Vehicle speed sensor	<ul style="list-style-type: none"> Ignition switch: ON Move the vehicle forward slowly 		0 V ↔ 5 V (repeat the change)

Terminal No.	Check item	Inspection conditions (engine status)		Normal condition:
87	Fuel temperature sensor	Ignition switch: ON	Fuel temperature: 0°C	3.2 - 3.6 V
			Fuel temperature: 20°C	2.3 - 2.7 V
			Fuel temperature: 40°C	1.4 - 1.8 V
			Fuel temperature: 80°C	0.4 - 0.8 V
88	Boost air temperature sensor	Ignition switch: ON	Intake air temperature: 0°C	3.2 - 3.8 V
			Intake air temperature: 20°C	2.3 - 2.9 V
			Intake air temperature: 40°C	1.5 - 2.1 V
			Intake air temperature: 80°C	0.4 - 1.0 V
89	Engine speed sensor	Engine: Idling		1.5 - 2.5 V
91	Neutral switch	Ignition switch: ON (Engine stops)	Set the selector lever to P or N	0 - 1 V
			Set the selector lever to D, 2, L, or R	System voltage

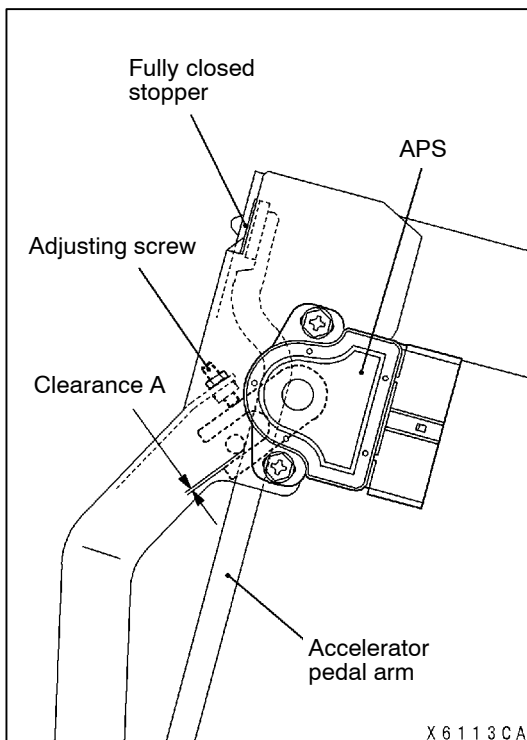
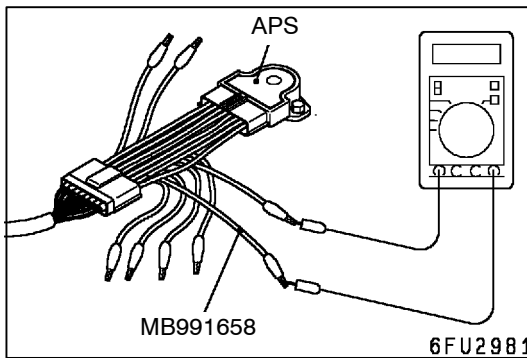
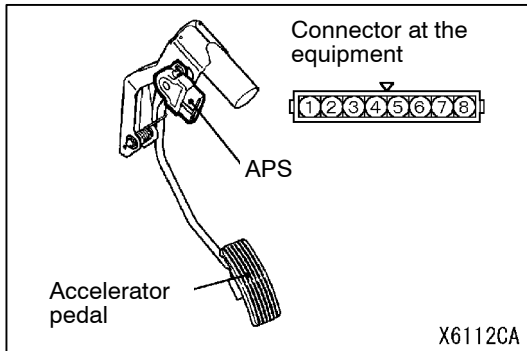
ON-VEHICLE SERVICE

INJECTION TIMING CHECK AND ADJUSTMENT

Refer to GROUP 11C - Engine Adjustment.

IDLE SPEED CHECK AND ADJUSTMENT

Refer to GROUP 11C - Engine Adjustment.



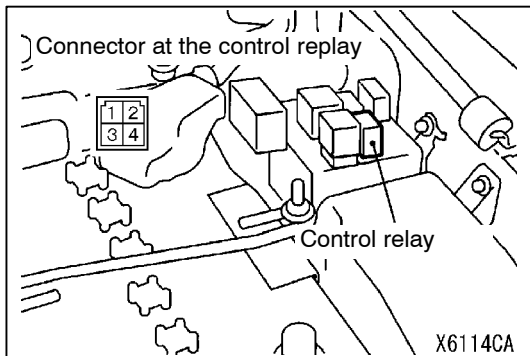
ACCELERATOR PEDAL POSITION SENSOR (APS) ADJUSTMENT

Caution

(1) APS is properly adjusted in the factory. Therefore, APS should not be moved carelessly.

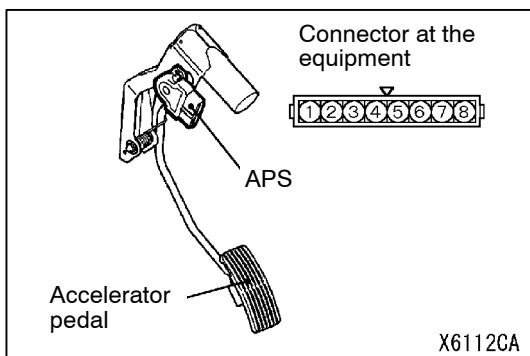
(2) If the adjustment is not done correctly, carry out a new adjustment in the following procedure:

1. Remove accelerator pedal complete.
2. Connect MUT-II to the diagnosis connector. If MUT-II is not used, the following operation should be done:
 - (1) Disconnect APS connector and connect the special tool (test harness: MB991658) between two connectors.
(Be careful not to take a wrong terminal No.)
 - (2) Connect a digital voltmeter between APS connector terminal No. 3 (APS1 output) and terminal No.1 (APS1 earth).
3. Loosen the APS mounting bolt to make it temporarily tightened.
4. Ensure that the accelerator pedal arm contacts the closing stopper.
5. Use the adjusting screw to make the clearance A (shown in the illustration) between 0.5 and 0.93 mm.
6. Secure the adjusting screw with the lock nut.
7. Turn on the ignition switch. (Engine does not start.)
8. Turn APS to make APS1 output the standard value.
Standard value: 0.985 - 1.085 V
9. Tighten the APS mounting bolt securely.
10. Install the accelerator pedal complete.



CONTROL RELAY CONTINUITY CHECK

System voltage	Terminal No.			
	1	2	3	4
When no current is supplied		○		○
When current is supplied	○	⊕	○	⊖



ACCELERATOR PEDAL POSITION SENSOR (APS) CHECK

1. Disconnect the APS connector.
2. Measure the resistance between APS connector terminal No.2 (APS1 power supply) and the terminal No.1 (APS1 earth) as well as the resistance between terminal No.8 (APS2 power supply) and terminal No.7 (APS2 output).

Standard value: 3.5 - 6.5 kΩ

3. Measure the resistance between APS connector terminal No.2 (APS1 power supply) and the terminal No.3 (APS1 output) as well as the resistance between terminal No.8 (APS2 power supply) and terminal No.7 (APS2 earth).

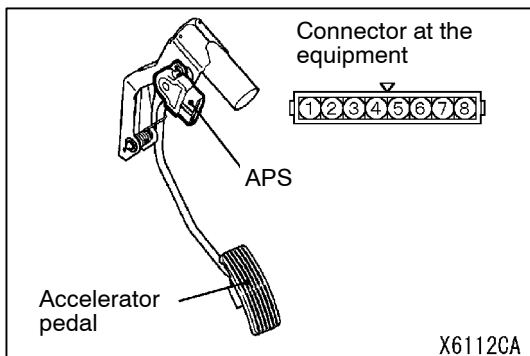
Normal condition:

Step on the accelerator pedal slowly.	Resistance smoothly changes in proportion to the travel of the accelerator pedal.
---------------------------------------	---

4. If the APS is out of the range of the standard value or the resistance does not change smoothly, replace APS.

NOTE

Make an adjustment on APS after replacement. (Refer to P.13C-42.)



IDLE SWITCH CHECK

1. Disconnect the accelerator pedal position sensor (APS) connector.
2. Check the continuity between the idle switch connector terminal No.4 (idle switch) and terminal No.5 (earth).

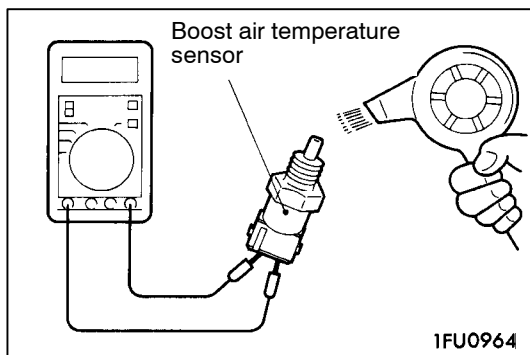
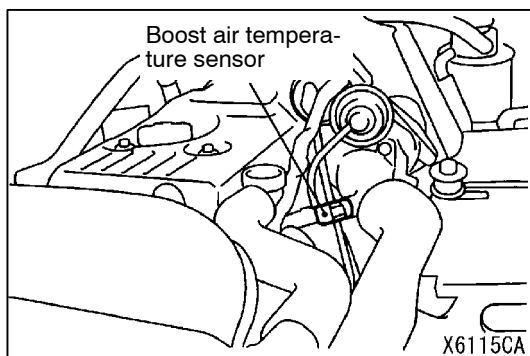
Normal condition:

Accelerator pedal	Continuity
Step on	None
Release	Yes

3. Replace APS if it is inoperative.

NOTE

Make an adjustment on APS after replacement.(Refer to P.13C-42.)

**BOOST AIR TEMPERATURE SENSOR (INTAKE AIR TEMPERATURE SENSOR) CHECK**

1. Remove the boost air temperature sensor.
2. Measure the resistance at the boost air temperature sensor connector terminal.

Standard value:

2.3 - 2.9 k Ω (at 20°C)

0.3 - 0.39 k Ω (at 80°C)

3. Measure the resistance at the sensor part being warmed up by a hair dryer.

Normal condition:

Temperature (°C)	Resistance value (k Ω)
Rising	Become smaller

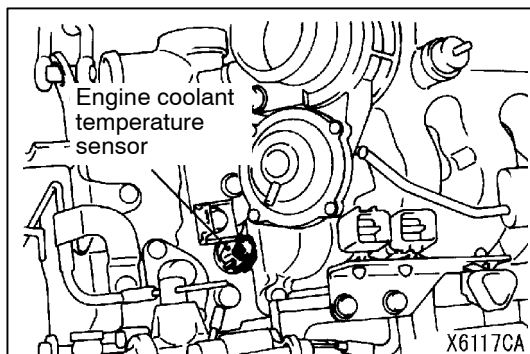
4. If the resistance is not within the range of the standard value or does not change at all, replace the boost air temperature sensor.

NOTE

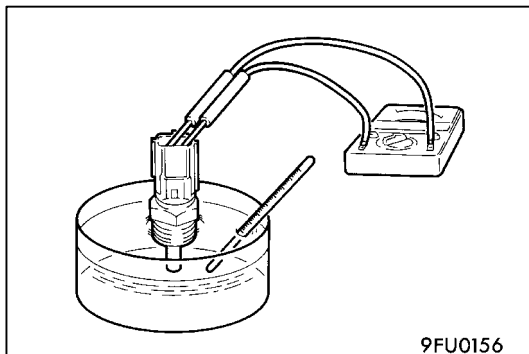
Replace the gasket as well.

5. Tighten the boost air temperature sensor to the specified torque.

Tightening torque: 15 \pm 1 N·m

**ENGINE COOLANT TEMPERATURE SENSOR CHECK**

1. Remove the engine coolant temperature sensor.



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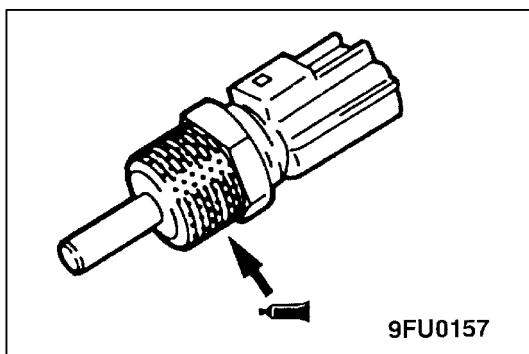
2. Measure the resistance between the terminals of the connectors while immersing the sensor part of the engine coolant temperature sensor in the hot water.

Standard value:

2.3 - 2.6 kΩ (at 20°C)

0.30 - 0.34 kΩ (at 80°C)

3. If the resistance is not within the range of the standard value, replace the engine coolant temperature sensor.



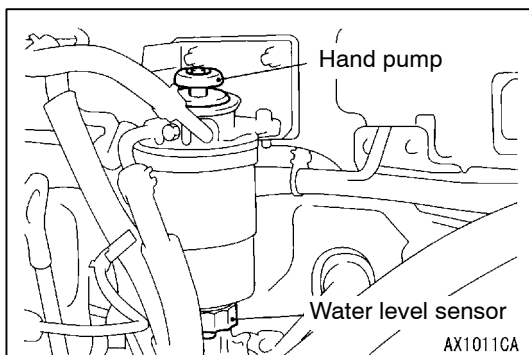
9FU0157

4. Apply the sealant to the thread of the engine coolant temperature sensor and tighten it to the specified torque.

Sealant:

3M Nut Locking Part No. 4171 or equivalent

Tightening torque: 40 ± 4 N·m



AX1011CA

EVACUATION OF WATER FROM FUEL FILTER

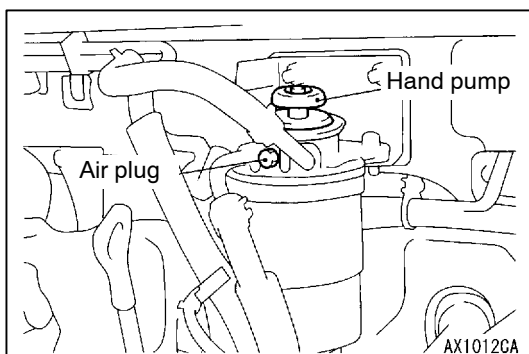
Water is in the filter when fuel filter warning lamp illuminates. Evacuate water by the following procedure.

1. Loosen the water level sensor.
2. After water is evacuated by using a hand pump, tighten the water level sensor to the specified torque.

Tightening torque: 2.5 ± 0.5 N·m

FUEL FILTER CARTRIDGE REPLACEMENT

Refer to GROUP 13D.



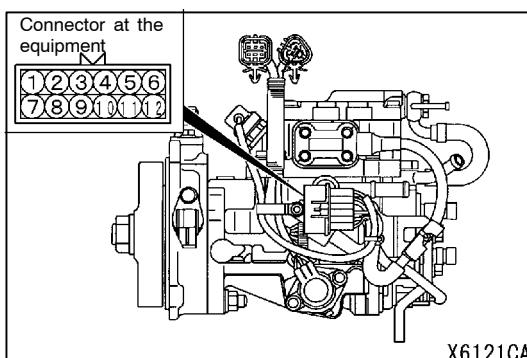
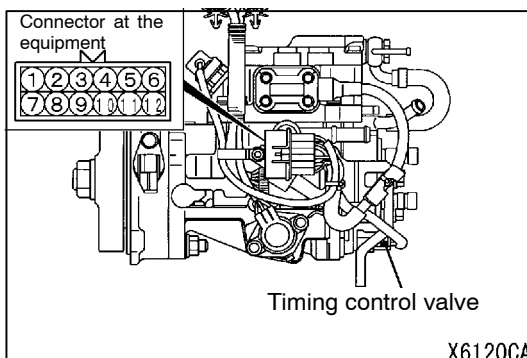
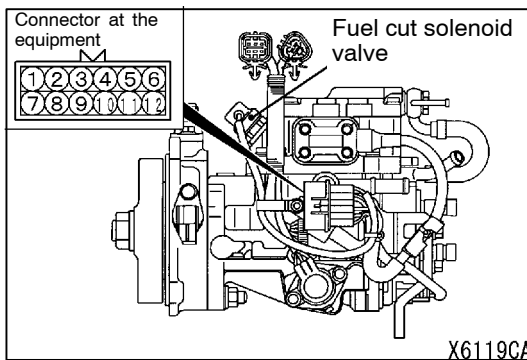
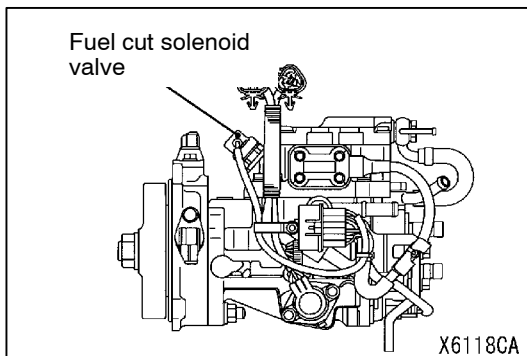
AX1012GA

EVACUATION OF AIR FROM FUEL LINE

When the following service work(s) is done, refill the fuel tank and then evacuate air from the fuel line.

- Fuel hose is removed
 - Fuel filter is replaced
 - Fuel injection nozzle is removed
 - If necessary for access, fuel is drained from the fuel tank.
1. Loosen the fuel filter air plug.

- Cover the circumference of the air plug hole with cloth and use a manual pump repeatedly until no bubbles come out of the plug hole, then tighten the air plug to the specified torque.
Tightening torque: 6.0 ± 1.0 N·m
- Repeat until the hand pump operation becomes stiff.



FUEL INJECTION PUMP CHECK

FUEL CUT SOLENOID VALVE CHECK

Operation noise check

- Attach the sound scope to the fuel cut solenoid valve to check for running noise when the ignition switch is "ON".

Coil resistance check

- Disconnect the injection pump connector (12 pin).
- Measure the resistance between terminal No.1 (fuel cut solenoid valve) and the injection pump body.

Standard value: $6.8 - 9.2 \Omega$

Timing control valve check

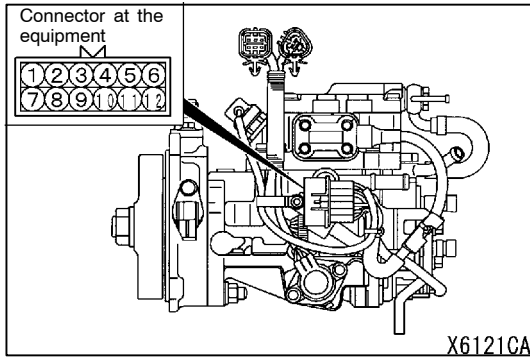
- Disconnect the injection pump connector (12 pin).
- Measure the resistance between terminal No.5 and terminal No.9.

Standard value: $10.8 - 11.2 \Omega$

GE actuator (electronic governor) check

- Disconnect the injection pump connector (12 pin).
- Measure the resistance between terminal No.6 and terminal No.10.

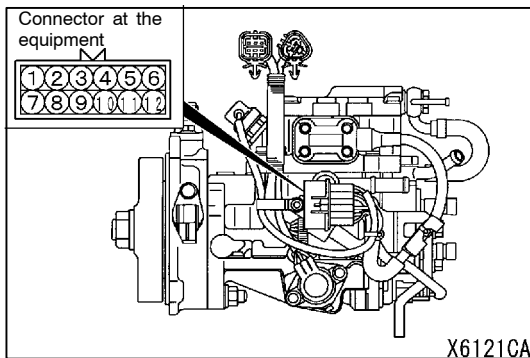
Standard value: $0.64 - 0.72 \Omega$



Fuel temperature sensor check

1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between terminal No.7 and terminal No.11.

Standard value: 1.4 - 2.6 Ω

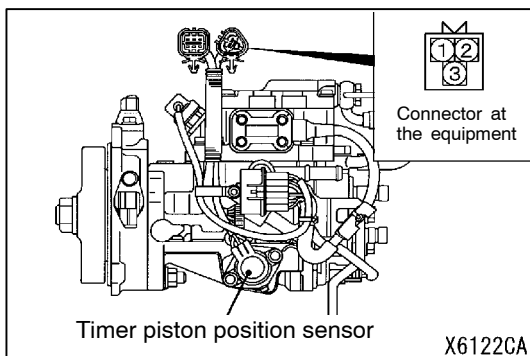


Control sleeve position sensor check

1. Disconnect the injection pump connector (12 pin).
2. Measure the resistance between the following terminals.

Standard value:

Terminal No.4 - Terminal No.12	11.2 - 12.4 Ω
Terminal No.4 - Terminal No.8	5.6 - 6.2 Ω
Terminal No.8 - Terminal No.12	5.6 - 6.2 Ω

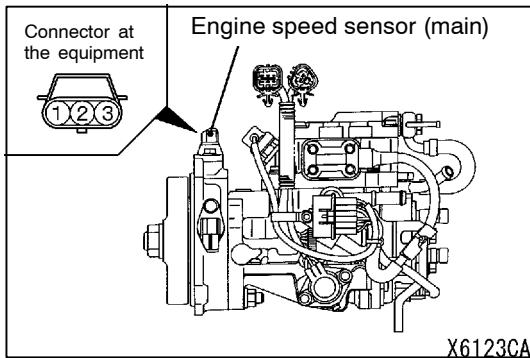


Timer piston position sensor check

1. Disconnect the timer piston position sensor connector.
2. Measure the resistance between the following terminals.

Standard value:

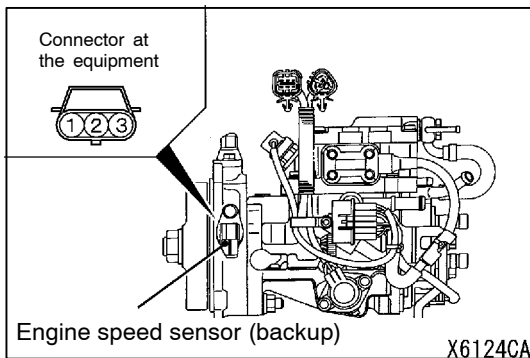
Terminal No.1 - Terminal No.2	160 - 168 Ω
Terminal No.1 - Terminal No.3	80 - 84 Ω
Terminal No.2 - Terminal No.3	80 - 84 Ω



Engine speed sensor (main) check

1. Disconnect the engine speed sensor connector.
2. Measure the resistance between terminal No.2 and terminal No.3.

Standard value: 2.15 kΩ



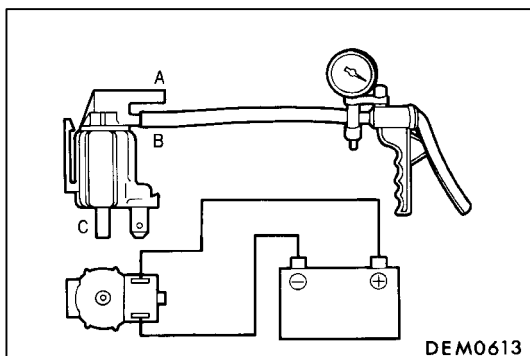
Engine speed sensor (backup) check

- (1) Disconnect the engine speed sensor connector.
- (2) Measure the resistance between terminal No.2 and terminal No.3.

Standard value: 2.15 kΩ

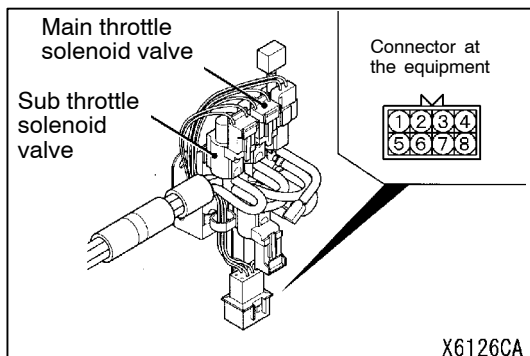
INTAKE AIR RESTRICTION EQUIPMENT CHECK MAIN/SUB THROTTLE SOLENOID VALVE OPERATION CHECK

1. Remove the main/sub throttle solenoid valve connector and vacuum hose.
2. Apply negative pressure to each nipple of the main/sub throttle solenoid valve with a hand vacuum pump to check air density for applying electrical charge to each solenoid valve terminal or not.



Main/sub throttle solenoid valve

System voltage	Normal condition:
When current is supplied	Leak negative pressure (negative pressure maintained when nipple A is closed)
Cold	Leak negative pressure (negative pressure maintained when nipple C is closed)



MAIN/SUB THROTTLE SOLENOID VALVE RESISTANCE CHECK

1. Disconnect the main/sub throttle solenoid valve intermediate harness.
2. Main/sub throttle solenoid valve coil resistance.

Standard value:

Throttle solenoid valve	Terminal to be measured	Resistance value Ω
Main	2 - 6	36 - 44
Sub	1 - 5	36 - 44

INJECTION NOZZLE CHECK AND ADJUSTMENT

Refer to the Engine Workshop Manual.

INJECTION NOZZLE

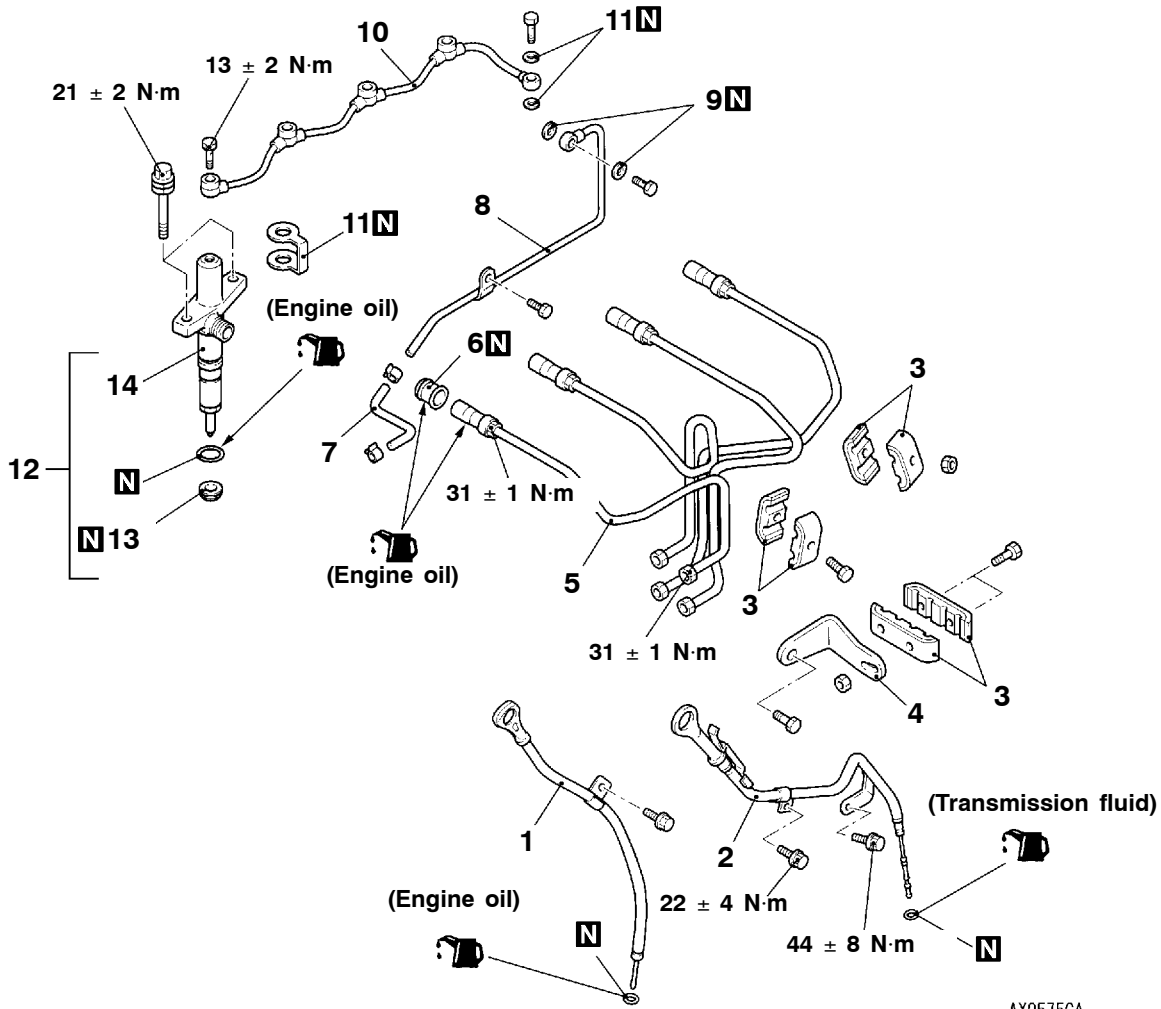
REMOVAL AND INSTALLATION

Pre-removal Operations

- Engine Cover Removal (Refer to GROUP 11C - Camshaft.)
- Battery and Battery Tray Removal
- Fuel filter removal (Refer to GROUP 13D.)
- Skid Plate and Under Cover Removal

Post-installation Operations

- Skid Plate and Under Cover Installation
- Fuel Filter Installation (Refer to GROUP 13D.)
- Battery and Battery Tray Installation
- Fuel Line Bleeding (Refer to P.13C-45.)
- Engine Cover Installation (Refer to GROUP 11C - Camshaft.)

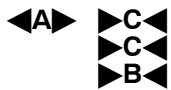


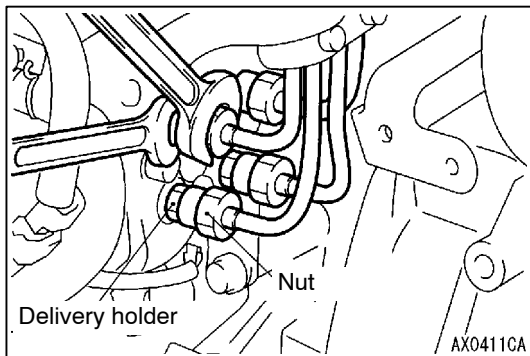
AX0575CA

Removal steps

1. Engine oil level gauge and guide
2. A/T oil level gauge and guide
3. Clamp
4. Injection pipe stay
5. Injection pipe
6. Injection pipe seal
7. Fuel return hose
8. Fuel return pipe

9. Fuel return pipe gasket
- Rocker cover (Refer to GROUP 11C - Camshaft.)
10. Fuel leak off pipe
11. Fuel leak off pipe gasket
12. Injection nozzle assembly
13. Nozzle gasket
14. Injection nozzle





REMOVAL SERVICE POINTS

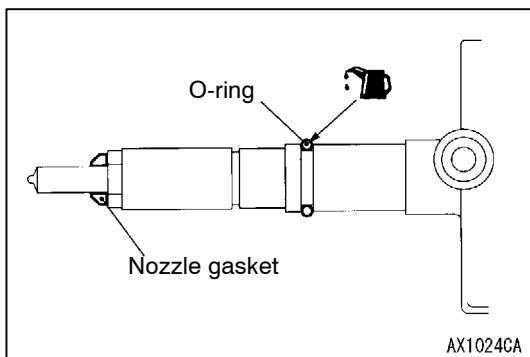
◀A▶ INJECTION PIPE REMOVAL

Hold the injection pump side delivery holder with a open-end wrench, and loosen the nut.

◀B▶ INJECTION NOZZLE ASSEMBLY REMOVAL

Caution

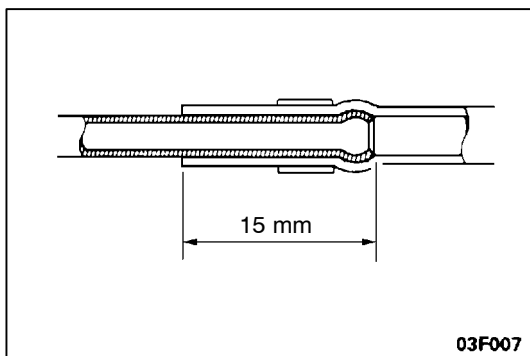
1. Since the injection nozzle assembly is required to re-install to the same cylinder, paste a label of the cylinder number when it is removed.
2. Plug the injection nozzle holes to prevent foreign materials from entering the cylinders.



INSTALLATION SERVICE POINTS

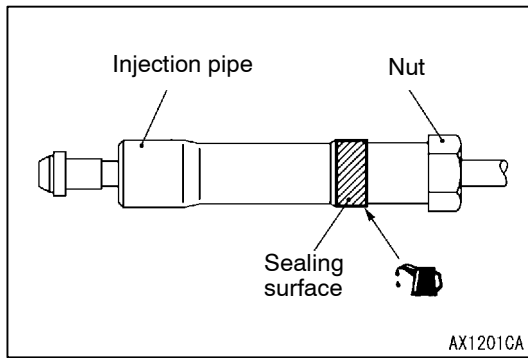
▶A◀ INJECTION NOZZLE/NOZZLE GASKET INSTALLATION

1. After cleaning the injection nozzle, apply a small amount of engine oil to a new O-ring, and install it, being careful not to damage it.
2. Install the nozzle gasket in the shown direction.



▶B◀ FUEL RETURN HOSE INSTALLATION

Insert the fuel return hose into the fuel pipe until the shown dimension is satisfied.

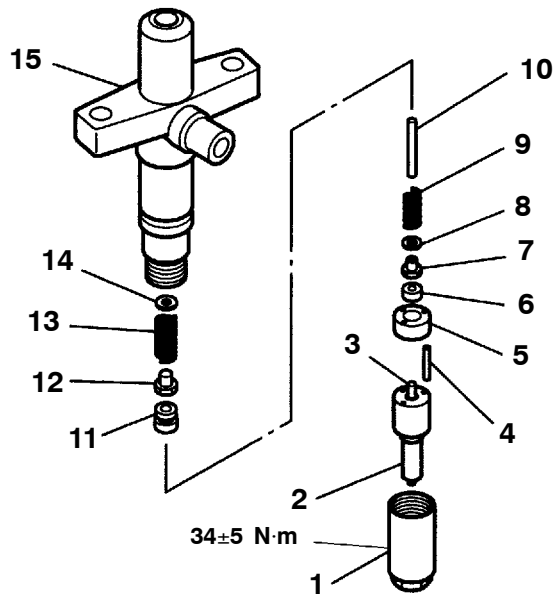


►C◄ INJECTION PIPE SEAL/INJECTION PIPE INSTALLATION

1. Apply a small amount of engine oil to a new injection pipe seal, and install it, being careful not to damage it.
2. Apply a small amount of engine oil to the injection pipe sealing surface, and then connect the injection pipes.
3. Secure the delivery holder at the injection pump side with a spanner in the same way as the removal procedure, then install the injection pipe nut.
4. Tighten the injection pipe nut to the specified torque.

Tightening torque: 31 ± 1 N·m

DISASSEMBLY AND REASSEMBLY



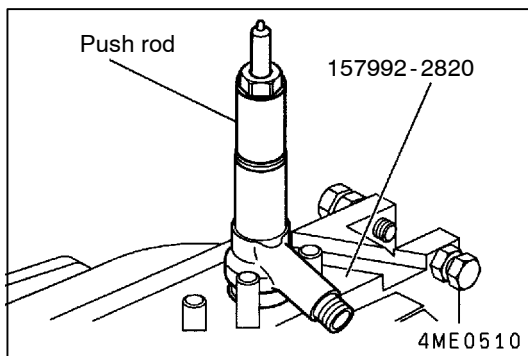
X6207CA

Disassembly steps



1. Retaining nut
2. Nozzle
3. Needle valve
4. Pin
5. Spacer
6. Lift piece
7. Spring seat
8. Shim

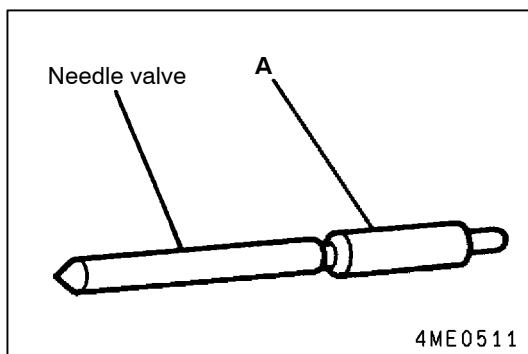
9. Second spring
10. Push rod
11. Collar
12. Spring seat
13. First spring
14. Shim
15. Nozzle holder



DISASSEMBLY SERVICE POINT

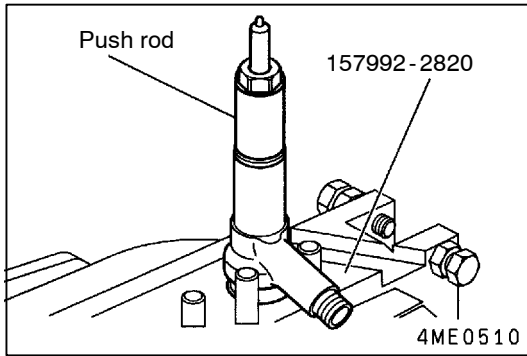
◀A▶ RETAINING NUT REMOVAL

Use the special tool to remove the retaining nut.



Caution

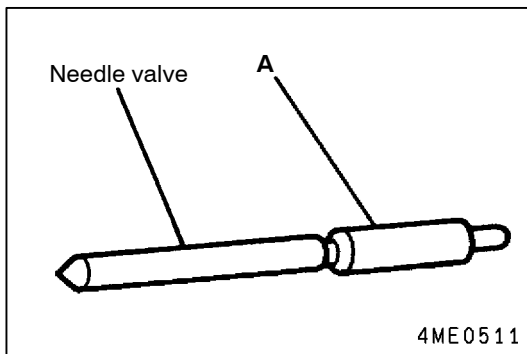
1. Never touch the "A" part of the needle valve.
2. Always handle the needle valve and the nozzle as a set per cylinder.



REASSEMBLY SERVICE POINT

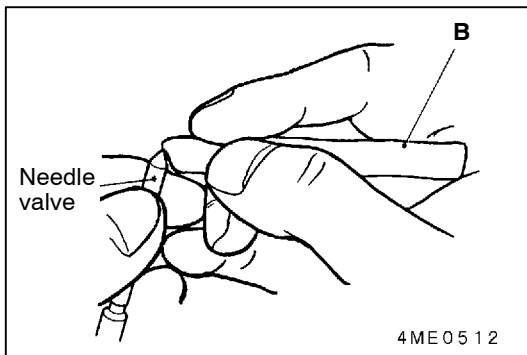
►A◄ RETAINING NUT INSTALLATION

Use the special tool to install the retaining nut.



Caution

1. Never touch the "A" part of the needle valve.
2. Always handle the needle valve and the nozzle as a set per cylinder.



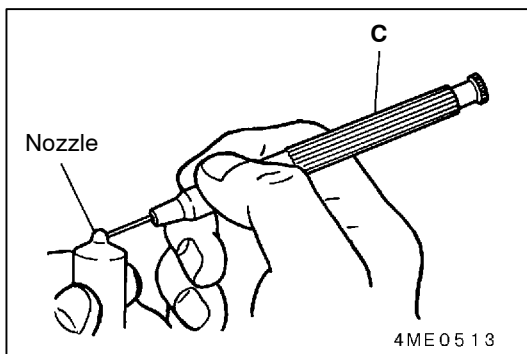
NOZZLE AND NEEDLE VALVE CLEANING

Clean the needle valve and nozzle with gas oil (cleaning solvent).

Remove carbon deposits with a cleaning tool in the following manner:

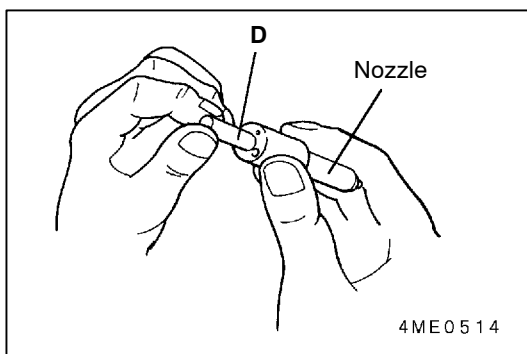
1. Clean the needle valve by removing carbon deposits from its tip using cleaning bar **B** of the cleaning tool.

Never use a wire brush or hard steel for cleaning.

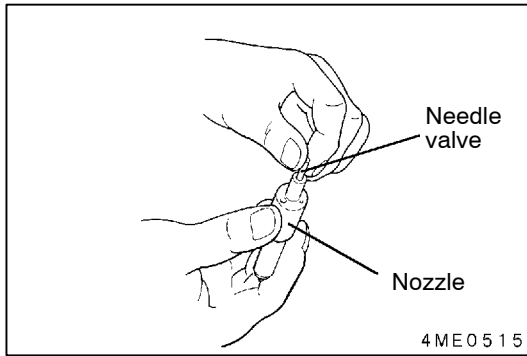


2. To clean the nozzle, remove carbon deposits from the orifices of the nozzle using needle cleaner **C** of the cleaning tool, by inserting it into the orifices and turning it.

Needle cleaner diameter: $\phi 0.21$ mm or less.



3. Clean the seat of the nozzle using cleaning needle **D** of the cleaning tool.
4. Use carbon remover to remove hard-to-remove, burnt-on carbon deposits.



INSPECTION

NOZZLE AND NEEDLE VALVE

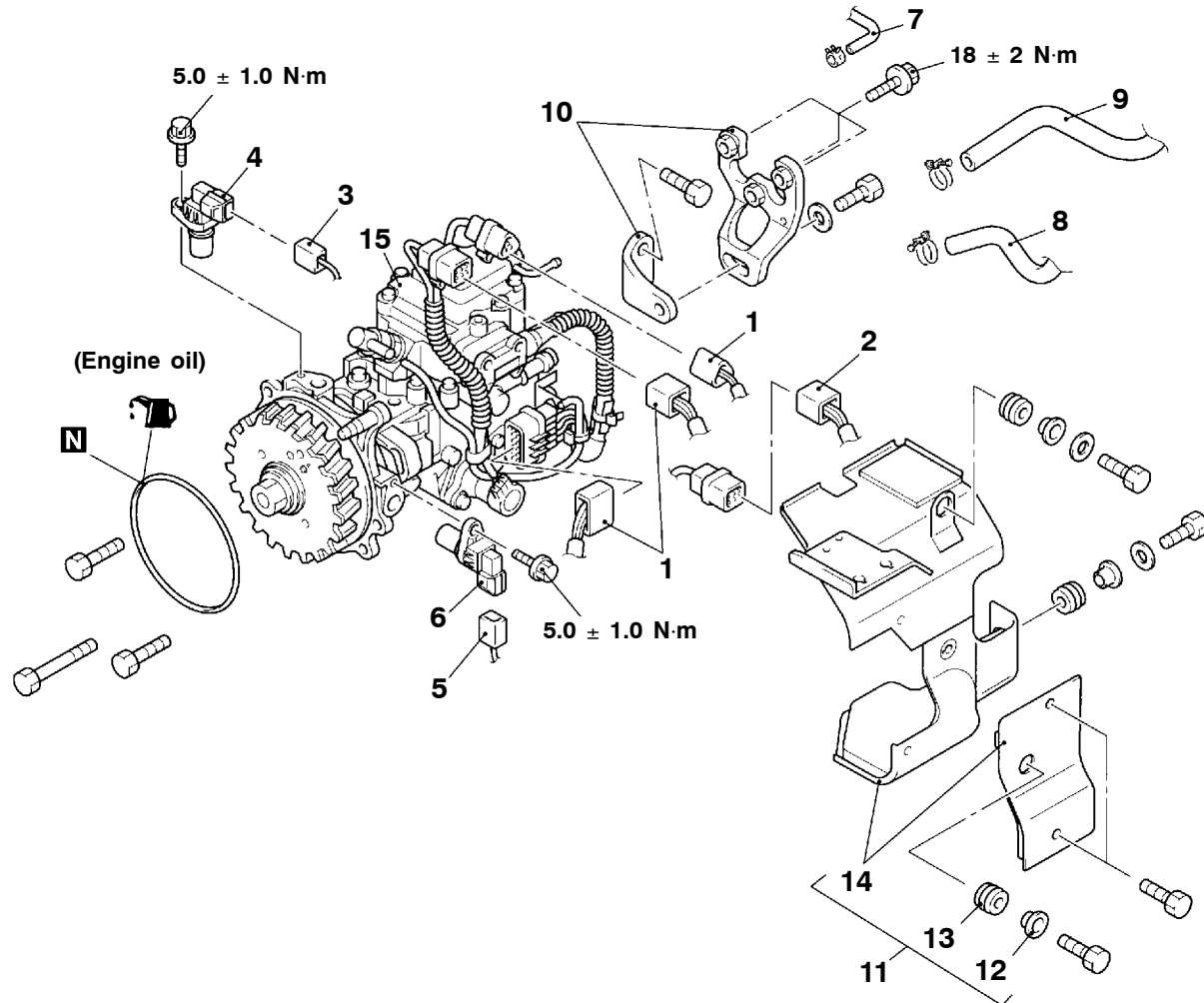
1. Immerse the needle valve and nozzle in gas oil (cleaning solvent) and clean them thoroughly.
2. Check and see if the needle valve drops by its own weight into the nozzle from the position where a third of its length is pulled out. (Repeat this several times rotating the needle valve.)
3. If the needle valve does not drop smoothly, repeat cleaning and repeat the test. If any fault is still found, replace both the needle valve and nozzle together as a set.

INJECTION PUMP

REMOVAL AND INSTALLATION

Pre-removal and Post-installation Operations

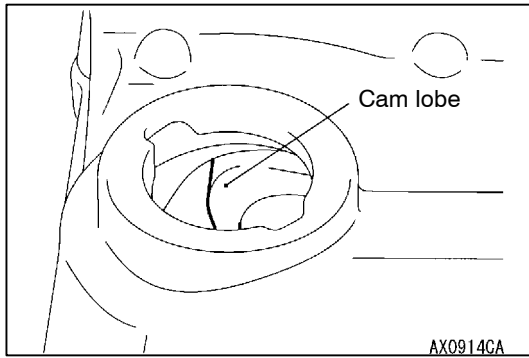
- Removal and Installation Of Engine Cover (Refer to GROUP 11C - Camshaft.)
- Removal and Installation of Battery and Battery Tray
- Removal and Installation of Injection Pipe (Refer to P.13C-50.)
- Removal and Installation of Air Cleaner (Refer to GROUP 15.)
- Removal and Installation of Intercooler Hose (Refer to GROUP 15.)
- Removal and Installation of Glow Plug Relay and Solenoid Valve Assembly
- Removal and Installation of Vacuum Pump (Refer to GROUP 11C.)



AX0577CA

Removal steps

- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Injection pump connector 2. Engine speed sensor connector 3. Engine speed sensor 1 connector 4. Engine speed sensor 1 5. Engine speed sensor 2 connector 6. Engine speed sensor 2 | <ol style="list-style-type: none"> 7. Fuel return hose 8. Fuel return hose 9. Fuel main hose 10. Injection pump stay 11. Injection pump cover assembly 12. Insulator collar 13. Insulator 14. Injection pump cover 15. Injection pump assembly |
|---|---|
- ◀C▶
▶B▶
▶A▶
▶A▶



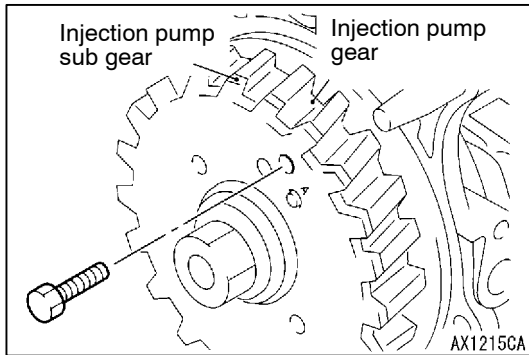
REMOVAL SERVICE POINT

◀▶ INJECTION PUMP ASSEMBLY REMOVAL

Make the timing mark of "0" position on the crankshaft pulley with that of the timing case and set No.1 cylinder to compression stroke TDC.

NOTE

Remove the oil filler cap. If the camshaft cam lobe is at the shown position, the No.1 cylinder is on the compression stroke TDC.



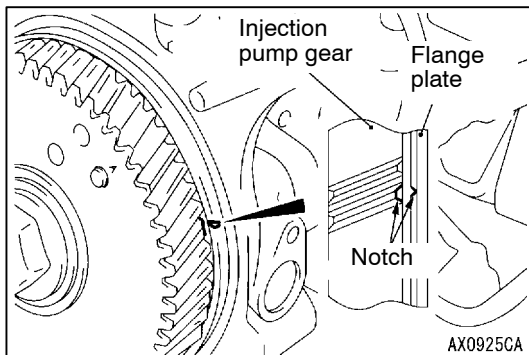
INSTALLATION SERVICE POINTS

▶▶ INJECTION PUMP ASSEMBLY INSTALLATION

1. Install the bolt (M6 × 16) to the show position in order to hold the injection pump gear and the injection pump sub gear in position.

NOTE

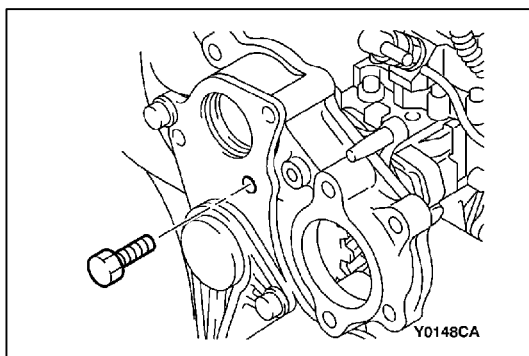
If the injection pump assembly or the injection pump gear assembly is replaced, the bolt has been assembled beforehand.



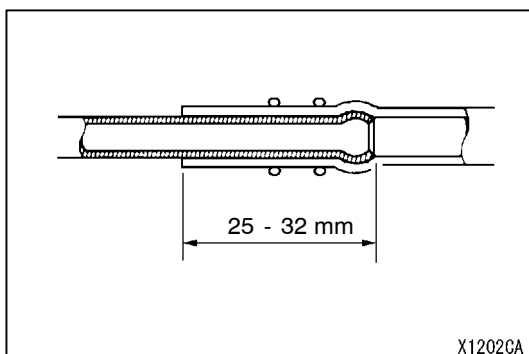
2. Make sure that No.1 cylinder is on the TDC of compression stroke.
3. Align the notch of the injection pump gear with the notch of the flange plate to install the injection pump assembly to the timing gear case.

NOTE

After installing the injection pump assembly, the characteristic of the gear makes the notch of the injection pump gear lag behind the notch of the flange plate by one tooth.

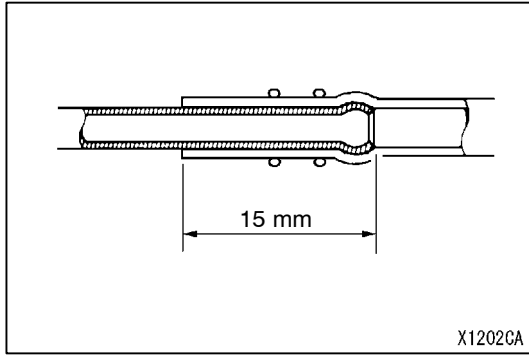


4. Remove the bolt, which has been assembled in Step 1.



▶▶ FUEL MAIN HOSE/FUEL RETURN HOSE INSTALLATION

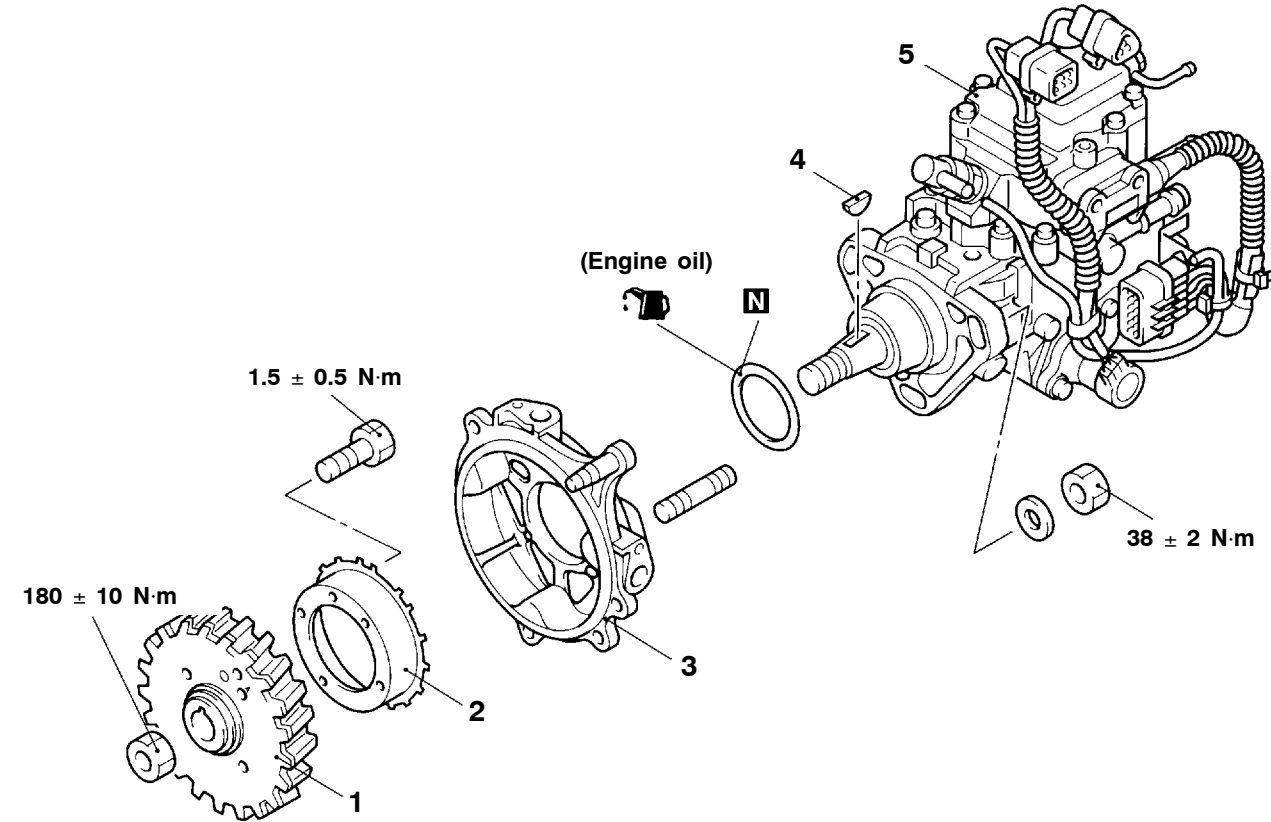
When connecting the fuel main hose or return hose to the fuel pipe, insert it up to the stepped part.



►◄ FUEL RETURN HOSE INSTALLATION

Insert the fuel return hose into the fuel pipe until the shown dimension is satisfied.

DISASSEMBLY AND ASSEMBLY



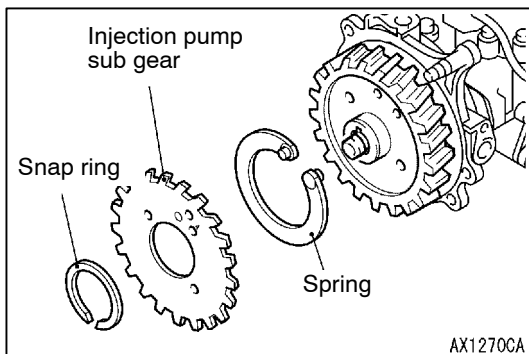
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Disassembly steps



1. Injection pump gear assembly
2. Sensor plate
3. Flange plate

4. Key
5. Injection pump



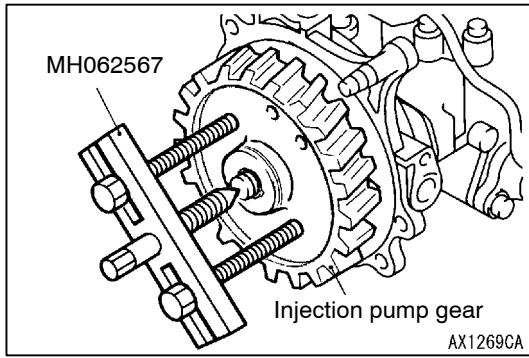
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DISASSEMBLY SERVICE POINT

►◄ INJECTION PUMP GEAR ASSEMBLY REMOVAL

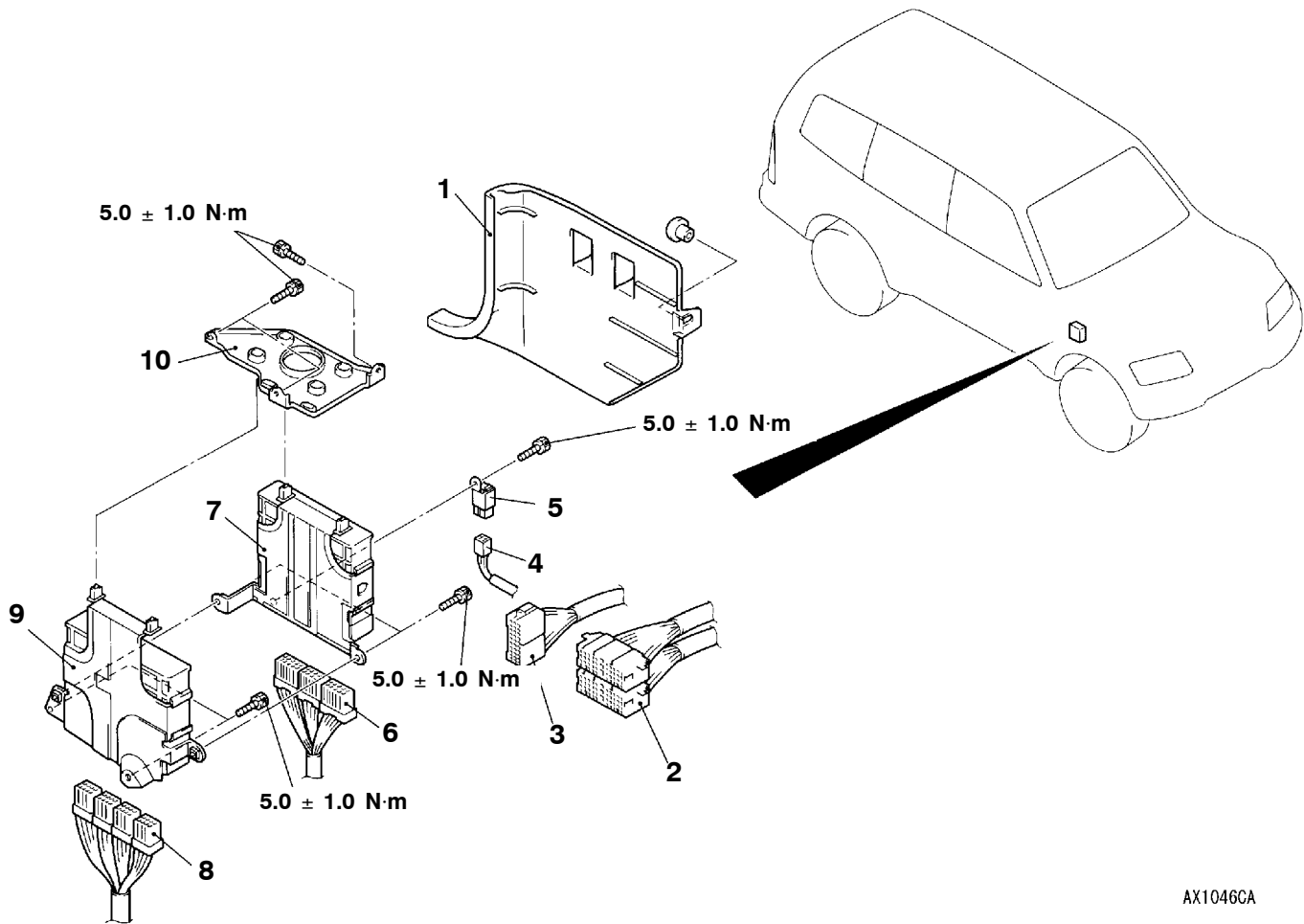
Remove the injection pump gear according to the following procedure.

1. Remove the snap ring.
2. Remove the injection pump sub gear.
3. Remove the spring.



4. Remove the injection pump gear with special tools.

ENGINE-ECU REMOVAL AND INSTALLATION



Removal steps

1. Cowl side trim (LH)
2. Joint of the instrument panel harness and front door harness (LH)
3. Joint of the instrument panel harness and floor harness (LH)
4. A/T control relay connector
5. A/T control relay

6. A/T-ECU connector
7. A/T-ECU
8. Engine-ECU connector
9. Engine-ECU
- Instrument panel (Refer to GROUP 52A.)
10. ECU bracket

NOTES