FOREWORD

This repair manual has been prepared to provide information covering general service repairs for the 1CD–FTV engine equipped on the TOYOTA AVENSIS/CORONA.

Applicable models: CDT220 series

Please note that the publications below have also been prepared as relevant service manuals for the components and system in this engine.

Manual Name	Pub. No.
• AVENSIS/CORONA Electrical Wiring Diagram	EWD330Y
• AVENSIS/CORONA Electrical Wiring Diagram Supplement	EWD373F

All information in this manual is based on the latest product information at the time of publication. However, specifications and procedures are subject to change without notice.

TOYOTA MOTOR CORPORATION

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CAUTION

This manual does not include all the necessary items about repair and service. This manual is made for the purpose of the use for the persons who have special techniques and certifications. In the cases that non–specialized or uncertified technicians perform repair or service only using this manual or without proper equipment or tool, that may cause severe injury to you or other people around and also cause damage to your customer's vehicle.

In order to prevent dangerous operation and damages to your customer's vehicle, be sure to follow the instruction shown below.

- Must read this manual thoroughly. It is especially important to have good understanding all the contents written in the PRECAUTION of "IN" section.
- The service method written in this manual is very effective to perform repair and service. When performing the operations following the procedures using this manual, be sure to use tools specified and recommended. If using non–specified or recommended tools and service method, be sure to confirm safety of the technicians and any possibility of causing personal injury or damage to the customer's vehicle before starting the operation.
- If part replacement is necessary, must replace the part with the same part number or equivalent part. Do not replace it with inferior quality.
- It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is important to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

INTRODUCTION

HOW TO USE THIS MANUAL

IN04V–03

GENERAL INFORMATION

1. INDEX

An INDEX is provided on the first page of each section to guide you to the item to be repaired. To assist you in finding your way through the manual, the section title and major heading are given at the top of every page.

2. PRECAUTION

At the beginning of each section, a PRECAUTION is given that pertains to all repair operations contained in that section.

Read these precautions before starting any repair task.

3. TROUBLESHOOTING

TROUBLESHOOTING tables are included for each system to help you diagnose the problem and find the cause. The fundamentals of how to proceed with troubleshooting are described on page IN–9.

Be sure to read this before performing troubleshooting.

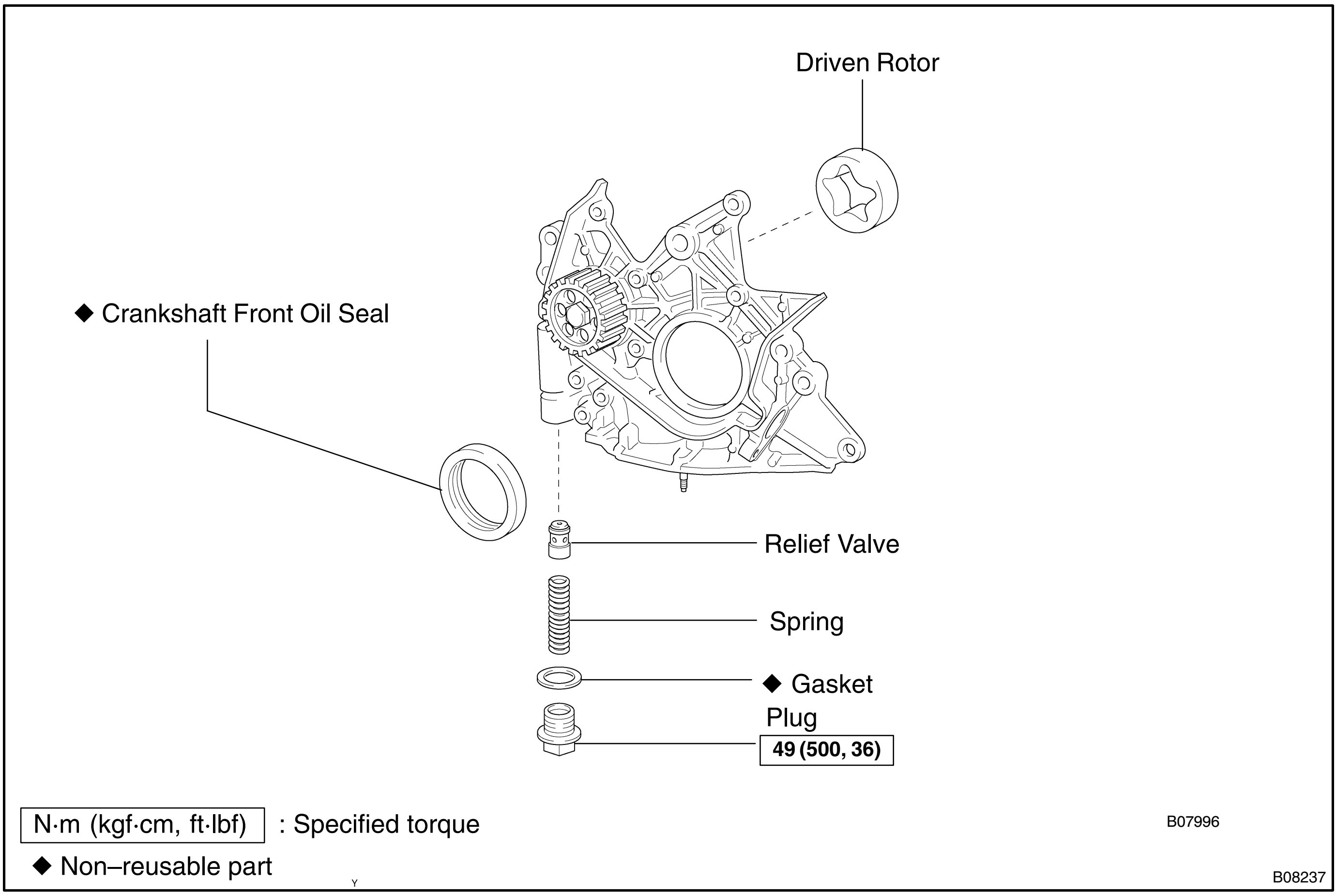
4. PREPARATION

Preparation lists the SST (Special Service Tools), recommended tools, equipment, lubricant and SSM (Special Service Materials) which should be prepared before beginning the operation and explains the purpose of each one.

5. REPAIR PROCEDURES

Most repair operations begin with an overview illustration. It identifies the components and shows how the parts fit together.

Example:



The procedures are presented in a step–by–step format:

- The illustration shows what to do and where to do it.
- The task heading tells what to do.
- The detailed text tells how to perform the task and gives other information such as specifications and warnings.

Example:

Task heading : what to do

Illustration: what to do and where

21. CHECK PISTON STROKE OF OVERDRIVE BRAKE

(a) Place SST and a dial indicator onto the overdrive brake piston as shown in the illustration.

SST 09350–30020 (09350–06120)

Set part No. *Component part No.*

Detailed text : how to do task

(b) Measure the stroke applying and releasing the compressed air (392 — 785 kPa, 4 — 8 kgf/cm^2 or 57 — 114 psi) as shown in the illustration.

Piston stroke: 1.40 — 1.70 mm (0.0551 — 0.0669 in.)

Specification

This format provides the experienced technician with a FAST TRACK to the information needed. The upper case task heading can be read at a glance when necessary, and the text below it provides detailed information. Important specifications and warnings always stand out in bold type.

6. REFERENCES

References have been kept to a minimum. However, when they are required you are given the page to refer to.

7. SPECIFICATIONS

Specifications are presented in bold type throughout the text where needed. You never have to leave the procedure to look up your specifications. They are also found in Service Specifications section for quick reference.

8. CAUTIONS, NOTICES, HINTS:

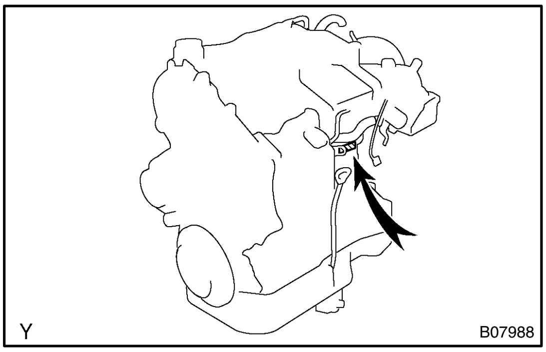
- CAUTIONS are presented in bold type, and indicate there is a possibility of injury to you or other people.
- NOTICES are also presented in bold type, and indicate the possibility of damage to the components being repaired.
- HINTS are separated from the text but do not appear in bold. They provide additional information to help you perform the repair efficiently.

9. SI UNIT

The UNITS given in this manual are primarily expressed according to the SI UNIT (International System of Unit), and alternately expressed in the metric system and in the English System.

Example:

Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)

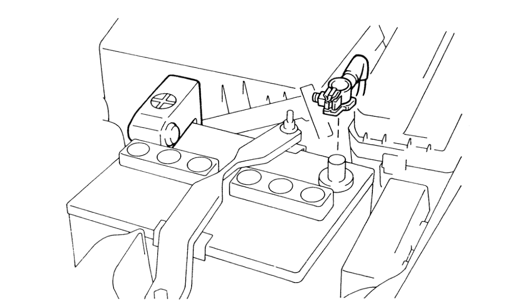


IDENTIFICATION INFORMATION

IN0E6–01

ENGINE SERIAL NUMBER

The engine serial number is stamped on the engine block, as shown in the illustration.


P23717

REPAIR INSTRUCTIONS

IN0E7–01

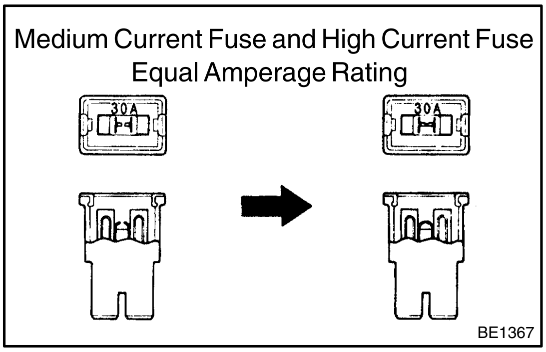
GENERAL INFORMATION

BASIC REPAIR HINT

(a) Use fender, seat and floor covers to keep the vehicle clean and prevent damage.
(b) During disassembly, keep parts in the appropriate order to facilitate reassembly.
(c) Observe the following operations:
 (1) Before performing electrical work, disconnect the negative (–) terminal cable from the battery.
 (2) If it is necessary to disconnect the battery for inspection or repair, always disconnect the negative (–) terminal cable which is grounded to the vehicle body.
 (3) To prevent damage to the battery terminal, loosen the cable nut and raise the cable straight up without twisting or prying it.
 (4) Clean the battery terminals and cable ends with a clean shop rag. Do not scrape them with a file or other abrasive objects.
 (5) Install the cable ends to the battery terminals with the nut loose, and tighten the nut after installation. Do not use a hammer to tap the cable ends onto the terminals.
 (6) Be sure the cover for the positive (+) terminal is properly in place.
(d) Check hose and wiring connectors to make sure that they are secure and correct.
(e) Non–reusable parts
 (1) Always replace cotter pins, gaskets, O–rings and oil seals etc. with new ones.
 (2) Non–reusable parts are indicated in the component illustrations by the ”◆” symbol.
(f) Precoated parts
 Precoated parts are bolts and nuts, etc. that are coated with a seal lock adhesive at the factory.
 (1) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.
 (2) When reusing precoated parts, clean off the old adhesive and dry with compressed air. Then apply the specified seal lock adhesive to the bolt, nut or threads.
 (3) Precoated parts are indicated in the component illustrations by the ”★” symbol.
(g) When necessary, use a sealer on gaskets to prevent leaks.

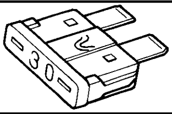
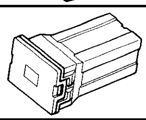
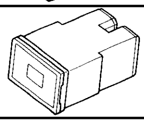
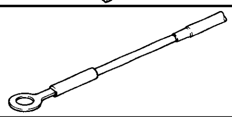
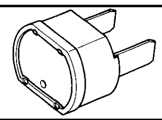
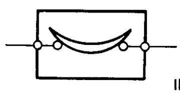
(h) Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.

(i) Use of special service tools (SST) and special service materials (SSM) may be required, depending on the nature of the repair. Be sure to use SST and SSM where specified and follow the proper work procedure. A list of SST and SSM can be found in section PP (Preparation) in this manual.



BE1367

(j) When replacing fuses, be sure the new fuse has the correct amperage rating. DO NOT exceed the rating or use one with a lower rating.

Illustration	Symbol	Part Name	Abbreviation
 BE5594	 IN0365	FUSE	FUSE
 BE5595	 IN0366	MEDIUM CURRENT FUSE	M–FUSE
 BE5596	 IN0367	HIGH CURRENT FUSE	H–FUSE
 BE5597	 IN0367	FUSIBLE LINK	FL
 BE5598	 IN0368	CIRCUIT BREAKER	CB

V00076

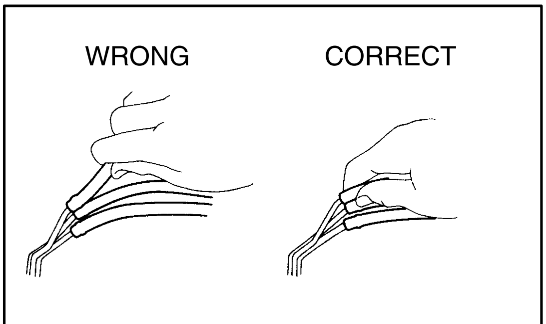
(k) Care must be taken when jacking up and supporting the vehicle. Be sure to lift and support the vehicle at the proper locations.

- Cancel the parking brake on the level place and shift the transmission in Neutral (or N position).
- When jacking up the front wheels of the vehicle at first place stoppers behind the rear wheels.
- When jacking up the rear wheels of the vehicle at first place stoppers behind the rear wheels.

- When either the front or rear wheels only should be jacked up, set rigid racks and place stoppers in front and behind the other wheels on the ground.
- After the vehicle is jacked up, be sure to support it on rigid racks. It is extremely dangerous to do any work on a vehicle raised on a jack alone, even for a small job that can be finished quickly.

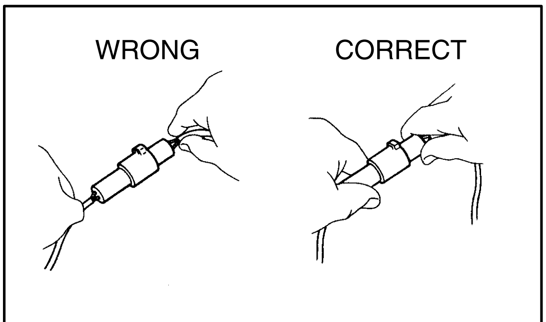
(l) Observe the following precautions to avoid damage to the following parts:

(1) Do not open the cover or case of the ECU unless absolutely necessary. (If the IC terminals are touched, the IC may be destroyed by static electricity.)



IN0253

(2) To disconnect vacuum hoses, pull off the end, not the middle of the hose.



IN0252

(3) To pull apart electrical connectors, pull on the connector itself, not the wires.

(4) Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard floor, they should be replaced and not reused.

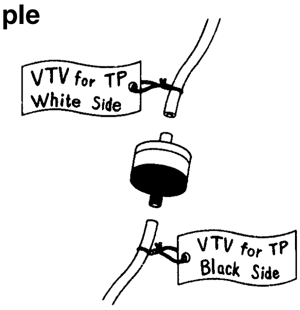
(5) When steam cleaning an engine, protect the electronic components, air filter and emission–related components from water.

(6) Never use an impact wrench to remove or install temperature switches or temperature sensors.

(7) When checking continuity at the wire connector, insert the tester probe carefully to prevent terminals from bending.

(8) When using a vacuum gauge, never force the hose onto a connector that is too large. Use a step–down adapter for adjustment. Once the hose has been stretched, it may leak.

Example



IN0002

(m) Tag hoses before disconnecting them:
  (1) When disconnecting vacuum hoses, use tags to identify how they should be reconnected.
  (2) After completing a job, double check that the vacuum hoses are properly connected. A label under the hood shows the proper layout.

(n) Unless otherwise stated, all resistance is measured at an ambient temperature of 20°C (68°F). Because the resistance may be outside specifications if measured at high temperatures immediately after the vehicle has been running, measurement should be made when the engine has cooled down.

FOR ALL OF VEHICLES

IN0E8–01

PRECAUTION

1. FOR VEHICLES EQUIPPED WITH A CATALYTIC CONVERTER

CAUTION:

If large amount of unburned gasoline flows into the converter, it may overheat and create a fire hazard. To prevent this, observe the following precautions and explain them to your customer.

(a) Use only unleaded gasoline.

(b) Avoid prolonged idling.
Avoid running the engine at idle speed for more than 20 minutes.

(c) Avoid spark jump test.
- (1) Perform spark jump test only when absolutely necessary. Perform this test as rapidly as possible.
- (2) While testing, never race the engine.

(d) Avoid prolonged engine compression measurement.
Engine compression tests must be done as rapidly as possible.

(e) Do not run engine when fuel tank is nearly empty.
This may cause the engine to misfire and create an extra load on the converter.

(f) Avoid coasting with ignition turned off and prolonged braking.

(g) Do not dispose of used catalyst along with parts contaminated with gasoline or oil.

2. IF VEHICLE IS EQUIPPED WITH MOBILE COMMUNICATION SYSTEM

For vehicles with mobile communication systems such as two–way radios and cellular telephones, observe the following precautions.

- (1) Install the antenna as far as possible away from the ECU and sensors of the vehicle's electronic system.
- (2) Install the antenna feeder at least 20 cm (7.87 in.) away from the ECU and sensors of the vehicle's electronic systems. For details about ECU and sensors locations, refer to the section on the applicable component.
- (3) Avoid winding the antenna feeder together with the other wiring as much as possible, and also avoid running the antenna feeder parallel with other wire harnesses.
- (4) Check that the antenna and feeder are correctly adjusted.
- (5) Do not install powerful mobile communications system.

3. FOR USING HAND–HELD TESTER

CAUTION:

Observe the following items for safety reasons:

- **Before using the hand–held tester, the hand–held tester's operator manual should be read throughly.**
- **Be sure to route all cables securely when driving with the hand–held tester connected to the vehicle. (i.e. Keep cables away from feet, pedals, steering wheel and shift lever.)**
- **Two persons are required when test driving with the hand–held tester, one person to drive the vehicle and one person to operate the hand–held tester.**

HOW TO TROUBLESHOOT ECU CONTROLLED SYSTEMS

GENERAL INFORMATION

IN050–03

A large number of ECU controlled systems are used in the AVENSIS/CORONA. In general, the ECU controlled system is considered to be a very intricate system requiring a high level of technical knowledge and expert skill to troubleshoot. However, the fact is that if you proceed to inspect the circuits one by one, troubleshooting of these systems is not complex. If you have adequate understanding of the system and a basic knowledge of electricity, accurate diagnosis and necessary repair can be performed to locate and fix the problem. This manual is designed through emphasis of the above standpoint to help service technicians perform accurate and effective troubleshooting, and is compiled for the following major ECU controlled systems:

System	Page
Engine	DI–1

The troubleshooting procedure and how to make use of it are described on the above pages.

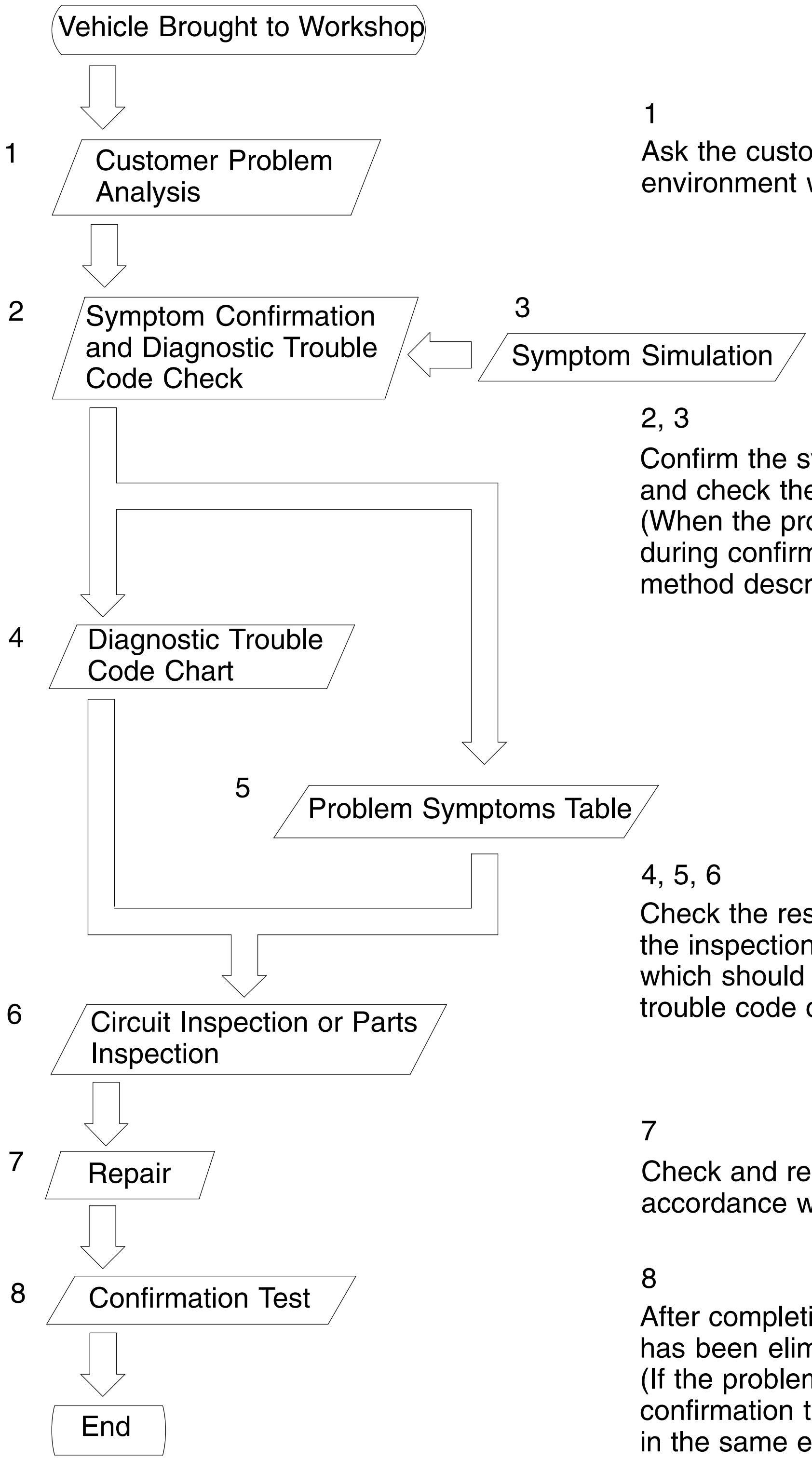
FOR USING HAND–HELD TESTER

- Before using the hand–held tester, the hand held–tester's operator manual should be read throughly.
- If the hand–held tester cannot communicate with ECU controlled systems when you have connected the cable of the hand–held tester to DLC3, turned the ignition switch ON and operated the scan tool, there is a problem on the vehicle side or tool side.
  (1) If communication is normal when the tool is connected to another vehicle, inspect the diagnosis data link line (Bus⊕line) or ECU power circuit of the vehicle.
  (2) If communication is still not possible when the tool is connected to another vehicle, the problem is probably in the tool itself, so perform the Self Test procedures outlined in the Tester Operator's Manual.

IN051–03

HOW TO PROCEED WITH TROUBLESHOOTING

Carry out troubleshooting in accordance with the procedure on the following page. Here, only the basic procedure is shown. Details are provided in each section, showing the most effective methods for each circuit. Confirm the troubleshooting procedures first for the relevant circuit before beginning troubleshooting of that circuit.



1
Ask the customer about the conditions and the environment when the problem occurred.

2, 3
Confirm the symptoms and the problem conditions, and check the diagnostic trouble codes.
(When the problem symptoms do not appear during confirmation, use the symptom simulation method described later on.)

4, 5, 6
Check the results obtained in Step 2, then confirm the inspection procedure for the system or the part which should be checked using the diagnostic trouble code chart or the problem symptoms table.

7
Check and repair the affected system or part in accordance with the instructions in Step 6.

8
After completing repairs, confirm that the problem has been eliminated.
(If the problem is not reproduced, perform the confirmation test under the same conditions and in the same environment as when it occurred for the first time.)

1. CUSTOMER PROBLEM ANALYSIS

In troubleshooting, the problem symptoms must be confirmed accurately and all preconceptions must be cleared away in order to give an accurate judgement. To ascertain just what the problem symptoms are, it is extremely important to ask the customer about the problem and the conditions at the time it occurred.

Important Point in the Problem Analysis:

The following 5 items are important points in the problem analysis. Past problems which are thought to be unrelated and the repair history, etc. may also help in some cases, so as much information as possible should be gathered and its relationship with the problem symptoms should be correctly ascertained for reference in troubleshooting. A customer problem analysis table is provided in the troubleshooting section for each system for your use.

Important Points in the Customer Problem Analysis

- What ——— Vehicle model, system name
- When ——— Date, time, occurrence frequency
- Where ——— Road conditions
- Under what conditions? ——— Running conditions, driving conditions, weather conditions
- How did it happen? ——— Problem symptoms

(Sample) Engine control system check sheet.

CUSTOMER PROBLEM ANALYSIS CHECK

ENGINE CONTROL SYSTEM Check Sheet

Inspector's Name

Customer's Name		Model and Model Year	
Driver's Name		Frame No.	
Data Vehicle Brought in		Engine Model	
License No.		Odometer Reading	km miles

Problem Symptoms	☐ Engine does not Start	☐ Engine does not crank ☐ No initial combustion ☐ No complete combustion
	☐ Difficult to Start	☐ Engine cranks slowly ☐ Other
	☐ Poor Idling	☐ Incorrect first idle ☐ Idling rpm is abnormal ☐ High (rpm) ☐ Low (rpm) ☐ Rough idling ☐ Other
	☐ Poor Drive ability	☐ Hesitation ☐ Back fire ☐ Muffler explosion (after–fire) ☐ Surging ☐ Knocking ☐ Other
	☐ Engine Stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ After accelerator pedal released ☐ During A/C operation ☐ Shifting from N to D ☐ Other
	☐ Others	

...onstant ☐ Sometimes (times per day/month)

2. SYMPTOM CONFIRMATION AND DIAGNOSTIC TROUBLE CODE CHECK

The diagnostic system in the AVENSIS/CORONA fulfills various functions. The first function is the Diagnostic Trouble Code Check in which a malfunction in the signal circuits to the ECU is stored in code in the ECU memory at the time of occurrence, to be output by the technician during troubleshooting. Another function is the Input Signal Check which checks if the signals from various switches are sent to the ECU correctly. By using these check functions, the problem areas can be narrowed down quickly and troubleshooting can be performed effectively. Diagnostic functions are incorporated in the following systems in the AVENSIS/CORONA.

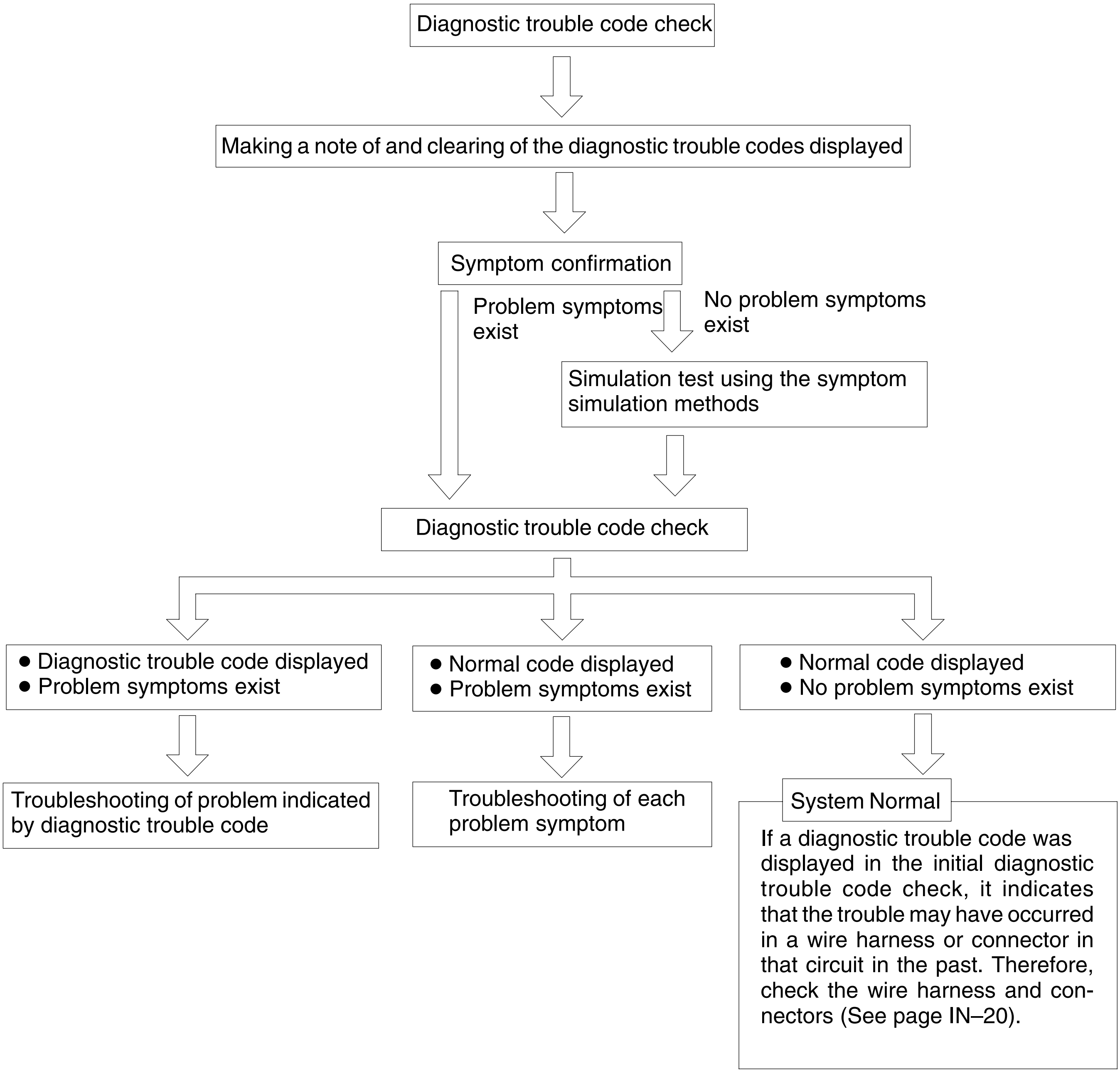
System	Diagnostic Trouble Code Check	Input Signal Check (Sensor Check)	Other Diagnosis Function
Engine	○ (with Test Mode)	○	Diagnostic Test Mode

In diagnostic trouble code check, it is very important to determine whether the problem indicated by the diagnostic trouble code is still occurring or occurred in the past but returned to normal at present. In addition, it must be checked in the problem symptom check whether the malfunction indicated by the diagnostic trouble code is directly related to the problem symptom or not. For this reason, the diagnostic trouble codes should be checked before and after the symptom confirmation to determine the current conditions, as shown in the table below. If this is not done, it may, depending on the case, result in unnecessary troubleshooting for normally operating systems, thus making it more difficult to locate the problem, or in repairs not pertinent to the problem. Therefore, always follow the procedure in correct order and perform the diagnostic trouble code check.

DIAGNOSTIC TROUBLE CODE CHECK PROCEDURE

Diagnostic Trouble Code Check (Make a note of and then clear)	Confirmation of Symptoms	Diagnostic Trouble Code Check	Problem Condition
Diagnostic Trouble Code Display	Problem symptoms exist	Same diagnostic trouble code is displayed	Problem is still occurring in the diagnostic circuit
		Normal code is displayed	The problem is still occurring in a place other than in the diagnostic circuit (The diagnostic trouble code displayed first is either for a past problem or it is a secondary problem)
	No problem symptoms exist		The problem occurred in the diagnostic circuit in the past
Normal Code Display	Problem symptoms exist	Normal code is displayed	The problem is still occurring in a place other than in the diagnostic circuit
	No problem symptoms exist	Normal code is displayed	The problem occurred in a place other than in the diagnostic circuit in the past

Taking into account the above points, a flow chart showing how to proceed with troubleshooting using the diagnostic trouble code check is shown below. This flow chart shows how to utilize the diagnostic trouble code check effectively, then by carefully checking the results, indicates how to proceed either to diagnostic trouble code troubleshooting or to troubleshooting of problem symptoms.

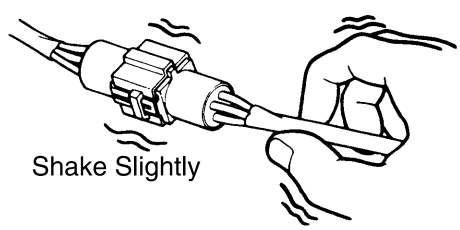
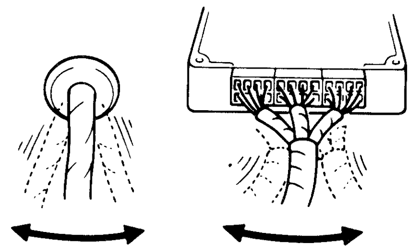
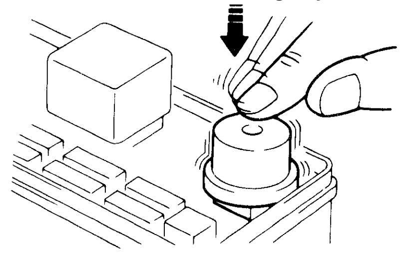


3. SYMPTOM SIMULATION

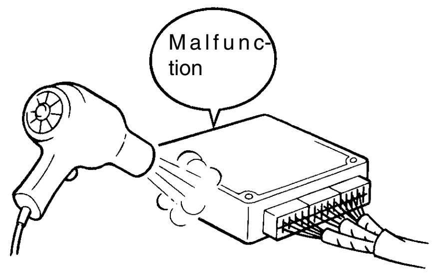
The most difficult case in troubleshooting is when there are no problem symptoms occurring. In such cases, a thorough customer problem analysis must be carried out, then simulate the same or similar conditions and environment in which the problem occurred in the customer's vehicle. No matter how much experience a technician has, or how skilled he may be, if he proceeds to troubleshoot without confirming the problem symptoms he will tend to overlook something important in the repair operation and make a wrong guess somewhere, which will only lead to a standstill. For example, for a problem which only occurs when the engine is cold, or for a problem which occurs due to vibration caused by the road during driving, etc., the problem can never be determined so long as the symptoms are confirmed with the engine hot condition or the vehicle at a standstill. Since vibration, heat or water penetration (moisture) is likely cause for problem which is difficult to reproduce, the symptom simulation tests introduced here are effective measures in that the external causes are applied to the vehicle in a stopped condition.

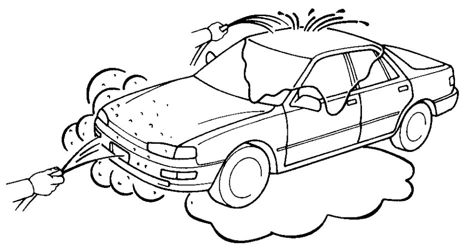
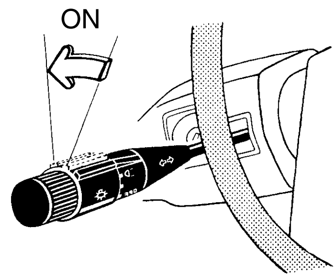
Important Points in the Symptom Simulation Test:

In the symptom simulation test, the problem symptoms should of course be confirmed, but the problem area or parts must also be found out. To do this, narrow down the possible problem circuits according to the symptoms before starting this test and connect a tester beforehand. After that, carry out the symptom simulation test, judging whether the circuit being tested is defective or normal and also confirming the problem symptoms at the same time. Refer to the problem symptoms table for each system to narrow down the possible causes of the symptom.

1	**VIBRATION METHOD: When vibration seems to be the major cause.**
CONNECTORS Slightly shake the connector vertically and horizontally. **WIRE HARNESS** Slightly shake the wire harness vertically and horizontally. The connector joint, fulcrum of the vibration, and body through portion are the major areas to be checked thoroughly.	  FI2331 FI2332
PARTS AND SENSOR Apply slight vibration with a finger to the part of the sensor considered to be the problem cause and check that the malfunction occurs. HINT: Applying strong vibration to relays may result in open relays.	 FI2330

V07268

<table>
<tr><td>2</td><td colspan="2">HEAT METHOD: When the problem seems to occur when the suspect area is heated.</td></tr>
<tr><td colspan="2">Heat the component that is the likely cause of the malfunction with a hair dryer or similar object. Check to see if the malfunction occurs.
NOTICE:
(1) Do not heat to more than 60°C (140°F). (Temperature is limited not to damage the components.)
(2) Do not apply heat directly to parts in the ECU.</td><td>

FI2334</td></tr>
<tr><td>3</td><td colspan="2">WATER SPRINKLING METHOD: When the malfunction seems to occur on a rainy day or in a high–humidity condition.</td></tr>
<tr><td colspan="2">Sprinkle water onto the vehicle and check to see if the malfunction occurs.
NOTICE:
(1) Never sprinkle water directly into the engine compartment, but indirectly change the temperature and humidity by applying water spray onto the radiator front surface.
(2) Never apply water directly onto the electronic components.
HINT:
If a vehicle is subject to water leakage, the leaked water may contaminate the ECU. When testing a vehicle with a water leakage problem, special caution must be taken.</td><td>
FI6649</td></tr>
<tr><td>4</td><td colspan="2">OTHER: When a malfunction seems to occur when electrical load is excessive.</td></tr>
<tr><td colspan="2">Turn on all electrical loads including the heater blower, head lights, rear window defogger, etc. and check to see if the malfunction occurs.</td><td>

FI2336</td></tr>
</table>

V07469

4. DIAGNOSTIC TROUBLE CODE CHART

The inspection procedure is shown in the table below. This table permits efficient and accurate troubleshooting using the diagnostic trouble codes displayed in the diagnostic trouble code check. Proceed with troubleshooting in accordance with the inspection procedure given in the diagnostic chart corresponding to the diagnostic trouble codes displayed. The engine diagnostic trouble code chart is shown below as an example.

- DTC No.
  Indicates the diagnostic trouble code.
- Page or Instructions
  Indicates the page where the inspection procedure for each circuit is to be found, or gives instructions for checking and repairs.

- Trouble Area
  Indicates the suspect area of the problem.

- Detection Item
  Indicates the system of the problem or contents of the problem.

DIAGNOSTIC TROUBLE CODE CHART

HINT:
Parameters listed in the chart may not be exactly the same as your reading due to the type of instrument or other factors.
If a malfunction code is displayed during the DTC check in check (test) mode, check the circuit for that code listed in the table below. For details of each code, turn to the page referred to under the ”See page” for the respective ”DTC No.” in the DTC chart.

DTC No. (See page)	Detection Item	Trouble Area	*1 Check Engine Warming Light Normal Mode/ Test Node	*2 Memory
12 (DI – 12)	Crankshaft Position Sensor Circuit Malfunction	● Open or short in crankshaft position sensor circuit ● Crankshaft position sensor ● Engine ECU	ON / N.A	○
13 (DI – 28)	Engine Speed Sensor Circuit Malfunction	● Open or short in engine speed sensor circuit ● Engine speed sensor ● Engine ECU	ON / N.A	○
15 (DI – 32)	Diesel Throttle Control Circuit Malfunction	● Open or short in E–VRV for main actuator circuit ● E–VRV for main actuator ● Diesel throttle position sensor circuit ● Diesel throttle position sensor ● Main actuator ● Vacuum hose disconnected or blocked ● Engine ECU	ON / N.A	○
	Interior IC Malfunction	● Engine ECU		

5. PROBLEM SYMPTOMS TABLE

The suspect circuits or parts for each problem symptom are shown in the table below. Use this table to troubleshoot the problem when a ”Normal” code is displayed in the diagnostic trouble code check but the problem is still occurring. Numbers in the table indicate the inspection order in which the circuits or parts should be checked.

HINT:

When the problem is not detected by the diagnostic system even though the problem symptom is present, it is considered that the problem is occurring outside the detection range of the diagnostic system, or that the problem is occurring in a system other than the diagnostic system.

- Page
  Indicates the page where the flow chart for each circuit is located.
- Circuit Inspection, Inspection Order
  Indicates the circuit which needs to be checked for each problem symptom. Check in the order indicated by the numbers.
- Problem Symptom
- Circuit or Part Name
  Indicates the circuit or part which needs to be checked.

PROBLEM SYMPTOMS TABLE

Symptom	Suspect Area	See page
Engine does not crank (Does not start)	1. Starter 2. Starter relay	ST–3 ST–14
No initial combustion (Does not start)	1. ECU power source circuit 2. Pre–heating system 3. Compression 4. Engine ECU	DI–93 ST–1 EM–2 IN–20
Cold engine (Difficult to start)	1. Pre–heating system 2. Starter signal circuit 3. Water temperature sensor 4. Injector 5. Fuel filter 6. Diesel throttle body 7. Engine ECU	ST–1 DI–115 ED–10 FU–1 DI–26 IN–20
	1. Starter signal circuit 2. Injector 3. Fuel filter 4. Diesel throttle body 7 Engine ECU	DI–115
	1. Fuel filter 2. Diesel throttle body 3 Engine ECU	

6. CIRCUIT INSPECTION

How to read and use each page is shown below.

● Diagnostic Trouble Code No. and Detection Item

● Circuit Description
The major role and operation, etc. of the circuit and its component parts are explained.

DTC	12	Crankshaft Position Sensor Circuit Malfunction

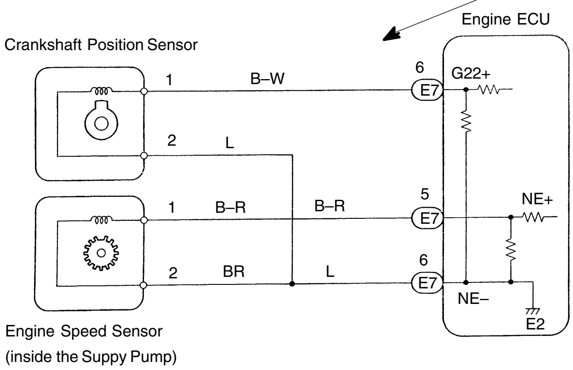
CIRCUIT DESCRIPTION

The crankshaft position sensor in the Engine Control System contains signal plate and a pickup coil for TDC signal. The TDC signal plate has 1 tooth on its outer circumference. The TDC signal sensor generates 1 signal for every engine revolution. The engine ECU detects the top dead center by the TDC signals. The NE signal plate has 52 teeth and is mounted in the supply pump. The NE signal sensor generates 52 signals of engine 2 revolutions. The engine ECU detects the engine speed and cam lift position of the supply pump. The engine ECU uses TDC signal and NE signals for injection control. And NE signal is used for injection volume control, also.

DTC No.	DTC Detecting Condition	Trouble Area
12	No TDC signal to engine ECU at 500 rpm or more	● Open or short in crankshaft position sensor circuit ● Crankshaft position sensor ● Engine ECU

● Indicates the diagnostic trouble code, diagnostic trouble code set parameter and suspect area of the problem.

WIRING DIAGRAM



● Wiring Diagram
This shows a wiring diagram of the circuit.
Use this diagram together with ELECTRICAL WIRING DIAGRAM to thoroughly understand the circuit.
Wire colors are indicated by an alphabetical code.
B = Black, L = Blue, R = Red, BR = Brown,
LG = Light Green, V = Violet, G = Green,
O = Orange, W = White, GR = Gray, P = Pink,
Y = Yellow
The first letter indicates the basic wire color and the second letter indicates the color of the stripe.

B02134

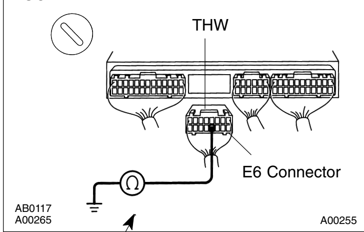
- Indicates the position of the ignition switch during the check.

LOCK Ignition Switch LOCK (OFF)
ON Ignition Switch ON
START Ignition Switch START
ACC Ignition Switch ACC

- Inspection Procedure
Use the inspection procedure to determine if the circuit is normal or abnormal, and if it is abnormal, use it to determine whether the problem is located in the sensors, actuators, wire harness or ECU.

INSPECTION PROCEDURE

1	Check continuity between terminal THW of ECU connector and body ground.



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E6 connector of ECU.

CHECK:
Measure resistance between terminal THW of ECU connector and body ground.

OK:
Resistance: 1 MΩ or higher

OK → **Go to step 3.**

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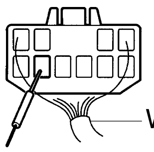
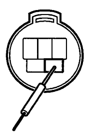
2	Check water temp. sensor (See page ED–10).

OK → **Replace water temp. sensor.**

- Indicates the place to check the voltage or resistance.
- Indicates the connector position to be checked, from the front or back side.

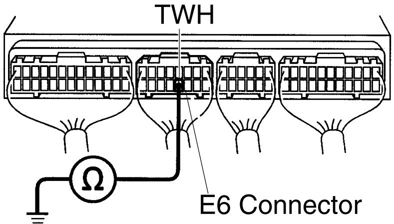


Check from the connector back side. (with harness)

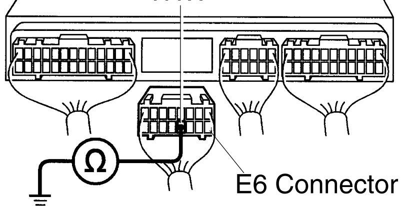


Check from the connector front side. (without harness)
In this case, care must be taken not to bend the terminals.

- Indicates the condition of the connector of ECU during the check.



Connector being checked is connected.



Connector being checked is disconnected.

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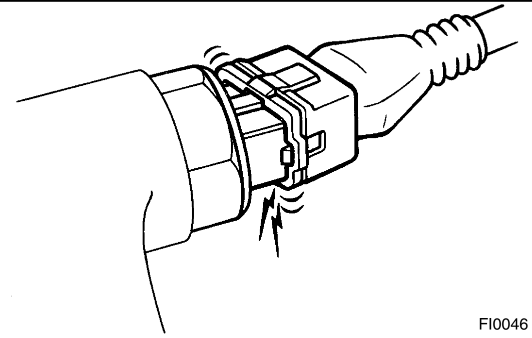
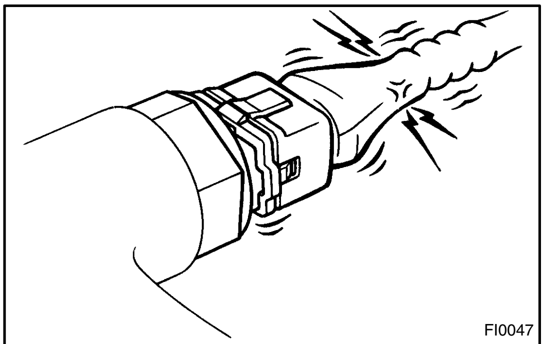
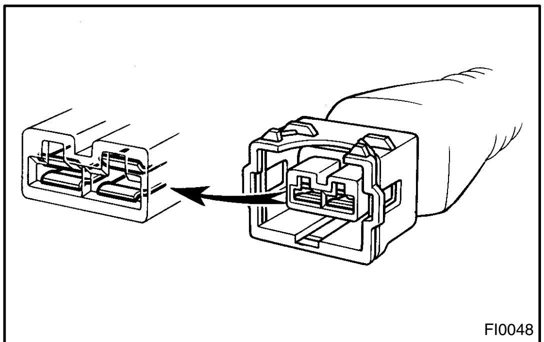
IN052–03


FI0046


FI0047


FI0048

HOW TO USE THE DIAGNOSTIC CHART AND INSPECTION PROCEDURE

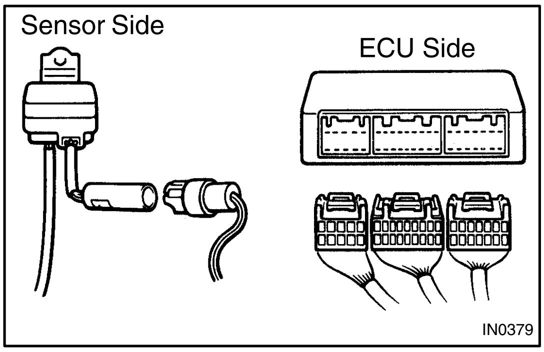
1. CONNECTOR CONNECTION AND TERMINAL INSPECTION

- For troubleshooting, diagnostic trouble code charts or problem symptom charts are provided for each circuit with detailed inspection procedures on the following pages.
- When all the component parts, wire harnesses and connectors of each circuit except the ECU are found to be normal in troubleshooting, then it is determined that the problem is in the ECU. Accordingly, if diagnosis is performed without the problem symptoms occurring, refer to step 8 to replace the ECU, even if the problem is not in the ECU. So always confirm that the problem symptoms are occurring, or proceed with inspection while using the symptom simulation method.
- The instructions ”Check wire harness and connector” and ”Check and replace ECU” which appear in the inspection procedure, are common and applicable to all diagnostic trouble codes. Follow the procedure outlined below whenever these instructions appear.

OPEN CIRCUIT:
This could be due to a disconnected wire harness, faulty contact in the connector, and a connector terminal pulled out, etc.
HINT:

- It is rarely the case that a wire is broken in the middle of it. Most cases occur at the connector. In particular, carefully check the connectors of sensors and actuators.
- Faulty contact could be due to rusting of the connector terminals, to foreign materials entering terminals or a deformation of connector terminals. Simply disconnecting and reconnecting the connectors once changes the condition of the connection and may result in a return to normal operation. Therefore, in troubleshooting, if no abnormality is found in the wire harness and connector check, but the problem disappears after the check, then the cause is considered to be in the wire harness or connectors.

SHORT CIRCUIT:
This could be due to a contact between wire harness and the body ground or to a short circuit occurred inside the switch, etc.
HINT:
When there is a short circuit between the wire harness and body ground, check thoroughly whether the wire harness is caught in the body or is clamped properly.



2. CONTINUITY CHECK (OPEN CIRCUIT CHECK)

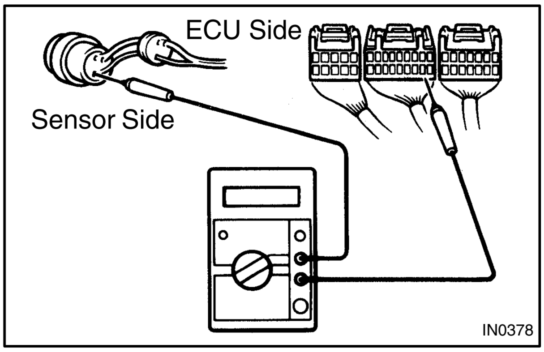
(a) Disconnect the connectors at both ECU and sensor sides.

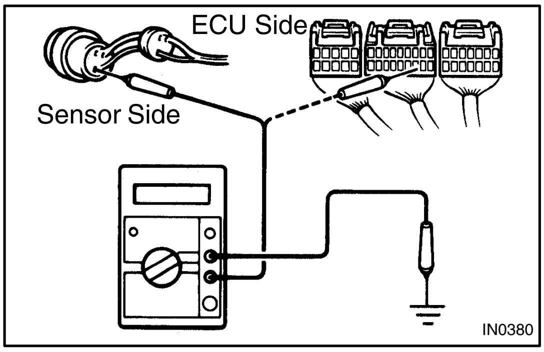
(b) Measure the resistance between the applicable terminals of the connectors.

Resistance: 1Ω or less

HINT:

- Measure the resistance while lightly shaking the wire harness vertically and horizontally.
- When tester probes are inserted into a connector, insert the probes from the back. For waterproof connectors in which the probes cannot be inserted from the back, be careful not to bend the terminals when inserting the tester probes.





3. RESISTANCE CHECK (SHORT CIRCUIT CHECK)

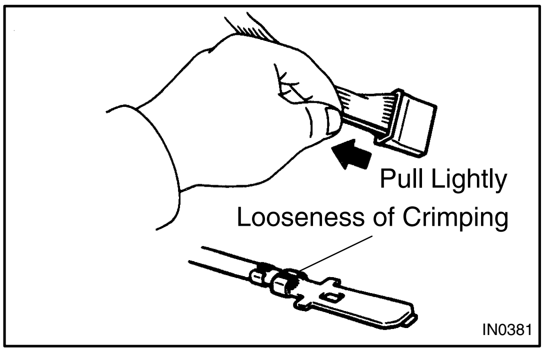
(a) Disconnect the connectors on both ends.

(b) Measure the resistance between the applicable terminals of the connectors and body ground. Be sure to carry out this check on the connectors on both ends.

Resistance: 1 MΩ or higher

HINT:

Measure the resistance while lightly shaking the wire harness vertically and horizontally.



4. VISUAL CHECK AND CONTACT PRESSURE CHECK

(a) Disconnect the connectors at both ends.

(b) Check for rust or foreign material, etc. in the terminals of the connectors.

(c) Check crimped portions for looseness or damage and check that the terminals are secured in lock portion.

HINT:

The terminals should not come out when pulled lightly.

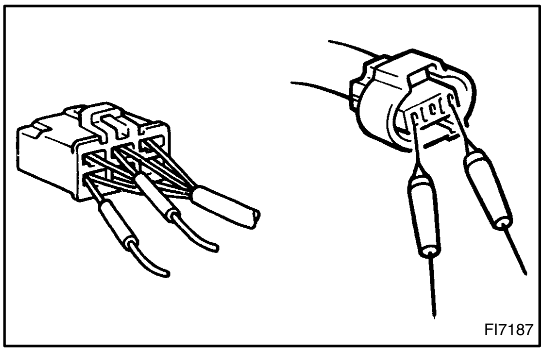
(d) Prepare a test male terminal and insert it in the female terminal, then pull it out.

NOTICE:

When testing a gold–plated female terminal, always use a gold–plated male terminal.

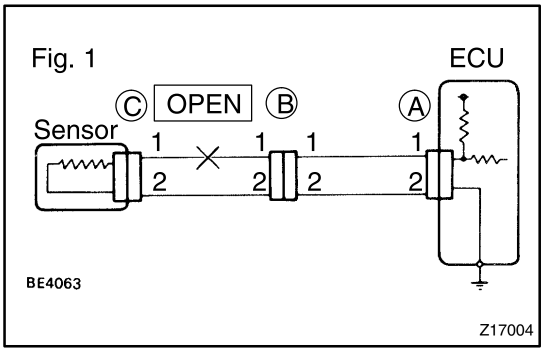
HINT:

When the test terminal is pulled out more easily than others, there may be poor contact in that section.



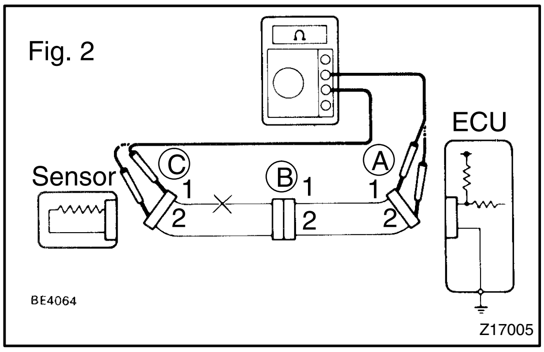
5. CONNECTOR HANDLING

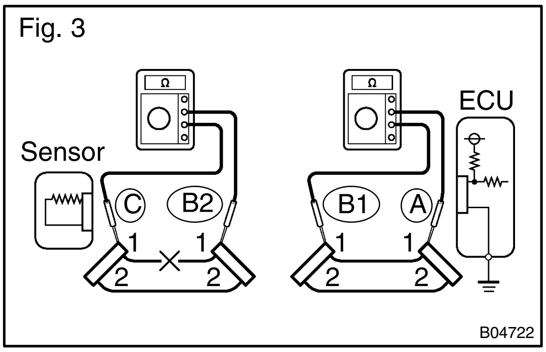
When inserting tester probes into a connector, insert them from the rear of the connector. When necessary, use mini test leads. For water resistant connectors which cannot be accessed from behind, take good care not to deform the connector terminals.



6. CHECK OPEN CIRCUIT

For the open circuit in the wire harness in Fig. 1, perform ”(a) Continuity Check” or ”(b) Voltage Check” to locate the section.

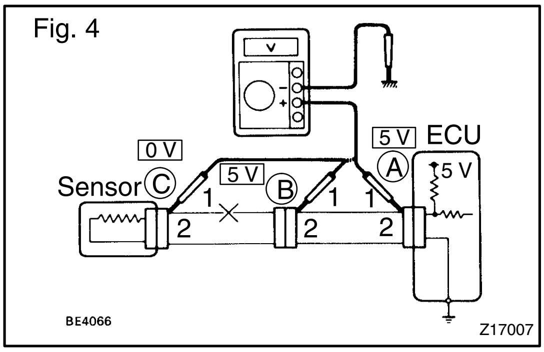




(a) Check the continuity.

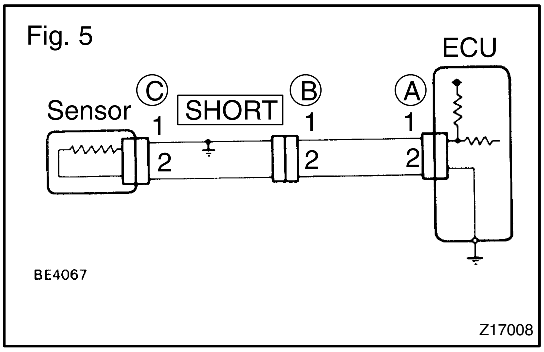
(1) Disconnect connectors ”A” and ”C” and measure the resistance between them.
In the case of Fig. 2,
Between terminal 1 of connector ”A” and terminal 1 of connector ”C” → No continuity (open)
Between terminal 2 of connector ”A” and terminal 2 of connector ”C” → Continuity
Therefore, it is found out that there is an open circuit between terminal 1 of connector ”A” and terminal 1 of connector ”C”.

(2) Disconnect connector ”B” and measure the resistance between the connectors.
In the case of Fig. 3,
Between terminal 1 of connector ”A” and terminal 1 of connector ”B1” → Continuity
Between terminal 1 of connector ”B2” and terminal 1 of connector ”C” → No continuity (open)
Therefore, it is found out that there is an open circuit between terminal 1 of connector ”B2” and terminal 1 of connector ”C”.



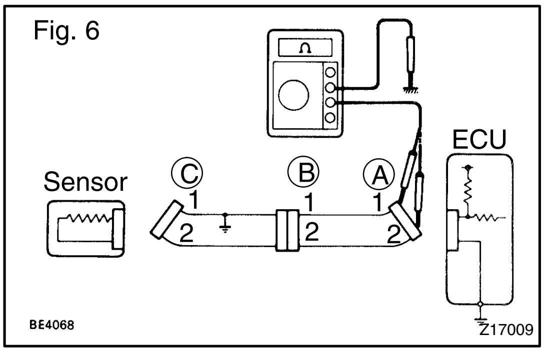
(b) Check the voltage.
In a circuit in which voltage is applied (to the ECU connector terminal), an open circuit can be checked for by conducting a voltage check.
As shown in Fig. 4, with each connector still connected, measure the voltage between body ground and terminal 1 of connector ”A” at the ECU 5V output terminal, terminal 1 of connector ”B”, and terminal 1 of connector ”C”, in that order.

If the results are:
5V: Between Terminal 1 of connector ”A” and Body Ground
5V: Between Terminal 1 of connector ”B” and Body Ground
0V: Between Terminal 1 of connector ”C” and Body Ground
Then it is found out that there is an open circuit in the wire harness between terminal 1 of ”B” and terminal 1 of ”C”.



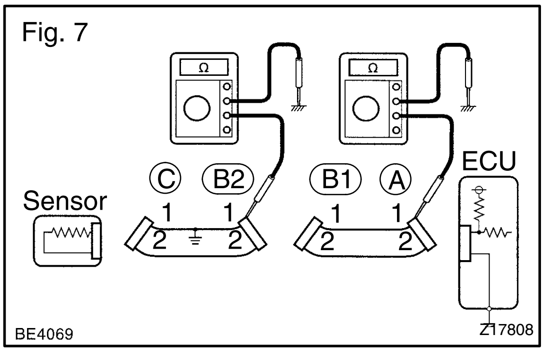
7. CHECK SHORT CIRCUIT

If the wire harness is ground shorted as in Fig. 5, locate the section by conducting a ”continuity check with ground”.



Check the continuity with ground.

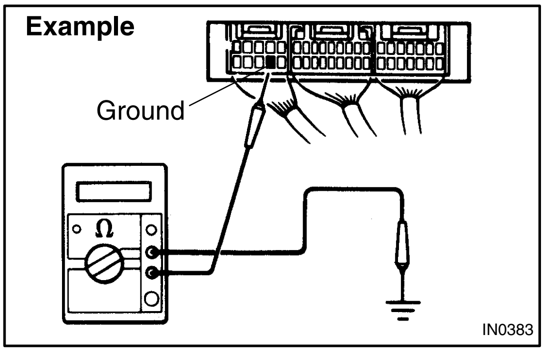
(1) Disconnect connectors ”A” and ”C” and measure the resistance between terminal 1 and 2 of connector ”A” and body ground.
In the case of Fig. 6
Between terminal 1 of connector ”A” and body ground → Continuity (short)
Between terminal 2 of connector ”A” and body ground → No continuity
Therefore, it is found out that there is a short circuit between terminal 1 of connector ”A” and terminal 1 of connector ”C”.



(2) Disconnect connector "B" and measure the resistance between terminal 1 of connector "A" and body ground, and terminal 1 of connector "B2" and body ground.
Between terminal 1 of connector "A" and body ground → No continuity
Between terminal 1 of connector "B2" and body ground → Continuity (short)
Therefore, it is found out that there is a short circuit between terminal 1 of connector "B2" and terminal 1 of connector "C".

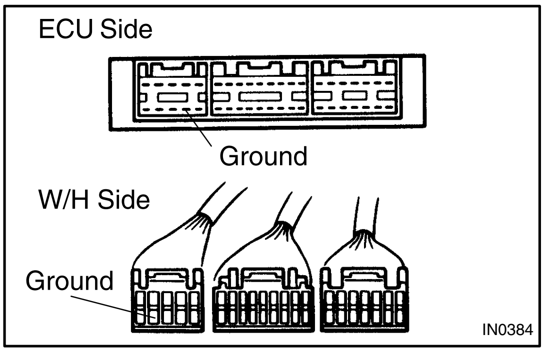
8. CHECK AND REPLACE ECU

First check the ECU ground circuit. If it is faulty, repair it. If it is normal, the ECU could be faulty, so replace the ECU with a normal functioning one and check that the symptoms appear.



(1) Measure the resistance between the ECU ground terminal and the body ground.

Resistance: 1 Ω or less



(2) Disconnect the ECU connector, check the ground terminals on the ECU side and the wire harness side for bend and check the contact pressure.

TERMS

ABBREVIATIONS USED IN THIS MANUAL

IN00S–13

Abbreviations	Meaning
A/C	Air Conditioning
AC	Alternating Current
ACC	Accessory
ACIS	Acoustic Control Induction System
ACSD	Automatic Cold Start Device
ALT	Alternator
AMP	Amplifier
APROX.	Approximately
A/T	Automatic Transmission (Transaxle)
BACS	Boost Altitude Compensation System
BAT	Battery
BTDC	Before Top Dead Center
BVSV	Bimetallic Vacuum Switching Valve
CB	Circuit Breaker
CCO	Catalytic Converter for Oxidation
DC	Direct Current
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
ECD	Electronic Control Diesel
ECT	Electronic Control Transmission
ECU	Electronic Control Unit
EDU	Electronic Driving Unit
EFI	Electronic Fuel Injection
E/G	Engine
EGR	Exhaust Gas Recirculation
EVAP	Evaporative Emission Control
E–VRV	Electronic Vacuum Regulating Valve
EX	Exhaust
FIPG	Formed In Place Gasket
FL	Fusible Link
Fr	Front
GND	Ground
HAC	High Altitude Compensator
IG	Ignition
IIA	Integrated Ignition Assembly
IN	Intake
ISC	Idle Speed Control
J/B	Junction Block
J/C	Junction Connector
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LH	Left–Hand

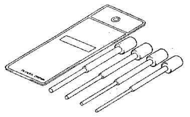
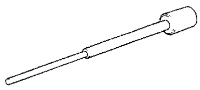
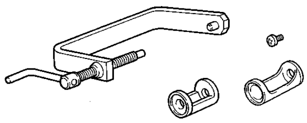
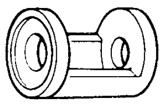
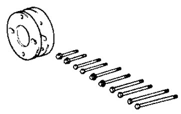
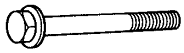
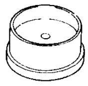
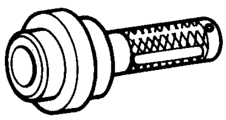
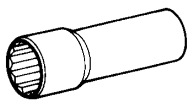
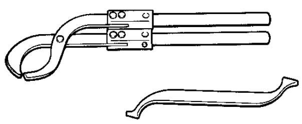
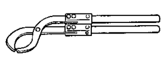
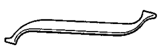
LHD	Left–Hand Drive
LO	Low
MAP	Manifold Absolute Pressure
MAX.	Maximum
MIL	Malfunction Indicator Lamp
MIN.	Minimum
MP	Multipurpose
M/T	Manual Transmission
N	Neutral
O2S	Oxygen Sensor
O/D	Overdrive
O/S	Oversize
PKB	Parking Brake
PS	Power Steering
RAM	Random Access Memory
R/B	Relay Block
RH	Right–Hand
RHD	Right–Hand Drive
ROM	Read Only Memory
Rr	Rear
SICS	Starting Injection Control System
SPEC	Specification
SSM	Special Service Materials
SST	Special Service Tools
STD	Standard
SW	Switch
TACH	Tachometer
TDC	Top Dead Center
TEMP.	Temperature
TM	Transmission
TMC	TOYOTA Motor Corporation
TWC	Three–Way Catalyst
U/D	Underdrive
VCV	Vacuum Control Valve
VIN	Vehicle Identification Number
VSV	Vacuum Switching Valve
w/	With
W/H	Wire Harness
w/o	Without
WU–TWC	Warm Up Three–Way Catalytic Converter
2WD	Two Wheel Drive Vehicle (4x2)
4WD	For Wheel Drive Vehicle (4x4)

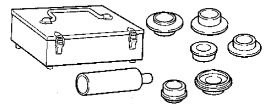
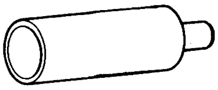
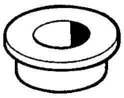
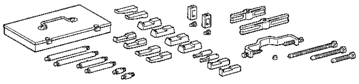
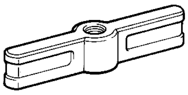
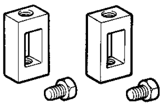
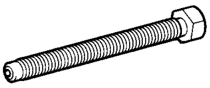
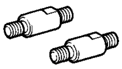
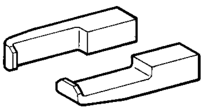
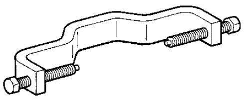
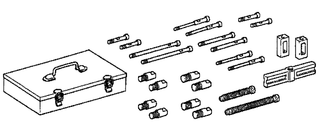
PREPARATION

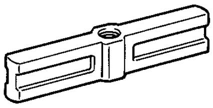
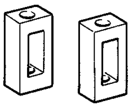
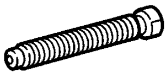
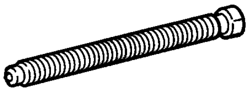
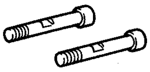
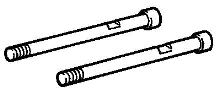
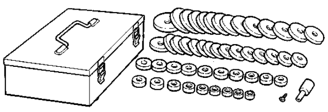
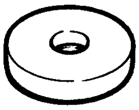
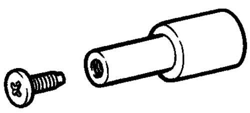
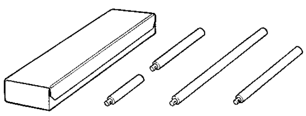
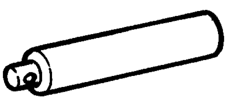
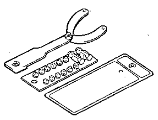
ENGINE MECHANICAL

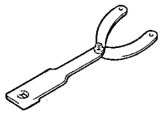
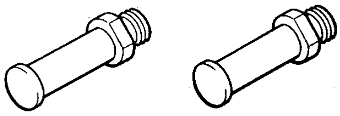
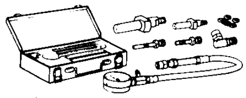
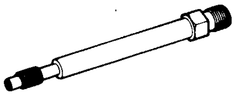
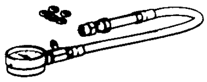
SST (Special Service Tools)

PP27K–01

	09201–10000	Valve Guide Bushing Remover & Replacer Set	
	(09201–01060)	Valve Guide Bushing Remover & Replacer 6	
	09202–70020	Valve Spring Compressor	
	(09202–00010)	Attachment	
	09213–54015	Crankshaft Pulley Holding Tool	
	(91651–60855)	Bolt	
	09223–15030	Oil Seal & Bearing Replacer	Crankshaft rear oil seal
	09223–46011	Crankshaft Front Oil Seal Replacer	Crankshaft timing pulley Camshaft oil seal
	09229–55010	Oil Cooler Relief Valve Wrench	
	09248–55050	Valve Clearance Adjust Tool Set	
	(09248–05510)	Valve Lifter Press	
	(09248–05520)	Valve Lifter Stopper	

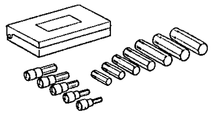
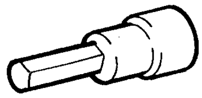
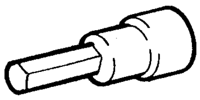
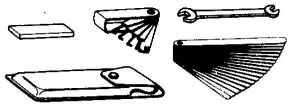
	09316–60011	Transmission & Transfer Bearing Replacer	
	(09316–00011)	Replacer Pipe	Crankshaft front oil seal
	(09316–00021)	Replacer ”A”	Crankshaft front oil seal
	09330–00021	Companion Flange Holding Tool	Crankshaft pulley
	09950–40011	Puller B Set	
	(09951–04010)	Hanger 150	Camshaft timing pulley
	(09952–04010)	Slide Arm	Camshaft timing pulley
	(09953–04020)	Center Bolt 150	Camshaft timing pulley
	(09954–04010)	Arm 25	Camshaft timing pulley
	(09955–04071)	Claw No.7	Camshaft timing pulley
	(09957–04010)	Attachment	Camshaft timing pulley
	(09958–04011)	Holder	Camshaft timing pulley
	09950–50012	Puller C Set	

	(09951–05010)	Hanger 150	Crankshaft pulley Supply pump drive pulley Crankshaft timing pulley
	(09952–05010)	Slide Arm	Crankshaft pulley Supply pump drive pulley Crankshaft timing pulley
	(09953–05010)	Center Bolt 100	Crankshaft pulley Supply pump drive pulley Crankshaft timing pulley
	(09953–05020)	Center Bolt 150	Crankshaft pulley Supply pump drive pulley Crankshaft timing pulley
	(09954–05020)	Claw No.2	Supply pump drive pulley Crankshaft timing pulley
	(09954–05030)	Claw No.3	Crankshaft pulley
	09950–60010	Replacer Set	
	(09951–00280)	Replacer 28	Nozzle holder gasket
	(09951–00500)	Replacer 50	Nozzle holder gasket
	(09952–06010)	Adapter	Nozzle holder gasket
	09950–70010	Handle Set	
	(09951–07100)	Handle 100	Valve guide bushing Nozzle holder gasket Crankshaft rear oil seal
	09960–10010	Variable Pin Wrench Set	

	(09962–01000)	Variable Pin Wrench Arm Assy	
	(09963–01000)	Pin 10	Camshaft timing pulley Supply pump drive pulley
	09992–00025	Cylinder Compression Check Gauge Set	
	(09992–00121)	No. 4 Attachment	
	(09992–00211)	Gauge Assy	

PP27L–01

RECOMMENDED TOOLS

	09040–00011	Hexagon Wrench Set .	
	(09043–20060)	Socket Hexagon Wrench 6.	Cylinder block oil orifice
	(09043–20080)	Socket Hexagon Wrench 8.	No.1 idler pulley bolt Oil jet pressure valve
	09200–00010	Engine Adjust Kit .	

PP12U–02

EQUIPMENT

Abrasive compound	
Caliper gauge	
Connecting rod aligner	
Cylinder gauge	
Dial indicator	
Dye penetrant	
Groove cleaning tool	
Heater	
Magnetic finger	
Micrometer	
Piston ring compressor	
Piston ring expander	
Plastic–faced hammer	
Plastigage	
Precision straight edge	
Press	
Ridge reamer	
Soft brush	
Spring tester	Valve spring
Steel square	
Thermometer	Valve spring
Torque wrench	
Valve seat cutter	
V–block	
Vernier calipers	
Wire brush	

PP27M–01

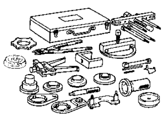
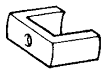
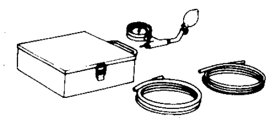
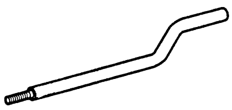
SSM (Special Service Materials)

08826–00080	Seal Packing Black or equivalent (FIPG)	Timing belt cover No.5 camshaft bearing cap Camshaft oil seal retainer Cylinder head semi–circular plug Cylinder head Rear oil seal retainer
08826–00100	Seal Packing 1282B, THREE BOND 1282B or equivalent (FIPG)	Engine coolant drain union
08833–00070	Adhesive 1324, THREE BOND 1324 or equivalent	Rear oil seal retainer stud bolt Drive plate bolt

TURBOCHARGING

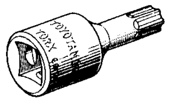
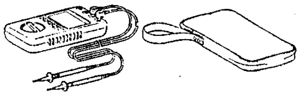
SST (Special Service Tools)

PP283–01

	09350–32014	TOYOTA Automatic Transmission Tool Set	
	(09351–32070)	No.2 Piston Spring Compressor	Bearing housing
	09992–00242	Turbocharger Pressure Gauge	
	09992–00600	Crank Type Spindle	

PP27N–01

RECOMMENDED TOOLS

	09042–00010	Torx Socket T30 .	Actuator
	09082–00040	TOYOTA Electrical Tester.	

PP12Y–02

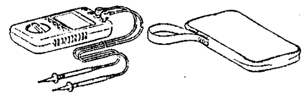
EQUIPMENT

Dial indicator	
Protractor	
Steel square	
Torque wrench	

EMISSION CONTROL

RECOMMENDED TOOLS

PP287–01

	09082–00040	TOYOTA Electrical Tester.	

PP288–01

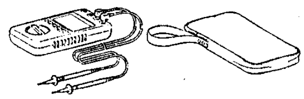
EQUIPMENT

MITYVAC (Hand–held vacuum tester	
Torque wrench	
Vacuum gauge	

ELECTRONIC CONTROL DIESEL

RECOMMENDED TOOLS

PP289–01

	09082–00040 TOYOTA Electrical Tester.	

EQUIPMENT

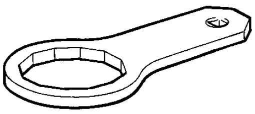
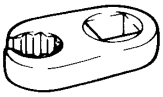
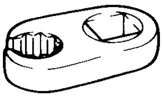
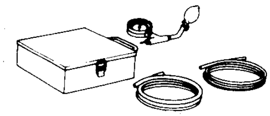
PP28A–01

19 mm deep socket wrench	
22 mm deep socket wrench	
OBD II scan tool	
Torque wrench	
Vacuum gauge	

ENGINE FUEL

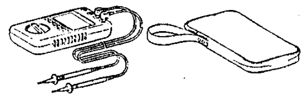
PP28B–01

SST (Special Service Tools)

	09228–64030	Fuel Filter Wrench	
	09023–12700	Union Nut Wrench 17mm	
	09023–12900	Union Nut Wrench 19mm	
	09992–00242	Turbocharger Pressure Gauge	

PP28C–01

RECOMMENDED TOOLS

	09082–00040 TOYOTA Electrical Tester.	

PP28D–01

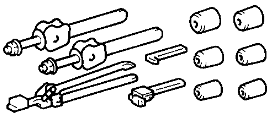
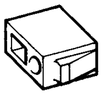
EQUIPMENT

Torque wrench	
OBD II scan tool	

COOLING

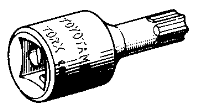
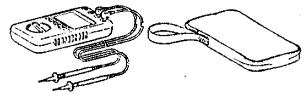
SST (Special Service Tools)

PP136–02

	09230–01010	Radiator Service Tool Set	
	09231–14010	Punch	

PP27O–01

RECOMMENDED TOOLS

	09042–00030	Torx Socket T20 .	No.1 cooling fan motor
	09082–00040	TOYOTA Electrical Tester.	

PP138–02

EQUIPMENT

Heater	
Radiator cap tester	
Thermometer	
Torque wrench	
Vernier calipers	

PP139–02

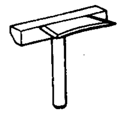
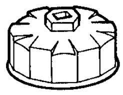
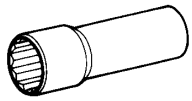
COOLANT

Item	Capacity	Classification
Engine coolant		”Toyota Long Life Coolant” or equivalent
w/ Power heater	7.1 liters (7.5 US qts, 6.3 Imp. qts)	
w/o Power heater	6.9 liters (7.3 US qts, 6.1 Imp. qts)	

LUBRICATION

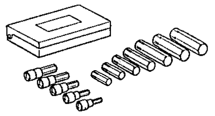
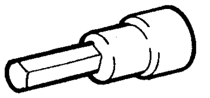
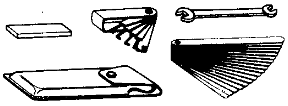
PP13A–02

SST (Special Service Tools)

	09032–00100	Oil Pan Seal Cutter	
	09228–10002	Oil Filter Wrench	
	09229–55010	Oil Cooler Relief Valve Wrench	

PP27P–01

RECOMMENDED TOOLS

	09040–00011	Hexagon Wrench Set .	
	(09043–20080)	Socket Hexagon Wrench 8.	Oil jet pressure valve
	09200–00010	Engine Adjust Kit .	

EQUIPMENT

PP13C–02

Oil pressure switch	
Torque wrench	

PP13D–02

LUBRICANT

Item	Capacity	Classification
Engine oil		API grade CF–4 (You may also use API CF or CE or CD)
Dry fill	6.5 liters (6.9 US qts, 5.7 Imp. qts)	
Drain and refill		
w/ Oil filter change	6.4 liters (6.8 US qts, 5.6 Imp. qts)	
w/o Oil filter change	5.4 liters (5.7 US qts, 4.8 Imp. qts)	

PP27Q–01

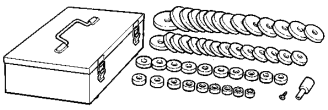
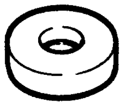
SSM (Special Service Materials)

08826–00080	Seal Packing Black or equivalent (FIPG)	Oil pump No.1 oil pan No.2 oil pan
08833–00070	Adhesive 1324, THREE BOND 1324 or equivalent	Oil pump stud bolt
08833–00080	Adhesive 1344 THREE BOND 1344 LOCTITE 242 or equivalent	Oil pressure switch

STARTING

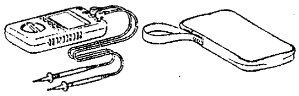
SST (Special Service Tools)

PP27R–01

	09950–60010	Replacer Set	
	(09951–00340)	Replacer 34	Brush holder

PP27S–01

RECOMMENDED TOOLS

	09082–00040	TOYOTA Electrical Tester.	

PP1MU–03

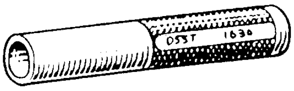
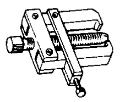
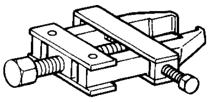
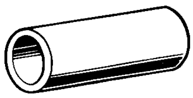
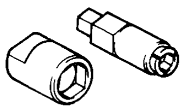
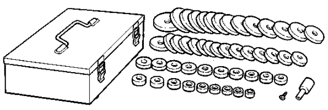
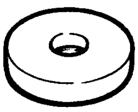
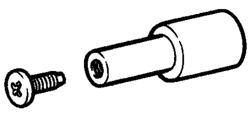
EQUIPMENT

Dial indicator	Commutator
Feeler gauge	
Sandpaper	Commutator
Vernier calipers	Commutator, Brush
Torque wrench	
V–block	
Vise	

CHARGING

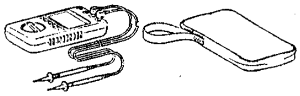
SST (Special Service Tools)

PP27E–01

	09285–76010	Injection Pump Camshaft Bearing Cone Replacer	Rotor rear bearing cover
	09286–46011	Injection Pump Spline Shaft Puller	Rectifier end frame
	09820–00021	Alternator Rear Bearing Puller	
	09820–00030	Alternator Rear Bearing Replacer	
	09820–63010	Alternator Pulley Set Nut Wrench Set	
	09950–60010	Replacer Set	Rotor front bearing
	(09951–00230)	Replacer 23	
	(09951–00500)	Replacer 50	
	(09952–06010)	Adapter	

PP1TH–03

RECOMMENDED TOOLS

 09082–00040	TOYOTA Electrical Tester.		

PP1TI–03

EQUIPMENT

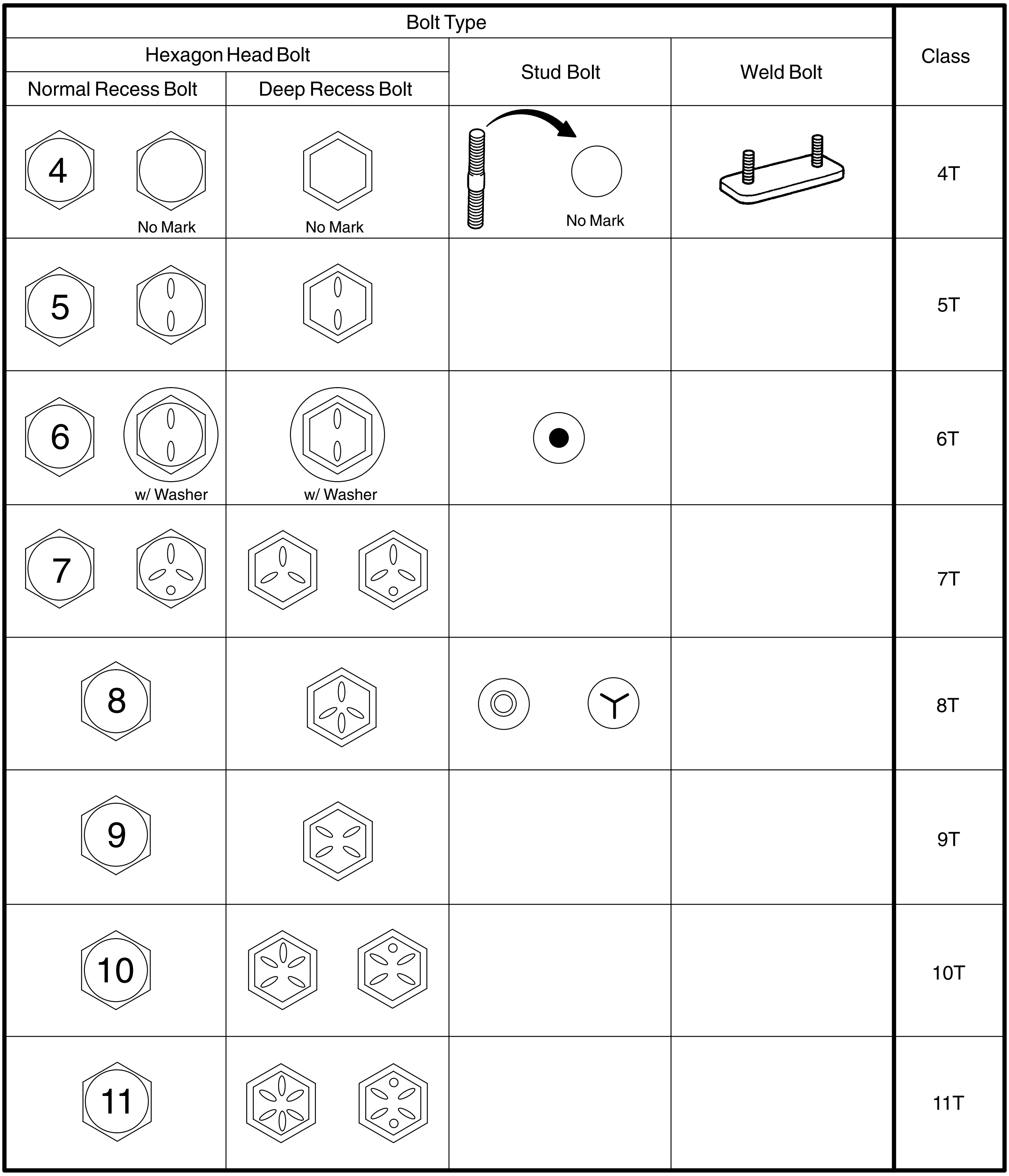
Ammeter(A)	
Battery specific gravity gauge	Except maintenance–free battery
Torque wrench	
Vernier calipers	Rotor (Slip ring)
Plastic hammer	
Belt Tension gauge	

SERVICE SPECIFICATIONS

STANDARD BOLT

HOW TO DETERMINE BOLT STRENGTH

SS0ZS–01



Bolt Type				Class
Hexagon Head Bolt		Stud Bolt	Weld Bolt	
Normal Recess Bolt	Deep Recess Bolt			
4 No Mark	No Mark	No Mark		4T
5				5T
6 w/ Washer	w/ Washer			6T
7				7T
8				8T
9				9T
10				10T
11				11T

B06431

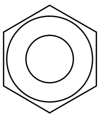
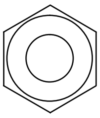
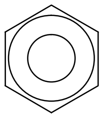
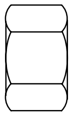
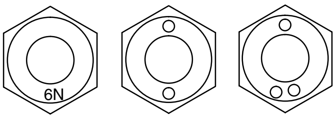
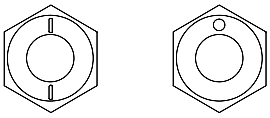
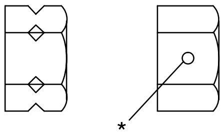
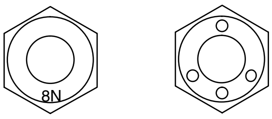
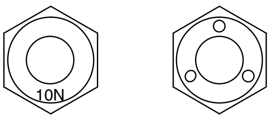
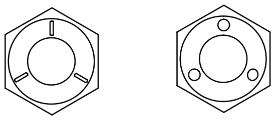
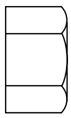
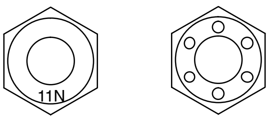
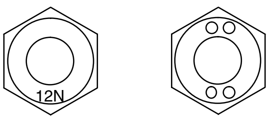
SS0ZT–01

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Diameter mm	Pitch mm	Specified torque					
			Hexagon head bolt			Hexagon flange bolt		
			N·m	kgf·cm	ft·lbf	N·m	kgf·cm	ft·lbf
4T	6	1	5	55	48 in.·lbf	6	60	52 in.·lbf
	8	1.25	12.5	130	9	14	145	10
	10	1.25	26	260	19	29	290	21
	12	1.25	47	480	35	53	540	39
	14	1.5	74	760	55	84	850	61
	16	1.5	115	1,150	83	–	–	–
5T	6	1	6.5	65	56 in.·lbf	7.5	75	65 in.·lbf
	8	1.25	15.5	160	12	17.5	175	13
	10	1.25	32	330	24	36	360	26
	12	1.25	59	600	43	65	670	48
	14	1.5	91	930	67	100	1,050	76
	16	1.5	140	1,400	101	–	–	–
6T	6	1	8	80	69 in.·lbf	9	90	78 in.·lbf
	8	1.25	19	195	14	21	210	15
	10	1.25	39	400	29	44	440	32
	12	1.25	71	730	53	80	810	59
	14	1.5	110	1,100	80	125	1,250	90
	16	1.5	170	1,750	127	–	–	–
7T	6	1	10.5	110	8	12	120	9
	8	1.25	25	260	19	28	290	21
	10	1.25	52	530	38	58	590	43
	12	1.25	95	970	70	105	1,050	76
	14	1.5	145	1,500	108	165	1,700	123
	16	1.5	230	2,300	166	–	–	–
8T	8	1.25	29	300	22	33	330	24
	10	1.25	61	620	45	68	690	50
	12	1.25	110	1,100	80	120	1,250	90
9T	8	1.25	34	340	25	37	380	27
	10	1.25	70	710	51	78	790	57
	12	1.25	125	1,300	94	140	1,450	105
10T	8	1.25	38	390	28	42	430	31
	10	1.25	78	800	58	88	890	64
	12	1.25	140	1,450	105	155	1,600	116
11T	8	1.25	42	430	31	47	480	35
	10	1.25	87	890	64	97	990	72
	12	1.25	155	1,600	116	175	1,800	130

SS0ZU–01

HOW TO DETERMINE NUT STRENGTH

Nut Type			Class
Present Standard Hexagon Nut	Old Standard Hexagon Nut		
	Cold Forging Nut	Cutting Processed Nut	
 No Mark			4N
 No Mark (w/ Washer)	 No Mark (w/ Washer)	 No Mark	5N (4T)
			6N
			7N (5T)
			8N
		 No Mark	10N (7T)
			11N
			12N

*: Nut with 1 or more marks on one side surface of the nut.

B06432

HINT:
Use the nut with the same number of the nut strength classification or the greater than the bolt strength classification number when tightening parts with a bolt and nut.
Example: Bolt = 4T
Nut = 4N or more

ENGINE MECHANICAL

SERVICE DATA

SS0JM–02

Compression pressure	at 250 rpm	2,746 kPa (28.0 kgf/cm^2, 398 psi) or more
	Minimum	2,256 kPa (23.0 kgf/cm^2, 327 psi) or more
	Difference of pressure between each cylinder	490 kPa (5.0 kgf/cm^2, 71 psi) or less
Valve clearance	at cold Intake	0.20 – 0.30 mm (0.008 – 0.012 in.)
	Exhaust	0.35 – 0.45 mm (0.014 – 0.018 in.)
	Adjusting shim thickness Mark 2.500	2.500 mm (0.0984 in.)
	Mark 2.550	2.550 mm (0.1004 in.)
	Mark 2.600	2.600 mm (0.1024 in.)
	Mark 2.650	2.650 mm (0.1043 in.)
	Mark 2.700	2.700 mm (0.1063 in.)
	Mark 2.750	2.750 mm (0.1083 in.)
	Mark 2.800	2.800 mm (0.1102 in.)
	Mark 2.850	2.850 mm (0.1122 in.)
	Mark 2.900	2.900 mm (0.1142 in.)
	Mark 2.950	2.950 mm (0.1161 in.)
	Mark 3.000	3.000 mm (0.1181 in.)
	Mark 3.050	3.050 mm (0.1201 in.)
	Mark 3.100	3.100 mm (0.1220 in.)
	Mark 3.150	3.150 mm (0.1240 in.)
	Mark 3.200	3.200 mm (0.1260 in.)
	Mark 3.250	3.250 mm (0.1280 in.)
	Mark 3.300	3.300 mm (0.1299 in.)
Idle speed	–	700 – 800 rpm
Maximum speed	–	5,100 – 5,250 rpm
Timing belt tensioner	Protrusion from housing end	9.8 – 10.6 mm (0.354 – 0.417 in.)
Cylinder head	Warpage Maximum Cylinder block side	0.08 mm (0.0031 in.)
	Manifold side	0.20 mm (0.0079 in.)
	Valve seat	
	Refacing angle Intake	25°, 45°, 70°
	Exhaust	25°, 45°, 65°
	Contacting angle	45°
	Contacting width Intake	1.2 – 1.6 mm (0.047 – 0.063 in.)
	Exhaust	1.6 – 2.0 mm (0.063 – 0.079 in.)
	Valve guide bushing bore diameter STD	10.985 – 11.006 mm (0.4325 – 0.4333 in.)
	O/S 0.05	11.035 – 11.056 mm (0.4344 – 0.4353 in.)
	Cylinder head bolt thread inside diameter STD	10.75 – 11.00 mm (0.4232 – 0.4331 in.)
	Minimum	10.40 mm (0.4094 in.)
	New cylinder head gasket thickness A	0.85 – 0.95 mm (0.0335 – 0.0374 in.)
	B	0.90 – 1.00 mm (0.0354 – 0.0394 in.)
	C	0.95 – 1.05 mm (0.0374 – 0.0413 in.)
	D	1.00 – 1.10 mm (0.0394 – 0.0433 in.)
	E	0.95 – 1.05 mm (0.0413 – 0.0453 in.)
Valve guide Bushing	Inside diameter	6.010 – 6.030 mm (0.2366 – 0.2374 in.)
	Outside diameter for repair part STD	11.033 – 11.044 mm (0.4344 – 0.4110 in.)
	O/S 0.05	11.083 – 11.094 mm (0.4363 – 0.4368 in.)

Valve	Valve overall length	STD Intake	102.53 mm (4.0366 in.)
		Exhaust	101.97 mm (4.0146 in.)
		Minimum Intake	102.10 mm (4.0197 in.)
		Exhaust	101.55 mm (3.9980 in.)
	Stem diameter	Intake	5.970 – 5.985 mm (0.1957 – 0.1963 in.)
		Exhaust	5.960 – 5.975 mm (0.2346 – 0.2352 in.)
	Stem oil clearance	STD Intake	0/025 – 0.060 mm (0.0010 – 0.0024 in.)
		Exhaust	0.035 – 0.070 mm (0.0014 – 0.0028 in.)
		Maximum Intake	0.08 mm (0.0031 in.)
		Exhaust	0.10 mm (0.0039 in.)
	Margin thickness	STD	0.9 mm (0.035 in.)
		Maximum	0.5 mm (0.020 in.)
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
	Free length		40.45 mm (1.5925 in.)
	Installed tension at 31.1 mm (1.224 in.)		177 – 195 N (18.0 – 19.9 kgf, 39.7 – 44.1 lbf)
Valve lifter	Cylinder head lifter bore diameter		28.010 – 28.031 mm (1.1028 – 1.1036 in.)
	Lifter diameter		27.975 – 27.985 mm (1.1014 – 1.1018 in.)
	Oil clearance	STD	0.025 – 0.056 mm (0.0010 – 0.0022 in.)
		Maximum	0.08 mm (0.0031 in.)
Camshaft	Thrust clearance		0.035 – 0.110 mm (0.0014 – 0.0043 in.)
	Journal oil clearance	STD	0.025 – 0.062 mm (0.0010 – 0.0024 in.)
		Maximum	0.08 mm (0.0031 in.)
	Journal diameter		26.969 – 26.985 mm (1.0618 – 1.0624 in.)
	Circle runout	Maximum	0.06 mm (0.0024 in.)
	Cam lobe height	STD Intake	46.57 – 46.67 mm (1.8335 – 1.8374 in.)
		Exhaust	47.52 – 47.62 mm (1.8709 – 1.8748 in.)
		Minimum Intake	46.10 mm (1.8150 in.)
		Exhaust	47.05 mm (1.8524 in.)
	Camshaft gear backlash	STD	0.014 – 0.070 mm (0.0006 – 0.0028 in.)
		Maximum	0.17 mm (0.0067 in.)
Manifold	Warpage	Maximum Intake	0.1 mm (0.004 in.)
		Exhaust	0.4 mm (0.016 in.)
Cylinder block	Cylinder head surface warpage	Maximum	0.20 mm (0.0079 in.)
	Cylinder bore diameter	STD	82.200 – 82.213 mm (3.2362 – 3.2367 in.)
		Maximum STD	86.40 mm (3.2441 in.)
		O/S 0.50	86.90 mm (3.4213 in.)
Piston and piston ring	Piston diameter		82.148 – 82.182 mm (3.2341 – 3.2355 in.)
	Piston oil clearance	STD	0.018 – 0.065 mm (0.0007 – 0.0026 in.)
		Minimum	0.14 mm (0.0055 in.)
	Piston ring groove clearance	STD No.1	0.08 – 0.12 mm (0.0031 – 0.0047 in.)
		No.2	0.06 – 0.10 mm (0.0024 – 0.0039 in.)
		Oil	0.03 – 0.07 mm (0.0012 – 0.0028 in.)
	Piston ring end gap	STD No.1	0.27 – 0.43 mm (0.0106 – 0.0169 in.)
		No.2	0.39 – 0.58 mm (0.0154 – 0.0228 in.)
		Oil	0.20 – 0.44 mm (0.0079 – 0.0173 in.)
		Maximum No.1	0.82 mm (0.0323 in.)
		No.2	1.00 mm (0.0394 in.)
		Oil	0.90 mm (0.0354 in.)

Connecting rod	Thrust clearance	STD	0.08 – 0.30 mm (0.0031 – 0.0118 in.)
		Maximum	0.40 mm (0.0157 in.)
	Connecting rod oil clearance	STD	0.038 – 0.056 mm (0.0015 – 0.0022 in.)
		Maximum	0.10 mm (0.0039 in.)
	Connecting rod bearing center wall	STD Mark 1	1.478 – 1.481 mm (0.0582 – 0.0583 in.)
	thickness (Reference)	Mark 2	1.481 – 1.484 mm (0.0583 – 0.0584 in.)
		Mark 3	1.484 – 1.487 mm (0.0584 – 0.0585 in.)
		Mark 4	1.487 – 1.490 mm (0.0585 – 0.0587 in.)
		Mark 5	1.490 – 1.493 mm (0.0587 – 0.0588 in.)
	Rod bend	Maximum per 100 mm (3.94 in.)	0.05 mm (0.0020 in.)
	Rod twist	Maximum per 100 mm (3.94 in.)	0.15 mm (0.0059 in.)
	Bushing inside diameter		31.015 – 31.027 mm (1.2211 – 1.2215 in.)
	Piston pin diameter		31.000 – 31.012 mm (1.2205 – 1.2209 in.)
	Piston pin oil clearance	STD	0.011 – 0.019 mm (0.0004 – 0.0007 in.)
		Maximum	0.025 mm (0.0010 in.)
	Connecting rod bolt tension portion diameter	STD	8.2 – 8.3 mm (0.323 – 0.327 in.)
		Minimum	8.0 mm (0.315 in.)
Crankshaft	Thrust clearance	STD	0.040 – 0.240 mm (0.0016 – 0.0094 in.)
		Maximum	0.30 mm (0.0118 in.)
	Thrust washer thickness	STD	2.680 – 2.730 mm (0.1055 – 0.1075 in.)
		U/S 0.125	2.743 – 2.793 mm (0.1080 – 0.1100 in.)
		U/S 0.250	2.805 – 2.855 mm (0.1104 – 0.1124 in.)
	Main journal oil clearance	STD	0.032 – 0.056 mm (0.0013 – 0.0022 in.)
		Maximum	0.10 mm (0.0039 in.)
	Main journal diameter		56.992 – 57.010 mm (2.2438 – 2.2445 in.)
	Main bearing center wall thickness	STD Mark 1	1.976 – 1.979 mm (0.0778 – 0.0779 in.)
	(Reference)	Mark 2	1.979 – 1.982 mm (0.0779 – 0.0780 in.)
		Mark 3	1.982 – 1.985 mm (0.07880– 0.0781 in.)
		Mark 4	1.985 – 1.988 mm (0.0781 – 0.0783 in.)
		Mark 5	1.988 – 1.991 mm (0.07853– 0.07874in.)
	Crank pin diameter		50.482 – 50.500 mm (1.9875 – 1.9882 in.)
	Circle runout	Maximum	0.025 mm (0.0010 in.)
	Main journal taper and out–of–round	Maximum	0.01 mm (0.0004 in.)
	Crank pin taper and out–of–round	Maximum	0.021mm (0.0004 in.)

SS0JN–02

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
No.2 idler pulley x Oil pump		36.8	375	27
Supply pump drive pulley x Supply pump		103	1,050	76
No.1 idler pulley x Cylinder head		35	350	25
Camshaft timing pulley x Camshaft		88.2	900	65
Timing belt tensioner x Water pump		21	210	15
Timing belt plate x Camshaft oil seal retainer		9	90	78 in.·lbf
Engine mounting bracket x Cylinder block		36.8	375	27
Engine mounting bracket x Water pump		63.7	650	47
Crankshaft pulley x Crankshaft		180	1,800	130
Glow plug for engine x Cylinder head		12.3	125	9
Cylinder head x Cylinder block	1st	45	460	33
	2nd	Turn 90°	Turn 90°	Turn 90°
	3rd	Turn 90°	Turn 90°	Turn 90°
	4th	Turn 90°	Turn 90°	Turn 90°
Camshaft bearing cap x Cylinder head		20	200	15
Camshaft oil seal retainer x Cylinder head		8.8	90	78 in.·lbf
Cylinder head cover x Cylinder head		13.2	135	10
No.2 nozzle leakage pipe x Cylinder head		21	215	15
Glow plug for power heater x Cylinder head		13	130	9
Vacuum pump x Cylinder head		28	280	20
EGR valve x Cylinder head		18.1	185	13
Water outlet x Cylinder head		20.5	210	15
No.3 timing belt cover x Cylinder head		7.4	75	65 in.·lbf
Intake Manifold x Cylinder head		20.5	210	15
Intake air connector with diesel throttle body x Intake manifold		20.5	210	15
Exhaust manifold x Cylinder head		46.5	475	34
Cylinder block oil orifice x Cylinder block		9	90	78 in.·lbf
Oil nozzle x Cylinder block		7.4	75	65 in.·lbf
Main bearing cap x Cylinder block		115	1,150	85
Connecting rod cap x Connecting rod	1st	30	300	22
	2nd	Turn 90°	Turn 90°	Turn 90°
Rear oil seal retainer x Cylinder block		7.4	75	65 in.·lbf
Oil jet pressure valve x Cylinder block		30	310	22
No.1 fuel pipe x Cylinder block	12 mm head	8.8	90	78 in.·lbf
	14 mm head	20.5	210	15
No.1 oil cooler pipe x Cylinder block		56.4	575	42
Engine coolant drain union x Cylinder block		28.5	290	21
Oil cooler union bolt X Cylinder block		171	1,745	126
Alternator bracket x Cylinder block		37	380	27
Drive belt adjusting bar x Oil pump		31.4	320	23
Flywheel x Crankshaft		88.2	900	65

TURBOCHARGING

SS0JO–02

SERVICE DATA

Turbocharger	Turbocharging pressure		58.5 – 78.9 kPa (0.60 – 0.80 kgf/cm^2, 8.5 – 11.4 psi)
	Turbine wheel axial play	Maximum	0.09 mm (0.0035 in.) or less
	Turbine wheel radial play	Maximum	0.16 mm (0.0063 in.) or less

SS0JP–02

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
G coupling		8.3	85	74 in.·lbf
Compressor housing x Bearing housing		4.7	48	42 in.·lbf
Turbocharger actuator x Compressor housing		7.8	80	69 in.·lbf
Turbo water pipe x Turbocharger		13.2	135	10
No.1 turbo oil pipe x Turbocharger		13.2	135	10
Turbocharger x Exhaust manifold		53	530	39
Turbo oil inlet pipe x Turbocharger, Cylinder block	Union bolt	31	320	23
	Nut	8.8	90	78 in.·lbf
Stay on No.1 turbo oil pipe x Cylinder head		8.8	90	78 in.·lbf
Exhaust manifold converter x Turbocharger		25	250	18
Exhaust manifold stay x Exhaust manifold converter		61	620	45
Exhaust manifold stay x Cylinder block		61	650	45
Turbocharger stay x Cylinder head		54	550	40
Turbocharger stay x Exhaust manifold converter		54	550	40
No.2 exhaust manifold heat insulator x Turbocharger		12	120	9
No.1 turbo heat insulator x Turbocharger	Bolt	12	120	9
	Nut	18.1	185	13
No.1 turbo heat insulator x Exhaust manifold converter		12	120	9
No.2 turbo heat insulator x Exhaust manifold converter		25	255	18

EMISSION CONTROL

SERVICE DATA

SS14C–01

E–VRV for EGR	Resistance	at 20˚C (68˚F)	11 – 13 Ω
EGR cut VSV	Resistance	at 20˚C (68˚F)	33 – 39 Ω

SS14D–01

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
EGR x Cylinder head	18.1	185	13
Exhaust manifold converter x Turbocharger assembly	25	255	18
Turbocharger stay x Exhaust manifold converter, Cylinder head	54	551	40
Exhaust manifold stay x Exhaust manifold converter, Cylinder block	61	622	45
Front exhaust pipe x Exhaust manifold converter	62	630	46
Front exhaust pipe x Exhaust tail pipe	44	440	32

ELECTRONIC CONTROL DIESEL

SERVICE DATA

SS14E–01

Water temperature sensor	Resistance	at –20°C (–4°F) at 0°C (0°F) at 20°C (68°F) at 40°C (104°F) at 60°C (140°F) at 80°C (176°F)	10 – 20 Ω 4 – 7 Ω 2 – 3 Ω 0.9 – 1.3 Ω 0.4 – 0.7 Ω 0.2 – 0.4 Ω
Intake air temperature sensor	Resistance	at –20°C (–4°F) at 0°C (0°F) at 20°C (68°F) at 40°C (104°F) at 60°C (140°F) at 80°C (176°F)	10 – 20 Ω 4 – 7 Ω 2 – 3 Ω 0.9 – 1.3 Ω 0.4 – 0.7 Ω 0.2 – 0.4 Ω
Fuel temperature sensor	Resistance	at 40°C (104°F)	0.5 – 3.0 Ω
Fuel pressure sensor	Power source voltage		4.5 – 5.5 V
Camshaft position sensor	Resistance	at Cold at Hot	1,630 – 2,740 Ω 2,065 – 3,225 Ω
Crankshaft position sensor	Resistance	at Cold at Hot	1,630 – 2,740 Ω 2,065 – 3,225 Ω
Air flow mater	Resistance (THA – E2)	at –20°C (–4°F) at 20°C (68°F) at 60°C (140°F)	12.5 – 16.9 kΩ 2.19 – 2.67 kΩ 0.50 – 0.68 kΩ
ECU	Voltage (PCR – E2)	at 20°C (68°F)	Approx. 1.0 V
	Resistance		
		LU+A – +B	15 – 30
		LU–A – +B	15 – 30
		LU+B – +B	15 – 30
		LU–B – +B	15 – 30
		THOP – E1	10 or less
	Coolant temp. 80°C (176°F)	THW – E2	0.2 – 0.4 k
	Intake air temp. 20°C (68°F)	THA – E2	2.0 – 3.0 k
	Fuel temp. 20°C (68°F)	THF – E2	2.0 – 3.0 k
	Cold (–10°C (14°F) to 50°C (122°F))	G+ – G–	1630 – 2740
	Hot (50°C (122°F) to 100°C (212°F))	G+ – G–	2065 – 3225
	Cold (–10°C (14°F) to 50°C (122°F))	NE+ – NE–	1630 – 2740
	Hot (50°C (122°F) to 100°C (212°F))	NE+ – NE–	2065 – 3225
	Accelerator pedal fully opened	PDL – E1	10 or less
		THAF – E2	2.0 – 3.0 k
		MREL – E01	60 – 80
		EDUREL – E01	60 – 80
	20°C (68°F)	EGR – +B	11 – 13
	20°C (68°F)	EGRC – +B	37 – 44
	20°C (68°F)	PA – +B	37 – 44
	20°C (68°F)	RINJ1 – E01	30 – 9600
	20°C (68°F)	RINJ2 – E01	30 – 9600
	20°C (68°F)	RINJ3 – E01	30 – 9600
	20°C (68°F)	RINJ4 – E01	30 – 9600
	20°C (68°F)	PCV1 – COM	1.5 – 1.8
	20°C (68°F)	PCV2 – COM	1.5 – 1.8

SS14F–01

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Diesel throttle body x Intake air connector	20.5	210	15
Water temperature sensor x Cylinder head	20.4	208	15
Intake air temperature sensor x Intake air connector	34.3	350	25
Camshaft position sensor x Cylinder head	8.8	90	78 in.·lbf
Crankshaft position sensor x Oil pump	8.8	90	78 in.·lbf

ENGINE FUEL

SS14G–01

SERVICE DATA

Fuel heater	Resistance	at 20°C (68°F)	0.5 – 2.0 Ω
Injector	Resistance	at 20°C (68°F)	2.5 – 3.1 Ω
SCV1	Resistance	at 20°C (68°F)	1.5 – 1.7 Ω
SCV2	Resistance	at 20°C (68°F)	1.5 – 1.7 Ω

SS14H–01

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Fuel heater x Fuel filter		1.96	20	17 in.·lbf
Nozzle holder clamp x Cylinder head		25.7	262	19
Nozzle leakage pipe x Injector	Hollow screw	16	163	12
	Union bolt	12.5	128	9
Check valve plug x Overflow screw		9.8	100	87 in.·lbf
Check valve x Cylinder head		21	214	15
Injection pipe, Fuel inlet pipe x Common rail	for use with SST	37	377	27
		41	418	30
Injection pipe x Injector	for use with SST	31	316	23
		34	347	25
Injection pipe clamp x Intake manifold		5	51	44 in.·lbf
Supply pump x Water pump		20.5	210	15
Supply pump stay x Cylinder block, Supply pump		20.5	210	15
Fuel inlet pipe x Supply pump	for use with SST	31	316	23
		34	347	25
Fuel inlet pipe clamp x Intake manifold		7.4	75	65 in.·lbf
Common rail x Cylinder head		43	440	32

COOLING

SERVICE DATA

SS0JV–02

Thermostat	Valve opening temperature		80 – 84°C (176 – 183°F)
	Valve lift	at 95°C (203°F)	8.5 mm (0.33 in.) or more
Radiator cap	Relief valve opening pressure	STD	93.3 – 122.7 kPa (0.95 – 1.25 kgf/cm^2, 13.5 – 17.8 psi)
		Minimum	79 kPa (0.8 kgf/cm^2, 11.5 psi)
Electric Cooling fan	Rotating amperage	No.1	Approx. 13.2 A
		No.2	Approx. 9.8 A

SS0JW–02

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Engine drain plug x Engine coolant drain union	13	130	9
Water pump x Cylinder block	31.4	320	23
Water pump x Supply pump	20.5	210	15
Water inlet x Cylinder block	8.8	90	78 in.·lbf

LUBRICATION

SS0JX–02

SERVICE DATA

Oil pressure		at idle speed	29 kPa (0.3 kgf/cm^2, 4.2 psi) or more
		at 4,500 rpm	245 – 588 kPa (2.5 – 6.0 kgf/cm^2, 36 – 85 psi)
Oil pump	Tip clearance	STD	0.08 – 0.16mm (0.0031 – 0.0063 in.)
		Maximum	0.20 mm (0.0079 in.)
	Body clearance	STD	0.10 – 0.17 mm (0.0039 – 0.0067 in.)
		Maximum	(0.20 mm (0.0079 in.)

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Engine oil drain plug x No.1 oil pan	34.3	350	25
Relief valve plug x Oil pump body	49	500	36
Oil pump x Cylinder block	31.4	320	23
Crankshaft position sensor x Oil pump	8.8	90	78 in.·lbf
No.1 oil pan x Cylinder block, Oil pump, Rear oil seal retainer			
10 mm head bolt and nut	8.0	80	69 in.·lbf
12 mm head bolt	20.5	210	15
Oil strainer x No.1 oil pan Bolt	20.5	210	15
Nut	13.2	135	10
Oil strainer x Oil pump	13.2	135	10
No.1 oil pan x No.2 oil pan	11.7	120	9
Oil level sensor x No.1 oil pan	5.4	55	48 in.·lbf
Oil dipstick x Supply pump stay	18	185	13
Drive belt adjusting bar x Oil pump	31.4	320	23
Drive belt adjusting bar x Alternator	18.1	185	13
Vacuum pump oil pipe x Cylinder block	8.8	90	78 in.·lbf
Turbo oil inlet pipe x Turbocharger, Cylinder block, Cylinder head			
Union bolt	31	320	23
Bolt and nut	8.8	90	78 in.·lbf
Oil cooler x Cylinder block	66	670	48
Oil nozzle x Cylinder block	7.4	75	65 in.·lbf
Oil jet pressure valve x Cylinder block	30	310	22

STARTING

SS0UY–03

SERVICE DATA

Pre–heating System	Light lighting time	at 28°C (82°F)	2.1 seconds
	Glow plug resistance	at 20°C (68°F)	Approx. 0.72 Ω
Starter	Rated voltage and output power		12 V 2.0 kW
	No–load characteristics	Current	160 A or less at 10.5 V
		rpm	3,000 rpm or more
	Brush length	STD	14.5 mm (0.571 in.)
		Minimum	9.0 mm (0.354 in.)
	Commutator		
	Diameter	STD	32.3 mm (1.272 in.)
		Minimum	30.5 mm (1.201 in.)
	Undercut depth	STD	0.9 mm (0.035 in.)
		Minimum	0.3 mm (0.012 in>)
	Circle runout	Maximum	0.03 mm (0.0012 in.)
	Armature thrust clearance	STD	0.3 mm (0.012 in.)
		Maximum	0.6 mm (0.024 in.)
	Pinion gear clearance	Maximum	3.9 mm (0.154 in.)

SS0UZ–03

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Glow plug x Cylinder head	13	130	10
Commutator end frame x Starter drive housing	6.5	66	58 in.·lbf
Commutator end cover x Brush holder	1.7	17	15 in.·lbf
Starter housing x Magnetic switch	5.0	51	44 in.·lbf
Lead wire x Terminal C of starter	8.0	82	71 in.·lbf

CHARGING

SERVICE DATA

SS0YW–05

Battery	Specific gravity	at 20°C (68°F)	1.25 – 1.29
	Voltage	at 20°C (68°F)	12.5 – 12.9 V
Drive belt	Deflection	New belt	9 – 11 mm (0.35 – 0.43 in.)
		Used belt	12 – 16 mm (0.47 – 0.63 in.)
	Tension	New belt	490 – 686 N (50 – 70 kgf)
		Used belt	245 – 441 N (25 – 45 kgf)
Alternator	Rated output		12 V 120 A
	Rotor coil resistance	at 20°C (68°F)	2.1 – 2.5 Ω
	Slip ring diameter	STD	14.2 – 14.4 mm (0.559 – 0.567 in.)
		Minimum	12.8 mm (0.504 in.)
	Brush exposed length	STD	9.5 – 11.5 mm (0.374 – 0.453in.)
		Minimum	1.5 mm (0.059 in.)
IC regulator	Regulatingvoltage	at 115°C (239°F)	13.2 – 14.0 V

SS0YX–05

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Retainer x Drive end frame	3.0	31	27 in.·lbf
Rectifier end frame x Drive end frame	4.5	46	40 in.·lbf
Rectifier end frame without cord clip x Drive end frame	4.5	46	40 in.·lbf
Rectifier end frame with cord clip x Drive end frame	5.4	55	48 in.·lbf
Alternator pulley x Rotor	110.5	1,125	81
Rectifier holder x Lead wire on rectifier end frame	2.94	30	26 in.·lbf
IC regulator x Rectifier end frame	1.96	20	17 in.·lbf
IC regulator x Rectifier holder	1.96	20	17 in.·lbf
Brush holder x Rectifier holder	1.96	20	17 in.·lbf
Brush holder x IC regulator	1.96	20	17 in.·lbf
Rear end cover x Rectifier holder	4.4	45	39 in.·lbf
Plate terminal x Rectifier holder	3.85	39	34 in.·lbf
Terminal insulator x Rectifier holder	4.1	42	36 in.·lbf

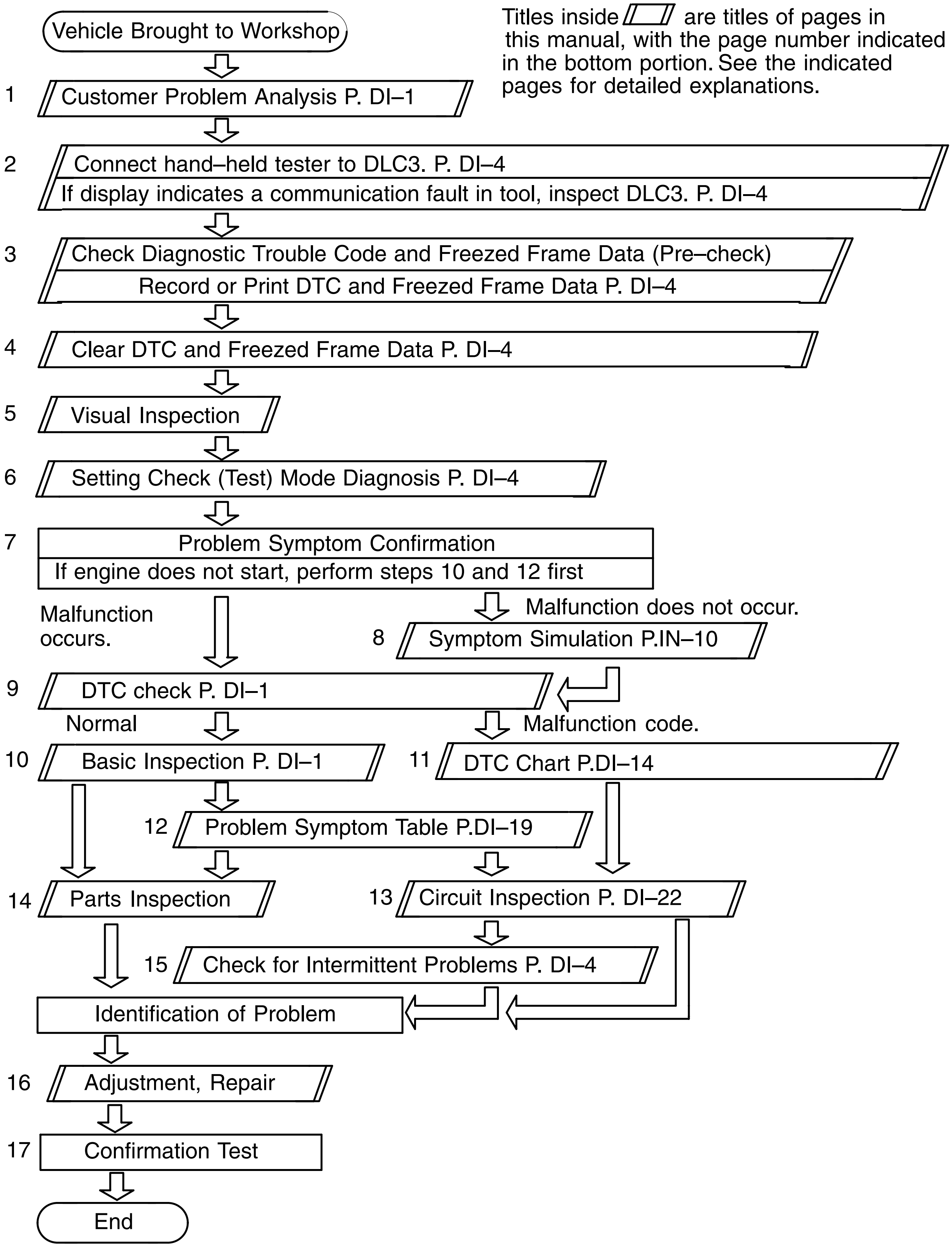
DIAGNOSTICS

ENGINE

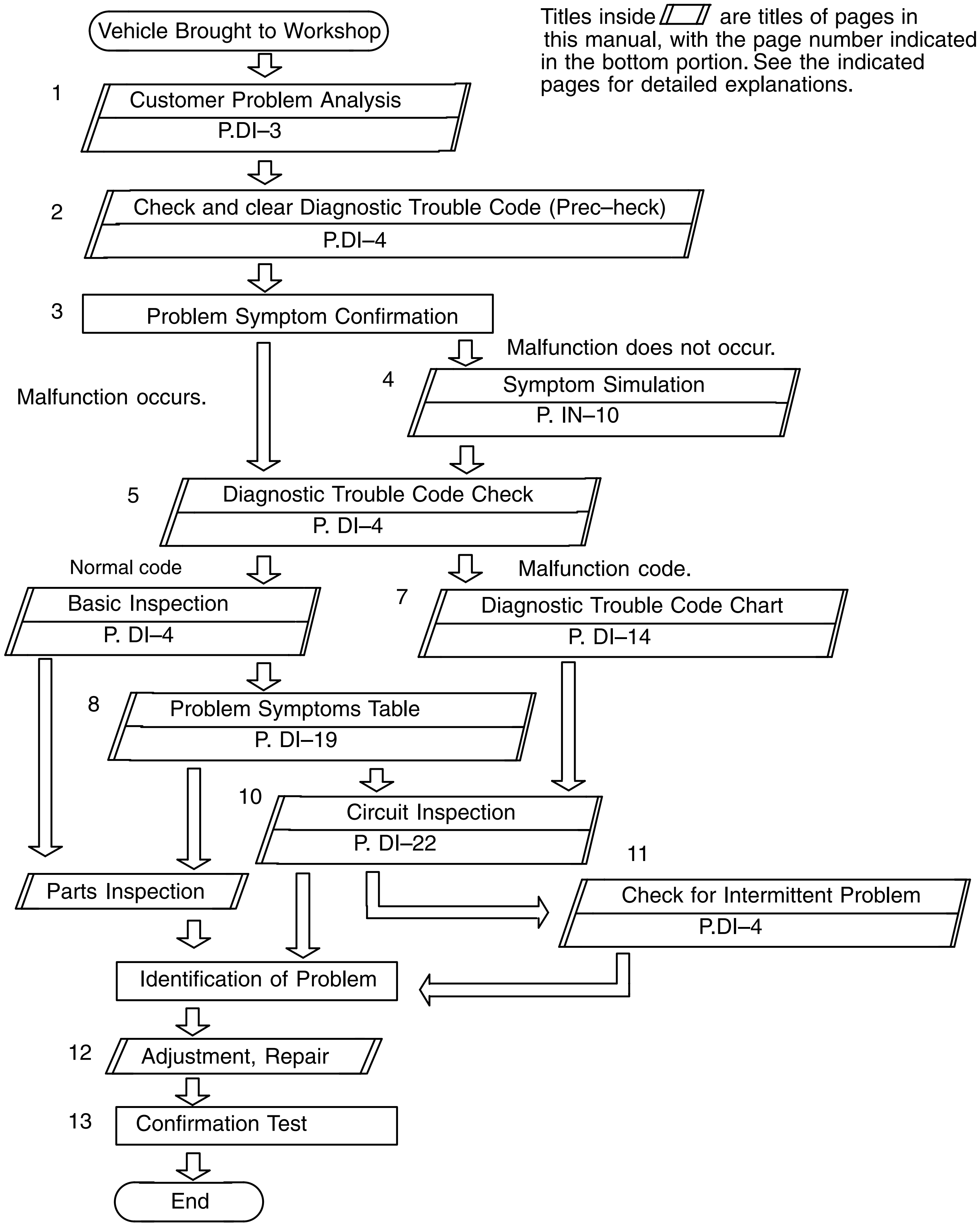
HOW TO PROCEED WITH TROUBLESHOOTING

DI31H–03

When using hand–held tester, troubleshoot in accordance with the procedure on the following pages.



When not using hand–held tester, troubleshoot in accordance with the procedure on the following pages.



DI31I–02

CUSTOMER PROBLEM ANALYSIS CHECK

ENGINE CONTROL SYSTEM Check Sheet

Inspector's Name ______________________

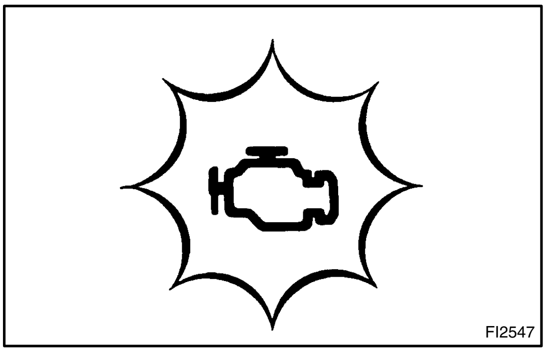
Customer's Name		Model and Model Year	
Driver's Name		Frame No.	
Date Vehicle Brought in		Engine Model	
License No.		Odometer Reading	km miles

Problem Symptoms	☐ Engine does not Start	☐ Engine does not crank ☐ No initial combustion ☐ No complete combustion
	☐ Difficult to Start	☐ Engine cranks slowly ☐ Other ______
	☐ Poor Idling	☐ Incorrect first idle ☐ Idling rpm is abnormal ☐ High (rpm) ☐ Low (rpm) ☐ Rough idling ☐ Other ______
	☐ Poor Driveability	☐ Hesitation ☐ Back fire ☐ Muffler explosion (after–fire) ☐ Surging ☐ Knocking ☐ Other ______
	☐ Engine Stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ After accelerator pedal released ☐ During A/C operation ☐ Shifting from N to D ☐ Other ______
	☐ Others	

Dates Problem Occurred		
Problem Frequency		☐ Constant ☐ Sometimes (times per day/month) ☐ Once only ☐ Other ______
Condition When Problem Occurs	Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Various/Other ______
	Outdoor Temperature	☐ Hot ☐ Warm ☐ Cool ☐ Cold (approx. ____°F/____°C)
	Place	☐ Highway ☐ Suburbs ☐ Inner city ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other ______
	Engine Temp.	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temp. ☐ Other ______
	Engine Operation	☐ Starting ☐ Just after starting (min.) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other ______

Condition of Malfunction indicator Lamp		☐ Remains on	☐ Sometimes lights up ☐ Does not light up
Diagnostic Trouble Code Inspection	Normal Mode (Precheck)	☐ Normal	☐ Malfunction code(s) (code) ☐ Freezed frame data ( )
	Check Mode	☐ Normal	☐ Malfunction code(s) (code) ☐ Freezed frame data ( )

DI69G–01


FI2547

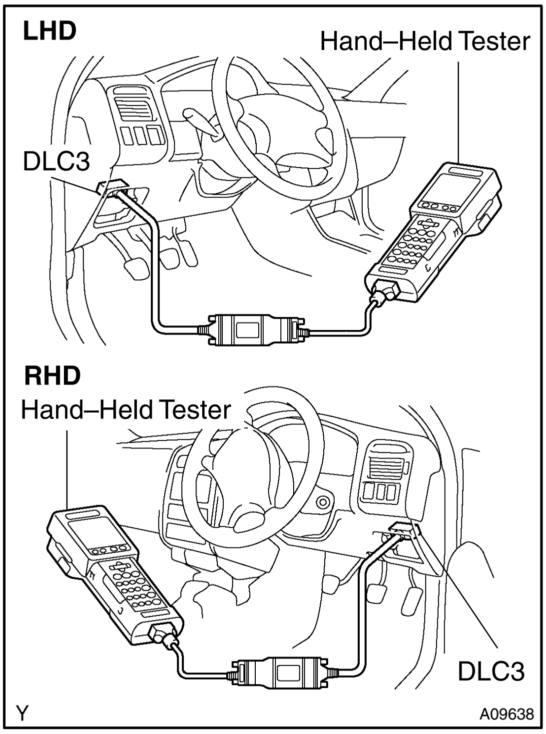
PRE–CHECK

1. DIAGNOSIS SYSTEM

(a) Description

- When troubleshooting Multiplex OBD (M–OBD) vehicles, the only difference from the usual troubleshooting procedure is that you connect the vehicle to the hand–held tester, and read off various data output from the vehicle's engine ECU.
- The vehicle's on–board computer lights up the check engine warning light on the instrument panel when the computer detects a malfunction in the computer itself or in drive system components. In addition to the check engine warning light lighting up when a malfunction is detected, the applicable diagnostic trouble codes are recorded in the engine ECU memory. (See page DI–14)

If the malfunction has been repaired, the check engine warning light goes off automatically but the diagnostic trouble codes remain recorded in the engine ECU memory.



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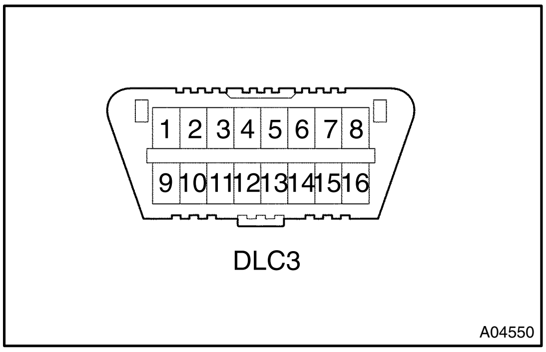
- To check the diagnostic trouble codes, connect the hand–held tester to Data Link Connector 3 (DLC3) on the vehicle or read the number of blinks of the check engine warning light when TC and CG terminals on the DLC3 are connected. The hand–held tester also enables you to erase the diagnostic trouble codes and activate the several actuators and check freeze frame date and various forms of engine data. (For operating instructions, see the hand–held tester instruction book.)
- The diagnosis system operates in normal mode during normal vehicle use. It also has a check (test) mode for technicians to simulate malfunction symptoms and troubleshoot. Some diagnostic trouble codes use 2 trip detection logic* to prevent erroneous detection and ensure thorough malfunction detection. By switching the engine ECU to check (test) mode using hand–held tester when troubleshooting, the technician can cause the check engine warning light to light up for a malfunction that is only detected once or momentarily. (hand–held tester only) (See page DI–14)

- *2 trip detection logic:
  When a logic malfunction is first detected, the malfunction is temporarily stored in the engine ECU memory.

If the same malfunction is detected again during the second drive test, this second detection causes the check engine warning light to light up. The 2 trip repeats the same mode a 2nd time. (However, the ignition switch must be turned OFF between the 1st trip and 2nd trip).

- Freeze frame data:
  Freeze frame data records the engine condition when malfunction is detected. Because freeze frame data records the engine conditions (fuel system, calculator load, engine coolant temperature, fuel trim, engine speed, vehicle speed, etc.) when the malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

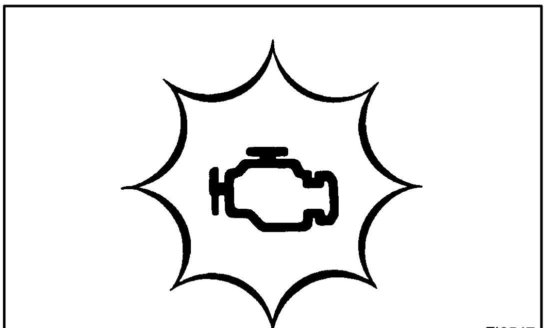
(b) Check the DLC3.
The vehicle's engine ECU uses ISO 14230 for communication. The terminal arrangement of the DLC3 complies with SAE J1962 and matches the ISO 14230 format.



Terminal No.	Connection/Voltage or Resistance	Condition
7	Bus ⊕ Line/Pulse generation	During transmission
4	Chassis Ground ↔ Body Ground/1 Ω or less	Always
16	Battery Positive ↔ Body Ground/9 – 14 V	Always

HINT:
If your display shows UNABLE TO CONNECT TO VEHICLE when you have connected the cable of the hand–held tester to the DLC3, turned the ignition switch ON and operated the hand–held tester, there is a problem on the vehicle side or tool side.

(1) If communication is normal when the tool is connected to another vehicle, inspect the DLC3 on the original vehicle.
(2) If communication is still not possible when the tool is connected to another vehicle, the problem is probably in the tool itself, so consult the Service Department listed in the tool's instruction manual.



FI2547

2. INSPECT DIAGNOSIS (Normal Mode)

(a) Check the check engine warning light.

(1) The check engine warning light comes on when the ignition switch is turned ON and the engine is not running.

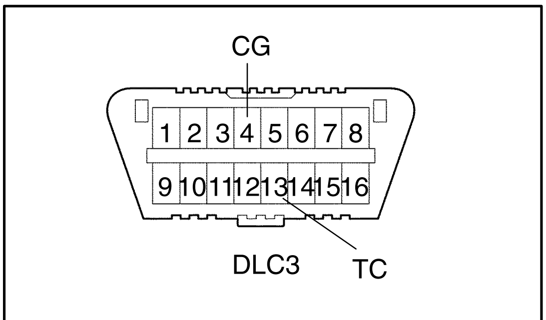
HINT:
If the check engine warning light does not light up, troubleshoot the combination meter.

(2) when the engine is started, the check engine warning light should go off. If the lamp remains on, the diagnosis system has detected a malfunction or abnormality in the system.

(b) Check the DTC using hand–held tester.

NOTICE:
When the diagnosis system is switched from the normal mode to the check (test) mode, it erases all DTCs and freezed frame data recorded in the normal mode. So before switching modes, always check the DTCs and freezed frame data, and note them down.

(1) Prepare the hand–held tester.
(2) Connect the hand–held tester to the DLC3.
(3) Turn the ignition switch ON and switch the hand–held tester main switch ON.
(4) Use the hand–held tester to check the DTCs and freezed frame data, note them down. (for operating instructions, see the hand–held tester's instruction book.)
(5) Confirm the details of the DTCs.



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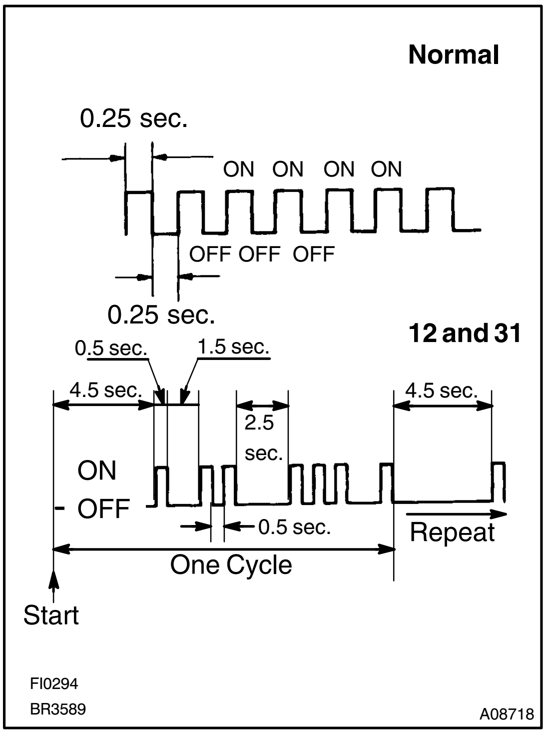
(c) Check the DTC not using hand–held tester.

(1) Turn the ignition switch ON.
(2) Using SST, connect between terminals 13 (TC) and 4 (CG) of the DLC3.

SST 09843–18040



(3) Read the DTC from the check engine warning light. As an example, the blinking patterns for codes; normal, 12 and 31 are as shown in the illustration.

HINT:
If a DTC is not output, check the diagnostic connector (DLC3) circuit (See page DI–111).

(4) Check the details of the malfunction using the DTC chart on page DI–14.

(5) After completing the check, disconnect terminals 13 (TC) and 4 (CG) and turn off the display.

HINT:
In the event of 2 or more malfunction codes, the indication will begin from the smaller numbered code to the larger in order.

NOTICE:
When simulating symptoms without a hand–held tester to check the DTCs, use the normal mode. For code on the DTCs chart subject to "2 trip detection logic", turn the ignition switch OFF after the symptom is simulated the first time. Then repeat the simulation process again. When the problem has been simulated twice, the check engine warning light lights up and the DTCs are recorded in the engine ECU.

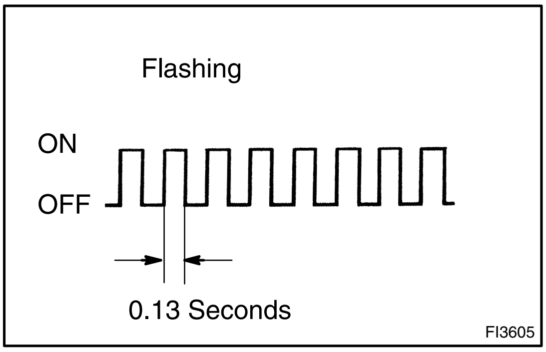
3. INSPECT DIAGNOSIS (Check (Test) Mode)

Hand–held tester only:
Compared to the normal mode, the check mode has an increased sensitivity to detect malfunctions.
Furthermore, the same diagnostic items which are detected in the normal mode can also be detected in the check (test) mode.

(a) Check the DTC.

(1) Initial conditions.
- Battery positive voltage 11 V or more
- Throttle valve fully closed
- Transmission in neutral position
- A/C switched OFF.

(2) Turn the ignition switch OFF.
(3) Prepare the hand–held tester.
(4) Connect the hand–held tester to the DLC3.
(5) Turn the ignition switch ON and push the hand–held tester main switch ON.



(6) Switch the hand–held tester from the normal mode to the check (test) mode. (Check that the check engine warning light flashes.)
(7) Start the engine. (The check engine warning light goes out after the engine start.)
(8) Simulate the conditions of the malfunction described by the customer.

NOTICE:
Leave the ignition switch ON until you have checked the DTCs, etc.

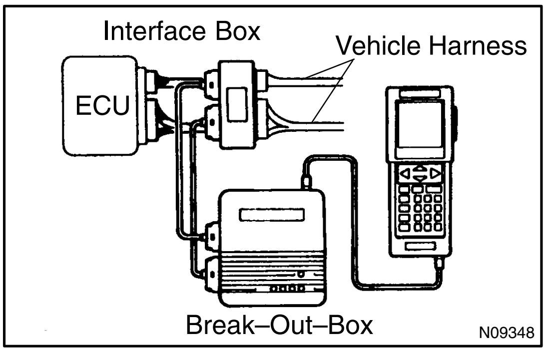
(9) After simulating the malfunction conditions, use the hand–held tester diagnosis selector to check the DTCs and freezed frame data, etc.

HINT:
Take care not to turn the ignition switch OFF. Turning the ignition switch OFF switches the diagnosis system from the check (test) mode to the normal mode, so all diagnostic codes, etc. are erased.

(10) After checking the DTCs, inspect the applicable circuit.

(b) Clear the DTC.
The following actions will erase the DTCs and freezed frame data.
- Operating the hand–held tester to erase the codes. (See the hand–held tester's instruction book for operating instructions.)
- Disconnecting the battery terminals or ECD fuse.

NOTICE:
If the hand–held tester switches the engine ECU from the normal mode to the check (test) mode or vice–versa, or if the ignition switch is turned from ON to ACC or OFF during the check (test) mode, the DTCs and freezed frame data will be erased.



(c) Measure the engine ECU terminal values using break–out box and hand–held tester.
(1) Hook up the break–out–box and hand–held tester to the vehicle.
(2) Read the engine ECU input/output values by following the prompts on the tester screen.

HINT:
Hand–held tester has a ”Snapshot” function.
This records the measured values and is effective in the diagnosis of intermittent problems.
Please refer to the hand–held tester/break–out–box operator's manual for further details.

4. FAIL–SAFE CHART

If any of the following codes is recorded, the engine ECU enters fail–safe mode.

DTC No.	Fail–Safe Operation	Fail–Safe Deactivation Conditions
12	Out put limit	Return to normal condition
15	Out put limit	+B OFF
19 (1)	Accelerator pedal closed position SW ON : Accelerator pedal position is fixed at 0 % Accelerator pedal closed position SW OFF : Out put limited accelerator pedal position	+B OFF
19 (2)	Accelerator pedal closed position SW ON : Accelerator pedal position is fixed at 0 % Accelerator pedal closed position SW OFF : Out put limited accelerator pedal position	+B OFF
	Out put limit	+B OFF
19 (3)	When the idle SW is faulty. Accelerator pedal closed position SW ON: Accelerator pedal position is fixed at 0 % Accelerator pedal closed position SW OFF: Out put limited accelerator pedal position	+B OFF
	When the idle SW is okay. Out put limited accelerator pedal position	+B OFF
19 (4)	Out put limit	+B OFF
22	Engine coolant temp. is fixed at 107°C (224.6°F)	Return to normal condition
24	Intake air temp. is fixed at 90°C (194.0°F)	Return to normal condition
32	Compensation value is set at fixed value	Return to normal condition
35	Turbo pressure is set at fixed value	Return to normal condition
39	Fuel temp. is fixed at 40°C (104.0°F)	Return to normal condition
42	Vehicle speed is fixed at 0 km/h (0 mph)	Vehicle speed > 0 km/h (0 mph)
49	Out put limit	+B OFF
78 (1)	Fuel cut	+B OFF
78 (3)	Out put limit	+B OFF
97	Fuel cut	IG OFF→ON or Starter ON
	Out put limit	

5. CHECK FOR INTERMITTENT PROBLEMS

Hand–held tester only:

By putting the vehicle's engine ECU in the check (test) mode, 1 trip detection logic is possible instead of 2 trip detection logic and sensitivity to detect open circuits is increased. This makes it easier to detect intermittent problems.

(a) Clear the DTC (See step 3).
(b) Set the check (test) mode (See step 3).
(c) Perform a simulation test (See page IN–10).
(d) Check the connector and terminal (See page IN–20).
(e) Handle the connector (See page IN–20).

6. BASIC INSPECTION

When the malfunction code is not confirmed in the DTC check, troubleshooting should be carried out in order for all possible circuits to be considered as the cases of the problems.

In many cases, by carrying out the basic engine check shown in the following flow chart, the location causing the problem can be found quickly and efficiently. Therefore, use of this check is essential in engine troubleshooting.

1	Is battery positive voltage 11 V or more when engine is stopped?

NO → Charge or replace battery.

YES

2	Is engine cranked?

NO → Proceed to problem symptoms table on page DI–19.

YES

3	Check air filter (See page EM–1).

NG → Repair or replace.

OK

4	Check fuel quality.

CHECK:

- Check that use only diesel fuel.
- Check that the fuel does not contain any impurity.

NG → Replace fuel.

OK

5	Check engine oil (See page LU–1).

NG → Add or replace.

OK

6	**Check coolant (See page CO–1).**

NG → **Replace coolant.**

OK

7	**Check diagnostic connector (DLC3) circuit (See page DI–111).**

NG → **Repair or replace.**

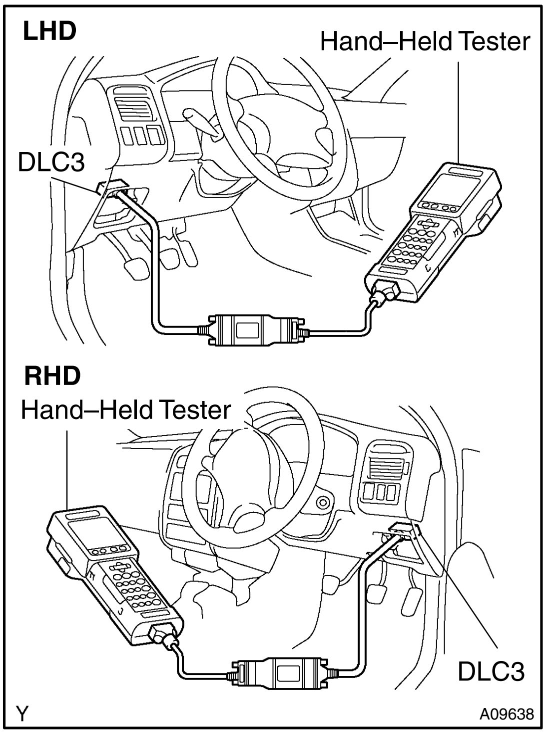
OK

8	**Check vacuum pump (See page EC–3).**

NG → **Repair or replace.**

OK

Proceed to problem symptoms table on page DI–19.



7. REFERENCE VALUE OF ENGINE ECU DATA

NOTICE:

The values given below for "Normal Condition" are representative values, so a vehicle may still be normal even if its values differ from those listed here. So do not decide whether a part is faulty or not solely according to the "Normal Condition" here.

HINT:

Engine engine ECU data can be monitored by hand–held tester.

(a) Connect the hand–held tester to the DLC3.

(b) Monitor engine ECU data by following the prompts on the tester screen.
Please refer to the hand–held tester operator's manual for further detail.

(c) Reference Value

Item	Inspection Condition	Reference Value
INJECTION VOLUME	Engine at idling*	3 – 10 mm^3/st
	Engine racing at 2,000 rpm*	3 – 10 mm^3/st
	Engine racing at 3,000 rpm*	5 – 12 mm^3/st
INJECTION TIMING	Engine at idling*	–0.5 – 1.5°CA
	Engine racing at 2,000 rpm*	1 – 3°CA
	Engine racing at 3,000 rpm*	2 – 4°CA
ENGINE SPD	RPM kept stable (Comparison with tachometer)	No great changes
PIM	Engine at idling*	87 – 107 kPa
	Engine racing at 2,000 rpm*	80 – 100 kPa
	Engine racing at 3,000 rpm*	95 – 125 kPa
ACCELE POSITION	Accelerator pedal fully closed	0 – 20 %
	Accelerator pedal fully opened	80 – 100 %
IDL SIG	Accelerator pedal full closed	700 – 800 rpm
STARTER SIG	During cranking	ON
A/C CUT SIG	A/C switch OFF	ON
EGR SYSTEM	Idling	ON
PS OIL PRESS SW	Power steering oil pressure switch signal	Turn steering wheel: ON
ACCEL CLOSE SW	Accelerator pedal fully closed	ON
AFM	Air Flow Rate Through Air Flow Meter	3 – 7 g/sec
COMN RAIL PRESS	Engine at idling*	27 – 37 Mpa
M – INJ/PILOT ON	Engine at idling*	500 – 1000 µs
M – INJ/PILOT OFF	Engine at idling*	0 µs
PILOT – INJ	Engine at idling*	430 – 530 µs
PUMP VCM ANGLE	Engine at idling*	70 – 90°CA

HINT:
*: All accessories and A/C are switched OFF.

DI31K–03

DIAGNOSTIC TROUBLE CODE CHART

HINT:
Parameters listed in the chart may not be exactly the same as you reading due to the type of instrument or other factors.
If a malfunction code is displayed during the DTC check in check (test) mode, check the circuit for the codes listed in the table below. For details of each code, turn to the page referred to under the "See page" for the respective "DTC No." in the DTC chart.

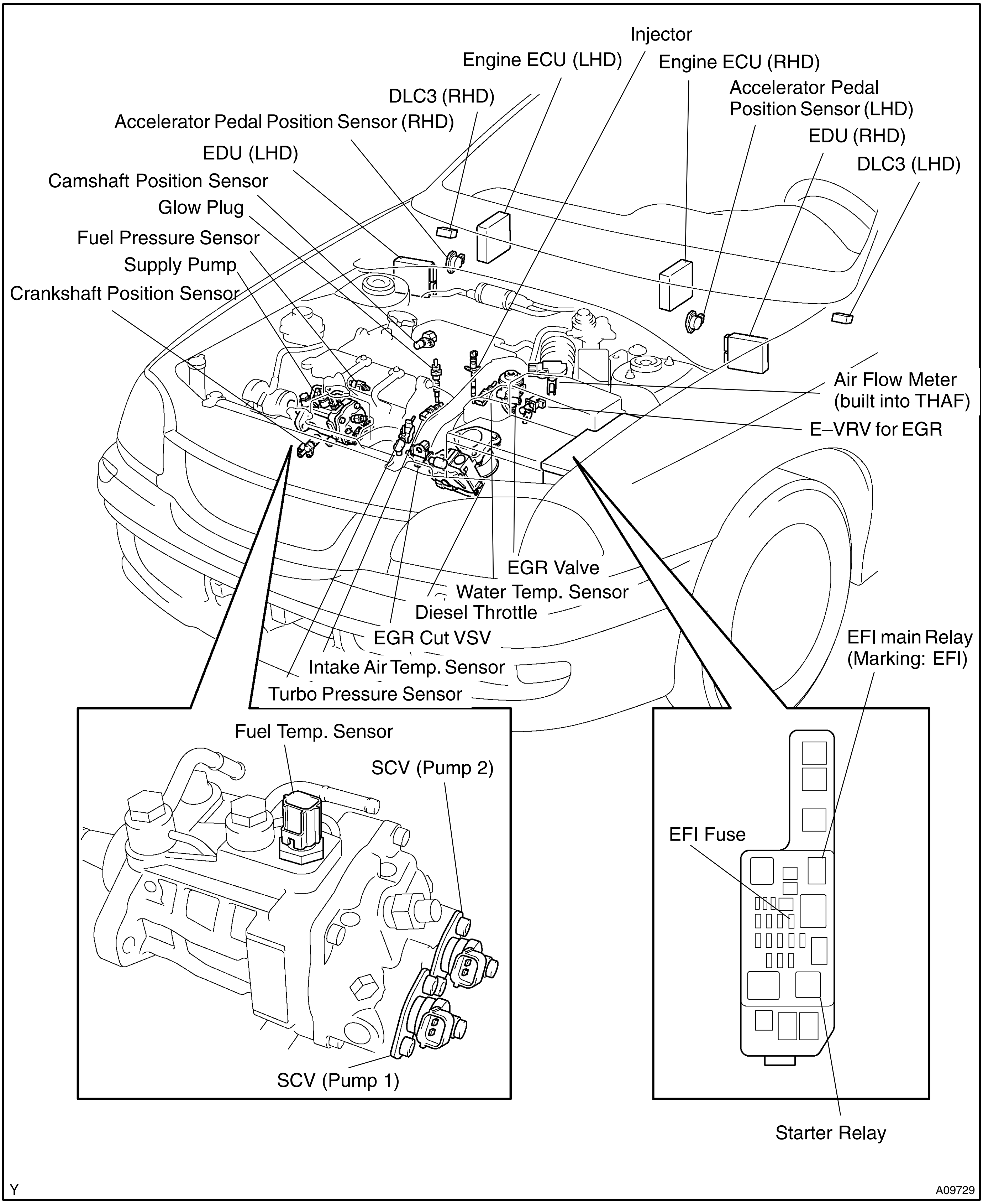
DTC No. (See page)	Detection Item	Trouble Area	*1 Check Engine Warning Light (Normal Mode/ Test Mode)	*2 Memory
12 (DI–22)	Engine speed Sensor Circuit Malfunction (TDC or G1 circuit)	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing pulley • Engine ECU	ON/ON	○
13 (DI–24)	Engine speed Sensor Circuit Malfunction (NE circuit)	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Crankshaft timing pulley • Engine ECU	ON/ON	○
15 (DI–26)	Throttle Control Motor Circuit Malfunction	• Open or short in throttle control motor circuit • Throttle control motor • Throttle valve • Engine ECU	ON/ON	○
19 (1) (DI–29)	Accelerator Pedal Position Sensor Circuit Malfunction (Open/ Short)	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • Engine ECU	ON/ON	○
19 (2) (DI–35)	Accelerator Pedal Position Sensor Circuit Malfunction (IDL Switch/Range)	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • Engine ECU	ON/ON	○
19 (3) (DI–40)	Accelerator Pedal Closed Position Switch Circuit Malfunction (Short)	• Open in accelerator pedal closed position switch circuit • Accelerator pedal closed position switch • Engine ECU	ON/ON	○
19 (4) (DI–40)	Accelerator Pedal Closed Position Switch Circuit Malfunction (Open)	• Short in accelerator pedal closed position switch circuit • Accelerator pedal closed position switch • Engine ECU	ON/ON	○
22 (DI–42)	Water Temp. Sensor Circuit Malfunction	• Open or short in water temp. sensor circuit • Water temp. sensor • Engine ECU	ON/ON	○
24 (1) (DI–47)	Intake Air Temp. Sensor Circuit Malfunction	• Open or short in intake air temp. sensor circuit • Intake air temp. sensor • Engine ECU	OFF/ON	○
24 (2) (DI–52)	Atmospheric Temp. Sensor Circuit Malfunction	• Open or short in atmospheric temp. sensor circuit • Atmospheric air temp. sensor (built into air flow meter) • Engine ECU	OFF/ON	○
31 (DI–57)	Air Flow Circuit Malfunction	• Open or short in air flow meter circuit • Air flow meter • Engine ECU	ON/ON	○
32 (DI–62)	Injector Correction Resistance Malfunction	• Open or short in injector correction resistance cuicuit • Injector correction resistance • Engine ECU	OFF/ON	○

35 (DI–64)	Turbo Pressure Sensor Circuit Malfunction	• Open or short in turbo pressure sensor circuit • Turbo pressure sensor • Open or short in VSV for turbo pressure sensor circuit • VSV for turbo pressure sensor • Vacuum hose disconnected or blocked • Engine ECU	ON/ON	○
39 (DI–71)	Fuel Temp. Sensor Circuit Malfunction	• Open or short in fuel temp. sensor circuit • Fuel pressure sensor • Engine ECU	ON/ON	○
42 (DI–76)	Vehicle Speed Sensor Signal Circuit Malfunction	• Open or short in vehicle speed sensor circuit • Vehicle speed sensor • Combination meter • Engine ECU	ON/ON	○
49 (DI–78)	Pressure Sensor Circuit Malfunction	• Open or short in fuel pressure sensor circiut for common rail • Fuel pressure sensor for common rail • Engine ECU	ON/ON	○
78(1) (DI–80)	Fuel pump Circuit Malfunction (Fuel Leakage)	• Open or short in EDU circuit • EDU • Open or short in injector circuit • Injector • Open or short in common rail pressure sensor circuit • Common rail pressure sensor • Fuel line between supply pump and common rail • Fuel line between common rail and injector • Pressure limiter • Engine ECU	ON/ON	○
78(2)(3) (DI–85)	Fuel pump Circuit Malfunction (Open Circuit) Fuel pump Circuit Malfunction (Over Force Feed)	• Open or short in SCV circuit • SCV • Supply pump • Engine ECU	ON/ON	○
97 (DI–89)	EDU Circuit Malfunction	• Open or short in EDU circuit • EDU • Open or short in SCV circit • SCV • Injector • Eghie ecu.	ON/ON	○
*3 99	Engine Immobilizer System Malfunction	• Open or short in engine immobilizer system circuit • Transponder key amplifier • Transponder key computer • Transponder key coil • Engine ECU	OFF/ON	○

*1: "ON" displayed in the diagnosis mode column indicates that the check engine warning light is lighted up when a malfunction is detected.
*2: "○" in the memory column indicates that a DTC code is recorded in the engine ECU memory when a malfunction occurs. Accordingly, output of diagnostic results in the normal or test mode is done with the ignition switch ON.
*3: See Pub. No. RM698E BE section.

DI31L–03

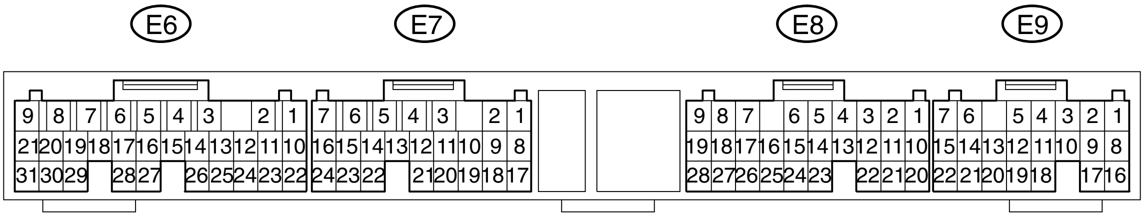
PARTS LOCATION



DI31M–03

TERMINALS OF ECU

Engine ECU Terminals



Y A09639

Symbols (Terminal No.)	Wiring Color	Condition	STD Voltage (V)
BATT (E9–2) – E1 (E6–22)	B–Y – BR	Always	9 – 14
+B (E9–1) – E1 (E6–22)	B–R – BR	IG switch ON	9 – 14
VC (E7–21) – E2 (E7–20)	R – L	IG switch ON	4.5 – 5.5
VCC (E8–8) – E2C (E8–27)	R – BR	IG switch ON	4.5 – 5.5
VA (E8–19) – E2C (E8–27)	L–B – BR	Accelerator pedal fully closed	0.6 – 1.3
		Accelerator pedal fully opened	2.8 – 4.5
VAS (E8–28) – E2C (E8–27)	L – BR	Accelerator pedal fully closed	0.6 – 1.3
		Accelerator pedal fully opened	2.8 – 4.5
IDL (E8–18) – E2C (E8–27)	G–R – BR	Accelerator pedal fully closed	9 – 14
		Accelerator pedal fully opened	0 – 3
PDL (E8–9) – E1 (E6–22)	B – BR	Accelerator pedal fully closed	9 – 14
		Accelerator pedal fully opened	0 – 3
PCR (E7–2) – E2 (E7–20)	G–W – L	IG switch ON	1.0 – 4.0
THAF (E7–13) – E2 (E7–20)	L–O – L	Atmospheric temp	0.5 – 3.8
PIM (E7–16) – E2 (E7–20)	LG – L	Apply vacuum 40 kPa (300 mmHg, 11.8 in.Hg)	1.0 – 1.8
		Apply vacuum 135 kPa (1,000 mmHg, 39.4 in.Hg)	2.3 – 3.2
THA (E7–22) – E2 (E7–20)	B–Y – L	Idling, air intake temp. 0°C (32°F) to 60°C (140°F)	0.2 – 3.8
THW (E7–14) – E2 (E7–20)	W – L	Idling, engine coolant temp. 60°C (140°F) to 120°C (248°F)	0.1 – 1.5
THF (E7–24) – E2 (E7–20)	Y–R – L	IG switch ON (at engine cold)	0.5 – 3.8
VG (E7–19) – EVG (E7–11)	V – GR–L	Idling, A/C switch OFF	0.5 – 3.0
IGSW (E9–9) – E1 (E6–22)	B – BR	IG switch ON	9 – 14
STA (E8–6) – E1 (E6–22)	B–W – BR	Cranking	6.0 or more
NE+ (E6–17) – NE– (E6–28)	L – B–W	Idling	Pulse generation (See page DI–24)
G+ (E6–16) – G– (E6–27)	B – W	Idling	Pulse generation (See page DI–22)
SP1 (E8–22) – E1 (E6–22)	G – BR	IG switch ON, Rotate driving wheel slowly	Pulse generation
EGR (E6 – 5) – E01 (E6–21)	W – BR	IG switch ON	9 – 14
		EGR ON	Pulse generation (See page DI–97)
PA (E7–17) – E01 (E6–21)	W – BR	VSV for atmospheric pressure leaning OFF	9 – 14
		VSV for atmospheric pressure leaning ON	0 – 3

#1 (E6–4) – E01 (E6–21)	L – BR	Idling	Pulse generation (See page DI–89)
#2 (E6–14) – E01 (E6–21)	L–B – BR		
#3 (E6–3) – E01 (E6–21)	L–R – BR		
#4 (E6–15) – E01 (E6–21)	L–W – BR		
INJF (E6–18) – E01 (E6–22)	Y–G – BR	Idling	Pulse generation
MREL (E9–7) – E01 (E6–21)	B–O – BR	IG switch ON	9 – 14
AC1 (E8–24) – E1 (E6–22)	L–B – BR	A/C switch ON (at idling)	0 – 1.5
		A/C switch OFF	9 – 14
TAC (E8–10) – E1 (E6–22)	B – BR	Idling	Pulse generation
SREL (E9–16) – E01 (E6–21)	G–R – BR	IG switch ON	9 – 14
W (E9–12) – E1 (E6–22)	Y–B – BR	Check engine warning light lights up	0 – 3
		Except check engine warning light lights up	9 – 14
GIND (E9–3) – E1 (E6–22)	R–W – BR	Glow indicator light lights up	0 – 3
		Except glow indicator light lights up	9 – 14
ACT (E8–13) – E1 (E6–22)	P – BR	IG switch ON	9 – 14
		At A/C cut controlled (Driving below 30 km/h, accelerator pedal fully opened for 5 sec.)	0 – 3
THWO (E9–6) – E1 (E6–22)	Y–G – BR	IG switch ON	Pulse generation (See page DI–107)
LU+A (E6–20) – E1 (E6–22)	P – BR	IG switch ON	Pulse generation
LU–A (E6–30) – E1 (E6–22)	P–L – BR	IG switch ON	Pulse generation
LU+B (E6–19) – E1 (E6–22)	P–B – BR	IG switch ON	Pulse generation
LU–B (E6–29) – E1 (E6–22)	L–O – BR	IG switch ON	Pulse generation
TC (E9–18) – E1 (E6–22)	R – BR	IG switch ON	9 – 14
EGRC (E6–1) – E1 (E6–22)	B–Y – BR	IG switch ON	0 – 3
		Maintain engine speed at 1500 rpm after warming up	9 – 14
SIL (E9–19) – E1 (E6–22)	W – BR	Connect hand–held tester to DLC3	Pulse generation
IMI (E9–14) – E1 (E6–22)	B – BR	Idling	Pulse generation
IMO (E9–21) – E1 (E6–22)	B–W – BR	A few sec. after engine staring	Pulse generation

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PROBLEM SYMPTOMS TABLE

When the malfunction code is not confirmed the DTC check and the problem still can not be confirmed in the basic inspection, then proceed to this step and perform troubleshooting according to the numbered order given in the table below.

Symptom	Suspect Area	See page
Does not crank (Difficult to start)	1. Starter 2. Starter relay 3. Water temp. sensor	ST–6 ST–14 ED–10
Cold engine (Difficult to start)	1. STA signal circuit 2. Injector 3. Fuel filter 4. Engine ECU 5. Supply pump 6. Fuel pressure sensor 7. Diesel throttle	DI–115 FU–4 FU–1 ED–20 FU–13 ED–13 ED–5
Hot engine (Difficult to start)	1. STA signal circuit 2. Injector 3. Fuel filter 4. Compression 5. Engine ECU 6. Supply pump 7. Fuel pressure sensor 8. Diesel throttle	DI–115 FU–4 FU–1 EM–2 ED–20 FU–13 ED–13 ED–5
Soon after starting (Engine stall)	1. Fuel filter 2. Injector 3. ECU power source circuit 4. Engine ECU 5. Supply pump 6. Fuel pressure sensor 7. Diesel throttle	FU–1 FU–4 DI–93 ED–20 FU–13 ED–13 ED–5
Others (Engine stall)	1. ECU power source circuit 2. Injector 3. Engine ECU 4. Supply pump 5. Fuel pressure sensor 6. Diesel throttle	DI–93 FU–4 ED–20 FU–13 ED–13 ED–5
Incorrect first idle (Poor idling)	1. Fuel filter 2. Injector 3. Engine ECU 4. Supply pump 5. Fuel pressure sensor	FU–1 FU–4 ED–20 FU–13 ED–13
High engine idle speed (Poor idling)	1. A/C signal circuit 2. Injector 3. STA signal circuit 4. Engine ECU 5. Supply pump 6. Fuel pressure sensor	DI–104 FU–4 ED–10 ED–20 FU–13 ED–13

Lower engine idle speed (Poor idling)	1. A/C signal circuit 2. Injector 3. EGR control circuit 4. Compression 5. Valve clearance 6. Fuel line (Air beed) 7. Engine ECU 8. Supply pump 9. Fuel pressure sensor 10.Diesel throttle	DI–104 FU–4 DI–97 EM–2 EM–5 – ED–20 FU–13 ED–13 ED–5
Rough idling (Poor idling)	1. Injector 2. Fuel line (Air beed) 3. EGR control circuit 4. Compression 5. Valve clearance 6. Engine ECU 7. Supply pump 8. Fuel pressure sensor 9. Diesel throttle	FU–4 – DI–97 EM–2 EM–5 ED–20 FU–13 ED–13 ED–5
Hunting at hot engine (Poor idling)	1. Injector 2. ECU power source circuit 3. Compression 4. Fuel line (Air beed) 5. Valve clearance 6. Engine ECU 7. Supply pump 8. Fuel pressure sensor 9. Diesel throttle	FU–4 DI–93 EM–2 – EM–5 ED–20 FU–13 ED–13 ED–5
Hunting at cold engine (Poor idling)	1. Injector 2. ECU power source circuit 3. Compression 4. Fuel line (Air beed) 5. Valve clearance 6. Engine ECU 7. Supply pump 8. Fuel pressure sensor 9. Diesel throttle	FU–4 DI–93 EM–2 – EM–5 ED–20 FU–13 ED–13 ED–5
Hesitation/ Poor acceleration (Poor driveability)	1. Injector 2. Fuel filter 3. EGR control circuit 4. Compression 5. Engine ECU 6. Supply pump 7. Fuel pressure sensor 8. Diesel throttle	FU–4 FU–1 DI–97 EM–2 ED–20 FU–13 ED–13 ED–5
Knocking (Poor driveability)	1. Injector 2. EGR control circuit 3. Engine ECU 4. Supply pump 5. Fuel pressure sensor	FU–4 DI–97 ED–20 FU–13 ED–13
Black smoke (Poor driveability)	1. Injector 2. EGR control circuit 3. Engine ECU 4. Supply pump 5. Fuel pressure sensor 6. Diesel throttle	FU–4 DI–97 ED–20 FU–13 ED–13 ED–5

White smoke (Poor driveability)	1. EGR control circuit 2. Injector 3. Fuel filter 4. Engine ECU 5. Supply pump 6. Fuel pressure sensor 7. Diesel throttle	DI–97 FU–4 FU–1 FU–1 FU–13 ED–13 ED–5
Surging/ Hunting (Poor driveability)	1. Injector 2. Engine ECU 3. Supply pump 4. Fuel pressure sensor	FU–4 ED–20 FU–13 ED–13

DI31O–03

CIRCUIT INSPECTION

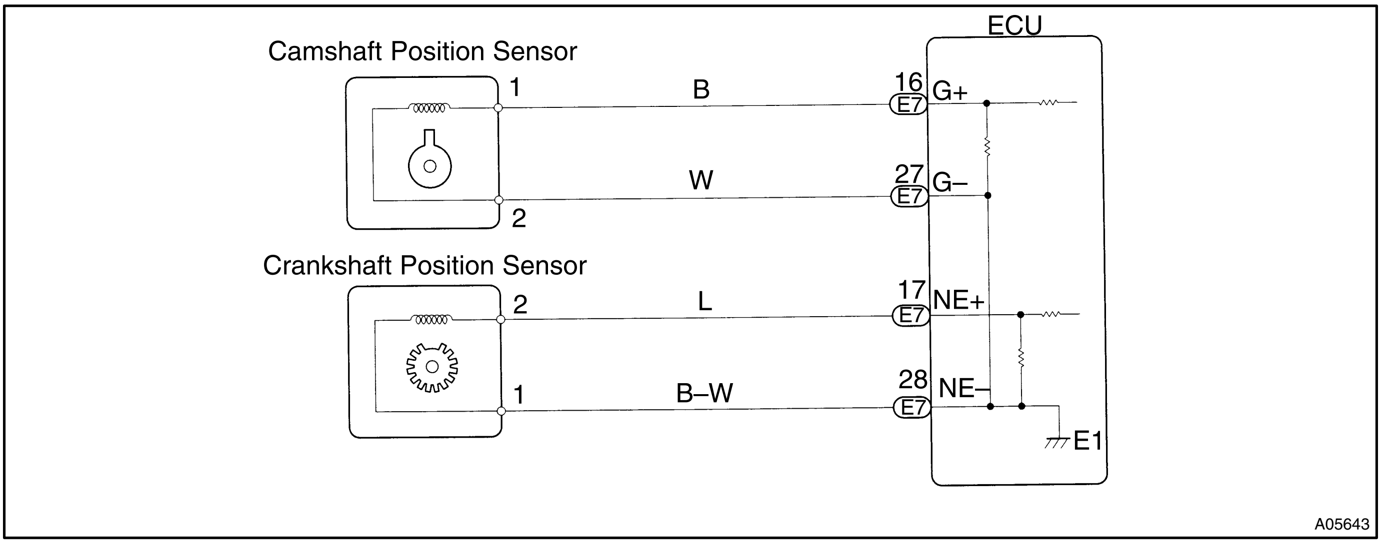
DTC	12	Engine Speed Sensor Circuit Malfunction 1 (TDC or G1 Circuit)

CIRCUIT DESCRIPTION

Camshaft position sensor (G1 signal) consists of a magnet, iron core and pickup coil.
The G1 signal plate has one tooth on its outer circumference and is installed the camshaft timing pulley. When the camshafts rotate, the protrusion on the signal plate and the air gap on the pickup coil change, causing fluctuations in the magnetic field and generating an electromotive force in the pickup coil.
The NE signal plate has 34 teeth and is mounted on the crankshaft timing pulley. The NE signal sensor generates 34 signals at every engine revolution. The engine ECU detects the standard crankshaft angle based on the G1 signal and the actual crankshaft angle and the engine speed by the NE signal.

DTC No.	DTC Detecting Condition	Trouble Area
12	No camshaft position sensor signal to ECU during cranking No camkshaft position sensor signal to ECU with engine speed 650 rpm or more	• Open or short in camkshaft position sensor circuit • Camshaft position sensor • Camshaft timing pulley • Engine ECU

WIRING DIAGRAM

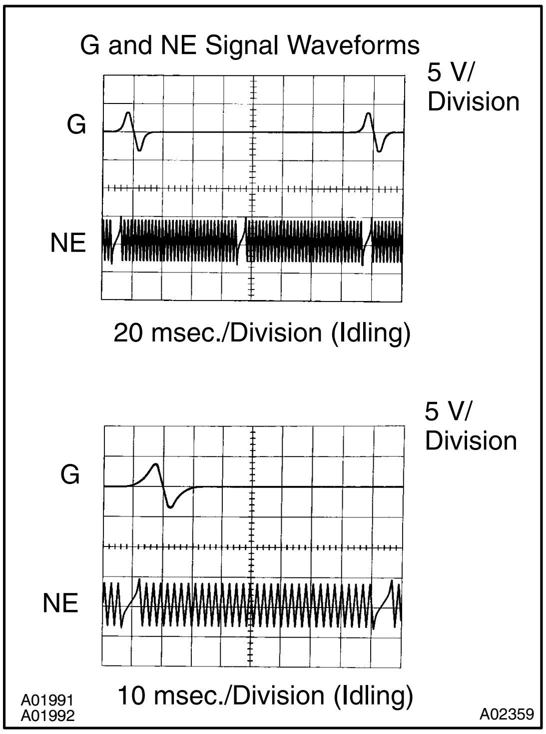


INSPECTION PROCEDURE

HINT:

- Perform troubleshooting of DTC 12 first. If no trouble is found, troubleshoot the following mechanical system.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

1	Check resistance of camshaft position sensor (See page ED–15).



Reference: INSPECTION USING OSCILLOSCOPE
During cranking or idling, check the wavefiorms between terminals G and G–, and NE and NE– of the ECU connector.
HINT:
The correct waveforms are as shown.

NG → **Replace camshaft position sensor.**

OK

2	Check for open and short in harness and connector between ECU and camshaft position sensor (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

3	Inspect sensor installation and signal plate tooth of camshaft timing pulley.

NG → **Tighten sensor. Replace camshaft timing pulley.**

OK

Check and replace ECU (See page IN–20).

DI31P–03

DTC	13	Engine Speed Sensor Circuit Malfunction 2 (NE Circuit)

CIRCUIT DESCRIPTION

Crankshaft position sensor (NE signal) consists of a magnet, iron core and pickup coil.
The NE signal plate has 34 teeth and is installed the crankshaft timing pulley. The NE signal sensor generates 34 signals of every engine revolution. The ECU detects the standard crankshaft angle based on the G1 signal, and the actual crankshaft angle and the engine speed by the NE signal.

DTC No.	DTC Detecting Condition	Trouble Area
13	No crankshaft position sensor signal to engine ECU for 0.5 sec. or more at 650 rpm or more	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Crankshaft timing pulley • Engine ECU
	No crankshaft position sensor signal to engine ECU for 2.0 sec. or more during cranking	

WIRING DIAGRAM

Refer to DTC12 on page DI–22.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

1	Check resistance of crankshaft position sensor (See page ED–16).

Reference: INSPECTION USING OSCILLOSCOPE
Refer to DTC 12 on page DI–22.

NG → **Replace crankshaft position sensor (See page ED–16).**

OK

2	Check for open and short in harness and connector between engine ECU and crankshaft position sensor (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

3	Inspect sensor installation and signal plate teeth of crankshaft timing pulley.

NG → **Tighten sensor. Replace crankshaft timing pulley**

OK

Check and replace engine ECU
(See page IN–20).

DI2UG–03

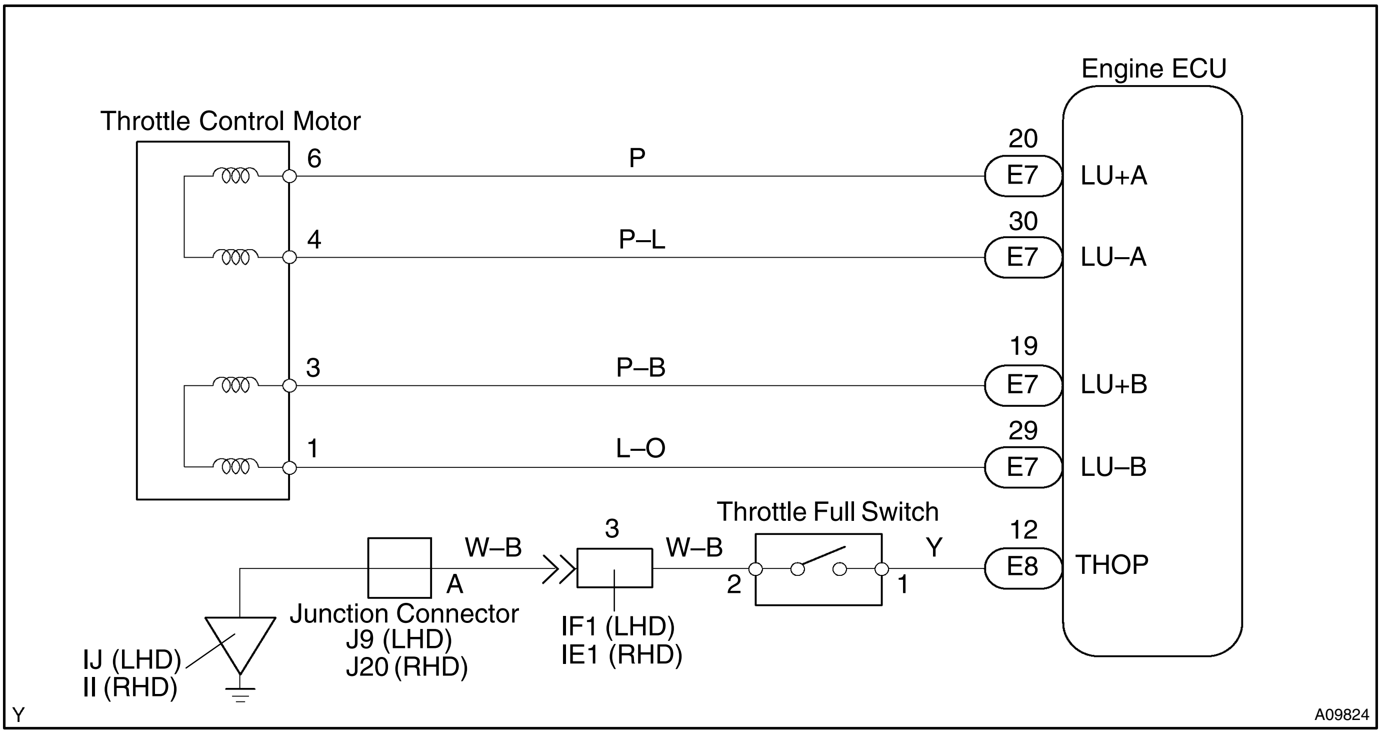
DTC	15	Throttle Control Motor Circuit Malfunction

CIRCUIT DESCRIPTION

Throttle control motor is operated by the engine ECU and it opens and closes the throttle valve.
The fully opening of the throttle valve is detected by the throttle fully open position switch which is mounted on the throttle body.
If this DTC is stored, the engine ECU shuts down the power for the throttle control motor.

DTC No.	DTC Detecting Condition	Trouble Area
15	Open or short in throttle control motor circuit Open or short in throttle full switch circuit	• Open or short in throttle control motor circuit • Throttle control motor • Throttle valve • Throttle drive gear • Diesel throttle body • Engine ECU

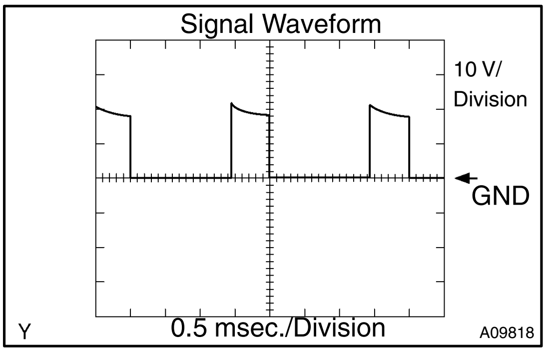
WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

1	Check throttle control motor circuit.



PREPARATION:
(a) Connect the oscilloscope between terminals LU+A/LU–A/LU+B/LU–B and E01 of the engine ECU.
(b) Start the engine.

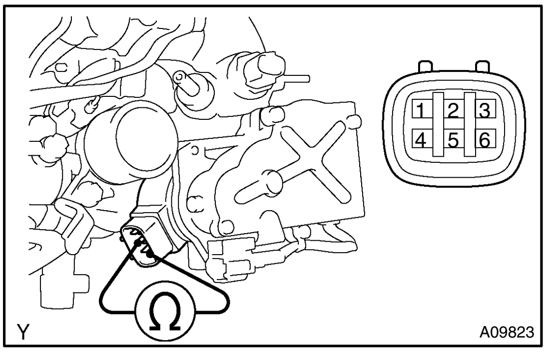
CHECK:
Check the waveform between terminals LU+A/LU–A/LU+B/LU–B and E01 of the engine ECU when the engine is racing.

OK:
The correct waveforms are as shown.

OK → **Check and replace engine ECU (See page IN–20).**

NG

2	Check throttle control motor.



PREPARATION:
Disconnect the throttle control motor connector.

CHECK:
- Measure the resistance between terminals 1/3 and 2 of the throttle control motor.
- Measure the resistance between terminals 4/6 and 5 of the throttle control motor.

OK:
Resistance: 18 – 22 Ω at 20°C (68°F)

NG → **Replace diesel throttle body assembly (See page ED–3).**

OK

3	Check for open and short in harness and connector between throttle control motor and engine ECU (See page IN–20).

NG → **Repair or replace.**

OK

Check and replace engine ECU
(See page ED–19).

DI31S–03

DTC	19 (1)	Accelerator Pedal Position Sensor Circuit Malfunction (Open/Short)

CIRCUIT DESCRIPTION

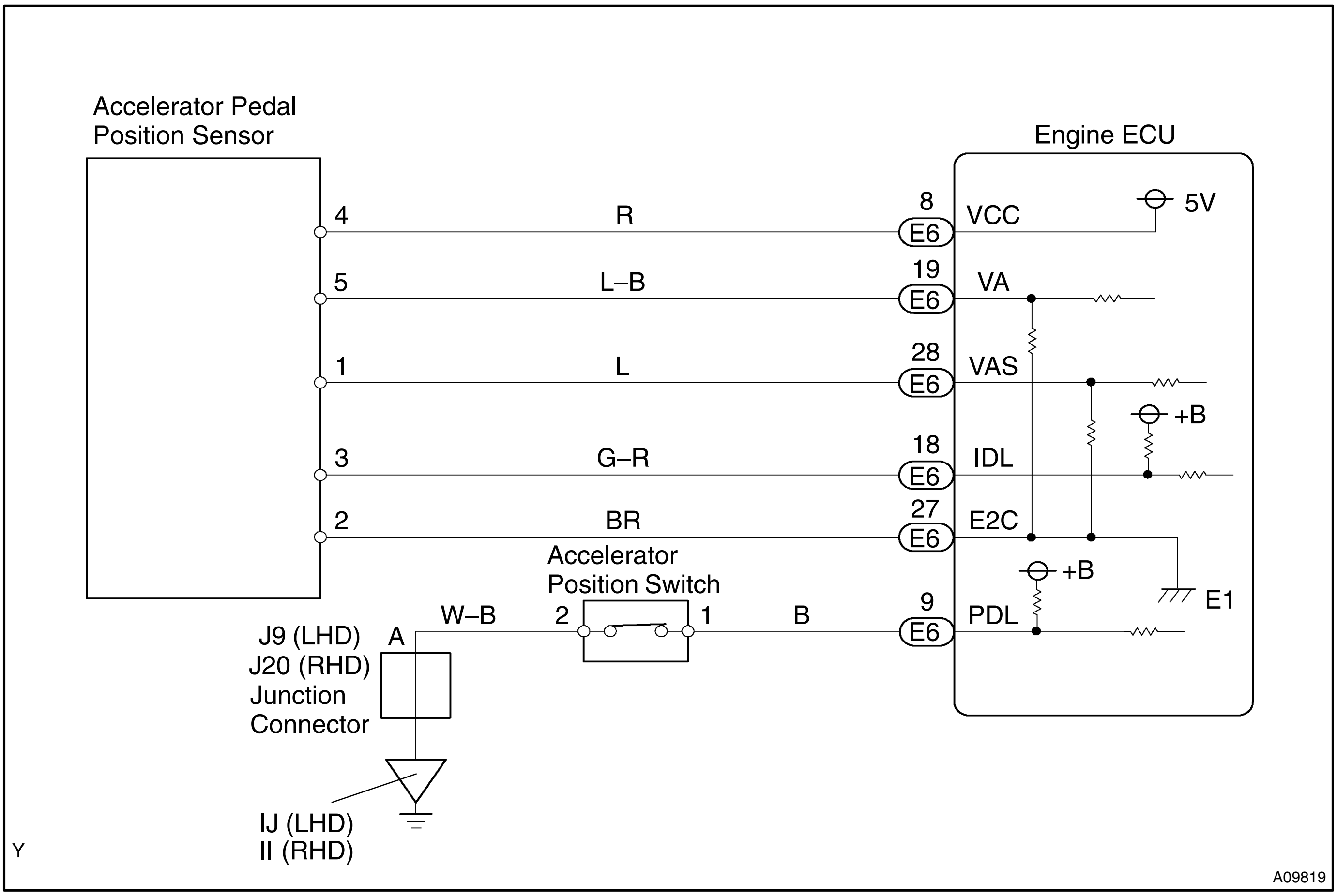
The accelerator pedal position sensor is mounted at the accelerator pedal and detects the accelerator pedal opening angle. When the accelerator pedal is fully closed, a voltage of approximately 0.9 V is applied to terminals VA, VAS of the engine ECU. The voltage applied to terminals VA, VAS of the engine ECU increases in proportion to the opening angle of the accelerator pedal and becomes approximately 3.8 V when the accelerator pedal is fully opened. The engine ECU judges the vehicle driving conditions from these signals input from terminals VA, VAS and uses them as one of the conditions to control the injection volume and diesel throttle valve position. The idle switch is mounted in the accelerator pedal position sensor and sends the IDL signal to the engine ECU when accelerator pedal is fully closed.
This system has 2 way accelerator pedal position sensor and accelerator pedal closed position switch for fail safe.

DTC No.	DTC Detecting Condition	Trouble Area
19 (1)	Open or short in accelerator pedal position sensor circuit for 0.05 sec. or more	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • Engine ECU

HINT:
After confirming DTC 19 (1), use the hand–held tester to confirm the accelerator pedal opening percentage and accelerator pedal close position switch condition.

Accelerator pedal opening position expressed as percentage		Trouble area
Accelerator pedal fully closed	Accelerator pedal fully open	
0 %	0 %	• VCC circuit open • VA, VAS circuit open or short
Approx. 100 %	Approx. 100 %	• E2C circuit open

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect the hand–held tester, read accelerator pedal opening percentage.**

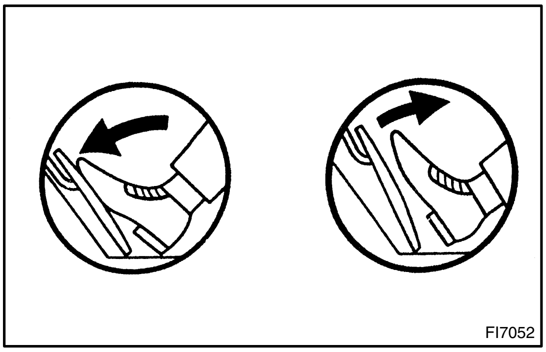
PREPARATION:

(a) Connect the hand–held tester to the DLC3.

(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:

Read the accelerator pedal opening percentage.



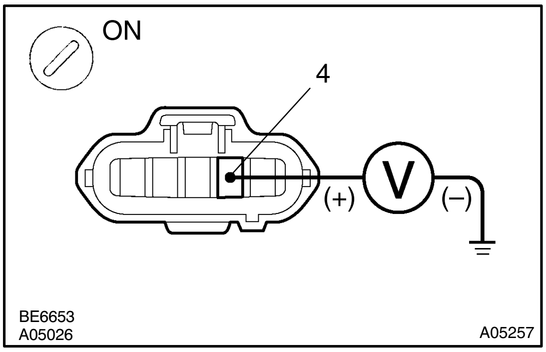
OK:

Accelerator pedal	Accelerator pedal opening position expressed as percentage
Fully open	Approx. 65 %
Fully closed	Approx. 18 %

OK	**Check for intermittent problems (See page DI–4).**

NG

2	**Check voltage between terminal 4 of wire harness side connector and body ground.**



PREPARATION:

(a) Disconnect the accelerator pedal position sensor connector.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminal 4 of the wire harness side connector and body ground.

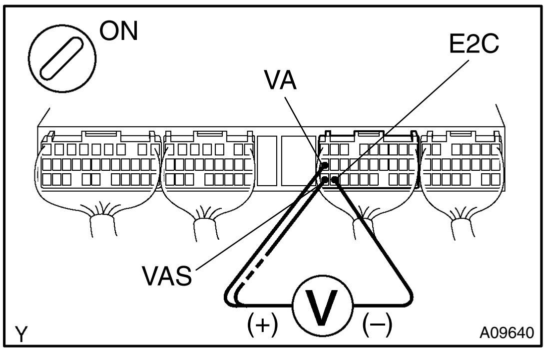
OK:

Voltage: 4.5 – 5.5 V

NG → **Go to step 5.**

OK

3	**Check voltage between terminals VA and E2C, and VAS and E2C of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals VA and E2C, and VAS and E2C of the engine ECU connector.

OK:

Accelerator pedal	Voltage
Fully closed	0.6 – 1.3 V
Fully open	2.8 – 4.5 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

4	**Check for open and short in harness and connector in VA and VAS circuits between engine ECU and accelerator pedal position sensor (See page IN–20).**

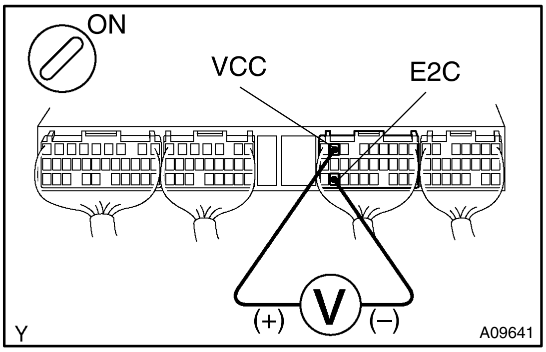
NG

Repair or replace harness or connector.

OK

Replace accelerator pedal position sensor.

5	**Check voltage between terminals VCC and E2C of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals VCC and E2C of the engine ECU connector.

OK:

Voltage: 4.5 – 5.5 V

NG

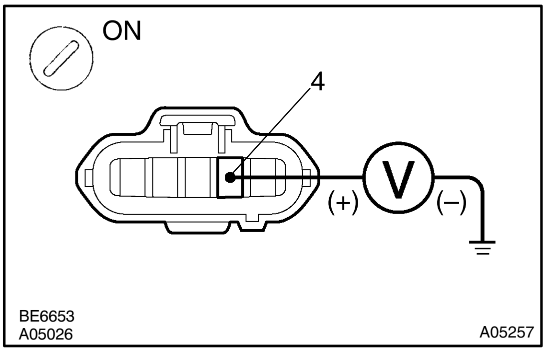
Check and replace engine ECU (See page IN–20).

OK

Check for open in harness and connector in VCC circuit between engine ECU and accelerator pedal position sensor (See page IN–20).

When not using hand–held tester:

1	**Check voltage between terminal 4 of wire harness side connector and body ground.**



PREPARATION:

(a) Disconnect the accelerator pedal position sensor connector.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminal 4 of the wire harness side connector and body ground.

OK:

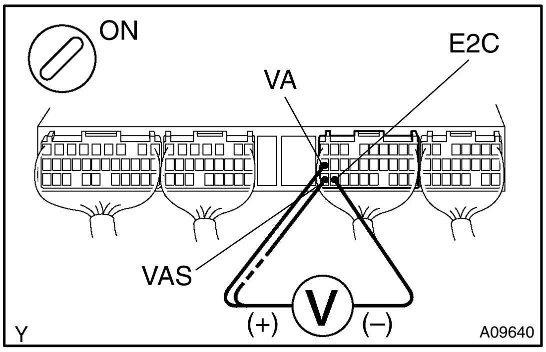
Voltage: 4.5 – 5.5 V

NG

Go to step 4.

OK

2	**Check voltage between terminals VA and E2C, and VAS and E2C of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals VA and E2C, and VAS and E2C of the engine ECU connector.

OK:

Accelerator pedal	Voltage
Fully closed	0.6 – 1.3 V
Fully open	2.8 – 4.5 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

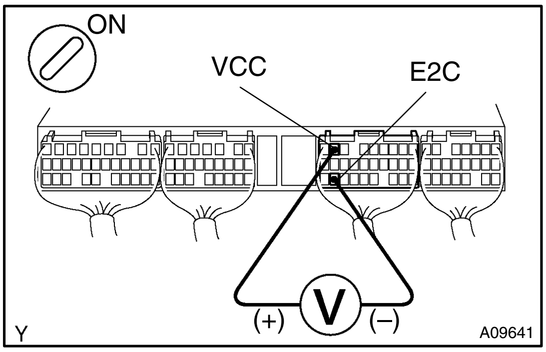
3	**Check for open and short in harness and connector in VA and VAS circuits between engine ECU and accelerator pedal position sensor (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

Replace accelerator pedal position sensor.

4	**Check voltage between terminals VCC and E2C of engine ECU connector.**



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals VCC and E2C of the engine ECU connector.

OK:
Voltage: 4.5 – 5.5 V

NG → **Check and replace engine ECU (See page IN–20).**

OK

Check for open in harness and connector in VCC circuit between engine ECU and accelerator pedal position sensor (See page IN–20).

DI31T–03

DTC	19 (2)	Accelerator Pedal Position Sensor Circuit Malfunction (IDL Switch/Range)

CIRCUIT DESCRIPTION

Refer to DTC 19 (1) on page DI–29.

DTC No.	DTC Detecting Condition	Trouble Area
19(2)	Condition (a) or (b) continues 0.5 sec. or more: (a) IDL ON and VA > 1.4 V (b) IDL ON and VAS >1.4 V	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • Engine ECU
	Condition (a) or (b) continues 0.5 sec. or more: (a) IDL OFF and VA < 0.6 V (b) IDL OFF and VAS < 0.6 V	
	Conditions (a) and (b) continue 0.05 sec. or more: (a) 0.6 V < VA < 4.4 V and 0.6 V < VAS < 4.4 V (b) VA – VAS > 0.5 V	

WIRING DIAGRAM

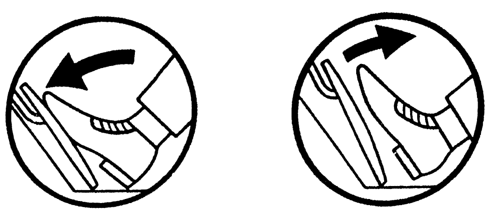
Refer to DTC 19 (1) on page DI–29.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect hand–held tester, read IDL signal.**



FI7052

PREPARATION:
(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:
Read the IDL signal.

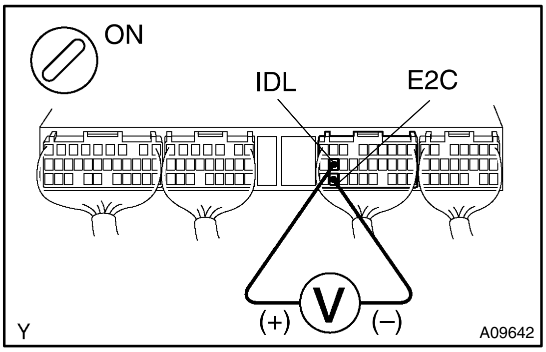
OK:

Accelerator Pedal	IDL Signal
Fully open	OFF
Fully closed	ON

OK → **Go to step 4.**

NG

2	Check voltage between terminals IDL and E2C of engine ECU connector.



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals IDL and E2C of the engine ECU connector.

OK:

Accelerator Pedal	Voltage
Fully closed	9 – 14 V
Fully open	0 – 3 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

3	Check for open and short in harness and connector in IDL circuit between engine ECU and accelerator pedal position sensor (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

Replace accelerator pedal position sensor.

4	Connect the hand–held tester, read the accelerator pedal operating percentage (See page DI–29, step 1).

OK → **Check for intermittent problems (See page DI–4).**

OK

5	Check voltage between terminal VCC of wire harness side connector and body ground (See page DI–29, step 2).

NG → Go to step 8.

OK

6	Check voltage between terminals VA and E2C, and VAS and E2C of engine ECU connector (See page DI–29, step 3).

OK → Check and replace engine ECU (See page IN–20).

NG

7	Check for open and short in harness and connector in VA and VAS circuits between engine ECU and accelerator pedal position sensor (See page IN–20).

NG → Repair or replace harness or connector.

OK

Replace accelerator pedal.

8	Check voltage between terminals VCC and E2C of engine ECU connector (See page DI–29, step 5).

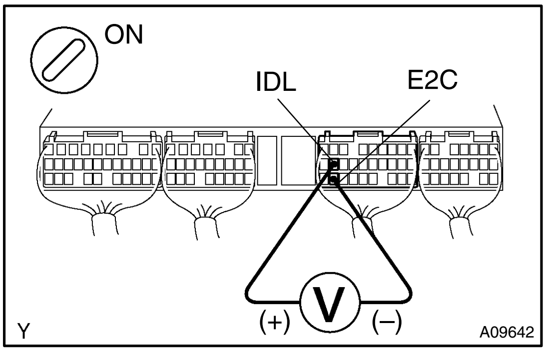
NG → Check and replace engine ECU (See page IN–20).

OK

Check for open in harness and connecter in VCC circuit between engine ECU and accelerator pedal position sensor (See page IN–20).

When not using hand–held tester:

1	Check voltage between terminals IDL and E2C of engine ECU connector.



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals IDL and E2C of the engine ECU connector.

OK:

Accelerator Pedal	Voltage
Fully closed	9 – 14 V
Fully open	0 – 3 V

OK → **Go to step 3.**

NG

2	Check for open and short in harness and connector in IDL circuit between engine ECU and accelerator pedal position sensor (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

Replace accelerator pedal position sensor.

3	Check voltage between terminal 4 of wire harness side connector and body ground (See page DI–29, step 2).

NG → **Go to step 6.**

OK

4	**Check voltage between terminals VA and E2C, and VAS and E2C of engine ECU connector (See page DI–29, step 3).**

OK → **Check and replace engine ECU (See page IN–20).**

NG

5	**Check for open and short in harness and connector in VA and VAS circuits between engine ECU and accelerator pedal position sensor (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

Replace accelerator pedal position sensor.

6	**Check voltage between terminals VCC and E2C of engine ECU connector (See page DI–29, step 5).**

NG → **Check and replace engine ECU (See page IN–20).**

OK

Check for open in harness and connector in VCC circuit between engine ECU and accelerator pedal position sensor (See page IN–20).

DI31U–03

DTC	19 (3)	Accelerator Pedal Closed Position Switch Circuit Malfunction (Short)

DTC	19 (4)	Accelerator Pedal Closed Position Switch Circuit Malfunction (Open)

CIRCUIT DESCRIPTION

Refer to DTC 19 (1) on page DI–29.

DTC No.	DTC Detecting Condition	Trouble Area
19 (3)	Conditions (a) and (b) continue 0.5 sec. or more: (a) PDL ON (b) VA > Fully closed study voltage +0.41 V	• Short in accelerator pedal closed position switch circuit • Accelerator pedal closed position switch • Engine ECU
19 (4)	PDL does not turn ON even once while driving vehicle (2 trip detection logic)	• Open in accelerator pedal closed position switch circuit • Accelerator pedal closed position switch • Engine ECU
	Conditions (a) and (b) continue 5 sec. or more: (a) PDL OFF (b) IDL ON	

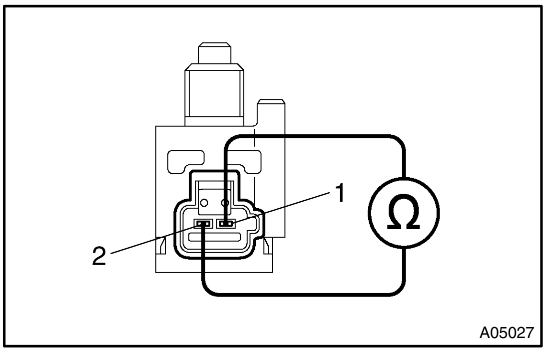
WIRING DIAGRAM

Refer to DTC 19 (1) on page DI–29.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

1	**Check accelerator pedal closed position switch.**



PREPARATION:
Disconnect the accelerator pedal closed position switch connector.

CHECK:
Measure the resistance between terminals of the accelerator pedal closed position switch.

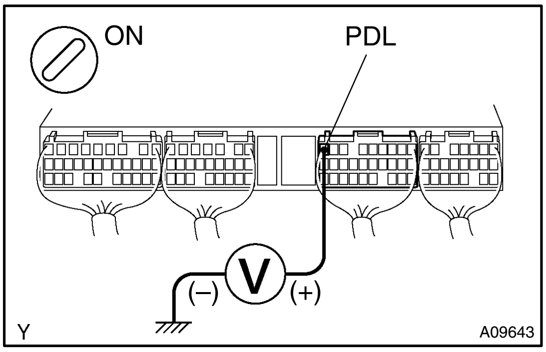
OK:

Terminals	Accelerator Pedal	Resistance
1 – 2	Fully closed	∞
1 – 2	Fully open	0 – 20 Ω

NG	**Replace accelerator pedal closed position switch (See page ED–17).**

OK

2	**Check voltage between terminal PDL of engine ECU connector and body ground.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminal PDL of the engine ECU connector and body ground.

OK:

Accelerator Pedal	Voltage
Fully closed	9 – 14 V
Fully open	0 – 3 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

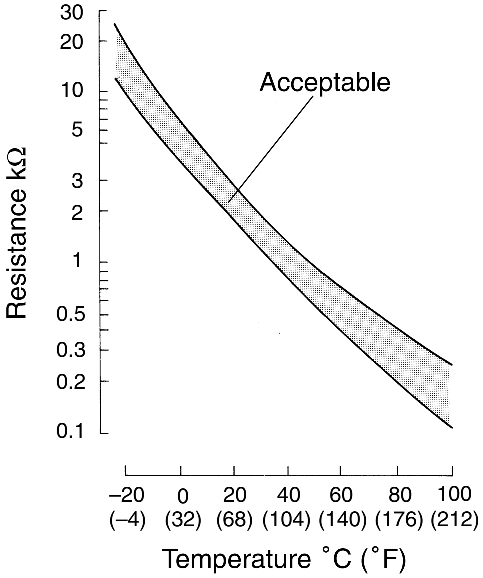
Check for open and short in harness and connector between engine ECU and accelerator pedal closed position switch and body ground (See page IN–20).

DI3S7–02

DTC	22	Water Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Fig. 1



FI4741

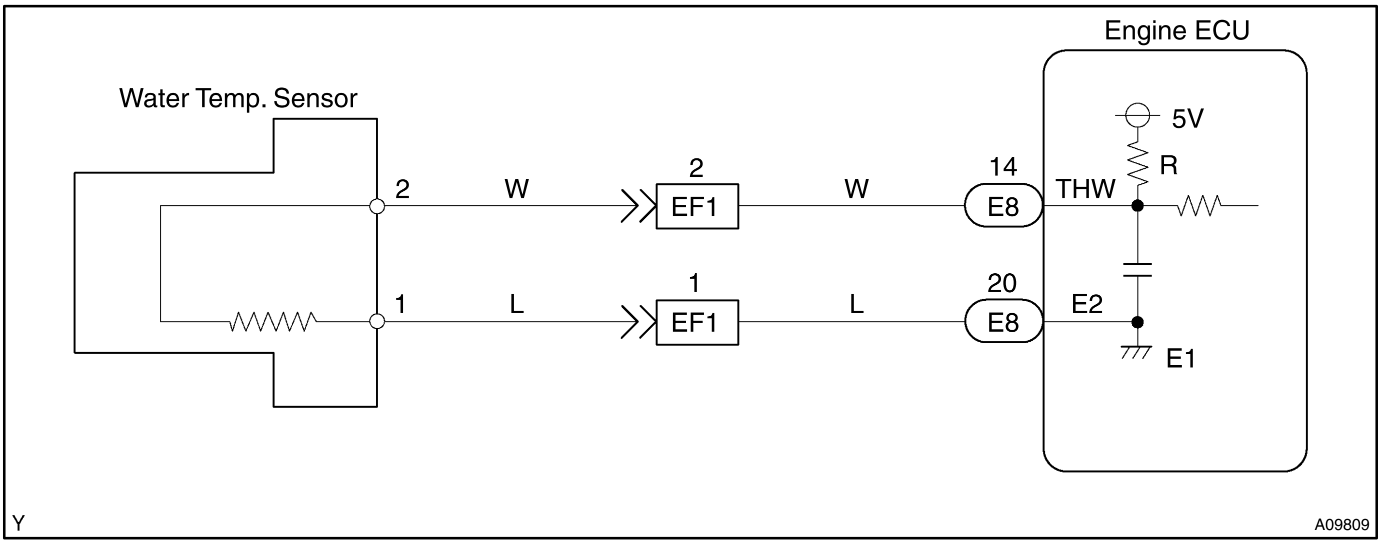
The water temperature sensor senses the coolant temperature. A thermistor built into the sensor changes the resistance value according to the coolant temperature. The lower the coolant temperature, the greater the thermistor resistance value, and the higher the coolant temperature, the lower the thermistor resistance value (See Fig. 1).
The water temperature sensor is connected to the engine ECU (See below). The 5 V power source voltage in the engine ECU is applied to the water temperature sensor from the terminal THW via a resistor R. That is, resistor R and the water temperature sensor are connected in series. When the resistance value of the water temperature sensor changes in accordance with changes in the coolant temperature, the potential at the terminal THW also changes. Based on this signal, the engine ECU increases the fuel injection volume to improve driveability during cold engine operation.

DTC No.	DTC Detecting Condition	Trouble Area
22	Open or short in water temp. sensor circuit for 0.5 sec. or more	• Open or short in water temp. sensor circuit • Water temp. sensor • Engine ECU

HINT:
After confirming DTC 22, use the hand–held tester to confirm the water temperature from the CURRENT DATA.

Temperature displayed	Malfunction
–40°C (–40°F)	Open circuit
140°C (284°F) or more	Short circuit

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTCs 22, 24 and 39 are output simultaneously, E2 (sensor ground) may be open.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect hand–held tester, and read value of water temperature.**

PREPARATION:

(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

Same as actual water temperature.

HINT:

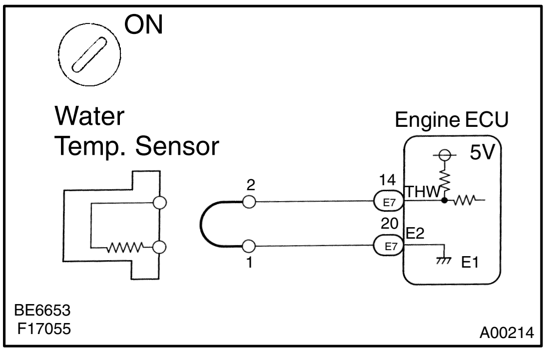
- If there is open circuit, hand–held tester indicates –40˚C (–40˚F).
- If there is short circuit, hand–held tester indicates 140˚C (284˚F) or more.

NG → **–40˚C (–40˚F) ... Go to step 2.**
140˚C (284˚F) or more ... Go to step 4.

OK

Check for intermittent problems
(See page DI–4).

2	**Check for open in harness or engine ECU.**



PREPARATION:

(a) Disconnect the water temperature sensor connector.
(b) Connect the sensor wire harness terminals together.
(c) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

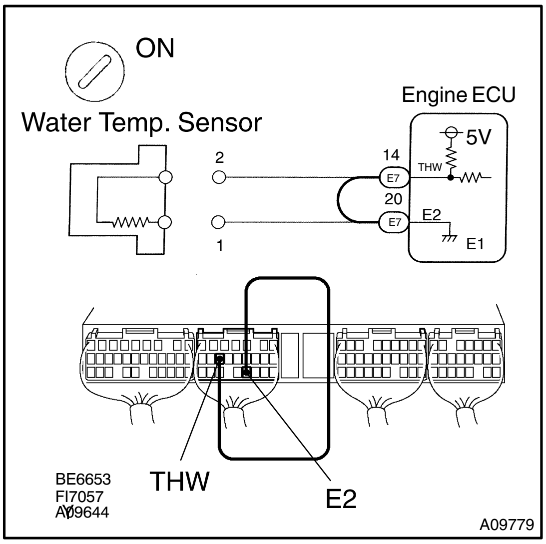
OK:

Temperature value: 140°C (284°F) or more

OK → **Confirm good connection at sensor. If OK, replace water temperature sensor.**

NG

3	**Check for open in harness or engine ECU.**



PREPARATION:

(a) Remove the glove compartment.
(b) Connect between terminals THW and E2 of the engine ECU connector.

HINT:

The water temperature sensor connector is disconnected. Before checking, do a visual and contact pressure check for the engine ECU connector (See page IN–20).

(c) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

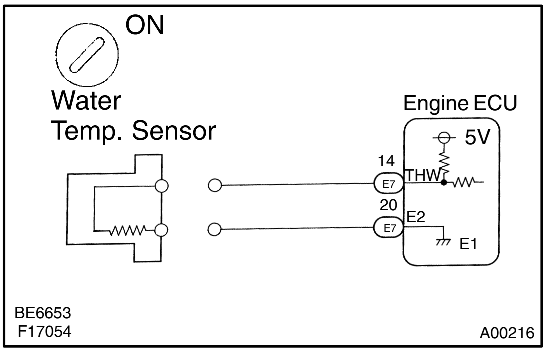
Temperature value: 140°C (284°F) or more

OK → **Open in harness between terminal E2 or THW, repair or replace harness.**

NG

Confirm good connection at engine ECU. If OK, replace engine ECU.

4	Check for short in harness and engine ECU.

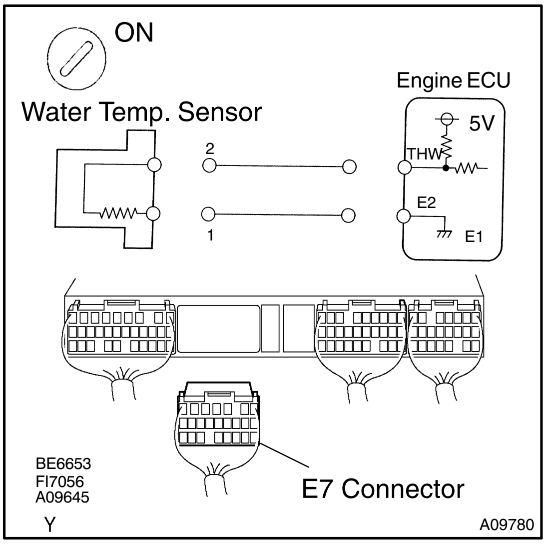


PREPARATION:
(a) Disconnect the water temperature sensor connector.
(b) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: –40°C (–40°F)

OK → **Replace water temperature sensor.**

NG

5	Check for short in harness or engine ECU.



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E7 connector from the engine ECU.
HINT:
The water temperature sensor connector is disconnected.
(c) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: –40°C (–40°F)

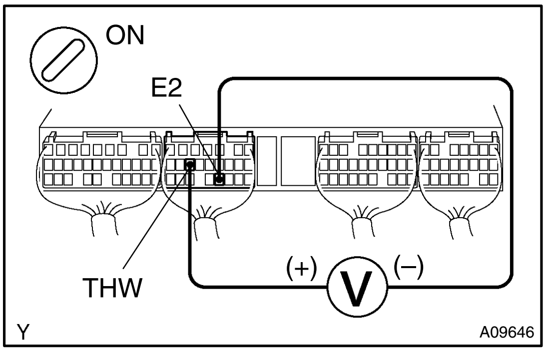
OK → **Repair or replace harness or connector.**

NG

Check and replace engine ECU
(See page IN–20).

When not using hand–held tester:

1	**Check voltage between terminals THW and E2 of engine ECU connector.**



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.
CHECK:
Measure the voltage between terminals THW and E2 of the engine ECU connector.
OK:

Water Temp. °C (°F)	Voltage
20 (68) (Engine is cool)	0.2 – 3.8 V
80 (176) (Engine is hot)	0.1 – 1.5 V

OK → **Check for intermittent problems (See page DI–4).**

NG

2	**Check water temperature sensor (See page ED–10).**

NG → **Replace water temperature sensor.**

OK

3	**Check for open and short in harness and connector between engine ECU and water temperature sensor (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

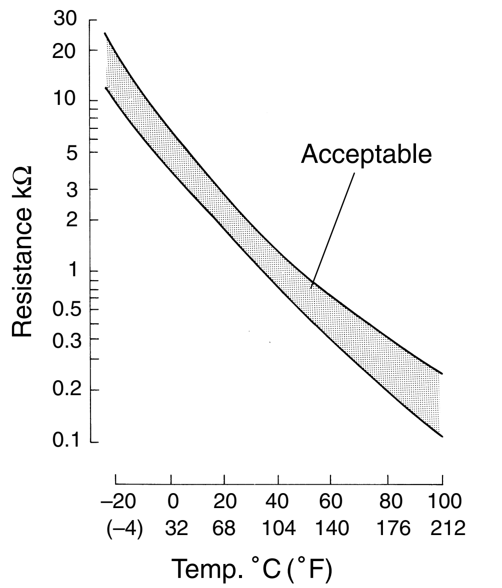
Check and replace engine ECU (See page IN–20).

DI69H–01

DTC	24 (1)	Intake Air Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Fig. 1



FI4741

The intake air temperature sensor is built into the intake manifold and senses the intake air temperature. A thermistor built in the sensor changes the resistance value according to the intake air temperature. The lower the intake air temperature, the greater the thermistor, the lower the thermistor resistance value (See Fig. 1).

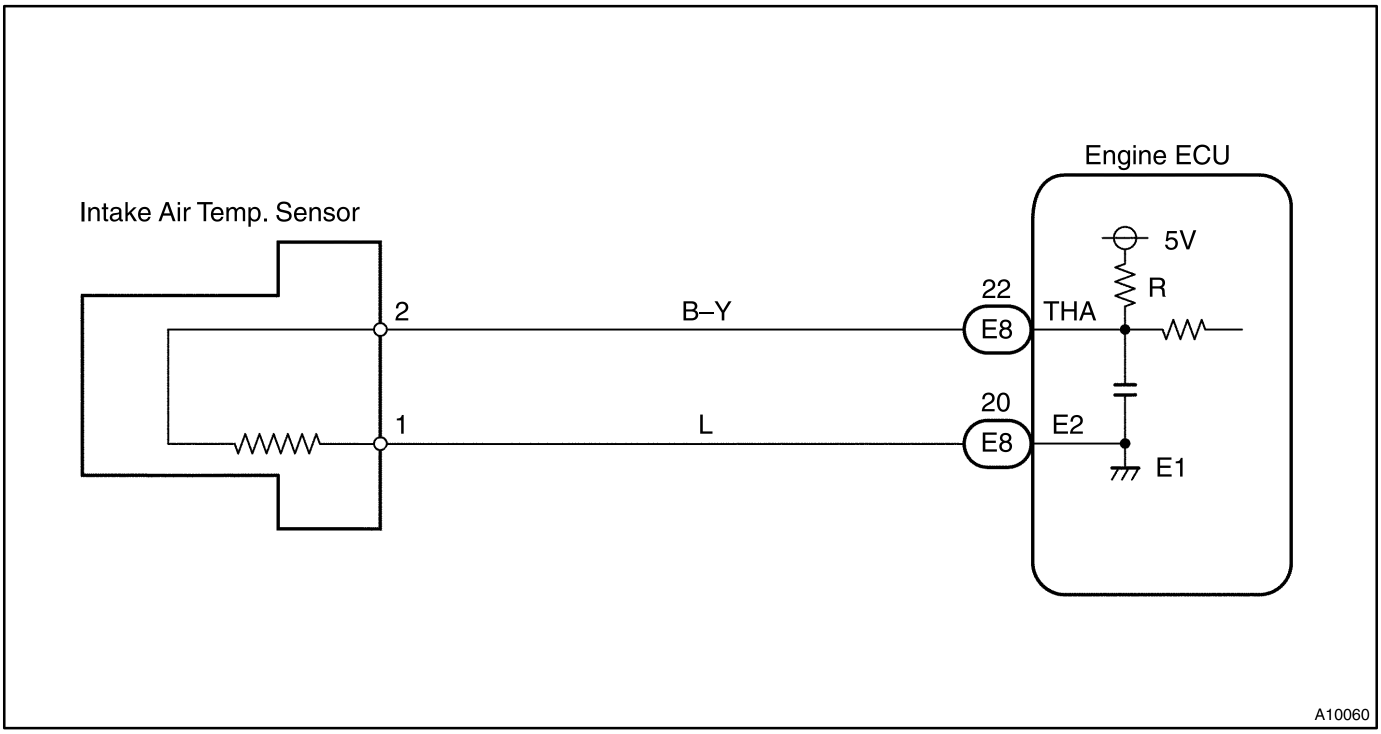
The intake air temperature sensor is connected to the engine ECU. The 5 V power source voltage in the engine ECU is applied to the intake air temperature sensor from terminal THA via a resistor R. That is the resistor R and the intake air temperature sensor are connected in series. When the resistance value of the intake air temperature sensor changes. Based on this signal, the engine ECU increases the fuel injection volume to improve drivability during cold engine operation.

DTC No.	DTC Detecting Condition	Trouble Area
24 (1)	Open or short in intake air temp. sensor circuit for 0.5 sec. or more	• Open or short in intake air temp. sensor circuit • Intake air temp. sensor • Engine ECU

HINT:
After confirming DTC 24, use the hand–held tester to confirm the intake air temperature from the CURRENT DATA.

Temperature displayed	Malfunction
–40°C (–40°F)	Open circuit
140°C (284°F) or more	Short circuit

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC 22, 24, 35 and 39, E2 (sensor ground) may be open.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect hand–held tester, and read value of water temperature.**

PREPARATION:

(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

Same as actual intake air temperature.

HINT:

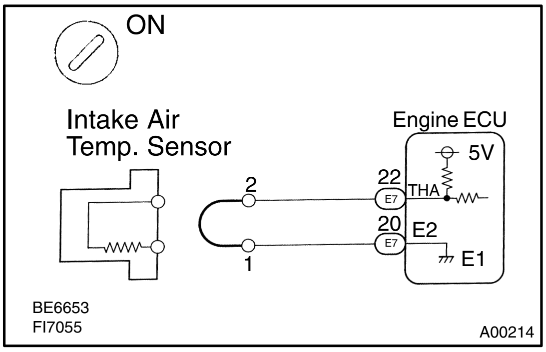
- If there is open circuit, hand–held tester indicates –40°C (–40°F).
- If there is short circuit, hand–held tester indicates 140°C (284°F) or more.

NG → **–40°C (–40°F) ... Go to step 2.**
140°C (284°F) or more ... Go to step 4.

OK

Check for intermittent problems (See page DI–4).

2	**Check for open in harness or engine ECU.**



PREPARATION:

(a) Disconnect the intake air temperature sensor connector.

(b) Connect the sensor wire harness terminals together.

(c) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

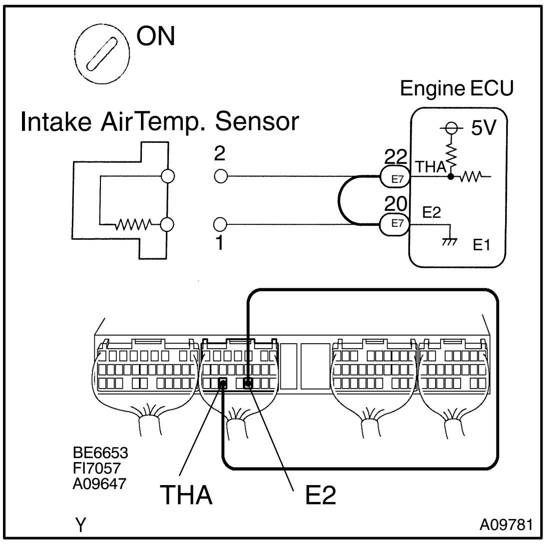
OK:

Temperature value: 140°C (284°F) or more

OK → **Confirm good connection at sensor. If OK, replace intake air temperature sensor.**

NG

3	**Check for open in harness or engine ECU.**



PREPARATION:

(a) Remove the glove compartment.

(b) Connect between terminals THA and E2 of the engine ECU connector.

HINT:

The intake air temperature sensor connector is disconnected. Before checking, do a visual and contact pressure check for the engine ECU connector (See page IN–20).

(c) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

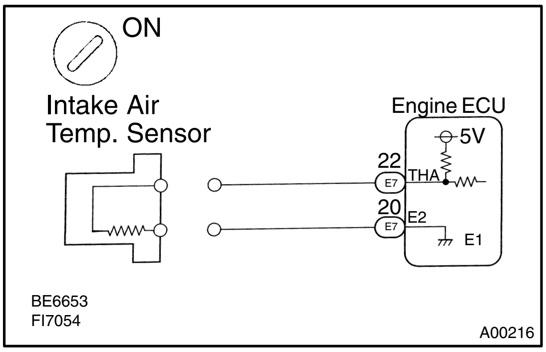
Temperature value: 140°C (284°F) or more

OK → **Open in harness between terminal E2 or THA, repair or replace harness.**

NG

Confirm good connection at engine ECU. If OK, replace engine ECU.

4	Check for short in harness and engine ECU.

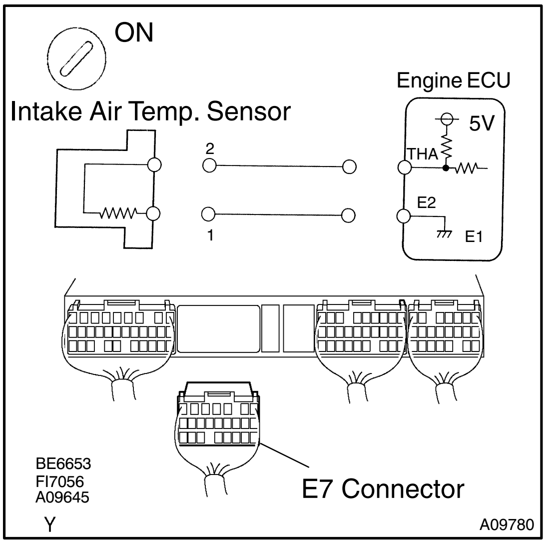


PREPARATION:
(a) Disconnect the intake air temperature sensor connector.
(b) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: –40°C (–40°F)

OK → **Replace intake air temperature sensor.**

NG

5	Check for short in harness or engine ECU.



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E7 connector from the engine ECU.
HINT:
The intake air temperature sensor connector is disconnected.
(c) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: –40°C (–40°F)

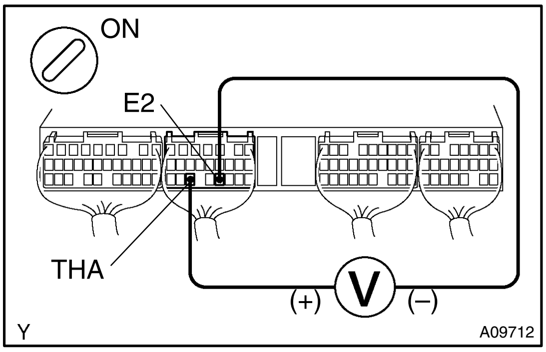
OK → **Repair or replace harness or connector.**

NG

Check and replace engine ECU
(See page IN–20).

When not using hand–held tester:

1	**Check voltage between terminals THA and E2 of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals THA and E2 of the engine ECU connector.

OK:

Intake Air Temp. °C (°F)	Voltage
20 (68) (Engine is cool)	0.2 – 3.8 V
80 (176) (Engine is hot)	0.1 – 1.5 V

OK → **Check for intermittent problems (See page DI–4).**

NG ↓

2	**Check intake air temperature sensor (See page ED–12).**

NG → **Replace intake air temperature sensor.**

OK ↓

3	**Check for open and short in harness and connector between engine ECU and intake air temperature sensor (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK ↓

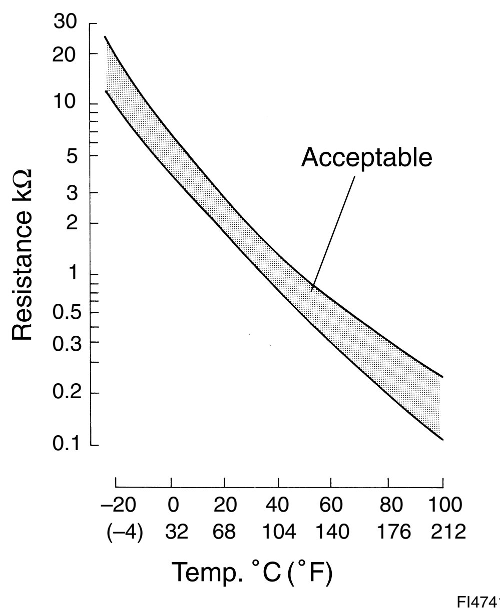
Check and replace engine ECU (See page IN–20).

DI69I–01

DTC	24 (2)	Atmospheric Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Fig. 1



The atmospheric temperature sensor is built into the air flow meter and senses the atmospheric temperature. A thermistor built in the sensor changes the resistance value according to the atmospheric temperature. The lower the atmospheric temperature, the greater the thermistor, the lower the thermistor resistance value (See Fig. 1).
The atmospheric temperature sensor is connected to the engine ECU. The 5 V power source voltage in the engine ECU is applied to the atmospheric temperature sensor from terminal THAF via a resistor R. That is resistor R and the atmospheric temperature sensor are connected in series. When the resistance value of the atmospheric temperature sensor changes. Based on this signal, the engine ECU increases the fuel injection volume to improve drivability during cold engine operation.

DTC No.	DTC Detecting Condition	Trouble Area
24	Open or short in atmospheric temp. sensor circuit for 0.5 sec. or more	• Open or short in atmospheric temp. sensor circuit • Atmospheric temp. sensor (built into air flow meter) • Engine ECU

HINT:
After confirming DTC 24, use the hand–held tester to confirm the atmospheric temperature from the CURRENT DATA.

Temperature displayed	Malfunction
–40°C (–40°F)	Open circuit
140°C (284°F) or more	Short circuit

WIRING DIAGRAM

Refer to DTC 31 on page DI–57

INSPECTION PROCEDURE

HINT:
- If DTC 22, 24, 35 and 39, E2 (sensor ground) may be open.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect hand–held tester, and read value of atmospheric temperature.**

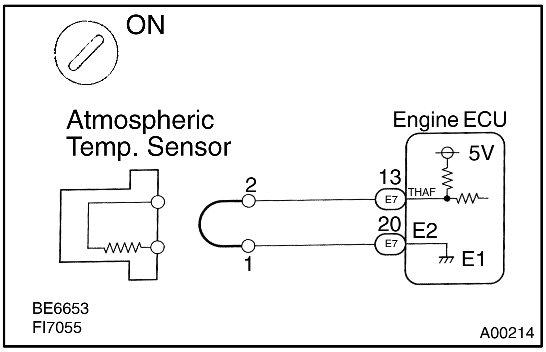
PREPARATION:
(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Same as actual atmospheric temperature.
HINT:
- If there is open circuit, hand–held tester indicates –40°C (–40°F).
- If there is short circuit, hand–held tester indicates 140°C (284°F) or more.

NG **–40°C (–40°F) ... Go to step 2.**
140°C (284°F) or more ... Go to step 4.

OK

Check for intermittent problems
(See page DI–4).

2	**Check for open in harness or engine ECU.**

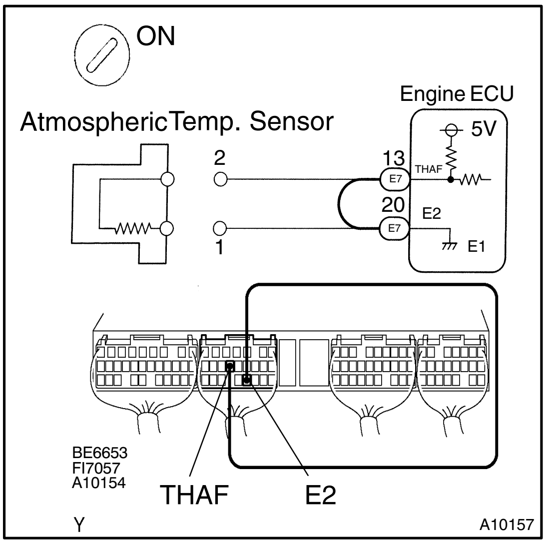


PREPARATION:
(a) Disconnect the air flow miter connector.
(b) Connect the sensor wire harness terminals together.
(c) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: 140°C (284°F) or more

OK **Confirm good connection at sensor. If OK, replace air flow meter.**

NG

3	**Check for open in harness or engine ECU.**



PREPARATION:

(a) Remove the glove compartment.

(b) Connect between terminals THAF and E2 of the engine ECU connector.

HINT:

The air flow meter connector is disconnected. Before checking, do a visual and contact pressure check for the engine ECU connector (See page IN–20).

(c) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

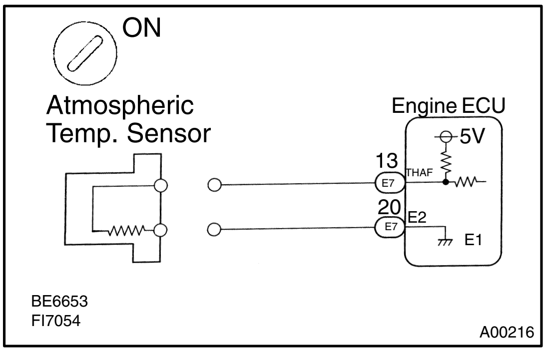
Temperature value: 140°C (284°F) or more

OK	**Open in harness between terminal E2 or THAF, repair or replace harness.**

NG

Confirm good connection at engine ECU. If OK, replace engine ECU.

4	**Check for short in harness and engine ECU.**



PREPARATION:

(a) Disconnect the air flow meter connector.

(b) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

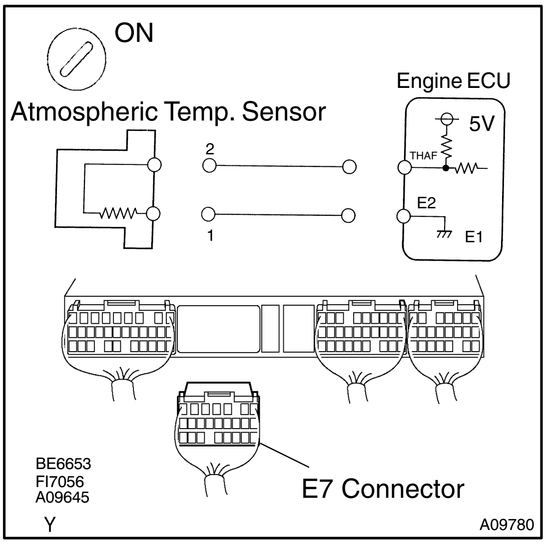
OK:

Temperature value: –40°C (–40°F)

OK	**Replace air flow meter.**

NG

5	**Check for short in harness or engine ECU.**



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E7 connector from the engine ECU.
HINT:
The air flow meter connector is disconnected.
(c) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: –40°C (–40°F)

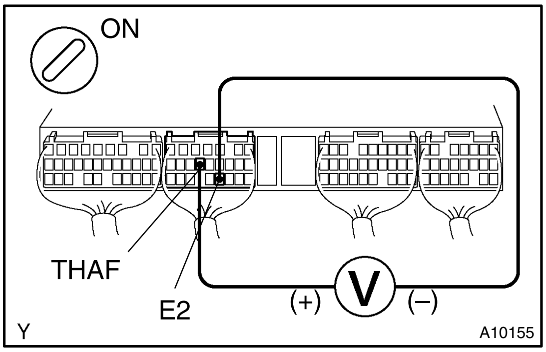
OK → **Repair or replace harness or connector.**

NG

Check and replace engine ECU
(See page IN–20).

When not using hand–held tester:

1	**Check voltage between terminals THAF and E2 of engine ECU connector.**



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.
CHECK:
Measure the voltage between terminals THAF and E2 of the engine ECU connector.
OK:

Atmospheric Temp. °C (°F)	Voltage
20 (68) (Engine is cool)	0.2 – 3.8 V
80 (176) (Engine is hot)	0.1 – 1.5 V

OK → **Check for intermittent problems**
(See page DI–4).

NG

2	Check atmospheric temperature sensor (See page ED–12).

NG → Replace air flow meter.

OK

3	Check for open and short in harness and connector between engine ECU and atmospheric temperature sensor (See page IN–20).

NG → Repair or replace harness or connector.

OK

Check and replace engine ECU
(See page IN–20).

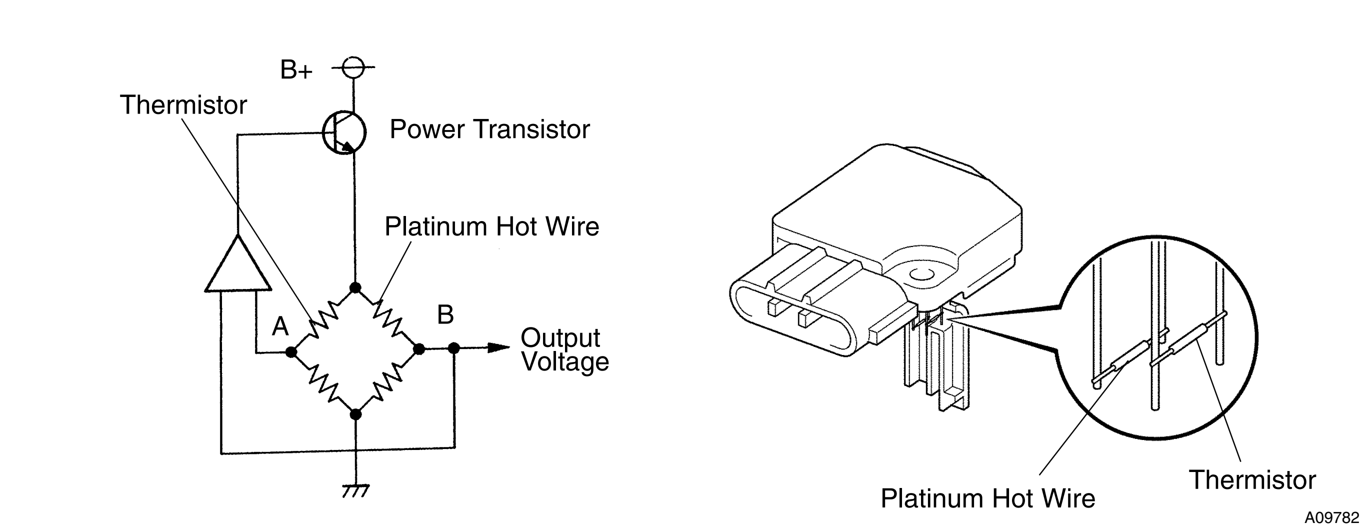
DI3OW–03

CIRCUIT INSPECTION

DTC	31	Air Flow Circuit Malfunction

CIRCUIT DESCRIPTION

The air flow meter uses a platinum hot wire. The hot wire air flow meter consists of a platinum hot wire, thermistor and a control circuit installed in a plastic housing. The hot wire air flow meter works on the principle that the hot wire and thermistor located in the intake air bypass of the housing detect any changes in the intake air temperature.
The hot wire is maintained at the set temperature by controlling the current flow through the hot wire. This current flow is then measured as the output voltage of the air flow meter.
The circuit is constructed so that the platinum hot wire and thermistor provide a bridge circuit with the power transistor controlled so that the potential of A and B remains equal to maintain the set temperature.

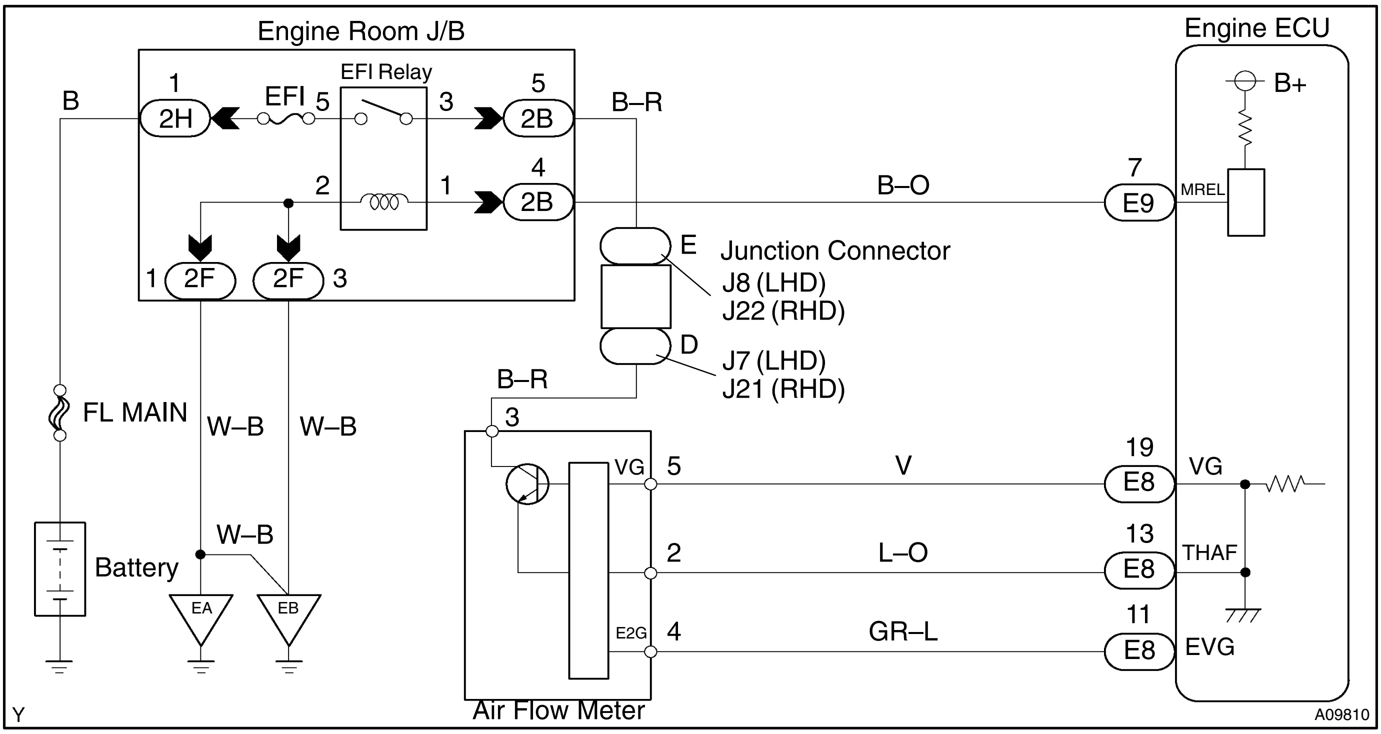


DTC No.	DTC Detecting Condition	Trouble Area
31	Open or short in air flow meter circuit with more than 3 sec.	• Open or short in air flow meter circuit • Air flow meter • Engine ECU

HINT:
After confirming DTC 31, use the hand–held tester to confirm the air flow ratio from the CURRENT DATA.

Air Flow Value (gm/sec.)	Malfunction
Approx. 0.0	• Air flow meter power source circuit open • VG circuit open or short
184.0 or more	• EVG circuit open

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect hand–held tester, and read value of air flow rate.**

PREPARATION:

(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.
(c) Start the engine.

CHECK:

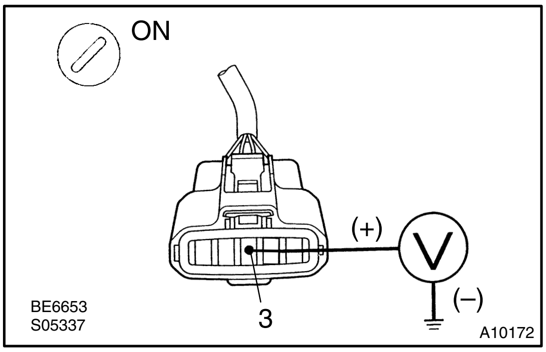
Read the air flow rate on the hand–held tester.

RESULT:

	Type I	Type II
Air Flow Rata (gm/sec.)	0.0	271.0 or more

Type I	Go to step 2.
Type II	Go to step 5.

2	Check voltage of air flow meter power source.

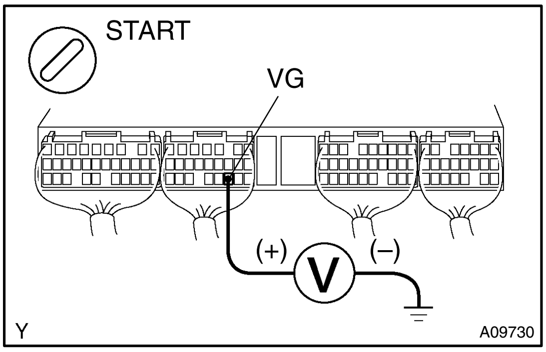


PREPARATION:
(a) Disconnect the air flow meter connector.
(b) Turn the ignition switch ON.
CHECK:
Measure the voltage between terminal 3 of the air flow meter connector and body ground.
OK:
Voltage: 9 – 14 V

NG	Check for open in harness and connector between EFI main relay (Marking: EFI) and air flow meter (See page IN–20).

OK

3	Check voltage between terminals VG of engine ECU connector and body ground.



PREPARATION:
(a) Remove the glove compartment door.
(b) Start the engine.
CHECK:
Measure the voltage between terminal VG of the engine ECU connector and body ground while the engine is idling.
OK:
Voltage:
0.5 – 3.0 V (P or N position and A/C switch OFF)

OK	Check and replace engine ECU (See page IN–20).

NG

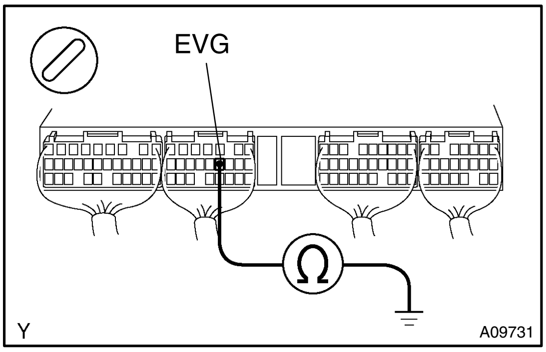
4	Check for open and short in harness and connector between air flow meter and engine ECU (See page IN–20).

NG	Repair or replace harness or connector.

OK

Replace air flow meter.

5	**Check continuity between terminal EVG of engine ECU connector and body ground.**



PREPARATION:
Remove the glove compartment.
CHECK:
Check the continuity between terminal EVG of the engine ECU connector and body ground.
OK:
Continuity (1 Ω or less)

NG → **Check and replace engine ECU (See page IN–20).**

OK

6	**Check for open in harness and connector between air flow meter and engine ECU (See page IN–20).**

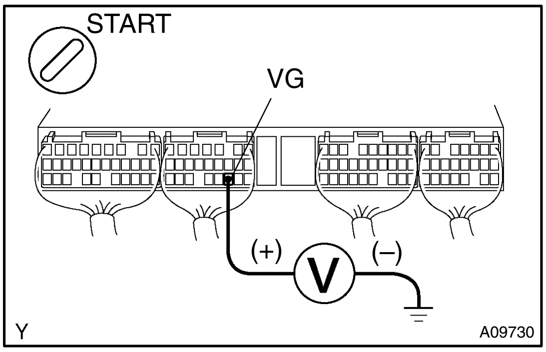
NG → **Repair or replace harness or connector.**

OK

Replace air flow meter.

When not using hand–held tester:

1	**Check voltage between terminals VG of engine ECU connector and body ground.**

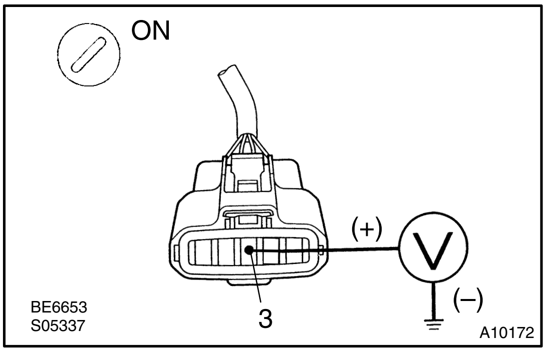


PREPARATION:
(a) Remove the glove compartment.
(b) Start the engine.
CHECK:
Measure the voltage between terminal VG of the engine ECU connector and body ground while the engine is idling.
OK:
Voltage:
0.5 – 3.0 V (P or N position and A/C switch OFF)

OK → **Check and replace engine ECU (See page IN–20).**

NG ↓

2	Check voltage of air flow meter power source.



PREPARATION:

(a) Disconnect the air flow meter connector.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminal 3 of the air flow meter connector and body ground.

OK:

Voltage: 9 – 14 V

NG → **Check for open in harness and connector between EFI main relay (Marking: EFI) and air flow meter (See page IN–20).**

OK ↓

3	Check for open in harness and connector between air flow meter and engine ECU (See page IN–20).

NG → **Repair or replace harness or connector.**

OK ↓

Replace air flow meter.

DI31X–03

DTC	32	Injector Correction Resistance Malfunction

CIRCUIT DESCRIPTION

The correction system is correcting a few vary between each injectors.

DTC No.	DTC Detecting Condition	Trouble Area
32	Open or short in circuit	• Injector correction resistance circuit • Injector correction resistance (built into injector) • Engine ECU

WIRING DIAGRAM

Refer to DTC 97 on page DI–89

INSPECTION PROCEDURE

HINT:

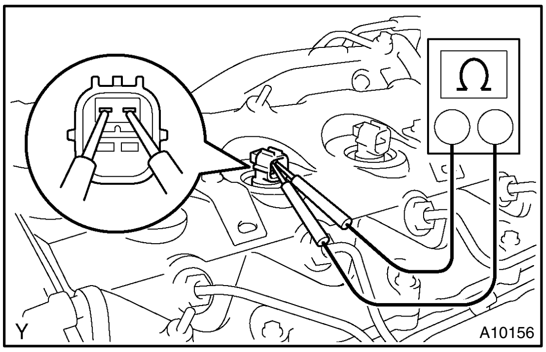
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

1	Check resistance of ECU terminal for injector correction resistance and body ground.

OK → **Check and replace engine ECU (See page ED–19).**

NG

2	Check resistance between terminals correction resistance of injector.



PREPARATION:

Disconnect the 4 injector connector.

CHECK:

Using an ohmmeter, measure the resistance between terminals as shown.

OK:

Resistance: 30 – 9530 Ω at 20°C

NG → **Replace the Injector.**

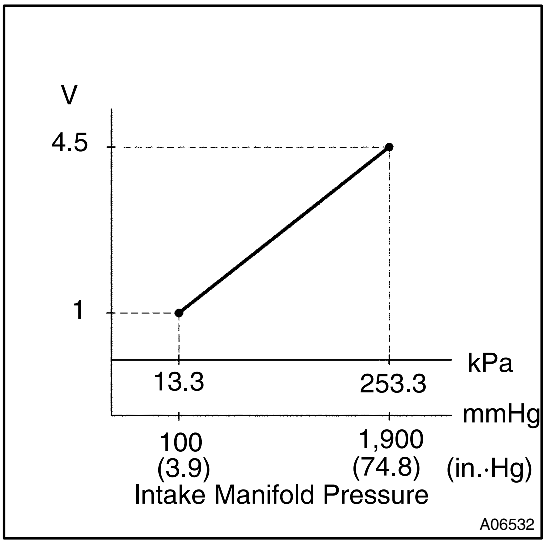
OK

Repair harness or connector.

DI31Z–03

DTC	35	Turbo Pressure Sensor Circuit Malfunction

CIRCUIT DESCRIPTION



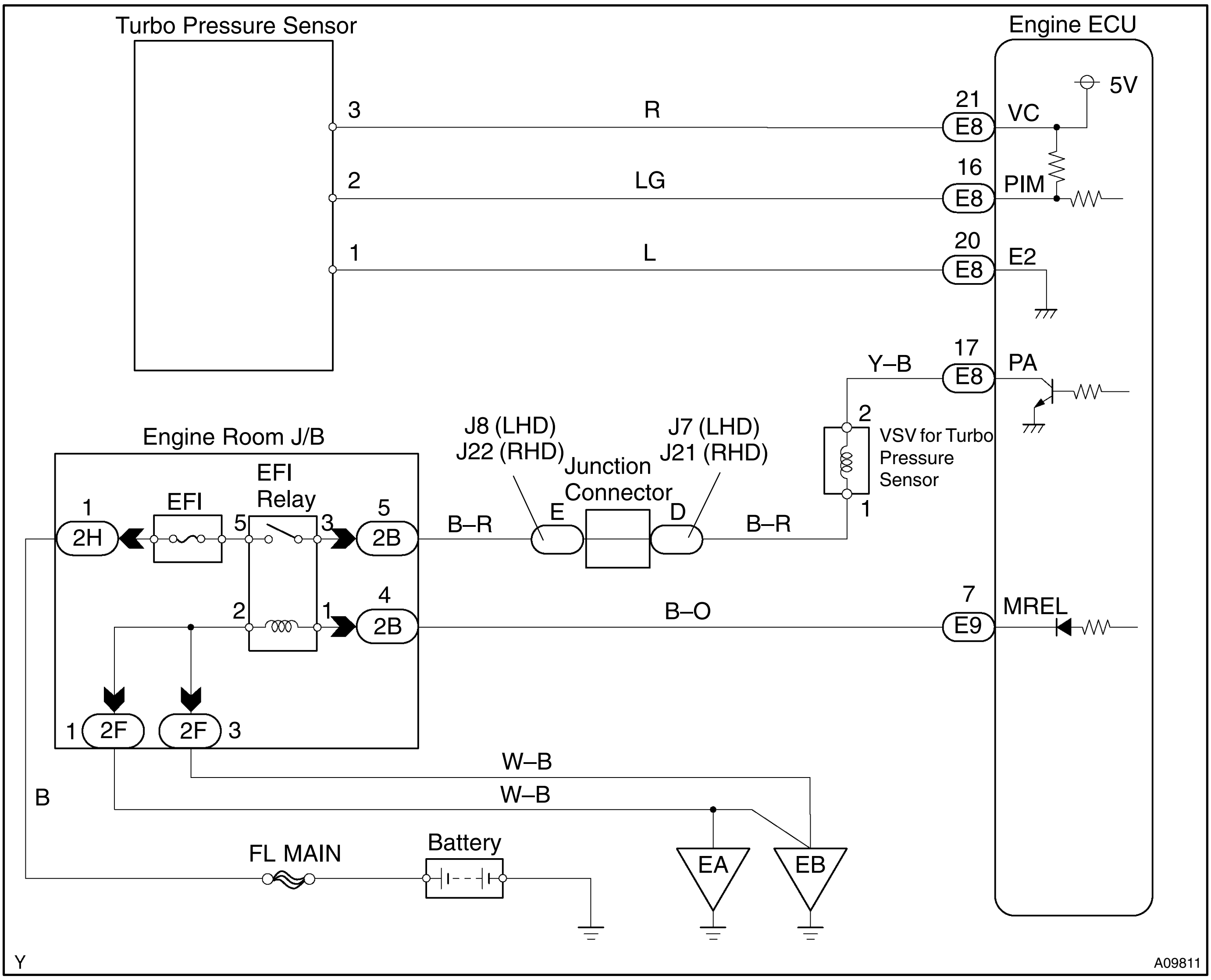
The turbo pressure sensor is connected to the intake manifold. The engine ECU detects the intake manifold pressure as a voltage by the sensor. The engine ECU uses the intake manifold pressure signal for correction of injection volume control and injection timing control.
The VSV for turbo pressure sensor switches the atmosphere applied to the turbo pressure sensor to the intake manifold pressure. The turbo pressure sensor monitors both the atmospheric pressure and intake manifold pressure and transmits the output voltage to the engine ECU, and the engine ECU uses this atmospheric pressure value for correcting the injection volume.

DTC No.	DTC Detecting Condition	Trouble Area
35	Open or short in turbo pressure sensor circuit for 2 sec. or more	• Open or short in turbo pressure sensor circuit • Turbo pressure sensor • Open or short in VSV for turbo pressure sensor circuit • VSV for turbo pressure sensor • Vacuum hose disconnected or blocked • Engine ECU

HINT:
After confirming DTC 35, use the hand–held tester to confirm the intake manifold pressure from the CURRENT DATA.

Intake Manifold Pressure (kPa)	Malfunction
Approx. 0	• PIM circuit short
130 or more	• VC circuit open or short • PIM circuit open • E2 circuit open

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC 22, 24, 35 and 39 are output simultaneously, E2 (sensor ground) may be open.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect the hand–held tester, and read value of intake manifold pressure.**

PREPARATION:

(a) Connect the hand–held tester to the DLC3.

(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:

Read the value of intake manifold pressure on the hand–held tester.

OK:

Same as atmospheric pressure.

OK → **Go to step 5.**

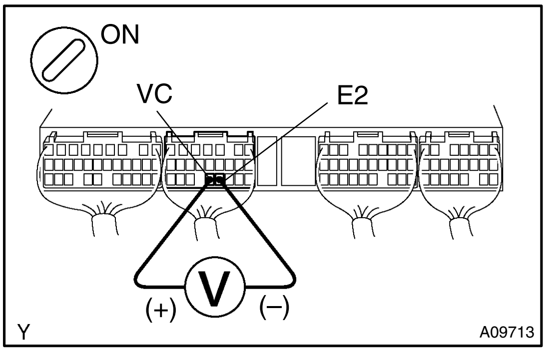
NG

2	**Check turbo pressure sensor (See page TC–21).**

NG → **Replace turbo pressure sensor.**

OK

3	**Check voltage between terminals VC and E2 of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals VC and E2 of the engine ECU connector.

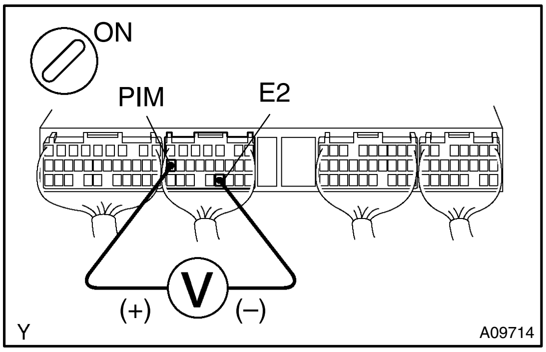
OK:

Voltage: 4.5 – 5.5 V

NG → **Check and replace engine ECU (See page IN–20).**

OK

4	**Check voltage between terminals PIM and E2 of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals PIM and E2 of the engine ECU connector.

OK:

Voltage: 1.7 – 2.9 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

Check for open and short in harness and connector between engine ECU and turbo pressure sensor (See page IN–20).

5	**Check connection of vacuum hose between turbo pressure sensor and VSV for turbo pressure sensor, and VSV for turbo pressure sensor and intake manifold.**

NG → **Repair or replace.**

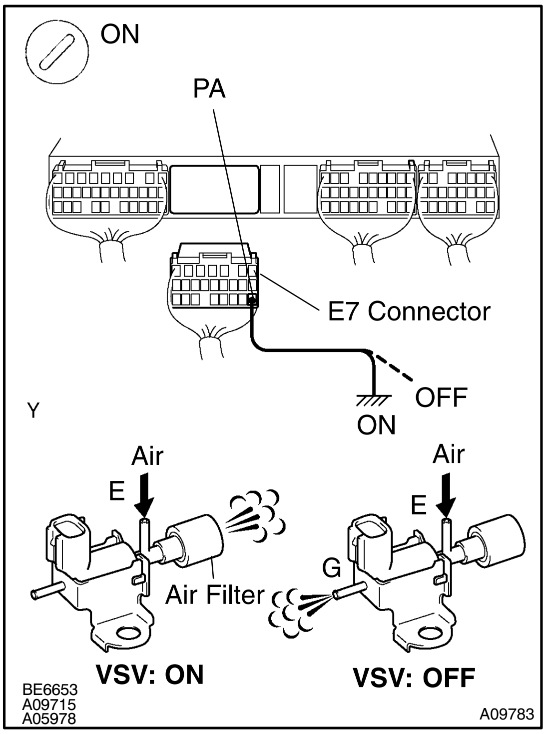
OK

6	**Check resistance of VSV for turbo pressure sensor (See page TC–24).**

NG → **Replace VSV for turbo pressure sensor.**

OK

7	**Check VSV for turbo pressure sensor.**



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E7 connector from the engine ECU.
(c) Turn the ignition switch ON.

CHECK:
Check the VSV function.
(a) Connect between terminal PA of the engine ECU connector and body ground (VSV is ON).
(b) Disconnect between terminal PA of the engine ECU connector and body ground (VSV is OFF).

OK:
VSV is ON:
Air from port E flows out through the air filter.
VSV is OFF:
Air from port E flows out through port G.

OK → **Check and replace engine ECU (See page IN–20).**

NG ↓

8	Check for open and short in harness and connector between engine ECU and VSV for turbo pressure sensor, and VSV for turbo pressure sensor and EFI main relay (Marking: EFI) (See page IN–20).

NG → **Repair harness or connector.**

OK ↓

Replace VSV for turbo pressure sensor.

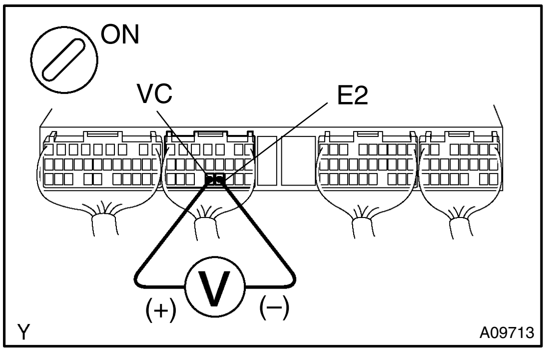
When not using hand–held tester:

1	Check turbo pressure sensor (See page TC–21).

NG → **Replace turbo pressure sensor.**

OK ↓

2	Check voltage between terminals VC and E2 of engine ECU connector.

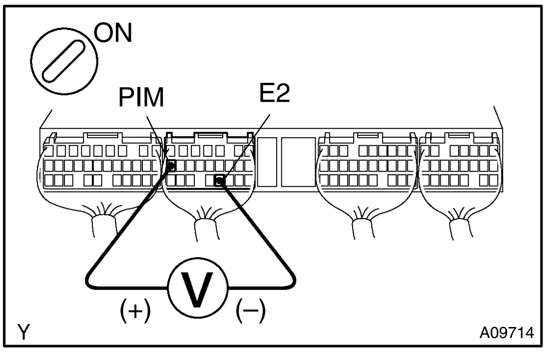


PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.
CHECK:
Measure the voltage between terminals VC and E2 of the engine ECU connector.
OK:
Voltage: 4.5 – 5.5 V

NG → **Check and replace engine ECU (See page IN–20).**

OK ↓

3	Check voltage between terminals PIM and E2 of engine ECU connector.



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals PIM and E2 of the engine ECU connector.

OK:

Voltage: 1.7 – 2.9 V

OK	Check and replace engine ECU (See page IN–20).

NG

4	Check for open and short in harness and connector between engine ECU and turbo pressure sensor (See page IN–20).

NG	Repair or replace harness or connector.

OK

5	Check connection of vacuum hose between turbo pressure sensor and VSV for turbo pressure sensor, and VSV for turbo pressure sensor and intake manifold.

NG	Repair or replace.

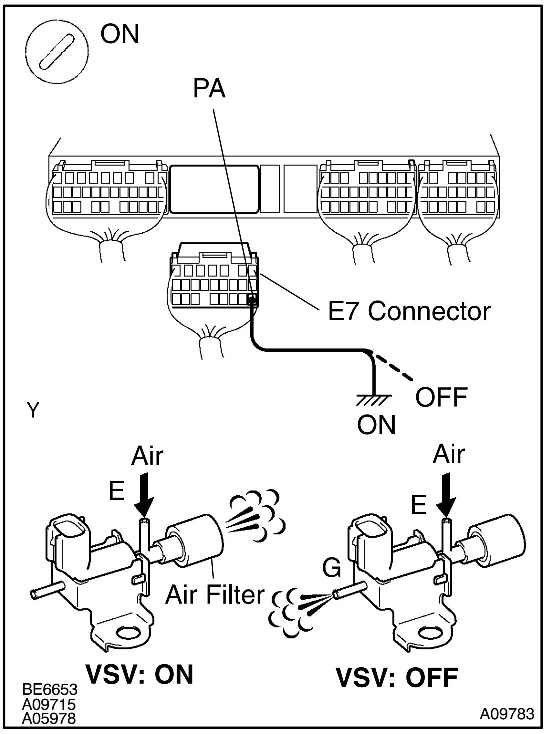
OK

6	Check resistance of VSV for turbo pressure sensor (See page TC–24).

NG	Replace VSV for turbo pressure sensor.

OK

7	**Check VSV for turbo pressure sensor.**



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E7 connector from the engine ECU.
(c) Turn the ignition switch ON.

CHECK:
Check the VSV function.
(a) Connect between terminal PA of the engine ECU connector and body ground (VSV is ON).
(b) Disconnect between terminal PA of the engine ECU connector and body ground (VSV is OFF).

OK:
VSV is ON:
Air from port E flows out through the air filter.
VSV is OFF:
Air from port E flows out through port G.

OK → **Check and replace engine ECU (See page IN–20).**

NG

8	**Check for open and short in harness and connector between engine ECU and VSV for turbo pressure sensor and ECD main relay (Marking: INJ) (See page IN–20).**

NG → **Repair harness or connector.**

OK

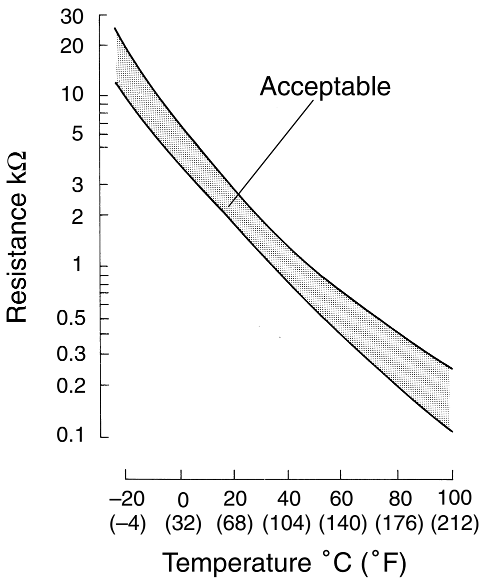
Replace VSV for turbo pressure sensor.

DI3S9–02

DTC	39	Fuel Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION

Fig. 1



FI4741

The fuel temperature sensor senses the fuel temperature. A thermistor built into the sensor changes the resistance value according to the fuel temperature. The lower the fuel temperature, the greater the thermistor resistance value, and the higher the fuel temperature, the lower the thermistor resistance value (See Fig. 1).

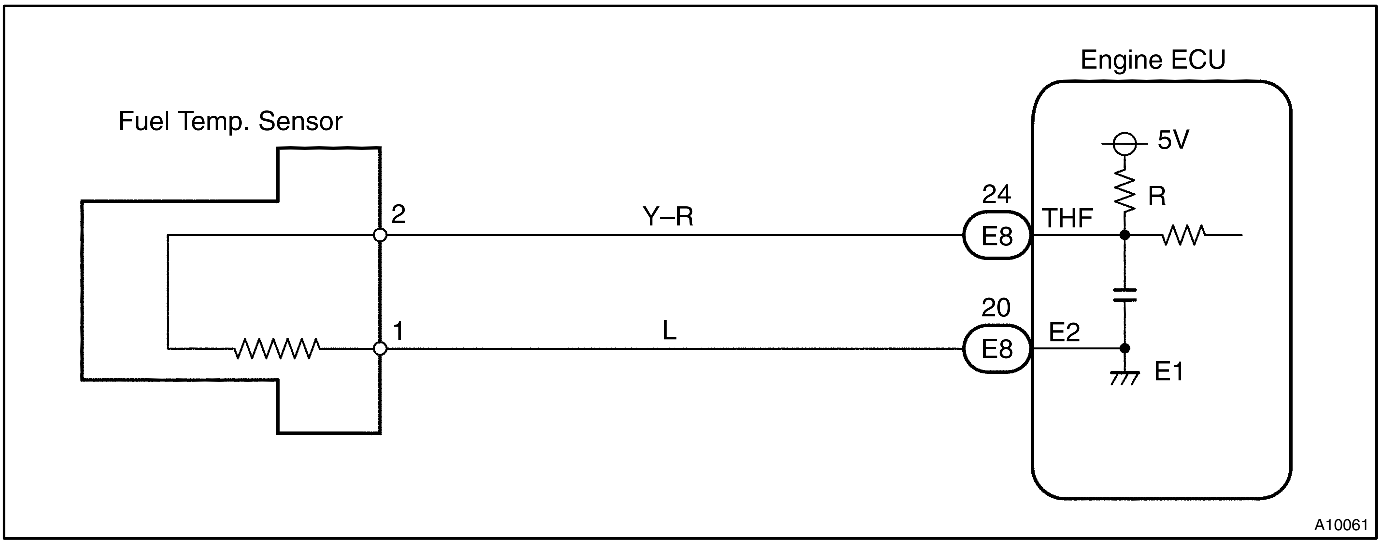
The fuel temperature sensor is connected to the engine ECU (See below). The 5 V power source voltage in the engine ECU is applied to the fuel temperature sensor from terminal THF via a resistor R. That is, resistor R and the fuel temperature sensor are connected in series. When the resistance value of the fuel temperature sensor changes in accordance with changes in the fuel temperature, the potential at terminal THF also changes. Based on this signal, the engine ECU. Based on this signal, the engine ECU performs the pressure control compensation of the supply pump and error detection compensation of the highly pressurized fuel system.

DTC No.	DTC Detecting Condition	Trouble Area
39	Open or short in fuel temp. sensor circuit for 0.5 sec. or more	• Open or short in fuel temp. sensor circuit • Fuel temp. sensor • Engine ECU

HINT:
After confirming DTC 39, use the hand–held tester to confirm the fuel temperature from the CURRENT DATA.

Temperature displayed	Malfunction
–40°C (–40°F)	Open circuit
140°C (284°F) or more	Short circuit

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

- If DTC 22, 24, 35 and 39 are output simultaneously, E2 (sensor ground) may be open.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Connect hand–held tester, and read value of fuel temperature.**

PREPARATION:

(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

Same as actual fuel temperature.

HINT:

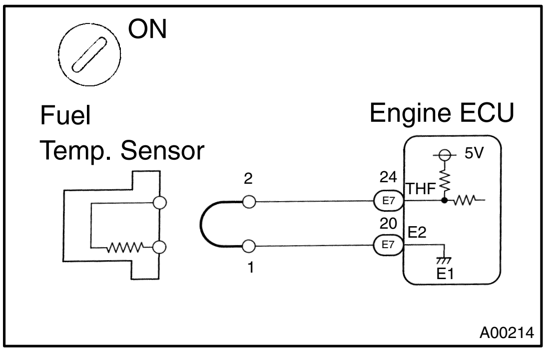
- If there is open circuit, hand–held tester indicates –40°C (–40°F).
- If there is short circuit, hand–held tester indicates 140°C (284°F) or more.

NG → **–40°C (–40°F) ... Go to step 2.**
140°C (284°F) or more ... Go to step 4.

OK

Check for intermittent problems (See page DI–4).

2	**Check for open in harness or engine ECU.**



PREPARATION:
(a) Disconnect the fuel temperature sensor connector.
(b) Connect the sensor wire harness terminals together.
(c) Turn the ignition switch ON.

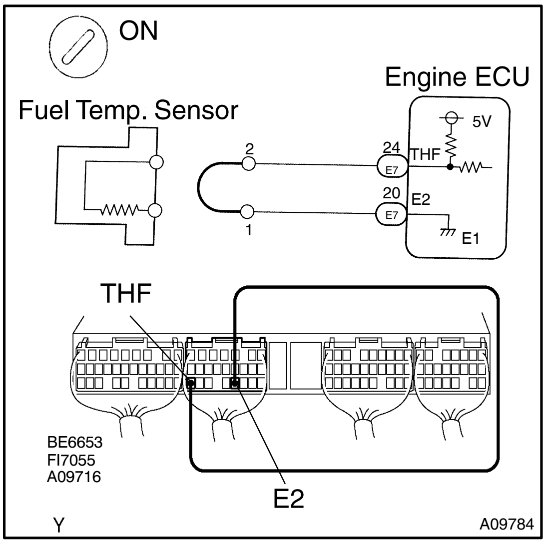
CHECK:
Read the temperature value on the hand–held tester.

OK:
Temperature value: 140°C (284°F) or more

OK → **Confirm good connection at sensor. If OK, replace fuel pump.**

NG

3	**Check for open in harness or engine ECU.**



PREPARATION:
(a) Remove the glove compartment.
(b) Connect between terminals THF and E2 of the engine ECU connector.

HINT:
The fuel temperature sensor connector is disconnected. Before checking, do a visual and contact pressure check for the engine ECU connector (See page IN–20).
(c) Turn the ignition switch ON.

CHECK:
Read the temperature value on the hand–held tester.

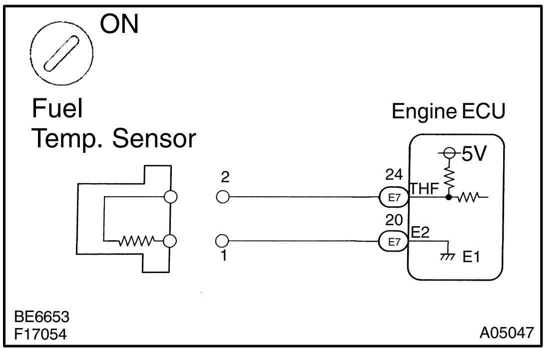
OK:
Temperature value: 140°C (284°F) or more

OK → **Open in harness between terminal E2 or THF, repair or replace harness.**

NG

Confirm good connection at engine ECU. If OK, replace engine ECU.

4	**Check for short in harness or engine ECU.**



PREPARATION:

(a) Disconnect the fuel temperature sensor connector.

(b) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

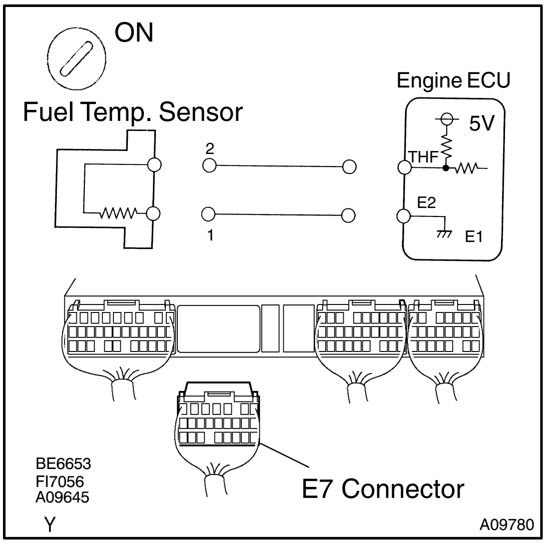
OK:

Temperature value: –40°C (–40°F)

OK	**Replace fuel temperature sensor.**

NG

5	**Check for short in harness or engine ECU.**



PREPARATION:

(a) Remove the glove compartment.

(b) Disconnect the E7 connector from the engine ECU.

HINT:

The fuel temperature sensor connector is disconnected.

(c) Turn the ignition switch ON.

CHECK:

Read the temperature value on the hand–held tester.

OK:

Temperature value: –40°C (–40°F)

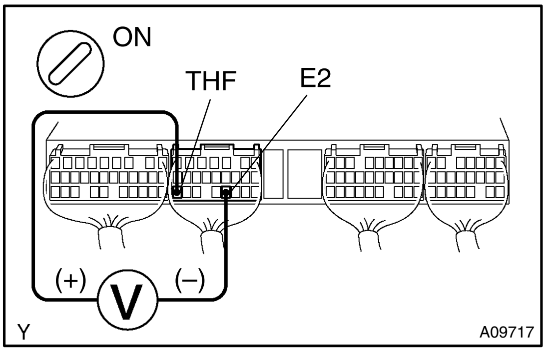
OK	**Repair or replace harness or connector.**

NG

Check and replace engine ECU
(See page IN–20).

When not using hand–held tester:

1	**Check voltage between terminals THF and E2 of engine ECU connector.**



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals THF and E2 of the engine ECU connecter.

OK:

Fuel Temp. °C (°F)	Voltage
20 (68) (Engine is cool)	0.2 – 3.8 V
80 (176) (Engine is hot)	0.1 – 1.5 V

OK → **Check for intermittent problems (See page DI–4).**

NG

2	**Check fuel temperature sensor (See page ED–11).**

NG → **Replace fuel temperature sensor.**

OK

3	**Check for open and short in harness and connector between engine ECU and fuel temperature sensor (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

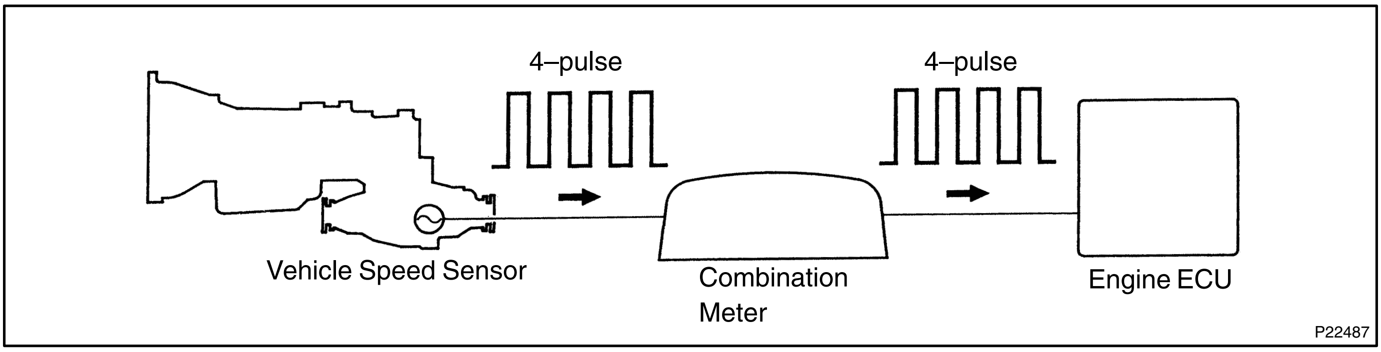
Check and replace engine ECU (See page IN–20).

DI321–03

DTC	42	Vehicle Speed Sensor Signal Circuit Malfunction

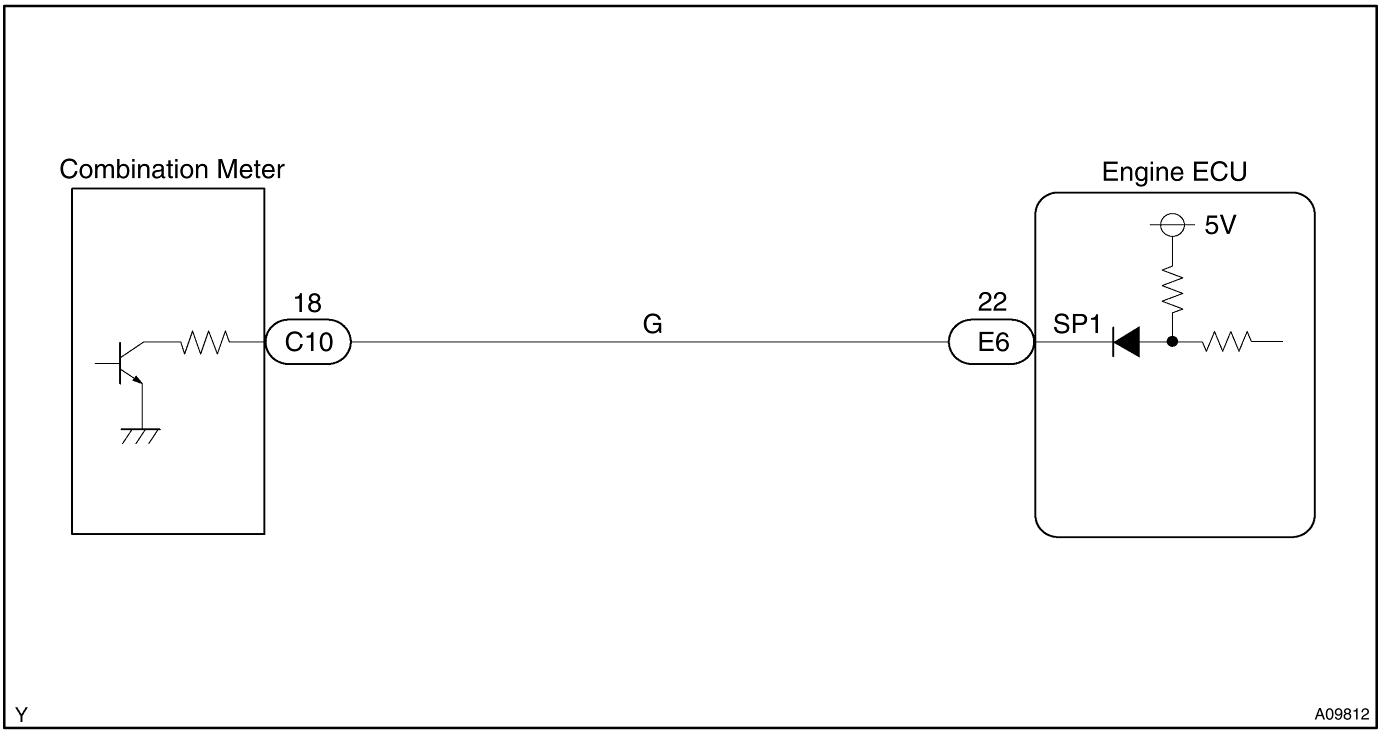
CIRCUIT DESCRIPTION

The vehicle speed sensor outputs a 4–pulse signal for every revolution of the rotor shaft, which is rotated by the transmission output shaft via the driven gear. After this signal is converted into a more precise rectangular waveform by the waveform shaping circuit inside the combination meter, it is then transmitted to the engine ECU. The engine ECU determines the vehicle speed based on the frequency of these pulse signals.



DTC No.	DTC Detecting Condition	Trouble Area
42	All conditions below are detected continuously for 8 sec. or more: (a) Vehicle speed signal: 0 km/h (0 mph) (b) Engine speed: 2,400 – 4,000 rpm (c) Engine coolant temp.: 60°C (176°F) or more (d) Accelerator pedal opening angle : 29 % or more	• Open or short in vehicle speed sensor circuit • Vehicle speed sensor • Combination meter • Engine ECU

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

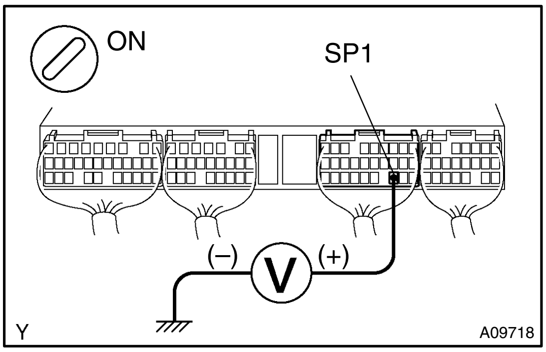
1	**Check operation of speedometer.**

CHECK:
Drive the vehicle and check if the operation of the speedometer in the combination meter is normal.
HINT:
The vehicle speed sensor is operating normally if the speedometer display is normal.

NG → **Check speedometer.**

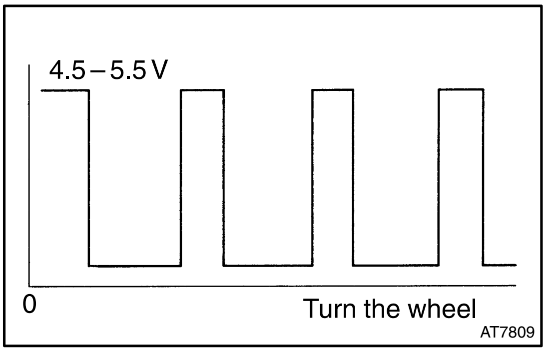
OK

2	**Check voltage between terminal SP1 of engine ECU connector and body ground.**



PREPARATION:
(a) Remove the glove compartment.
(b) Shift the shift lever to the neutral.
(c) Jack up one of the front wheels.
(d) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminal SP1 of the engine ECU connector and body ground when the wheel is turned slowly.



OK:
Voltage is generated intermittently.

NG → **Check and repair harness and connector between combination meter and engine ECU (See page IN–20).**

OK

Check and replace engine ECU (See page IN–20).

DI64V–02

DTC	49	Fuel Pressure Circuit Malfunction

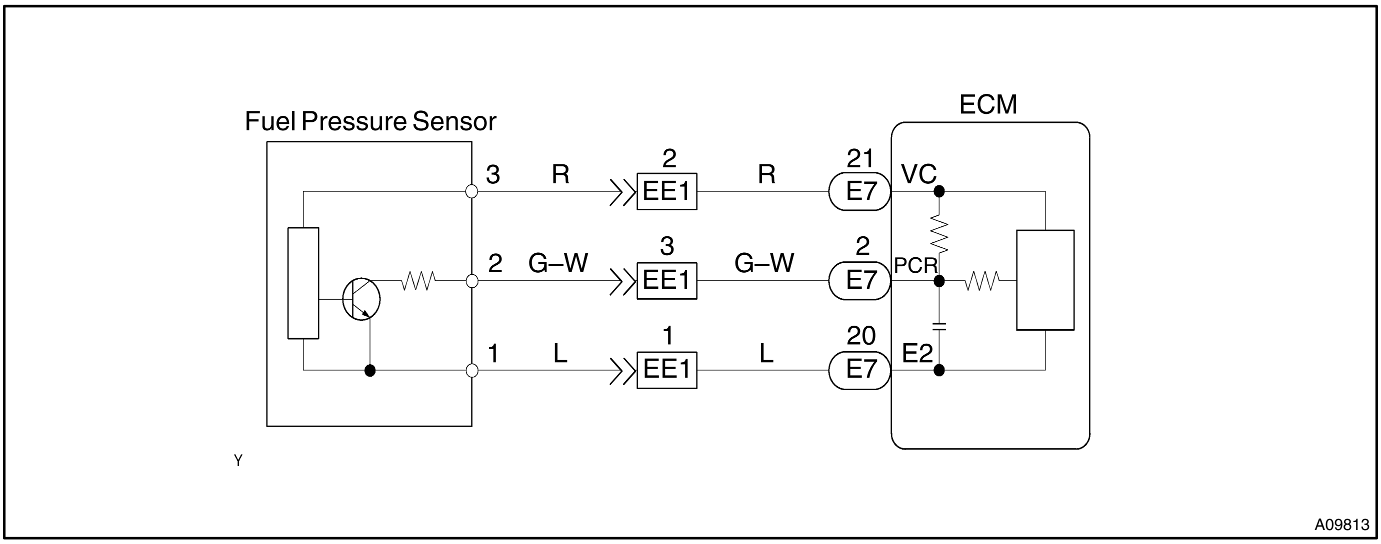
CIRCUIT DESCRIPTION

Fuel pressure sensor installed on a Common Rail detects the fuel pressure and controls to feed back the pump dischage in order to keep the target pressure (20 – 135 Mpa) set by the engine control computer.

DTC No.	DTC Detecting Condition	Trouble Area
P49	Open or short in fuel pressure sensor circuit for common rail	• Open or short in fuel pressure sensor circuit for common rail • Fuel pressure sensor for common rail • ECU

HINT:
After confirming DTC 49, use the hand–held tester to confirm the fuel rail pressure from the CURRENT DATA.

WIRING DIAGRAM

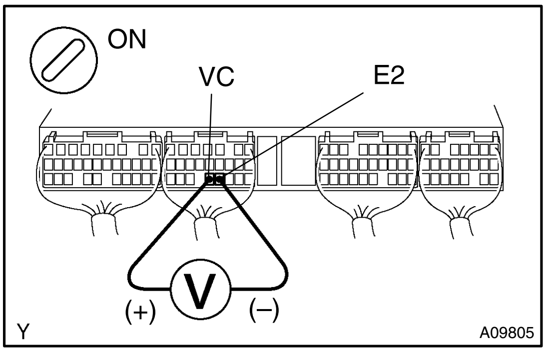


INSPECTION PROCEDURE

HINT:

- If DTC 22, 24, 39 and 49 are output simultaneously, E2 (sensor ground) may be open.
- Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

1	Check voltage between terminals VC and E2 of ECM connector.



PREPARATION:

(a) Remove the glove compartment.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals VC and E2 of the ECU connector.

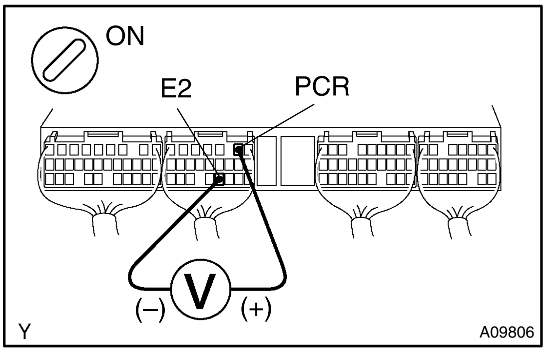
OK:

Voltage: 4.5 – 5.5 V

NG → **Check and replace engine ECU (See page IN–20).**

OK

2	Check voltage between terminals PCR and E2 of ECU connector.



PREPARATION:

(a) Remove the glove compartment.

(b) Start the engine.

CHECK:

Measure the voltage between terminals PCR and E2 of the engine ECU connector.

OK:

Voltage: 4.6 V at 20°C (68°F)

OK → **Check and replace engine ECU (See page IN–20).**

NG

3	Check for open and short in harness and connector between fuel pressure sensor for common rail and engine ECU (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

Replace common rail assembly (See page FU–21).

DI69J–01

DTC	78 (1)	Fuel Pump Circuit Malfunction (Fuel Leakage)

CIRCUIT DESCRIPTION

Refer to DTC 49 on page DI–78.
Refer to DTC 97 on page DI–89.

DTC No.	DTC Detecting condition	Trouble Area
78 (1)	Pressure change of common rail is abnormal against injection quantify and supply quantify of supply pump	• Open or short in EDU circuit • EDU • Open or short in injector circuit • Injector • Open or short in common rail pressure sensor circuit • Common rail pressure sensor • Fuel line between supply pump and common rail • Fuel line between common rail and injector • Pressure limiter • Engine ECU

WIRING DIAGRAM

Refer to DTC 49 on page DI–78.
Refer to DTC 97 on page DI–89.

INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	**Are there any other codes (besides DTC 39, DTC 49, DTC 78 (2), DTC 78 (3) or DTC 97) being output?**

YES → **Go to relevant DTC chart (See page DI–14).**

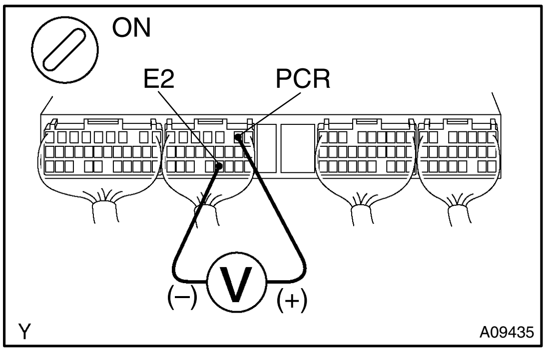
NO

2	**Open engine hood and check if there is any fuel leakage (See page FU–8).**

NG → **Check and replace.**

OK

3	**Check voltage between terminals PCR and E2 of engine ECU connector.**



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals PCR and E2 of the engine ECU connector.

OK:
Voltage: Approx. 1 V at 20°C (68°F)

OK → **Go to step 5.**

NG

4	**Check for open and short in harness and connector between common rail pressure sensor and engine ECU (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

Replace common rail assembly (See page FU–22).

5	**Connect hand–held tester, and read value of compensation of injection quantify between cylinders.**

PREPARATION:
(a) Connect the hand held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:
Read the compensation of the injection quantify between the cylinders on the hand–held tester.

OK:
STD: –3 – 3 mm^3/st
Maximum: –4 – 4 mm^3/st

NG → **Replace corresponding cylinder injector.**

OK

6	Check if any fuel is mixed with engine oil.

NG → Replace injector (See page FU–6).

OK

7	When you start engine, check that if any white smoke is coming out from exhaust pipe.

NG → Replace injector (See page FU–6).

OK

Peplace injector (See page FU–6) and common rail assembly (See page FU–22).

When not using hand–held tester:

1	Are there any other codes (besides DTC 39, DTC 49, DTC 78 (2), DTC 78 (3) or DTC 97) being output?

YES → Go to relevant DTC chart (See page DI–14).

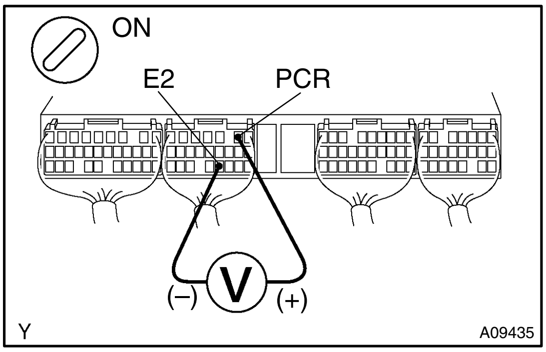
NO

2	Open engine hood and check if there is any fuel leakage (See page FU–8).

NG → Check and replace leakage parts.

OK

3	Check voltage between terminals PCR and E2 of engine ECU connector.



PREPARATION:
(a) Remove the glove compartment.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals PCR and E2 of the engine ECU connector.

OK:
Voltage: Approx. 1 V at 20°C (68°F)

NG → **Go to step 5.**

OK

4	Check for open and short in harness and connector between common rail pressure sensor and engine ECU (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

Replace common rail assembly (See page FU–22).

5	Check if any fuel is mixed with engine oil.

NG → **Replace injector.**

OK

6	When you start the engine, check that if any white smoke is coming out from exhaust pipe.

NG → **Replace injector (See page FU–6).**

OK

Go to step 1 in DTC 78 (2), DTC 78 (3).

DI69K–01

DTC	78 (2)	Fuel Pump Circuit Malfunction (Open Circuit)

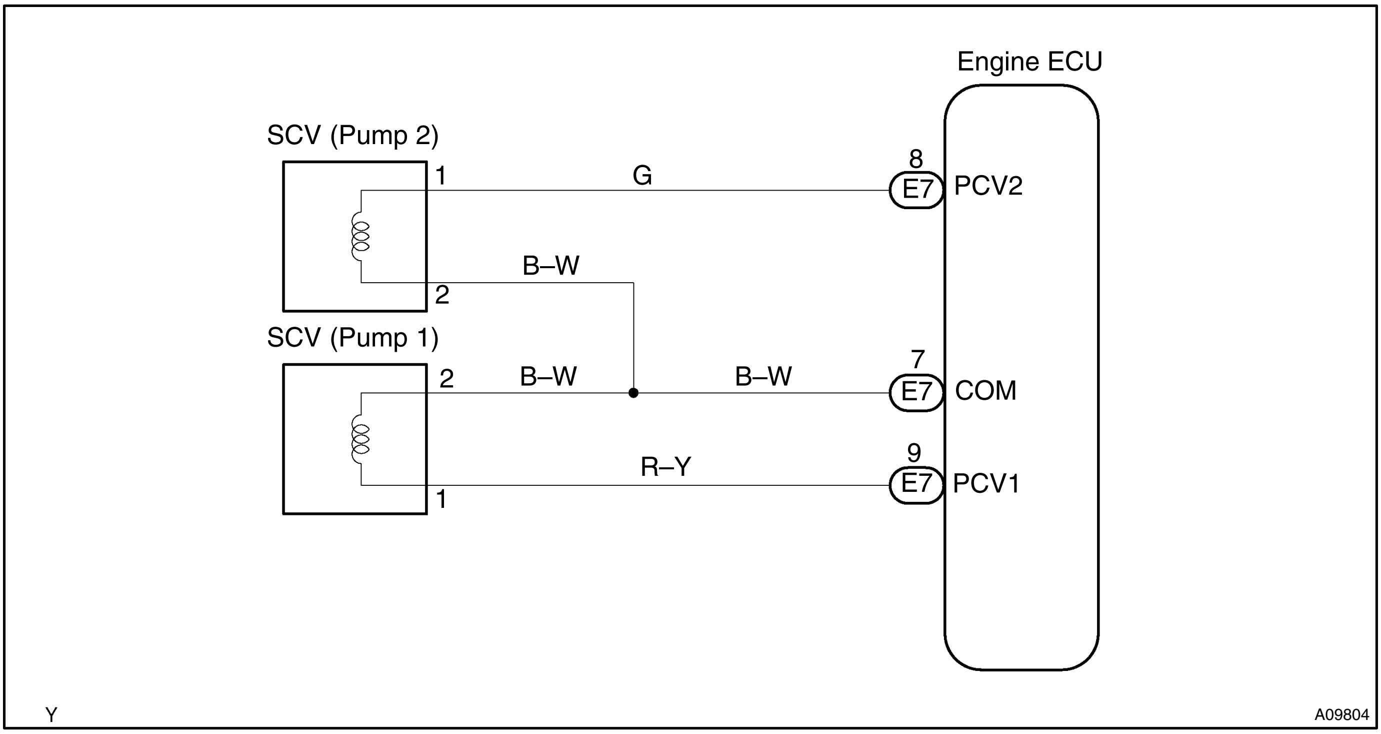
DTC	78 (3)	Fuel Pump Circuit Malfunction (Over Force Feed)

CIRCUIT DESCRIPTION

Supply pump is a tandem type and has two circuits of the fuel suction and force feed processes that achieve both high pressure force feed of fuel and reduction of driving torque.
In the suction process, it control SCV (Suction Control Valve) which suctions fuel by a plunger.

DTC No.	DTC Detecting condition	Trouble Area
78 (2) 78 (3)	Pressure change of common rail against supply quantify of supply pump is abnormal	• Open or short in SCV circuit • SCV • Supply pump • Engine ECU

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:
Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ratio was lean or rich, etc. at the time of the malfunction.

When using hand–held tester:

1	Are there any other codes (besides DTC 39, DTC 49 or DTC 97) being output?

YES → Go to relevant DTC chart (See page DI–14).

NO

2	Check SCV (See page FU–13).

OK → Replace supply pump (See page FU–16).

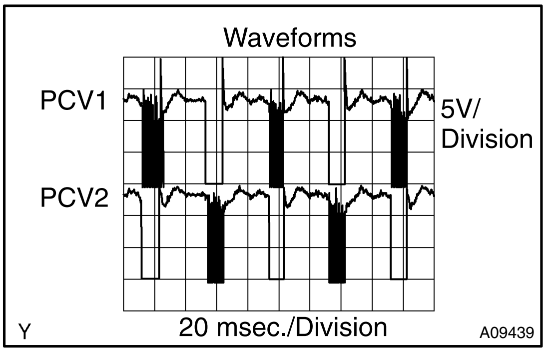
OK

3	Check for open and short in harness and connector between SCV and engine ECU (See page IN–20).

NG → Repair or replace harness or connector.

OK

4	Check voltage between terminals PCV1 and COM, and PCV2 and COM of engine ECU connector.



Reference: INSPECTION USING OSCILLOSCOPE
During cranking or idling, check the waveforms between terminals PCV1 and COM, and PCV2 and COM of the engine ECU connector.
HINT:
The correct waveforms are as shown.

NG → Check and replace engine ECU (See page ED–20).

OK

Replace supply pump (See page FU–16).

When not using hand–held tester:

1	**Check SCV (See page FU–13).**

NG → **Replace supply pump (See page FU–16).**

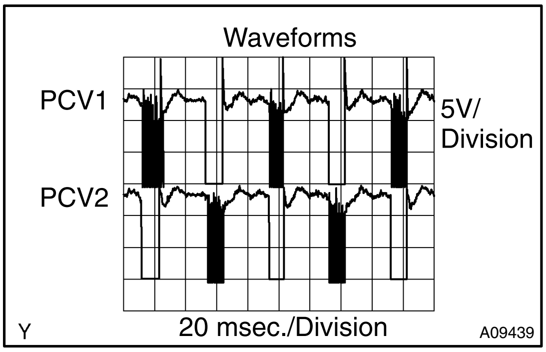
OK

2	**Check for open and short in harness and connector between SCV and engine ECU (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

3	**Check voltage between terminals PCV1 and COM, and PCV2 and COM of engine ECU connector.**



Reference: INSPECTION USING OSCILLOSCOPE
During cranking or idling, check the waveforms between terminals PCV1 and COM, and PCV2 and COM of the engine ECU connector.
HINT:
The correct waveforms are as shown.

NG → **Check and replace engine ECU (See page ED–20).**

OK

4	**Check if engine will start.**

YES → **Replace supply pump (See page FU–16).**

NO

Peplace injector (See page FU–6) and common rail assembly (See page FU–22).

DI69L–01

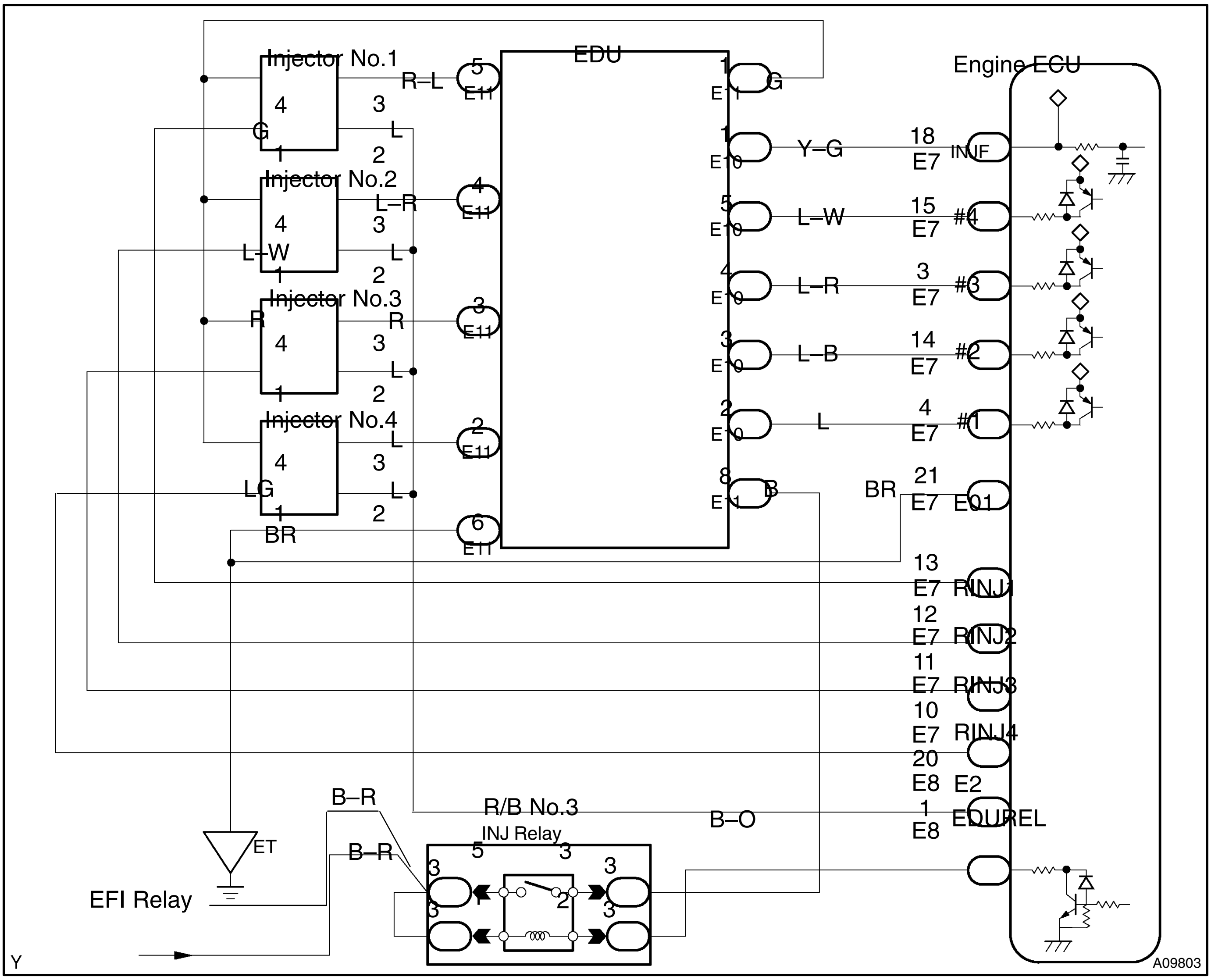
DTC	97	EDU Circuit Malfunction

CIRCUIT DESCRIPTION

The ECU has been adopted to drive the injector at high speeds. The EDU has realized high–speed driving under high fuel pressure conditions through the use of a DC/DC converter that provides a high–voltage, quick–charging system.
The engine ECU constantly monitors the EDU and stops the engine in case an abnormal condition is detected.

DTC No.	DTC Detecting condition	Trouble Area
97	Open or short in EDU circuit	• Open or short in EDU circuit • EDU • Open or short in SCV circuit • SCV • Injector • Engine ECU

WIRING DIAGRAM

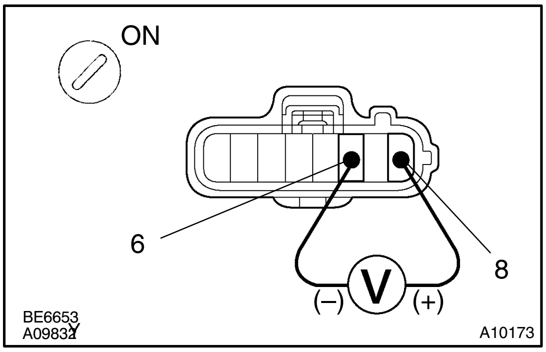


INSPECTION PROCEDURE

HINT:

Read freeze frame data using hand–held tester. Because freeze frame records the engine conditions when the malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, the air–fuel ration was lean or rich, etc. at the time of the malfunction.

1	**Check voltage of EDU power source.**



PREPARATION:

(a) Disconnect the EDU connector.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals 6 and 8 of the wire harness side connector.

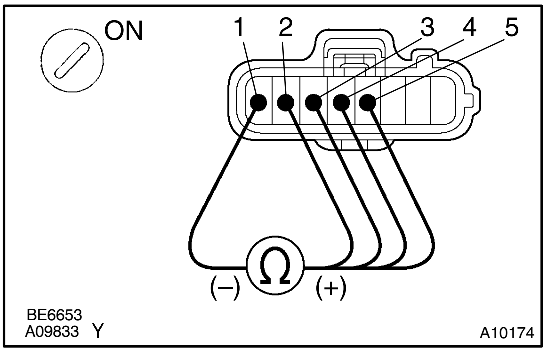
OK:

Voltage: 9 – 14 V

NG	**Check EDU power source circuit (See page DI–93).**

OK

2	**Check resistance between terminals 1 and 2 – 5 of wire harness side connector.**



PREPARATION:

(a) Disconnect the EDU connector.

(b) Turn the ignition switch ON.

CHECK:

Measure the resistance between terminals 1 and 2 – 5 of the wire harness side connector.

OK:

Resistance: 2.5 – 3.1 Ω at 20°C (68°F)

OK	**Go to step 4.**

NG

3	**Check injector (See page FU–4).**

NG	**Replace injector.**

OK

Repair or replace harness or connector.

4	**Check SCV (See page FU–13).**

NG → **Replace supply pump (See page FU–16).**

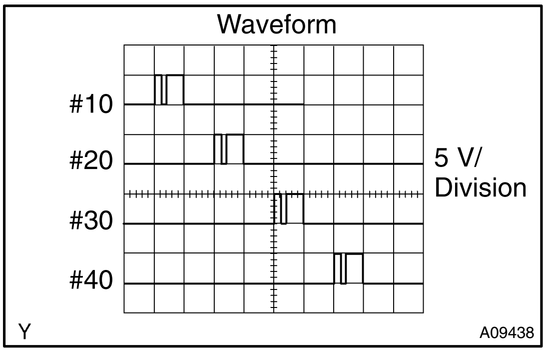
OK

5	**Check for open and short in harness and connector between SCV and ECU.**

NG → **Repair or replace harness or connector.**

OK

6	**Check voltage between terminals #1 – #4 and E01 of engine ECU connector.**



PREPARATION:
Remove the glove compartment.

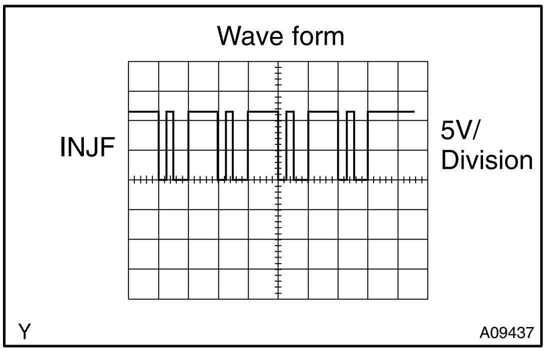
CHECK:
During cranking or idling, check the waveform between terminals #1 – #4 and E01 of the engine ECU connector with the oscilloscope.

OK:
Voltage: The correct waveform are as shown.

NG → **Check and replace ECU (See page IN–20).**

OK

7	Check voltage between terminals INJF and E01 of engine ECU connector.



PREPARATION:
Remove the glove compartment.
CHECK:
During cranking or idling, check the wave form between terminals INJF and E01 of the engine ECU connector with the oscilloscope.
OK:
Voltage: The correct waveform are as shown.

NG → **Check and replace ECU (See page IN–20).**

NG

8	Check for open and short in harness and connector between EDU and engine ECU (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

Replace EDU.

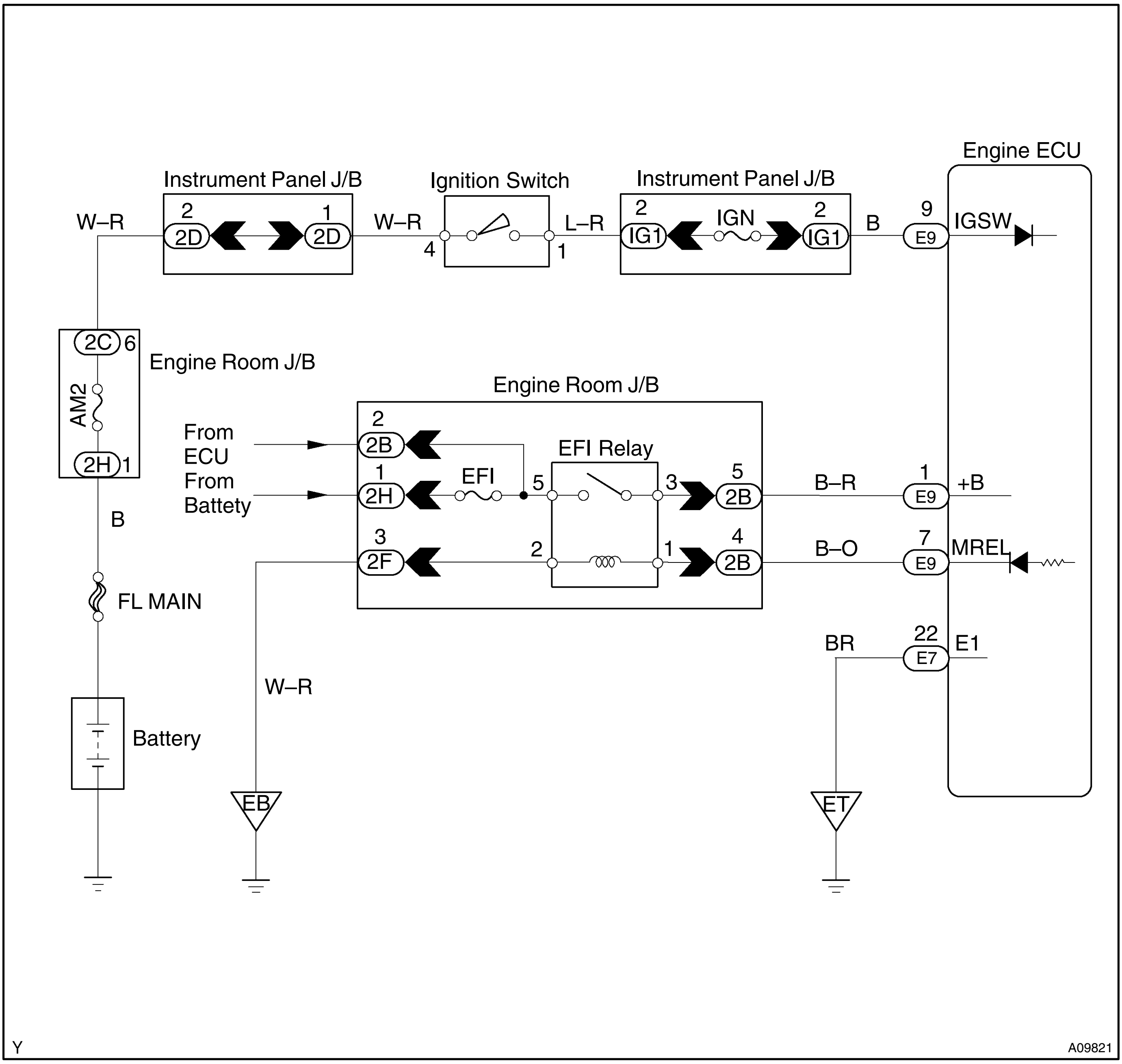
DI322–03

ECU Power Source Circuit

CIRCUIT DESCRIPTION

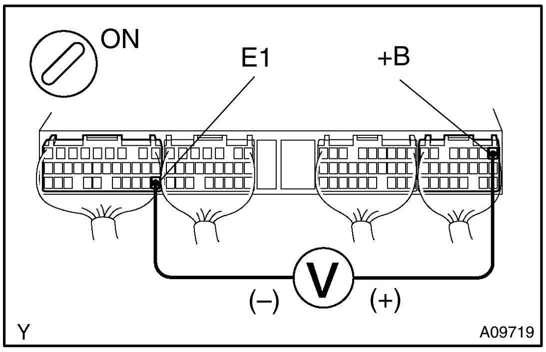
When the ignition switch is turned ON, battery positive voltage is applied to the coil, closing the contacts of the EFI relay (Marking: EFI) and supplying power to the terminal +B of the engine ECU.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	Check voltage between terminals +B and E1 of engine ECU connector.



PREPARATION:
(a) Remove the glove compartment door.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals +B and E1 of the engine ECU connector.

OK:
Voltage: 9 – 14 V

OK → **Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).**

NG

2	Check for open in harness and connector between terminal E1 of engine ECU and body ground (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

3	Check EFI main relay (Marking: EFI) (See page ED–9).

NG → **Replace EFI main relay.**

OK

4	Check EFI fuse.

PREPARATION:
Remove the EFI fuse from the engine room J/B.

CHECK:
Check the continuity of the EFI fuse.

OK:
Continuity

NG → **Check for short in all harness and components connected to EFI fuse.**

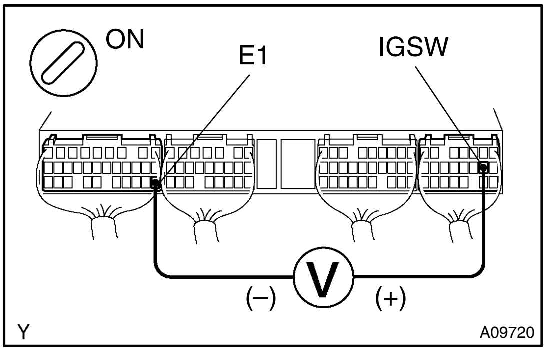
OK

5	**Check for open in harness and connector between engine ECU and EFI main relay (Marking: EFI), and EFI main relay and battery (See page IN–20).**

NG → **Repair harness or connector.**

OK

6	**Check voltage between terminals IGSW and E1 of engine ECU connector.**



PREPARATION:

(a) Remove the glove compartment door.

(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminals IGSW and E1 of the engine ECU connector.

OK:

Voltage : 9 – 14 V

OK → **Go to step 9.**

NG

7	**Check ignition switch (See Pub. No. RM698E BE section).**

NG → **Replace ignition switch.**

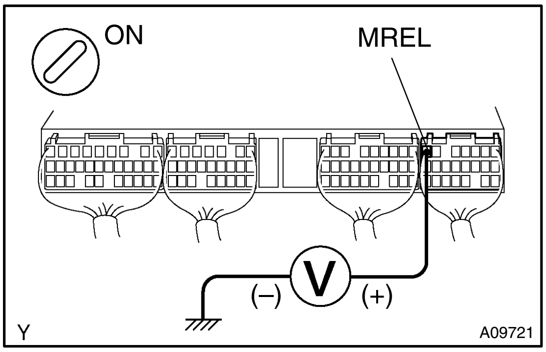
OK

8	**Check for open in harness and connector between ignition switch and engine ECU (See page IN–20).**

NG | **Repair or replace harness or connector.**

OK

9	**Check voltage between terminal MREL of engine ECU connector and body ground.**



PREPARATION:
(a) Remove the glove compartment door.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminal MREL of the engine ECU connector and body ground.

OK:
Voltage: 9 – 14 V

OK | **Check and replace engine ECU (See page IN–20).**

NG

Check for open in harness and connector between engine ECU and EFI main relay (Marking: EFI), and EFI main relay and body ground (See page IN–20).

DI3SC–02

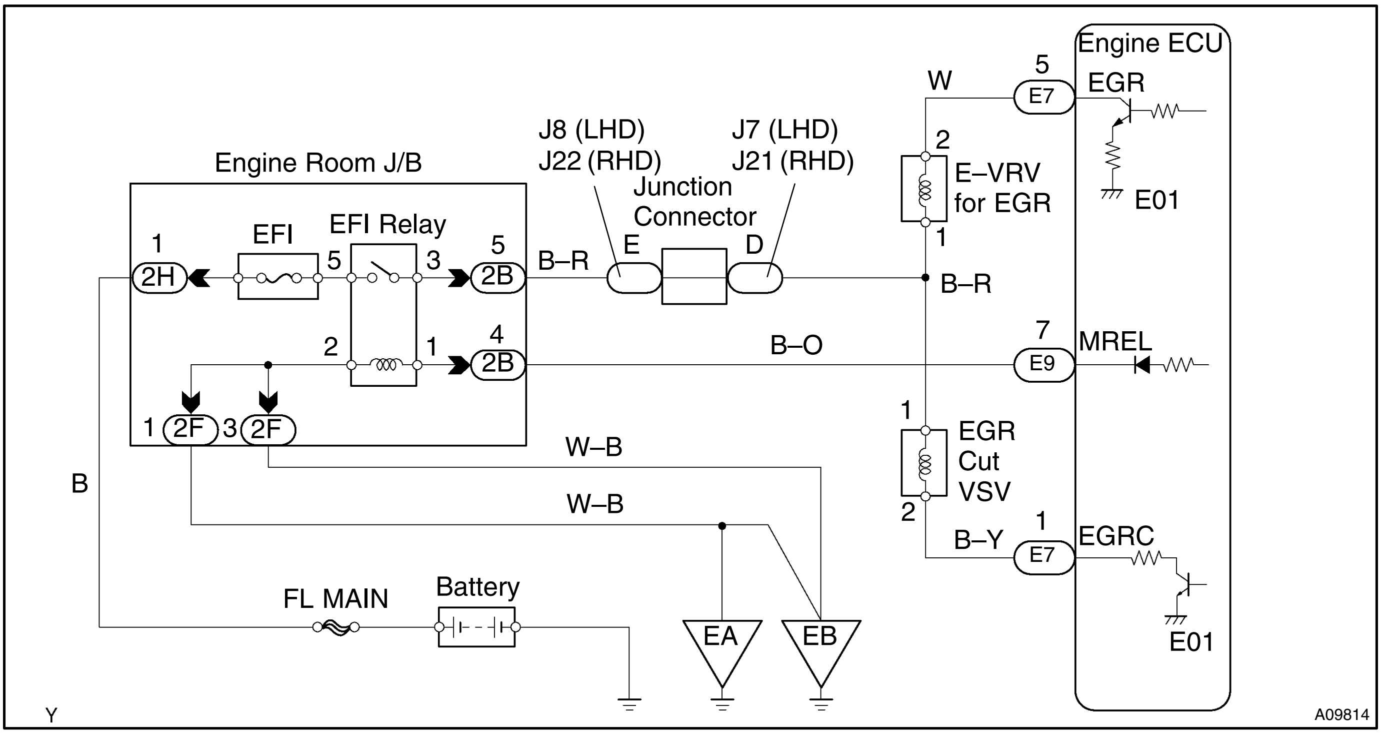
EGR Control Circuit

CIRCUIT DESCRIPTION

The EGR system recirculates exhaust gas, which is controlled to the proper quantity to suit the driving conditions into the intake air mixture to slow down combustion, reduce the combustion temperature and reduce NOx emissions,
The lift amount of EGR valve is controlled by the vacuum which is regulated by the E–VRV operated by the engine ECU.
If even one of the following conditions is fulfilled, the VSV is turned ON by a signal from the ECU. This results in atmospheric air acting on the EGR valve, closing the EGR valve and shutting off the exhaust gas (EGR cut–off).
Under the following conditions, EGR is cut to maintain driveability.

- Before the engine is warmed up
- Engine speed over 4,000 rpm

WIRING DIAGRAM



INSPECTION PROCEDURE

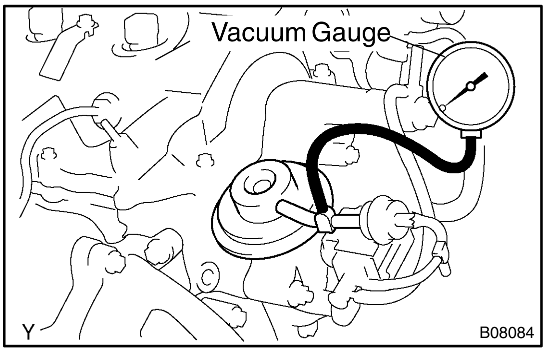
When using hand–held tester:

1	Check connection of vacuum hose.

NG → Repair or replace.

OK

2	Check vacuum between EGR valve and VSV for EGR at 1,500 rpm.



PREPARATION:
(a) Using a 3–way connector, connect a vacuum gauge to the hose between the VSV and EGR valve.
(b) Warm up the engine to above 80˚C (176˚F).
CHECK:
Check the vacuum at 1,500 rpm.
RESULT:

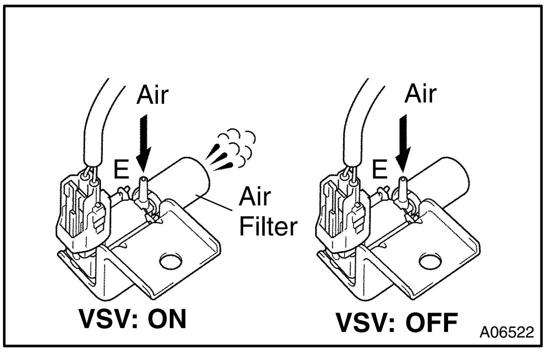
Type	Vacuum
I	0 kPa (0 mmHg, 0 in. Hg)
II	0 kPa (0 mmHg, in. Hg) – 28 kPa (210 mmHg, 8.3 in. Hg)
III	Above 28 kPa (210 mmHg, 8.3 in. Hg)

Type I → **Go to step 7.**

Type III → **Go to step 10**

Type II

3	Check VSV circuit for EGR.



PREPARATION:
(a) Disconnect the vacuum hose from the VSV for the EGR.
(b) Connect the hand–held tester to the DLC3.
(c) Turn the ignition switch ON and push the hand–held tester main switch ON.
(d) Select the ACTIVE TEST mode on the hand–held tester.
CHECK:
Check the operation of VSV for EGR when it is operated by the hand–held tester.
OK:
VSV is ON:
Air from port E flows out through air filter.
VSV is OFF:
Air does not flow from port E to air filter.

OK → **Check connection, damage and blockage of vacuum hose.**

NG

4	**Check VSV for EGR (See page EC–7).**

NG — **Replace VSV for EGR.**

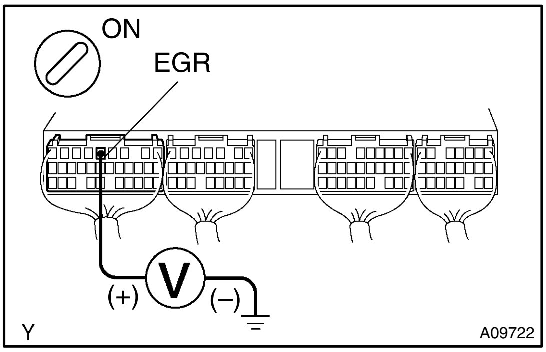
OK

5	**Check for open and short in harness and connector between VSV for EGR and engine ECU (See page IN–20).**

NG — **Repair or replace harness or connector.**

OK

6	**Check voltage between terminal EGR of engine ECU connector and body ground.**



PREPARATION:

(a) Remove the glove compartment door.

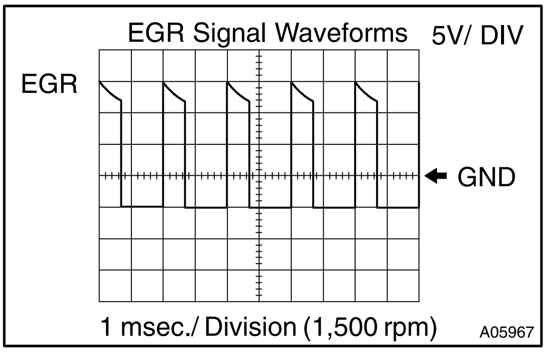
(b) Turn the ignition switch ON.

CHECK:

Measure the voltage between terminal EGR of the engine ECU connector and body ground.

OK:

Voltage: 9 – 14 V



Reference: INSPECTION USING OSCILLOSCOPE

During EGR system is ON (engine speed 1,500 rpm), check the waveform between terminals EGR and E1 of engine ECU connector.

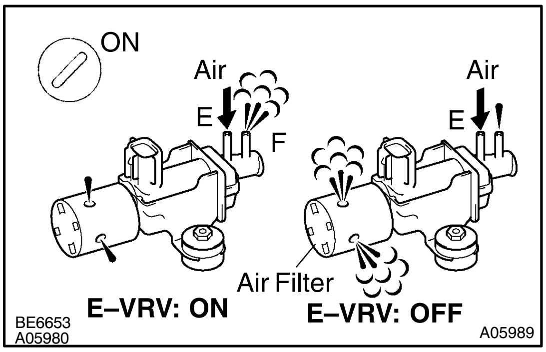
HINT:

The correct waveform is as shown.

NG — **Go to step 8.**

OK

7	Check operation of E–VRV.



PREPARATION:

(a) Disconnect the vacuum hoses from the E–VRV.
(b) Connect the hand–held tester to the DLC3.
(c) Turn the ignition switch ON and the push hand–held tester main switch ON.
(d) Select the ACTIVE TEST mode on the hand–held tester.

CHECK:

Check the operation of the E–VRV when it is operated by the hand–held tester.

OK:

E–VRV ON:
Air from port E flows out through port F.
E–VRV OFF:
Air from port E flows out through air filter.

OK → **Go to step 10.**

NG

8	Check E–VRV for EGR (See page EC–7).

NG → **Replace E–VRV.**

OK

9	Check for open and short in harness and connector between E–VRV and engine ECU, and E–VRV and EFI main relay (Marking : EFI) (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

10	Check EGR valve (See page EC–7).

NG → **Replace the EGR valve.**

OK

Check and replace engine ECU (See page IN–20).

When not using hand–held tester:

1	Check the connection of vacuum hose.

NG → Repair or replace.

OK

2	Check vacuum between EGR valve and VSV for EGR at 1,500 rpm (See page DI–97, step 2).

Type I → Go to step 6.

Type III → Go to step 9.

Type II

3	Check VSV for EGR (See page EC–7).

NG → Replace VSV for EGR.

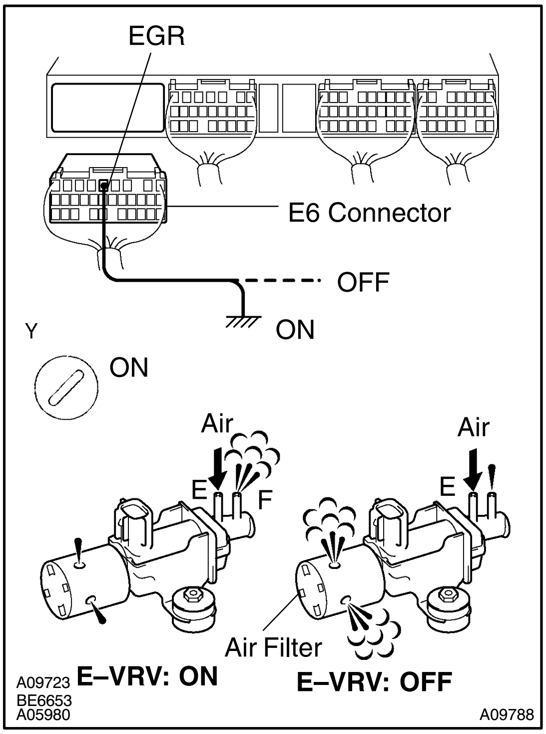
OK

4	Check for open and short in harness and connector between VSV for EGR and engine ECU (See page IN–20).

NG → Repair or replace harness or connector.

OK

5	Check operation of E–VRV.



PREPARATION:
(a) Remove the glove compartment door.
(b) Disconnect the E6 connector from the engine ECU.
(c) Turn the ignition switch ON.

CHECK:
Check the E–VRV operation.
(1) Connect between terminal EGR of the engine ECU connector and body ground (ON).
(2) Disconnect between terminal EGR of the engine ECU connector and body ground (OFF).

OK:
E–VRV ON:
Air from port E flows out through port F.
E–VRV OFF:
Air from port E flows out through air filter.

OK	Go to step 9.

NG

6	Check E–VRV (See page EC–7).

NG	Replace E–VRV.

OK

7	Check for open and short in harness and connector between E–VRV and engine ECU, and E–VRV and EFI main relay (Marking : EFI) (See page IN–20).

NG	Repair or replace harness or connector.

OK

8	Check EGR valve (See page EC–7).

NG → **Replace EGR valve.**

OK ↓

Check and replace engine ECU (See page IN–20).

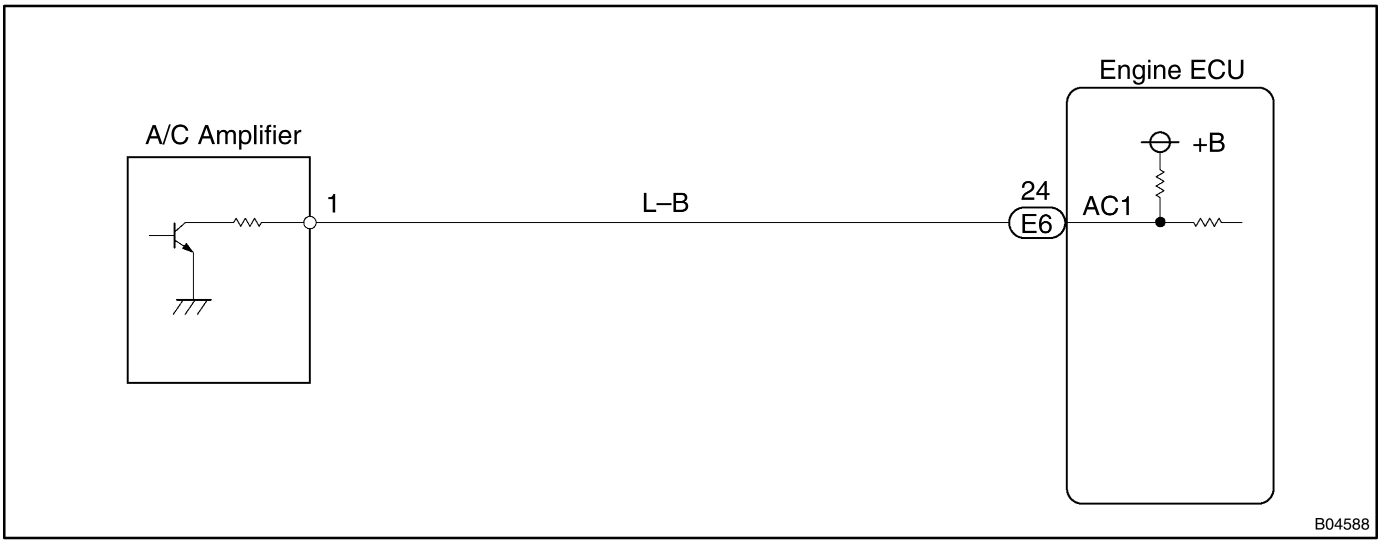
DI326–03

A/C Signal Circuit

CIRCUIT DESCRIPTION

When the A/C compressor is ON, the A/C amplifier sends the A/C signal to the engine ECU, then engine ECU increases the fuel injection volume to improve driveability during engine idling.

WIRING DIAGRAM



INSPECTION PROCEDURE

When using hand–held tester:

1	Connect hand–held tester, and check A/C signal.

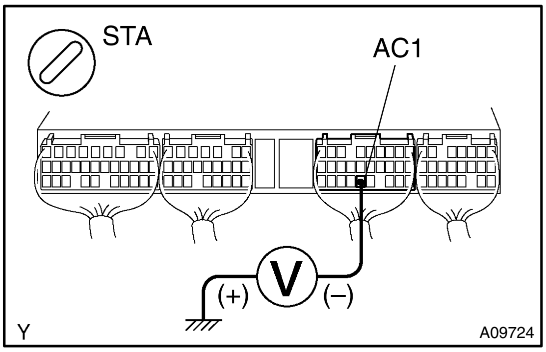
PREPARATION:
(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.
CHECK:
Read the A/C signal on the hand–held tester while the A/C compressor is ON.
OK:

A/C Switch Condition	OFF	ON
A/C Signal	OFF	ON

OK → **Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).**

NG

2	Check voltage between terminal AC1 of engine ECU copnnector and body ground.



PREPARATION:
(a) Remove the glove compartment door.
(b) Start the engine.

CHECK:
Measure the voltage between terminal AC1 of the engine ECU connector and body ground when the A/C switch is turned to ON and OFF.

OK:

A/C Switch Condition	Voltage
ON	Below 1.5 V
OFF	9 – 14 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

3	Check for open and short in harness and connector between engine ECU and A/C amplifier (See page IN–20).

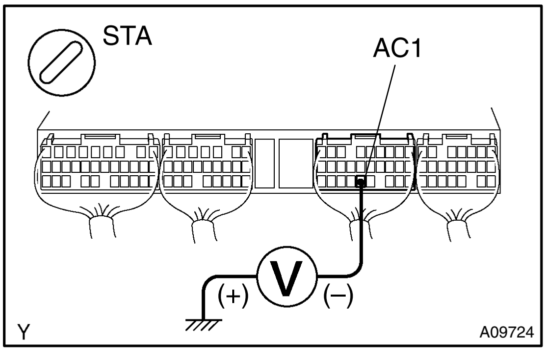
NG → **Repair or replace harness or connector.**

OK

Check and replace A/C amplifier.

When not using hand–held tester:

1	**Check voltage between terminal AC1 of engine ECU connector and body ground.**



PREPARATION:
(a) Remove the glove compartment door.
(b) Start the engine.

CHECK:
Measure the voltage between terminal AC1 of the engine ECU connector and body ground when the A/C switch is turned to ON and OFF.

OK:

A/C Switch Condition	Voltage
ON	Below 1.5 V
OFF	9 – 14 V

OK → **Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).**

NG

2	**Check for open and short in harness and connector between engine ECU and A/C amplifier (See page IN–20).**

NG → **Repair or replace harness or connector.**

OK

Check and replace A/C amplifier.

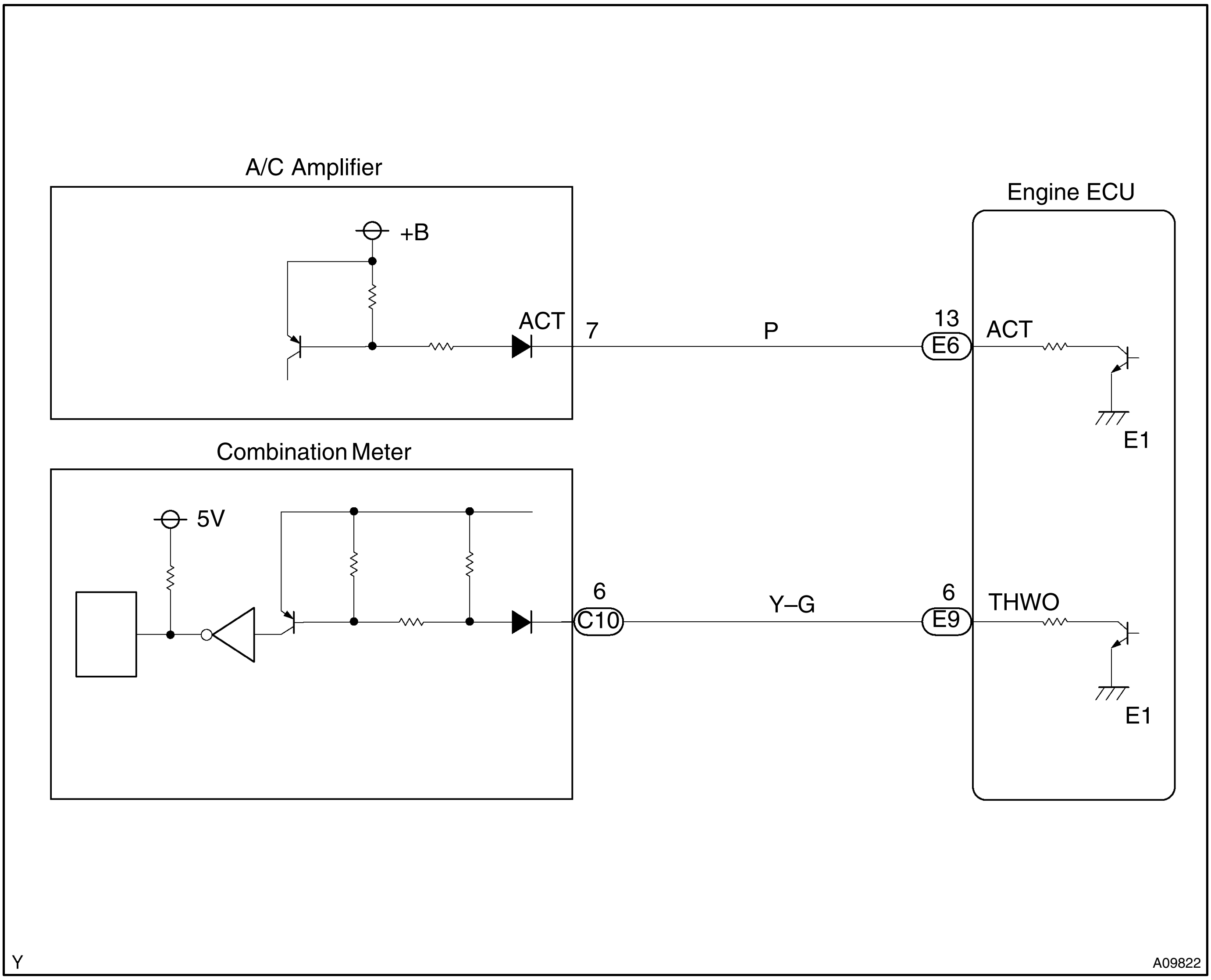
DI3SD–02

A/C Cut Control Circuit

CIRCUIT DESCRIPTION

This circuit cuts air conditioning operation during vehicle acceleration in order to increase acceleration performance. During acceleration with the vehicle speed at 30 km/h (19 mph) or less and accelerator pedal opening angle at 45° or more, the A/C magnetic switch is turned OFF for several seconds.
The air conditioning is also controlled by the ECU out putting the engine coolant temperature to A/C amplifier.

WIRING DIAGRAM



INSPECTION PROCEDURE
When using hand–held tester

1	**Connect the hand–held tester and check operation of air conditioning cut control.**

PREPARATION:
(a) Connect the hand held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.
(c) Start the engine and air conditioning switch ON.
HINT:
A/C magnetic clutch is turned ON.
(d) Select the ACTIVE TEST mode on the hand–held tester.
CHECK:
Check operation of A/C magnetic clutch cut when air conditioning cut control is operated by the hand–held tester.
OK:
A/C magnet clutch is turned OFF.

OK	**Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).**

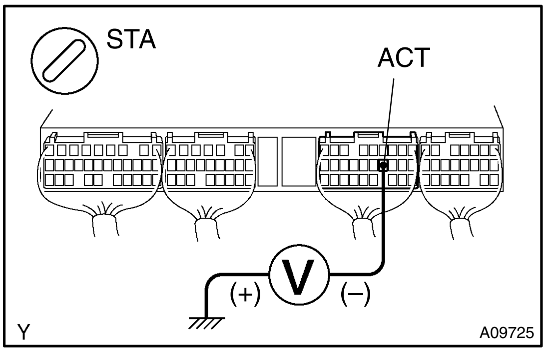
NG

2	**Check for open and short in harness and connector between engine ECU and A/C amplifier (See page IN–20).**

NG	**Repair or replace harness or connector.**

OK

3	**Check voltage between terminal ACT of engine ECU and body ground.**



PREPARATION:

(a) Remove the glove compartment door.
(b) Start the engine.

CHECK:

Measure voltage between terminal ACT of engine ECU connector and body ground when A/C switch is turned to ON and OFF.

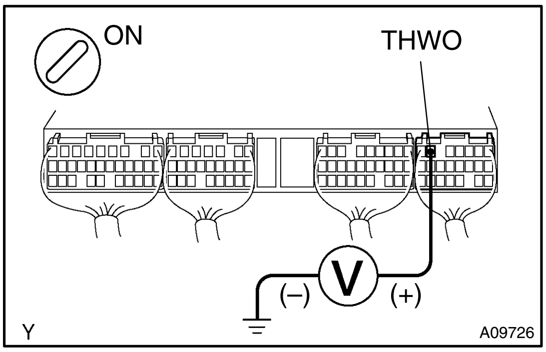
OK:

A/C switch condition	Voltage
Engine at idling	9 – 14 V
IG ON Engine stop	0 – 3 V

OK → **Check and replace A/C amplifier.**

NG

4	**Check voltage between terminal THWO of engine ECU and body ground.**



PREPARATION:

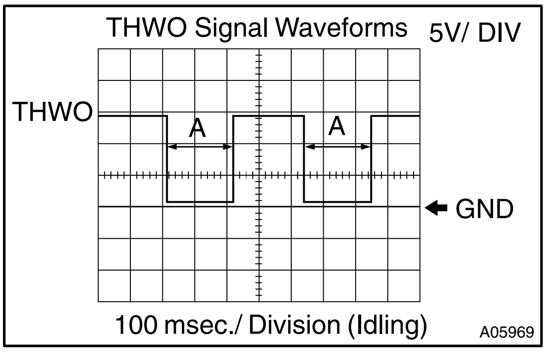
(a) Remove the glove compartment door.
(b) Turn the ignition switch ON.

CHECK:

Measure voltage between terminal THWO of engine ECU and body ground.

OK:

Voltage is generated intermittently.



Reference: INSPECTION USING OSCILLOSCOPE

During idling, check waveform between terminals THWO and E1 of engine ECU.

HINT:

The correct waveform is as shown.

Water temp.	30°C or less	Approx. 75°C	90°C or more
A	65 msec.	335.8 msec.	393 msec.

OK → **Check and replace A/C amplifier.**

NG

5	Check for open and short in harness and connector between engine ECU and Combination meter (See page IN–20).

NG → Repair or replace harness or connector.

OK ↓

Check and replace engine ECU (See page IN–20).

When not using hand–held tester

1	Check voltage between terminal ACT of engine ECU and body ground (See page DI–107, Step 3).

OK → Check and replace A/C amplifier.

NG ↓

2	Check voltage between terminal THWO of engine ECU and body ground (See page DI–107, Step 4).

OK → Check and replace A/C amplifier.

NG ↓

3	Check for open and short in harness and connector between engine ECU and A/C amplifier (See page IN–20).

NG → Repair or replace harness or connector.

OK ↓

Check and replace engine ECU.

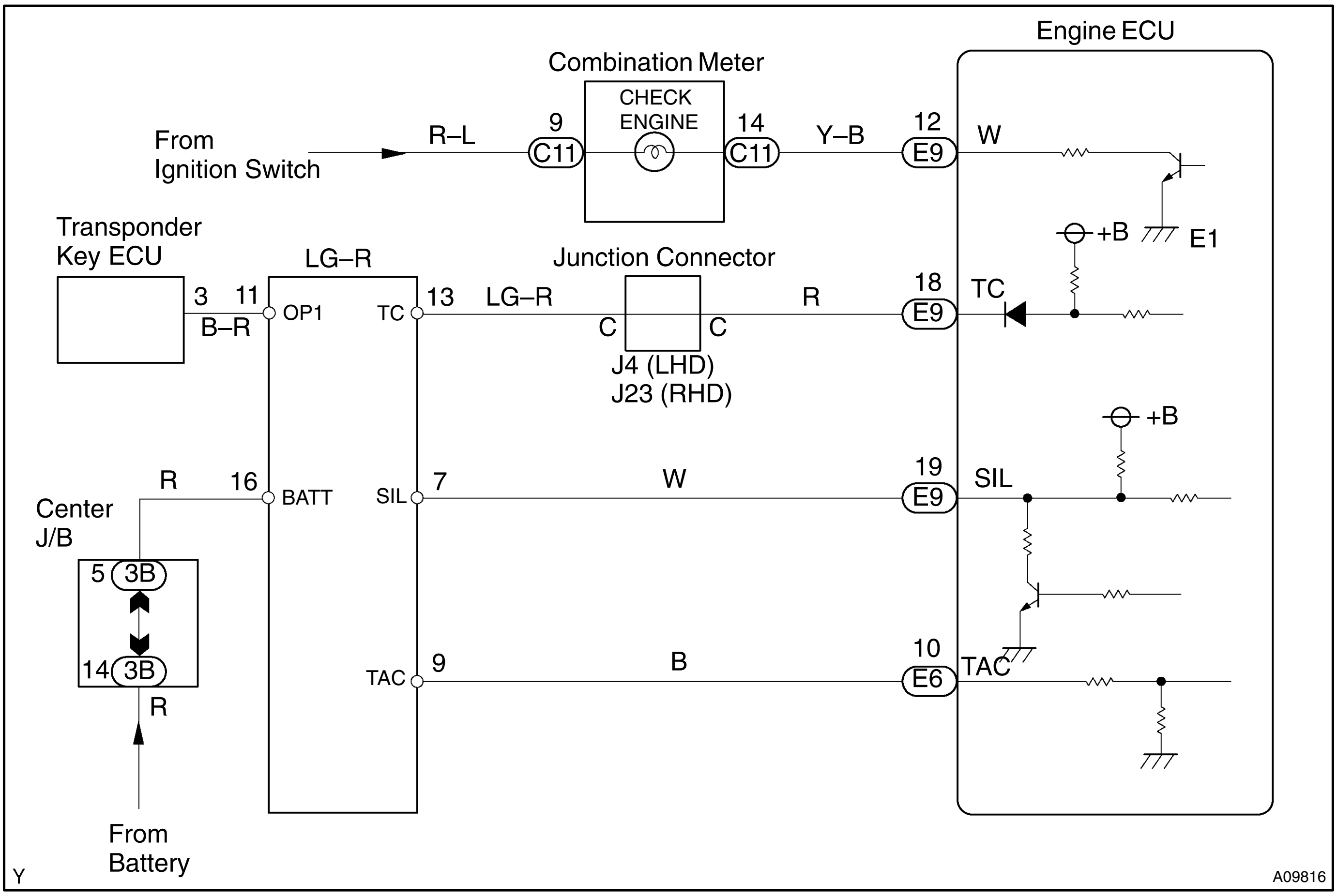
DI69M–01

Diagnostic Connector (DLC3) Circuit

CIRCUIT DESCRIPTION

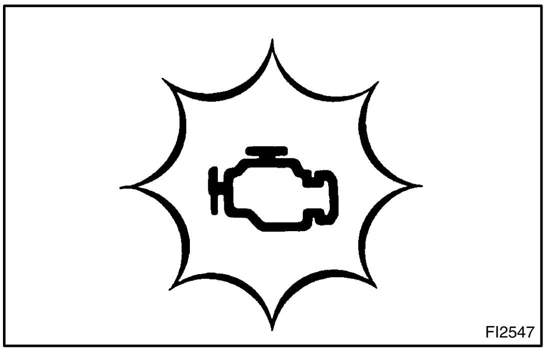
Terminals TC and CG are located in the DLC3.
The DLC3 is located under the finish lower panel. When terminals TC and CG are connected, DTC in normal mode or test mode can be read from the check engine warning light in the combination meter.
Also, terminal SIL is located in the DLC3. This terminal is used by the M–OBD communication with hand–held tester.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	**Check check engine warning light condition.**


FI2547

PREPARATION:
(a) Turn the ignition switch ON.
(b) Using SST, connect terminals TC and CG of the DLC3.
SST 09843–18040

CHECK:
Check the check engine warning light condition.

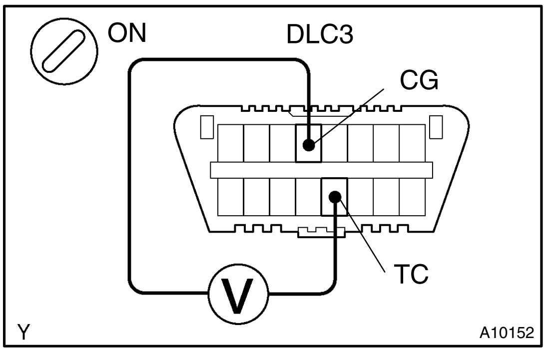
OK:
Check engine warning light : Blinking

HINT:
If this inspection OK and there is no hand–held tester, do not need to do the following steps and this circuit is OK. Proceed to next circuit inspection shown on problem symptom table (See page DI–19).

OK	**Go to step 7.**

NG

2	**Check voltage between terminals TC and CG of DLC3.**



A10152

PREPARATION:
Turn the ignition switch ON.

CHECK:
Measure the voltage between terminals TC and CG of the DLC3.

OK:
Voltage : 9 – 14 V

OK	**Go to step 5.**

NG

3	**Check continuity terminal CG of DLC3 and body ground.**

NG	**Repair or replace harness or connector.**

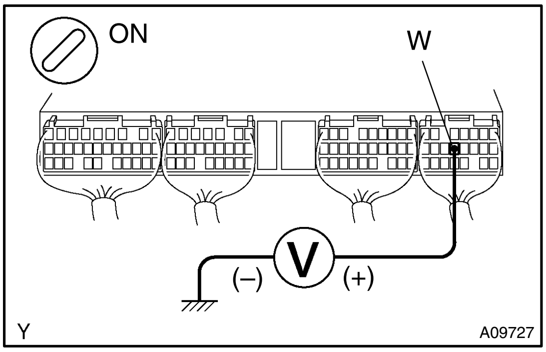
OK

4	Check for open and short in harness and connector between terminal TC of DLC3 and terminal TC of engine ECU (See page IN–20).

NG → **Repair or replace harness or connector.**

OK

5	Check voltage between terminal W of engine ECU connector and body ground.



PREPARATION:
(a) Remove the glove compartment door.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminal W of the engine ECU connector and body ground.

OK:
Voltage: 9 – 14 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

6	Check bulb of check engine warning light.

NG → **Replace bulb.**

OK

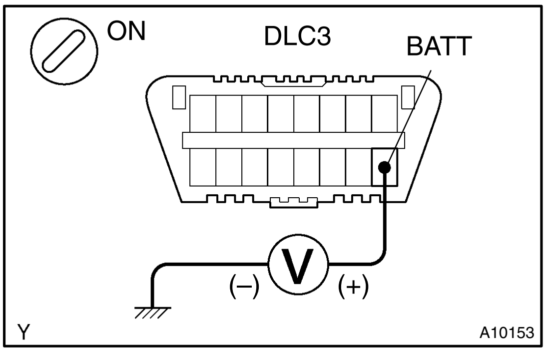
Check for open in harness and connector between terminal W of engine ECU and combination meter (See page IN–20).

7	**Can you read the DTC (including normal DTC) using hand–held tester?**

YES → **Proceed to next circuit inspection shown on problem symptom table (See page DI–19).**

NO

8	**Check voltage between terminal BATT of DLC3 and body ground.**



CHECK:
Measure the voltage between terminal BATT of the DLC3 and body ground.
OK:
Voltage: 9 – 14 V

NG → **Check for open and short in harness and connector between terminal BATT of DLC3 and fusible link block (See page IN–20).**

OK

Check for open and short in harness and connector between terminal SIL of DLC3 and terminal SIL of engine ECU (See page IN–20).

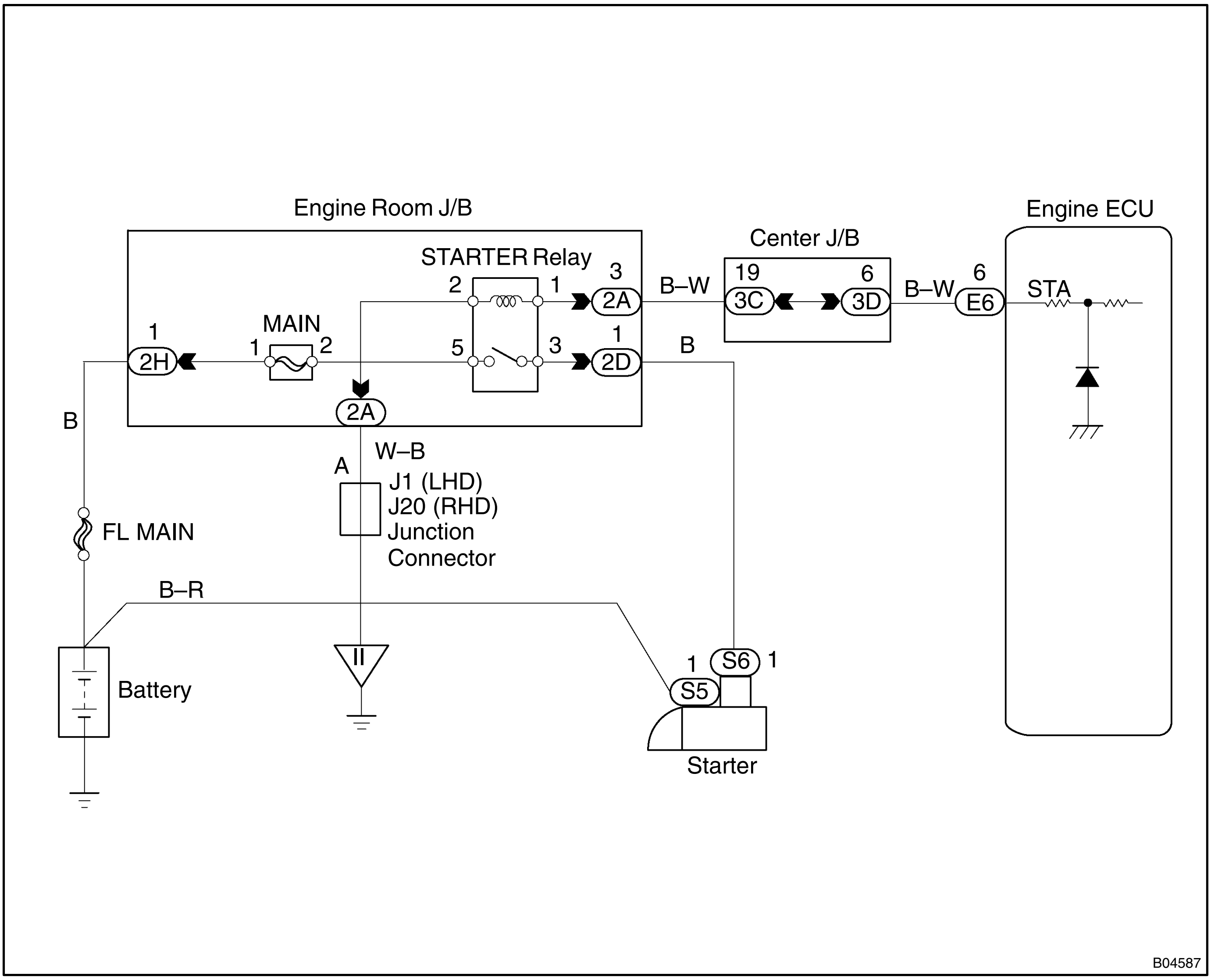
DI325–03

Starter Signal Circuit

CIRCUIT DESCRIPTION

When the engine is being cranked, the intake air flow is slow, so fuel vaporization is poor. A rich mixture is therefore necessary in order to achieve good start ability. While the engine is being cranked, the battery positive voltage is applied to terminal STA of the engine ECU. The starter signal is mainly used to increase the fuel injection volume for the starting injection control and after–start injection control.

WIRING DIAGRAM



INSPECTION PROCEDURE

HINT:

This diagnostic chart is based on the premise that the engine is being cranked under normal conditions. If the engine does not crank, proceed to the problem symptoms table on page DI–19.

When using hand–held tester:

1	**Connect hand–held tester, and check STA signal.**

PREPARATION:
(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.

CHECK:
Read the STA signal on the hand–held tester while the starter operates.

OK:

Ignition Switch Position	ON	STA
STA Signal	OFF	ON

OK → **Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).**

NG

2	**Check for open in harness and connector between engine ECU and starter relay (See page IN–20).**

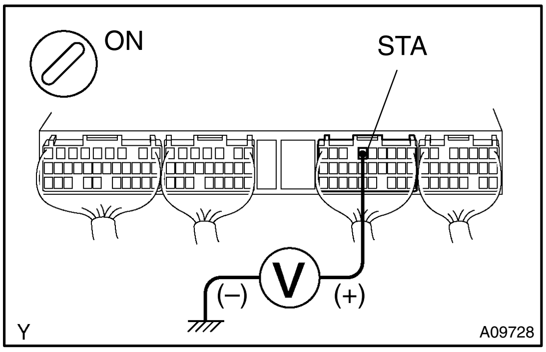
NG → **Repair or replace harness or connector.**

OK

Check and replace engine ECU (See page IN–20).

When not using hand–held tester:

1	**Check starter signal.**



PREPARATION:
(a) Remove the glove compartment door.
(b) Turn the ignition switch ON.

CHECK:
Measure the voltage between terminal STA of the engine ECU connector and body ground during cranking.

OK:
Voltage: 6.0 V or more

OK → **Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).**

NG

2	Check for open in harness and connector between engine ECU and starter relay (See page IN–20).

NG → Repair or replace harness or connector.

OK

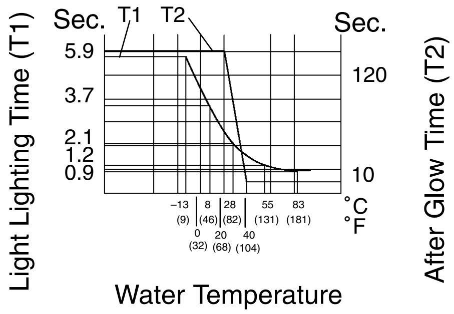
Check and replace engine ECU (See page IN–20).

DI323–03

Pre–Heating Control Circuit

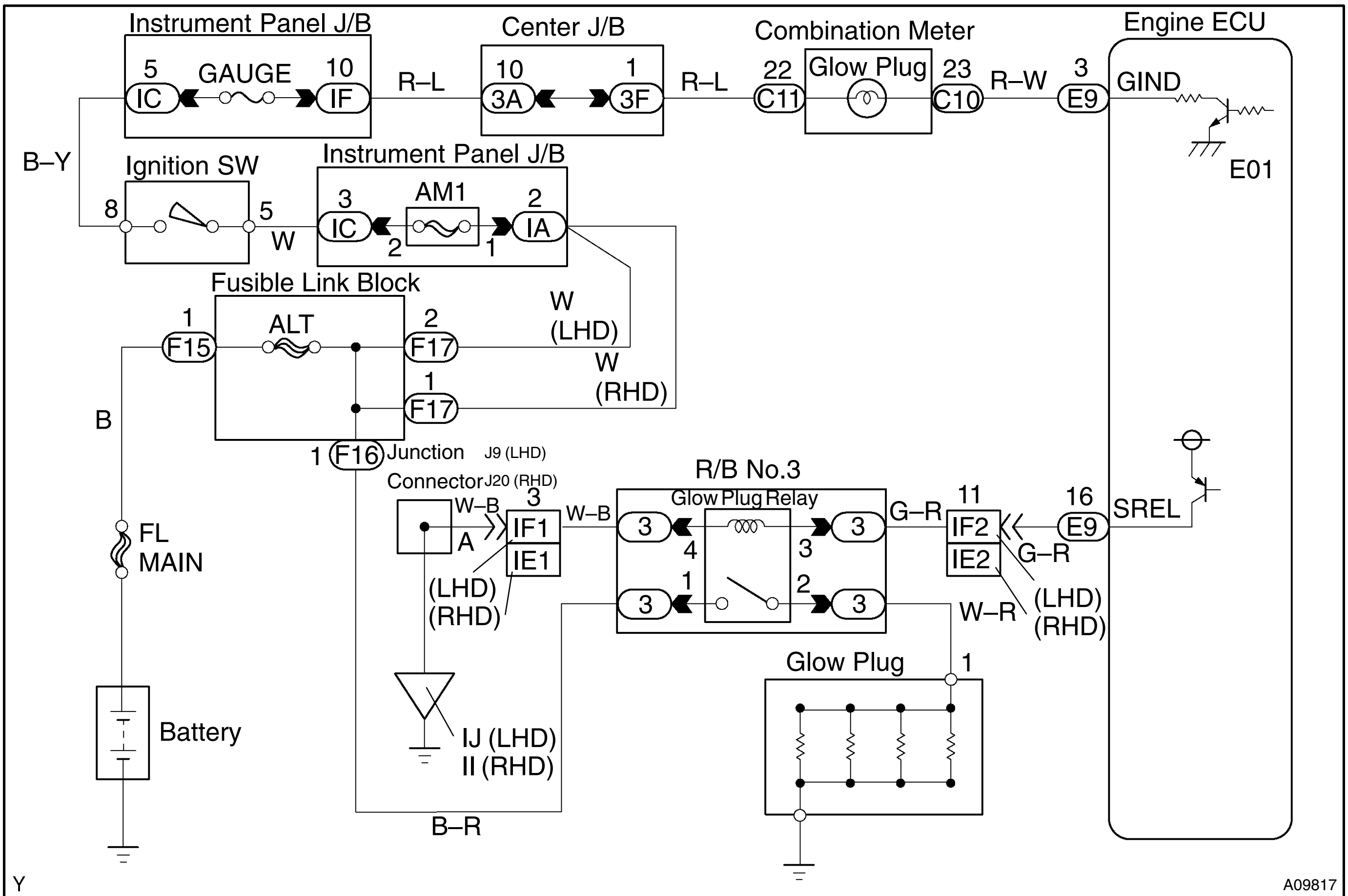
CIRCUIT DESCRIPTION

When the ignition switch turns ON, the engine ECU calculates the glow indicator lighting time/heating corresponding to the coolant temperature at that time and turns ON the glow indicator light/glow plug relay.
As the ceramics is used for a glow plug material, the current control is not performed.



A05568

WIRING DIAGRAM



A09817

INSPECTION PROCEDURE

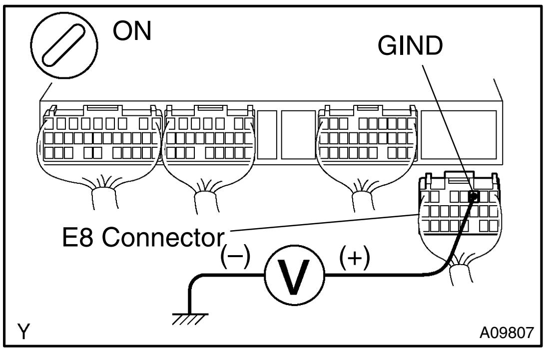
1	Does glow indicator light up?

PREPARATION:
Turn the ignition switch ON.
CHECK:
Does the glow indicator light up?
OK:
The glow indicator lights up for 0.5 sec. or more.

OK → **Go to step 5.**

NG

2	Check voltage between terminal GIND of engine ECU connector and body ground.



PREPARATION:
(a) Remove the glove compartment door.
(b) Disconnect the E8 connector from the engine ECU.
(c) Turn ignition switch ON.
CHECK:
Measure the voltage between terminal GIND of the engine ECU connector and body ground.
OK:
Voltage: 9 – 14 V

OK → **Check and replace engine ECU (See page IN–20).**

NG

3	Check GAUGE fuse.

PREPARATION:
Remove the GAUGE fuse.
CHECK:
Measure the continuity of the GAUGE fuse.
OK:
Continuity

NG → **Check for short in all harness and components connected to GAUGE fuse.**

OK

4	Check glow indicator light bulb.

NG → Replace bulb.

OK

Check for open in harness and connector between combination meter and engine ECU, and combination meter and GAUGE fuse (See page IN–20).

5	Check glow indicator lighting time (See page ST–1).

NG → Check and replace engine ECU (See page IN–20).

OK

6	Are there any DTC being output?

YES → Go to relevant DTC chart.

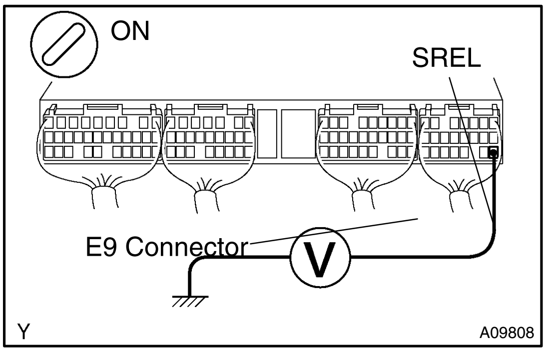
NO

7	Check glow plug relay (See page ST–1).

NG → Replace glow plug relay.

OK

8	Check voltage between terminal SREL of engine ECU connector and body ground at cranking.



PREPARATION:
(a) Remove the glove compartment door.
(b) Disconnect the E9 connector from the engine ECU.
(c) Turn the ignition switch STA.

CHECK:
Measure the voltage between terminal SREL of the engine ECU connector and body ground at cranking.

OK:
Voltage: 9 – 14 V

NG → **Check and replace engine ECU (See page IN–20).**

OK

9	Check for open and short in harness and connector between glow plug relay and engine ECU, and glow plug relay and body ground (See page IN–20).

NG → **Repair harness or connector.**

OK

10	Check resistance of glow plug (See page ST–1).

NG → **Replace glow plug.**

OK

11	Inspect glow plug installation.

NG → **Tighten glow plug.**

OK

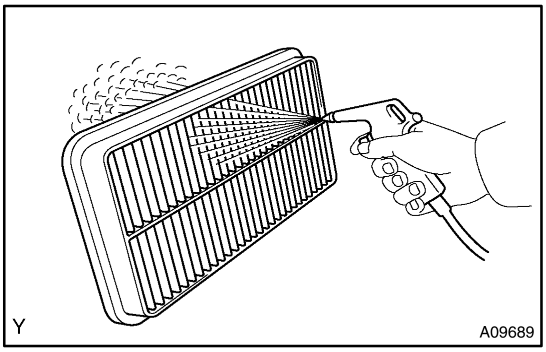
12	**Check for open in harness and connector between glow plug relay and glow plug (See page IN–20).**

NG → **Repair harness or connector.**

OK

Proceed to next circuit inspection shown on problem symptoms table (See page DI–19).

ENGINE MECHANICAL



AIR FILTER

EM0HP–02

INSPECTION

1. REMOVE AIR FILTER

2. INSPECT AIR FILTER

Visually check that the filter is not excessively dirty or oily.

3. CLEAN AIR FILTER

Clean the filter element with compressed air. First blow from the inside thoroughly. Then blow off the out side of the filter element.

4. REINSTALL AIR FILTER

COMPRESSION

EM0HQ–02

INSPECTION

HINT:

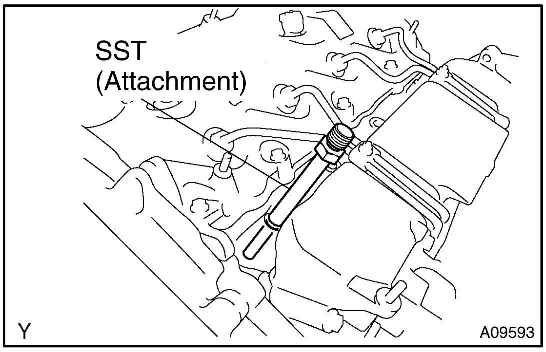
If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. WARM UP AND STOP ENGINE

Allow the engine to warm up to normal operating temperature.

2. REMOVE GLOW PLUGS (See page EM–12)

3. DISCONNECT INJECTOR CONNECTORS

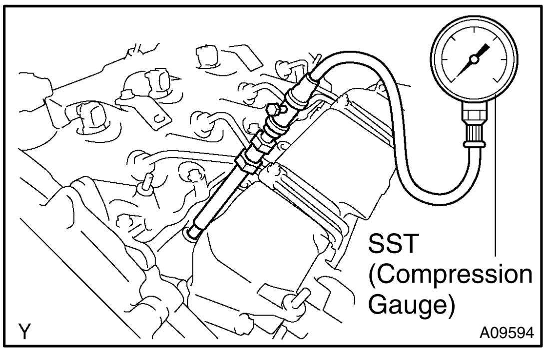


4. CHECK CYLINDER COMPRESSION PRESSURE

HINT:

Turn the starter before measuring the compression and discharge the foreign objects.

(a) Install SST (attachment) to the glow plug hole.
SST 09992–00025 (09992–00121)
Torque: 12.3 N·m (125 kgf·cm, 9 ft·lbf)



(b) Connect SST (compression gauge) to the SST (attachment).
SST 09992–00025 (09992–00211)

(c) Fully open the throttle valve, and start the engine.

(d) While cranking the engine, measure the compression pressure.

HINT:

Always use a fully charged battery to obtain engine revolution of 250 rpm or more.

(e) Repeat steps (a) through (d) for each cylinder.

NOTICE:

This measurement must be done in as short a time as possible.

Compression pressure:
2,746 kPa (28.0 kgf/cm^2, 398 psi) or more
Minimum pressure:
2,256 kPa (23.0 kgf/cm^2, 327 psi) or more
Difference between each cylinder:
490 kPa (5.0 kgf/cm^2, 71 psi) or less

(f) If the cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder the glow plug hole and repeat steps (a) through (d) for the cylinder with low compression.
- If adding oil helps the compression, chances are that the piston rings and/or cylinder bore are worn or damaged.
- If pressure stays low, a valve may be sticking or seating improperly, or there may be leakage past the gasket.

(g) Remove SST.
SST 09992–00025 (09992–00121, 09992–00211)

5. RECONNECT INJECTOR CONNECTORS

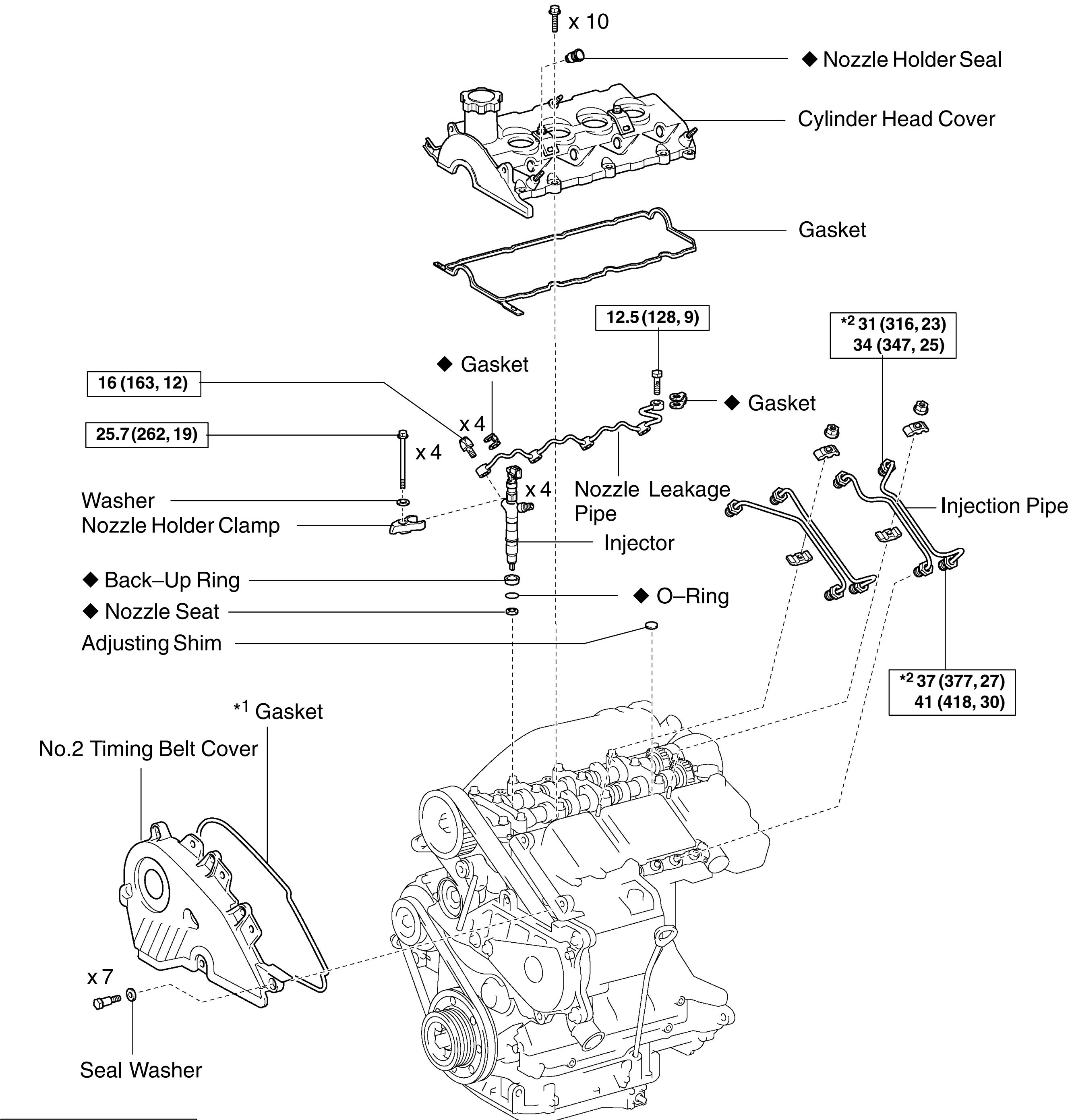
6. REINSTALL GLOW PLUGS (See page EM–18)

7. START ENGINE AND CHECK FOR LEAK

VALVE CLEARANCE

COMPONENTS

EM138–02



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

Y A09685

EM139–01

INSPECTION

HINT:

Inspect and adjust the valve clearance when the engine is cold.

NOTICE:

- **Befor removing the injection pipes, clean them up with a soft brush and compressed air.**
- **After removing the injection pipe, affix the gum tape on the supply pump, common rail and the whole injector installatoin area of the cylinder head cover for preventing dust from coming into them.**
- **After removing the cylinder head cover, put a vinyl bag and rubber band for preventing from mixing foreign objects over the injector inlet.**

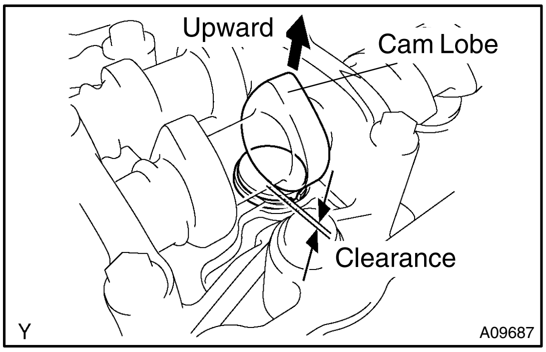
1. REMOVE NO.2 TIMING BELT COVER (See page EM–12)

2. REMOVE INJECTION PIPES (See page FU–6)

3. REMOVE CYLINDER HEAD COVER (See page EM–28)

4. REMOVE NOZZLE LEAKAGE PIPE (See page FU–6)

5. REMOVE INJECTORS (See page FU–6)



6. INSPECT VALVE CLEARANCE

(a) Turn the crankshaft so that the cam lobe of the camshaft on the inspecting valve points upward.

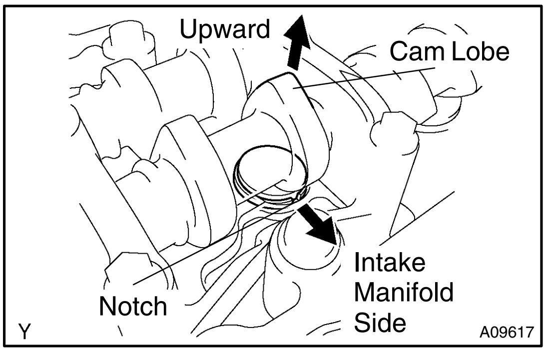
(b) Using a feeler gauge, measure the clearance between the valve lifter and camshaft.

(c) Measure the clearance at 16 places.

(d) Record the out–of–specification valve clearance measurements. They will be used later to determine the required replacement adjusting shim.

Valve clearance (Cold):

Intake	0.20 – 0.30 mm (0.008 – 0.012 in.)
Exhaust	0.35 – 0.45 mm (0.014 – 0.018 in.)

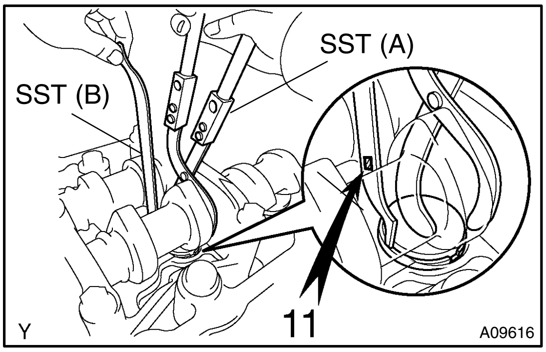


7. ADJUST VALVE CLEARANCE

(a) Remove the adjusting shim.

(1) Turn the crankshaft so that the cam lobe of the camshaft on the adjusting valve points upward.

(2) Position the notch of the valve lifter facing the intake manifold side.

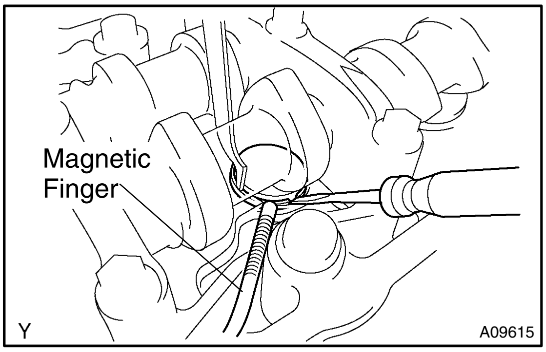


(3) Using SST (A), press down the valve lifter and place SST (B) between the camshaft and valve lifter. Remove SST (A).

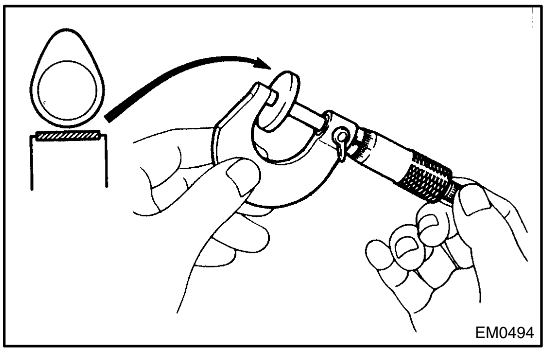
SST 09248–55050 (09248–05510, 09248–05520)

HINT:

Apply SST (B) on the side marked with ”11”.



(4) Remove the adjusting shim with a small screwdriver and magnetic finger.



(b) Determine the replacement adjusting shim size by following the Formula or Charts:

(1) Using a micrometer, measure the thickness of the removed shim.

(2) Calculate the thickness of a new shim so that the valve clearance comes within specified value.

T .... Thickness of removed adjusting shim
A .... Measured valve clearance
N .... Thickness of new adjusting shim

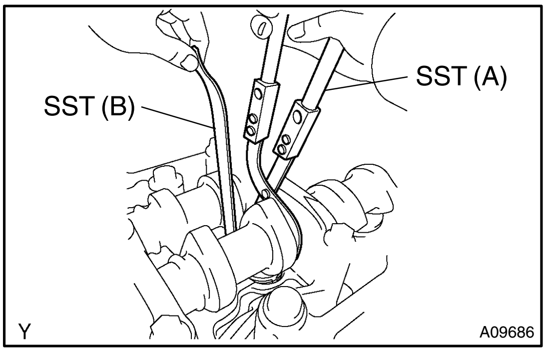
Intake: N = T + (A – 0.25 mm (0.010 in.))

Exhaust: N = T + (A – 0.40 mm (0.016 in.))

(3) Select a new shim with a thickness as close as possible to the calculated value.

HINT:

Shims are available in 17 sizes in increments of 0.05 mm (0.0020 in.), from 2.50 mm (0.0984 in.) to 3.30 mm (0.1299 in.).



(c) Install a new adjusting shim.
(1) Place a new adjusting shim on the valve lifter.
(2) Using SST (A), press down the valve lifter and remove SST (B).
SST 09248–55050 (09248–05510, 09248–05520)
(d) Recheck the valve clearance.

8. REINSTALL INJECTORS (See page FU–8)

9. REINSTALL NOZZLE LEAKAGE PIPE (See page FU–8)

10. REINSTALL CYLINDER HEAD COVER (See page EM–46)

11. REINSTALL INJECTION PIPES (See page FU–8)

12. REINSTALL NO.2 TIMING BELT COVER (See page EM–18)

Adjusting Shim Selection Chart (Intake)

Installed shim thickness mm (in.) / Measured clearance mm (in.)	2.500 (0.0984)	2.525 (0.0994)	2.550 (0.1004)	2.575 (0.1014)	2.600 (0.1024)	2.625 (0.1033)	2.650 (0.1043)	2.675 (0.1053)	2.700 (0.1063)	2.725 (0.1073)	2.750 (0.1083)	2.775 (0.1093)	2.800 (0.1102)	2.825 (0.1112)	2.850 (0.1122)	2.875 (0.1132)	2.900 (0.1142)	2.925 (0.1152)	2.950 (0.1161)	2.975 (0.1171)	3.000 (0.1181)	3.025 (0.1191)	3.050 (0.1201)	3.075 (0.1211)	3.100 (0.1220)	3.125 (0.1230)	3.150 (0.1240)	3.175 (0.1250)	3.200 (0.1260)	3.225 (0.1270)	3.250 (0.1280)	3.275 (0.1289)	3.300 (0.1299)
0.000 ~ 0.020 (0.0000 ~ 0.0008)									01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23
0.021 ~ 0.040 (0.0008 ~ 0.0016)									01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25
0.041 ~ 0.060 (0.0016 ~ 0.0024)								01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25
0.061 ~ 0.080 (0.0024 ~ 0.0031)							01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25
0.081 ~ 0.100 (0.0032 ~ 0.0039)						01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27
0.101 ~ 0.120 (0.0040 ~ 0.0047)					01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27
0.121 ~ 0.140 (0.0048 ~ 0.0055)					01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29
0.141 ~ 0.160 (0.0056 ~ 0.0063)				01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29
0.161 ~ 0.180 (0.0063 ~ 0.0071)			01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29
0.181 ~ 0.199 (0.0071 ~ 0.0078)		01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31
0.200 ~ 0.300 (0.0079 ~ 0.0118)																																	
0.301 ~ 0.320 (0.0119 ~ 0.0126)	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33	
0.321 ~ 0.340 (0.0126 ~ 0.0134)	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33		
0.341 ~ 0.360 (0.0134 ~ 0.0142)	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33			
0.361 ~ 0.380 (0.0142 ~ 0.0150)	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33				
0.381 ~ 0.400 (0.0150 ~ 0.0157)	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33				
0.401 ~ 0.420 (0.0158 ~ 0.0165)	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33					
0.421 ~ 0.440 (0.0166 ~ 0.0173)	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33						
0.441 ~ 0.460 (0.0174 ~ 0.0181)	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33							
0.461 ~ 0.480 (0.0181 ~ 0.0189)	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33								
0.481 ~ 0.500 (0.0189 ~ 0.0197)	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33								
0.501 ~ 0.520 (0.0197 ~ 0.0205)	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33									
0.521 ~ 0.540 (0.0205 ~ 0.0213)	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33										
0.541 ~ 0.560 (0.0213 ~ 0.0220)	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33											
0.561 ~ 0.580 (0.0221 ~ 0.0228)	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33												
0.581 ~ 0.600 (0.0229 ~ 0.0236)	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33												
0.601 ~ 0.620 (0.0237 ~ 0.0244)	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33													
0.621 ~ 0.640 (0.0244 ~ 0.0252)	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33														
0.641 ~ 0.660 (0.0252 ~ 0.0260)	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33															
0.661 ~ 0.680 (0.0260 ~ 0.0268)	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33																
0.681 ~ 0.700 (0.0268 ~ 0.0276)	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33																
0.701 ~ 0.720 (0.0276 ~ 0.0283)	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33																	
0.721 ~ 0.740 (0.0284 ~ 0.0291)	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33																		
0.741 ~ 0.760 (0.0292 ~ 0.0299)	21	23	23	25	25	27	27	29	29	31	31	33	33	33																			
0.761 ~ 0.780 (0.0300 ~ 0.0307)	21	23	23	25	25	27	27	29	29	31	31	33	33																				
0.781 ~ 0.800 (0.0307 ~ 0.0315)	23	23	25	25	27	27	29	29	31	31	33	33	33																				
0.801 ~ 0.820 (0.0315 ~ 0.0323)	23	25	25	27	27	29	29	31	31	33	33	33																					
0.821 ~ 0.840 (0.0323 ~ 0.0331)	25	25	27	27	29	29	31	31	33	33	33																						
0.841 ~ 0.860 (0.0331 ~ 0.0339)	25	27	27	29	29	31	31	33	33	33																							
0.861 ~ 0.880 (0.0339 ~ 0.0346)	25	27	27	29	29	31	31	33	33																								
0.881 ~ 0.900 (0.0347 ~ 0.0354)	27	27	29	29	31	31	33	33	33																								
0.901 ~ 0.920 (0.0355 ~ 0.0362)	27	29	29	31	31	33	33	33																									
0.921 ~ 0.940 (0.0363 ~ 0.0370)	29	29	31	31	33	33	33																										
0.941 ~ 0.960 (0.0370 ~ 0.0378)	29	31	31	33	33	33																											
0.961 ~ 0.980 (0.0378 ~ 0.0386)	29	31	31	33	33																												
0.981 ~ 1.000 (0.0386 ~ 0.0394)	31	31	33	33	33																												
1.001 ~ 1.020 (0.0394 ~ 0.0402)	31	33	33	33																													
1.121 ~ 1.040 (0.0402 ~ 0.0409)	33	33	33																														
1.041 ~ 1.060 (0.0410 ~ 0.0417)	33	33																															
1.161 ~ 1.080 (0.0418 ~ 0.0425)	33																																
1.081 ~ 1.100 (0.0426 ~ 0.0433)	33																																

New shim thickness mm (in.)

Shim No.	Thickness	Shim No.	Thickness
01	2.500 (0.0984)	19	2.950 (0.1161)
03	2.550 (0.1004)	21	3.000 (0.1181)
05	2.600 (0.1024)	23	3.050 (0.1201)
07	2.650 (0.1043)	25	3.100 (0.1220)
09	2.700 (0.1063)	27	3.150 (0.1240)
11	2.750 (0.1083)	29	3.200 (0.1260)
13	2.800 (0.1102)	31	3.250 (0.1280)
15	2.850 (0.1122)	33	3.300 (0.1299)
17	2.900 (0.1142)		

Intake valve clearance (Cold):

0.20 – 0.30 mm (0.008 – 0.012 in.)

EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.450 mm (0.0177 in.). Replace the 2.800 mm (0.1102 in.) shim with a new No.21 shim.

Adjusting Shim Selection Chart (Exhaust)

Installed shim thickness mm (in.) / Measured clearance mm (in.)	2.500 (0.0984)	2.525 (0.0994)	2.550 (0.1004)	2.575 (0.1014)	2.600 (0.1024)	2.625 (0.1033)	2.650 (0.1043)	2.675 (0.1053)	2.700 (0.1063)	2.725 (0.1073)	2.750 (0.1073)	2.775 (0.1093)	2.800 (0.1102)	2.825 (0.1112)	2.850 (0.1122)	2.875 (0.1132)	2.900 (0.1142)	2.925 (0.1152)	2.950 (0.1161)	2.975 (0.1171)	3.000 (0.1181)	3.025 (0.1191)	3.050 (0.1201)	3.075 (0.1211)	3.100 (0.1220)	3.125 (0.1230)	3.150 (0.1240)	3.175 (0.1250)	3.200 (0.1260)	3.225 (0.1270)	3.250 (0.1280)	3.275 (0.1289)	3.300 (0.1299)
0.000 ~ 0.020 (0.0000 ~ 0.0008)															01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17
0.021 ~ 0.040 (0.0008 ~ 0.0016)															01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19
0.041 ~ 0.060 (0.0016 ~ 0.0024)														01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19
0.061 ~ 0.080 (0.0024 ~ 0.0031)													01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19
0.081 ~ 0.100 (0.0032 ~ 0.0039)												01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21
0.101 ~ 0.120 (0.0040 ~ 0.0047)											01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21
0.121 ~ 0.140 (0.0048 ~ 0.0055)											01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23
0.141 ~ 0.160 (0.0056 ~ 0.0063)										01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23
0.161 ~ 0.180 (0.0063 ~ 0.0071)									01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23
0.181 ~ 0.200 (0.0071 ~ 0.0079)								01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25
0.201 ~ 0.220 (0.0079 ~ 0.0087)							01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25
0.221 ~ 0.240 (0.0087 ~ 0.0094)							01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25
0.241 ~ 0.260 (0.0095 ~ 0.0102)						01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27
0.261 ~ 0.280 (0.0103 ~ 0.0110)					01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27
0.281 ~ 0.300 (0.0111 ~ 0.0118)				01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29
0.301 ~ 0.320 (0.0119 ~ 0.0126)			01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29
0.321 ~ 0.340 (0.0126 ~ 0.0134)			01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29
0.341 ~ 0.349 (0.0134 ~ 0.0137)		01	01	01	03	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31
0.350 ~ 0.450 (0.0138 ~ 0.0177)																																	
0.451 ~ 0.460 (0.0178 ~ 0.0181)	03	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33	
0.461 ~ 0.480 (0.0181 ~ 0.0189)	05	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33		
0.481 ~ 0.500 (0.0189 ~ 0.0197)	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33	33		
0.501 ~ 0.520 (0.0197 ~ 0.0205)	05	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33			
0.521 ~ 0.540 (0.0205 ~ 0.0213)	07	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33				
0.541 ~ 0.560 (0.0213 ~ 0.0220)	07	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33					
0.561 ~ 0.580 (0.0221 ~ 0.0228)	09	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33						
0.581 ~ 0.600 (0.0229 ~ 0.0236)	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33	33						
0.601 ~ 0.620 (0.0237 ~ 0.0244)	09	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33							
0.621 ~ 0.640 (0.0244 ~ 0.0252)	11	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33								
0.641 ~ 0.660 (0.0252 ~ 0.0260)	11	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33									
0.661 ~ 0.680 (0.0260 ~ 0.0268)	13	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33										
0.681 ~ 0.700 (0.0268 ~ 0.0276)	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33	33										
0.701 ~ 0.720 (0.0276 ~ 0.0283)	13	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33											
0.721 ~ 0.740 (0.0284 ~ 0.0291)	15	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33												
0.741 ~ 0.760 (0.0292 ~ 0.0299)	15	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33													
0.761 ~ 0.780 (0.0300 ~ 0.0307)	17	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33														
0.781 ~ 0.800 (0.0307 ~ 0.0315)	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33	33														
0.801 ~ 0.820 (0.0315 ~ 0.0323)	17	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33															
0.821 ~ 0.840 (0.0323 ~ 0.0331)	19	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33																
0.841 ~ 0.860 (0.0331 ~ 0.0339)	19	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33																	
0.861 ~ 0.880 (0.0339 ~ 0.0346)	21	21	23	23	25	25	27	27	29	29	31	31	33	33	33																		
0.881 ~ 0.900 (0.0347 ~ 0.0354)	21	23	23	25	25	27	27	29	29	31	31	33	33	33	33																		
0.901 ~ 0.920 (0.0355 ~ 0.0362)	21	23	23	25	25	27	27	29	29	31	31	33	33	33																			
0.921 ~ 0.940 (0.0363 ~ 0.0370)	23	23	25	25	27	27	29	29	31	31	33	33	33																				
0.941 ~ 0.960 (0.0370 ~ 0.0378)	23	25	25	27	27	29	29	31	31	33	33	33																					
0.961 ~ 0.980 (0.0378 ~ 0.0386)	25	25	27	27	29	29	31	31	33	33	33																						
0.981 ~ 1.000 (0.0386 ~ 0.0394)	25	27	27	29	29	31	31	33	33	33	33																						
1.001 ~ 1.020 (0.0394 ~ 0.0402)	25	27	27	29	29	31	31	33	33	33																							
1.021 ~ 1.040 (0.0402 ~ 0.0409)	27	27	29	29	31	31	33	33	33																								
1.041 ~ 1.060 (0.0410 ~ 0.0417)	27	29	29	31	31	33	33	33																									
1.061 ~ 1.080 (0.0418 ~ 0.0425)	29	29	31	31	33	33	33																										
1.081 ~ 1.100 (0.0426 ~ 0.0433)	29	31	31	33	33	33	33																										
1.101 ~ 1.120 (0.0433 ~ 0.0441)	29	31	31	33	33	33																											
1.121 ~ 1.140 (0.0441 ~ 0.0449)	31	31	33	33	33																												
1.141 ~ 1.160 (0.0449 ~ 0.0457)	31	33	33	33																													
1.161 ~ 1.180 (0.0457 ~ 0.0465)	33	33	33																														
1.181 ~ 1.200 (0.0465 ~ 0.0472)	33	33	33																														
1.201 ~ 1.220 (0.0473 ~ 0.0480)	33	33																															
1.221 ~ 1.240 (0.0481 ~ 0.0488)	33																																

New shim thickness mm (in.)

Shim No.	Thickness	Shim No.	Thickness
01	2.500 (0.0984)	19	2.950 (0.1161)
03	2.550 (0.1004)	21	3.000 (0.1181)
05	2.600 (0.1024)	23	3.050 (0.1201)
07	2.650 (0.1043)	25	3.100 (0.1220)
09	2.700 (0.1063)	27	3.150 (0.1240)
11	2.750 (0.1083)	29	3.200 (0.1260)
13	2.800 (0.1102)	31	3.250 (0.1280)
15	2.850 (0.1122)	33	3.300 (0.1299)
17	2.900 (0.1142)		

Exhaust valve clearance (Cold):
0.35 – 0.45 mm (0.014 – 0.018 in.)

EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.590 mm (0.0232 in.). Replace the 2.800 mm (0.1102 in.) shim with a new No.21 shim.

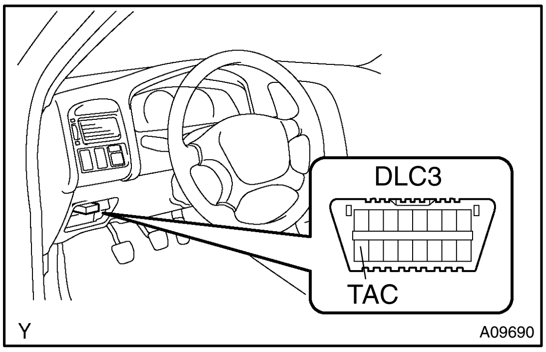
IDLE SPEED AND MAXIMUM SPEED

EM0W5–02

INSPECTION

1. **INITIAL CONDITIONS**

(a) Engine at normal operating temperature.
(b) Air cleaner installed.
(c) All pipes and hoses of air induction system connected.
(d) All accessories switched OFF.
(e) All vacuum lines properly connected.
(f) ECD system wiring connectors fully plugged.
(g) Valve clearance set correctly.



2. **CONNECT TACHOMETER**

Connect the tester probe of a tachometer to terminal 9 (TAC) of the DLC3.

3. **INSPECT IDLE SPEED**

(a) Start the engine.
(b) Check the idle speed.
Idle speed: 700 – 800 rpm

If the idle speed is not as specified, check the troubleshooting in DI section.

4. **INSPECT MAXIMUM SPEED**

(a) Start the engine.
(b) Depress the accelerator pedal all the way.
(c) Check the maximum speed.
Maximum speed: 5,100 – 5,250 rpm

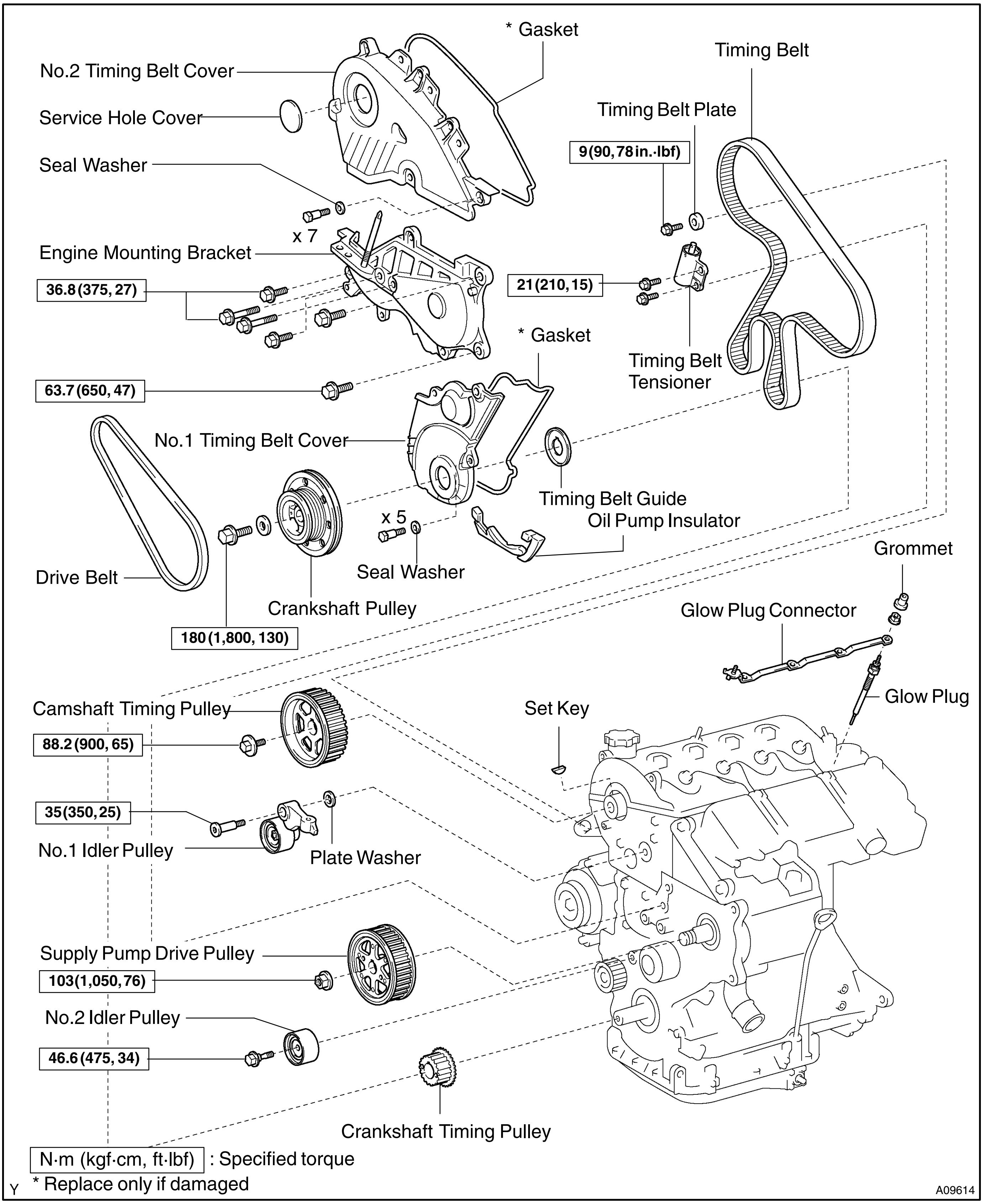
If the maximum speed is not as specified, check the trouble-shooting in DI section.

5. **DISCONNECT TACHOMETER**

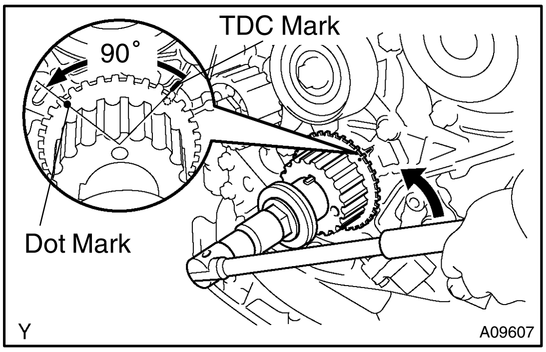
TIMING BELT

COMPONENTS

EM0HV–02



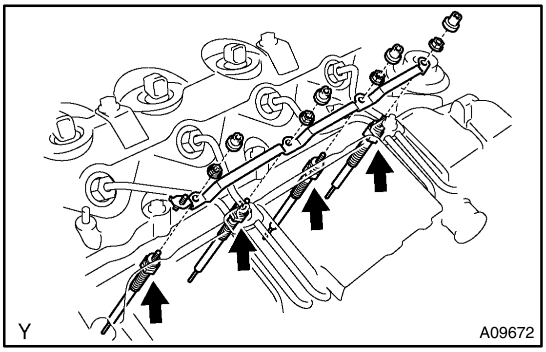
EM13A–01



REMOVAL

NOTICE:

Under the condition with the timing belt removed, in case of rotating the camshaft, make the position of the crankshaft rotated counterclockwise by 90° from TDC/compression of No.1 cylinder.



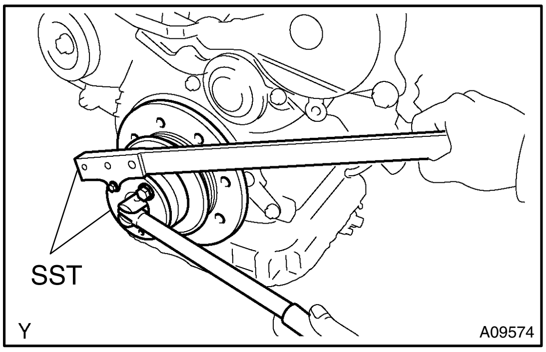
1. REMOVE GLOW PLUGS FOR ENGINE

(a) Remove the 4 grommets.

(b) Remove the 4 nuts and glow plug connector.

(c) Remove the 4 glow plugs.

2. REMOVE DRIVE BELT



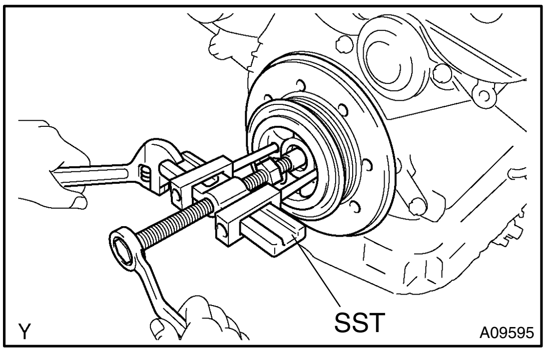
3. REMOVE CRANKSHAFT PULLEY

(a) Using SST, remove the pulley bolt.

SST 09213–54015 (91651–60855), 09330–00021

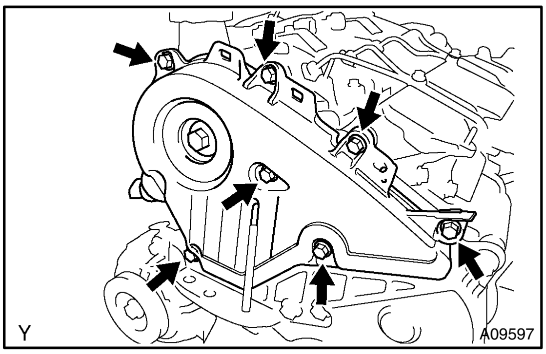
HINT:

When using bolt (91651–60855), a plate washer (5 mm or 0.20 in.) must be inserted between the bolt and SST.



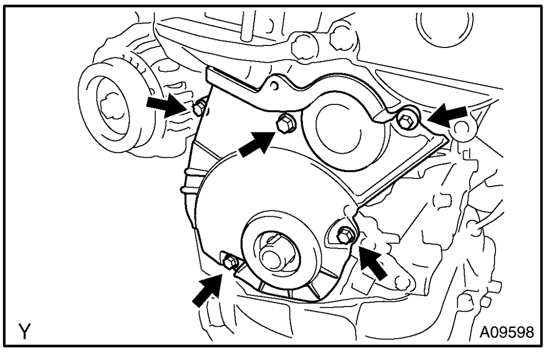
(b) Using SST, remove the pulley.

SST 09950–50012 (09951–05010, 09952–05010, 09953–05010, 09953–05020, 09954–05030)



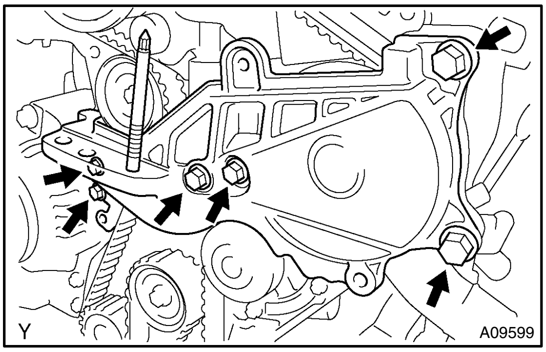
4. REMOVE NO.2 TIMING BELT COVER

Remove the 7 bolts, 7 seal washers and timing belt cover.



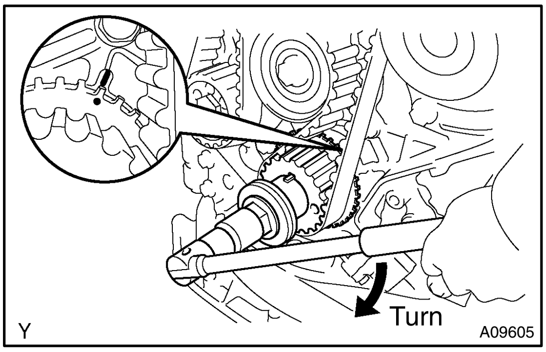
5. **REMOVE NO.1 TIMING BELT COVER**
(a) Remove the 5 bolts, 5 seal washers and timing belt cover.
(b) Remove the oil pump insulator.

6. **REMOVE TIMING BELT GUIDE**

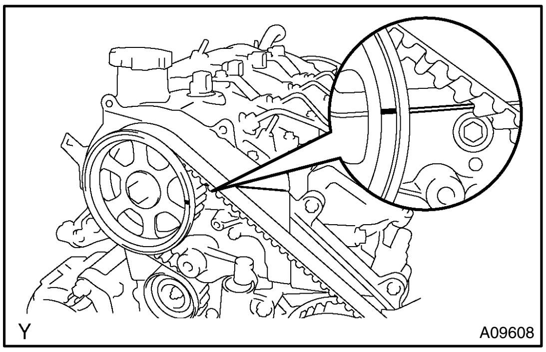


7. **REMOVE ENGINE MOUNTING BRACKET**

Remove the 6 bolts and engine mounting bracket.

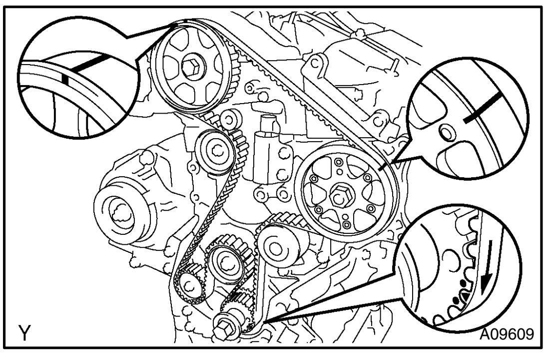


8. **SET NO.1 CYLINDER TO TDC/COMPRESSION**
(a) Using the crankshaft pulley bolt, align the dot mark of the crankshaft timing pulley with the TDC mark of the oil pump by turning the crankshaft.



(b) Check that the timing mark of the camshaft timing pulley is aligned with the top end of the cylinder head.

If not, revolve the crankshaft 1 (360°) and align the mark as above.

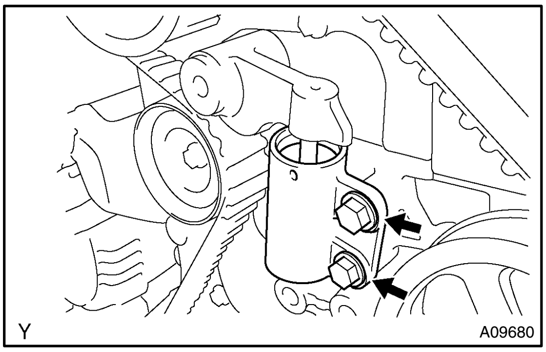


9. **REMOVE TIMING BELT**

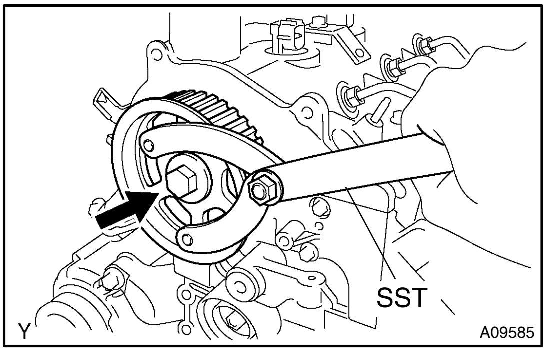
HINT:

If re–using the timing belt, draw a direction arrow on the timing belt (in direction of engine revolution), and place matchmarks on the pulleys and timing belt.

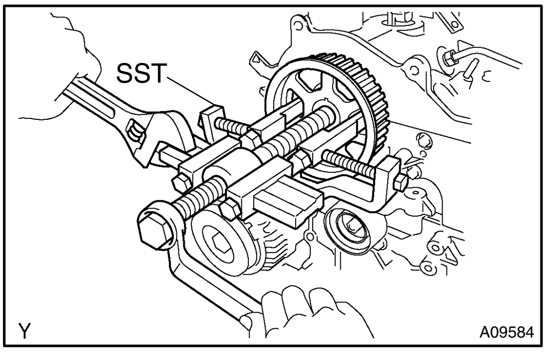
(a) Remove the bolt and timing belt plate.



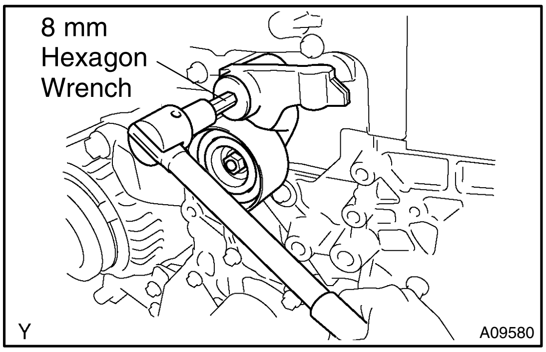
(b) Alternately loosen the 2 bolts, and remove them and the timing belt tensioner.
(c) Remove the timing belt.



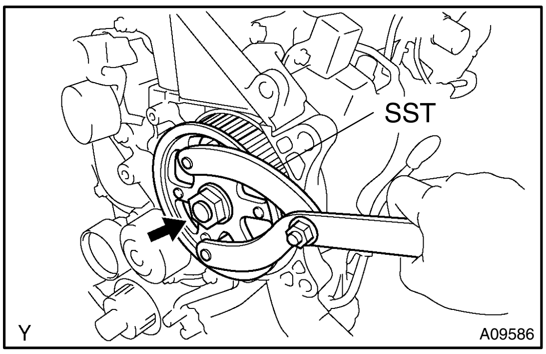
10. REMOVE CAMSHAFT TIMING PULLEY
(a) Using SST, remove the pulley bolt.
SST 09960–10010 (09962–01400, 09963–01000)



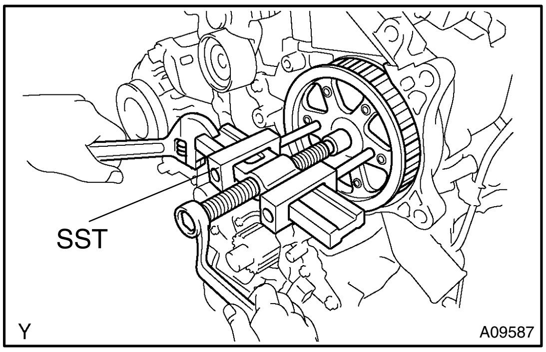
(b) Using SST, remove the timing pulley.
SST 09950–40011 (09951–04010, 09952–04010, 09953–04020, 09954–04010, 09955–04071, 09957–04010, 09958–04011)
(c) Remove the set key.



11. REMOVE NO.1 IDLER PULLEY
Using an 8 mm hexagon wrench, remove the idler pulley shaft, idler pulley and plate washer.



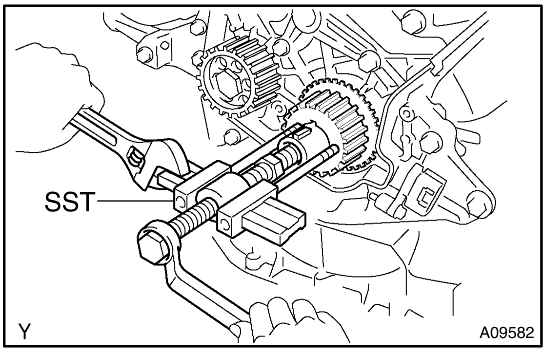
12. REMOVE SUPPLY PUMP DRIVE PULLEY
(a) Using SST, remove the pulley nut.
SST 09960–10010 (09962–01000, 09963–01000)



(b) Using SST, remove the drive pulley.
SST 09950–50012 (09951–05010, 09952–05010, 09953–05020, 09954–05020)

13. REMOVE NO.2 IDLER PULLEY

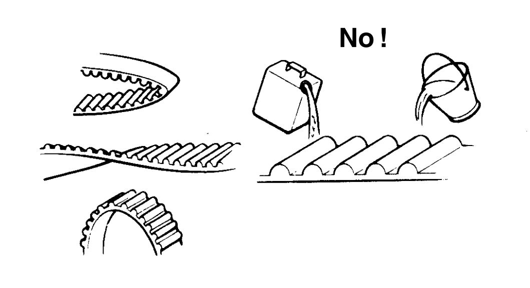
Remove the bolt and idler pulley.



14. REMOVE CRANKSHAFT TIMING PULLEY

If the pulley cannot be removed by hand, use SST to remove the timing pulley.
SST 09950–05012 (09951–05010, 09952–05010, 09953–05010, 09953–05020, 09954–05020)

EM13B–01



EM0126

INSPECTION

1. INSPECT TIMING BELT

NOTICE:

- **Do not bend, twist or turn the timing belt inside out.**
- **Do not allow the timing belt to come into contact with oil, water or steam.**
- **Do not utilize timing belt tension when installing or removing the mounting bolt of the camshaft timing pulley.**

If there are any defects, as shown in the illustration, check these points:

(a) Premature parting
- Check the proper installation.
- Check the timing belt cover gasket for damage and proper installation is locked.

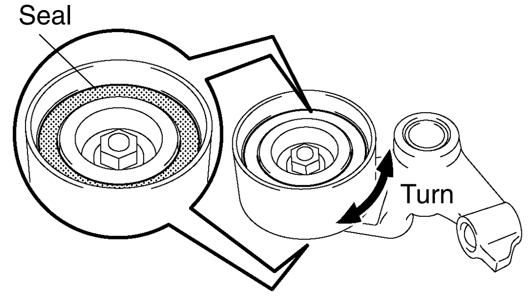
(b) If the belt teeth are cracked or damaged, check to see if either camshaft or water pump is locked.

(c) If there is noticeable wear or cracks on the belt face, check to see if there are nicks on the side of the idler pulley lock.

(d) If there is wear or damage on only one side of the belt, check the belt guide and the alignment of each pulley.

(e) If there is noticeable wear on the belt teeth, check the timing cover for damage, and check gasket has been installed correctly and for foreign material on the pulley teeth.

If necessary, replace the timing belt.



Y A09578

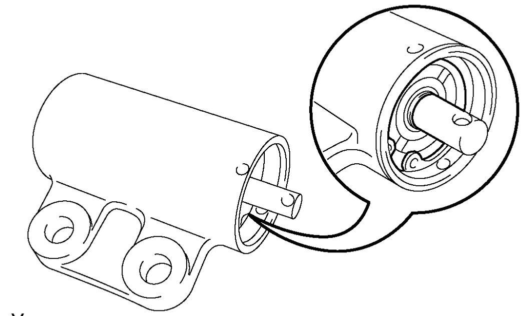
2. INSPECT IDLER PULLEYS

(a) Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.

(b) Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.


Y A09590

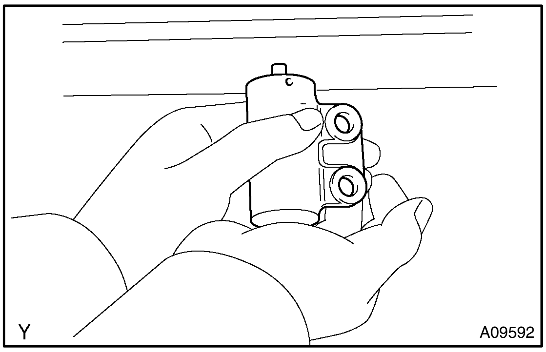
3. INSPECT TIMING BELT TENSIONER

(a) Visually check the seal portion of the tensioner for oil leakage.

HINT:

If there is only the faintest trace of oil on the seal on the push rod side, the tensioner is all right.

If leakage is found, replace the tensioner.

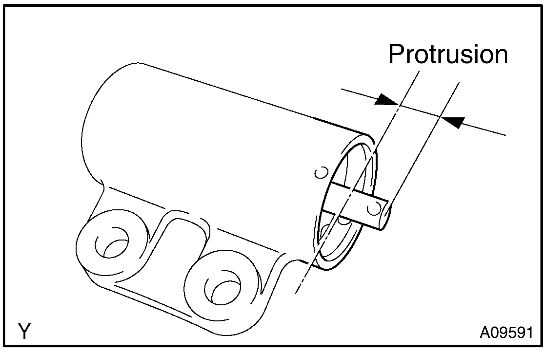


(b) Hold the tensioner with both hands and push the push rod strongly as shown to check that it doesn't move.

If the push rod moves, replace the tensioner.

NOTICE:

Never hold the tensioner push rod facing downward.



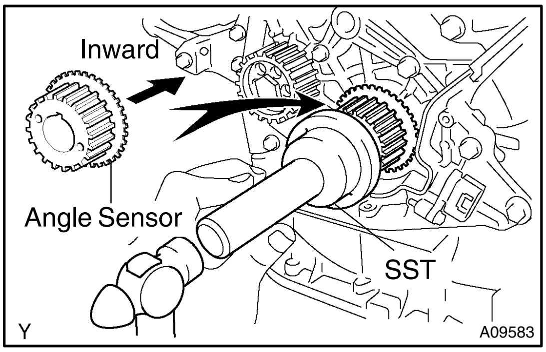
(c) Measure the protrusion of the push rod from the housing end.

Protrusion: 9.0 – 10.6 mm (0.354 – 0.417 in.)

If the protrusion is not as specified, replace the tensioner.

EM13C–01

INSTALLATION

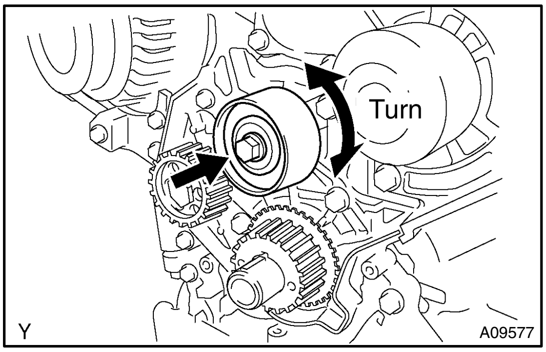


1. INSTALL CRANKSHAFT TIMING PULLEY

(a) Align the pulley set key with the key groove of the timing pulley.

(b) Using SST and a hammer, tap in the timing pulley, facing the angle sensor inward.

SST 09223–46011

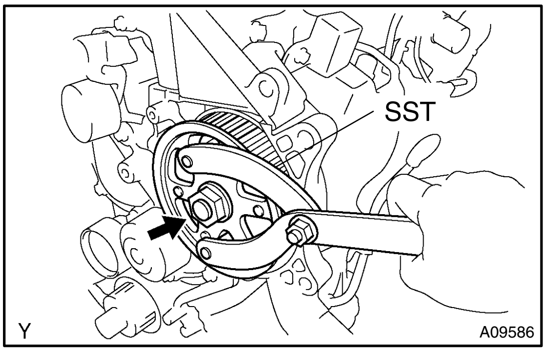


2. INSTALL NO.2 IDLER PULLEY

(a) Install the idler pulley with the bolt.

Torque: 46.6 N·m (475 kgf·cm, 34 ft·lbf)

(b) Check that the idler pulley moves smoothly.



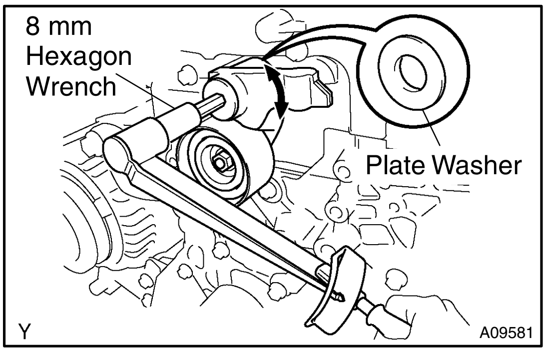
3. INSTALL SUPPLY PUMP DRIVE PULLEY

(a) Align the pulley set key with the key groove of the drive pulley, and slide on the timing pulley.

(b) Using SST, install the pulley nut.

SST 09960–10010 (09962–01000, 09963–01000)

Torque: 103 N·m (1,050 kgf·cm, 76 ft·lbf)

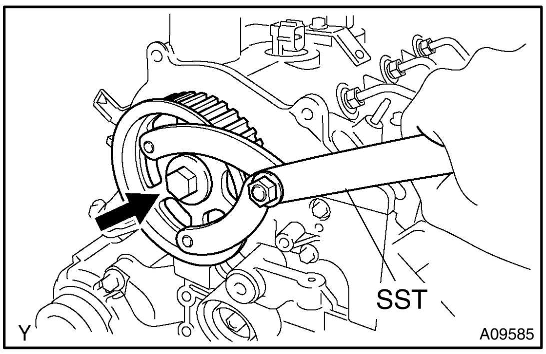


4. INSTALL NO.1 IDLER PULLEY

(a) Using an 8 mm hexagon wrench, install the plate washer and idler pulley with the idler pulley shaft.

Torque: 35 N·m (350 kgf·cm, 25 ft·lbf)

(b) Check that the pulley bracket moves smoothly.



5. INSTALL CAMSHAFT TIMING PULLEY

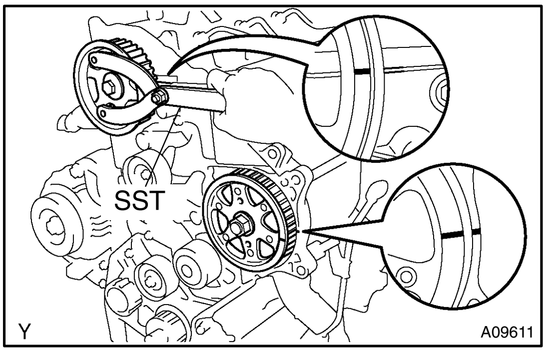
(a) Install the pulley set key to the key groove of the camshaft.

(b) Align the pulley set key with the key groove of the timing pulley, and slide on the timing pulley.

(c) Using SST, install the pulley bolt.

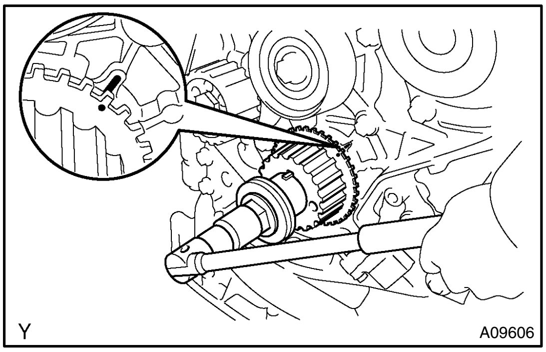
SST 09960–10010 (09962–01000, 09963–01000)

Torque: 88.2 N·m (900 kgf·cm, 65 ft·lbf)



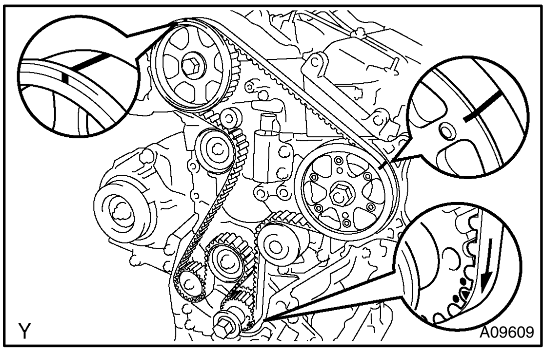
6. SET NO.1 CYLINDER TO TDC/COMPRESSION

(a) Using SST, set the timing and drive pulleys at each position.
SST 09960–10010 (09962–01400, 09963–01000)



(b) Using the crankshaft pulley bolt, align the dot mark of the crankshaft timing pulley with the TDC mark of the oil pump by turning the crankshaft.

NOTICE:
When turning the camshaft or crankshaft, the valve heads will hit against the piston top so do not turn them more than necessary.



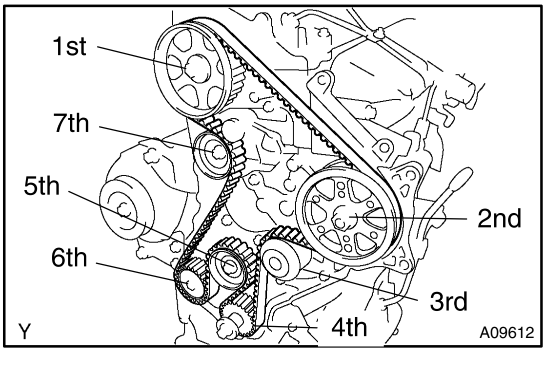
7. INSTALL TIMING BELT

NOTICE:
The engine should be cold.

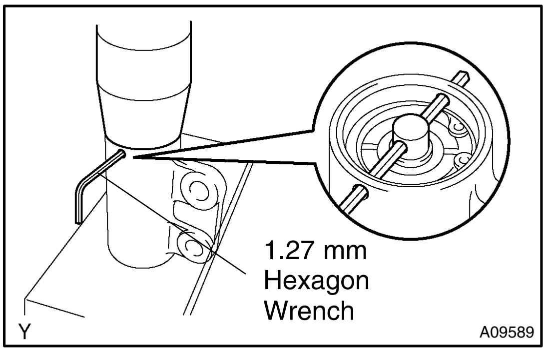
HINT:
If re–using the timing belt, align the points marked during removal, and install the timing belt with the arrow pointing in the direction of engine revolution.

(a) Remove any oil or water on each pulleys, and keep them clean.

NOTICE:
Only wipe the pulleys; do not use any cleansing agent.



(b) Install the timing belt in this order:
1st: Camshaft timing pulley
2nd: Supply pump drive pulley
3rd: Water pump pulley
4th: Crankshaft timing pulley
5th: No.2 idler pulley
6th: Oil pump pulley
7th: No.1 idler pulley

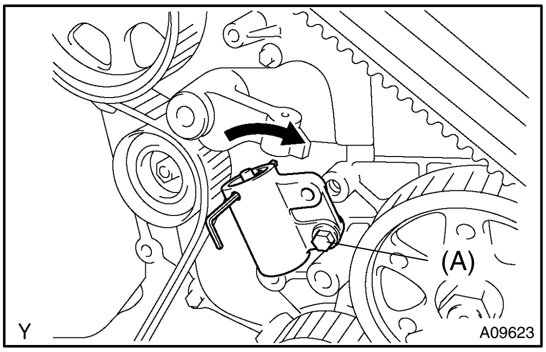


8. SET TIMING BELT TENSIONER

(a) Using a press, slowly press in the push rod using 981 – 9,807 N (100 – 1,000 kgf, 200 – 2,205 lbf) of pressure.

(b) Align the holes of the push rod and housing, pass a 1.27 mm hexagon wrench through the holes to keep the setting position of the push rod.

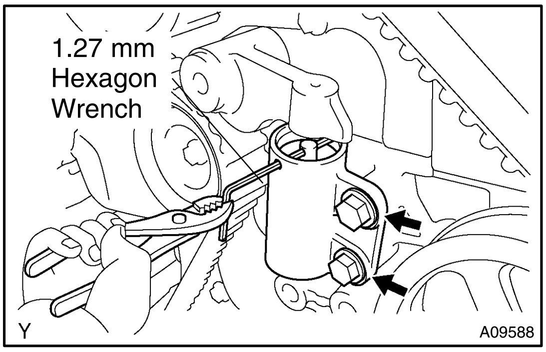
(c) Release the press.



9. INSTALL TIMING BELT TENSIONER

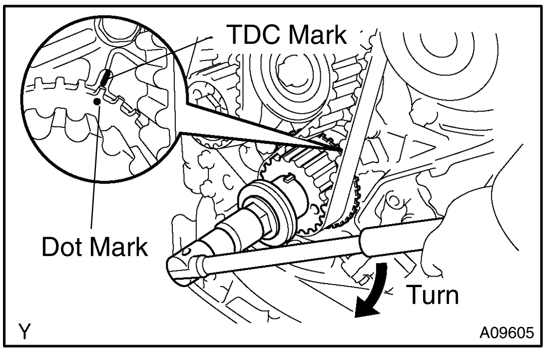
(a) Temporarily install the tensioner with the bolt (A).

(b) Turn the tensioner clockwise and temporarily install the other bolt.



(c) Alternately tighten the 2 bolts.
Torque: 21 N·m (210 kgf·cm, 15 ft·lbf)

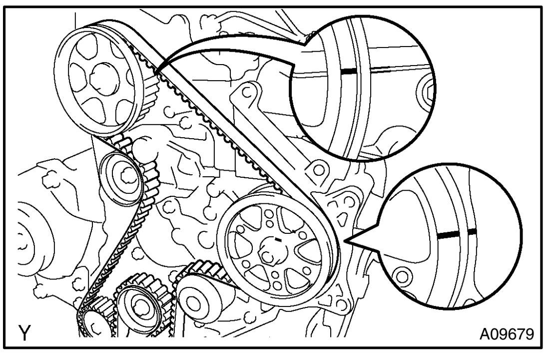
(d) Remove the 1.27 mm hexagon wrench from the tensioner.



10. CHECK VALVE TIMING

(a) Slowly turn the crankshaft 2 revolutions from TDC to TDC.

NOTICE:
Always turn the crankshaft clockwise.

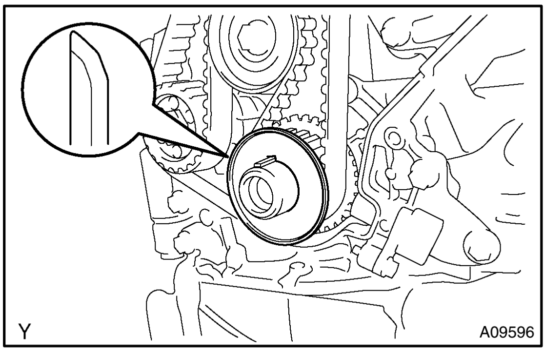


(b) Check that each pulley aligns with the timing marks as shown in the illustration.

If the timing marks do not align, remove the timing belt and reinstall it.

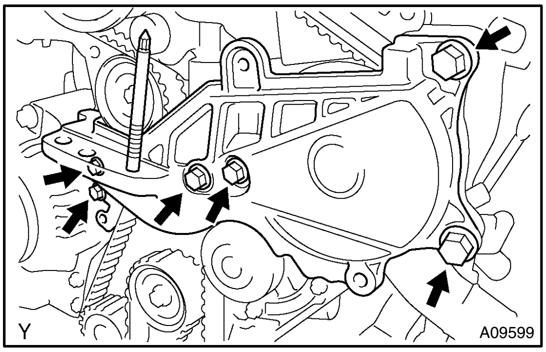
(c) Remove the crankshaft pulley bolt.

11. INSTALL TIMING BELT PLATE
Torque: 9 N·m (90 kgf·cm, 78 in.·lbf)



12. INSTALL TIMING BELT GUIDE

Install the belt guide, facing the cap side outward.



13. INSTALL ENGINE MOUNTING BRACKET

Install the engine mounting bracket with the 6 bolts.

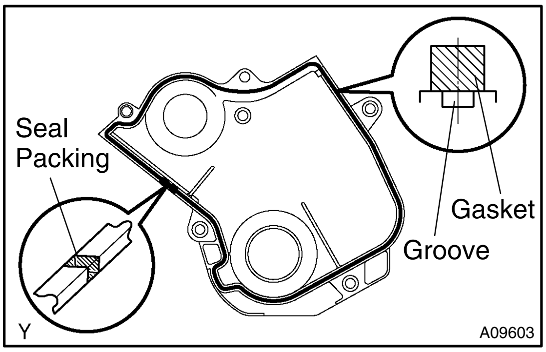
Torque:
36.8 N·m (375 kgf·cm, 27 ft·lbf) for 14 mm head bolt
63.7 N·m (650 kgf·cm, 47 ft·lbf) for 17 mm head bolt

14. INSTALL NO.1 TIMING BELT COVER

(a) Check that the timing belt cover gasket have cracks or peeling, etc.

If the gasket has cracks or peeling, etc., replace it using these steps:

- Using a screwdriver and gasket scraper, remove all the old gasket material.
- Thoroughly clean all components to remove all the loose material.

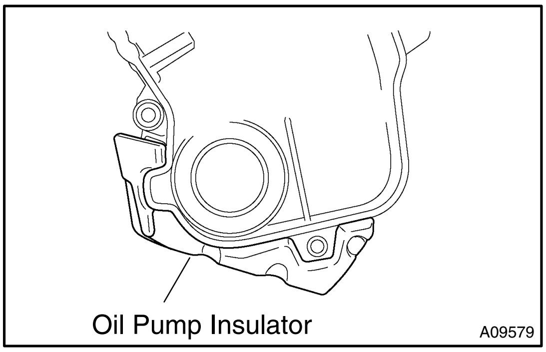


- Remove the backing paper from a new gasket and install the gasket evenly to the part of the timing belt cover shaded black in the illustration.

NOTICE:
- **Affix the gasket at the center of the groove.**
- **At the corner portion, affix the gasket without making its thickness lessen.**

- After installing the gasket, press down on it so that the adhesive firmly sticks to the timing belt cover.
- In case that there is a clearance between the joint portion of the gasket, apply the same amount of seal packing as the width and height of the gasket.

Seal packing: Part No. 08826–00080 or equivalent



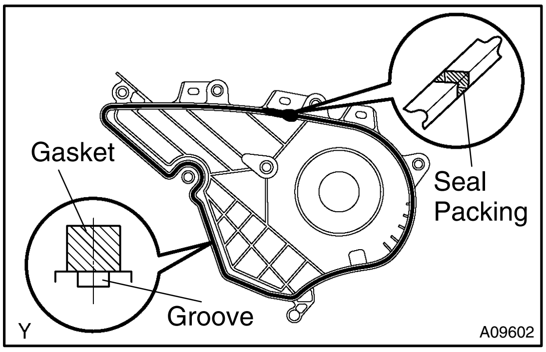
(b) Install the oil pump insulator to the belt cover.
(c) Install the No.1 timing belt cover and gasket with the 5 bolts and 5 seal washers.
(d) After installing the belt cover, check that there is no peeling off of the gasket.

15. INSTALL NO.2 TIMING BELT COVER

(a) Check that the timing belt cover gasket have cracks or peeling, etc.

If the gasket has cracks or peeling, etc., replace it using these steps:

- Using a screwdriver and gasket scraper, remove all the old gasket material.
- Thoroughly clean all components to remove all the loose material.



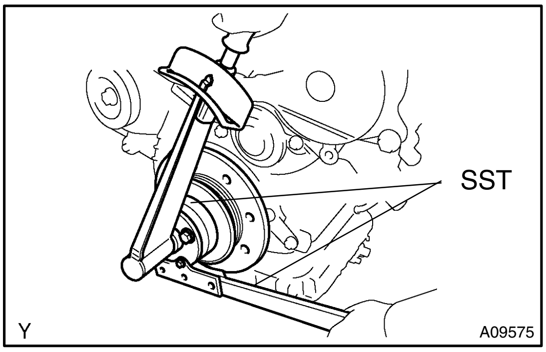
- Remove the backing paper from a new gasket and install the gasket evenly to the part of the timing belt cover shaded black in the illustration.

NOTICE:

- **Affix the gasket at the center of the groove.**
- **At the corner portion, affix the gasket without making its thickness lessen.**
  - After installing the gasket, press down on it so that the adhesive firmly sticks to the timing belt cover.
  - In case that there is a clearance between the joint portion of the gasket, apply the same amount of seal packing as the width and height of the gasket.

Seal packing: Part No. 08826–00080 or equivalent

(b) Install the No.2 timing belt cover and gasket with the 7 bolts and 7 seal washers.

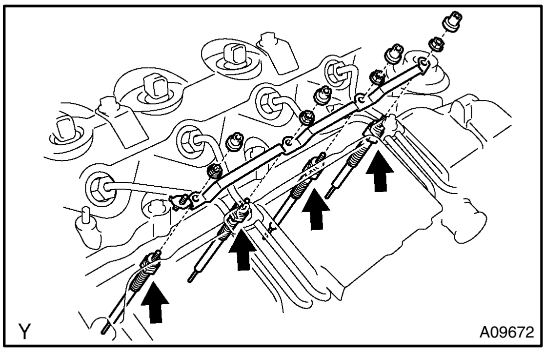


16. INSTALL CRANKSHAFT PULLEY

(a) Align the pulley set key with the key groove of the pulley, and slide the pulley to the crankshaft.
(b) Using SST, install the pulley bolt.
SST 09213–54015 (91651–60855) 09330–00021
Torque: 180 N·m (1,800 kgf·cm, 130 ft·lbf)

HINT:
When using bolt (91651–60855), a plate washer (5 mm or 0.20 in.) must be inserted between the bolt and SST.

17. INSTALL DRIVE BELT



18. **INSTALL GLOW PLUGS FOR ENGINE**

(a) Install the 4 glow plugs.
Torque: 12.3 N·m (125 kgf·cm, 9 ft·lbf)

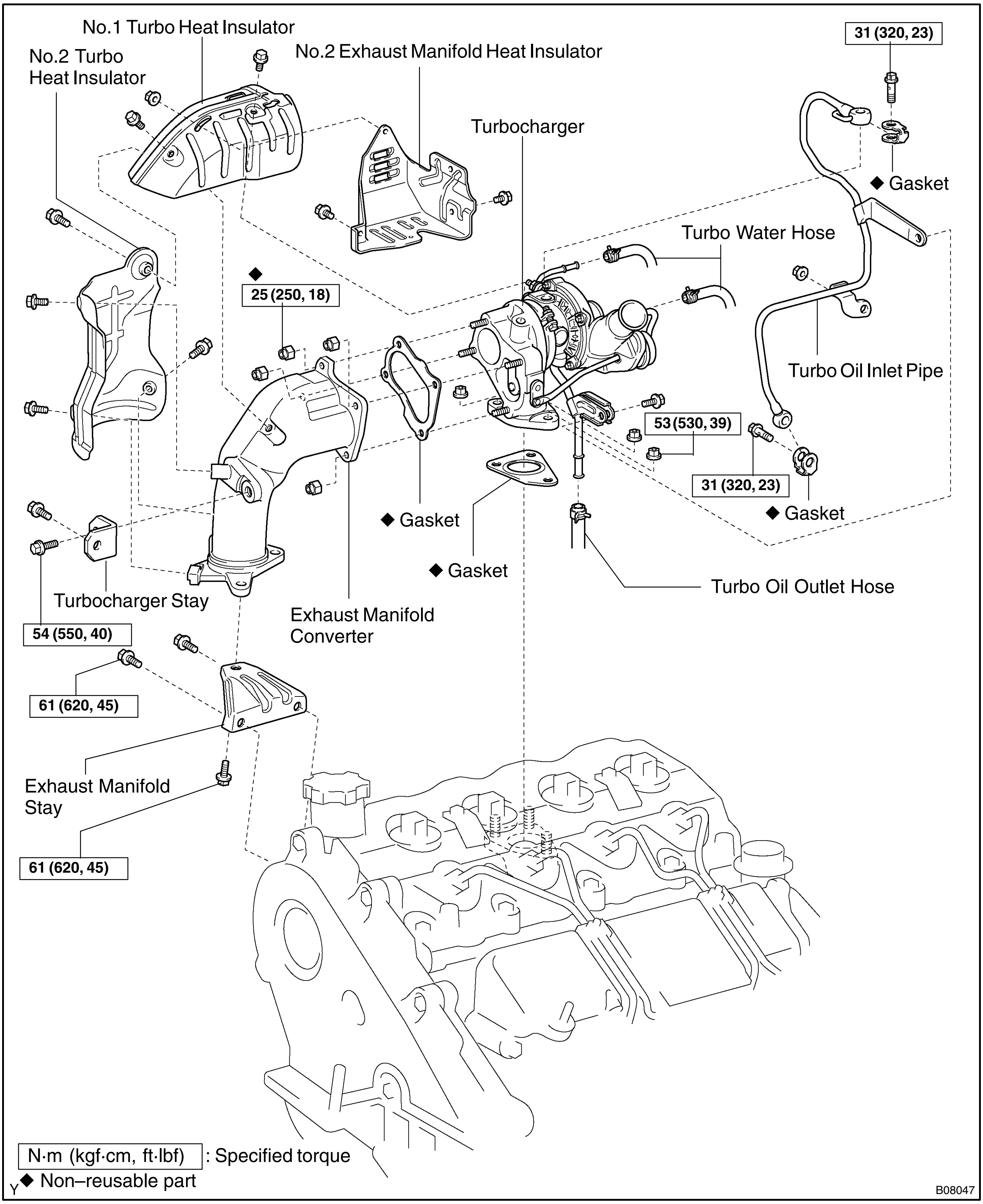
(b) Install the glow plug connector with the 4 nuts.

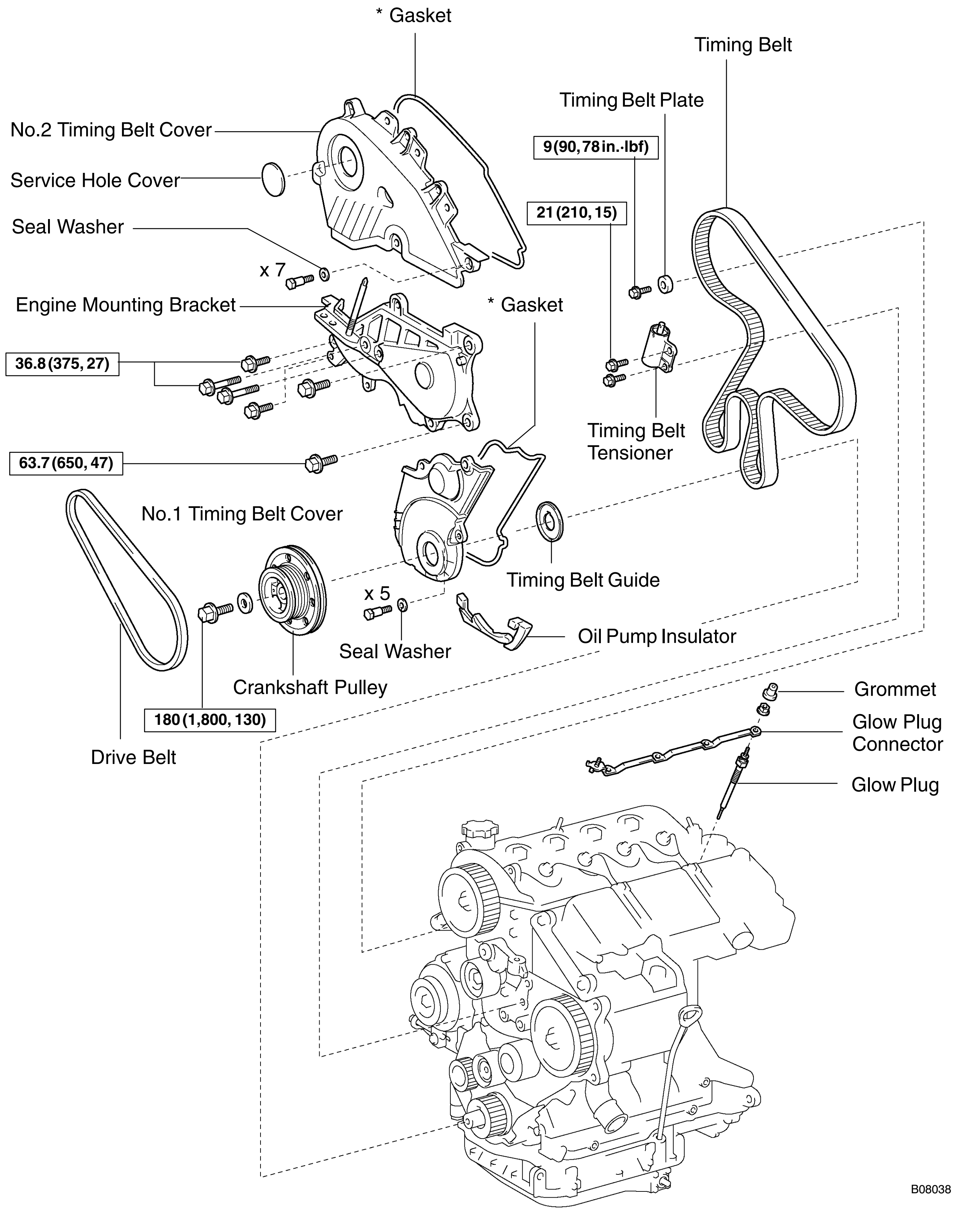
(c) Install the 4 grommets.

CYLINDER HEAD

COMPONENTS

EM13L–01



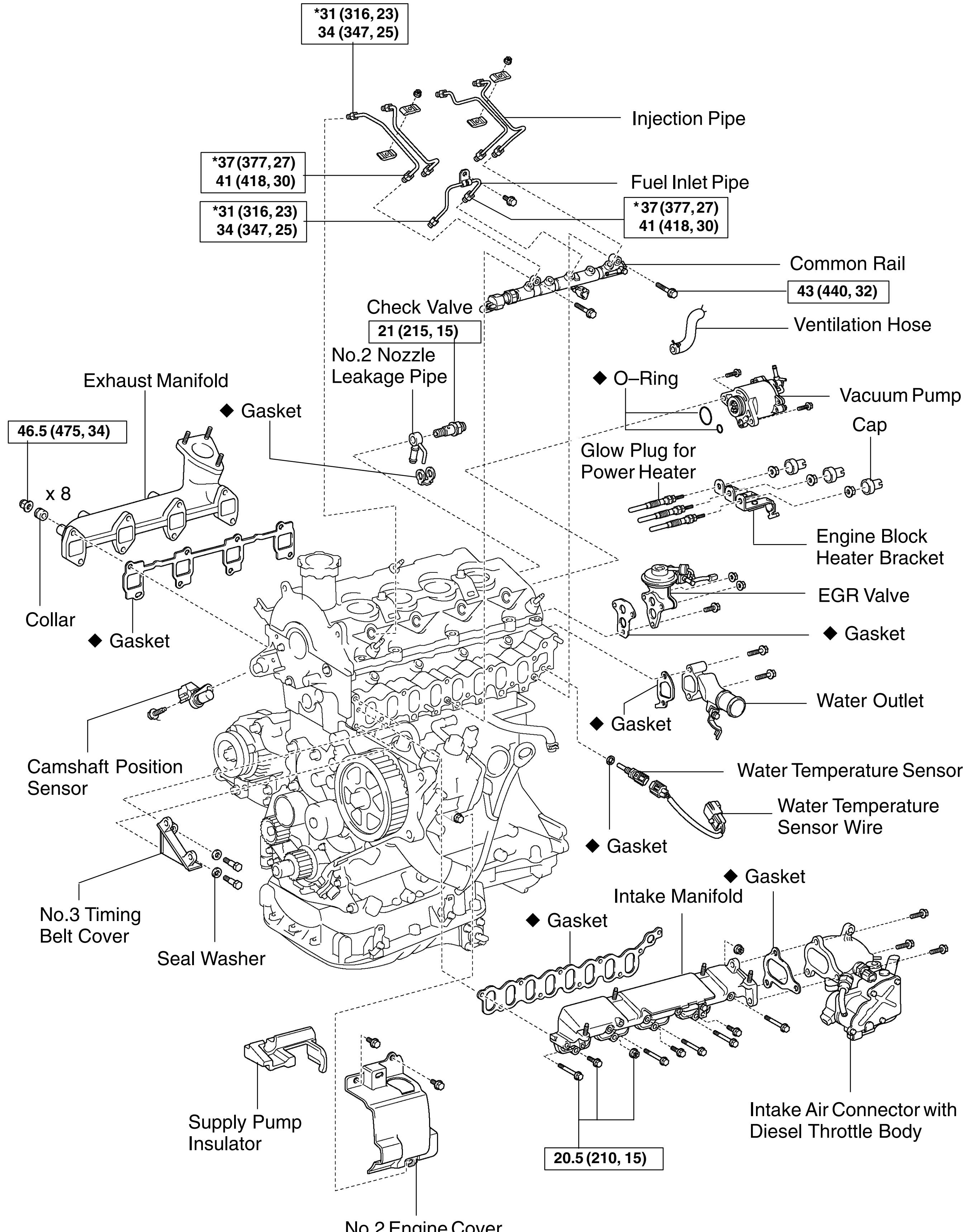


Y

N·m (kgf·cm, ft·lbf) : Specified torque

* Replace only if damaged

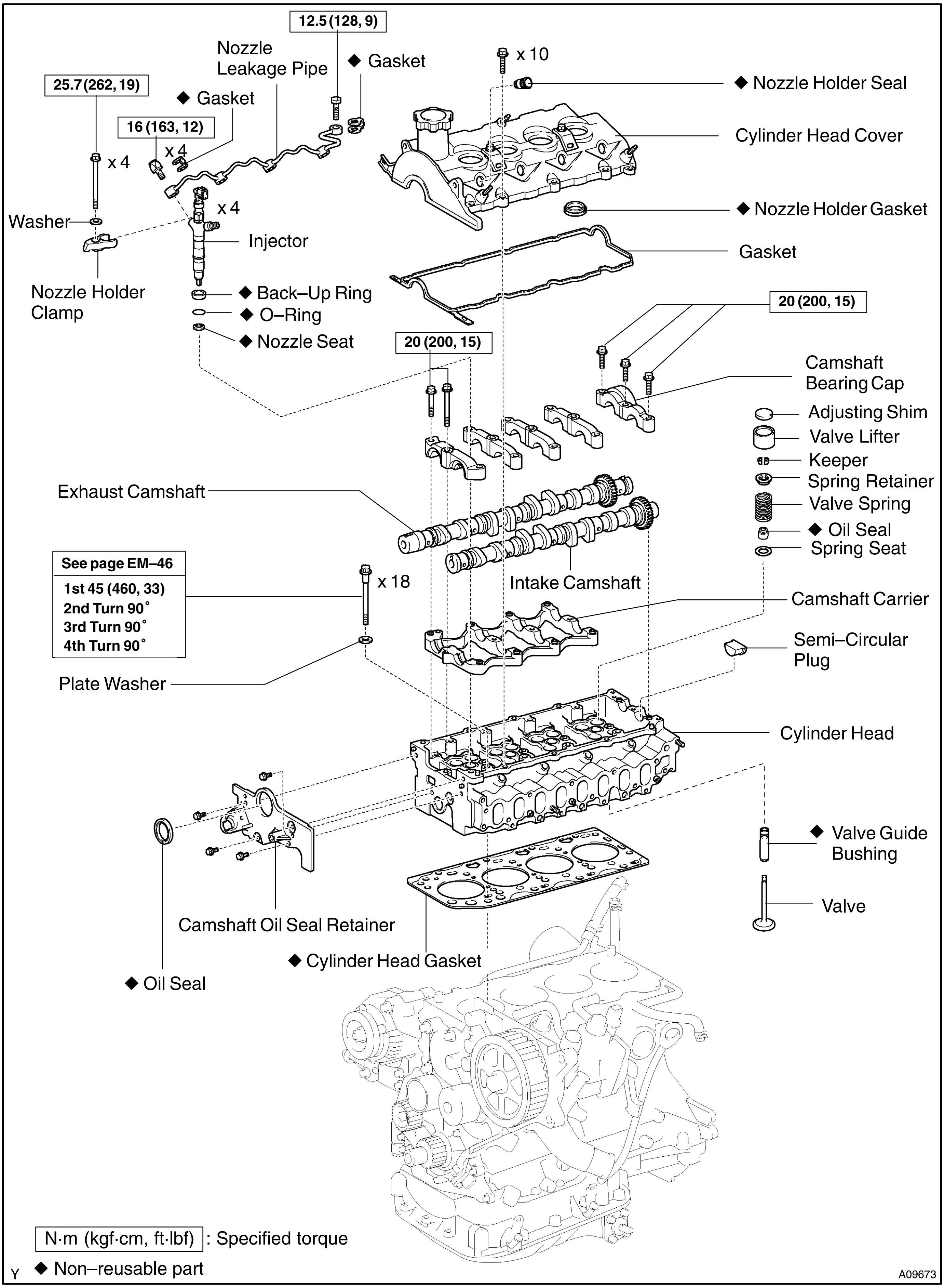
A09681



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

* For use with SST


12.5 (128, 9)
Nozzle Leakage Pipe
◆ Gasket
x 10
◆ Nozzle Holder Seal
25.7 (262, 19)
◆ Gasket
16 (163, 12)
x 4
x 4
Cylinder Head Cover
Washer
x 4
◆ Nozzle Holder Gasket
Injector
Gasket
Nozzle Holder Clamp
◆ Back–Up Ring
◆ O–Ring
◆ Nozzle Seat
20 (200, 15)
20 (200, 15)
Camshaft Bearing Cap
Adjusting Shim
Valve Lifter
Keeper
Spring Retainer
Exhaust Camshaft
Valve Spring
◆ Oil Seal
Spring Seat
See page EM–46
1st 45 (460, 33)
2nd Turn 90°
3rd Turn 90°
4th Turn 90°
x 18
Intake Camshaft
Camshaft Carrier
Semi–Circular Plug
Plate Washer
Cylinder Head
◆ Valve Guide Bushing
Valve
Camshaft Oil Seal Retainer
◆ Cylinder Head Gasket
◆ Oil Seal
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
A09673

EM13M–01

REMOVAL

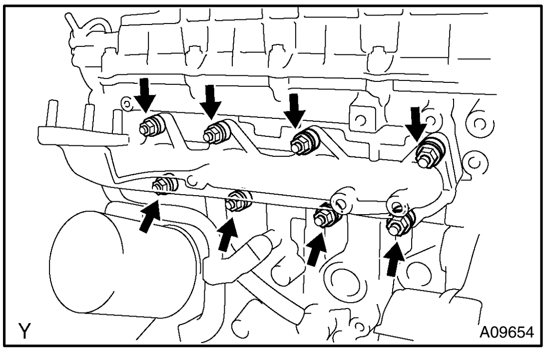
NOTICE:

- **Befor removing the inlet pipe and fuel injection pipes, clean them up with a soft brush and compressed air.**
- **After removing the injection pipe, affix the gum tape on the supply pump, common rail and the whole injector installatoin area of the cylinder head cover for preventing dust from coming into them.**
- **After removing the cylinder head cover, put a vinyl bag and rubber band for preventing from mixing foreign objects over the injector inlet.**

1. REMOVE TURBOCHARGER (See page TC–7)

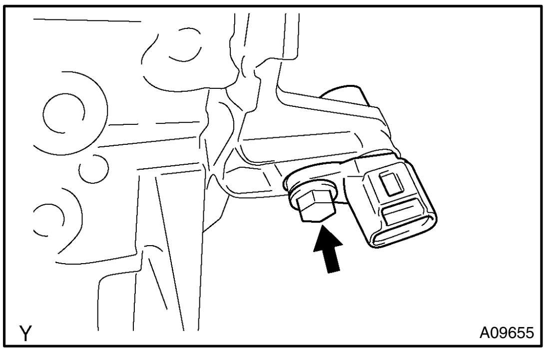
2. REMOVE TIMING BELT (See page EM–12)

3. REMOVE CAMSHAFT TIMING PULLEY (See page EM–12)

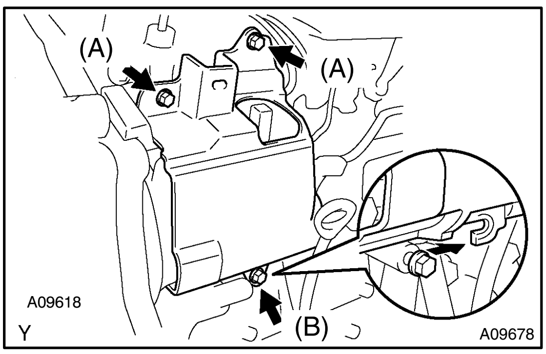


4. REMOVE EXHAUST MANIFOLD

Remove the 8 nuts, 8 collars, exhaust manifold and gasket.



5. REMOVE CAMSHAFT POSITION SENSOR



6. REMOVE NO.2 ENGINE COVER

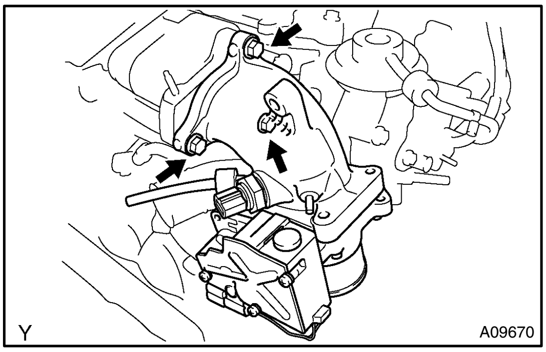
(a) Remove the 2 bolts (A).

(b) Loosen the bolt (B) and remove the cover.

7. REMOVE SUPPLY PUMP INSULATOR

8. REMOVE FUEL INLET PIPE (See page FU–16)

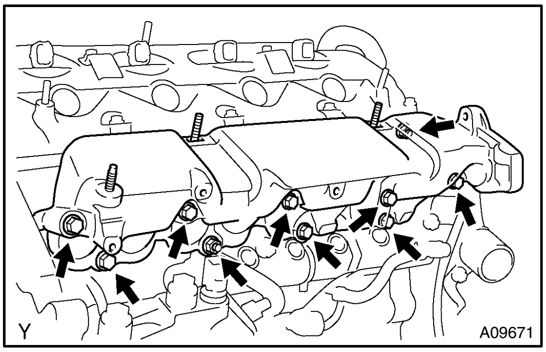
9. REMOVE INJECTION PIPES (See page FU–6)



10. REMOVE INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY

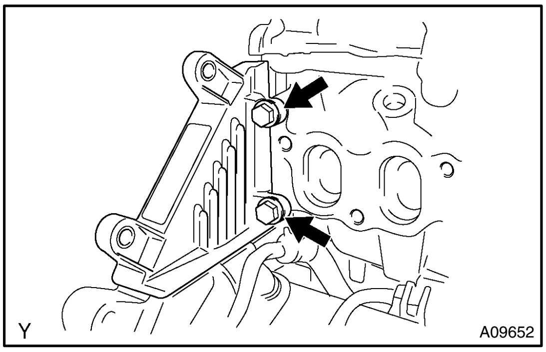
Remove the 3 bolts, the intake air connector with diesel throttle body and gasket.

11. LOOSEN COMMON RAIL SET BOLTS



12. REMOVE INTAKE MANIFOLD

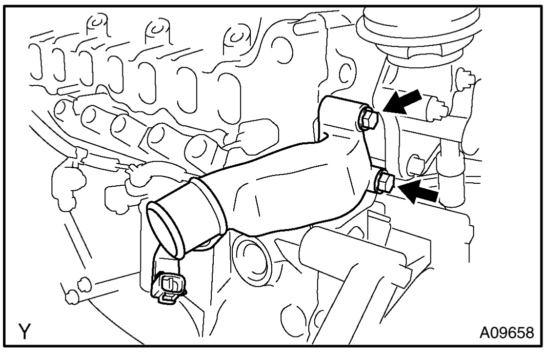
Remove the 8 bolts, 2 nuts, intake manifold and gasket.



13. REMOVE NO.3 TIMING BELT COVER

Remove the 2 bolts, 2 seal washers and timing belt cover.

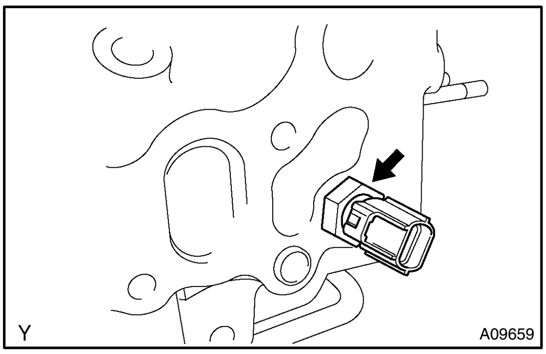
14. REMOVE VENTILATION HOSE



15. REMOVE WATER OUTLET

Remove the 2 bolts, water outlet and gasket.

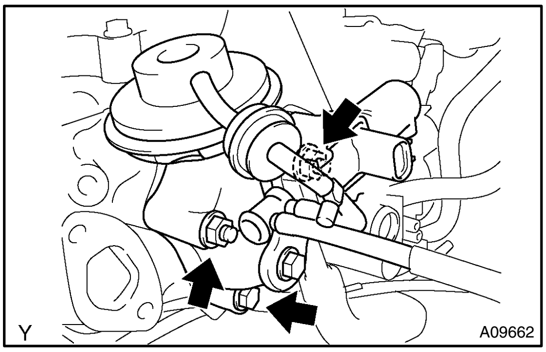
16. REMOVE COMMON RAIL (See page FU–22)



17. REMOVE WATER TEMPERATURE SENSOR

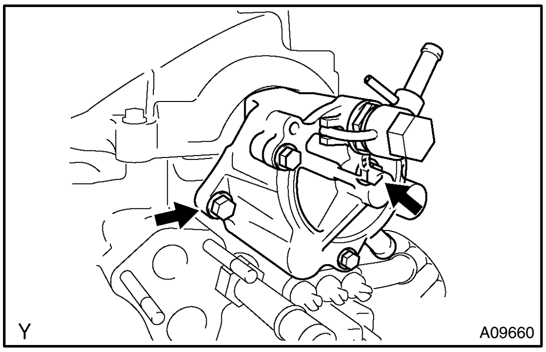
(a) Remove the water temperature sensor wire.

(b) Remove the water temperature sensor and gasket.



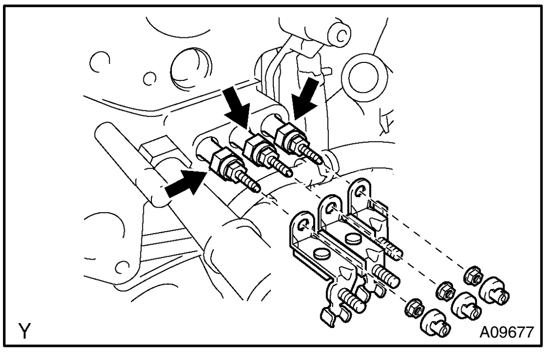
18. REMOVE EGR VALVE

Remove the bolt, 2 nuts, the EGR valve and gasket.



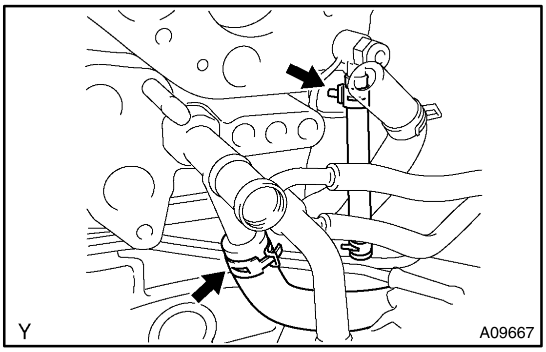
19. REMOVE VACUUM PUMP

Remove the 2 bolts, vacuum pump and 2 O–rings.

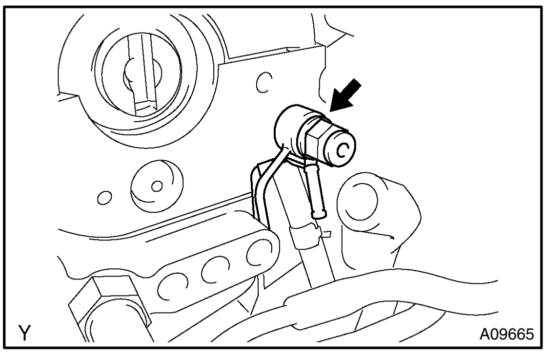


20. REMOVE GLOW PLUGS FOR POWER HEATER

(a) Remove the 3 caps.
(b) Remove the 3 nuts and engine block heater bracket.
(c) Remove the 3 glow plugs.

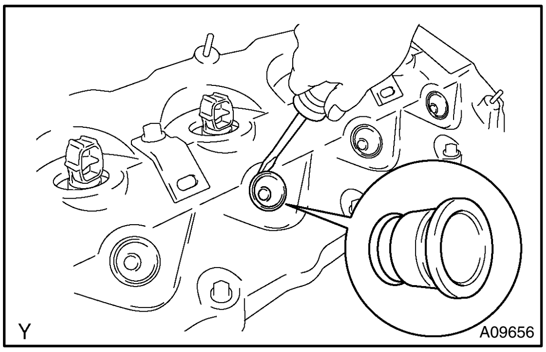


21. DISCONNECT FUEL HOSE AND NO.2 OIL COOLER HOSE



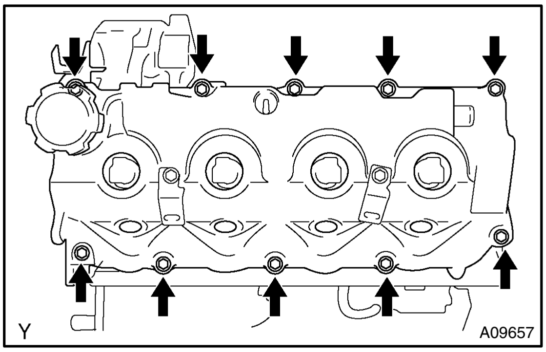
22. REMOVE NO.2 NOZZLE LEAKAGE PIPE

Remove the check valve, leakage pipe and gasket.



23. REMOVE CYLINDER HEAD COVER

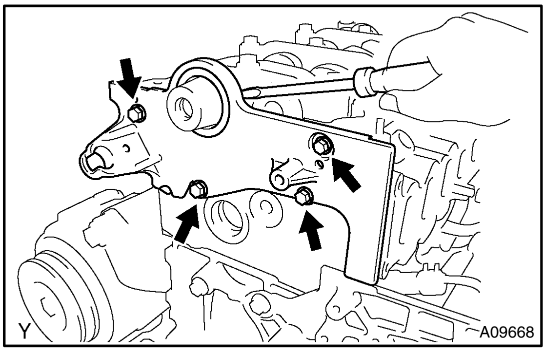
(a) Using a screwdriver, pry out the 4 nozzle holder seals.



(b) Remove the 10 bolts, cylinder head cover and gasket.

24. REMOVE NOZZLE LEAKAGE PIPE (See page FU–6)

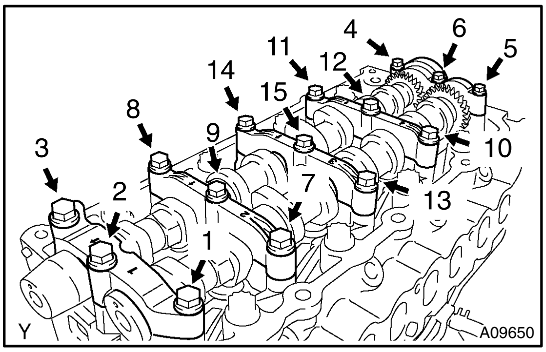
25. REMOVE INJECTORS (See page FU–6)



26. REMOVE CAMSHAFT OIL SEAL RETAINER

(a) Remove the 4 bolts.

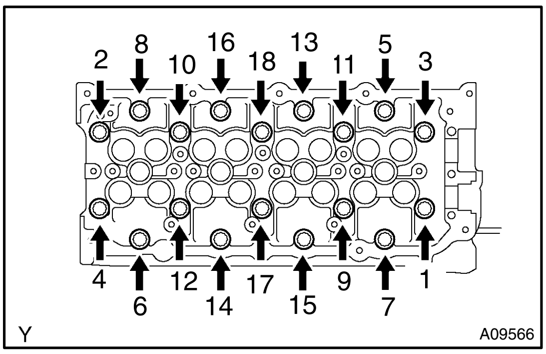
(b) Using a screwdriver, remove the oil seal retainer by prying the portions between the oil seal retainer and camshaft bearing cap.



27. REMOVE CAMSHAFTS

(a) Uniformly loosen and remove the 15 bearing cap bolts in several passes and in the sequence shown.

(b) Remove the 5 bearing caps, 2 camshafts and camshaft carrier.

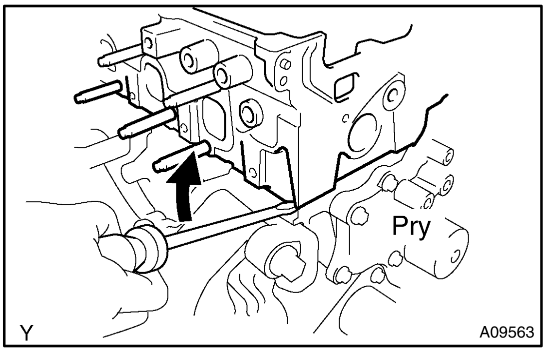


28. REMOVE CYLINDER HEAD

(a) Uniformly loosen the 18 cylinder head bolts in several passes and in the sequence shown. Remove the 18 cylinder head bolts and plate washers.

NOTICE:

Cylinder head warpage or cracking could result from removing bolts in incorrect order.



(b) Lift the cylinder head from the dowels on the cylinder block, and place the cylinder head on wooden blocks on a bench.

HINT:
If the cylinder head is lift off, pry between the cylinder head and cylinder block with a screwdriver.

NOTICE:
Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

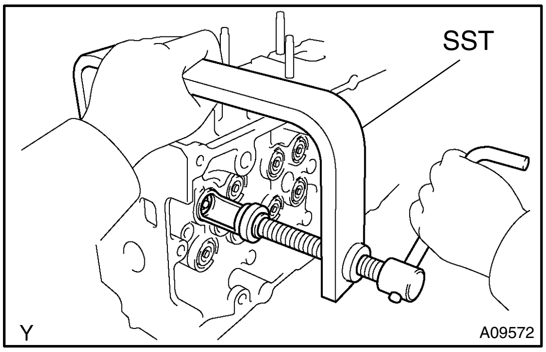
EM13D–01

DISASSEMBLY

1. REMOVE VALVE LIFTERS

HINT:

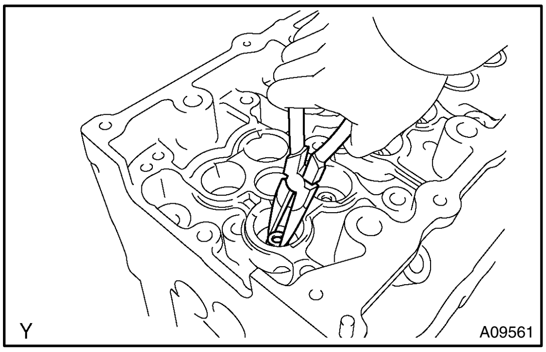
Arrange the valve lifters in the correct order.



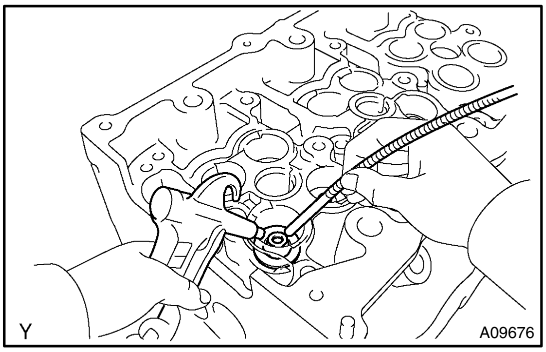
2. REMOVE VALVES

(a) Using SST, compress the valve spring and remove the 2 keepers.
SST 09202–70020 (09202–00010)

(b) Remove the spring retainer, valve spring and valve.



(c) Using needle–nose pliers, remove the oil seal.

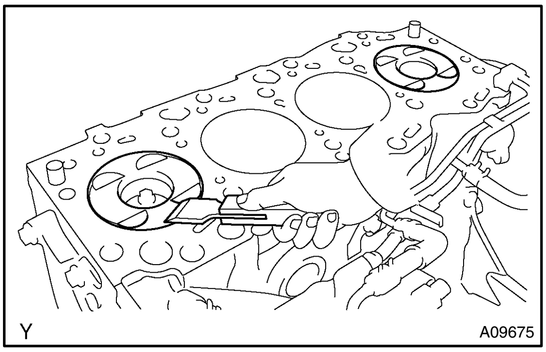


(d) Using compressed air and a magnetic finger, remove the spring seat by blowing air.

HINT:

Arrange the valves, valve springs, spring seats and spring retainers in the correct order.

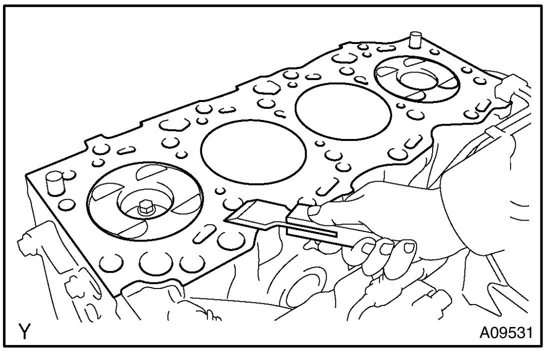
EM13E–01



INSPECTION

1. **CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK**

(a) Turn the crankshaft, and bring each piston to top dead center (TDC). Using a gasket scraper, remove all the carbon from the top surface of the piston.



(b) Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

NOTICE:

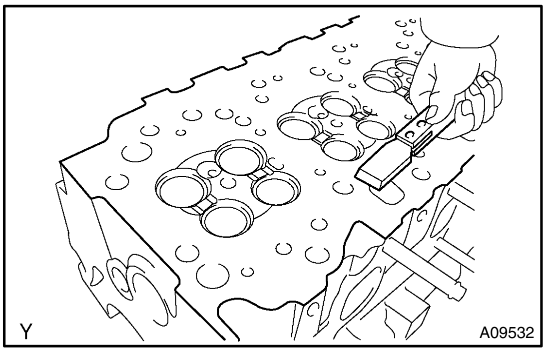
Be careful not to scratch the cylinder head contact surface.

(c) Using compressed air, blow carbon and oil from the bolt holes.

CAUTION:

Protect your eyes when using high–pressure compressed air.

2. **INSPECT TOP SURFACE OF CYLINDER BLOCK FOR FLATNESS (See page EM–64)**

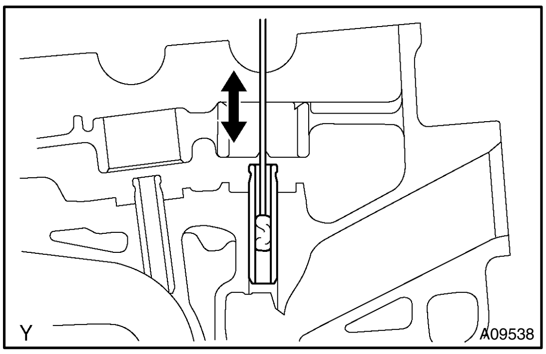


3. **CLEAN CYLINDER HEAD**

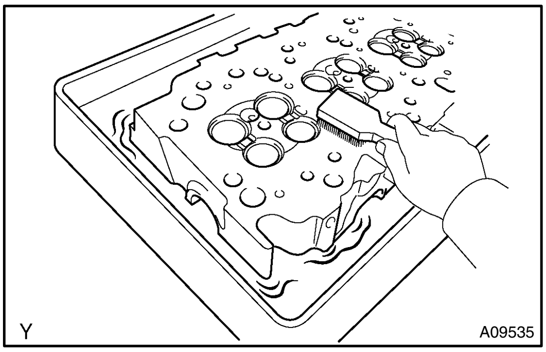
(a) Using a gasket scraper, remove all the gasket material from the contact surface of the cylinder block.

NOTICE:

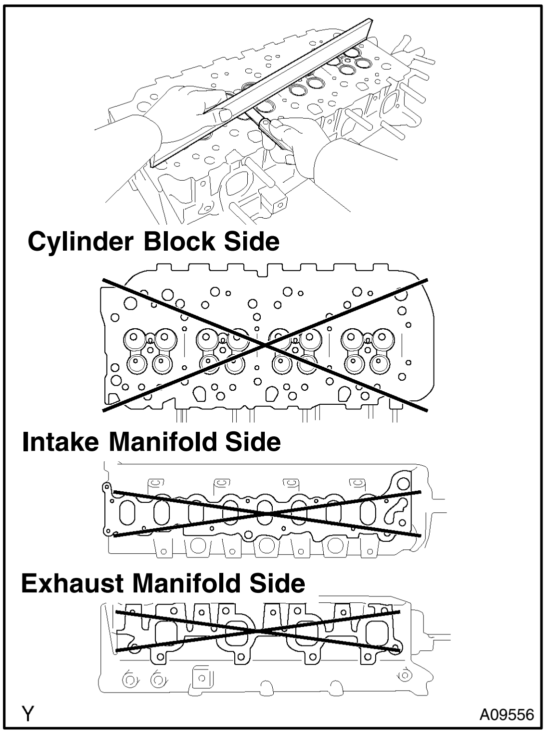
Be careful not to scratch the cylinder block contact surface.



(b) Using a valve guide bushing brush and solvent, clean all the guide bushings.

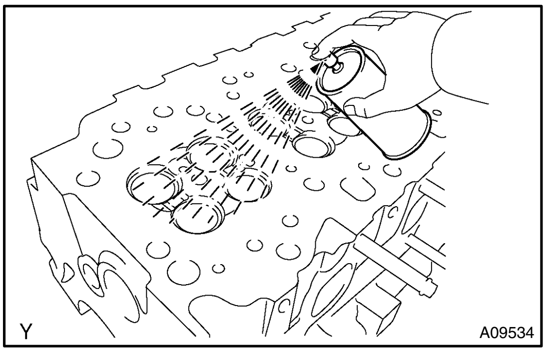


(c) Using a soft brush and solvent, thoroughly clean the cylinder head.

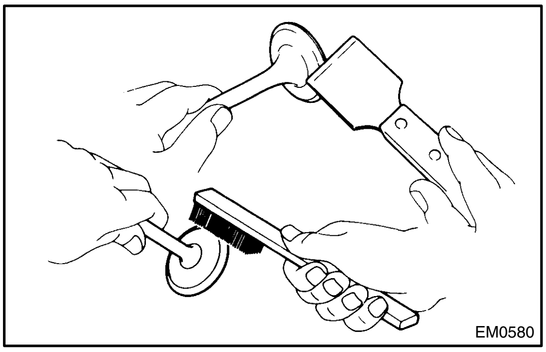


4. INSPECT CYLINDER HEAD

(a) Inspect for flatness.
Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.
Maximum warpage:
0.08 mm (0.0031 in.) for cylinder block side
0.20 mm (0.0079 in.) for manifold side
If warpage is greater than maximum, replace the cylinder head.

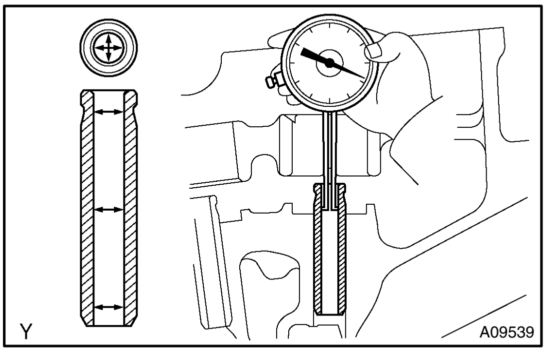


(b) Inspect for cracks.
Using a dye penetrant, check the intake ports, exhaust ports and cylinder block contact surface for cracks.
If cracked, replace the cylinder head.



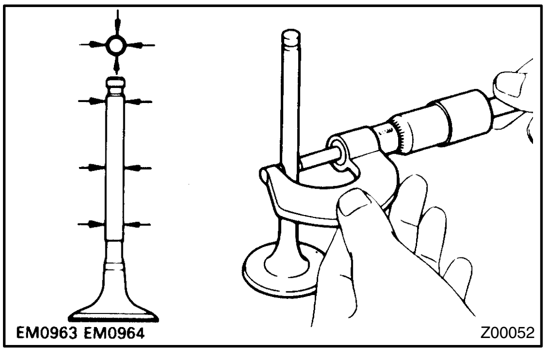
5. CLEAN VALVES

(a) Using a gasket scraper, chip off any carbon from the valve head.
(b) Using a wire brush, thoroughly clean the valve.



6. **INSPECT VALVE STEMS AND GUIDE BUSHINGS**

(a) Using a caliper gauge, measure the inside diameter of the guide bushing.
Bushing inside diameter:
6.010 – 6.030 mm (0.2366 – 0.2374 in.)



(b) Using a micrometer, measure the diameter of the valve stem.
Valve stem diameter:

Intake	5.970 – 5.985 mm (0.1957 – 0.1963 in.)
Exhaust	5.960 – 5.975 mm (0.2346 – 0.2352 in.)

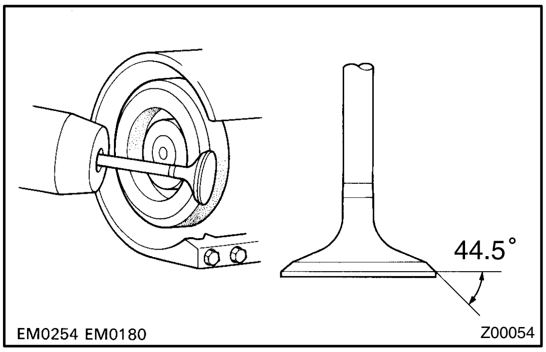
(c) Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.
Standard oil clearance:

Intake	0.025 – 0.060 mm (0.0010 – 0.0024 in.)
Exhaust	0.035 – 0.070 mm (0.0014 – 0.0028 in.)

Maximum oil clearance:

Intake	0.08 mm (0.0031 in.)
Exhaust	0.10 mm (0.0039 in.)

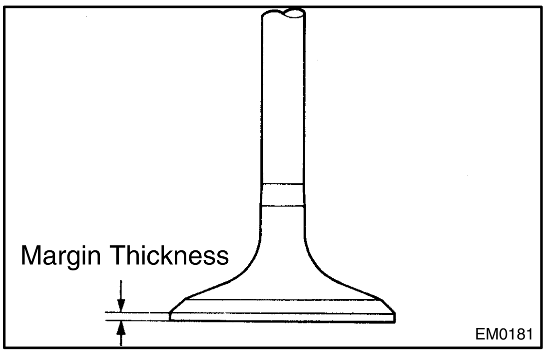
If the clearance is greater than maximum, replace the valve and guide bushing. (See page EM–42)



7. **INSPECT AND GRIND VALVES**

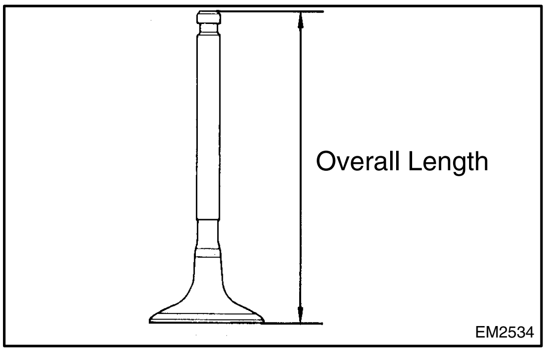
(a) Grind the valve enough to remove pits and carbon.

(b) Check that the valve is ground to the correct valve face angle.
Valve face angle: 44.5°



(c) Check the valve head margin thickness.
Standard margin thickness: 0.9 mm (0.035 in.)
Minimum margin thickness: 0.6 mm (0.024 in.)

If the margin thickness is less than minimum, replace the valve.



(d) Check the valve overall length.

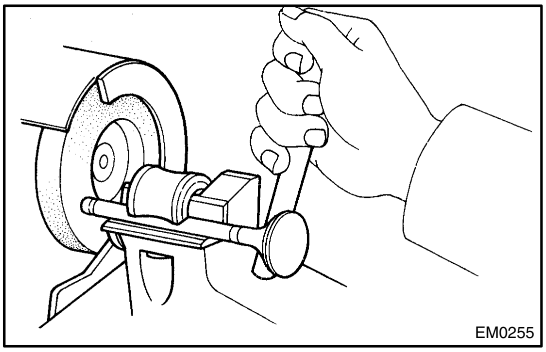
Standard overall length:

Intake	102.53 mm (4.0366 in.)
Exhaust	101.97 mm (4.0146 in.)

Minimum overall length:

Intake	102.10 mm (4.0197 in.)
Exhaust	101.55 mm (3.99801in.)

If the overall length is less than minimum, replace the valve.

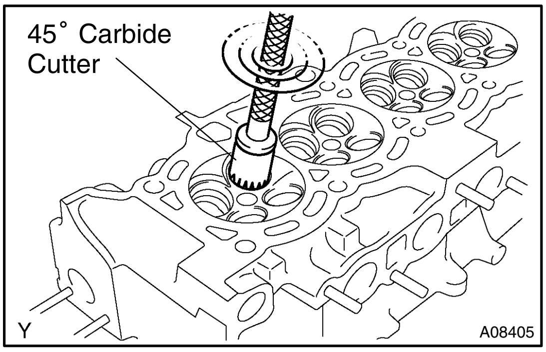


(e) Check the surface of the valve stem tip for wear.

If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

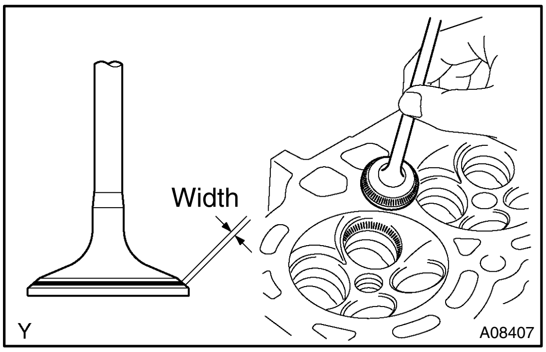
NOTICE:

Do not grind off more than the minimum length.



8. INSPECT AND CLEAN VALVE SEATS

(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.

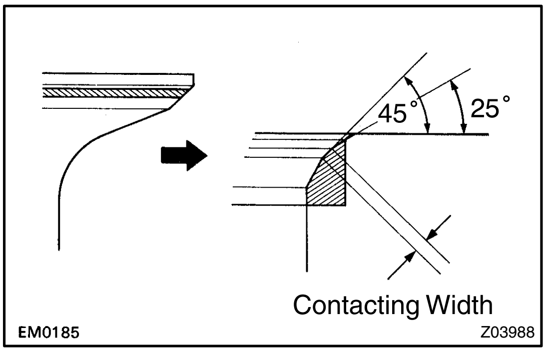


(b) Check the valve seating position.
Apply a light coat of prussian blue (or white lead) to the valve face. Lightly press the valve against the seat. Do not rotate valve.

(c) Check the valve face and seat for the following:

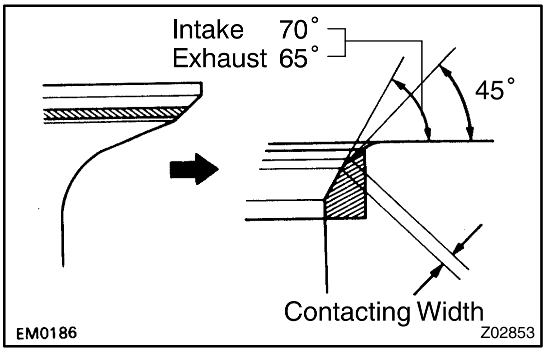
- If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- Check that the seat contact is in the middle of the valve face with the following width:

Intake	1.2 – 1.6 mm (0.047 – 0.063 in.)
Exhaust	1.6 – 2.0 mm (0.063 – 0.079 in.)



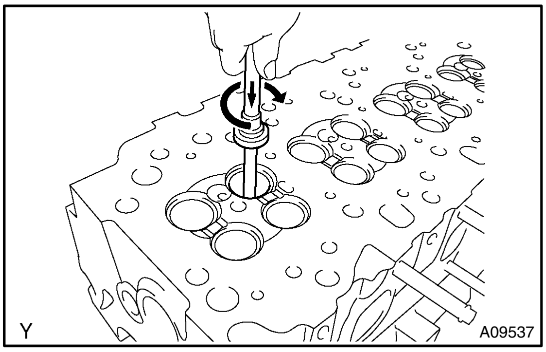
If not, correct the valve seats as follows:

(1) If the seating is too high on the valve face, use 25° and 45° cutters to correct the seat.



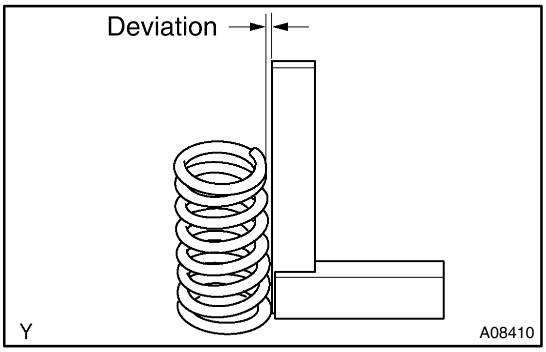
(2) Intake:
If the seating is too low on the valve face, use 70° and 45° cutters to correct the seat.

(3) Exhaust:
If the seating is too low on the valve face, use 65° and 45° cutters to correct the seat.



(d) Hand–lap the valve and valve seat with an abrasive compound.

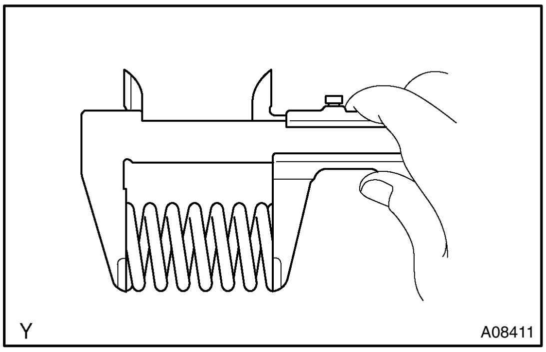
(e) After hand–lapping, clean the valve and valve seat.



9. INSPECT VALVE SPRINGS

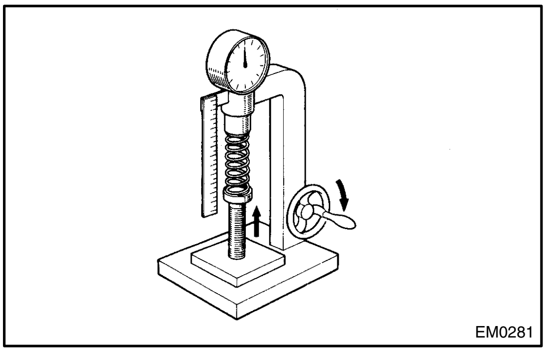
(a) Using a steel square, measure the deviation of the valve spring.
Maximum deviation: 2.0 mm (0.079 in.)

If the deviation is greater than maximum, replace the valve spring.



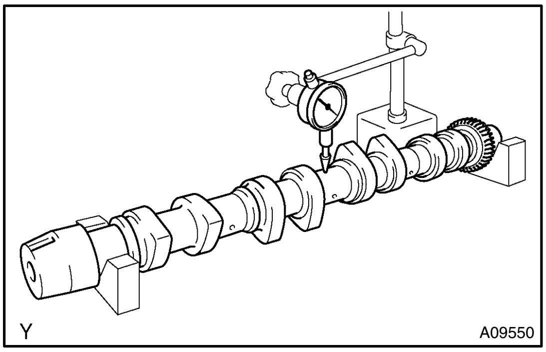
(b) Using a vernier caliper, measure the free length of the valve spring.
Free length: 40.45 mm (1.5925 in.)

If the free length is not as specified, replace the valve spring.



(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.
Installed tension:
177 – 195 N (18.0 – 19.9 kgf, 39.7 – 44.1 lbf)
at 31.1 mm (1.224 in.)

If the installed tension is not as specified, replace the valve spring.

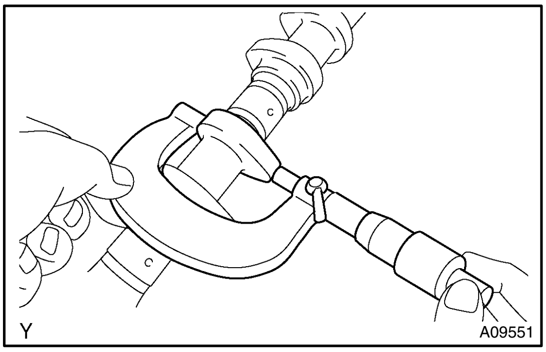


10. INSPECT CAMSHAFTS

(a) Inspect the circle runout.
   (1) Place the camshaft on V–blocks.
   (2) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.06 mm (0.0024 in.)

If the circle runout is greater than maximum, replace the camshaft.



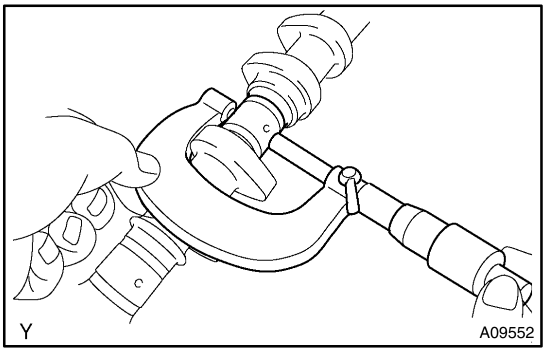
(b) Using a micrometer, measure the cam lobe height.
Standard cam lobe height:

Intake	46.57 – 46.67 mm (1.8335 – 1.8374 in.)
Exhaust	47.52 – 47.62 mm (1.8709 – 1.8748 in.)

Minimum cam lobe height:

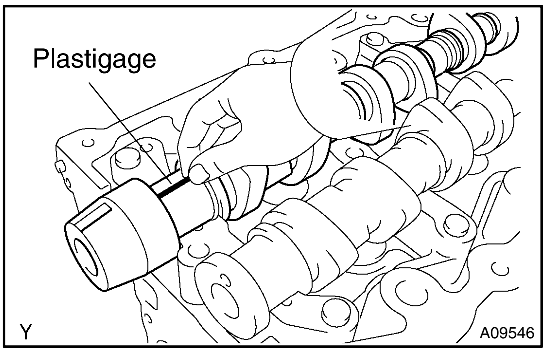
Intake	46.10 mm (1.8150 in.)
Exhaust	47.05 mm (1.8524 in.)

If the cam lobe height is less than minimum, replace the camshaft.



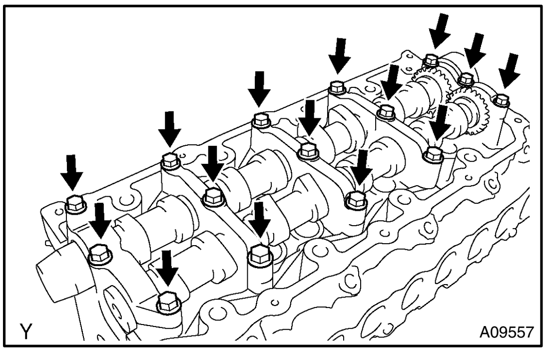
(c) Using a micrometer, measure the journal diameter.
Journal diameter:
26.969 – 26.985 mm (1.0618 – 1.0624 in.)

If the journal diameter is not as specified, check the oil clearance.



(d) Inspect the journal oil clearance.
   (1) Clean the bearing caps and camshaft carrier.
   (2) Check that bearings for flaking and scoring.

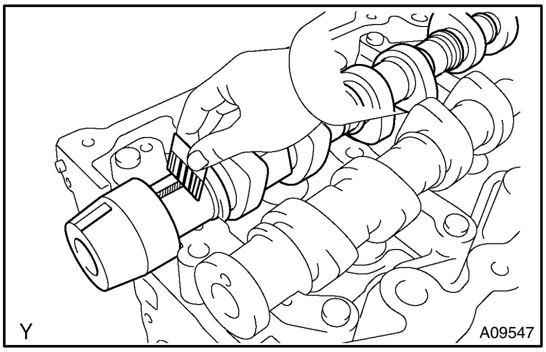
If the bearings are damaged, replace the bearing caps, camshaft carrier and cylinder head as a set.
   (3) Place the camshaft carrier and camshafts on the cylinder head.
   (4) Lay a strip of Plastigage across each of the camshaft journals.



(5) Install the bearing caps. (See page EM–46)

NOTICE:
Do not turn the camshaft.

(6) Remove the bearing caps.

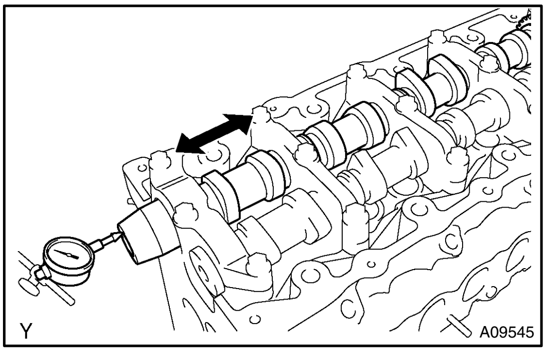


(7) Measure the Plastigage at its widest point.

Standard oil clearance:
0.025 – 0.062 mm (0.0010 – 0.0024 in.)
Maximum oil clearance: 0.08 mm (0.0031 in.)

If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps, camshaft carrier and cylinder head as a set.

(8) Completely remove the Plastigage.



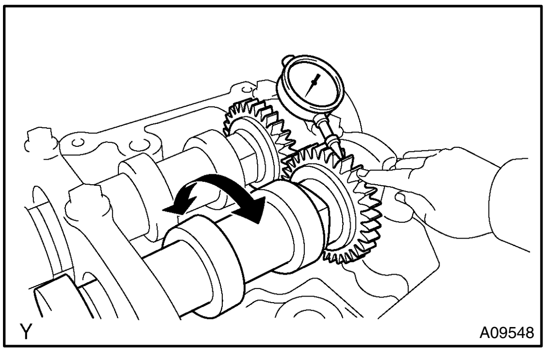
(e) Inspect the camshaft thrust clearance.

(1) Install the camshaft. (See page EM–46)

(2) Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard thrust clearance:
0.035 – 0.110 mm (0.0014 – 0.0043 in.)

If the thrust clearance is not as specified, replace the camshaft. If necessary, replace the bearing caps, camshaft carrier and cylinder head as a set.



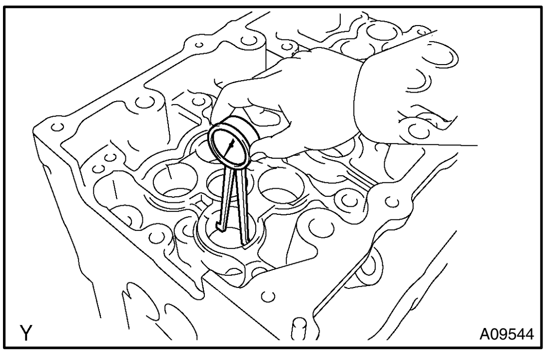
(f) Inspect the camshaft gear backlash.

(1) Install the camshafts. (See page EM–46)

(2) Using a dial indicator, measure the backlash.

Standard backlash:
0.014 – 0.070 mm (0.0006 – 0.0028 in.)
Maximum backlash: 0.17 mm (0.0067 in.)

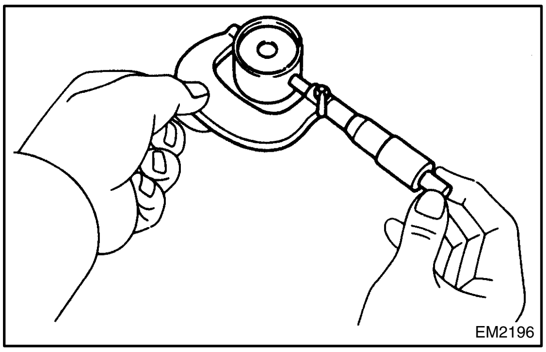
If the backlash is greater then maximum, replace the camshafts.



11. INSPECT VALVE LIFTERS AND LIFTER BORES

(a) Using a caliper gauge, measure the lifter bore diameter of the cylinder head.

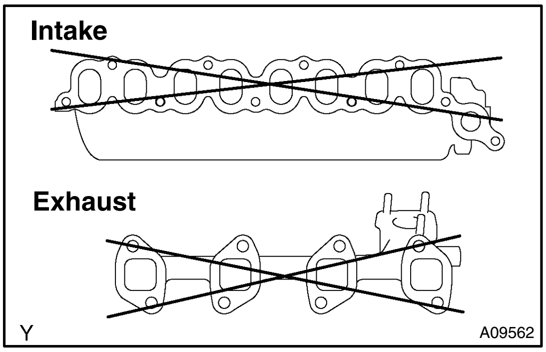
Lifter bore diameter:
28.010 – 28.031 mm (1.1028 – 1.1036 in.)



(b) Using a micrometer, measure the lifter diameter.
Lifter diameter:
27.975 – 27.985 mm (1.1014 – 1.1018 in.)

(c) Subtract the lifter diameter measurement from the lifter bore diameter measurement.
Standard oil clearance:
0.025 – 0.056 mm (0.0010 – 0.0022 in.)
Maximum oil clearance: 0.08 mm (0.0031 in.)

If the oil clearance is greater than maximum, replace the lifter. If necessary, replace the cylinder head.

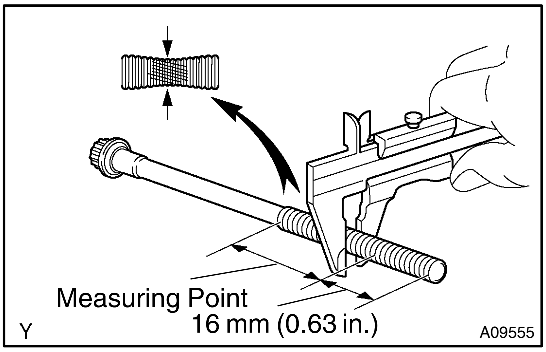


12. INSPECT MANIFOLDS

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.
Maximum warpage:

Intake	0.1 mm (0.0039 in.)
Exhaust	0.4 mm (0.0157 in.)

If warpage is greater than maximum, replace the manifold.



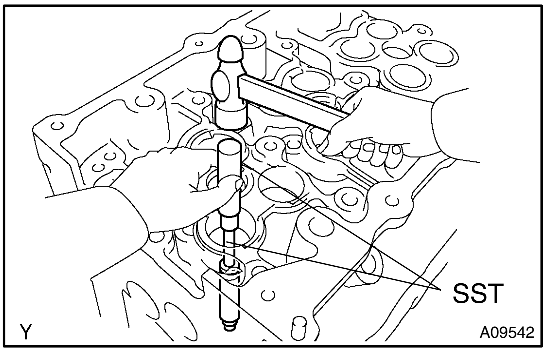
13. INSPECT CYLINDER HEAD BOLTS

Using vernier calipers, measure the tension portion diameter of the bolt.
Standard outside diameter:
10.75 – 11.00 mm (0.4232 – 0.4331 in.)
Minimum outside diameter: 10.40 mm (0.4094 in.)

If the diameter is less than minimum, replace the bolt.

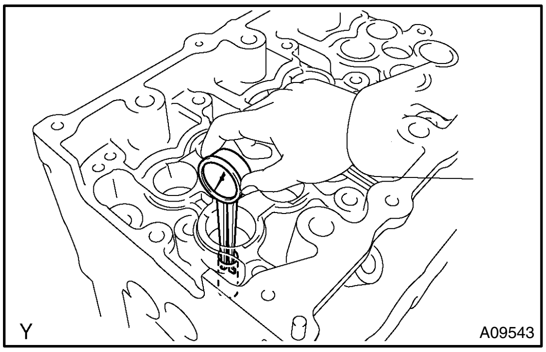
EM13F–01

REPLACEMENT



1. REPLACE VALVE GUIDE BUSHINGS

(a) Using SST and a hammer, tap out the guide bushing.
SST 09201–10000 (09201–01060),
09950–70010 (09951–07100)

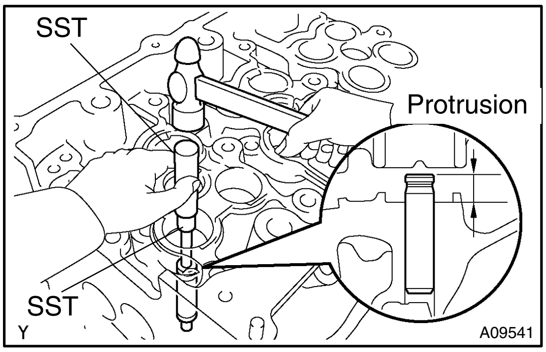


(b) Using a caliper gauge, measure the bushing bore diameter of the cylinder head.

Both intake and exhaust

Bushing bore diameter mm (in.)	Bushing size
10.985 – 11.006 (0.4325 – 0.4333)	Use STD
11.035 – 11.056 (0.4344 – 0.4353)	Use O/S 0.05

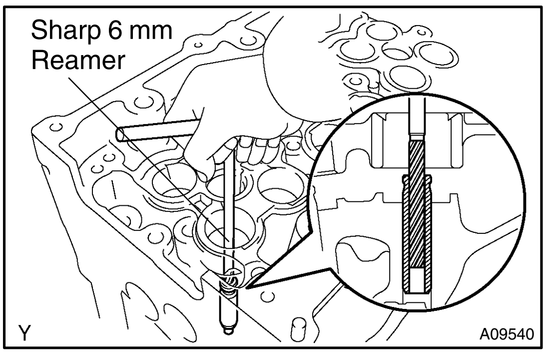
(c) Select a new guide bushing (STD or O/S 0.05).
If the bushing bore diameter of the cylinder head is greater than 11.006 mm (0.4333 in.), machine the bushing bore to the following dimensions:
11.035 – 11.056 mm (0.4344 – 0.4353 in.)
If the bushing bore diameter of the cylinder head is greater than 11.056 mm (0.4353 in.), replace the cylinder head.



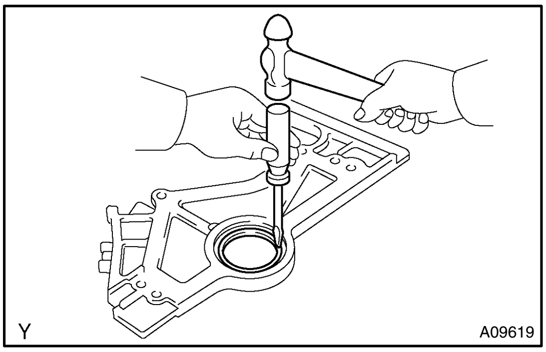
(d) Using SST and a hammer, tap in a new guide bushing to the specified protrusion height.
Protrusion height:

Intake	10.05 – 10.45 mm (0.3957 – 0.4114 in.)
Exhaust	9.65 – 10.05 mm (0.3799 – 0.3957 in.)

SST 09201–10000 (09201–01060),
09950–70010 (09951–07100)



(e) Using a sharp 6 mm reamer, ream the guide bushing to obtain the specified standard clearance (See page EM–34) between the guide bushing and valve stem.



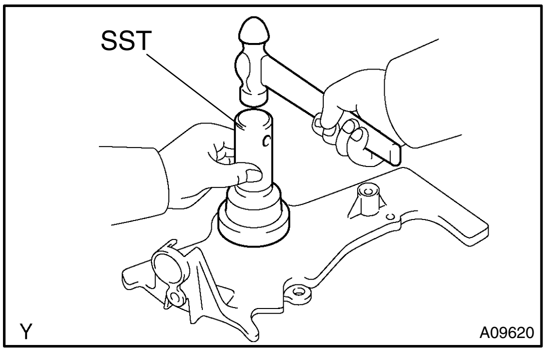
2. REPLACE CAMSHAFT OIL SEAL

HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

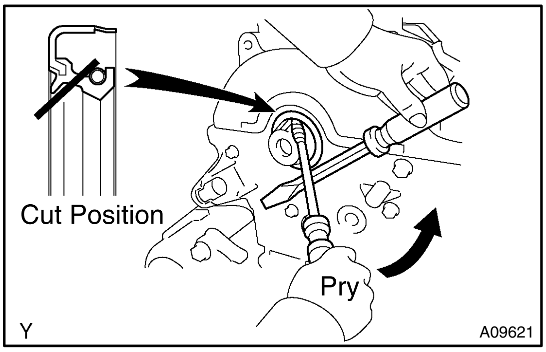
(a) If the camshaft oil seal retainer is removed from the cylinder head:

(1) Using a screwdriver and hammer, tap out the oil seal.



(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the camshaft oil seal retainer edge.

SST 09223–46011



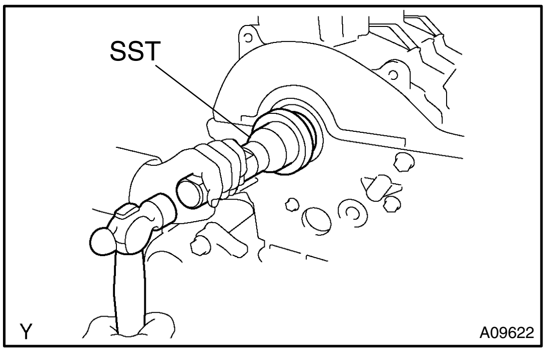
(b) If the camshaft oil seal retainer is installed to the cylinder head:

(1) Using a knife, cut off the oil seal lip.

(2) Using a screwdriver, pry out the oil seal.

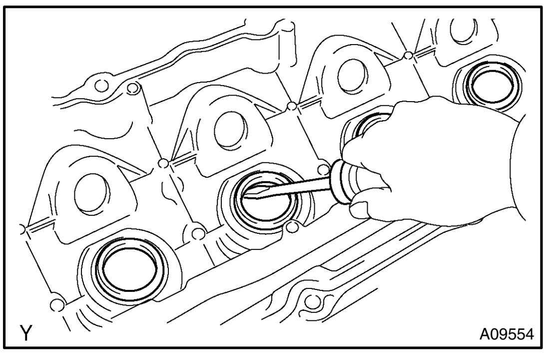
NOTICE:

Be careful not to damage the camshaft. Tape the screwdriver tip.



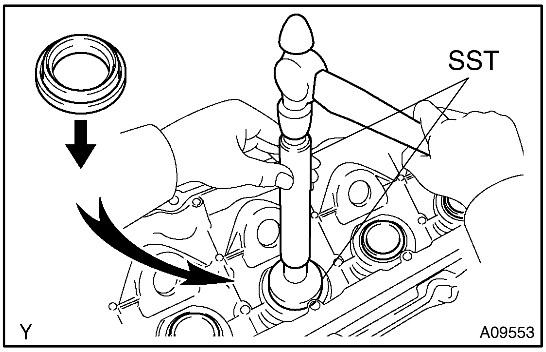
(3) Using SST and a hammer, tap in a new oil seal until its surface is flush with the camshaft oil seal retainer edge.

SST 09223–46011



3. REPLACE NOZZLE HOLDER GASKETS

(a) Using a screwdriver, pry off the nozzle holder gasket.



(b) Using SST and a hammer, tap in a new nozzle holder gasket until its surface is flush with the upper edge of the cylinder head cover.
SST 09950–60010 (09951–00280, 09951–00500, 09952–06010), 09950–70010 (09951–07100)

(c) Apply a light coat of MP grease to the nozzle holder gasket lip.

EM13G–01

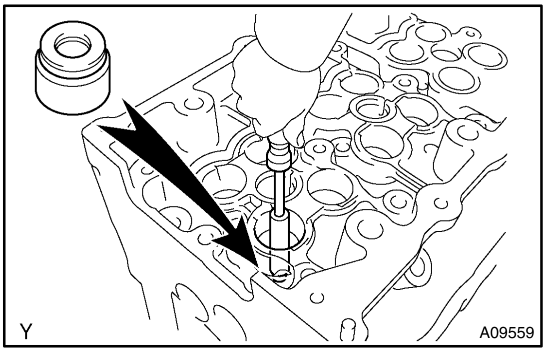
REASSEMBLY

HINT:

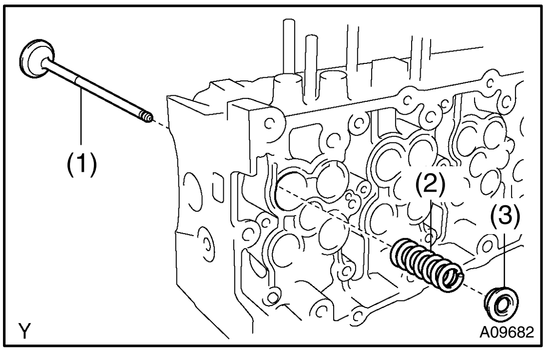
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

1. INSTALL VALVES

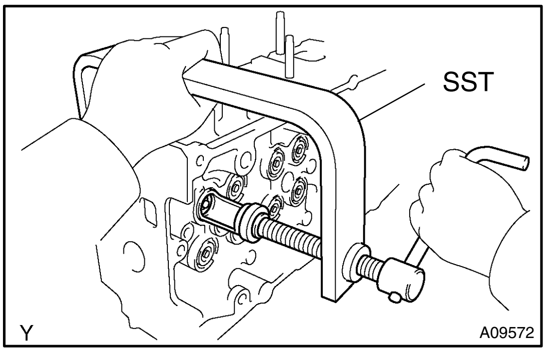
(a) Install the spring seat.



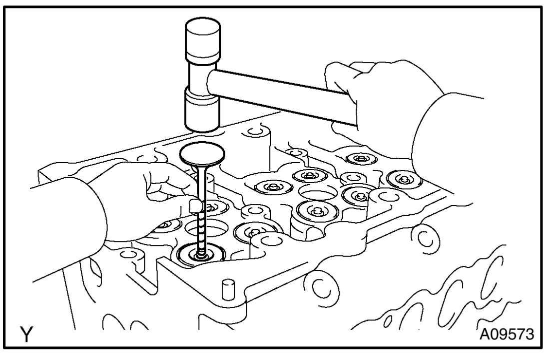
(b) Install a new oil seal on the valve guide bushing.



(c) Install the valve (1), valve spring (2) and spring retainer (3).



(d) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST 09202–70020 (09202–00010)



(e) Using a plastic–faced hammer and the valve stem (not in use) tip wound with vinyl tape, lightly tap the valve stem tip to assure proper fit.

NOTICE:
Be careful not do damage the valve stem tip.

2. INSTALL VALVE LIFTERS

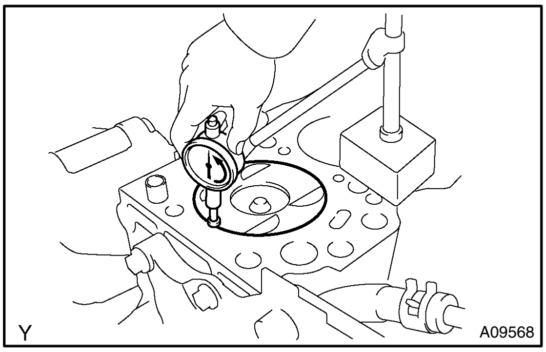
(a) Install the valve lifter.
(b) Check that the valve lifter rotates smoothly by hand.

EM13N–01

INSTALLATION

NOTICE:

- **In case of having the cylinder head and/or commom rail and/or injectors replaced, must replace injection pipes, too.**
- **In case of having the cylinder head and/or cylinder block and/or commom rail replaced, must replace fuel inlet pipe, too.**
- **In case of having the size of the cylinder head gasket changed also, must change the fuel inlet pipe.**



1. CHECK PISTON PROTRUSION AND SELECT CYLINDER HEAD GASKET

(a) Check piston protrusions for each cylinder.

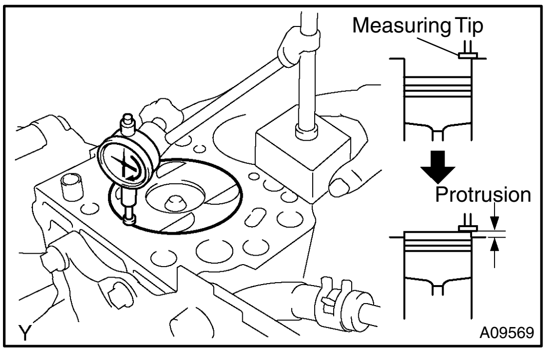
(1) Clean the cylinder block with solvent.

(2) Set the piston of the cylinder to be measured to slightly before TDC.

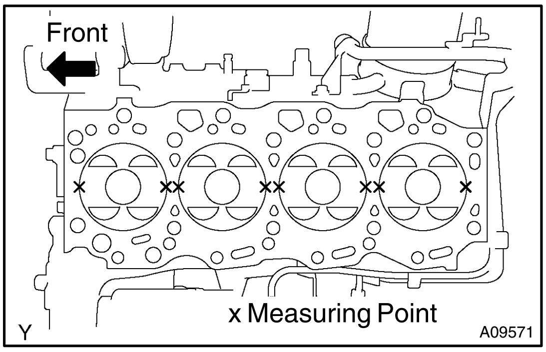
(3) Place a dial indicator on the cylinder block, and set the dial indicator at 0 mm (0 in.).

HINT:

- Use a dial indicator measuring tip as shown in the illustration.
- Make sure that the measuring tip is square to the cylinder block gasket surface and piston head when taking the measurements.



(4) Find where the piston head protrudes most by slowly turning the crankshaft clockwise and counterclockwise.



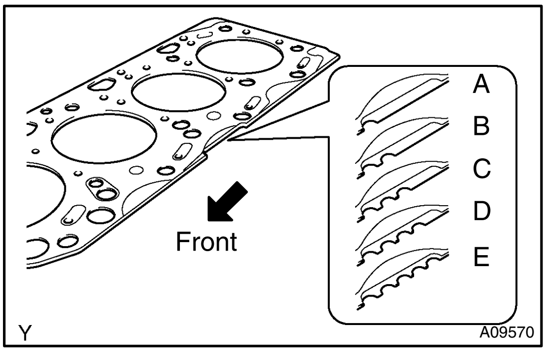
(5) Measure each cylinder at 2 places as shown in the illustration, marking a total of 8 measurements.

(6) For the piston protrusion valve of each cylinder, use the average of the 2 measurements of each cylinder.

Protrusion: 0.165 – 0.425 mm (0.0065 – 0.0168 in.)

When removing piston and connecting rod assembly:

If the protrusion is not as specified, remove the piston and connecting rod assembly and reinstall it. (See page EM–56)



(b) Select new cylinder head gasket.

HINT:

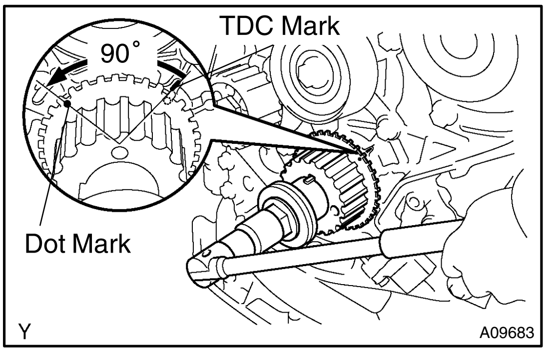
There are 5 sizes of new cylinder head gaskets, marked ”A”, ”B”, ”C”, ”D” or ”E” according.

New installed cylinder head gasket thickness:

A	0.85 – 0.95 mm (0.0335 – 0.0374 in.)
B	0.90 – 1.00 mm (0.0354 – 0.0394 in.)
C	0.95 – 1.05 mm (0.0374 – 0.0413 in.)
D	1.00 – 1.10 mm (0.0394 – 0.0433 in.)
E	1.05 – 1.15 mm (0.0413 – 0.0453 in.)

Select the largest piston protrusion value from the measurements made, then select a new appropriate gasket according to the table below.

Piston protrusion mm (in.)	Gasket size
0.165 – 0.220 (0.0065 – 0.0087)	Use A
0.220 – 0.270 (0.0087 – 0.0106)	Use B
0.270 – 0.320 (0.0106 – 0.0126)	Use C
0.320 – 0.370 (0.0126 – 0.0146)	Use D
0.370 – 0.425 (0.0146 – 0.0167)	Use E

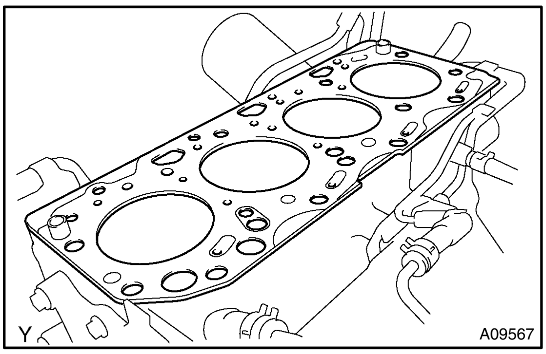


2. SET NO.1 CYLINDER TO APPROX. 90° BTDC/COMPRESSION

Using the crankshaft pulley bolt, turn the crankshaft, and set the dot mark of the crankshaft timing pulley at the position of 90° BTDC.

NOTICE:

If the timing belt is disengaged, having the crankshaft timing pulley at wrong angle can cause the piston head and valve head to come into contact with each other.



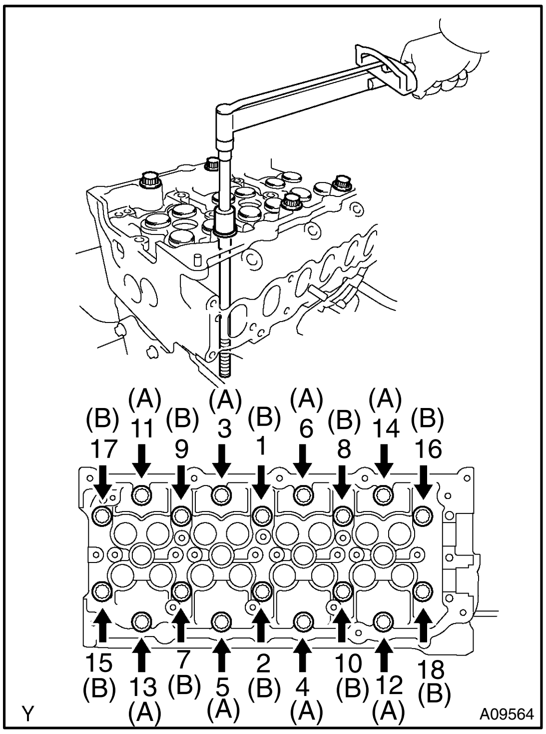
3. PLACE CYLINDER HEAD ON CYLINDER BLOCK

(a) Place a new cylinder head gasket in position on the cylinder block.

NOTICE:

Be careful of the installation direction.

(b) Place the cylinder head in position on the cylinder head gasket.



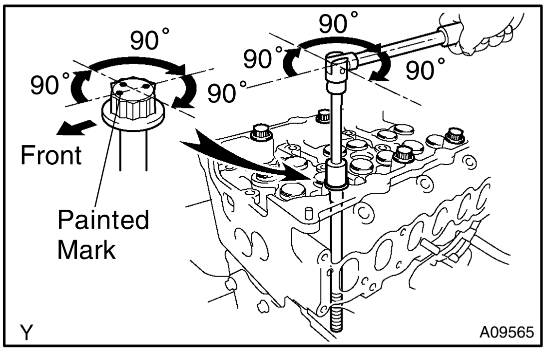
4. INSTALL CYLINDER HEAD BOLTS

HINT:
- The cylinder head bolts are tightened in 4 progressive steps (steps (c) ,(e), (f) and (g)).
- If any cylinder head bolt is broken or deformed, replace it.

(a) Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts and plate washers.
(b) Install the plate washer to the cylinder head bolt.
(c) Install and uniformly tighten the 18 cylinder head bolts and plate washers in several passes and in the sequence shown.
Torque: 45 N·m (460 kgf·cm, 33 ft·lbf)

HINT:
Each bolt length is indicated in the illustration.
Bolt length:
(A) 160 mm (6.30 in.)
(B) 104 mm (4.09 in.)

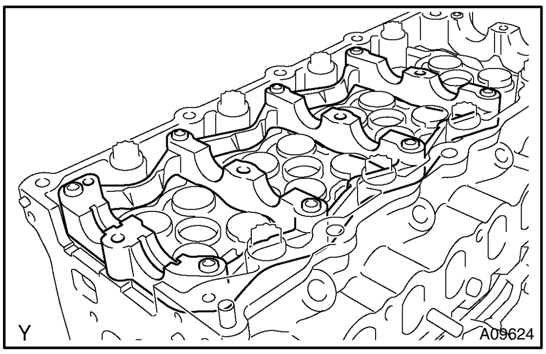
If any of the cylinder head bolt does not meet the torque specification, replace the cylinder head bolt.



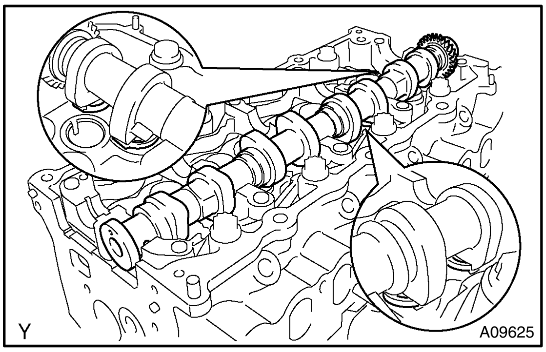
(d) Mark the front of the cylinder head bolt with paint.
(e) Retighten the cylinder head bolts by 90° in the numerical order shown first.
(f) Retighten the cylinder head bolts by 90° in the numerical order shown secondary.
(g) Retighten the cylinder head bolts by additional 90° in the numerical order shown third.
(h) Check that the painted mark is at the intake manifold side now.

5. INSTALL CAMSHAFTS

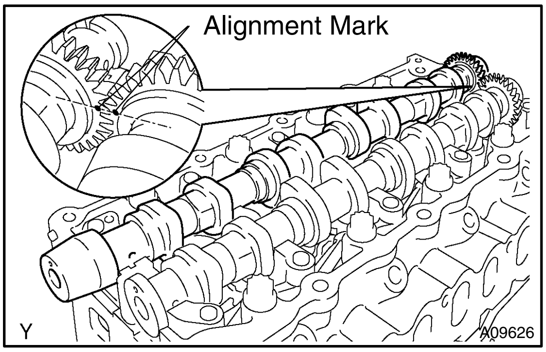
NOTICE:
Since the thrust clearance of the camshaft is small, the camshaft must be kept leveled while it is being installed. If the camshaft is not kept leveled, the portion of the cylinder head receiving the shaft thrust may crack or be damaged, causing the camshaft to seize or break. To avoid this, the following steps should be carried out.



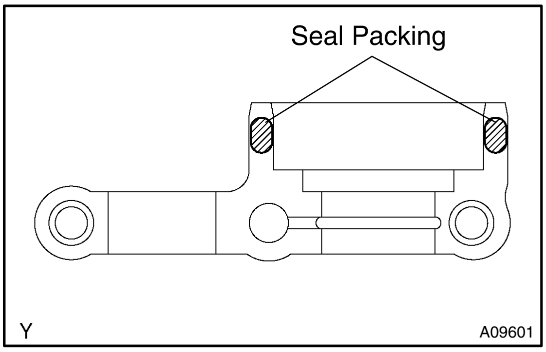
(a) Place the camshaft carrier in position on the cylinder head.



(b) Install the intake camshaft.
(1) Apply engine oil to the cam and gear of the camshaft, and the journal of the camshaft carrier.
(2) Place the intake camshaft on top of the camshaft carrier as shown in the illustration so that the No.3 and No.4 of cylinder cam lobes face downward.

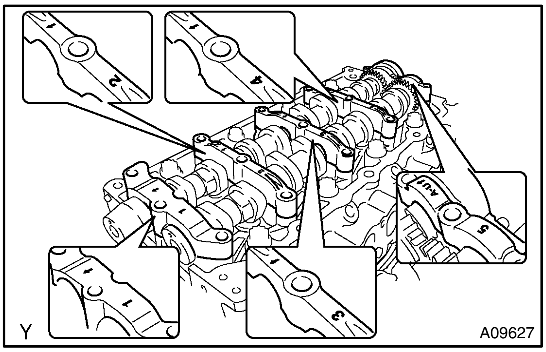


(c) Install the exhaust camshaft.
(1) Apply engine oil to the cam and gear of the camshaft, and the journal of the camshaft carrier.
(2) Engage the exhaust camshaft gear to the intake camshaft gear by matching the alignment marks on each gear.
(3) Roll down the exhaust camshaft onto the bearing journals while engaging gears with each other.

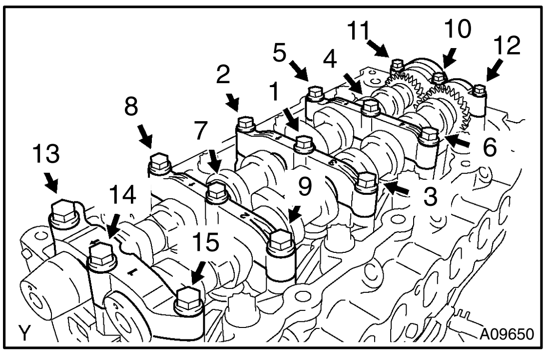


(d) Install the camshaft bearing caps.
(1) Remove any old packing (FIPG) material from the No.5 camshaft bearing cap.
(2) Apply a seal packing to the No.5 camshaft bearing cap as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent



(3) Place the 5 bearing caps in their proper locations.



(4) Install and uniformly tighten the 15 bearing cap bolts in several passes and in the sequence shown.

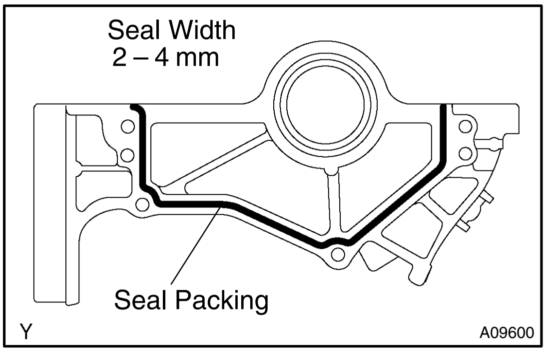
Torque: 20 N·m (200 kgf·cm, 15 ft·lbf)

6. CHECK AND ADJUST VALVE CLEARANCE
(See page EM–5)

7. INSTALL CAMSHAFT OIL SEAL RETAINER

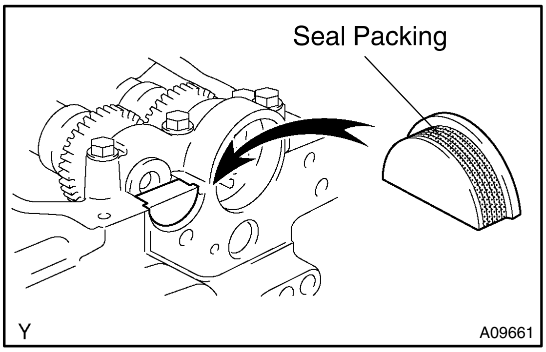
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil seal retainer and cylinder block.

- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

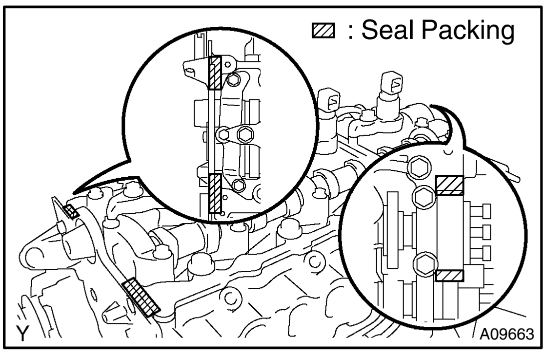


(b) Apply seal packing to the oil seal retainer as shown in the illustration.
Seal packing: Part No. 08826–00080 or equivalent
- Install a nozzle that has been cut to a 2 – 4 mm (0.08 – 0.16 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

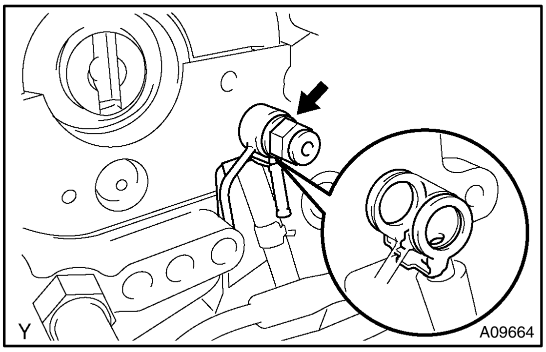
(c) Install the oil seal retainer with the 4 bolts. Uniformly tighten the 4 bolts in several passes.
Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)



8. INSTALL SEMI–CIRCULAR PLUG
(a) Remove any old packing (FIPG) material.
(b) Apply a seal packing to the semi–circular plug grooves.
Seal packing: Part No. 08826–00080 or equivalent
(c) Install the semi–circular plug to the cylinder head.
9. INSTALL INJECTORS (See page FU–8)
10. INSTALL NOZZLE LEAKAGE PIPE (See page FU–8)



11. INSTALL CYLINDER HEAD COVER
(a) Remove any old packing (FIPG) material.
(b) Apply a seal packing to the cylinder head.
Seal packing: Part No. 08826–00080 or equivalent
(c) Install the gasket to the head cover.
(d) Install the cylinder head cover with the 10 bolts.
Torque: 13.2 N·m (135 kgf·cm, 10 ft·lbf)
(e) Install new 4 nozzle holder seals.

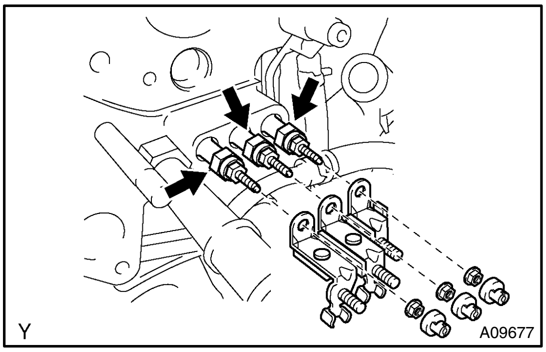


12. INSTALL NO.2 NOZZLE LEAKAGE PIPE

Install a new gasket and the leakage pipe with the check valve.

Torque: 21 N·m (215 kgf·cm, 15 ft·lbf)

13. CONNECT FUEL HOSE AND NO.2 OIL COOLER HOSE



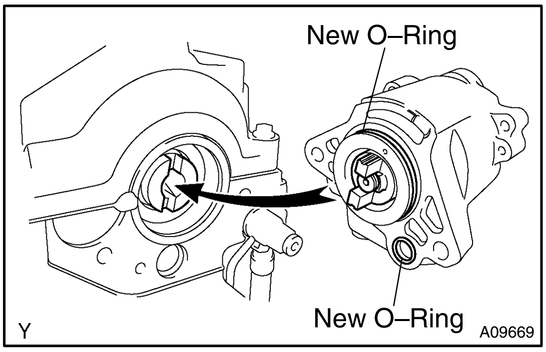
14. INSTALL GLOW PLUGS FOR POWER HEATER

(a) Install the 3 glow plugs.

Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

(b) Install the engine block heater bracket with the 3 nuts.

(c) Install the 3 caps.

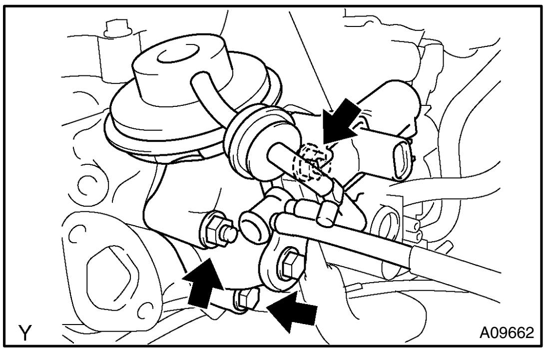


15. INSTALL VACUUM PUMP

(a) Install 2 new O–rings to the vacuum pump.

(b) Insert the vacuum pump, aligning the slit of the exhaust camshaft with the coupling of the vacuum pump. Install the 2 bolts.

Torque: 28 N·m (280 kgf·cm, 20 ft·lbf)



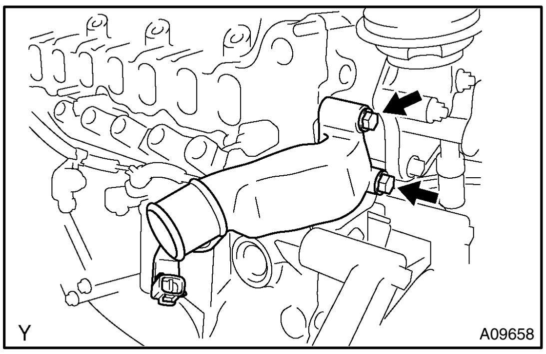
16. INSTALL EGR VALVE

Install a new gasket and the EGR valve with the bolt and 2 nuts.

Torque: 18.1 N·m (185 kgf·cm, 13 ft·lbf)

17. INSTALL WATER TEMPERATURE SENSOR

18. TEMPORARILY INSTALL COMMON RAIL

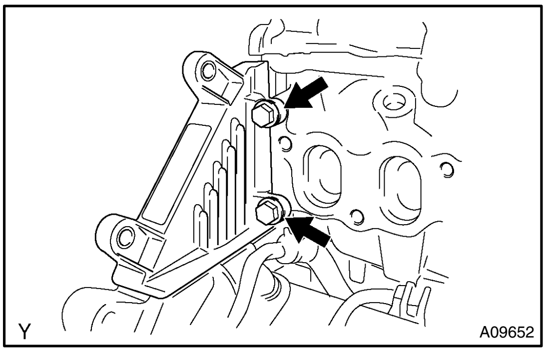


19. INSTALL WATER OUTLET

Install a new gasket and the water outlet with the 2 bolts.

Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

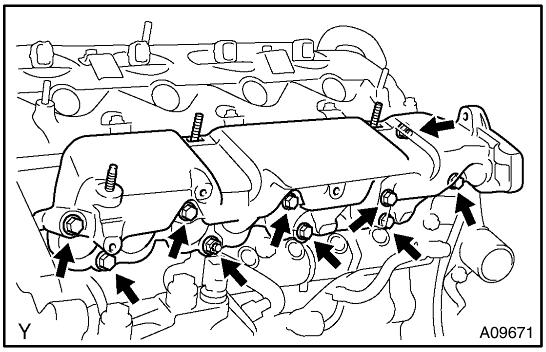
20. INSTALL VENTILATION HOSE



21. INSTALL NO.3 TIMING BELT COVER

Install the timing belt cover with the 2 bolts and 2 seal washers.

Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)



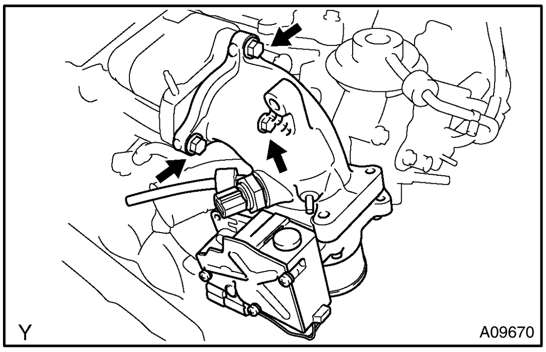
22. INSTALL INTAKE MANIFOLD

Install a new gasket and the intake manifold with the 8 bolts and 2 nuts.

Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

23. TIGHTEN COMMON RAIL SET BOLTS (See page FU–23)

Torque: 43 N·m (440 kgf·cm, 32 ft·lbf)



24. INSTALL INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY

Install a new gasket and the intake air connector with diesel throttle body with the 3 bolts.

Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

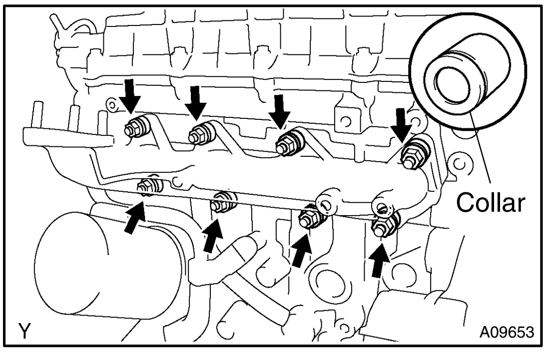
25. INSTALL INJECTION PIPES (See page FU–8)

26. INSTALL FUEL INLET PIPE (See page FU–8)

27. INSTALL SUPPLY PUMP INSULATOR (See page FU–18)

28. INSTALL NO.2 ENGINE COVER

29. INSTALL CAMSHAFT POSITION SENSOR



30. INSTALL EXHAUST MANIFOLD

Install the exhaust manifold with the 8 collars and 8 nuts.

Torque: 46.5 N·m (475 kgf·cm, 34 ft·lbf)

31. INSTALL CAMSHAFT TIMING PULLEY (See page EM–18)

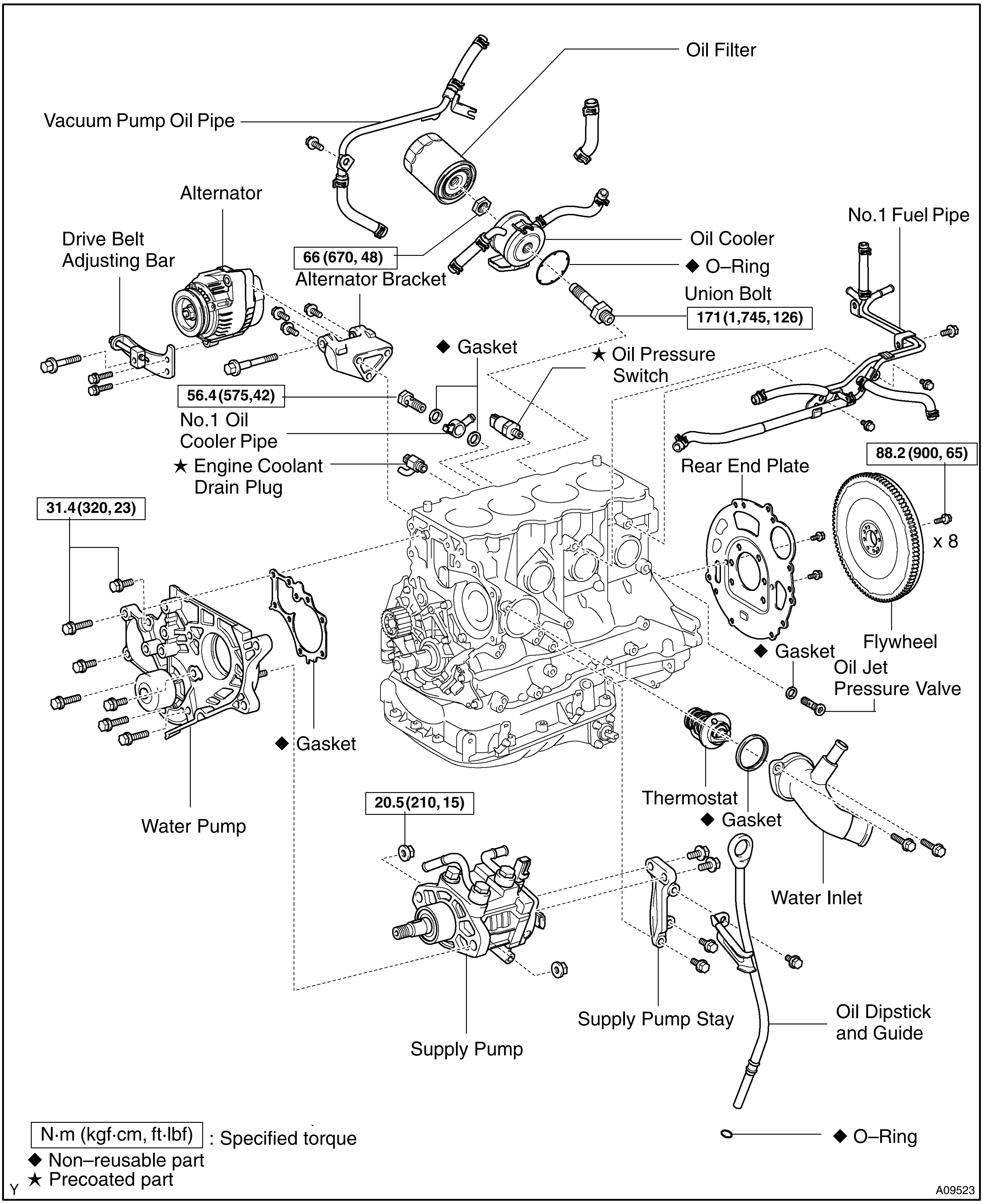
32. INSTALL TIMING BELT (See page EM–18)

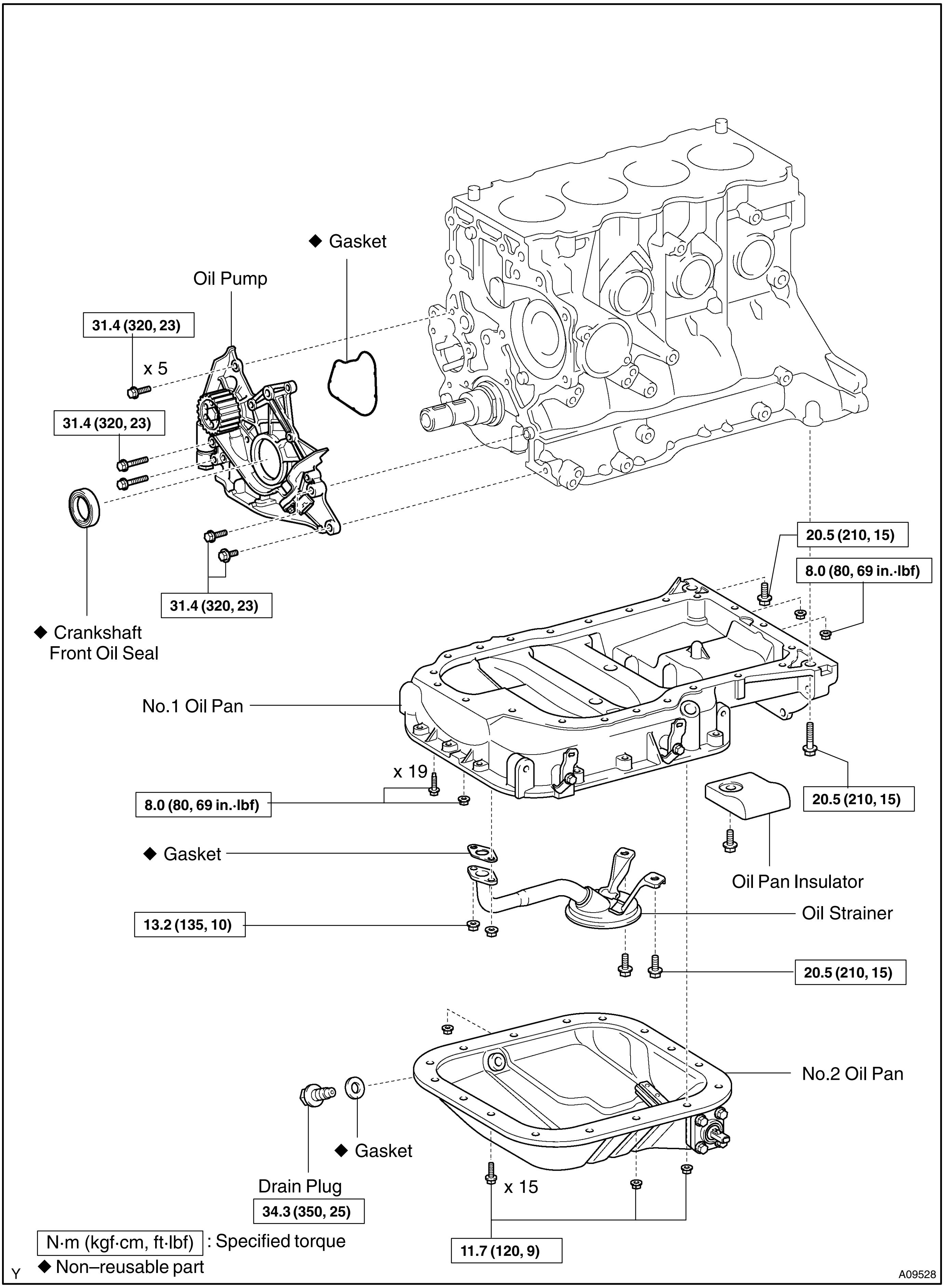
33. INSTALL TURBOCHARGER (See page TC–18)

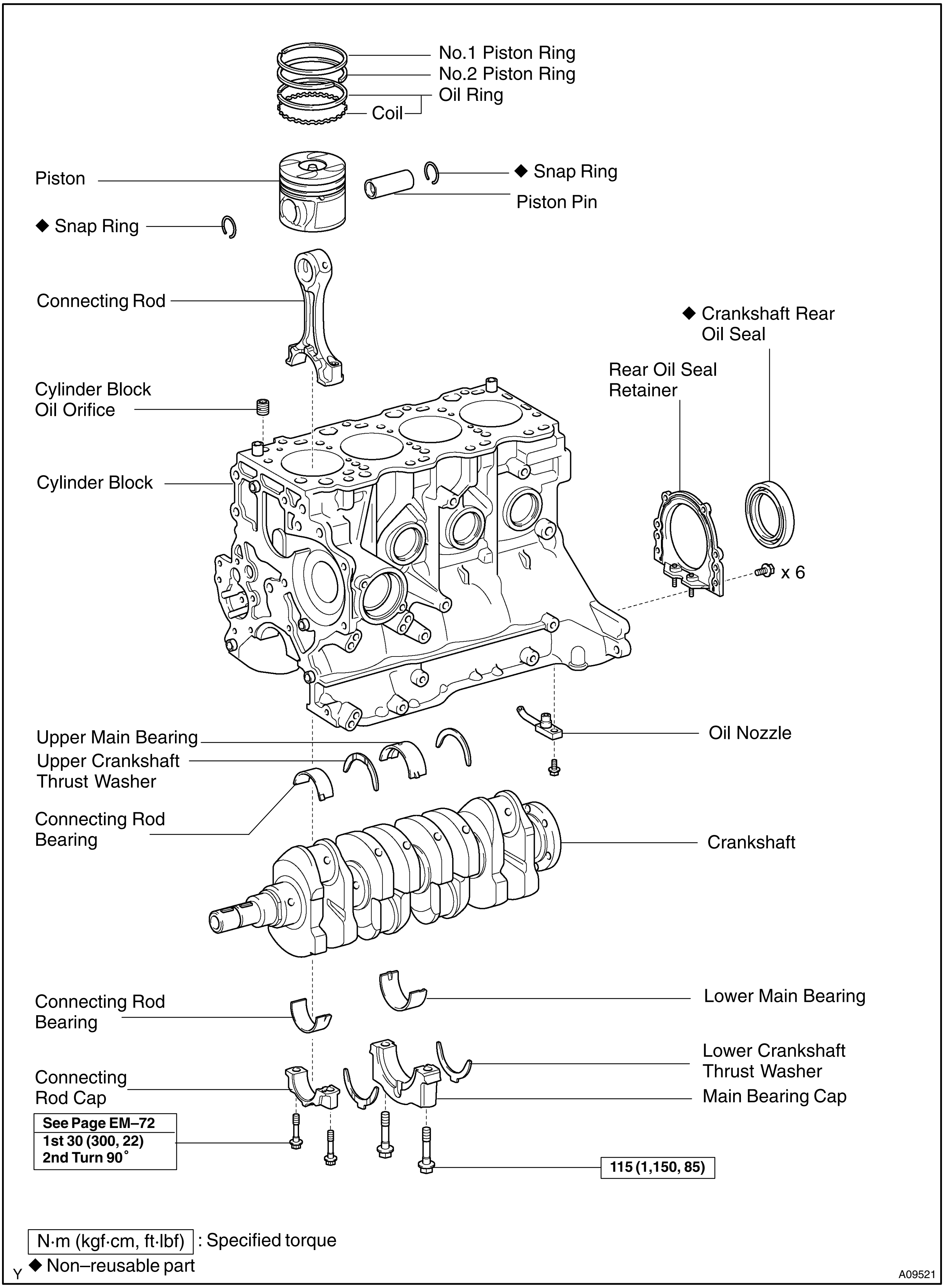
CYLINDER BLOCK

COMPONENTS

EM13H–01



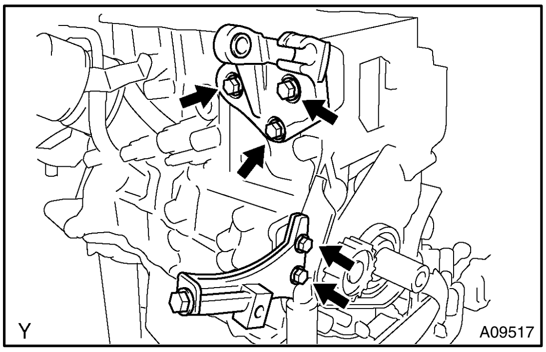

◆ Gasket
Oil Pump
31.4 (320, 23)
x 5
31.4 (320, 23)
31.4 (320, 23)
◆ Crankshaft
Front Oil Seal
20.5 (210, 15)
8.0 (80, 69 in.·lbf)
No.1 Oil Pan
x 19
8.0 (80, 69 in.·lbf)
20.5 (210, 15)
◆ Gasket
Oil Pan Insulator
Oil Strainer
13.2 (135, 10)
20.5 (210, 15)
No.2 Oil Pan
◆ Gasket
Drain Plug
x 15
34.3 (350, 25)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
11.7 (120, 9)
Y
A09528


No.1 Piston Ring
No.2 Piston Ring
Oil Ring
Coil
Piston
◆ Snap Ring
Piston Pin
◆ Snap Ring
Connecting Rod
◆ Crankshaft Rear Oil Seal
Rear Oil Seal Retainer
Cylinder Block Oil Orifice
Cylinder Block
x 6
Upper Main Bearing
Upper Crankshaft Thrust Washer
Oil Nozzle
Connecting Rod Bearing
Crankshaft
Lower Main Bearing
Connecting Rod Bearing
Lower Crankshaft Thrust Washer
Connecting Rod Cap
Main Bearing Cap
See Page EM–72
1st 30 (300, 22)
2nd Turn 90°
115 (1,150, 85)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
A09521

EM13K–01

DISASSEMBLY

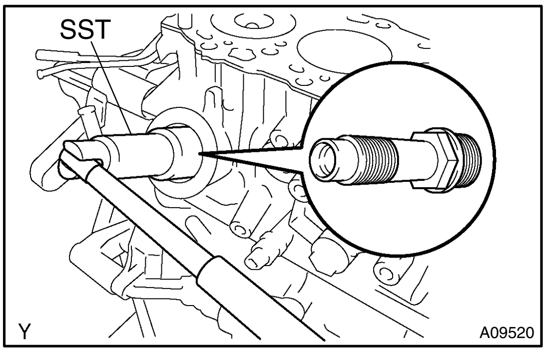
1. REMOVE FLYWHEEL
2. REMOVE REAR END PLATE
3. INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY
4. REMOVE TIMING BELT AND PULLEYS (See page EM–12)
5. REMOVE CYLINDER HEAD (See page EM–28)
6. REMOVE SUPPLY PUMP (See page FU–16)
7. REMOVE WATER PUMP (See page CO–6)
8. REMOVE WATER INLET AND THERMOSTAT (See page CO–10)
9. REMOVE ALTERNATOR



10. **REMOVE ALTERNATOR BRACKET AND DRIVE BELT ADJUSTING BAR**

(a) Remove the 3 bolts and alternator bracket.
(b) Remove the 2 bolts and adjusting bar.

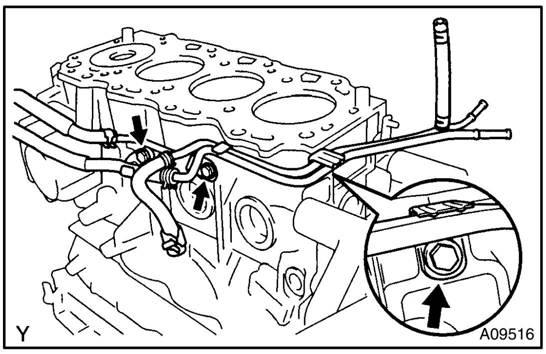
11. **REMOVE OIL COOLER (See page LU–19)**



12. **REMOVE OIL COOLER UNION BOLT**

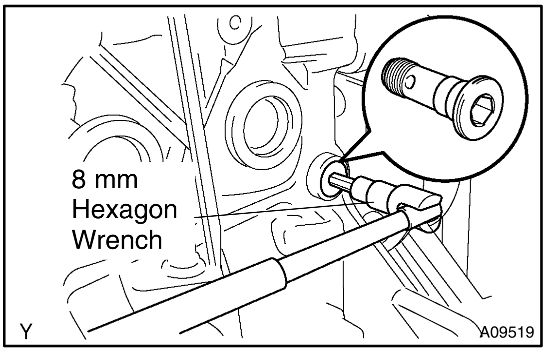
Using SST, remove the union bolt.
SST 09229–55010

13. **REMOVE ENGINE COOLANT DRAIN UNION**
14. **REMOVE NO.1 OIL COOLER PIPE**
15. **REMOVE OIL PRESSURE SWITCH (See page LU–1)**



16. **REMOVE NO.1 FUEL PIPE**

Remove the 3 bolts and fuel pipe.

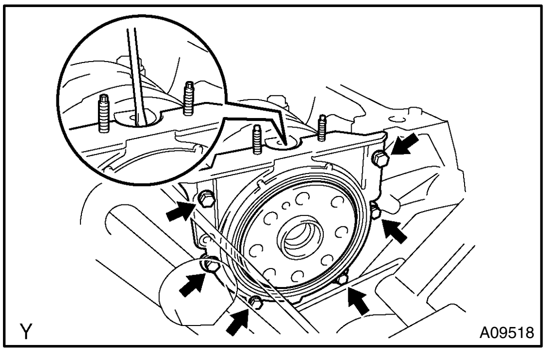


17. REMOVE OIL JET PRESSURE VALVE

Using an 8 mm hexagon wrench, remove the pressure valve and gasket.

18. REMOVE NO.2 OIL PAN, OIL STRAINER AND NO.1 OIL PAN (See page LU–7)

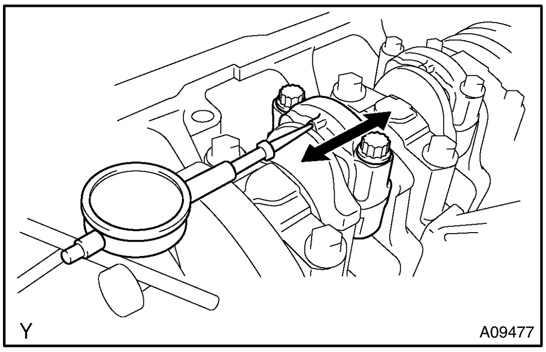
19. REMOVE OIL PUMP (See page LU–7)



20. REMOVE REAR OIL SEAL RETAINER

(a) Remove the 6 bolts.

(b) Using a screwdriver, remove the oil seal retainer by prying the portions between the oil seal retainer and main bearing cap.

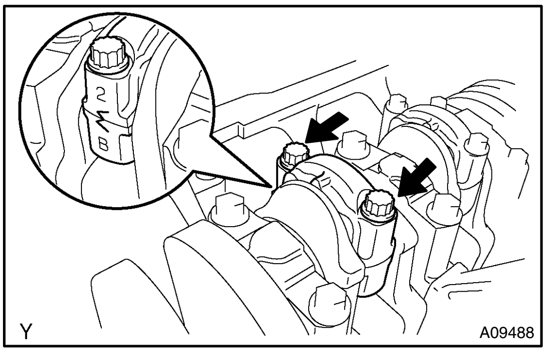


21. CHECK CONNECTING ROD THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

Standard thrust clearance:
0.08 – 0.30 mm (0.0031 – 0.0118 in.)
Maximum thrust clearance: 0.40 mm (0.0157 in.)

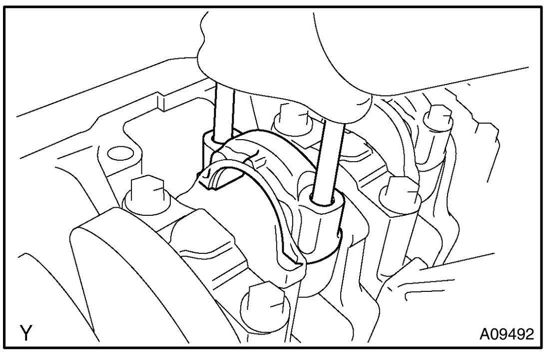
If the thrust clearance is greater than maximum, replace the connecting rod assembly(s). If necessary, replace the crankshaft.



22. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE

(a) Check the matchmarks on the connecting rod and cap to ensure correct reassembly.

(b) Remove the 2 connecting rod cap bolts.



(c) Using 2 removed connecting rod cap bolts, remove the connecting rod cap and lower bearing by wiggling the connecting rod cap right and left.

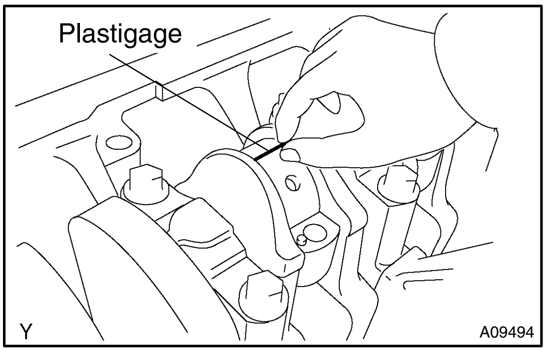
HINT:

Keep the lower bearing inserted with the connecting rod cap.

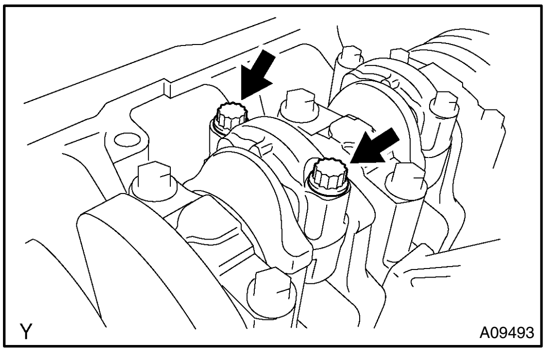
(d) Clean the crank pin and bearing.

(e) Check the crank pin and bearing for pitting and scratches.

If the crank pin or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.



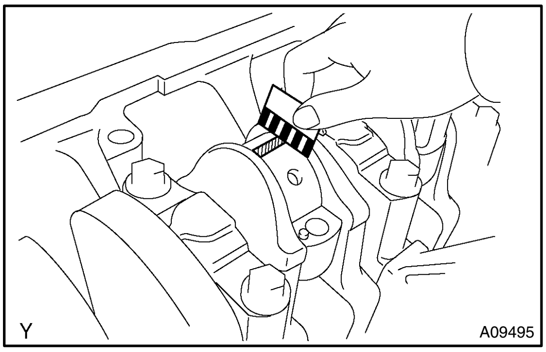
(f) Lay a strip of Plastigage across the crank pin.



(g) Install the connecting rod cap with the 2 bolts.
(See page EM–72)

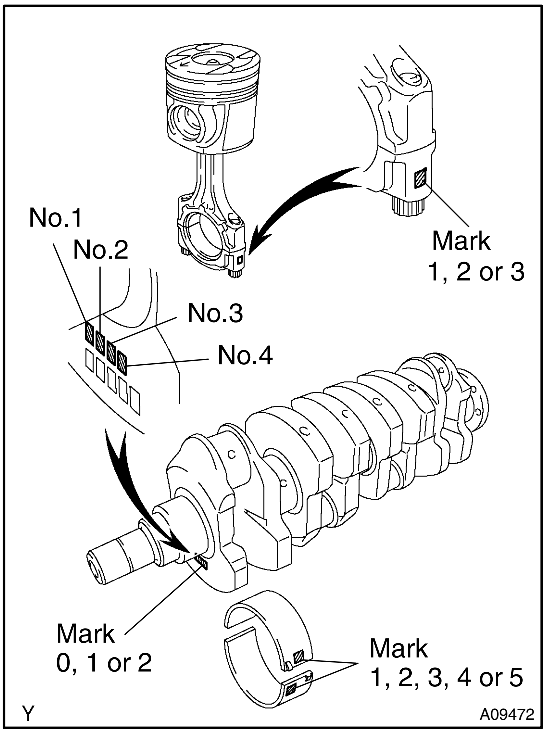
NOTICE:
Do not turn the crankshaft.

(h) Remove the 2 bolts, connecting rod cap and lower bearing. (See procedure (b) and (c))



(i) Measure the Plastigage at its widest point.
Standard oil clearance:
0.038 – 0.056 mm (0.0015 – 0.0022 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, replace the crankshaft.



HINT:
If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the crankshaft and connecting rod cap, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked ”1”, ”2”, ”3”, ”4” and ”5” accordingly.

	Number marked								
Connecting rod cap	1			2			3		
Crankshaft	0	1	2	0	1	2	0	1	2
Use bearing	1	2	3	2	3	4	3	4	5

EXAMPLE: Connecting rod cap ”2” + Crankshaft ”1”
= Total number 3 (Use bearing ”3”)

Reference

Connecting rod big end inside diameter:

Mark "1"	53.500 – 53.506 mm (2.1063 – 2.1065 in.)
Mark "2"	53.506 – 53.512 mm (2.1065 – 2.1068 in.)
Mark "3"	53.512 – 53.518 mm (2.1068 – 2.1070 in.)

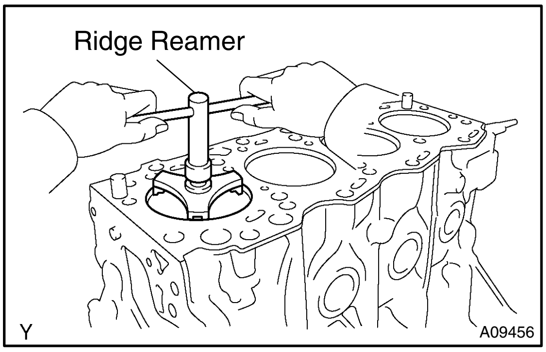
Crankshaft crank pin diameter:

Mark "0"	50.494 – 50.500 mm (1.9880 – 1.9882 in.)
Mark "1"	50.488 – 50.494 mm (1.9877 – 1.9880 in.)
Mark "2"	50.482 – 50.488 mm (1.9875 – 1.9877 in.)

Standard sized bearing center wall thickness:

Mark "1"	1.478 – 1.481 mm (0.0582 – 0.0583 in.)
Mark "2"	1.481 – 1.484 mm (0.0583 – 0.0584 in.)
Mark "3"	1.484 – 1.487 mm (0.0584 – 0.0585 in.)
Mark "4"	1.487 – 1.490 mm (0.0585 – 0.0587 in.)
Mark "5"	1.490 – 1.493 mm (0.0587 – 0.0588 in.)

(j) Completely remove the Plastigage.



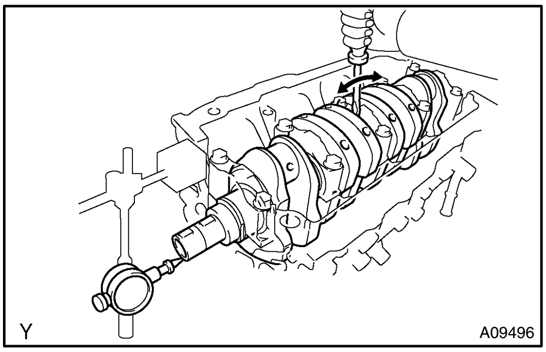
23. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

(a) Using a ridge reamer, remove all the carbon from the top of the cylinder.

(b) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

HINT:

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in the correct order.



24. CHECK CRANKSHAFT THRUST CLEARANCE

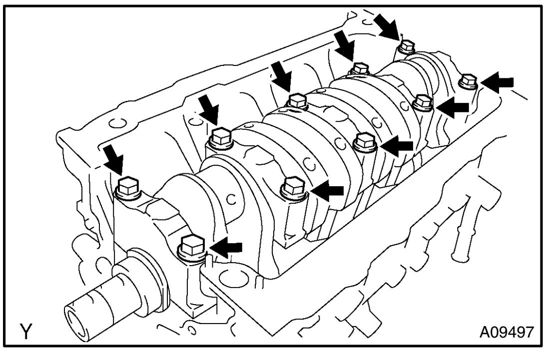
Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance:
0.040 – 0.240 mm (0.0016 – 0.0094 in.)
Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust washer as a set.

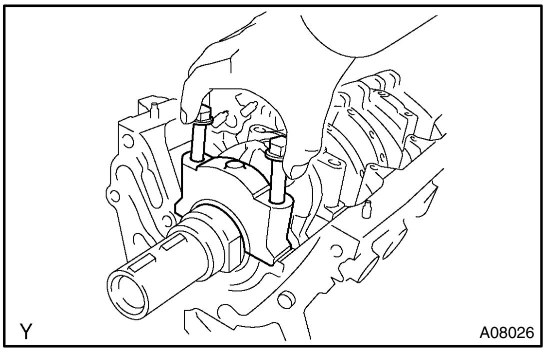
Thrust washer thickness:

STD	2.680 – 2.730 mm (0.1055 – 0.1075 in.)
O/S 0.125	2.743 – 2.793 mm (0.1080 – 0.1100 in.)
O/S 0.250	2.805 – 2.855 mm (0.1104 – 0.1124 in.)



25. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

(a) Uniformly loosen and remove the 10 main bearing cap bolts.



(b) Using the removed main bearing cap bolts, wiggle the cap back and forth, and remove the 5 main bearing caps, 5 lower bearings and 2 lower thrust washers (No.3 main bearing cap only).

HINT:

- Keep the lower bearing and main bearing cap together.
- Arrange the main bearing caps and lower thrust washers in the correct order.

(c) Lift out the crankshaft.

HINT:

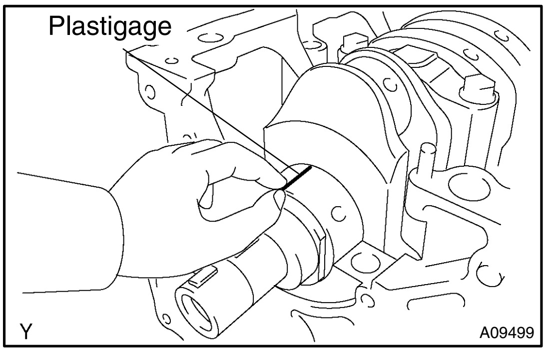
Keep the upper bearing and upper thrust washers together with the cylinder block.

(d) Clean each main journal and bearing.

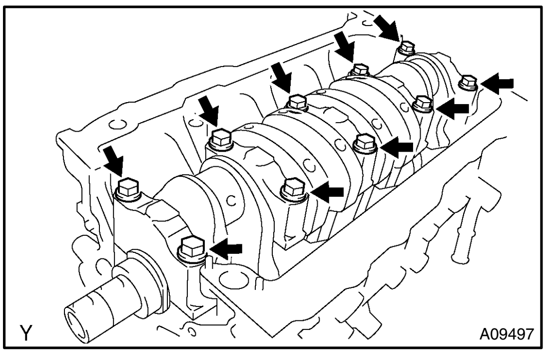
(e) Check each main journal and bearing for pitting and scratches.

If the journal or bearing is damaged, replace the bearings. If necessary, replace the crankshaft.

(f) Place the crankshaft on the cylinder block.



(g) Lay a strip of Plastigage across each journal.

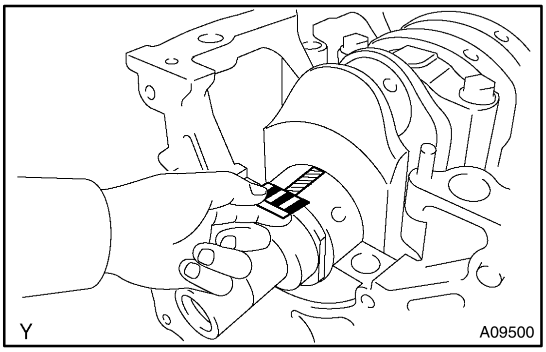


(h) Install the main bearing caps. (See page EM–72)

NOTICE:

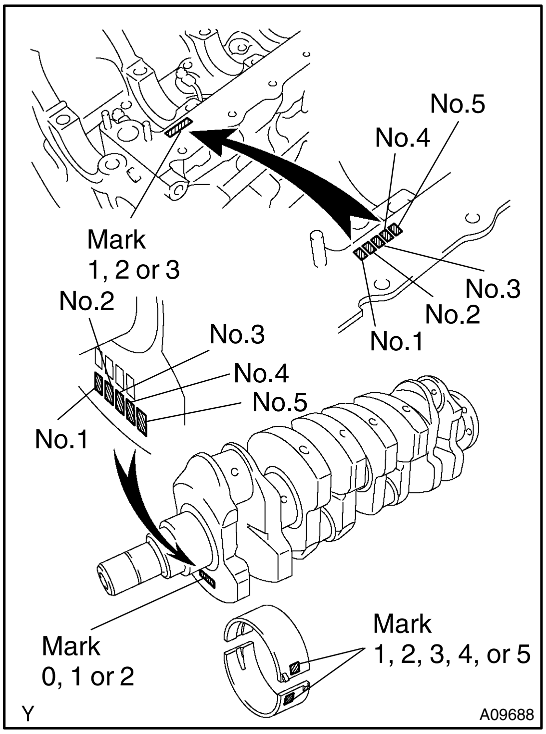
Do not turn the crankshaft.

(i) Remove the main bearing caps.
(See procedure (a) and (b) above)



(j) Measure the Plastigage at its widest point.
Standard oil clearance:
0.032 – 0.050 mm (0.0013 – 0.0020 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, replace the crankshaft.



HINT:
If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, select the correct bearing by adding together the numbers imprinted on the cylinder block and crankshaft, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked ”1”, ”2”, ”3”, ”4” and ”5” accordingly.

	Number marked								
Cylinder block	1			2			3		
Crankshaft	0	1	2	0	1	2	0	1	2
Use bearing	1	2	3	2	3	4	3	4	5

EXAMPLE: Cylinder block ”2” + Crankshaft ”1”
= Total number 3 (Use bearing ”3”)

Reference
Cylinder block main journal bore diameter:

Mark ”1”	61.000 – 61.006 mm (2.4016 – 2.4018 in.)
Mark ”2”	61.006 – 61.012 mm (2.4018 – 2.4020 in.)
Mark ”3”	61.012 – 61.018 mm (2.4020 – 2.4023 in.)

Crankshaft main journal diameter:

Mark ”0”	57.004 – 57.010 mm (2.2442 – 2.2445 in.)
Mark ”1”	56.998 – 57.004 mm (2.2440 – 2.2442 in.)
Mark ”2”	56.992 – 56.998 mm (2.2438 – 2.2440 in.)

Standard sized bearing center wall thickness:

Mark ”1”	1.976 – 1.979 mm (0.0778 – 0.0779 in.)
Mark ”2”	1.979 – 1.982 mm (0.0779 – 0.0780 in.)
Mark ”3”	1.982 – 1.985 mm (0.0780 – 0.0781 in.)
Mark ”4”	1.985 – 1.988 mm (0.0781 – 0.0783 in.)
Mark ”5”	1.988 – 1.991 mm (0.0783 – 0.0784 in.)

(k) Completely remove the Plastigage.

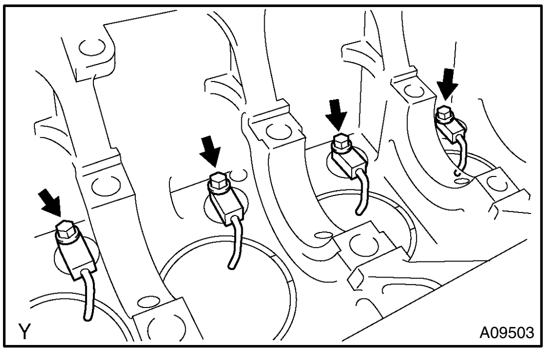
26. REMOVE CRANKSHAFT

(a) Lift out the crankshaft.

(b) Remove the 5 upper bearings and 2 upper thrust washers from the cylinder block.

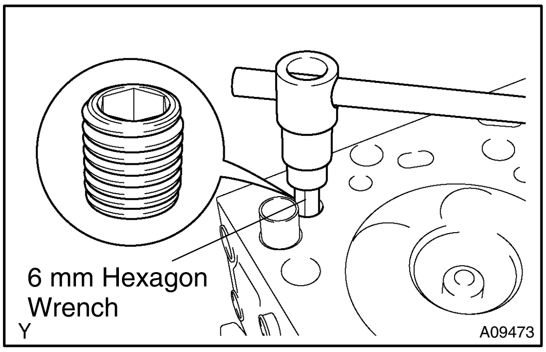
HINT:

Arrange the main bearing caps, bearings and thrust washers in the correct order.



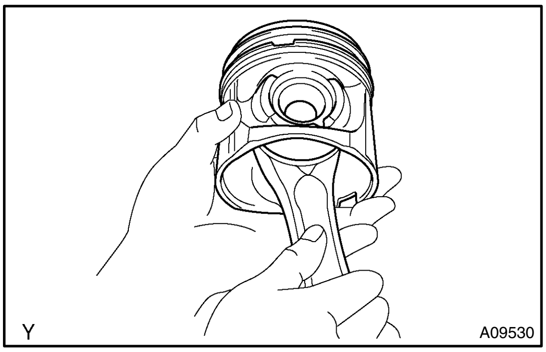
27. REMOVE OIL NOZZLES

Remove the bolt and oil nozzle. Remove the 4 oil nozzles.



28. REMOVE CYLINDER BLOCK OIL ORIFICE

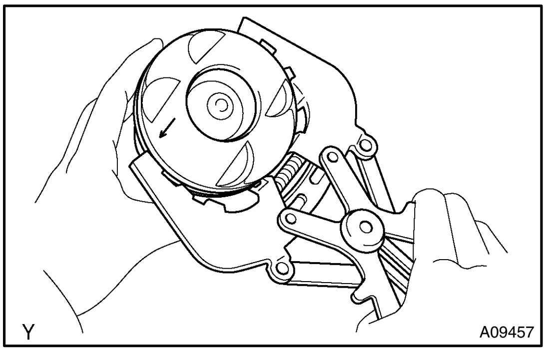
Using a 6 mm hexagon wrench, remove the oil orifice.



29. CHECK FIT BETWEEN PISTON AND PISTON PIN

Try to move the piston back and forth on the piston pin.

If any movement is felt, replace the piston and pin as a set.



30. REMOVE PISTON RINGS

(a) Using a piston ring expander, remove the No.1 piston ring, No.2 piston ring and oil ring.

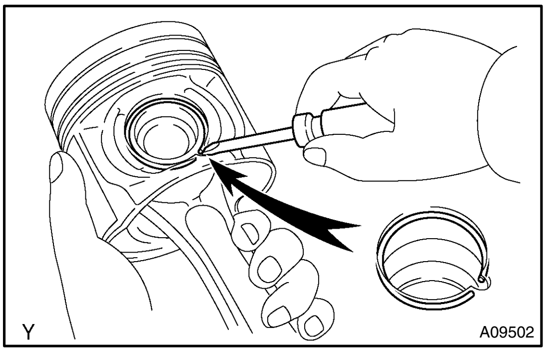
NOTICE:

Make the expansion of the piston ring as small as necessary.

(b) Remove the coil by hand.

HINT:

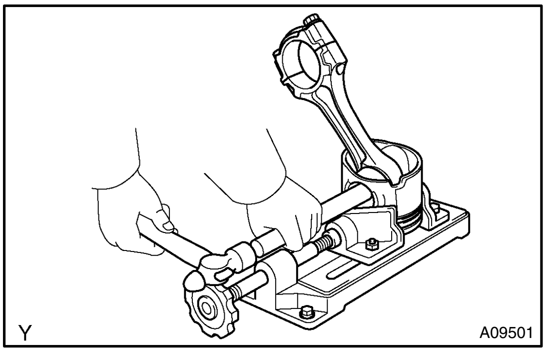
Arrange the piston rings in correct order only.



31. DISCONNECT CONNECTING ROD FROM PISTON

(a) Using a small screwdriver, pry off the snap rings from the piston.

(b) Gradually heat the piston to approx. 60˚C (140˚F).



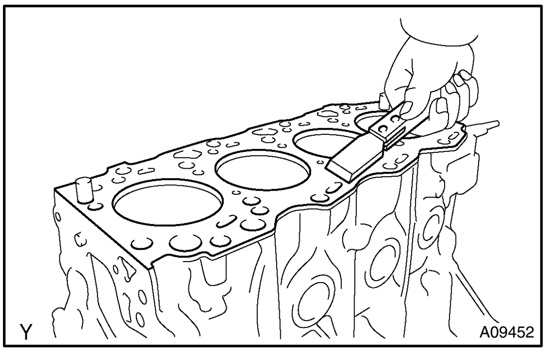
(c) Using a plastic–faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.

HINT:

- The piston and pin are a matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in the correct order.

EM13I–02

INSPECTION

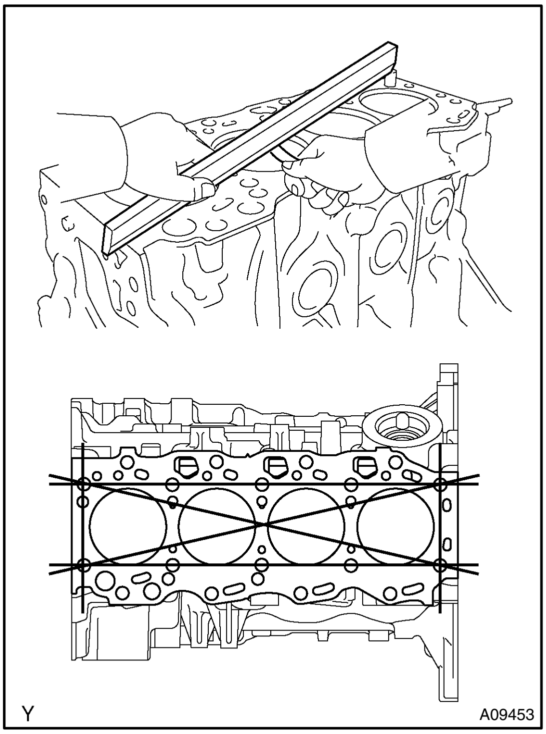


1. CLEAN CYLINDER BLOCK

Remove the gasket material.

(1) Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

(2) Using a soft brush and solvent, thoroughly clean the cylinder block.



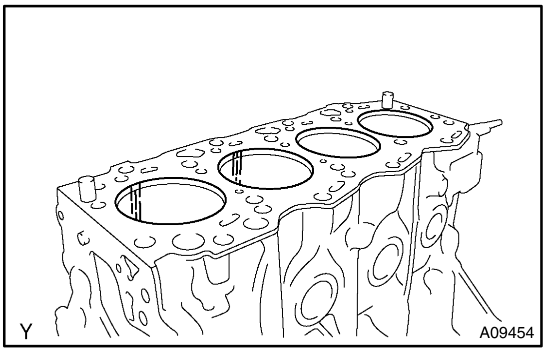
2. INSPECT CYLINDER BLOCK

(a) Inspect for flatness.

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

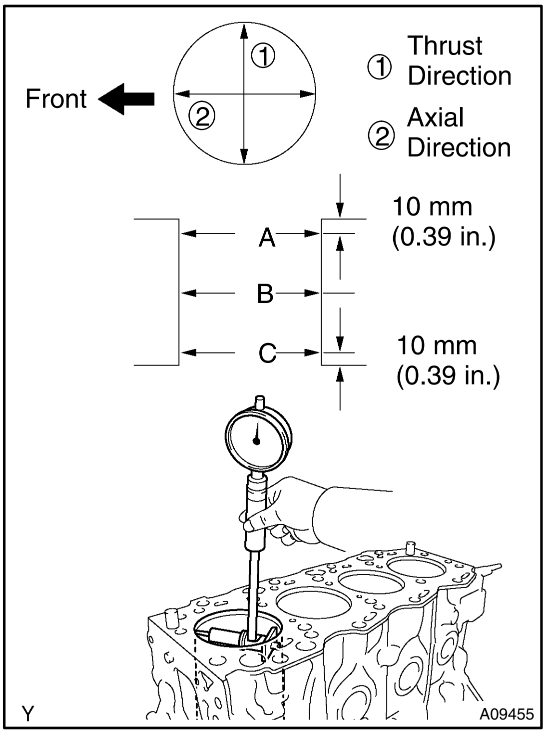
Maximum warpage: 0.05 mm (0.0020 in.)

If warpage is greater than maximum, replace the cylinder block.

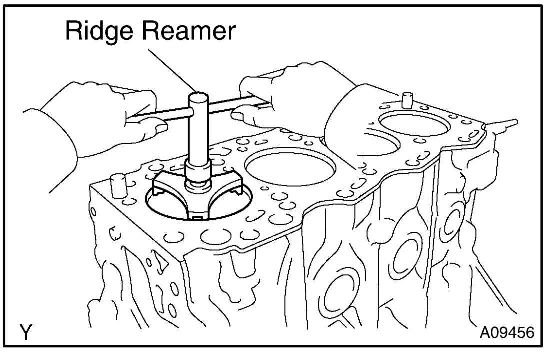


(b) Visually check the cylinder for vertical scratches.

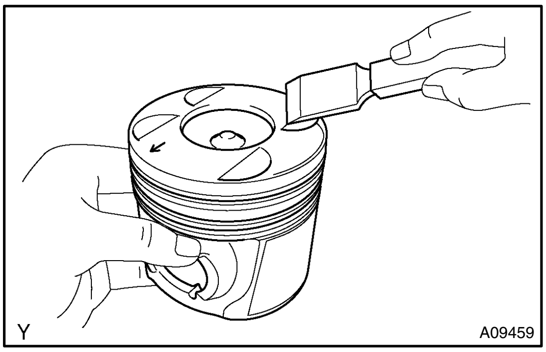
If deep scratches are found, replace the cylinder block.



(c) Inspect the cylinder bore diameter.
Using a cylinder gauge, measure the cylinder bore diameter at the positions A, B and C in the thrust and axial directions.
Standard diameter:
82.200 – 82.213 mm (3.2362 – 3.2367 in.)
Maximum diameter: 82.400 mm (3.2441 in.)
If the diameter is greater than maximum, replace the cylinder block.

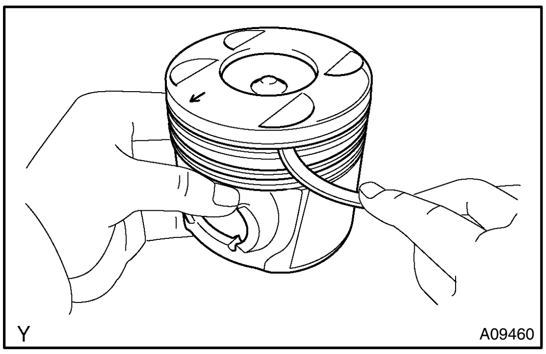


(d) Remove the cylinder ridge.
If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.

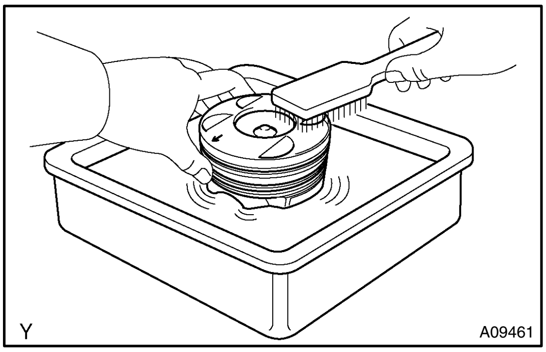


3. CLEAN PISTON

(a) Using a gasket scraper, remove the carbon from the piston top.



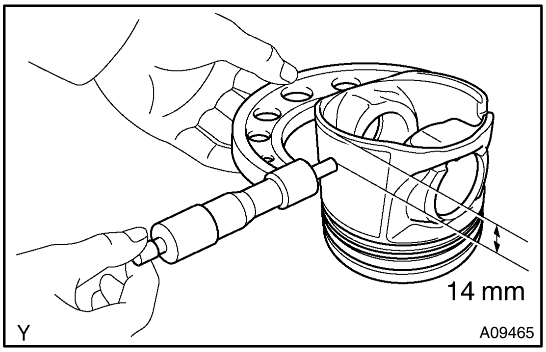
(b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.



(c) Using solvent and a brush, thoroughly clean the piston.

NOTICE:

Do not use a wire brush.



4. INSPECT PISTON AND PISTON RING

(a) Inspect the piston oil clearance.

(1) Using a micrometer, measure the piston diameter at a right angles to the piston pin center line, 14 mm (0.55 n.) below the skirt bottom edge.

Piston diameter:

82.148 – 82.182 mm (3.2341 – 3.2355 in.)

(2) Measure the cylinder bore diameter in the thrust directions. (See step 2)

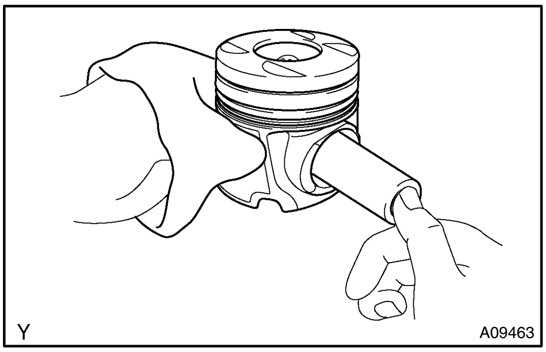
(3) Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance:

0.018 – 0.065 mm (0.0007 – 0.0026 in.)

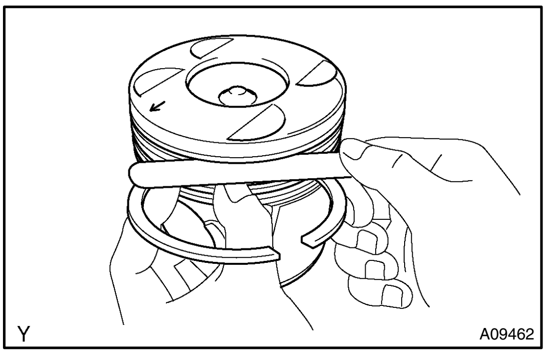
Maximum oil clearance: 0.14 mm (0.0055 in.)

If the oil clearance is greater than maximum, replace all the 4 pistons. If necessary, replace the cylinder block.



(b) Inspect the piston pin fit.

At 60 C° (140 °F), you should be able to push the piston pin into the piston pin hole with your thumb.



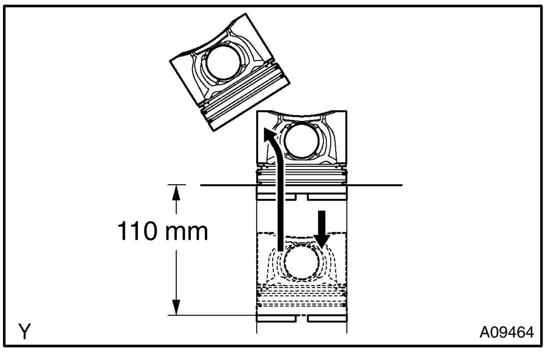
(c) Inspect the piston ring groove clearance.

Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.

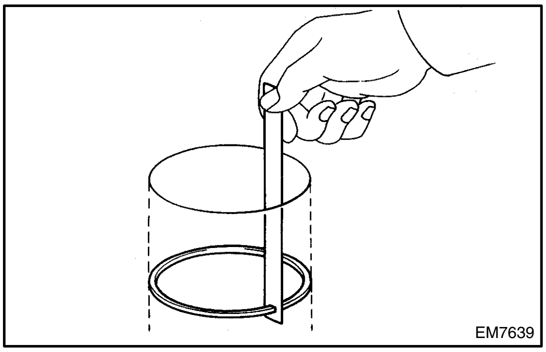
Ring groove clearance:

No.1	0.08 – 0.12 mm (0.0031 – 0.0047 in.)
No.2	0.06 – 0.10 mm (0.0024 – 0.0039 in.)
Oil	0.03 – 0.07 mm (0.0012 – 0.0028 in.)

If the clearance is not as specified, replace the piston.



(d) Inspect the piston ring end gap.
 (1) Insert the piston ring into the cylinder bore.
 (2) Using a piston, push the piston ring a little beyond the bottom of the ring travel, 110 mm (4.33 in.) from the top of the cylinder block.



 (3) Using a feeler gauge, measure the end gap.

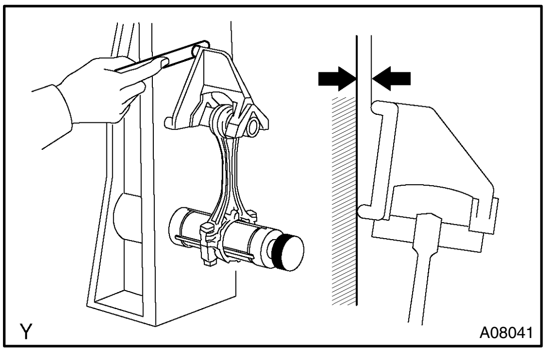
Standard end gap:

No.1	0.27– 0.43 mm (0.0106 – 0.0169 in.)
No.2	0.39– 0.58 mm (0.0154 – 0.0228 in.)
Oil	0.20– 0.44 mm (0.0079 – 0.0173 in.)

Maximum end gap:

No.1	0.82 mm (0.0323 in.)
No.2	1.00 mm (0.0394 in.)
Oil	0.90 mm (0.0354 in.)

If the end gap is greater than maximum, replace the piston ring. If the end gap is greater than maximum, even with a new piston ring, replace the cylinder block.



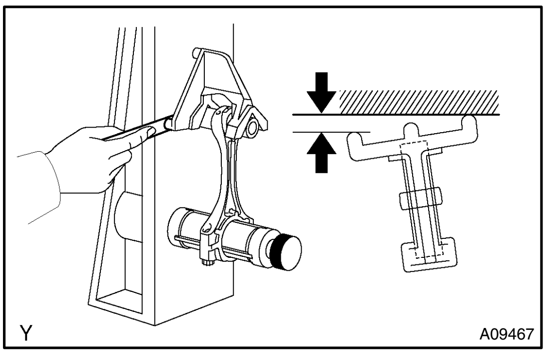
5. INSPECT CONNECTING ROD AND PISTON PIN

(a) Using a rod aligner and feeler gauge, check the connecting rod alignment.
 (1) Check for out–of–alignment.

Maximum out–of–alignment:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

If out–of–alignment is greater than maximum, replace the connecting rod assembly.

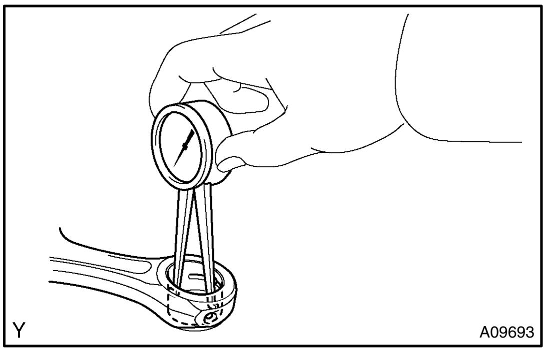


 (2) Check for twist

Maximum twist:

0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

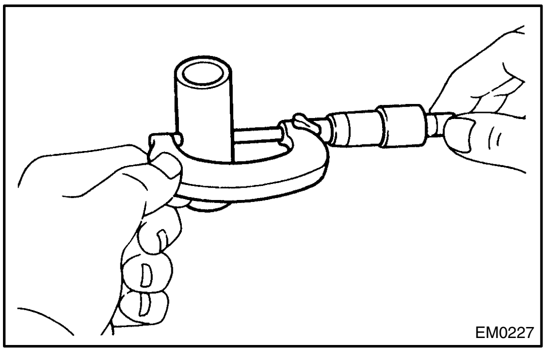
If twist is greater than maximum, replace the connecting rod assembly.



(b) Inspect the piston pin oil clearance.

(1) Using a caliper gauge, measure the inside diameter of the connecting rod bushing.

Bushing inside diameter:
31.015 – 31.027 mm (1.2211 – 1.2215 in.)



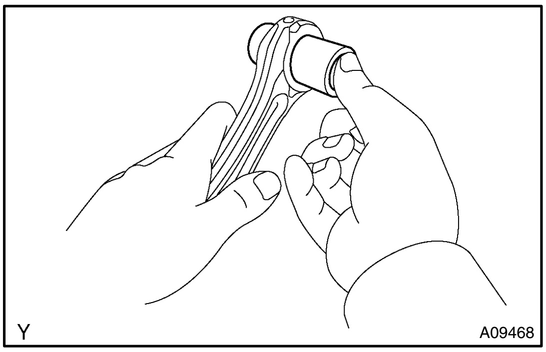
(2) Using a micrometer, measure the piston pin diameter.

Piston pin diameter:
31.000 – 31.012 mm (1.2205 – 1.2209 in.)

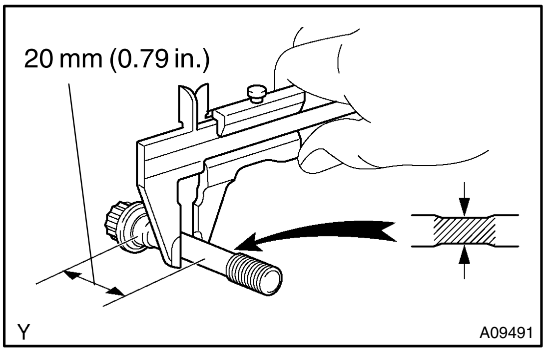
(3) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.

Standard oil clearance:
0.011 – 0.019 mm (0.0004 – 0.0007 in.)
Maximum oil clearance: 0.025 mm (0.0010 in.)

If the oil clearance is greater than maximum, replace the connecting rod. If necessary, replace the piston and piston pin as a set.



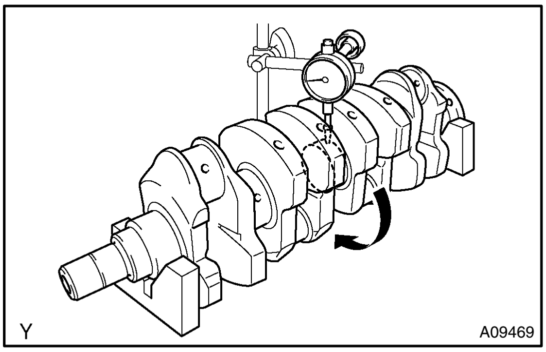
(c) Inspect the piston pin fit at normal room temperature.
Coat the piston pin with engine oil, and push it into the connecting rod with your thumb.



(d) Inspect the connecting rod bolt.
Using vernier calipers, measure the tension portion diameter.

Standard diameter:
8.2 – 8.3 mm (0.323 – 0.327 in.)
Minimum diameter: 8.0 mm (0.315 in.)

If the diameter is less than minimum, replace the connecting rod bolt.



6. **INSPECT CRANKSHAFT**

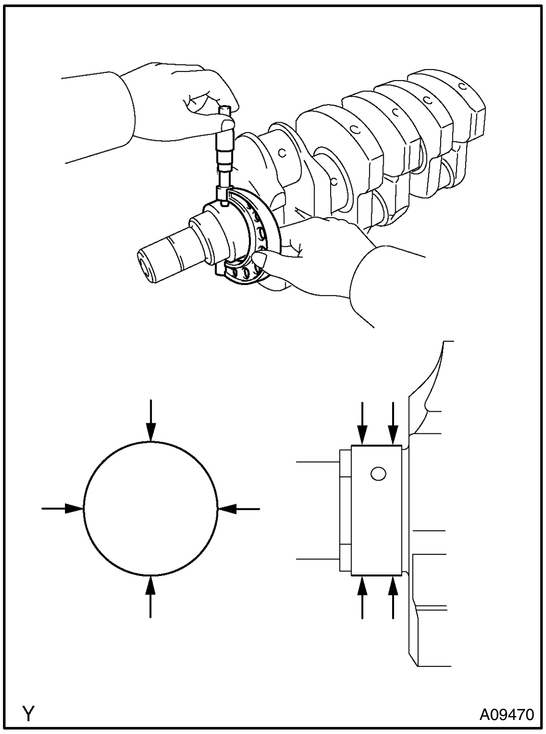
(a) Inspect for circle runout.

(1) Place the crankshaft on V–blocks.

(2) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.025 mm (0.0010 in.)

If the circle runout is greater than maximum, replace the crankshaft.



(b) Inspect the main journals and crank pins.

(1) Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:

56.992 – 57.010 mm (2.2438 – 2.2445 in.)

Crank pin diameter:

50.482 – 50.500 mm (1.9875 – 1.9882 in.)

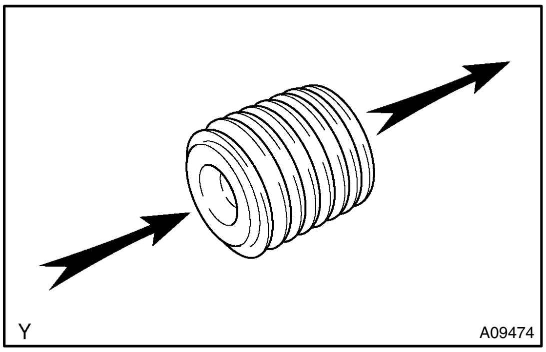
If the diameter is not as specified, replace the crankshaft.

(2) Check each main journal and crank pin for taper and out–of–round as shown.

Maximum taper and out–of–round:

0.01 mm (0.0004 in.)

If the taper and out–of–round is greater than maximum, replace the crankshaft.



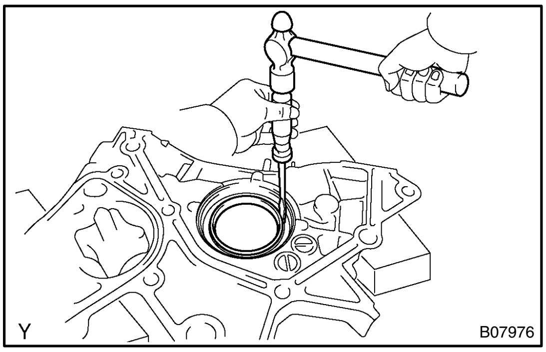
7. **INSPECT CYLINDER BLOCK OIL ORIFICE**

Check the oil orifice for clogging.

If necessary, replace the oil orifice.

EM13O–01

REPLACEMENT



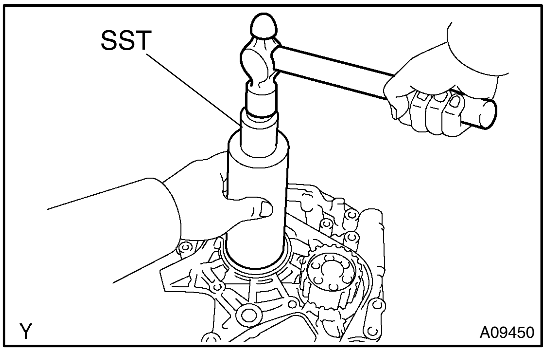
1. REPLACE CRANKSHAFT FRONT OIL SEAL

HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

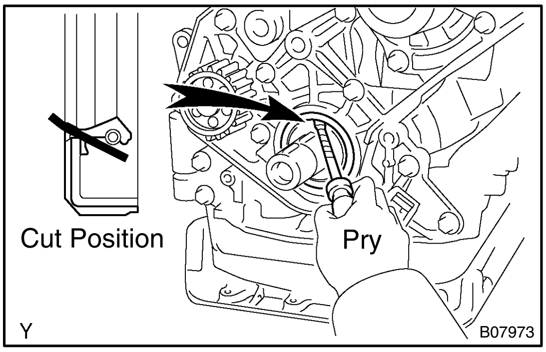
(a) If the oil pump is removed from the cylinder block:

(1) Using a screwdriver and hammer, tap out the oil seal.



(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the oil pump edge.

SST 09316–60011 (09316–00011, 09316–00021)



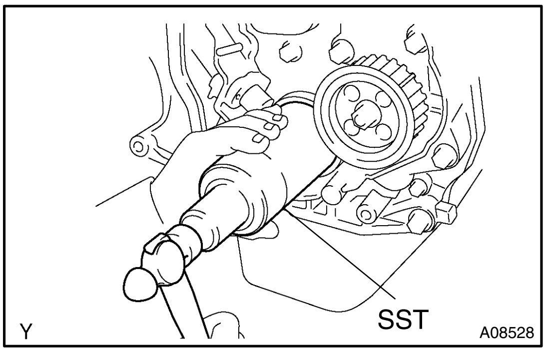
(b) If the oil pump is installed to the cylinder block:

(1) Using a knife, cut off the oil seal lip.

(2) Using a screwdriver, pry out the oil seal.

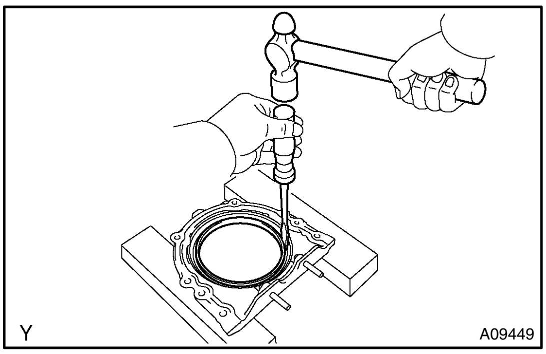
NOTICE:

Be careful not to damage the crankshaft. Tape the screwdriver tip.



(3) Using SST and a hammer, tap in the oil seal until its surface is flush with the oil pump edge.

SST 09316–60011 (09316–00011)



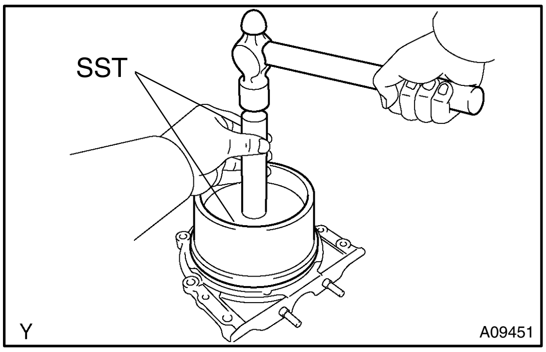
2. REPLACE CRANKSHAFT REAR OIL SEAL

HINT:

There are 2 methods ((a) and (b)) to replace the oil seal.

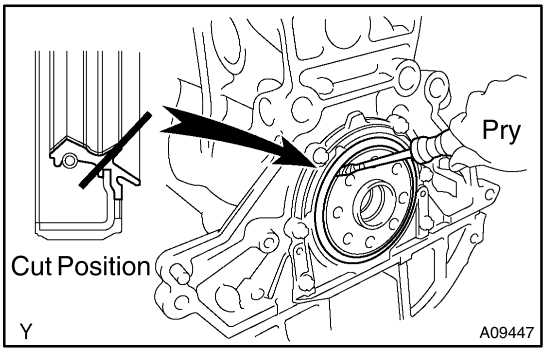
(a) If the rear oil seal retainer is removed from the cylinder block:

(1) Using a screwdriver and hammer, tap out the oil seal.



(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the rear oil seal retainer edge.

SST 09223–15030, 09950–70010 (09951–07100)



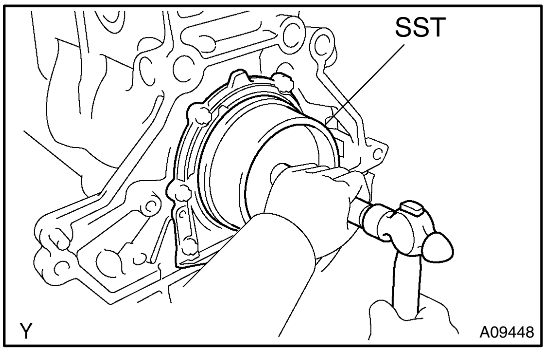
(b) If rear oil seal retainer is installed to cylinder block:

(1) Using a knife, cut off the oil seal lip.

(2) Using a screwdriver, pry out the oil seal.

NOTICE:

Be careful not to damage the crankshaft. Tape the screwdriver tip.



(3) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

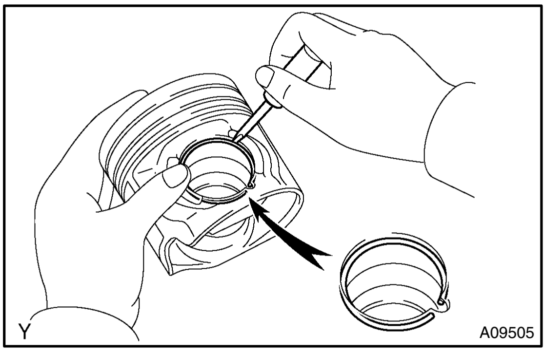
SST 09223–15030, 09950–70010 (09951–07100)

EM13J–01

REASSEMBLY

HINT:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O–rings and oil seals with new parts.

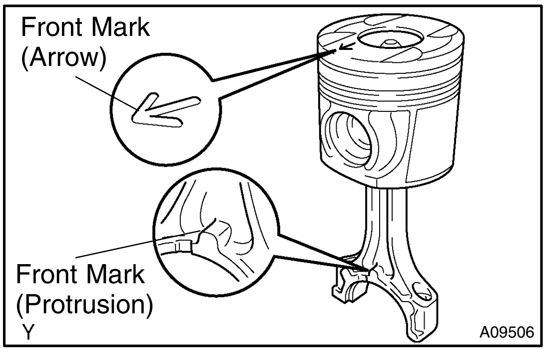


1. ASSEMBLE PISTON AND CONNECTING ROD

(a) Install a new snap ring on one side of the piston pin hole.

(b) Gradually heat the piston to 60˚C (140˚F).

(c) Coat the piston pin and piston hole of the piston with engine oil.

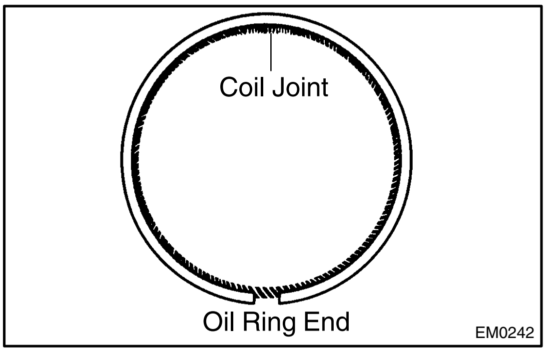


(d) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.

(e) Install a new snap ring on the other side of the piston pin hole.

2. INSTALL PISTON RINGS

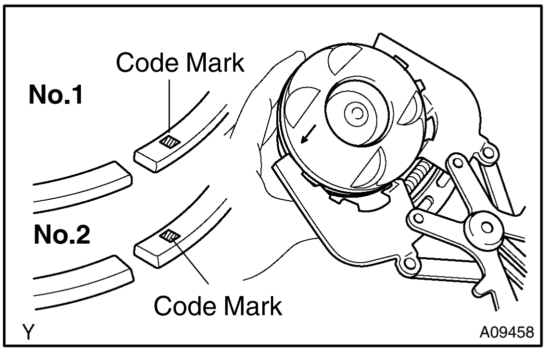
(a) Install the coil by hand.



(b) Using a piston ring expander, install the oil ring.

HINT:

Face the end gap of the oil ring in the opposite direction coil joint.



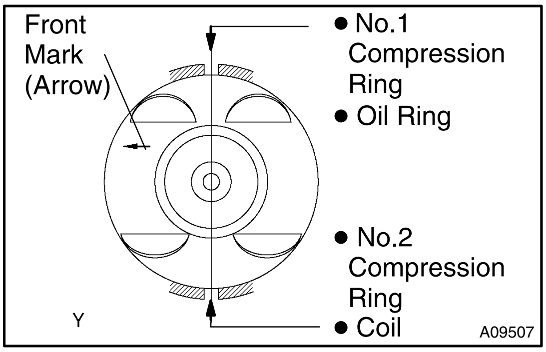
(c) Using a piston ring expander, install the No.2 and No.1 piston rings with the code mark facing upward.

Code mark:

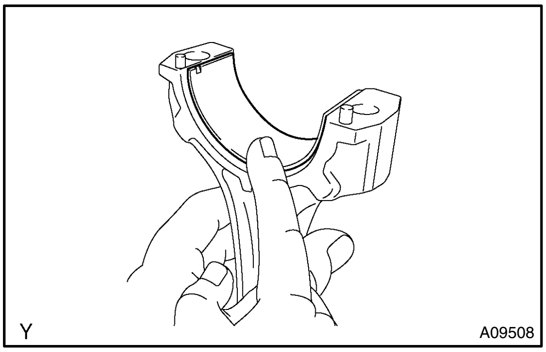
No.1	1T
No.2	2T

NOTICE:

Make the expansion of the piston ring as small as necessary.



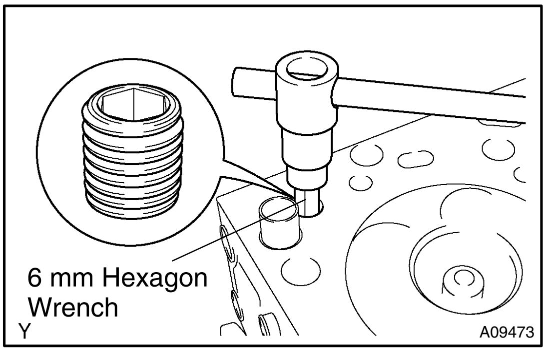
(d) Position the piston rings so that the ring ends are as shown.



3. INSTALL CONNECTING ROD BEARINGS

(a) Align the bearing claw with the groove of the connecting rod or connecting cap.

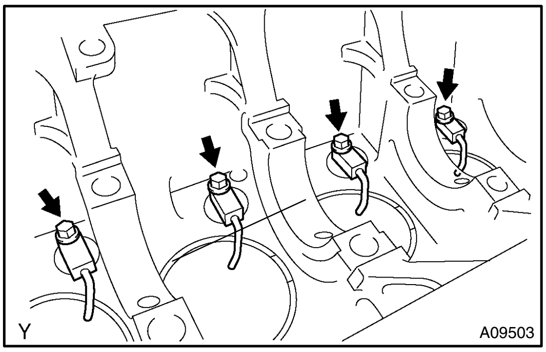
(b) Install the bearings in the connecting rod and connecting rod cap.



4. INSTALL CYLINDER BLOCK OIL ORIFICE

Using a 6 mm hexagon wrench, install the oil orifice.

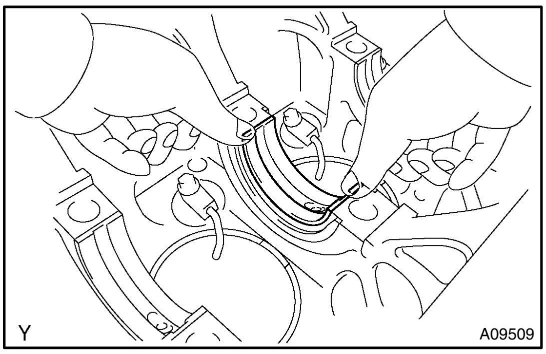
Torque: 9 N·m (90 kgf·cm, 78 in.·lbf)



5. INSTALL OIL NOZZLES

Install the oil nozzle with the bolt. Install the 4 oil nozzles.

Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)

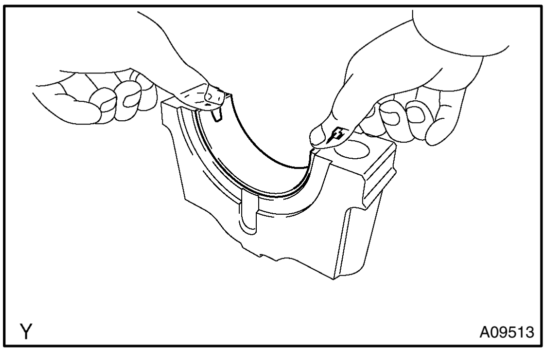


6. INSTALL MAIN BEARINGS

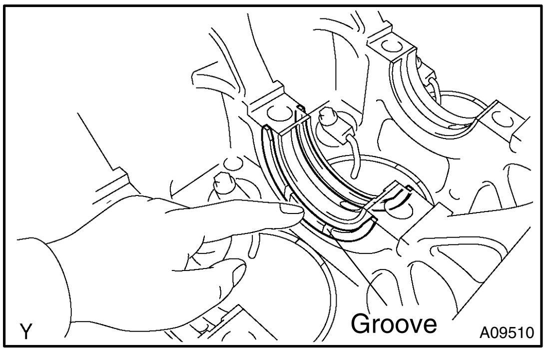
HINT:

Upper bearings have an oil groove and oil holes; lower bearings do not.

(a) Align the bearing claw with the claw groove of the cylinder block, and push in the 5 upper bearings.



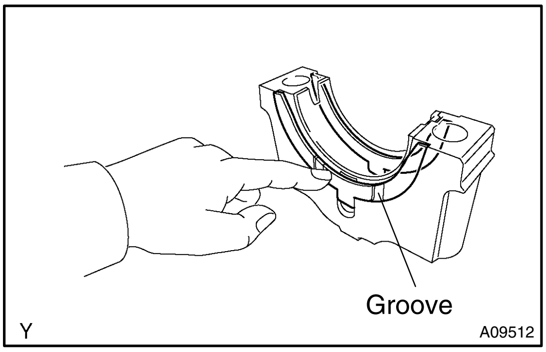
(b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.



7. INSTALL UPPER THRUST WASHERS

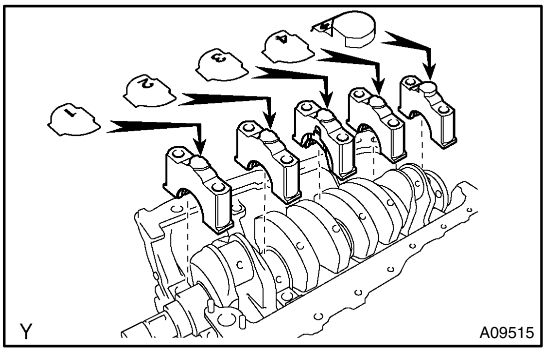
Install the 2 thrust washers under the No.3 journal position of the cylinder block with the oil grooves facing outward.

8. PLACE CRANKSHAFT ON CYLINDER BLOCK



9. INSTALL MAIN BEARING CAPS AND LOWER THRUST WASHERS

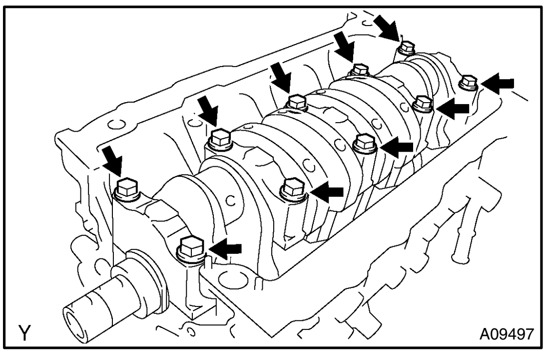
(a) Install the 2 thrust washers on the No.3 bearing cap with the oil grooves facing outward.



(b) Install the 5 main bearing caps in their proper locations.

HINT:

Each bearing cap has a number and a front mark.



(c) Apply a light coat of engine oil on the threads and under the heads of the main bearing cap bolts.

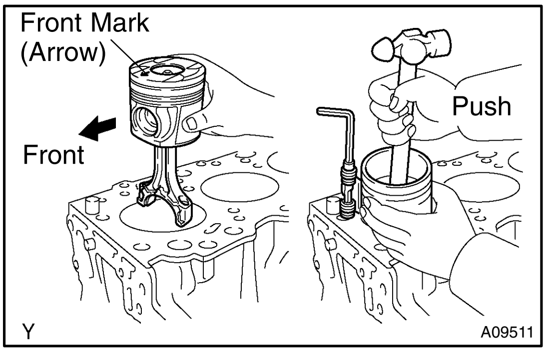
(d) Install and uniformly tighten the 10 bolts of the main bearing cap in several passes.

Torque: 115 N·m (1,150 kgf·cm, 85 ft·lbf)

(e) Check that the crankshaft turns smoothly.

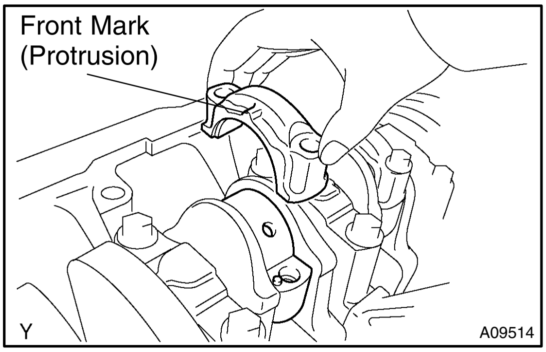
10. CHECK CRANKSHAFT THRUST CLEARANCE

(See page EM–56)



11. INSTALL PISTON AND CONNECTING ROD ASSEMBLES

Using a piston ring compressor, push the correct numbered piston and connecting rod assemblies into each cylinder with the front mark of the piston facing forward.



12. PLACE CONNECTING ROD CAP ON CONNECTING ROD

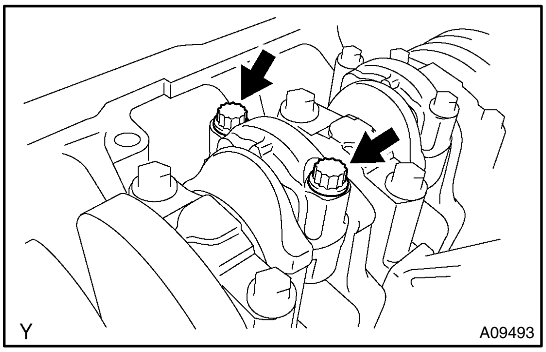
(a) Match the numbered connecting rod cap with the connecting rod.

(b) Install the connecting rod cap with the front mark facing forward.

13. INSTALL CONNECTING ROD CAP BOLTS

HINT:

- The cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any of the connecting rod cap bolts is broken or deformed, replace it.

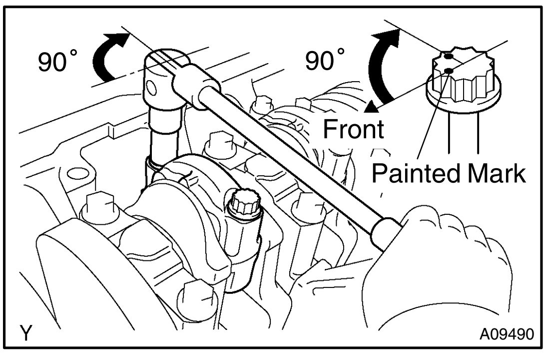


(a) Apply a light coat of engine oil on the threads and under the heads of the of the connecting rod cap bolts.

(b) Install and alternately tighten the 2 cap bolts in several passes.

Torque: 30 N·m (300 kgf·cm, 22 ft·lbf)

If any of the cap bolts does not meet the torque specification, replace the connecting rod cap bolts.



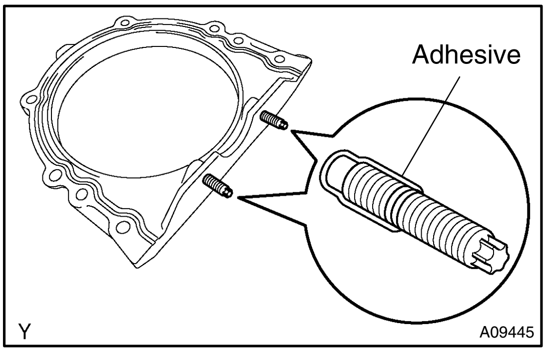
(c) Mark the front of the cap bolt with the paint.

(d) Relight the cap bolts 90° as shown.

(e) Check that the painted mark is now at a 90° angle to the front.

(f) Check that the crankshaft turns smoothly.

14. CHECK CONNECTING ROD THRUST CLEARANCE (See page EM–56)



15. INSTALL STUD BOLT OF REAR OIL SEAL RETAINER

HINT:

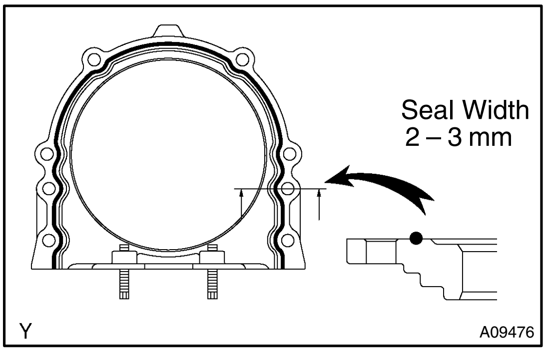
When using a new rear oil seal retainer, stud bolt must be installed.

Apply adhesive to the threads of the stud bolt and install it.

Adhesive: Part No. 08833–00070, THREE BOND 1324 or equivalent

16. INSTALL REAR OIL SEAL RETAINER

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil seal retainer and cylinder block.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.



(b) Apply seal packing to the oil seal retainer as shown in the illustration.

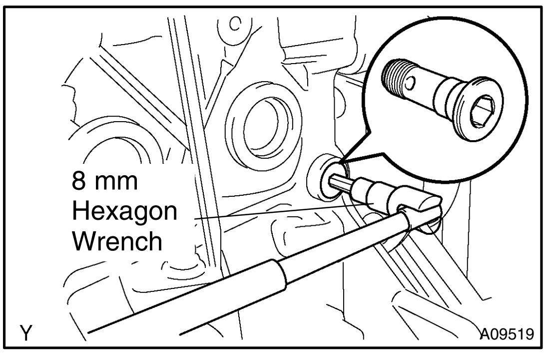
Seal packing: Part No. 08826–00080 or equivalent
- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install the oil seal retainer with the 6 bolts. Uniformly tighten the bolt in several passes.

Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)

17. INSTALL OIL PUMP (See page LU–14)

18. INSTALL NO.1 OIL PAN, OIL STRAINER AND NO.2 OIL PAN (See page LU–14)



19. INSTALL OIL JET PRESSURE VALVE

Using an 8 mm hexagon wrench, install a new gasket and the pressure valve.

Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)

20. INSTALL NO.1 FUEL PIPE

Install the fuel pipe with the 3 bolts.

Torque:

8.8 N·m (90 kgf·cm, 78 in.·lbf) for 12 mm head

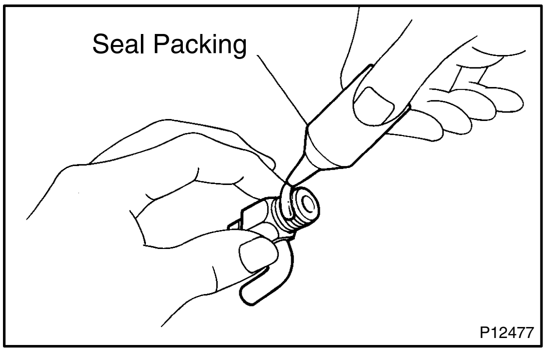
20.5 N·m (210 kgf·cm, 15 ft·lbf) for 14 mm head

21. INSTALL OIL PRESSURE SWITCH (See page LU–1)

22. INSTALL NO.1 OIL COOLER PIPE

Install 2 new gaskets and the oil cooler pipe with the union bolt.

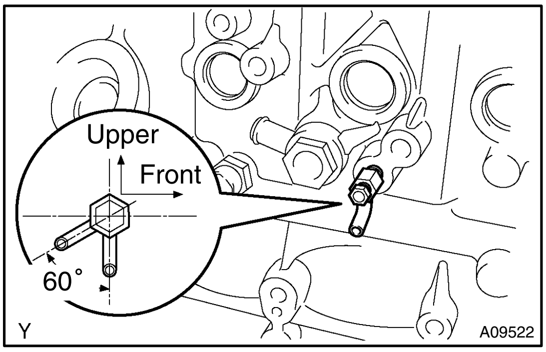
Torque: 56.4 N·m (575 kgf·cm, 42 ft·lbf)



23. INSTALL ENGINE COOLANT DRAIN UNION

(a) Apply seal packing to 2 or 3 threads.

Seal packing: Part No. 08826–00100 or equivalent

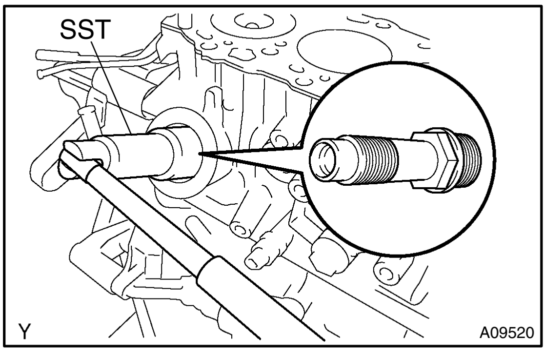


(b) Install the drain union.

Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)

HINT:

After applying the specified torque, if the drain pipe of the drain union is not at the position shown in the illustration, rotate the drain union further to clockwise and make the drain pipe face downward.



24. INSTALL OIL COOLER UNION BOLT

Using SST, install the union bolt.

SST 09229–55010

Torque: 171 N·m (1,745 kgf·cm, 126 ft·lbf)

25. INSTALL OIL COOLER (See page LU–21)

26. REMOVE ALTERNATOR BRACKET AND DRIVE BELT ADJUSTING BAR

(a) Install the alternator bracket with the 3 bolts.

Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)

(b) Install the adjusting bar with the 2 bolts.

Torque: 31.4 N·m (320 kgf·cm, 23 ft·lbf)

27. INSTALL ALTERNATOR

28. INSTALL THERMOSTAT AND WATER INLET (See page CO–12)

29. INSTALL WATER PUMP (See page CO–8)

30. INSTALL SUPPLY PUMP (See page FU–18)

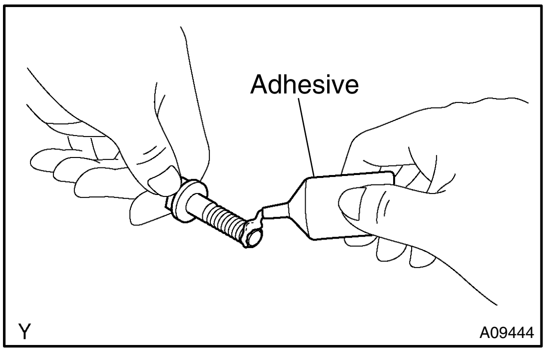
31. INSTALL CYLINDER HEAD (See page EM–46)

32. INSTALL TIMING BELT AND PULLEYS (See page EM–18)

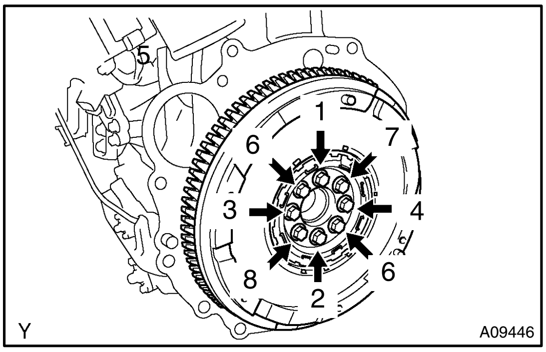
33. DISCONNECT ENGINE FROM ENGINE STAND

34. INSTALL REAR END PLATE

35. INSTALL FLYWHEEL



(a) Apply adhesive to 2 or 3 threads of the bolt end.
Adhesive: Part No. 08833–00070, THREE BOND 1324 or equivalent



(b) Install and uniformly tighten the 8 bolts in several passes and in the sequence shown.
Torque: 88.2 N·m (900 kgf·cm, 65 ft·lbf)

TURBOCHARGING

TROUBLESHOOTING

TC00N–02

PROBLEM SYMPTOMS TABLE

HINT:
Before troubleshooting the turbocharger, first check the engine itself. (valve clearance, engine compression, etc.)

INSUFFICIENT ACCELERATION, LACK OF POWER OR EXCESSIVE FUEL CONSUMPTION

Possible Cause	Check Procedure and Correction Method	See page
5. Turbocharging pressure too low	Check turbocharging pressure.	TC–4
6. Restricted intake system	Check intake air system, and repair or replace parts as necessary.	EM–1 EM–28
7. Leak in intake air system	Check intake air system, and repair or replace parts as necessary.	EM–1 EM–28
8. Restricted exhaust system	Check exhaust system, and repair or replace parts as necessary.	EM–28 EC–10
9. Leak in exhaust system	Check exhaust system, and repair or replace parts as necessary.	EM–28 EC–10
10.Erratic turbocharger operation	Check rotation of turbine shaft, and replace bearing housing if necessary. Check axial and radial plays of turbine shaft, and replace bearing housing if necessary.	TC–12

ABNORMAL NOISE

Possible Cause	Check Procedure and Correction Method	See page
1. Turbocharging heat insulator resonance	Check for loose, improperly installed or deformed insulator nuts and bolt, and repair or replace as necessary.	TC–7
2. Exhaust pipe leaking or vibrating	Check for deformed exhaust pipe, loose bolts or damaged gasket, and repair or replace as necessary.	EC–10
3. Erratic turbocharger operation	Check rotation of turbine shaft, and replace bearing housing if necessary. Check axial and radial plays of turbine shaft, and replace bearing housing if necessary.	TC–12

EXCESSIVE OIL CONSUMPTION OR WHITE EXHAUST

NOTICE:
Some oil mist in blowby from PCV is normal. Do not mistake it for oil leak from turbocharger.

Possible Cause	Check Procedure and Correction Method	See page
Faulty turbocharger oil seal	Check for oil leakage in exhaust system. • Remove exhaust manifold converter from turbocharger, and check for excessive carbon deposits on turbine wheel. Excessive carbon deposits indicate a faulty turbocharger. Check for oil leakage in intake air system. • Check for axial and radial plays of turbine shaft, and replace bearing housing if necessary.	TC–12

TURBOCHARGER

TC00O–02

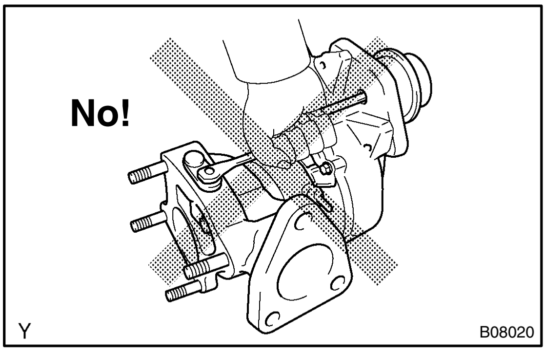
PRECAUTION

MAINTENANCE PRECAUTION

(a) Do not stop the engine immediately after pulling a trailer or after high speed or uphill driving. Idle the engine for 20 – 120 seconds, depending on how hard the vehicle has been driven.

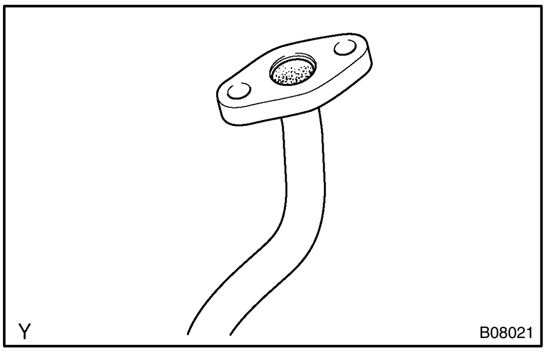
(b) Avoid sudden acceleration or racing immediately after starting a cold engine.

(c) If the turbocharger is found to be defective and must be replaced, check for the cause, and repair or replace these items as necessary:
- Engine oil level and quality
- Conditions under which the turbocharger was used
- Oil lines leading to the turbocharger



(d) Use caution when removing and reinstalling the turbocharger assembly do not drop it or bang it against anything or grasp it by easily–deformed parts, such as the actuator or push rod, when moving it.

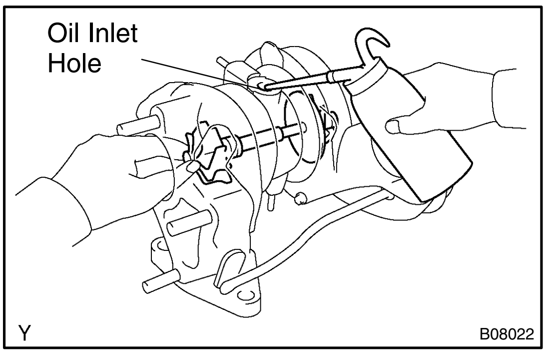
(e) Before removing the turbocharger, plug the intake and exhaust ports and oil inlet to prevent entry of dirt or other foreign material.



(f) If replacing the turbocharger, check for accumulation of sludge particles in the oil pipe, and if necessary, replace the oil pipe.

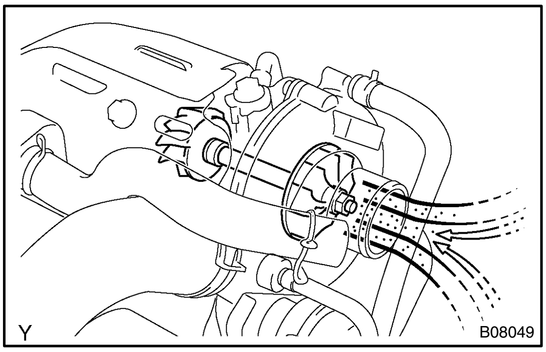
(g) Completely remove the gasket adhered to the lubrication oil pipe frange and turbocharger oil frange.

(h) When replacing the bolts or nuts, use only authorized replacement parts to prevent breakage or deformation.



(i) If replacing the turbocharger, put 20 cm^3 (1.2 cu in.) of fresh oil into the turbocharger oil inlet hole and turn the turbine wheel by hand to spread oil to the bearing.

(j) If overhauling or replacing the engine, cut the fuel supply after reassembly and crank the engine for 30 seconds to distribute oil throughout the engine then allow the engine to idle for 60 seconds.



(k) If the engine is running without the air cleaner, case cover and hose, entry of foreign particles will damage the wheels which run at extremely high speed.

TC00P–02

ON–VEHICLE INSPECTION

1. INSPECT INTAKE AIR SYSTEM

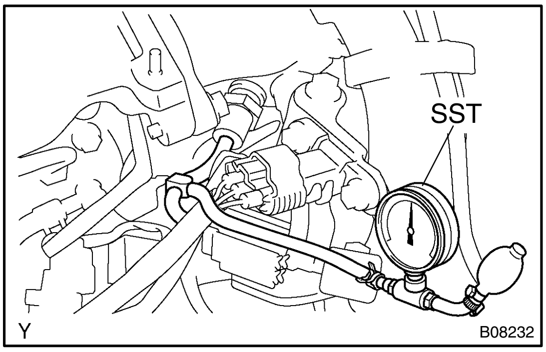
Check for leakage or clogging between the air cleaner housing and turbocharger inlet and between the turbocharger outlet and cylinder head.

- Clogged air cleaner...Clean or replace element
- Hoses collapsed or deformed...Repair or replace
- Leakage from connections...Check each connection and repair
- Cracks in components...Check and replace

2. INSPECT EXHAUST SYSTEM

Check for leakage or clogging between the cylinder head and turbocharger inlet and between the turbocharger outlet and exhaust pipe.

- Deformed components...Repair or replace
- Foreign material in passages...Remove
- Leakage from components...Repair or replace
- Cracks in components...Check and replace



3. CHECK TURBOCHARGING PRESSURE

(a) Warm up engine.

(b) Using a 3–way connector, connect SST (turbocharger pressure gauge) to the hose leading to the intake air connector.
SST 09992 – 00242

(c) Press in the clutch pedal, then press the accelerator pedal down as far as it will go. Measure the turbocharging pressure at maximum speed (5,100 – 5,250 rpm).
Standard pressure:
58.5 – 78.9 kPa (0.60 – 0.80 kgf/cm^2, 8.5 – 11.4 psi)

If the pressure is less than specified, check the intake air and exhaust systems for leakage.
If there is no leakage, check the turbocharger.
If the pressure is above specification, check if the actuator hose it disconnected or cracked. If not, check the turbocharger.

4. INSPECT TURBINE SHAFT ROTATION (See page TC–12)

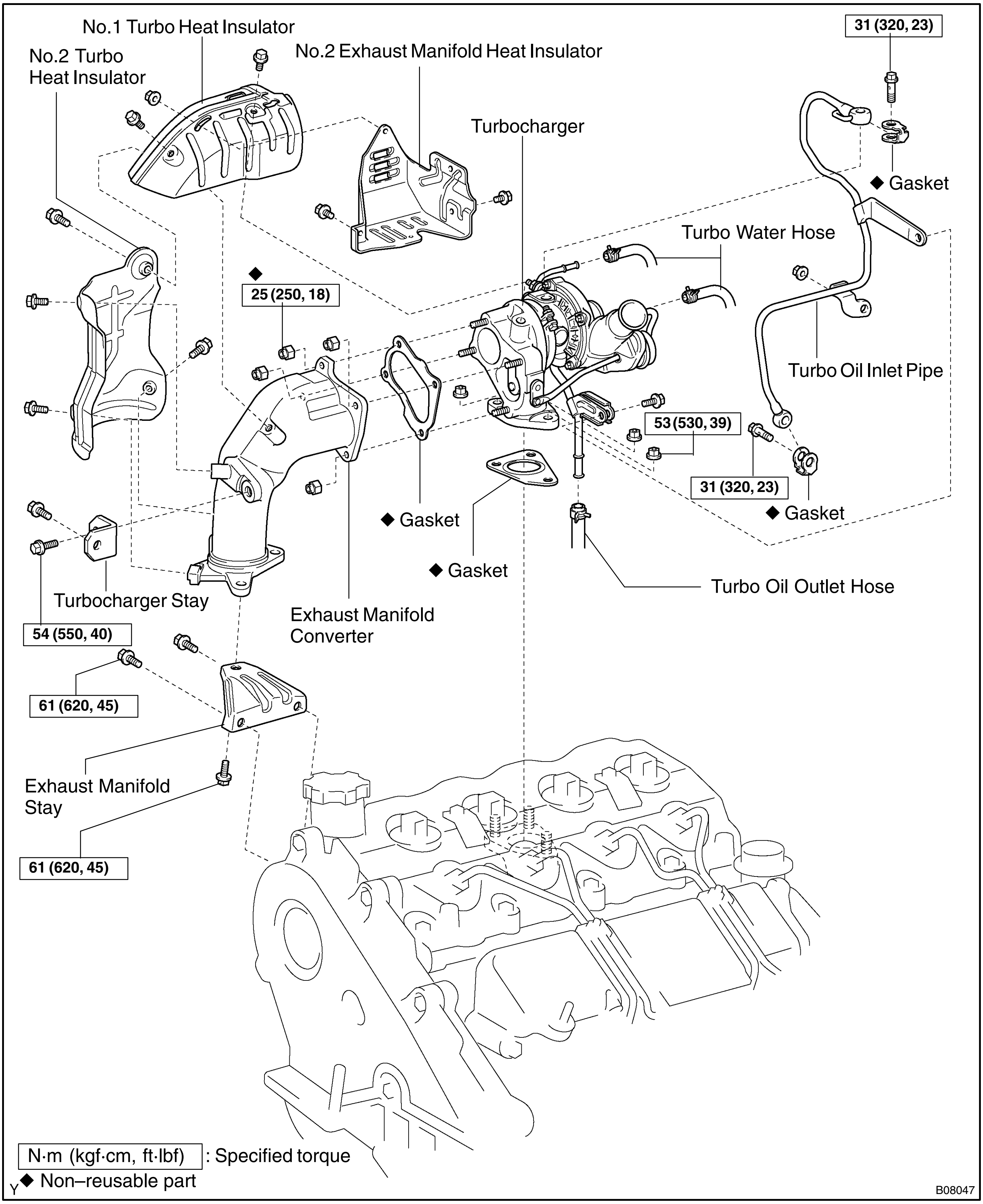
5. INSPECT ACTUATOR OPERATION (See page TC–12)

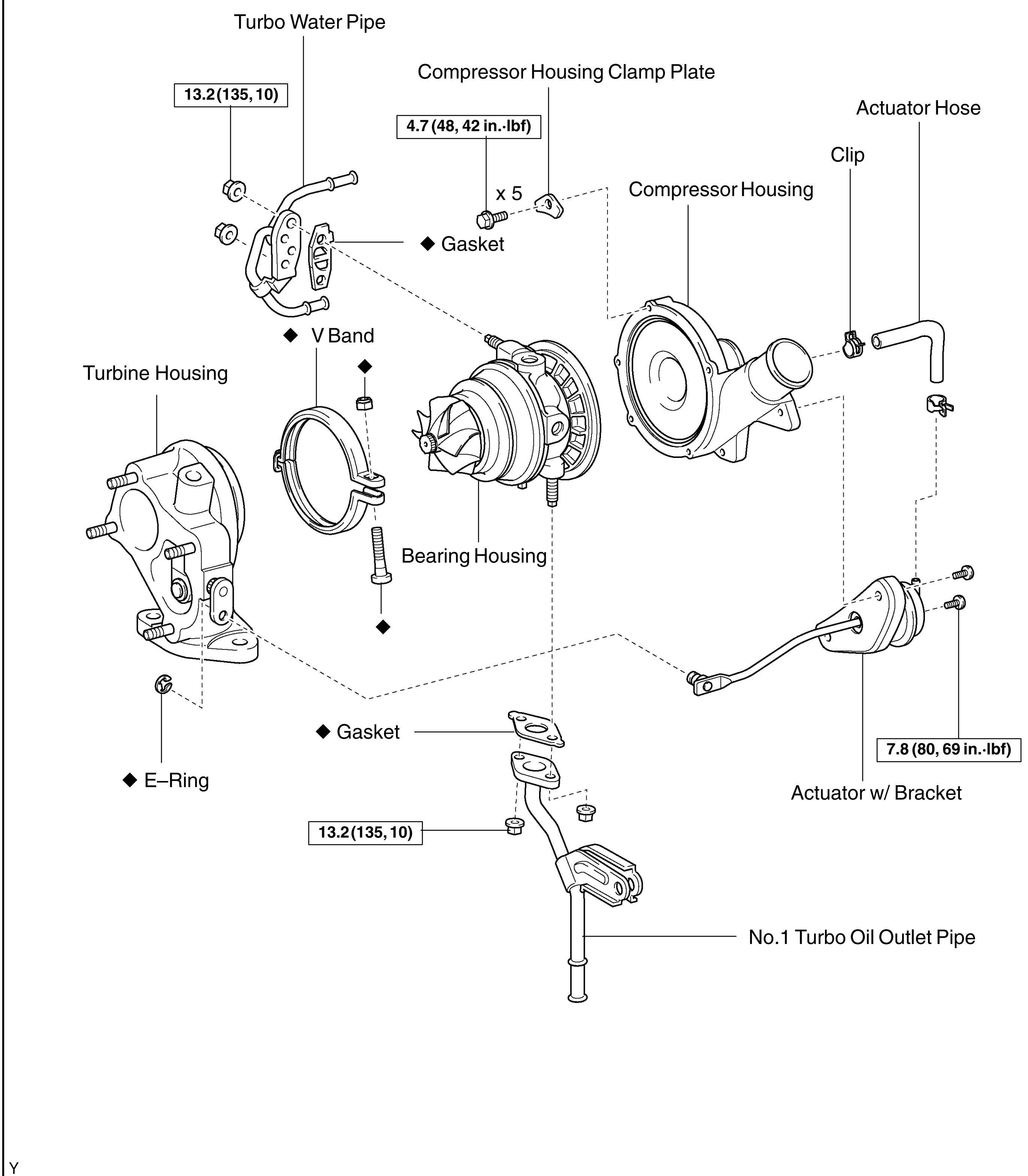
6. INSPECT TURBO PRESSURE SENSOR (See page TC–21)

7. INSPECT VSV FOR TURBOCHARGING PRESSURE CONTROL (See page TC–24)

TC00Q–02

COMPONENTS





N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part

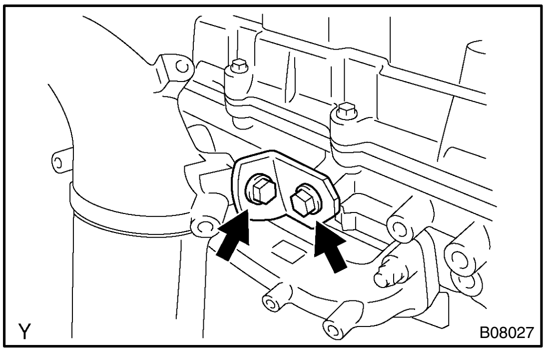
TC02S–01

REMOVAL

1. DRAIN ENGINE COOLANT

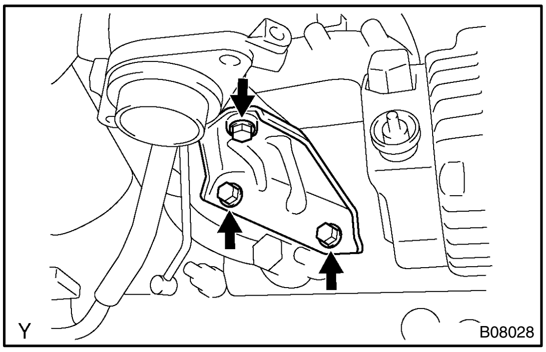
2. REMOVE HEAT INSULATORS

(a) Remove the 4 bolts and No.2 turbo heat insulator.
(b) Remove the 2 bolts, nut and No.1 turbo heat insulator.
(c) Remove the 2 bolts and No.2 exhaust manifold heat insulator.



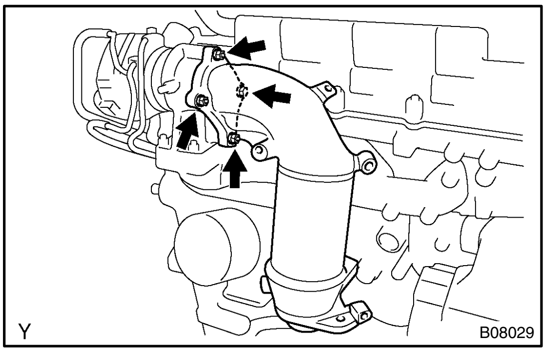
3. REMOVE TURBOCHARGER STAY

Remove the 2 bolts and turbocharger stay.



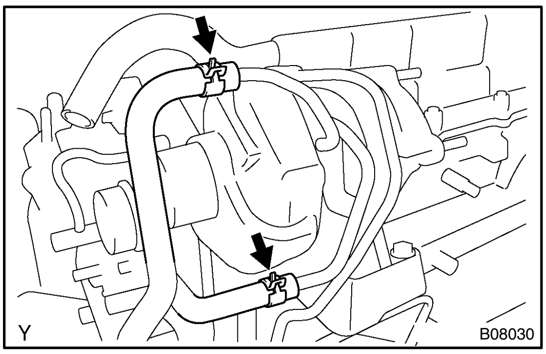
4. REMOVE EXHAUST MANIFOLD STAY

Remove the 3 bolts and exhaust manifold stay.



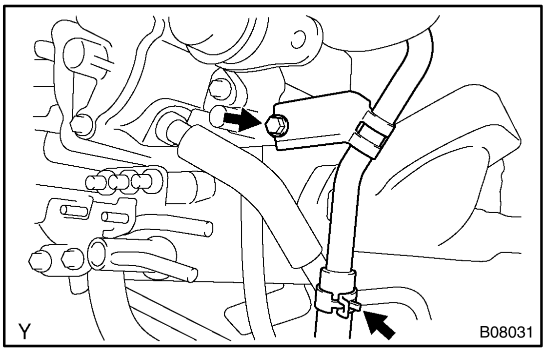
5. REMOVE EXHAUST MANIFOLD CONVERTER

Remove the 4 nuts, exhaust manifold converter and gasket.



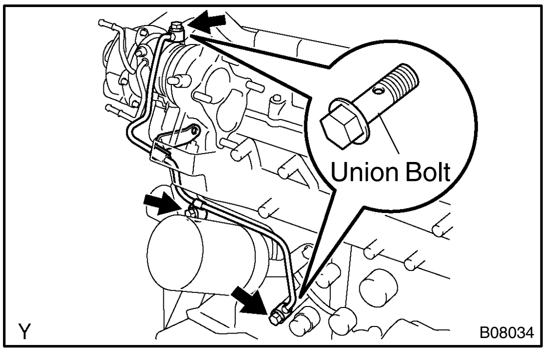
6. REMOVE TURBOCHARGER ASSEMBLY

(a) Disconnect the 2 turbo water hoses.

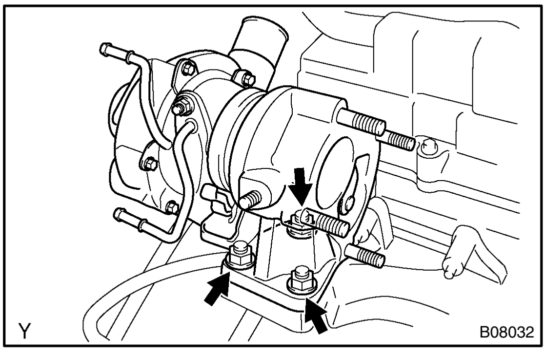


(b) Remove the bolt holding the stays on the No.1 turbo oil outlet pipe and turbo oil inlet pipe to the cylinder head.

(c) Disconnect the turbo oil outlet hose.



(d) Remove the 2 union bolts, 2 gaskets, nut and turbo oil inlet pipe.



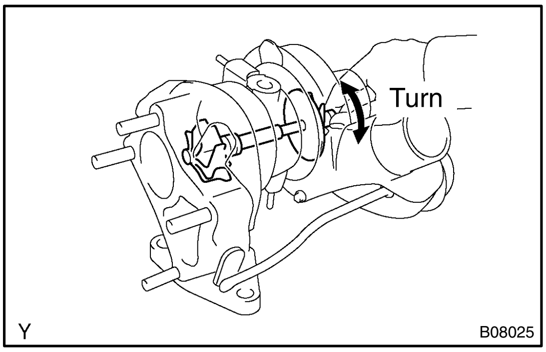
(e) Remove the 3 nuts, turbocharger and gasket.

NOTICE:

Do not make the actuator push rod deformed with a tool.

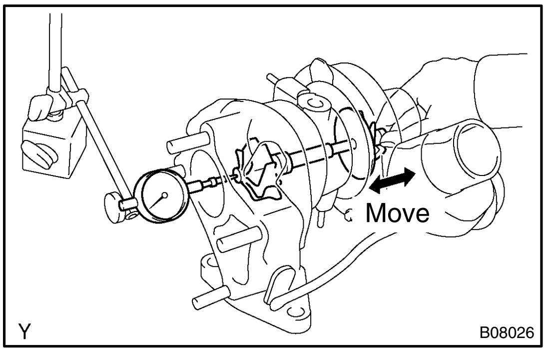
TC02T–02

DISASSEMBLY



1. INSPECT TURBINE SHAFT ROTATION

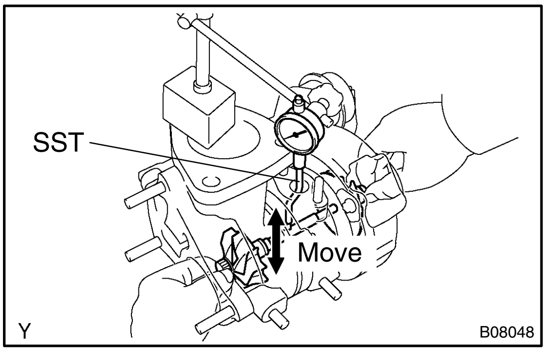
Grasp the edge of the turbine shaft, and turn it.
Check that the turbine shaft turns smoothly.
If the turbine shaft turns remarkably heavily or is stuck, replace the bearing housing. At that time, check also the interference with the turbine housing and compressor housing.



2. INSPECT AXIAL PLAY OF TURBINE SHAFT

(a) Using a dial indicator, insert the needle of the dial indicator into the exhaust side.
(b) Move the turbine shaft in an axial direction, measure the axial play of the turbine shaft.
Maximum oil clearance: 0.09 mm (0.0035 in.) or less

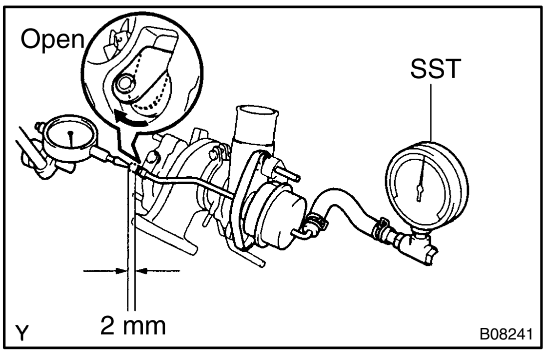
If the axial play is greater than maximum, replace the bearing housing. At that time, check also the interference with the turbine housing and compressor housing.



3. INSPECT RADIAL PLAY OF TURBINE SHAFT

(a) Using SST and a dial indicator, insert the needle of the dial indicator into the oil outlet hole, and set it in the center of the turbine shaft.
SST 09992–00600
(b) Move the turbine shaft in a radial direction, measure the radial play of the turbine shaft.
Maximum oil clearance: 0.16 mm (0.0063 in.) or less

If the radial play is greater than maximum, replace the bearing housing. At that time, check also the interference with the turbine housing and compressor housing.



4. INSPECT ACTUATOR AND WASTE GATE VALVE OPERATION

(a) Disconnect the actuator hose from the compressor housing.
(b) Using SST and a dial indicator, read the graduation of SST when the actuator push rod moved 2 mm (0.079 in.).
Standard pressure:
156 – 169 kPa (1.59 – 1.72 kgf/cm^2, 22.6 – 24.5 psi)

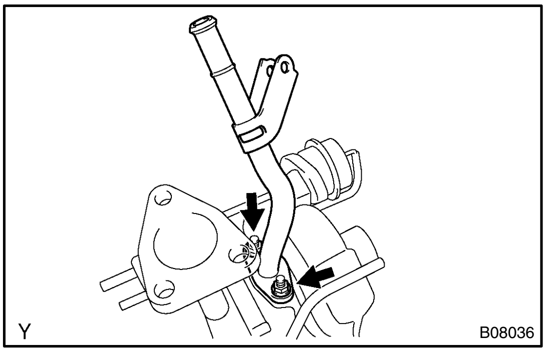
(c) Move the actuator push rod, and check that the waste gate valve is open.

If operation is not as specified, replace the actuator and/or turbine housing.

NOTICE:

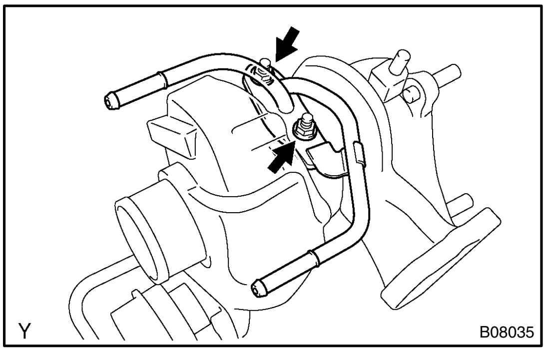
Never apply more than 197 kPa (2.01 kgf/cm^2, 28.5 psi) of pressure of the actuator.

(d) Reconnect the actuator hose to the compressor hosing.



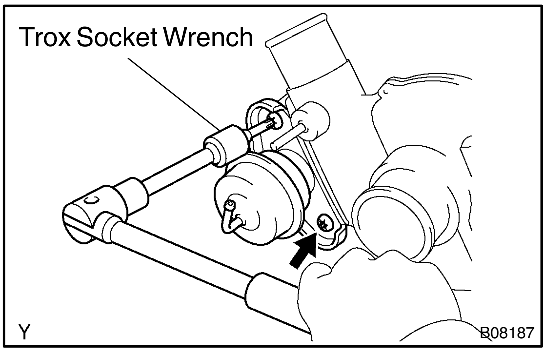
5. REMOVE NO.1 TURBO OIL OUTLET PIPE FROM TURBOCHARGER

Remove the 2 nuts, outlet pipe and gasket.



6. REMOVE TURBO WATER PIPE FROM TURBOCHARGER

Remove the 2 nuts, water pipe and gasket.

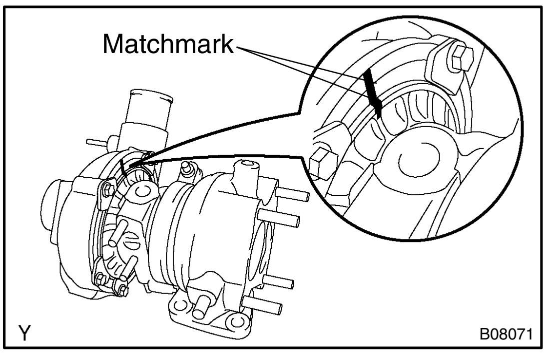


7. REMOVE ACTUATOR w/ BRACKET

(a) Remove the actuator hose.

(b) Using a trox socket wrench (T30), remove the 2 screws holding the actuator to the compressor housing.

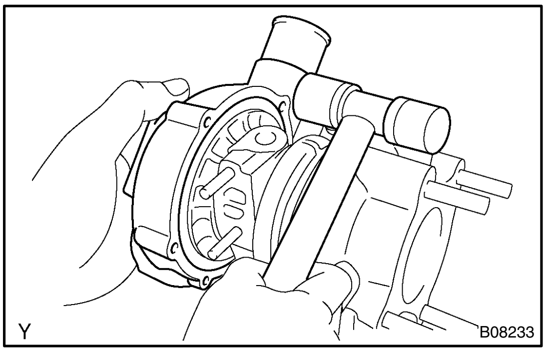
(c) Remove the E–ring holding the actuator push rod to the waste gate valve link, and remove the actuator w/ bracket.



8. REMOVE COMPRESSOR HOUSING

(a) Place the matchmarks on the compressor housing and bearing housing.

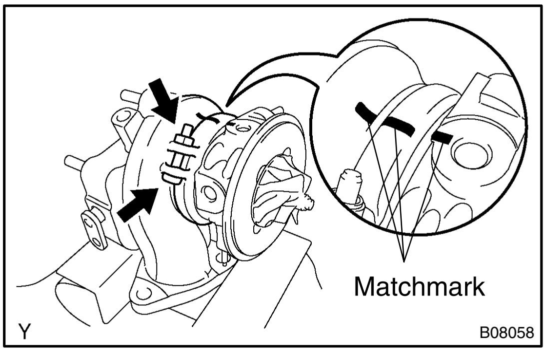
(b) Remove the 5 bolts and 5 camp plates.



(c) Using a plastic–faced hammer, tap out the compressor housing.

NOTICE:

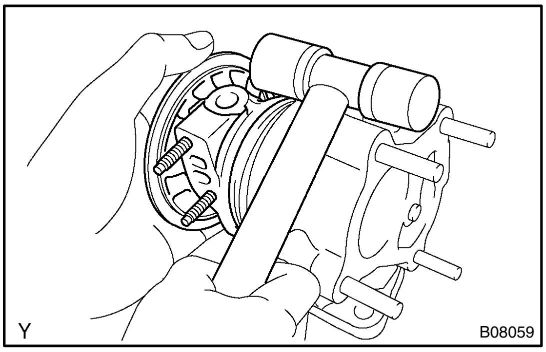
Remove the compressor housing as straight as possible and do not make the impeller wheel interfere with the compressor housing.



9. REMOVE BEARING HOUSING

(a) Place the matchmarks on the V band, turbine housing and bearing housing.

(b) Remove the flat head square neck bolt, nut and V band.



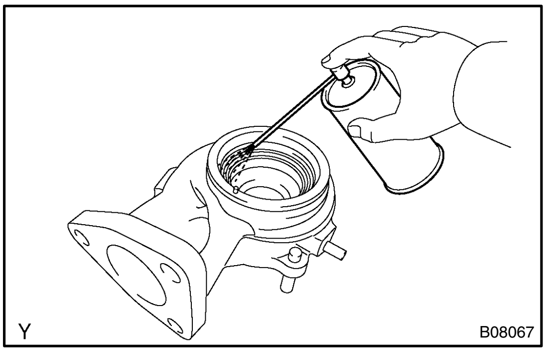
(c) Using a plastic–faced hammer, tap out the bearing housing.

NOTICE:

Remove the bearing housing as straight as possible and do not make the turbine wheel interfere with the turbine housing.

TC02R–01

INSPECTION

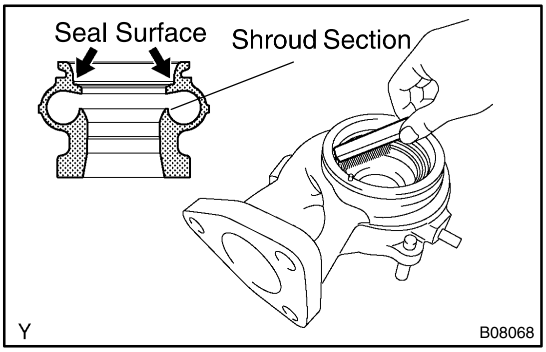


1. CLEAN AND INSPECT TURBINE HOUSING

(a) Spray the engine conditioner to the section where the carbon dirt is adhered.

NOTICE:

Be careful not to erase the matchmark of the turbine housing.



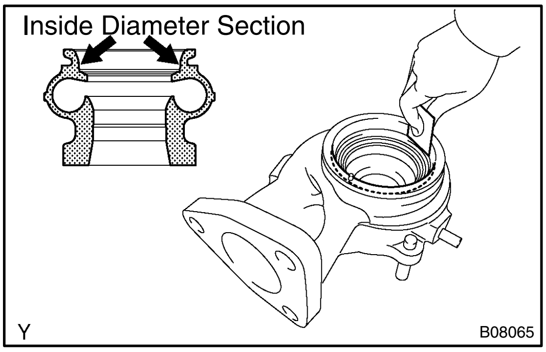
(b) Using a wire brush, remove all the carbon dirt inside the turbine housing.

NOTICE:

Clean the seal surface and shroud section shown in the illustration sufficiently. And clean the waste gate valve seat sufficiently, too.

HINT:

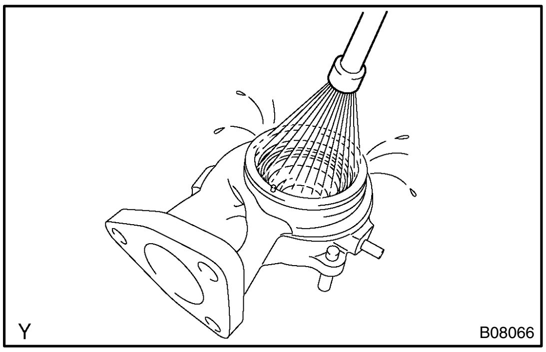
When the carbon dirt is heavily adhered, remove it using the screwdriver and the like.



(c) Clean the inside diameter section with a sandpaper (No.100) until the metal surface can be seen.

NOTICE:

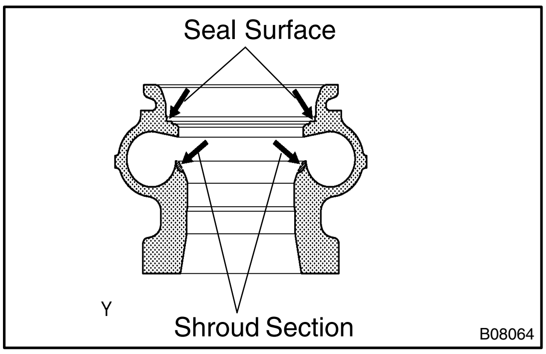
If the cleaning is not enough, installation of the bearing housing becomes harder, so clean it sufficiently.



(d) Wash with compressed air or a steam cleaner.

NOTICE:

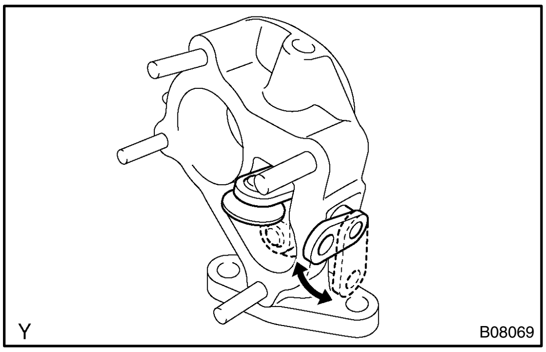
Wash sufficiently without leaving any irregular objects.



(e) Check that there is no severe damage on the seal surface with the bearing housing.

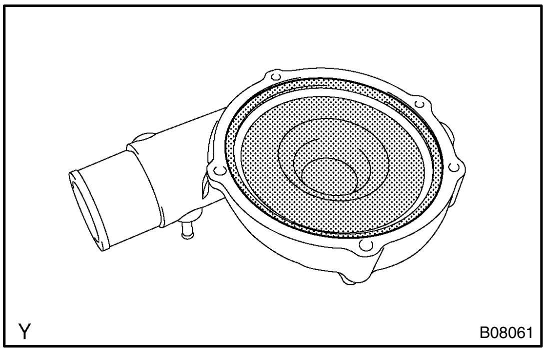
(f) Check that there is no bore made by the interference with the turbine wheel in the shroud section.

If the turbine housing is having remarkable damage or bore, replace the turbine housing and bearing housing.



(g) Move the waste gate valve link and check that it runs smoothly without sticking.

If the link is bad running, clean again. If it is bad running, even after cleaning, replace the turbine housing.



2. CLEAN AND INSPECT COMPRESSOR HOUSING

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the compressor housing and bearing housing.

  (1) Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces.

  (2) Thoroughly clean all components to remove all the loose material.

  (3) Using a non–residue solvent, clean both sealing surfaces.

(b) Wipe off the dirt from the inside of the housing with a shop rag.

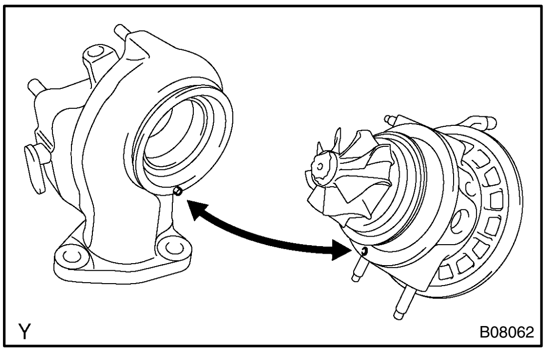
(c) Check that there is no severe interference with the impeller wheel.

If it is having bur made by a slight interference damage, remove it with a sandpaper (No.400) and blow with compressed air.

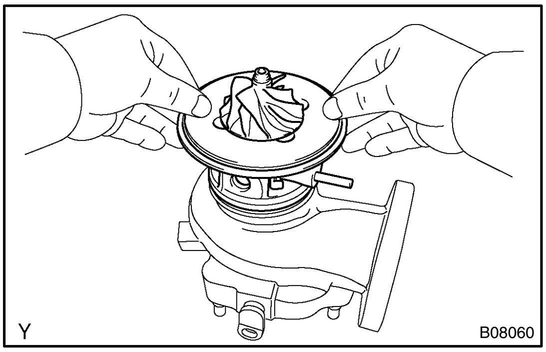
TC02U–02

REASSEMBLY

1. INSTALL BEARING HOUSING



(a) Align the pin of the turbine housing with the pin hole of the bearing housing.



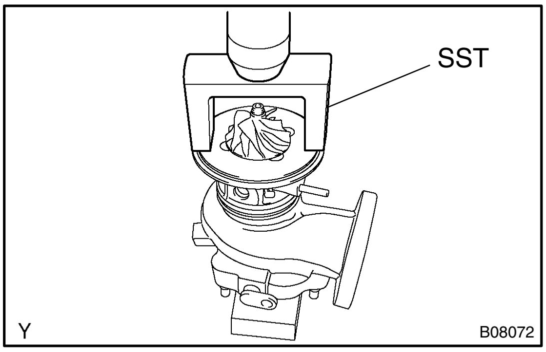
(b) Install the bearing housing to the turbine housing.

NOTICE:

- **Install the bearing housing straight, and be careful not to damage the turbine wheel.**
- **In case of having difficulty of pressing in the bearing housing to install with a hand due to hard engagement, apply the procedure (c).**

HINT:

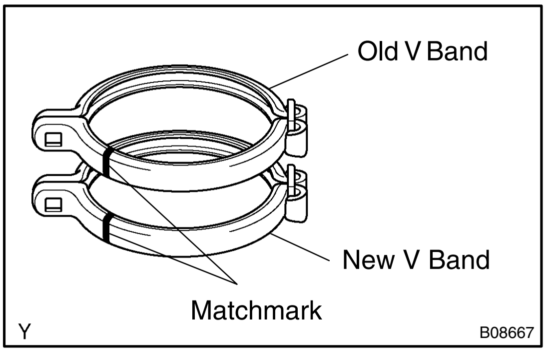
Apply a little penetrate rust prevention lubricant onto the engagement section to make installation easier.



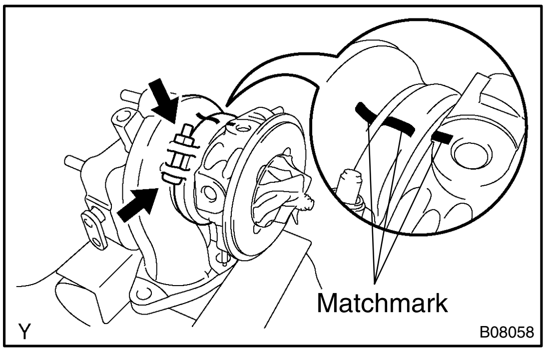
(c) In case that the engagement of the bearing housing is hard, using SST and a press, install the bearing housing while checking the smooth rotation of the impeller wheel.
SST 09350–32014 (09351–32070)

NOTICE:

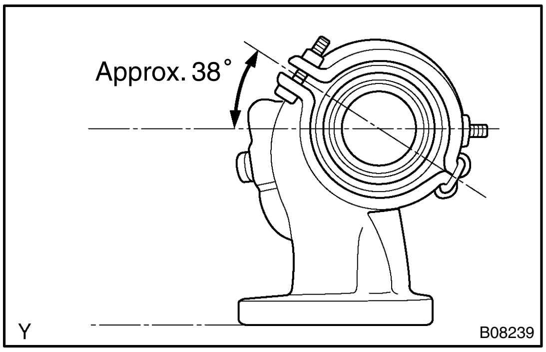
- **Do not hold the turbine housing with the stud bolts.**
- **Be sure to install the bearing housing straight without tilting as the shaft may bent and cause the irregular noise.**
- **Press in the bearing housing slowly. When the rotation of the impeller wheel becomes heavy, return the press immediately and do the operation again.**
- **After installed, check that the turbine shaft turns smoothly.**



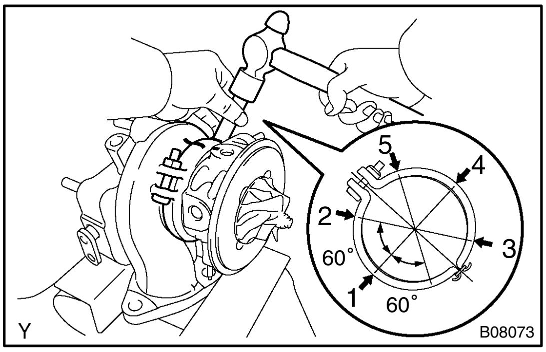
(d) Place a new and old (used) V bands in line, then reprint the matchmark position on the old V band to the new one.



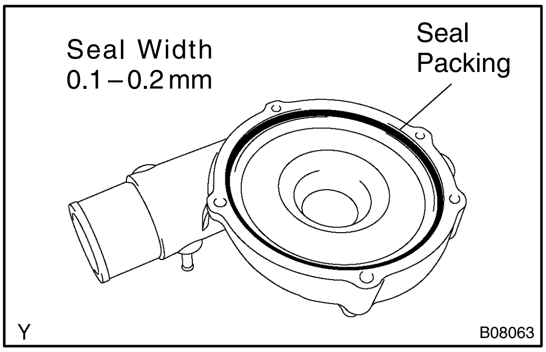
(e) Align the matchmarks on the new V band, turbine housing and bearing housing, and temporarily torque with a new bolt and nut.
Torque: 8.3 N·m (85 kgf·cm, 74 in.·lbf)



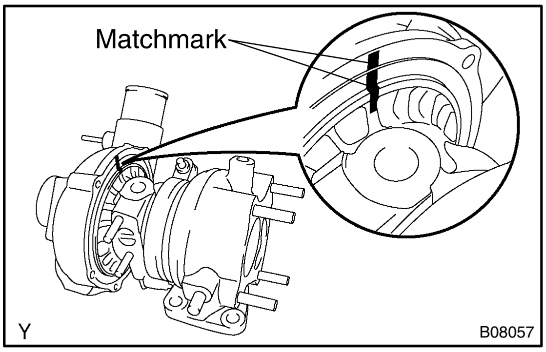
HINT:
When the marks are erased, make the matching openings meet at the position shown in the illustration.



(f) Using a brass bar and hammer, hit 2 or 3 times lightly at each place in order of 1 through 5.
(g) Torque the bolt and nut more.
Torque: 8.3 N·m (85 kgf·cm, 74 in.·lbf)
(h) Using a brass bar and hammer, hit 2 or 3 times lightly at each place of 1 and 4.
(i) Torque the bolt and nut completely.
Torque: 8.3 N·m (85 kgf·cm, 74 in.·lbf)



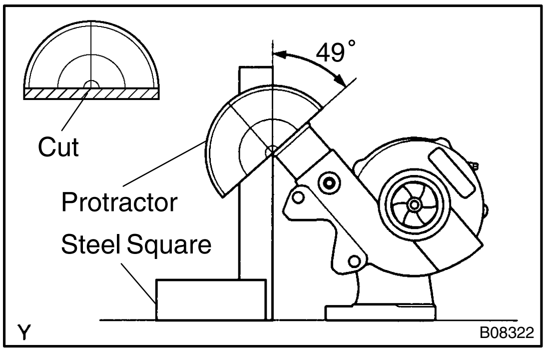
2. INSTALL COMPRESSOR HOUSING
(a) In case of reusing the compressor housing and bearing housing:
(1) Apply seal packing to the compressor housing as shown in the illustration.
Seal packing: Part No. 08826–00080 or equivalent
NOTICE:
Avoid applying an excessive amount to the surface.
- Install a nozzle that has been cut to a 0.1 – 0.2 mm (0.004 – 0.08 in.) opening.
- Parts must be assembled within 7 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(2) Align the matchmarks on the compressor housing and bearing housing, and install them.

NOTICE:

- **Do not make the impeller wheel interfere with the compressor housing.**
- **Check that the turbine shaft turns smoothly.**



(3) Using a steel square and protractor, check the installation angle of the outlet port of the compressor housing shown in the illustration.

(4) Install the 5 clamp plates and bolts.

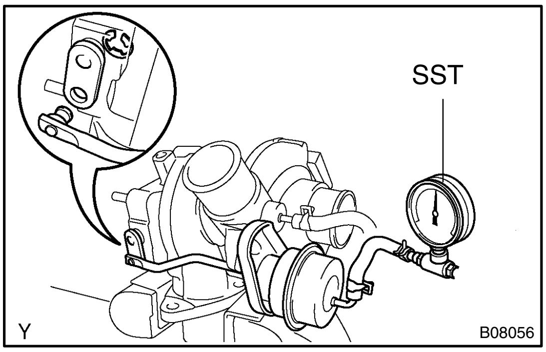
Torque: 4.7 N·m (48 kgf·cm, 42 in.·lbf)

(b) In case of using a new compressor housing and/or bearing housing:

(1) Temporally install the compressor housing on the bearing housing, make the installation angle of the outlet port of the compressor housing meet at the position shown in the illustration, and place the matchmarks.

(2) Remove the compressor housing.

(3) The following procedure is the same as that of reusing the compressor housing and/or bearing housing.



3. INSTALL ACTUATOR w/ BRACKET

(a) Using a trox wrench (T30), install the actuator w/ bracket to the compressor housing with the 2 screws.

Torque: 7.8 N·m (80 kgf·cm, 69 in.·lbf)

(b) Using SST, move the actuator push rod.

NOTICE:

Never apply more than 197 kPa (2.01 kgf/cm^2, 28.5 psi) of pressure of the actuator.

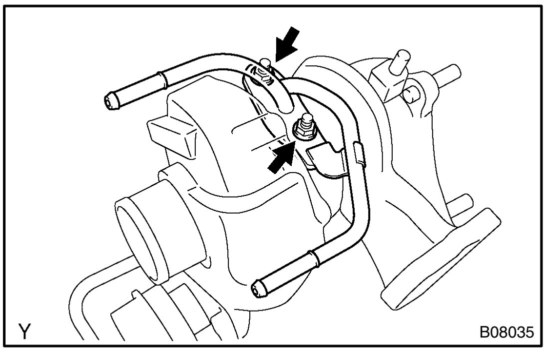
(c) Connect the actuator push rod to the waste gate valve link with a new E–ring.

NOTICE:

Do not use a hammer, etc. to force the actuator push rod onto the waste gate valve link.

(d) Remove the SST.

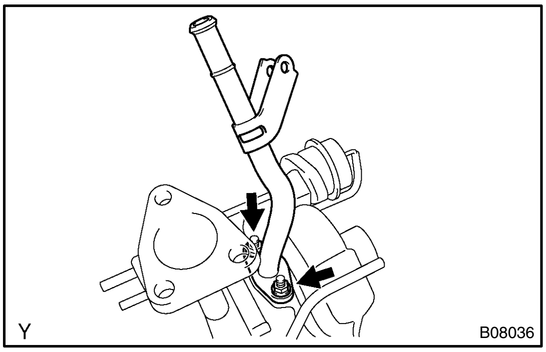
(e) Connect the actuator hose.



4. INSTALL TURBO WATER PIPE TO TURBOCHARGER

Install a new gasket and the water pipe with the 2 nuts.

Torque: 13.2 N·m (135 kgf·cm, 10 ft·lbf)

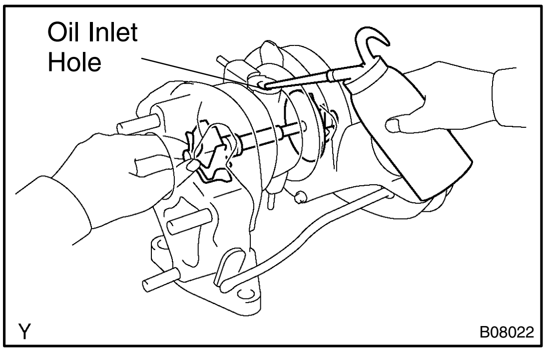


5. INSTALL NO.1 TURBO OIL OUTLET PIPE TO TURBOCHARGER

Install a new gasket and the outlet pipe with the 2 nuts.

Torque: 13.2 N·m (135 kgf·cm, 10 ft·lbf)

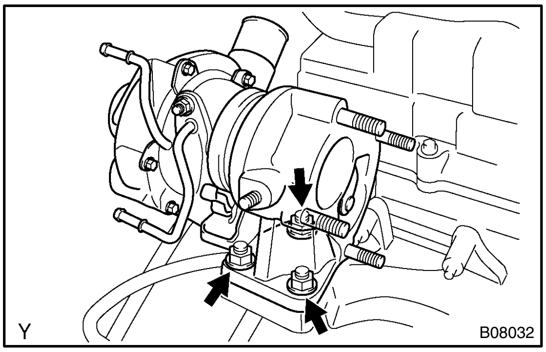
TC00U–02



INSTALLATION

NOTICE:

After replacing the turbocharger assembly, pour approx. 20 cm^3 (1.2 cu in.) of fresh oil into the oil inlet hole and turn the turbine wheel by hand to splash oil on the bearing.



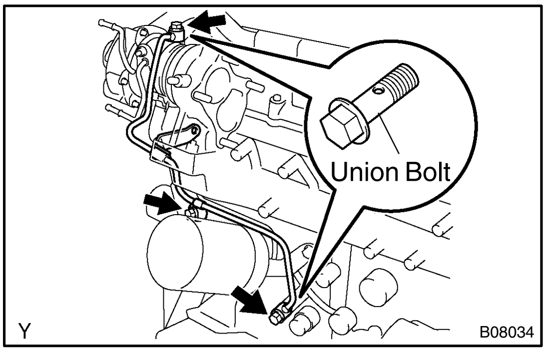
1. INSTALL TURBOCHARGER ASSEMBLY

(a) Install a new gasket and the turbocharger assembly with the 3 nuts.

Torque: 53 N·m (530 kgf·cm, 39 ft·lbf)

NOTICE:

Do not make the actuator push rod deformed with a tool.



(b) Apply a light coat of engine oil to 2 new gaskets and on the threads and under the heads of the union bolts.

(c) Install the 2 gaskets and the turbo oil inlet pipe with the 2 union bolts and nut.

NOTICE:

Use the new gasket by separating it into two.

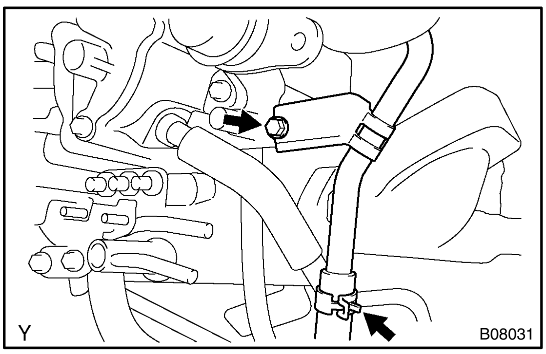
HINT:

The turbocharger side union bolt is yellow and the cylinder block side union bolt is black.

Torque:

31 N·m (320 kgf·cm, 23 ft·lbf) for union bolt

8.8 N·m (90 kgf·cm, 78 in.·lbf) for nut

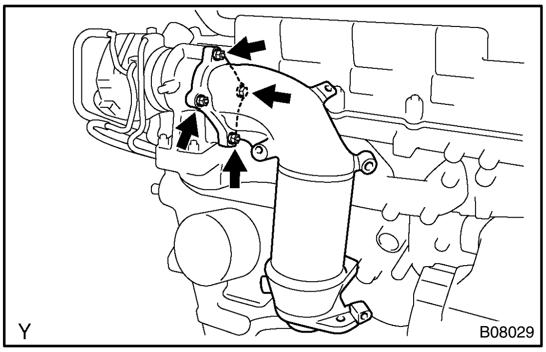


(d) Connect the turbo oil outlet hose.

(e) Connect the stays on the turbo oil inlet pipe and No.1 turbo oil outlet pipe to the cylinder head with the bolt.

Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

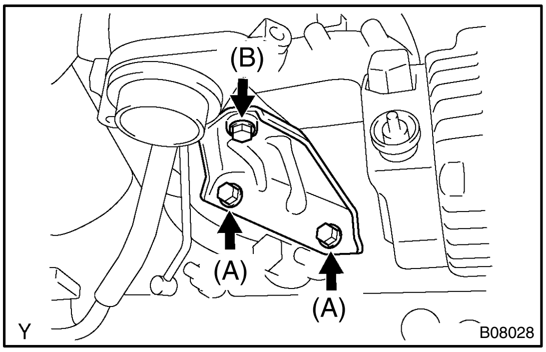
(f) Connect the 2 turbo water hoses.



2. INSTALL EXHAUST MANIFOLD CONVERTER

Install a new gasket and the exhaust manifold converter with the 4 new nuts.

Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)



3. INSTALL EXHAUST MANIFOLD STAY

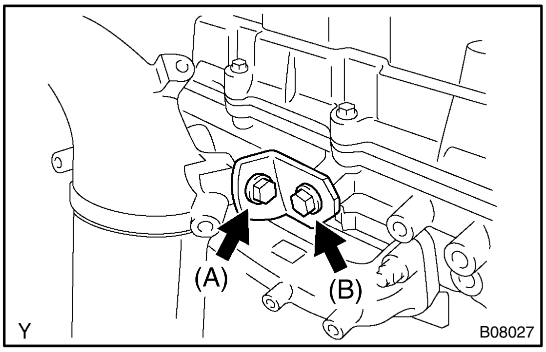
(a) Temporarily install the exhaust manifold stay with the 2 bolts (A).

(b) Install and torque the bolt (B).

Torque: 61 N·m (620 kgf·cm, 45 ft·lbf)

(c) Torque the 2 bolts (A).

Torque: 61 N·m (620 kgf·cm, 45 ft·lbf)



4. INSTALL TURBOCHARGER STAY

(a) Temporarily install the turbocharger stay with the bolt (A).

(b) Temporarily torque the bolt (B) by 30 N·m (305 kgf·cm, 22 ft·lbf) or less without making any clearance between the cylinder head and stay.

(c) Torque the bolt (A).

Torque: 54 N·m (550 kgf·cm, 40 ft·lbf)

(d) Torque the bolt (B).

Torque: 54 N·m (550 kgf·cm, 40 ft·lbf)

5. INSTALL HEAT INSULATORS

(a) Install the No.2 exhaust manifold heat insulator with the 2 bolts.

Torque: 12 N·m (120 kgf·cm, 9 ft·lbf)

(b) Install the No.1 turbo heat insulator with the 2 bolts and nut.

Torque:
12 N·m (120 kgf·cm, 9 ft·lbf) for bolt
18.1 N·m (185 kgf·cm, 13 ft·lbf) for nut

(c) Install the No.2 turbo heat insulator with the 4 bolts.

Torque: 25 N·m (255 kgf·cm, 18 ft·lbf)

6. FILL WITH ENGINE COOLANT (See page CO–2)

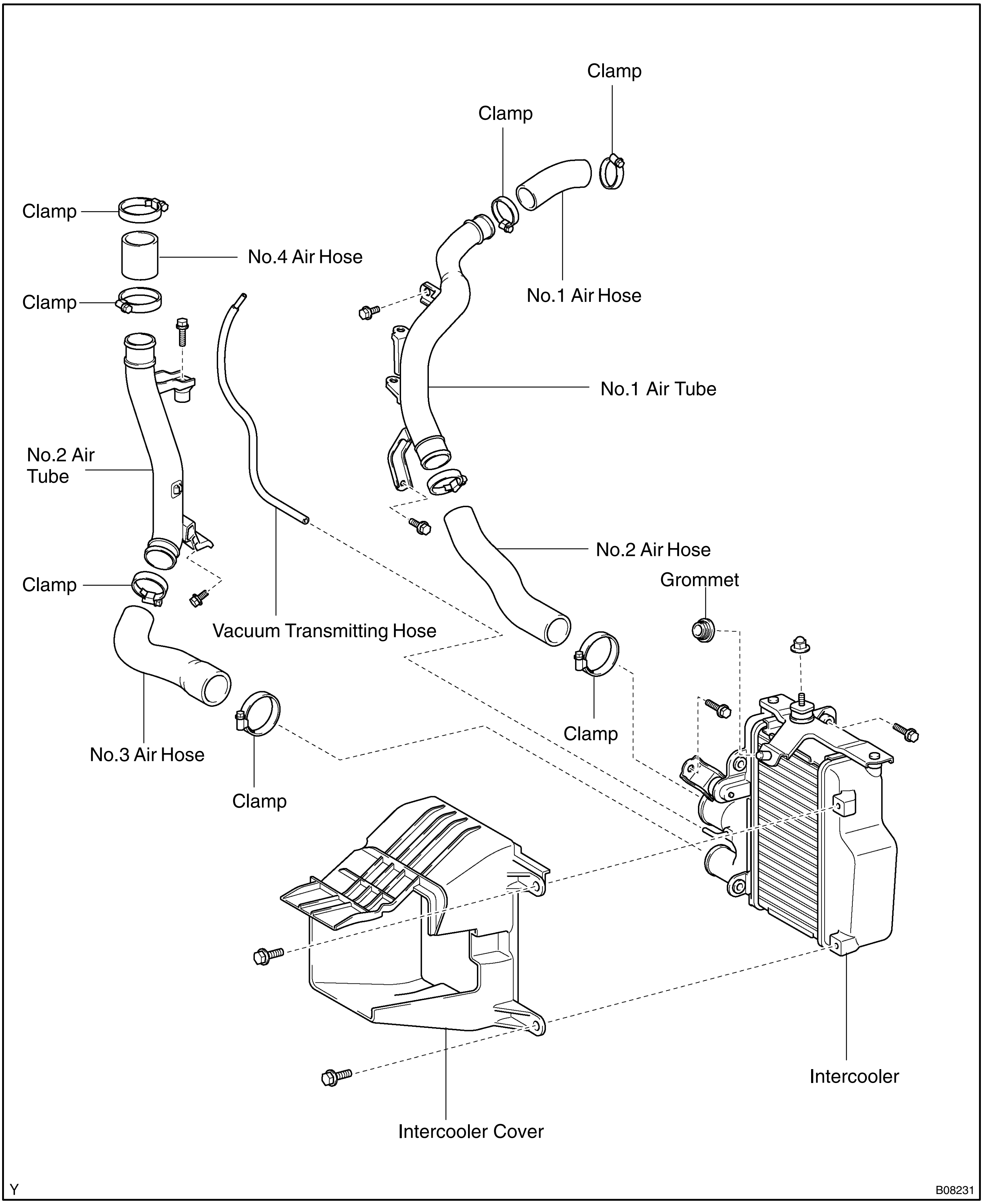
7. START ENGINE AND CHECK FOR LEAK

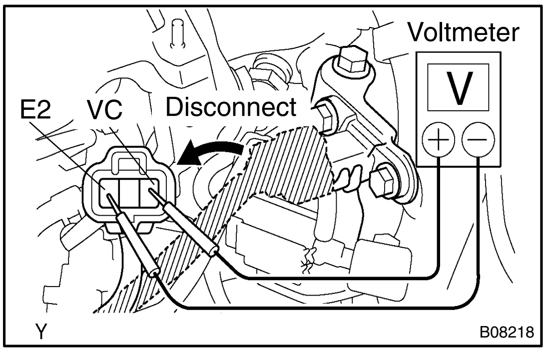
8. CHECK ENGINE OIL LEVEL

INTERCOOLER

COMPONENTS

TC02P–01





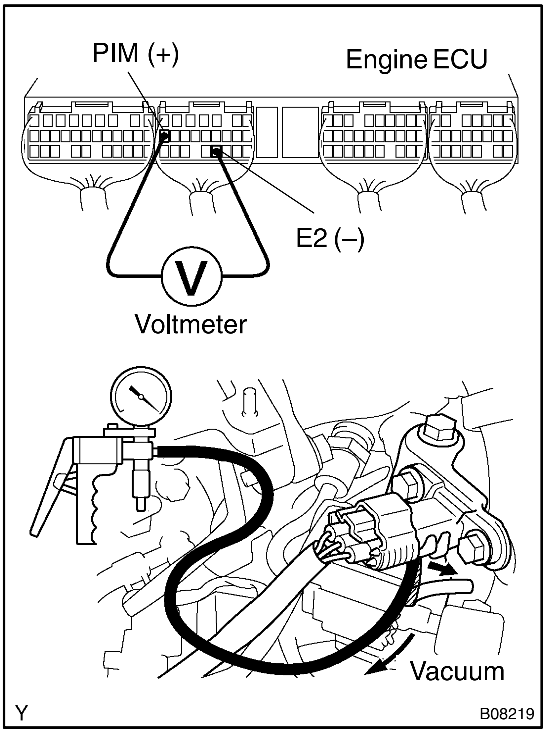
TURBO PRESSURE SENSOR

TC00V–02

INSPECTION

1. **INSPECT POWER SOURCE VOLTAGE OF TURBO PRESSURE SENSOR**

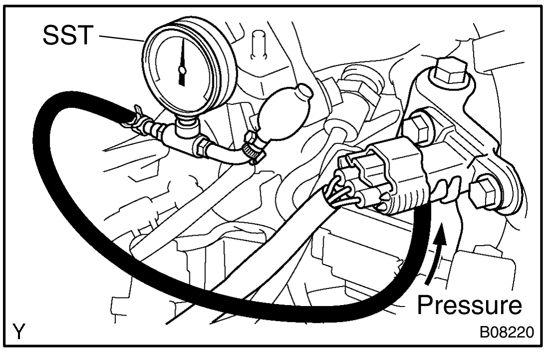
(a) Disconnect the turbo pressure sensor connector.
(b) Turn the ignition switch ON.
(c) Using a voltmeter, measure the voltage between connector terminals VC and E2 of the wiring harness side.
Voltage: 4.5 – 5.5 V
(d) Turn the ignition switch OFF.
(e) Reconnect the turbo pressure sensor connector.



2. **INSPECT SUPPLY POWER OF TURBO PRESSURE SENSOR**

(a) Turn the ignition switch ON.
(b) Disconnect the vacuum hose from the turbo pressure sensor.
(c) Connect a voltmeter to terminals PIM and E2 of the ECU and measure the output voltage under ambient atmospheric pressure.
(d) Apply vacuum to the turbo pressure sensor in 13.3 kPa (100 mmHg, 3.94 in.Hg) segments to 66.7 kPa (500 mmHg, 19.96 in.Hg).
(e) Measure the voltage drop from step (c) above for each segment.
Voltage drop:

Apply vacuum kPa (mmHg, in.Hg)	Voltage drop V
13.3 (100, 3.94)	0.1 – 0.3
26.7 (200, 7.87)	0.3 – 0.5
40.0 (300, 11.81)	0.5 – 0.7
57.3 (400, 15.75)	0.7 – 0.9
66.7 (500, 19.96)	0.9 – 1.0



(f) Using SST (turbocharger pressure gauge), apply pressure to the turbo pressure sensor in 19.6 kPa (0.20 kgf/cm^2, 2.84 psi) segments to 98.0 kPa (1.00 kgf/cm^2, 14.2 psi).
SST 09992–00242

(g) Measure the voltage up from step (c) above for each segment.

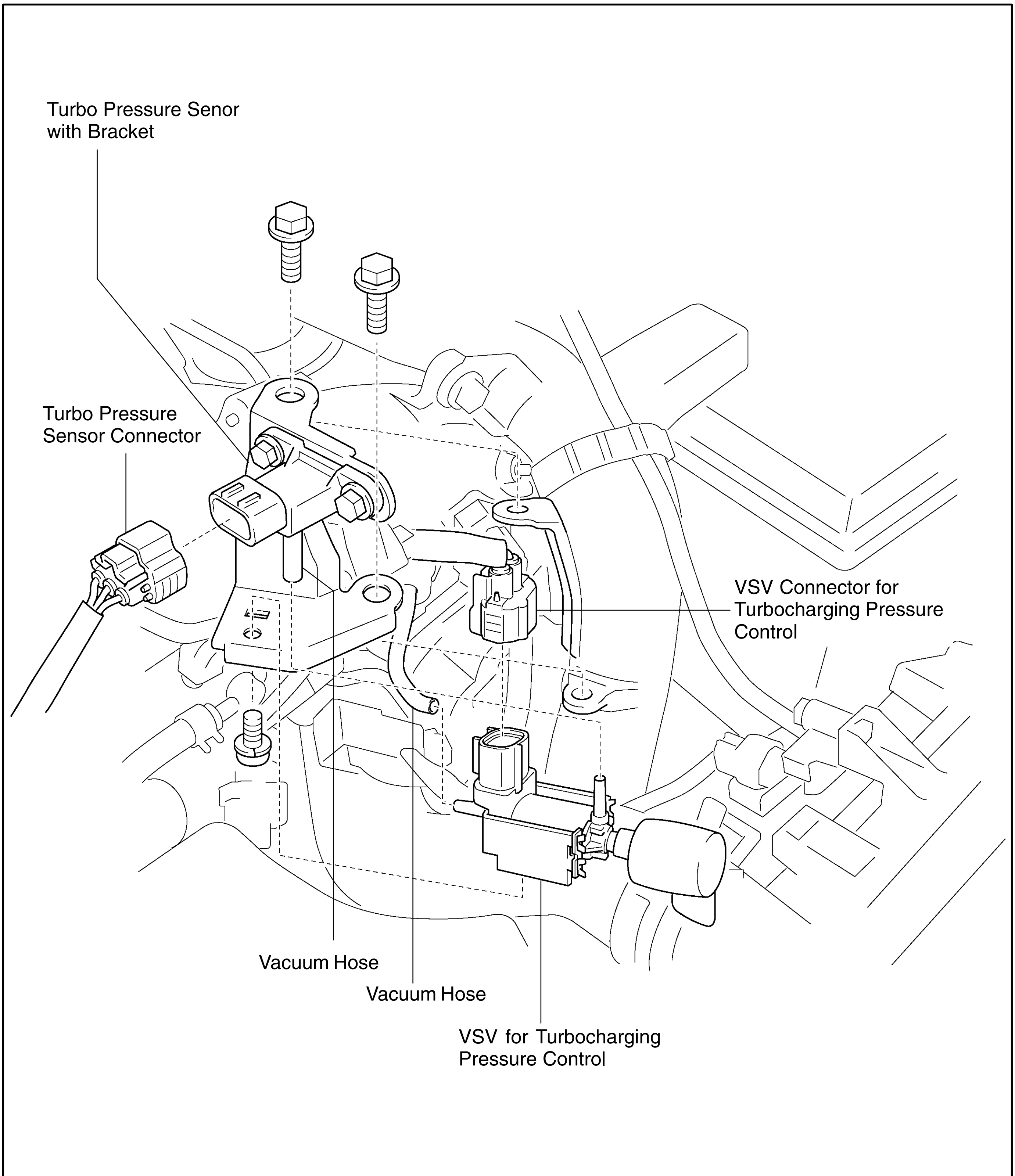
Voltage up:

Applied pressure kPa (kgf/cm^2, psi)	Voltage up V
19.6 (0.20, 2.84)	0.1 – 0.4
39.2 (0.40, 5.69)	0.4 – 0.7
58.8 (0.60, 8.53)	0.7 – 1.0
78.5 (0.80, 11.4)	1.0 – 1.3
98.0 (1.00, 14.2)	1.3 – 1.6

VSV FOR TURBOCHARGING PRESSURE CONTROL

COMPONENTS

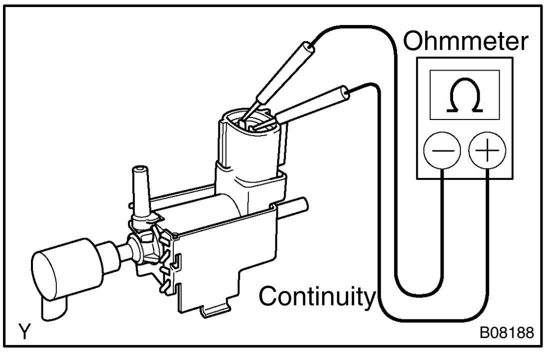
TC02Q–01



TC00X–02

INSPECTION

1. REMOVE VSV

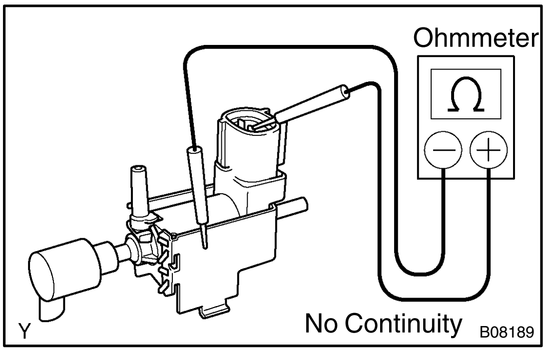


2. INSPECT VSV FOR OPEN CIRCUIT

Using an ohmmeter, check that the there is continuity between the terminals.

Resistance: 37 – 44 Ω at 20°C (68°F)

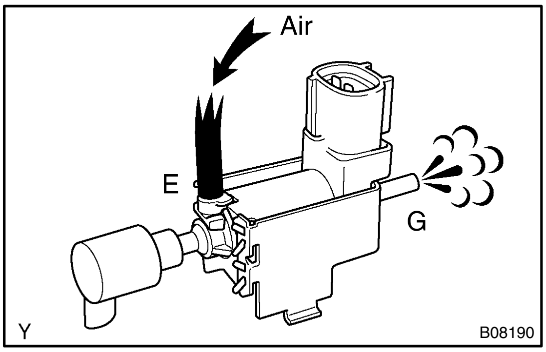
If there is no continuity, replace the VSV.



3. INSPECT VSV FOR GROUND

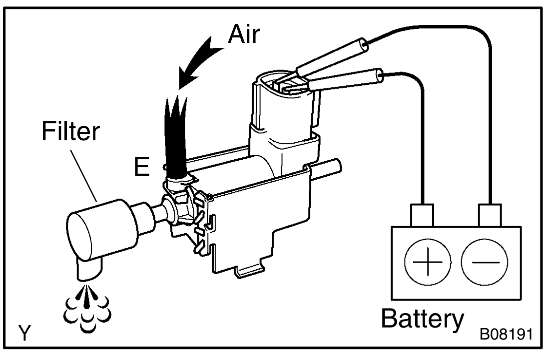
Using an ohmmeter, check that there is no continuity between each terminal and the body.

If there is continuity, replace the VSV.



4. INSPECT VSV OPERATION

(a) Check that air does not flow from port E to G.



(b) Apply battery voltage across the terminals.

(c) Check that air flows from port E to filter.

If operation is not as specified, replace the VSV.

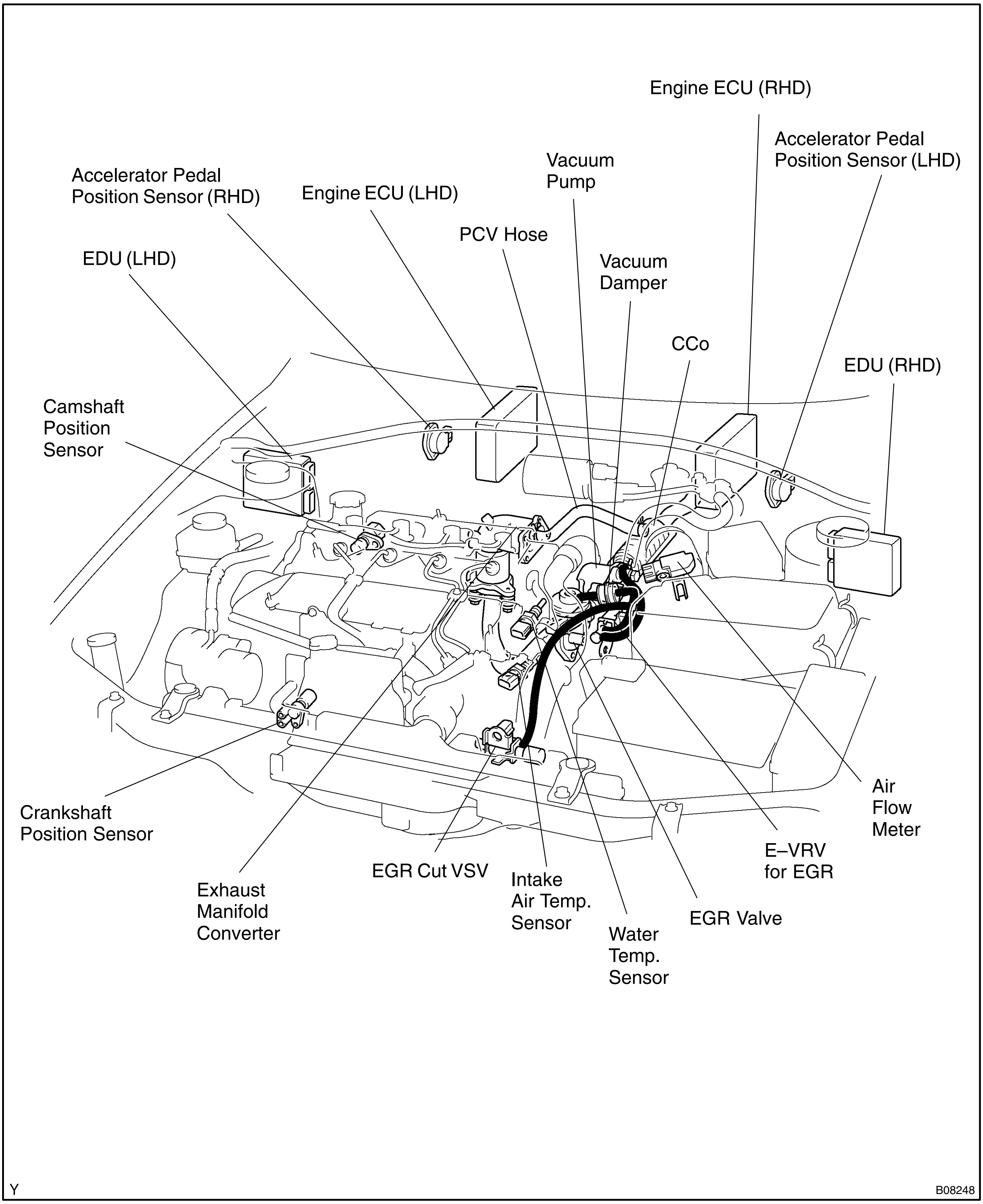
5. REINSTALL VSV

EMISSION CONTROL

PARTS LAYOUT AND SCHEMATIC DRAWING

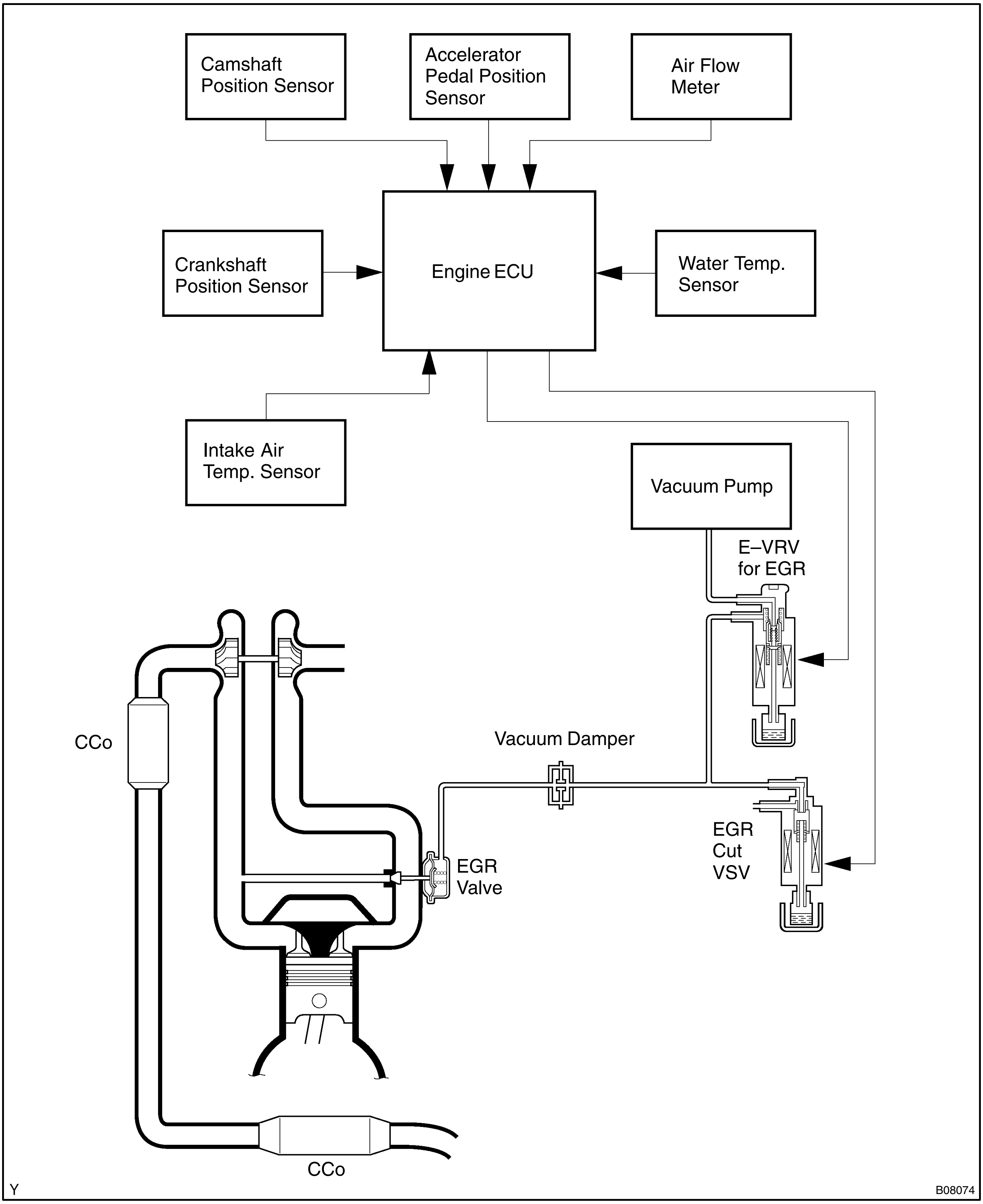
EC0CQ–01

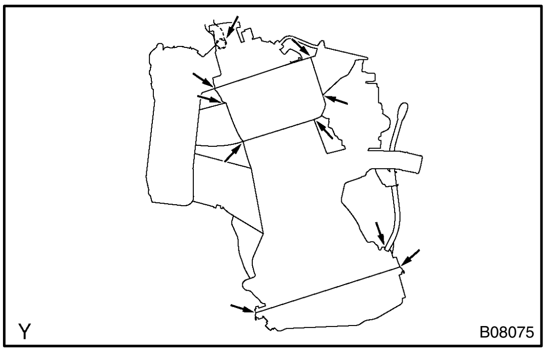
LOCATION



EC0CR–01

DRAWING





POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

EC0CS–01

INSPECTION

VISUALLY INSPECT HOSE AND CONNECTION

Check for cracks, leaks or damage.

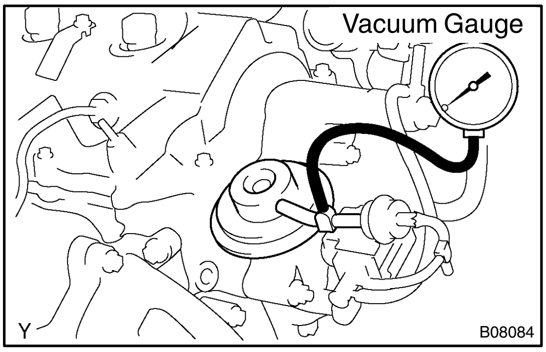
EXHAUST GAS RECIRCULATION (EGR) SYSTEM

EC0CT–01

ON–VEHICLE INSPECTION

HINT:
In a malfunction where the EGR system is always on, black smoke or white smoke may be output from the exhaust pipe. If this occurs, inspect the EGR system also.

NOTICE:
Always stop the engine when installing or removing the vacuum gauge, or removing the vacuum hose.



1. INSTALL VACUUM GAUGE

Using a 3 way connector, connect a vacuum gauge to the hose between the EGR valve and E–VRV.

2. INSPECT SEATING OF EGR VALVE

Start the engine and check that the engine starts and run at idle.

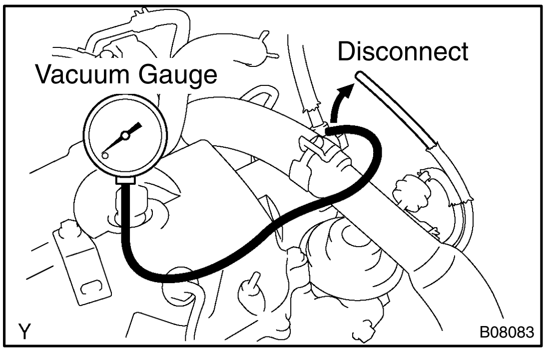
3. INSPECT COLD ENGINE CONDITION

(a) The coolant temperature should be below 20°C (64°F).
(b) Check that the vacuum gauge indicates 0 at idle.

4. INSPECT HOT ENGINE CONDITION

(a) Warm up the engine, the coolant temperature should be above 70°C (104°F) and below 96°C (205°F).
(b) Check that the vacuum gauge indicates about more than 28.0 kPa (210 mmHg, 8.3 in.Hg) at idle.
(c) Check that the vacuum gauge indicator increases about more than 28.0 kPa (210 mm Hg, 8.3 in.Hg) at 1,500 rpm.
(d) When the accelerator pedal is quickly depress to the full open, check that the vacuum gauge indicator drops momentarily.
(e) Keep the engine speed at more than 4,400 rpm.
(f) Check that the vacuum gauge indicates 0.
(g) When the accelerator pedal is releaced, check that the vacuum gauge indicator drops momentarily while the engine speed decreases from more than 4,000 rpm to idle.

5. REMOVE VACUUM GAUGE



6. CHECK OUTPUT VACUUM WITH VACUUM GAUGE

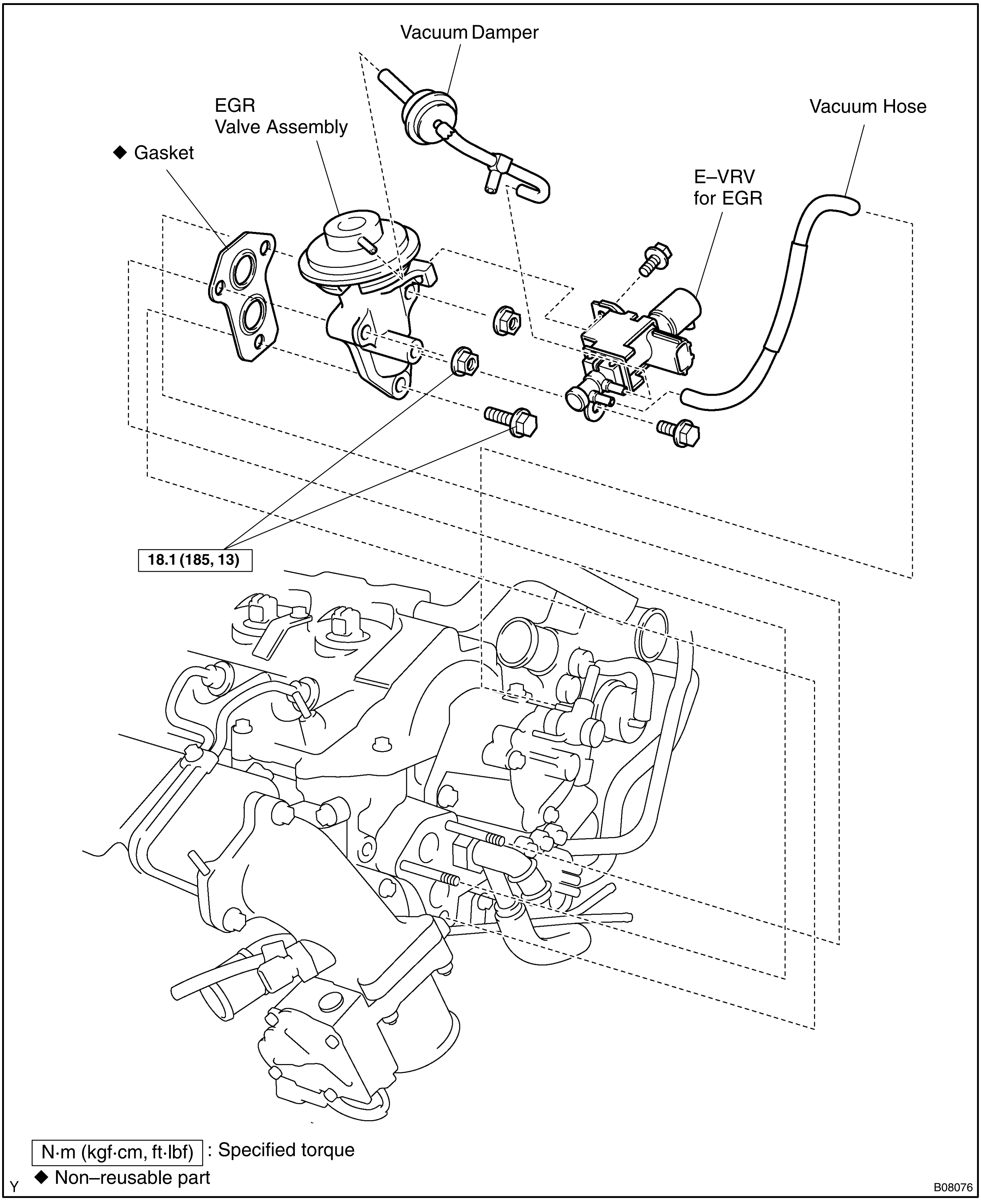
(a) Connect a vacuum gauge to the output pipe.

(b) Warm up the engine and check that the vacuum gauge indicates above 86.7 kPa (650 mmHg, 25.59 in.Hg).

If a problem is found, repair the vacuum pump.

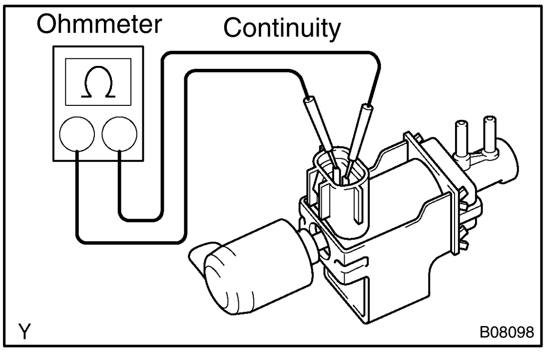
EC0CU–01

COMPONENTS



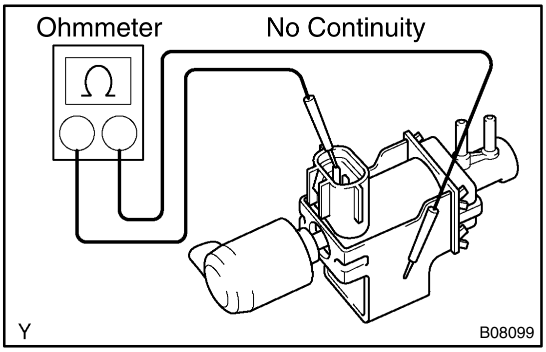
EC0CV–01

INSPECTION

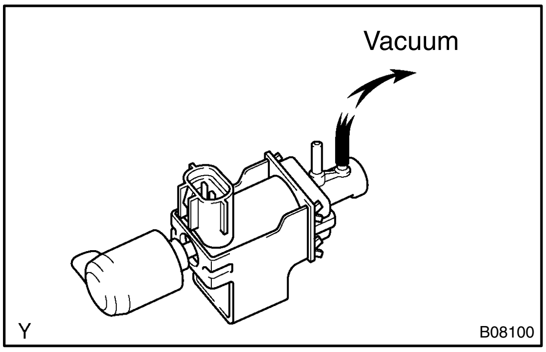


1. INSPECT E–VRV

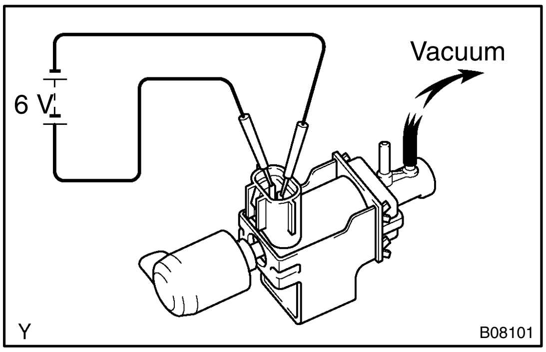
(a) Inspect the E–VRV for open circuit.
Using an ohmmeter, measure the resistance between terminals as shown.
Resistance: 11 – 13 Ω at 20°C (68°F)
If the resistance is not specified, replace the E–VRV.



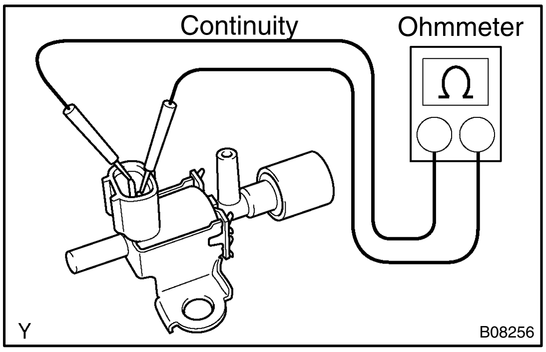
(b) Inspect the E–VRV for ground.
Using an ohmmeter, check that there is no continuity between terminals and E–VRV body.
If there is continuity, replace the E–VRV.



(c) Inspect the E–VRV for air tightness.
Check that when vacuum is applied to the vacuum outlet port shown, the needle of vacuum pump indicates an increase of 66.7 kPa (500 mmHg, 19.7 in. Hg) or more.
If a problem is found, replace the E–VRV

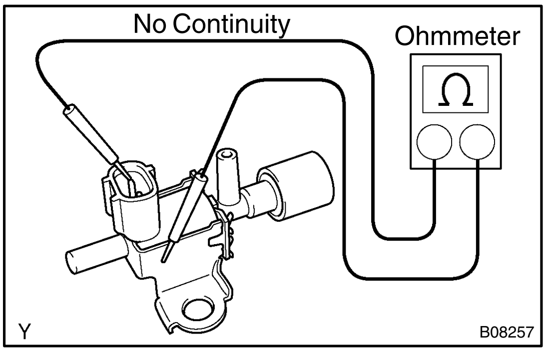


(d) Inspect the E–VRV operation.
(1) Apply about 6 V of DC power to the terminals.
(2) Check that when vacuum is applied to the vacuum outlet port shown, the need does not move.
If operation is not as specified, replace the E–VRV.

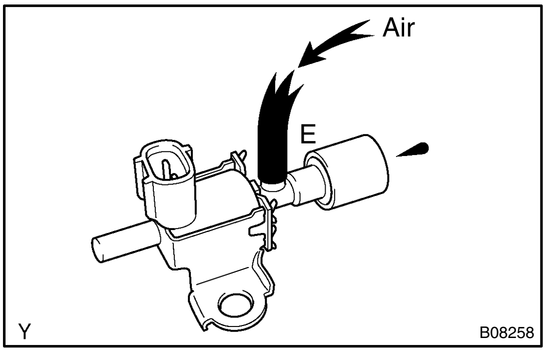


2. INSPECT VSV

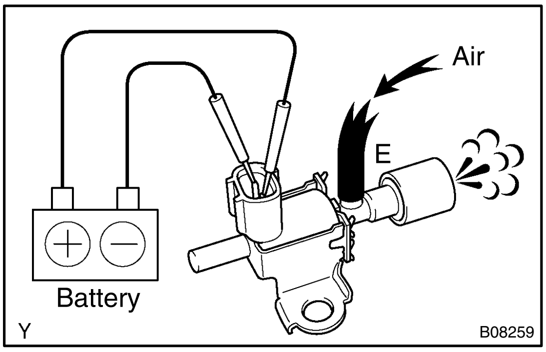
(a) Inspect the VSV for open circuit.
Using an ohmmeter, check that there is continuity between terminals.
Resistance: 33 – 39 Ω at 20°C (68°F)
If there is no continuity, replace the VSV



(b) Inspect the VSV for ground.
Using an ohmmeter, check that there is no continuity between terminals and body.
If there is continuity, replace the VSV.



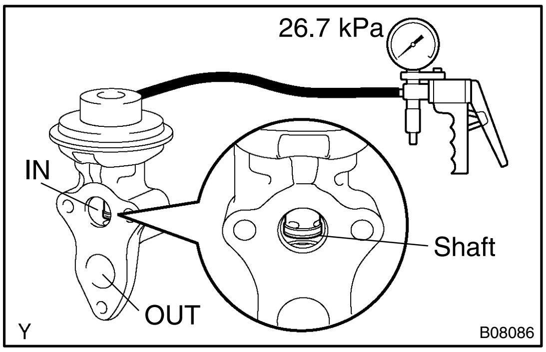
(c) Inspect the VSV operation.
(1) Check that air does not flows from port E to the filter.



(2) Apply battery voltage across the terminals.
(3) Check that air flows from port E to filter.
If operation is not as specified, replace the VSV.

3. INSPECT EGR VALVE

(a) Remove the EGR valve.



(b) When a vacuum of 26.7 kPa (200 mmHg, 7.87 in.Hg) is applied to the diaphragm chamber, check that the shaft rises up and that air flows from IN to OUT.
(c) Maintain the above conditions, and check again that there are no leaks.
(d) Check the valve for sticking and heavy carbon deposits.
If a problem is found, replace it.
(e) Reinstall the EGR valve with the new gasket.

4. INSPECT ACCELERATOR POSITION SENSOR (See page DI–29, DI–35 and DI–40)

5. INSPECT INTAKE AIR TEMPERATURE SENSOR (See page ED–12)

6. INSPECT WATER TEMPERATURE SENSOR (See page ED–10)

7. INSPECT CAMSHAFT POSITION SENSOR (See page ED–15)

8. INSPECT CRANKSHAFT POSITION SENSOR (See page ED–16)

9. INSPECT AIR FLOW METER (See page ED–7)

CATALYTIC CONVERTER FOR OXIDATION (CCo) SYSTEM

EC0CW–01

ON–VEHICLE INSPECTION

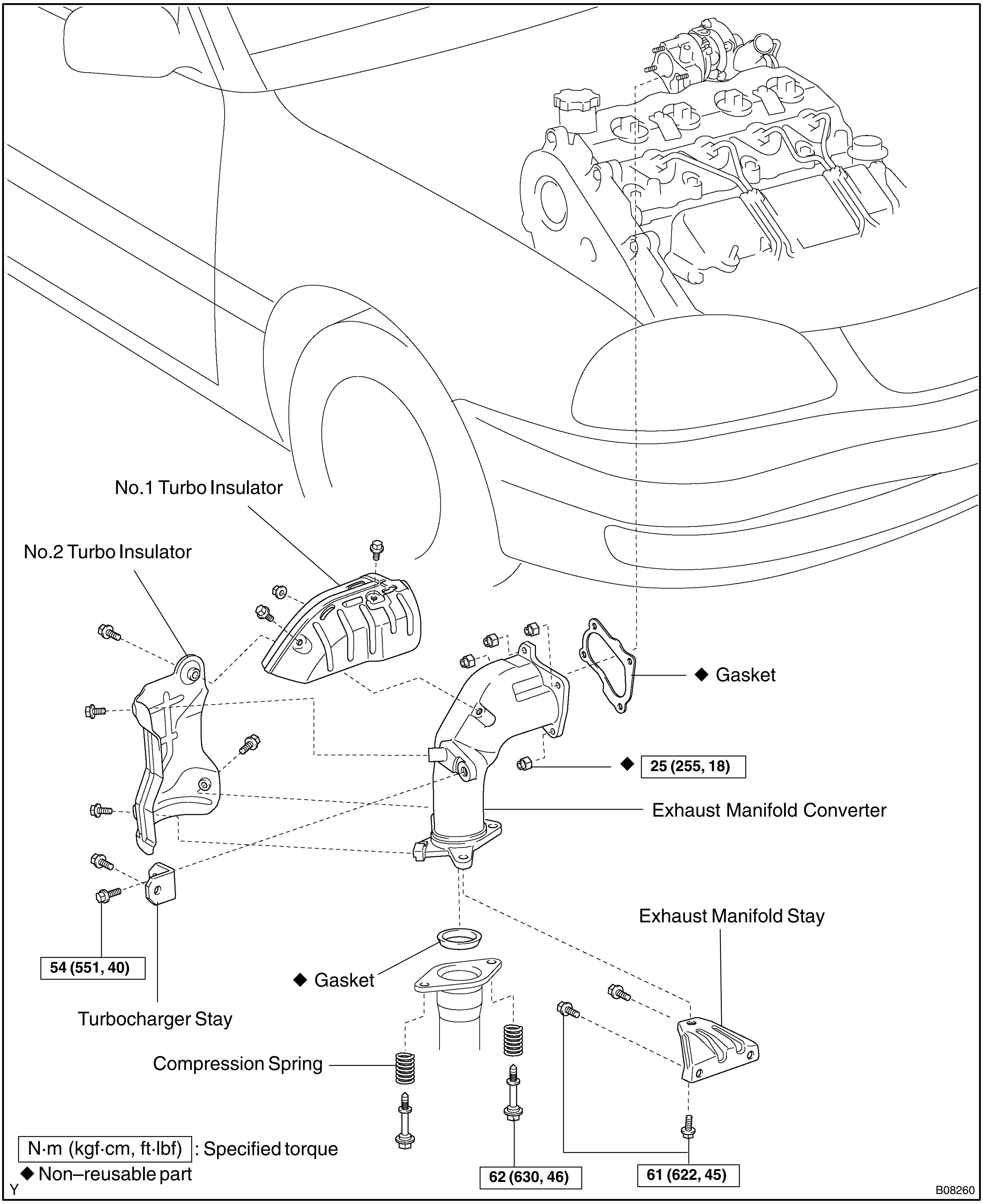
1. **CHECK CONNECTIONS FOR LOOSENESS OR DAMAGE**
2. **CHECK CLAMPS FOR WEAKNESS, CRACKS OR DAMAGE**
3. **CHECK FOR DENTS OR DAMAGE**

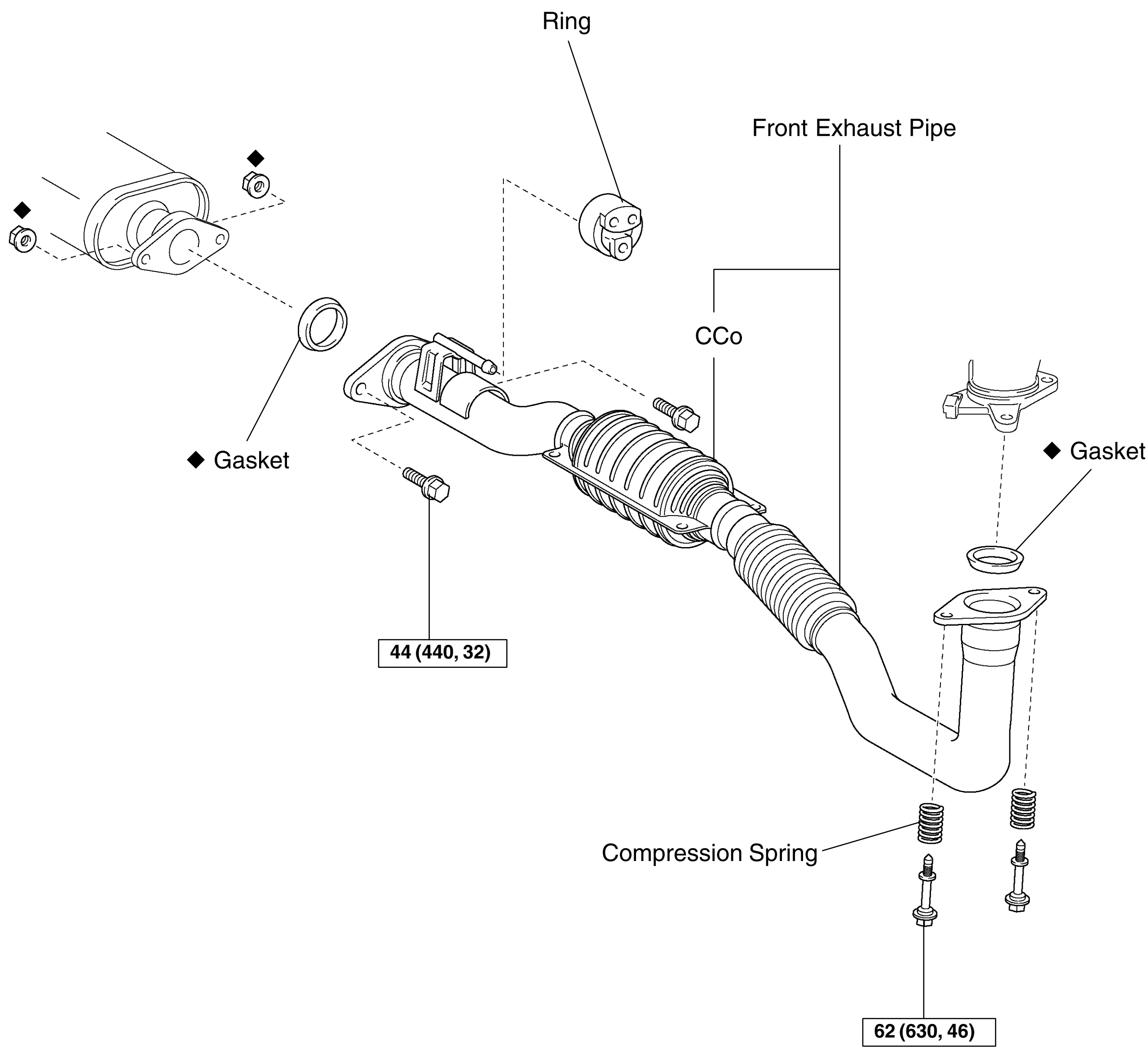
If any part of the protector is damaged or dented to the extent that it contacts the CCo, repair or replace it.

4. **CHECK HEAT INSULATOR FOR DAMAGE**
5. **CHECK FOR ADEQUATE CLEARANCE BETWEEN CATALYTIC CONVERTER AND HEAT INSULATOR**

EC0CX–01

COMPONENTS





N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part

B08261

ELECTRONIC CONTROL DIESEL

ECD SYSTEM

ED027–01

PRECAUTION

1. BEFORE WORKING ON FUEL SYSTEM, DISCONNECT NEGATIVE (–) TERMINAL CABLE FROM BATTERY

HINT:

- Any DTC code retained by the computer will be erased when the negative (–) terminal cable is removed from the battery.
- Therefore, if necessary, read the diagnosis before removing the negative (–) terminal cable from the battery.

2. DO NOT SMOKE OR WORK NEAR AN OPEN FLAME WHEN WORKING ON FUEL SYSTEM

3. KEEP DIESEL FUEL AWAY FROM RUBBER OR LEATHER PARTS

4. AIR INDUCTION SYSTEM

(a) Separation of the engine oil dipstick, oil filler cap, PCV hose, etc. may cause the engine to run out of tune.

(b) Disconnection, looseness or cracks in the parts of the air induction system between the throttle body and cylinder head will allow air suction and cause the engine to run out of tune.

5. ELECTRONIC CONTROL SYSTEM

(a) Before removing ECD wiring connectors, terminals, etc., first disconnect the power by either turning the ignition switch OFF or disconnecting the negative (–) terminal cable from the battery.

HINT:

Always check the DTC before disconnecting the negative (–) terminal cable from the battery.

(b) When installing the battery, be especially careful not to in correctly connect the positive (+) and negative (–) cables.

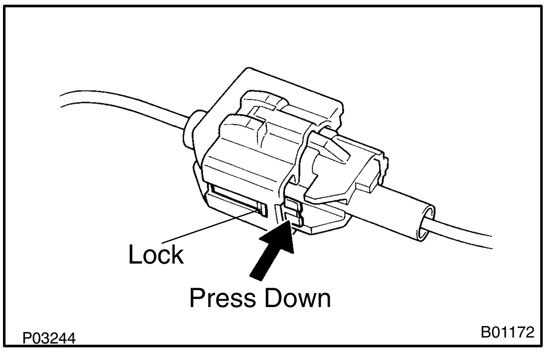
(c) Do not permit parts to receive a severe impact daring removal or installation. Handle all ECD parts carefully, especially the engine ECU.

(d) Do not be careless during troubleshooting as there are numerous transistor circuits and even slight terminal contact can further troubles.

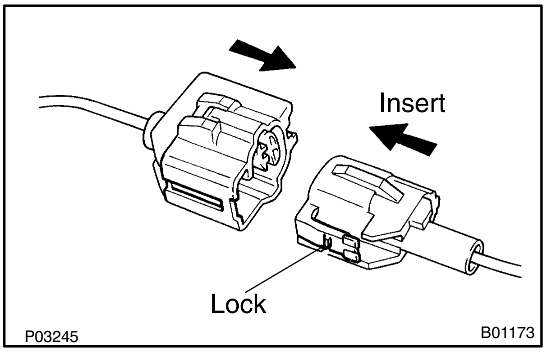
(e) Do not open the engine ECU cover.

(f) When inspecting during rainy weather, take care to prevent entry of water. Also, when washing the engine compartment, prevent water from getting on the ECD parts and wiring connectors.

(g) Parts should be replaced as an assembly.



(h) Care is required when pulling out and inserting wiring connectors.
 (1) Release the lock and pull out the connector, pulling on the connectors.



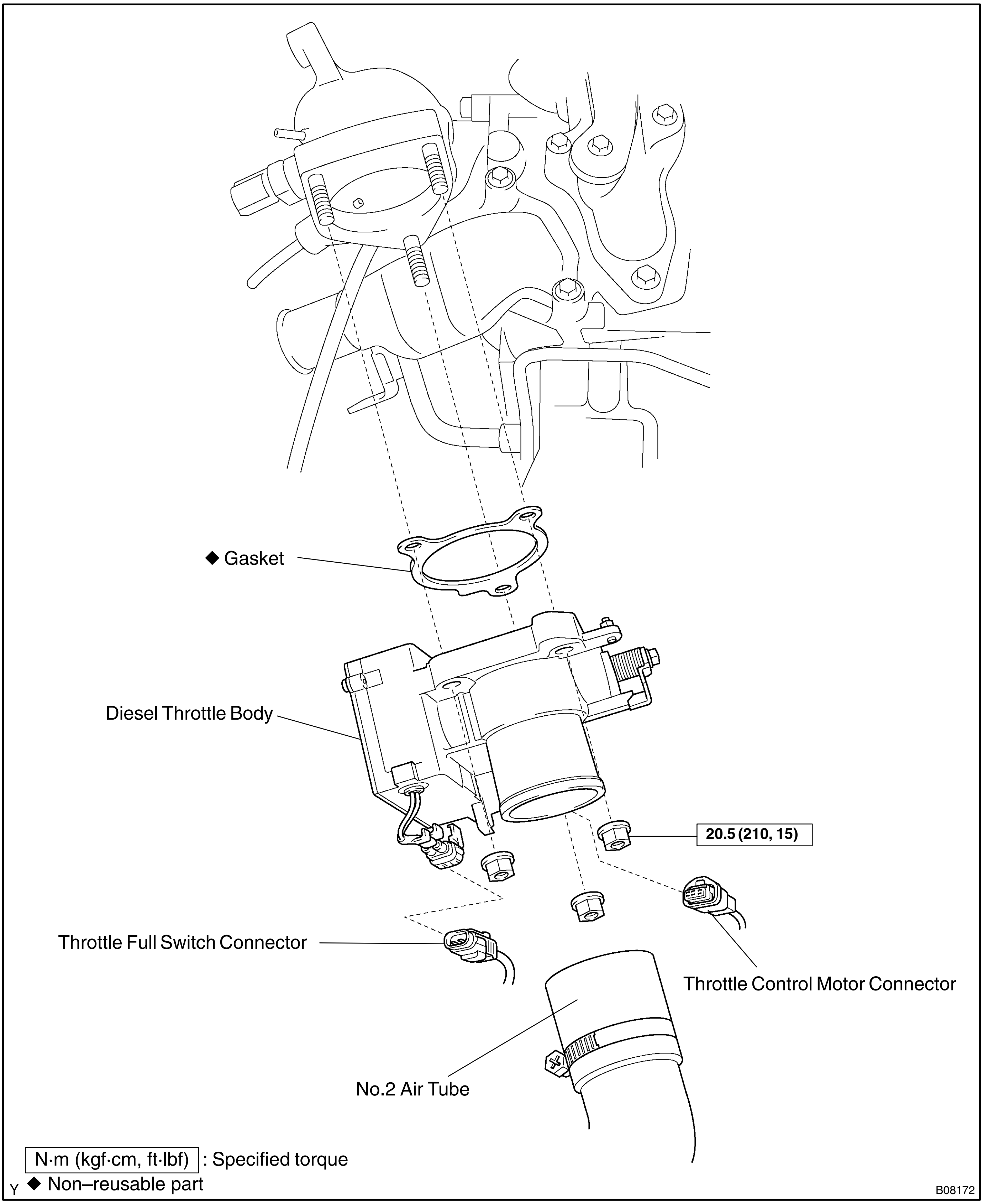
 (2) Fully insert the connector and check that it locked.

(i) When inspecting a connector with a volt/ohmmeter.
 (1) Carefully take out the water–proofingrubber if it is a water–proof type connector.
 (2) Insert the test probe in to the connector from the wiring side when checking the continuity, amperage or voltage.
 (3) Do not apply unnecessary force to the terminal.
 (4) After checking, install the water–proofing rubber on the connector securely.

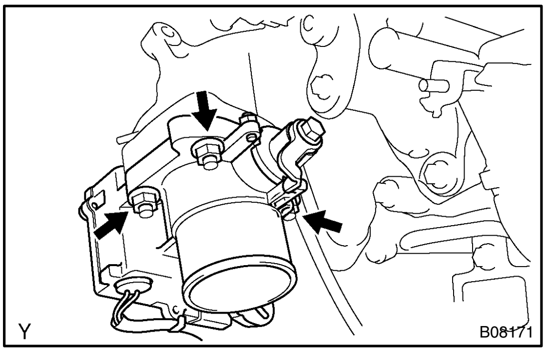
DIESEL THROTTLE

COMPONENTS

ED028–01



ED029–01



REMOVAL

1. DISCONNECT NO.2 AIR TUBE

2. REMOVE DIESEL THROTTLE BODY

(a) Disconnect the throttle control motor connector and throttle full switch connector.

(b) Remove the 3 nuts, diesel throttle body and gasket.

Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

HINT:

At the time of installation, please refer to the following items.

Place a new gasket to the No.3 intake manifold.

ED02A–01

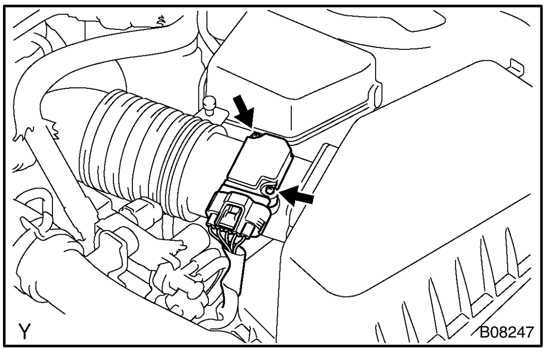
INSPECTION

INSPECT DIESEL THROTTLE BODY (See page DI–26)

ED02B–01

INSTALLATION

Installation is in the reverse order of removal. (See page ED–4)



AIR FLOW METER

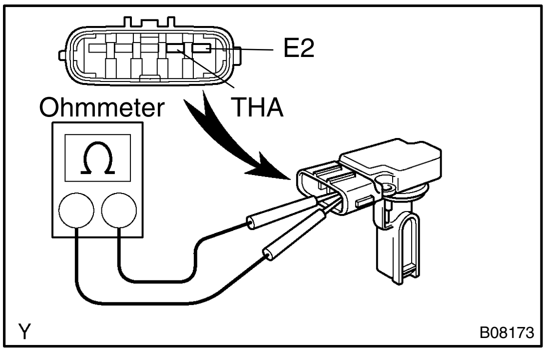
ED02L–01

INSPECTION

1. DISCONNECT AIR FLOW METER CONNECTOR

2. REMOVE AIR FLOW METER

Remove the 2 screws and air flow meter.

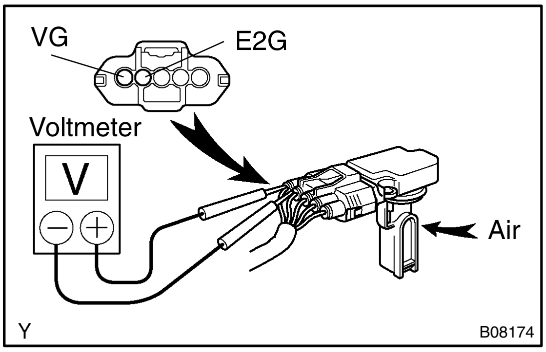


3. INSPECT AIR FLOW METER

(a) Using an ohmmeter, measure the resistance between terminals THA and E2.

Terminals	Resistance	Temperature
THA – E2	12.5 – 16.9 kΩ	–20°C (–4°F)
THA – E2	2.19 – 2.67 kΩ	20°C (68°F)
THA – E2	0.50 – 0.68 kΩ	60°C (140°F)

If the resistance is not as specified, replace the air flow meter.



(b) Inspect for operation.

(1) Connect the air flow meter connector.

(2) Connect the negative (–) terminal cable to the battery.

(3) Turn the ignition switch ON.

(4) Using a voltmeter, connect the positive (+) tester probe to terminal VG, and negative (–) tester probe to terminal E2G.

(5) Blow air into the air flow meter, and check that the voltage fluctuates.

If operation is not as specified, replace the air flow meter.

(6) Turn the ignition switch OFF.

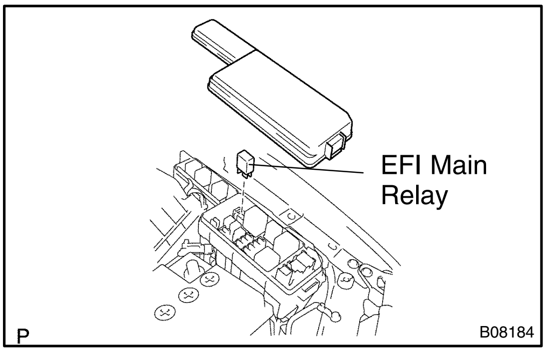
(7) Disconnect the negative (–) terminal cable from the battery.

(8) Disconnect the air flow meter connector.

4. REINSTALL AIR FLOW METER

Install the air flow meter with the 2 screws.

5. RECONNECT AIR FLOW METER CONNECTOR



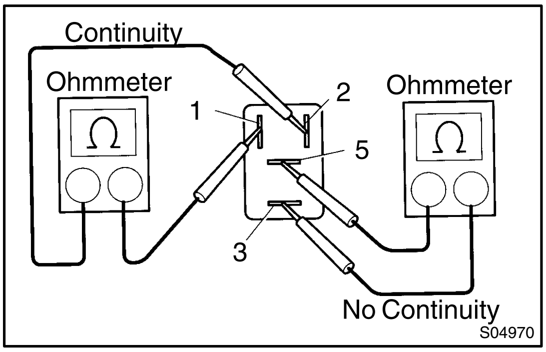
EFI MAIN RELAY

ED02M–01

INSPECTION

1. REMOVE ENGINE J/B COVER

2. REMOVE EFI MAIN RELAY (Marking: EFI)



3. INSPECT EFI MAIN RELAY

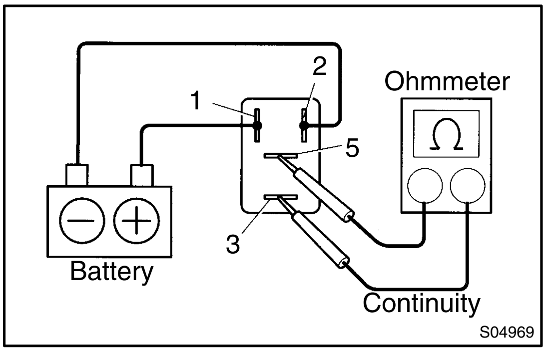
(a) Inspect the relay continuity.

(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

If there is no continuity, replace the relay.

(2) Check that there is no continuity between terminals 3 and 5.

If there is continuity, replace the relay.



(b) Inspect the relay operation.

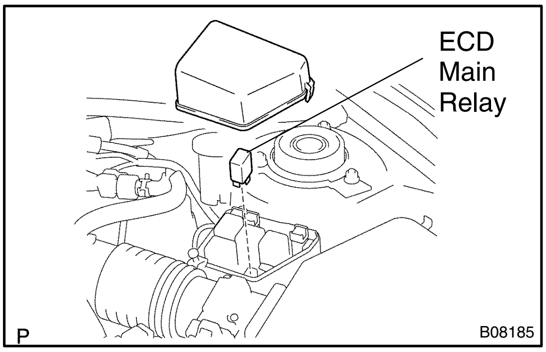
(1) Apply battery voltage across terminals 1 and 2.

(2) Using an ohmmeter, check that there is continuity between terminals 3 and 5.

If there is no continuity, replace the relay.

4. REINSTALL EFI MAIN RELAY

5. REINSTALL ENGINE J/B COVER



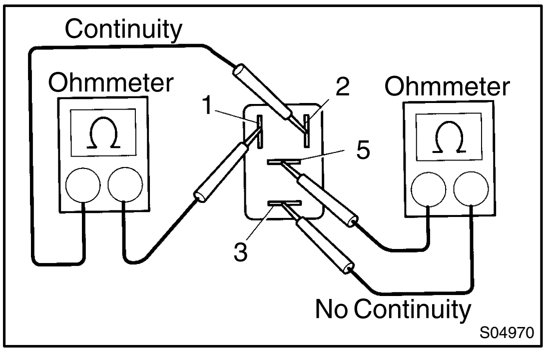
ECD MAIN RELAY

ED02C–01

INSPECTION

1. REMOVE NO.3 RELAY BOX COVER

2. REMOVE ECD MAIN RELAY (Marking: INJ)



3. INSPECT ECD MAIN RELAY

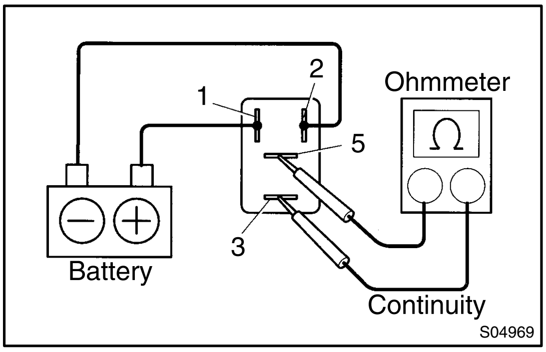
(a) Inspect the relay continuity.

(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

If there is no continuity, replace the relay.

(2) Check that there is no continuity between terminals 3 and 5.

If there is continuity, replace the relay.



(b) Inspect the relay operation.

(1) Apply battery voltage across terminals 1 and 2.

(2) Using an ohmmeter, check that there is continuity between terminals 3 and 5.

If there is no continuity, replace the relay.

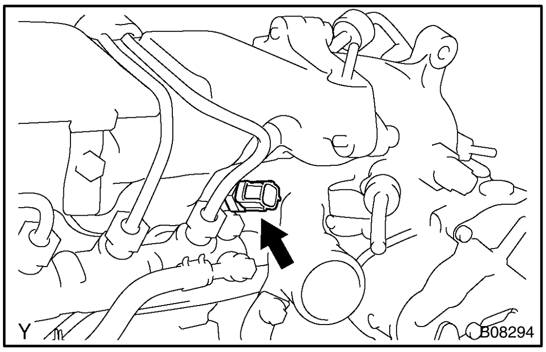
4. REINSTALL ECD MAIN RELAY

5. REINSTALL RELAY BOX COVER

WATER TEMPERATURE SENSOR

ED02D–01

INSPECTION

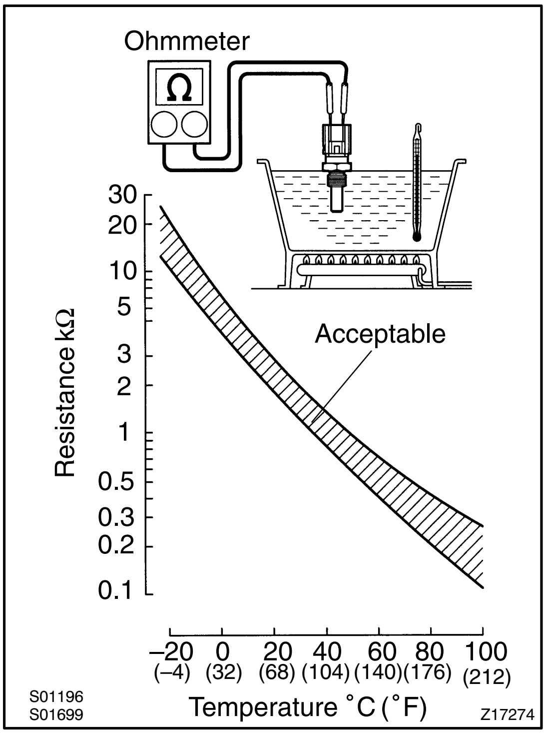


1. DRAIN ENGINE COOLANT

2. REMOVE WATER TEMPERATURE SENSOR

(a) Disconnect the sensor connector.

(b) Using a 19 mm deep socket wrench, remove the sensor and gasket.



3. INSPECT WATER TEMPERATURE SENSOR

Using an ohmmeter, measure the resistance between the terminals.

Resistance: Refer to the chart graph

If the resistance is not as specified, replace the water temperature sensor.

4. REINSTALL WATER TEMPERATURE SENSOR

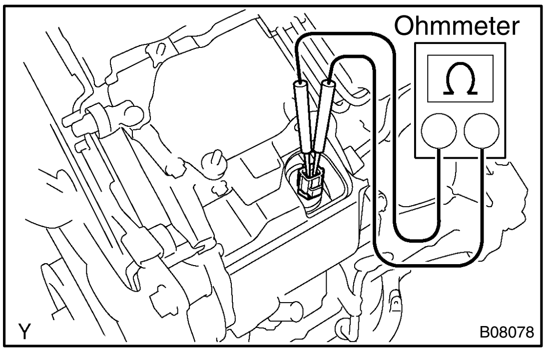
(a) Using a 19 mm deep socket wrench, install a new gasket and the sensor.

Torque: 20.4 N·m (208 kgf·cm, 15 ft·lbf)

(b) Connect the sensor connector.

5. REFILL WITH ENGINE COOLANT

(See page CO–2)



FUEL TEMPERATURE SENSOR

ED02F–01

INSPECTION

1. DISCONNECT FUEL TEMPERATURE SENSOR CONNECTOR

2. INSPECT FUEL TEMPERATURE SENSOR

Using an ohmmeter, measure the resistance between terminals.

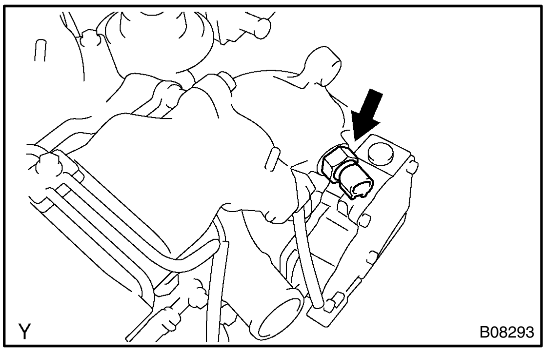
Resistance: 0.5 – 3.0 Ω at 40°C (104°F)

If the resistance is not specified, replace the supply pump assembly. (See page FU–16)

NOTICE:

In case of having the supply pump assembly replaced, must replace fuel inlet pipe, too.

3. RECONNECT FUEL TEMPERATURE SENSOR CONNECTOR



INTAKE AIR TEMPERATURE SENSOR

ED02E–01

INSPECTION

1. **REMOVE INTAKE AIR TEMP. SENSOR**

(a) Disconnect the sensor connector.

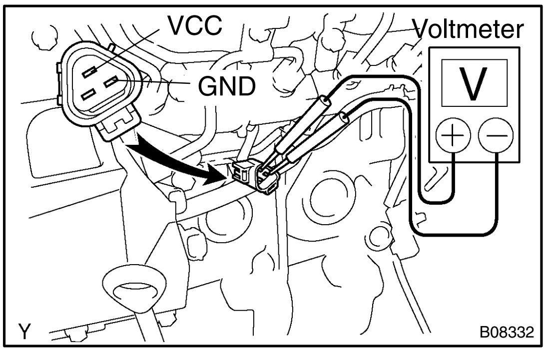
(b) Using a 22 mm deep socket wrench, remove the intake air temp. sensor.

2. **INSPECT INTAKE AIR TEMP. SENSOR**
   (See page ED–10)

3. **REINSTALL INTAKE AIR TEMP. SENSOR**

(a) Using a 22 mm deep socket wrench, install the intake air temp. sensor.
Torque: 34.3 N·m (350 kgf·cm, 25 ft·lbf)

(b) Connect the sensor connector.



FUEL PRESSURE SENSOR

ED02G–01

INSPECTION

1. INSPECT POWER SOURCE VOLTAGE OF FUEL PRESSURE SENSOR

(a) Disconnect the sensor connector.
(b) Turn the ignition switch ON.
(c) Using a voltmeter, measure the voltage between connector terminals VCC and GND of the wiring harness side.
Voltage: 4.5 – 5.5 V
(d) Turn the ignition switch OFF.
(e) Reconnect the sensor connector.

2. INSPECT VOLTAGE BETWEEN TERMINALS PCR AND E2 (See page DI–80)

TURBO PRESSURE SENSOR

ED02H–01

INSPECTION

INSPECT TURBO PRESSURE SENSOR (See page TC–21)

CAMSHAFT POSITION SENSOR

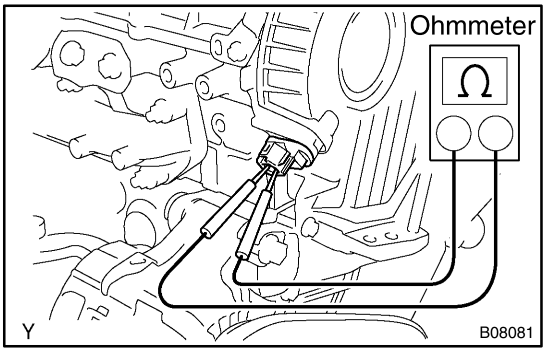
ED02I–01

INSPECTION

NOTICE:

"Cold" and "Hot" in the following sentences express the temperature of the sensor itself. "Cold" is from –10°C (14°F) to 50°C (122°F) and "Hot" is from 50°C (122°F) to 100°C (212°F).

1. DISCONNECT CAMSHAFT POSITION SENSOR CONNECTOR



2. INSPECT CAMSHAFT POSITION SENSOR

Using an ohmmeter, measure the resistance between terminals.

Resistance:

Cold	1,630 – 2,740 Ω
Hot	2,065 – 3,225 Ω

If the resistance is not as specified, replace the camshaft position sensor.

Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

NOTICE:

Be careful not drop and shock the sensor.

HINT:

Apply engine oil to the O–ring.

3. RECONNECT CAMSHAFT POSITION SENSOR CONNECTOR

CRANKSHAFT POSITION SENSOR

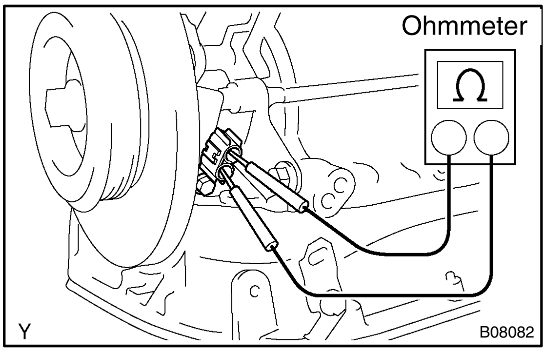
ED02J–01

INSPECTION

NOTICE:

”Cold” and ”Hot” in the following sentences express the temperature of the sensor itself. ”Cold” is from –10°C (14°F) to 50°C (122°F) and ”Hot” is from 50°C (122°F) to 100°C (212°F).

1. DISCONNECT CRANKSHAFT POSITION SENSOR CONNECTOR



2. INSPECT CRANKSHAFT POSITION SENSOR

Using an ohmmeter, measure the resistance between terminals.

Resistance:

Cold	1,630 – 2,740 Ω
Hot	2,065 – 3,225 Ω

If the resistance is not as specified, replace the crankshaft position sensor.

Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

NOTICE:

Be careful not drop and shock the sensor.

HINT:

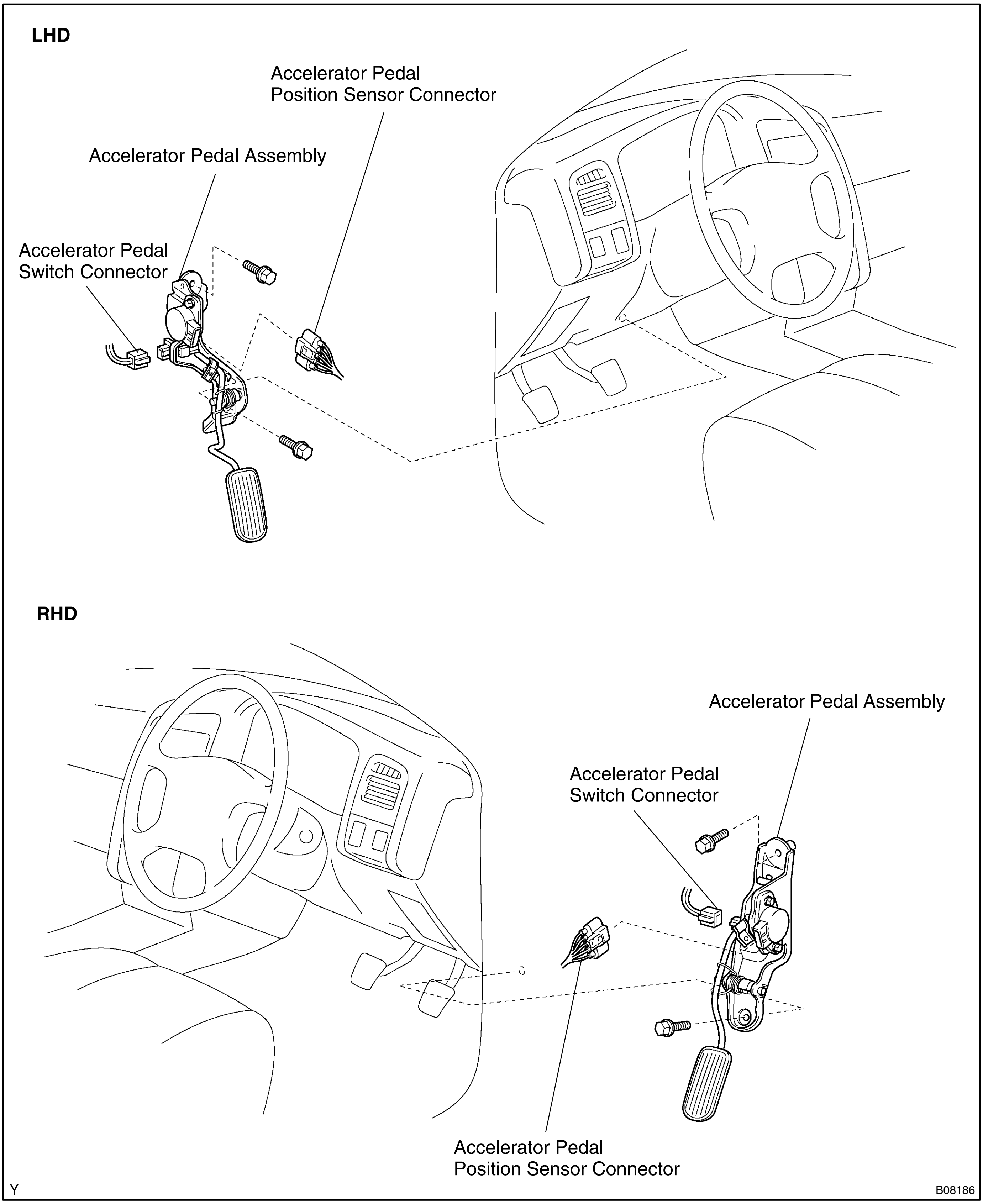
Apply engine oil to the O–ring.

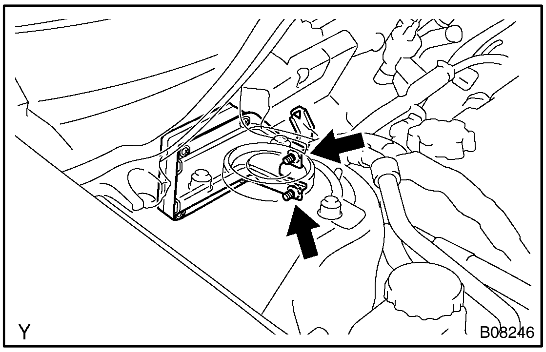
3. RECONNECT CRANKSHAFT POSITION SENSOR CONNECTOR

ACCELERATOR PEDAL

ED02K–01

COMPONENTS





ELECTRONIC DRIVING UNIT (EDU)

ED02N–01

INSPECTION

1. REMOVE EDU

(a) Disconnect the 2 connectors.

(b) Remove the 2 bolts and EDU.

2. INSPECT EDU (See page DI–89)

3. INSTALL EDU

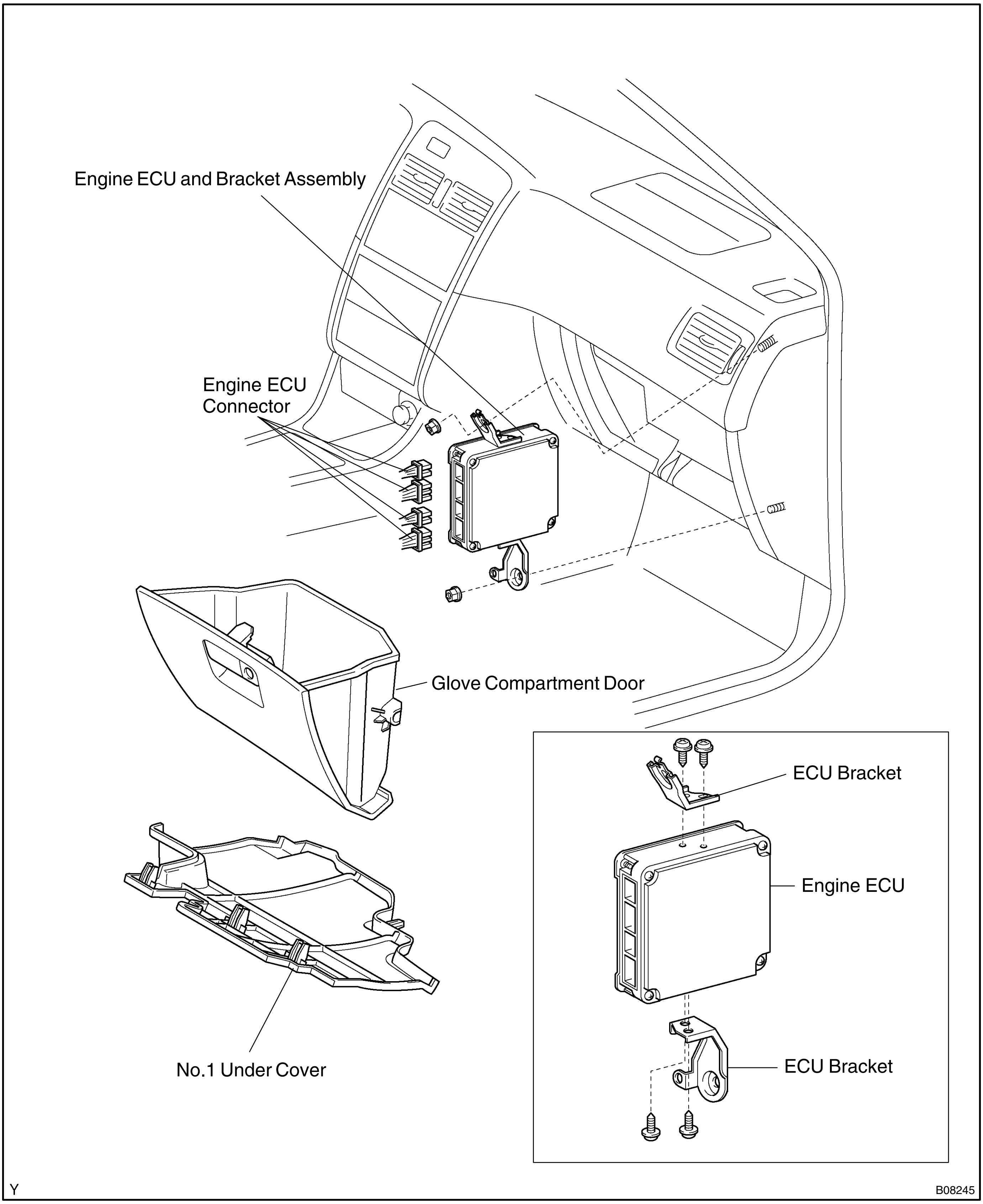
(a) Install the EDU with the 2 bolts.

(b) Connect the 2 connectors.

ENGINE ECU

COMPONENTS

ED02O–01



ED02P–01

INSPECTION

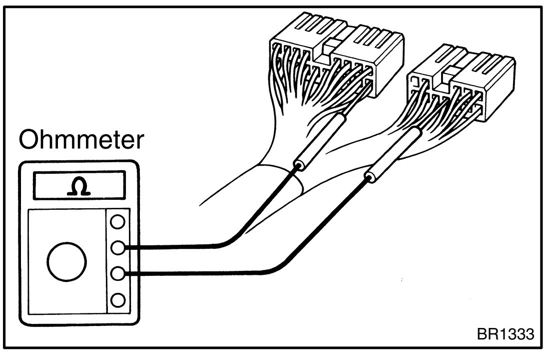
HINT:
The ECD circuit can be checked by measuring the resistance and voltage at the wiring connectors of the engine ECU.

1. REMOVE ENGINE ECU FROM VEHICLE BODY

2. INSPECT VOLTAGE OF ENGINE ECU
(See page DI–17)

3. INSPECT RESISTANCE OF ECD CIRCUITRY

Terminals	Condition	STD resistance (Ω)
LU+A – +B	–	15 – 30
LU–A – +B	–	15 – 30
LU+B – +B	–	15 – 30
LU–B – +B	–	15 – 30
THOP – E1	–	10 or less
THW – E2	Coolant temp. 80°C (176°F)	0.2 – 0.4 k
THA – E2	Intake air temp. 20°C (68°F)	2.0 – 3.0 k
THF – E2	Fuel temp. 20°C (68°F)	2.0 – 3.0 k
G+ – G–	Cold (–10°C (14°F) to 50°C (122°F)) Hot (50°C (122°F) to 100°C (212°F))	1630 – 2740 2065 – 3225
NE+ – NE–	Cold (–10°C (14°F) to 50°C (122°F)) Hot (50°C (122°F) to 100°C (212°F))	1630 – 2740 2065 – 3225
PDL – E1	Accelerator pedal fully opened	10 or less
THAF – E2	–	2.0 – 3.0 k
MREL – E01	–	60 – 80
EDUREL – E01	–	60 – 80
EGR – +B	20°C (68°F)	11 – 13
EGRC – +B	20°C (68°F)	37– 44
PA – +B	20°C (68°F)	37 – 44
RINJ1 – E01	20°C (68°F)	30 – 9600
RINJ2 – E01	20°C (68°F)	30 – 9600
RINJ3 – E01	20°C (68°F)	30 – 9600
RINJ4 – E01	20°C (68°F)	30 – 9600
PCV1 – COM	20°C (68°F)	1.5 – 1.8
PCV2 – COM	20°C (68°F)	1.5 – 1.8



(a) Turn the ignition switch OFF.
(b) Disconnect the 4 connectors from the engine ECU.
(c) Measure the resistance between each terminal of the wiring connectors.

NOTICE:

- **Do not touch the engine ECU terminals.**
- **The tester probe should be inserted in the wiring connector from the wiring side.**

ENGINE FUEL

FUEL FILTER

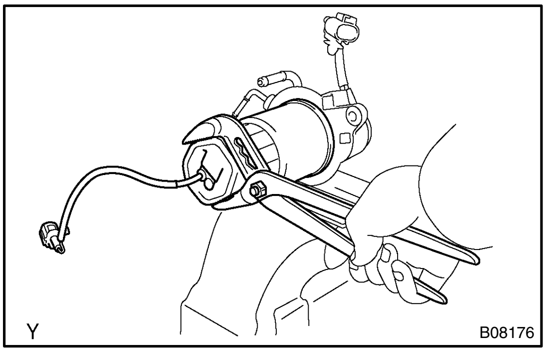
FU064–01

REPLACEMENT

1. REMOVE FUEL FILTER ASSEMBLY FROM FUEL FILTER SUPPORT

2. DRAIN FUEL FROM FUEL FILTER

Loosen the drain plug, and drain the fuel from the fuel filter.

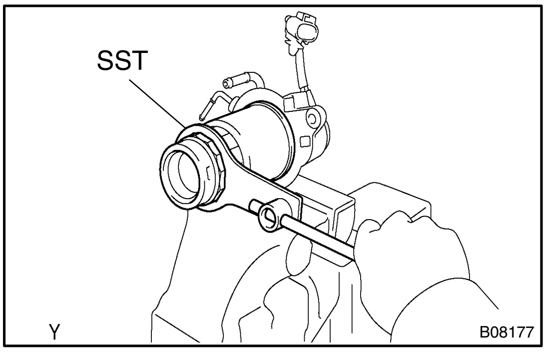


3. REMOVE FUEL FILTER WARNING SWITCH FROM FUEL FILTER

(a) Mount the fuel filter in a soft jaw vise.

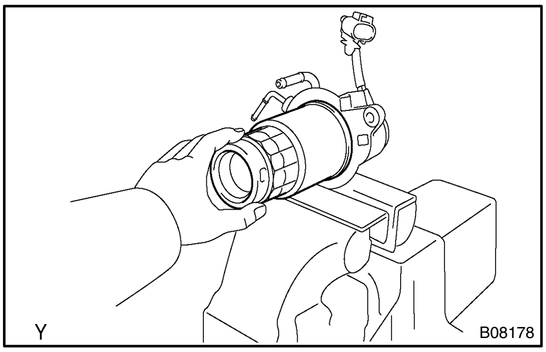
(b) Using pliers, remove the warning switch and O–ring.

NOTICE:
Be careful not to damage the warning switch.



4. REMOVE FUEL FILTER

Using SST, remove the fuel filter.
SST 09228–64030



5. INSTALL NEW FUEL FILTER

(a) Check and clean the fuel filter installation surface.

(b) Apply fuel to the gasket of a new fuel filter.

(c) Lightly screw the fuel filter into place, and tighten it until the gasket comes into contact with the seat.

(d) Tighten it additional 3/4 turn by hand.

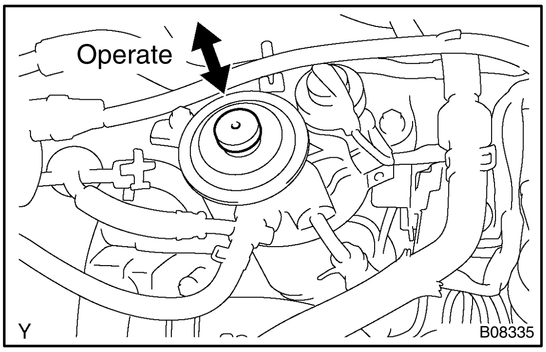
6. INSTALL FUEL FILTER WARNING SWITCH TO NEW FUEL FILTER

(a) Install a new O–ring to the warning switch.

(b) Apply fuel to the O–ring of the warning switch.

(c) Install the warning switch to a new fuel filter by hand.

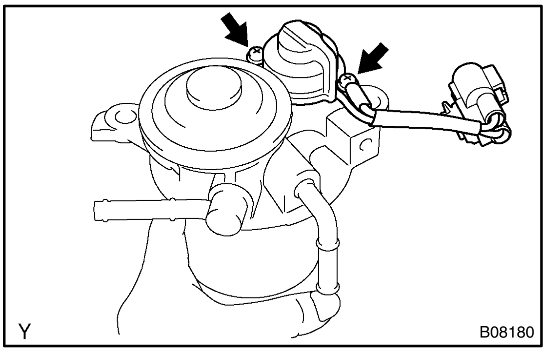
7. REINSTALL FUEL FILTER ASSEMBLY TO FUEL FILTER SUPPORT



8. REFILL FUEL FILTER WITH FUEL

Operate the hand pump until you feel more resistance.

9. START ENGINE AND CHECK FOR FUEL LEAK

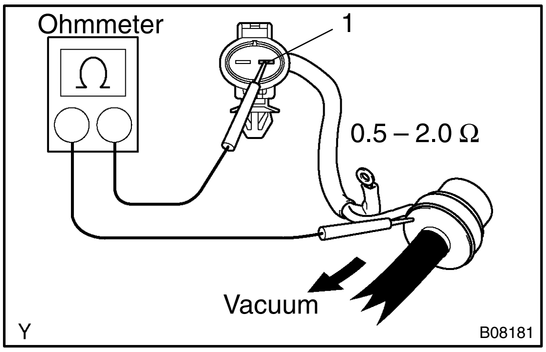


FUEL HEATER

INSPECTION

FU065–01

1. REMOVE FUEL HEATER

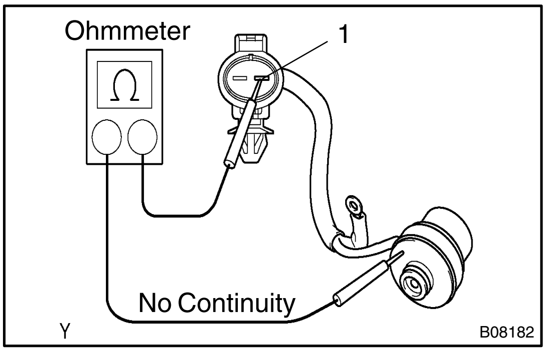


2. INSPECT FUEL HEATER

(a) Apply a vacuum of 34.7 ± 5.3 kPa (260 ± 40 mmHg, 10.24 ± 1.57 in.Hg) or more to the vacuum switch port.

(b) Using an ohmmeter, measure the resistance between terminal 1 and the switch body.
Resistance: 0.5 – 2.0 Ω at 20°C (68°F)

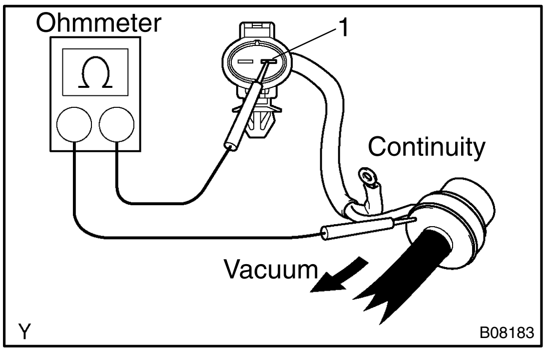
If the resistance is not as specified, replace the fuel heater and vacuum switch assembly.



3. INSPECT VACUUM SWITCH CONTINUITY

Using an ohmmeter, check that there is no continuity between terminal 1 and the switch body.

If continuity is not as specified, replace the fuel heater and vacuum switch assembly.



4. INSPECT VACUUM SWITCH OPERATION

(a) Apply a vacuum of 34.7 ± 5.3 kPa (260 ± 40 mmHg, 10.24 ± 1.57 in.Hg) or more to the vacuum switch port.

(b) Using an ohmmeter, check that there is continuity between terminal 1 and the switch body.

If operation is not as specified, replace the fuel heater and vacuum switch assembly.

5. REINSTALL FUEL HEATER
Torque: 1.96 N·m (20 kgf·cm, 17 in.·lbf)

INJECTOR

FU066–01

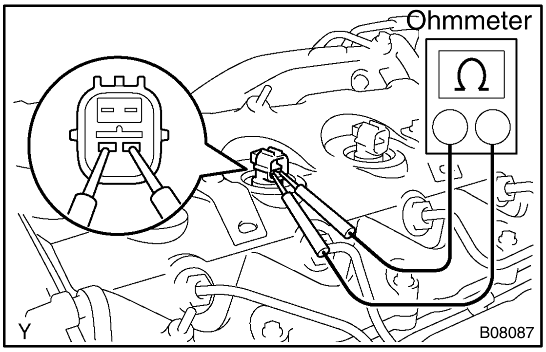
ON–VEHICLE INSPECTION

NOTICE:

In case of having the injectors replaced, must replace injection pipes, too.

INSPECT INJECTORS

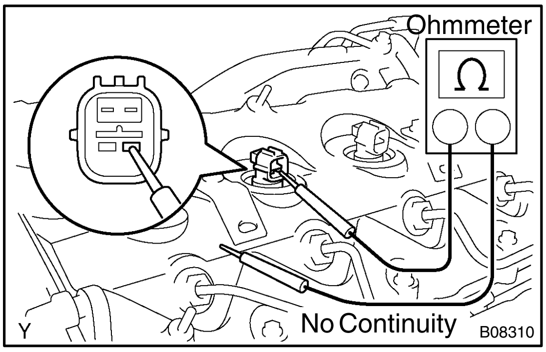
(a) Disconnect the 4 injector connectors.



(b) Using an ohmmeter, measure the resistance between terminals as shown.

Resistance: 2.5 – 3.1 Ω at 20°C (68°F)

If the resistance is not specified, replace the injector. (See page FU–6)



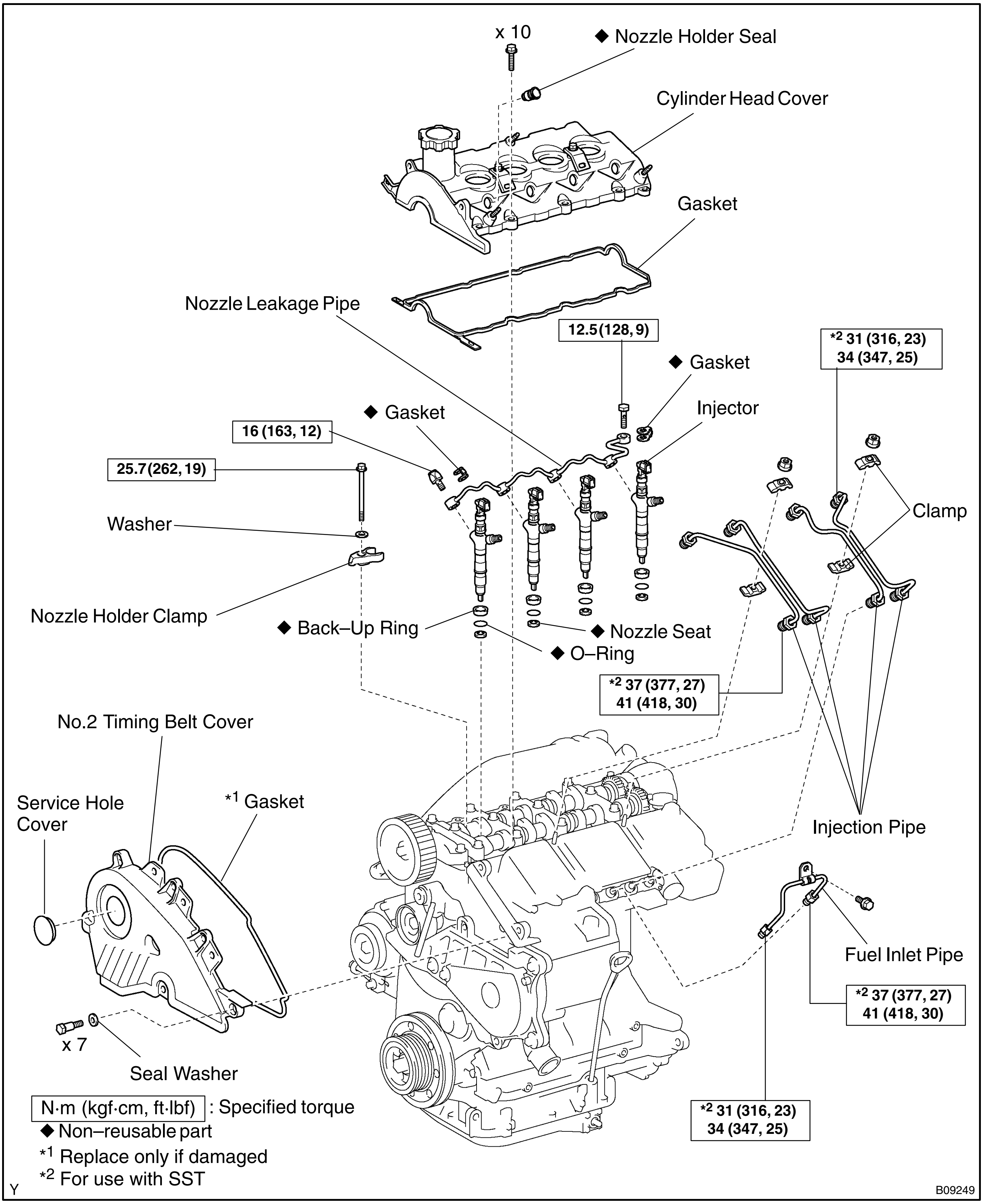
(c) Using an ohmmeter, check that there is no continuity between the injector terminal and ground as shown.

If there is continuity, replace the injector. (See page FU–6)

(d) Reconnect the 4 injector connectors.

FU067–01

COMPONENTS



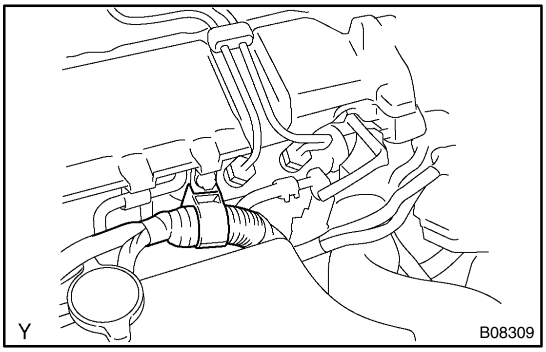
FU068–01

REMOVAL

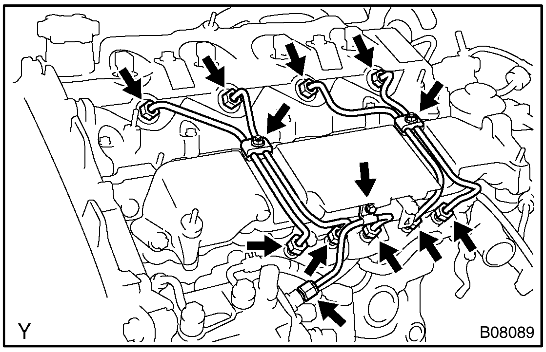
NOTICE:
When removing the injection pipes, clean them up with a brush and compressed air.

1. REMOVE INJECTION PIPES

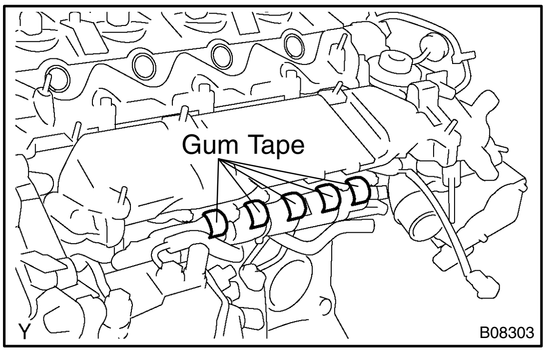
(a) Remove the reservoir tank.



(b) Remove the wire bracket and slide the engine wire.



(c) Remove the fuel inlet pipe. (See page FU–16)
(d) Remove the 2 nuts and 2 upper injection pipe clamps from the intake manifold.
(e) Using SST, remove the injection pipe from the common rail side.
SST 09023–12900
(f) Using SST, remove the injection pipe from the injector side.
SST 09023–12700

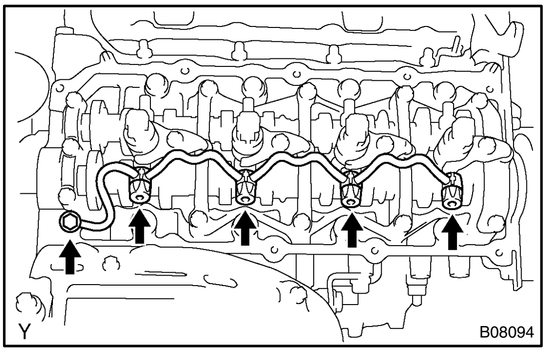


NOTICE:
- **After removing the fuel pipe, affix the gum tape on the common rail for preventing dust from coming into them.**
- **After removing the fuel pipe, put a vinyl bag and rubber band for preventing from mixing foreign objects over the injectors inlet.**

(g) Remove the 2 lower injection pipe clamps from the intake manifold.

2. REMOVE NO.2 TIMING BELT COVER (See page EM–12)

3. REMOVE CYLINDER HEAD COVER (See page EM–28)

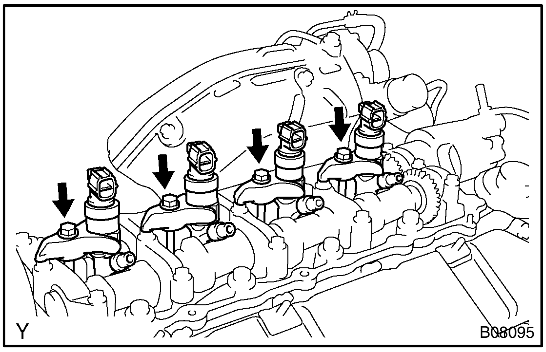


4. REMOVE NOZZLE LEAKAGE PIPE

Remove the union bolt, 4 hollow screws, nozzle leakage pipe and 5 gaskets from the cylinder head and injector.

NOTICE:

When removing the return pipe, place the shop rag and the likes under pipe.



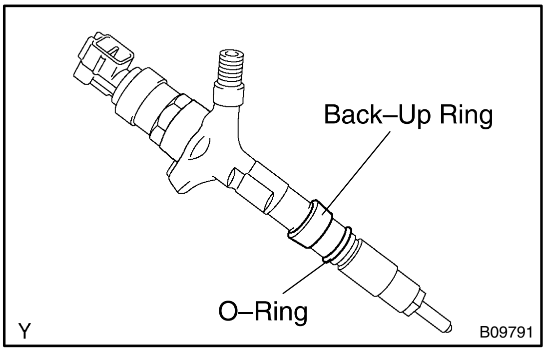
5. REMOVE INJECTORS

(a) Remove the 4 bolts, 4 washers and 4 nozzle holder clamps.

(b) Disconnect the 4 injectors from the cylinder head.

HINT:

Arrange the injectors in correct order.



(c) Remove the O–ring and back–up ring from each injector.

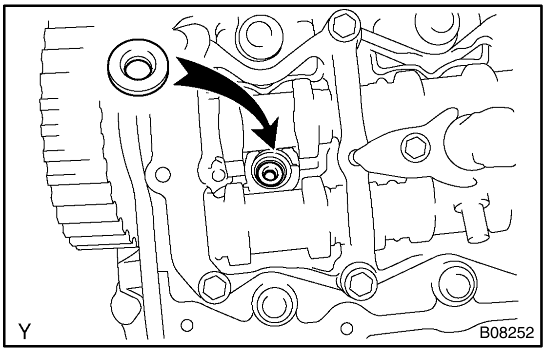
(d) Remove the 4 nozzle seats from the cylinder head.

FU069–01

INSTALLATION

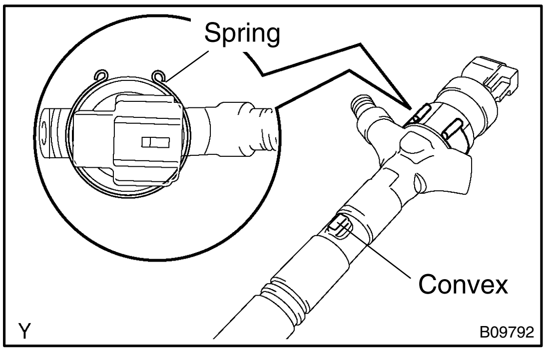
NOTICE:

- **When installing, clean up the seal surface of the injector, injection pipe, fuel inlet pipe, supply pump and common rail with clean light oil.**
- **In case of having the common rail and/or injectors replaced, must replace injection pipes, too.**
- **In case of having the supply pump and/or common rail replaced, must replace fuel inlet pipe, too.**



1. INSTALL INJECTORS

(a) Install 4 new nozzle seats to the cylinder head.



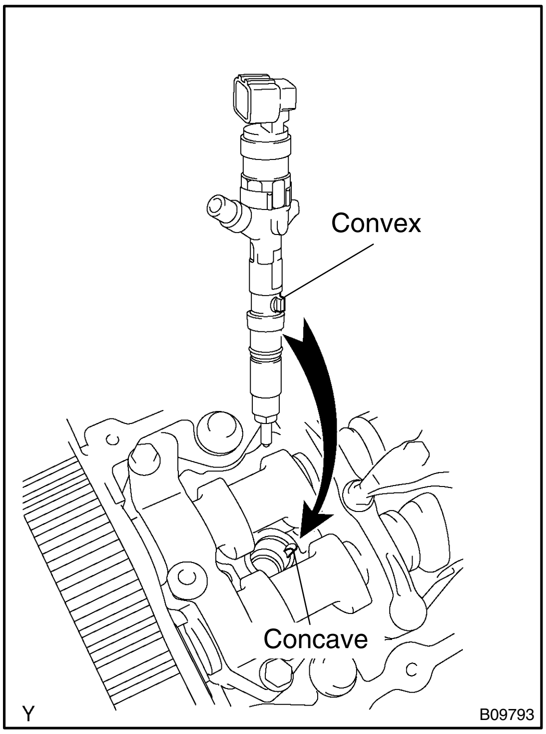
(b) Set the spring to each injector.

NOTICE:

Be sure to make the opening direction of the spring and the direction of the injector positioning convex meet.

(c) Install a new back–up ring and O–ring to each injector.

(d) Apply a light coat of oil onto O–ring to each injector.

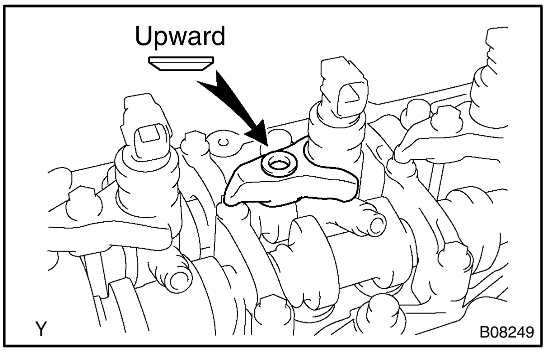


(e) Meet the injector positioning convex to the positioning concave at the cylinder head side and install the injector to the cylinder head.

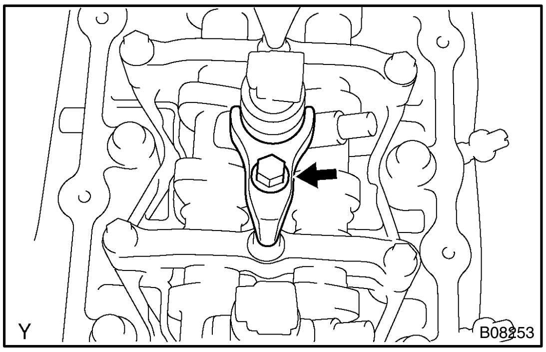
NOTICE:

- **At this time, insert the injector until it touches the nozzle sheet surface.**
- **When installing the injector to the cylinder head and in case that the injector comes to float up with the reaction of O–ring, pull out the injector once, install it again.**
- **During the time after equipping the head cover and before installing the injection pipe, install the irregular object prevention cover.**
- **Do not exchange the injector cylinder.**

(f) Place the 4 nozzle holder clamps to each injector.



(g) Set the washer on the nozzle holder clamp as shown in the illustration.



(h) Tighten the bolt.

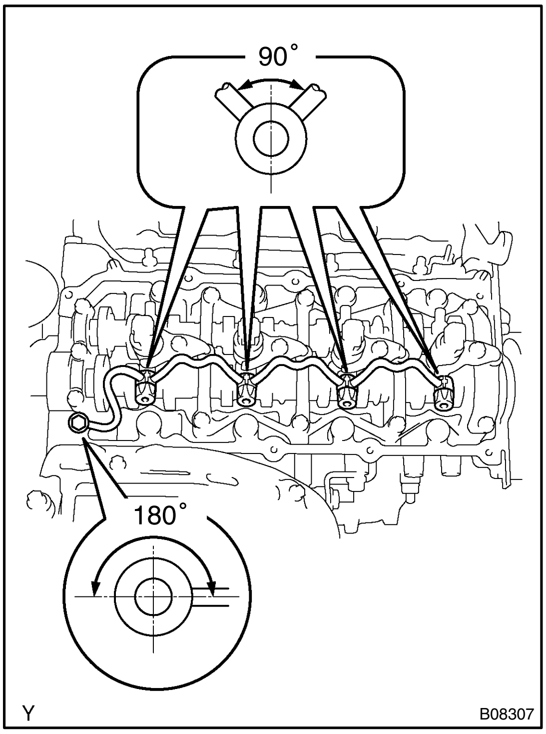
HINT:

Apply a light coat of engine oil on the threads and under the heads of the nozzle holder clamp bolts.

Torque: 25.7 N·m (262 kgf·cm, 19 ft·lbf)

NOTICE:

At this time, the clamp has its cam cap bolt as a fulcrum and clip the injector at the fork portion.



2. INSTALL NOZZLE LEAKAGE PIPE

(a) Place the leakage pipe and 5 new gaskets.

NOTICE:

Do the installation of the gasket craw within the angle range shown in the illustration.

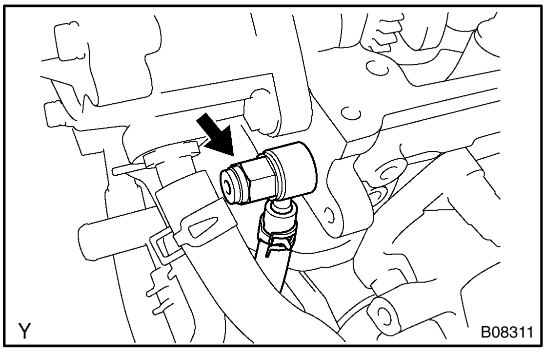
(b) Apply a light coat of oil onto 4 hollow screws and union bolt.

(c) Tighten the 4 hollow screws and union bolt by hand.

(d) Tighten the 4 hollow screws and union bolt.

Torque:
Hollow screw:
16 N·m (163 kgf·cm, 12 ft·lbf)
Union bolt:
12.5 N·m (128 kgf·cm, 9 ft·lbf)

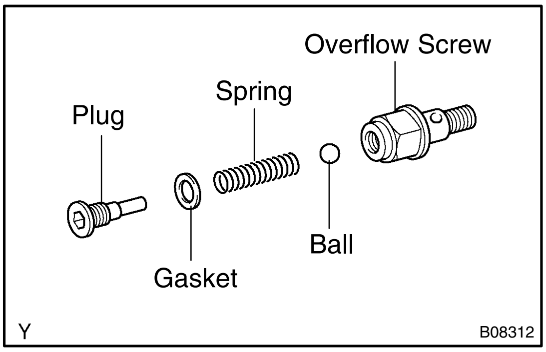
(e) Check that there are no leaks from nozzle leakage pipe connection.



(1) Disconnect the fuel hose, and remove the check valve, No.2 nozzle leakage pipe and gasket.

(2) Purchase a new check valve.

Part No. 23122 – 27010



(3) Remove the plug, gasket, spring and ball.

(4) Install the plug with the gasket to the overflow screw.

Torque: 9.8 N·m (100 kgf·cm, 87 in.·lbf)

(5) Install the No.2 nozzle leakage pipe and gasket with the check valve to the cylinder head.

Torque: 21 N·m (214 kgf·cm, 15 ft·lbf)

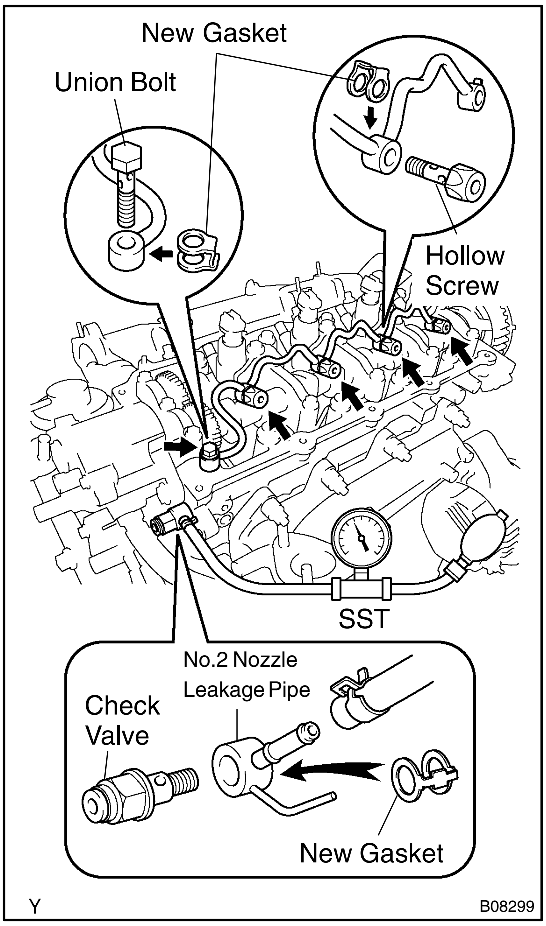
(6) Apply a light coat of soapy water (any fluid to detect fuel leakage) on the nozzle leakage pipe connection.

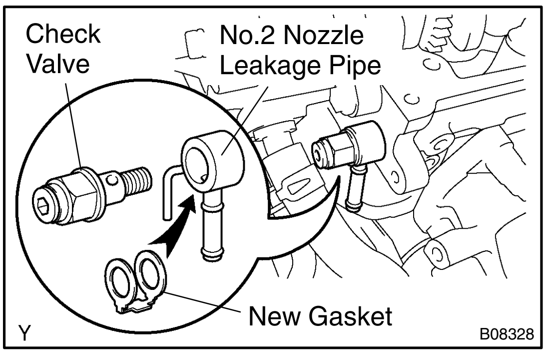
(7) Using SST (turbocharger pressure gauge), apply the SST to the fuel return side of the No.2 nozzle leakage pipe, and maintain 100 kPa (1 kgf/cm^2, 14.5 psi) of pressure for 600 seconds to check that there are no bubbles from applying the soapy water place.

SST 09992–00242

(8) After checking fuel leaks, wipe off soapy water from nozzle leakage pipe connection.

(9) Remove SST, check valve, No.2 nozzle leakage pipe and gasket.





(10) Reinstall the No.2 nozzle leakage pipe and a new gasket with the check valve.

Torque: 21 N·m (214 kgf·cm, 15 ft·lbf)

HINT:

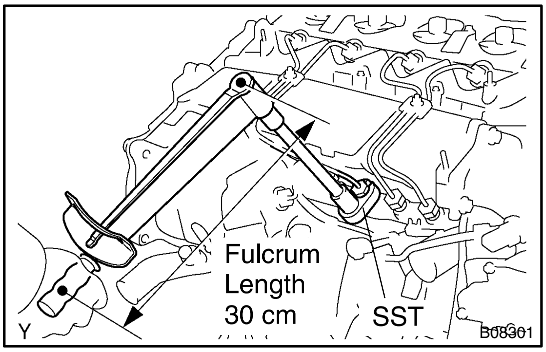
Never reinstall the disassembled check valve on the engine.

(11) Reconnect the fuel hose to the No.2 nozzle leakage pipe.

3. INSTALL CYLINDER HEAD COVER (See page EM–46)

4. **INSTALL NO.2 TIMING BELT COVER (See page EM–18)**
5. **INSTALL INJECTION PIPE**

(a) Install the 2 lower injection pipe clamps to the intake manifold.
(b) Remove the vinyl bag and rubber band from the injectors.
(c) Remove the gum tape from the common rail.
(d) Temporarily tighten the injection pipe.



(e) Using SST, tighten the injection pipe from the common rail side.
SST 09023–12900
Torque:
37 N·m (377 kgf·cm, 27 ft·lbf) for use with SST
41 N·m (418 kgf·cm, 30 ft·lbf)

HINT:
Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

(f) Using SST, tighten the injection pipe from the injector side.
SST 09023–12700
Torque:
31 N·m (316 kgf·cm, 23 ft·lbf) for use with SST
34 N·m (347 kgf·cm, 25 ft·lbf)

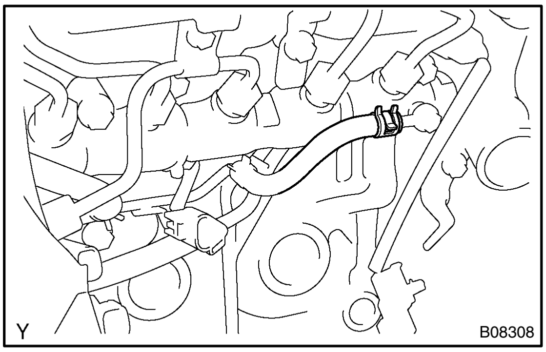
HINT:
Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

(g) Install the 2 upper injection pipe clamps and 2 nuts.
Torque: 5 N·m (51 kgf·cm, 44 in.·lbf)
(h) Install the fuel inlet pipe (See page FU–18)
(i) Install the engine wire.
(j) Install the reservoir tank.

6. **CHECK FUEL LEAK**

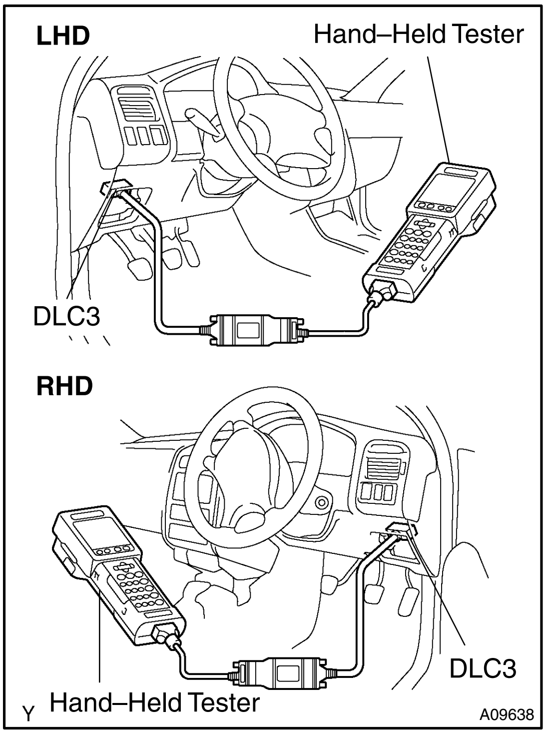
CAUTION:
- **During ACTIVE TEST mode, engine speed goes high and combustion noise becomes loud, so pay attention.**
- **During ACTIVE TEST mode, fuel becomes high–pressured, so take much care for not expose your eyes, hands, or body to the escaped fuel.**

(a) Check that there are no leaks from any part of the fuel system at the engine stops.
If there is fuel leakage, replace these parts.
(b) While cranking or start the engine, check that there are no leaks from any part of the fuel system.
If there is fuel leakage, replace these parts.



(c) Disconnect the return hose from the common rail.
(d) While cranking the engine, check fuel leaks from the return pipe.

If there is fuel leakage, replace the common rail assembly. (See page FU–22)



(e) Connect the hand–held tester to the DLC3.
(f) Start the engine and push the hand–held tester main switch ON.
(g) Select the FUEL LEAK test of ACTIVE TEST mode on the hand–held tester.
(h) If you have no hand–held tester, depress the accelerator pedal quickly and fully to increase the engine speed at maximum and keep it for 2 seconds. Repeat this operation several times.
(i) Check that there are no leaks from any part of the fuel system.

NOTICE:
However, if the leakage from the return pipe is less than 10 cc (0.6 cu in.) in a minute, it is acceptable.

If there is fuel leakage, replace these parts.

(j) Reconnect the return hose to the common rail.

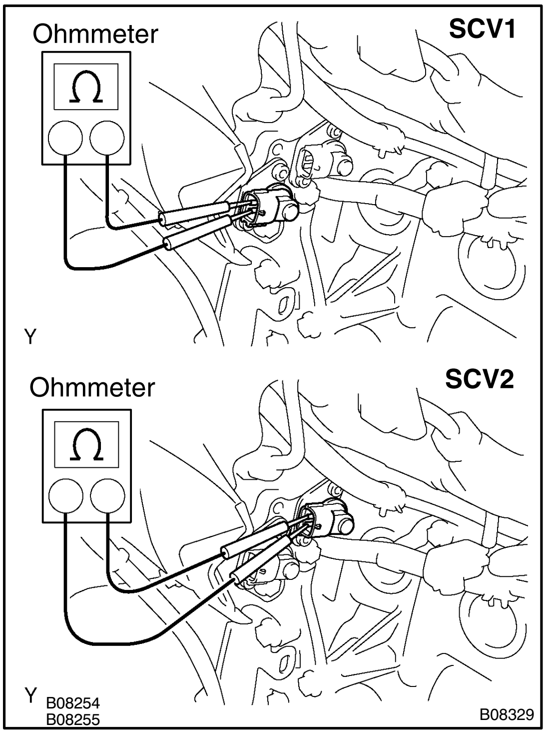
SUPPLY PUMP

FU06A–01

ON–VEHICLE INSPECTION

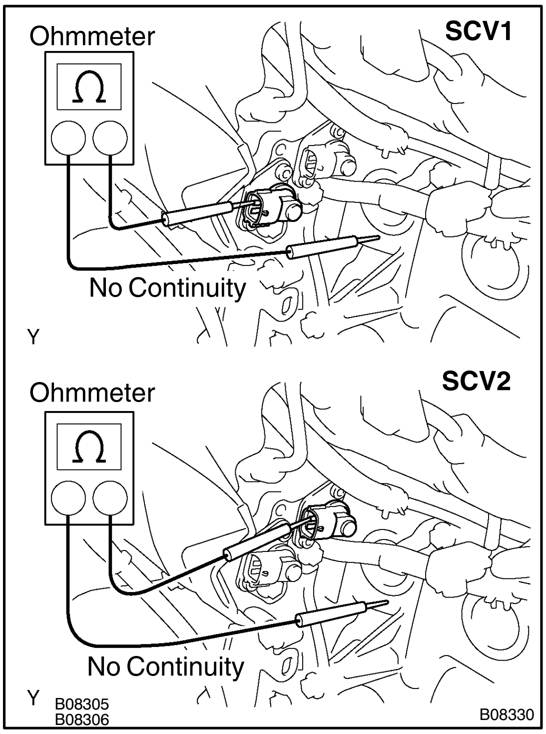
INSPECT SCV1 AND SCV2

(a) Disconnect the SCV1 and SCV2 connectors.



(b) Using an ohmmeter, measure the resistance between terminals as shown.
Resistance: 1.5 – 1.7 Ω at 20°C (68°F)

If the resistance is not specified, replace the pump.
(See page FU–16)



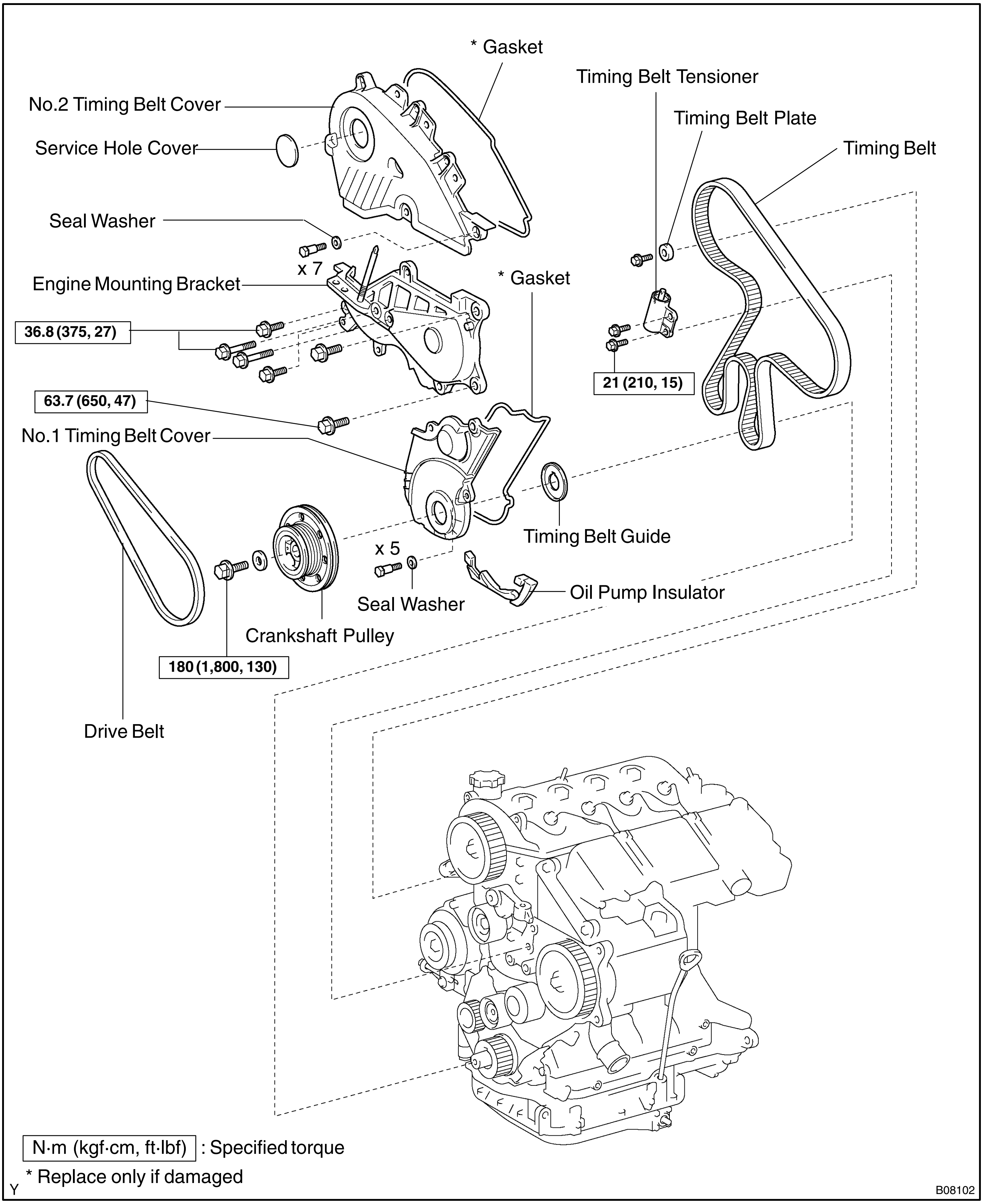
(c) Using an ohmmeter, check that there is no continuity between the terminal and ground as shown.

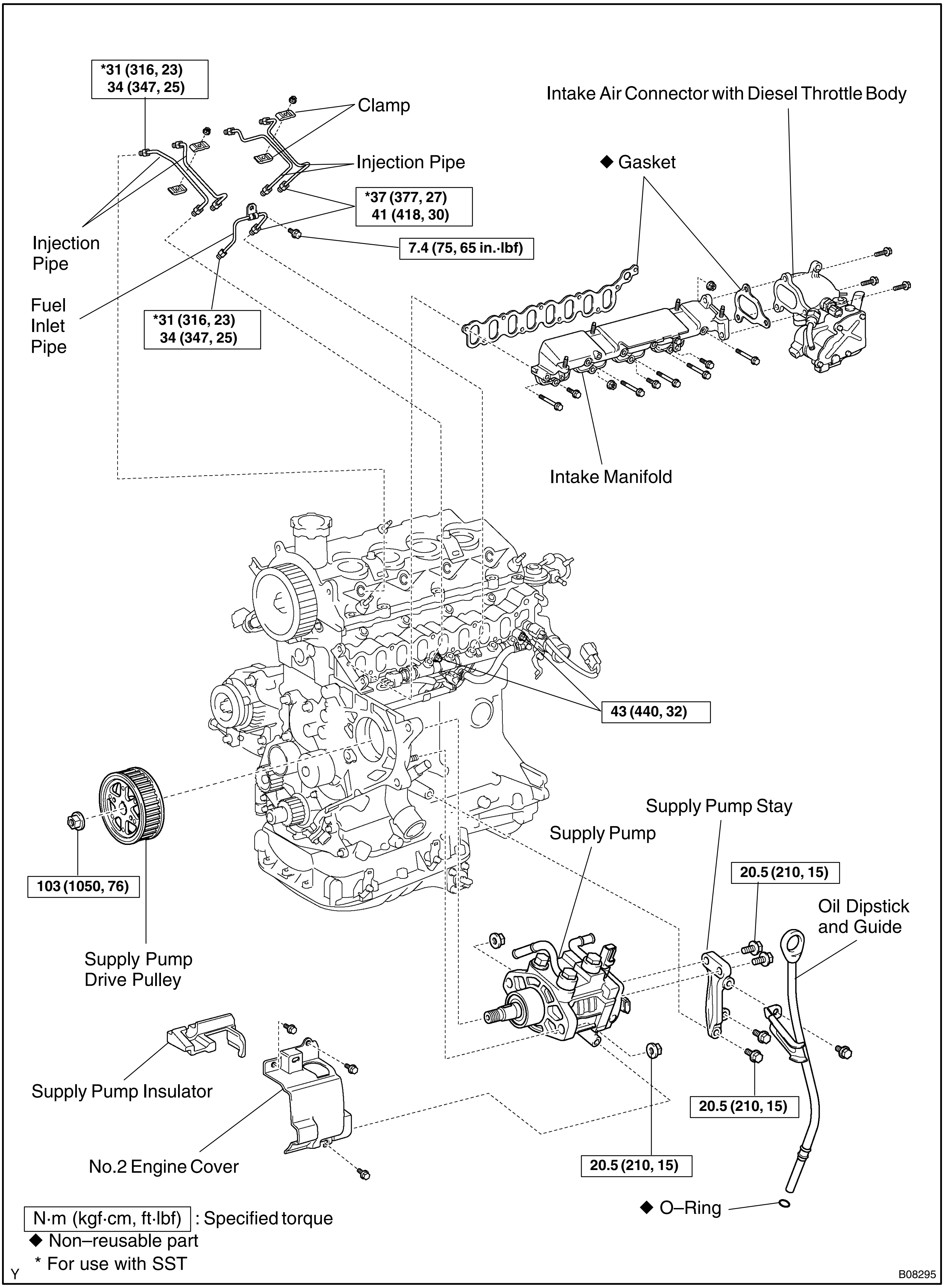
If there is continuity replace the pump.
(See page FU–16)

(d) Reconnect the SCV1 and SCV2 connectors.

FU06B–01

COMPONENTS



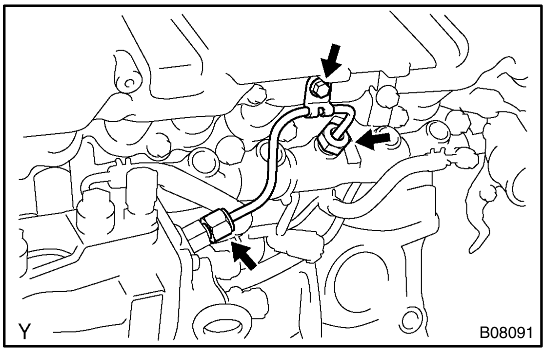

*31 (316, 23)
34 (347, 25)
Clamp
Intake Air Connector with Diesel Throttle Body
Injection Pipe
◆ Gasket
*37 (377, 27)
41 (418, 30)
7.4 (75, 65 in.·lbf)
Injection Pipe
Fuel Inlet Pipe
*31 (316, 23)
34 (347, 25)
Intake Manifold
43 (440, 32)
Supply Pump Stay
Supply Pump
20.5 (210, 15)
103 (1050, 76)
Oil Dipstick and Guide
Supply Pump Drive Pulley
Supply Pump Insulator
20.5 (210, 15)
No.2 Engine Cover
20.5 (210, 15)
◆ O–Ring
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
* For use with SST
Y
B08295

FU06C–01

REMOVAL

NOTICE:
When removing the injection pipes and fuel inlet pipe, clean them up with a brush and compressed air.

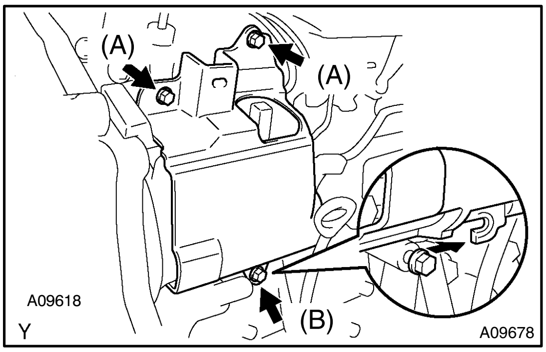
1. **REMOVE CRANKSHAFT PULLEY (See page EM–12)**
2. **REMOVE TIMING BELT COVER AND ENGINE MOUNTING BRACKET (See page EM–12)**
3. **REMOVE TIMING BELT (See page EM–12)**
4. **REMOVE INJECTION PIPE (See page FU–6)**



5. **REMOVE FUEL INLET PIPE**

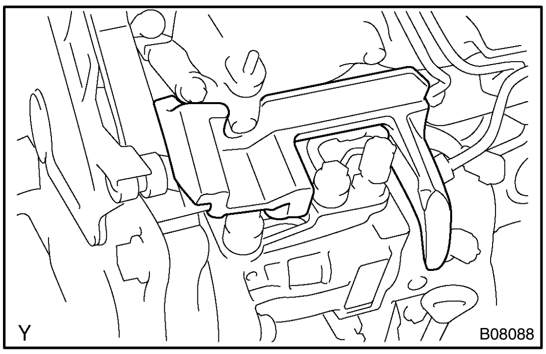
(a) Remove the pipe clamp bolt from the intake manifold.
(b) Using SST, remove the fuel inlet pipe from the common rail side.
SST 09023–12900
(c) Using SST, remove the fuel inlet pipe from the pump side.
SST 09023–12700

NOTICE:
After removing the fuel pipe, affix the gum tape on the pump, common rail, and the whole injector installation area of the cylinder head cover for preventing dust from coming into them.

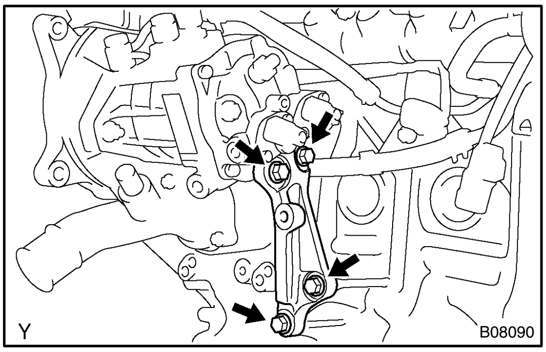


6. **REMOVE NO.2 ENGINE COVER**

(a) Remove the 2 bolts (A).
(b) Loosen the bolt (B) and remove the cover.



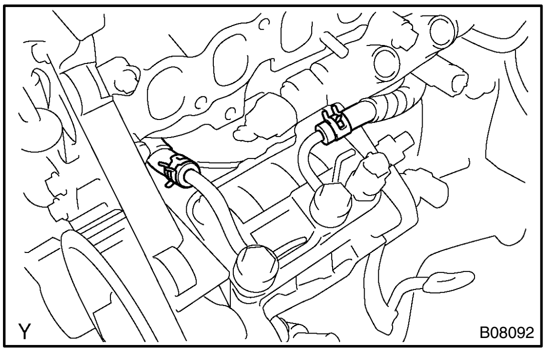
7. **REMOVE SUPPLY PUMP INSULATOR**
8. **LOOSEN COMMON RAIL 2 BOLTS**
9. **REMOVE INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY (See page EM–28)**
10. **REMOVE INTAKE MANIFOLD (See page EM–28)**
11. **REMOVE SUPPLY PUMP DRIVE PULLEY (See page EM–12)**
12. **REMOVE OIL DIPSTICK AND GUIDE (See page LU–7)**



13. REMOVE SUPPLY PUMP STAY

Remove the 4 bolts and supply pump stay.

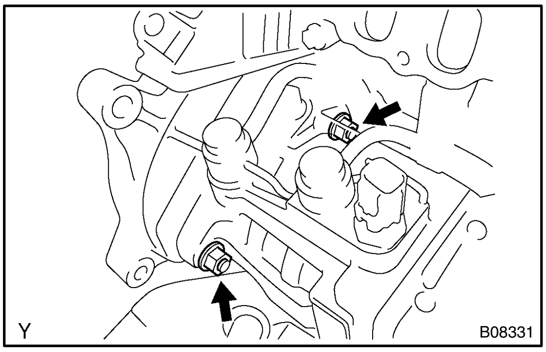
14. REMOVE SUPPLY PUMP



(a) Disconnect the 2 fuel hoses from the pump.

NOTICE:

After disconnecting the fuel hose, affix the gum tape on the No.2 fuel pipe for preventing dust from coming into them.



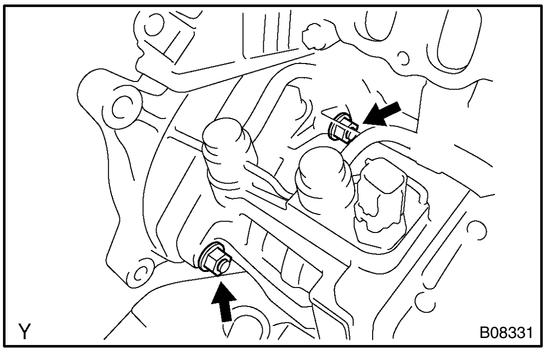
(b) Remove the 2 nuts and pump.

FU06D–01

INSTALLATION

NOTICE:

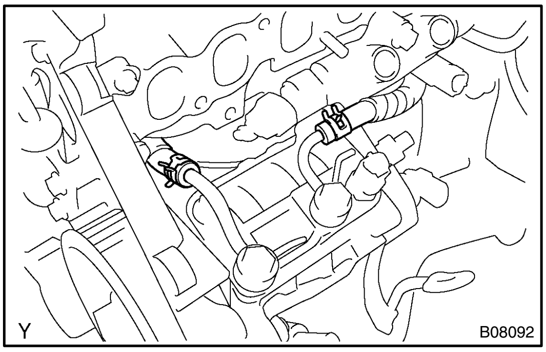
- **When installing, clean up the seal surface of the injector, injection pipe, fuel inlet pipe, supply pump and common rail with clean light oil.**
- **In case of having the common rail and/or injectors replaced, must replace injection pipes, too.**
- **In case of having the supply pump and/or common rail replaced, must replace fuel inlet pipe, too.**



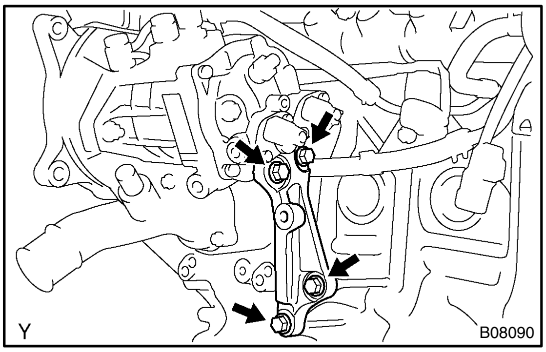
1. INSTALL SUPPLY PUMP

(a) Install the pump with the 2 nuts.
Torque: 20.5 N·m (210 kgf·cm, 15 ft·lb)

(b) Remove the gum tape from the No.2 fuel pipe.



(c) Connect the 2 fuel hoses to the pump.



2. INSTALL SUPPLY PUMP STAY

(a) Tighten the 2 bolts at the supply pump side until 2 or 3 threads of a screw.

(b) Stick the supply pump stay to both of the cylinder block and supply pump and torque the cylinder block side.
Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

(c) Torque the supply pump side.
Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

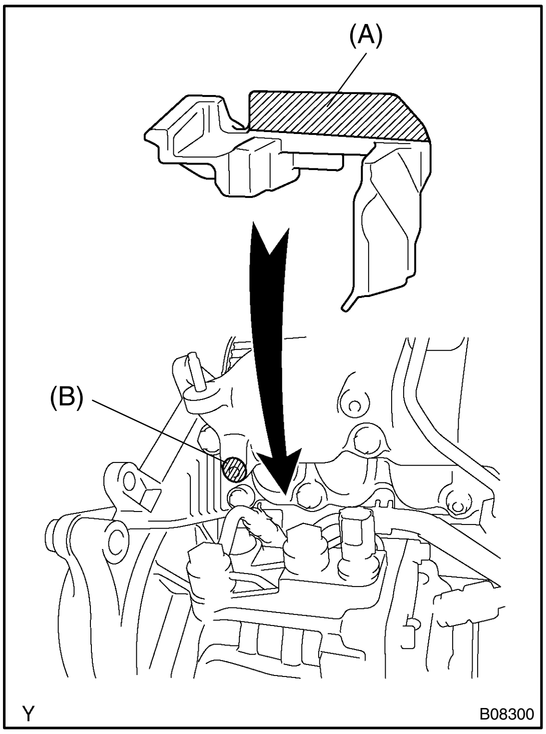
3. INSTALL OIL DIPSTICK AND GUIDE (See page LU–14)

4. INSTALL SUPPLY PUMP DRIVE PULLEY (See page EM–18)

5. INSTALL INTAKE MANIFOLD (See page EM–46)

6. INSTALL INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY (See page EM–46)

7. TIGHTEN COMMON RAIL 2 BOLTS
Torque: 43 N·m (440 kgf·cm, 32 ft·lbf)



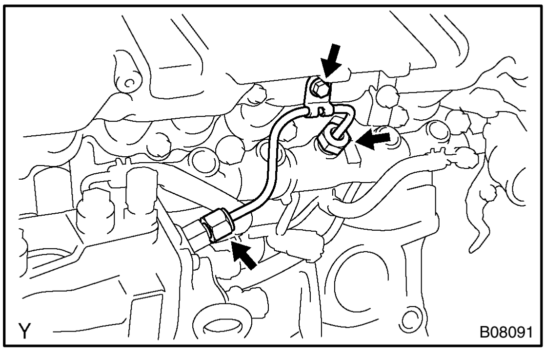
8. INSTALL SUPPLY PUMP INSULATOR

Set your standard to equalize the surfaces of the shaded portion (A) of the supply pump insulator and the shaded portion (B) of the intake manifold shown in the illustration.

NOTICE:

Check that the insulator is not touching the union bolt of the pump.

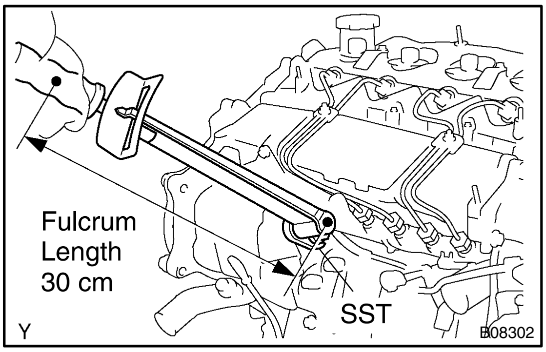
9. INSTALL NO.2 ENGINE COVER



10. INSTALL FUEL INLET PIPE

(a) Remove the gum tape from the common rail and supply pump.

(b) Temporarily tighten the inlet pipe and pipe clamp bolt.



(c) Using SST, tighten the inlet pipe from the common rail side.

Torque:

37 N·m (377 kgf·cm, 27 ft·lbf) for use with SST

41 N·m (418 kgf·cm, 30 ft·lbf)

SST 09023–12900

HINT:

Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

(d) Using SST, tighten the inlet pipe from the pump side.

Torque:

31 N·m (316 kgf·cm, 23 ft·lbf) for use with SST

34 N·m (347 kgf·cm, 25 ft·lbf)

SST 09023–12700

HINT:

Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

(e) Tighten the pipe clamp bolt.

Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)

11. INSTALL INJECTION PIPE (See page FU–8)

HINT:

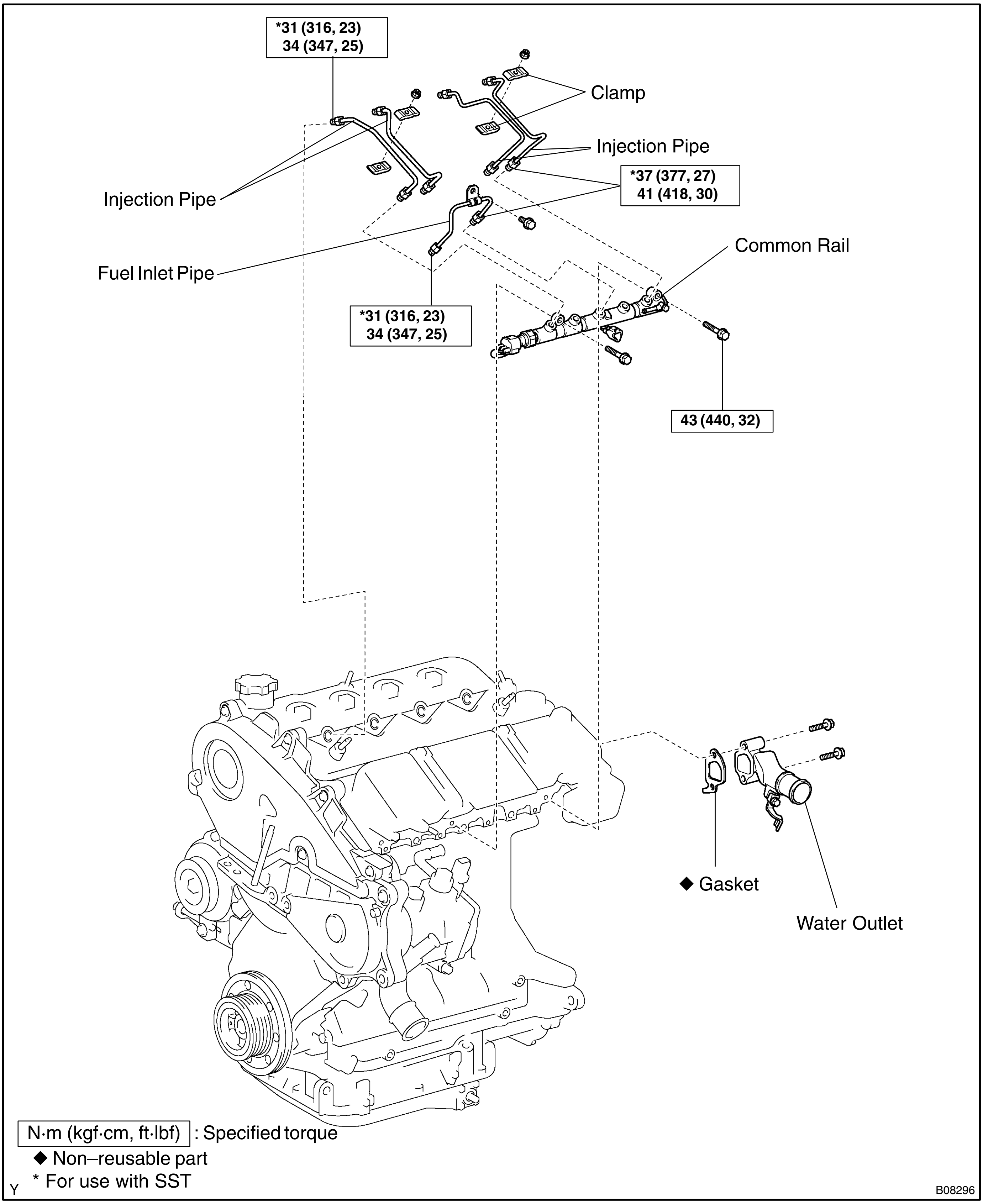
Remove the gum tape from the cylinder head cover.

12. INSTALL TIMING BELT (See page EM–18)
13. INSTALL ENGINE MOUNTING BRACKET AND TIMING BELT COVER (See page EM–18)
14. INSTALL CRANKSHAFT PULLEY (See page EM–18)
15. CHECK FUEL LEAK (See page FU–8)

COMMON RAIL

COMPONENTS

FU06E–01



FU06F–01

REMOVAL

NOTICE:

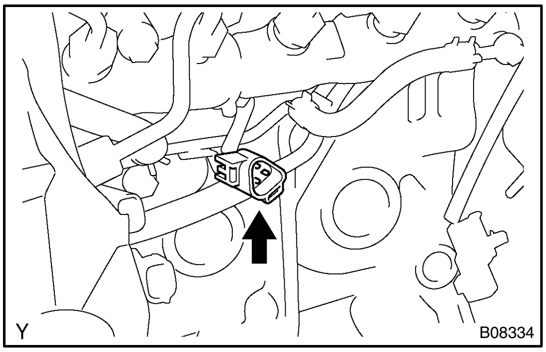
When removing the injection pipes and fuel inlet pipe, clean them up with a brush and compressed air.

1. REMOVE INJECTION PIPE (See page FU–6)

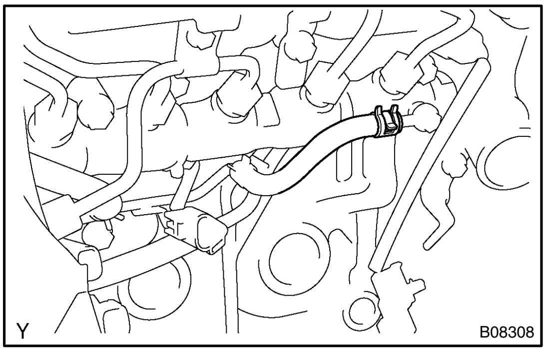
2. REMOVE FUEL INLET PIPE (See page FU–16)

3. REMOVE WATER OUTLET (See page EM–28)

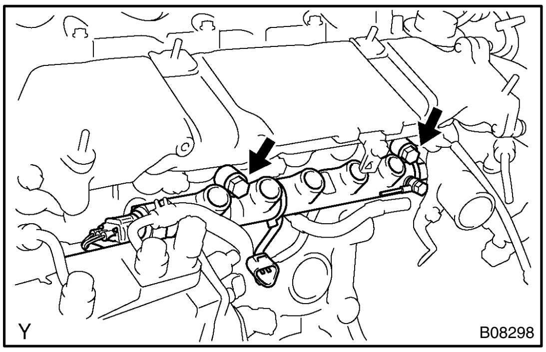
4. REMOVE COMMON RAIL



(a) Disconnect the fuel pressure sensor connector from the bracket.



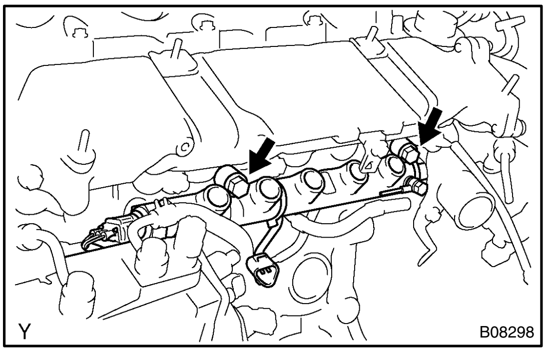
(b) Disconnect the return hose from the common rail.



(c) Remove the 2 bolts and common rail.

FU06G–01

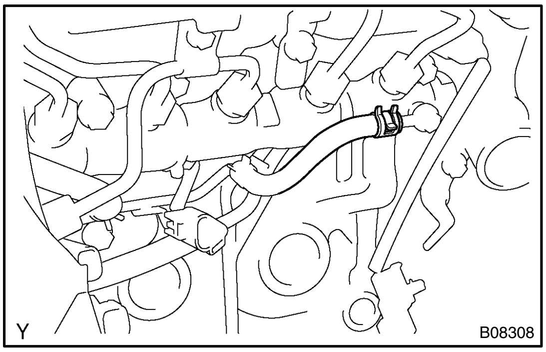
INSTALLATION



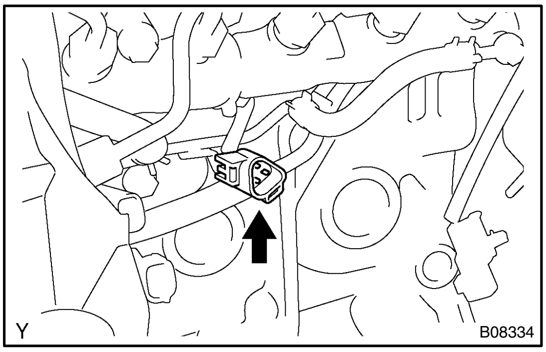
NOTICE:
In case of having the common rail, must replace injection pipes and fuel inlet pipe, too.

1. INSTALL COMMON RAIL

(a) Install the common rail with the 2 bolts.
Torque: 43 N·m (440 kgf·cm, 32 ft·lbf)



(b) Connect the return hose to the common rail.



(c) Connect the fuel pressure sensor connector to the bracket.

2. INSTALL WATER OUTLET (See page EM–46)

3. INSTALL INJECTION PIPE (See page FU–8)

4. INSTALL FUEL INLET PIPE (See page FU–18)

5. CHECK FUEL LEAK (See page FU–8)

FUEL PRESSURE LIMITTER

FU06H–01

ON–VEHICLE INSPECTION

CAUTION:

- **During ACTIVE TEST mode, engine speed goes high and combustion noise becomes loud, so pay attention.**
- **During ACTIVE TEST mode, fuel becomes high–pressured, so take much care for not expose your eyes, hands, or body to the escaped fuel.**

NOTICE:

- **In case of having the common rail and/or injectors replaced, must replace injection pipes, too.**
- **In case of having the common rail replaced, must replace fuel inlet pipe, too.**

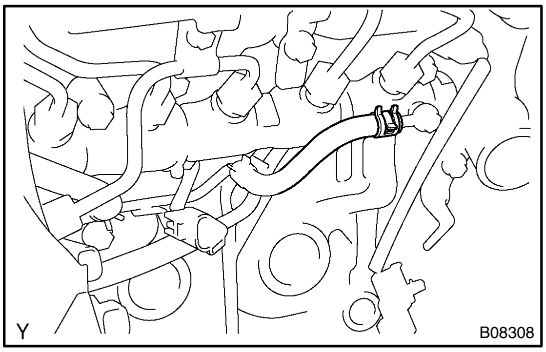
INSPECT FUEL PRESSURE LIMITTER

(a) Chek that there are no leaks from any part of the fuel system at the engine stops.

If there is fuel leakage, replace these parts.

(b) While cranking or start the engine, check that there are no leaks from any part of the fuel system.

If there is fuel leakage, replace these parts.

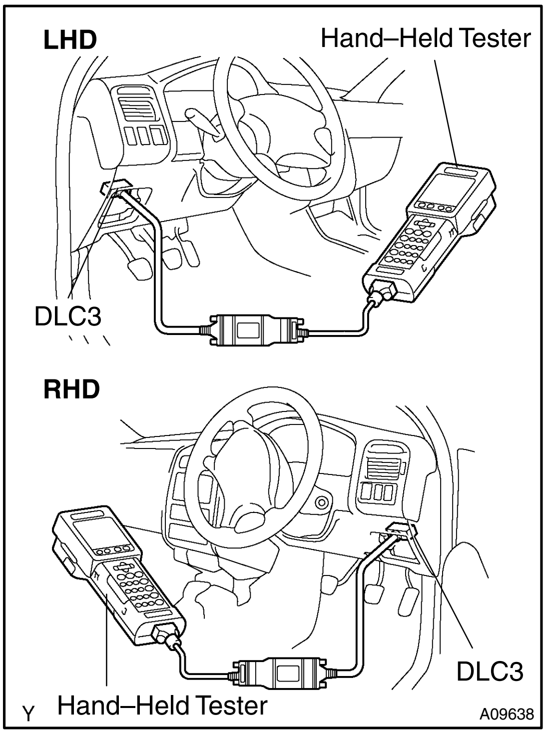


(c) Disconnect the return hose from the common rail.

(d) While cranking the engine, check fuel leaks from the return pipe.

If there is fuel leakage, replace the common rail assembly.

(See page FU–22)



(e) Connect the hand–held tester to the DLC3.
(f) Start the engine and push the hand–held tester main switch ON.
(g) Select the FUEL LEAK test of ACTIVE TEST mode on the hand–held tester.
(h) If you have no hand–held tester, depress the accelerator pedal quickly and fully to increase the engine speed at maximum and keep it for 2 seconds. Repeat this operation several times.
(i) Check that there are no leaks from any part of the fuel system.

NOTICE:
However, if the leakage from the return pipe is less than 10 cc (0.6 cu in.) in a minute, it is acceptable.

If there is fuel leakage, replace these parts.
(j) Reconnect the return hose to the common rail.

COOLING

COOLANT

CO066–05

INSPECTION

HINT:

Check the coolant level when the engine is cold.

1. CHECK ENGINE COOLANT LEVEL AT RADIATOR RESERVOIR

The engine coolant level should be between the ”LOW” and ”FULL” lines.

If low, check the leakage and add ”Toyota Long Life Coolant” or equivalent up to between the ”LOW” and ”FULL” lines.

2. CHECK ENGINE COOLANT QUALITY

(a) Remove the radiator cap.

CAUTION:

To avoid the danger of being burned, do not remove the radiator cap and air release valve while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.

(b) There should not be any excessive deposits of rust or scale around the radiator cap or water filler hole, and the coolant should be free from oil.

If excessively dirty, clean the coolant passages and replace the coolant.

(c) Reinstall the radiator cap.

CO0UB–02

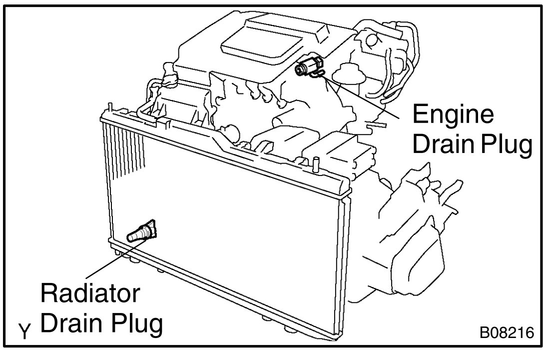
REPLACEMENT

CAUTION:

To avoid the danger of being burned, do not remove the radiator cap and air release valve while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.

1. **DRAIN ENGINE COOLANT**

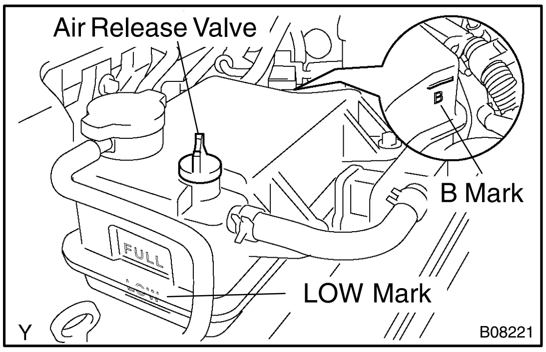
(a) Remove the radiator cap.



(b) Loosen the radiator and engine drain plugs, and drain the coolant.

(c) Close the drain plugs.

Torque: 13 N·m (130 kgf·cm, 9 ft·lbf) for engine



2. **FILL ENGINE COOLANT**

(a) Turn the air release valve counterclockwise and pull it out.

(b) Slowly fill the system with coolant up to B mark.

- Use of improper coolants may damage engine cooling system.
- Use ”Toyota Long Life Coolant” or equivalent and mix it with plan water according to the manufacturer’s directions.
- Using of coolant which includes more than 50 % (freezing protection down to –35°C (–31°F) or 60 % (freezing protection down to –50°C (–58°F)) of ethylene–glycol is recommended but not more than 70 %.

NOTICE:

- **Do not use an alcohol type coolant or plain water alone.**
- **The coolant should be mixed with plain water (preferably demineralized water or distilled water).**

Capacity:

w/ Power heater	7.1 liter (7.5 US qts, 6.3 Imp. qts)
w/o Power heater	6.9 liter (7.3 US qts, 6.1 Imp. qts)

(c) Close the air release valve and install the radiator cap securely.

(d) Start the engine.

HINT:

Warm up the engine with the speed of 2,000 rpm or more and continue doing it until the thermostat has open and the radiator reservoir has become hot.

(e) Check the coolant level is above LOW mark.

(f) After the engine has become cold, check that the water level becomes below FULL line.

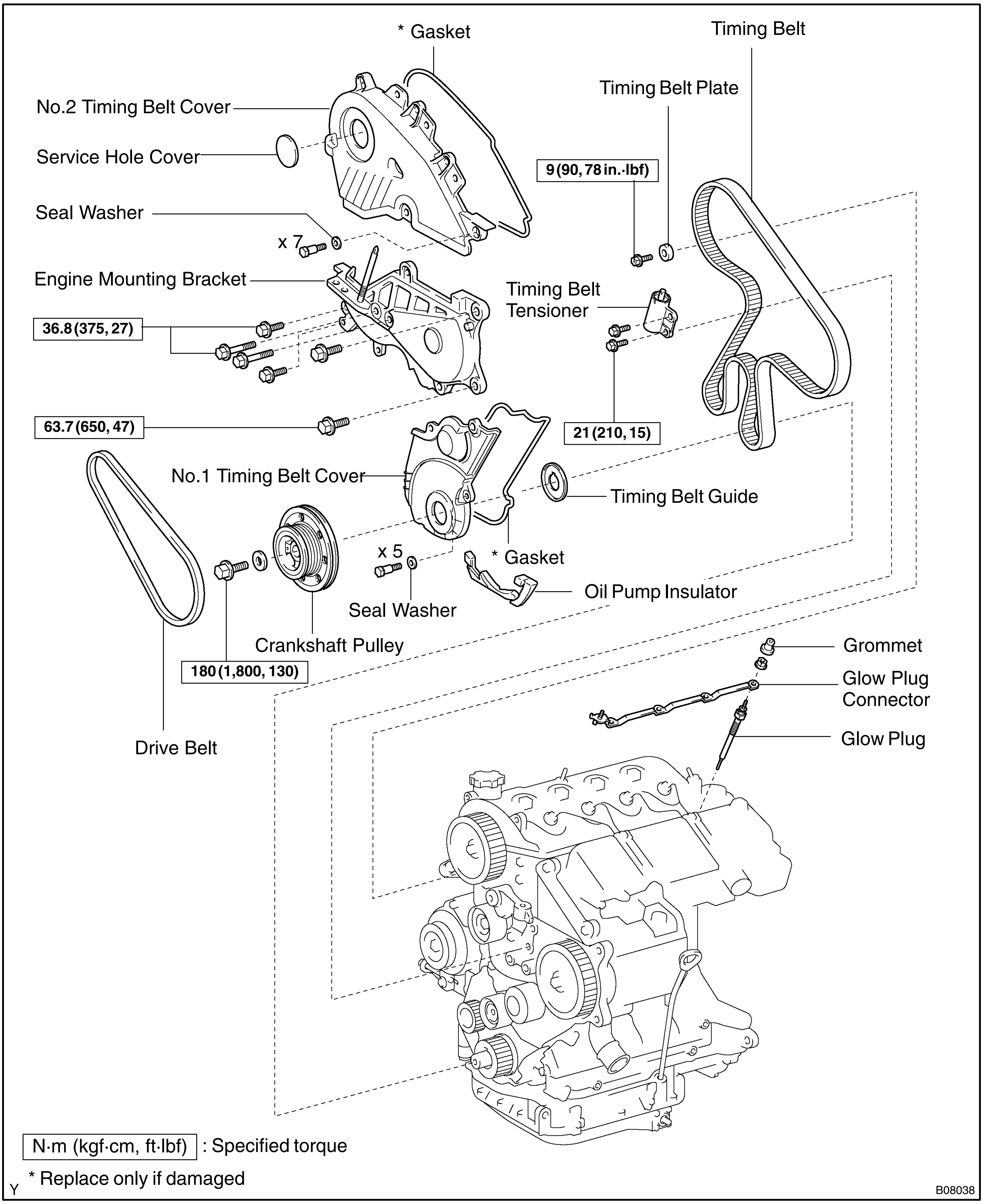
3. CHECK ENGINE COOLANT FOR LEAK

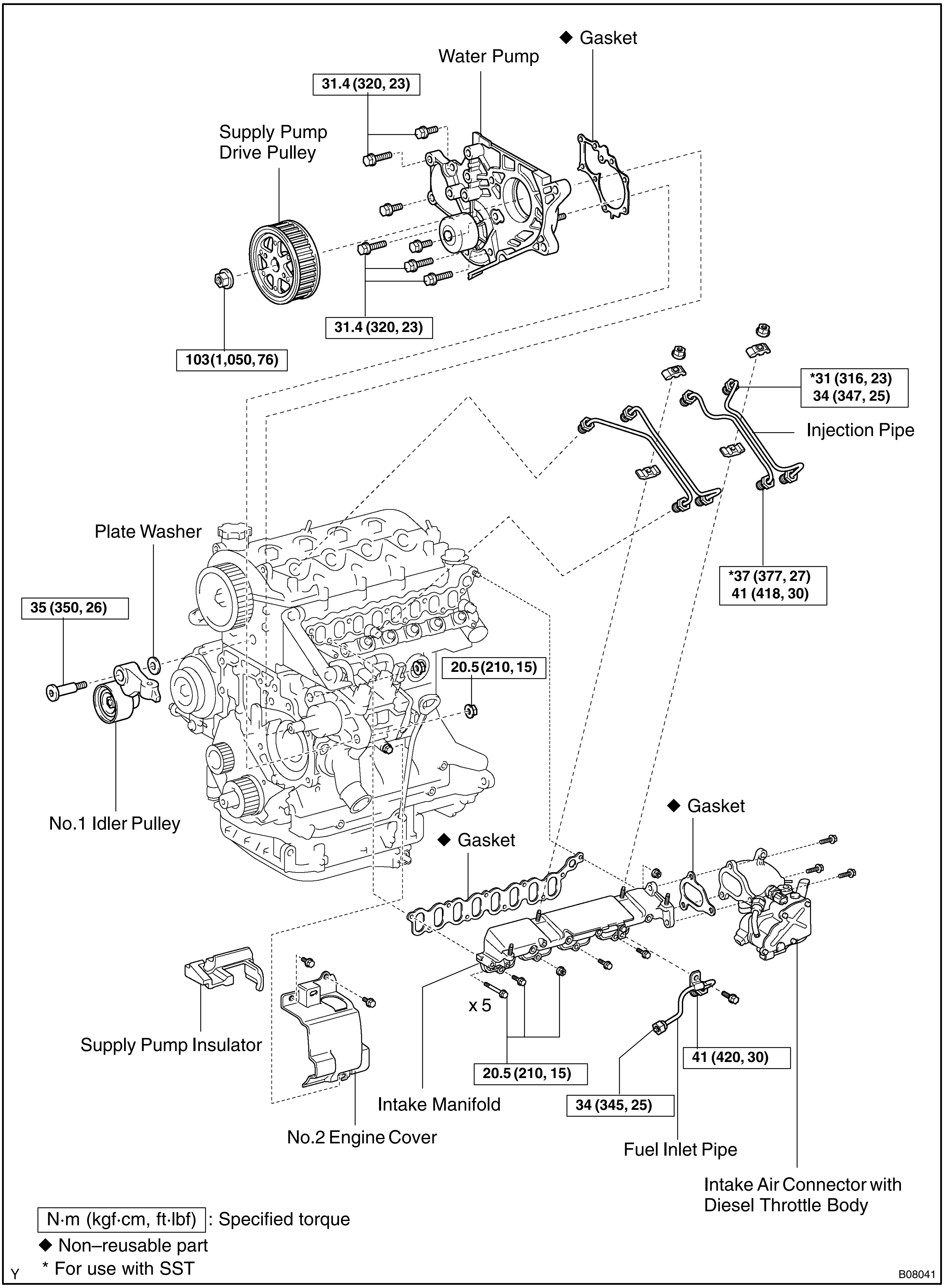
4. CHECK ENGINE COOLANT SPECIFIC GRAVITY CORRECTLY

WATER PUMP

COMPONENTS

CO068–05




◆ Gasket
Water Pump
31.4 (320, 23)
Supply Pump
Drive Pulley
31.4 (320, 23)
103 (1,050, 76)
*31 (316, 23)
34 (347, 25)
Injection Pipe
*37 (377, 27)
41 (418, 30)
Plate Washer
35 (350, 26)
20.5 (210, 15)
No.1 Idler Pulley
◆ Gasket
◆ Gasket
x 5
Supply Pump Insulator
20.5 (210, 15)
41 (420, 30)
34 (345, 25)
Intake Manifold
No.2 Engine Cover
Fuel Inlet Pipe
Intake Air Connector with
Diesel Throttle Body
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
* For use with SST
Y
B08041

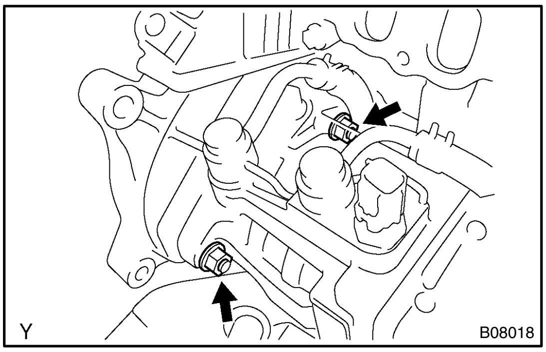
CO0VC–01

REMOVAL

NOTICE:

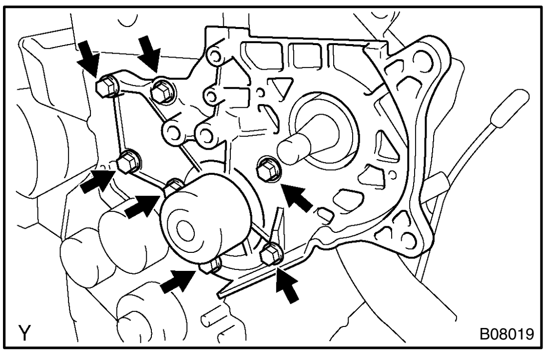
- **Befor removing the injection pipes and fuel inlet pipe, clean them up with a soft brush and compressed air.**
- **After removing the fuel inlet pipe and injection pipe, affix the gum tape on the supply pump, common rail and the whole injector installatoin area of the cylinder head cover for preventing dust from coming into them.**

1. **DRAIN ENGINE COOLANT**
2. **REMOVE TIMING BELT (See page EM–12)**
3. **REMOVE NO.1 IDLER AND SUPPLY PUMP DRIVE PULLEYS (See page EM–12)**
4. **REMOVE NO.2 ENGINE COVER (See page CO–10)**
5. **REMOVE SUPPLY PUMP INSULATOR**
6. **REMOVE FUEL INLET PIPE (See page FU–16)**
7. **REMOVE INJECTION PIPES (See page FU–6)**
8. **REMOVE INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY (See page EM–28)**
9. **REMOVE INTAKE MANIFOLD (See page EM–28)**



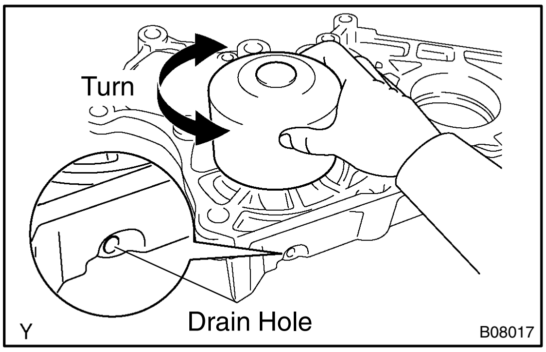
10. **REMOVE WATER PUMP**

(a) Remove the 2 supply pump set nuts.



(b) Remove the 7 bolts, water pump and gasket.

CO06A–05



INSPECTION

1. INSPECT WATER PUMP

(a) Visually check the drain hole for coolant leakage.

If leakage is found, replace the water pump.

(b) Turn the pulley, and check that the water pump bearing moves smoothly and quietly.

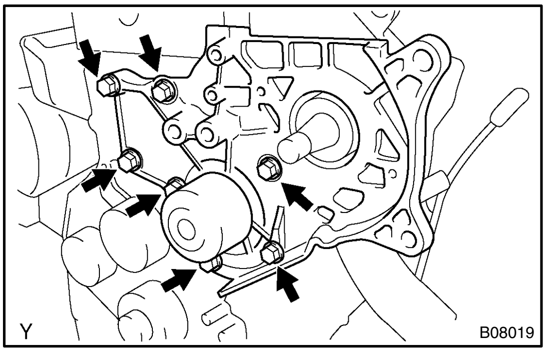
If necessary, replace the water pump.

2. INSPECT TIMING BELT COMPONENTS (See page EM–11)

CO0VD–01

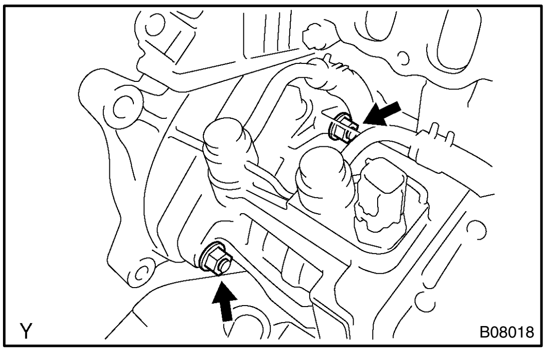
INSTALLATION

NOTICE:
In case of having the water pump replaced, must replace the fuel inlet pipe, too.



1. INSTALL WATER PUMP

(a) Install a new gasket and the water pump with the 7 bolts.
Torque: 31.4 N·m (320 kgf·cm, 23 ft·lbf)



(b) Install the 2 supply pump set nuts.
Torque: 20.5 N·m (210 kgf·cm, 15 ft·lbf)

2. INSTALL INTAKE MANIFOLD (See page EM–46)

3. INSTALL INTAKE AIR CONNECTOR WITH DIESEL THROTTLE BODY (See page EM–46)

4. INSTALL INJECTION PIPES (See page FU–8)

5. INSTALL FUEL INLET PIPE (See page FU–18)

6. INSTALL SUPPLY PUMP INSULATOR (See page FU–18)

7. INSTALL NO.2 ENGINE COVER

8. INSTALL SUPPLY PUMP DRIVE AND NO.1 IDLER PULLEYS (See page EM–18)

9. INSTALL TIMING BELT (See page EM–18)

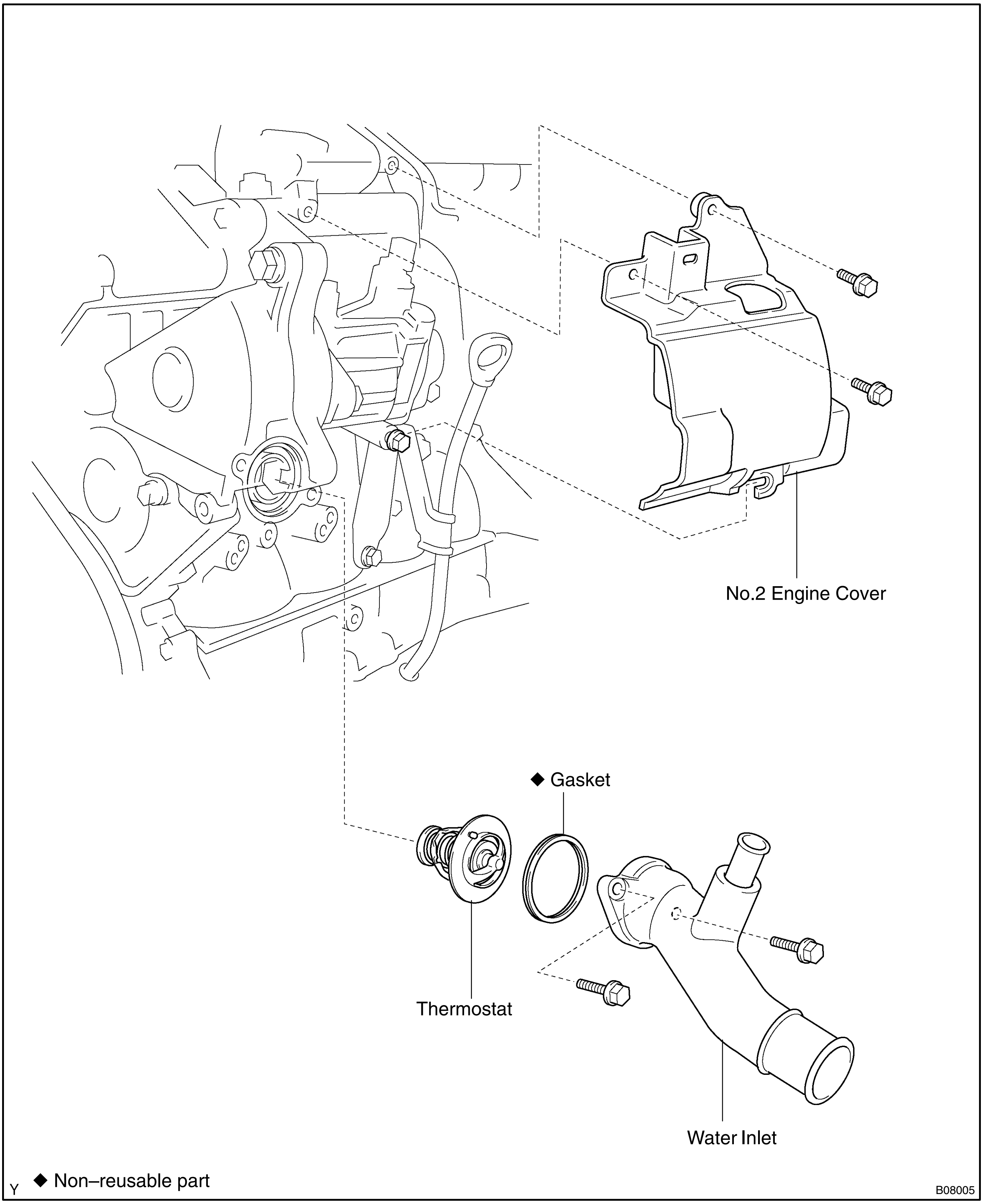
10. FILL WITH ENGINE COOLANT

11. START ENGINE AND CHECK FOR COOLANT LEAK

THERMOSTAT

CO06C–05

COMPONENTS

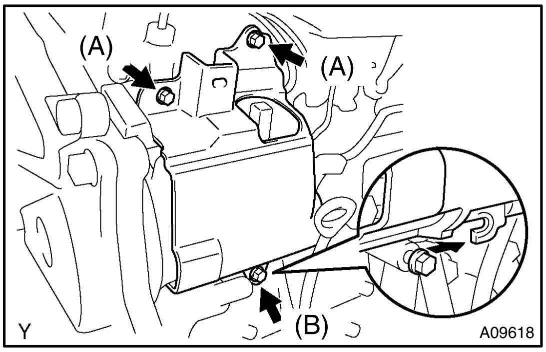


CO0VE–01

REMOVAL

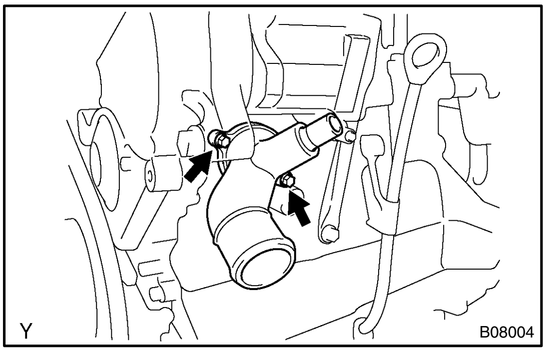
HINT:
Removal of the thermostat would have an adverse effect, causing a decline in cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. DRAIN ENGINE COOLANT



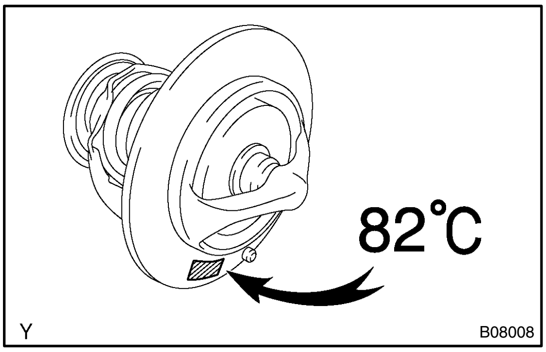
2. REMOVE NO.2 ENGINE COVER

(a) Remove the 2 bolts (A).
(b) Loosen the bolt (B) and remove the cover.



3. REMOVE WATER INLET AND THERMOSTAT

(a) Remove the 2 bolts and water inlet from the cylinder block.
(b) Remove the thermostat.
(c) Remove the gasket from the thermostat.



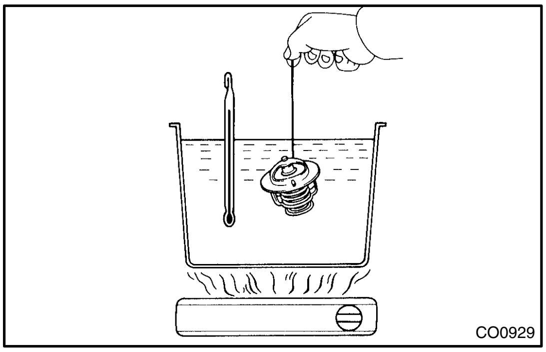
INSPECTION

INSPECT THERMOSTAT

HINT:

The thermostat is numbered with the valve opening temperature.

CO06E–05

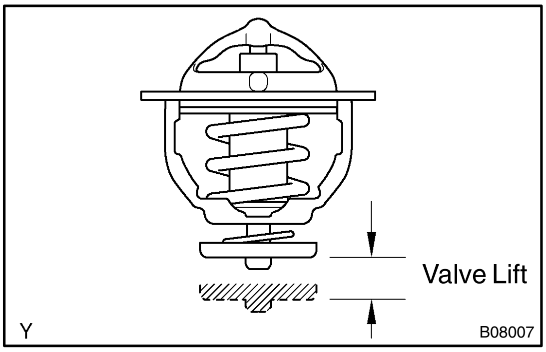


(a) Immerse the thermostat in water and gradually heat the water.

(b) Check the valve opening temperature.

Valve opening temperature: 80 – 84°C (176 – 183°F)

If the valve opening temperature is not as specified, replace the thermostat.



(c) Check the valve lift.

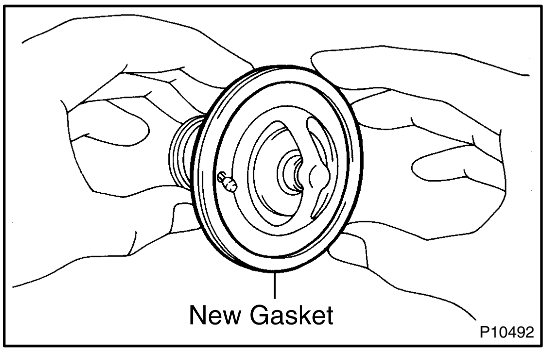
Valve lift: 8.5 mm (0.33 in.) or more at 95°C (203°F)

If the valve lift is not as specified, replace the thermostat.

(d) Check that the valve is fully closed when the thermostat is at low temperature (below 40°C (104°F)).

If not closed, replace the thermostat.

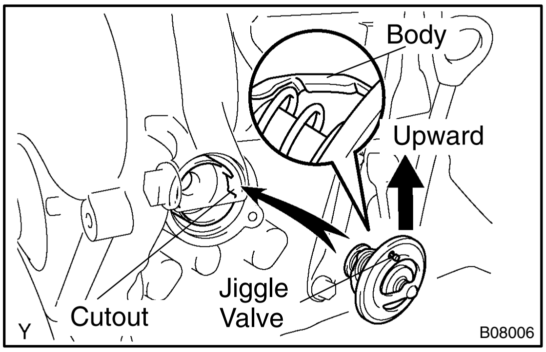
CO0VF–01



INSTALLATION

1. PLACE THERMOSTAT IN CYLINDER BLOCK

(a) Install a new gasket to the thermostat.



(b) Face the jiggle valve of the thermostat upward, and insert the thermostat body in the flange cutout on the cylinder block.

2. INSTALL WATER INLET

Install the water inlet with the 2 bolts.

Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

3. INSTALL NO.2 ENGINE COVER

4. FILL WITH ENGINE COOLANT

5. START ENGINE AND CHECK FOR COOLANT LEAK

RADIATOR

CO06G–05

ON–VEHICLE CLEANING

Using water or a steam cleaner, remove any mud or dirt from the radiator core.

NOTICE:

If using a high pressure type cleaner, be careful not to deform the fins of the radiator core. (i.e. Maintain a distance between the cleaner nozzle and radiator core.)

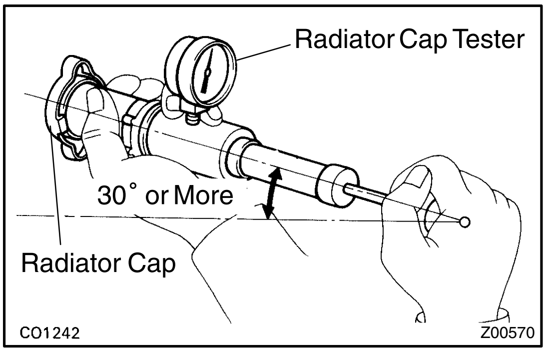
CO06H–06

ON–VEHICLE INSPECTION

1. REMOVE RADIATOR CAP

CAUTION:

To avoid the danger of being burned, do not remove the radiator cap while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.



2. INSPECT RADIATOR CAP

NOTICE:

- **If the radiator cap has contaminations, always rinse it with water.**
- **Before using a radiator cap tester, wet the relief valve and pressure valve with engine coolant or water.**
- **When performing steps (a) and (b) below, keep the tester at an angle of over 30° above the horizontal.**

(a) Using a radiator cap tester, slowly pump the tester and check if air is coming from the vacuum valve.
Pump speed: 1 push/(3 seconds or more)

NOTICE:

Push the pump at a constant speed.

If air is not coming from the vacuum valve, replace the radiator cap.

(b) Pump the tester, and measure the relief valve opening pressure.
Pump speed: 1 push within 1 second

NOTICE:

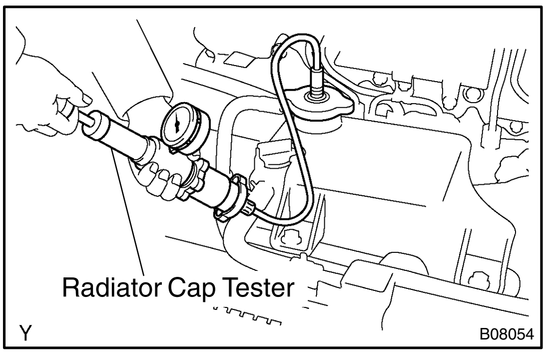
This pump speed is for the first pump only (in order to close the vacuum valve). After this, the pump speed can be reduced.

Standard opening pressure:
93.3 – 122.7 kPa (0.95 – 1.25 kgf/cm^2, 13.5 – 17.8 psi)
Minimum opening pressure:
78 kPa (0.8 kgf/cm^2, 11.4 psi)

HINT:

Use the tester's maximum reading as the opening pressure.

If the opening pressure is less than minimum, replace the radiator cap.



3. INSPECT COOLING SYSTEM FOR LEAK

(a) Fill the radiator with coolant, and attach a radiator cap tester.

(b) Warm up the engine.

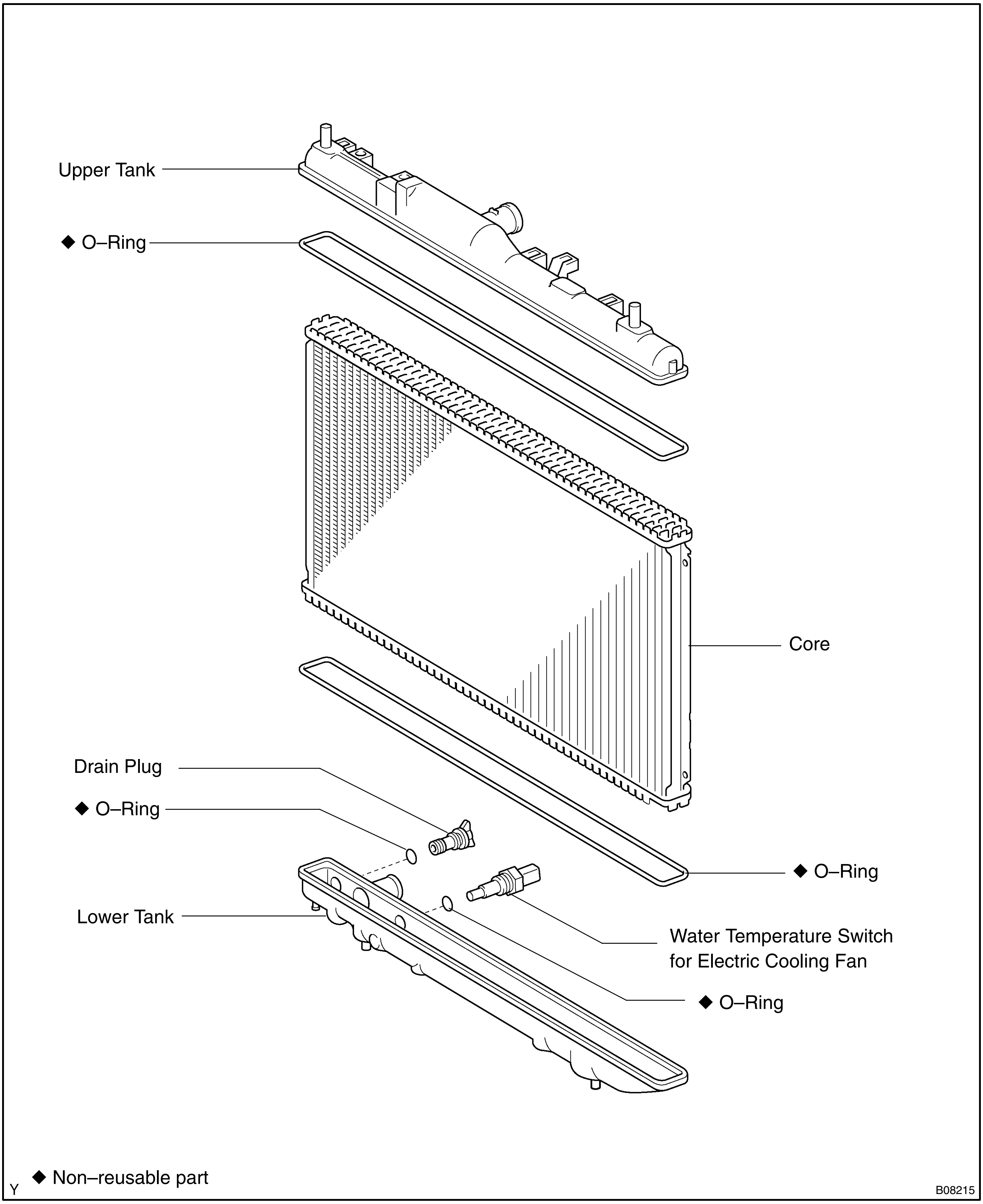
(c) Pump it to 118 kPa (1.2 kgf/cm^2, 17.1 psi), and check that the pressure does not drop.

If the pressure drops, check the hoses, radiator or water pump for leak. If no external leak is found, check the heater core, cylinder block and head.

4. REINSTALL RADIATOR CAP

CO0VG–01

COMPONENTS



CO0VH–01

DISASSEMBLY

1. REMOVE DRAIN PLUG

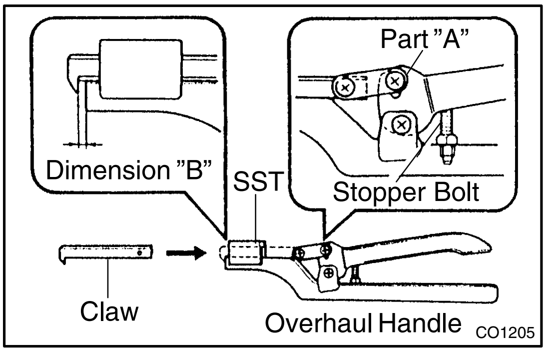
(a) Remove the drain plug.

(b) Remove the O–ring.

2. REMOVE WATER TEMPERATURE SWITCH

(a) Remove the water temperature switch.

(b) Remove the O–ring.



3. ASSEMBLE SST

SST 09230–01010

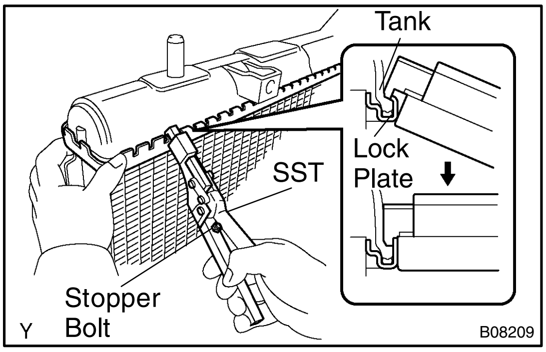
(a) Install the claw to the overhaul handle, inserting it in the hole in part "A" as shown in the diagram.

(b) While gripping the handle, adjust the stopper bolt so that dimension "B" is as shown in the illustration.

Dimension B: 0.2 – 0.3 mm (0.008 – 0.012 in)

NOTICE:

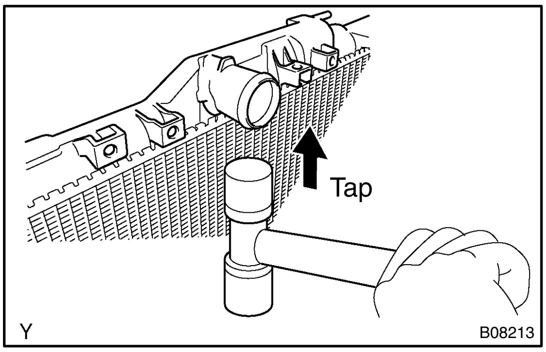
If this adjustment is not done the claw may be damaged.



4. UNCAULK LOCK PLATES

Using SST to release the caulking, squeeze the handle until stopped by the stopper bolt.

SST 09230–01010

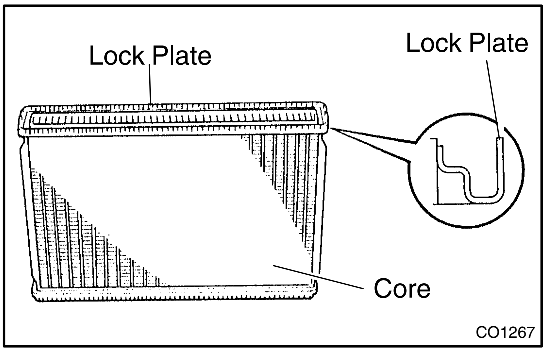


5. REMOVE TANKS AND O–RINGS

Lightly tap the radiator inlet or outlet (or bracket of the radiator) with a soft–faced hammer, and remove the tank and the O–ring.

CO0VI–01

REASSEMBLY



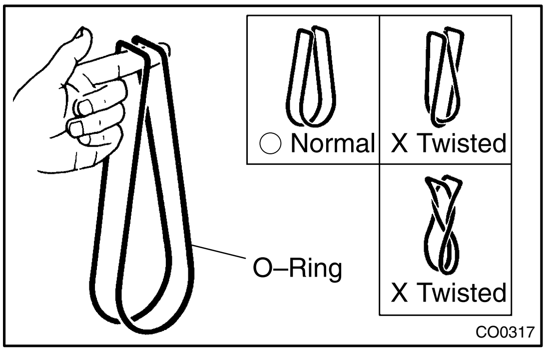
1. INSPECT LOCK PLATE FOR DAMAGE

HINT:

- If the sides of the lock plate groove are deformed, reassembly of the tank will be impossible.
- Therefore, first correct any deformation with pliers or similar object. Water leakage will result if the bottom of the lock plate groove is damaged or dented.

NOTICE:

The radiator can only be recaulked 2 times. After the 2nd time, the radiator core must be replaced.

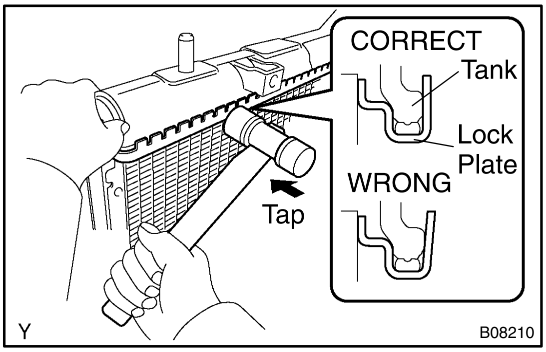


2. INSTALL NEW O–RINGS AND TANKS

(a) After checking that there are no foreign objects in the lock plate groove, install the new O–ring without twisting it.

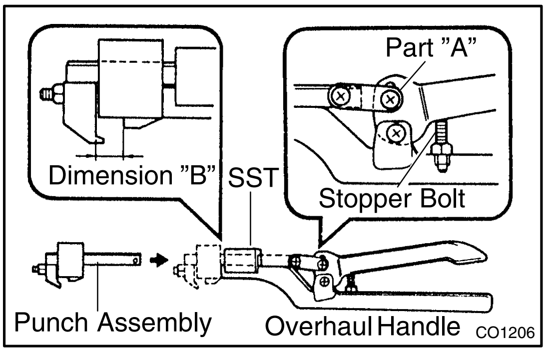
HINT:

When cleaning the lock plate groove, lightly rub it with sand paper without scratching it.



(b) Install the tank without damaging the O–ring.

(c) Tap the lock plate with a soft–faced hammer so that there is no gap between it and the tank.



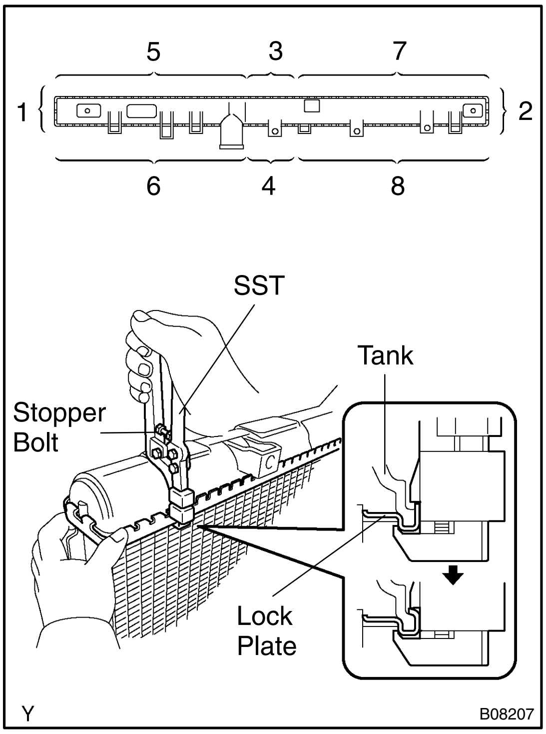
3. ASSEMBLE SST

SST 09230–01010, 09231–14010

(a) Install the punch assembly to the overhaul handle, inserting it in the hole in part "A" as shown in the illustration.

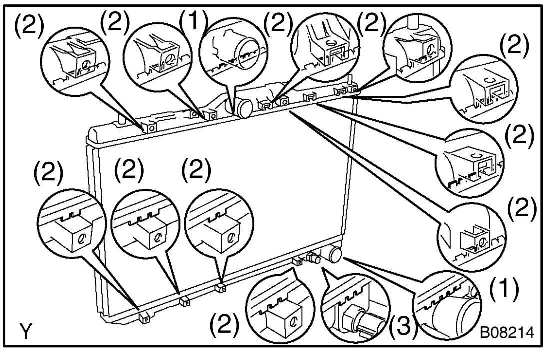
(b) While gripping the handle, adjust the stopper bolt so that dimension "B" is as shown in the illustration.

Dimension B: 8.4 mm (0.331 in.)



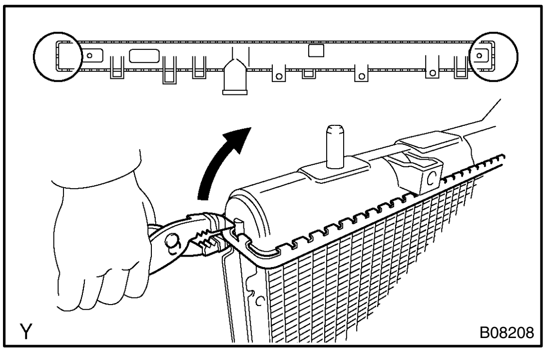
4. CAULK LOCK PLATE

(a) Lightly press SST against the lock plate in the order shown in the illustration. After repeating this a few times, fully caulk the lock plate by squeezing the handle until stopped by the stopper plate.
SST 09230–01010

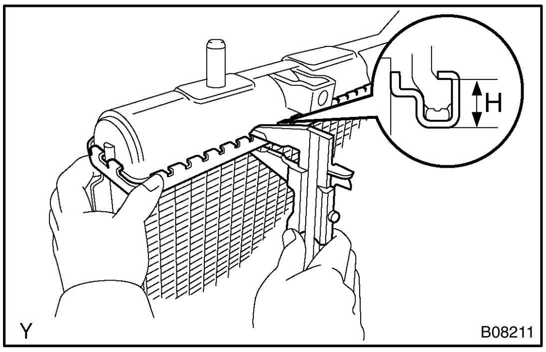


HINT:

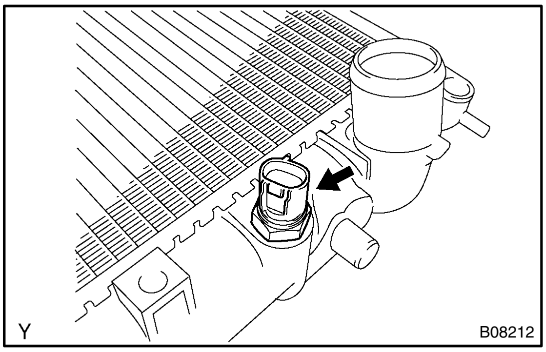
- Do not stake the areas protruding around the pipes (1), brackets (2) and flange (3).



- The points shown in the illustration cannot be staked with the SST. Use pliers or similar object and be careful not to damage the core plates.



(b) Check the lock plate height (H) after completing the caulking.
Plate height (H): 7.40 – 7.80 mm (0.2913 – 0.3071 in.)
If not within the specified height, adjust the stopper bolt of the handle again and caulk again.



5. INSTALL WATER TEMPERATURE SWITCH

(a) Install a new O–ring to the water temperature switch.

(b) Install the water temperature switch.

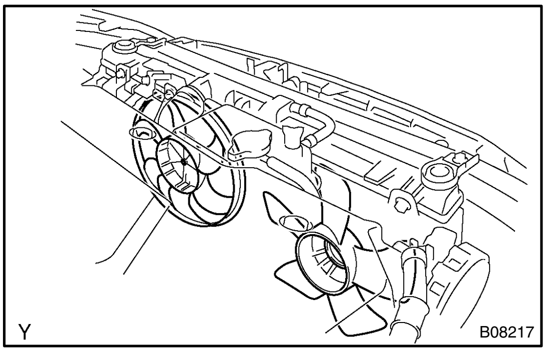
6. INSTALL DRAIN PLUG

(a) Install a new O–ring to the drain plug.

(b) Install the drain plug.

ELECTRIC COOLING FAN

CO0VJ–01

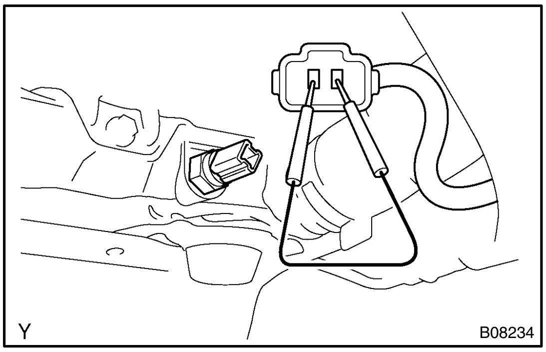


ON–VEHICLE INSPECTION

1. CHECK COOLING FAN OPERATION WITH LOW TEMPERATURE (Below 83°C (181°F))

(a) Turn the ignition switch ON.

(b) Check that the cooling fan stops.



(c) Disconnect the water temperature switch connector.

(d) Connect the terminals on the water temperature switch connector.

(e) Check that the cooling fan rotates.

If not, check the fuse, cooling fan relay, cooling fan, and check for a open circuit between the cooling fan relay and water temperature switch.

(f) Reconnect the water temperature switch connector.

2. CHECK COOLING FAN OPERATION WITH HIGH TEMPERATURE (Above 93°C (199°F))

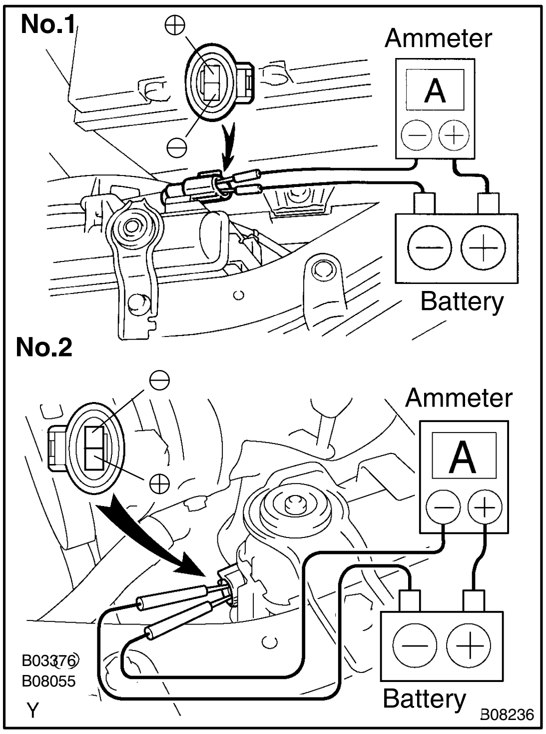
(a) Start the engine, and raise coolant temperature to above 93°C (199°F).

HINT:

Coolant temperature is the detected value by the water temperature switch on the radiator lower tank.

(b) Check that the cooling fan rotates.

If not, replace the water temperature switch.



3. INSPECT COOLING FANS

(a) Disconnect the cooling fan connector.

(b) Connect battery and ammeter to the cooling fan connector.

(c) Check that the cooling fan rotates smoothly, and check the reading on the ammeter.

Standard amperage:

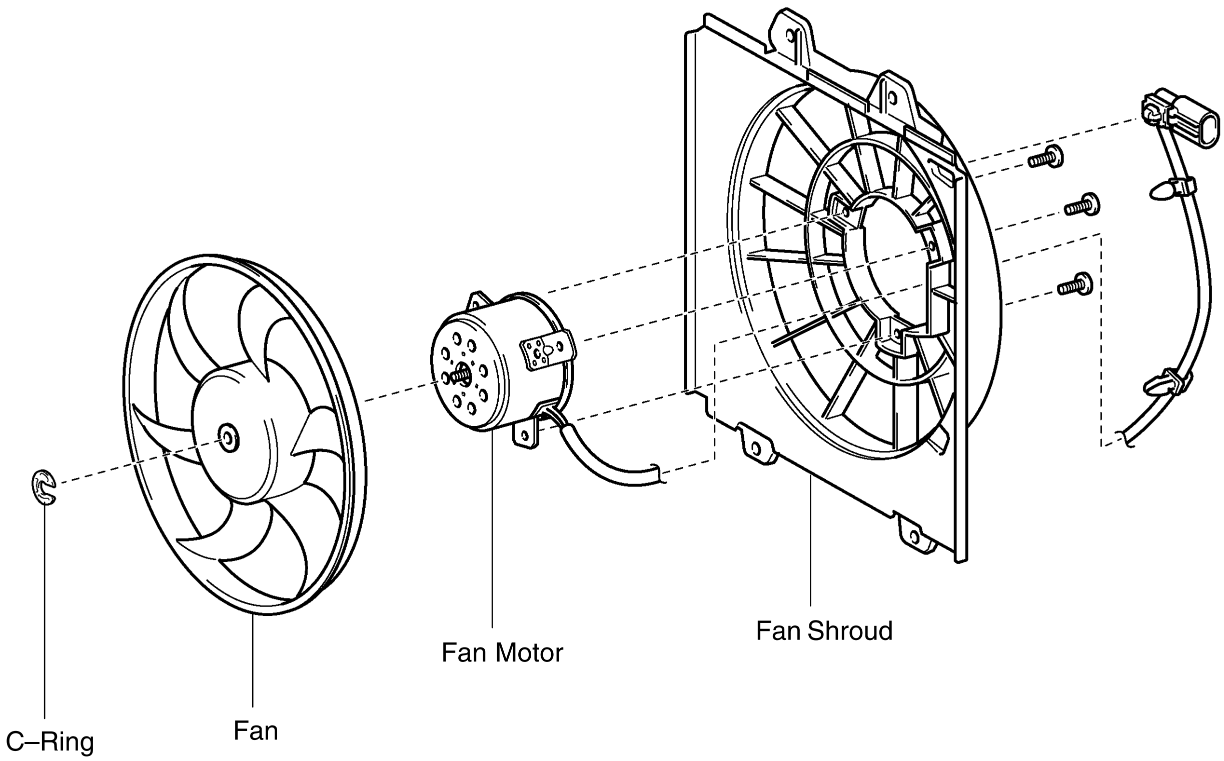
No.1	At 20°C (68°F)	Approx. 13.2 A
No.2	At 20°C (68°F)	Approx. 9.8 A

(d) Reconnect the cooling fan connector.

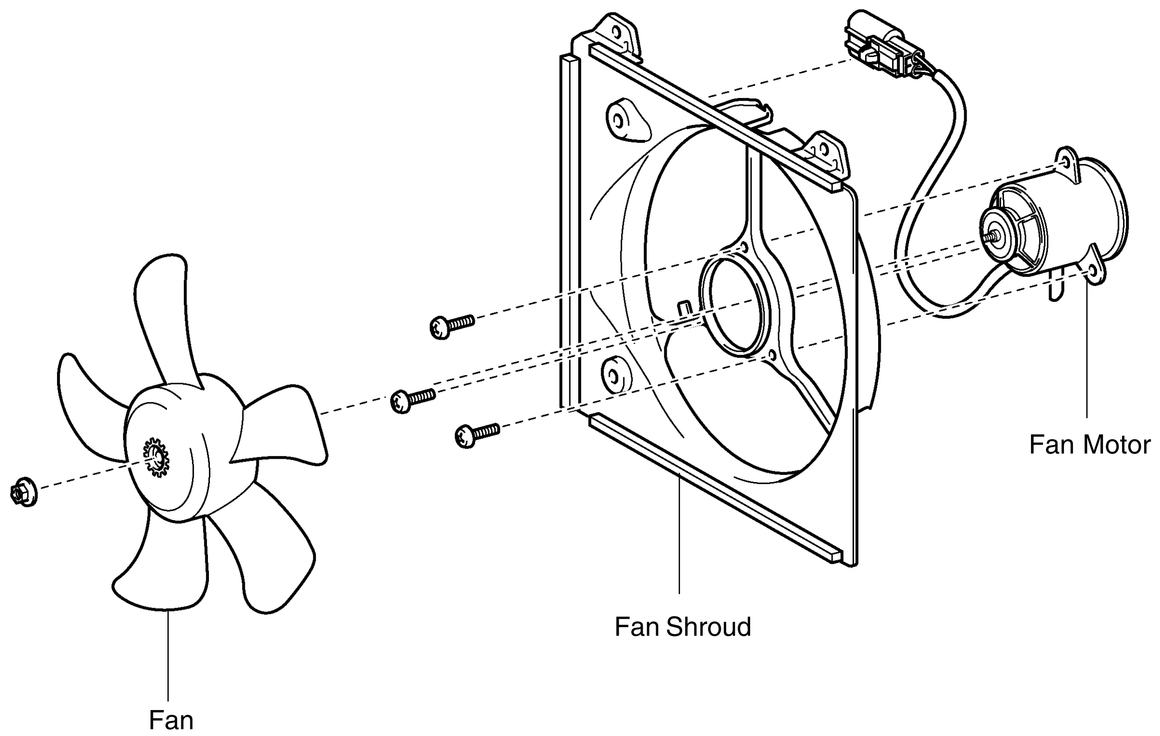
CO0F9–02

COMPONENTS

No.1 Cooling Fan

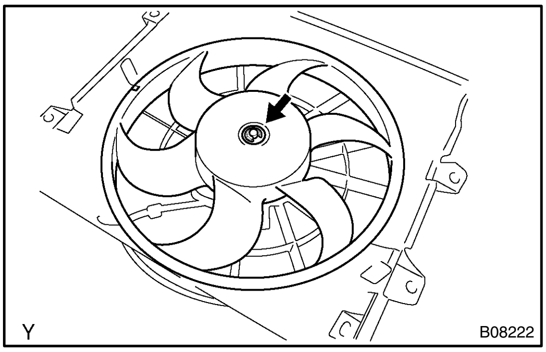


No.2 Cooling Fan



CO0VK–01

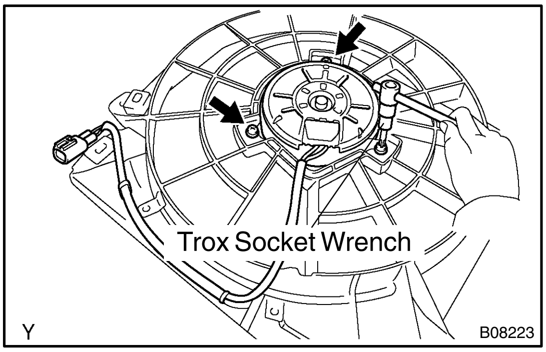
DISASSEMBLY



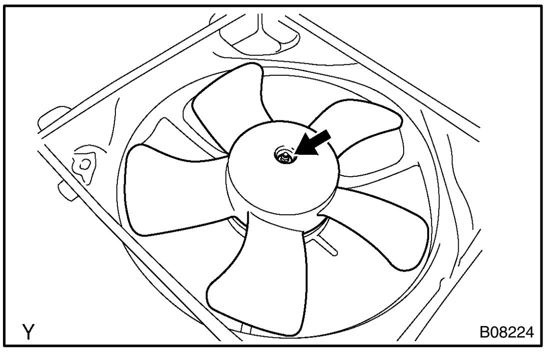
1. REMOVE NO.1 COOLING FAN

(a) Remove the C–ring and fan.

(b) Disconnect the lead wire and connector holder from the fan shroud.



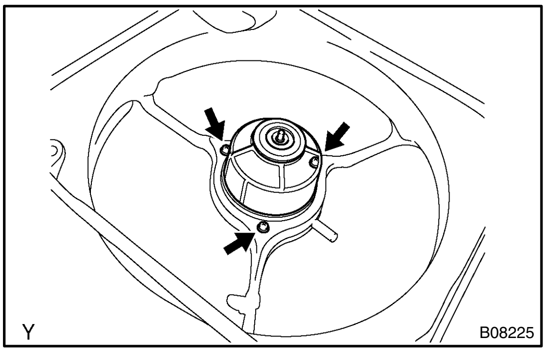
(c) Using a trox socket wrench (T20), remove the 3 screws and fan motor.



2. REMOVE NO.2 COOLING FAN

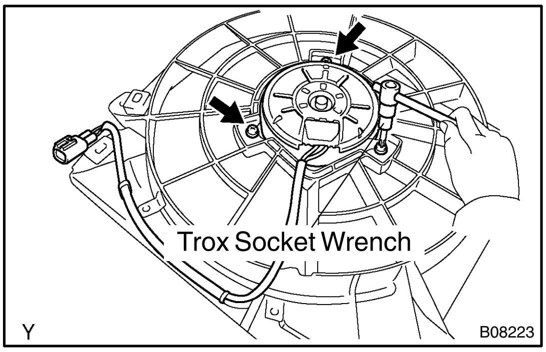
(a) Remove the nut and fan.

(b) Disconnect the lead wire and connector holder from the fan shroud.



(c) Remove the 3 screws and fan motor.

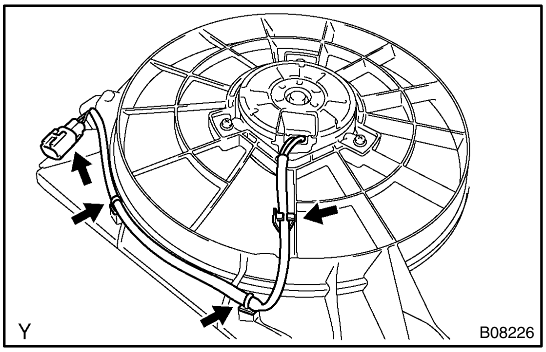
CO0VL–01



REASSEMBLY

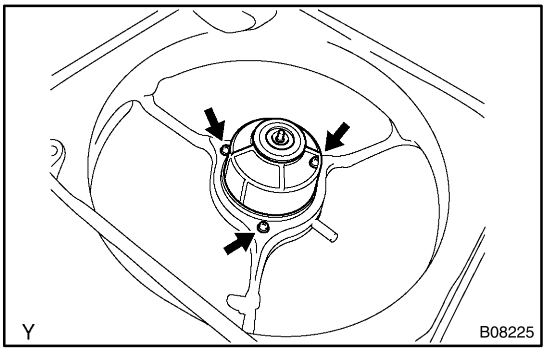
1. INSTALL NO.1 FAN MOTOR

(a) Using a trox socket wrench (T20), install the fan motor with the 3 screws.



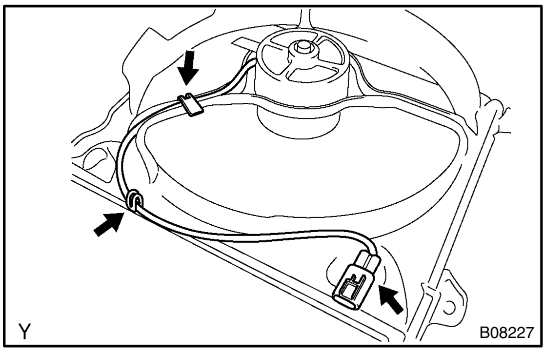
(b) Connect the lead wire and connector holder to the fan shroud.

(c) Install the fan with the C–ring.



2. INSTALL NO.2 FAN MOTOR

(a) Install the fan motor with the 3 screws.



(b) Connect the lead wire and connector holder to the fan shroud.

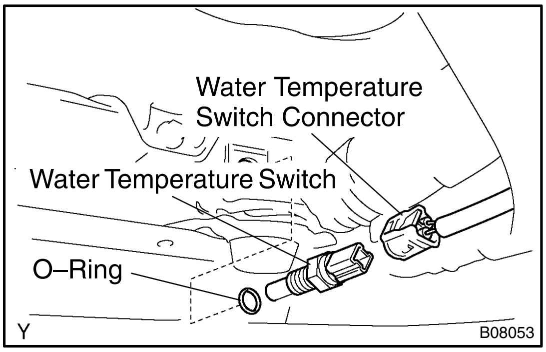
(c) Install the fan with the nut.

WATER TEMPERATURE SWITCH

CO0AJ–04

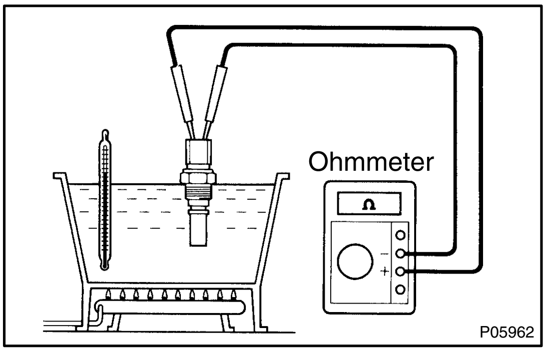
INSPECTION

1. **REMOVE ENGINE UNDER COVER**
2. **DRAIN ENGINE COOLANT**



3. **REMOVE WATER TEMPERATURE SWITCH**

(a) Disconnect the connector.
(b) Remove the water temperature switch.
(c) Remove the O–ring from the water temperature switch.



4. **INSPECT WATER TEMPERATURE SWITCH**

(a) Using an ohmmeter, check that there is continuity between the terminals when the coolant temperature is above 93°C (199°F).

If there is no continuity, replace the switch.

(b) Using an ohmmeter, check that there is no continuity between the terminals when the coolant temperature is below 83°C (181°F).

If there is continuity, replace the switch.

5. **REINSTALL WATER TEMPERATURE SWITCH**

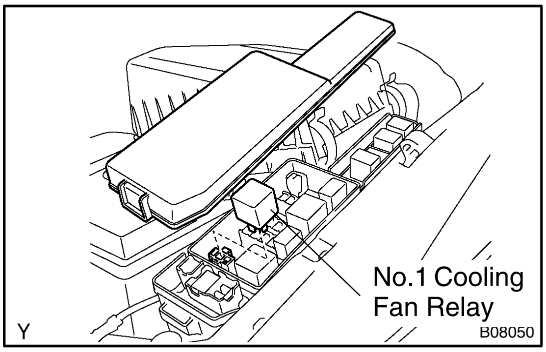
(a) Install a new O–ring to the water temperature switch.
(b) Install the water temperature switch.
(c) Connect the connector.

6. **REINSTALL ENGINE UNDER COVER**
7. **REFILL WITH ENGINE COOLANT**
8. **START ENGINE AND CHECK FOR COOLANT LEAK**

COOLING FAN RELAY

CO0BB–03

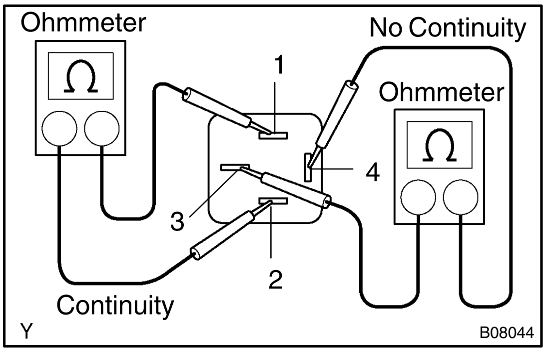
INSPECTION



1. INSPECT NO.1 COOLING FAN RELAY

(a) Remove the relay box cover.

(b) Remove the No.1 cooling fan relay. (Marking: FAN NO.1)



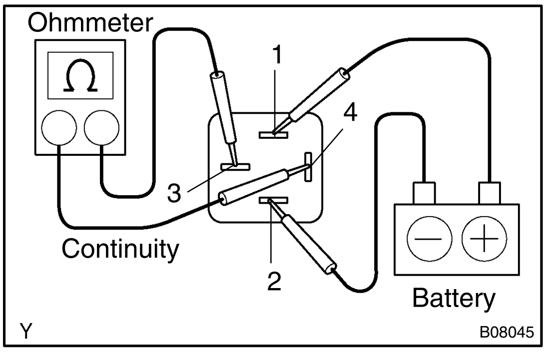
(c) Inspect the No.1 cooling fan relay continuity.

(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

If there is no continuity, replace the relay.

(2) Check that there is no continuity between terminals 3 and 4.

If there is continuity, replace the relay.



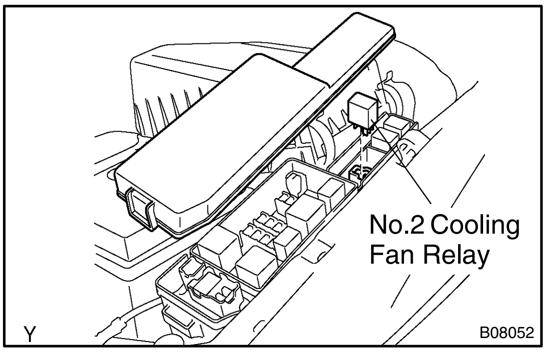
(d) Inspect the No.1 cooling fan relay operation.

(1) Apply battery positive voltage across terminals 1 and 2.

(2) Using an ohmmeter, check that there is continuity between terminals 3 and 4.

If there is no continuity, replace the relay.

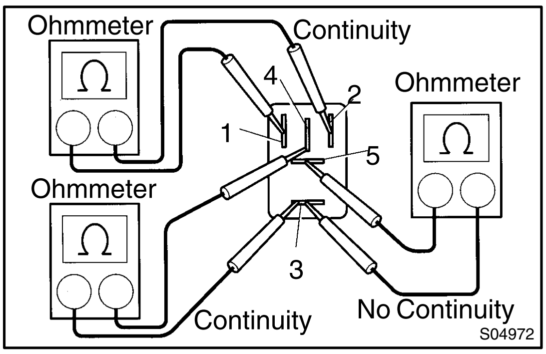
(e) Reinstall the No.1 cooling fan relay.



2. INSPECT NO.2 COOLING FAN RELAY

(a) Remove the relay box cover.

(b) Remove the No.2 cooling fan relay. (Marking: FAN NO.2)



(c) Inspect the No.2 cooling fan relay continuity.

(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

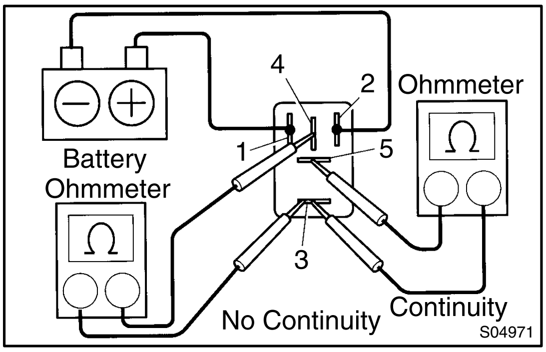
If there is no continuity, replace the relay.

(2) Check that there is continuity between terminals 3 and 4.

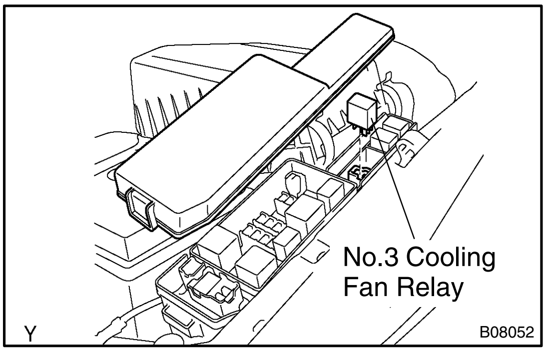
If there is no continuity, replace the relay.

(3) Check that there is no continuity between terminals 3 and 5.

If there is continuity, replace the relay.

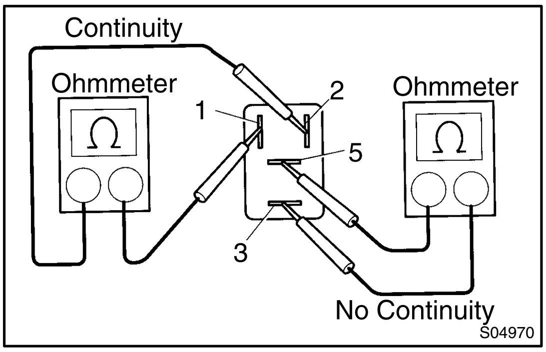


(d) Inspect the No.2 cooling fan relay operation.
(1) Apply battery positive voltage across terminals 1 and 2.
(2) Using an ohmmeter, check that there is no continuity between terminals 3 and 4.
If there is continuity, replace the relay.
(3) Check that there is continuity between terminals 3 and 5.
If there is no continuity, replace the relay.
(e) Reinstall the No.2 cooling fan relay.
(f) Reinstall the relay box cover.

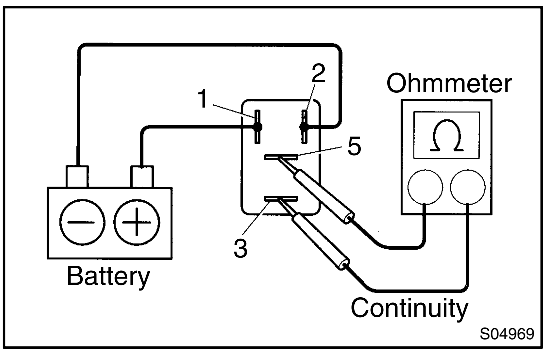


3. INSPECT NO.3 COOLING FAN RELAY

(a) Remove the relay box cover.
(b) Remove the No.3 cooling fan relay. (Marking: FAN NO.3)

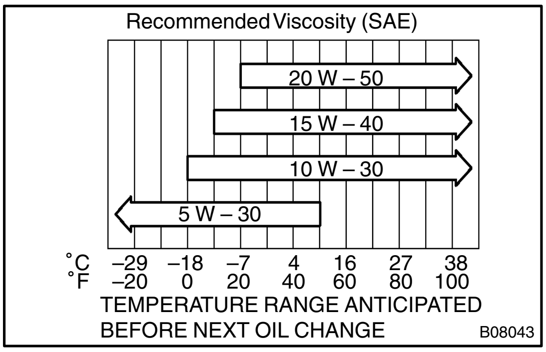


(c) Inspect the No.3 cooling fan relay continuity.
(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.
If there is no continuity, replace the relay.
(2) Check that there is no continuity between terminals 3 and 5.
If there is continuity, replace the relay.



(d) Inspect the No.3 cooling fan relay operation.
(1) Apply battery positive voltage across terminals 1 and 2.
(2) Using an ohmmeter, check that there is continuity between terminals 3 and 5.
If there is no continuity, replace the relay.
(e) Reinstall the No.3 cooling fan relay.

LUBRICATION



OIL AND FILTER

LU0H8–01

INSPECTION

1. CHECK ENGINE OIL QUALITY

Check the oil for deterioration, entry of water, discoloring or thinning.

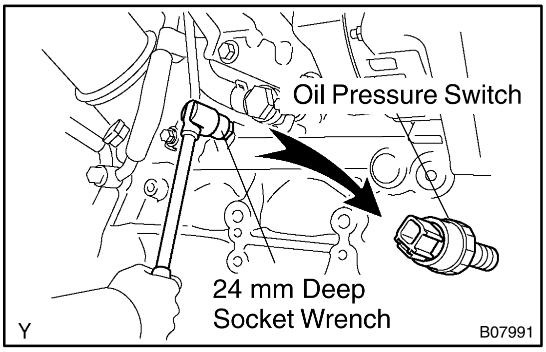
If the quality is visibly poor, replace the oil.

Oil grade:
API grade CF–4 or CF
(You may also use API CE or CD)
Recommended viscosity:
Refer to illustration

2. CHECK ENGINE OIL LEVEL

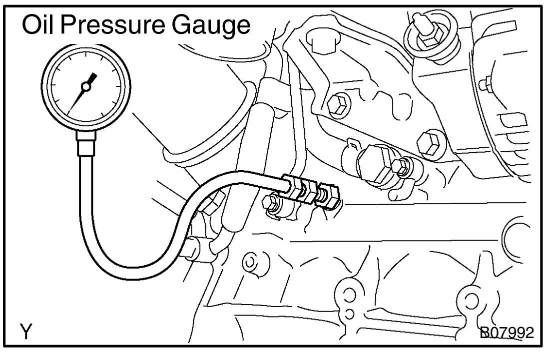
After warming up the engine, and then 5 minutes after the engine stops, oil level should be between the low level and full level marks of the dipstick.

If low, check for leakage and add oil up to the full level mark.



3. CHECK OIL PRESSURE

(a) Using a 24 mm deep socket wrench, remove the oil pressure switch.



(b) Install the oil pressure gauge.

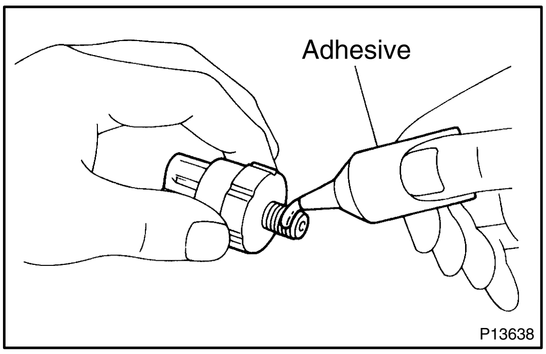
(c) Allow the engine to warm up to normal operating temperature.

(d) Check the oil pressure.

Oil pressure:

At idle	29 kPa (0.3 kgf/cm^2, 4.2 psi) or more
At 4,500 rpm	245 – 588 kPa (2.5 – 6.0 kgf/cm^2, 36 – 85 psi)

(e) Remove the oil pressure gauge.



(f) Apply adhesive to 2 or 3 threads of the oil pressure switch.

Adhesive:
Part No. 08833–00080, THREE BOND 1344, LOCTITE 242 or equivalent

(g) Reinstall the oil pressure switch.

(h) Start the engine and check for oil leak.

LU0GJ–02

REPLACEMENT

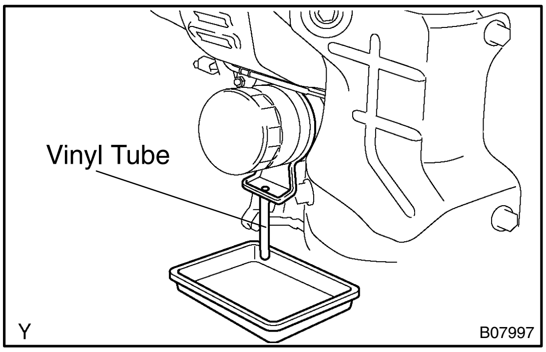
CAUTION:

- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Care should be taken, therefore, when changing engine oil to minimize the frequency and length of time your skin is exposed to used engine oil. Protective clothing and gloves that cannot be penetrated by oil should be worn. The skin should be thoroughly washed with soap and water, or use water–less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.**
- **In order to preserve the environment, used oil and used oil filters must be disposed of only at designated disposal sites.**

1. DRAIN ENGINE OIL

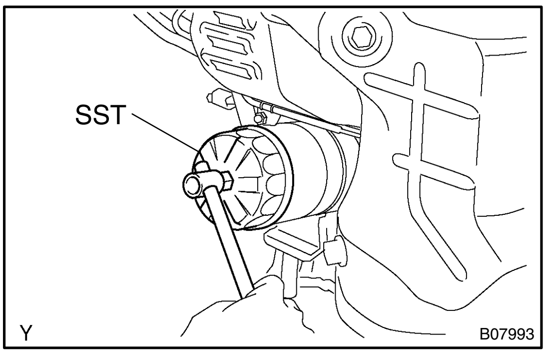
(a) Remove the oil filler cap.

(b) Remove the oil drain plug, and drain the oil into a container.



2. REPLACE OIL FILTER

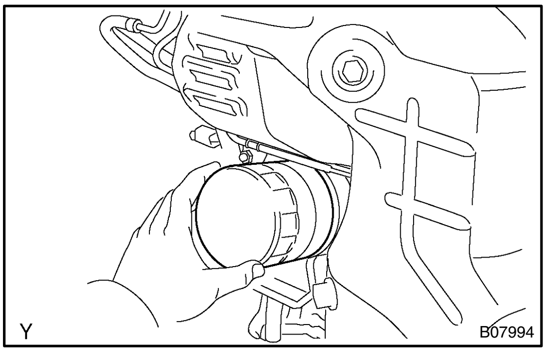
(a) Install a vinyl tube on the pipe of the oil drain container.



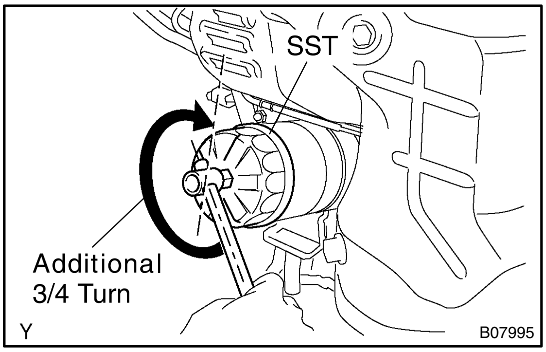
(b) Using SST, remove the oil filter.
SST 09228–10002

(c) Clean the oil filter contacting the oil filter mounting.

(d) Lubricate the filter rubber gasket with clean engine oil.



(e) Tighten the oil filter by hand until the rubber gasket contacts the seat of the filter mounting.



(f) Using SST, give it an additional 3/4 turn to seat the filter.
SST 09228–10002

(g) Remove the vinyl tube.

3. FILL WITH ENGINE OIL

(a) Clean and install the oil drain plug with a new gasket.
Torque: 34.3 N·m (350 kgf·cm, 25 ft·lbf)

(b) Fill with new engine oil.
Capacity:

Drain and refill	w/ Oil filter change w/o Oil filter change	6.4 liters (6.8 US qts, 5.6 Imp. qts) 5.4 liters (5.7 US qts, 4.8 Imp. qts)
Dry fill		6.5 liters (6.9 US qts, 5.7 Imp. qts)

(c) Reinstall the oil filler cap.

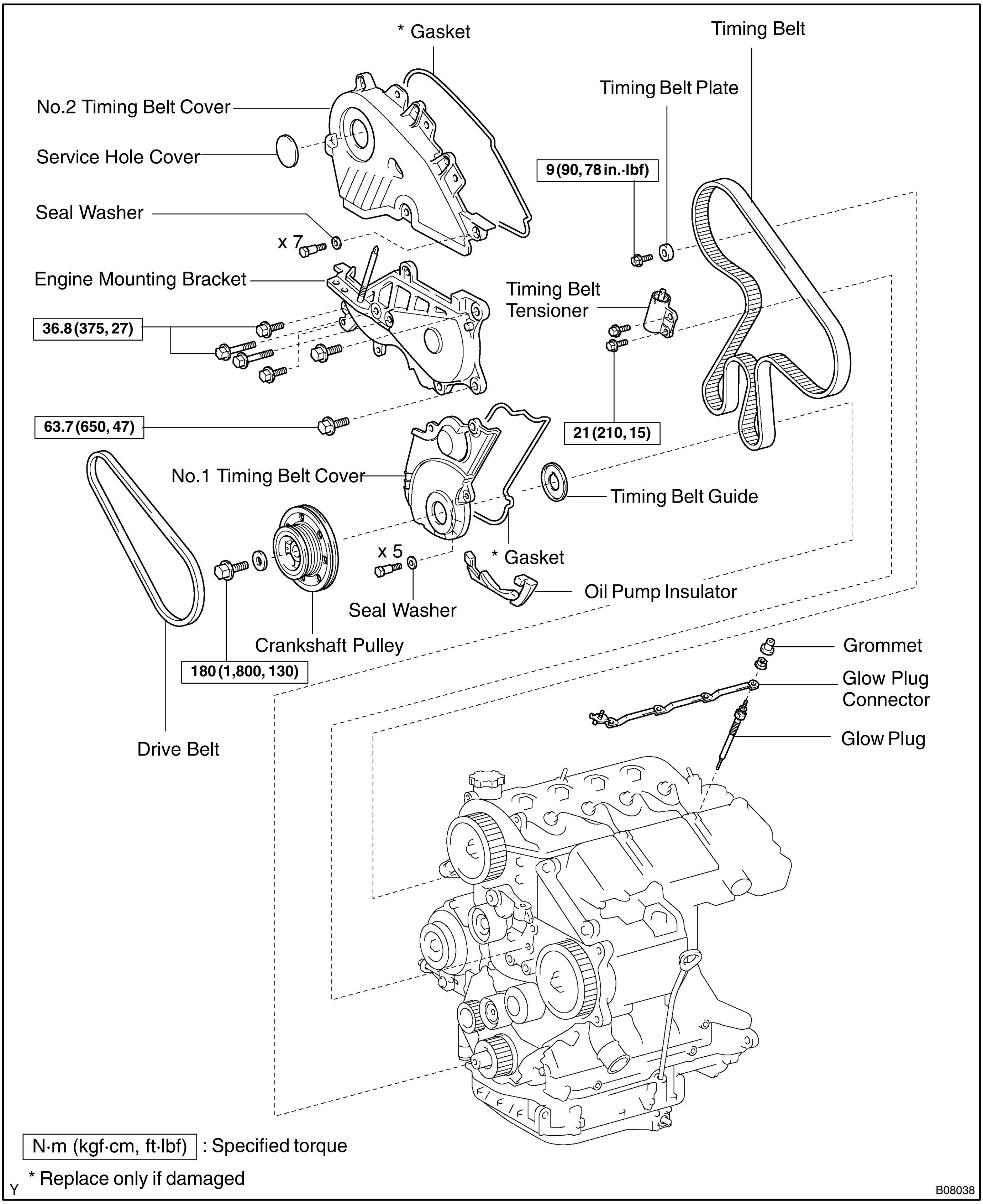
4. START ENGINE AND CHECK FOR OIL LEAK

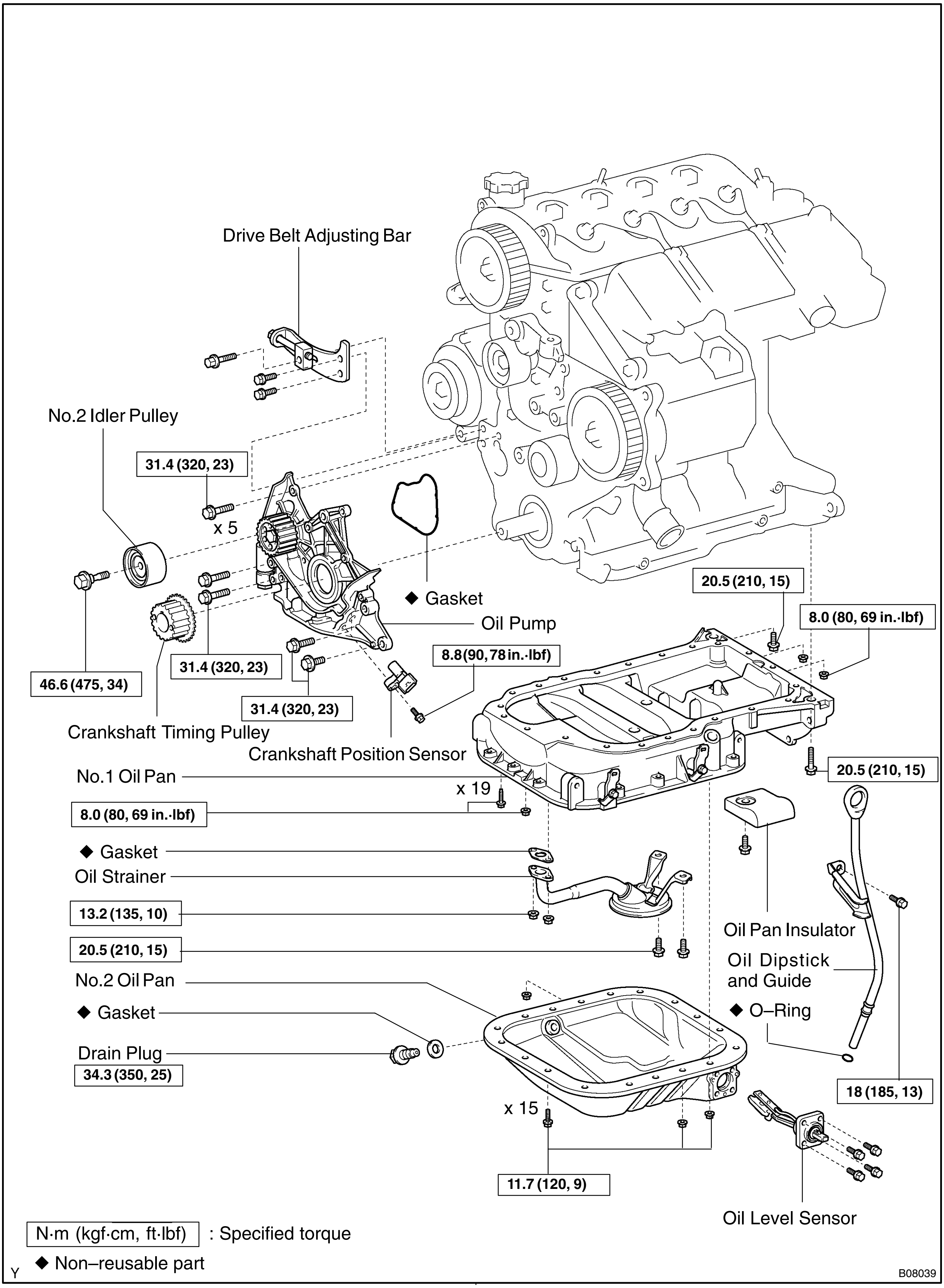
5. RECHECK ENGINE OIL LEVEL

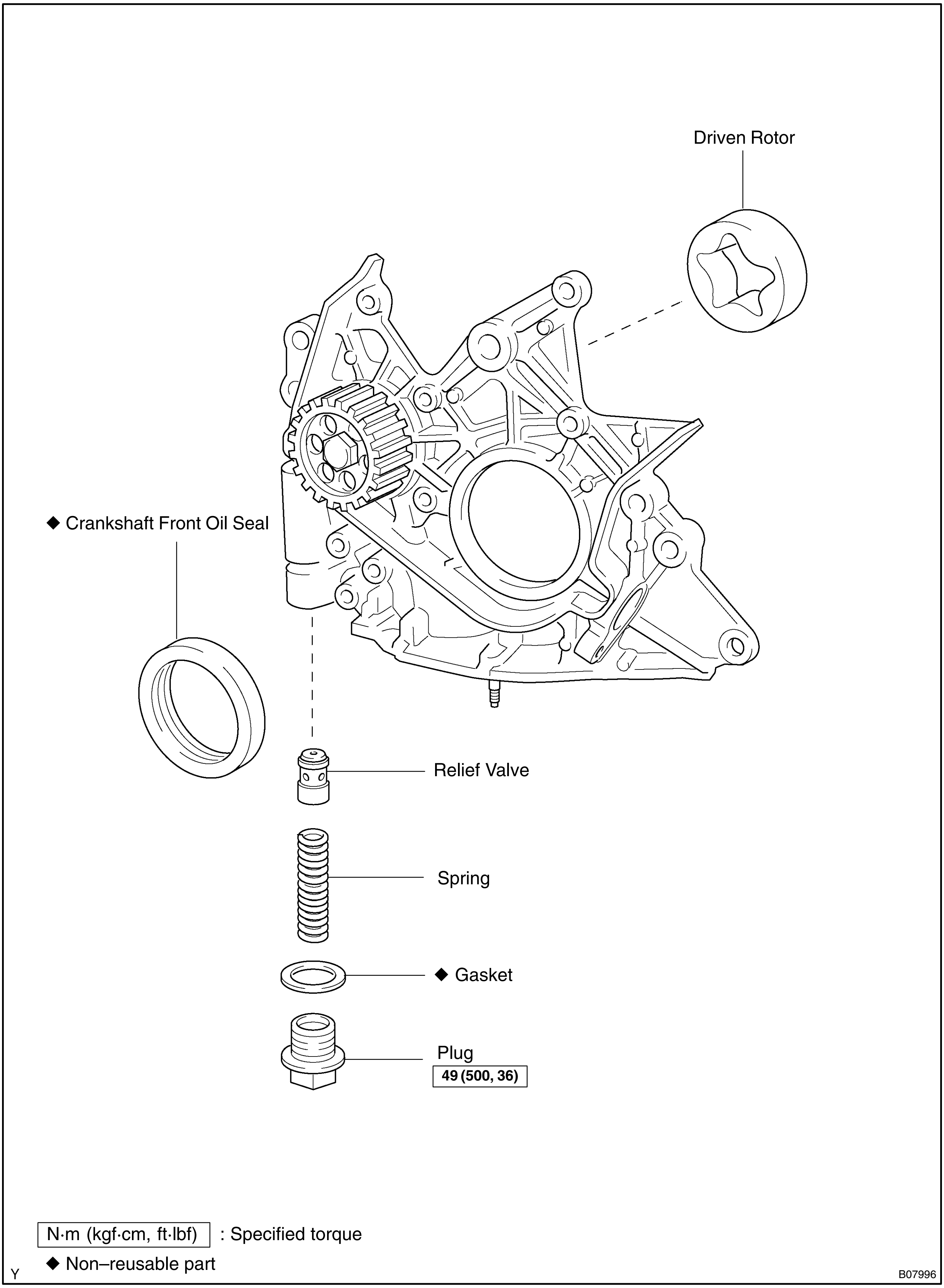
OIL PUMP

COMPONENTS

LU03J–05




Drive Belt Adjusting Bar
No.2 Idler Pulley
31.4 (320, 23)
x 5
◆ Gasket
Oil Pump
20.5 (210, 15)
8.0 (80, 69 in.·lbf)
8.8 (90, 78 in.·lbf)
46.6 (475, 34)
31.4 (320, 23)
31.4 (320, 23)
Crankshaft Timing Pulley
Crankshaft Position Sensor
No.1 Oil Pan
x 19
20.5 (210, 15)
8.0 (80, 69 in.·lbf)
◆ Gasket
Oil Strainer
13.2 (135, 10)
20.5 (210, 15)
Oil Pan Insulator
Oil Dipstick and Guide
No.2 Oil Pan
◆ Gasket
◆ O–Ring
Drain Plug
34.3 (350, 25)
18 (185, 13)
x 15
11.7 (120, 9)
Oil Level Sensor
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
B08039

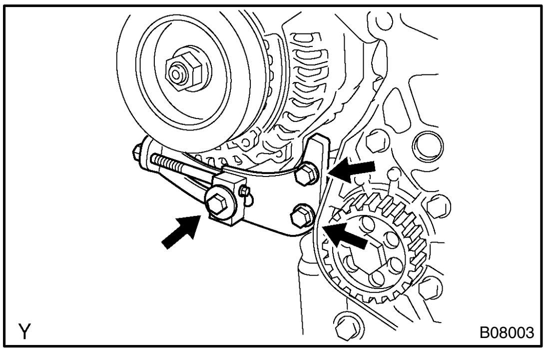

Driven Rotor
◆ Crankshaft Front Oil Seal
Relief Valve
Spring
◆ Gasket
Plug
49 (500, 36)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
B07996

LU0H9–01

REMOVAL

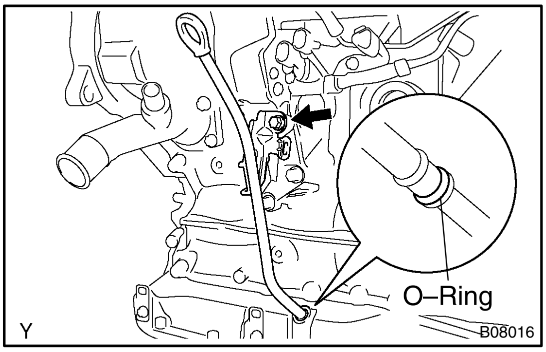
HINT:
When repairing the oil pump, the oil pan and strainer should be removed and cleaned.

1. **DRAIN ENGINE OIL**
2. **REMOVE TIMING BELT (See page EM–12)**
3. **REMOVE NO.2 IDLER AND CRANKSHAFT TIMING PULLEYS (See page EM–12)**



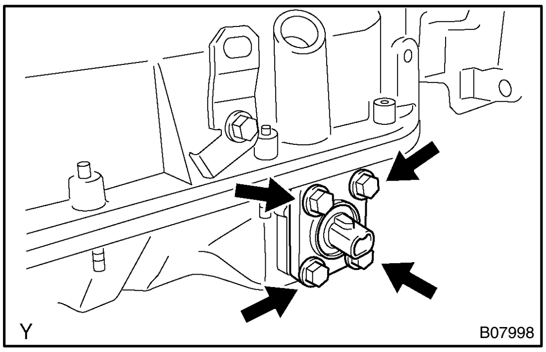
4. **REMOVE DRIVE BELT ADJUSTING BAR**

Remove the 3 bolts and adjusting bar.



5. **REMOVE OIL DIPSTICK AND GUIDE**

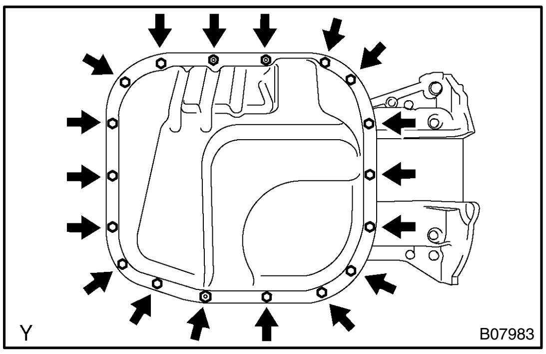
(a) Remove the bolt holding the dipstick guide to the supply pump stay.
(b) Pull out the dipstick guide together with the dipstick from the No.1 oil pan.
(c) Remove the O–ring from the dipstick guide.



6. **REMOVE OIL LEVEL SENSOR**

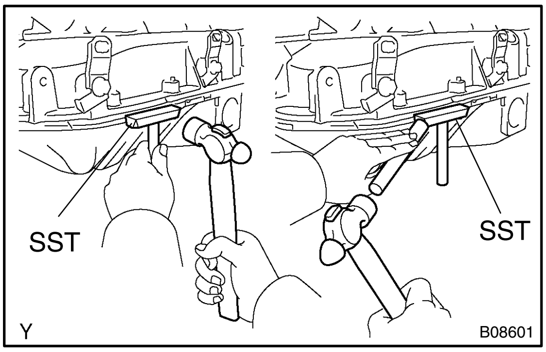
Remove the 4 bolts and level sensor.

NOTICE:
Be careful not to drop the oil level sensor when removing it.



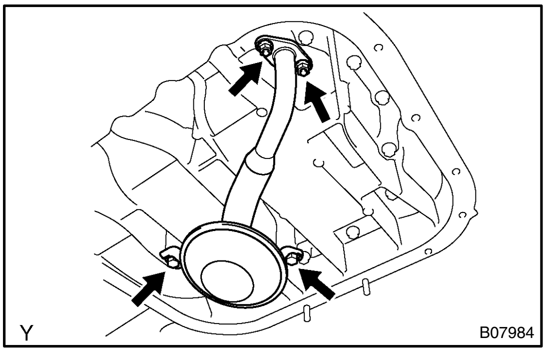
7. **REMOVE NO.2 OIL PAN**

(a) Remove the 15 bolts and 3 nuts.



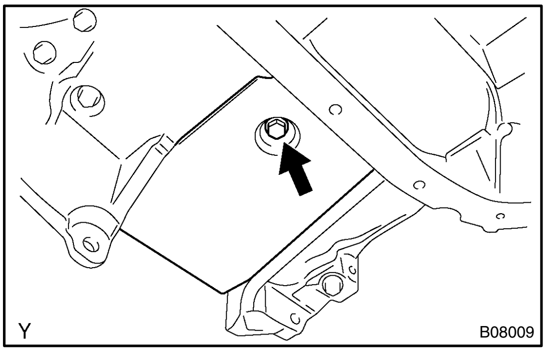
(b) Insert the blade of SST between the No.1 and No.2 oil pans, and cut off applied sealer and remove the No.2 oil pan.
SST 09032–00100

NOTICE:
Be careful not to damage the contact surfaces of the No.1 and No.2 oil pans.



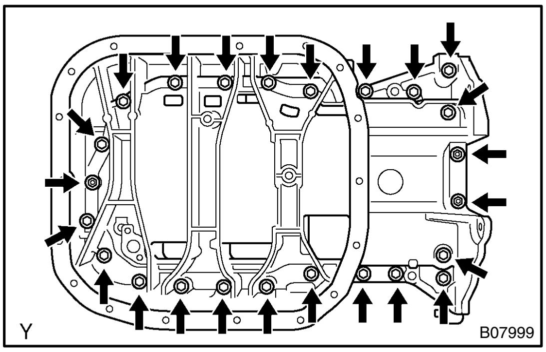
8. REMOVE OIL STRAINER

Remove the 2 bolts, 2 nuts, oil strainer and gasket.



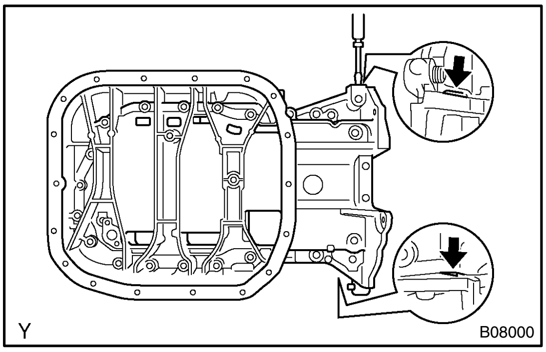
9. REMOVE OIL PAN INSULATOR

Remove the bolt and oil pan insulator.



10. REMOVE NO.1 OIL PAN

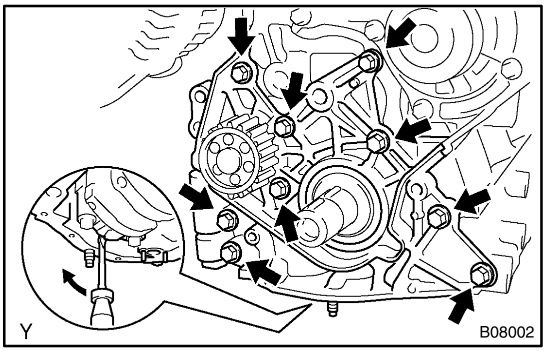
(a) Remove the 21 bolts and 3 nuts.



(b) Using a screwdriver, remove the oil pan by prying the portions between the cylinder block and No.1 oil pan.

NOTICE:
Be careful not to damage the contact surfaces of the cylinder block and No.1 oil pan.

11. REMOVE CRANKSHAFT POSITION SENSOR



12. REMOVE OIL PUMP

(a) Remove the 9 bolts.

(b) Remove the oil pump by prying a screwdriver between the the oil pump and main bearing cap.

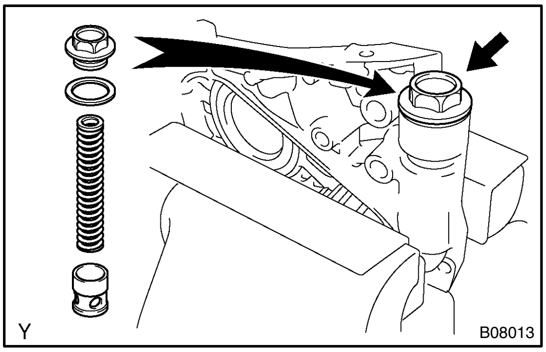
(c) Remove the gasket.

LU0HA–01

DISASSEMBLY

1. REMOVE DRIVEN ROTOR

Pull out the driven rotor.



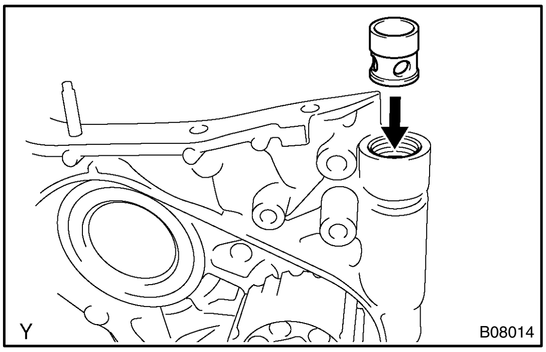
2. REMOVE RELIEF VALVE

(a) Carefully mount the oil pump body in a soft jaw vise.

(b) Remove the plug, gasket, spring and relief valve.

LU0HH–01

INSPECTION



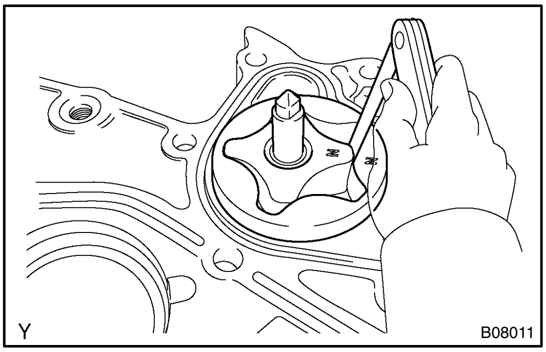
1. INSPECT RELIEF VALVE

Coat the valve with engine oil and check that it falls smoothly into the valve hole by its own weight.

If it doesn't, replace the relief valve. If necessary, replace the oil pump assembly.

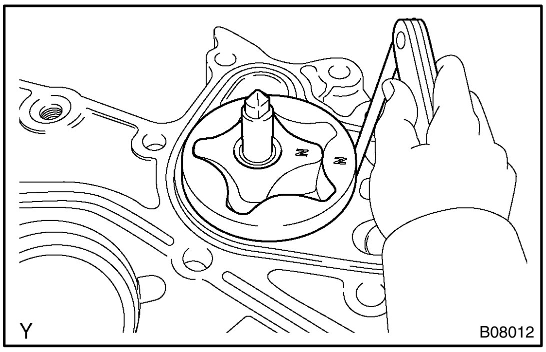
2. INSPECT DRIVE AND DRIVEN ROTORS

(a) Place the driven rotor into the oil pump body.
(See page LU–14)



(b) Inspect the rotors for tip clearance.
Using a feeler gauge, measure the clearance between the drive and driven rotor tips.
Standard tip clearance:
0.08 – 0.16 mm (0.0031 – 0.0063 in.)
Maximum tip clearance: 0.20 mm (0.0079 in.)

If the tip clearance is greater than maximum, replace the oil pump assembly.



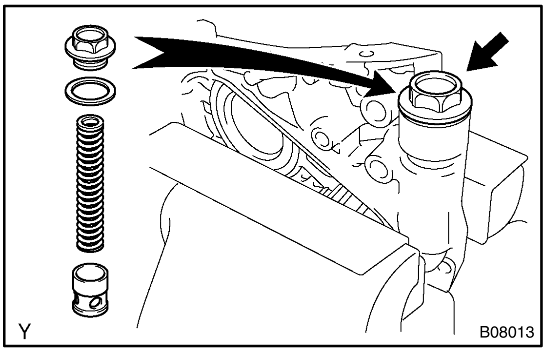
(c) Inspect the rotors for body clearance.
Using a feeler gauge, measure the clearance between the driven rotor and body.
Standard body clearance:
0.10 – 0.17 mm (0.0039 – 0.0067 in.)
Maximum body clearance: 0.20 mm (0.0079 in.)

If the tip clearance is greater than maximum, replace the oil pump assembly.

LU0HB–01
REPLACEMENT
REPLACE CRANKSHAFT FRONT OIL SEAL (See page EM–70)

LU0GM–02

REASSEMBLY

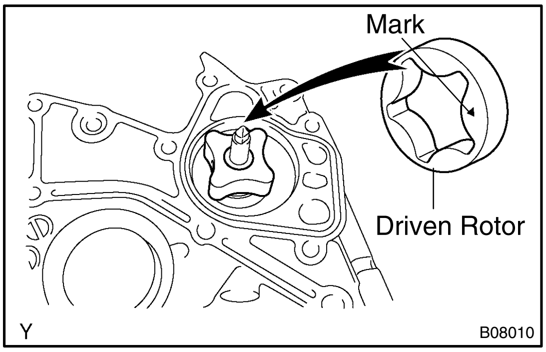


1. INSTALL RELIEF VALVE

(a) Insert the relief valve and spring into the oil pump body.

(b) Install the plug with a new gasket.

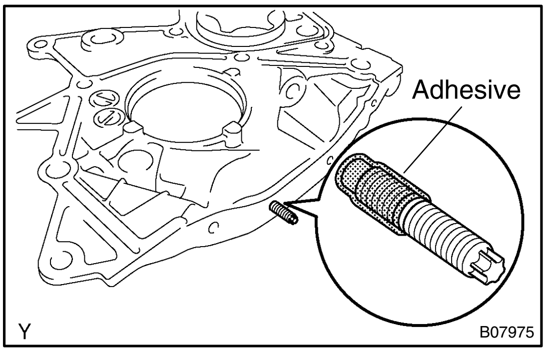
Torque: 49 N·m (500 kgf·cm 36 ft·lbf)



2. INSTALL DRIVEN ROTOR

Install the driven rotor into pump with the mark on the driven rotor facing the pump body side.

LU0HC–01



INSTALLATION

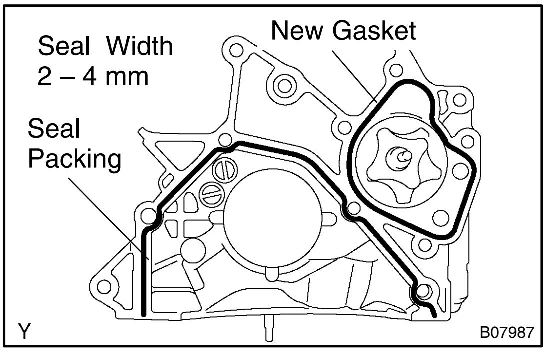
1. INSTALL OIL PUMP STUD BOLT

HINT:
When using a new oil pump, stud bolt must be installed.
Apply adhesive to the threads of the stud bolt and install it.

Adhesive: Part No. 08833–00070, THREE BOND 1324 or equivalent

2. INSTALL OIL PUMP

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil pump and cylinder block.
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

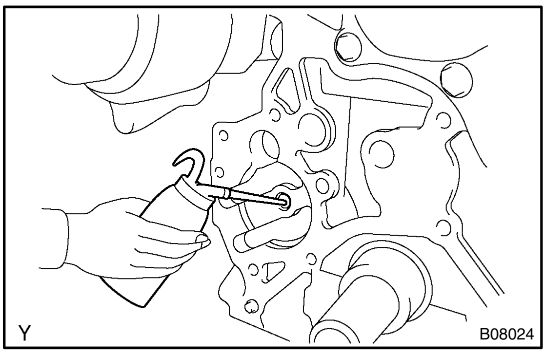


(b) Apply seal packing to the oil pump as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent

NOTICE:
Avoid applying an excessive amount to the surface.
- Install a nozzle that has been cut to a 2 – 4 mm (0.08 – 0.16 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

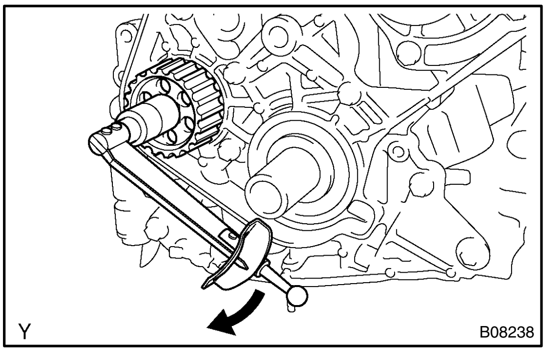
(c) Install a new gasket to the oil pump.



(d) Pour in 0.5 cm^3 (0.03 cu in.) or more of engine oil into the bushing of the cylinder block.

(e) Install the oil pump with the 9 bolts.

Torque: 31.4 N·m (320 kgf·cm, 23 ft·lbf)

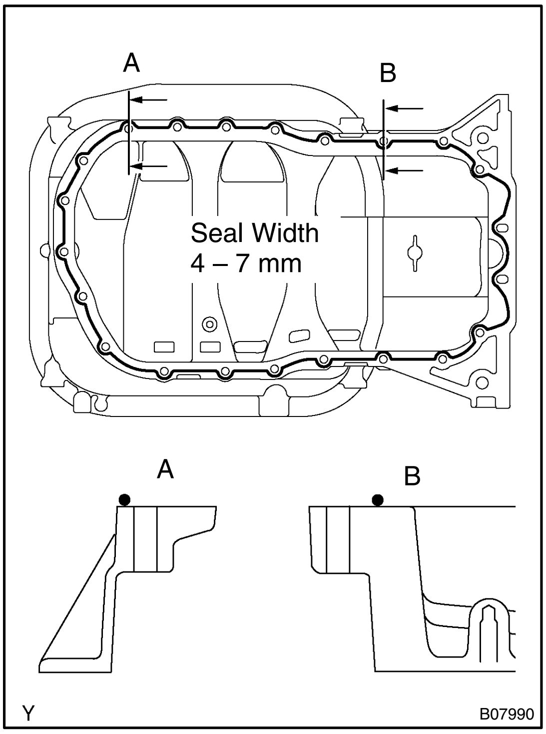


(f) Measure the oil pump rotating torque.
 (1) Check that the pump rotates smoothly without abnormal noise.
 (2) Using a torque wrench, check the pump rotating torque.
 Rotating torque: 3.0 N·m (30 kgf·cm, 26 in.·lbf) or less

3. INSTALL CRANKSHAFT POSITION SENSOR
Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

4. INSTALL NO.1 OIL PAN

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the No.1 oil pan, cylinder block, oil pump and rear oil seal retainer.
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.

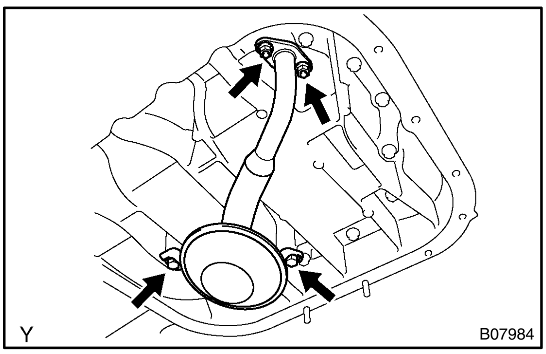


(b) Apply seal packing to the No.1 oil pan as shown in the illustration.
 Seal packing: Part No. 08826–00080 or equivalent
- Install a nozzle that has been cut to a 4 – 7 mm (0.16 – 0.28 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

(c) Install the oil pan with the 21 bolts and 3 nuts.
 Torque:
 8.0 N·m (80 kgf·cm, 69 in.·lbf) for 10 mm head bolt and nut
 20.5 N·m (210 kgf·cm, 15 ft·lbf) for 12 mm head bolt

5. INSTALL OIL PAN INSULATOR

Install the oil pan insulator with the bolt.
Torque: 7.5 N·m (75 kgf·cm, 65 in.·lbf)



6. INSTALL OIL STRAINER

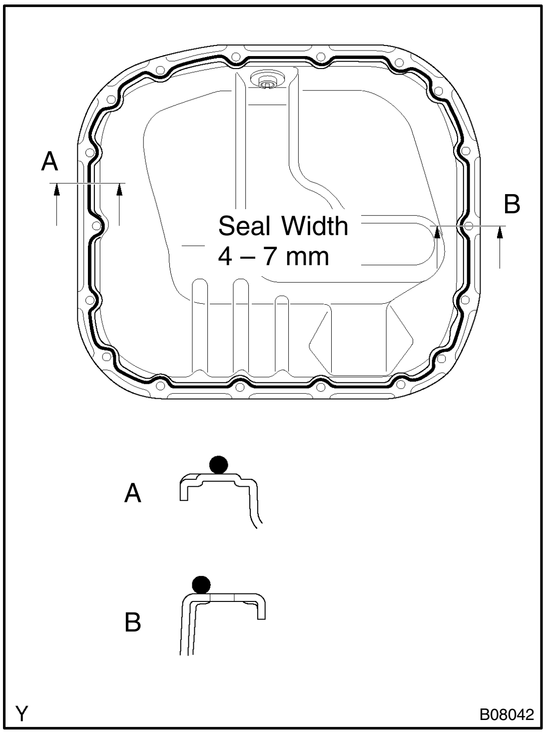
Install a new gasket and the oil strainer with the 2 bolts and 2 nuts.
Torque:
20.5 N·m (210 kgf·cm, 15 ft·lbf) for bolt
13.2 N·m (135 kgf·cm, 10 ft·lbf) for nut

7. INSTALL NO.2 OIL PAN

(a) Remove any old seal packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the No.1 and No.2 oil pans.

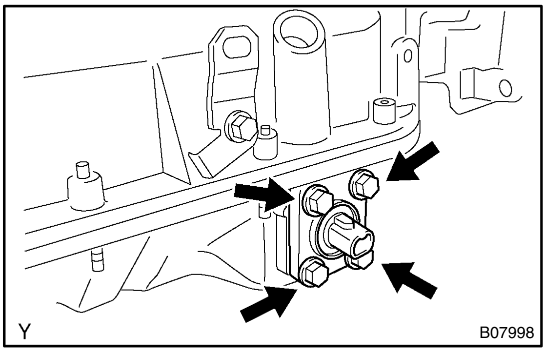
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surface.

NOTICE:
Do not use a solvent which will affect the painted surfaces.



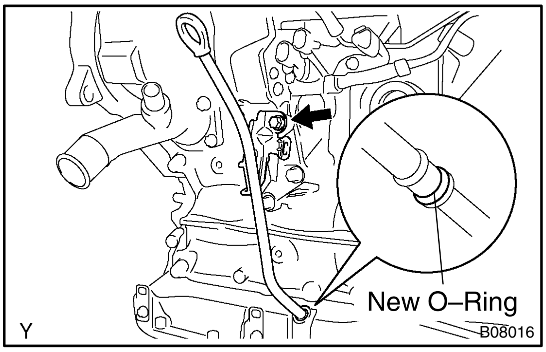
(b) Apply a seal packing to the oil pan shown in the illustration.
Seal packing: Part No. 08826–00080 or equivalent
- Install a nozzle that has been cut to a 4 – 7 mm (0.16 – 0.28 in.) opening.
- Parts must be assembled within 15 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall the cap.

(c) Install the oil pan with the 15 bolts and 3 nuts. Uniformly tighten the bolts and nuts in several passes.
Torque: 11.7 N·m (120 kgf·cm, 9 ft·lbf)



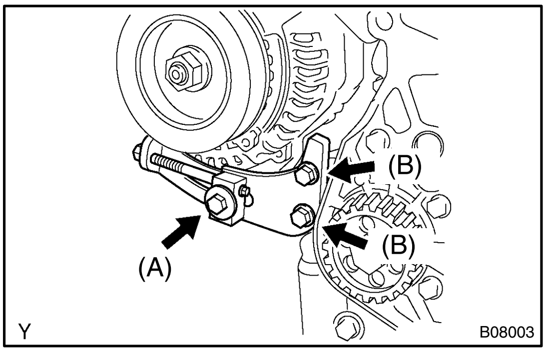
8. INSTALL OIL LEVEL SENSOR

Install the level sensor with the 4 bolts.
Torque: 5.4 N·m (55 kgf·cm, 48 in.·lbf)



9. INSTALL OIL DIPSTICK AND GUIDE

(a) Install a new O–ring to the dipstick guide.
(b) Apply engine oil to the O–ring.
(c) Push in the dipstick guide end into the guide hole of the No.1 oil pan.
(d) Install the dipstick guide with the bolt.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)
(e) Apply engine oil to the O–ring on the dipstick.
(f) Install the dipstick.



10. INSTALL DRIVE BELT ADJUSTING BAR

Install the adjusting bar with the 3 bolts.

Torque:
18.1 N·m (185 kgf·cm, 13 ft·lbf) for bolt (A)
31.4 N·m (320 kgf·cm, 23 ft·lbf) for bolt (B)

HINT:
Tighten the bolt (A) after having the drive belt installed.

11. INSTALL CRANKSHAFT TIMING AND NO.2 IDLER PULLEYS (See page EM–18)

12. INSTALL TIMING BELT (See page EM–18)

13. FILL WITH ENGINE OIL

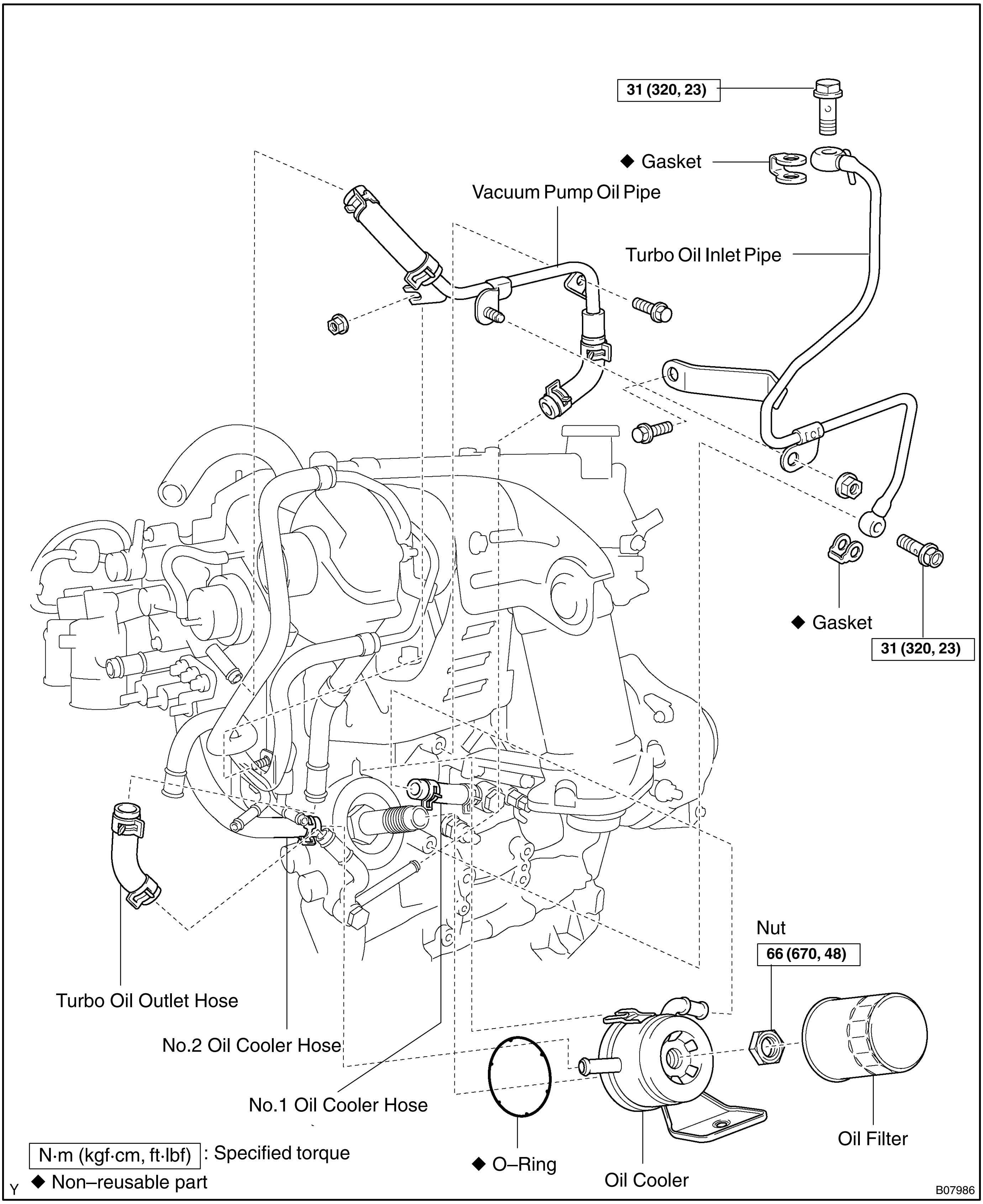
14. START ENGINE AND CHECK FOR OIL LEAK

15. RECHECK ENGINE OIL LEVEL

OIL COOLER

COMPONENTS

LU03Q–05

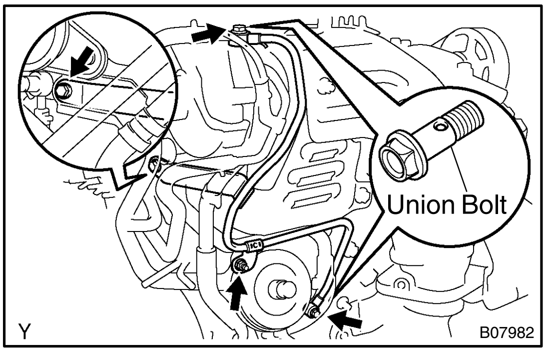


LU0HI–01

REMOVAL

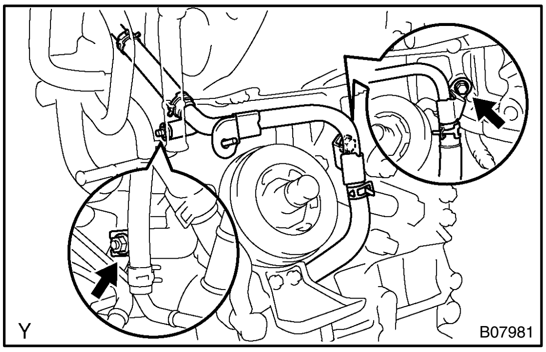
1. DRAIN ENGINE COOLANT

2. REMOVE OIL FILTER (See page LU–2)



3. REMOVE TURBO OIL INLET PIPE

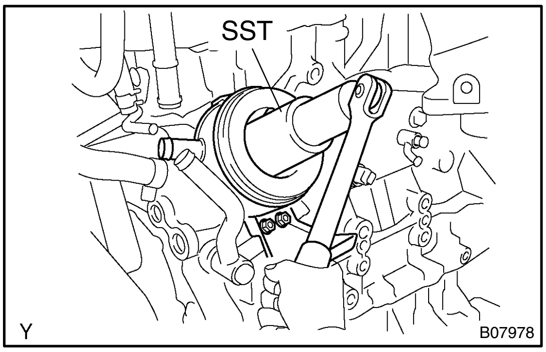
Remove the 2 union bolts, 2 gaskets, bolt, nut and inlet pipe.



4. REMOVE VACUUM PUMP OIL PIPE

(a) Disconnect the 2 oil hoses.

(b) Remove the bolt, nut and oil pipe.

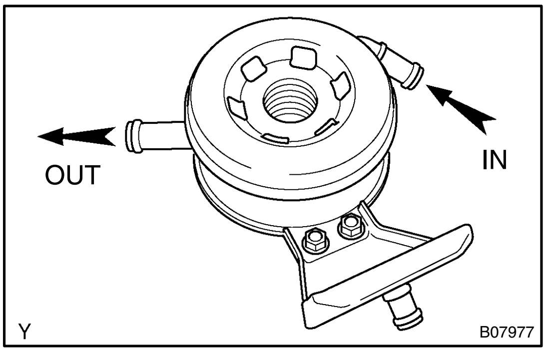


5. REMOVE OIL COOLER

(a) Using SST, remove the nut and oil cooler.
SST 09229–55010

(b) Remove the O–ring from the oil cooler.

LU03S–05



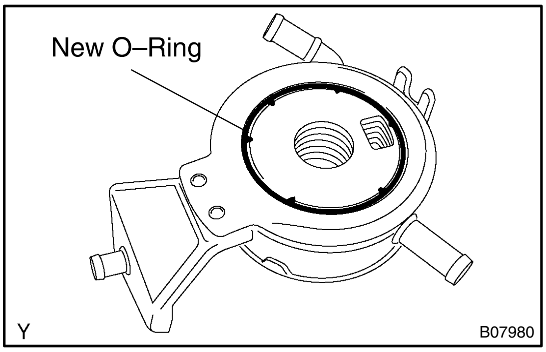
INSPECTION

INSPECT OIL COOLER

Check the oil cooler for damage or clogging.
If necessary, replace the oil cooler.

LU0HJ–02

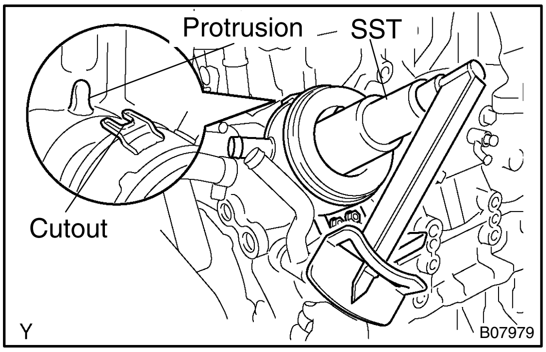
INSTALLATION



1. INSTALL OIL COOLER

(a) Clean the oil cooler contact surface on the oil cooler mounting.

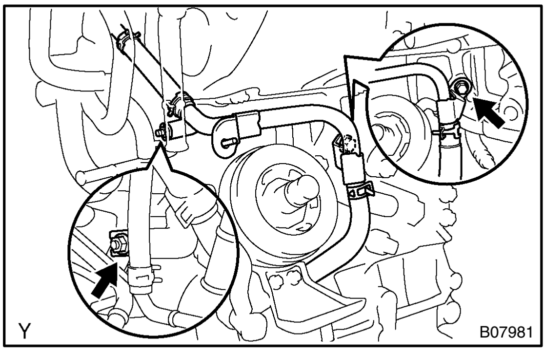
(b) Install a new O–ring to the oil cooler.



(c) Apply a light coat of engine oil on the threads and under the nut.

(d) Align the cutout of the oil cooler with the protrusion of the cylinder block.

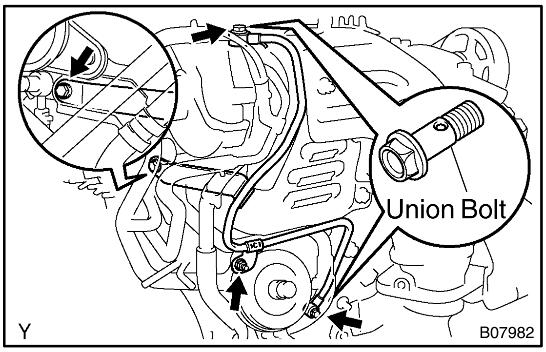
(e) Using SST, install the oil cooler with the nut.
SST 0929–55010
Torque: 66 N·m (670 kgf·cm, 48 ft·lbf)



2. INSTALL VACUUM PUMP OIL PIPE

(a) Install the oil pipe with the bolt and nut.
Torque: 8.8 N·m (90 kgf·cm, 78 in.·lbf)

(b) Connect the 2 oil hoses.



3. INSTALL TURBO OIL INLET PIPE

(a) Apply a light coat of engine oil to 2 new gaskets and on the threads and under the heads of the union bolts.

(b) Install the 2 gaskets and the inlet pipe with the 2 union bolts, bolt and nut.

NOTICE:
Use the new gasket by separating it into two.

HINT:
The turbocharger side union bolt is yellow and the cylinder block side union bolt is black.

Torque:
31 N·m (320 kgf·cm, 23 ft·lbf) for union bolt
8.8 N·m (90 kgf·cm, 78 in.·lbf) for bolt and nut

4. INSTALL OIL FILTER (See page LU–2)

5. FILL WITH ENGINE COOLANT

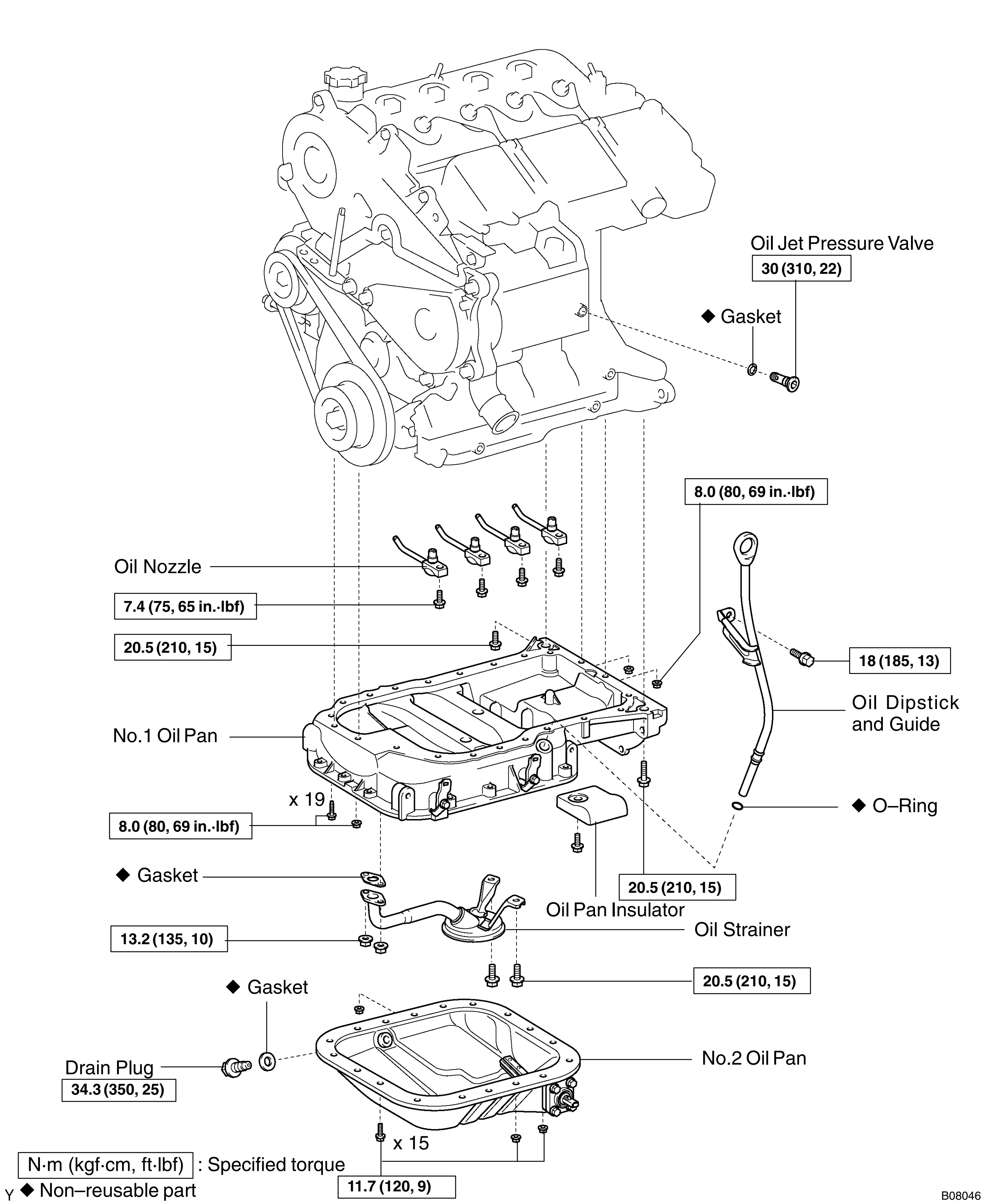
6. START ENGINE AND CHECK FOR LEAK

7. CHECK ENGINE OIL LEVEL

OIL NOZZLE AND OIL JET PRESSURE VALVE

COMPONENTS

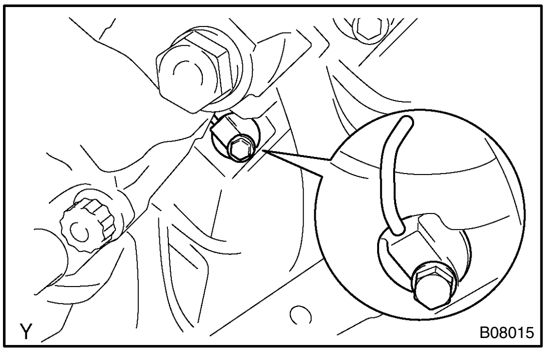
LU0HD–01



LU0HE–01

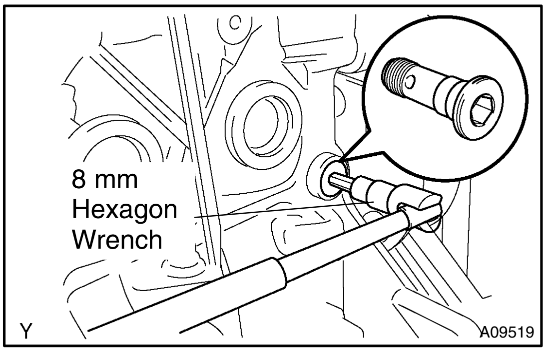
REMOVAL

1. REMOVE NO.2 AND NO.1 OIL PANS
(See page LU–7)



2. REMOVE OIL NOZZLES

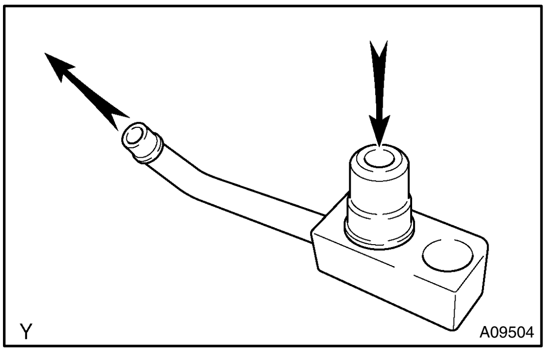
Remove the bolt and oil nozzle. Remove the 4 oil nozzles.



3. REMOVE OIL JET PRESSURE VALVE

Using an 8 mm hexagon wrench, remove the pressure valve and gasket.

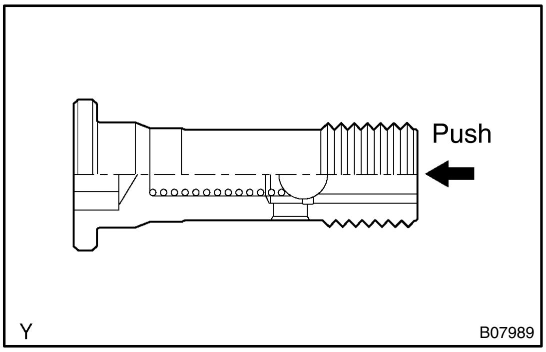
LU0HF–01



INSPECTION

1. INSPECT OIL NOZZLES

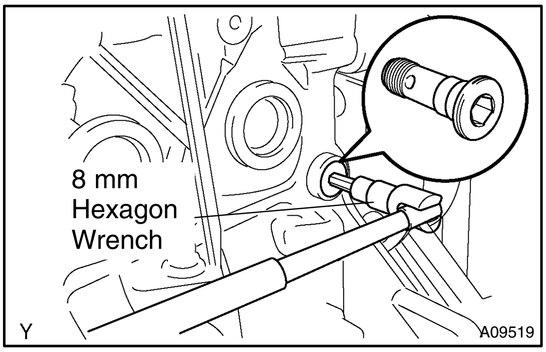
Check the oil nozzle for damage or clogging.
If necessary, replace the oil nozzle.



2. INSPECT OIL JET PRESSURE VALVE

Push the valve with a wooden stick to check if it is stuck.
If stuck, replace the pressure valve.

LU0HG–01

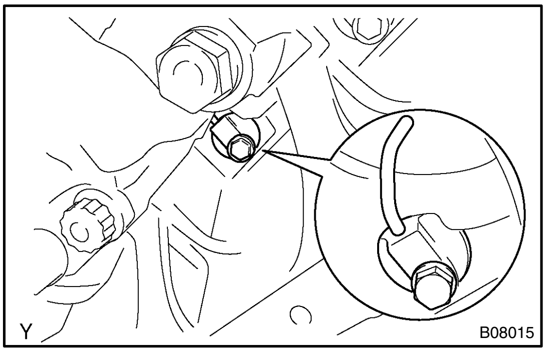


INSTALLATION

1. INSTALL OIL JET PRESSURE VALVE

Using an 8 mm hexagon wrench, install a new gasket and the pressure valve.

Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)



2. INSTALL OIL NOZZLES

Install the oil nozzle with the bolt. Install the 4 oil nozzles.

Torque: 7.4 N·m (75 kgf·cm, 65 in.·lbf)

3. INSTALL NO.1 AND NO.2 OIL PANS

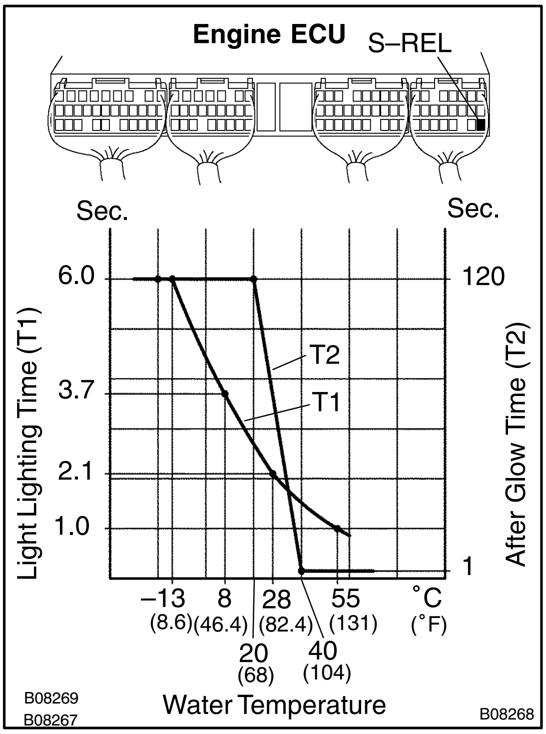
(See page LU–14)

STARTING

PRE–HEATING SYSTEM

ST0GU–01

INSPECTION



1. INSPECT LIGHTING TIME OF GLOW INDICATOR LIGHT

Turn the ignition switch ON, and measure the lighting time.

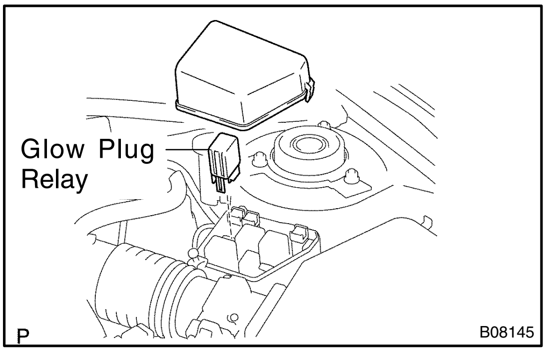
Light lighting time (T1): Refer to the chart graph

2. INSPECT AFTER GLOW TIME

Turn the ignition switch to START, after the engine starts, measure the time when the battery voltage is applied to terminal S–REL of the engine ECU.

After glow time (T2): Refer to the chart graph

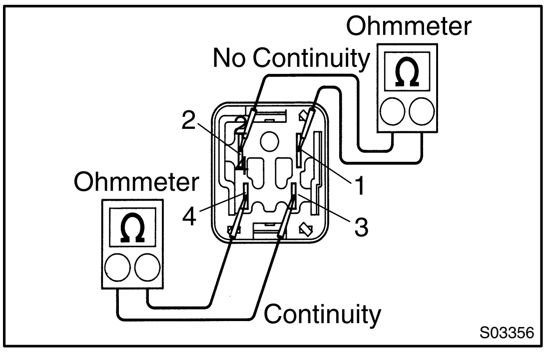
3. INSPECT ENGINE ECU (See page DI–118)



4. INSPECT GLOW PLUG RELAY (Making: GLOW)

(a) Remove the relay box cover.

(b) Remove the glow plug relay.



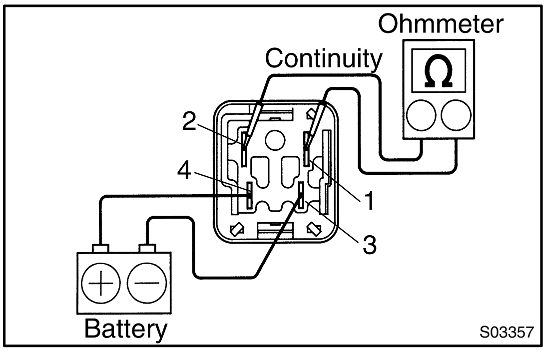
(c) Inspect the glow plug relay continuity.

(1) Using an ohmmeter, check that there is no continuity between terminals 1 and 2.

If there is continuity, replace the relay.

(2) Check that there is continuity between terminals 3 and 4.

If there is no continuity, replace the relay.



(d) Inspect the glow plug relay operation.

(1) Apply battery voltage across terminals 3 and 4.

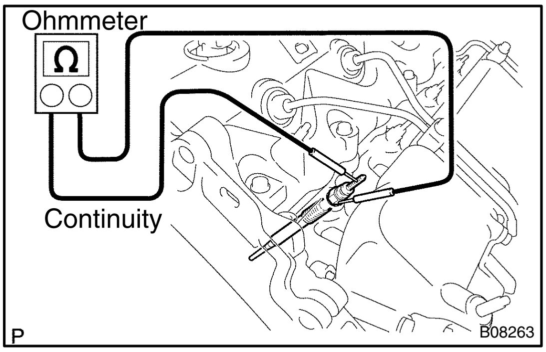
(2) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

If there is no continuity, replace the relay.

(e) Reinstall the glow plug relay.

(f) Reinstall the relay box cover.

5. INSPECT WATER TEMPERATURE SENSOR (See page ED–10)



6. INSPECT GLOW PLUGS

Using an ohmmeter, check that there is continuity between the glow plug terminal and ground.

Standard resistance: Approx. 0.72 Ω at 20°C (68°F)

If there is no continuity, replace the glow plug.

Torque: 13 N·m (130 kgf·cm, 10 ft·lbf)

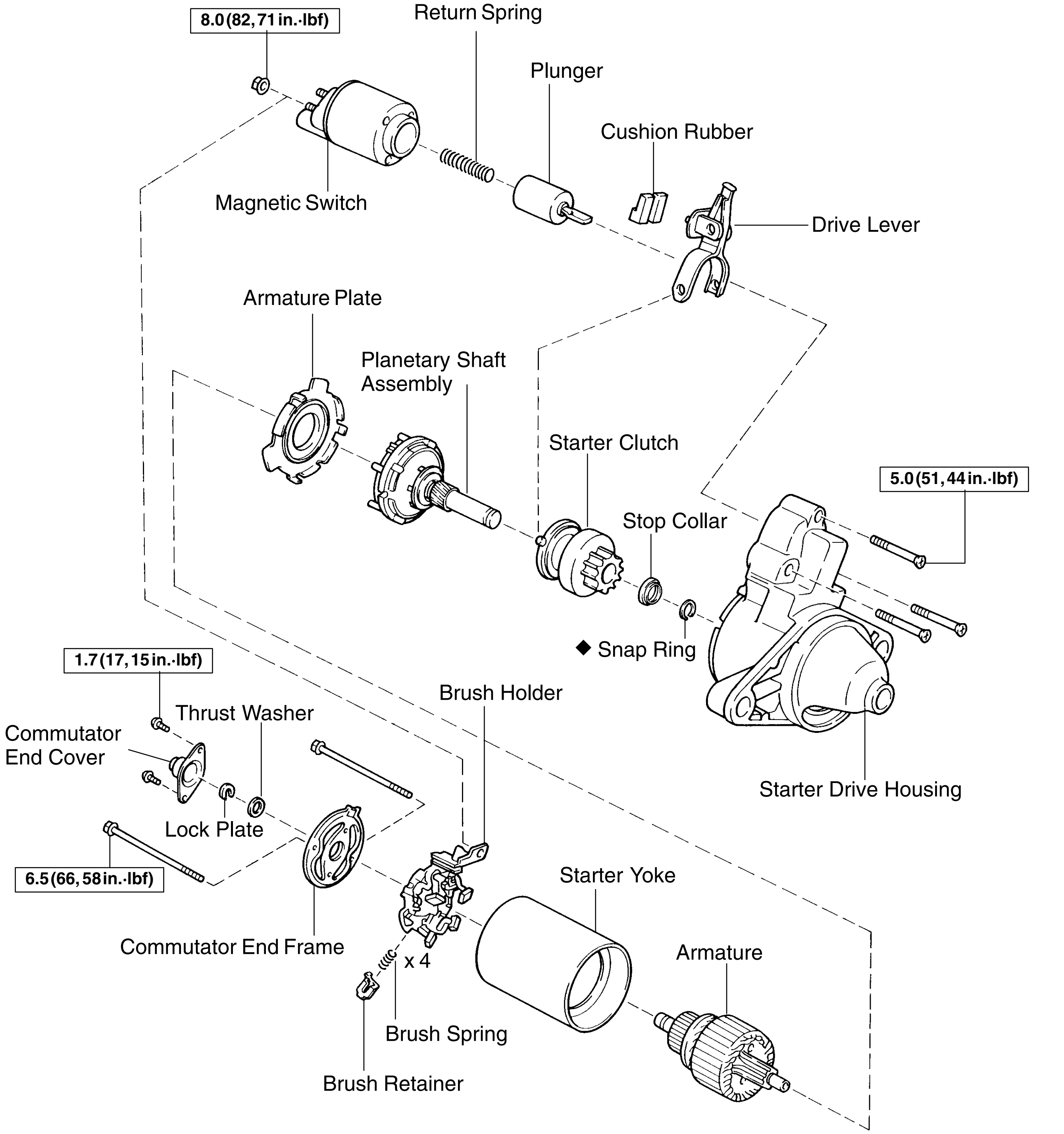
NOTICE:

- **Be careful not to damage the glow plug pipes as it could cause an open circuit or shorten life of the glow plugs.**
- **Avoid getting oil and gasoline on the glow plug when cleaning.**
- **During inspection, be sure to wipe any oil of the terminal and bakelite washer with a dry cloth.**
- **Be careful no to apply more than 11 V to the glow plug as it could cause an open circuit.**

STARTER

COMPONENTS

ST0FJ–02

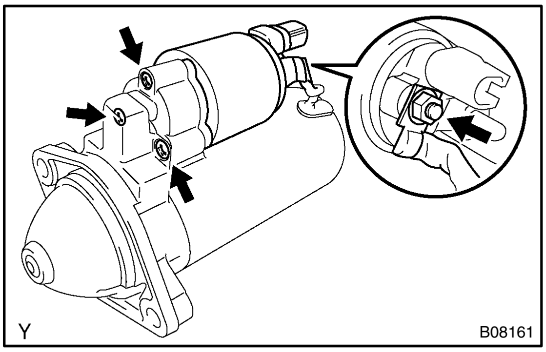


N ◆ Non–reusable part

B08266

ST0GV–01

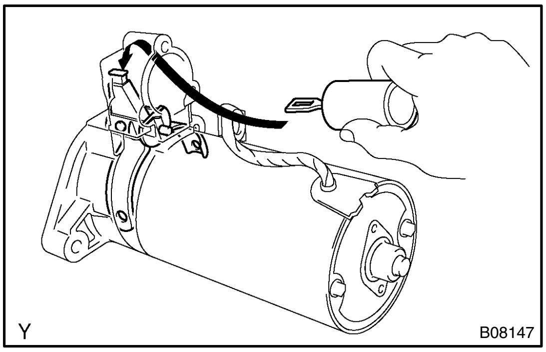
DISASSEMBLY



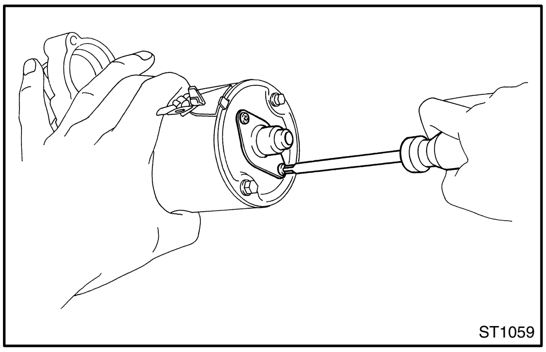
1. REMOVE MAGNETIC SWITCH

(a) Remove the nut, and disconnect lead wire from the magnetic switch terminal.

(b) Remove the 3 screws, magnetic switch and return spring.

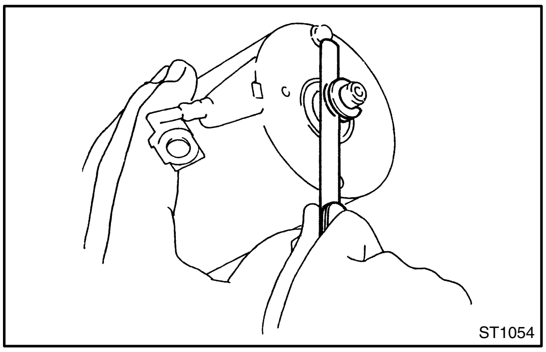


(c) Pull the plunger, and disconnect the plunger hook from the upper side of the drive lever.



2. REMOVE COMMUTATOR END COVER

(a) Remove the 2 screws and end cover.



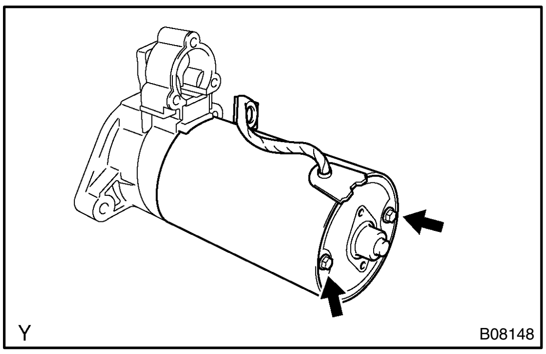
(b) Using a feeler gauge, measure the armature thrust clearance between the lock plate and end frame.

Standard thrust clearance: 0.3 mm (0.012 in.)

Maximum thrust clearance: 0.6 mm (0.024 in.)

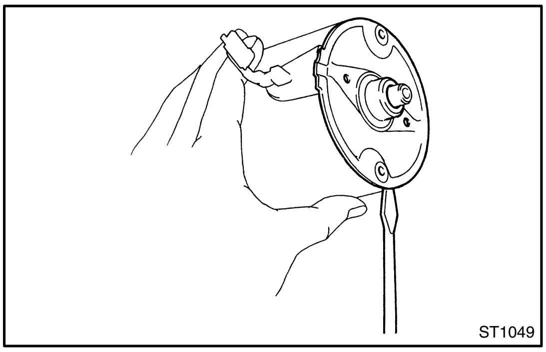
If the thrust clearance is greater the than maximum, replace the thrust washer.

(c) Remove the lock plate and thrust washer.



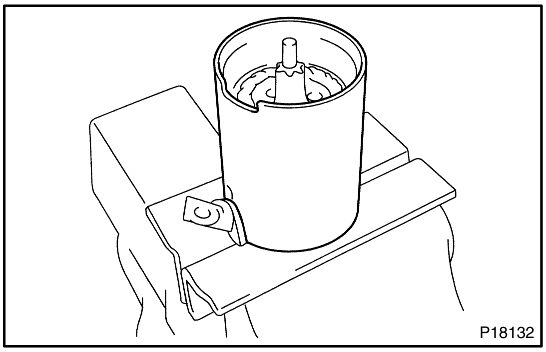
3. REMOVE STARTER YOKE AND ARMATURE

Remove the 2 through bolts, and pull out the starter yoke together with the armature.



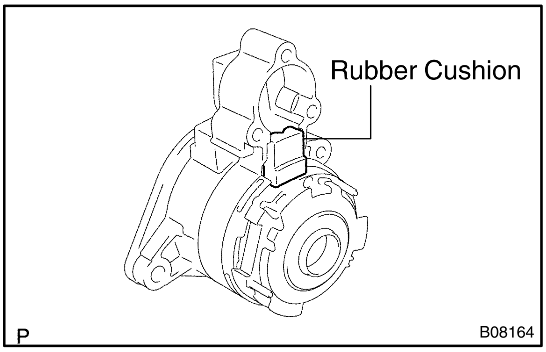
4. REMOVE COMMUTATOR END FRAME

Using a screwdriver, pry out the commutator end frame.



5. REMOVE STARTER YORK FROM ARMATURE

6. REMOVE ARMATURE FROM BRUSH HOLDER

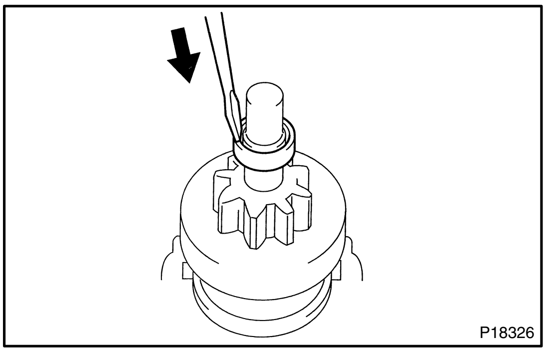


7. REMOVE ARMATURE PLATE

8. REMOVE PLANETARY SHAFT ASSEMBLY AND STARTER CLUTCH

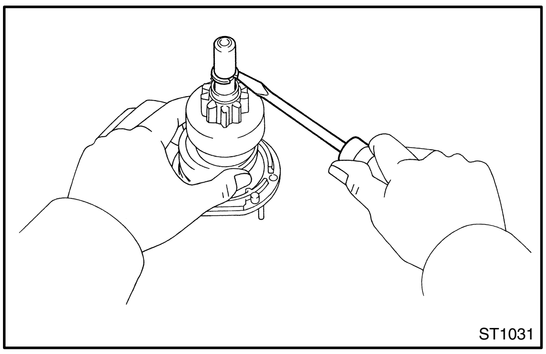
(a) Remove the rubber cushion.
(b) Remove the planetary shaft and starter clutch assembly.

9. REMOVE DRIVE LEVER FROM STARTER CLUTCH



10. REMOVE STARTER CLUTCH FROM PLANETARY SHAFT

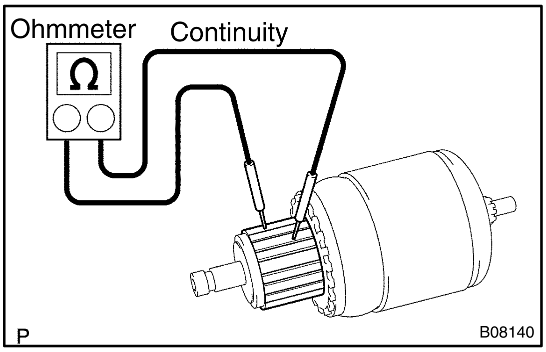
(a) Using a screwdriver, tap in the stop collar towards the starter clutch.



(b) Using a screwdriver, pry out the snap ring.
(c) Remove the stop collar from the shaft.

ST0GW–01

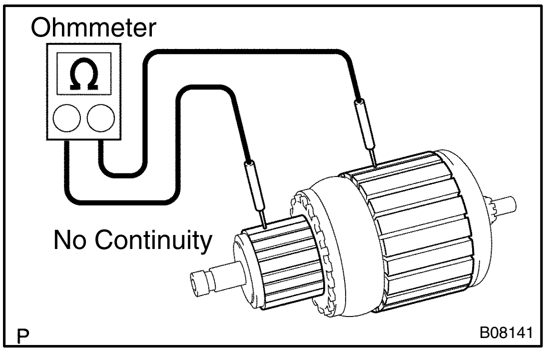
INSPECTION



1. INSPECT ARMATURE COIL

(a) Check the commutator for open circuit.
Using an ohmmeter, check that there is continuity between the segments of the commutator.

If there is no continuity between any segments, replace the armature.



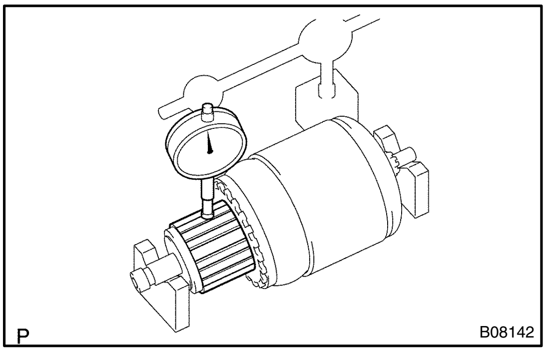
(b) Check the commutator for ground.
Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

If there is continuity, replace the armature.

2. INSPECT COMMUTATOR

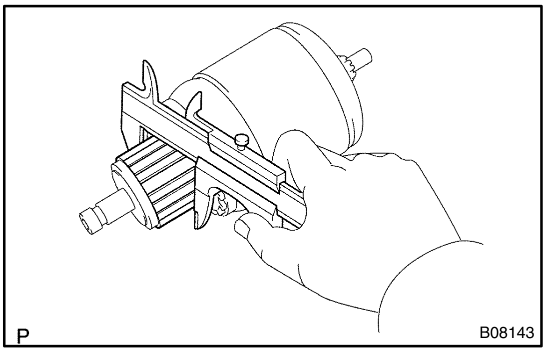
(a) Check the commutator for the dirty and burnt surface.

If the surface is dirty or burnt, correct with sandpaper (No.400) or a lathe.



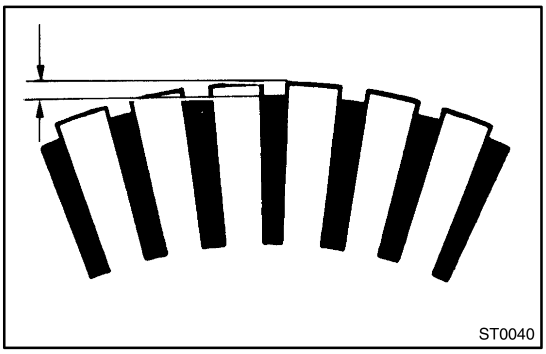
(b) Check for the commutator circuit runout.
(1) Place the commutator on V–blocks.
(2) Using a dial indicator, measure the circle runout.
Maximum circle runout: 0.03 mm (0.0012 in.)

If the circle runout is greater than maximum, correct it on a lathe.



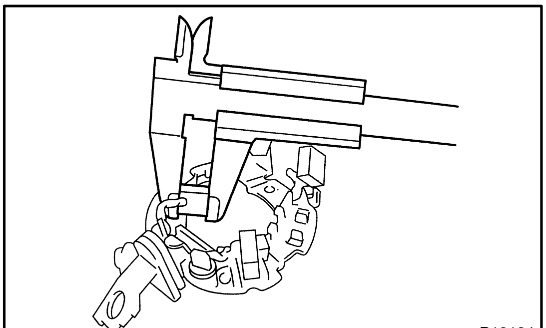
(c) Using vernier calipers, measure the commutator diameter.
Standard diameter: 32.3 mm (1.272 in.)
Minimum diameter: 30.5 mm (1.201 in.)

If the diameter is less than minimum, replace the armature.



(d) Check that the undercut depth is clean and free of foreign materials. Smooth out the edge.
Standard undercut depth: 0.9 mm (0.035 in.)
Minimum undercut depth: 0.3 mm (0.012 in.)

If the undercut depth is less than minimum, correct it with a hacksaw blade.


P18134

3. INSPECT BRUSH

Using vernier calipers, measure the brush length.

Standard length: 14.5 mm (0.571 in.)

Minimum length: 9.0 mm (0.354 in.)

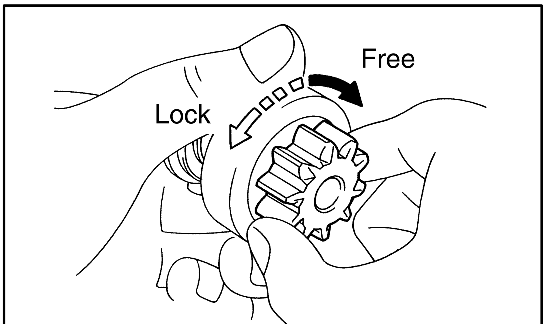
If the length is less than minimum, replace the brush holder.

4. INSPECT CLUTCH AND GEAR

(a) Check the gear teeth on the starter clutch for wear or damage.

If the gear is damaged, replace it.

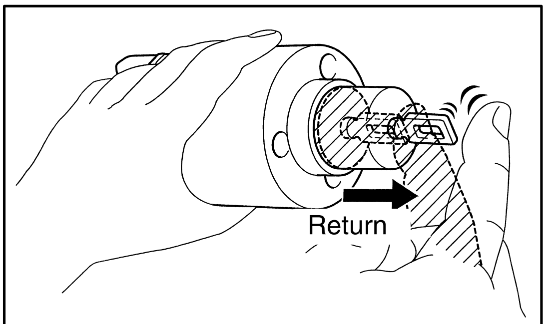
If damaged, replace the clutch assembly. If damaged, also check the drive plate ring gear for wear or damage.



S02257

(b) Check the starter clutch.
Rotate the clutch pinion gear clockwise and check that it turns freely. Try to rotate the clutch pinion gear counterclockwise and check that it locks.

If necessary, replace the starter clutch.

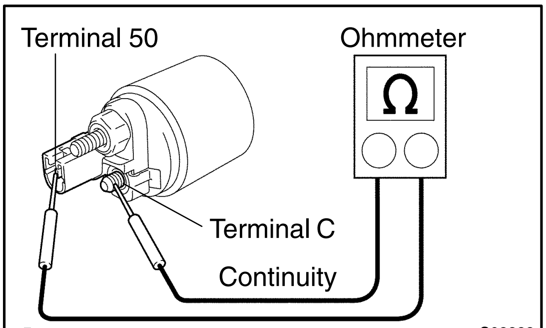


P18126

5. INSPECT MAGNETIC SWITCH

(a) Check the plunger.
Push in the plunger and check that it returns quickly to its original position.

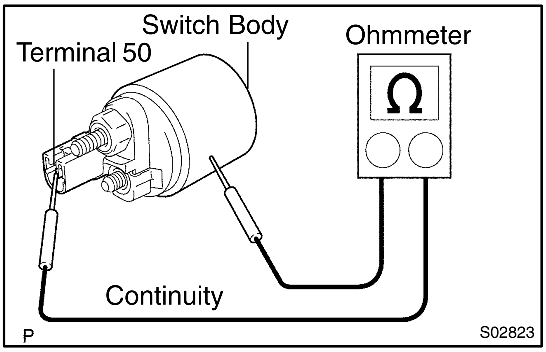
If necessary, replace the magnetic switch.



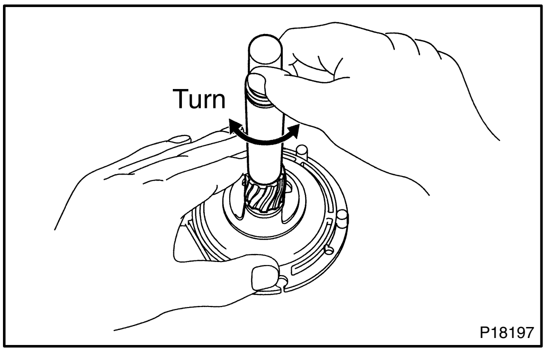
P S02822

(b) Check the pull–in coil for open circuit.
Using an ohmmeter, check that there is continuity between terminals 50 and C.

If there is no continuity, replace the magnetic switch.



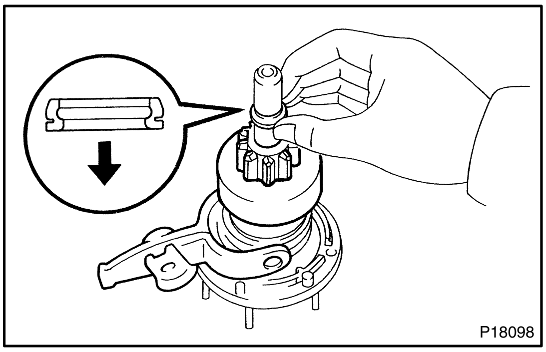
(c) Check the hold–in coil for open circuit.
Using an ohmmeter, check that there is continuity between terminal 50 and the switch body.
If there is no continuity, replace the magnetic switch.



6. INSPECT PLANETARY SHAFT
Turn the shaft, and check that it is not rough or worn.
If it feels rough or worn, replace the planetary shaft assembly.

ST0GX–01

REASSEMBLY

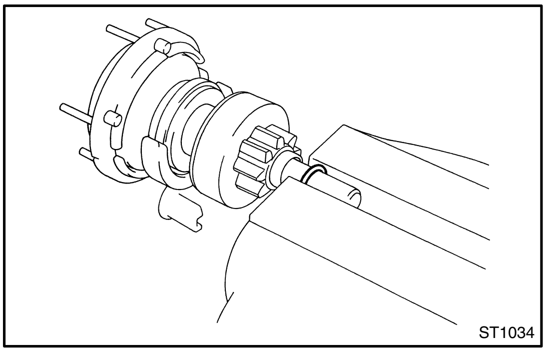


1. INSTALL DRIVE LEVER TO STARTER CLUTCH

2. INSTALL STARTER CLUTCH TO PLANETARY SHAFT

(a) Apply grease to the bushing and spline of the starter clutch and planetary shaft.

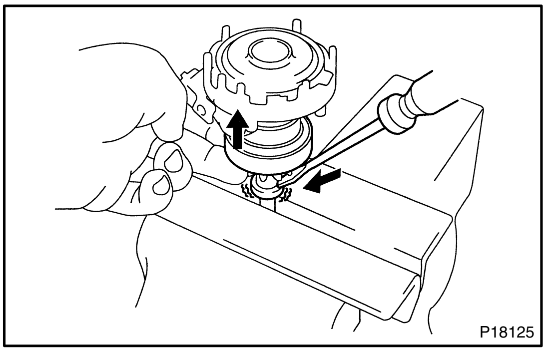
(b) Place the starter clutch and stop collar on the planetary shaft as shown in the illustration.



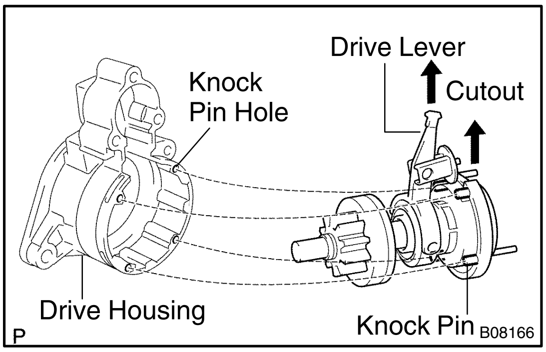
(c) Install a new snap ring to the planetary shaft groove.

(d) Using a vise, compress the snap ring.

(e) Check that the snap ring fits correctly.



(f) Using a screwdriver, tap the stop collar to slide it onto the snap ring.

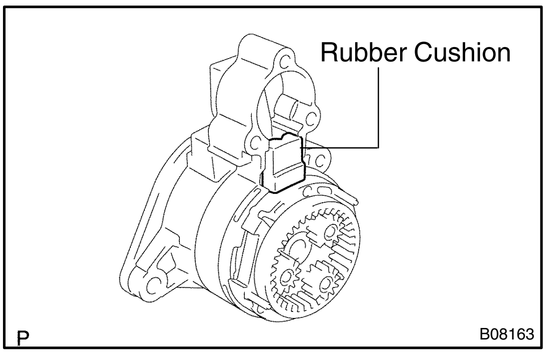


3. INSTALL PLANETARY SHAFT ASSEMBLY AND STARTER CLUTCH

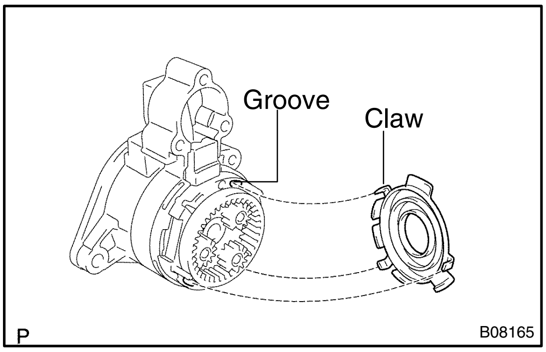
(a) Set the planetary shaft and drive lever in position as shown in the illustration.

(b) Align the holes of the driver housing with the knock pins.

(c) Install the planetary shaft and starter clutch to the drive housing.



(d) Install the rubber cushion.

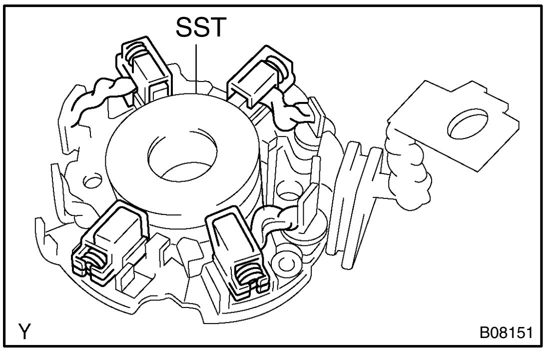


4. INSTALL ARMATURE PLATE

(a) Set the armature plate in position as shown in the illustration.

(b) Align the claw grooves of the internal gear with the claws of the armature plate.

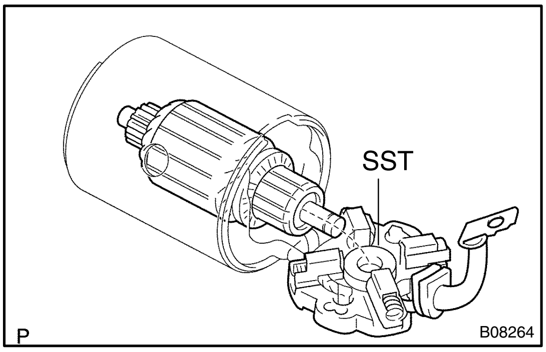
(c) Install the armature plate to the internal gear.



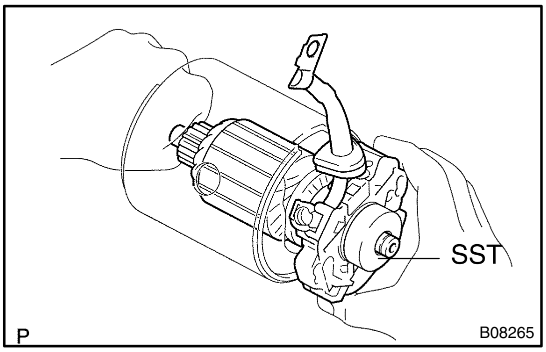
5. INSTALL BRUSH HOLDER TO ARMATURE

(a) Install the 4 brush retainers and 4 brush springs to the brush holder.

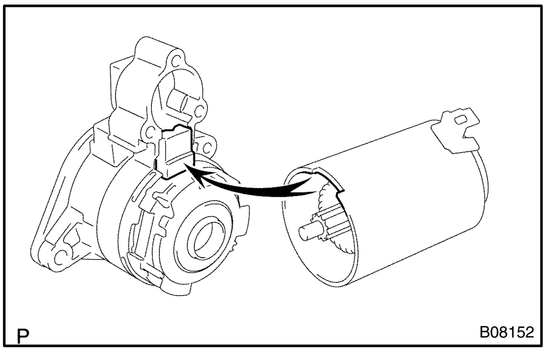
(b) Using SST, install the 4 brushes to the brush holder.
SST 09950–60010 (09951–00340)



(c) Attach the brush holder to the armature.



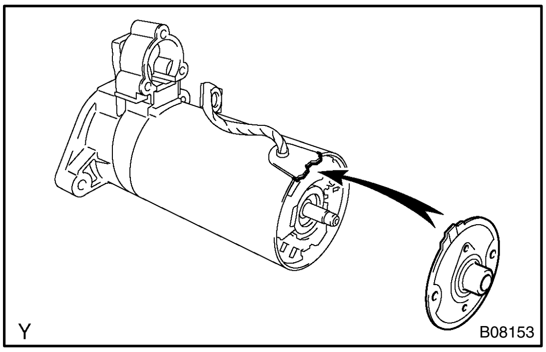
(d) Push the armature, and remove the SST.



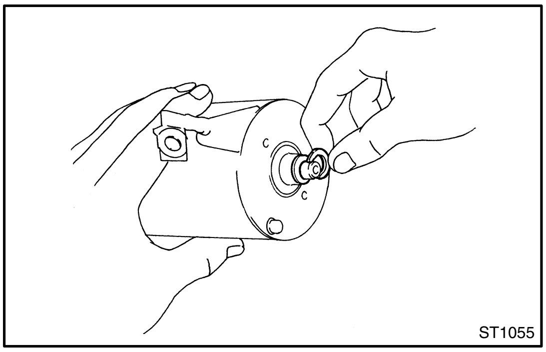
6. INSTALL STARTER YOKE AND ARMATURE ASSEMBLY

(a) Align the cushion rubber on the starter drive housing with the cutout of the starter yoke.

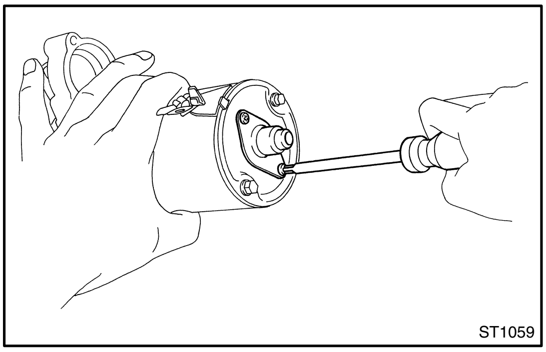
(b) Install the starter yoke and armature assembly.



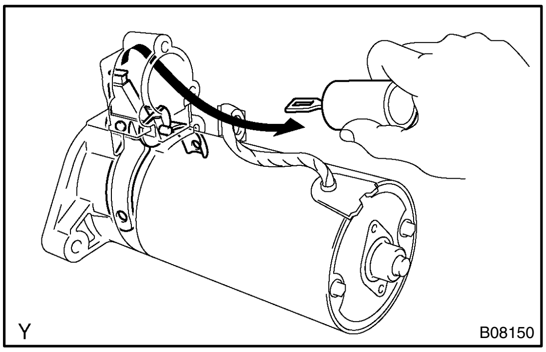
(c) Align the commutator end frame with the brush holder rubber part as shown in the illustration.
(d) Install the commutator end frame with the 2 through bolts.
Torque: **6.5 N·m (66 kgf·cm, 58 in.·lbf)**



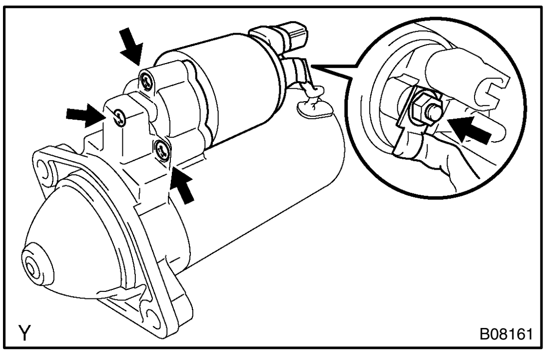
7. INSTALL COMMUTATOR END COVER
(a) Install the thrust washer and lock plate.
(b) Check the armature thrust clearance between the lock plate and the end frame. (See page ST–4)



(c) Pack grease to the commutator end cover.
(d) Install the commutator end cover with the 2 screws.
Torque: **1.7 N·m (17 kgf·cm, 15 in.·lbf)**



8. INSTALL MAGNETIC SWITCH
(a) Hang the plunger hook to the upper side of the drive lever.
(b) Install the return spring into the plunger.

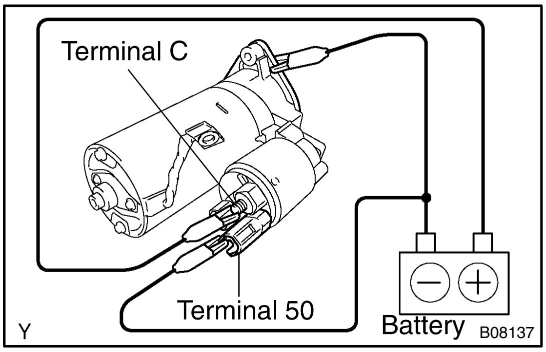


(c) Install the return spring and magnetic switch with the 3 screws.
Torque: **5.0 N·m (51 kgf·cm, 44 in.·lbf)**
(d) Connect the lead wire to the magnetic switch terminal with the nut.
Torque: **8.0 N·m (82 kgf·cm, 71 in.·lbf)**

ST0GY–01

TEST

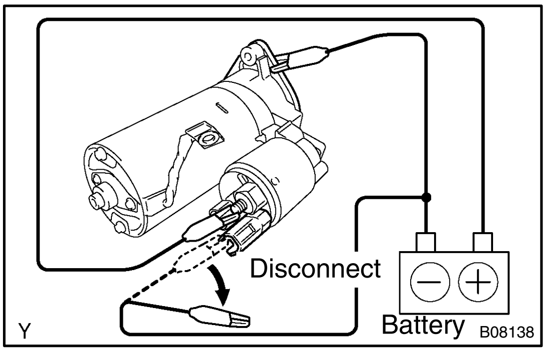
NOTICE:
These tests must be done within 3 to 5 seconds to avoid burning out the coil.



1. DO PULL–IN TEST

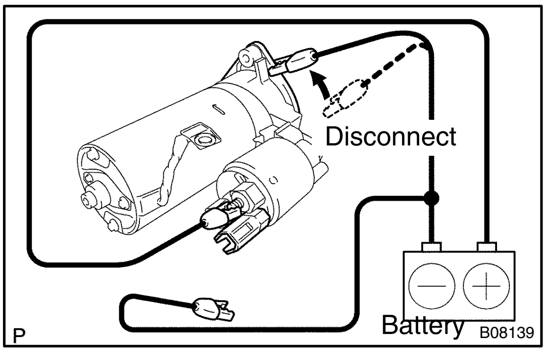
(a) Disconnect the field coil lead from terminal C.
(b) Connect the battery to the magnetic switch as shown. Check that the clutch pinion gear moves outward.

If the clutch pinion gear does not move, replace the magnetic switch.



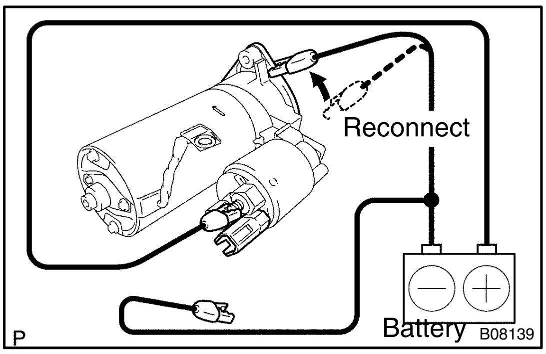
2. DO HOLD–IN TEST

With the battery connected as above and with the clutch pinion gear out, disconnect the negative (–) lead from terminal C. Check that the clutch pinion gear remains out.
If the clutch pinion gear returns inward, replace the magnetic switch.



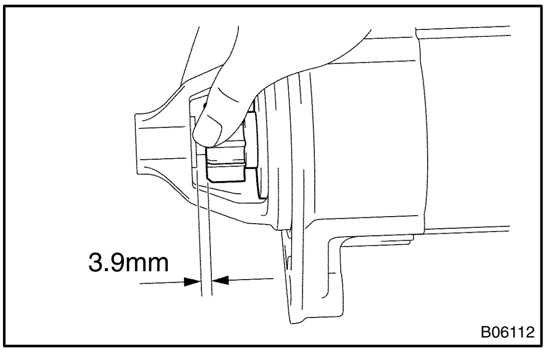
3. INSPECT CLUTCH PINION GEAR RETURN

Disconnect the negative (–) lead from the starter housing. Check that the clutch pinion gear returns inward.
If the clutch pinion gear does not return, replace the magnetic switch.

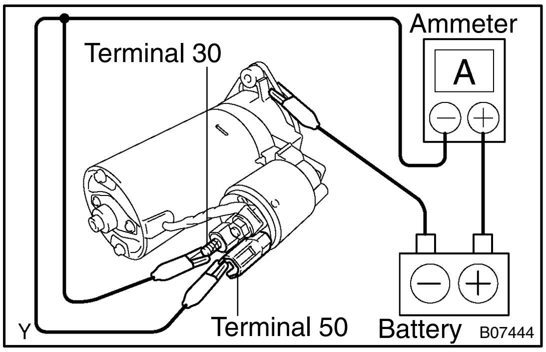


4. INSPECT CLUTCH PINION GEAR CLEARANCE

(a) Reconnect the negative (–) lead to the starter housing.

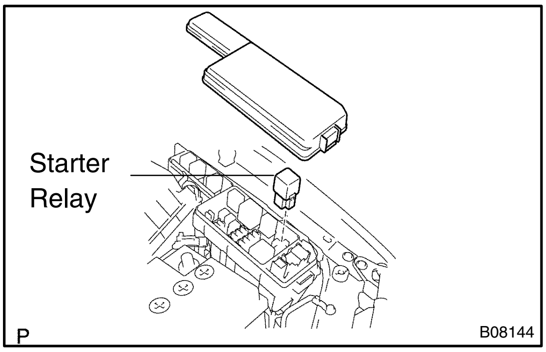


(b) Move the pinion gear toward the armature to remove slack and measure the clearance between the pinion gear end and stop collar.
Maximum clearance: 3.9 mm (0.154 in.)



5. DO NO–LOAD PERFORMANCE TEST

(a) Connect the field coil lead to terminal C. Make sure the lead is not grounded.
(b) Connect the battery and ammeter to the starter as shown.
(c) Check that the starter rotates smoothly and steadily with the clutch pinion gear moving out. Check that the ammeter reads the specified current.
Specified current: 160 A or less at 10.5 V

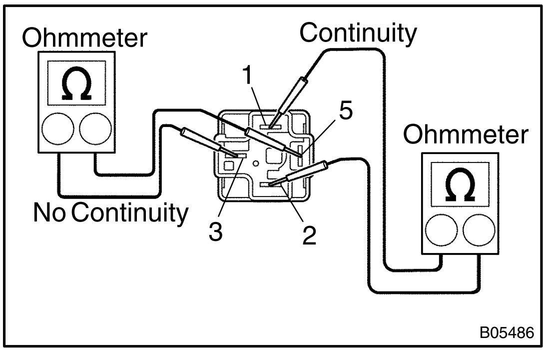


STARTER RELAY

ST08J–05

INSPECTION

1. **REMOVE RELAY BOX COVER**
2. **REMOVE STARTER RELAY**



3. **INSPECT STARTER RELAY**

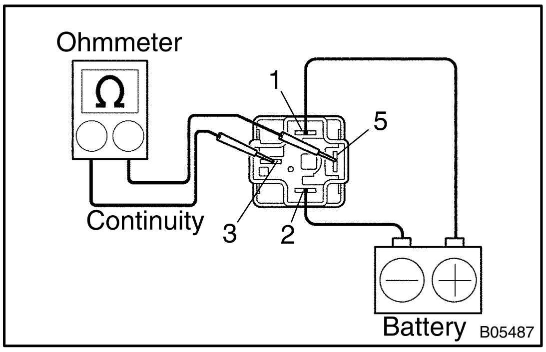
(a) Inspect the relay continuity.

(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

If there is no continuity, replace the relay.

(2) Check that there is no continuity between terminals 3 and 5.

If there is continuity, replace the relay.



(b) Inspect the relay operation.

(1) Apply battery voltage across terminals 1 and 2.

(2) Using an ohmmeter, check that there is continuity between terminals 3 and 5.

If there is no continuity, replace the relay.

4. **REINSTALL STARTER RELAY**
5. **REINSTALL RELAY BOX COVER**

CHARGING

CHARGING SYSTEM

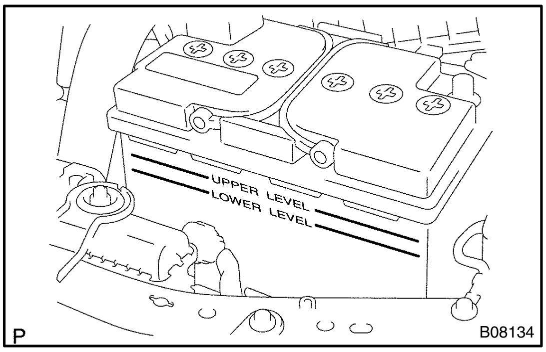
CH0AA–01

PRECAUTION

1. **Check that the battery cables are connected to the correct terminals.**
2. **Disconnect the battery cables when the battery is given a quick charge.**
3. **Do not perform tests with a high voltage insulation resistance tester.**
4. **Never disconnect the battery while the engine is running.**

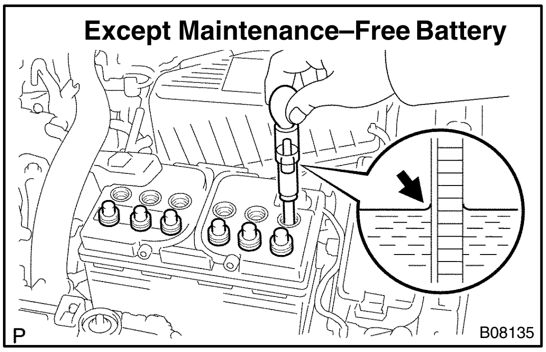
CH0AB–02

ON–VEHICLE INSPECTION



1. CHECK BATTERY ELECTROLYTE LEVEL

Check the electrolyte quantity of each cell.
Maintenance–Free Battery:
If under the lower level, replace the battery (or add distilled water if possible) and check the charging system.
Except Maintenance–Free Battery:
If under the lower level, add distilled water.

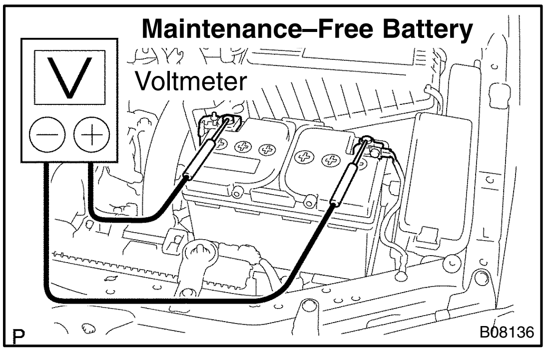


2. Except Maintenance–Free Battery:
CHECK BATTERY SPECIFIC GRAVITY

Check the specific gravity of each cell.

Standard specific gravity:
1.25 – 1.29 at 20°C (68°F)

If the specific gravity is less than specification, charge the battery.

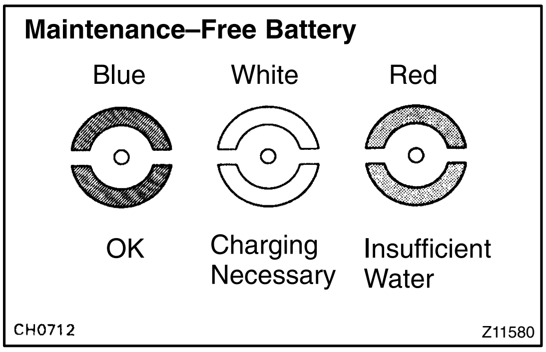


3. Maintenance–Free Battery:
CHECK BATTERY VOLTAGE

(a) After having driven the vehicle and in the case that 20 minutes have not passed after having stopped the engine, turn the ignition switch ON and turn on the electrical system (headlight, blower motor, rear defogger etc.) for 60 seconds to remove the surface charge.
(b) Turn the ignition switch OFF and turn off the electrical systems.
(c) Measure the battery voltage between the negative (–) and positive (+) terminals of the battery.

Standard voltage:
12.5 – 12.9 V at 20°C (68°F)

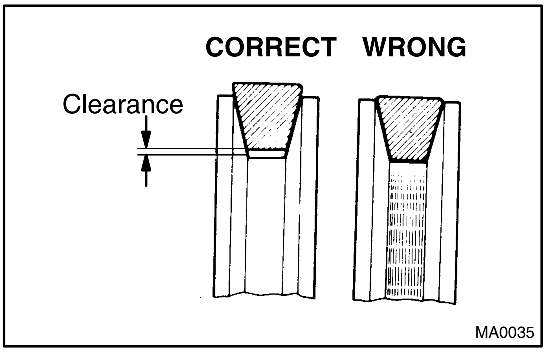
If the voltage is less than specification, charge the battery.



HINT:
Check the indicator as shown in the illustration.

4. CHECK BATTERY TERMINALS, FUSIBLE LINK AND FUSES

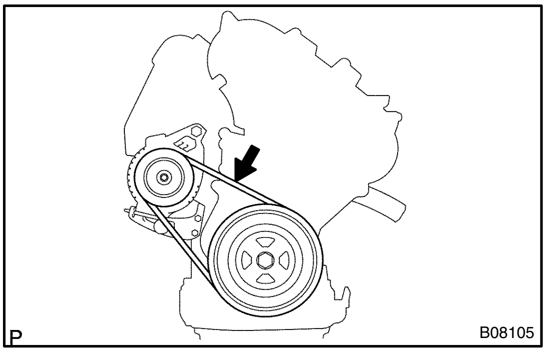
(a) Check that the battery terminals are not loose or corroded.
If the terminals are corroded, clean the terminals.
(b) Check the fusible link and fuses for continuity.



5. **INSPECT DRIVE BELT**

(a) Visually check the drive belt for cracks, oiliness or wear. Check that the belt does not touch the bottom of the pulley groove.

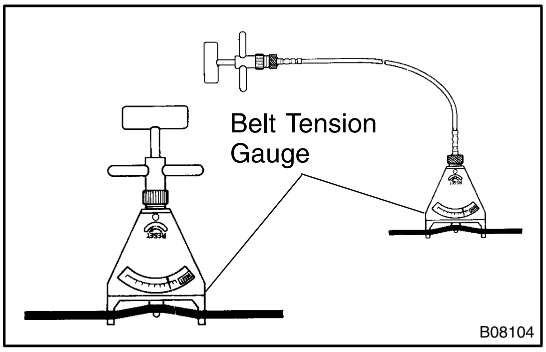
If the belt has any of the avobe defects, reprace it.



(b) Check the drive belt deflection by pressing on the belt at the points indicated in the illustration with 98 N (10 kgf, 22 lbf) of pressure.

Drive belt deflection:
New belt 9 – 11 mm (0.35 – 0.43 in.)
Used belt 12 – 16 mm (0.47 – 0.63 in.)

If necessary, adjust the drive belt deflection.



(c) Reference using a belt tension gauge, measure the belt tension.

Belt tension gauge:
BTG–20 (95506–00020)
Drive belt tension:
New belt 490 – 686 N (50 – 70 kgf)
Used belt 245 – 441 N (25 – 45 kgf)

If the belt tension is not as specified, adjust it.

HINT:

- ”New belt” refers to a belt which has been used less than 5 minutes on a running engine.
- ”Used belt” refers to a belt which has been used on a running engine for 5 minutes or more.
- After installing a new belt, run the engine for about 5 minutes and recheck the belt tension.

6. **VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES**

(a) Check that the wiring is in good condition.

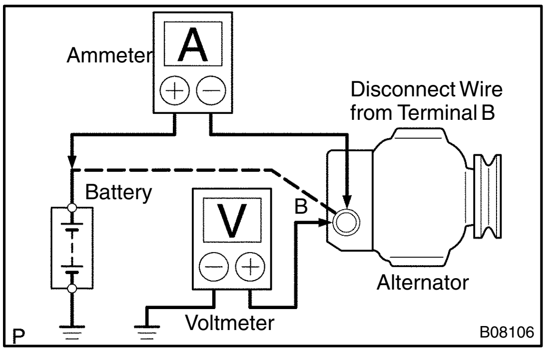
(b) Check that there is no abnormal noise from the alternator while the engine is running.

7. **INSPECT DISCHARGE WARNING LIGHT CIRCUIT**

(a) Turn the ignition switch ”ON”. Check that the discharge warning light comes on.

(b) Start the engine. Check that the light goes off.

If the light does not operate as specified, troubleshoot the discharge warning light circuit.



8. INSPECT CHARGING CIRCUIT WITHOUT LOAD

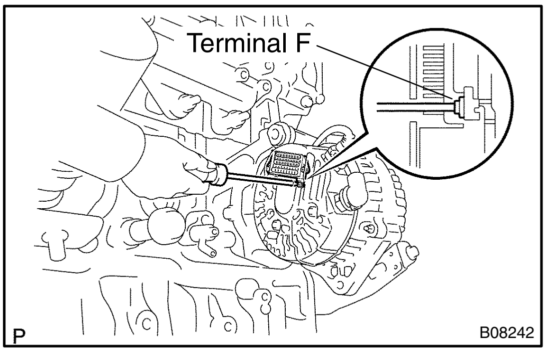
HINT:

If a battery/alternator tester is available, connect the tester to the charging circuit as per manufacturer's instructions.

(a) If a tester is not available, connect a voltmeter and ammeter to the charging circuit as follows:
- Disconnect the wire from terminal B of the alternator and connect it to the negative (–) lead of the ammeter.
- Connect the positive (+) lead of the ammeter to terminal B of the alternator.
- Connect the positive (+) lead of the voltmeter to terminal B of the alternator.
- Ground the negative (–) lead of the voltmeter.

(b) Check the charging circuit as follows:
With the engine running from idle to 5,000 rpm, check the reading on the ammeter and voltmeter.
Standard amperage:
10 A or less
Standard voltage:
13.2 – 14.0 V at 115°C (239°F)

If the voltmeter reading is more than the standard voltage, replace the voltage regulator.



If the voltmeter reading is less than the standard voltage, check the voltage regulator and generator as follows:
- With terminal F grounded, start the engine and check the voltmeter reading of terminal B.
- If the voltmeter reading is more than the standard voltage, replace the IC regulator.
- If the voltmeter reading is less than the standard voltage, check the alternator.

9. INSPECT CHARGING CIRCUIT WITH LOAD

(a) With the engine running at 2,000 rpm, turn on the high beam headlights and place the heater blower switch at "HI".

(b) Check the reading on the ammeter.
Standard amperage:
30 A or more

If the ammeter reading is less than the standard amperage, repair the alternator.

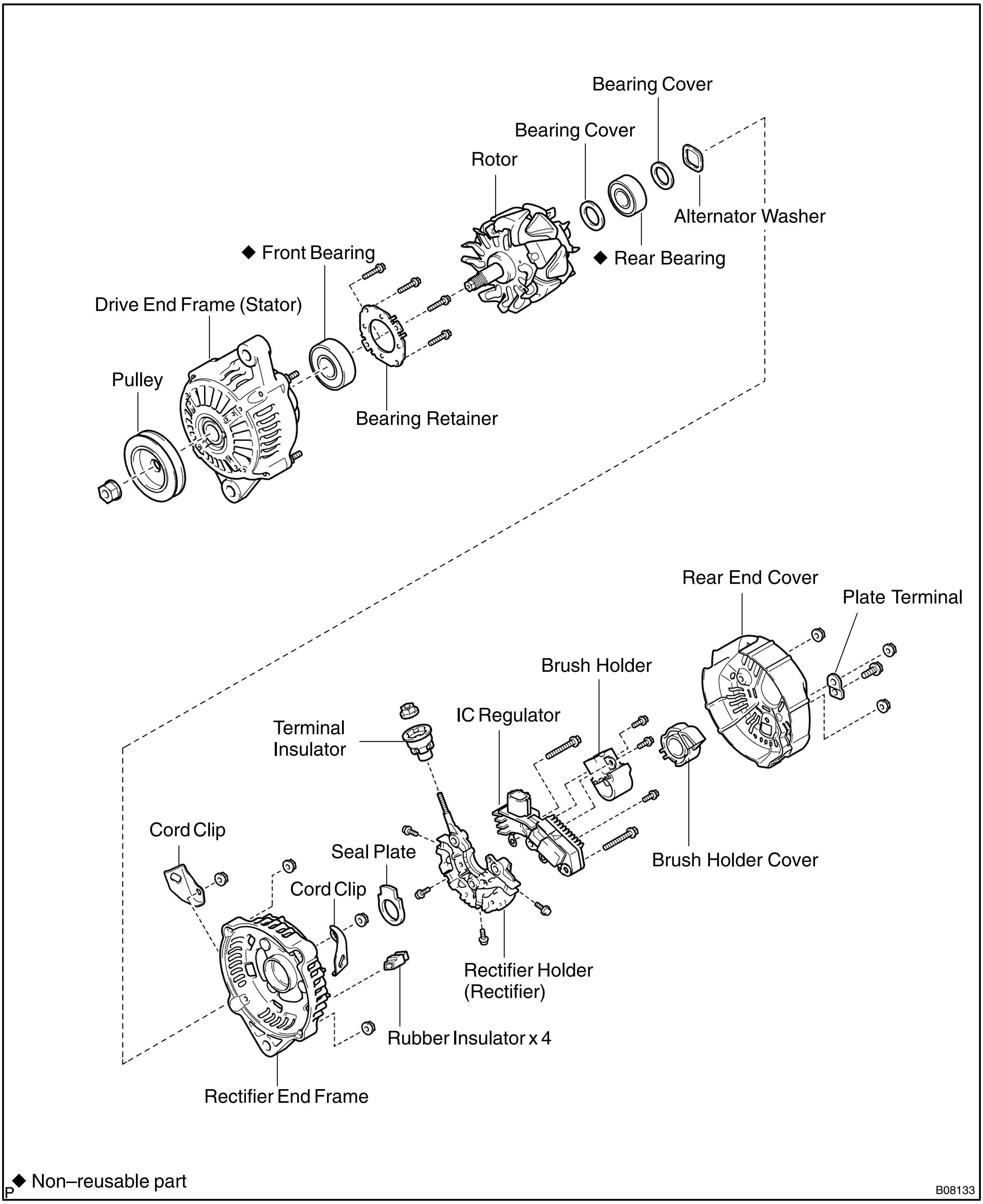
HINT:

If the battery is fully charged, the indication will sometimes be less than the standard amperage.

ALTERNATOR

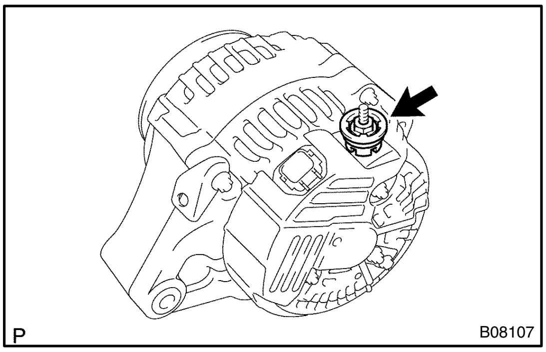
COMPONENTS

CH0AC–03



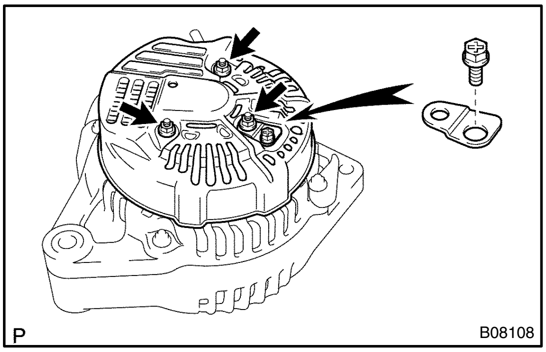
CH0BQ–01

DISASSEMBLY

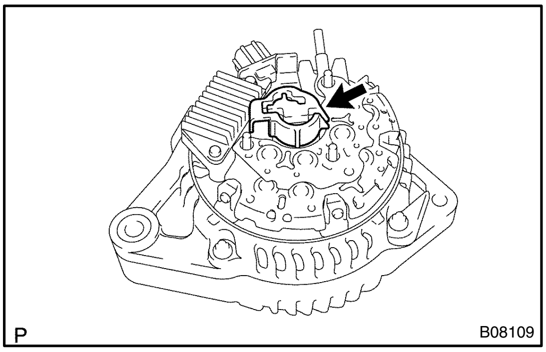


1. REMOVE REAR END COVER

(a) Remove the nut and terminal insulator.

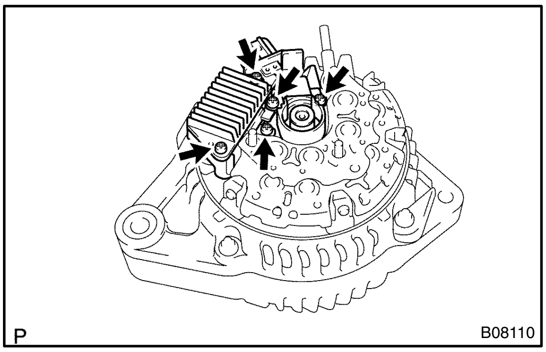


(b) Remove the 3 nuts, bolt, plate terminal and rear end cover.

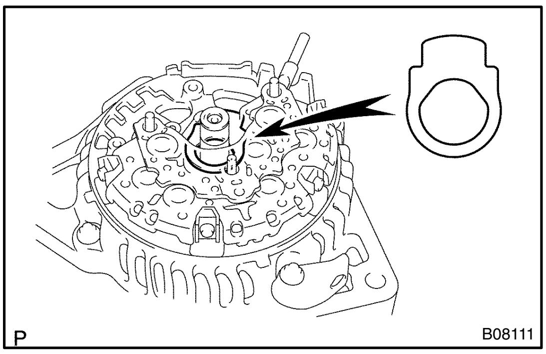


2. REMOVE BRUSH HOLDER AND IC REGULATOR

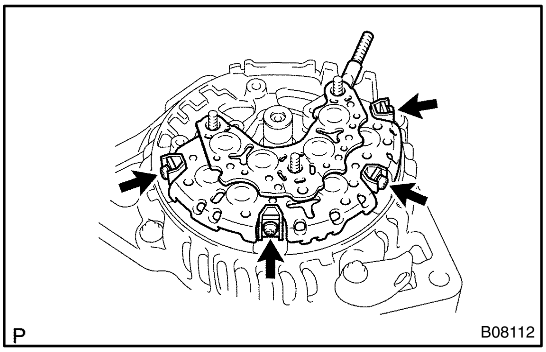
(a) Remove the brush holder cover from the brush holder.



(b) Remove the 5 screws, brush holder and IC regulator.

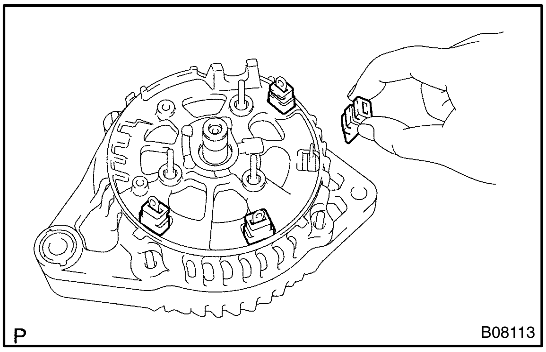


(c) Remove the seal plate from the rectifier end frame.

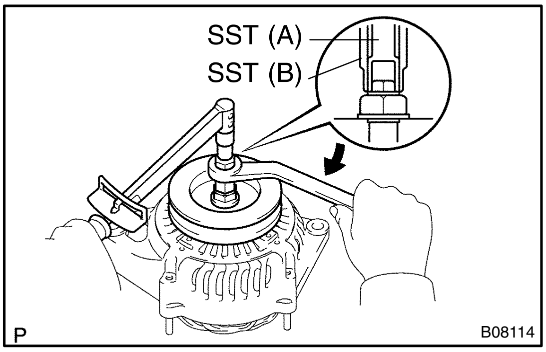


3. REMOVE RECTIFIER HOLDER

(a) Remove the 4 screws and rectifier holder.



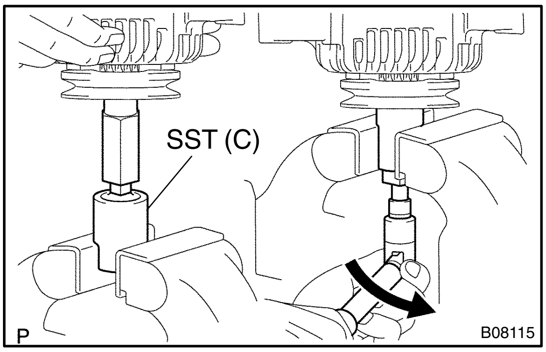
(b) Remove the 4 rubber insulators.



4. REMOVE PULLEY

(a) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820–63010
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(b) Check that SST (A) is secured to the rotor shaft.



(c) As shown in the illustration, mount SST (C) in a vise, and install the alternator to SST (C).

(d) To loosen the pulley nut, turn SST (A) in the direction shown in the illustration.

NOTICE:
To prevent damage to the rotor shaft, do not loosen the pulley nut more than one–half of a turn.

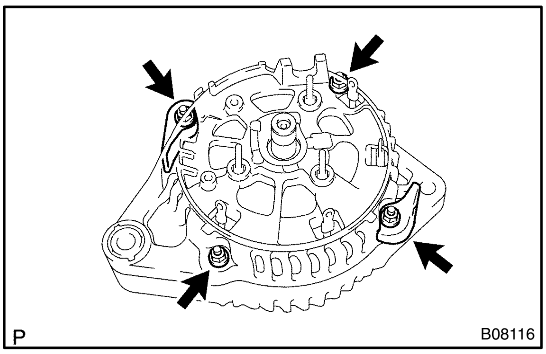
(e) Remove the alternator from SST (C).

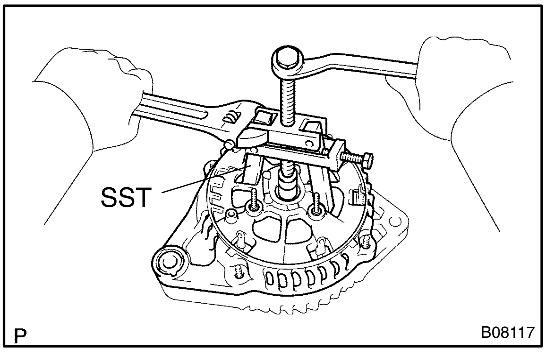
(f) Turn SST (B), and remove SST (A and B).

(g) Remove the pulley nut and pulley.

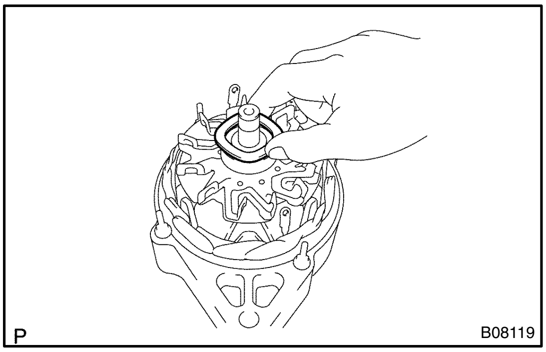
5. REMOVE RECTIFIER END FRAME

(a) Remove the 4 nuts and cord clip.

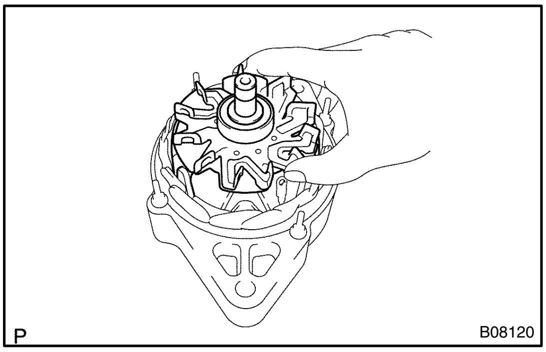




(b) Using SST, remove the rectifier end frame.
SST 09286–46011



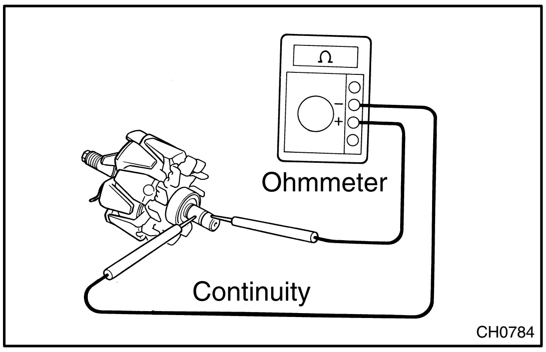
(c) Remove the alternator washer.



6. REMOVE ROTOR FROM DRIVE END FRAME

CH0AE–03

INSPECTION

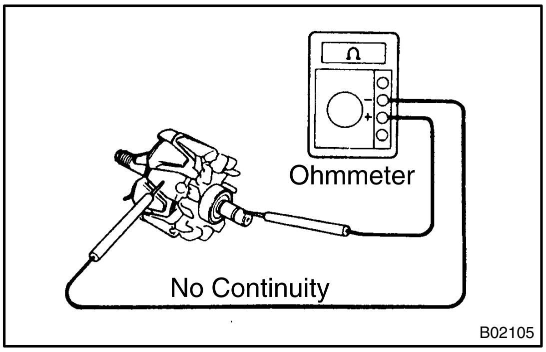


1. INSPECT ROTOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the slip rings.

Standard resistance:
2.1 – 2.5 Ω at 20°C (68°F)

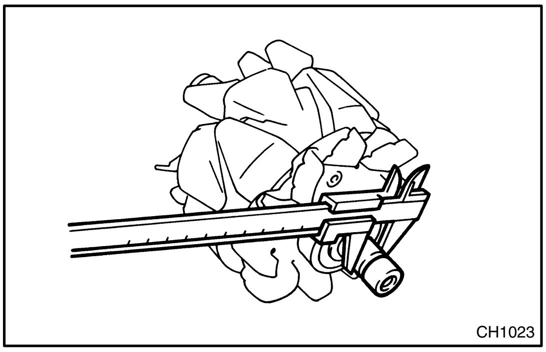
If there is no continuity, replace the rotor.



2. INSPECT ROTOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the slip ring and rotor.

If there is continuity, replace the rotor.



3. INSPECT SLIP RINGS

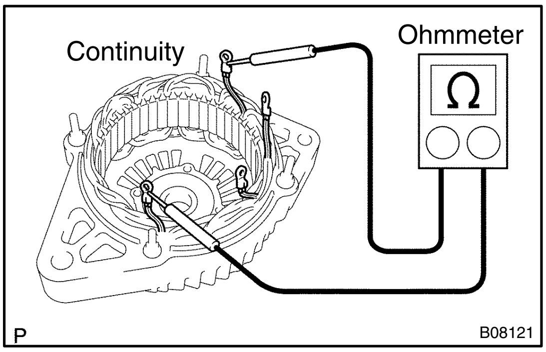
(a) Check that the slip rings are not rough or scored.

If rough or scored, replace the rotor.

(b) Using vernier calipers, measure the slip ring diameter.

Standard diameter:
14.2 – 14.4 mm (0.559 – 0.567 in.)
Minimum diameter:
12.8 mm (0.504 in.)

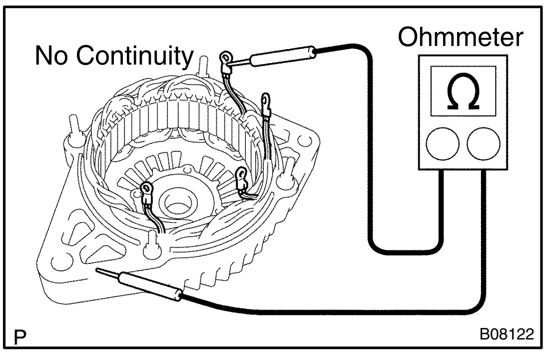
If the diameter is less than minimum, replace the rotor.



4. INSPECT STATOR FOR OPEN CIRCUIT

Using an ohmmeter, check that there is continuity between the coil leads.

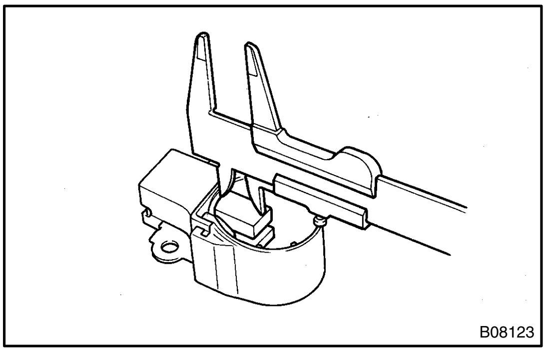
If there is no continuity, replace the drive end frame assembly.



5. INSPECT STATOR FOR GROUND

Using an ohmmeter, check that there is no continuity between the coil lead and drive end frame.

If there is continuity, replace the drive end frame assembly.

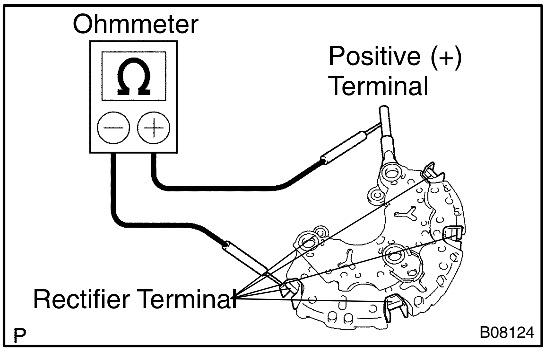


6. INSPECT EXPOSED BRUSH LENGTH

Using a scale and vernier caliper, measure the exposed brush length.

Standard exposed length:
9.5 – 11.5 mm (0.374 – 0.452 in.)
Minimum exposed length:
1.5 mm (0.059 in.)

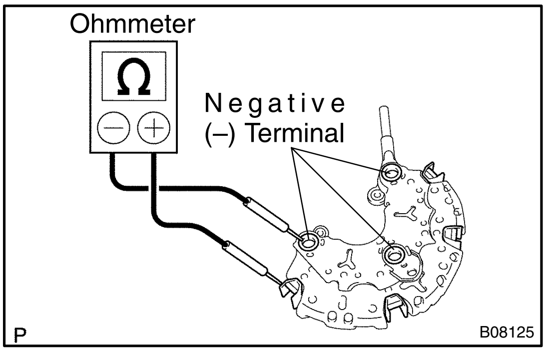
If the exposed length is less than minimum, replace the brush holder.



7. INSPECT POSITIVE RECTIFIER

(a) Using an ohmmeter, connect one tester probe to the positive (+) terminal and the other to each rectifier terminal.
(b) Reverse the polarity of the tester probes and repeat step (a).
(c) Check that one shows continuity and the other shows no continuity.

If continuity is not as specified, replace the rectifier holder.



8. INSPECT NEGATIVE RECTIFIER

(a) Using an ohmmeter, connect one tester probe to each negative (–) terminal and the other to each rectifier terminal.
(b) Reverse the polarity of the tester probes and repeat step (a).
(c) Check that one shows continuity and the other shows no continuity.

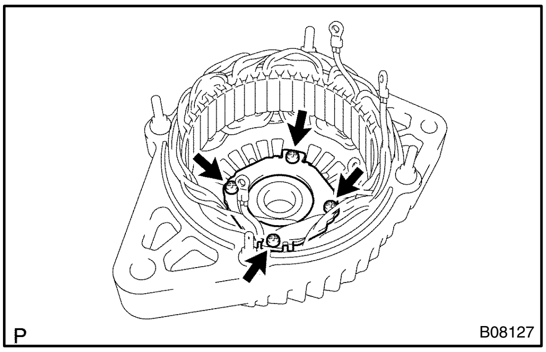
If continuity is not as specified, replace the rectifier holder.

9. INSPECT FRONT AND REAR BEARING

Check that the bearing is not rough or worn.
If necessary, replace the bearing.

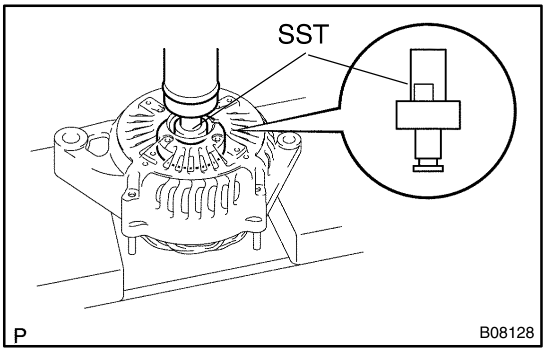
CH0AF–03

REPLACEMENT

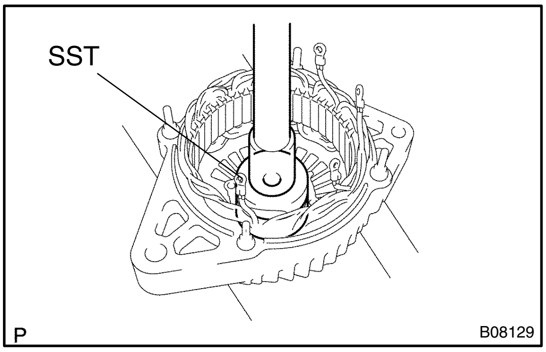


1. REPLACE FRONT BEARING

(a) Remove the 4 screws and bearing retainer.

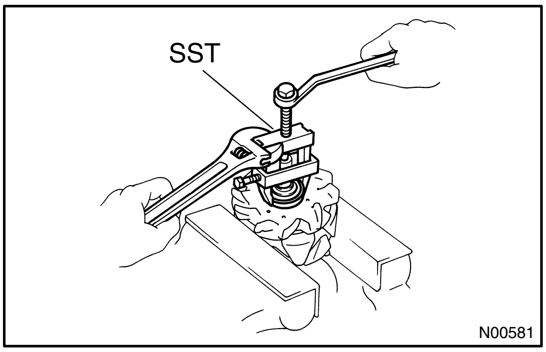


(b) Using SST and a press, press out the bearing.
SST 09950–60010 (09951–00270, 09952–06010)



(c) Using SST and a press, press in a new bearing.
SST 09950–60010 (09951–00500)

(d) Install the bearing retainer with the 4 screws.
Torque: 3.0 N·m (31 kgf·cm, 27 in.·lbf)

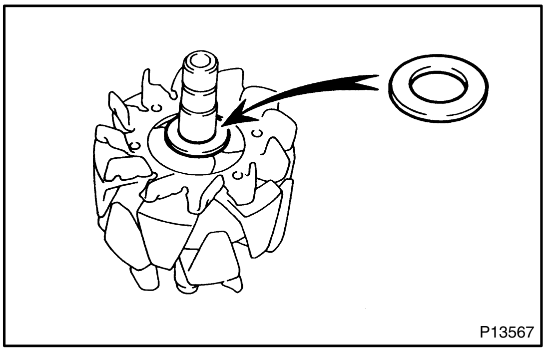


2. REPLACE REAR BEARING

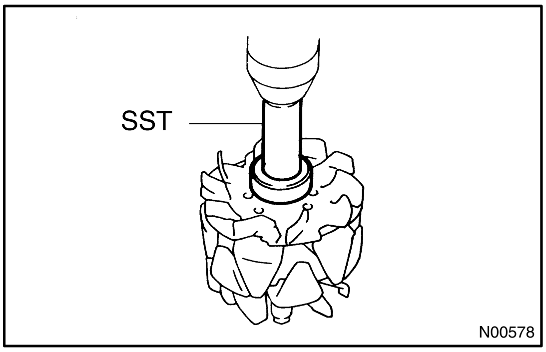
(a) Using SST, remove the bearing cover (outside) and bearing.
SST 09820–00021

NOTICE:
Be careful not to damage the fan.

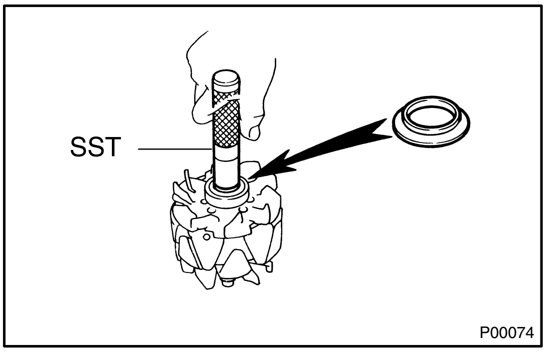
(b) Remove the bearing cover (inside).



(c) Place the bearing cover (inside) on the rotor.



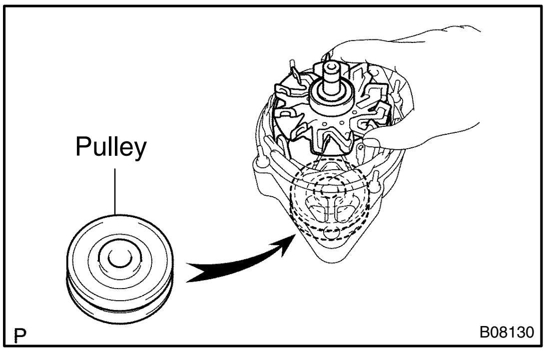
(d) Using SST and a press, press in a new bearing.
SST 09820–00030



(e) Using SST, push in the bearing cover (outside).
SST 09285–76010

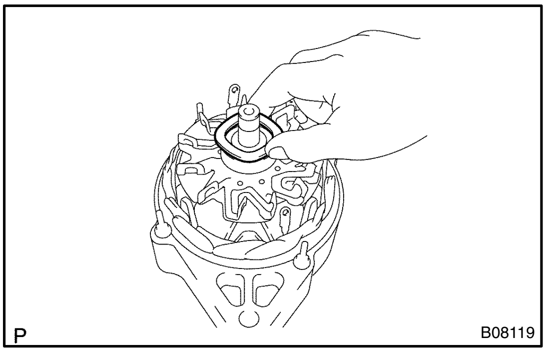
CH0BR–01

REASSEMBLY



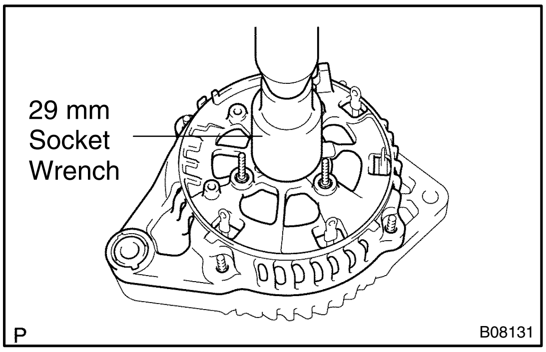
1. PLACE DRIVE END FRAME ON PULLEY

2. INSTALL ROTOR TO DRIVE END FRAME

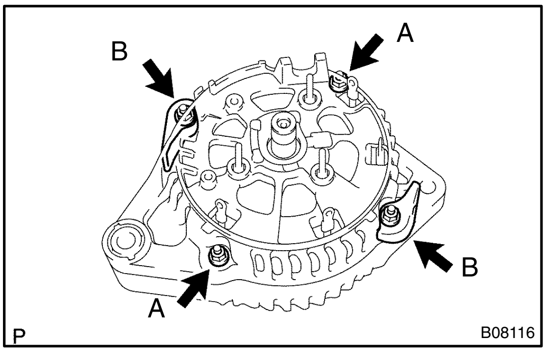


3. INSTALL RECTIFIER END FRAME

(a) Place the alternator washer on the rotor.

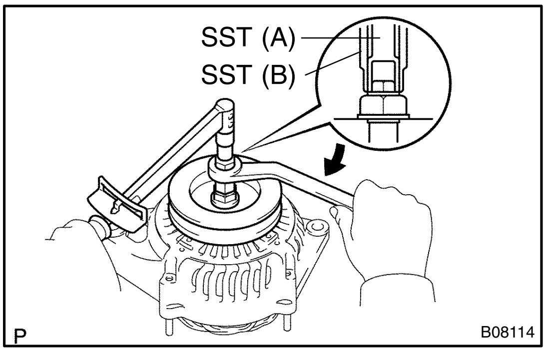


(b) Using a 29 mm socket wrench and press, slowly press in the rectifier end frame.



(c) Install the cord clip and 4 nuts.

Torque:
A: 4.5 N·m (46 kgf·cm, 40 in.·lbf)
B: 5.4 N·m (55 kgf·cm, 48 in.·lbf)

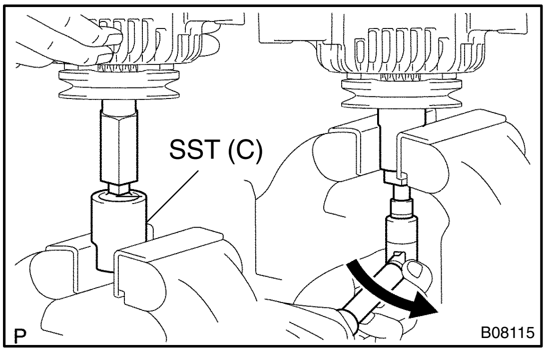


4. INSTALL PULLEY

(a) Install the pulley to the rotor shaft by tightening the pulley nut by hand.

(b) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820–63010
Torque: 39 N·m (400 kgf·cm, 29 ft·lbf)

(c) Check that SST (A) is secured to the pulley shaft.

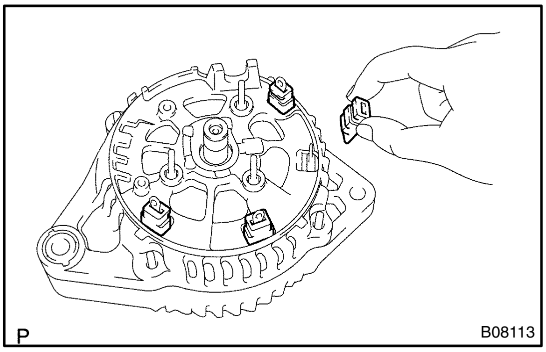


(d) As shown in the illustration, mount SST (C) in a vise, and install the alternator to SST (C).

(e) To torque the pulley nut, turn SST (A) in the direction shown in the illustration.
Torque: 110.5 N·m (1,125 kgf·cm, 81 ft·lbf)

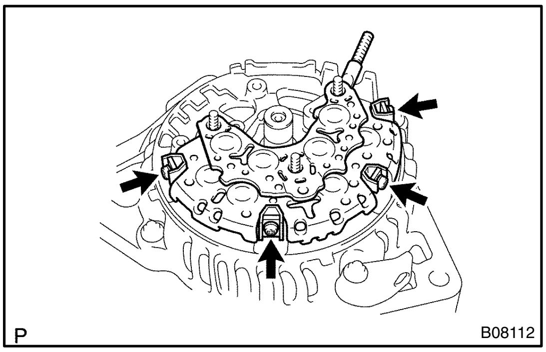
(f) Remove the alternator from SST (C).

(g) Turn SST (B), and remove SST (A and B).

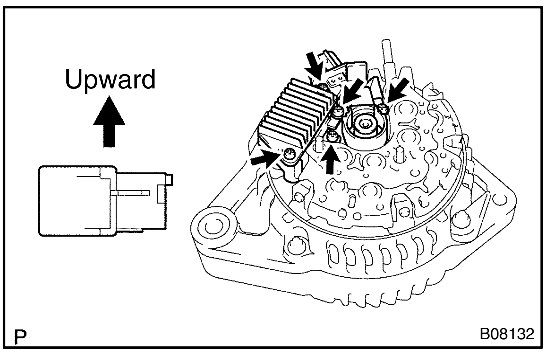


5. INSTALL RECTIFIER HOLDER

(a) Install the 4 rubber insulators on the lead wires.



(b) Install the rectifier holder while pushing it with the 4 screws.
Torque: 2.94 N·m (30 kgf·cm, 26 in.·lbf)



6. INSTALL IC REGULATOR AND BRUSH HOLDER

(a) Place the seal plate on the rectifier end frame.

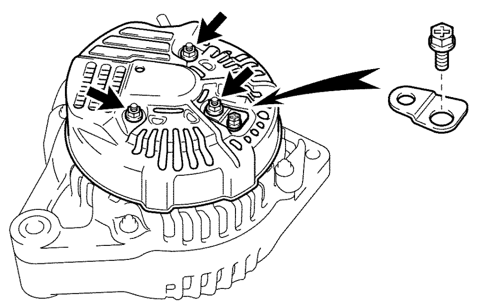
(b) Place the IC regulator and brush holder on the rectifier end frame.

NOTICE:

Be careful of the holder installation direction.

(c) Install the 5 screws.
Torque: 1.96 N·m (20 kgf·cm, 17 in.·lbf)

(d) Place the brush holder cover on the brush holder.



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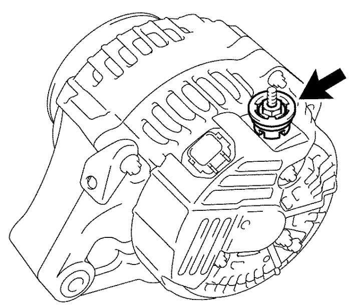
7. INSTALL REAR END COVER

(a) Install the rear end cover and plate terminal with the 3 nuts and screw.
Torque:
Screw: 3.85 N·m (39 kgf·cm, 34 in.·lbf)
Nuts: 4.4 N·m (45 kgf·cm, 39 in.·lbf)



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(b) Install the terminal insulator with the nut.
Torque: 4.1 N·m (42 kgf·cm, 36 in.·lbf)

8. CHECK THAT ROTOR ROTATES SMOOTHLY

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