SECTION 13A

MPI (Multi-point Fuel Injection)

CONTENTS

GENERAL

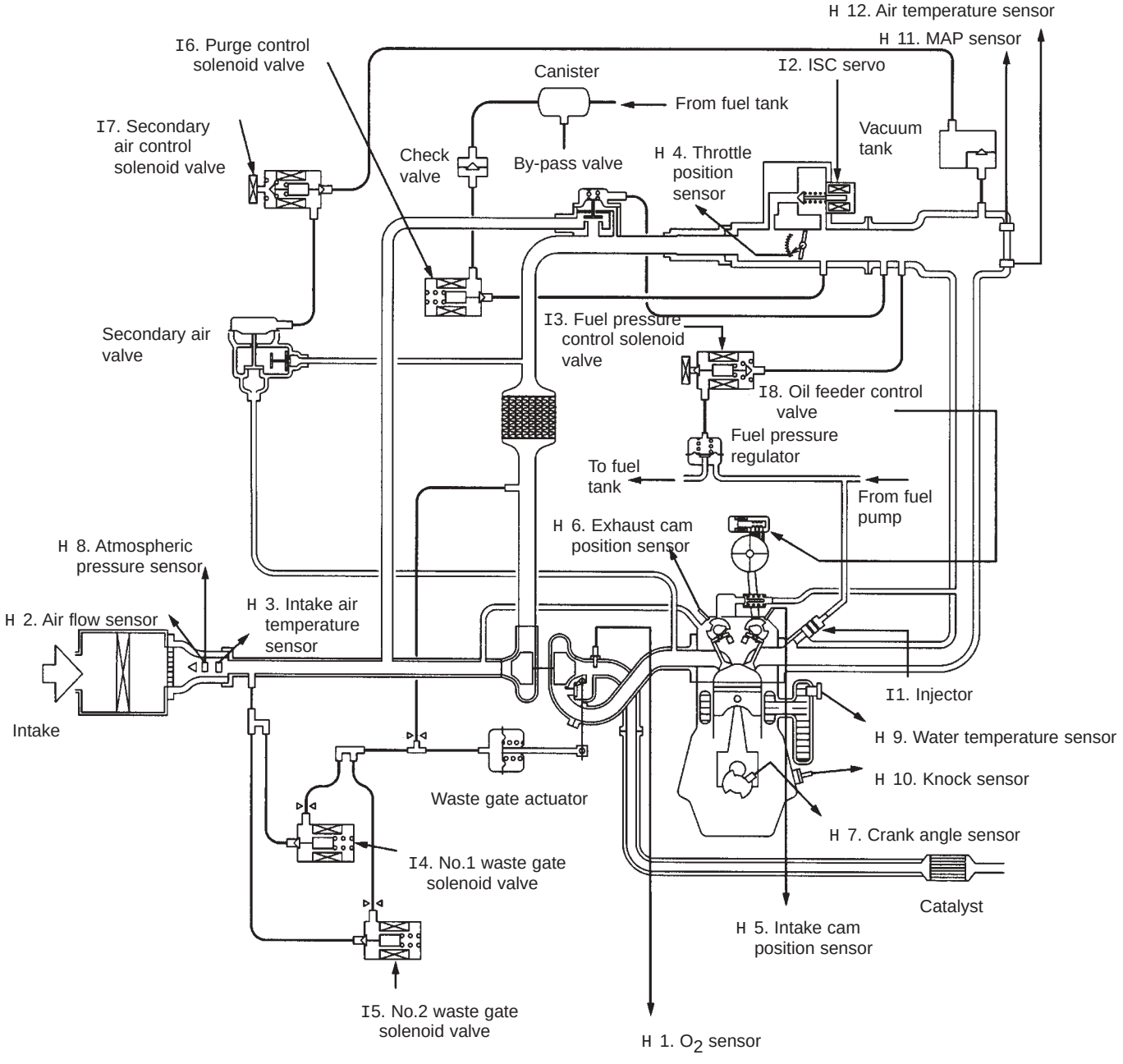
Servicing guidelines have been changed because of the changes listed below.
- A variable valve timing control system (V.V.T.) has been adopted. Because of this, an oil feeder control valve and an intake cam position sensor have been added.
- A manifold absolute pressure (MAP) sensor has been added.
- An air temperature sensor has been added.

MPI system diagram

H 1. O_2 sensor H 2. Air flow sensor H 3. Intake air temp. sensor H 4. Throttle position sensor H 5. Intake Cam position sensor H 6. Exhaust Cam position sensor H 7. Crank angle sensor H 8. Atmospheric pressure sensor H 9. Water temp. sensor H 10. Knock sensor H 11. Manifold absolute pressure (MAP) sensor H 12. Air temp. sensor	• Power supply • Ignition switch IG • Ignition switch ST • Vehicle speed sensor • A/C switch • A/C load signal • Power steering fluid pressure switch • Alternator FR signal • Inter-cooler water spray switch (auto) • Inter-cooler water spray switch (manual)

È Engine ECU È

I1. Injector I2. ISC servo (Stepper motor) I3. Fuel pressure control solenoid valve I4. No. 1 Waste gate solenoid valve I5. No. 2 Waste gate solenoid valve I6. Purge control solenoid valve I7. Secondary air control solenoid valve I8. Oil feeder control valve	• Engine control relay • Fuel pump relay 2,3 (ON/OFF) • Fuel pump relay (HI/LO switch) • A/C relay • Ignition coil • Fan controller • Condenser fan relay (HI) • Condenser fan relay (LO) • Engine warning light • Diagnosis output terminal • Alternator G terminal • Inter-cooler water spray relay • Inter-cooler water spray lamp • O_2 sensor heater

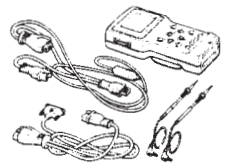
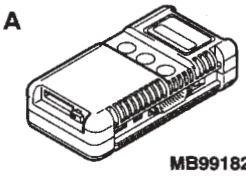
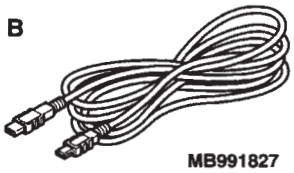
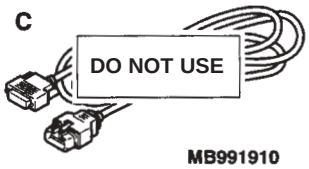
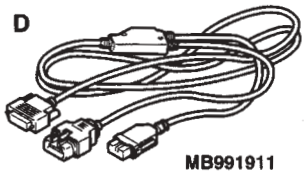
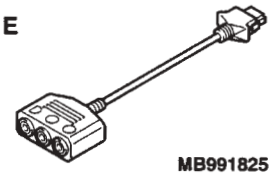
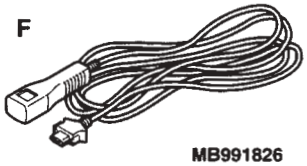


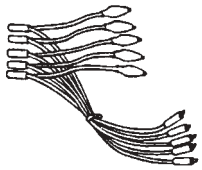
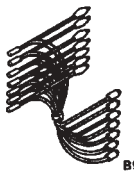
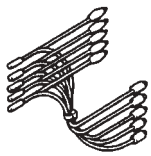
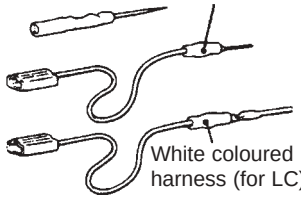
AK403814 AB

Servicing standards

Item		Standard level
Revolutions when idling r/min		800 ± 50
Air temperature sensor resistance kΩ	at -20 ºC	13~18
	at 0 ºC	5.1~6.9
	at 20 ºC	2.0~3.0
	at 40 ºC	0.9~1.5
	at 60 ºC	0.40~0.78
	at 80 ºC	0.23~0.42
Oil feeder control valve resistance (at 20 ºC) Ω		6.9~7.9

Special tools

Tool	Number	Name	Function
	MB991502	MUT-II sub ASSY	Checking the MPI system
A  MB991824 B  MB991827 C  DO NOT USE MB991910 D  MB991911 E  MB991825 F  MB991826 MB991955	MB991955 A:MB991824 B:MB991827 C:MB991910 D:MB991911 E:MB991825 F:MB991826	MUT-III sub ASSY A: Vehicle Communication Interface (V.C.I..) B: USB cable C: MUT-III Main harness A (For vehicles fitted with CAN) D: MUT-III Main harness B (For vehicles not fitted with CAN) E: Adaptor F: Trigger harness	**Note** **If a MUT-III main harness A is connected to a vehicle not fitted with CAN, there is a chance that a pulse signal will be entered in the simulated vehicle speed line, when the MUT-III is activated. Therefore, use a MUT-III main harness B with vehicles not fitted with CAN.**

Tool	Number	Name	Function
	MB991348	Test harness	Inspection using an oscilloscope
 B991709	MB991709	Test harness	• Troubleshooting voltage measurement • Inspection using an oscilloscope
 B991658	MB991658	Test harness	Inspection using an oscilloscope
	MD998478	Test harness (3P, triangular)	• Troubleshooting voltage measurement • Inspection using an oscilloscope
Red coloured harness (for DLI)  White coloured harness (for LC) 00005906	MB991223	Inspection harness set connector • Pin contact pressure inspection harness • Commercial tester connection probe (for ordinary connectors)	Terminal voltage measurement

TROUBLESHOOTING

1. Diagnosis Functions

1-1 Engine warning light (Check engine lamp)
Changes have been made to engine warning lights.
Checklist for engine warning lights.

Engine ECU
Air flow sensor (AFS)
Manifold absolute pressure (MAP) sensor system
Intake air temperature sensor
Throttle position sensor (TPS)
Water temperature sensor
Crank angle sensor
Exhaust cam position sensor
Injector
Ignition coil (with built-in power transistor)
Atmospheric pressure sensor
O_2 sensor
O_2 sensor heater
Fuel system malfunction
Knock sensor
Intake cam position sensor system
Oil feeder control valve system

1-2 Checking of freeze frame data
Additions have been made to the freeze frame data tables.
Checklist for data tables

Item number	Type of data	Units/condition
95	MAP sensor	kPa

1-3 Failsafe and back-up functions
If one of the diagnosis functions detects that one of the main sensors is malfunctioning, it will ensure that the car can be driven safely, in accordance with the pre-set control logic.

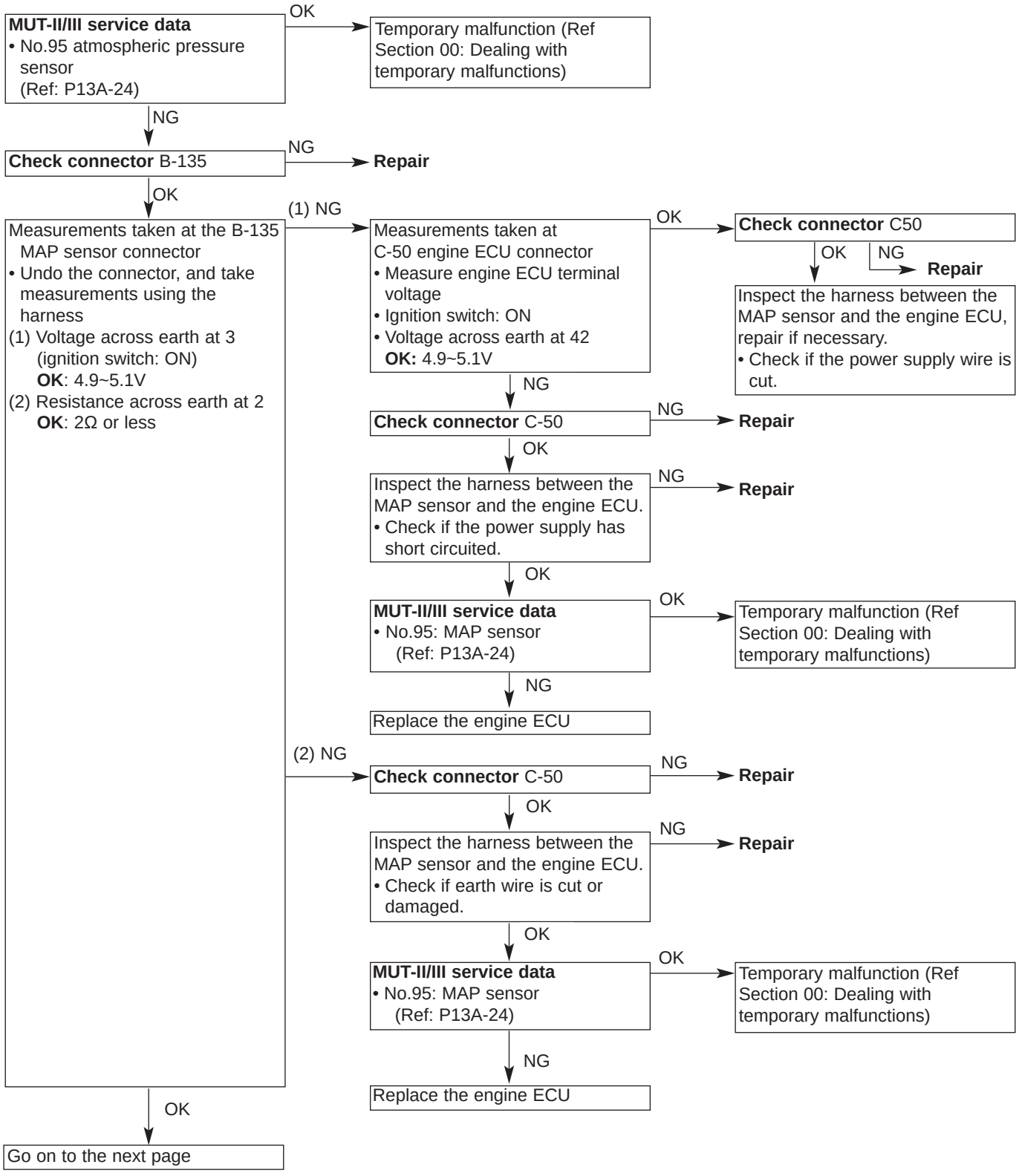
Malfunctioning item	Control measures taken when a malfunction occurs
Air temperature sensor	Regulation of the intake air temperature at 25ºC.
Exhaust cam position sensor	(1) Simultaneous flushing out of all fuel pipes. (But only if the No. 1 cylinder has not been detected in the TDC position after the ignition switch has been turned "ON".) (2) Cutting off the fuel 4 seconds after the malfunction has been detected. (But only if the No. 1 cylinder has not been detected in the TDC position after the ignition switch has been turned "ON".)
Intake cam position sensor	The oil feeder control valve should be switched "OFF", and the angle of the cam should be in the reset position.

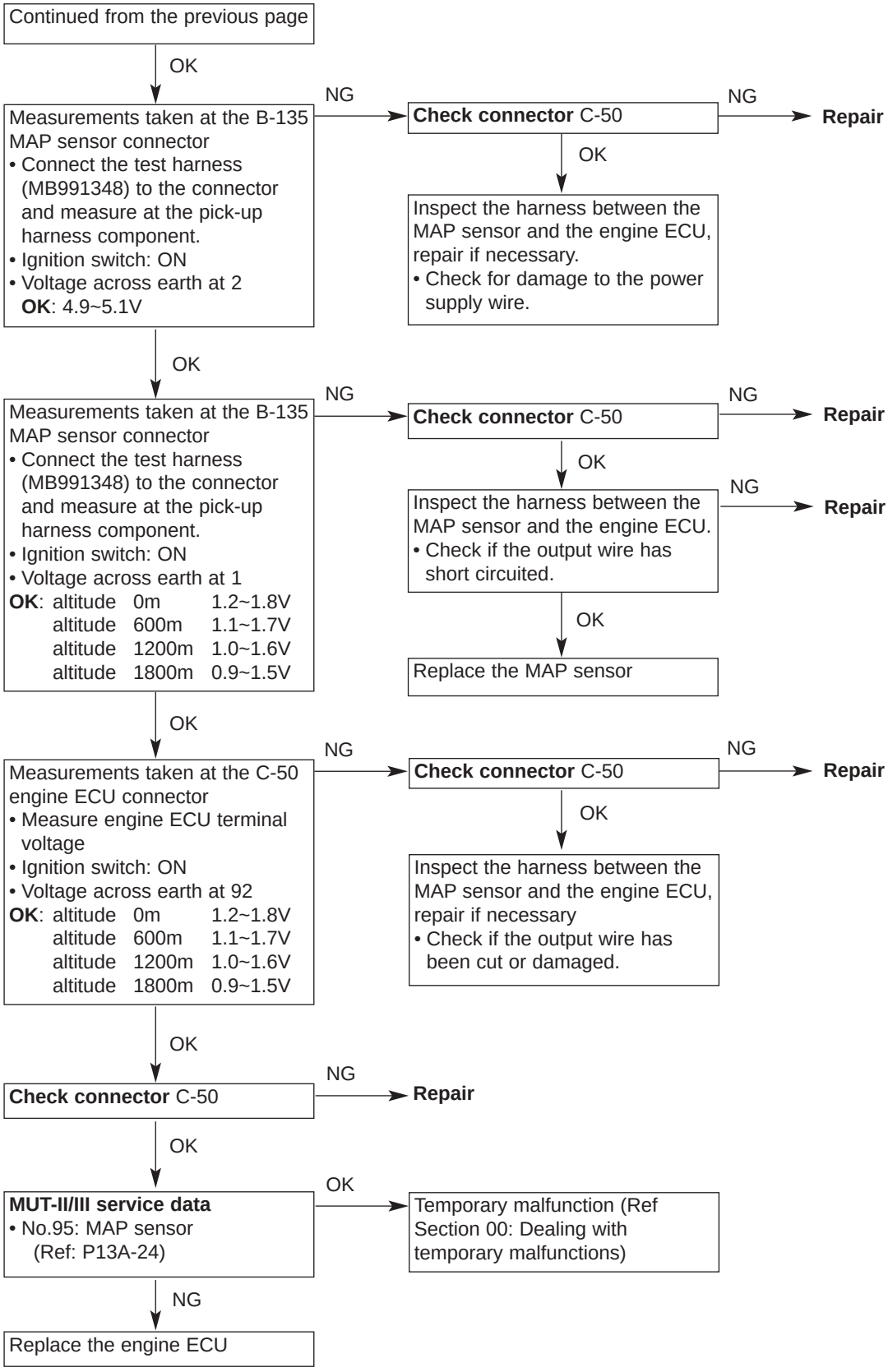
2. Diagnosis code classification table

Code No.	Diagnosis item	Page
P0105	MAP sensor	13A-7
P0340	Exhaust cam position sensor system	13A-9
P1012	Intake cam position sensor system	13A-11
P1021	Oil feeder control valve system	13A-13
P2226	Atmospheric pressure system	13A-14

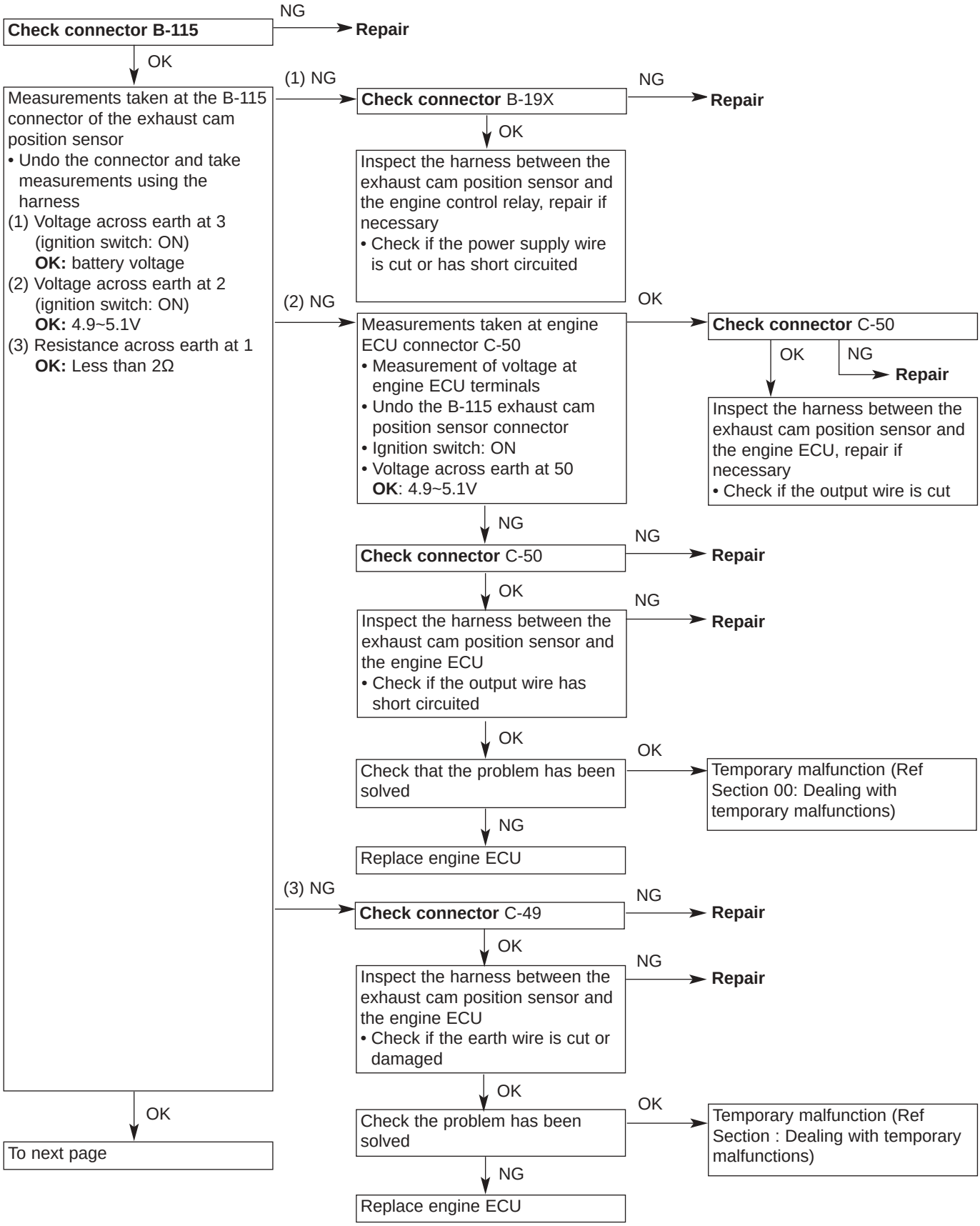
3. INSPECTION PROCEDURES FOR EACH DIAGNOSIS CODE

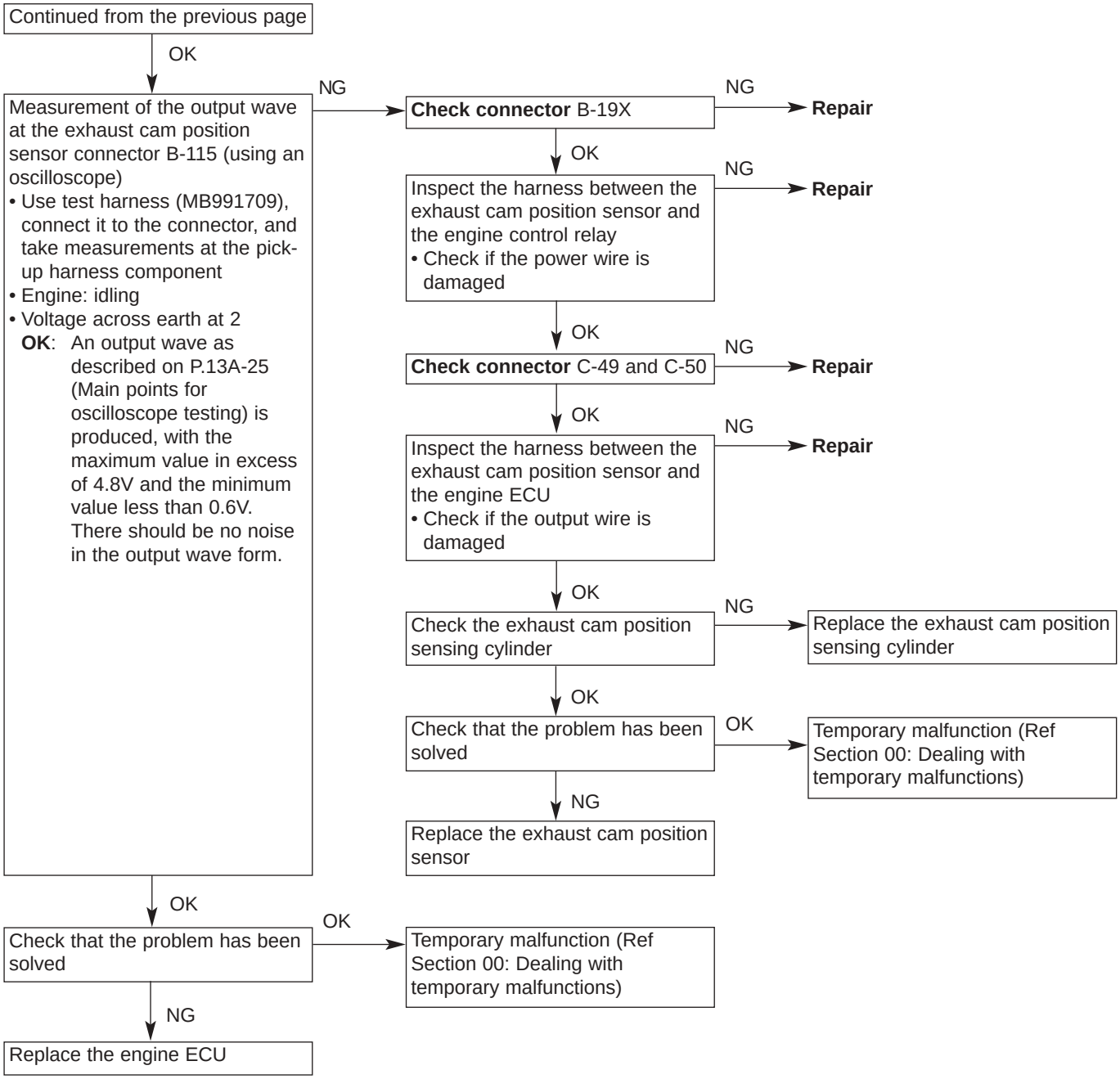
Code No. P0105 MAP sensor system	Probable cause of the malfunction
Conditions for the inspection • Ignition switch: ON • Wait for 2 seconds after the ignition switch has been turned on or the engine has started. Evaluation conditions • Sensor output voltage is 4.6V or more for 4 seconds (when atmospheric pressure is more than 313 kPa) • Sensor output voltage is 0.2V or less for 4 seconds (when atmospheric pressure is more than 14 kPa)	• MAP sensor malfunction • Broken circuit or short circuit in the MAP sensor circuit • Poor connector contact • Engine ECU malfunction




Continued from the previous page
OK
Measurements taken at the B-135 MAP sensor connector
• Connect the test harness (MB991348) to the connector and measure at the pick-up harness component.
• Ignition switch: ON
• Voltage across earth at 2
OK: 4.9~5.1V
NG
Check connector C-50
NG
Repair
OK
Inspect the harness between the MAP sensor and the engine ECU, repair if necessary.
• Check for damage to the power supply wire.
OK
Measurements taken at the B-135 MAP sensor connector
• Connect the test harness (MB991348) to the connector and measure at the pick-up harness component.
• Ignition switch: ON
• Voltage across earth at 1
OK: altitude 0m 1.2~1.8V
altitude 600m 1.1~1.7V
altitude 1200m 1.0~1.6V
altitude 1800m 0.9~1.5V
NG
Check connector C-50
NG
Repair
OK
Inspect the harness between the MAP sensor and the engine ECU.
• Check if the output wire has short circuited.
NG
Repair
OK
Replace the MAP sensor
OK
Measurements taken at the C-50 engine ECU connector
• Measure engine ECU terminal voltage
• Ignition switch: ON
• Voltage across earth at 92
OK: altitude 0m 1.2~1.8V
altitude 600m 1.1~1.7V
altitude 1200m 1.0~1.6V
altitude 1800m 0.9~1.5V
NG
Check connector C-50
NG
Repair
OK
Inspect the harness between the MAP sensor and the engine ECU, repair if necessary
• Check if the output wire has been cut or damaged.
OK
Check connector C-50
NG
Repair
OK
MUT-II/III service data
• No.95: MAP sensor (Ref: P13A-24)
OK
Temporary malfunction (Ref Section 00: Dealing with temporary malfunctions)
NG
Replace the engine ECU

Code No.P0340 Exhaust cam position sensor system	Probable cause of the malfunction
Conditions for inspection • Ignition switch: ON • With engine cranking or running Evaluation conditions • The sensor output voltage does not change for 4 seconds (with no input of pulse signals)	• Malfunction of the exhaust cam position sensor • Broken circuit or short circuit in the exhaust cam position sensor circuit, or poor connector contact • Malfunction of engine ECU

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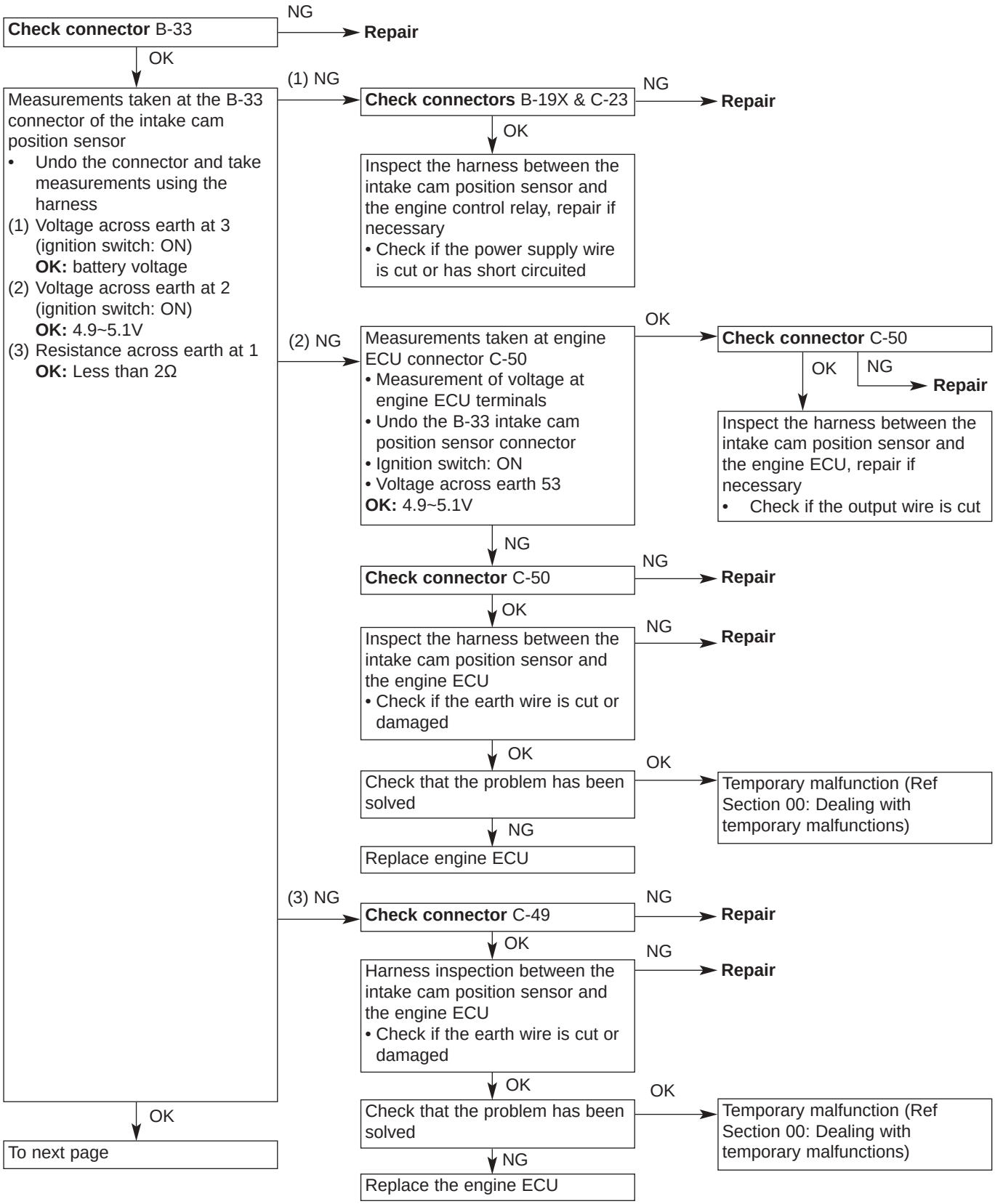
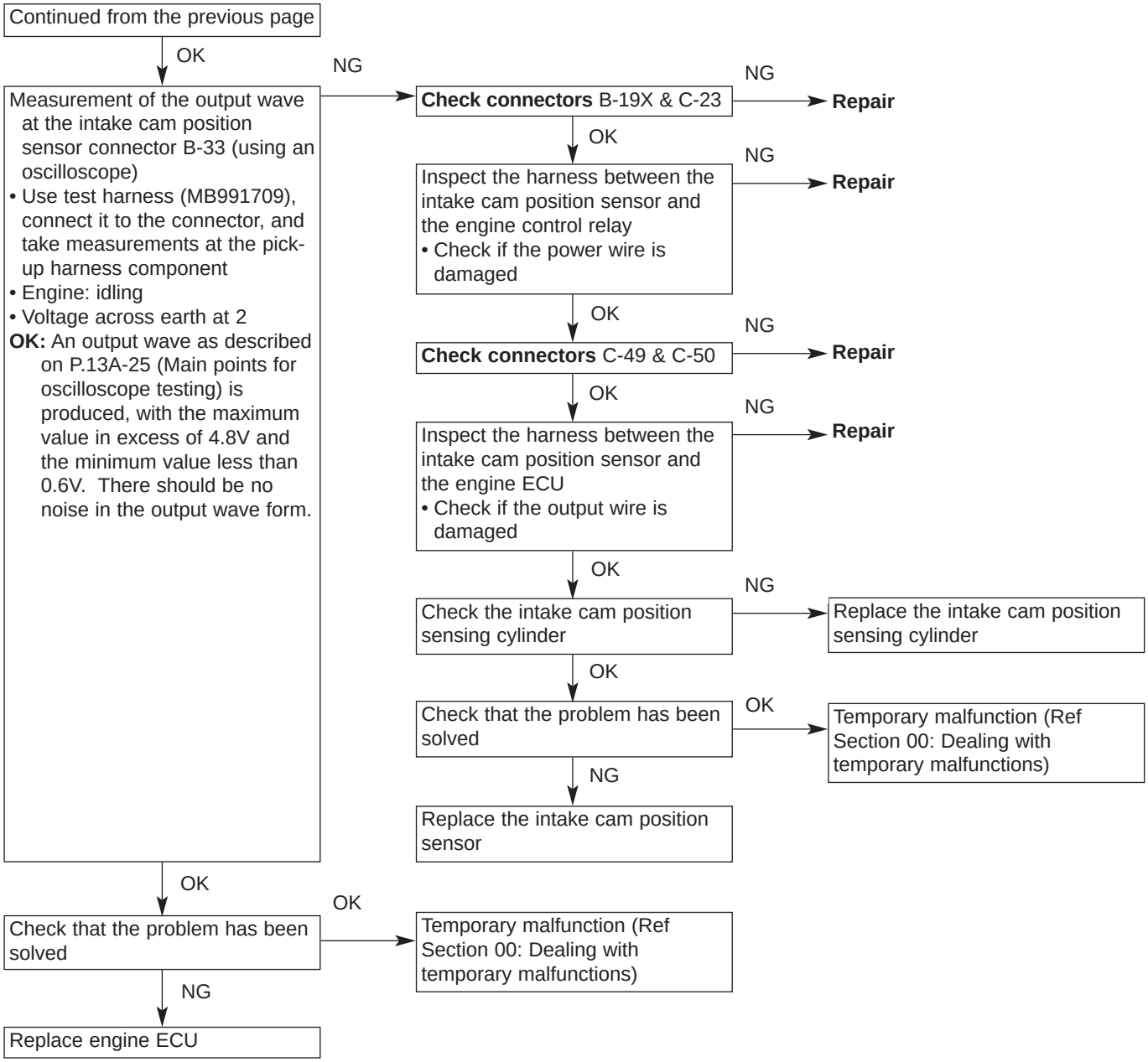
OK
Measurement of the output wave at the exhaust cam position sensor connector B-115 (using an oscilloscope)
• Use test harness (MB991709), connect it to the connector, and take measurements at the pick-up harness component
• Engine: idling
• Voltage across earth at 2
OK: An output wave as described on P.13A-25 (Main points for oscilloscope testing) is produced, with the maximum value in excess of 4.8V and the minimum value less than 0.6V. There should be no noise in the output wave form.
NG
Check connector B-19X
NG
Repair
OK
Inspect the harness between the exhaust cam position sensor and the engine control relay
• Check if the power wire is damaged
NG
Repair
OK
Check connector C-49 and C-50
NG
Repair
OK
Inspect the harness between the exhaust cam position sensor and the engine ECU
• Check if the output wire is damaged
NG
Repair
OK
Check the exhaust cam position sensing cylinder
NG
Replace the exhaust cam position sensing cylinder
OK
Check that the problem has been solved
OK
Temporary malfunction (Ref Section 00: Dealing with temporary malfunctions)
NG
Replace the exhaust cam position sensor
OK
Check that the problem has been solved
OK
Temporary malfunction (Ref Section 00: Dealing with temporary malfunctions)
NG
Replace the engine ECU

Code No.P1012 Intake cam position sensor system	Probable cause of the malfunction
Conditions for inspection • With engine cranking or running Evaluation conditions • Sensor output voltage does not change for 4 seconds (with no input of pulse signals)	• Malfunction of the intake cam position sensor • Broken circuit or short circuit in the intake cam position sensor circuit, or poor connector contact • Malfunction of engine ECU

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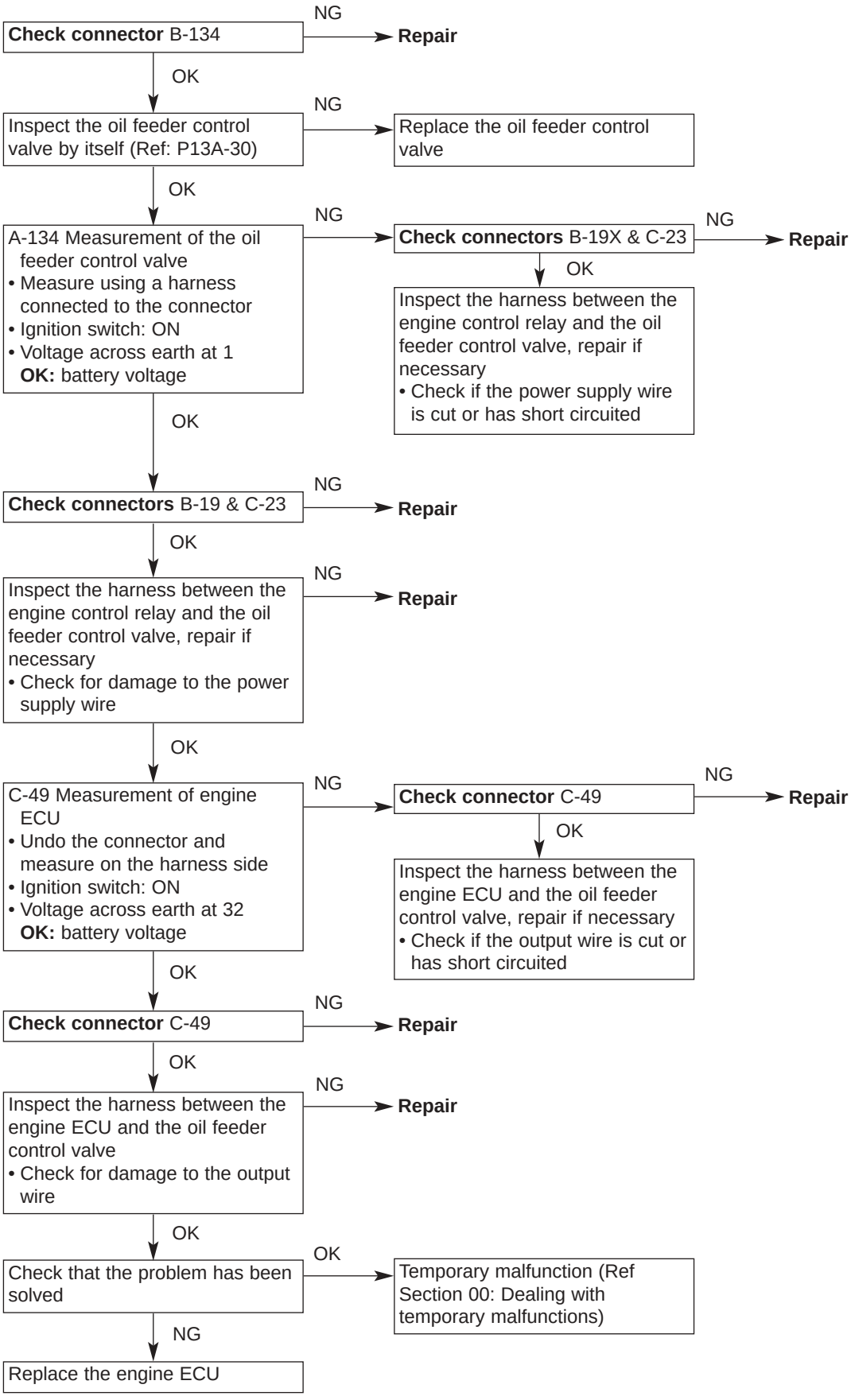
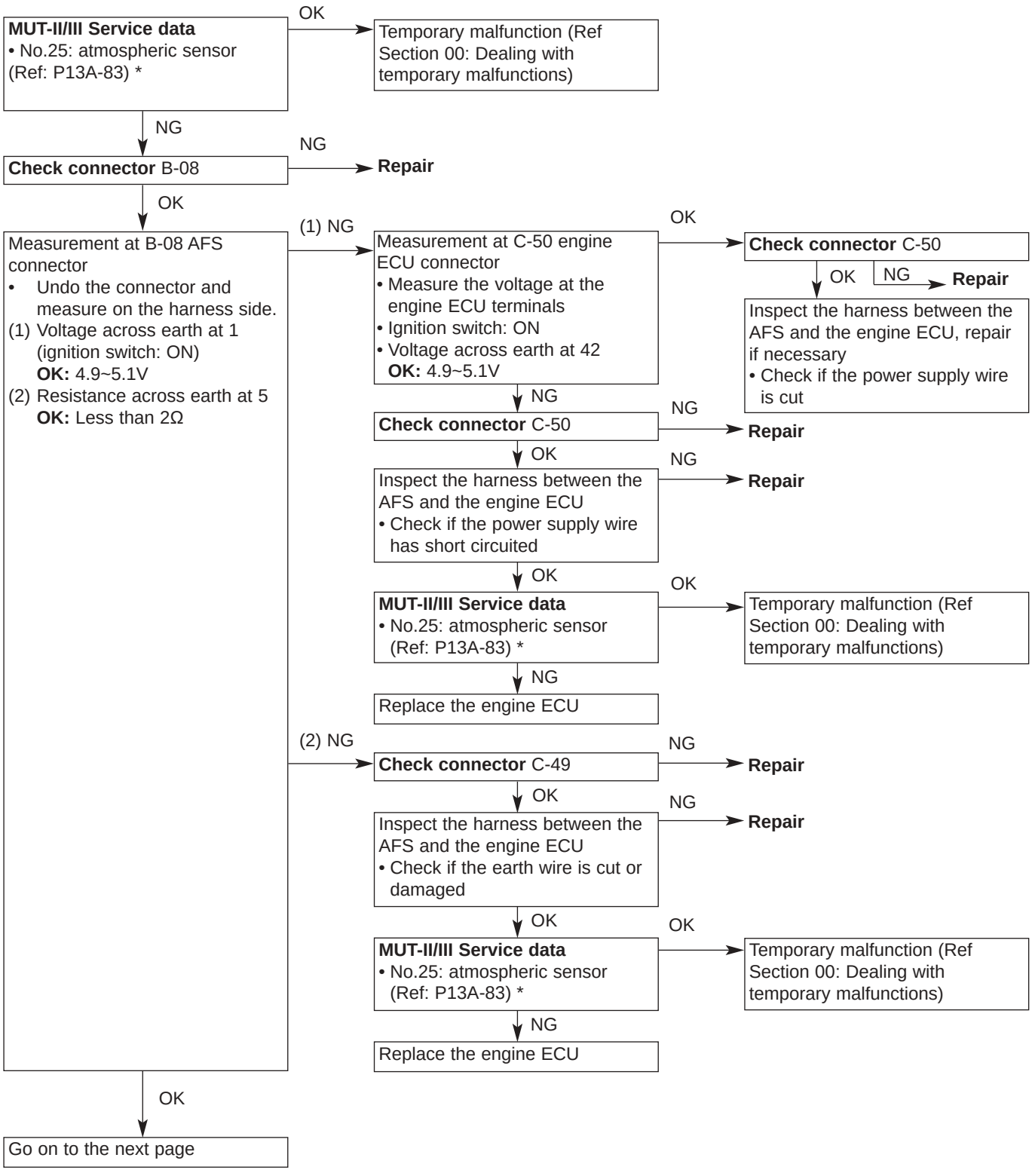
OK
Measurement of the output wave at the intake cam position sensor connector B-33 (using an oscilloscope)
• Use test harness (MB991709), connect it to the connector, and take measurements at the pick-up harness component
• Engine: idling
• Voltage across earth at 2
OK: An output wave as described on P.13A-25 (Main points for oscilloscope testing) is produced, with the maximum value in excess of 4.8V and the minimum value less than 0.6V. There should be no noise in the output wave form.
NG
Check connectors B-19X & C-23
NG
Repair
OK
Inspect the harness between the intake cam position sensor and the engine control relay
• Check if the power wire is damaged
NG
Repair
OK
Check connectors C-49 & C-50
NG
Repair
OK
Inspect the harness between the intake cam position sensor and the engine ECU
• Check if the output wire is damaged
NG
Repair
OK
Check the intake cam position sensing cylinder
NG
Replace the intake cam position sensing cylinder
OK
Check that the problem has been solved
OK
Temporary malfunction (Ref Section 00: Dealing with temporary malfunctions)
NG
Replace the intake cam position sensor
OK
Check that the problem has been solved
OK
Temporary malfunction (Ref Section 00: Dealing with temporary malfunctions)
NG
Replace engine ECU

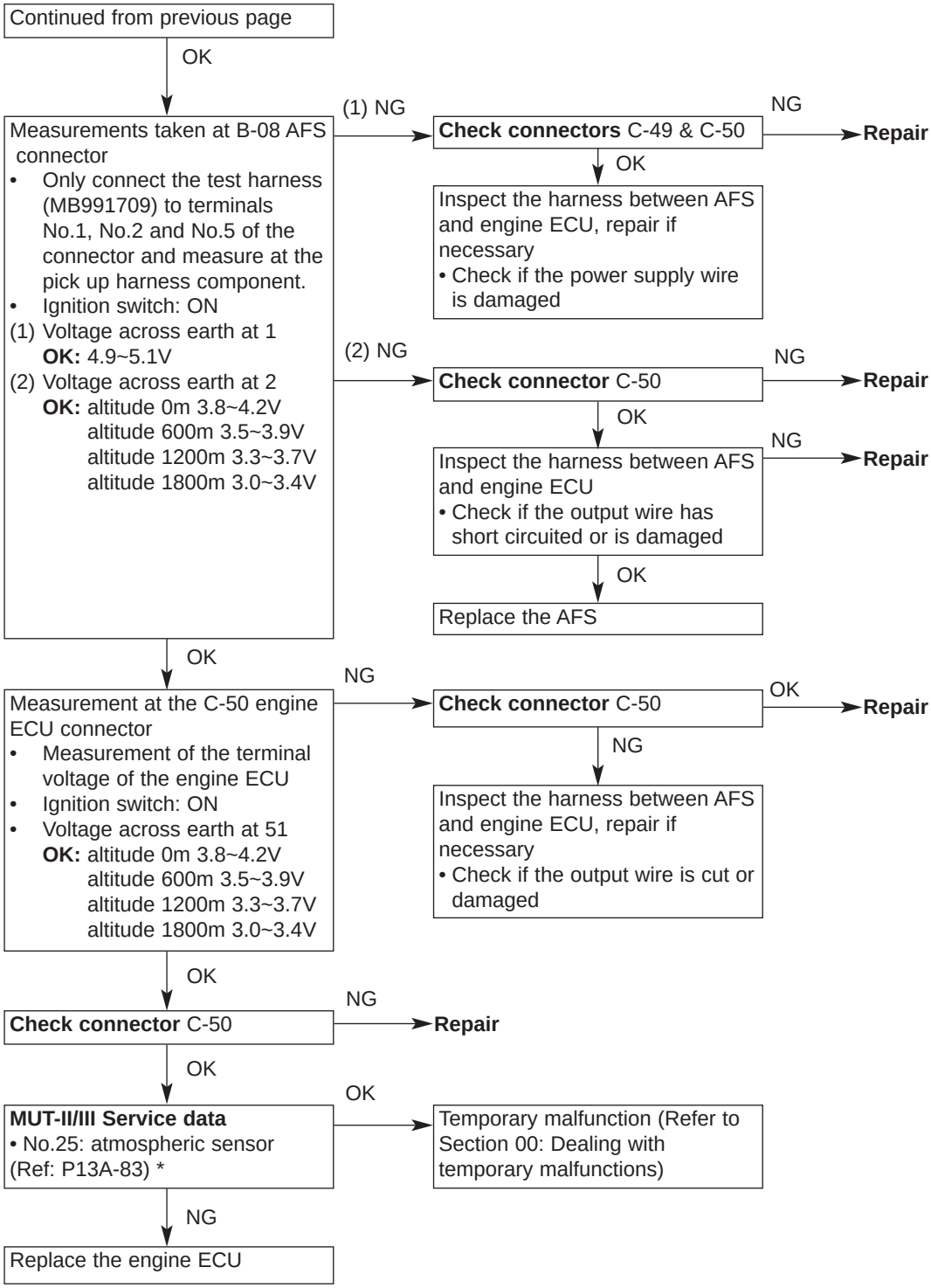
Code No.P1021 Oil feeder control valve system	Probable cause of the malfunction
Conditions for inspection • Oil feeder control valve: OFF Evaluation conditions • Operational terminal voltage of the oil feeder control valve in the ECU is abnormal for 4 seconds	• Malfunction of the oil feeder control valve • Broken circuit or short circuit in the oil feeder control valve circuit, or poor connector contact • Malfunction of engine ECU



Code No.P2226 Atmospheric pressure sensor system	Probable cause of the malfunction
Conditions for inspection • Ignition switch: ON • Wait for 2 seconds after the ignition switch has been turned on or the engine has started. Evaluation conditions • Output voltage from the sensor is more than 4.5V (when atmospheric pressure is in excess of 114kPa) for 4 seconds. Or, • Output voltage from the sensor is more than 0.2V (when atmospheric pressure is less than 5kPa) for 4 seconds.	• Malfunction of the atmospheric pressure sensor • Broken circuit or short circuit in the atmospheric pressure sensor circuit, or poor connector contact • Malfunction of engine ECU



*: Refer to the 03-1 Service Manual for the Lancer Evolution VIII (No.1036K07)



*: Refer to the 03-1 Service Manual for the Lancer Evolution VIII (No.1036K07)

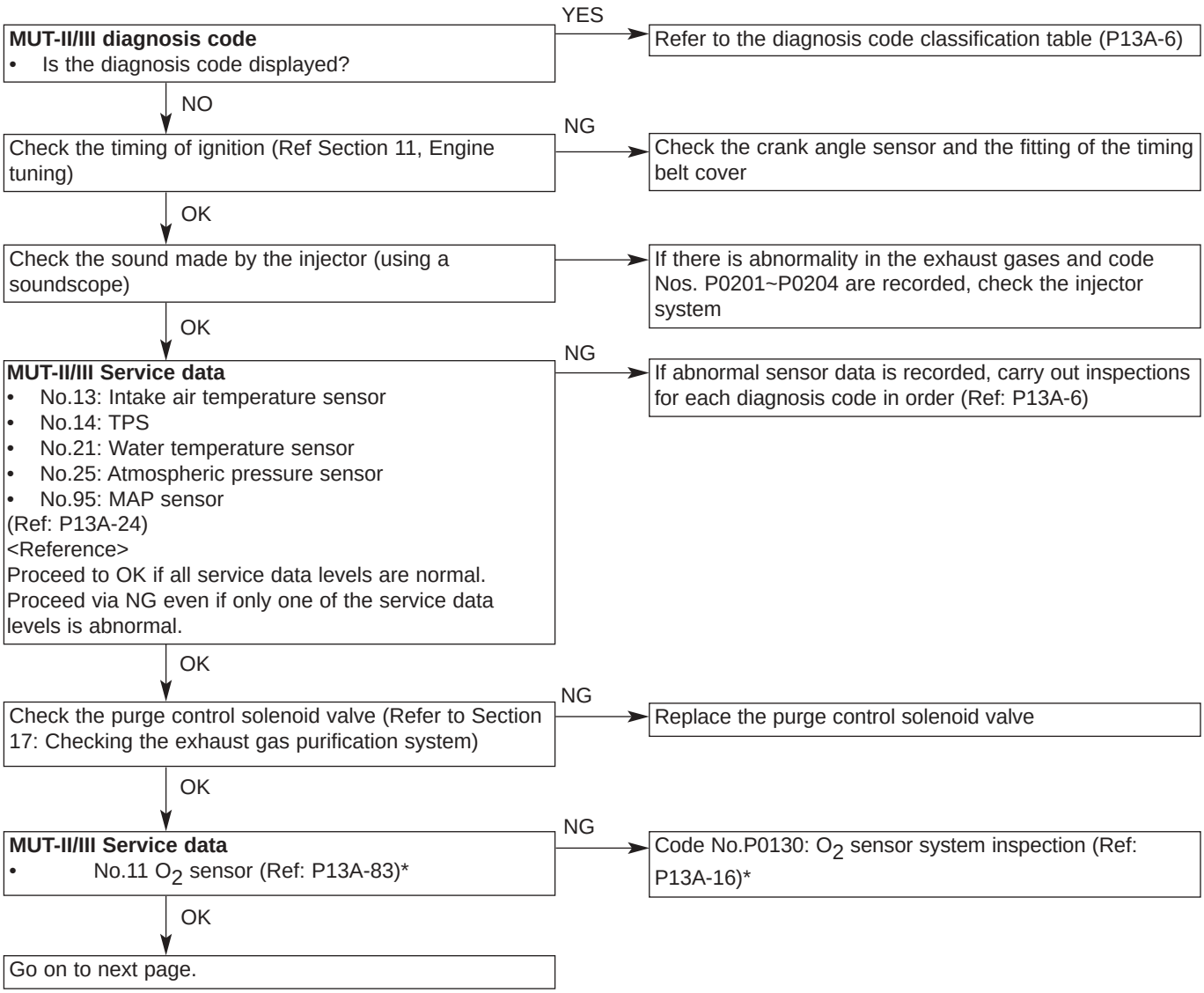
4. Checklist of faults

Inspection procedure	Fault to be checked	Reference page
11	Engine seems hesitant	13A-16
	Acceleration malfunction	
	Engine seems to stumble	
	Engine has a power surge	
15	Mis-timed ignition	13A-18
35	Inter-cooler water spray circuit system	13A-19
37	No.2 waste gate solenoid valve system	13A-21
38	Air temperature sensor system	13A-22

5. Inspection procedure for each type of fault

Inspection procedure 11

Engine seems hesitant, acceleration malfunction, engine seems to stumble, engine has a power surge	**Probable causes of the malfunction**
Probable causes of the malfunction are noted in the right hand column.	• Malfunction of the air/fuel mixing control system • Malfunction of the ignition system • Malfunction of the fuel system • Malfunction of the intake system • Malfunction of the exhaust gas purification system • Failure of compression pressure • Malfunction of the turbocharger system



*: Refer to the 03-1 Service Manual for the Lancer Evolution VIII (No.1036K07)

Continued from previous page

OK

Check the spark plug wire (Ref: Section 16: Ignition apparatus)

NG → Replace the spark plug wire

OK

Check the spark plug (Ref: Section 16: Ignition apparatus)

NG → Replace the spark plug

OK

Check connectors B-123 & B-119

NG → **Repair**

OK

Check the ignition coil (Ref: Section 16: Ignition Apparatus)

NG → Replace the ignition coil

OK

Inspect the harness and the connectors between each cylinder's ignition coil and the body earth, and between the engine ECU and the ignition coil. Check for cut or short circuited wires, or other damage.

NG → **Repair**

OK

MUT-II/III Actuator test
- No.12: Waste gate solenoid valve (Ref: P13A-87)*2

NG → Inspection procedure 33: Inspection of the No.1 waste gate solenoid valve (Ref: P13A-78) *2
Inspection procedure 37: Inspection of the No.2 waste gate solenoid valve (Ref: P13A-21)

OK

Check the supercharge pressure of the turbo charger (Ref: Section 15: Intake/Exhaust car servicing)

NG → **Repair**

OK

Check the supercharge pressure control system (Ref: Section 15: Intake/Exhaust car servicing)

NG → **Repair**

OK

MUT-II/III Actuator test
- No.09: Fuel pressure control solenoid valve (Ref: P13A-87)

NG → Inspection procedure 31: Inspection of the fuel control solenoid valve (Ref: P13A-76) *2

OK

Check the fuel pressure (Ref: P13D-109)

NG → **Repair**

OK

Check the compression pressure (Ref: Section 11: Engine tuning)

NG → **Repair**

OK

Measurements taken at B-108 air temperature sensor connector
- Using the test harness (MB991658), connect it to only connectors No.1 and No.2 and measure at the pick-up harness component.
- Ignition switch: ON
- Voltage across earth at 1

OK: surrounding temperature -20ºC 3.8~4.4V
surrounding temperature 0ºC 3.2~3.8V
surrounding temperature 20ºC 2.3~2.9V
surrounding temperature 40ºC 1.5~2.1V
surrounding temperature 60ºC 0.8~1.4V
surrounding temperature 80ºC 0.4~1.0V

NG → Inspection procedure 38: Inspection of the air temperature sensor (Ref: P13A-22)

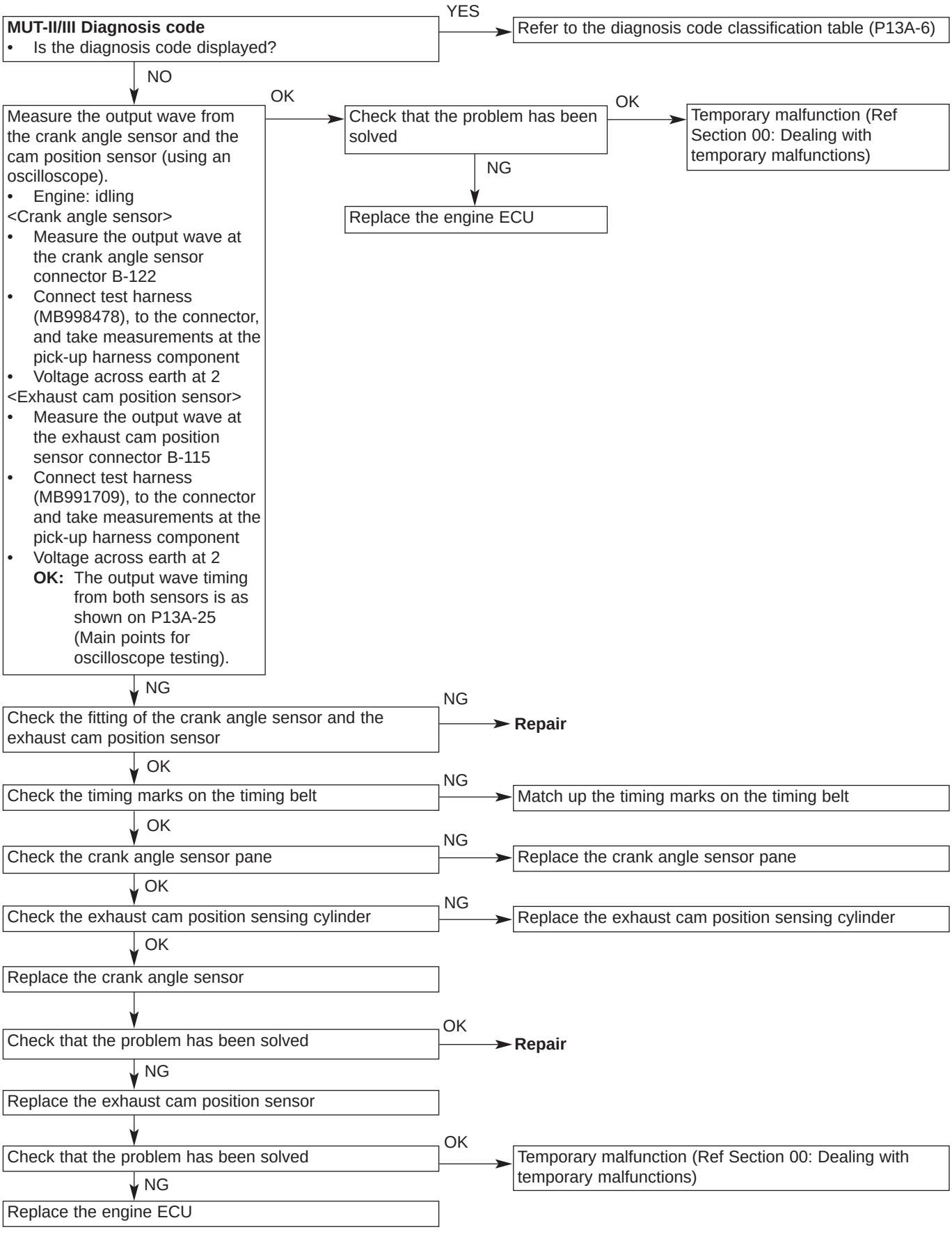
OK

If the intake hose and the inlet manifold are damaged check the air intake and repair as necessary.

*: Refer to the 01-1 Service Manual for the Lancer Evolution VIII (No.1036K02)
*: Refer to the 03-1 Service Manual for the Lancer Evolution VIII (No.1036K07)

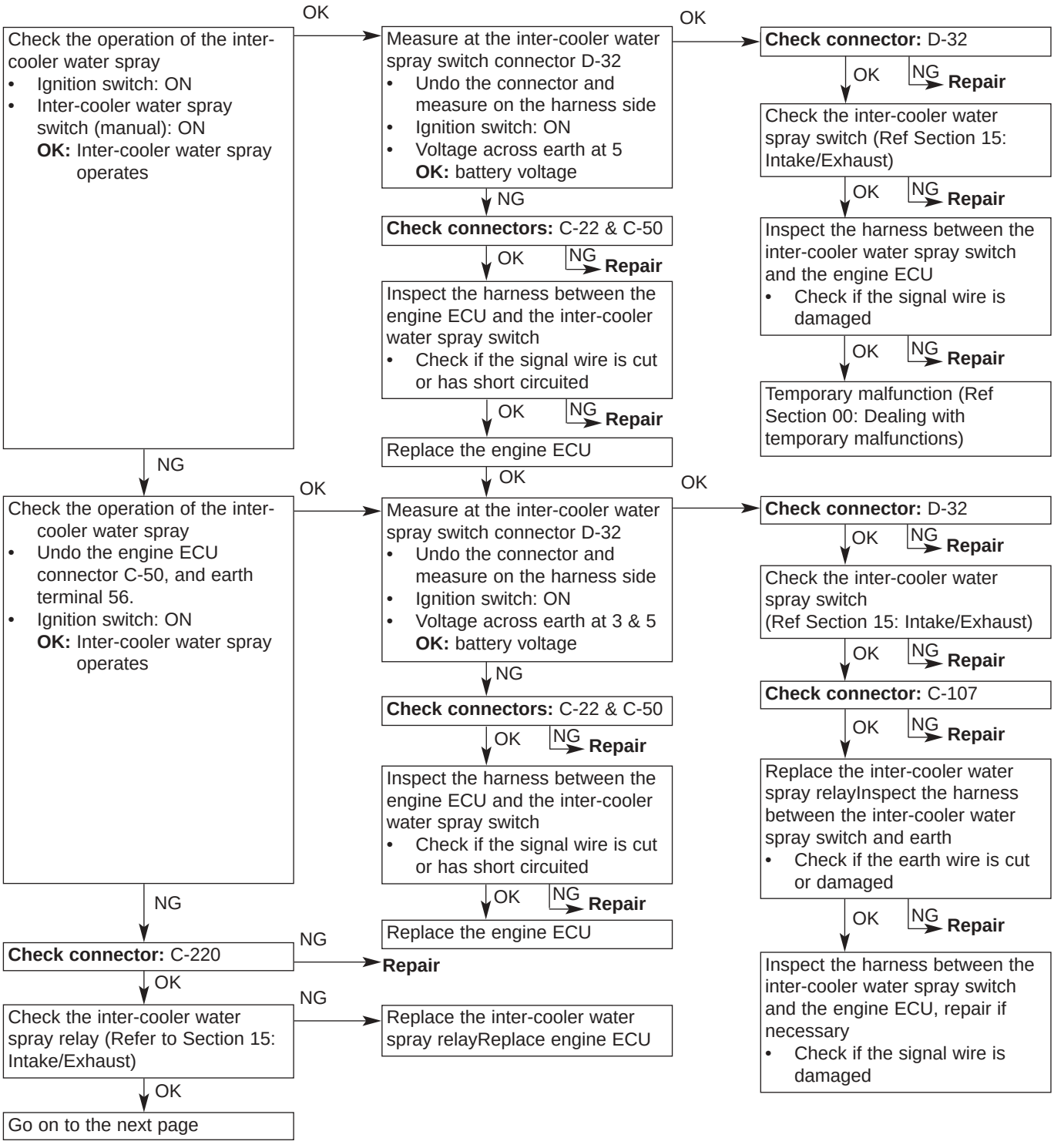
Inspection procedure 15

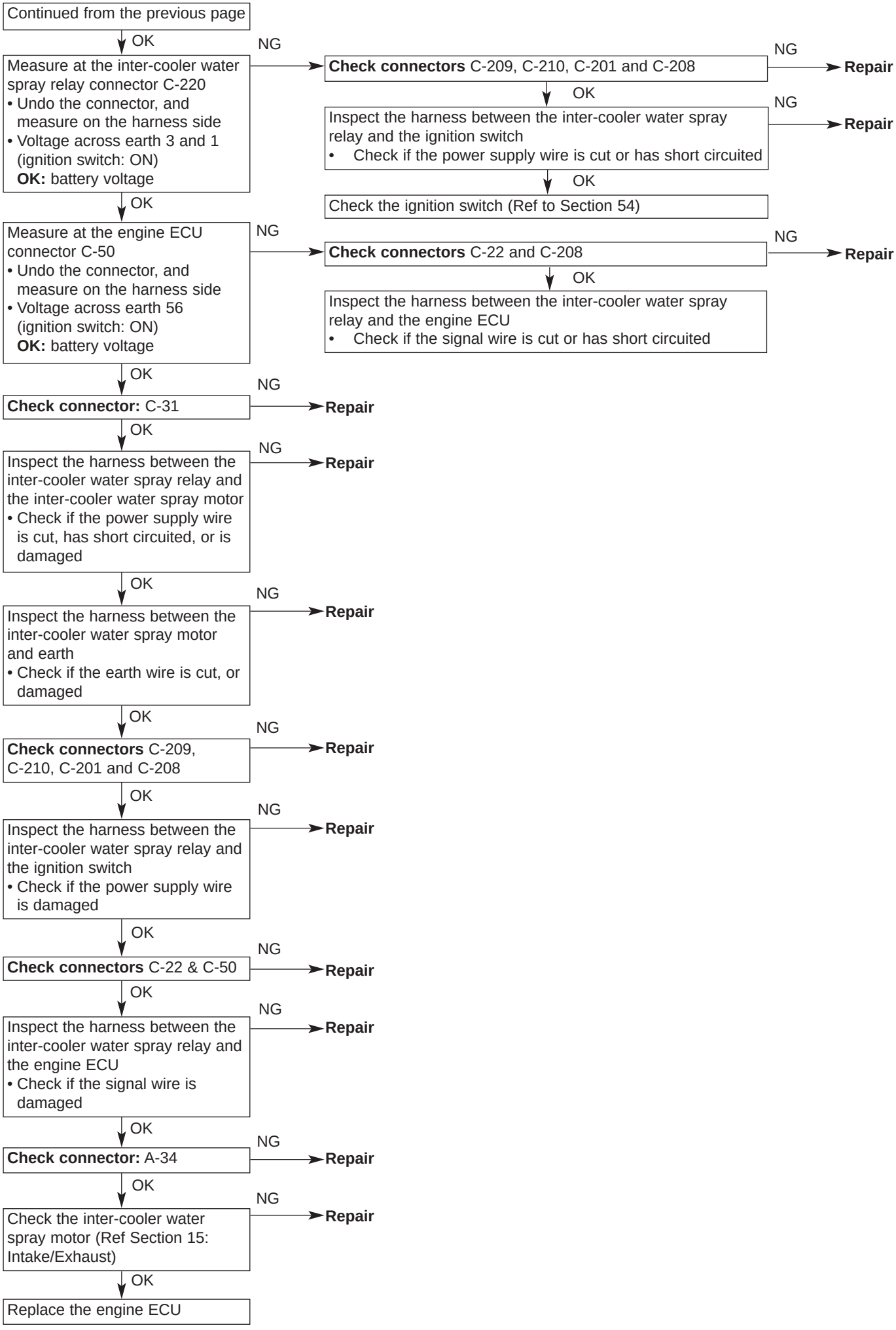
Miss-timed ignition	Probable causes of the malfunction
Probable causes of the malfunction are noted in the right hand column.	• Malfunction of the crank angle sensor • Malfunction of the exhaust cam position sensor • Malfunction of the timing belt • Malfunction of the engine ECU



Inspection procedure 35

Inter-cooler water spray circuit system	Probable causes of the malfunction
• If the inter-cooler water spray switch (manual) is turned ON, the inter-cooler water spray manual 'ON' signal will be input in the engine ECU. When this signal is received, the engine ECU will turn the inter-cooler water spray relay ON, and will start the inter-cooler water spray motor. Water will be sprayed into the inter-cooler to cool intake air, and filling efficiency will improve. • If the inter-cooler water spray switch (auto) is turned ON, the inter-cooler water spray auto 'ON' signal will be input in the engine ECU. When this signal is received the engine ECU will intermittently run at a high load, it will turn the inter-cooler water spray relay ON, and it will start the inter-cooler water spray motor. Water will be sprayed into the inter-cooler to cool intake air, and filling efficiency will improve.	• Malfunction of the inter-cooler water spray switch. • Malfunction of the inter-cooler water spray relay. • Malfunction of the inter-cooler water spray motor. • Circuit break, short circuit or a faulty connection in the inter-cooler water spray relay circuit. • Circuit break, short circuit or a faulty connection in the inter-cooler water spray switch circuit. • Malfunction of the ignition switch. • Malfunction of the engine ECU.

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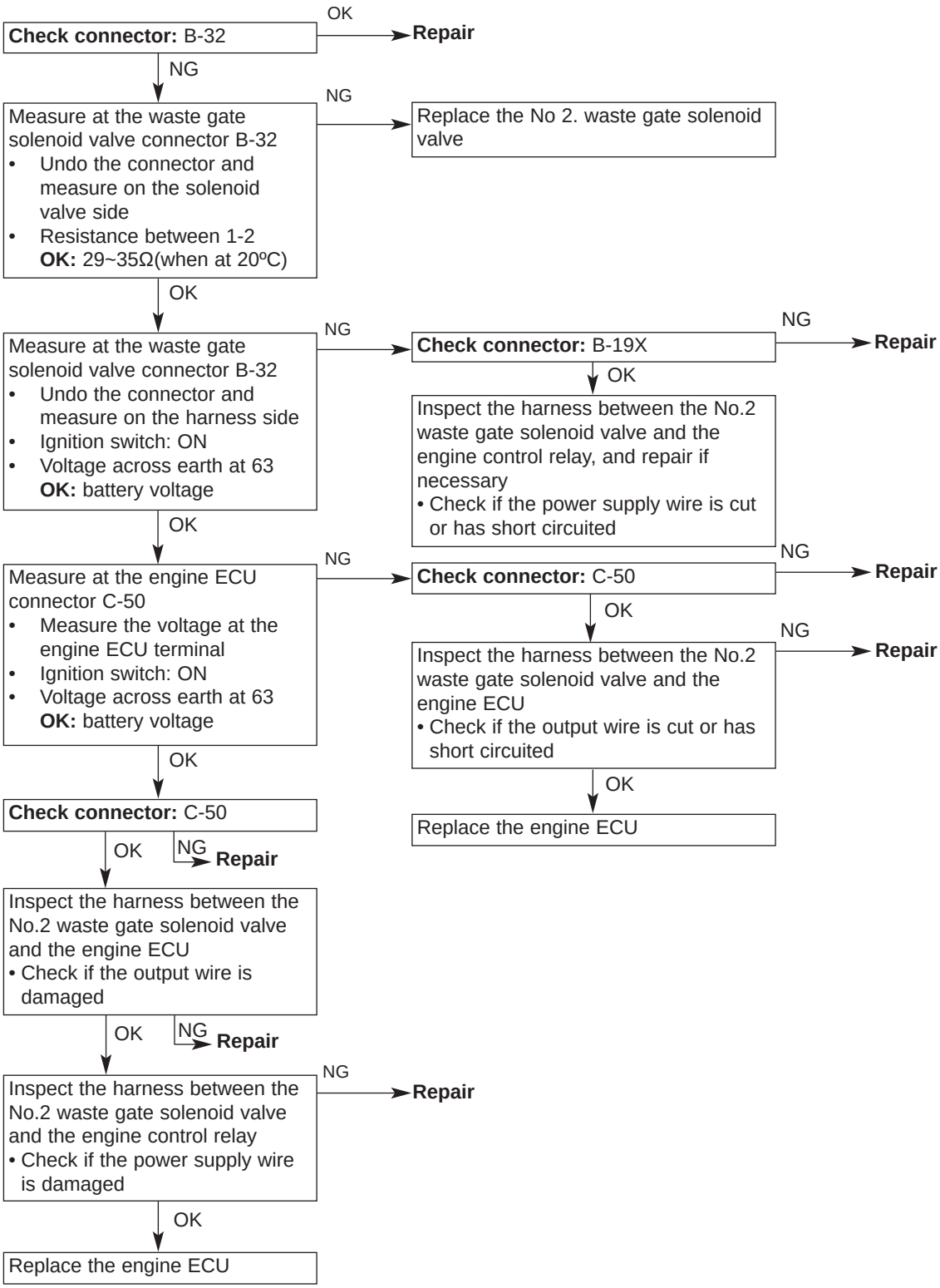
OK
Measure at the inter-cooler water spray relay connector C-220
• Undo the connector, and measure on the harness side
• Voltage across earth 3 and 1 (ignition switch: ON)
OK: battery voltage
NG
Check connectors C-209, C-210, C-201 and C-208
NG
Repair
OK
Inspect the harness between the inter-cooler water spray relay and the ignition switch
• Check if the power supply wire is cut or has short circuited
NG
Repair
OK
Check the ignition switch (Ref to Section 54)
OK
Measure at the engine ECU connector C-50
• Undo the connector, and measure on the harness side
• Voltage across earth 56 (ignition switch: ON)
OK: battery voltage
NG
Check connectors C-22 and C-208
NG
Repair
OK
Inspect the harness between the inter-cooler water spray relay and the engine ECU
• Check if the signal wire is cut or has short circuited
OK
Check connector: C-31
NG
Repair
OK
Inspect the harness between the inter-cooler water spray relay and the inter-cooler water spray motor
• Check if the power supply wire is cut, has short circuited, or is damaged
NG
Repair
OK
Inspect the harness between the inter-cooler water spray motor and earth
• Check if the earth wire is cut, or damaged
NG
Repair
OK
Check connectors C-209, C-210, C-201 and C-208
NG
Repair
OK
Inspect the harness between the inter-cooler water spray relay and the ignition switch
• Check if the power supply wire is damaged
NG
Repair
OK
Check connectors C-22 & C-50
NG
Repair
OK
Inspect the harness between the inter-cooler water spray relay and the engine ECU
• Check if the signal wire is damaged
NG
Repair
OK
Check connector: A-34
NG
Repair
OK
Check the inter-cooler water spray motor (Ref Section 15: Intake/Exhaust)
NG
Repair
OK
Replace the engine ECU

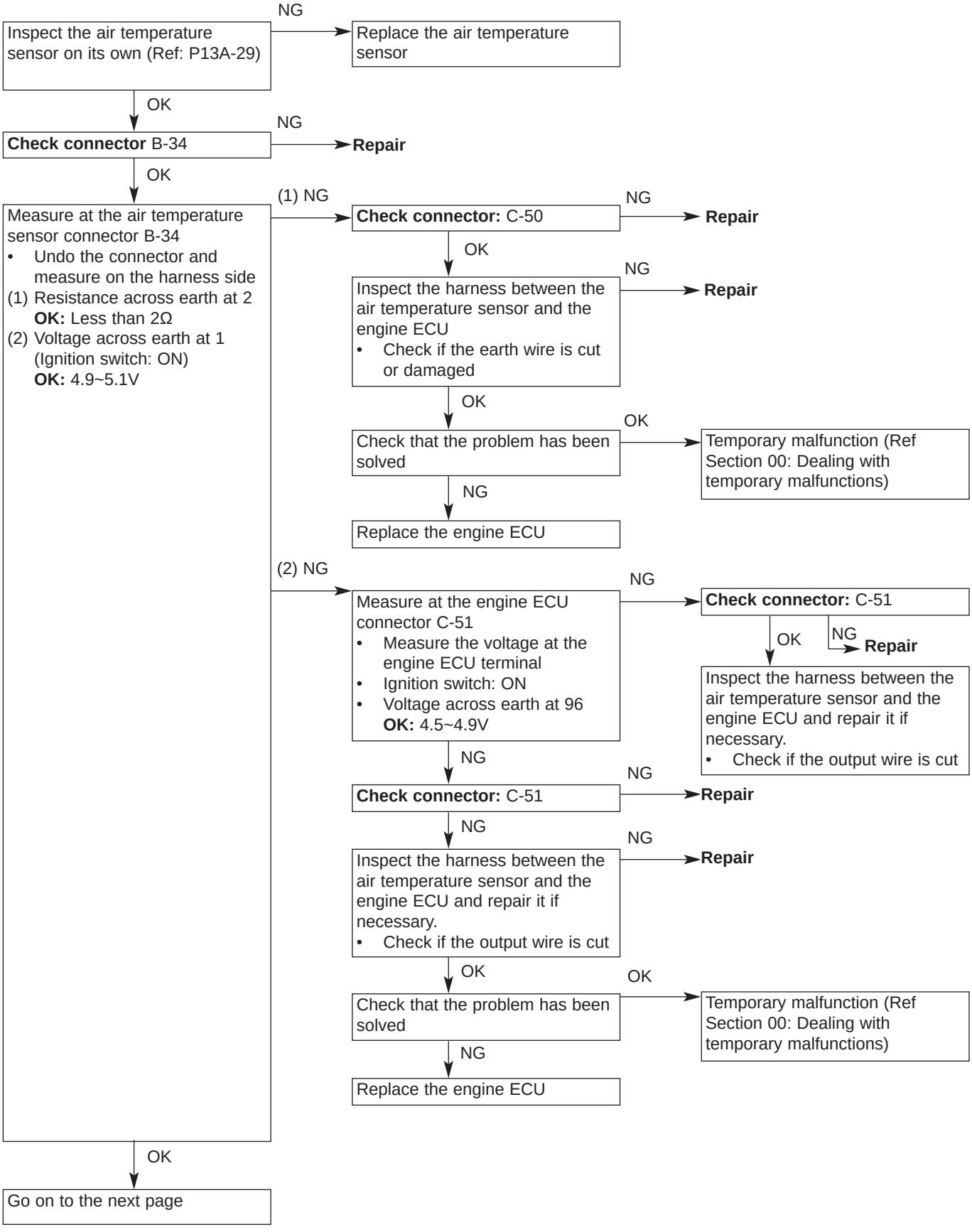
Inspection procedure 37

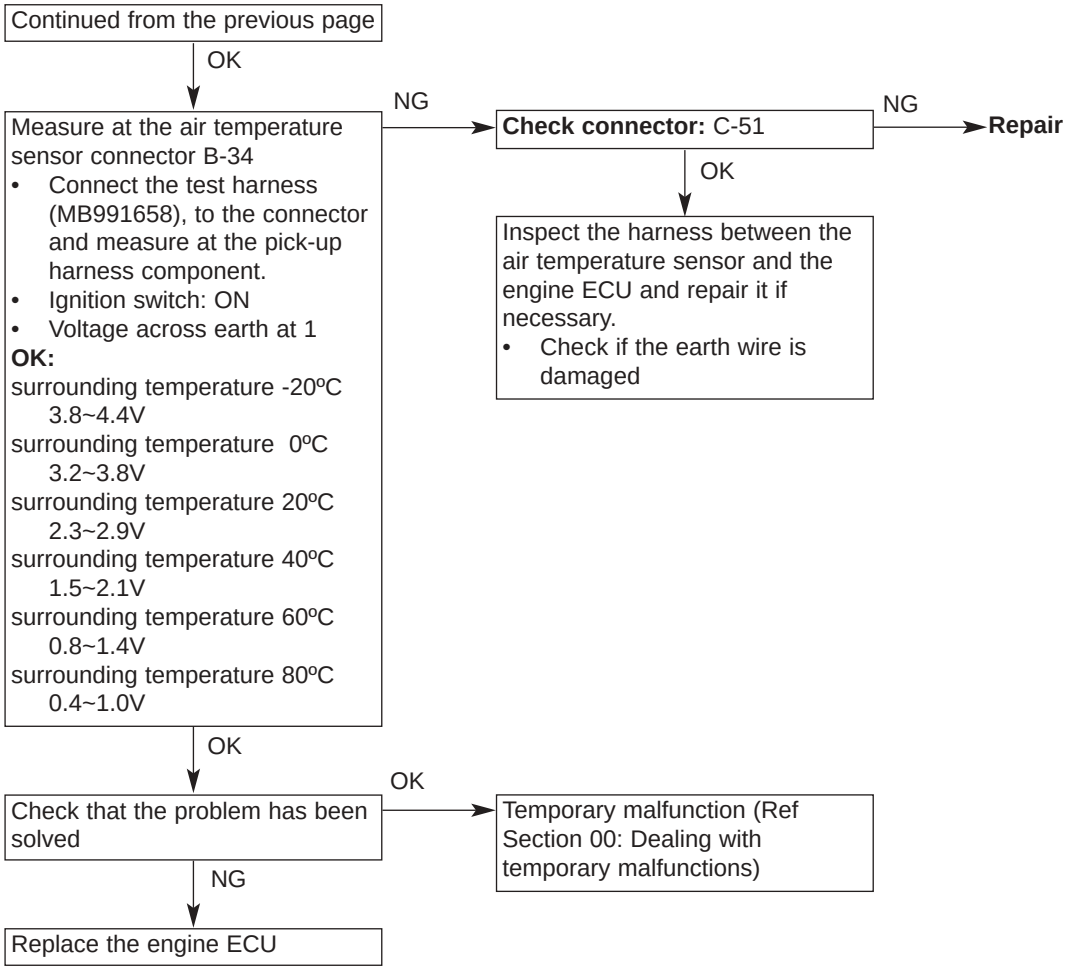
No.2 waste gate solenoid valve system	Probable causes of the malfunction
The No.2 waste gate solenoid valve controls the supercharge pressure introduced to the waste gate actuator in the turbocharger.	• Malfunction of the No.2 waste gate solenoid valve. • Circuit break, short circuit or a faulty connection in the No.2 waste gate solenoid valve circuit. • Malfunction of the engine ECU.



Inspection procedure 38

Air temperature sensor system	Probable causes of the malfunction
The air temperature sensor controls the temperature inside the inlet manifold, and compensates for any burning of fuel.	• Malfunction of the air temperature sensor. • Circuit break, short circuit or a faulty connection in the air temperature sensor circuit. • Malfunction of the engine ECU.




Continued from the previous page
OK
Measure at the air temperature sensor connector B-34
• Connect the test harness (MB991658), to the connector and measure at the pick-up harness component.
• Ignition switch: ON
• Voltage across earth at 1
OK:
surrounding temperature -20ºC
3.8~4.4V
surrounding temperature 0ºC
3.2~3.8V
surrounding temperature 20ºC
2.3~2.9V
surrounding temperature 40ºC
1.5~2.1V
surrounding temperature 60ºC
0.8~1.4V
surrounding temperature 80ºC
0.4~1.0V
NG
Check connector: C-51
NG
Repair
OK
Inspect the harness between the air temperature sensor and the engine ECU and repair it if necessary.
• Check if the earth wire is damaged
OK
Check that the problem has been solved
OK
Temporary malfunction (Ref Section 00: Dealing with temporary malfunctions)
NG
Replace the engine ECU

6. Service data table

Item No.	Items to be checked	Conditions for checking			Normal condition	Code No. or checking procedure No.	Reference page
25	Atmospheric pressure sensor	Ignition switch: **ON**	altitude: 0m altitude: 600m altitude: 1200m altitude: 1800m		101kPa 95kPa 88kPa 81kPa	Code No. P2226	13A-14
7E	V.V.T. phase angle	Engine: after warming up	Idle running without a load		0~5°CA	-	-
			Without a load 3,000r/min		8~12°CA		
95	Manifold absolute pressure (MAP) sensor	• Engine cooling water temperature: 80~95 ºC • Lights, electric cooling fan, ancillary devices: **OFF** • Transmission: neutral • Ignition switch: **ON**	Engine stopped	altitude: 0m altitude: 600m altitude: 1200m altitude: 1800m	101kPa 95kPa 88kPa 81kPa	Code No. P0105	13A-7
			Idle running		31~45 kPa		
			Vigorous racing		Changes in response to the intake manifold negative pressure		

7. Engine ECU checks

7-1 Terminal voltage table

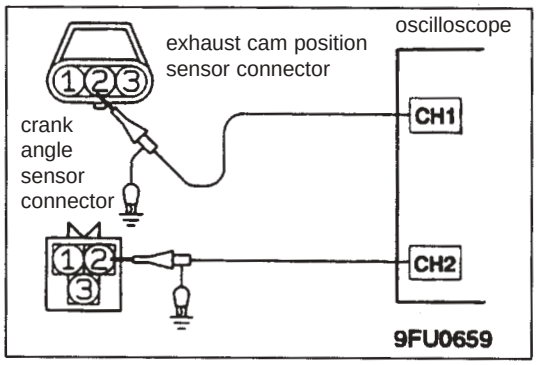
Item No.	Items to be checked	Conditions for checking (engine condition)		Normal condition
32	Oil feeder control valve	Ignition switch: **ON**		Battery voltage
		Running with a high load		4~10V
50	Exhaust cam position sensor	Engine: cranking		0.4~3.0V
		Engine: idle running		0.5~2.0V
53	Intake cam position sensor	Engine: cranking		0.4~3.0V
		Engine: idle running		0.5~2.0V
56	Inter-cooler spray relay	Ignition switch: **ON**		Battery voltage
		Ignition switch: **LOCK (OFF)**		Less than 1V
63	No.2 waste gate solenoid valve	Ignition switch: **ON**		Battery voltage
		Accelerating with two-speed throttle fully open (over 3,500r/min)		Voltage drops
92	MAP sensor	Ignition switch: **ON**	altitude: 0m	1.2~1.8V
			altitude: 600m	1.1~1.7V
			altitude: 1200m	1.0~1.6V
			altitude: 1800m	0.9~1.5V
		Engine: after warming up, idling		0.46~0.66V
		Engine: after warming up, suddenly push the accelerator when the engine is idling		Changes in response to intake manifold negative pressure
96	Air temperature sensor	Ignition switch: **ON**	when intake air temp is -20 ºC	3.8~4.4V
			when intake air temp is 0 ºC	3.2~3.8V
			when intake air temp is 20 ºC	2.3~2.9V
			when intake air temp is 40 ºC	0.8~1.4V
			when intake air temp is 80 ºC	0.4~1.0V

7-2 Table showing resistance and continuity across the terminals of harness side connectors

Terminal number	Item to be checked	Standard value, normal condition (conditions for checking)
32-47	Oil feeder control valve	6.9~7.9Ω (when at 20 ºC)
63-47	No.2 waste gate solenoid valve	29~35Ω (when at 20 ºC)
96-49	Air temperature sensor	13~18kΩ (when intake air temp is –20 ºC)
		5.1~6.9kΩ (when intake air temp is 0 ºC)
		2.0~3.0kΩ (when intake air temp is 20 ºC)
		0.9~1.5kΩ (when intake air temp is 40 ºC)
		0.40~0.78kΩ (when intake air temp is 60 ºC)
		0.23~0.42kΩ (when intake air temp is 80 ºC)

8. Checks using an oscilloscope

Sensor output signals and actuator drive signals can be checked visually by taking waveform measurements using an oscilloscope.



8.1 Exhaust cam position sensor and the crank angle sensor

<Measurement method>

(1) Disconnect the exhaust cam position sensor connector, and connect the special test harness (MB991709) in its place.
(2) Disconnect the crank angle sensor connector, and connect the special test harness (MB998478) in its place.
(3) Connect the No.2 terminal of the exhaust cam position sensor connector and the No.2 terminal (the black coloured clip on the special tool) of the crank angle sensor connector, to the probes for each channel on the oscilloscope.

Note

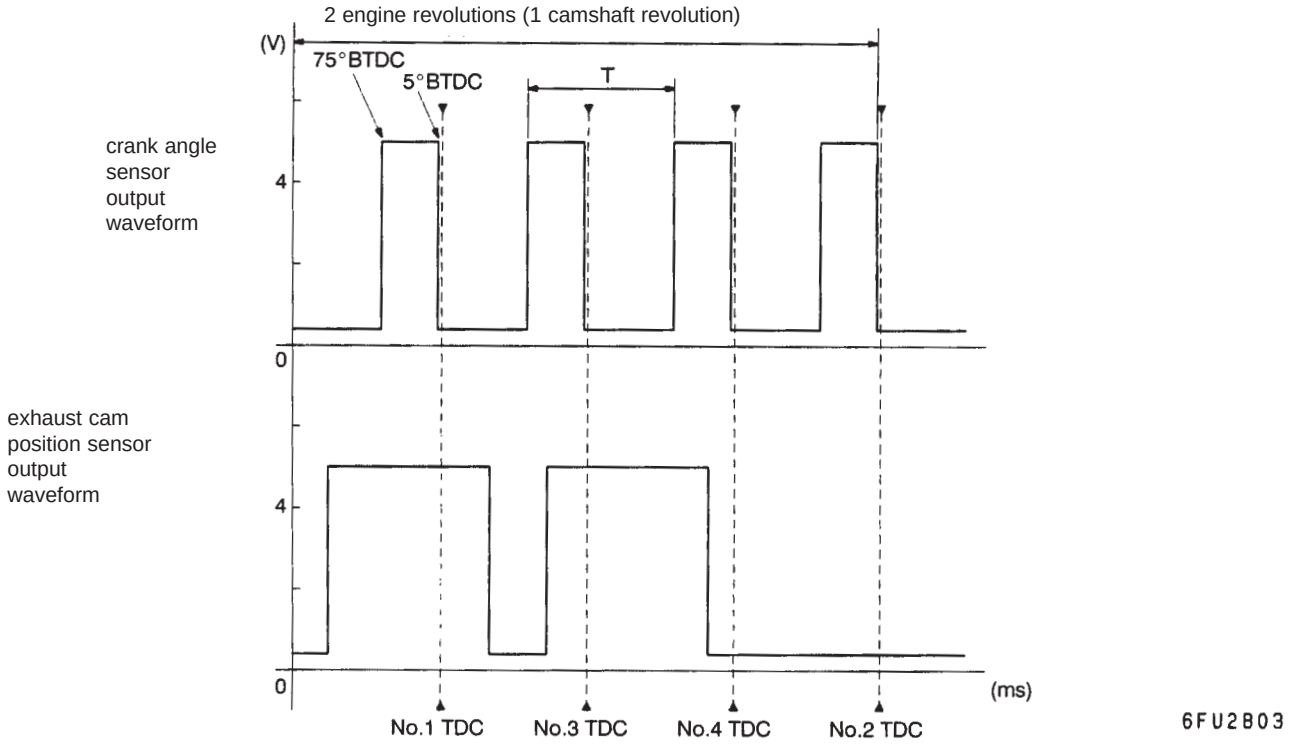
When measuring at the engine ECU connector, connect the probes for each channel on the oscilloscope to No.50 terminal (exhaust cam position sensor), and to No.43 terminal (crank angle sensor).

<Standard waveforms>

Observation conditions

	Exhaust cam position sensor	Crank angle sensor
Probe switch	X1	x1
AC-GND-DC	DC	DC
TIME/DIV.	10ms	10 ms
VOLTS/DIV.	2V	2V
Other	-	-
Engine	Idling	

Standard waveform

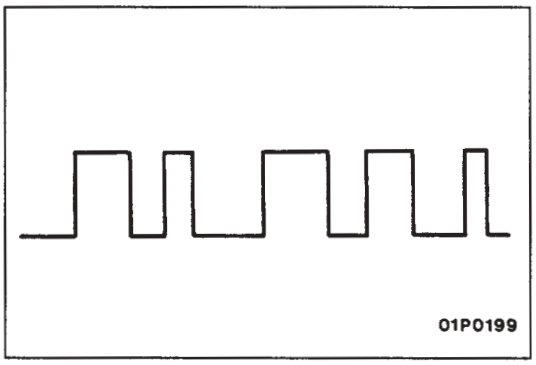


<Explanation of waveforms>

- The exhaust cam position sensor detects the compression top dead centre for each cylinder, and by simultaneous observation of these and other controlling signals, it is possible to distinguish between the cylinders.
- The crank angle sensor detects the crank angle for each cylinder. There is an output of 4 evenly spaced crank angle sensor HIGH signals for every 2 revolutions of the engine. Therefore, by measuring the cycle time (seconds), engine revolution speed can calculated according to the following formula:
  Engine revolution speed = 2/4T (seconds) x 60 = 30/T (seconds)

<Waveform observation points>

- Check that the cycle time gets shorter as the engine revolution speed increases.



<Examples of abnormal waveforms>

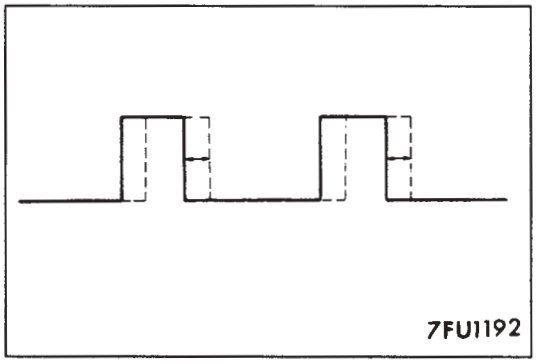
- Example 1

Waveform characteristics

A rectangular waveform is produced even though the engine has not been started.

Cause of the problem

Sensor interface fault



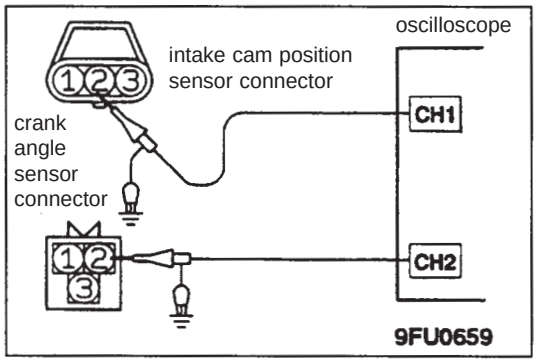
- Example 2

Waveform characteristics

The waveform is displaced to the left or the right.

Cause of the problem

The timing belt is loose.
There is an abnormality in the sensor disc.



8-2 Intake cam position sensor
<Measurement method>

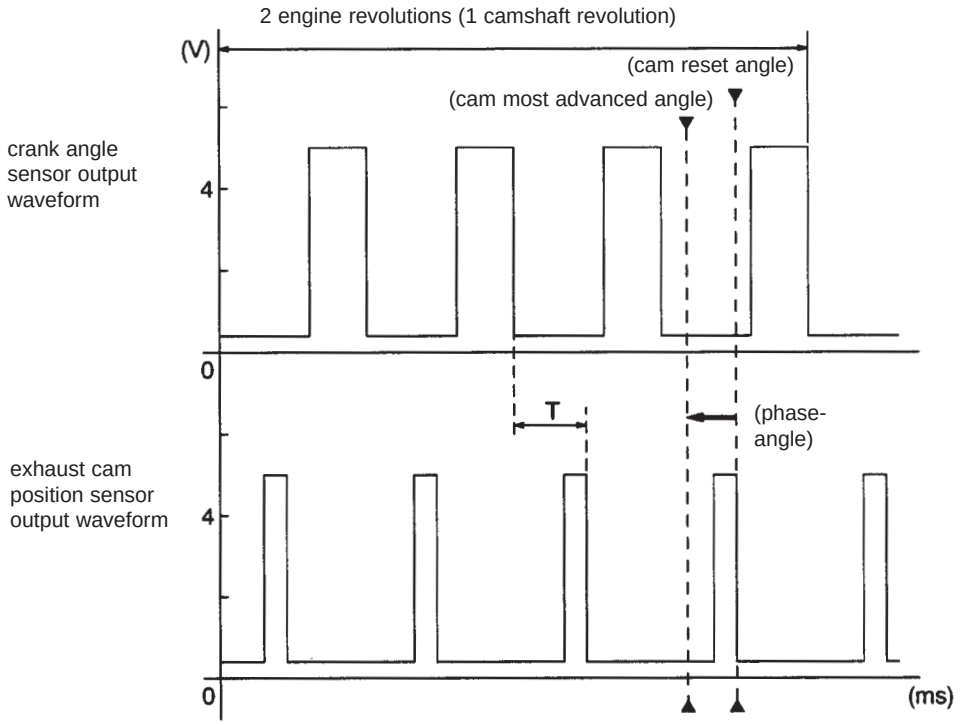
(1) Disconnect the intake cam position sensor connector and connect the special test harness (MB991709) in its place. (All terminals should be connected).
(2) Connect the oscilloscope probe to the No.2 terminal of the intake cam position sensor connector.
Note
When measuring at the engine ECU connector, connect the No.53 terminal (intake cam position sensor) to the oscilloscope probe.
(3) When checking the output signal of the intake cam position sensor, observe the output signal of the crank angle sensor at the same time.

<Standard waveforms>

Observation conditions

	Intake cam position sensor	Crank angle sensor
Probe switch	X1	x1
AC-GND-DC	DC	DC
TIME/DIV.	10ms	10 ms
VOLTS/DIV.	2V	2V
Other	-	-
Engine	Idling	

Standard waveform



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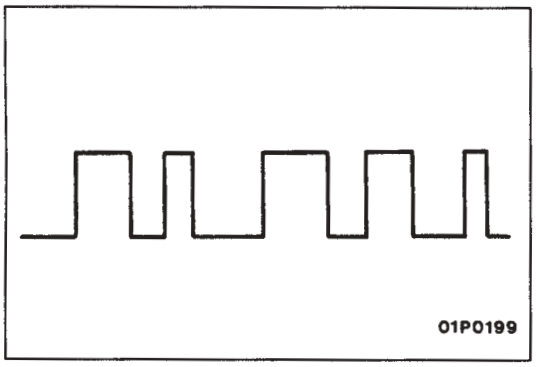
<Explanation of waveforms>

- The intake cam position sensor detects the position of the inlet camshaft. The notch located on the intake side of the camshaft creates 4 output pulses for each revolution of the camshaft.
- When the time difference between the rise and fall of the output waveform from the crank angle sensor and the rise and fall of the output waveform from the intake cam position sensor is long the cam is at the reset angle, when the time difference is short the cam is at the most advanced angle.
  Note
  When the cam is at the most advanced angle, the rise and fall of the output waveform from the intake cam position sensor should be at an advancing angle of about 60°.

<Waveform observation points>

- As engine revolutions approach 2500r/min, check that the time difference (T) between the rise and fall of the output waveform from the crank angle sensor, and the rise and fall of the output waveform from the intake cam position sensor, gets shorter.



<Examples of abnormal waveforms>

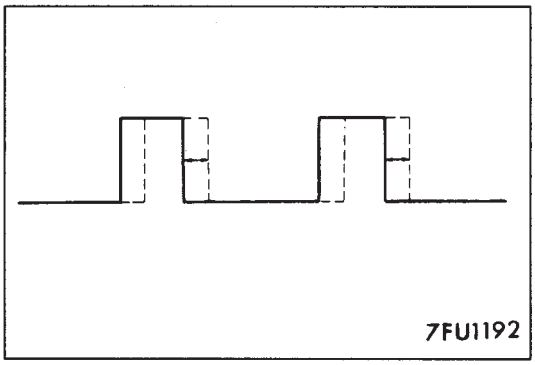
- Example 1

  Waveform characteristics

  A rectangular waveform is produced even though the engine has not been started.

  Cause of the problem

  Sensor interface fault



- Example 2

Waveform characteristics
The waveform is displaced to the left or the right.

Cause of the problem
The timing belt is loose
There is an abnormality in the fuel pump camshaft

On-vehicle servicing

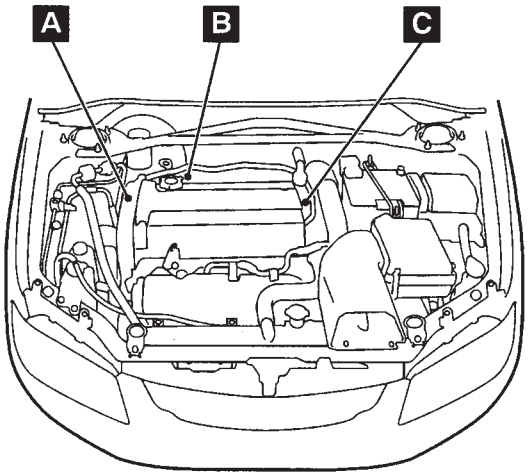
1. Adjusting standard engine revolutions when idling

The standard engine revolutions when idling have been changed. All other servicing requirements are the same as before.

Standard engine revolutions when idling: 800 ± 50 r/min

2. Layout diagram for MPI system components

Name	Code	Name	Code
Intake cam position sensor	C	Oil feeder control valve	A
Air temperature sensor	B	Manifold absolute pressure sensor	B
Exhaust cam position sensor	C		



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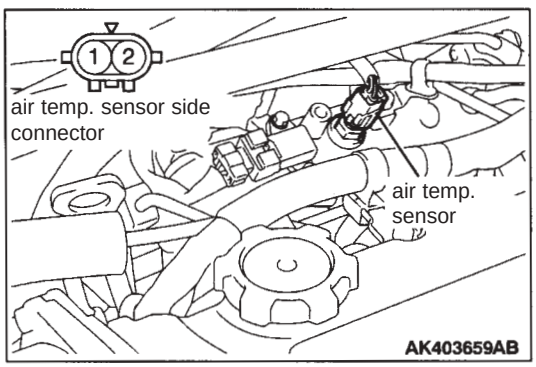
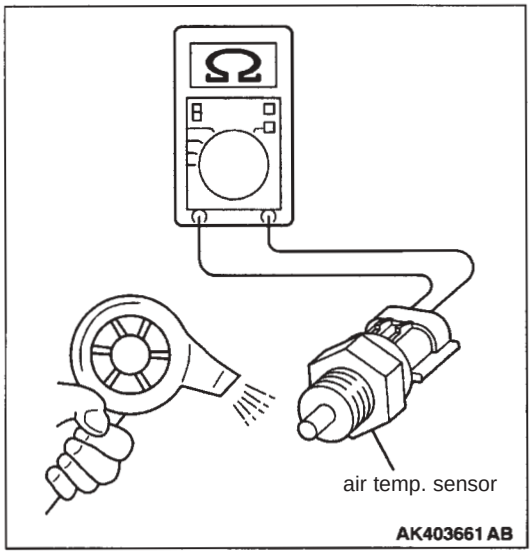


3. Inspection of the air temperature sensor

(1) Disconnect the air temperature sensor connector.
(2) Measure the resistance across the terminals of the air temperature sensor connector.
Standard values:
13~18 kΩ (when at -20 °C)
5.1~6.9 kΩ (when at 0 °C)
2.0~3.0 kΩ (when at 20 °C)
0.9~1.5 kΩ (when at 40 °C)
0.40~0.78 kΩ (when at 60 °C)
0.23~0.42 kΩ (when at 80 °C)

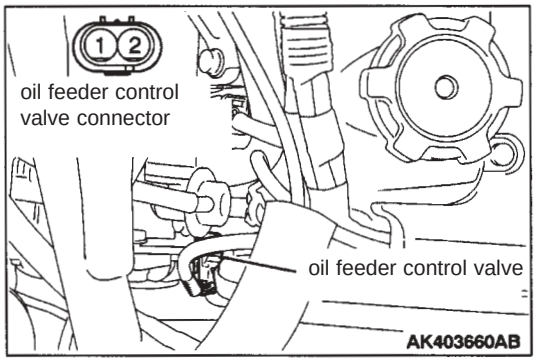
(3) Remove the air temperature sensor



(4) Use a hair dryer to increase the temperature and measure the resistance.
Normal conditions:

Temperature (ºC)	Resistance (kΩ)
Temperature increases	Resistance decreases

(5) If the resistance deviates from the standard values, or if it does not change, replace the air temperature sensor.
(6) Tighten the air temperature sensor to the specified torque.
Tightening torque: 14 ± N·m



4. Inspection of the oil feeder control valve

Checking the operation of the valve
(1) Disconnect the oil feeder control valve connector.
(2) Apply battery voltage across the terminals of the connector on the oil feeder control valve side, and check that the sound of the oil feeder control valve operating can be heard.

Caution
There is a chance that the coil may be damaged, so apply the voltage in as short a time as possible.

Resistance across the terminals
(1) Remove the oil feeder control valve connector.
(2) Measure the resistance across the terminals of the connector on the oil feeder control valve side.
Standard value: 6.9~7.9 kΩ (when at 20 ºC)
(3) If the resistance deviates from the standard value, replace the oil feeder control valve.