TOYOTA

1KD-FTV ENGINE

REPAIR MANUAL

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FOREWORD

This repair manual has been prepared to provide information covering general service repairs for the 1KD–FTV engine equipped on the LAND CRUISER/LAND CRUISER PRADO.

Applicable models: KDJ90, 95 series

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 IN
PREPARATION PP
SERVICE SPECIFICATIONS SS
DIAGNOSTICS DI
ENGINE MECHANICAL EM
TURBOCHARGING TC
EMISSION CONTROL EC
ELECTRONIC CONTROL DIESEL ED
ENGINE FUEL FU
COOLING CO
LUBRICATION LU
STARTING ST
CHARGING CH
ALPHABETICAL INDEX ID

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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.

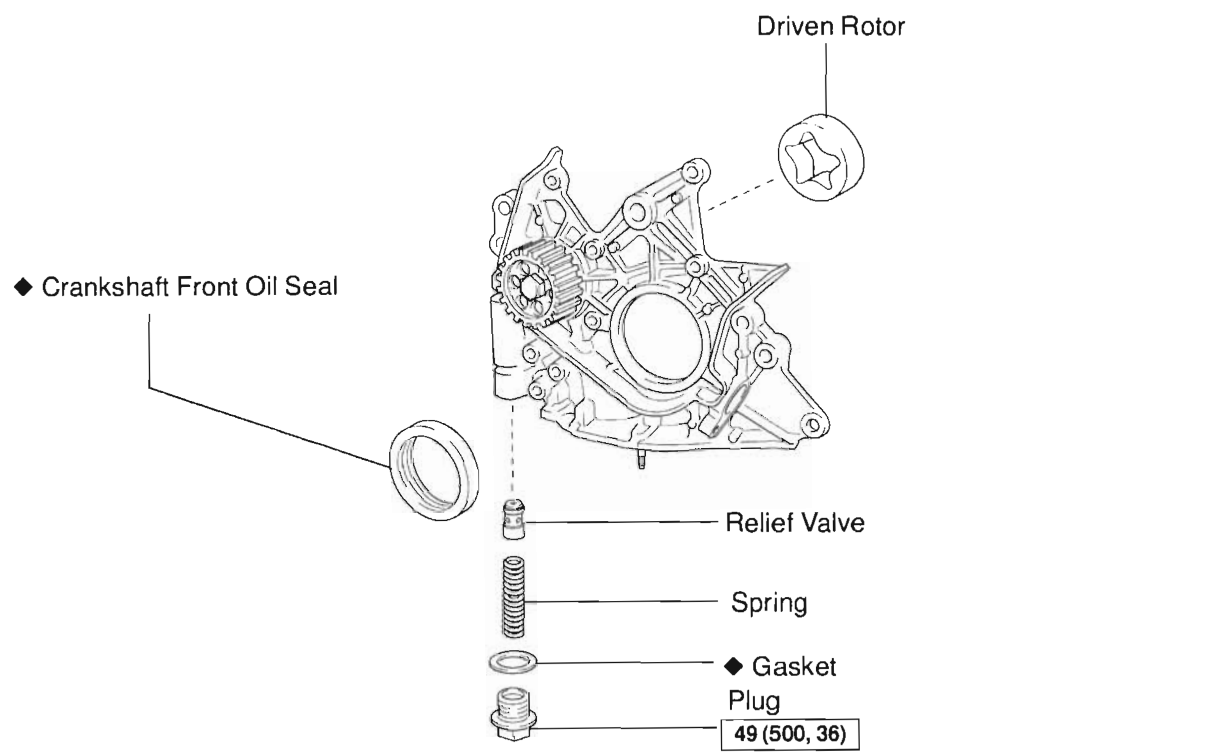
4. PREPARATION

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:



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

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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:

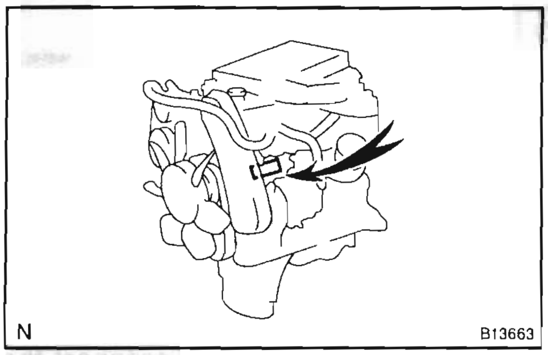
- CAUTIONS are presented in bold type, and indicate there is a possibility of injury to you or other people.
- NOTICES are also presented in bold type, and indicate the possibility of damage to the components being repaired.
- HINTS are separated from the text but do not appear in bold. They provide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

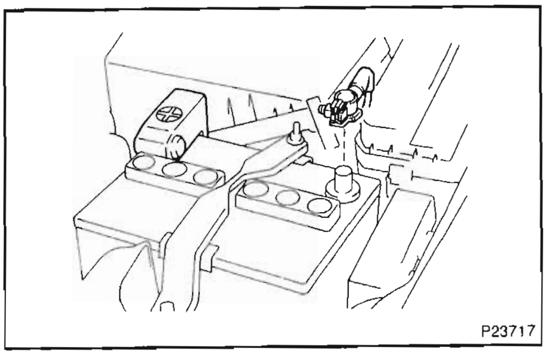


IDENTIFICATION INFORMATION

IN0E6–04

ENGINE SERIAL NUMBER

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

REPAIR INSTRUCTIONS

IN0E7–01

GENERAL INFORMATION

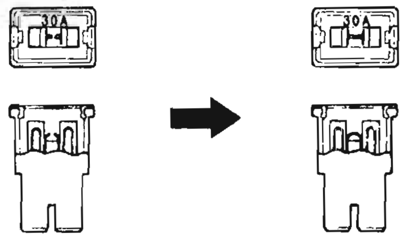
BASIC REPAIR HINT

(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.

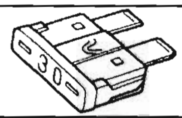
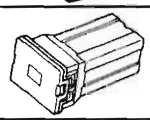
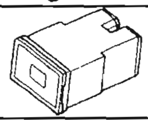
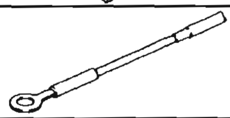
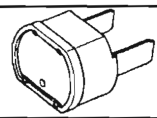
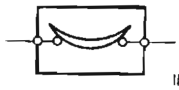
(i) Use of special service tools (SST) and special service materials (SSM) may be required, depending on the nature of the repair. Be sure to use SST and SSM where specified and follow the proper work procedure. A list of SST and SSM can be found in section PP (Preparation) in this manual.

Medium Current Fuse and High Current Fuse
Equal Amperage Rating



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

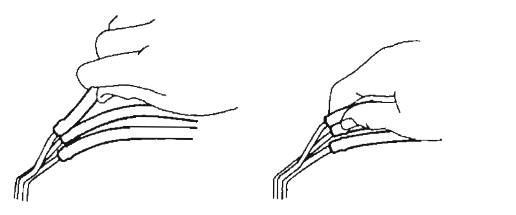
(k) Care must be taken when jacking up and supporting the vehicle. Be sure to lift and support the vehicle at the proper locations.
- Cancel the parking brake on the level place and shift the transmission in Neutral (or N position).
- When jacking up the front wheels of the vehicle at first place stoppers behind the rear wheels.
- When jacking up the rear wheels of the vehicle at first place stoppers behind the rear wheels.

IN

- 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.

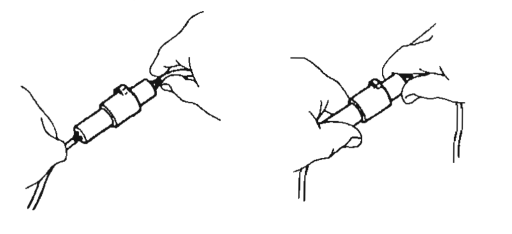
(l) Observe the following precautions to avoid damage to the following parts:

(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.

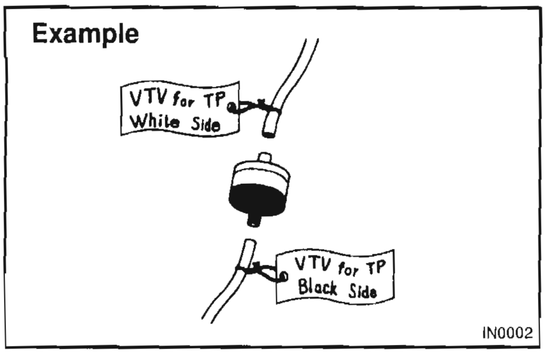
(4) Be careful not to drop electrical components, such as sensors or relays. If they are dropped on a hard floor, they should be replaced and not reused.

(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.



(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.

IN

(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

IN050-08

A large number of ECU controlled systems are used in the LAND CRUISER/LAND CRUISER PRADO. 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.

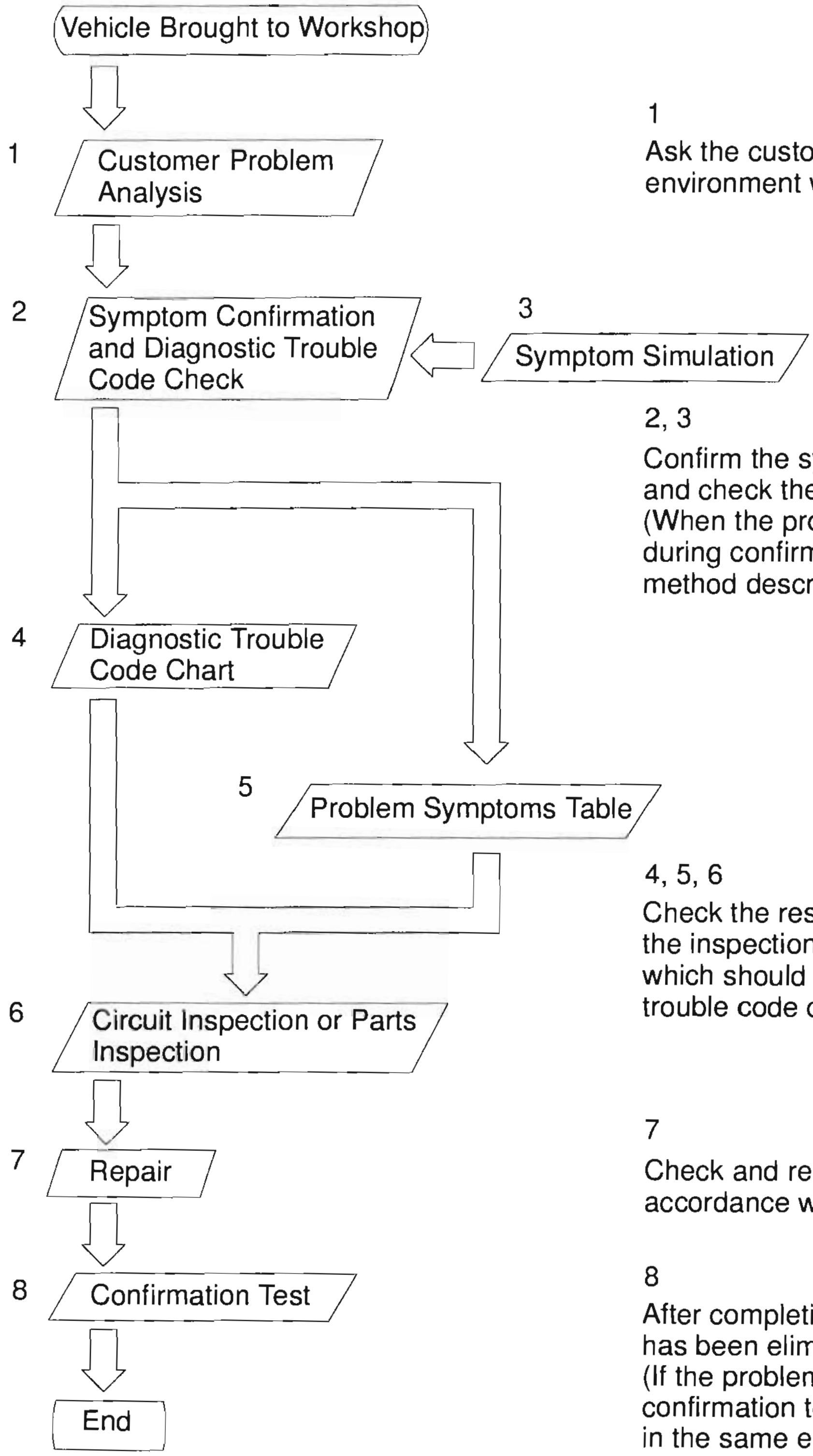
FOR USING HAND–HELD TESTER

- 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.

IN051–08

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	

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

2. SYMPTOM CONFIRMATION AND DIAGNOSTIC TROUBLE CODE CHECK

The diagnostic system in the LAND CRUISE/LAND CRUISER PRADO 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 LAND CRUISER/LAND CRUISER PRADO.

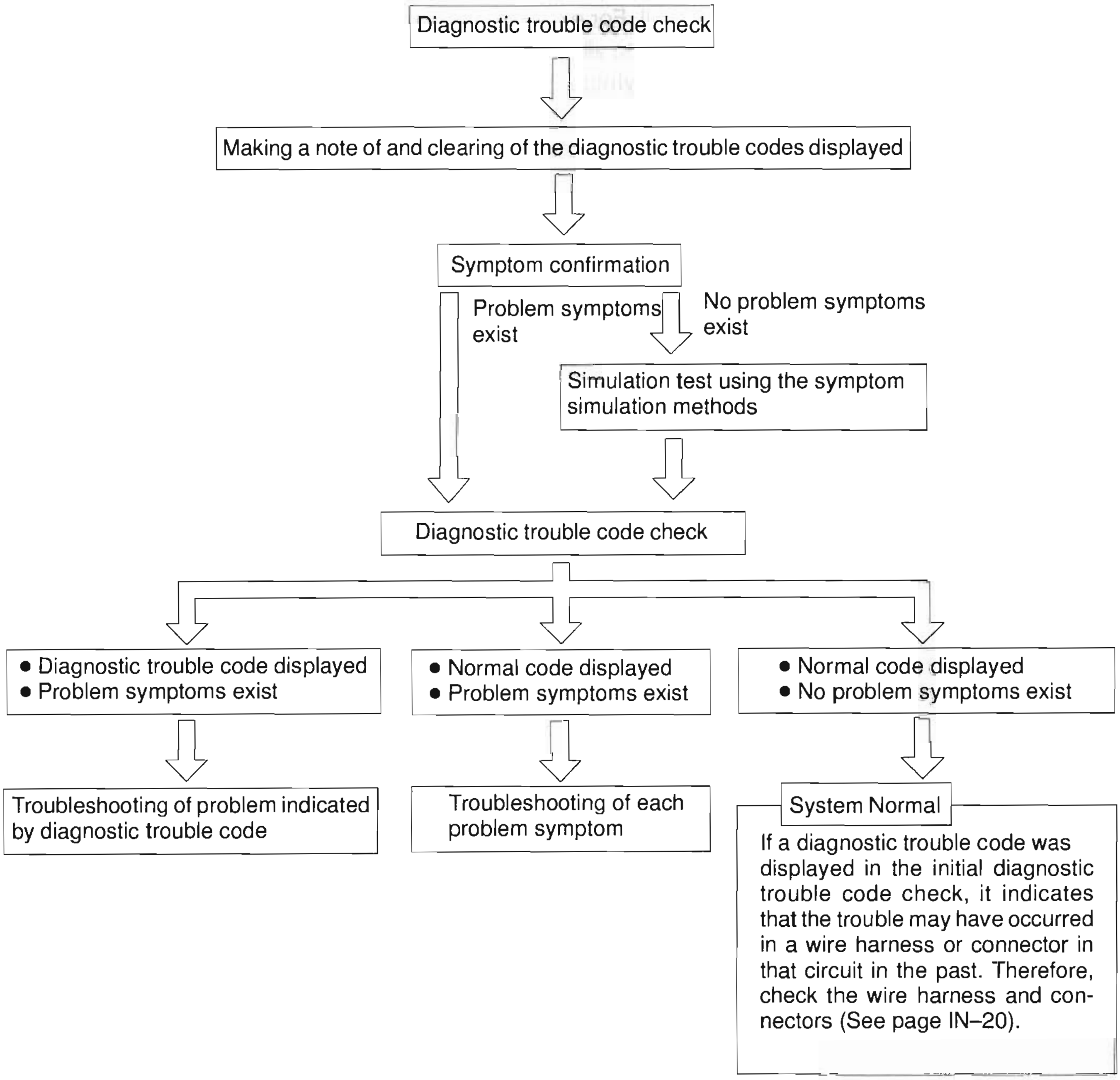
System	Diagnostic Trouble Code Check	Input Signal Check (Sensor Check)	Other Diagnosis Function
Engine	○ (with Test Mode)	○	Diagnostic Test Mode

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.

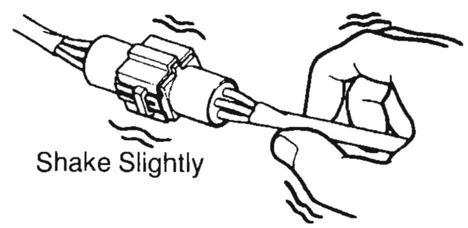
Important Points in the Symptom Simulation Test:

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.**

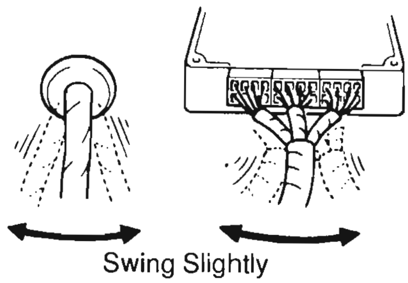
CONNECTORS

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.

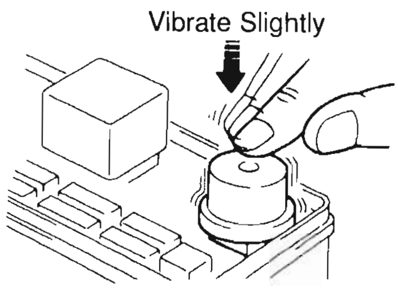


F12331
F12332

PARTS AND SENSOR

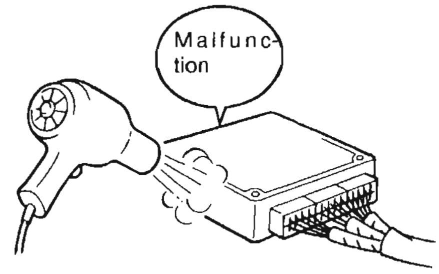
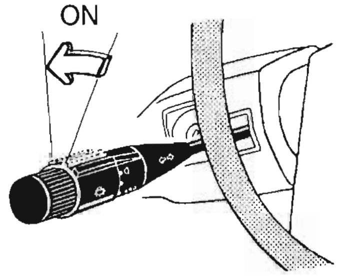
Apply slight vibration with a finger to the part of the sensor considered to be the problem cause and check that the malfunction occurs.

HINT: Applying strong vibration to relays may result in open relays.



F12330

V07268

2	**HEAT METHOD: When the problem seems to occur when the suspect area is heated.**
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.**	 FI2334
3	**WATER SPRINKLING METHOD: When the malfunction seems to occur on a rainy day or in a high–humidity condition.**
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.	 FI6649
4	**OTHER: When a malfunction seems to occur when electrical load is excessive.**
Turn on all electrical loads including the heater blower, head lights, rear window defogger, etc. and check to see if the malfunction occurs.	 FI2336

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 Warning 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–5 ST–20
No initial combustion (Does not start)	1. ECU power source circuit 2. Pre–heating system 3. Compression 4. Engine ECU	DI–93 ST–2 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–2 DI–116 ED–11 FU–1 DI–26 IN–20
	1. Starter signal circuit 2. Injector 3. Fuel filter 4. Diesel throttle body 5. Engine ECU	DI–116
	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

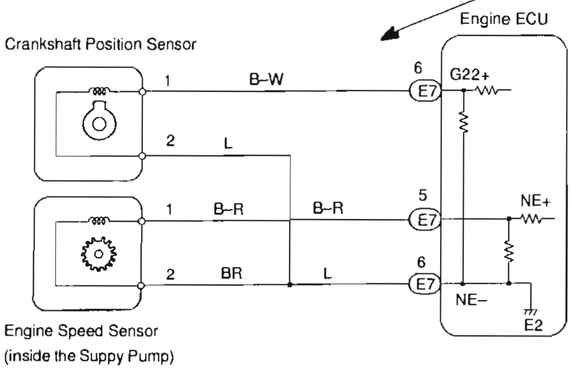
CIRCUIT DESCRIPTION

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

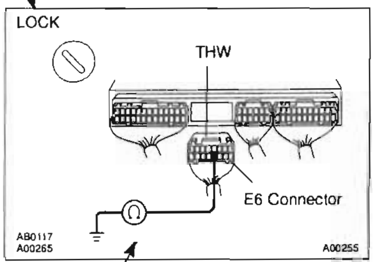
- Indicates the position of the ignition switch during the check.

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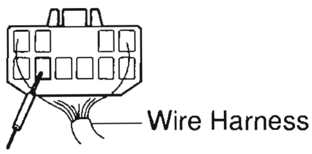
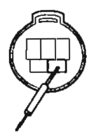
2	**Check water temp. sensor (See page ED–10).**

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.

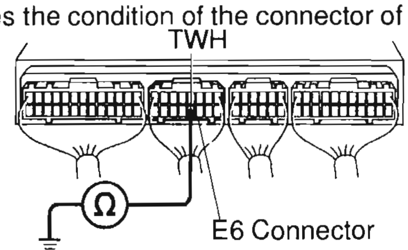


Check from the connector back side. (with harness)

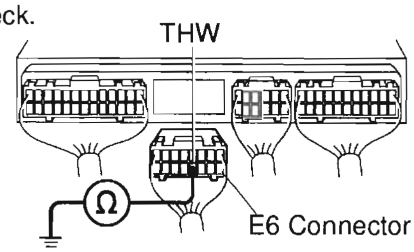


Check from the connector front side. (without harness) In this case, care must be taken not to bend the terminals.

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



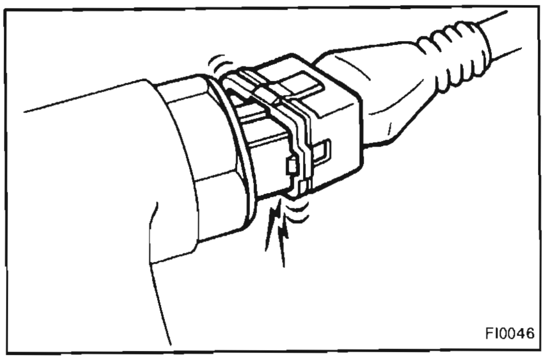
Connector being checked is connected.

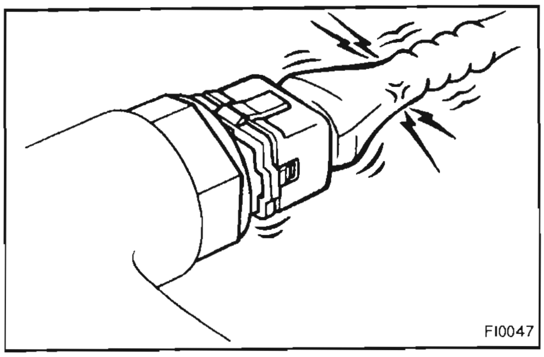


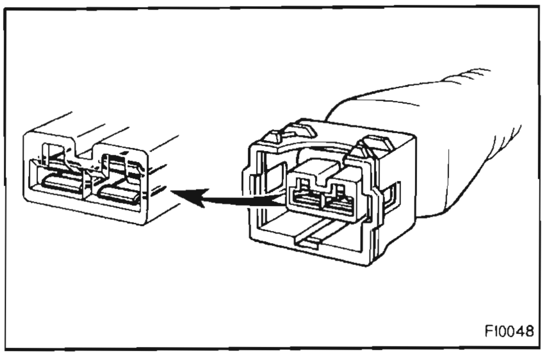
Connector being checked is disconnected.

V08425

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:

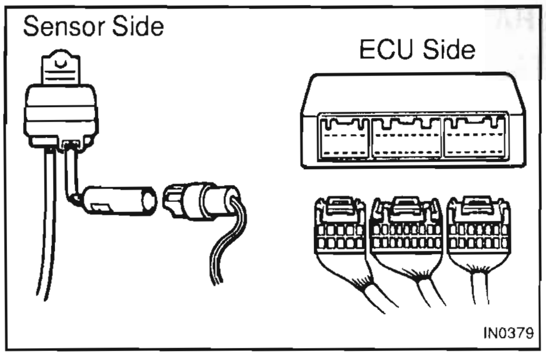
- It is rarely the case that a wire is broken in the middle of it. Most cases occur at the connector. In particular, carefully check the connectors of sensors and actuators.
- Faulty contact could be due to rusting of the connector terminals, to foreign materials entering terminals or a deformation of 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)

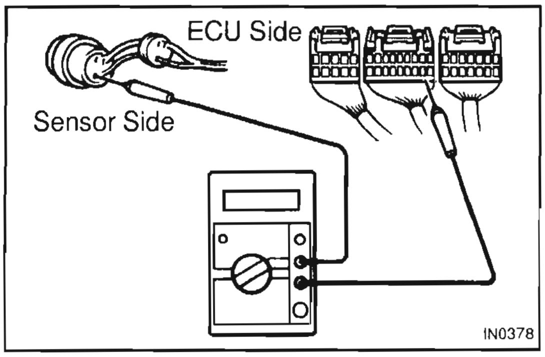
(a) Disconnect the connectors at both ECU and sensor sides.

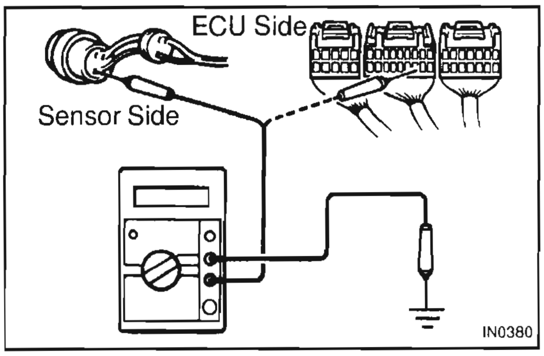
(b) Measure the resistance between the applicable terminals of the connectors.

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)

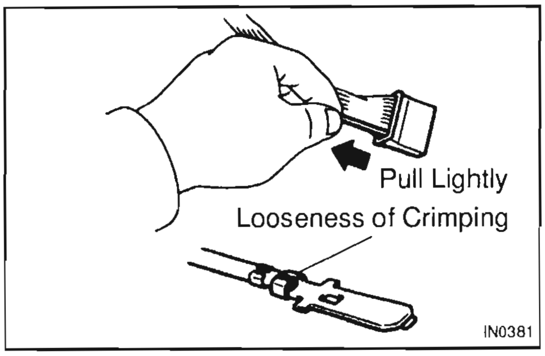
(a) Disconnect the connectors on both ends.

(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.

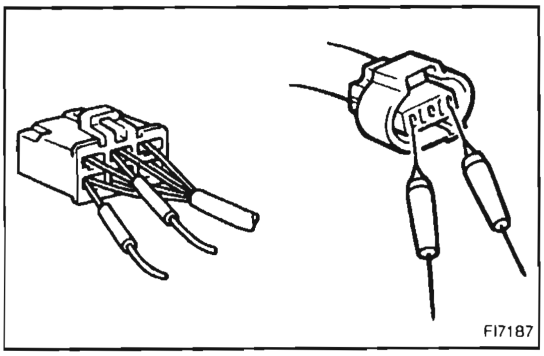
(d) Prepare a test male terminal and insert it in the female terminal, then pull it out.

NOTICE:

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

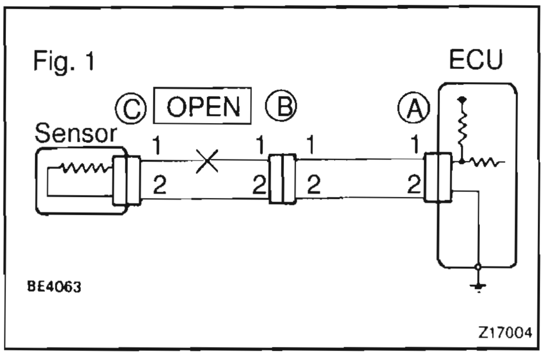
HINT:

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



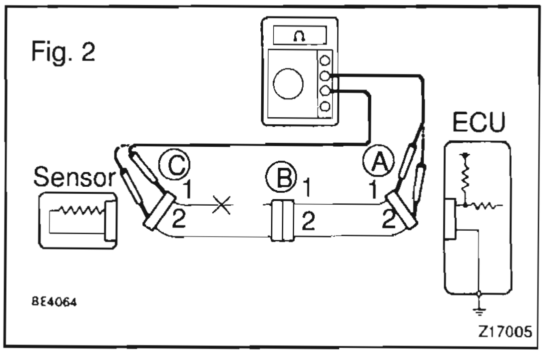
5. CONNECTOR HANDLING

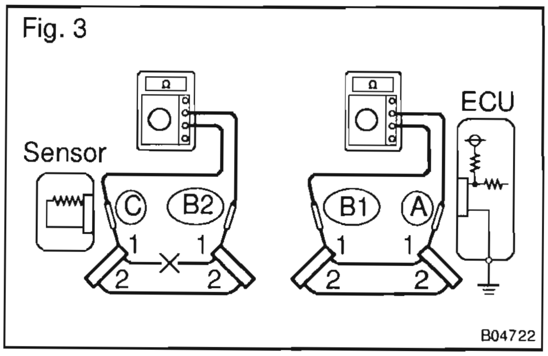
When inserting tester probes into a connector, insert them from the rear of the connector. When necessary, use mini test leads. For water resistant connectors which cannot be accessed from behind, take good care not to deform the connector terminals.



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.



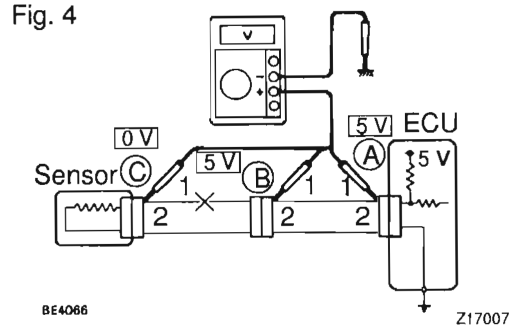


(a) Check the continuity.

(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".

Fig. 4



BE4066 Z17007

(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.

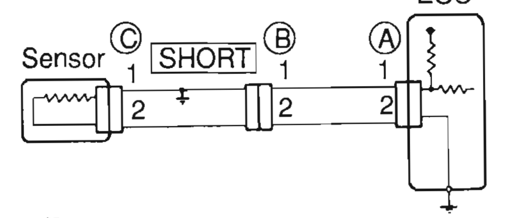
As shown in Fig. 4, with each connector still connected, measure the voltage between body ground and terminal 1 of connector "A" at the ECU 5V output terminal, terminal 1 of connector "B", and terminal 1 of connector "C", in that order.

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".

Fig. 5

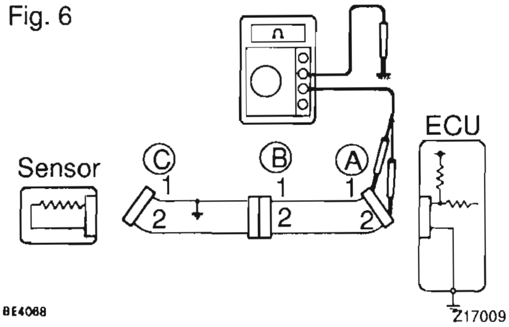


BE4067 Z17008

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".

Fig. 6



BE4068 Z17009

Check the continuity with ground.

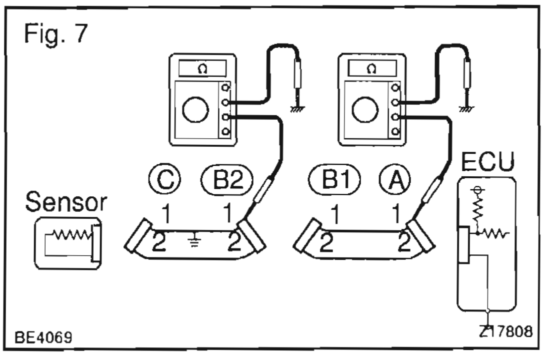
(1) Disconnect connectors "A" and "C" and measure the resistance between terminal 1 and 2 of connector "A" and body ground.

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

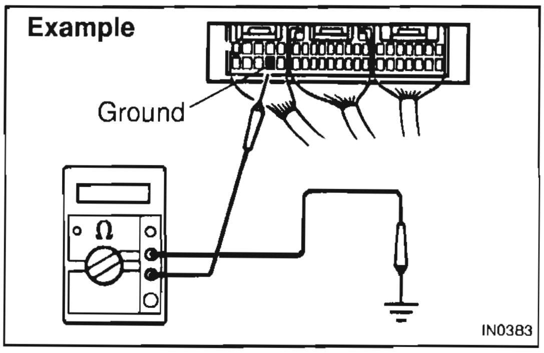
Therefore, it is found out that there is a short circuit between terminal 1 of connector "A" and terminal 1 of connector "C".



(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".

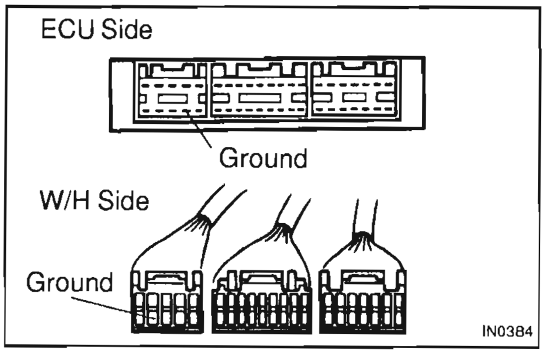
8. CHECK AND REPLACE ECU

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
APPROX.	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)

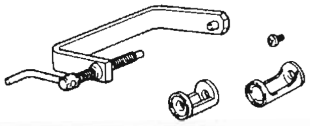
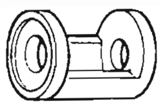
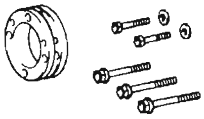
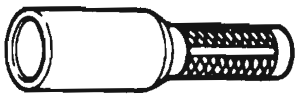
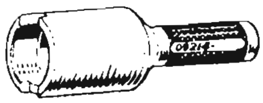
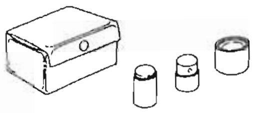
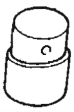
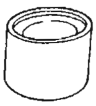
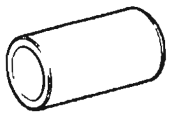
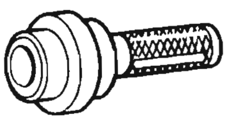
PREPARATION

ENGINE MECHANICAL PP–1
TURBOCHARGING PP–8
EMISSION CONTROL PP–11
ELECTRONIC CONTROL DIESEL PP–13
ENGINE FUEL PP–15
COOLING PP–18
LUBRICATION PP–22
STARTING PP–27
CHARGING PP–30

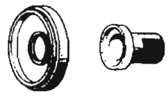
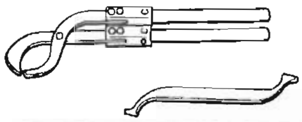
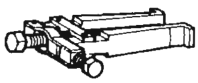
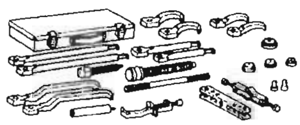
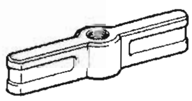
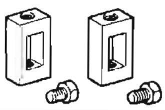
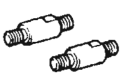
ENGINE MECHANICAL

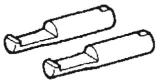
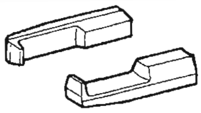
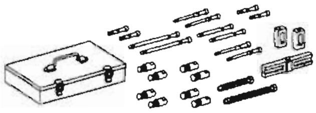
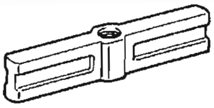
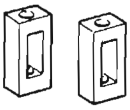
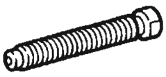
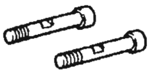
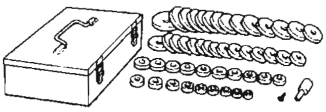
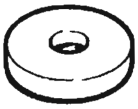
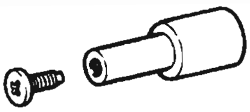
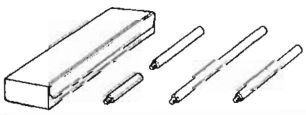
SST (Special Service Tools)

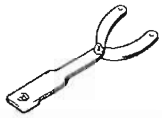
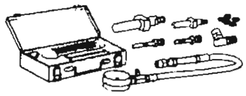
PP3G9–01

	09202–70020	Valve Spring Compressor	CYLINDER HEAD
	(09202–00010)	Attachment	CYLINDER HEAD
	09213–58012	Crankshaft Pulley Holding Tool	TIMING GEAR
	09214–60010	Crankshaft Pulley & Gear Replacer	TIMING GEAR
	09214–76011	Crankshaft Pulley Replacer	TIMING GEAR
	09222–67010	Connecting Rod Bushing Remover & Replacer <mk2>	CYLINDER BLOCK
	(09222–06010)	Remover & Replacer	CYLINDER BLOCK
	(09222–06020)	Guide	CYLINDER BLOCK
	(09222–06030)	Base <mk2>	CYLINDER BLOCK
	09223–00010	Cover & Seal Replacer	TIMING GEAR
	09223–15030	Oil Seal & Bearing Replacer	CYLINDER BLOCK
	09223–50010	Crankshaft Front oil Seal Replacer	CYLINDER HEAD

PP

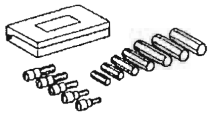
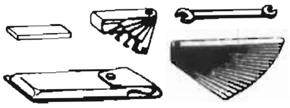
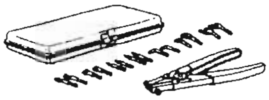
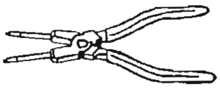
	09223–78010	Crankshaft Oil Seal Replacer	TIMING GEAR
	09248–55050	Valve Clearance Adjust Tool Set	VALVE CLEARANCE
	(09248–05510)	Valve Lifter Press	VALVE CLEARANCE
	(09248–05520)	Valve Lifter Stopper	VALVE CLEARANCE
	(09252–10010)	No. 1 Replacer Handle	CYLINDER BLOCK
	09308–10010	Oil Seal Puller	TIMING GEAR
	09330–00021	Companion Flange Holding Tool	TIMING GEAR
	09950–20017	Universal Puller <mk2>	TIMING GEAR
	09950–40011	Puller B Set	TIMING GEAR TIMING BELT
	(09951–04010)	Hanger 150	TIMING GEAR TIMING BELT
	(09952–04010)	Slide Arm	TIMING GEAR TIMING BELT
	(09953–04020)	Center Bolt 150	TIMING GEAR TIMING BELT
	(09954–04010)	Arm 25	TIMING GEAR TIMING BELT

	(09955–04041)	Claw No.4	TIMING GEAR
	(09955–04061)	Claw No.6	TIMING BELT
	09950–50012	Puller C Set	TIMING GEAR
	(09951–05010)	Hanger 150	TIMING GEAR
	(09952–05010)	Slide Arm	TIMING GEAR
	(09953–05010)	Center Bolt 100	TIMING GEAR
	(09954–05020)	Claw No.2	TIMING GEAR
	09950–60010	Replacer Set	CYLINDER HEAD
	(09951–00280)	Replacer 28	CYLINDER HEAD
	(09951–00500)	Replacer 50	CYLINDER HEAD
	(09952–06010)	Adapter	CYLINDER HEAD
	09950–70010	Handle Set	CYLINDER HEAD
	(09951–07100)	Handle 100	CYLINDER HEAD

	09960–10010	Variable Pin Wrench Set	TIMING GEAR
	(09962–01000)	Variable Pin Wrench Arm Assy	TIMING GEAR
	(09963–00600)	Pin 6	TIMING GEAR
	09992–00025	Cylinder Compression Check Gauge Set	COMPRESSION
	(09992–00121)	No. 4 Attachment	COMPRESSION
	(09992–00211)	Gauge Assy	COMPRESSION

PP27L-02

RECOMMENDED TOOLS

	09040–00011	Hexagon Wrench Set .	
	09200–00010	Engine Adjust Kit .	
	09904–00010	Expander Set .	
	09905–00013	Snap Ring Pliers .	

PP12U-04

EQUIPMENT

Carbide cutter	
Caliper gauge	
Connecting rod aligner	
Cylinder gauge	
Dial indicator	
Dye penetrant	
Engine tune–up tester	
Gasket scraper	
Heater	
Micrometer	
Magnetic finger	
Piston ring compressor	
Piston ring expander	
Plastigage	
Precision straight edge	
Soft brush	
Spring tester	Valve spring
Steel square	Valve spring
Tachometer	
Thermometer	
Torque wrench	
Valve seat cutter	
V–block	
Vernier calipers	

PP3GA–01

SSM (Special Service Materials)

	08826–00080	Seal Packing Black or equivalent (FIPG)	
	08826–00100	Seal Packing 1282B, THREE BOND 1282B or equivalent (FIPG)	Water temperature sender gauge
	08833–00070	Adhesive 1324, THREE BOND 1324 or equivalent	Flywheel Drive plate

TURBOCHARGING

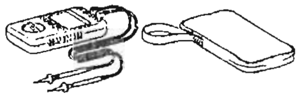
SST (Special Service Tools)

PP3GB–01

	09992–00242 Turbocharger Pressure Gauge	TURBOCHARGER

PP3GC–01

RECOMMENDED TOOLS

	09082–00040	TOYOTA Electrical Tester.	

PP12Y–03

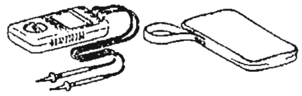
EQUIPMENT

Dial indicator	
Protractor	
Steel square	
Torque wrench	

EMISSION CONTROL

RECOMMENDED TOOLS

PP287-01

	09082–00040	TOYOTA Electrical Tester.	

EQUIPMENT

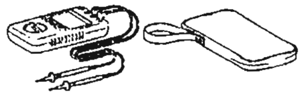
PP288–01

MITYVAC (Hand–held vacuum tester	
Torque wrench	
Vacuum gauge	

ELECTRONIC CONTROL DIESEL

RECOMMENDED TOOLS

PP289-01

	09082–00040	TOYOTA Electrical Tester.	

PP28A-01

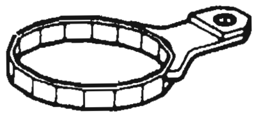
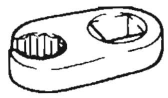
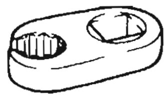
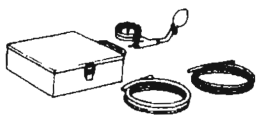
EQUIPMENT

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

ENGINE FUEL

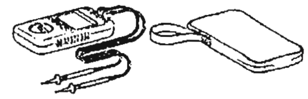
SST (Special Service Tools)

PP28B–02

	09228–64010	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

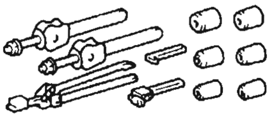
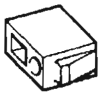
EQUIPMENT

Torque wrench	
OBD II scan tool	

COOLING

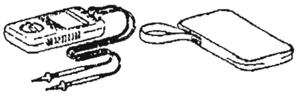
SST (Special Service Tools)

PP136-04

	09230–01010	Radiator Service Tool Set	RADIATOR
	09231–14010	Punch	RADIATOR

PP3G4-01

RECOMMENDED TOOLS

 09082–00040	TOYOTA Electrical Tester.	

PP138-02

EQUIPMENT

Heater	
Radiator cap tester	
Thermometer	
Torque wrench	
Vernier calipers	

PP139-05

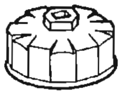
COOLANT

Item	Capacity	Classification
Engine coolant		"Toyota Long Life Coolant" or equivalent
w/ Rear heater		
M/T	10.5 liters (11.1 US qts, 9.2 Imp. qts)	
A/T	11.0 liters (11.6 US qts, 9.7 Imp. qts)	
w/o Power heater		
M/T	9.5 liters (10.0 US qts, 8.4 Imp. qts)	
A/T	10.0 liters (10.6 US qts, 8.8 Imp. qts)	

LUBRICATION

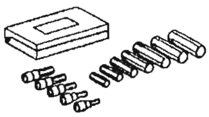
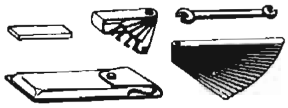
SST (Special Service Tools)

PP3G6–01

	09032–00100	Oil Pan Seal Cutter	OIL PUMP
	09228–10002	Oil Filter Wrench	OIL AND FILTER

PP3G5-01

RECOMMENDED TOOLS

	09040–00011	Hexagon Wrench Set .	
	09200–00010	Engine Adjust Kit .	

EQUIPMENT

PP13C–04

Oil pressure gauge	
Torque wrench	

PP13D–04

LUBRICANT

Item	Capacity	Classification
Engine oil		API grade CF–4
Dry fill	7.5 liters (7.9 US qts, 6.6 Imp. qts)	(You may also use API CF or CE or CD)
Drain and refill		
w/ Oil filter change	7.0 liters (7.4 US qts, 6.2 Imp. qts)	
w/o Oil filter change	6.4 liters (6.8 US qts, 5.6 Imp. qts)	

PP3G7–01

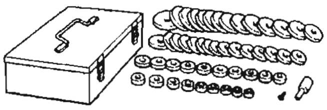
SSM (Special Service Materials)

	08826–00080	Seal Packing Black or equivalent (FIPG)	Oil pump Oil pan
	08833–00080	Adhesive 1344 THREE BOND 1344 LOCTITE 242 or equivalent	Oil pressure switch

STARTING

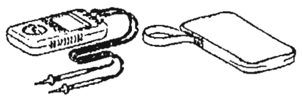
SST (Special Service Tools)

PP27R–01

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

RECOMMENDED TOOLS

PP27S–01

	09082–00040 TOYOTA Electrical Tester.	

PP1MU–03

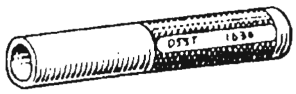
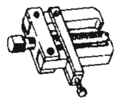
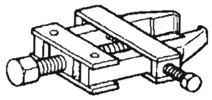
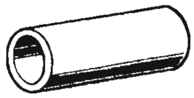
EQUIPMENT

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

CHARGING

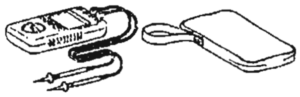
SST (Special Service Tools)

PP3G2-01

	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	

PP17H–03

RECOMMENDED TOOLS

	09082–00040 TOYOTA Electrical Tester.	

PP1TI–04

EQUIPMENT

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

SERVICE SPECIFICATIONS

STANDARD BOLT SS–1
ENGINE MECHANICAL SS–4
TURBOCHARGING SS–9
EMISSION CONTROL SS–11
ELECTRONIC CONTROL DIESEL SS–13
ENGINE FUEL SS–15
COOLING SS–17
LUBRICATION SS–19
STARTING SS–21
CHARGING SS–23

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

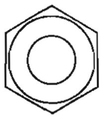
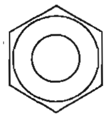
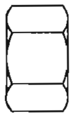
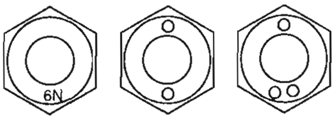
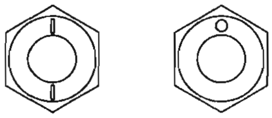
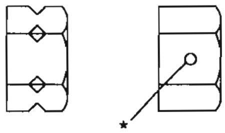
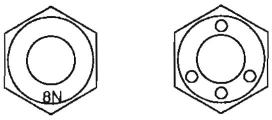
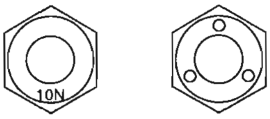
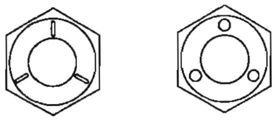
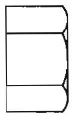
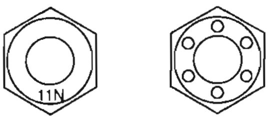
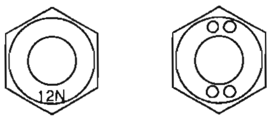
SS0ZT–01

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

SS0JM-04

SERVICE DATA

Compression pressure	at 250 rpm	2,700 kPa (27.5 kgf/cm², 391 psi) or more
	Minimum	2,200 kPa (22.5 kgf/cm², 320 psi) or more
	Difference of pressure between each cylinder	500 kPa (5.0 kgf/cm², 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	
	2525	2.525 mm (0.0994 in.)
	2550	2.550 mm (0.1004 in.)
	2575	2.575 mm (0.1014 in.)
	2600	2.600 mm (0.1024 in.)
	2625	2.625 mm (0.1033 in.)
	2650	2.650 mm (0.1043 in.)
	2675	2.675 mm (0.1053 in.)
	2700	2.700 mm (0.1063 in.)
	2725	2.725 mm (0.1073 in.)
	2750	2.750 mm (0.1083 in.)
	2775	2.775 mm (0.1093 in.)
	2800	2.800 mm (0.1102 in.)
	2825	2.825 mm (0.1112 in.)
	2850	2.850 mm (0.1122 in.)
	2875	2.875 mm (0.1132 in.)
	2900	2.900 mm (0.1142 in.)
	2925	2.925 mm (0.1152 in.)
	2950	2.950 mm (0.1161 in.)
	2975	2.975 mm (0.1171 in.)
	3000	3.000 mm (0.1181 in.)
	3025	3.025 mm (0.1191 in.)
	3050	3.050 mm (0.1201 in.)
	3075	3.075 mm (0.1211 in.)
	3100	3.100 mm (0.1220 in.)
	3125	3.125 mm (0.1230 in.)
	3150	3.150 mm (0.1240 in.)
	3175	3.175 mm (0.1250 in.)
	3200	3.200 mm (0.1260 in.)
	3225	3.225 mm (0.1270 in.)
	3250	3.250 mm (0.1280 in.)
	3275	3.275 mm (0.1289 in.)
	3300	3.300 mm (0.1299 in.)
Idle speed	–	650 – 750 rpm
Maximum speed	–	4,500 – 4,700 rpm
Timing belt tensioner	Protrusion from housing end	8.1 – 8.9 mm (0.319 – 0.350 in.)
Timing gear	Idler gear thrust clearance STD	0.06 – 0.11 mm (0.0024 – 0.0043 in.)
	Maximum	0.30 mm (0.0118 in.)
	Idler gear inside diameter	44.000 – 44.025 mm (1.7323 – 1.7333 in.)
	Idler gear shaft diameter	43.955 – 43.990 mm (1.7305 – 1.7319 in.)
	Idler gear oil clearance STD	0.010 – 0.070 mm (0.0004 – 0.0028 in.)
	Maximum	0.20 mm (0.0079 in.)
	Gear backlash STD	0.02 – 0.15 mm (0.0008 – 0.0060 in.)
	Maximum	0.20 mm (0.0079 in.)

SS

Cylinder head	Warpage		0.15 mm (0.0059 in.)
	Valve seat		
	Refacing angle	Intake	25°, 45°, 70°
		Exhaust	25°, 45°, 75°
	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 outer diameter	STD	11.8 – 12.0 mm (0.465 – 0.472 in.)
		Minimum	11.6 mm (0.457 in.)
	New cylinder head gasket thickness	A	0.80 – 0.90 mm (0.0315 – 0.0354 in.)
		B	0.85 – 0.95 mm (0.0335 – 0.0374 in.)
		C	0.90 – 1.00 mm (0.0354 – 0.0394 in.)
		D	0.95 – 1.05 mm (0.0374 – 0.0413 in.)
		E	1.00 – 1.10 mm (0.0394 – 0.0443 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	105.15 – 105.75 mm (4.1398 – 4.1634 in.)
		Exhaust	105.02 – 105.62 mm (4.1346 – 4.1583 in.)
		Minimum Intake	104.65 mm (4.1201 in.)
		Exhaust	104.52 mm (4.1150 in.)
	Stem diameter	Intake	5.970 – 5.985 mm (0.23504 – 0.23563 in.)
		Exhaust	5.960 – 5.975 mm (0.23465 – 0.23524 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 Intake	1.1 mm (0.043 in.)
		Exhaust	1.2 mm (0.047 in.)
		Minimum Intake	0.6 mm (0.023 in.)
		Exhaust	0.7 mm (0.027 in.)
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
	Free length	Paint color	
		Blue	46.8 mm (1.843 in.)
		None	46.5 mm (1.831 in.)
	Installed tension at 33.1 mm (1.303 in.)	Paint color	
		Blue	149.9 – 166.1 N (15.3 – 16.9 kgf, 33.7 – 37.4 lbf)
		None	150.2 – 165.8 N (15.3 – 16.9 kgf, 33.8 – 37.3 lbf)
Valve lifter	Cylinder head lifter bore diameter		31.000 – 31.021 mm (1.22047 – 1.22130 in.)
	Lifter diameter		30.966 – 30.976 mm (1.21913 – 1.21953 in.)
	Oil clearance	STD	0.024 – 0.055 mm (0.00094 – 0.00217 in.)
		Maximum	0.08 mm (0.0031 in.)
Camshaft	Thrust clearance		0.035 – 0.185 mm (0.00138 – 0.00728 in.)
	Journal oil clearance	STD	0.025 – 0.062 mm (0.0010 – 0.0024 in.)
		Maximum	0.08 mm (0.0031 in.)
	Journal diameter		27.969 – 27.985 mm (1.1011 – 1.1018 in.)
	Circle runout	Maximum	0.03 mm (0.0012 in.)
	Cam lobe height	STD Intake	47.180 – 47.280 mm (1.85748 – 1.86141 in.)
		Exhaust	48.070 – 48.170 mm (1.89252 – 1.89645 in.)
		Minimum Intake	46.76 mm (1.8409 in.)
		Exhaust	47.65 mm (1.8760 in.)
	Camshaft gear backlash	STD	0.035 – 0.185 mm (0.00138 – 0.00728 in.)
		Maximum	0.189 mm (0.00744 in.)
Manifold	Warpage	Maximum	0.4 mm (0.016 in.)

SS

Cylinder block	Cylinder head surface warpage Warpage	Maximum	0.10 mm (0.0039 in.)
	Cylinder bore diameter	STD Mark 1	96.000 – 96.010 mm (3.7795 – 3.7799 in.)
		Mark 2	96.010 – 96.020 mm (3.7799 – 3.7803 in.)
		Mark 3	96.020 – 96.030 mm (3.7803 – 3.7807 in.)
		Maximum	96.23 mm (3.7886 in.)
	Main journal bore diameter	STD Mark 1	75.000 – 75.006 mm (2.9528 – 2.9530 in.)
		Mark 2	75.006 – 75.012 mm (2.9530 – 2.9532 in.)
		Mark 3	75.012 – 75.018 mm (2.9532 – 2.9535 in.)
Piston and piston ring	Piston diameter	STD Mark 1	95.920 – 95.930 mm (3.77637 – 3.77676 in.)
		Mark 2	95.930 – 95.940 mm (3.77676 – 3.77715 in.)
		Marl 3	95.940 – 95.950 mm (3.77715 – 3.77755 in.)
	Piston oil clearance	STD	0.070 – 0.090 mm (0.00276 – 0.00354 in.)
		Maximum	0.14 mm (0.0055 in.)
	Piston ring groove clearance	STD No.1	0.091 – 0.135 mm (0.00358 – 0.00531 in.)
		No.2	0.090 – 0.130 mm (0.00358 – 0.00512 in.)
		Oil	0.030 – 0.070 mm (0.00118 – 0.00276 in.)
	Piston ring end gap	STD No.1	0.27 – 0.39 mm (0.0106 – 0.0154 in.)
		No.2	0.47 – 0.57 mm (0.0185 – 0.0224 in.)
		Oil	0.20 – 0.40 mm (0.0079 – 0.0157 in.)
		Maximum No.1	0.85 mm (0.0335 in.)
		No.2	1.07 mm (0.0421 in.)
		Oil	0.77 mm (0.0303 in.)
Balance shaft	Thrust clearance	STD	0.065 – 0.140 mm (0.0026 – 0.0055 in.)
		Maximum	0.25 mm (0.0098 in.)
	No.1 journal oil clearance	STD	0.040 – 0.079 mm (0.0957 – 0.0976 in.)
		Maximum	0.180 mm (0.0071 in.)
	No.2 journal oil clearance	STD	0.040 – 0.079 mm (0.0957 – 0.0976 in.)
		Maximum	0.190 mm (0.0075 in.)
	No.3 journal oil clearance	STD	0.050 – 0.089 mm (0.0020 – 0.0035 in.)
		Maximum	0.180 mm (0.0071 in.)
	No.1 Bearing inside diameter		42.000 – 42.020 mm (1.6535 – 1.6543 in.)
	No.2 Bearing inside diameter		41.000 – 41.020 mm (1.6142 – 1.6150 in.)
	No.3 Bearing inside diameter		32.000 – 31.020 mm (1.2598 – 1.2606 in.)
	No.1 journal diameter		41.941 – 41.960 mm (1.6512 – 1.6520 in.)
	No.2 journal diameter		40.931 – 40.950 mm (1.6115 – 1.6122 in.)
	No.3 journal diameter		31.941 – 31.960 mm (1.2575 – 1.2583 in.)

Connecting rod	Thrust clearance	STD	0.10 – 0.30 mm (0.0039 – 0.0118 in.)
		Maximum	0.40 mm (0.0157 in.)
	Connecting rod oil clearance	STD	0.036 – 0.054 mm (0.0014 – 0.0021 in.)
		Maximum	0.10 mm (0.0039 in.)
	Connecting rod bearing center wall thickness (Reference)	STD Mark 2	1.486 – 1.489 mm (0.0585 – 0.0586 in.)
		Mark 3	1.489 – 1.492 mm (0.0586 – 0.0587 in.)
		Mark 4	1.492 – 1.495 mm (0.0587 – 0.0589 in.)
		Mark 5	1.495 – 1.498 mm (0.0589 – 0.0590 in.)
		Mark 6	1.498 – 1.501 mm (0.0590 – 0.0591 in.)
	Rod bend	Maximum per 100 mm (3.94 in.)	0.03 mm (0.0012 in.)
	Rod twist	Maximum per 100 mm (3.94 in.)	0.15 mm (0.0059 in.)
	Bushing inside diameter		34.012 – 34.024 mm (1.33905 – 1.33952 in.)
	Piston pin diameter		33.996 – 34.008 mm (1.33842 – 1.33889 in.)
	Piston pin oil clearance	STD	0.012 – 0.020 mm (0.00047 – 0.00079 in.)
		Maximum	0.03 mm (0.0012 in.)
	Connecting rod bolt tension portion diameter	STD	8.500 – 8.600 (0.3346 – 0.3385 in.)
		Minimum	8.30 mm (0.3268 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 (STD)	2.430 – 2.480 mm (0.0957 – 0.0976 in.)
		(U/S 0.25)	2.555 – 2.605 mm (0.1006 – 0.1026 in.)
		(U/S 1.125)	2.493 – 2.543 mm (0.0981 – 0.1001 in.)
	Main journal oil clearance	STD (STD)	0.036–0.054 mm (0.0014 – 0.0021 in.)
		(U/S 0.25 and U/S 0.50)	0.037 – 0.077 mm (0.0015 – 0.0030 in.)
		Maximum	0.10 mm (0.0039 in.)
	Main journal diameter	STD Mark 1	69.994 – 70.000 mm (2.7557 – 2.7559 in.)
		Mark 2	69.988 – 69.994 mm (2.7554 – 2.7557 in.)
		Mark 3	69.982 – 69.988 mm (2.7552 – 2.7554 in.)
	Main bearing center wall thickness (Reference)		
		STD Mark 2	2.482 – 2.485 mm (0.09772 – 0.09783 in.)
		Mark 3	2.485 – 2.488 mm (0.09783 – 0.09795 in.)
		Mark 4	2.488 – 2.491 mm (0.09795 – 0.09807 in.)
		Mark 5	2.491 – 2.494 mm (0.09807 – 0.09819 in.)
		Mark 6	2.494 – 2.497 mm (0.09819 – 0.09831 in.)
	Crank pin diameter	STD Mark 1	58.994 – 59.000 mm (2.3226 – 2.3228 in.)
		Mark 2	58.988 – 58.994 mm (2.3224 – 2.3226 in.)
		Mark 3	58.982 – 58.988 mm (2.3221 – 2.3224 in.)
	Circle runout	Maximum	0.06 mm (0.0024 in.)
	Main journal taper and out–of–round	Maximum	0.002 mm (0.0008 in.)
	Crank pin taper and out–of–round	Maximum	0.002 mm (0.0008 in.)
	Main bearing cap bolt outer diameter	STD	13.500 – 14.000 mm (0.5315 – 0.5512 in.)
		Maximum	12.60 mm (0.4961 in.)

SS0JN–04

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
No 1 camshaft timing pulley x Camshaft		98	1,000	72
Cylinder head cover x Cylinder head		9.0	90	78 in.·lbf
No. 2 camshaft timing pulley x Supply pump drive gear		31	316	23
Timing belt tensioner x Timing gear case		13	133	9
Timing belt cover x Timing belt No. 2 cover		6.0	6	53 in.·lbf
Supply pump drive gear set nut		103	1,050	76
Thrust plate x Idler gear shaft		50	510	37
Timing gear cover x Timing gear case		13	133	9
Vacuum pipe x Timing gear cover		13	133	9
Crankshaft position sensor x Timing gear cover		8.5	87	75 in.·lbf
Camshaft position sensor x Timing gear cover		8.5	87	75 in.·lbf
Crankshaft pulley Crankshaft		365	3,700	268
Vacuum pump x Timing gear cover		21	214	15
Timing belt No. 2 cover x Cylinder head, Cylinder block		10	102	7
Water outlet housing x Cylinder head		19	194	14
Engine hanger No. 1 x Cylinder head		47	479	35
Cylinder head x Cylinder block	1st	85	867	63
	2nd	Turn 90°	Turn 90°	Turn 90°
	3rd	Turn 90°	Turn 90°	Turn 90°
Camshaft bearing cap x Cylinder head		19	194	14
Intake manifold x Cylinder head		29	296	21
E–VRV x Intake manifold		20	204	15
Connecting rod cap x Connecting rod	1st	35	357	26
	2nd	Turn 90°	Turn 90°	Turn 90°
Main bearing cap x Cylinder block		50	510	37
		Turn 90°	Turn 90°	Turn 90°
Oil nozzle x Cylinder		25	260	19
Rear oil seal retainer x Cylinder block		13	133	9
Balance shaft driven gear x Balance shaft		36	367	27
Balance shaft thrust washer x Cylinder block		13	133	9
Engine Mounting x Cylinder block		68	693	50
Rear end plate x Cylinder block		8.0	85	74 in.·lbf
Flywheel x Crankshaft		145	1,479	107
Drive plate x Crankshaft		178	1,820	131

TURBOCHARGING

SERVICE DATA

SS0JO–03

Turbocharger	Turbocharging pressure		205 kPa (2.1 kgf/cm^2, 15.6 psi)
	Turbine shaft axial play		0.15 mm (0.0063 in.)
	Turbine shaft radial play		0.13 mm (0.0051 in.)
Step motor	Rod stroke		11 ± 0.03 mm (0.43 ± 0.0012 in.)
Compensate resistor	Resistance	Mark	
		1	214 – 228 Ω
		2	285 – 303 Ω
		3	372 – 394 Ω
		4	472 – 502 Ω
		5	600 – 638 Ω
		6	763 – 811 Ω
		7	989 – 1,051 Ω
		8	1,290 – 1,370 Ω
		9	1,727 – 1,833 Ω

SS0JP–03

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Turbo water pipe x turbocharger	Bolt: Nut:	8.0 12	82 122	71 in.·lbf 9
Compressor inlet elbow x Turbocharger		19	194	14
Exhaust manifold x Turbocharger		52	530	38
Exhaust manifold x Cylinder head		52	530	38
Turbo oil pipe x Turbocharger		13	133	10
Turbo oil pipe x Cylinder block	Bolt: Union bolt	12 26	122 265	9 19
Turbocharger stay x Turbocharger, Cylinder block		19	194	14
Turbine outlet elbow x Turbocharger		39	398	29
Oil level gauge guide x Water inlet		8.0	82	71 in.·lbf
Exhaust manifold heat insulator x Turbocharger		12	122	9
Turbo insulator x Turbocharger		12	122	9
PCV pipe x Cylinder head		20	204	15
No. 1 water by–pass pipe x Cylinder head		18	184	13
Intercooler x Cylinder head (See page TC–12)	Bolt A: Bolt B:	12 18	122 184	9 13
Intake air temperature sensor x Intercooler		29.4	300	22
Intake air connector x Intercooler		10	102	7

SS

EMISSION CONTROL

SERVICE DATA

SS14C–02

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

TORQUE SPECIFICATION

SS14D–03

Part tightened	N·m	kgf·cm	ft·lbf
VSV assembly x Throttle body	8.0	82	71 in.·lbf
E–VRV for EGR x Intake manifold	20	204	15
EGR cooler x EGR valve, Cylinder head	13	133	10
Front exhaust pipe x Exhaust manifold	62	630	46
Front exhaust pipe x Exhaust tail pipe	43	438	32
Protector x Front exhaust pipe	10.5	107	8

ELECTRONIC CONTROL DIESEL

SERVICE DATA

SS14E-03

Air flow mater	Resistance (THA – E2) at –20°C (–4°F) at 20°C (68°F) at 60°C (140°F)	13.6 – 18.4 kΩ 2.21 – 2.69 kΩ 0.493 – 0.667 kΩ
VSV for turbo pressure sensor	Resistance at 20°C (68°F)	37 – 44 Ω
Fuel temperature sensor	Resistance at 20°C (68°F) at 80°C (176°F)	2.21 – 2.79 Ω 0.287 – 0.349 Ω
Intake air temperature sensor	Resistance at 20°C (68°F)	2.187 – 2.673 Ω
Fuel pressure sensor	Voltage	4.75 – 5.25 V
Turbo pressure sensor	Voltage	4.5 – 5.5 V
	Voltage drop Applied vacuum 13.3 kPa (100 mmHg, 3.94 in.Hg) 26.7 kPa (200 mmHg, 7.87 in.Hg) 40.0 kPa (300 mmHg, 11.81 in.Hg)	 0.1 – 0.3 V 0.3 – 0.5 V 0.5 – 0.7 V
	Voltage up Applied pressure 19.6 kPa (0.20 kgf/cm^2, 2.84psi) 39.2 kPa (0.40 kgf/cm^2, 5.69psi) 58.8 kPa (0.60 kgf/cm^2, 8.53psi) 78.5 kPa (0.80 kgf/cm^2, 11.4psi) 98.0 kPa (1.00 kgf/cm^2, 1.42 psi)	 0.1 – 0.4 V 0.4 – 0.7 V 0.7 – 1.0 V 1.0 – 1.3 V 1.3 – 1.6V
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
Accelerator pedal position sensor	Resistance at 20°C	1.5 – 6.0 kΩ

SS14F-02

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Diesel throttle body x Intake manifold	20	204	15
Water temperature sensor x Cylinder block	20	208	15
Intake air temperature sensor x Intercooler	34.3	350	25
Camshaft position sensor x Timing gear case	8.5	87	75 in.·lbf
Crankshaft position sensor x Timing gear case	8.5	87	75 in.·lbf

ENGINE FUEL

SERVICE DATA

SS14G–03

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
Supply pump (SCV1 and SCV2)	Resistance	at 20°C (68°F)	1.5 – 1.7 Ω

SS14H–03

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Fuel filler bracket x Fuel filter		1.96	20	17 in.·lbf
Nozzle holder clamp x Cylinder head		21.6	220	16
Nozzle leakage pipe x Injector	Hollow screw Union bolt	16 12.5	163 128	12 9
Check valve plug x Overflow screw		9.8	100	87 in.·lbf
Check valve x Cylinder head		21	214	15
Injection pipe clamp x Intake manifold		5	51	44 in.·lbf
Injection pipe, Fuel inlet pipe x Common rail	for use with SST	31.6 35	322 357	23 26
Injection pipe x Injector	for use with SST	31.9 35	325 357	24 26
Nozzle leakage pipe No.2 x Cylinder head	Check valve	21	214	15
Nozzle leakage pipe No.2 x Common rail	Bolt: Union bolt	12.7 12.7	130 130	9 9
Supply pump x Timing gear case		21	214	15
Supply pump stay x Cylinder block, Supply pump		21	214	15
Fuel inlet pipe x Supply pump	for use with SST	31.6 35	325 357	24 26
Common rail x Cylinder head		38	387	28

COOLING

SS0JV-08

SERVICE DATA

Thermostat	Valve opening temperature Valve lift	 at 95°C (203°F)	80 – 84°C (176 – 183°F) 10.0 mm (0.394 in.) or more
Radiator cap	Relief valve opening pressure	STD Minimum	93 – 123 kPa (0.95 – 1.25 kgf/cm^2, 13.5 – 17.8 psi) 79 kPa (0.8 kgf/cm^2, 11.5 psi)

SS0JW–05

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Engine drain plug x Engine coolant drain union	8	80	69 in.·lbf
Water pump x Cylinder block	13	130	9
Water pump pulley x Fun coupling	18	185	13
Water inlet x Cylinder block	13	130	9

LUBRICATION

SERVICE DATA

SS0JX-04

Oil pressure		at idle speed	29 kPa (0.3 kgf/cm^2, 4.2 psi) or more
		at 4,500 rpm	245 kPa (2.5 kgf/cm^2, 36 psi)
Oil pump	Tip clearance	STD	0.06 – 0.16mm (0.0024 – 0.0063 in.)
		Maximum	0.21 mm (0.0083 in.)
	Body clearance	STD	0.10 – 0.17 mm (0.0039 – 0.0067 in.)
		Maximum	(0.20 mm (0.0079 in.)
	Side clearance	STD	0.03 – 0.09 mm (0.0012 – 0.0035 in.)
		Maximum	0.15 mm (0.0059 in.)

SS0JY–04

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Oil pan x Drain plug		34	350	25
Relief valve x Oil pump		42	425	31
Oil pump x Cylinder block	Bolt	13	130	9
	Union bolt	16	160	12
Supply pump x Oil pump		21	210	15
Oil strainer x Cylinder block		8	82	71 in.·lbf
Oil pan x Cylinder block		16	165	12
Alternator bracket x Oil pump		21	210	15
Oil cooler cover x Drain plug		8	80	69 in.·lbf
Oil cooler cover x Oil cooler		16	160	12
Oil cooler cover x Cylinder bolck		13	130	9
Oil nozzle x Cylinder bolck		26	260	19

STARTING

SERVICE DATA

SS0UY-09

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	M/T	12 V 2.2 kW
		M/T (Cold area spec,), A/T	12 V 2.7 kW
		A/T (Cold area spec,)	12 V 3.3 kW
	No–load characteristics		
	Current	2.2 kw	120 A or less at 11.5 V
		2.7 kw	180 A or less at 11.0
		3.3 kw	220 A or less at 11.0
	rpm	2.2 kw	4,000 rpm or more
		2.7 kw	3,500 rpm or more
		3.3 kw	4,200 rpm or more
	Brush length		
	STD	2.2 kw	16.5 mm (0.650 in.)
		2.7 kw	20.5 mm (0.807 in.)
		3.3 kw	21.0 mm (0.827 in.)
	Minimum	2.2 kw	9.0 mm (0.354 in.)
		2.7 kw	11.0 mm (0.433 in.)
		3.3 kw	12.0 mm (0.472 in.)
	Commutator		
	Diameter	STD	
		2.2 kw	35 mm (1.38 in.)
		2.7 kw	36 mm (1.42 in.)
		3.3 kw	43 mm (1.65 in.)
		Minimum	
		2.2 kw	34 mm (1.34 in.)
		2.7 kw	35 mm (1.38 in.)
		3.3 kw	42 mm (1.65 in.)
	Undercut depth	STD	0.7 mm (0.027 in.)
		Minimum	0.2 mm (0.008 in.)
	Circle runout	Maximum	0.05 mm (0.0020 in.)
	Magnetic switch		
	contact plate for wear	Maximum	
		2.2 kw	0.9 mm (0.035 in.)
		2.7, 3.3 kw	1.6 mm (0.063 in.)

SS0UZ–07

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Glow plug x Cylinder head		13	130	10
Starter housing x Magnetic switch assembly	2.2, 2.7 kw	9.3	95	82 in.·lbf
	3.3 kw	11	115	8
Field frame x Starter housing	2.2 kw	13	130	9
	2.7 kw	9.3	95	82 in.·lbf
	3.3 kw	14	145	10
Lead wire x Terminal C	2.2 kw	5.9	60	52 in.·lbf
	2.7, 3.3 kw	24	240	17
Terminal nut x Terminal 30 of starter, Terminal C of starter	2.2 kw	17	173	12
	2.7, 3.3 kw	30	310	22
End cover x Magnetic switch housing		3.6	36	32 in.·lbf

CHARGING

SERVICE DATA

SS0YW-09

Battery	Specific gravity	at 20°C (68°F)	1.25 – 1.29
	Voltage	at 20°C (68°F)	12.5 – 12.9 V
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	Regulating voltage	at 115°C (239°F)	13.2 – 14.8 V

TORQUE SPECIFICATION

SS0YX–08

Part tightened	N·m	kgf·cm	ft·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
Rectifier holder x Lead wire on rectifier end frame	2.94	30	26 in.·lbf
IC regulator x Rectifier end frame	2.0	20	18 in.·lbf
IC regulator x Rectifier holder	2.0	20	18 in.·lbf
Brush holder x Rectifier holder	2.0	20	18 in.·lbf
Brush holder x IC regulator	2.0	20	18 in.·lbf
Rear end cover x Rectifier holder	4.4	45	39 in.·lbf
Plate terminal x Rectifier holder	3.8	39	34 in.·lbf
Terminal insulator x Rectifier holder	4.1	42	36 in.·lbf

DIAGNOSTICS

ENGINE DI–1
HOW TO PROCEED WITH TROUBLESHOOTING DI–1
CUSTOMER PROBLEM ANALYSIS CHECK ... DI–3
PRE–CHECK DI–4
DIAGNOSTIC TROUBLE CODE CHART DI–13
PARTS LOCATION DI–15
TERMINALS OF ECU DI–16
PROBLEM SYMPTOMS TABLE DI–19
CIRCUIT INSPECTION DI–22

DI

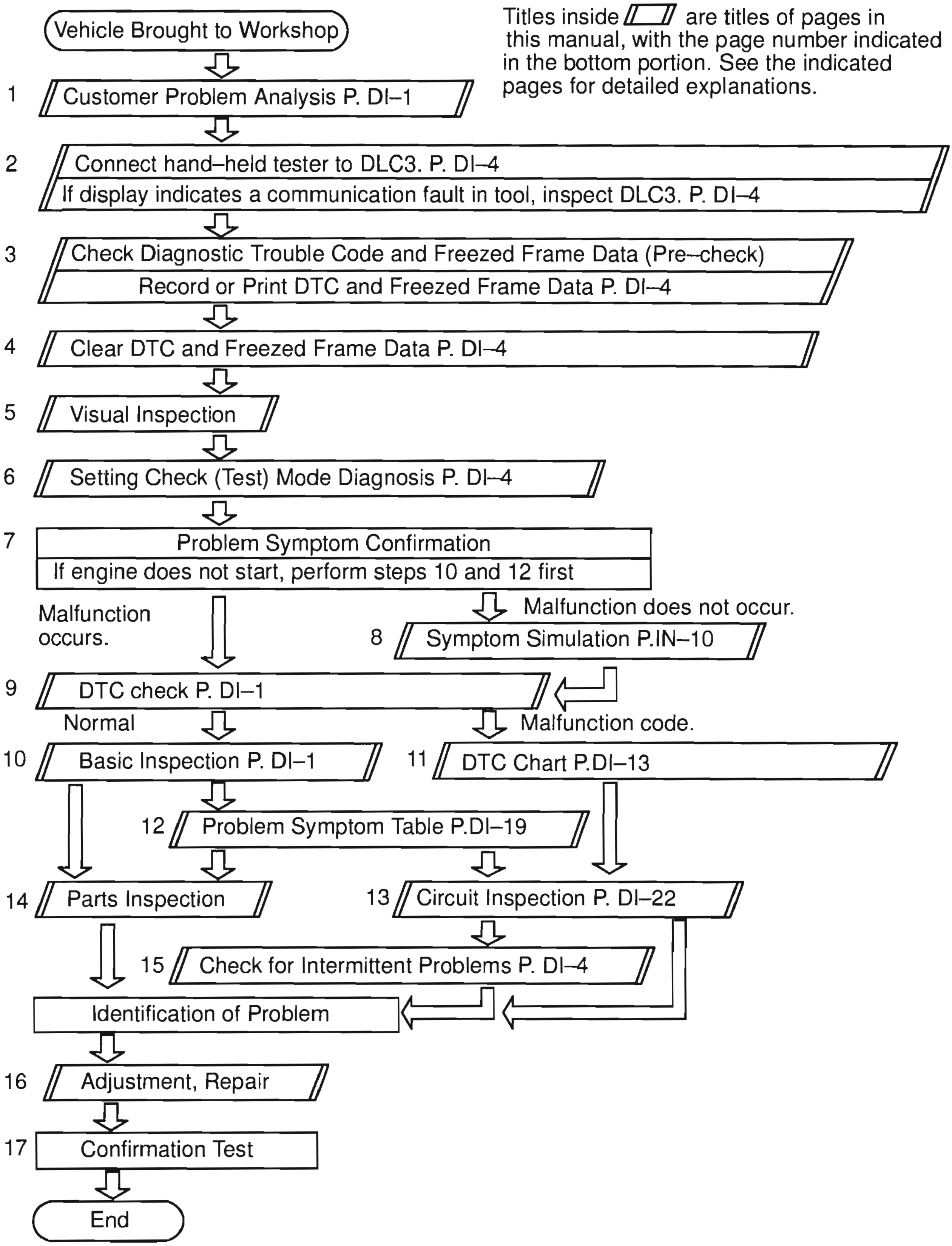
ENGINE

HOW TO PROCEED WITH TROUBLESHOOTING

DI31H–03

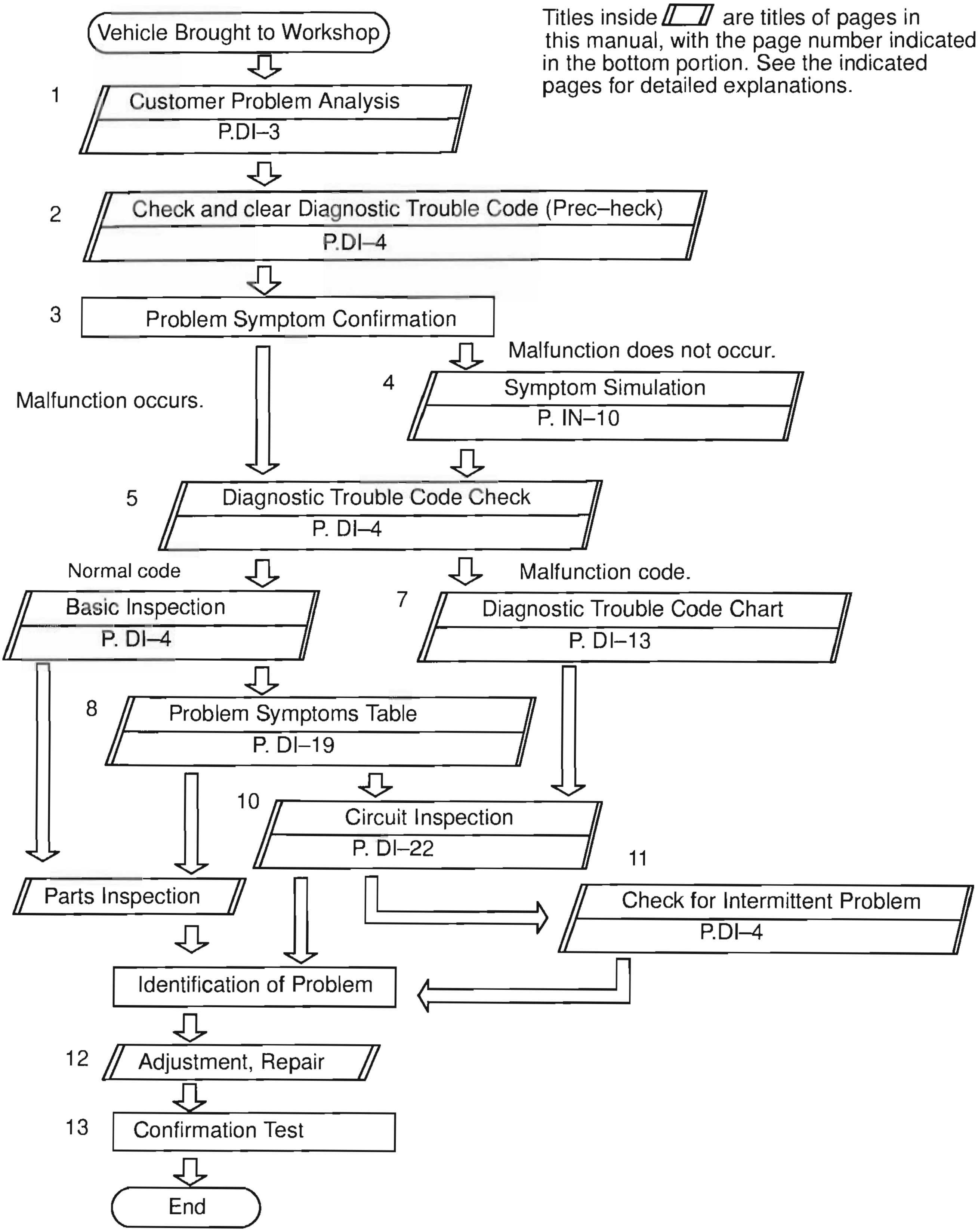
When using hand–held tester, troubleshoot in accordance with the procedure on the following pages.

Titles inside ▱ are titles of pages in this manual, with the page number indicated in the bottom portion. See the indicated pages for detailed explanations.



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

Titles inside ▱ are titles of pages in this manual, with the page number indicated in the bottom portion. See the indicated pages for detailed explanations.



D131I–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 ______

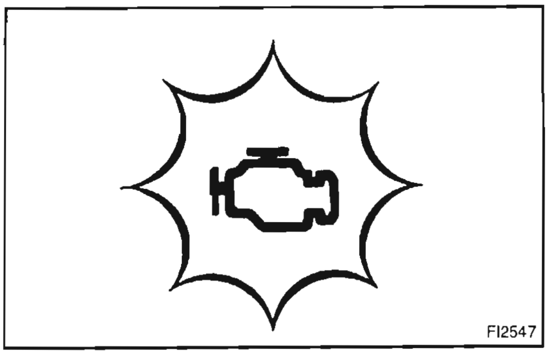
Condition of Malfunction indicator Lamp		☐ Remains on	☐ Sometimes lights up ☐ Does not light up
Diagnostic Trouble Code Inspection	Normal Mode (Precheck)	☐ Normal	☐ Malfunction code(s) (code) ☐ Freezed frame data ( )
	Check Mode	☐ Normal	☐ Malfunction code(s) (code) ☐ Freezed frame data ( )

D169G–02

PRE–CHECK

1. DIAGNOSIS SYSTEM

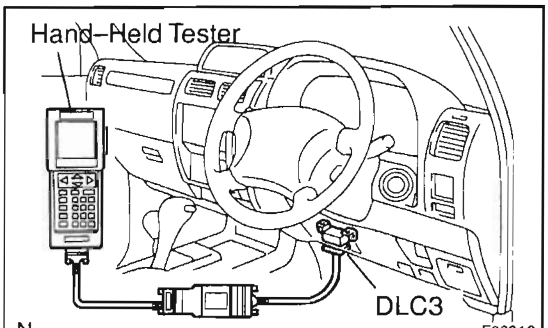
(a) Description



FI2547

- 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–13)

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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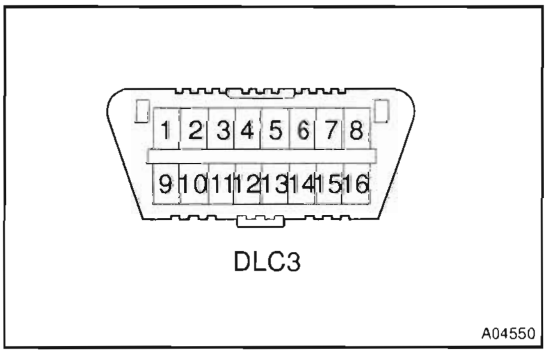
- To check the diagnostic trouble codes, connect the hand–held tester to Data Link Connector 3 (DLC3) on the vehicle or read the number of blinks of the check engine warning light when TC and CG terminals on the DLC3 are connected. The hand–held tester also enables you to erase the diagnostic trouble 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–13)

- *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.

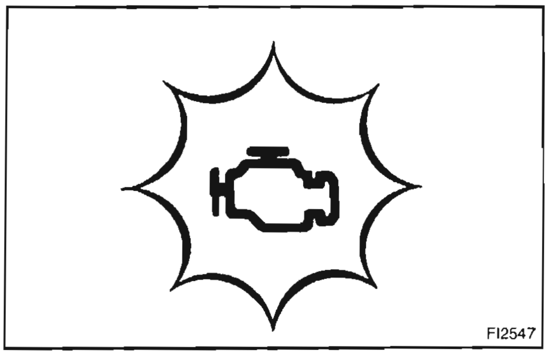


(b) Check the DLC3.
The vehicle's engine ECU uses ISO 14230 for communication. The terminal arrangement of the DLC3 complies with SAE J1962 and matches the ISO 14230 format.

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.

- If communication is normal when the tool is connected to another vehicle, inspect the DLC3 on the original vehicle.
- 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.



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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.

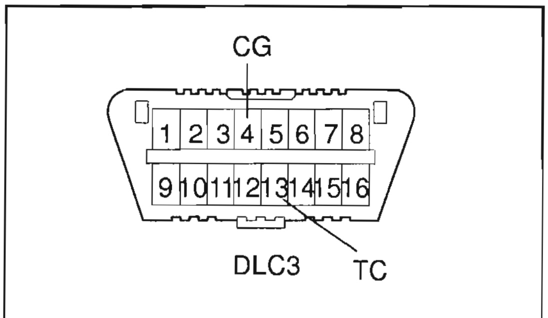
HINT:
If the check engine warning light does not light up, troubleshoot the combination meter.

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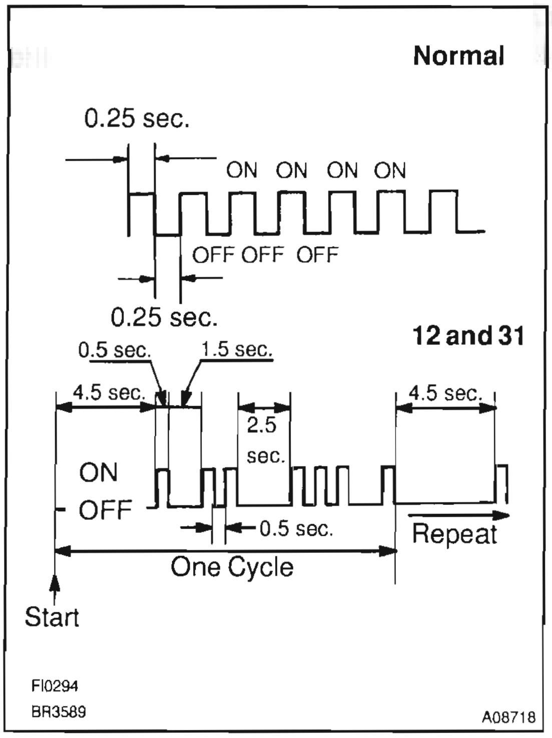
(c) Check the DTC not using hand–held tester.

(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–112).

(4) Check the details of the malfunction using the DTC chart on page DI–13.

(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.

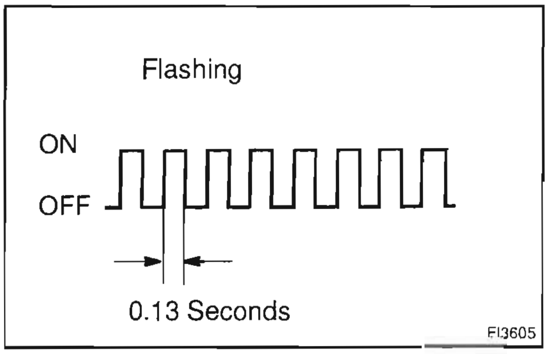
NOTICE:
When simulating symptoms without a hand–held tester to check the DTCs, use the normal mode. For code on the DTCs chart subject to "2 trip detection logic", turn the ignition switch OFF after the symptom is simulated the first time. Then repeat the simulation process again. When the problem has 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.

DI

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

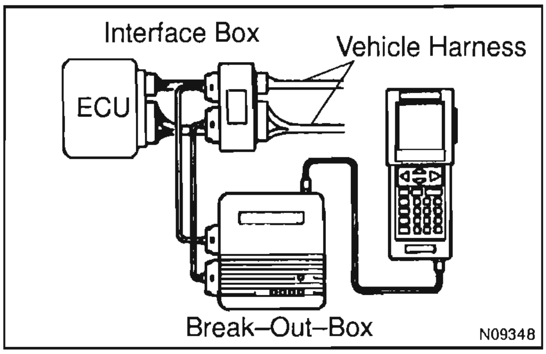
HINT:
Take care not to turn the ignition switch OFF. Turning the ignition switch OFF switches the diagnosis system from the check (test) mode to the normal mode, so all diagnostic codes, etc. are erased.

(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)	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 170°C (338°F)	Return to normal condition
32	Compensation value is set at fixed value	Return to normal condition
34	Turbo charger control link fully open	+B OFF
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–112).

NG → **Repair or replace.**

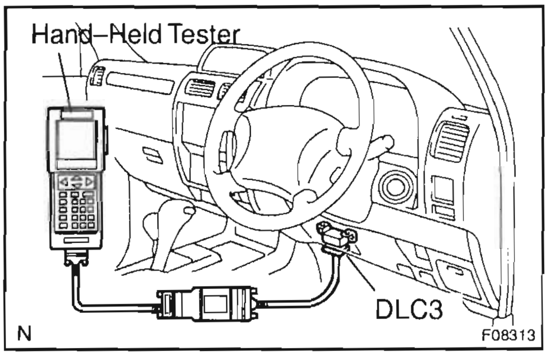
OK

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 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*	5 – 12 mm^3/st
	Engine racing at 3,000 rpm*	7 – 14 mm^3/st

INJECTION TIMING	Engine at idling*	–7°CA
	Engine racing at 2,000 rpm*	–7 – –4°CA
	Engine racing at 3,000 rpm*	2 – 5°CA
ENGINE SPD	RPM kept stable (Comparison with tachometer)	No great changes
PIM	Engine at idling*	90 – 100 kPa
	Engine racing at 2,000 rpm*	95 – 115 kPa
	Engine racing at 3,000 rpm*	100 – 120 kPa
ACCELE POSITION	Accelerator pedal fully closed	0 – 20 %
	Accelerator pedal fully opened	80 – 100 %
IDL SIG	Accelerator pedal full closed	650 – 750 rpm
STARTER SIG	During cranking	ON
A/C CUT SIG	A/C switch OFF	ON
EGR SYSTEM	Idling	ON
ACCEL CLOSE SW	Accelerator pedal fully closed	ON
AFM	Air Flow Rate Through Air Flow Meter at idling	5 – 10 g/sec
COMN RAIL PRESS	Engine at idling*	30 – 40 Mpa
M – INJ/PILOT ON	Engine at idling*	700 – 900 μs
M – INJ/PILOT OFF	Engine at idling*	0 μs
PILOT – INJ	Engine at idling*	500 – 600 μs
PUMP VCM ANGLE	Engine at idling*	70 – 90°CA

HINT:

*: Flat and level place, complete warning–up, shift lever to Nor P position, all accessories and A/C are switched OFF.

DI31K-08

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.

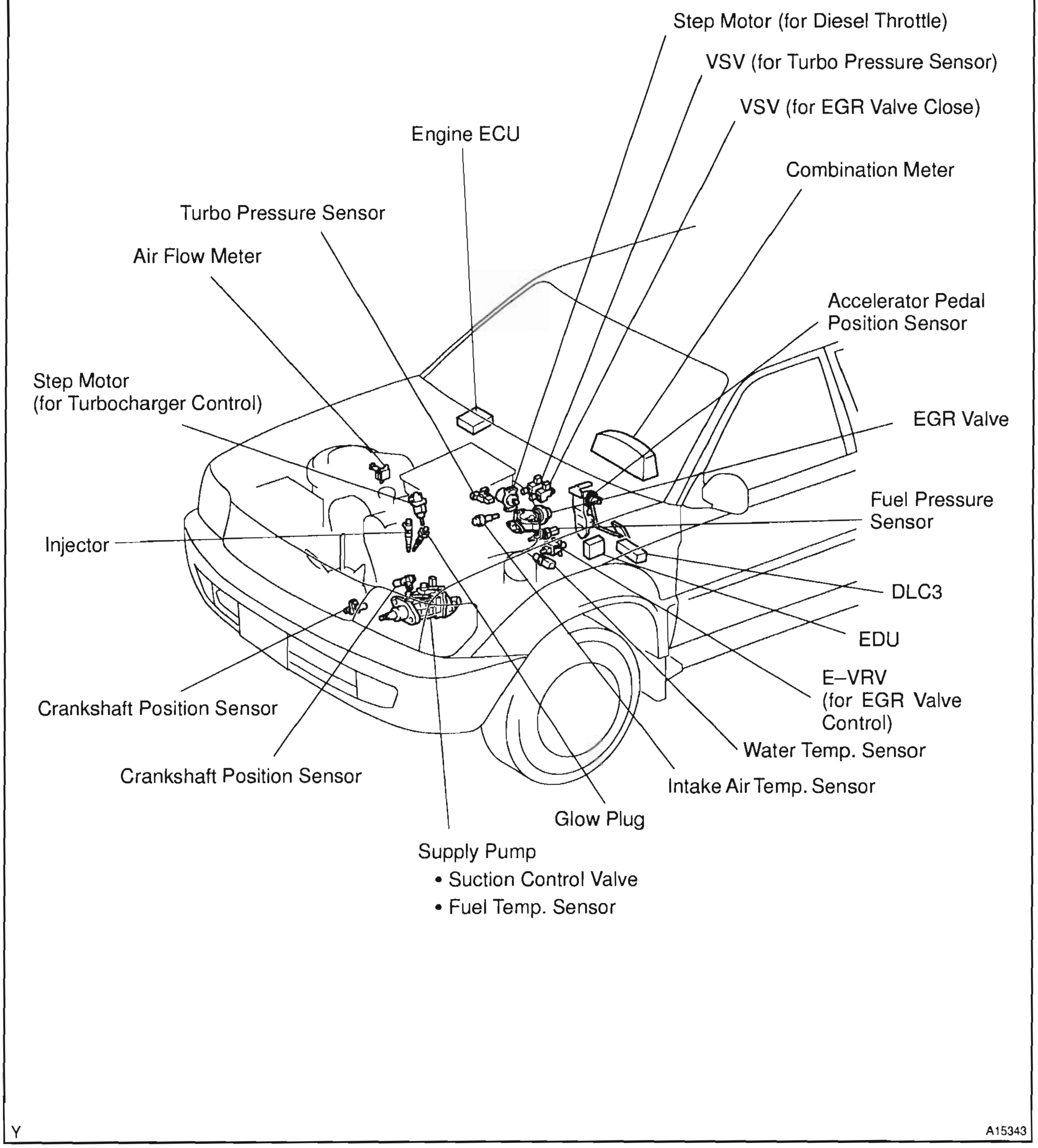
DTC No. (See page)	Detection Item	Trouble Area	*1 Check Engine Warning Light (NormalMode/ Test Mode)	*2 Memory
12 (DI–22)	Engine speed Sensor Circuit Malfunction (TDC or G1 circuit)	• Open or short in camshaft position sensor circuit • Camshaft position sensor • Camshaft timing pulley • Engine ECU	ON/ON	○
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–28)	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–34)	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	○
22 (DI–36)	Water Temp. Sensor Circuit Malfunction	• Open or short in water temp. sensor circuit • Water temp. sensor • Engine ECU	ON/ON	○
24 (1) (DI–41)	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–46)	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–51)	Air Flow Circuit Malfunction	• Open or short in air flow meter circuit • Air flow meter • Engine ECU	ON/ON	○
32 (DI–56)	Injector Correction Resistance Malfunction	• Open or short in injector correction resistance cuicuit • Injector correction resistance • Engine ECU	OFF/ON	○
34 (1) (DI–57)	Step motor for turbocharger control circuit malfunction	• Step motor • Wire harness • Engine ECU	ON/ON	○
34 (2) (DI–59)	Turbocharger system malfunction	• Turbocharger • EGR valve • Air flow meter • Engine ECU	ON/ON	○

34 (3) (DI–59)	Turbocharger stick detected (Close)	• Turbocharger • EGR valve • Air flow meter • Engine ECU	ON/ON	○
35 (DI–61)	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 • Turbocharger • EGR valve • Air flow meter • Engine ECU	ON/ON	○
39 (DI–70)	Fuel Temp. Sensor Circuit Malfunction	• Open or short in fuel temp. sensor circuit • Fuel pressure sensor • Engine ECU	ON/ON	○
42 (DI–75)	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–77)	Common Rail Pressure Sensor Circuit Malfunction	• Open or short in fuel pressure sensor circuit for common rail • Fuel pressure sensor for common rail • Engine ECU	ON/ON	○
78(1) (DI–79)	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–84)	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–88)	EDU Circuit Malfunction	• Open or short in EDU circuit • EDU • Open or short in SCV circuit • SCV • Injector • Engine ecu.	ON/ON	○
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.

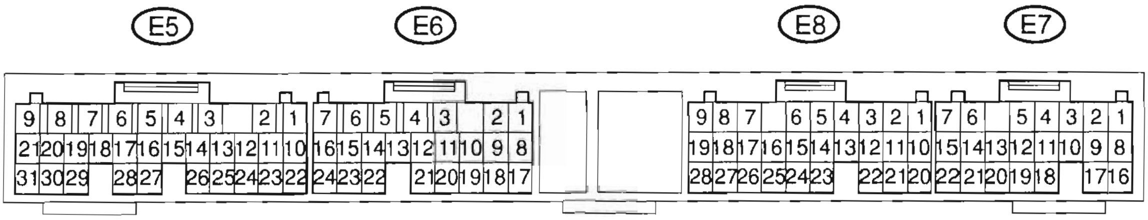
DI31L-06

PARTS LOCATION



DI8J4–01

TERMINALS OF ECU

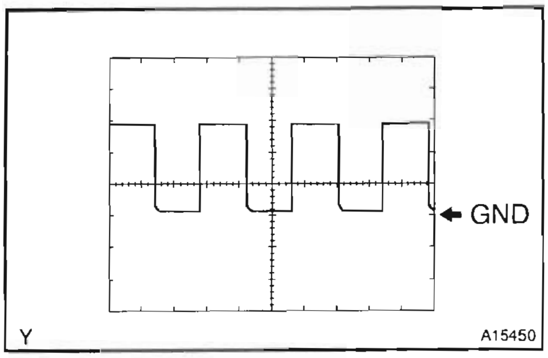


Symbols (Terminal No.)	Wiring Color	Condition	STD Voltage (V)
BATT (E7–2) – E1 (E5–22)	B–Y – BR	Always	9 – 14
+B (E7–1) – E1 (E5–22)	B–R – BR	IG switch ON	9 – 14
VC (E6–21) – E2 (E6–20)	B – BR	IG switch ON	4.5 – 5.5
VCC (E8–8) – E2C (E8–27)	G–Y – BR–W	IG switch ON	4.5 – 5.5
VCC2 (E8–13) – E2C (E8–27)	Y–B – BR–W	IG switch ON	4.5 – 5.5
VA (E8–19) – E2C (E8–27)	Y–R – BR–W	Accelerator pedal fully closed	0.3 – 0.8
		Accelerator pedal fully opened	2.9 – 4.9
VAS (E8–28) – E2C2 (E8–24)	GR – BR	Accelerator pedal fully closed	0.3 – 0.8
		Accelerator pedal fully opened	2.9 – 4.9
PCR (E6–23) – E2 (E6–20)	G–R – BR	IG switch ON	1.0 – 4.0
THAF (E6–13) – E2 (E6–20)	Y–B – BR	Atmospheric temp	0.5 – 3.8
PIM (E6–16) – E2 (E6–20)	B–Y – BR	Apply vacuum 40 kPa (300 mmHg, 11.8 in.Hg)	0.2 – 0.8
		Apply pressure 69 kPa (0.7 kg/cm^2, 9.96 lb/in^2.)	3.2 – 3.8
THA (E6–22) – E2 (E6–20)	L–Y – BR	Idling, air intake temp. 0°C (32°F) to 80°C (176°F)	0.5 – 3.4
THW (E6–14) – E2 (E6–20)	G – BR	Idling, engine coolant temp. 60°C (140°F) to 120°C (248°F)	0.2 – 1.0
THF (E6–24) – E2 (E6–20)	W – BR	IG switch ON (at engine cold)	0.5 – 3.8
VG (E6–19) – EVG (E6–11)	B – B	Idling, A/C switch OFF	0.5 – 3.0
IGSW (E7–9) – E1 (E5–22)	B–O – BR	IG switch ON	9 – 14
STA (E7–15) – E1 (E5–22)	R – BR	Cranking	6.0 or more
NE+ (E5–17) – NE– (E5–28)	B – W	Idling	Pulse generation (See page DI–24)
G+ (E5–16) – G– (E5–27)	B – W	Idling	Pulse generation (See page DI–22)
SPD (E8–22) – E1 (E5–22)	V–W – BR	IG switch ON, Rotate driving wheel slowly	Pulse generation (See page DI–75)
EGR (E5 – 2) – E01 (E5–21)	G–B – W–B	IG switch ON	9 – 14
		EGR ON (Maintain engine speed at 1,500 rpm after warning up)	Pulse generation (See page DI–97)
PA (E6–17) – E01 (E5–21)	R–B – W–B	Starter ON	9 – 14
#1 (E5–15) – E01 (E5–21)	W–L – W–B	Idling	Pulse generation (See page DI–88)
#2 (E5–14) – E01 (E5–21)	W–R – W–B		
#3 (E5–13) – E01 (E5–21)	L–Y – W–B		
#4 (E5–12) – E01 (E5–21)	W–G – W–B		
INJF (E5–18) – E01 (E5–21)	W – W–B	Idling	Pulse generation (See page DI–88)
MREL (E7–7) – E01 (E5–21)	L–B – W–B	IG switch ON	9 – 14

A/C (E8–6) – E1 (E5–22)	B–Y – BR	A/C switch ON (at idling)	0 – 1.5
		A/C switch OFF	9 – 14
TACH (E8–10) – E1 (E5–22)	B – BR	Idling	Pulse generation*1
SREL (E7–16) – E01 (E5–21)	G–R – W–B	IG switch ON	9 – 14
W (E7–12) – E1 (E5–22)	Y–R – BR	Check engine warning light lights up	0 – 3
		Except check engine warning light lights up	9 – 14
GIND (E7–3) – E1 (E5–22)	B–R – BR	Glow indicator light lights up	0 – 3.0
		Except glow indicator light lights up	9 – 14
ACT (E8–5) – E1 (E5–22)	L–B – BR	IG switch ON	9 – 14
		At A/C cut controlled (Driving below 30 km/h, accelerator pedal fully opened for 5 sec.)	0 – 3.0
LU+A (E5–20) – E1 (E5–22)	W – BR	IG switch ON	Pulse generation*2
LU–A (E5–30) – E1 (E5–22)	R – BR		
LU+B (E5–19) – E1 (E5–22)	G – BR		
LU–B (E5–29) – E1 (E5–22)	Y – BR		
TC (E7–18) – E1 (E5–22)	P–L – BR	IG switch ON	9 – 14
EGRC (E5–1) – E1 (E5–22)	R–W – BR	IG switch ON	0 – 3.0
		Maintain engine speed at 1500 rpm after warming up	9 – 14
SIL (E7–19) – E1 (E5–22)	V–W – BR	Connect hand–held tester to DLC3	Pulse generation*3
IMI (E7–14) – E1 (E5–22)	P–G – BR	Idling	Pulse generation*4
IMO (E7–21) – E1 (E5–22)	BR–R – BR	A few sec. after engine staring	Pulse generation*4
STP (E8–14) – E1 (E5–22)	G–W – BR	Brake pedal depressed	7.5 –14
		Brake pedal released	0 –1.5
ST1– (E8–23) – E1 (E5–22)	R–G – BR	Brake pedal depressed	0 –1.5
		Brake pedal released	7.5 – 14
INJ1 (E5–26) – E1 (E5–22)	L–B – BR	Idling	0.5 – 4.5
INJ2 (E5–25) – E1 (E5–22)	L–R – BR		
INJ3 (E5–24) – E1 (E5–22)	L–W – BR		
INJ4 (E5–23) – E1 (E5–22)	R–G – BR		
VN+A (E5–6) – E1(E5–22)	Y–B – BR	Idling	Pulse generation*5
VN–A (E5–5) – E1(E5–22)	Y–R – BR		
VN+B (E5–4) – E1(E5–22)	Y–G – BR		
VN–B (E5–3) – E1(E5–22)	Y – BR		
PCV1 (E5–9) – E1(E5–22)	B–Y – BR	Idling	Pulse generation (See page DI–84)
PCV2 (E5–8) – E1(E5–22)	B–R – BR		
HSW (E8–25) – E1 (E5–22)	W – BR	Heater idle up switch ON	0 – 3.0
		Heater idle up switch OFF	9 – 14
VCH (E8–18) – E1 (E5–22)	G – BR	Power heater ON	0 – 1.5
		Power heater OFF	7.5 – 14
VCT (E8–15) – E1 (E5–22)	Y – BR	IG switch ON	9 –14
		Power heater OFF operation	0 – 3.0

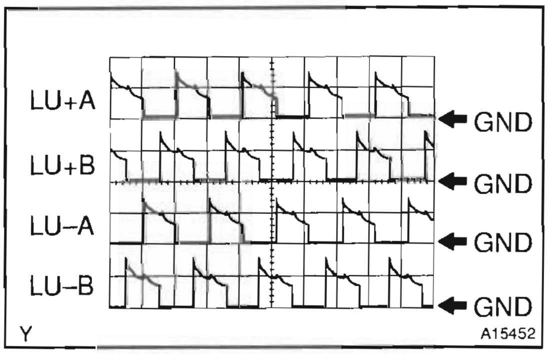
REFERENCE:

INSPECTION USING OSCILLOSCOPE



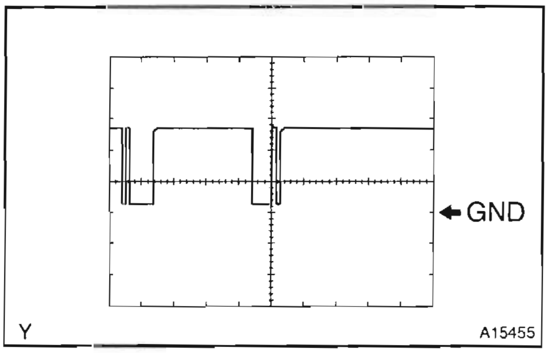
*1: TACH ↔ E1

Measure set: 5 V/DIV, 10 ms/DIV



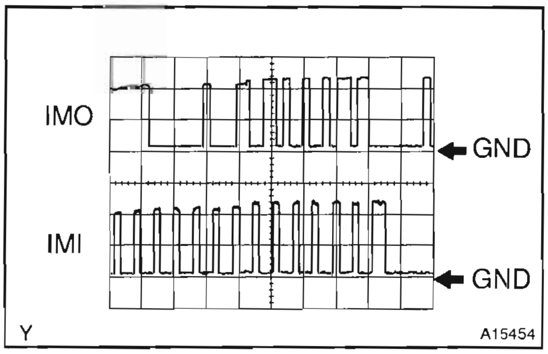
*2: LU+A, LU–A, LU+B, LU–B ↔ E1

Measure set: 20 V/DIV, 10 ms/DIV



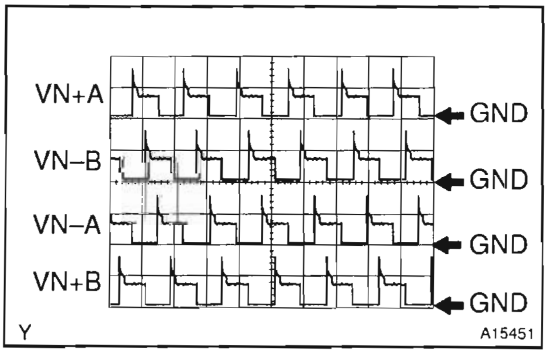
*3: SIL ↔ E1

Measure set: 5 V/DIV, 1 ms/DIV



*4: IMI, IMO ↔ E1

Measure set: 5 V/DIV, 100 ms/DIV



*5: VN+A, VN–A, VN+B, VN–B ↔ E1

Measure set: 20 V/DIV, 50 ms/DIV

DI3IN–07

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–19 ST–20 ED–11
Cold 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 9. Glow plug system	DI–116 FU–4 FU–1 EM–2 ED–24 FU–13 ED–14 ED–6 ST–2
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–116 FU–4 FU–1 EM–2 ED–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14
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–105 FU–4 DI–116 ED–24 FU–13 ED–14

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–105 FU–4 DI–97 EM–2 EM–5 – ED–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14 ED–6
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–24 FU–13 ED–14 ED–6
Knocking (Poor driveability)	1. Injector 2. EGR control circuit 3. Engine ECU 4. Supply pump 5. Fuel pressure sensor	FU–4 DI–97 ED–24 FU–13 ED–14
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–24 FU–13 ED–14 ED–6

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 ED–23 FU–13 ED–14 ED–6
Surging/ Hunting (Poor driveability)	1. Injector 2. Engine ECU 3. Supply pump 4. Fuel pressure sensor	FU–4 ED–24 FU–13 ED–14

DI31O–07

CIRCUIT INSPECTION

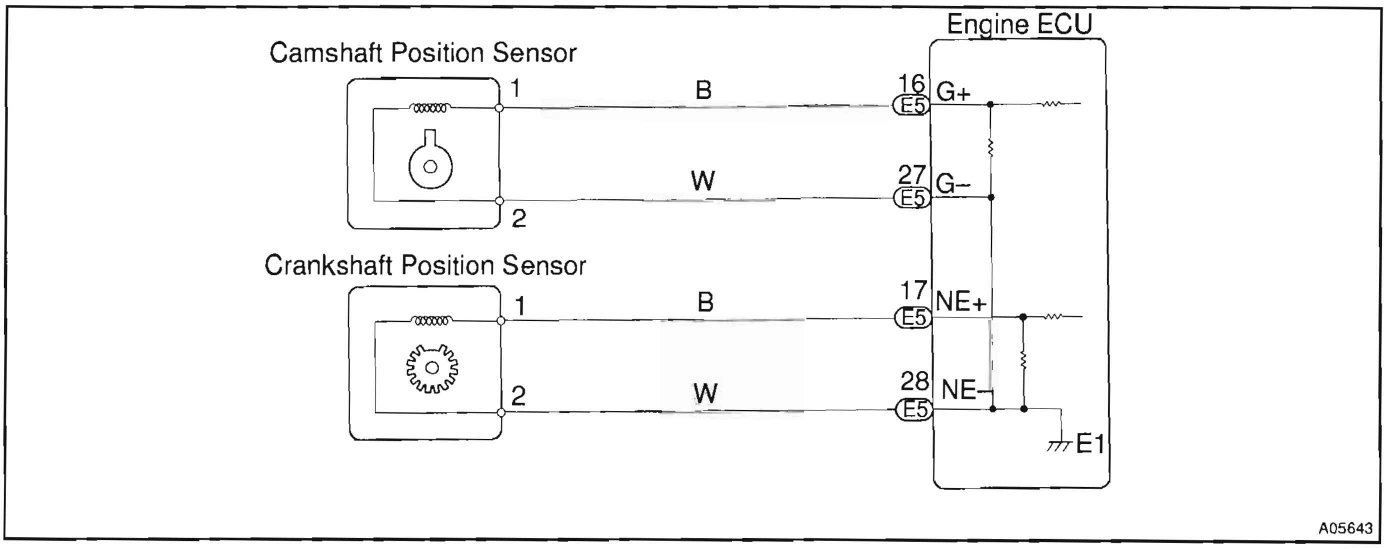
DTC	12	Engine Speed Sensor Circuit Malfunction 1 (TDC or G1 Circuit)

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 pump drive shaft 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 crank angle sensor plate. 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

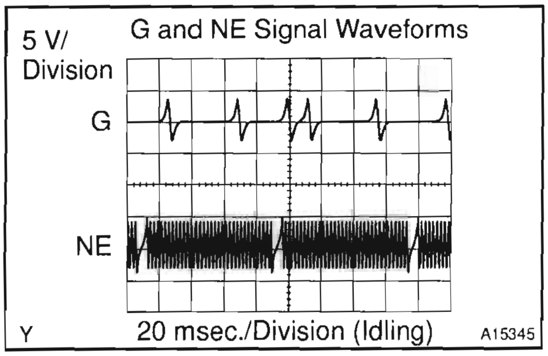


INSPECTION PROCEDURE

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–17).



Reference: INSPECTION USING OSCILLOSCOPE
During cranking or idling, check the waveforms 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 pump drive shaft pulley.

NG → **Tighten sensor. Replace pump drive shaft pulley.**

OK

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

DI31P–08

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 crank angle sensor plate. 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 No crankshaft position sensor signal to engine ECU for 2.0 sec. or more during cranking	• Open or short in crankshaft position sensor circuit • Crankshaft position sensor • Crank angle sensor plate • Engine ECU

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–18).**

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

NG → **Replace crankshaft position sensor (See page ED–18).**

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 crank angle sensor plate.

NG → Tighten sensor. Replace crank angle sensor plate.

OK

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

DI8J5-01

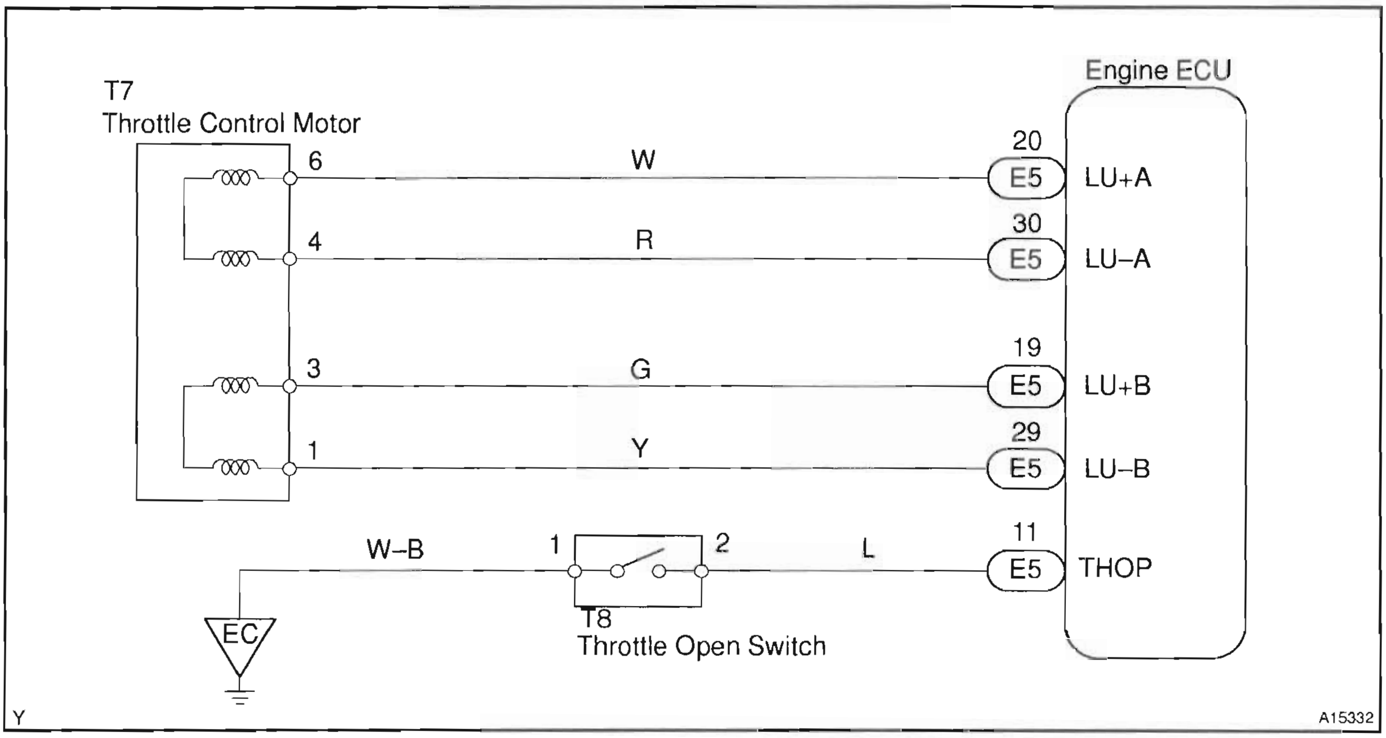
DTC	15	Throttle Control Motor Circuit Malfunction

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

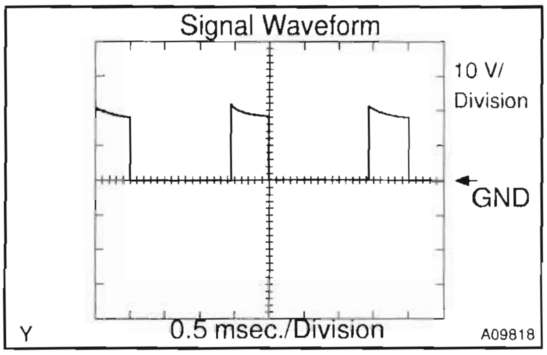
WIRING DIAGRAM



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 (See page ED–6).**

NG → **Replace diesel throttle body assembly (See page ED–4).**

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–23).

DI31S–05

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

CIRCUIT DESCRIPTION

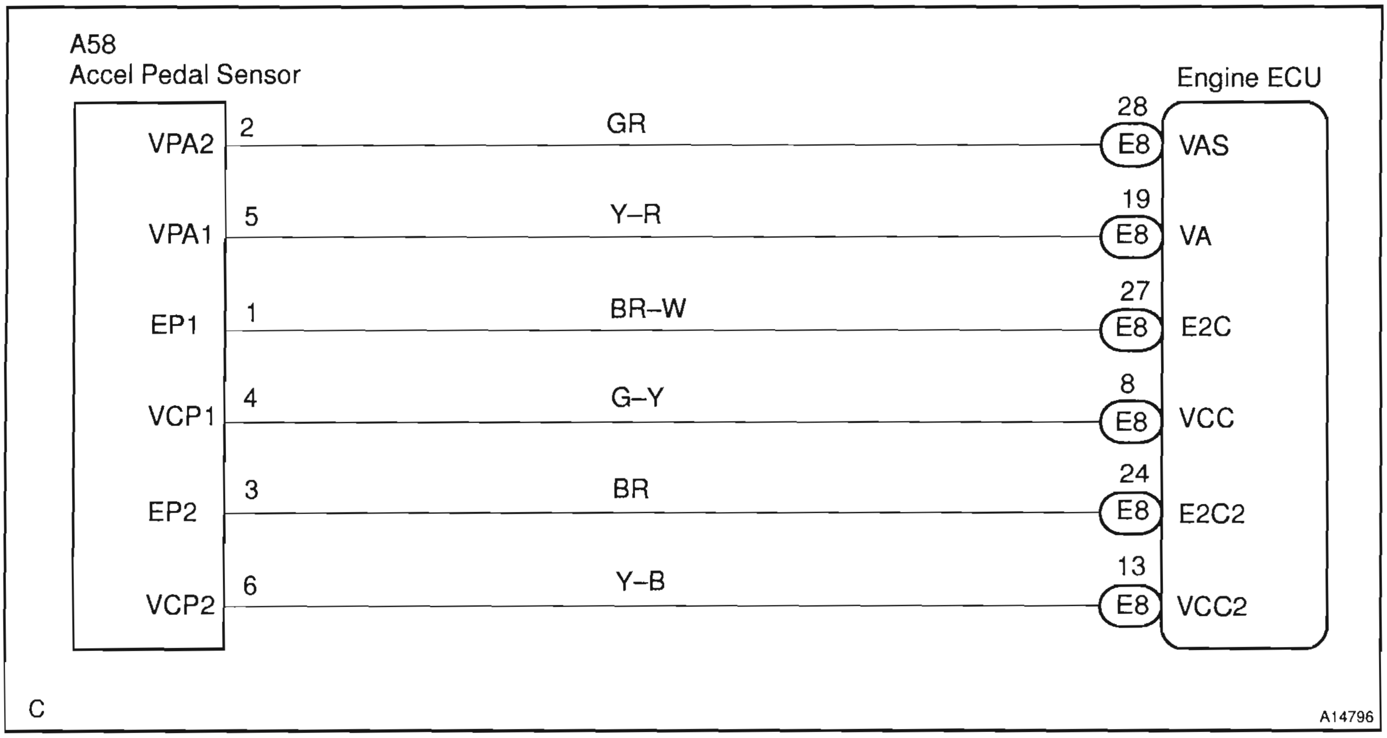
The accelerator pedal position sensor is mounted at the accelerator pedal and detects the accelerator pedal opening angle. When the accelerator pedal is fully closed, a voltage of approximately 0.8 V is applied to terminals VA, VAS of the engine ECU. The voltage applied to terminals VA, VAS of the engine 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.
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)	Condition (a) or (b) continues 0.5 sec. or more: (a) VA < 0.2 V (b) VAS < 0.5 V	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • Engine ECU
	Conditions (a) and (b) continue 2.0 sec. or more: (a) VA > 4.8 V (b) 0.2 < VA < 3.45 V, VAS > 4.8 V	

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.**

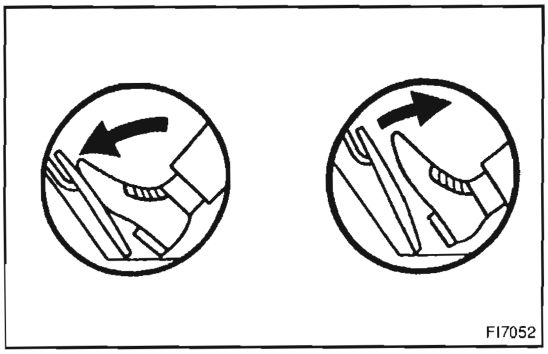
PREPARATION:

(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.



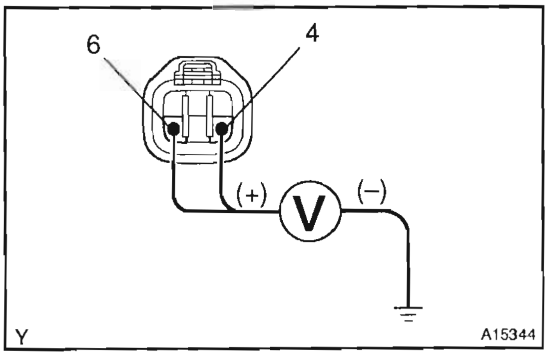
OK:

Accelerator pedal	Accelerator pedal opening position expressed as percentage
Fully open	Approx. 75 %
Fully closed	Approx. 16 %

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

NG

2	**Check voltage between terminal 4, 6 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, 6 of the wire harness side connector and body ground.

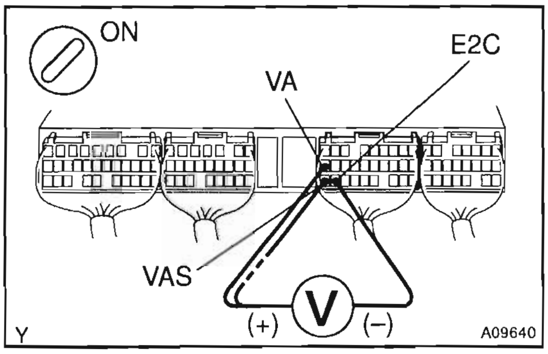
OK:

Voltage: 4.5 – 5.5 V

NG > **Go to step 5.**

OK

3	**Check voltage between terminals VA and E2C, and VAS and E2C2 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 E2C2 of the engine ECU connector.

OK:

Accelerator pedal	Voltage (V)
Fully closed	VA: 0.5 – 1.1 VAS: 0.9 – 2.3
Fully open	VA: 3.0 – 4.6 VAS: 3.4 – 5.0

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

NG

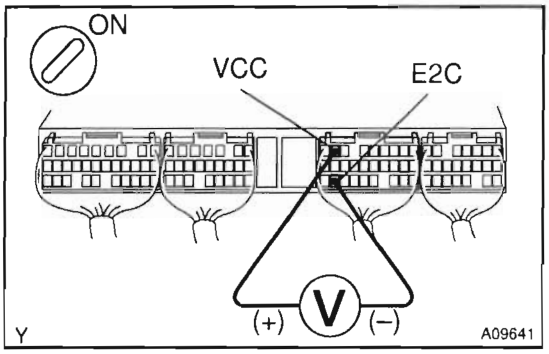
4	**Check for open and short in harness and connector in VA and VAS circuits between engine ECU and accelerator pedal position sensor (See page IN–20).**

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

OK

Replace accelerator pedal assembly.

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

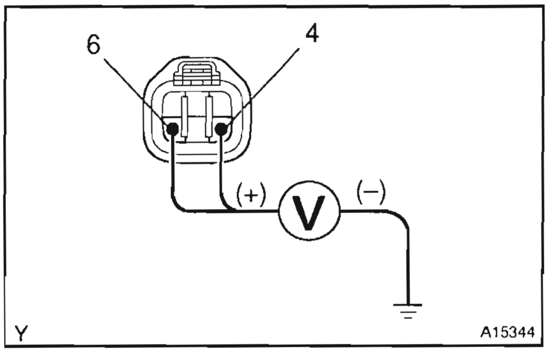
NG → **Check and replace engine ECU (See page IN–20).**

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, 6 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, 6 of the wire harness side connector and body ground.

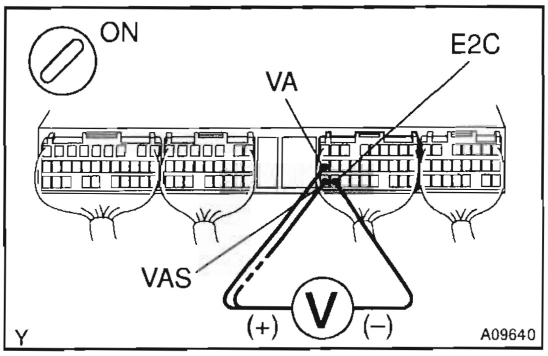
OK:

Voltage: 4.5 – 5.5 V

NG → **Go to step 4.**

OK

2	**Check voltage between terminals VA and E2C, and VAS and E2C2 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 E2C2 of the engine ECU connector.

OK:

Accelerator pedal	Voltage (V)
Fully closed	VA: 0.5 – 1.1 VAS: 0.9 – 2.3
Fully open	VA: 3.0 – 4.6 VAS: 3.4 – 5.0

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

NG

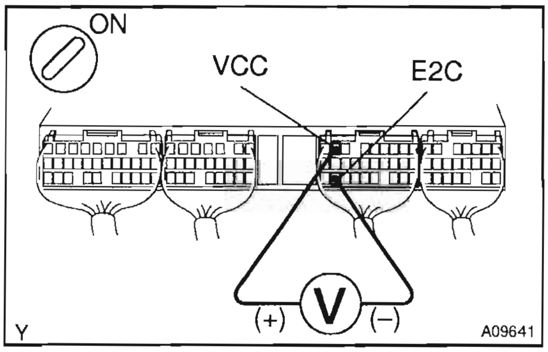
3	**Check for open and short in harness and connector in VA and VAS circuits between engine ECU and accelerator pedal position sensor (See page IN–20).**

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

OK

Replace accelerator pedal assembly.

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).

DI8J6–01

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

CIRCUIT DESCRIPTION

Refer to DTC 19 (1) on page DI–28.

DTC No.	DTC Detecting Condition	Trouble Area
19 (2)	Withe the ECU sensor completed learning and when the electric potential difference of No. 1 and No. 2 sensors has become more than 1.2 V or less than 0.4 V.	• Open or short in accelerator pedal position sensor circuit • Accelerator pedal position sensor • Engine ECU
	Either one of the followings continues more than 2.0 seconds. (c) When the electrical potential difference of No. 1 and No. 2 sensors is beside the specified value. (d) VPA2 ≧ 4.9 V (e) Accelerator idling criterion voltage of No. 1 and No. 2 in less than 0.04 V.	

WIRING DIAGRAM

Refer to DTC 19 (1) on page DI–28.

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 voltage between terminal VCC and VCC2 of wire harness side connector and body ground (See page DI–28).**

NG → **Go to step 4.**

OK

2	**Check voltage between terminals VA and E2C, and VAS and E2C2 of engine ECU connector (See page DI–28).**

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.

4	Check voltage between terminals VCC and E2C, VCC2 and E2C2 of engine ECU connector (See page DI–28, step 5).

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

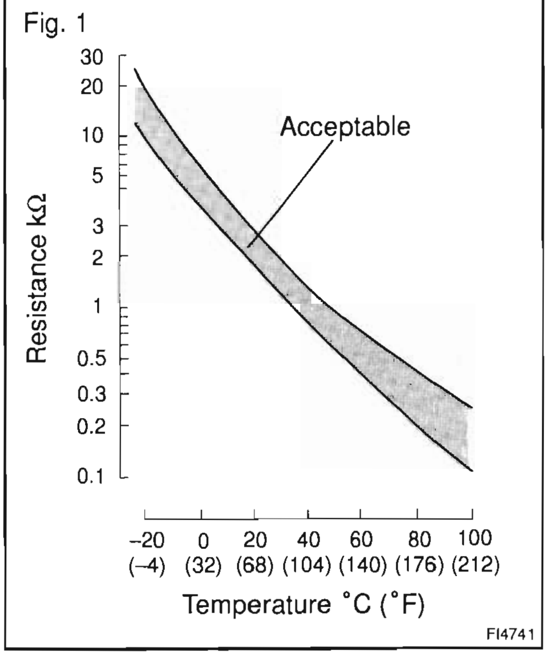
OK

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

DI3S7–04

DTC	22	Water Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION



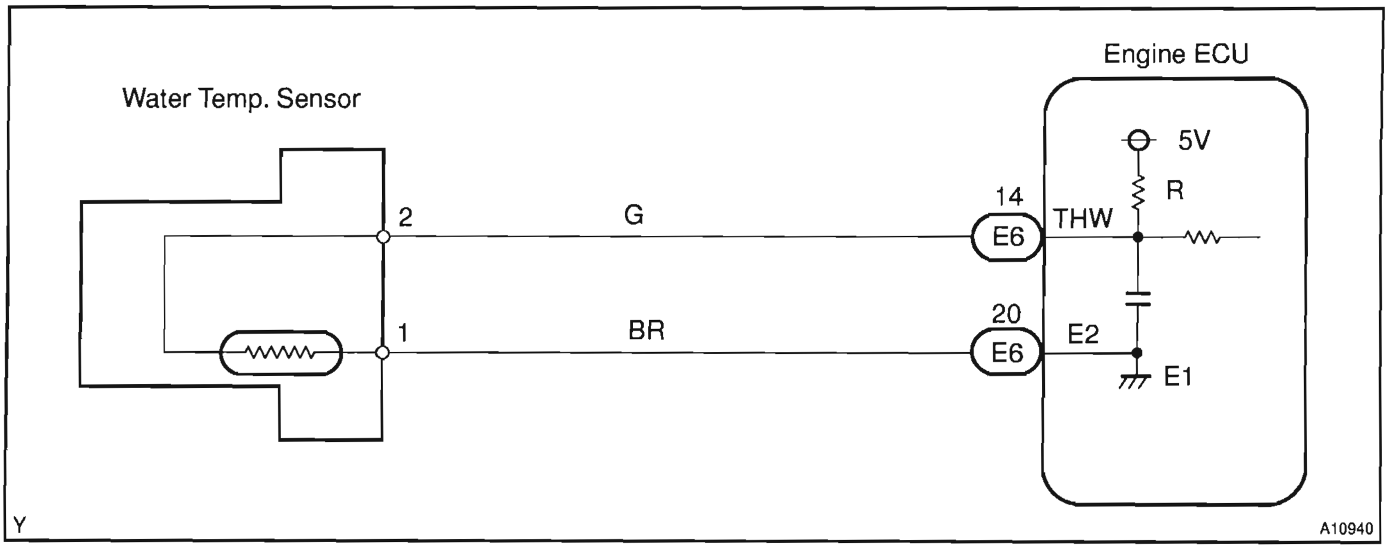
The water temperature sensor senses the coolant temperature. A thermistor built into the sensor changes the resistance value according to the coolant temperature. The lower the coolant temperature, the greater the thermistor resistance value, and the higher the coolant temperature, the lower the thermistor 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:

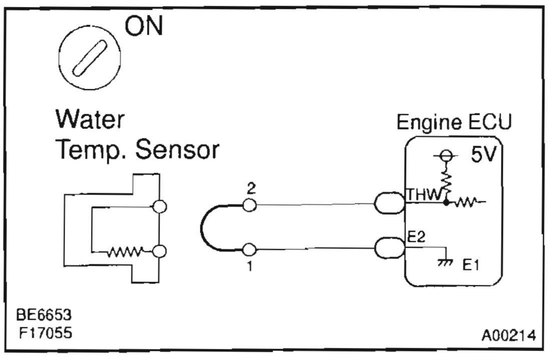
- If there is open circuit, hand–held tester indicates –40°C (–40°F).
- If there is short circuit, hand–held tester indicates 140°C (284°F) or more.

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.

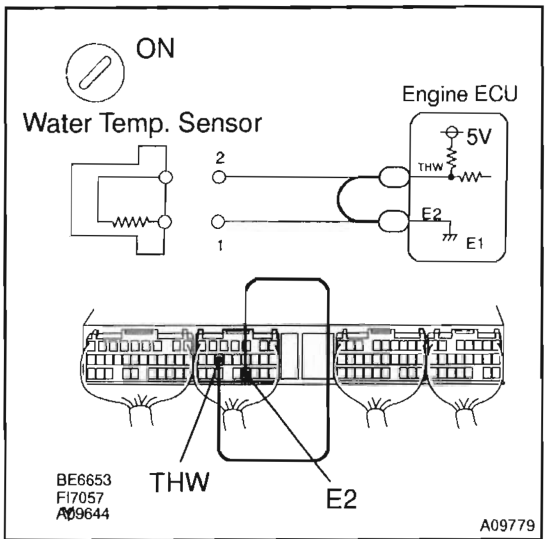
OK:

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:

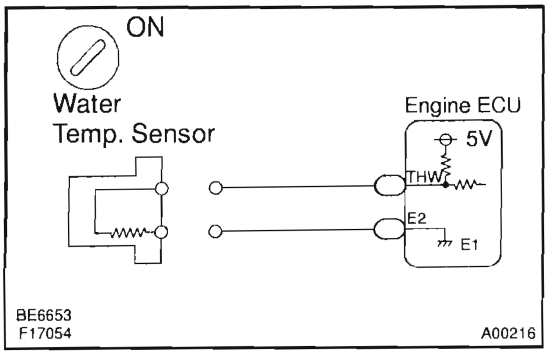
Temperature value: 140°C (284°F) or more

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.

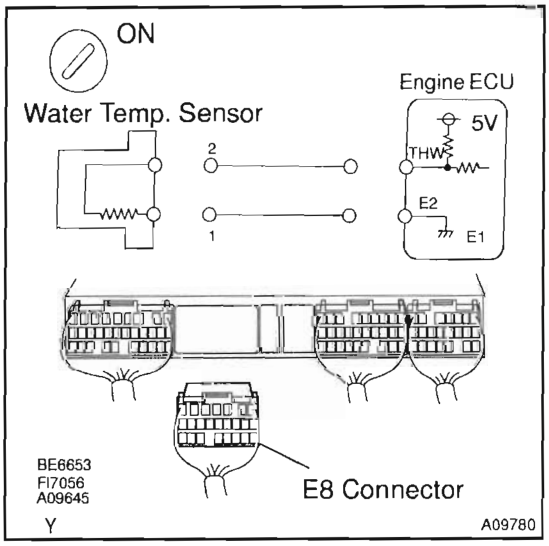


PREPARATION:
(a) Disconnect the water temperature sensor connector.
(b) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: –40°C (–40°F)

OK → **Replace water temperature sensor.**

NG ↓

5	Check for short in harness or engine ECU.



PREPARATION:
(a) Remove the glove compartment.
(b) Disconnect the E8 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)

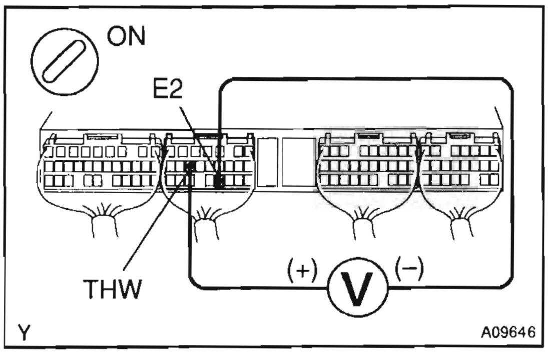
OK → **Repair or replace harness or connector.**

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–11).

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

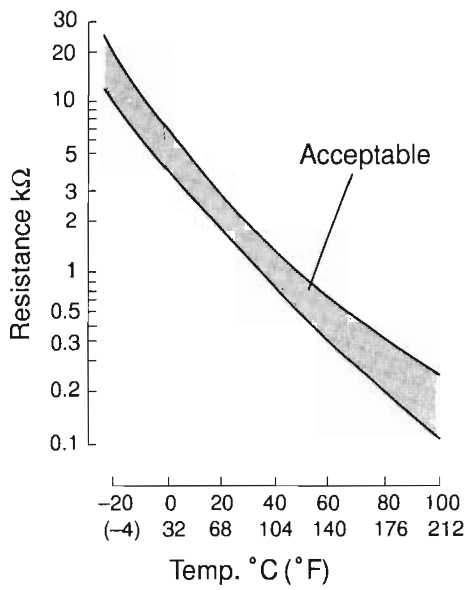
Check and replace engine ECU (See page IN–20).

DI69H–03

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

CIRCUIT DESCRIPTION

Fig. 1



FI4741

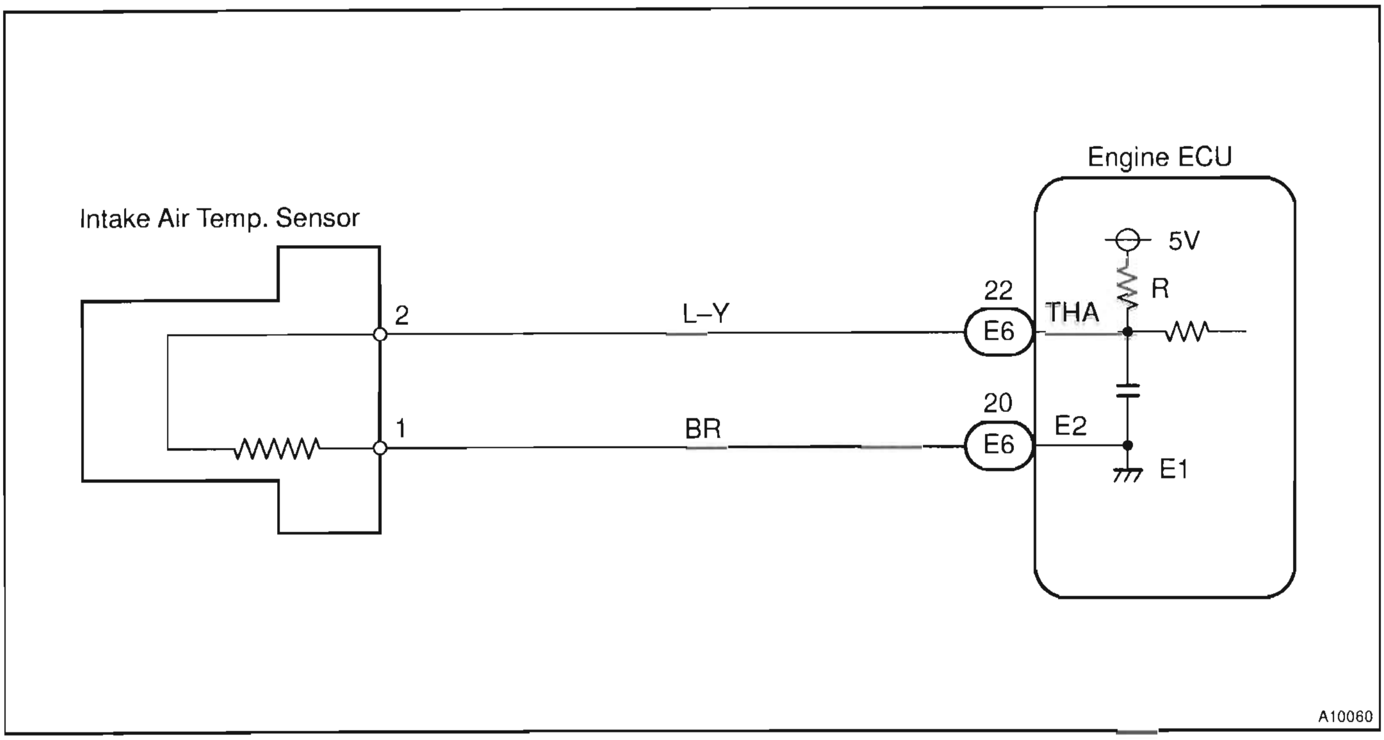
The intake air temperature sensor is built into the intake manifold and senses the intake air temperature. A thermistor built in the sensor changes the resistance value according to the intake air temperature. The lower the intake air temperature, the greater the thermistor resistance value, and the higher the intake air temperature, 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:

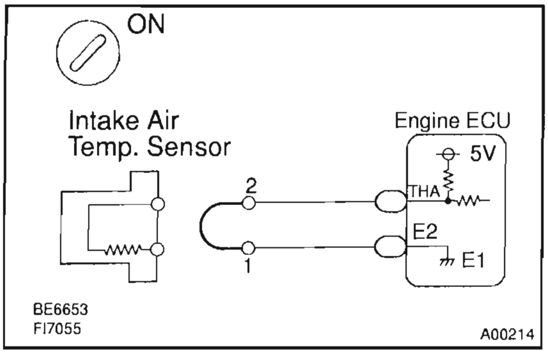
- If there is open circuit, hand–held tester indicates –40°C (–40°F).
- If there is short circuit, hand–held tester indicates 140°C (284°F) or more.

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.

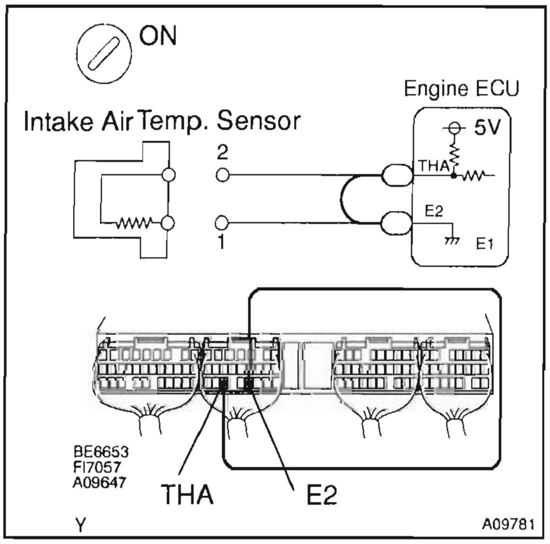
OK:

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:

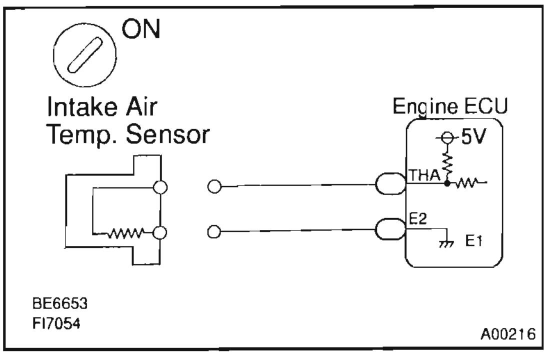
Temperature value: 140°C (284°F) or more

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.

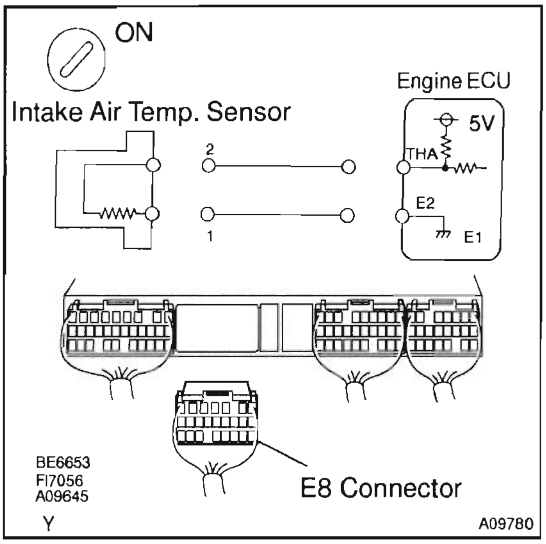
OK:

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 E8 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)

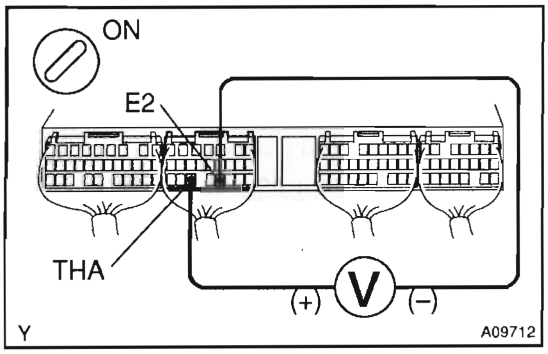
OK → **Repair or replace harness or connector.**

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–13).**

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.**

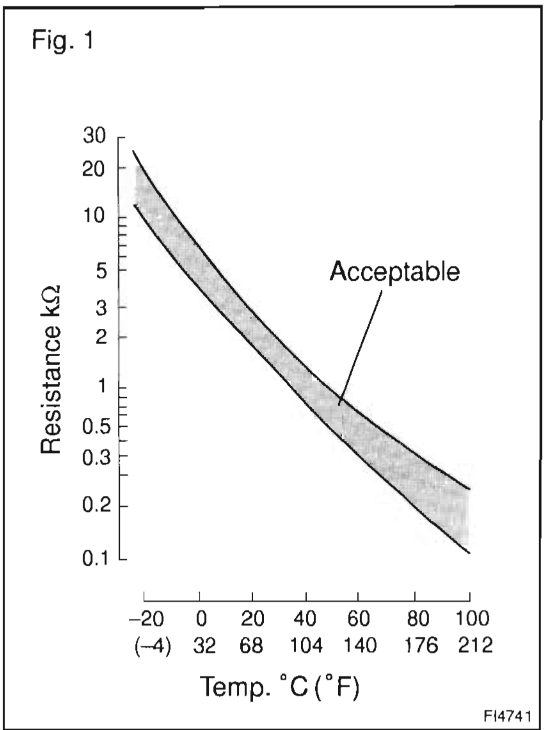
OK

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

DI691–03

DTC	24 (2)	Atmospheric Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION



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 resistance value, and the higher the atmospheric temperature, 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–51

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.

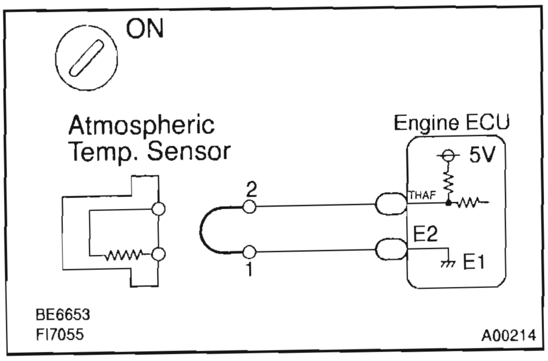
PREPARATION:
(a) Connect the hand–held tester to the DLC3.
(b) Turn the ignition switch ON and push the hand–held tester main switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Same as actual atmospheric temperature.
HINT:
- If there is open circuit, hand–held tester indicates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

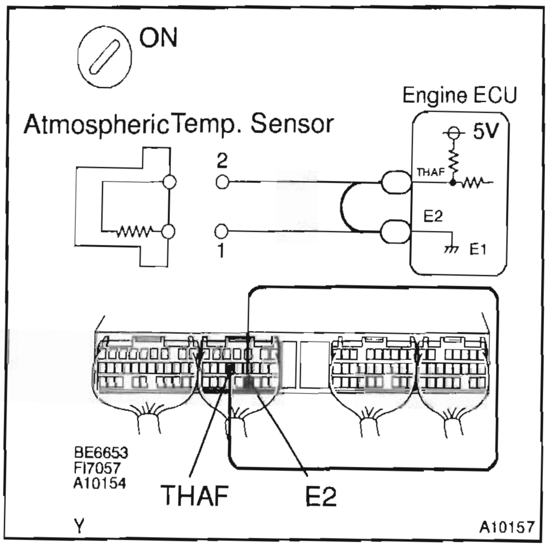


PREPARATION:
(a) Disconnect the air flow miter connector.
(b) Connect the sensor wire harness terminals together.
(c) Turn the ignition switch ON.
CHECK:
Read the temperature value on the hand–held tester.
OK:
Temperature value: 140°C (284°F) or more

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.

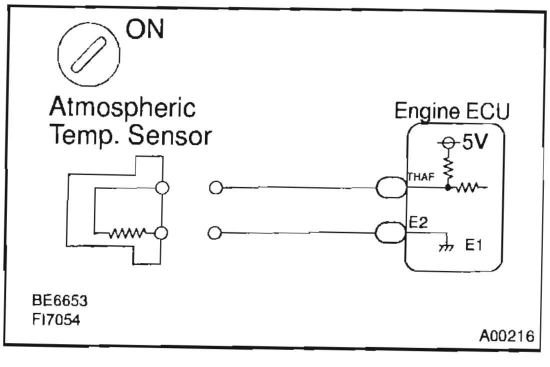
OK:
Temperature value: 140°C (284°F) or more

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.

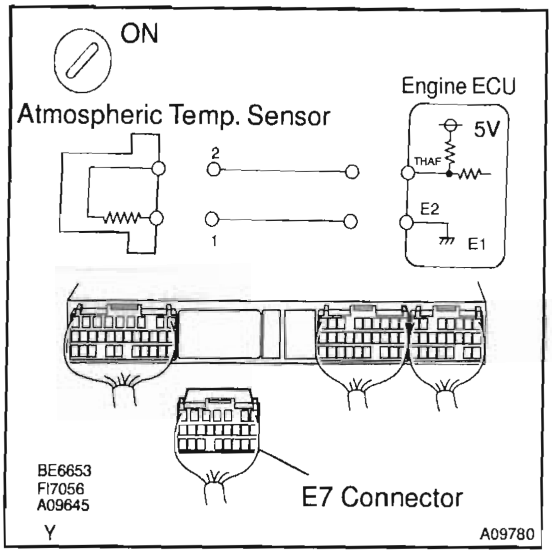
CHECK:
Read the temperature value on the hand–held tester.

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)

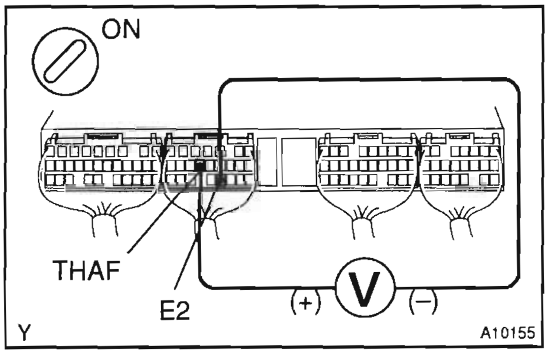
OK → **Repair or replace harness or connector.**

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–13).

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

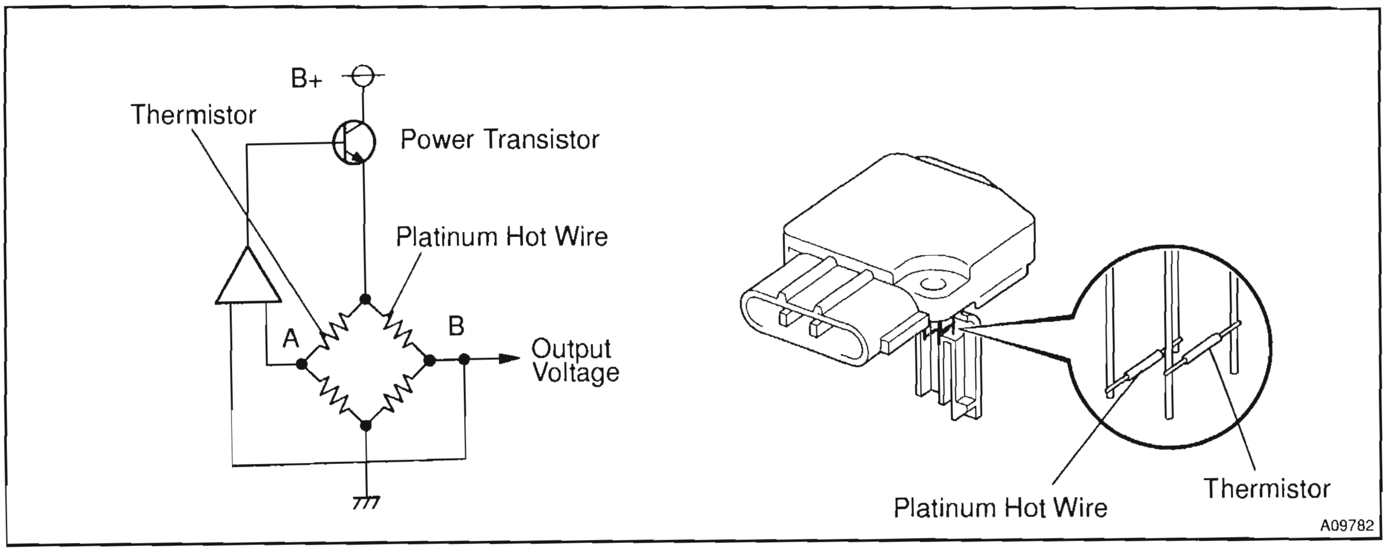
Check and replace engine ECU
(See page IN–20).

DI3OW–11

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.

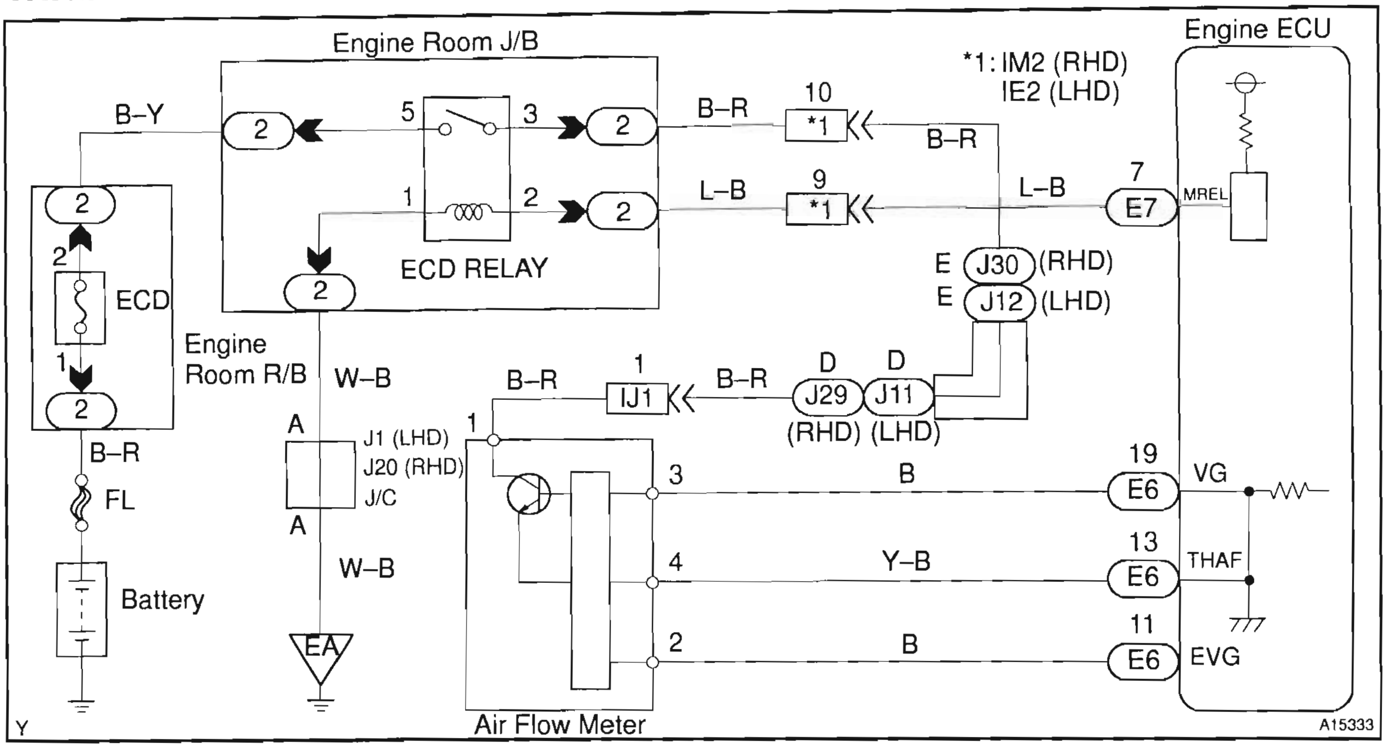


DTC No.	DTC Detecting Condition	Trouble Area
31	Open or short in air flow meter circuit with more than 3 sec.	• Open or short in air flow meter circuit • Air flow meter • Engine ECU

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:

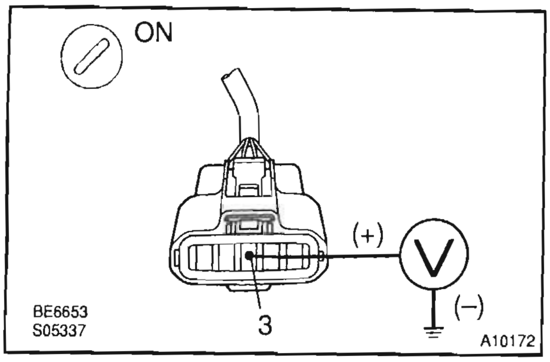
Read the air flow rate on the hand–held tester.

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.

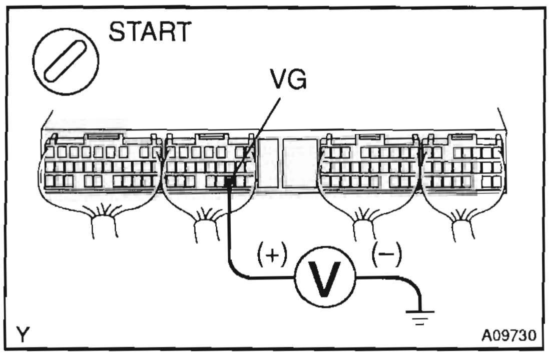
OK:

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

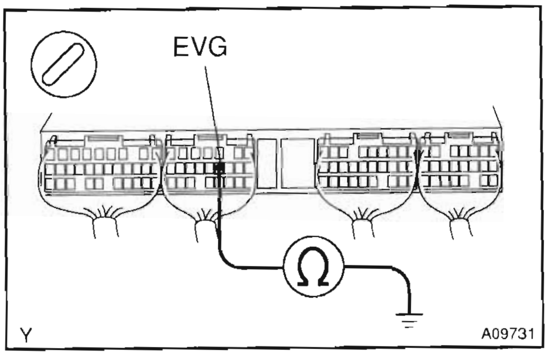
4	Check for open and short in harness and connector between air flow meter and engine ECU (See page IN–20).

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).**

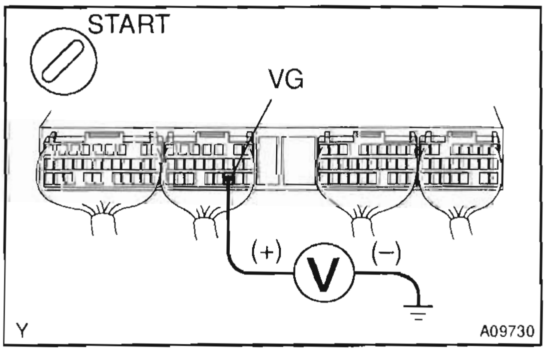
NG → **Repair or replace harness or connector.**

OK

Replace air flow meter.

When not using hand–held tester:

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

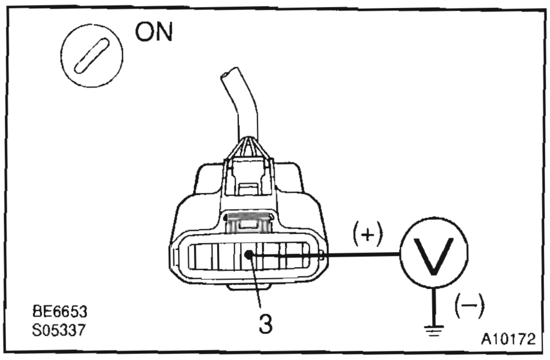


PREPARATION:
(a) Remove the glove compartment.
(b) Start the engine.
CHECK:
Measure the voltage between terminal VG of the engine ECU connector and body ground while the engine is idling.
OK:
Voltage:
0.5 – 3.0 V (P or N position and A/C switch OFF)

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.

DI8J7–01

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–88

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–23).**

NG ↓

2	**Check resistance between terminals correction resistance of injector (See page FU–4).**

NG → **Replace the Injector.**

OK ↓

Repair harness or connector.

DI8J8-01

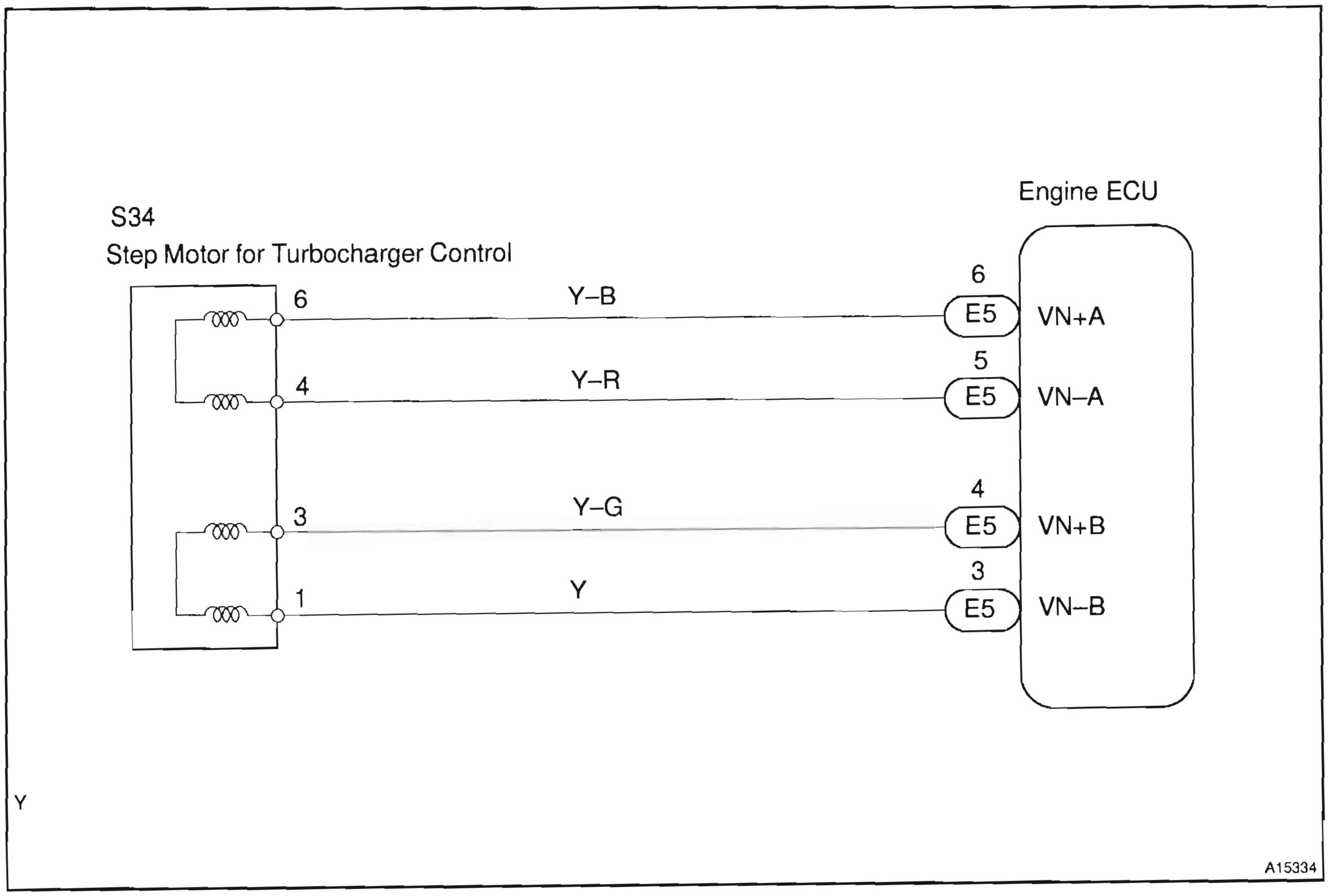
DTC	34 (1)	Step motor for turbocharger control circuit malfunction (Open/short)

CIRCUIT DESCRIPTION

DTC No.	DTC Detecting Condition	Trouble Area
34 (1)	When temporary error* is detected and , whil the step motor control is kept, 31 errors are detected within0.5 sec.	• Step motor • Wire harness • Engine ECU

*: When an error is detected from comparison berween the current condition of the step motor and the monitor signal.

WIRING DIAGRAM



INSPECTION PROCEDURE

1	Inspect step motor for turbocharger control (See page TC–3).

NG → Replace turbocharger assembly.

OK ↓

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

NG → Repair or replace harness or connector.

OK ↓

Check and replace engine ECU
(See page ED–23).

DI8J9–01

DTC	34 (2)	Turbocharger system malfunction

DTC	34 (3)	Turbocharger stick detected (Close)

CIRCUIT DESCRIPTION

DTC No.	DTC Detecting Condition	Trouble Area
34 (2)	When the condition that the turbocharger pressure exceeds the standard value for 0.5 sec. or more is detected.	• Turbocharger • EGR valve • Air flow meter • Engine ECU
34 (3)	When the condition that for 60 sec. or more the turbocharger pressure is 20 kPa (0.2 kgf/cm^2, 1.4 psi) or more above the value that is set based on the engine revolution and the amount of fuel injection is detected.	

INSPECTION PROCEDURE

HINT:

If DTC 35 is output simultaneously, first troubleshoot DTC 35.

1	Check turbocharger assembly (See page TC–1).

NG → Replace turbocharger.

OK

2	Check EGR valve (See page EC–6)

NG → Replace EGR valve.

OK

3	Check air flow meter (See page ED–3)

NG → Replace air flow meter.

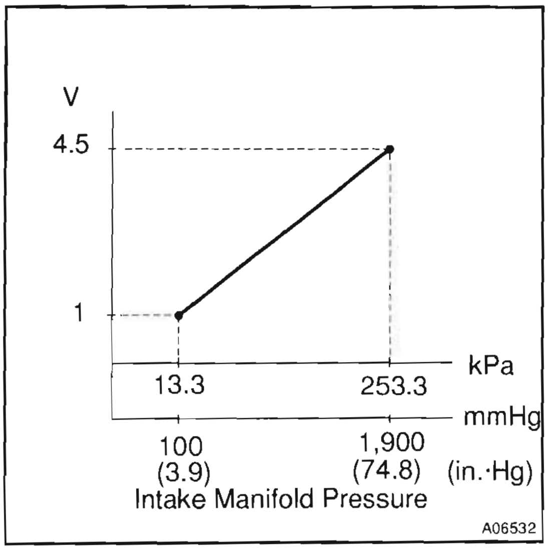
OK

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

DI312-06

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.

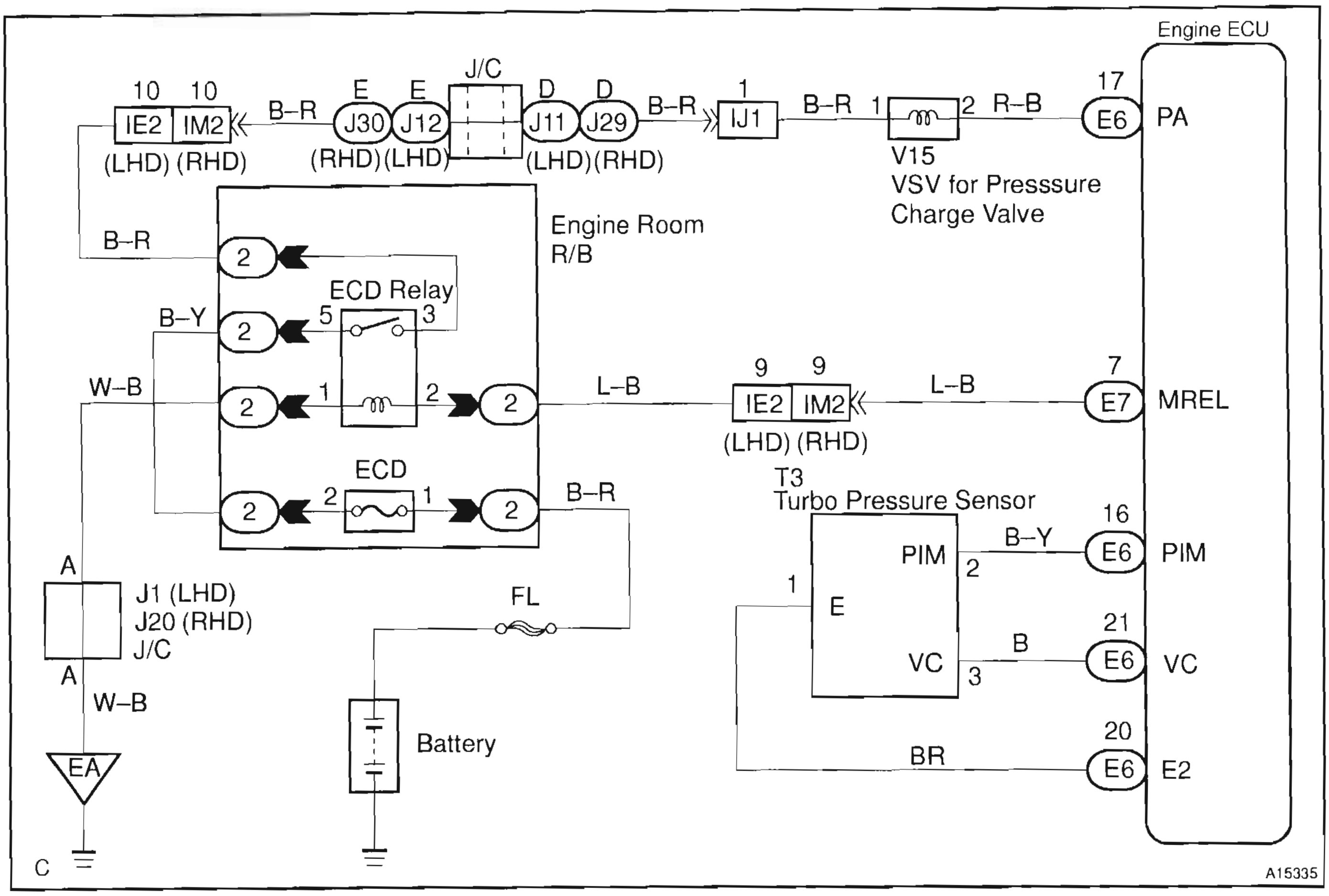
The VSV for turbo pressure sensor switches the atmosphere applied to the turbo pressure sensor to the intake manifold pressure. The turbo pressure sensor monitors both the atmospheric pressure and intake manifold pressure and transmits the output voltage to the engine ECU, and the engine ECU uses this 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 • Turbocharger • EGR valve • Air flow meter • 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
250 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.

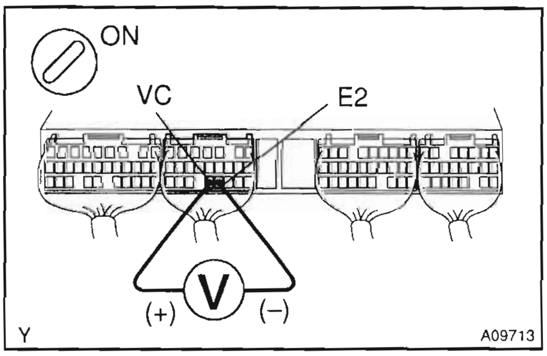
NG

2	Check turbo pressure sensor (See page ED–15).

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.

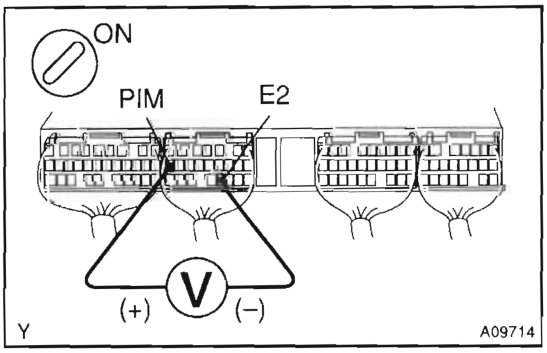
OK:

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.**

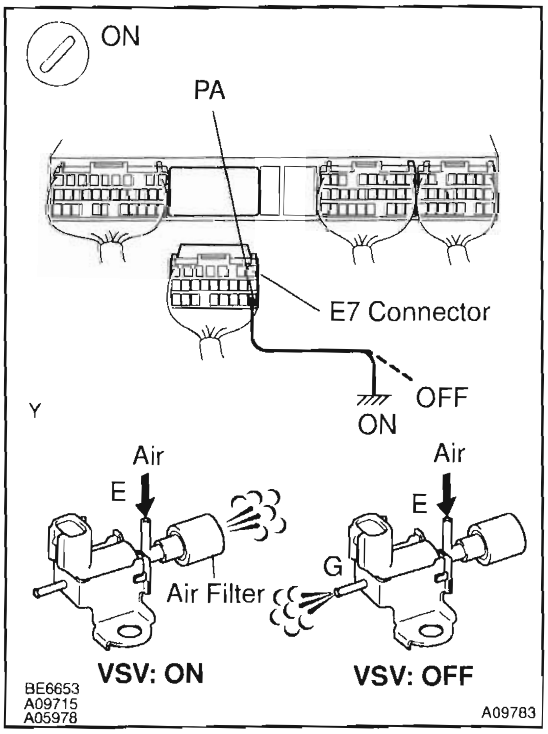
OK

6	**Check resistance of VSV for turbo pressure sensor (See page ED–15).**

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 → Go to step 9.

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.

9	Check turbocharger assembly (See page TC–1).

NG → Replace turbocharger.

OK ↓

10	Check EGR valve (See page EC–6)

NG → Replace EGR valve.

OK ↓

11	Check air flow meter (See page ED–3)

NG → Replace air flow meter.

OK ↓

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

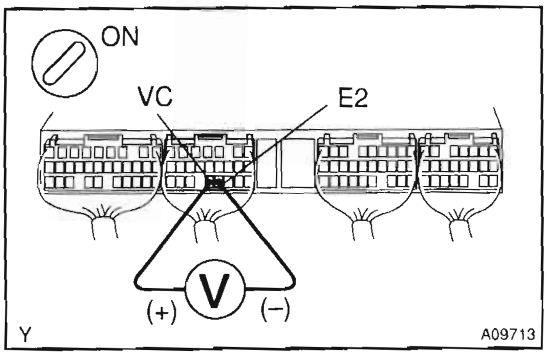
When not using hand–held tester:

1	**Check turbo pressure sensor (See page ED–15).**

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.

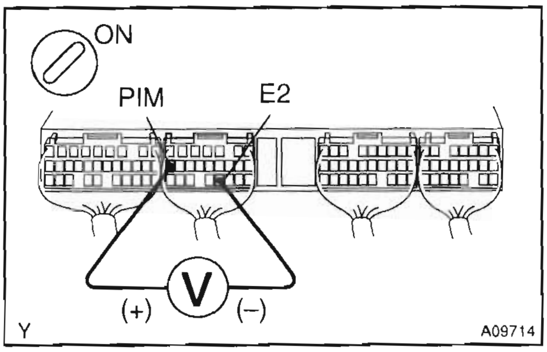
OK:

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.

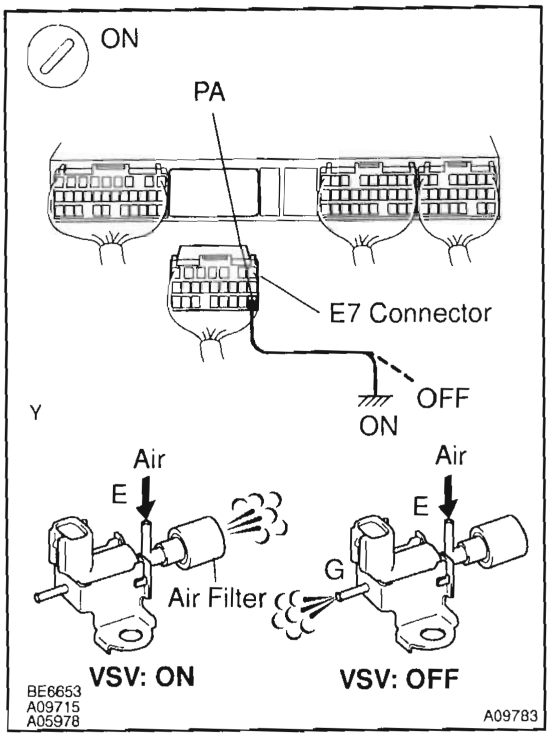
OK

6	Check resistance of VSV for turbo pressure sensor (See page ED–15).

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	**Go to step 11.**

NG

8	**Check turbocharger assembly (See page TC–1).**

NG	**Replace turbocharger.**

OK

9	**Check EGR valve (See page EC–6)**

NG	**Replace EGR valve.**

OK

10	**Check air flow meter (See page ED–3)**

NG	**Replace air flow meter.**

OK

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

11	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.

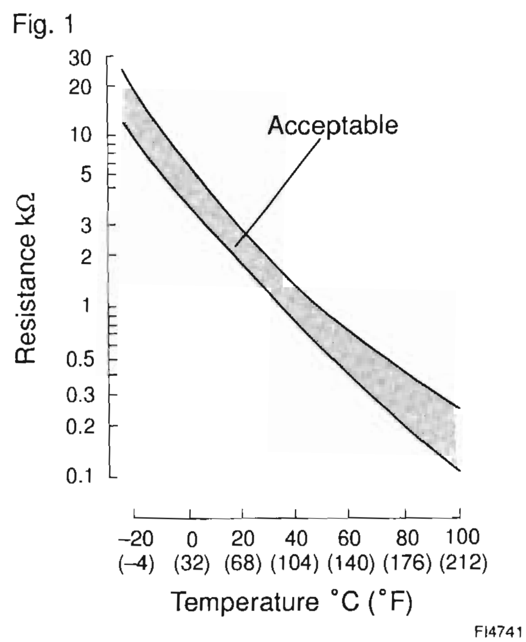
OK

Replace VSV for turbo pressure sensor.

013S9–04

DTC	39	Fuel Temp. Sensor Circuit Malfunction

CIRCUIT DESCRIPTION



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).

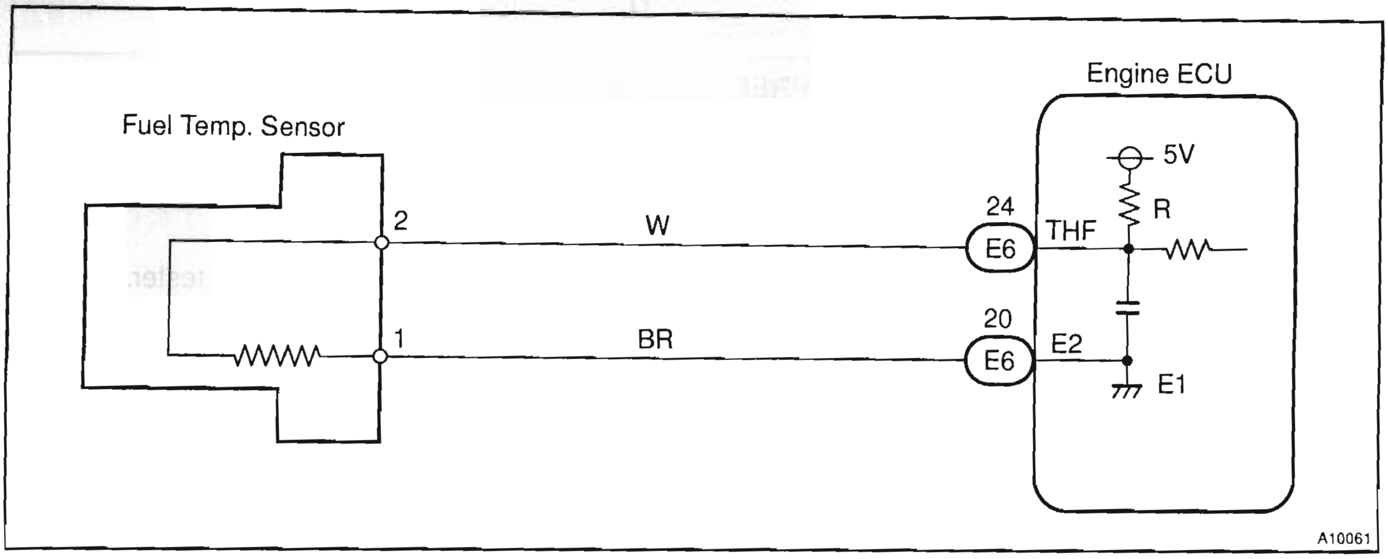
The fuel temperature sensor is connected to the engine ECU (See below). The 5 V power source voltage in the engine ECU is applied to the fuel temperature sensor from terminal THF via a resistor R. That is, resistor R and the fuel temperature sensor are connected in series. When the resistance value of 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:

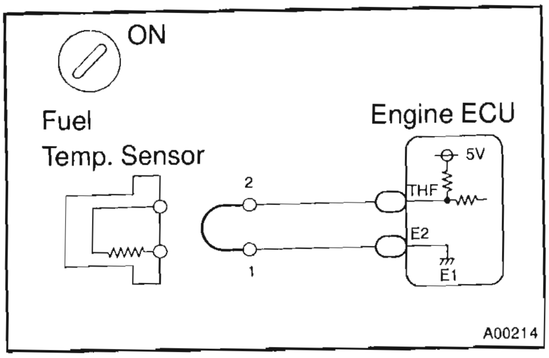
- If there is open circuit, hand–held tester indicates –40°C (–40°F).
- If there is short circuit, hand–held tester indicates 140°C (284°F) or more.

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.

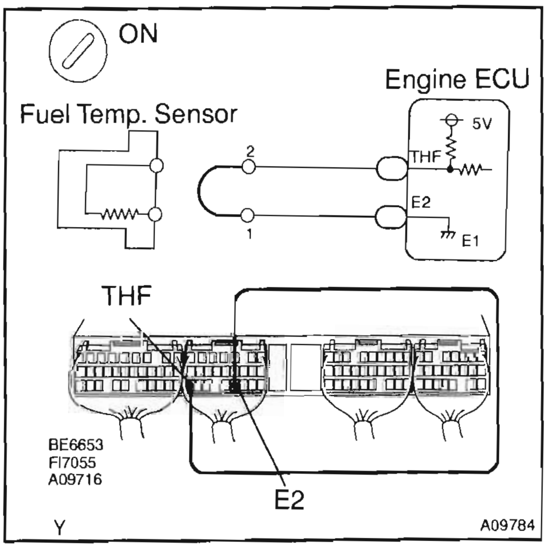
OK:

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:

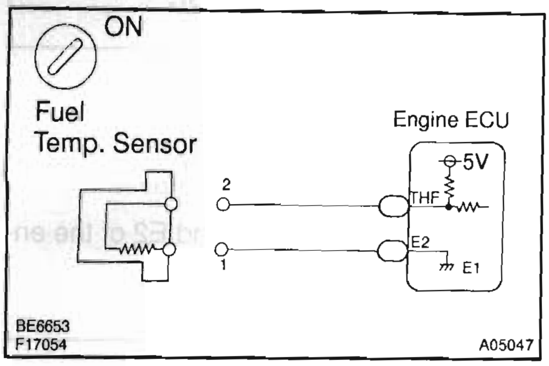
Temperature value: 140°C (284°F) or more

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.

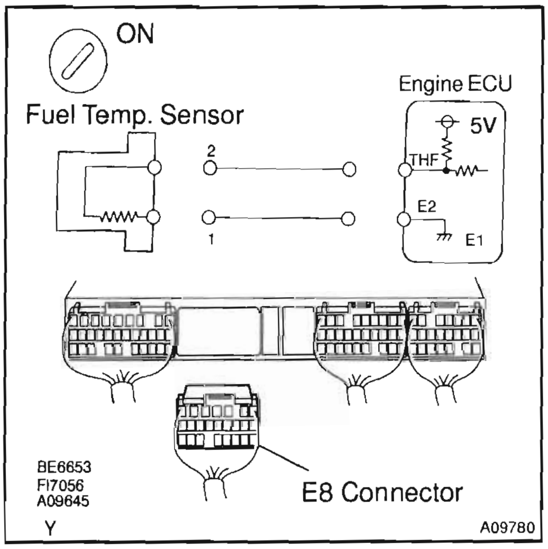
OK:

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 E8 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)

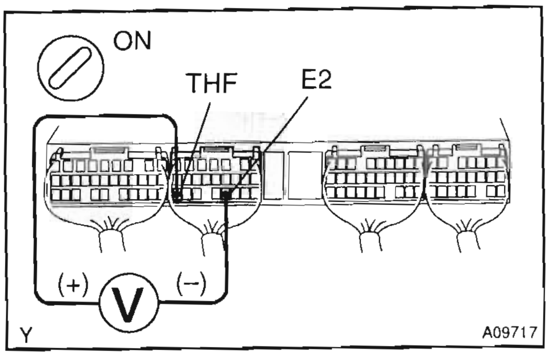
OK → **Repair or replace harness or connector.**

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–12).**

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

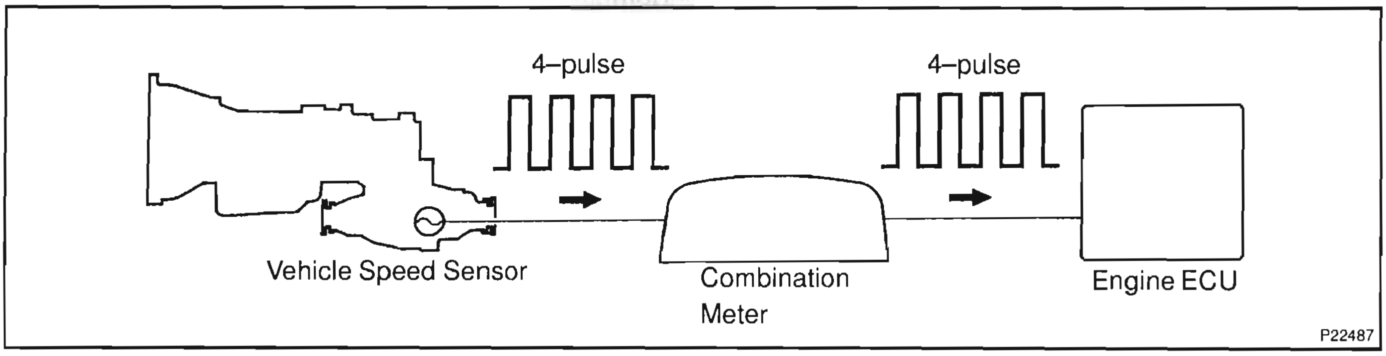
Check and replace engine ECU (See page IN–20).

DI321–06

DTC	42	Vehicle Speed Sensor Signal Circuit Malfunction

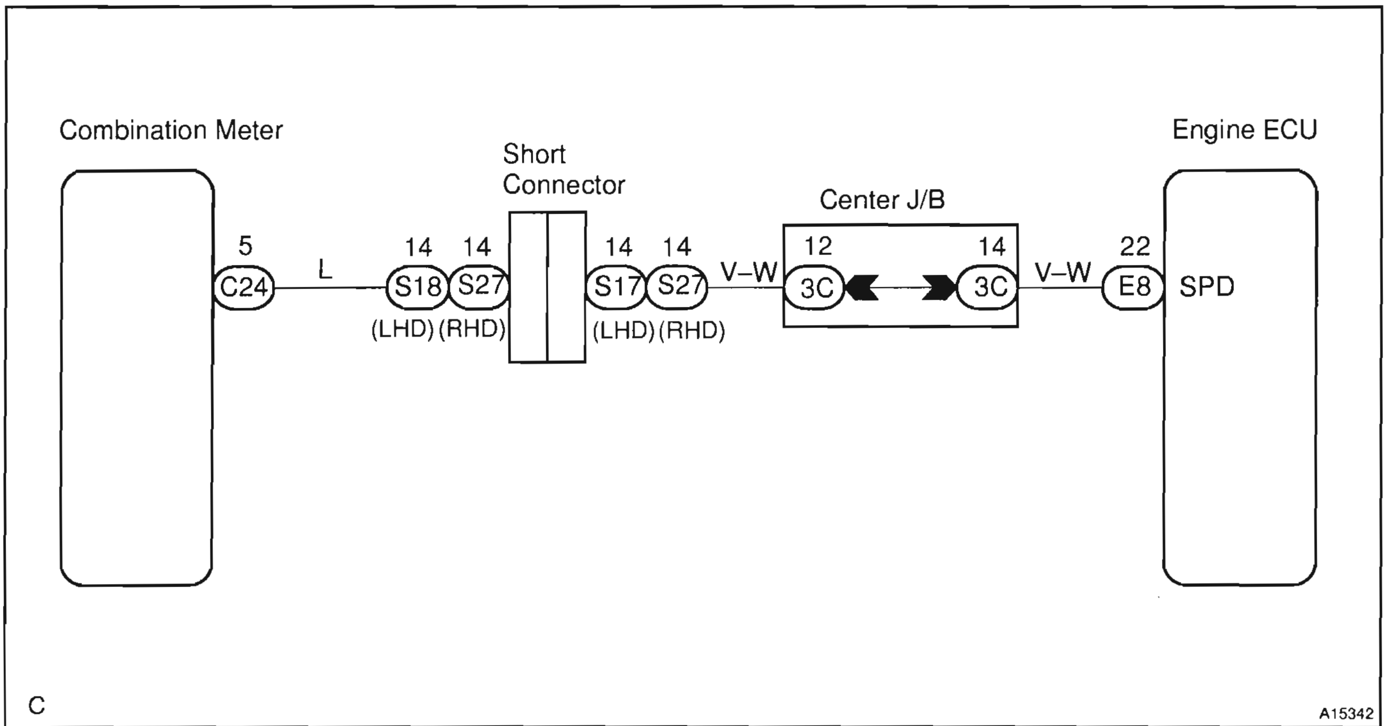
CIRCUIT DESCRIPTION

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.

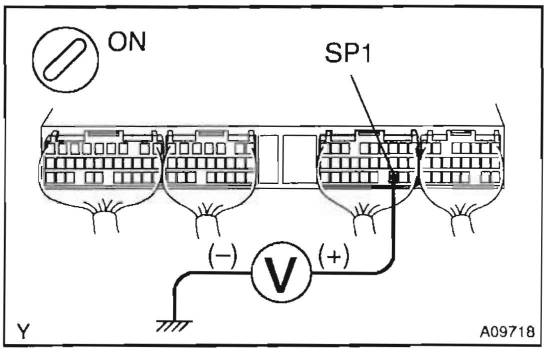
HINT:

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.

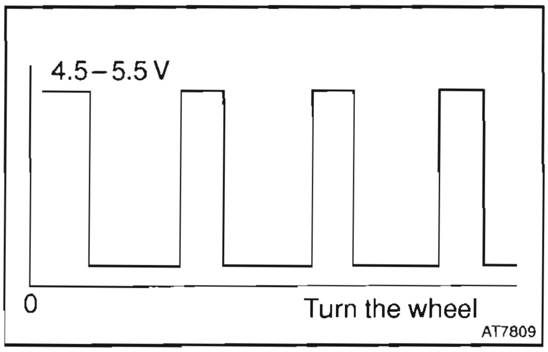
(b) Shift the shift lever to the neutral.

(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–05

DTC	49	Fuel Pressure Circuit Malfunction

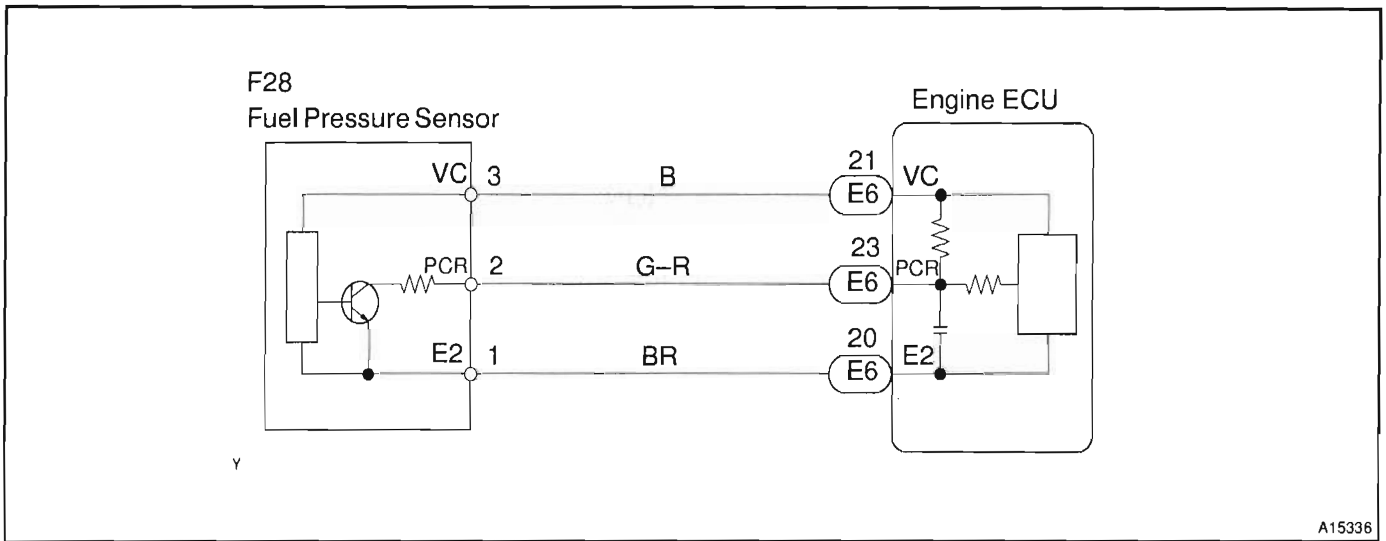
CIRCUIT DESCRIPTION

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

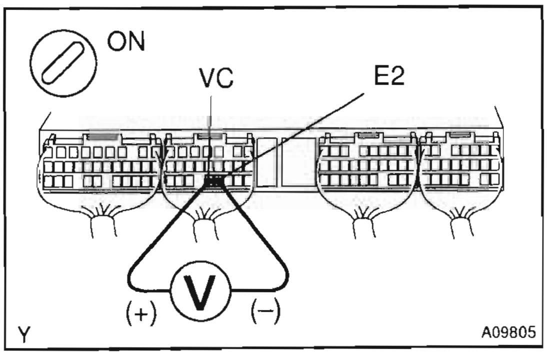


INSPECTION PROCEDURE

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.

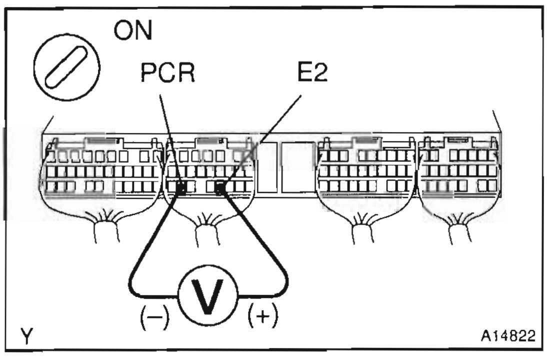
OK:

Voltage: 4.75 – 5.25 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: 1.7 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–20).

DI69J–03

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

CIRCUIT DESCRIPTION

Refer to DTC 49 on page DI–77.
Refer to DTC 97 on page DI–88.

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–77.
Refer to DTC 97 on page DI–88.

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–13).**

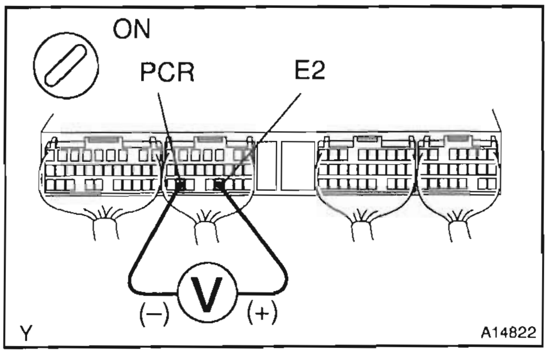
NO

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–21).

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–21).

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–13).

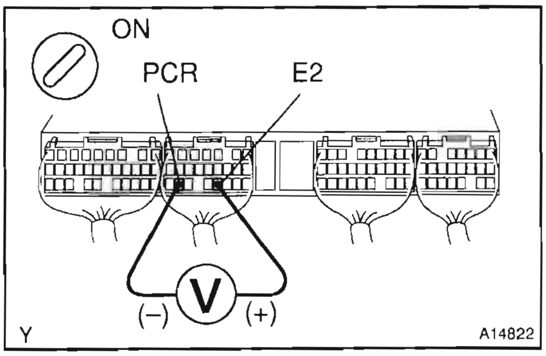
NO

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–21).

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–03

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

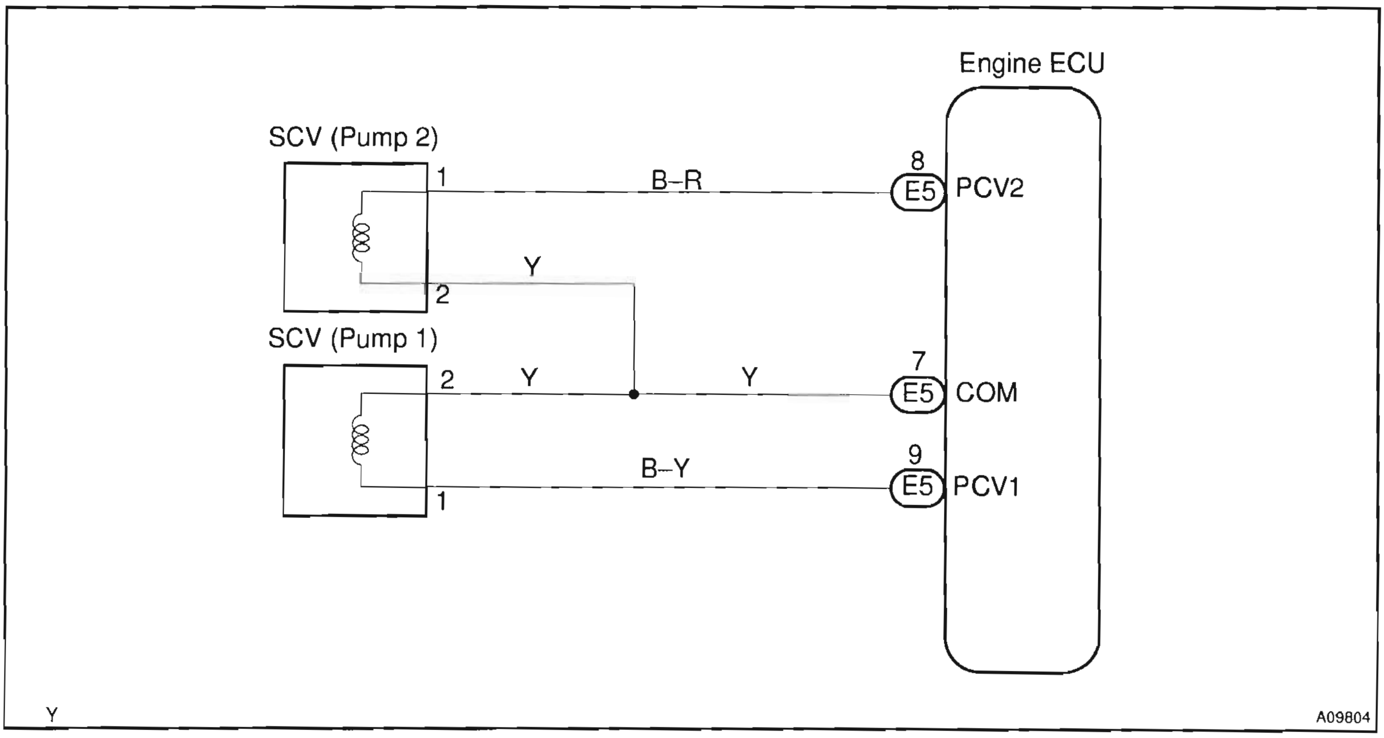
DTC	78 (3)	Fuel Pump Circuit Malfunction (Over Force Feed)

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–13).

NO

2	Check SCV (See page FU–13).

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

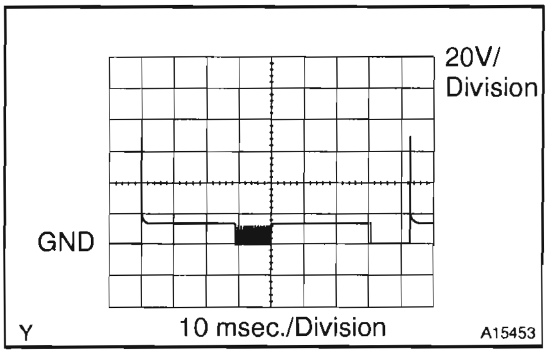
OK

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–24).

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).

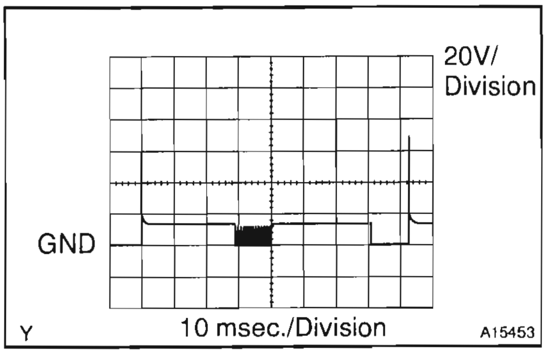
OK

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–24).

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–21).

DI69L–03

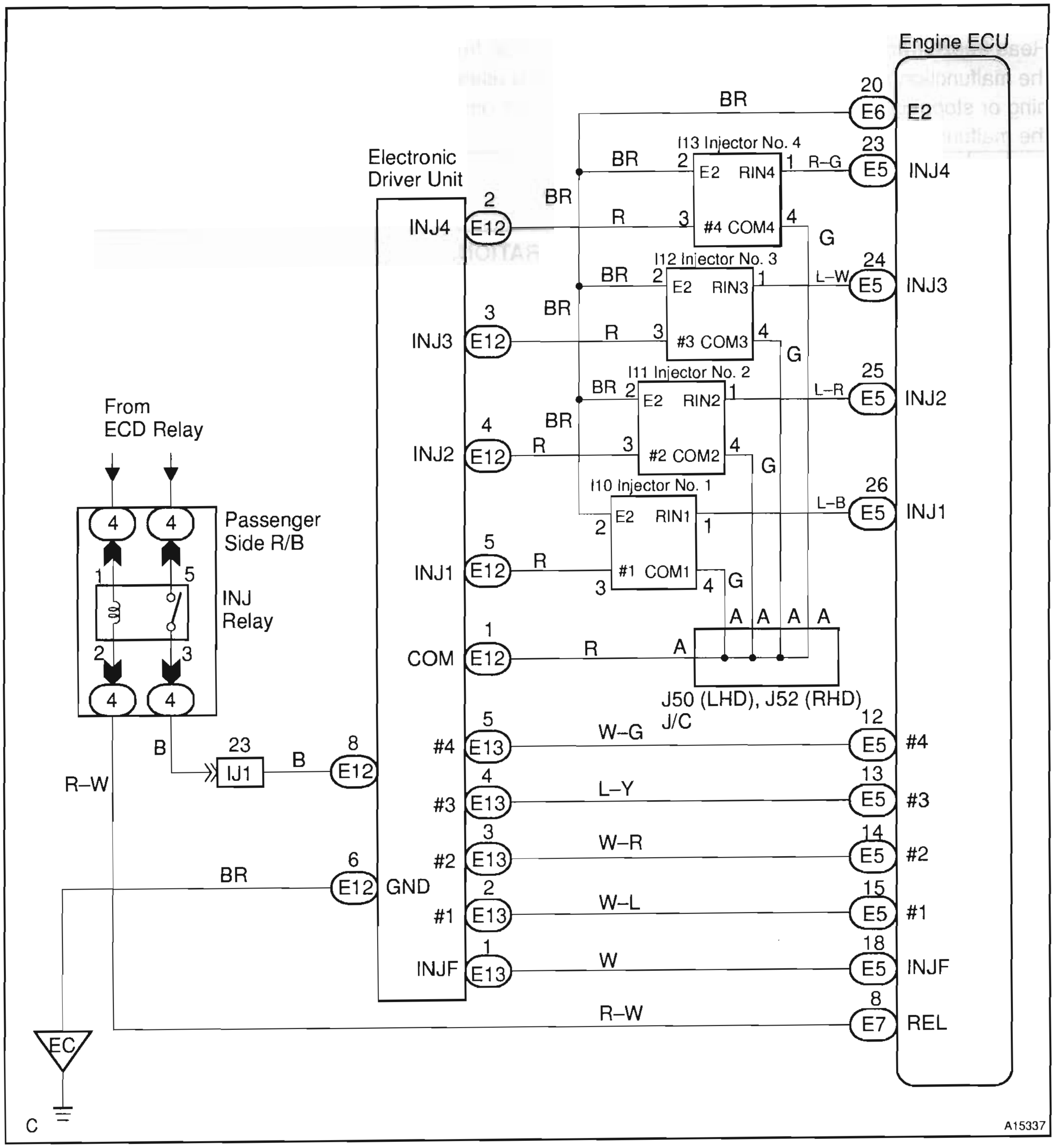
DTC	97	EDU Circuit Malfunction

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

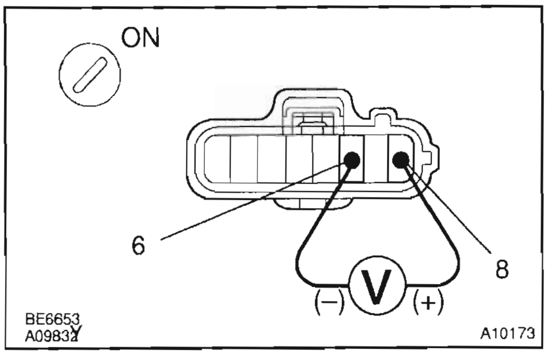


INSPECTION PROCEDURE

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.

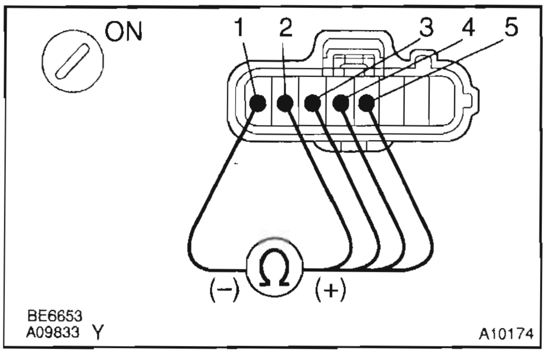
OK:

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).

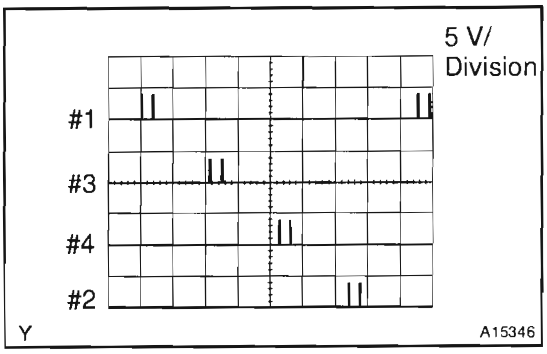
OK

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.

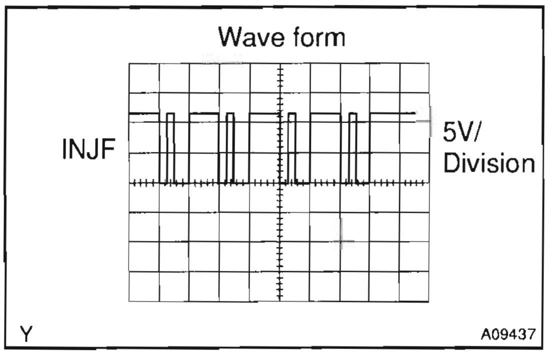
OK:

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.

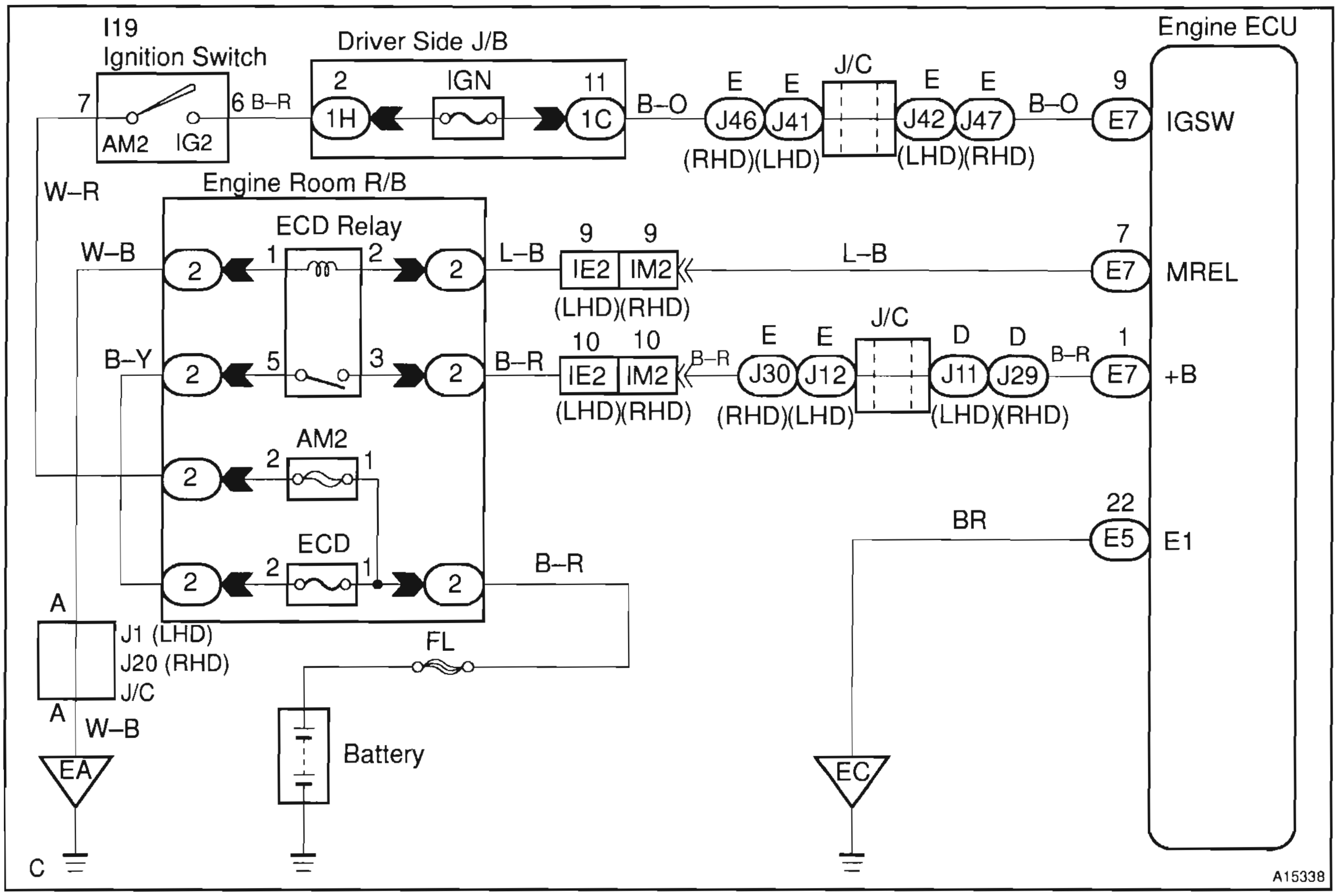
DI322-05

ECU Power Source Circuit

CIRCUIT DESCRIPTION

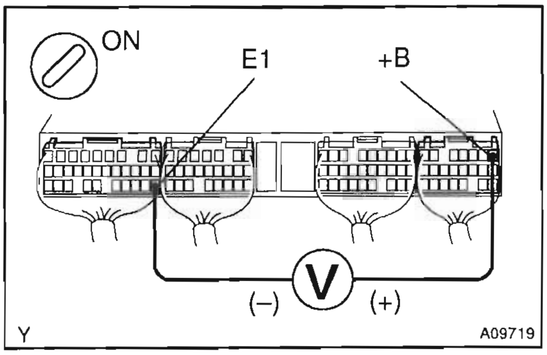
When the ignition switch is turned ON, battery positive voltage is applied to the coil, closing the contacts of the EFI relay (Marking: EFI) and supplying power to the terminal +B of the engine ECU.

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–8).

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.**

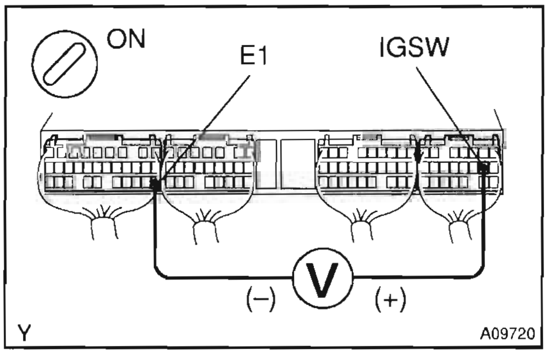
OK

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. RM517E BE section).

NG → Replace ignition switch.

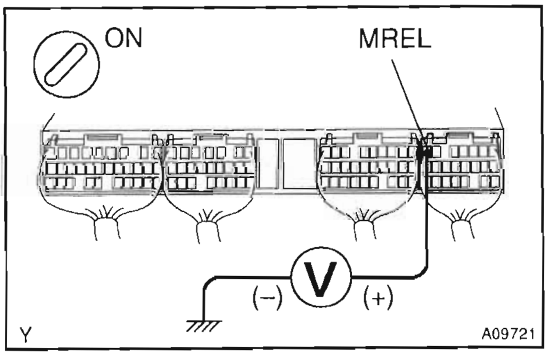
OK

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–05

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,

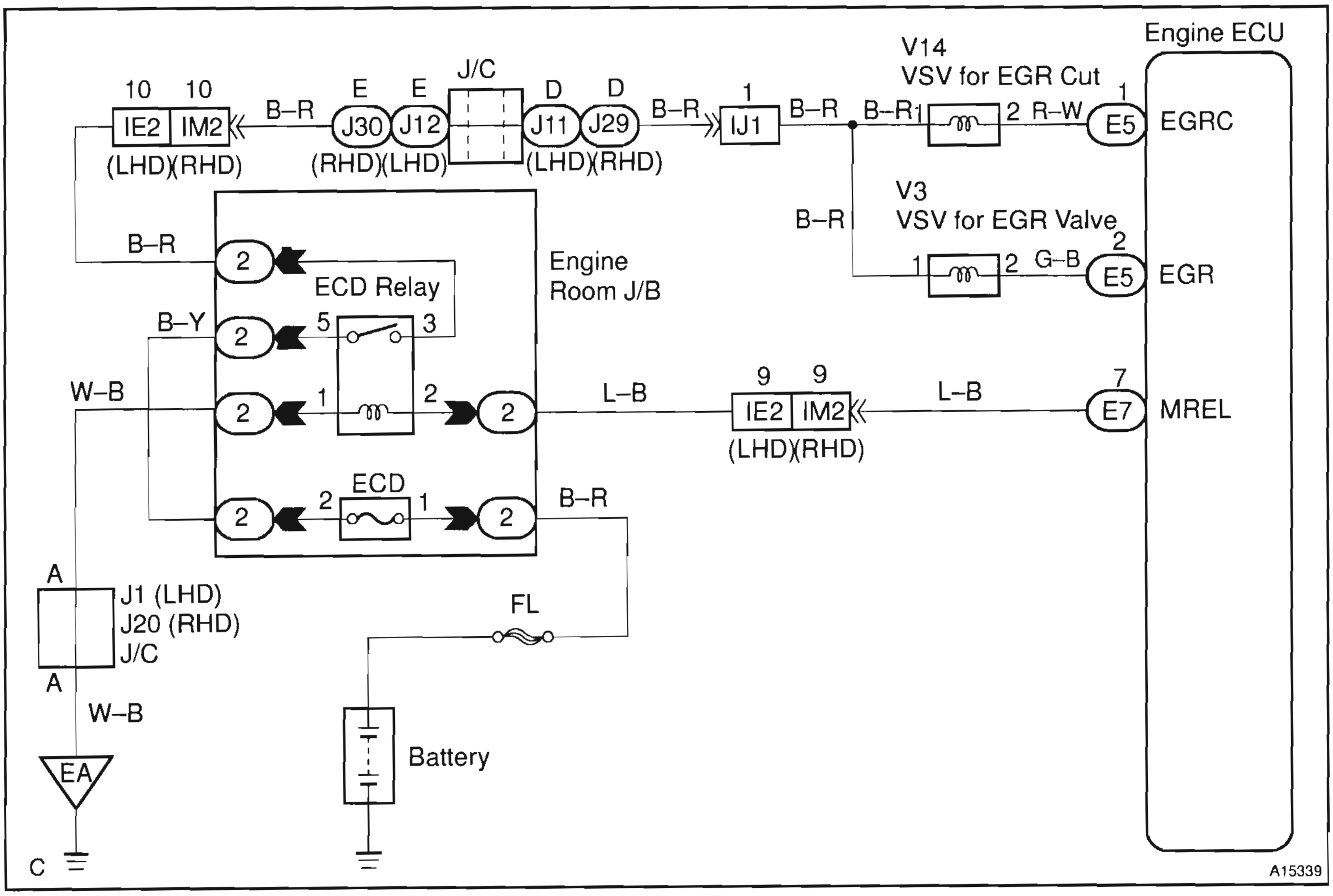
The lift amount of EGR valve is controlled by the vacuum which is regulated by the E–VRV operated by the engine ECU.

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

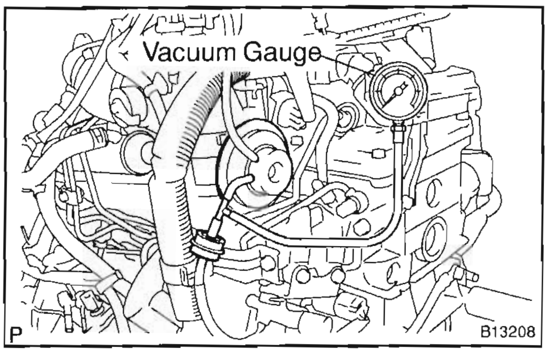
When using hand–held tester:

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:

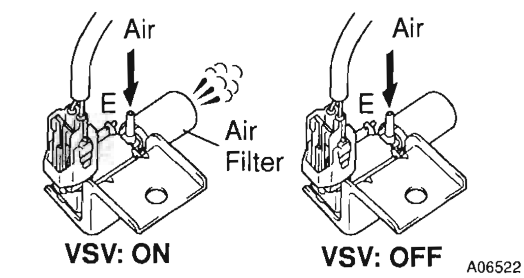
Type	Vacuum
I	0 kPa (0 mmHg, 0 in. Hg)
II	0 kPa (0 mmHg, in. Hg) – 28 kPa (210 mmHg, 8.3 in. Hg)
III	Above 28 kPa (210 mmHg, 8.3 in. Hg)

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–6).**

NG → **Replace VSV for EGR.**

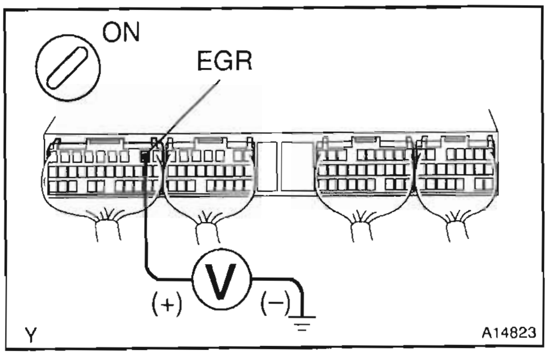
OK

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.

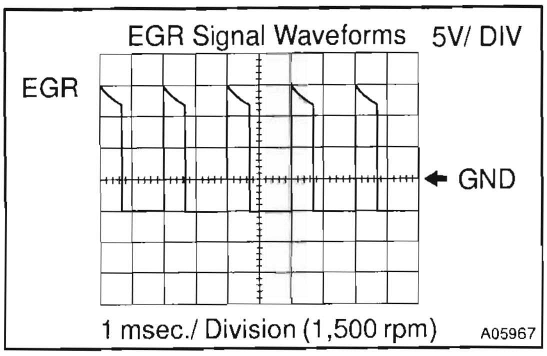
(b) Turn the ignition switch ON.

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.

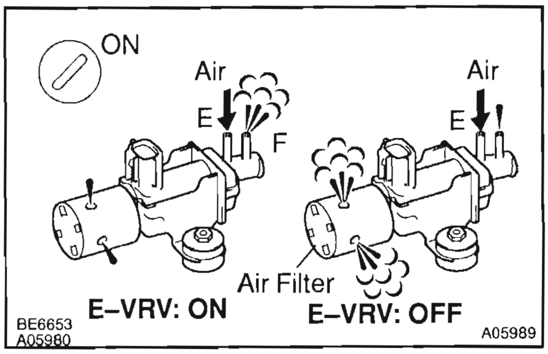
HINT:

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–6).

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–6).

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–6).

NG → Replace VSV for EGR.

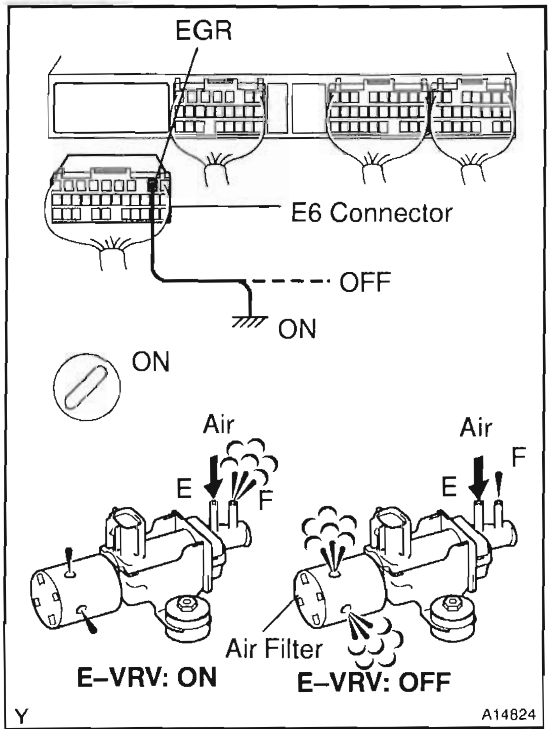
OK ↓

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–6).

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–6).

NG → Replace EGR valve.

OK ↓

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

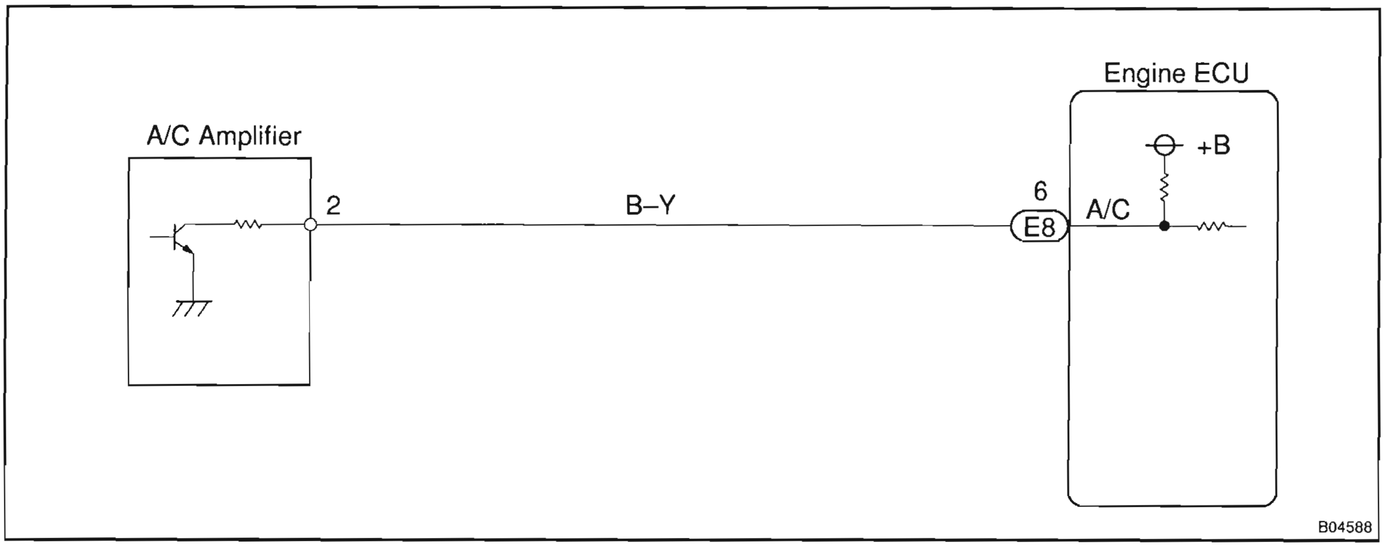
DI326-05

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.

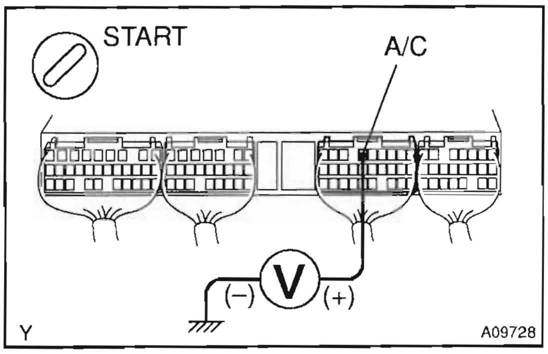
OK:

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 A/C of engine ECU copnnector and body ground.



PREPARATION:

(a) Remove the glove compartment door.

(b) Start the engine.

CHECK:

Measure the voltage between terminal A/C 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).

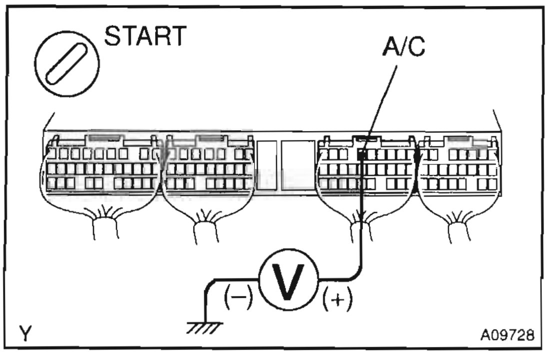
NG 〉 **Repair or replace harness or connector.**

OK

Check and replace A/C amplifier.

When not using hand–held tester:

1	Check voltage between terminal A/C of engine ECU connector and body ground.



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

CHECK:
Measure the voltage between terminal A/C 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.

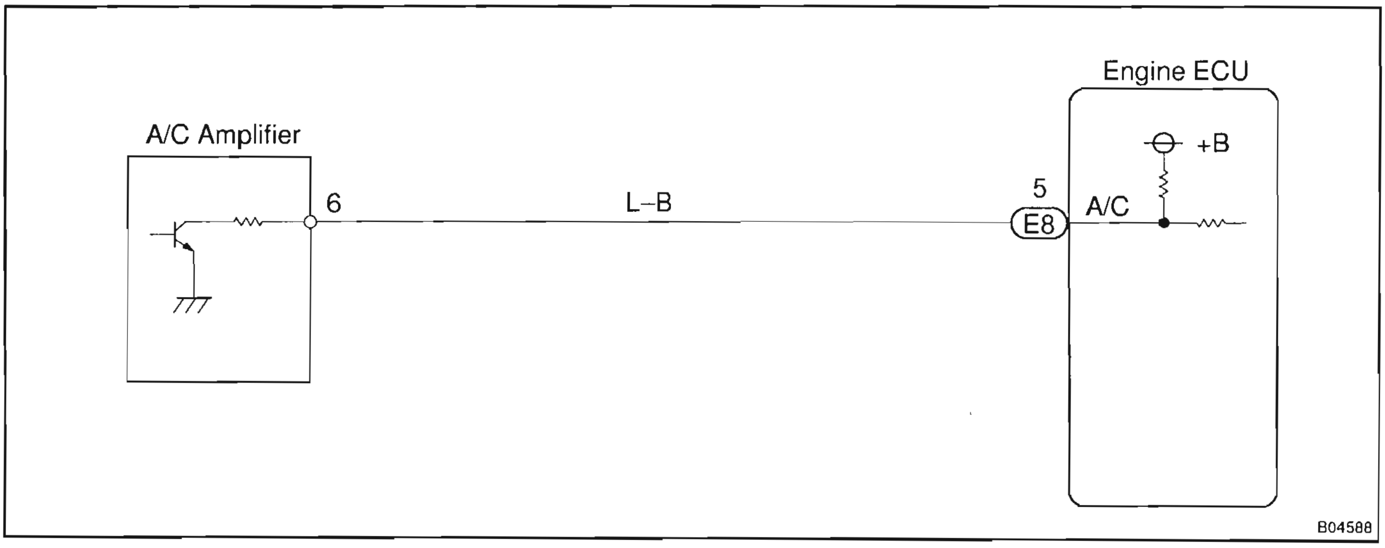
DI8JA-01

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).**

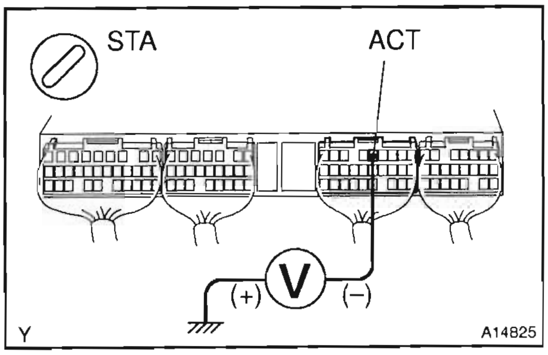
NG

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 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–108).

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

NG

2	Check voltage between terminal THWO of engine ECU and body ground (See page DI–108).

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.

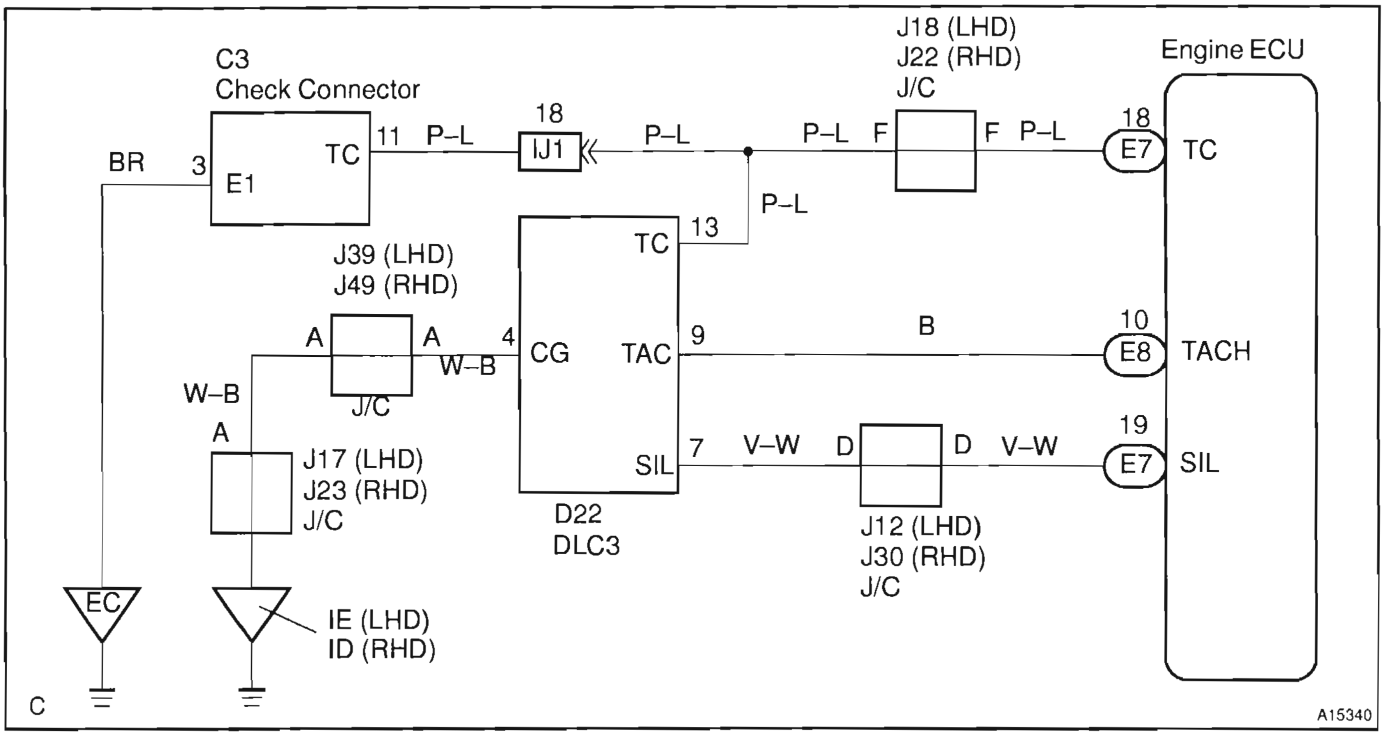
DI69M–03

Diagnostic Connector (DLC3) Circuit

CIRCUIT DESCRIPTION

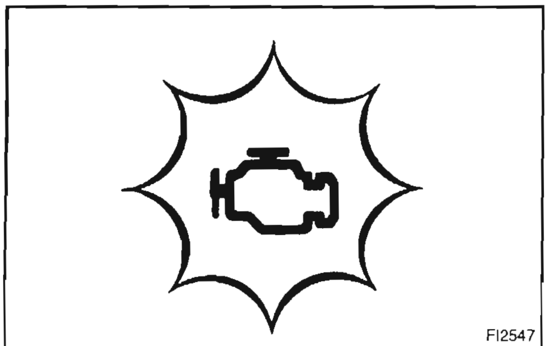
Terminals TC and CG are located in the DLC3.
The DLC3 is located under the finish lower panel. When terminals TC and CG are connected, DTC in normal mode or test mode can be read from the check engine warning light in the combination meter.
Also, terminal SIL is located in the DLC3. This terminal is 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.

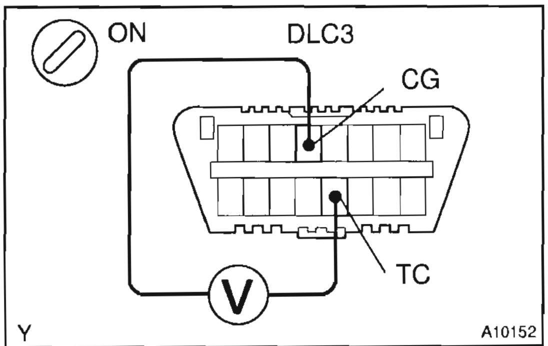
OK:
Check engine warning light : Blinking

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.**

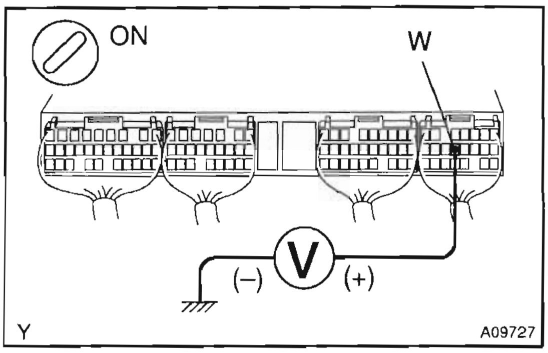
OK

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

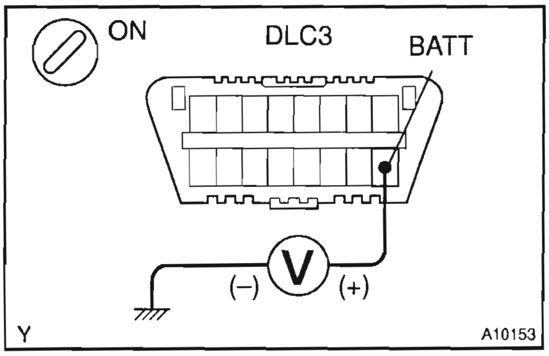
Check for open in harness and connector between terminal W of engine ECU and combination meter (See page IN–20).

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).

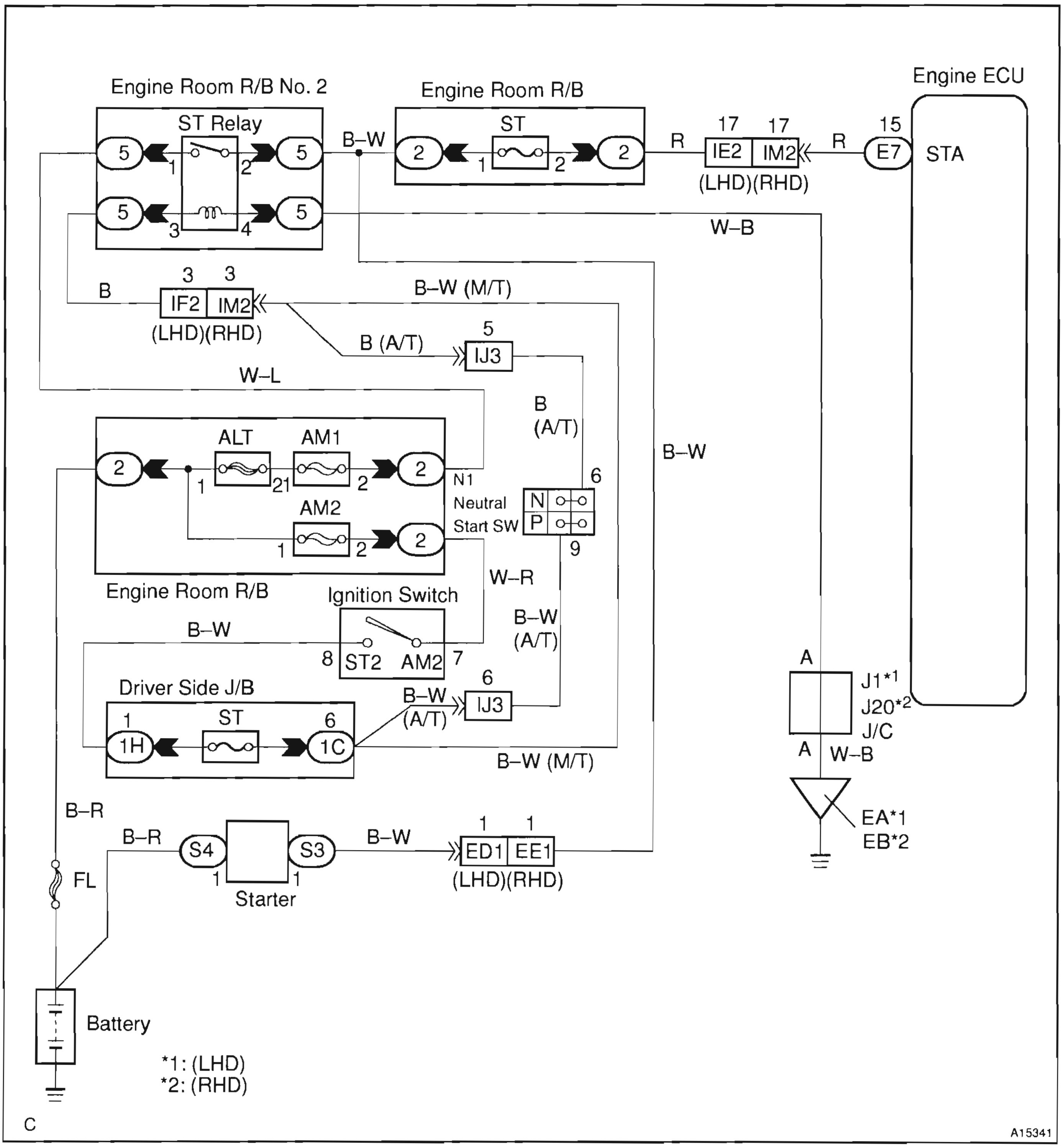
DI325–06

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).**

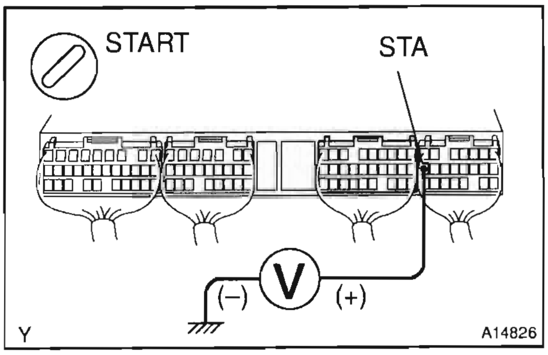
NG → **Repair or replace harness or connector.**

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 START.

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.**

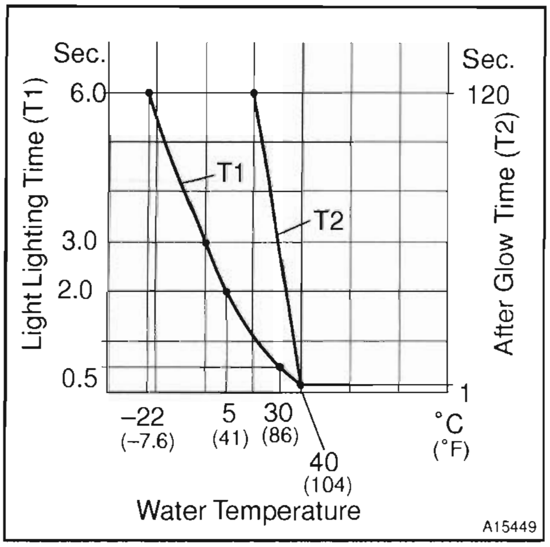
OK ↓

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

DI323-05

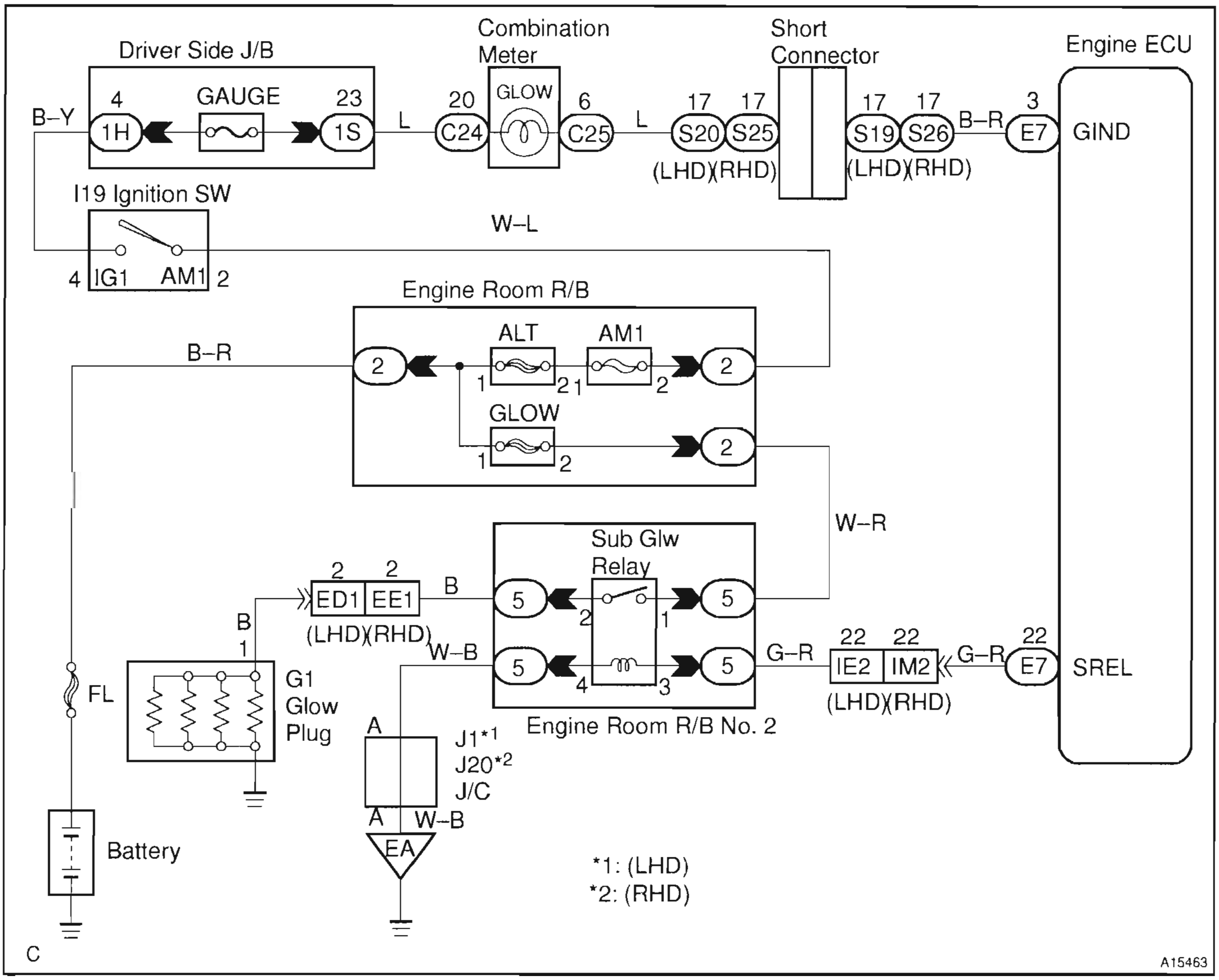
Pre–Heating Control Circuit

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.

WIRING DIAGRAM



INSPECTION PROCEDURE

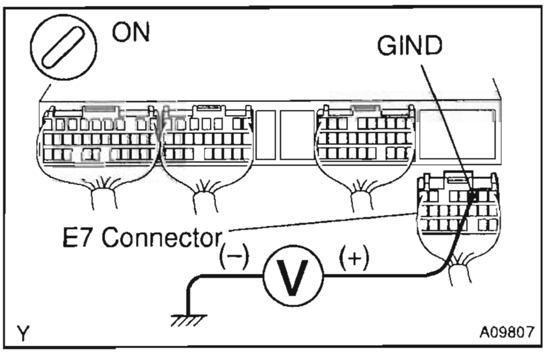
1	**Does glow indicator light up?**

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 E7 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–2).

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

OK

6	Are there any DTC being output?

YES → **Go to relevant DTC chart.**

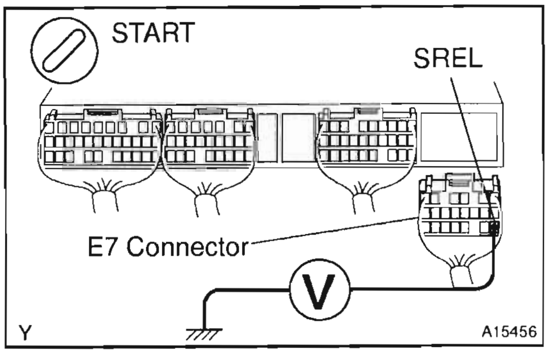
NO

7	**Check glow plug relay (See page ST–2).**

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 E7 connector from the engine ECU.

(c) Turn the ignition switch START.

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–2).**

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).

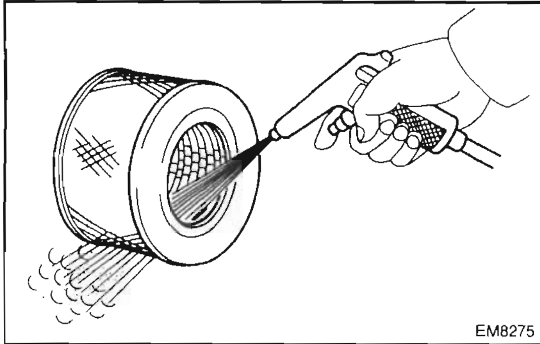
NG → Repair harness or connector.

OK

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

ENGINE MECHANICAL

AIR FILTER EM–1
COMPRESSION EM–2
VALVE CLEARANCE EM–4
IDLE SPEED AND MAXIMUM SPEED EM–9
TIMING BELT EM–10
TIMING GEAR EM–19
CYLINDER HEAD EM–38
CYLINDER BLOCK EM–61


EM8275

AIR FILTER

EM1M0–01

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

EM1M1–01

INSPECTION

HINT:

If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

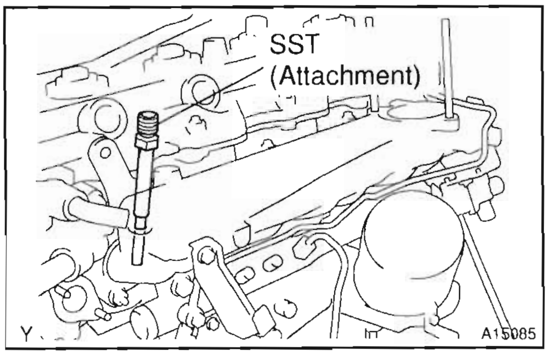
1. WARM UP AND STOP ENGINE

Allow the engine to warm up to normal operating temperature.

2. REMOVE GLOW PLUGS (See page EM–11)

3. DISCONNECT INJECTOR CONNECTORS

EM



4. CHECK CYLINDER COMPRESSION PRESSURE

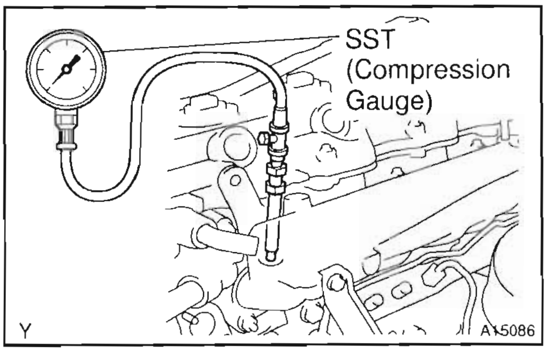
HINT:

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: 13 N·m (133 kgf·cm, 10 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:
2,700 kPa (27.5 kgf/cm^2, 391 psi) or more
Minimum pressure:
2,200 kPa (22.5 kgf/cm^2, 320 psi) or more
Difference between each cylinder:
500 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.

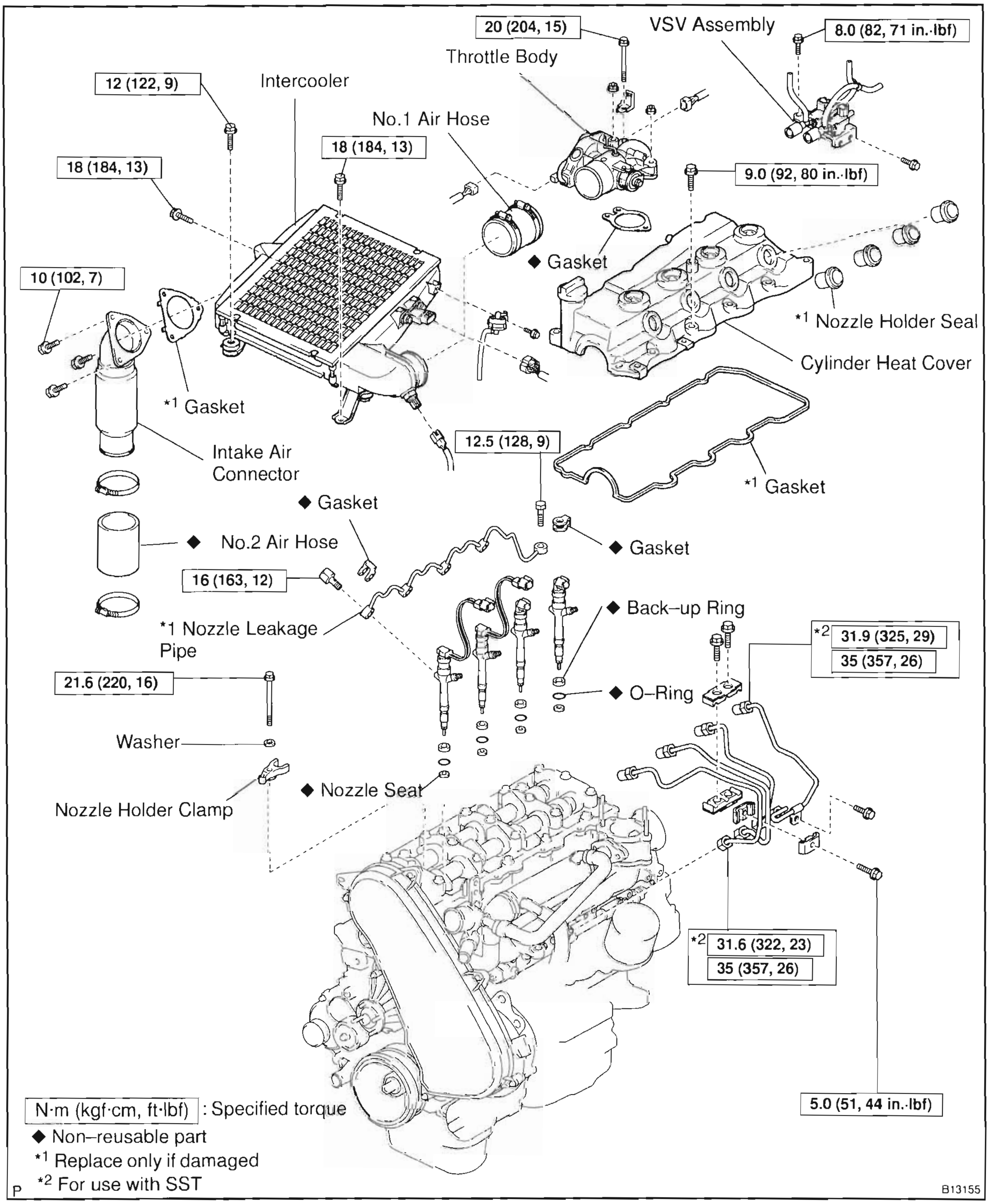
(g) Remove SST.
SST 09992–00025 (09992–00121, 09992–00211)

5. RECONNECT INJECTOR CONNECTORS

6. REINSTALL GLOW PLUGS (See page EM–16)

7. START ENGINE AND CHECK FOR LEAK

VALVE CLEARANCE
COMPONENTS



EM1M3–01

INSPECTION

HINT:

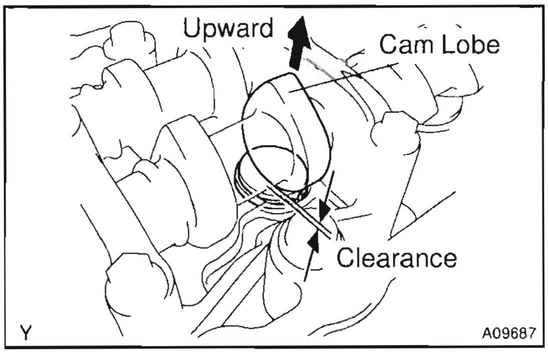
Inspect and adjust the valve clearance when the engine is cold.

NOTICE:

- **Before 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 installation 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.**

EM

1. **REMOVE INTERCOOLER (See page EM–11)**
2. **REMOVE CYLINDER HEAD COVER (See page EM–41)**
3. **REMOVE INJECTORS (See page FU–6)**



4. **INSPECT VALVE CLEARANCE**

(a) Turn the crankshaft so that the cam lobe of the camshaft on the inspecting valve points upward.

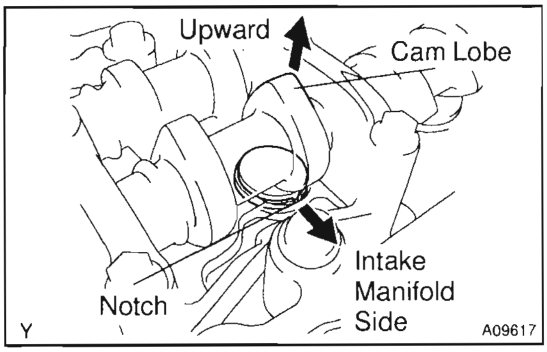
(b) Using a feeler gauge, measure the clearance between the valve lifter and camshaft.

(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.)

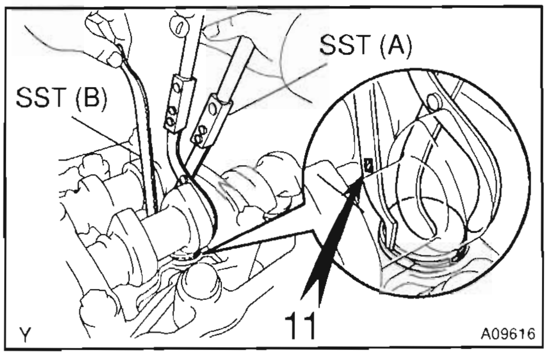


5. **ADJUST VALVE CLEARANCE**

(a) Remove the adjusting shim.

(1) Turn the crankshaft so that the cam lobe of the camshaft on the adjusting valve points upward.

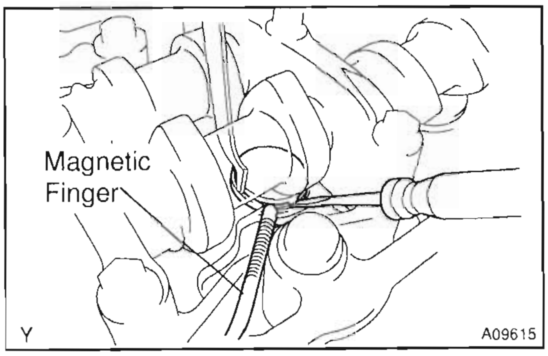
(2) Position the notch of the valve lifter facing the intake manifold side.



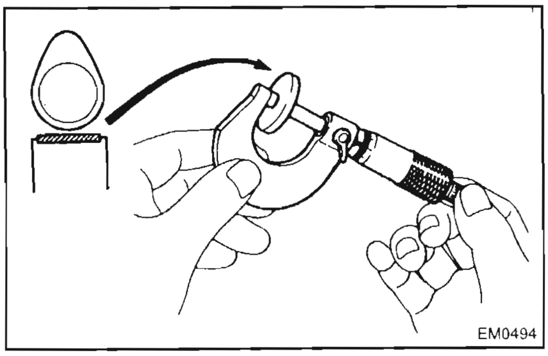
(3) Using SST (A), press down the valve lifter and place SST (B) between the camshaft and valve lifter. Remove SST (A).

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.

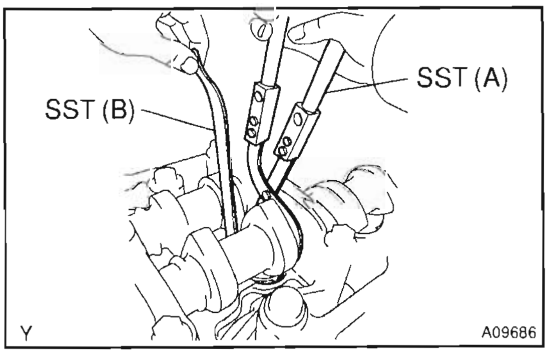
(2) Calculate the thickness of a new shim so that the valve clearance comes within specified value.

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 32 sizes in increments of 0.025 mm (0.0020 in.), from 2.525 mm (0.0994 in.) to 3.300 mm (0.1299 in.).



(c) Place a new adjusting shim on the valve lifter.

(d) Using SST (A), press down the valve lifter and remove SST (B).

SST 09248–55050 (09248–05510, 09248–05520)

(e) Recheck the valve clearance.

6. REINSTALL INJECTORS (See page FU–8)

7. REINSTALL CYLINDER HEAD COVER (See page EM–56)

8. REINSTALL INTERCOOLER (See page EM–16)

Adjusting Shim Selection Chart (Intake)

Measured clearance mm (in.) \ Installed shim thickness mm (in.)	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	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
0.021 - 0.040 (0.0008 - 0.0016)										01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.041 - 0.060 (0.0016 - 0.0024)									01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.061 - 0.080 (0.0024 - 0.0031)								01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.081 - 0.100 (0.0032 - 0.0039)							01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.101 - 0.120 (0.0040 - 0.0047)							01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.121 - 0.140 (0.0048 - 0.0055)						01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
0.141 - 0.160 (0.0056 - 0.0063)					01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.161 - 0.180 (0.0063 - 0.0071)				01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0.181 - 0.199 (0.0071 - 0.0078)			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0.200 - 0.300 (0.0079 - 0.0118)																																
0.301 - 0.320 (0.0119 - 0.0126)	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
0.321 - 0.340 (0.0126 - 0.0134)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
0.341 - 0.360 (0.0134 - 0.0142)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
0.261 - 0.380 (0.0142 - 0.0150)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					
0.381 - 0.400 (0.0150 - 0.0157)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.401 - 0.420 (0.0158 - 0.0165)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.421 - 0.440 (0.0166 - 0.0173)	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32							
0.441 - 0.460 (0.0174 - 0.0181)	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32								
0.461 - 0.480 (0.0181 - 0.0189)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32									
0.481 - 0.500 (0.0189 - 0.0197)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.501 - 0.520 (0.0197 - 0.0205)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.521 - 0.540 (0.0205 - 0.0213)	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32											
0.541 - 0.560 (0.0213 - 0.0220)	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32												
0.561 - 0.580 (0.0221 - 0.0228)	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32													
0.581 - 0.600 (0.0229 - 0.0236)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.601 - 0.620 (0.0237 - 0.0244)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.621 - 0.640 (0.0244 - 0.0252)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32															
0.641 - 0.660 (0.0252 - 0.0260)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																
0.661 - 0.680 (0.0260 - 0.0268)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																	
0.681 - 0.700 (0.0268 - 0.0276)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.701 - 0.720 (0.0276 - 0.0283)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.721 - 0.740 (0.0284 - 0.0291)	20	21	22	23	24	25	26	27	28	29	30	31	32																			
0.741 - 0.760 (0.0292 - 0.0299)	21	22	23	24	25	26	27	28	29	30	31	32																				
0.761 - 0.780 (0.0300 - 0.0307)	22	23	24	25	26	27	28	29	30	31	32																					
0.781 - 0.800 (0.0307 - 0.0315)	23	24	25	26	27	28	29	30	31	32																						
0.801 - 0.820 (0.0315 - 0.0323)	23	24	25	26	27	28	29	30	31	32																						
0.821 - 0.840 (0.0323 - 0.0331)	24	25	26	27	28	29	30	31	32																							
0.841 - 0.860 (0.0331 - 0.0339)	25	26	27	28	29	30	31	32																								
0.861 - 0.880 (0.0339 - 0.0346)	26	27	28	29	30	31	32																									
0.881 - 0.900 (0.0347 - 0.0354)	27	28	29	30	31	32																										
0.901 - 0.920 (0.0355 - 0.0362)	27	28	29	30	31	32																										
0.921 - 0.940 (0.0363 - 0.0370)	28	29	30	31	32																											
0.941 - 0.960 (0.0370 - 0.0378)	29	30	31	32																												
0.961 - 0.980 (0.0378 - 0.0386)	30	31	32																													
0.981 - 1.000 (0.0386 - 0.0394)	31	32																														
1.001 - 1.020 (0.0394 - 0.0402)	31	32																														
1.021 - 1.040 (0.0402 - 0.0409)	32																															

New shim thickness mm (in.)

No.	Shim mark	Thickness	Shim mark	No.	Thickness
01	2525	2.525 (0.0994)	2925	17	2.925 (0.1152)
02	2550	2.550 (0.1004)	2950	18	2.950 (0.1161)
03	2575	2.575 (0.1014)	2975	19	2.975 (0.1171)
04	2600	2.600 (0.1024)	3000	20	3.000 (0.1181)
05	2625	2.625 (0.1033)	3025	21	3.025 (0.1191)
06	2650	2.650 (0.1043)	3050	22	3.050 (0.1201)
07	2675	2.675 (0.1053)	3075	23	3.075 (0.1211)
08	2700	2.700 (0.1063)	3100	24	3.100 (0.1220)
09	2725	2.725 (0.1073)	3125	25	3.125 (0.1230)
10	2750	2.750 (0.1083)	3150	26	3.150 (0.1240)
11	2775	2.775 (0.1093)	3175	27	3.175 (0.1250)
12	2800	2.800 (0.1102)	3200	28	3.200 (0.1260)
13	2825	2.825 (0.1112)	3225	29	3.225 (0.1270)
14	2850	2.850 (0.1122)	3250	30	3.250 (0.1280)
15	2875	2.875 (0.1132)	3275	31	3.275 (0.1289)
16	2900	2.900 (0.1142)	3300	32	3.300 (0.1299)

Intake valve clearance (Cold):
0.20 – 0.30 mm (0.0079 – 0.0118 in.)

EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.350 mm (0.0138 in.). Replace the 2.800 mm (0.1102 in.) shim with a new No.16 2.900 mm (0.1142 in.) shim.

A15091

EM

EM

Adjusting Shim Selection Chart (Exhaust)

Measured clearance mm (in.) \ Installed shim thickness mm (in.)	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	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
0.021 - 0.040 (0.0008 - 0.0016)																01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
0.041 - 0.060 (0.0016 - 0.0024)															01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
0.061 - 0.080 (0.0024 - 0.0031)														01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
0.081 - 0.100 (0.0032 - 0.0039)													01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
0.101 - 0.120 (0.0040 - 0.0047)													01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
0.121 - 0.140 (0.0048 - 0.0055)												01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
0.141 - 0.160 (0.0056 - 0.0063)											01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
0.161 - 0.180 (0.0063 - 0.0071)										01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.181 - 0.200 (0.0071 - 0.0079)									01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.201 - 0.220 (0.0079 - 0.0087)									01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0.221 - 0.240 (0.0087 - 0.0094)								01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0.241 - 0.260 (0.0095 - 0.0102)							01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
0.261 - 0.280 (0.0103 - 0.0110)						01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
0.281 - 0.300 (0.0111 - 0.0118)					01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.301 - 0.320 (0.0119 - 0.0126)					01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.321 - 0.340 (0.0126 - 0.0134)				01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0.341 - 0.344 (0.0134 - 0.0135)			01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0.350 - 0.450 (0.0138 - 0.0177)																																
0.451 - 0.470 (0.0178 - 0.0185)	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32		
0.471 - 0.490 (0.0185 - 0.0193)	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
0.491 - 0.510 (0.0193 - 0.0201)	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32				
0.511 - 0.530 (0.0201 - 0.0209)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					
0.531 - 0.550 (0.0209 - 0.0217)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.551 - 0.570 (0.0217 - 0.0224)	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32						
0.571 - 0.590 (0.0225 - 0.0232)	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32							
0.591 - 0.610 (0.0233 - 0.0240)	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32								
0.611 - 0.630 (0.0241 - 0.0248)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32									
0.631 - 0.650 (0.0248 - 0.0256)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.651 - 0.670 (0.0256 - 0.0264)	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32										
0.671 - 0.690 (0.0264 - 0.0272)	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32											
0.691 - 0.710 (0.0272 - 0.0280)	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32												
0.711 - 0.730 (0.0280 - 0.0287)	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32													
0.731 - 0.750 (0.0288 - 0.0295)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.751 - 0.770 (0.0296 - 0.0303)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32														
0.771 - 0.790 (0.0304 - 0.0311)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32															
0.791 - 0.810 (0.0311 - 0.0319)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																
0.811 - 0.830 (0.0319 - 0.0327)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32																	
0.831 - 0.850 (0.0327 - 0.0335)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.851 - 0.870 (0.0335 - 0.0343)	19	20	21	22	23	24	25	26	27	28	29	30	31	32																		
0.871 - 0.890 (0.0343 - 0.0350)	20	21	22	23	24	25	26	27	28	29	30	31	32																			
0.891 - 0.910 (0.0351 - 0.0358)	21	22	23	24	25	26	27	28	29	30	31	32																				
0.911 - 0.930 (0.0359 - 0.0366)	22	23	24	25	26	27	28	29	30	31	32																					
0.931 - 0.950 (0.0367 - 0.0374)	23	24	25	26	27	28	29	30	31	32																						
0.951 - 0.970 (0.0374 - 0.0382)	23	24	25	26	27	28	29	30	31	32																						
0.971 - 0.990 (0.0382 - 0.0390)	24	25	26	27	28	29	30	31	32																							
0.991 - 1.010 (0.0390 - 0.0398)	25	26	27	28	29	30	31	32																								
1.011 - 1.030 (0.0398 - 0.0406)	26	27	28	29	30	31	32																									
1.031 - 1.050 (0.0406 - 0.0413)	27	28	29	30	31	32																										
1.051 - 1.070 (0.0414 - 0.0421)	27	28	29	30	31	32																										
1.071 - 1.090 (0.0422 - 0.0429)	28	29	30	31	32																											
1.091 - 1.110 (0.0430 - 0.0437)	29	30	31	32																												
1.111 - 1.130 (0.0437 - 0.0445)	30	31	32																													
1.131 - 1.150 (0.0445 - 0.0453)	31	32																														
1.151 - 1.170 (0.0453 - 0.0461)	31	32																														
1.171 - 1.190 (0.0461 - 0.0469)	32																															

New shim thickness mm (in.)

No.	Shim mark	Thickness	Shim mark	No.	Thickness
01	2525	2.525(0.0994)	2925	17	2.925(0.1152)
02	2550	2.550 (0.1004)	2950	18	2.950(0.1161)
03	2575	2.575 (0.1014)	2975	19	2.975 (0.1171)
04	2600	2.600 (0.1024)	3000	20	3.000 (0.1181)
05	2625	2.625 (0.1033)	3025	21	3.025 (0.1191)
06	2650	2.650 (0.1043)	3050	22	3.050(0.1201)
07	2675	2.675 (0.1053)	3075	23	3.075 (0.1211)
08	2700	2.700 (0.1063)	3100	24	3.100 (0.1220)
09	2725	2.725(0.1073)	3125	25	3.125 (0.1230)
10	2750	2.750(0.1083)	3150	26	3.150(0.1240)
11	2775	2.775 (0.1093)	3175	27	3.175 (0.1250)
12	2800	2.800 (0.1102)	3200	28	3.200(0.1260)
13	2825	2.825 (0.1112)	3225	29	3.225 (0.1270)
14	2850	2.850 (0.1122)	3250	30	3.250 (0.1280)
15	2875	2.875 (0.1132)	3275	31	3.275(0.1289)
16	2900	2.900 (0.1142)	3300	32	3.300 (0.1299)

Exhaust valve clearance (Cold):
0.35 – 0.45 mm (0.0138 – 0.0177 in.)

EXAMPLE: The 2.800 mm (0.1102 in.) shim is installed, and the measured clearance is 0.500 mm (0.0197 in.). Replace the 2.800 mm (0.1102 in.) shim with a new No.16 2.900 mm (0.1142 in.) shim.

N

A15092

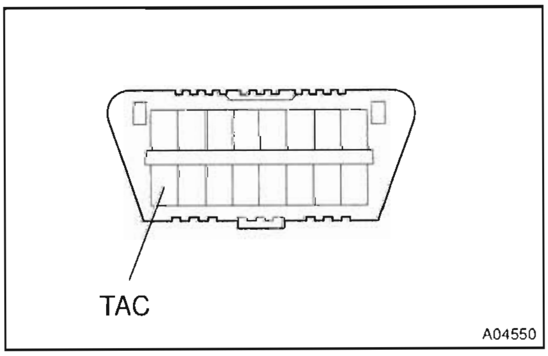
IDLE SPEED AND MAXIMUM SPEED

EM1M4-01

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: 650 – 750 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: 4,500 – 4,700 rpm

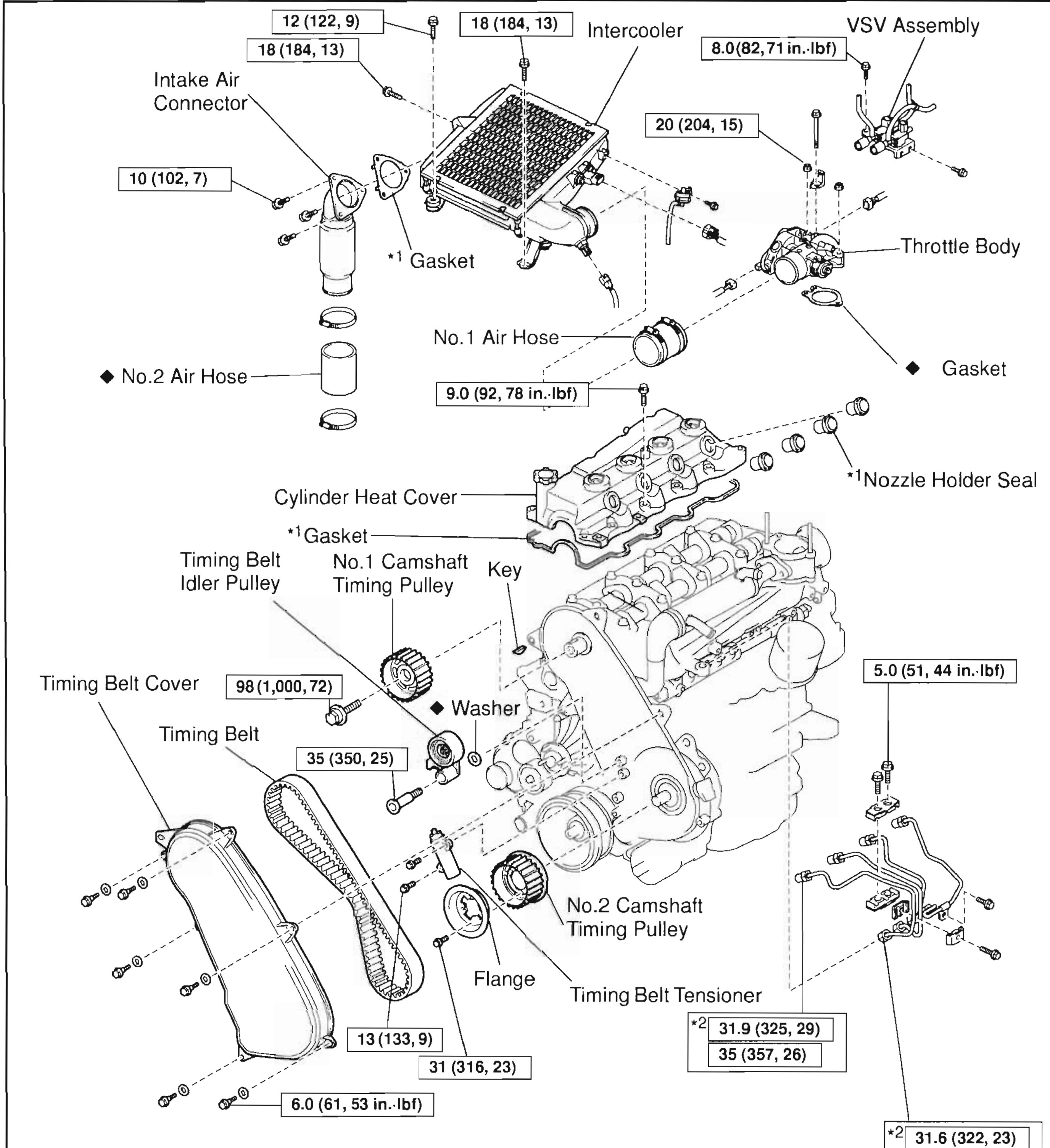
If the maximum speed is not as specified, check the troubleshooting in DI section.

5. DISCONNECT TACHOMETER

TIMING BELT

COMPONENTS

EM0RR–04



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

A15093

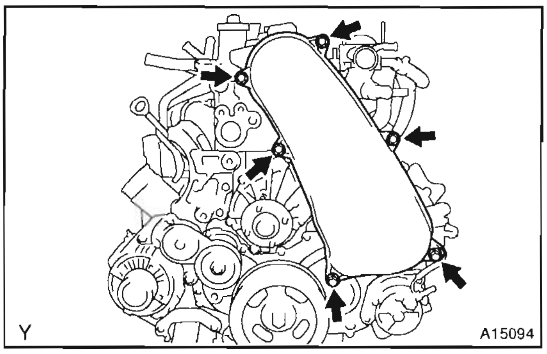
EM

EM1M5-01

REMOVAL

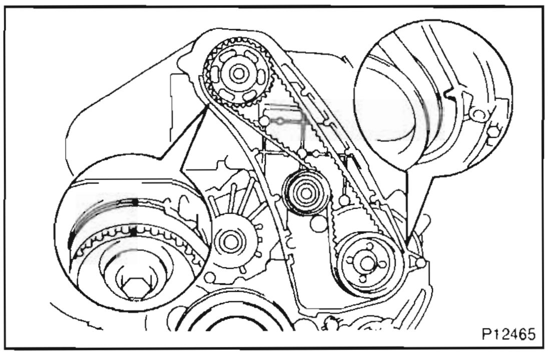
HINT:

If replacing the timing belt before the timing belt warning light comes on, (light comes on after 100,000 km of driving), be sure to reset the timing belt counter of the speedometer to zero.



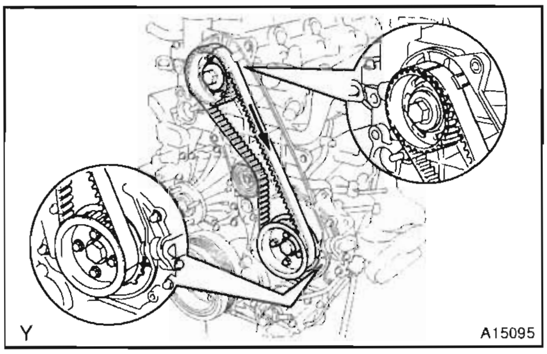
1. REMOVE TIMING BELT COVER

Remove the 6 bolts seal washers and timing belt cover.



2. SET NO.1 CYLINDER TO TDC / COMPRESSION

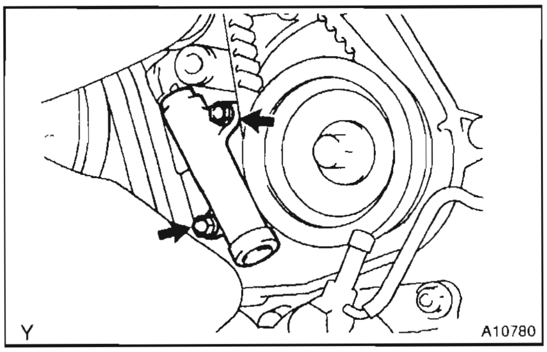
Turn the crankshaft pulley clockwise, set both No.1 and No.2 camshaft pulley grooves at TDC marks.



3. IF RE–USING TIMING BELT, MARK TIMING BELT

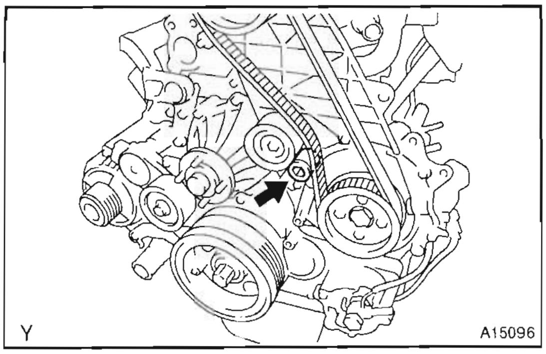
HINT:

If reusing the timing belt, draw a direction arrow on the bolt (in the direction of engine revolution), and place matchmarks on the pulleys and belt as shown in the illustration.



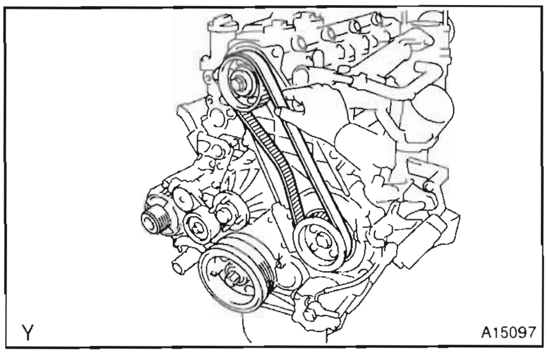
4. REMOVE TIMING BELT TENSIONER

Alternately loosen the 2 bolts, remove them and timing belt tensioner.

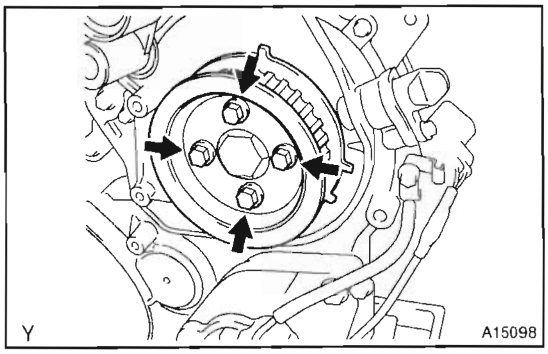


5. REMOVE TIMING BELT IDLER PULLEY

Using a 10 mm hexagon wrench, remove the bolt, timing belt idler pulley and washer.



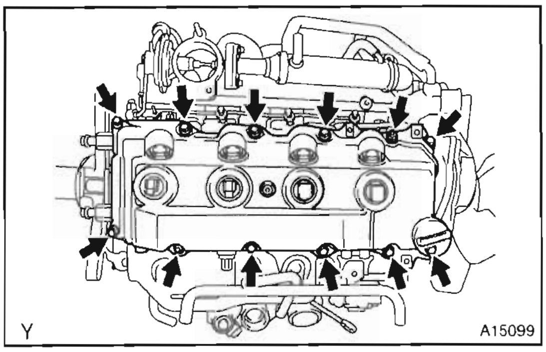
6. REMOVE TIMING BELT



7. REMOVE PUMP DRIVE SHAFT PULLEY

Remove the 4 bolts, pump drive shaft pulley flange and pump drive shaft pulley.

8. REMOVE INTERCOOLER (See page TC–11)



9. REMOVE CYLINDER HEAD COVER

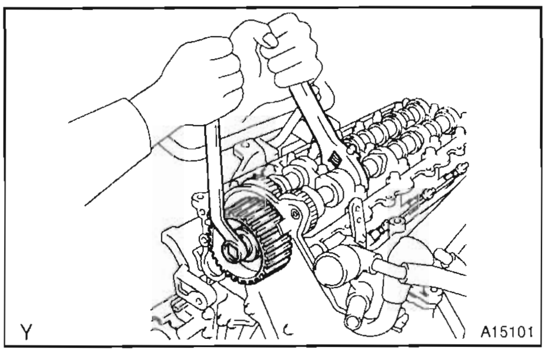
(a) Disconnect the 4 injector connectors

(b) Remove the 2 bolts and disconnect the engine wire protector.

(c) Using SST, remove the 4 injection pipes (See page FU–6).

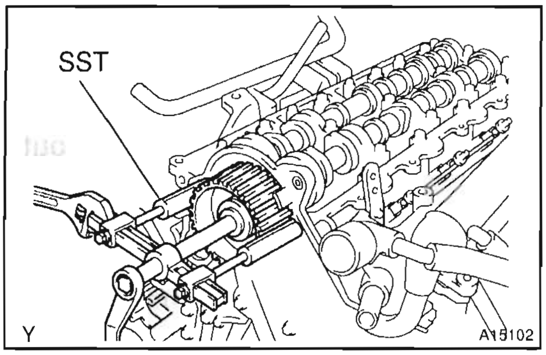
(d) Remove the 4 nozzle holder seals.

(e) Remove the 10 bolts, 2 nuts, cylinder head cover and gasket.



10. REMOVE NO.1 CAMSHAFT TIMING PULLEY

(a) Hold the hexagonal wrench head portion of the camshaft with a wrench, and remove the No.1 camshaft timing pulley bolt.



(b) Using SST, remove the No.1 camshaft timing pulley.
SST 09950–40011 (09951–04010, 09952–04010, 09953–04020, 09954–04010, 09955–04061)

(c) Remove the set key.

EM1SB–02

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 mount bolt of the camshaft timing pulley.**

If there are any defects, check these points:

(a) Premature parting
  - Check for proper installation.
  - Check the timing cover gasket for damage and proper installation.

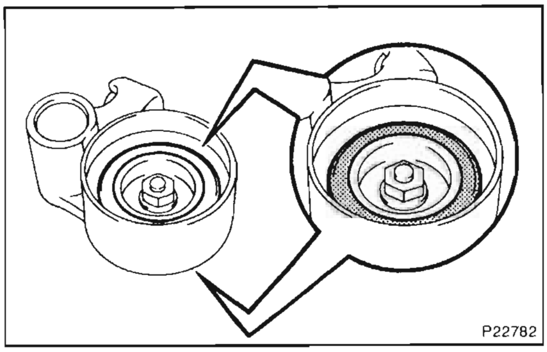
(b) If the belt teeth are cracked or damaged, check to see if the camshaft is locked.

(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.

(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 timing cover for damage and check gasket has been installed correctly and for foreign material on the pulley teeth.

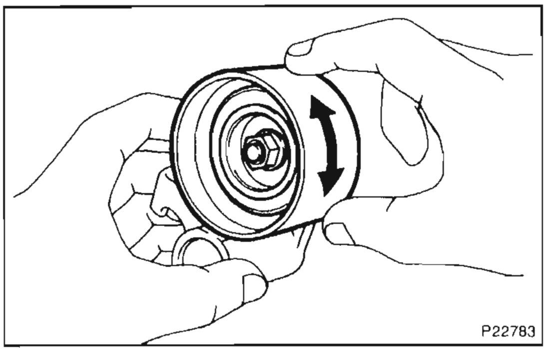
If necessary, replace the timing belt.


P22782

2. INSPECT IDLER PULLEY

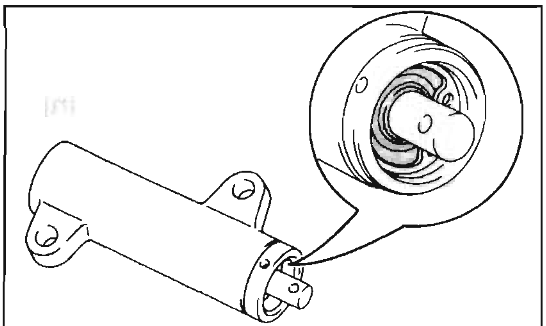
(a) Visually check the seal portion of the idler pulley for oil leakage.

If leakage is found, replace the idler pulley.


P22783

(b) Check that the idler pulley turns smoothly.

If necessary, replace the idler pulley.


P22742

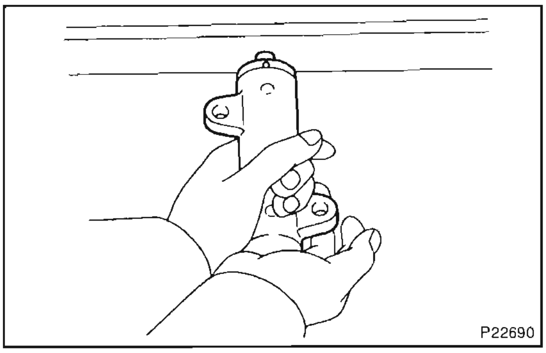
3. INSPECT TIMING BELT TENSIONER

(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.

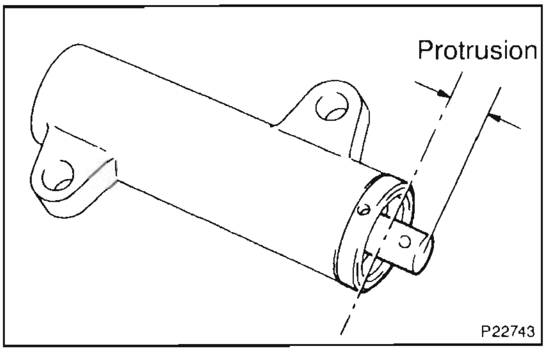

P22690

(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.



P22743

(c) Measure the protrusion of the push rod from the housing end.

Protrusion: 8.1 – 8.9 mm (0.319 – 0.350 in.)

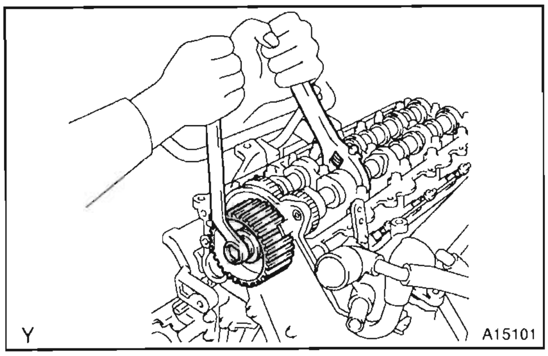
If the protrusion is not as specified, replace the tensioner.

EM1M6–02

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 NO.1 CAMSHAFT TIMING PULLEY

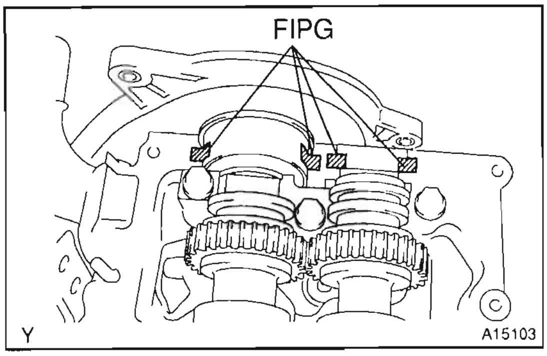
(a) Install the set key to the key groove of the camshaft.

(b) Align the pulley set key with the key groove of the No.1 camshaft timing pulley, slide the No.1 camshaft timing pulley.

(c) Temporarily install the No.1 timing pulley bolt.

(d) Hold the hexagon wrench head portion of the camshaft with a wrench, and tighten the No.1 camshaft timing pulley bolt.

Torque: 98 N·m (1,000 kgf·cm, 72 ft·lbf)

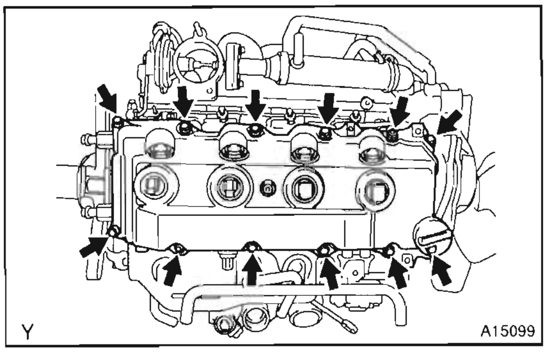


2. INSTALL CYLINDER HEAD COVER

(a) Remove any old packing (FIPG) material.

(b) Apply seal packing to the cylinder head s shown the illustration.

Seal packing: Part No. 08826–0080 or equivalent



(c) Install the gasket to the cylinder head cover.

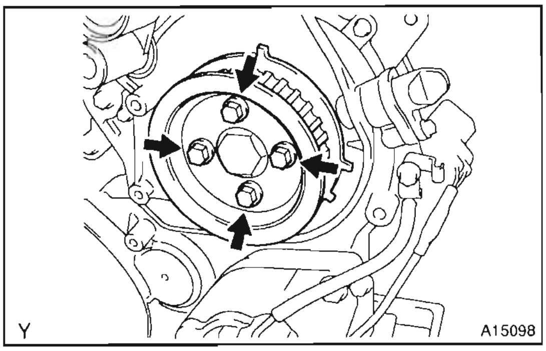
HINT:

Replace the gasket if any damage is identified.

(d) Install the cylinder head cover with the 10 bolts and 2 nuts.

Torque: 9.0 N·m (92 kgf·cm, 78 in.·lbf)

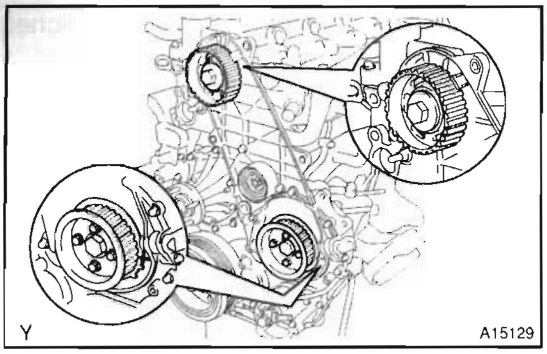
3. INSTALL INTERCOOLER (See page TC–12)



4. INSTALL PUMP DRIVE SHAFT PULLEY

Align the knock pin of the injection pump drive gear with the knock pin hole of the pump drive shaft pulley, install the pulley and No.2 camshaft timing pulley flanges with the 4 bolts.

Torque: 31 N·m (316 kgf·cm, 23 ft·lbf)

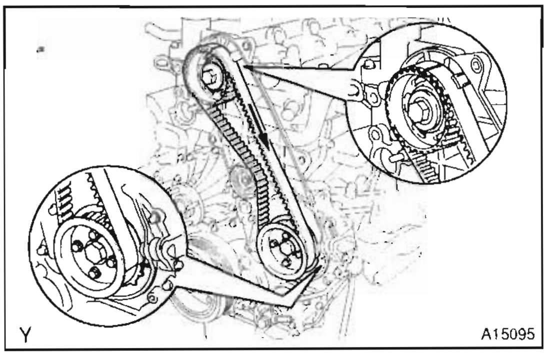


5. SET NO.1 CYLINDER TO TDC / COMPRESSION

Set the timing pulley at each position.

NOTICE:

When turning the crankshaft, the valve heads will hit against the position top. So do not turn it more than necessary.



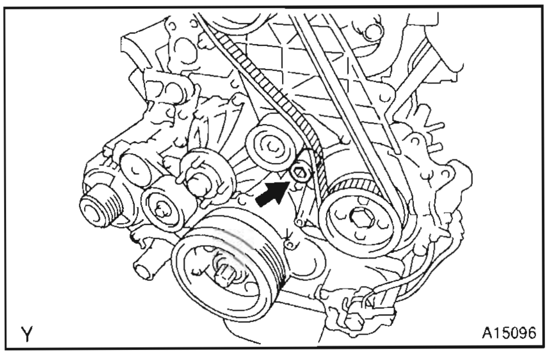
6. INSTALL TIMING BELT

NOTICE:

The engine should be cold.

HINT:

If re–using the timing belt, align the points marked during removal, and install the belt with the arrow pointing in the direction of engine revolution.

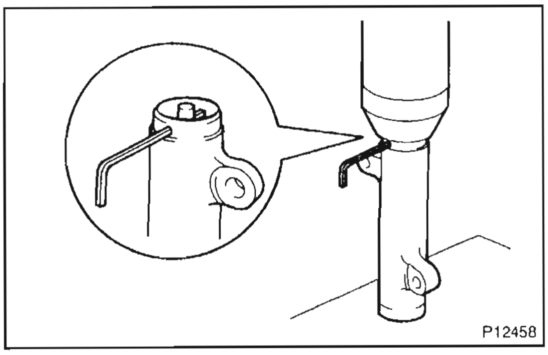


7. INSTALL TIMING BELT IDLER PULLEY

(a) Using a 10 mm hexagon wrench, install the washer and timing belt idler pulley with the bolt.
Torque: 35 N·m (350 kgf·cm, 25 ft·lbf)

(b) Check that the idler pulley moves smoothly.

If it doesn't move smoothly, check the idler pulley and washer.

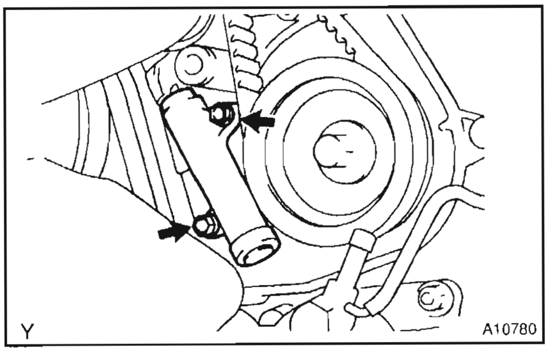


8. SET TIMING BELT TENSIONER

(a) Using a press, slowly press in the push rod using 981 – 9,807 N (100 – 1,000 kgf, 220 –2,205 lbf) of force.

(b) Align the holes of the push rod and housing, pass a 1.5 mm hexagon wrench through the holes to keep the setting position of the push rod.

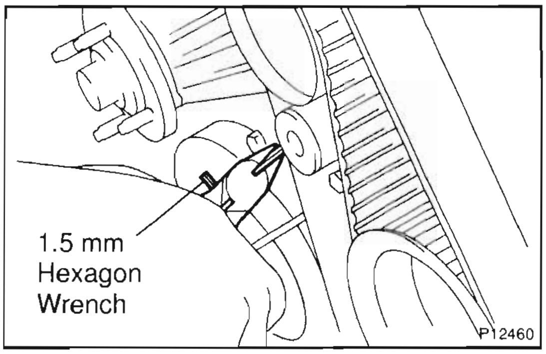
(c) Release the press.



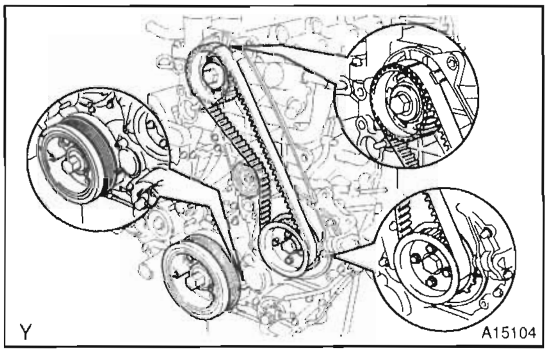
9. INSTALL TIMING BELT TENSIONER

(a) Temporarily install the timing belt tensioner with the 2 bolts while pushing the idler pulley toward the timing belt.

(b) Tighten the 2 bolts.
Torque: 13 N·m (133 kgf·cm, 9 ft·lbf)



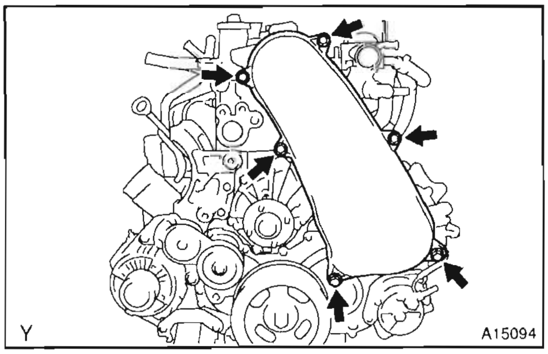
(c) Remove the 1.5 mm hexagon wrench from the tensioner.



10. CHECK VALVE TIMING

Turn the crankshaft pulley clockwise and check that each pulley aligns with the timing marks (TDC mark) as shown in the illustration.

If the marks do not align, remove the timing belt and reinstall it.



11. INSTALL TIMING BELT COVER

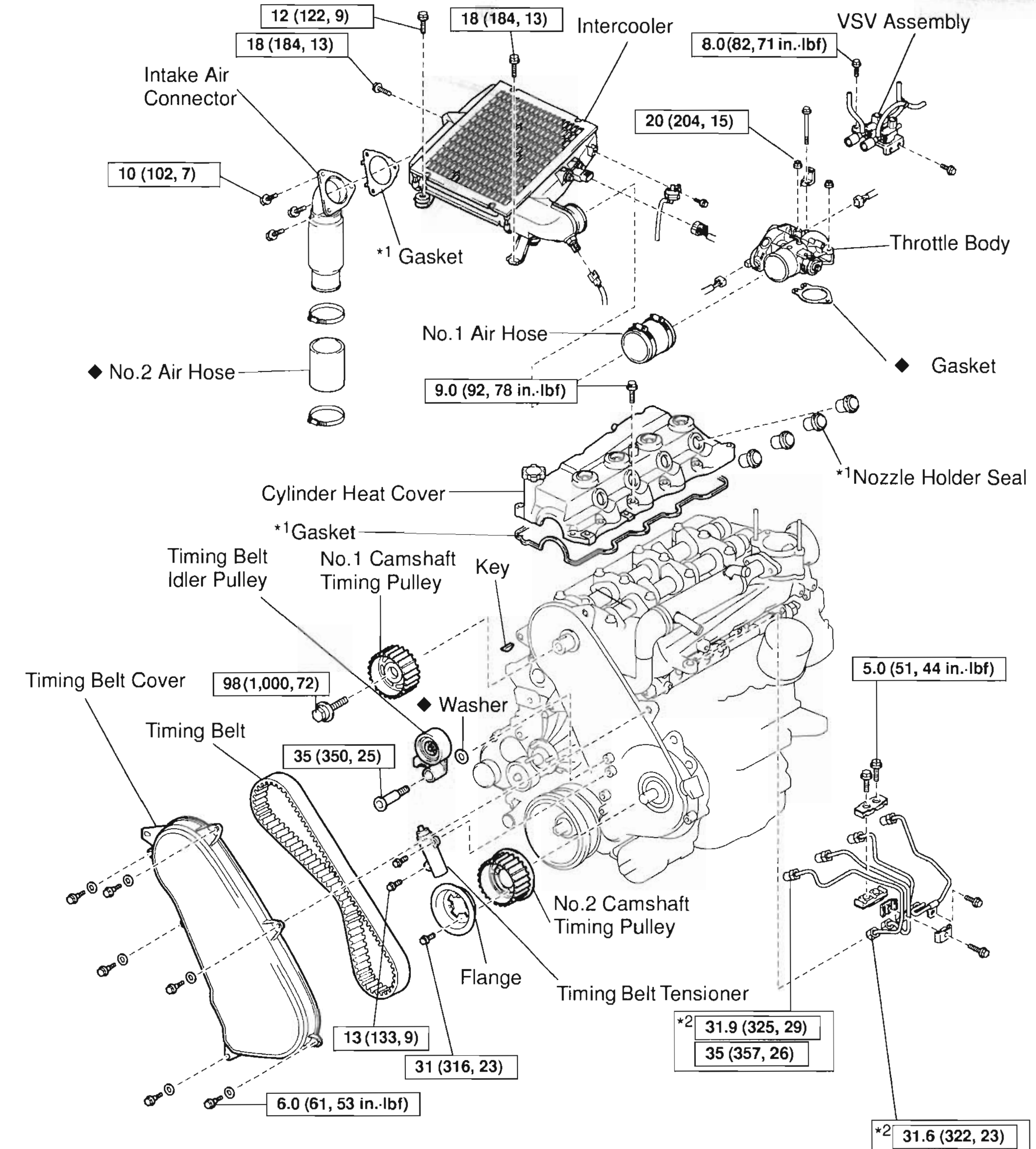
Install the timing belt cover with the 6 seal washers and bolts.

Torque: 6.0 N·m (61 kgf·cm, 53 in.·lbf)

TIMING GEAR

COMPONENTS

EM156–02



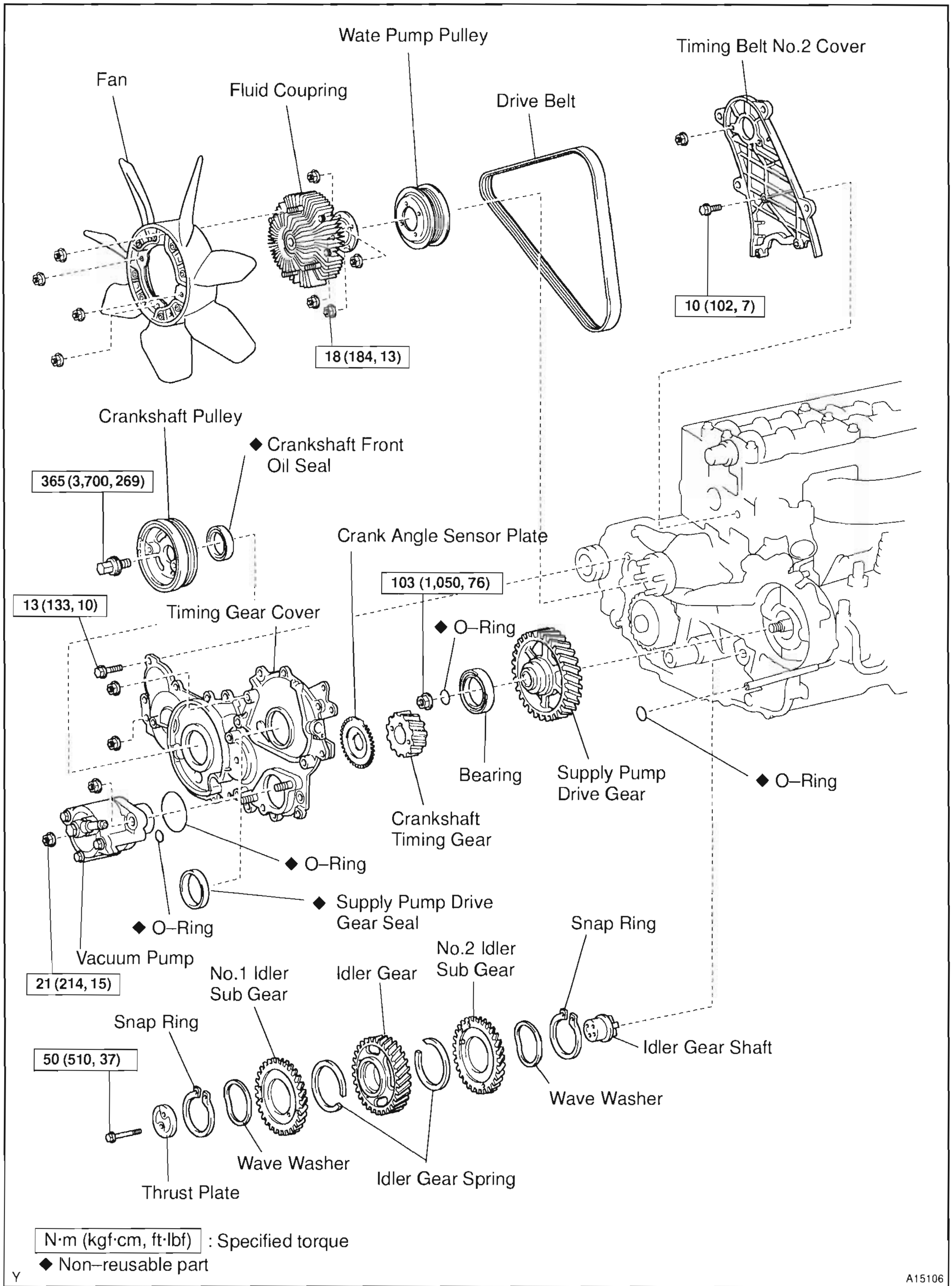
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

A15093

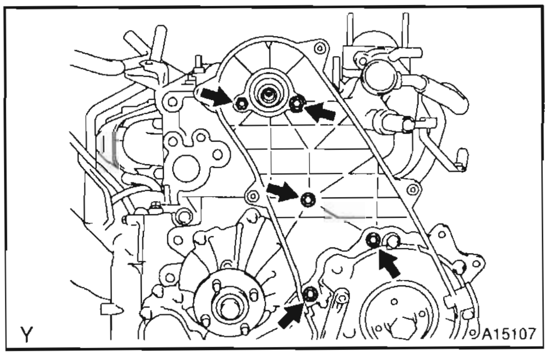

Wate Pump Pulley
Timing Belt No.2 Cover
Fan
Fluid Coupring
Drive Belt
10 (102, 7)
18 (184, 13)
Crankshaft Pulley
◆ Crankshaft Front Oil Seal
365 (3,700, 269)
Crank Angle Sensor Plate
103 (1,050, 76)
13 (133, 10)
Timing Gear Cover
◆ O–Ring
Bearing
Supply Pump Drive Gear
◆ O–Ring
Crankshaft Timing Gear
◆ O–Ring
◆ Supply Pump Drive Gear Seal
◆ O–Ring
Snap Ring
Vacuum Pump
No.2 Idler Sub Gear
21 (214, 15)
No.1 Idler Sub Gear
Idler Gear
Snap Ring
Idler Gear Shaft
50 (510, 37)
Wave Washer
Wave Washer
Idler Gear Spring
Thrust Plate
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
A15106

EM0RW–03

REMOVAL

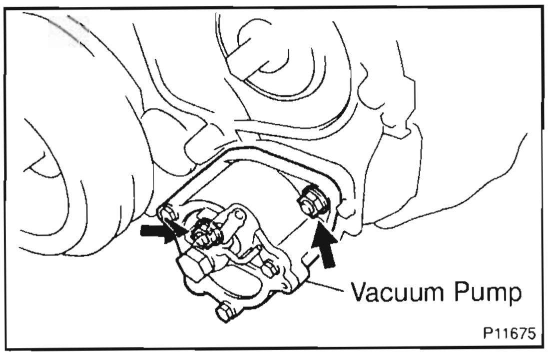
NOTICE:
When removing the crankshaft pulley and timing gear as the timing belt is off and the valve interferes with the piston, never,turn the crankshaft to the right beyond the dead point above the No. 1 cylinder.

1. **REMOVE TIMING BELT AND PULLEYS**
   (See page EM–11)
2. **REMOVE DRIVE BELT, FAN AND WATER PUMP PULLEY (See page CO–5)**



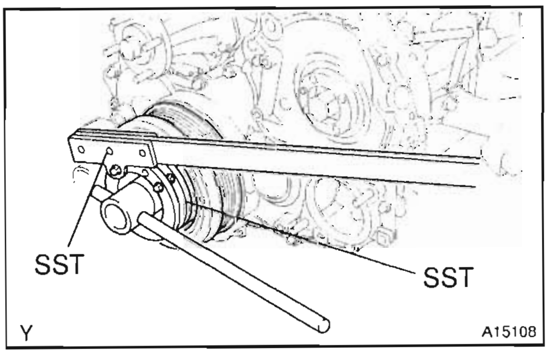
3. **REMOVE TIMING BELT NO. 2 COVER**

Remove the 4 bolts, nut and timing belt No. 2 cover.



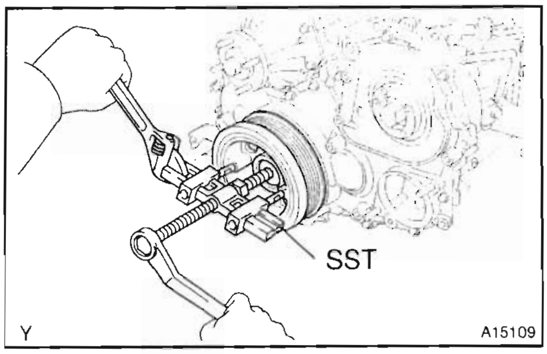
4. **REMOVE VACUUM PUMP**

(a) Remove the vacuum hose.
(b) Remove the 2 nuts and vacuum pump.
(c) Remove 2 the O–rings.

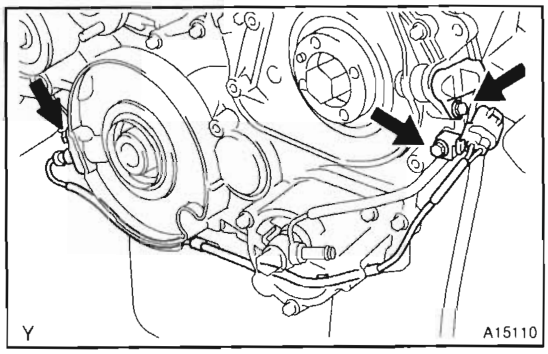


5. **REMOVE CRANKSHAFT PULLEY**

(a) Using SST, remove the pulley bolt and plate.
SST 09213–58012, 09330–00021

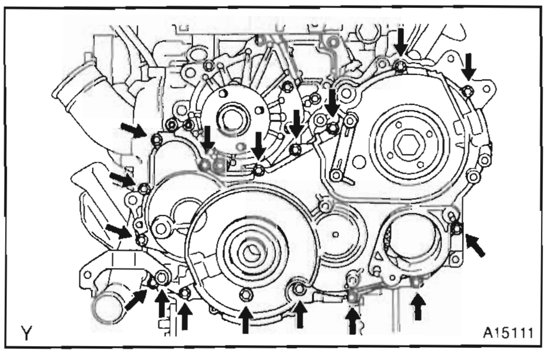


(b) Using SST, remove the crankshaft pulley.
SST 09950–50012, (09951–05010, 09952–05010, 09953–05010, 09954–05020)

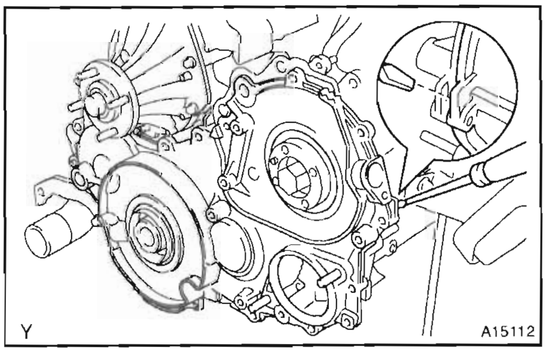


6. REMOVE TIMING GEAR COVER

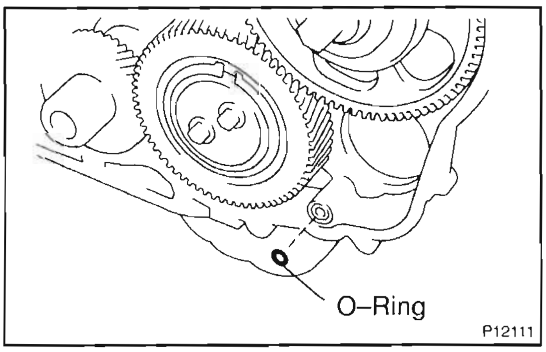
(a) Remove the bolt, crankshaft position sensor and O–ring.
(b) Remove the bolt, crankshaft position sensor and O–ring and disconnect the 3 clamps.
(c) Remove the bolt, nut and washer and disconnect the vacuum pipe.



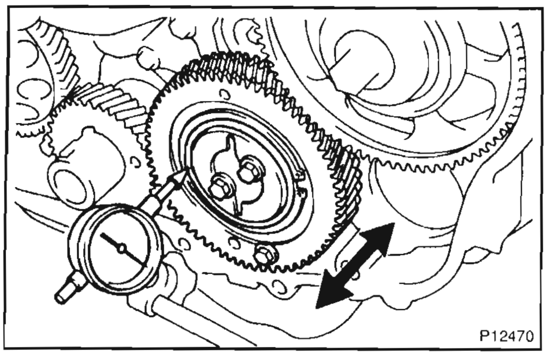
(d) Remove the 14 bolts and 2 nuts.



(e) Using a screwdriver, pry out the timing gear cover.



(f) Remove the O–ring.
(g) Remove the crank angle sensor plate.



7. CHECK THRUST CLEARANCE OF IDLER GEAR

Using a dial indicator, measure the thrust clearance.

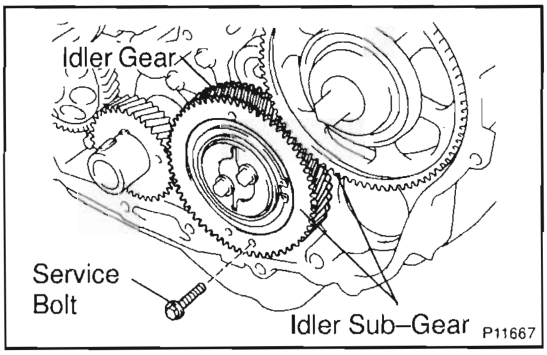
Standard thrust clearance:
0.06 – 0.11 mm (0.0024 – 0.0043 in.)
Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than maximum, replace the thrust plate. If necessary, replace the idler gear and/or idler gear shaft.

8. REMOVE TIMING GEARS

NOTICE:

- **The matchmarks on each gear faces the front of the engine.**
- **Take care not to damage the gear teeth when removing and installing the gears. Do not use parts that are scratched or damaged, they cause noise.**



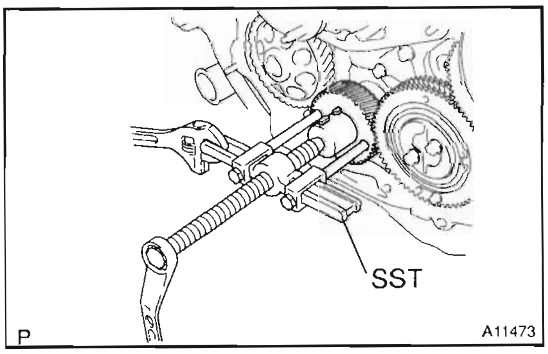
(a) Remove the crankshaft timing gear.

(1) Secure the idler sub–gears to the idler gear with a service bolt.

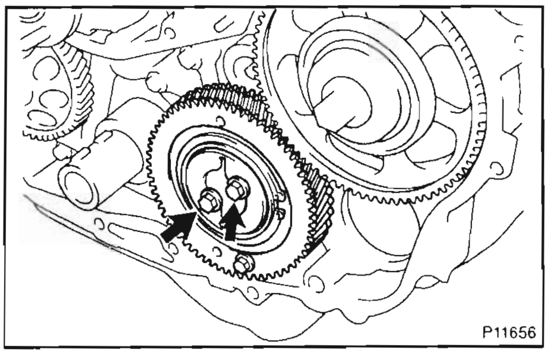
Recommended service bolt:

Thread diameter	6 mm
Thread pitch	1.0 mm
Bolt length	28.0 mm (1.10 in.)

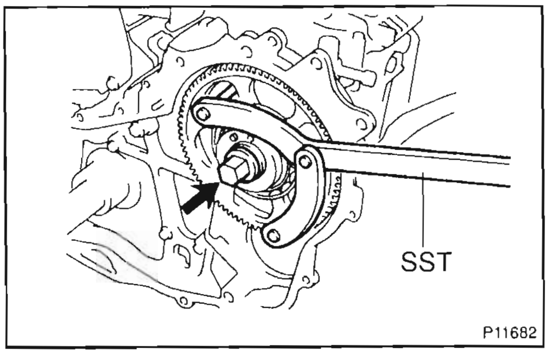
HINT:
When removing the idler gear, make sure that the torsional spring force of the sub–gears has been eliminated by the above operation.



(2) Using SST, remove the crankshaft timing gear.
SST 09950–50012 (09951–05010, 09952–05010, 09953–05010, 09954–05020)



(b) Remove the 2 bolts, thrust plate, idler gear assembly and idler gear shaft.

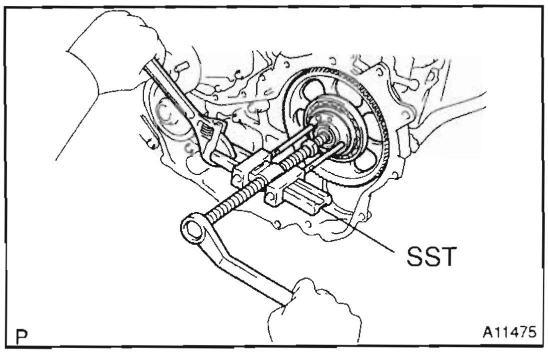


(c) Remove the supply pump drive gear.

(1) Using SST, remove the supply pump drive gear set nut.

SST 09960–10010 (09962–01000, 09963–00600)

(2) Remove the O–ring.

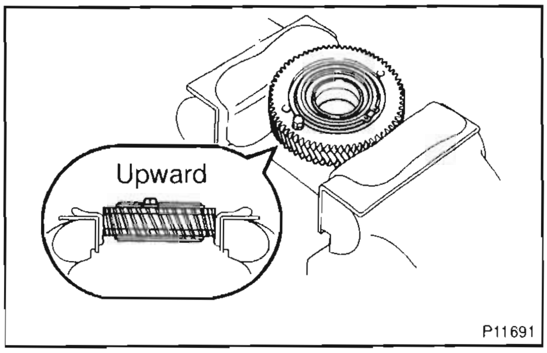


(3) Using SST, remove the supply pump drive gear.

SST 09950–50012 (09951–05010, 09952–05010, 09953–05010, 09954–05020)

NOTICE:

- **Tighten the 2 bolts of SST more than 8 mm (0.31 in.).**
- **Set the SST so that it is balanced.**

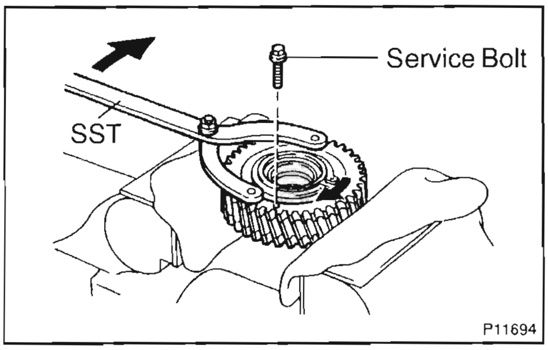


9. DISASSEMBLY IDLER GEAR

(a) Mount the idler gear and No.2 idler sub–gear in a vise.

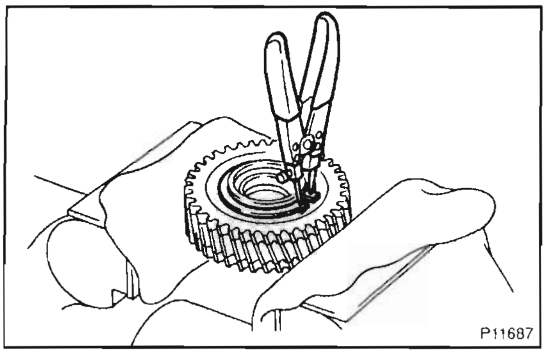
NOTICE:

Be careful not to damage the gears.

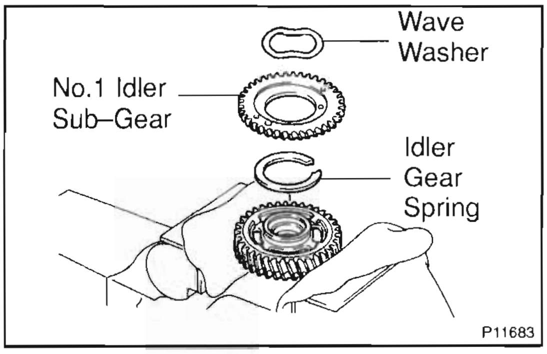


(b) Using SST, turn the No.1 idler sub–gear clockwise and remove the service bolt.

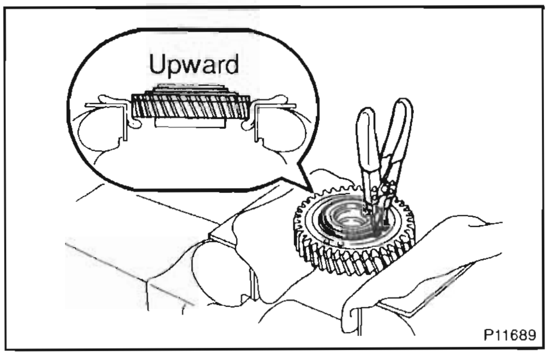
SST 09960–10010 (09962–01000, 09963–00600)



(c) Using snap ring pliers, remove the snap ring.



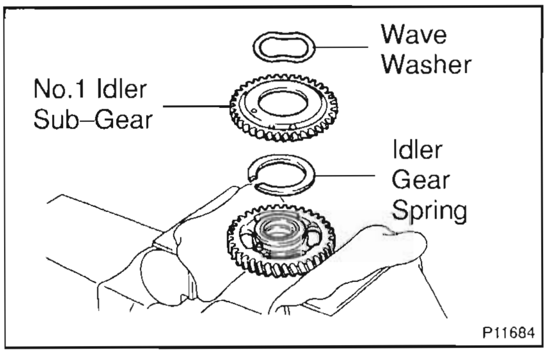
(d) Remove the wave washer.
(e) Remove the No.1 idler sub–gear.
(f) Remove the idler gear spring.
(g) Remove the idler gear assembly from the vice and turn it upside down.



(h) Mount the idler gear in a vise.

NOTICE:
Be careful not to damage the gear.

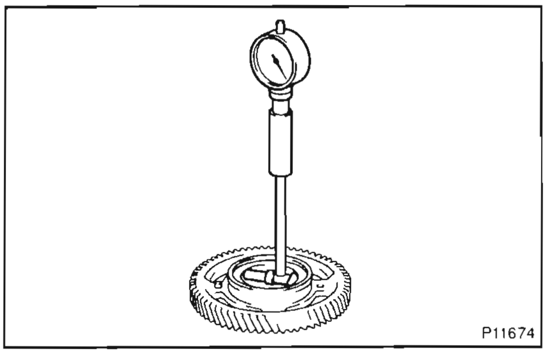
(i) Using snap ring pliers, remove the snap ring.



(j) Remove the wave washer.
(k) Remove the No.2 idler sub–gear.
(l) Remove the idler gear spring.

EM157–02

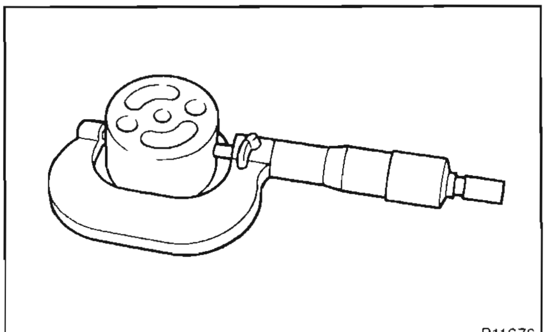
INSPECTION


P11674

1. INSPECT IDLER GEAR

(a) Using a cylinder gauge, measure the inside diameter of the idler gear.

Idler gear inside diameter:
44.000 – 44.025 mm (1.7323 – 1.7333 in.)


P11676

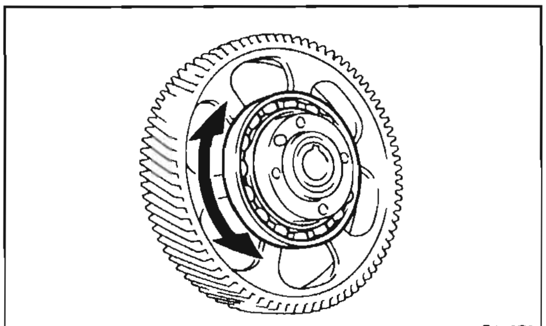
(b) Using a micrometer, measure the diameter of the idler gear shaft.

Idler gear shaft diameter:
43.955 – 43.990 mm (1.7305 – 1.7319 in.)

(c) Subtract the idler gear shaft diameter measurement from the idler gear inside diameter measurement.

Standard oil clearance:
0.010 – 0.070 mm (0.0004 – 0.0028 in.)
Maximum oil clearance: 0.20 mm (0.0079 in.)

If the clearance is greater than maximum, replace the gear and shaft.


P11673

2. INSPECT RADIAL BALL BEARING BEARING

Check that bearing is not rough or worn.
If necessary, replace the bearing. (See page EM–28)

3. CHECK BACKLASH OF TIMING GEARS

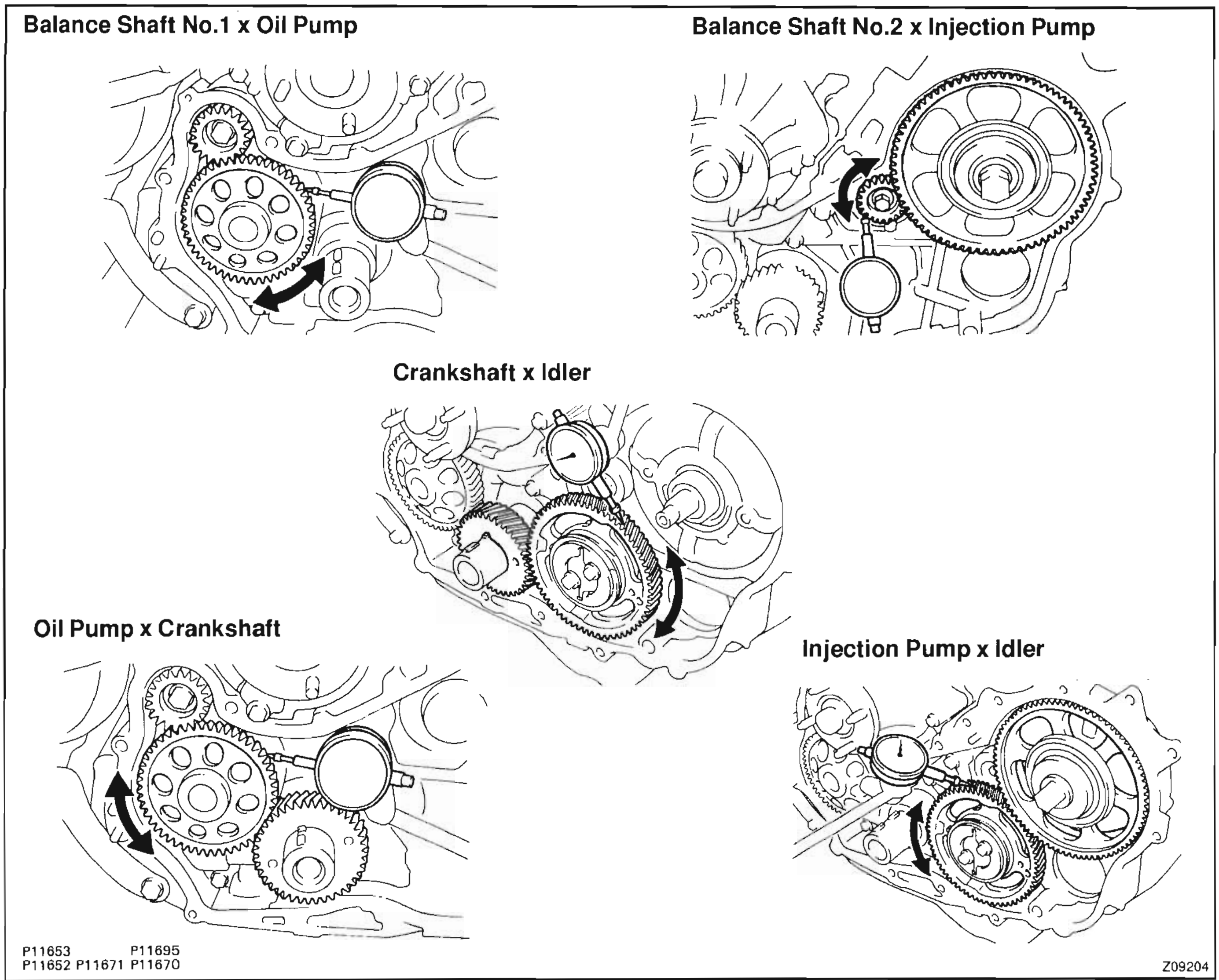
Using a dial indicator, measure the backlash.

Standard gear backlash:

0.02 – 0.15 mm (0.0008 – 0.0060 in.)

Maximum gear backlash: 0.20 mm (0.0079 in.)

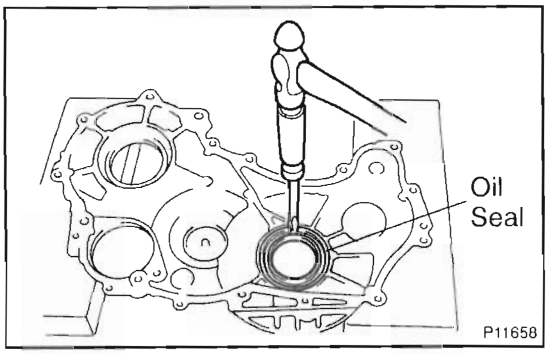
If the gear backlash is greater than maximum, replace the gears as a set.



EM158-02

REPLACEMENT

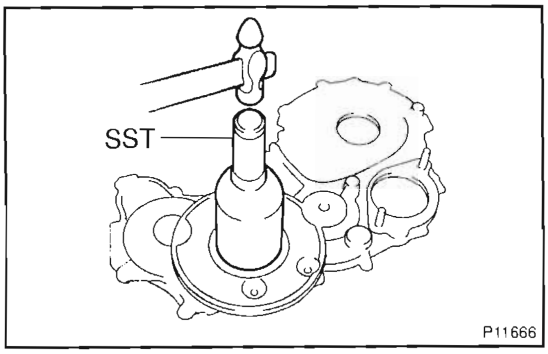
HINT:
There are 2 methods (a and b) to replace the oil seal as follows:



1. REPLACE CRANKSHAFT FRONT OIL SEAL

(a) If the timing gear cover is removed from the cylinder block:

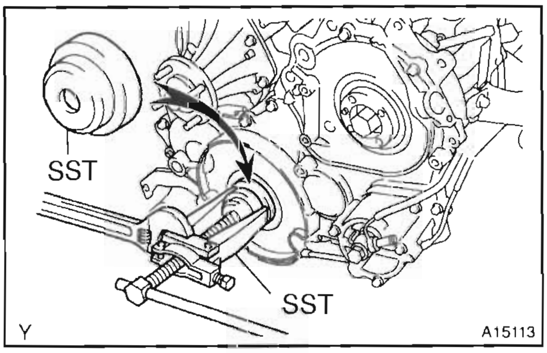
(1) Using a screwdriver and hammer, tap out the oil seal.



(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.

SST 09214–76011

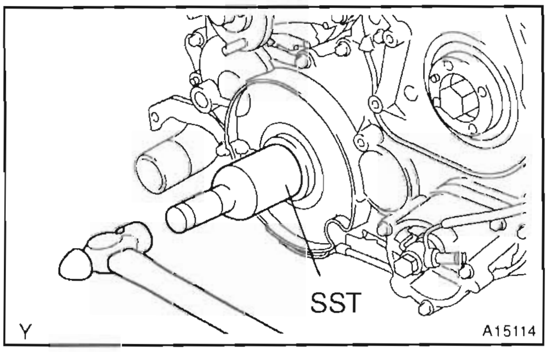
(3) Apply MP grease to the oil seal lip.



(b) If the timing gear cover is installed to the cylinder block:

(1) Using SST, remove the oil seal.

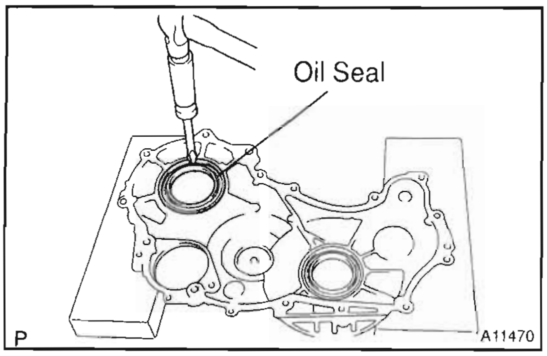
SST 09308–10010, 09950–20017



(2) Apply MP grease to a new oil seal lip.

(3) Using SST and a hammer, tap in the oil seal until its surface is flush with the timing gear cover edge.

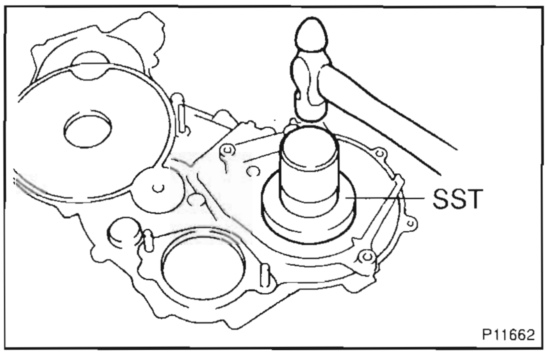
SST 09214–76011



2. **REPLACE SUPPLY PUMP DRIVE GEAR OIL SEAL**

(a) If the timing gear cover is removed from cylinder block:

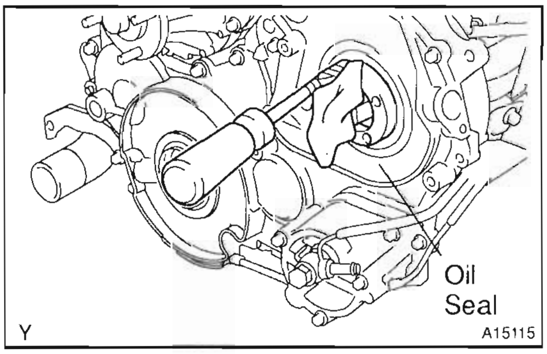
(1) Using a screwdriver and hammer, tap out the oil seal.



(2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.

SST 09223–78010

(3) Apply MP grease to the oil seal lip.

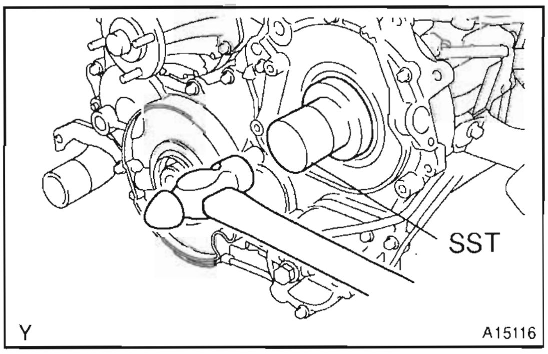


(b) If the timing gear cover is installed to the cylinder block:

(1) Using a screwdriver, pry out the oil seal.

NOTICE:

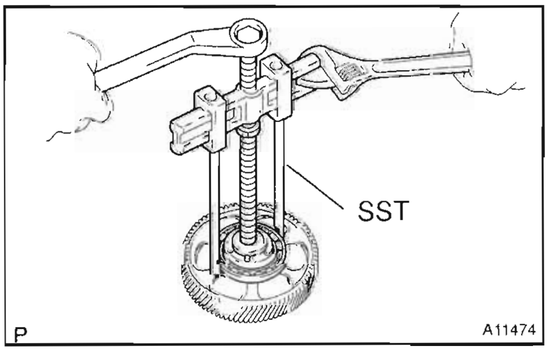
Be careful not to damage the supply pump drive gear. Tape the screwdriver tip.



(2) Apply MP grease to the oil seal lip.

(3) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.

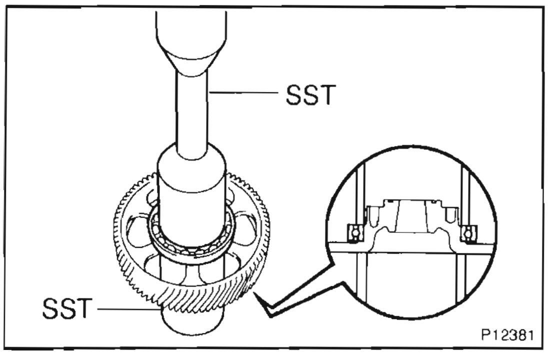
SST 09223–78010



3. **REPLACE RADIAL BALL BEARING**

(a) Using SST, remove the bearing.

SST 09950–40011 (09951–04010, 09952–04010, 09953–04020, 09954–04010, 09955–04041)



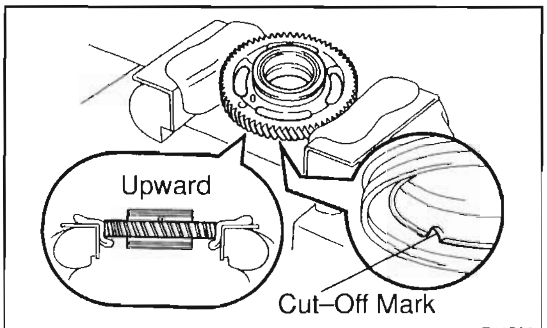
(b) Using SST and a press, press in a new bearing.
SST 09214–76011, 09223–00010

EM1M7–01

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.**



P11790

1. ASSEMBLE IDLER GEAR

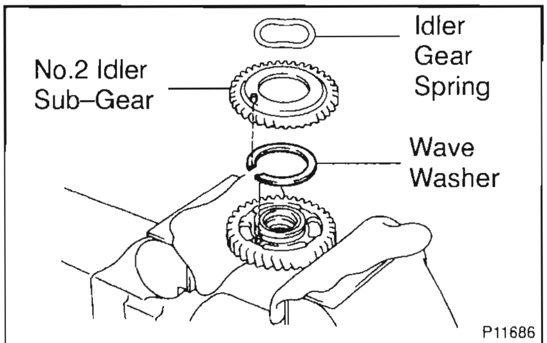
(a) Mount the idler gear in a vise.

HINT:

Install the idler gear with the cut–off mark facing downward.

NOTICE:

Be careful not to damage the gear.



P11686

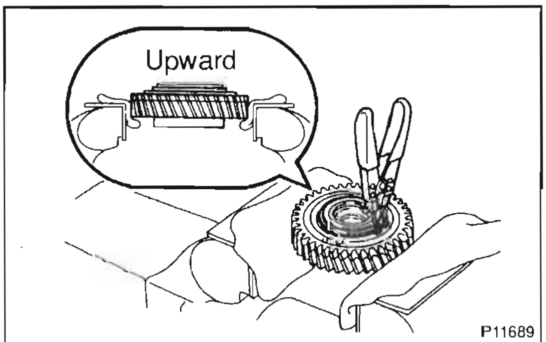
(b) Install the idler gear spring.

(c) Install the No.2 idler sub–gear.

(d) Install the wave washer.

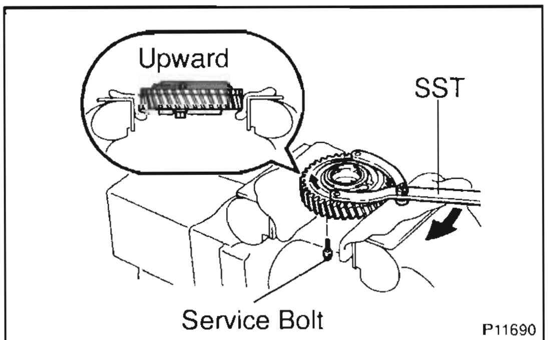
HINT:

Align the pins on the gears with the spring ends.



P11689

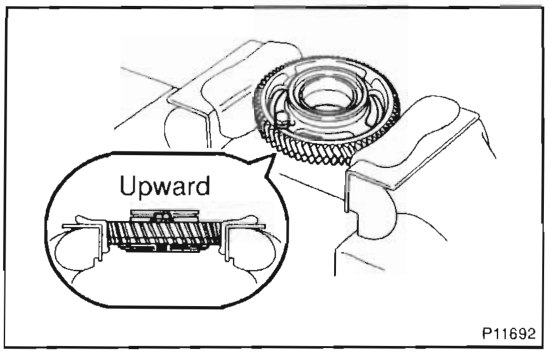
(e) Using snap ring pliers, install the snap ring.



P11690

(f) Using SST, align the holes of the idler gear and No.2 idler sub–gear by turning the No.2 idler sub–gear clockwise, and install a service bolt.
SST 09960–10010 (09962–01000, 09963–00600)

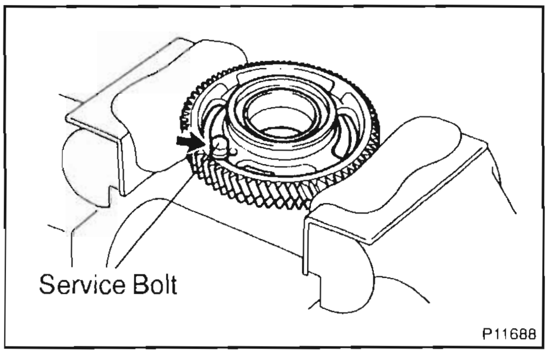
(g) Remove the idler gear assembly from the vice and turn it upside down.



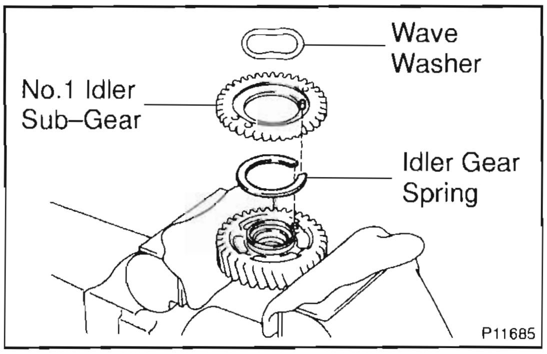
(h) Mount the idler gear and No.2 idler sub–gear in a vise.

NOTICE:

Be careful not to damage the gears.



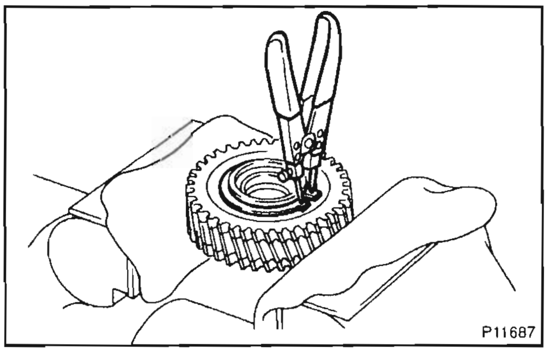
(i) Remove the service bolt.



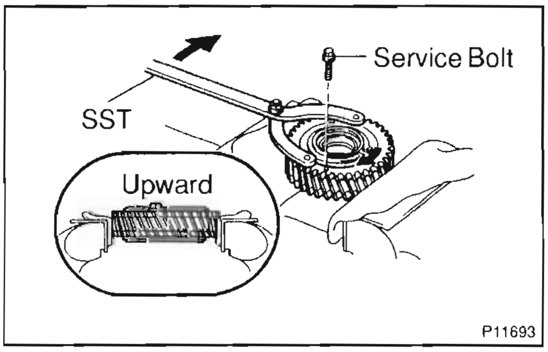
(j) Install the idler gear spring.
(k) Install the No.1 idler sub–gear.
(l) Install the wave washer.

HINT:

Align the pins on the gears with the spring ends.



(m) Using snap ring pliers, install the snap ring.

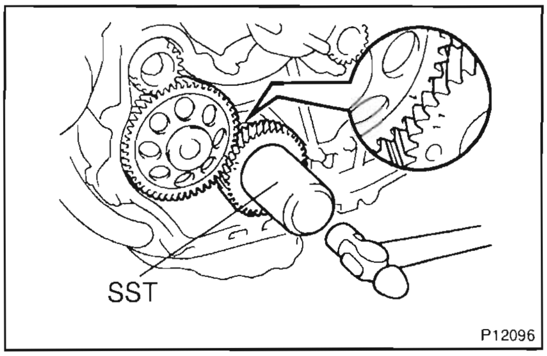


(n) Using SST, align the holes of the idler gear and No.1 idler sub–gear by turning the No.1 idler sub–gear clockwise, and install a service bolt.
SST 09960–10010 (09962–01000, 09963–00600)

2. INSTALL TIMING GEAR

NOTICE:

- **The matchmarks on each gear faces the front of the engine.**
- **Take care not to damage the gear teeth when removing and installing the gears. Do not use parts that are scratched or damaged, they cause noise.**



P12096

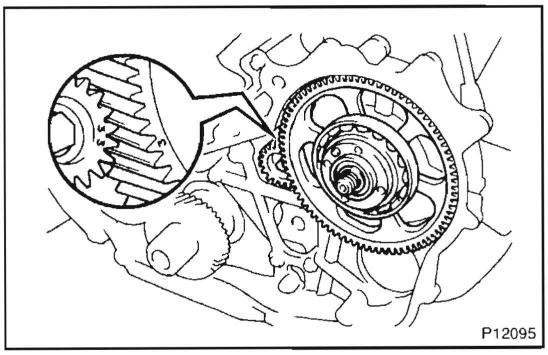
(a) Install the crankshaft timing gear.

(1) With the crankshaft key groove facing upward, install the crankshaft timing gear into the crankshaft.

(2) When doing this, the matchmarks of the oil pump drive shaft gear and crankshaft timing gear should be matched at "1".

(3) Using SST and a hammer, tap in the timing gear.

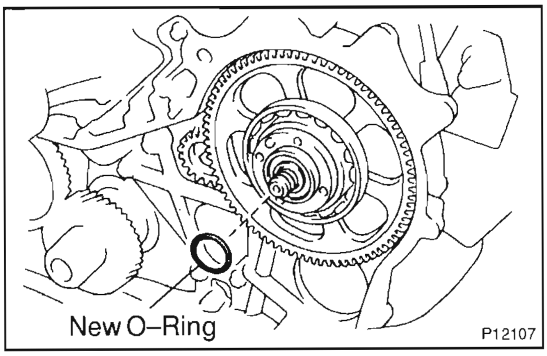
SST 09223–00010


P12095

(b) Install the supply pump drive gear.

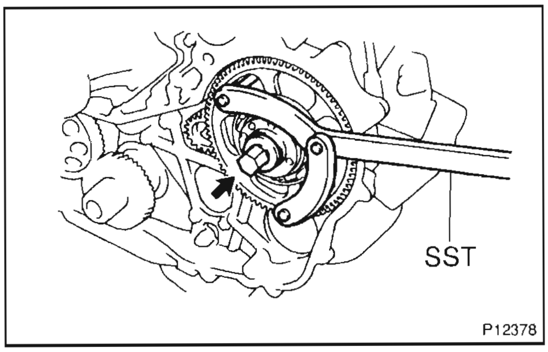
(1) Install the set key to the groove of the supply pump drive shaft.

(2) The matchmarks on the No.2 balance shaft driven gear should be aligned with "3" marks.



P12107

(3) Install a new O–ring to the supply pump drive gear.



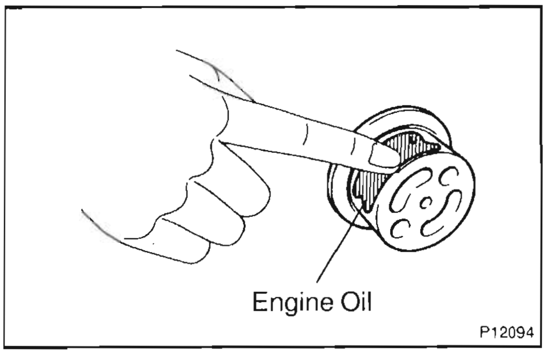
P12378

(4) Install the supply pump drive gear set nut.

(5) Using SST, torque the nut.

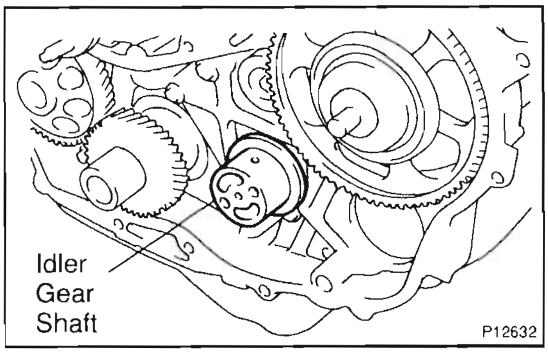
SST 09960–10010 (09962–01000, 09963–00600)

Torque: 103 N·m (1,050 kgf·cm, 76 ft·lbf)

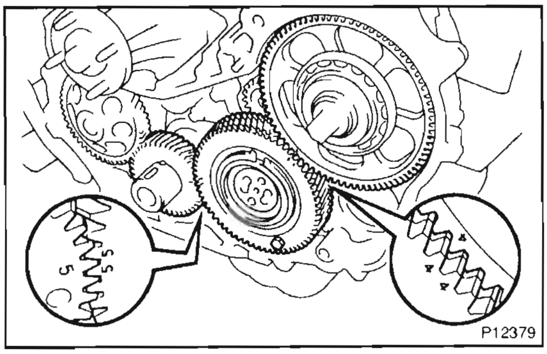


(c) Install the idler gear.

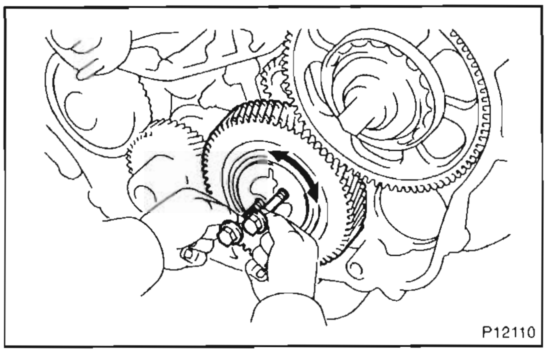
(1) Coat the idler gear shaft with engine oil as shown in the illustration.



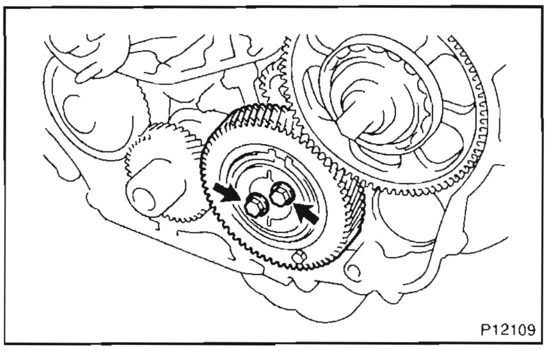
(2) Install the idler gear shaft to the cylinder block.



(3) Align the idler gear assembly timing marks "5" and "4" with the crankshaft timing gear mark "5" and supply pump drive gear timing mark "4" respectively, and mesh the gears.

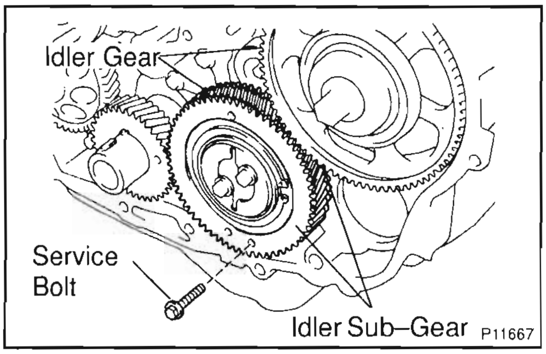


(4) Align the thrust plate set bolt holes.



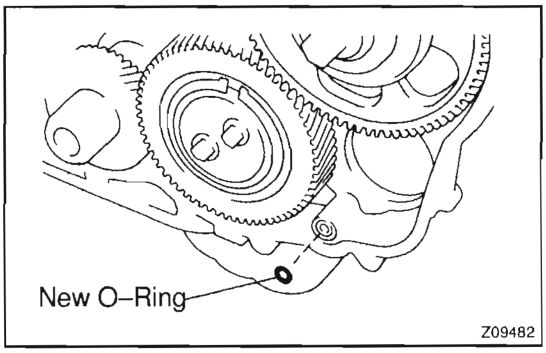
(5) Install the thrust plate with the 2 bolts. Torque the bolts.

Torque: 50 N·m (510 kgf·cm, 37 ft·lbf)



(6) Remove the service bolt.

(d) Install the crank angle sensor plate.

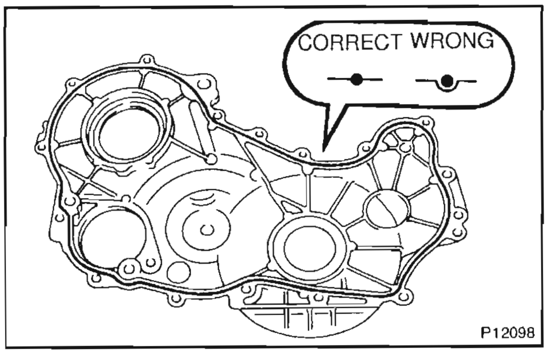


3. INSTALL TIMING GEAR COVER

(a) Install a new O–ring to the timing gear case.

(b) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the timing gear cover and cylinder block.

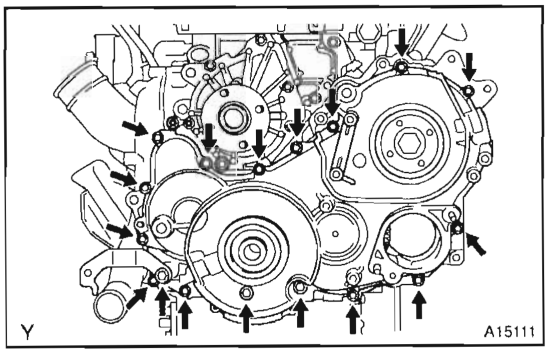
- Using a razor blade and gasket scraper, remove all the old packing (FIPG) material from the gasket surfaces and sealing groove.
- Thoroughly clean all components to remove all the loose material.
- Using a non–residue solvent, clean both sealing surfaces.



(c) Apply seal packing to the timing gear cover as shown in the illustration.

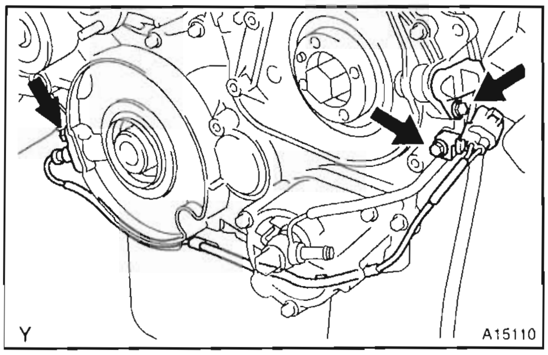
Seal packing: Part No. 08826–00080 or equivalent

- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

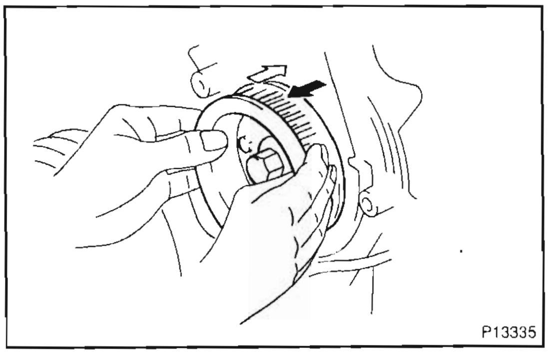


(d) Install the timing gear cover with the 14 bolts and 2 nuts.

Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)

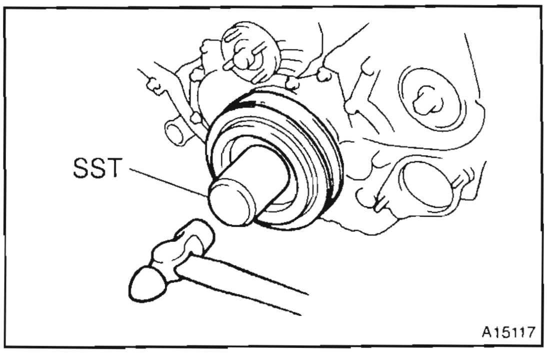


(e) Connect the vacuum pipe with the bolt, nut and washer.
Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)
(f) Install a new O–rings to crankshaft position sensor and camshaft position sensor.
(g) Install the crankshaft position sensor with the bolt, and connect the 3 clamps.
Torque: 8.5 N·m (87 kgf·cm, 75 in.·lbf)
(h) Install the camshaft position sensor with the bolt.
Torque: 8.5 N·m (87 kgf·cm, 75 in.·lbf)

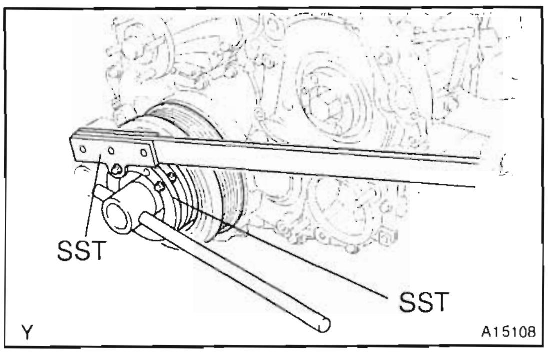


4. CHECK SUPPLY PUMP DRIVE SHAFT THRUST CLEARANCE
(a) Temporarily install the No.2 camshaft timing pulley and flange with the 4 bolts.
(b) Move the No.2 camshaft timing pulley back and forth to check that the supply pump drive shaft has sufficient thrust clearance.
Reference: 0.15 – 0.55 mm (0.0059 – 0.0217 in.)

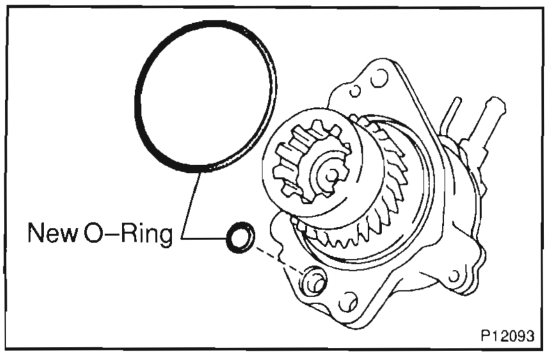
If the thrust clearance is not sufficient, loosen the 2 supply pump nuts and 3 pump stay bolts, then retighten them.
If the thrust clearance is still not sufficient, remove the timing gear cover and then reinstall it.



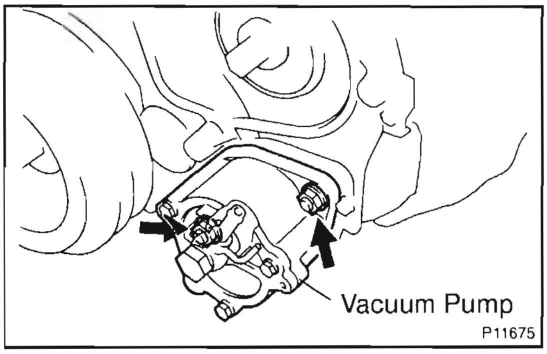
5. INSTALL CRANKSHAFT PULLEY
(a) Align the pulley set key with the key groove of the pulley.
(b) Using SST and a hammer, tap in the pulley.
SST 09214–60010



(c) Using SST, install and torque the plate bolt.
SST 09213–58012, 09330–00021
Torque: 365 N·m (3,700 kgf·cm, 269 ft·lbf)

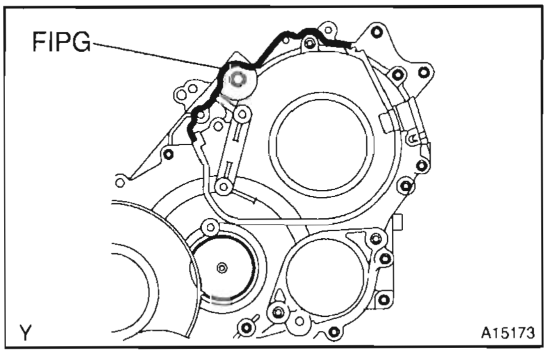


6. **INSTALL VACUUM PUMP**
(a) Install 2 new O–rings to the vacuum pump.

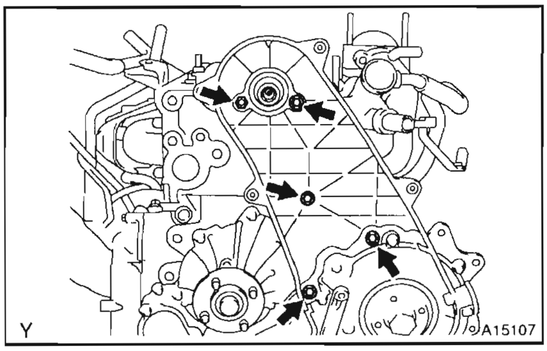


(b) Install the vacuum pump with the 2 nuts.
Torque: 21 N·m (214 kgf·cm, 15 ft·lbf)

7. **INSTALL TIMING BELT NO. 2 COVER**
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of timing gear cover and timing belt No. 2 cover.
- 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 timing gear cover 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 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(c) Install the timing belt No. 2 cover with the 4 bolts and nut.
Torque: 10 N·m (102 kgf·cm, 7 ft·lbf)

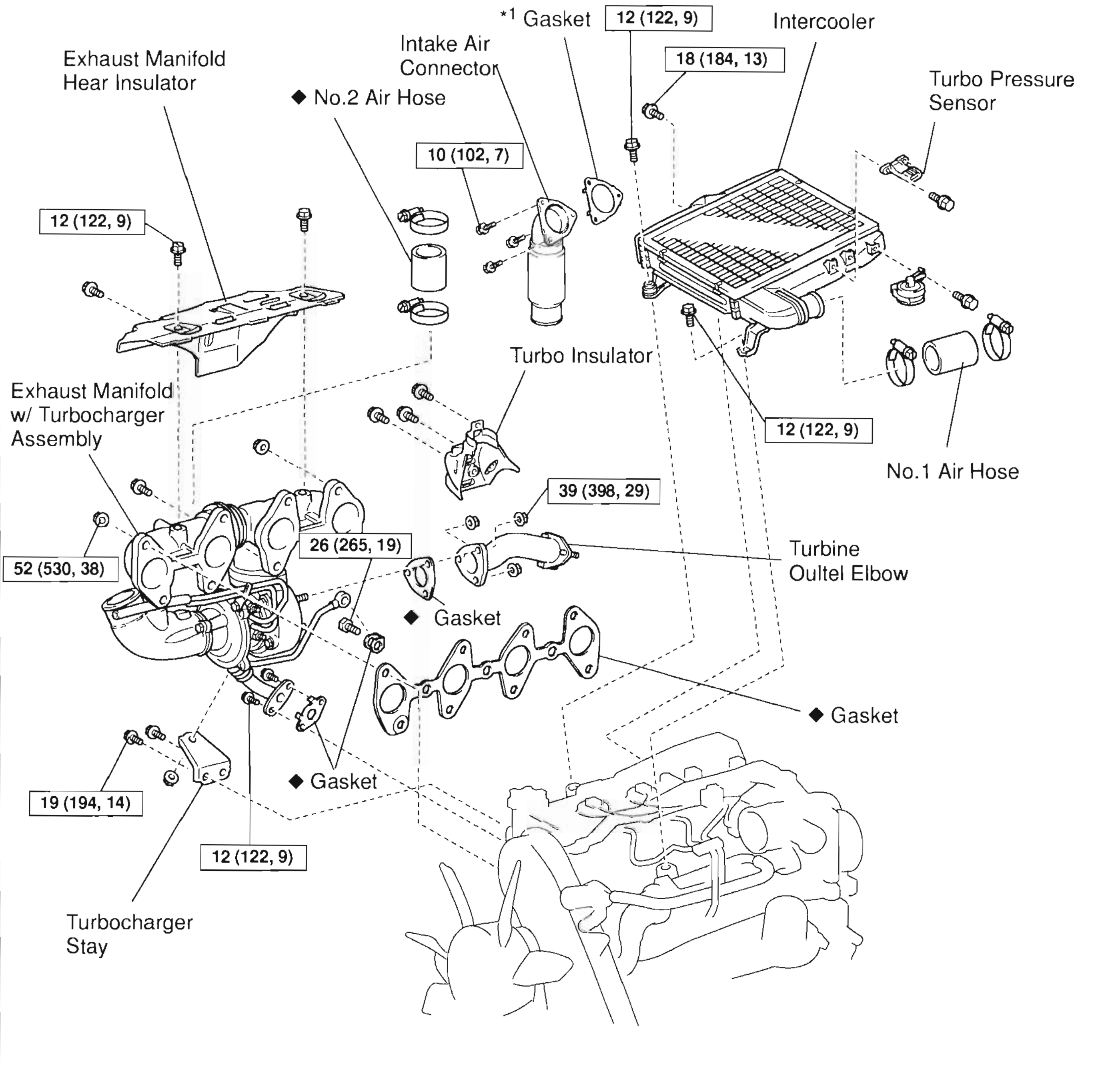
8. **INSTALL TIMING BELT AND PULLEYS**
(See page EM–16)

9. **INSTALL WATER PUMP PULLEY, FAN AND DRIVE BELT (See page CO–8)**

CYLINDER HEAD

COMPONENTS

EMISC–02

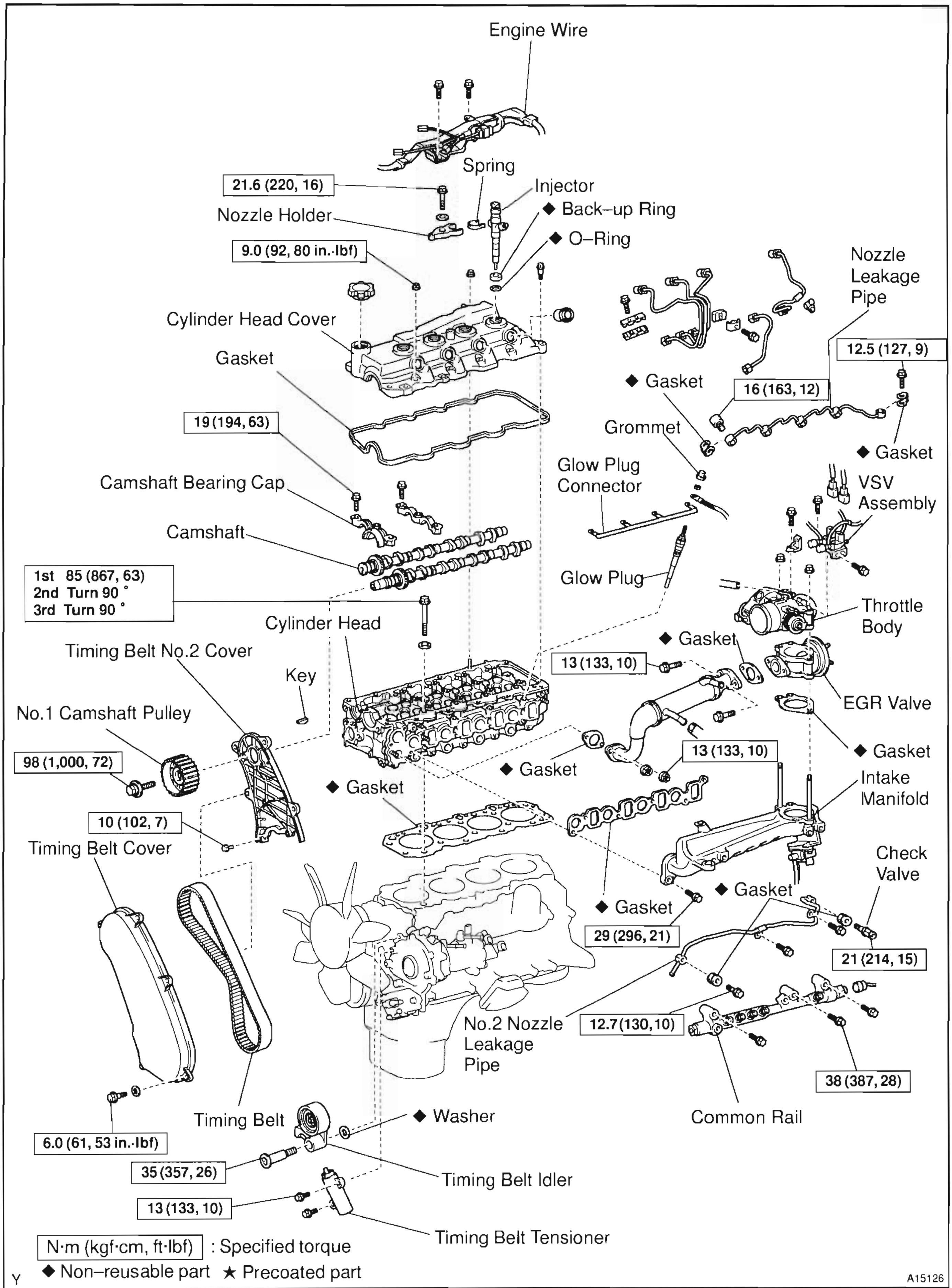


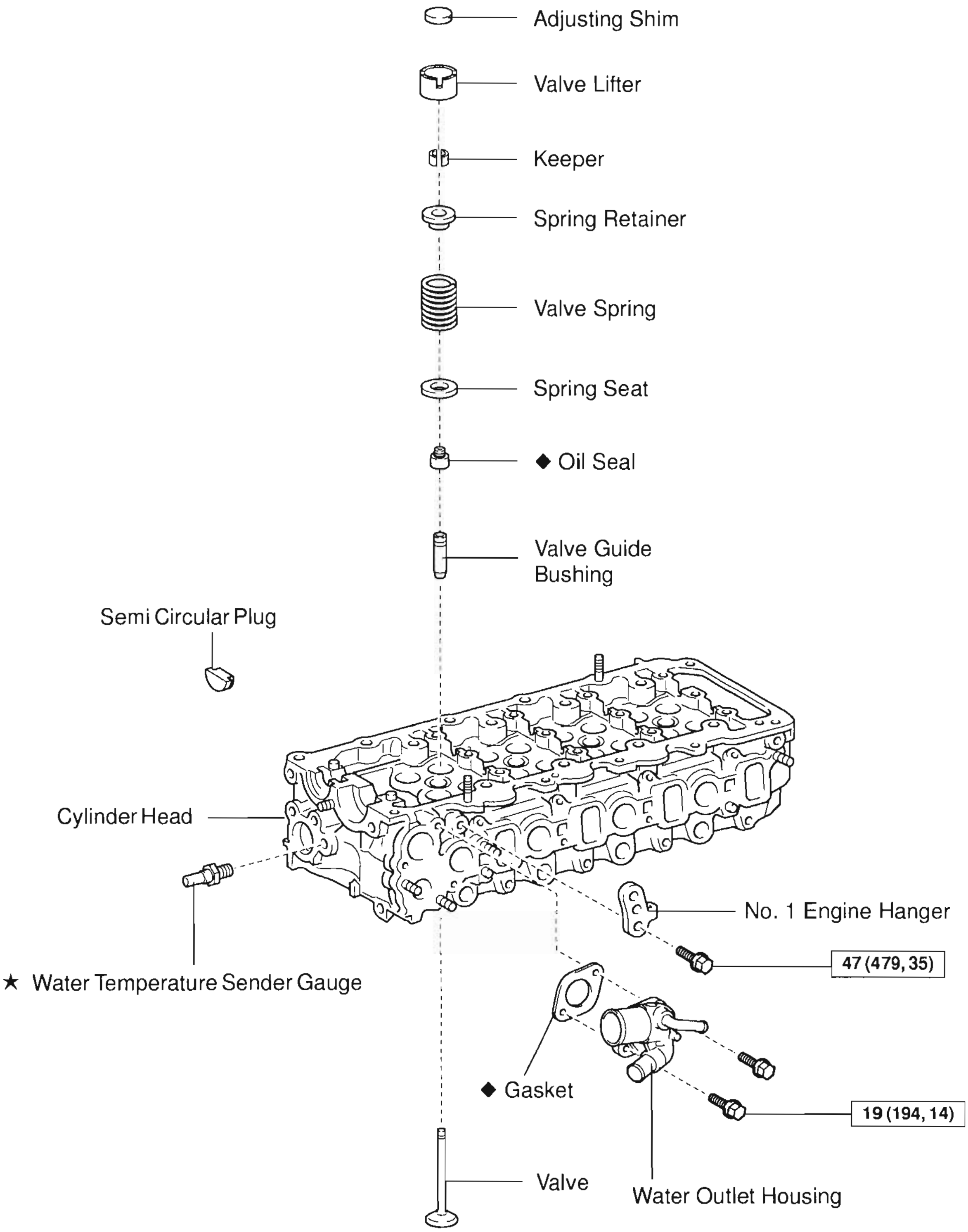
| N·m (kgf·cm, ft·lbf) | : Specified torque

◆ Non–reusable part
*1 Replace only if damaged

Y

A15125


Engine Wire
Spring
21.6 (220, 16)
Injector
Nozzle Holder
◆ Back–up Ring
◆ O–Ring
9.0 (92, 80 in.·lbf)
Nozzle Leakage Pipe
Cylinder Head Cover
Gasket
12.5 (127, 9)
◆ Gasket
16 (163, 12)
19 (194, 63)
Grommet
◆ Gasket
Glow Plug Connector
Camshaft Bearing Cap
VSV Assembly
Camshaft
1st 85 (867, 63)
2nd Turn 90°
3rd Turn 90°
Glow Plug
Throttle Body
Cylinder Head
◆ Gasket
Timing Belt No.2 Cover
13 (133, 10)
Key
EGR Valve
No.1 Camshaft Pulley
◆ Gasket
13 (133, 10)
98 (1,000, 72)
◆ Gasket
Intake Manifold
◆ Gasket
10 (102, 7)
Timing Belt Cover
Check Valve
◆ Gasket
◆ Gasket
29 (296, 21)
21 (214, 15)
No.2 Nozzle Leakage Pipe
12.7 (130, 10)
38 (387, 28)
Timing Belt
◆ Washer
Common Rail
6.0 (61, 53 in.·lbf)
35 (357, 26)
Timing Belt Idler
13 (133, 10)
Timing Belt Tensioner
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part ★ Precoated part
Y
A15126



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

★ Precoated part

Y A15127

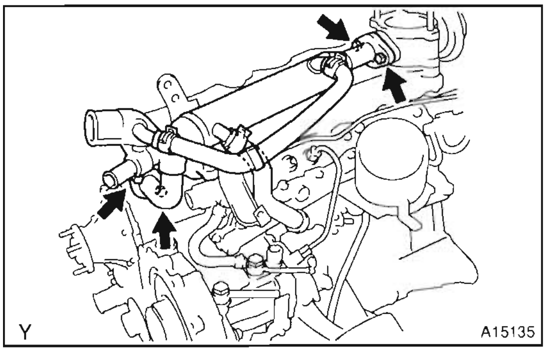
EM1MB–01

REMOVAL

NOTICE:

When removing the injection pipes, clean them up with a brush and compressed air.

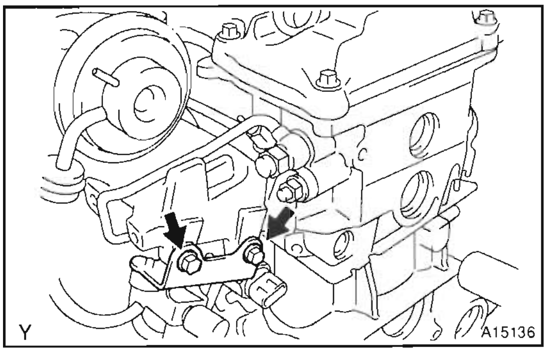
1. **DRAIN ENGINE COOLANT**
2. **REMOVE INTERCOOLER (See page TC–11)**
3. **REMOVE TURBOCHARGER AND EXHAUST MANIFOLD ASSEMBLY (See page TC–5)**
4. **DISCONNECT ENGINE WIRE**
5. **REMOVE DIESEL THROTTLE BODY (See page ED–5)**
6. **REMOVE INJECTION PIPE (See page FU–6)**
7. **REMOVE FUEL INLET PIPE (See page FU–16)**
8. **REMOVE CYLINDER HEAD COVER (See page EM–11)**
9. **REMOVE INJECTORS (See page FU–6)**



10. **REMOVE EGR COOLER PIPE**

(a) Remove the 2 water hoses.

(b) Remove the 2 bolts, nuts, EGR cooler pipe and 2 gaskets.

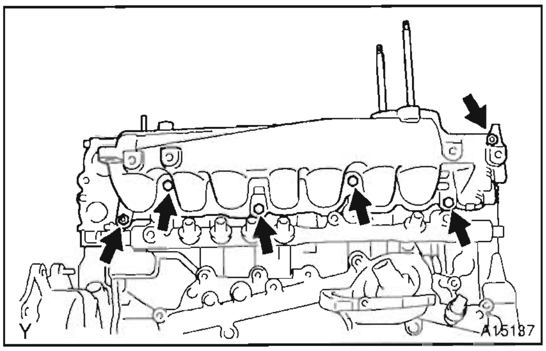


11. **REMOVE EVRV**

(a) Disconnect the vacuum hose, and remove the 2 bolts and E–VRV.

(b) Remove the EGR valve and gasket.

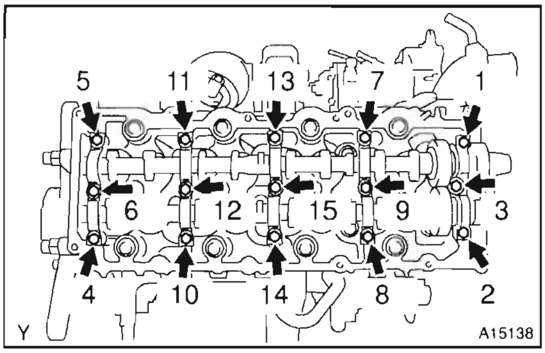
12. **REMOVE OIL FILTER (See page LU–2)**
13. **REMOVE LEAKAGE PIPE NO. 2 (See page FU–6)**



14. **REMOVE INTAKE MANIFOLD**

Remove the 4 bolts, 2 nuts, intake manifold and gasket.

15. **REMOVE GLOW PLUG (See page ST–1)**
16. **REMOVE COMMON RAIL (See page FU–21)**

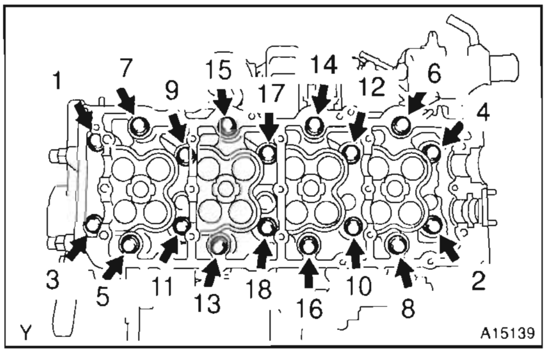


17. REMOVE CAMSHAFT

(a) Uniformly loosen and remove the 15 bolts in several passes, in the sequence shown.

(b) Remove the 5 camshaft bearing caps.

(c) Remove the intake and exhaust camshafts.



18. REMOVE CYLINDER HEAD

(a) Uniformly loosen and remove the 18 cylinder head bolts, in several passes, in the sequence shown.

NOTICE:

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 head on wooden blocks on a bench.

HINT:

If the cylinder head is difficult to lift off, pry with a screwdriver between the cylinder head and block.

NOTICE:

Be careful not to damage the contact surfaces of cylinder head and block.

EM1MC–01

DISASSEMBLY

1. REMOVE WATER OUTLET HOUSING

Remove the 2 bolts, water outlet housing and gasket.

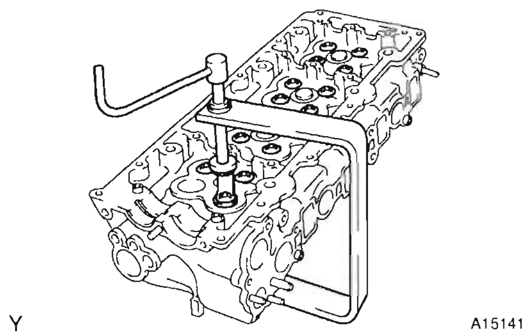
2. REMOVE ENGINE HANGER NO. 1

3. REMOVE SEMI CIRCULAR PLUG

4. REMOVE VALVE LIFTERS AND SHIMS

HINT:

Arrange the valve lifters and shims in correct order.



Y A15141

5. REMOVE VALVES

(a) Using SST, compress the valve spring and remove the 2 keepers.
SST 09202–70020 (09202–00010)

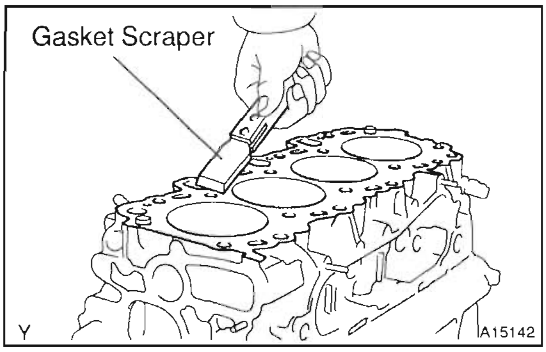
(b) Remove the spring retainer, valve spring, valve and spring seat.

HINT:

Arrange the valves, valve springs, spring seats and spring retainers in correct order.

(c) Using needle–nose pliers, remove the oil seal.

EM1MD-01



INSPECTION

1. **CLEAN TOP SURFACES OF PISTONS AND CYLINDER BLOCK**

(a) Turn the crankshaft, and bring each piston to the top dead center (TDC). Using a gasket scraper, remove all the carbon from the piston top surface.

(b) Remove all the gasket material from the top of the cylinder block.

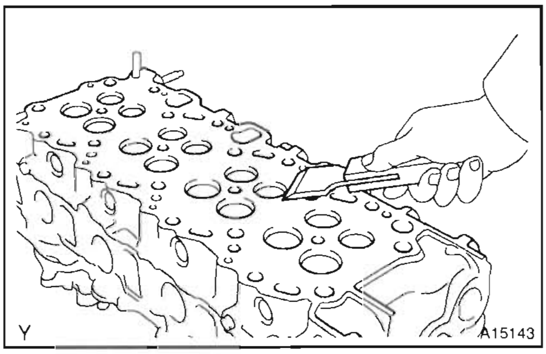
NOTICE:

Be careful not to scratch the surfaces.

(c) Using compressed air, blow carbon and oil from the bolt holes.

CAUTION:

Protect your eyes when using high–compressed air.

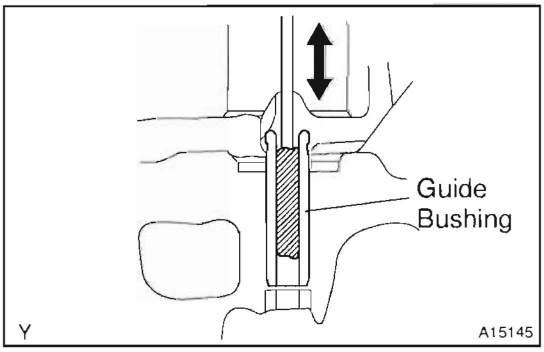


2. **REMOVE GASKET MATERIAL**

Using a gasket scraper, remove all the gasket material from the cylinder block contact surface.

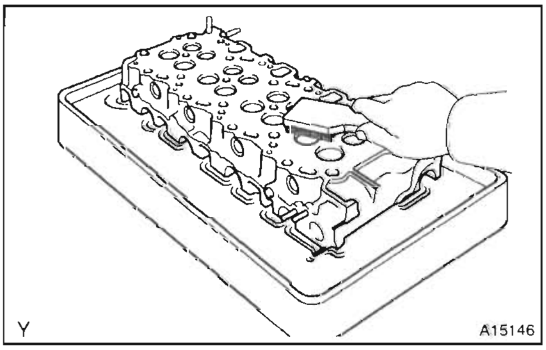
NOTICE:

Be careful not to scratch the cylinder block contact surface.



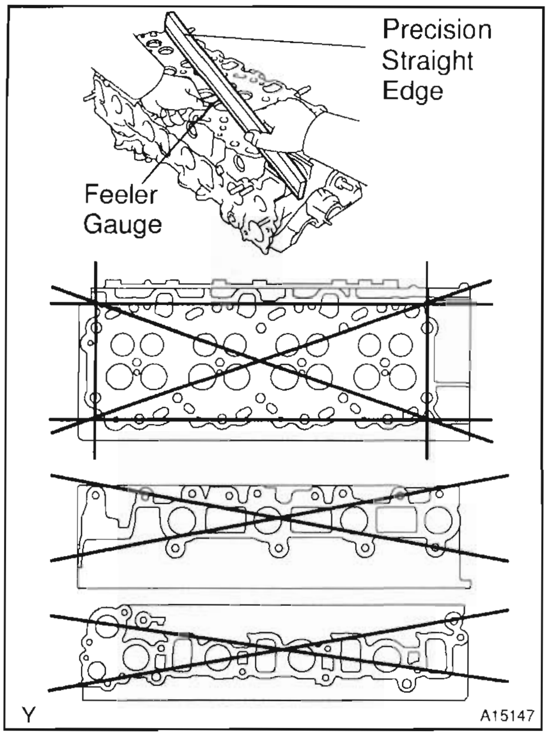
3. **CLEAN VALVE GUIDE BUSHINGS**

Using a valve guide bushing brush and solvent, clean all the guide bushings.



4. **CLEAN CYLINDER HEAD**

Using soft brush and solvent, thoroughly clean the cylinder head.

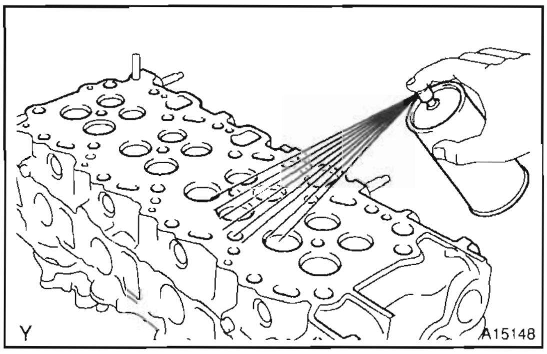


5. INSPECT FOR FLATNESS

Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and manifolds for warpage.

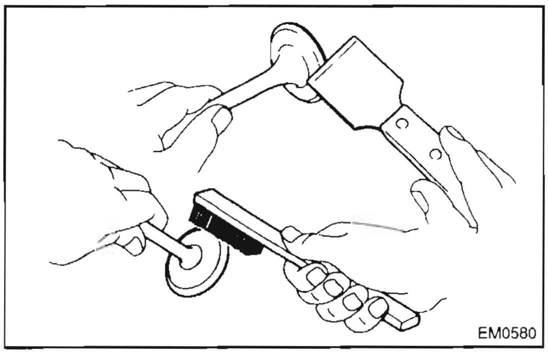
Maximum warpage: 0.15 mm (0.0059 in.)

If warpage is greater than maximum, replace the cylinder head.



6. INSPECT FOR CRACKS

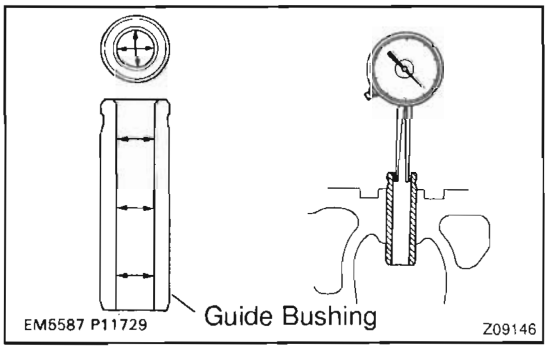
Using a dye penetrate, check the combustion chambers, intake ports, exhaust ports and surface contacting the cylinder block. If cracked, replace the cylinder head.



7. CLEAN VALVES

(a) Using a gasket scraper, chip off any carbon from the valve head.

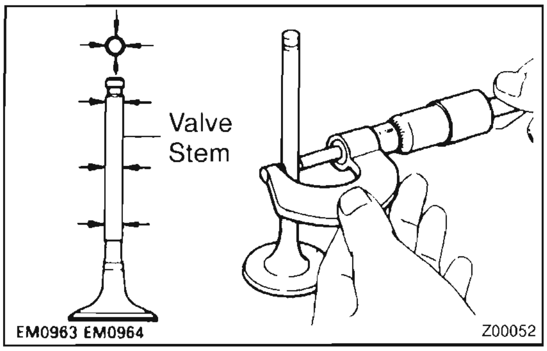
(b) Using a wire brush, thoroughly clean the valve.



8. 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 (0.23661 – 0.23740 in.)



(b) Using a micrometer, measure the diameter of the valve stem.
Valve stem diameter:

Intake	5.970 – 5.985 mm (0.23504 – 0.23563 in.)
Exhaust	5.960 – 5.975 mm (0.23465 – 0.23524 in.)

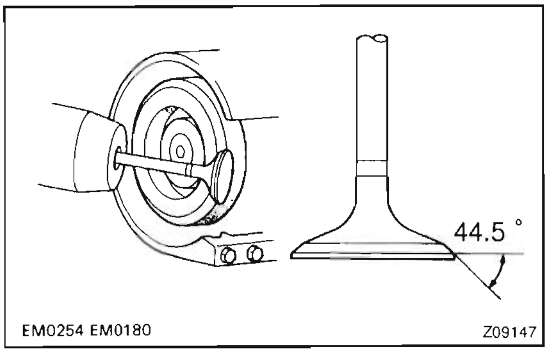
(c) Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.
Standard oil clearance:

Intake	0.025 – 0.060 mm (0.0010 – 0.0024 in.)
Exhaust	0.035 – 0.070 mm (0.0014 – 0.0028 in.)

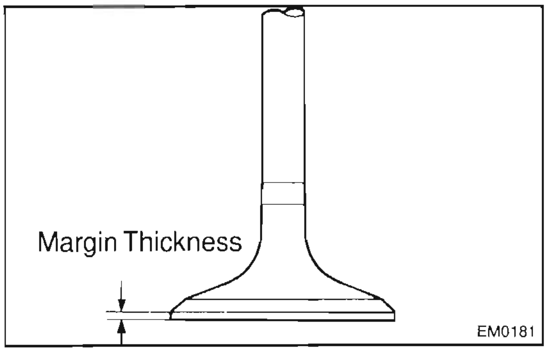
Maximum oil clearance:

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–52)



9. **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°



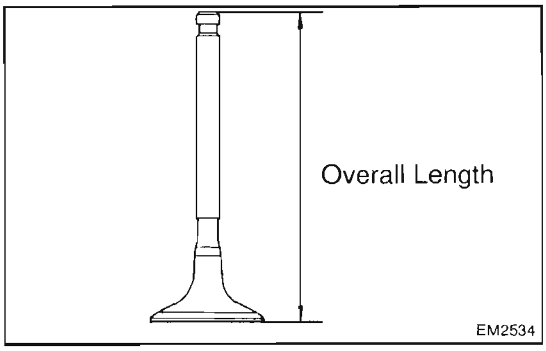
(c) Check the valve head margin thickness.
Standard margin thickness:

Intake	1.1 mm (0.043 in.)
Exhaust	1.2 mm (0.047 in.)

Minimum margin thickness:

Intake	0.6 mm (0.023 in.)
Exhaust	0.7 mm (0.027 in.)

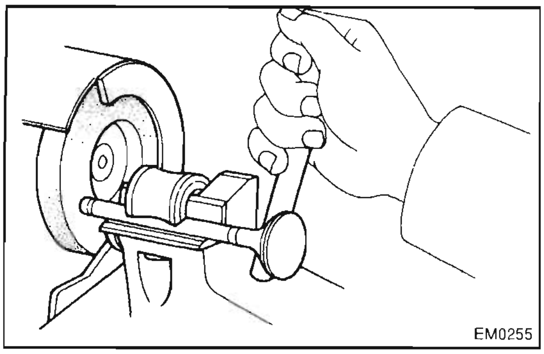
If the margin thickness is less than minimum, replace the valve.



(d) Check the valve overall length.
Standard overall length:

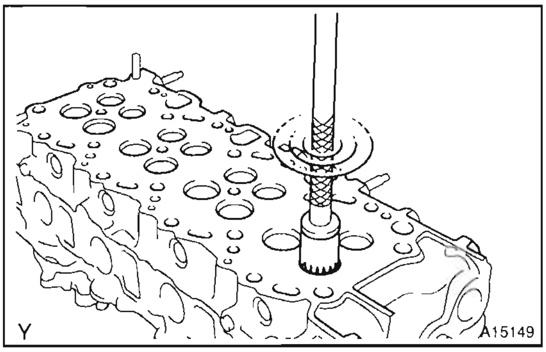
Intake	105.15 – 105.75 mm (4.1398 – 4.1634 in.)
Exhaust	105.02 – 105.62 mm (4.1346 – 4.1583 in.)

Minimum overall length:
Intake: 104.65 mm (4.1201 in.)
Exhaust: 104.52 mm (4.1150in.)
If the overall length is less than minimum, replace the valve.



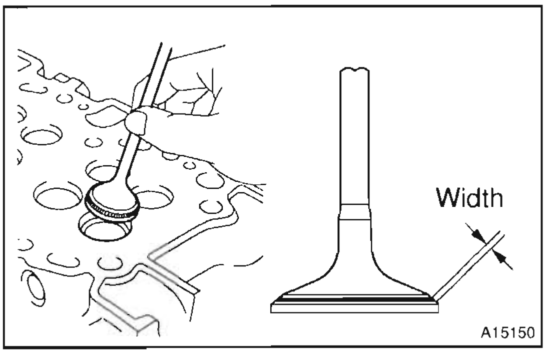
(e) Check the surface of the valve stem tip for wear.
If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

NOTICE:
Do not grind off more than minimum overall length.



10. INSPECT AND CLEAN VALVE SEATS

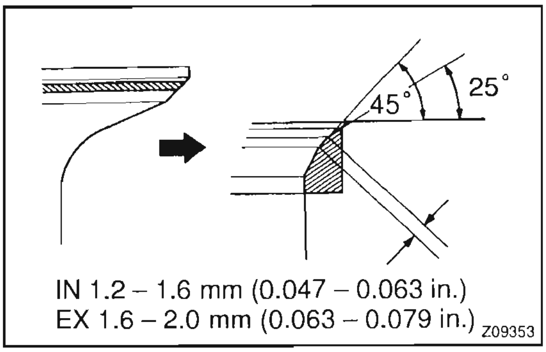
(a) Using a 45° carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.



(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.

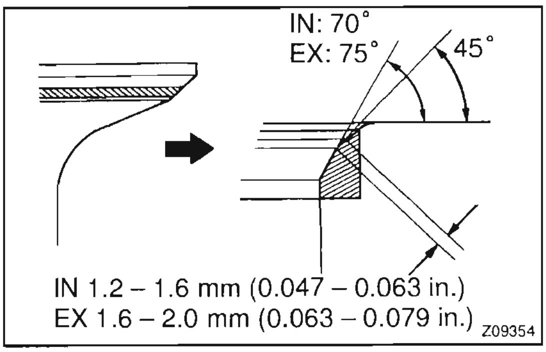
(c) Check the valve face and seat for the following:
- If blue appears 360° around the valve face, the valve is concentric. If not, replace the valve.
- If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
- Check that the seat contact is in the middle 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.)



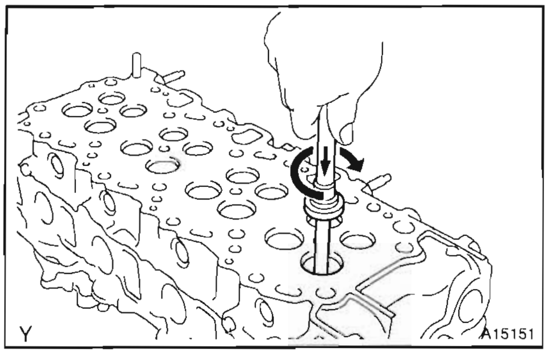
If not, correct the valve seats as follows:

(1) If the seating is too high on the valve face, use 25° and 45° cutters to correct the seat.

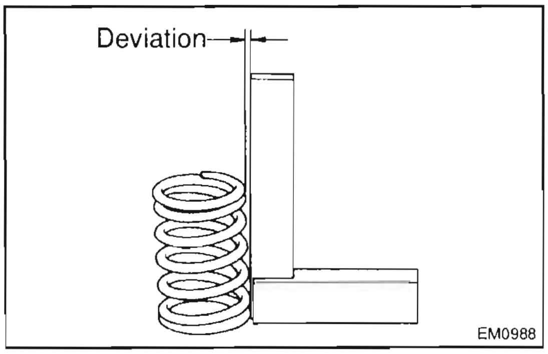


(2) Intake:
If the seating is too low on the valve face, use 70° and 45° cutters to correct the seat.

(3) Exhaust:
If the seating is too low on the valve face, use 75° and 45° cutters to correct the seat.



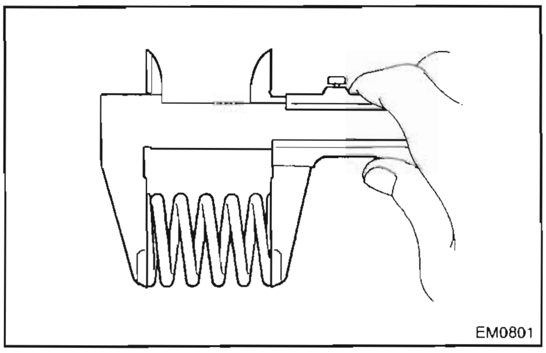
(d) Hand–lap the valve and valve seat with an abrasive compound.
(e) After hand–lapping, clean the valve and valve seat.



11. INSPECT VALVE SPRINGS

(a) Using a steel square, measure the deviation of the valve spring.
Maximum deviation: 2.0 mm (0.079 in.)

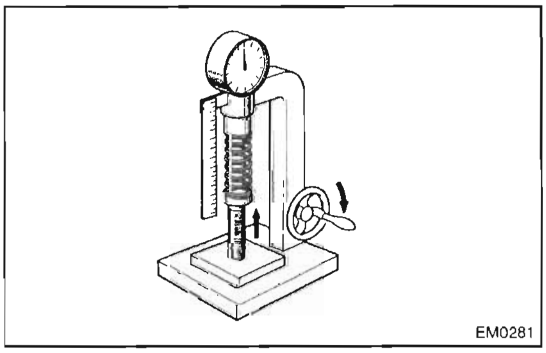
If the deviation is greater than maximum, replace the valve spring.



(b) Using a vernier caliper, measure the free length of the valve spring.
Free length:

Paint Color	
Blue	46.8 mm (1.843 in.)
None	46.5 mm (1.831 in.)

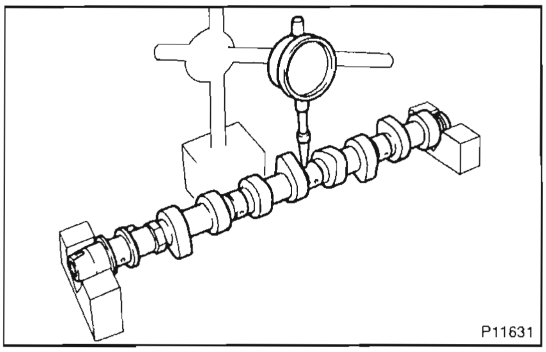
If the free length is not as specified, replace the valve spring.



(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.
Installed tension: at 33.1 mm (1.303 in.)

If the installed tension is not as specified, replace the valve spring.

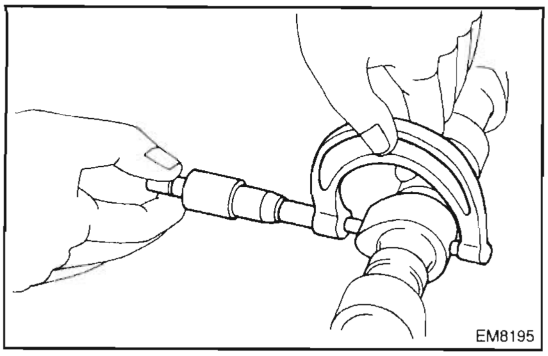
Paint Color	
Blue	149.9 – 166.1 N (15.3 – 16.9 kgf, 33.7 – 37.4 lbf)
None	150.2 – 165.8 N (15.3 – 16.9 kgf, 33.8 – 37.3 lbf)



12. INSPECT CAMSHAFT FOR RUNOUT

(a) Place the camshaft on V–blocks.
(b) Using a dial indicator, measure the circle runout at the center journal.
Maximum circle runout: 0.03 mm (0.0012 in.)

If the circle runout is greater than maximum, replace the camshaft.



13. **INSPECT CAM LOBES**

Using a micrometer, measure the cam lobe height.

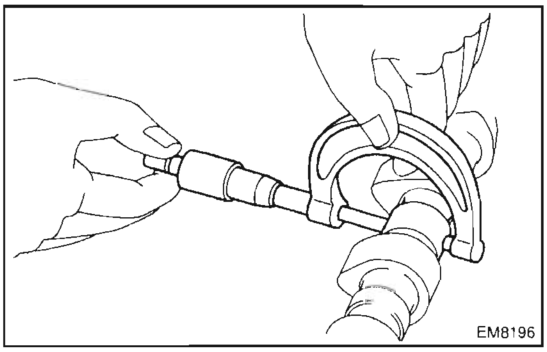
Standard cam lobe height:

Intake	47.180 – 47.280 mm (1.85748 – 1.86141 in.)
Exhaust	48.070 – 48.170 mm (1.89252 – 1.89645 in.)

Minimum cam lobe height:

Intake	46.76 mm (1.8409 in.)
Exhaust	47.65 mm (1.8760 in.)

If the cam lobe height is less than minimum, replace the camshaft.



14. **INSPECT CAMSHAFT JOURNALS**

Using a micrometer, measure the journal diameter.

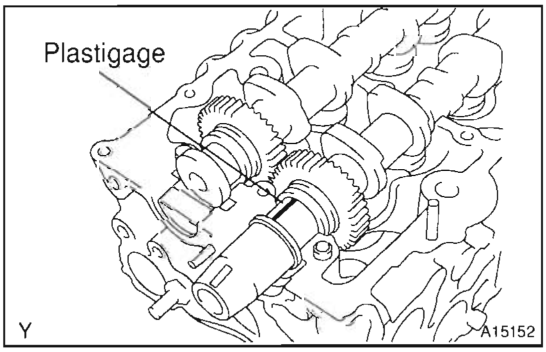
Journal diameter:
27.969 – 27.985 mm (1.1011 – 1.1018 in.)

If the journal diameter is not as specified, check the oil clearance.

15. **INSPECT CAMSHAFT BEARINGS**

Check the bearings for flaking and scoring.

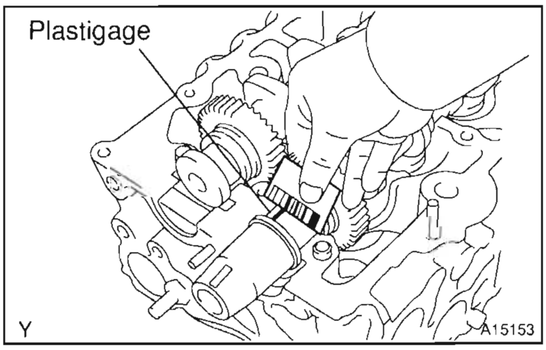
If the bearings are damaged, replace the bearing caps and cylinder head as a set.



16. **INSPECT CAMSHAFT JOURNAL OIL CLEARANCE**

(a) Clean the bearing caps and camshaft journals.
(b) Place the camshaft on the cylinder head.
(c) Lay a strip of Plastigage across each of the camshaft journals.
(d) Install the bearing caps. (See page EM–56)
Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)

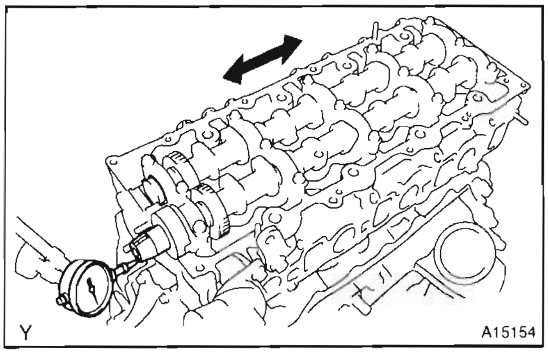
NOTICE:
Do not turn the camshaft.



(e) Remove the bearing caps.
(f) Measure the Plastigage at its widest point.
Standard oil clearance:
0.025 – 0.062 mm (0.0010 – 0.0024 in.)
Maximum oil clearance: 0.10 mm (0.039 in.)

If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(g) Completely remove the Plastigage.



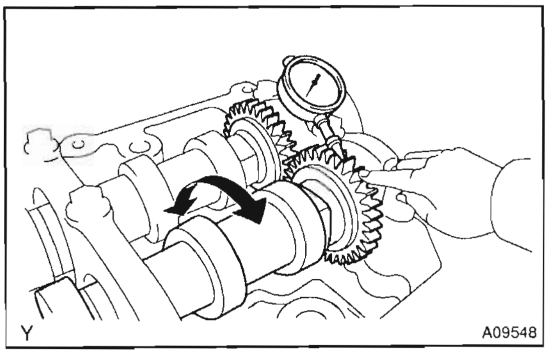
17. INSPECT CAMSHAFT THRUST CLEARANCE

(a) Install the camshaft. (See page EM–56)

(b) Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

Standard thrust clearance:
0.035 – 0.185 mm (0.00138 – 0.00728 in.)
Maximum thrust clearance: 0.25 mm (0.0098 in.)

If the thrust clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.



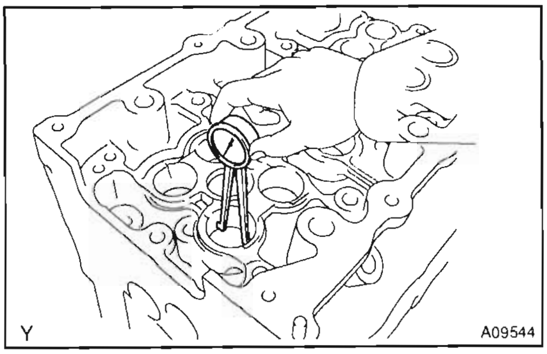
18. INSPECT CAMSHAFT GEAR BACKLASH

(a) Install the camshafts. (See page EM–56)

(b) Using a dial indicator, measure the backlash.

Standard backlash:
0.035 – 0.089 mm (0.00138 – 0.00350 in.)
Maximum backlash: 0.189 mm (0.00744 in.)

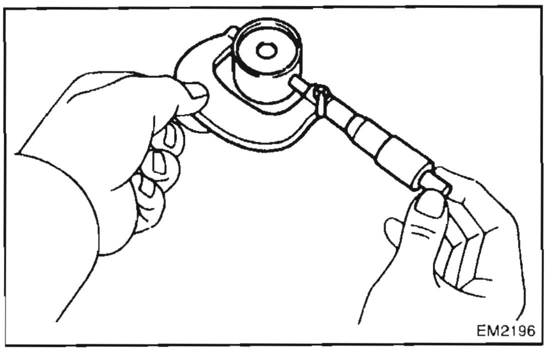
If the backlash is greater than maximum, replace the camshafts.



19. INSPECT VALVE LIFTERS AND LIFTER BORES

(a) Using a caliper qugem measure the lifter bore diameter of the cylinder head.

Lifter diameter:
31.000 – 31.021 mm (1.22047 – 1.22130in.)



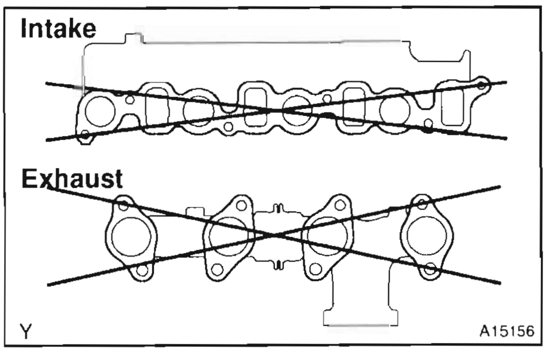
(b) Using a micrometer, measure the lifter diameter.

Lifter diameter:
30.966 – 30.976 mm (1.21913 – 1.21953 in.)

(c) Substract the lifter diameter measurement from the lifter bore diameter measurement.

Standard oil clearance:
0.024 – 0.055 mm (0.00094 – 0.00217 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.

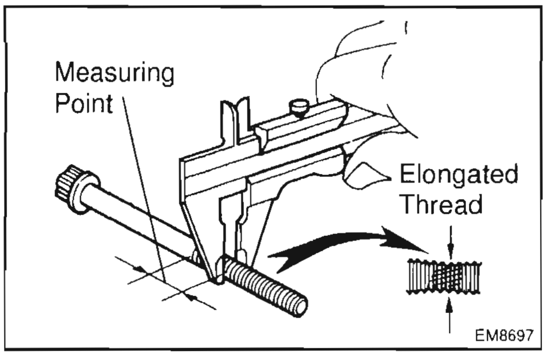


20. INSPECT INTAKE AND EXHAUST MANIFOLDS

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage: 0.40 mm (0.0157 in.)

If warpage is greater than maximum, replace the manifold.



21. INSPECT CYLINDER HEAD BOLTS

Using vernier calipers, measure the minimum outer diameter of the compressed thread at the measuring point.

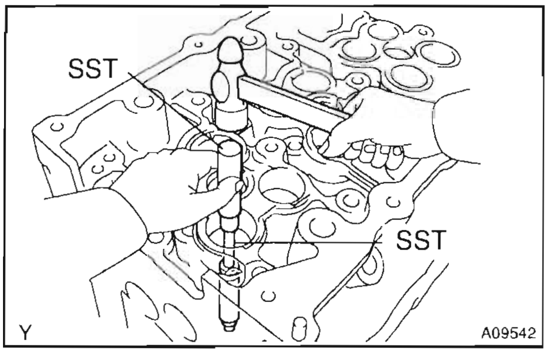
Standard outer diameter:
11.8 – 12.0 mm (0.465 – 0.472 in.)
Minimum outer diameter: 11.6 mm (0.457 in.)

If the outer diameter is less than minimum, replace the bolt.

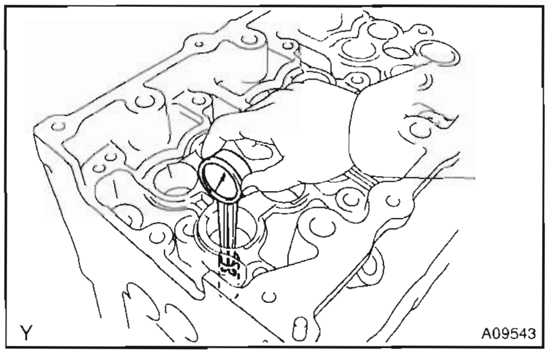
EM1ME-01

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 cylinder head.

Both intake and exhaust

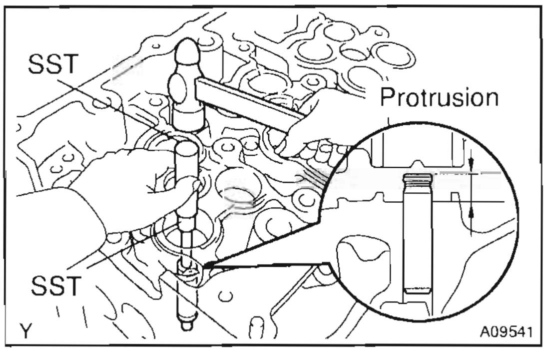
Bushing bore diameter mm (in.)	Bushing size
10.985 – 11.006 (0.4325 – 0.4333)	Use STD
11.035 – 11.056 (0.4344 – 0.4353)	Use O/S 0.05

V03700

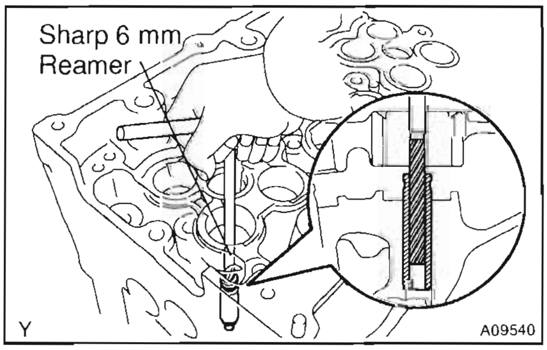
(c) Select a new guide bushing (STD or O/S 0.05).
If the bushing bore diameter of the cylinder head is greater than 11.006 mm (0.4333 in.), machine the bushing bore to the following dimension:

Rebored cylinder head bushing bore dimension:
11.035 – 11.056 mm (0.4344 – 0.4353 in.)

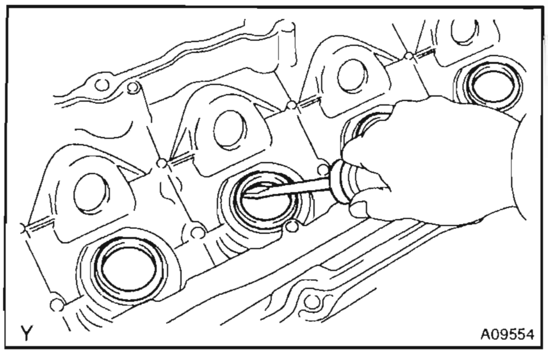
If the bushing bore diameter of the cylinder head is greater than 13.077 mm (0.5148 in.), replace the cylinder head.



(d) Using SST and a hammer, tap in a new guide bushing until there is 10.3 – 10.7 mm (0.406 – 0.421 in.) protruding from the cylinder head.
SST 09201–10000 (09201–01060) 09950–70010 (09951–07100)



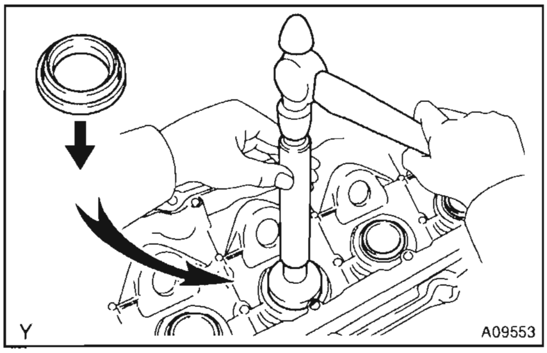
(e) Using a sharp 6 mm reamer, ream the guide bushing to obtain the standard specified clearance (See page EM–44) between the guide bushing and valve stem.



Y A09554

2. REPLACE NOZZLE HOLDER GASKETS

(a) Using a screwdriver, pry off the nozzle holder gasket.



Y A09553

(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)

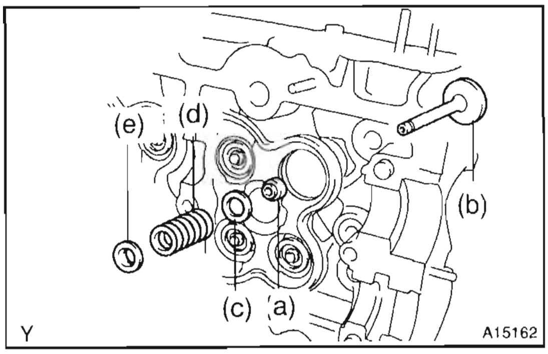
(c) Apply a light coat of MP grease to the nozzle holder gasket lip.

EMIMF–01

REASSEMBLY

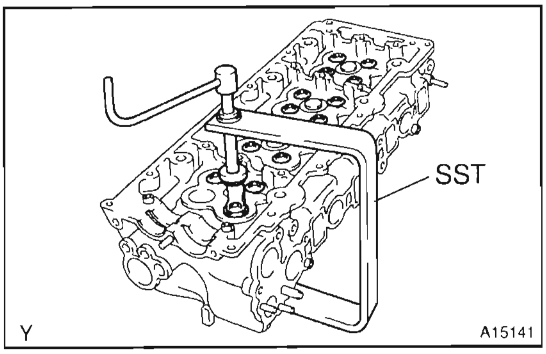
HINT:

- 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.

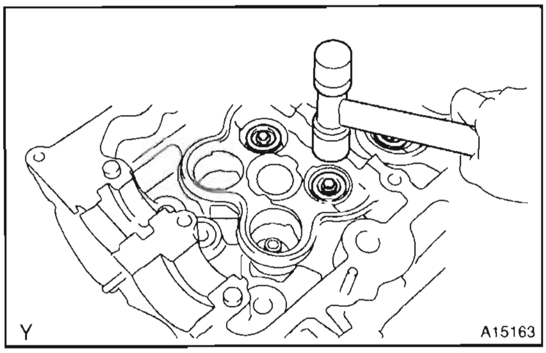


1. INSTALL VALVES

(a) Install the oil seal.
(b) Install the valve.
(c) Install the spring seat.
(d) Install the valve spring.
(e) Install the spring retainer.



(f) Using SST, compress the valve spring and place the 2 keepers around the valve stem.
SST 09202–70020 (09202–00010)

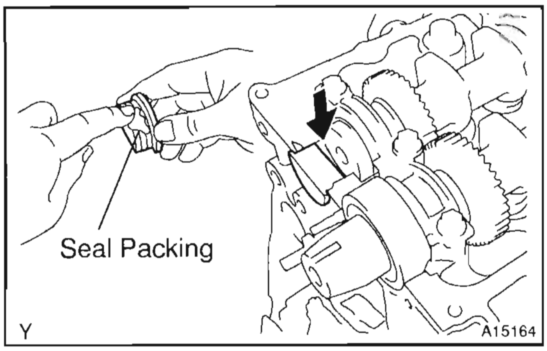


(g) Using a plastic–faced hammer, lightly tap the valve stem tip to assure a proper fit.

2. INSTALL VALVE LIFTERS AND SHIMS

(a) Install the valve lifter and shim.
(b) Check that the valve lifter rotates smoothly by hand.

3. INSTALL WATER TEMPERATURE SENDER GAUGE



4. INSTALL SEMI CIRCULAR PLUG

(a) Remove any old packing (FIPG) material.
(b) Apply seal packing to the semi circular plug as shown.
Seal packing: Part No. 08826–00080 or equivalent
Thickness: 0.5 mm (0.020 in.)
(c) Install the semi circular plug to the cylinder head.

NOTICE:
Prevent FIPG from being stuck to the camshaft thrust groove.

5. INSTALL WATER OUTLET HOUSING

Install a new gasket, the water outlet pipe with the 2 bolts.

Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)

6. INSTALL ENGINE HANGER NO. 1

Install the engine hanger to the cylinder head.

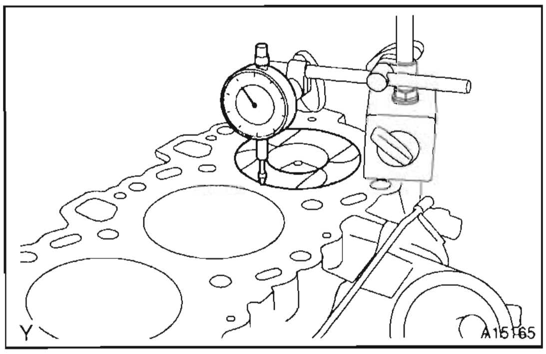
Torque: 47 N·m (479 kgf·cm, 35 ft·lbf)

EM1MG-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.**



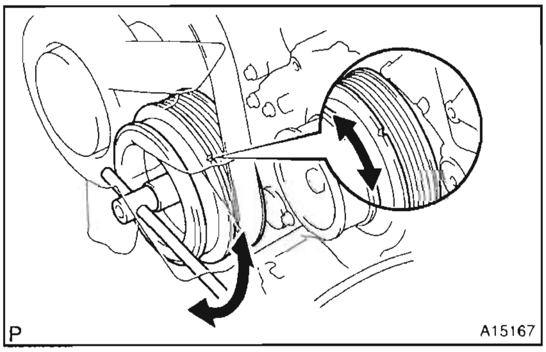
1. CHECK PISTON PROTRUSION AND SELECT CYLINDER HEAD GASKET

(a) Check the piston protrusions for each cylinder.

(1) Clean the cylinder block with solvent.

(2) Sent the piston of the cylinder to be measured to slightly before TDC.

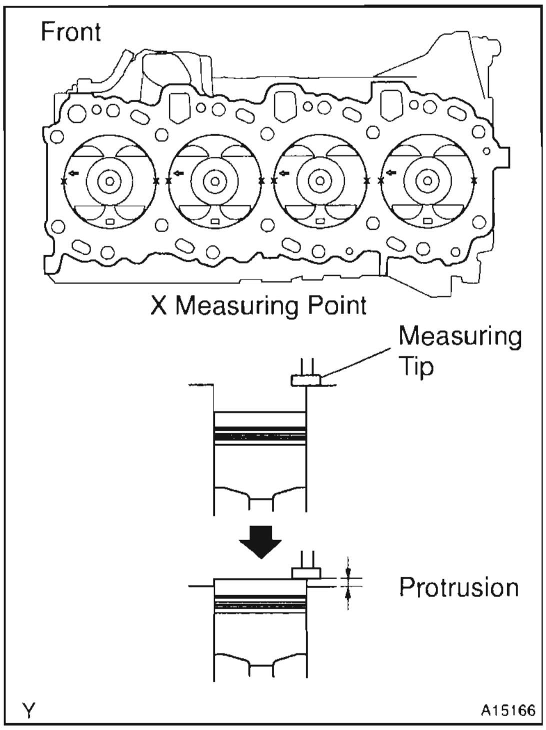
(3) Place a dial indicator on the cylinder block, and set the dial indicator at 0 mm (0 in.).



HINT:

- Use a dial indicator measuring tip a 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.

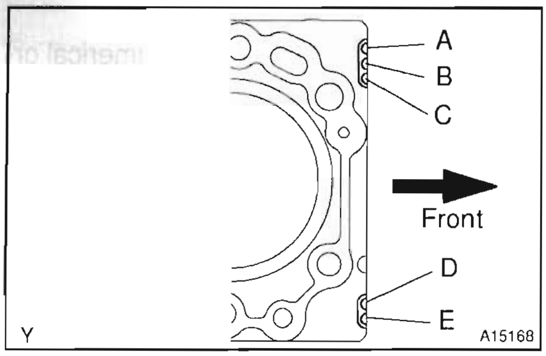


(5) Measure each cylinder at 2 places as shown in the illustration, making a total of 8 measurements.

(6) For the piston protrusion value of each cylinder, use the average of the 2 measurements of each cylinder.

Protrusion: 0.005 – 0.254 mm (0.00020 – 0.01000 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.



(b) Select a new cylinder head gasket.

HINT:

There are 5 sizes of new cylinder head gaskets, marked "A", "B", "C", "D" or "E" according.

Installed cylinder head gasket thickness:

A	0.80 – 0.90 mm (0.0315 – 0.0354 in.)
B	0.85 – 0.95 mm (0.0335 – 0.0374 in.)
C	0.90 – 1.00 mm (0.0354 – 0.0394 in.)
D	0.95 – 1.05 mm (0.0374 – 0.0413 in.)
E	1.00 – 1.10 mm (0.0394 – 0.0433 in.)

Select the largest piston protrusion value from the measurements made, then select the appropriate cylinder head gasket according to the table below.

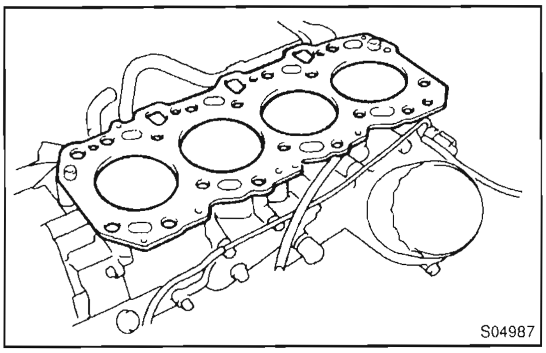
Piston protrusion mm (in.)	Gasket size
0.005 – 0.054 (0.00019 – 0.00213)	Use A
0.055 – 0.104 (0.00217 – 0.00409)	Use B
0.105 – 0.154 (0.00413 – 0.00606)	Use C
0.155 – 0.204 (0.00610 – 0.00803)	Use D
0.205 – 0.255 (0.00807 – 0.01004)	Use E

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.



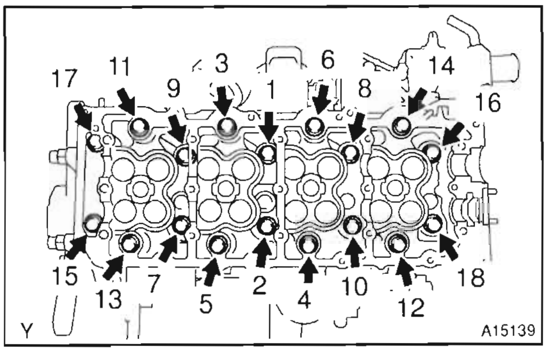
3. PLACE CYLINDER HEAD ON CYLINDER BLOCK

(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

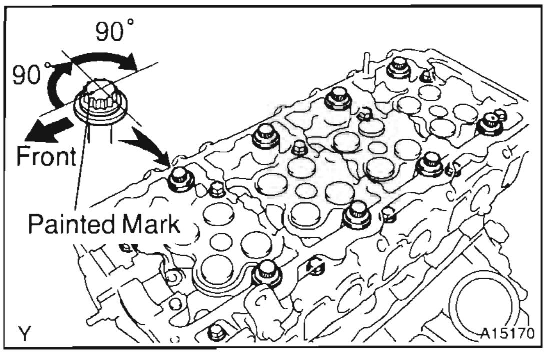
HINT:

- The cylinder head bolts are tightened in 3 progressive steps (steps (b), (d) and (e)).
- If any bolts 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.

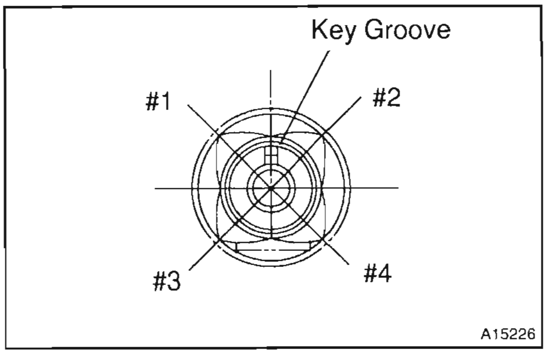
(b) Install and uniformly tighten the 18 cylinder head bolts, in several passes, in the sequence shown.

Torque: 85 N·m (867 kgf·cm, 63 ft·lbf)

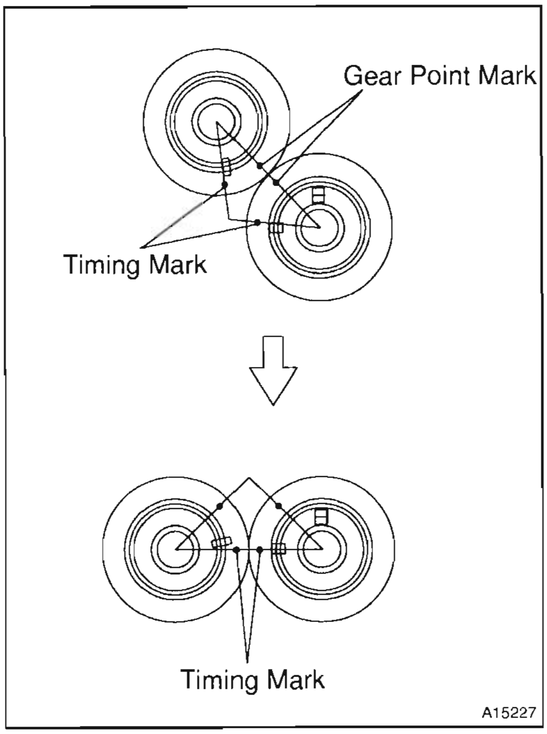


(c) Mark the front of the cylinder head bolt with paint.
(d) Retighten the cylinder head bolts 90° in the numerical order shown.
(e) Retighten cylinder head bolts by an additional 90°.
(f) Check that the painted mark is now facing rearward.

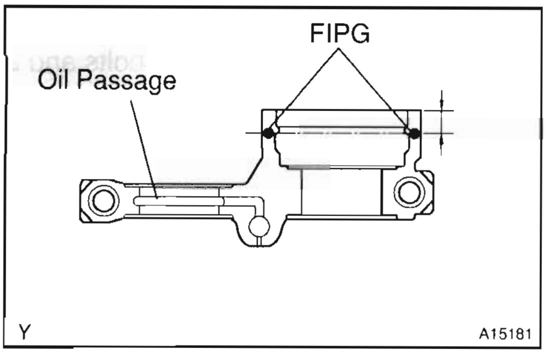
5. INSTALL GLOW PLUG AND GLOW PLUG CONNECTOR (See page ST–4)



6. INSTALL CAMSHAFT
(a) Rotate the crankshaft about 90° counterclockwise from the TDC position to lower the piston.
(b) Place the camshaft No. 1 with its camlobs #3 and #4 facing downward on the cylinder head as shown in the illustration.

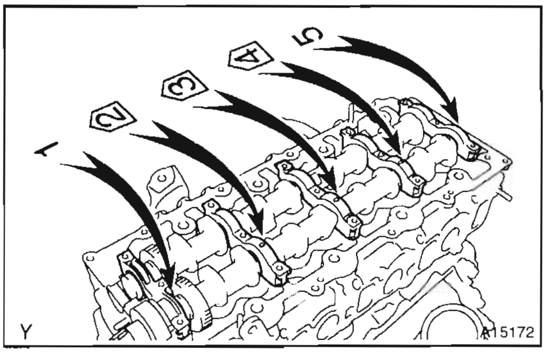


(c) Mesh the gear point marks of the camshaft No. 1 and No. 2.
(d) Rotate the camshaft No. 2 with its gear in mesh to place it on the journal of exhaust side cylinder head as shown in the illustration.
(e) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the bearing cap No. 1 and cylinder head.
- 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.

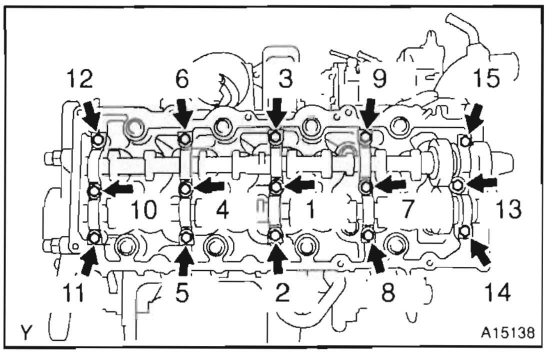


(f) Apply seal packing to the camshaft bearing cap No. 1 as shown in the illustration.
Seal packing: Part No. 08826–00080 or equivalent
Thickness: 0.5 mm (0.020 in.)
- Install a nozzle that has been cut to a 4 mm (0.16 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.

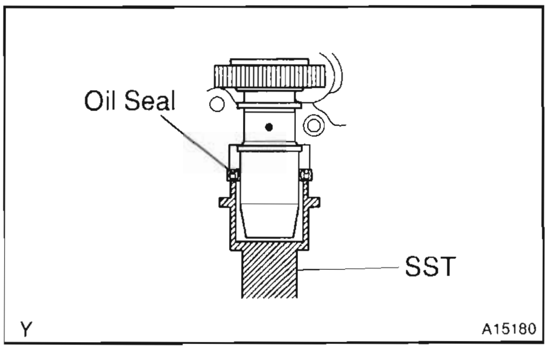
NOTICE:
Prevent FIPG from being stuck to the oil passage of the bearing cap No. 1.



(g) Install the 5 bearing caps in their proper locations.



(h) Install and uniformly tighten the 10 bearing cap bolts in several passes in the sequence shown.

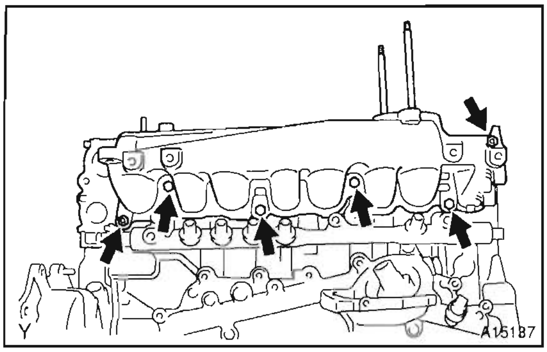


7. INSTALL CAMSHAFT OIL SEAL

Using SST and hammer, install the camshaft oil seal.
SST 09223–50010

8. INSTALL COMMON RAIL (See page FU–22)

9. INSTALL GLOW PLUG (See page ST–1)



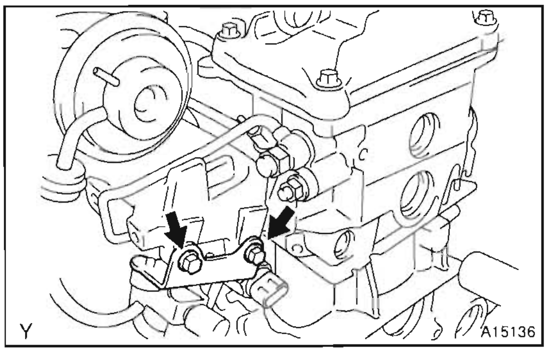
10. INSTALL INTAKE MANIFOLD

Install a new gasket and intake manifold with the 4 bolts and 2 nuts.

Torque: 29 N·m (296 kgf·cm, 21 ft·lbf)

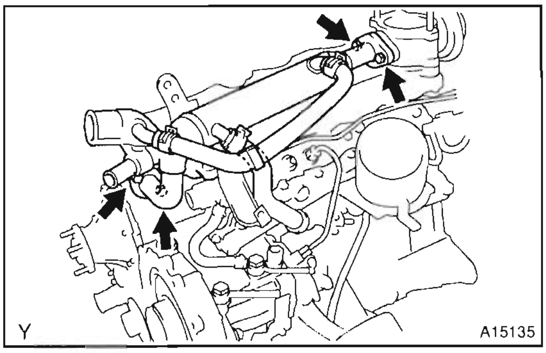
11. INSTALL EGR VALVE

(a) Install the gasket and EGR valve.



(b) Install the E–VRV with the 2 bolts, and connect the vacuum hose.

Torque: 20 N·m (204 kgf·cm, 15 ft·lbf)



12. INSTALL EGR COOLER PIPE

(a) Install new 2 gaskets and EGR cooler pipe with the 2 bolts and nuts.

(b) Install the 2 water hoses.

13. INSTALL INJECTOR (See page FU–8)

14. INSTALL LEAKAGE PIPE NO. 2 (See page FU–8)

15. INSTALL CYLINDER HEAD COVER (See page EM–16)

16. INSTALL FUEL INLET PIPE (See page FU–18)

17. INSTALL INJECTION PIPE (See page FU–8)

18. CONNECT ENGINE WIRE

19. INSTALL DIESEL THROTTLE BODY (See page ED–7)

20. INSTALL TURBOCHARGER AND EXHAUST MANIFOLD ASSEMBLY (See page TC–8)

21. INSTALL INTERCOOLER (See page TC–12)

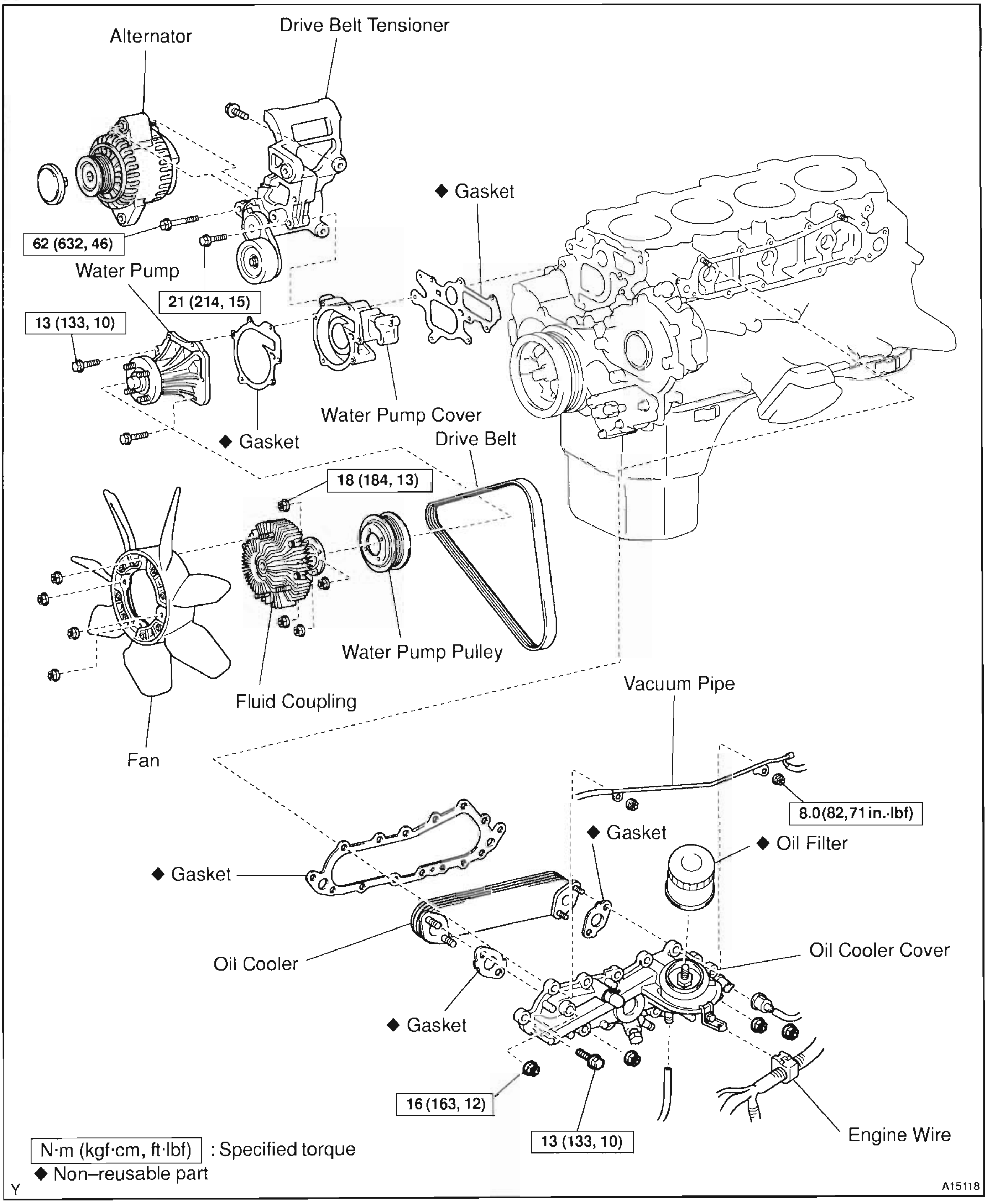
22. INSTALL OIL FILTER (See page LU–2)

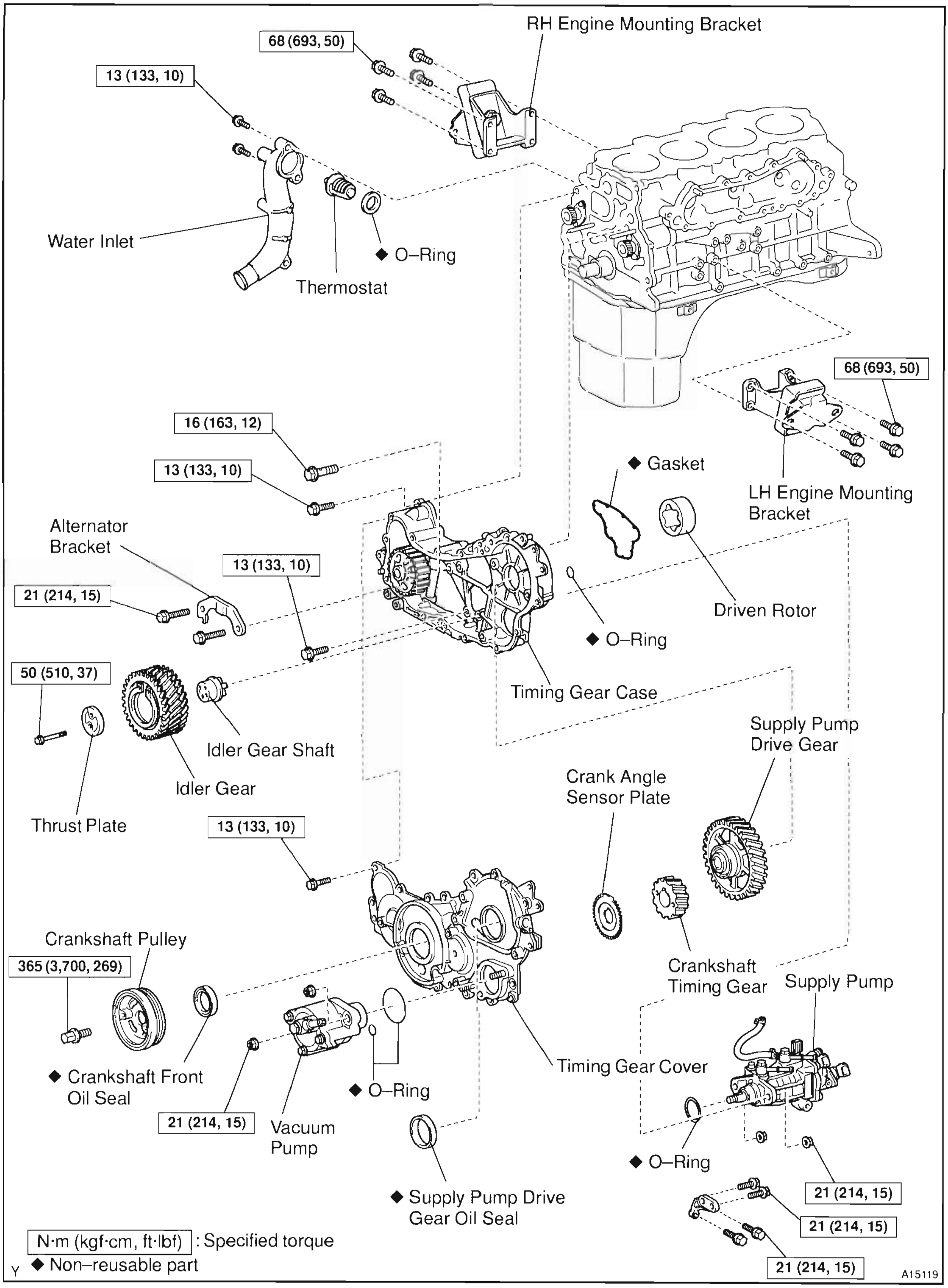
23. FILL WITH ENGINE OIL AND ENGINE COOLANT

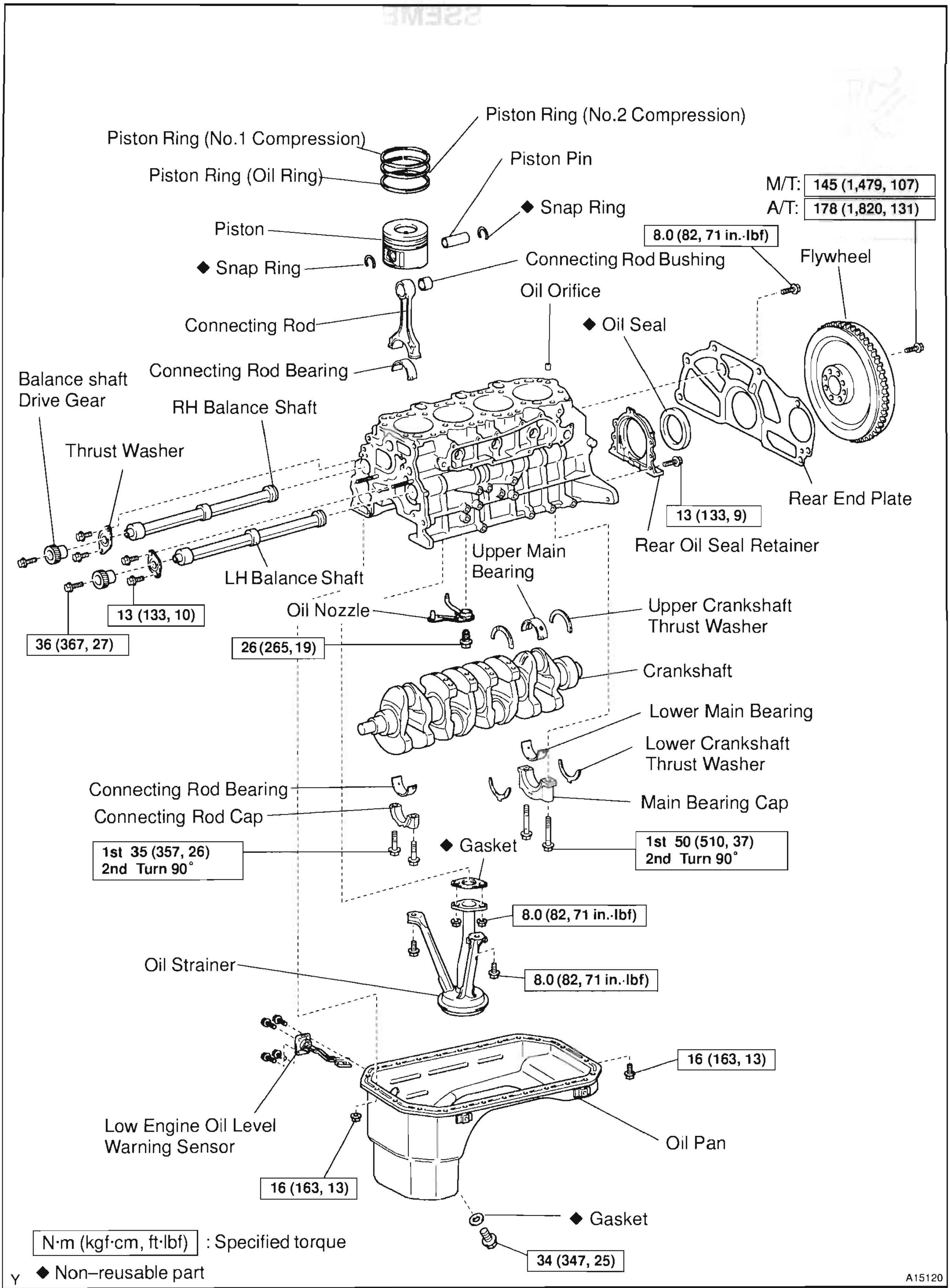
CYLINDER BLOCK

COMPONENTS

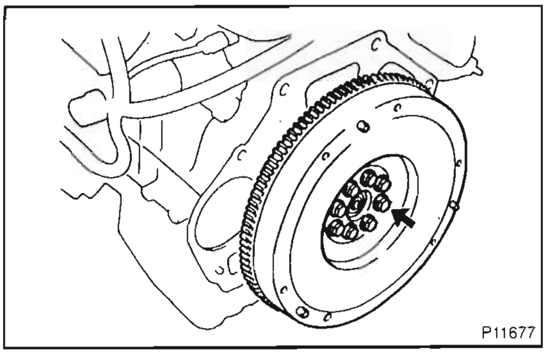
EM15J–02




RH Engine Mounting Bracket
68 (693, 50)
13 (133, 10)
Water Inlet
◆ O-Ring
Thermostat
68 (693, 50)
16 (163, 12)
13 (133, 10)
◆ Gasket
LH Engine Mounting Bracket
Alternator Bracket
13 (133, 10)
21 (214, 15)
Driven Rotor
◆ O-Ring
50 (510, 37)
Timing Gear Case
Supply Pump Drive Gear
Idler Gear Shaft
Crank Angle Sensor Plate
Idler Gear
Thrust Plate
13 (133, 10)
Crankshaft Pulley
365 (3,700, 269)
Crankshaft Timing Gear
Supply Pump
◆ Crankshaft Front Oil Seal
Timing Gear Cover
◆ O-Ring
21 (214, 15)
Vacuum Pump
◆ O-Ring
◆ Supply Pump Drive Gear Oil Seal
21 (214, 15)
21 (214, 15)
21 (214, 15)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non-reusable part
A15119


Piston Ring (No.2 Compression)
Piston Ring (No.1 Compression)
Piston Ring (Oil Ring)
Piston Pin
◆ Snap Ring
Piston
◆ Snap Ring
Connecting Rod Bushing
M/T: 145 (1,479, 107)
A/T: 178 (1,820, 131)
8.0 (82, 71 in.·lbf)
Flywheel
Oil Orifice
◆ Oil Seal
Connecting Rod
Connecting Rod Bearing
Balance shaft Drive Gear
RH Balance Shaft
Thrust Washer
Rear End Plate
13 (133, 9)
Rear Oil Seal Retainer
Upper Main Bearing
LH Balance Shaft
13 (133, 10)
36 (367, 27)
Oil Nozzle
26 (265, 19)
Upper Crankshaft Thrust Washer
Crankshaft
Lower Main Bearing
Lower Crankshaft Thrust Washer
Connecting Rod Bearing
Connecting Rod Cap
Main Bearing Cap
1st 35 (357, 26)
2nd Turn 90°
◆ Gasket
1st 50 (510, 37)
2nd Turn 90°
8.0 (82, 71 in.·lbf)
Oil Strainer
8.0 (82, 71 in.·lbf)
16 (163, 13)
Low Engine Oil Level Warning Sensor
Oil Pan
16 (163, 13)
◆ Gasket
34 (347, 25)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
A15120

EM1M8–01

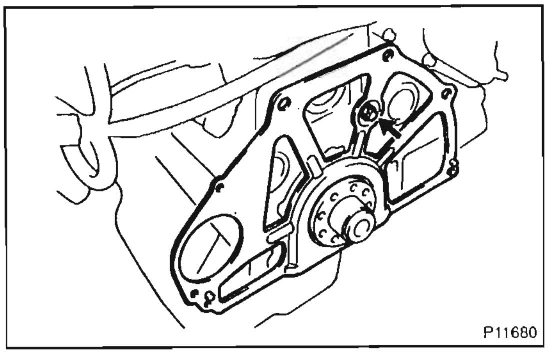


P11677

DISASSEMBLY

1. **REMOVE CLUTCH COVER AND DISC**
2. **REMOVE FLYWHEEL**

Remove the 8 bolts and flywheel.

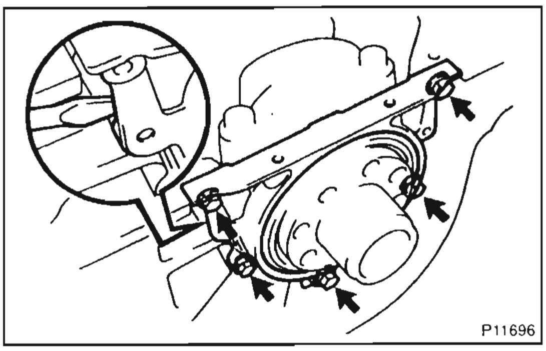


P11680

3. **REMOVE REAR END PLATE**

Remove the bolt and end plate.

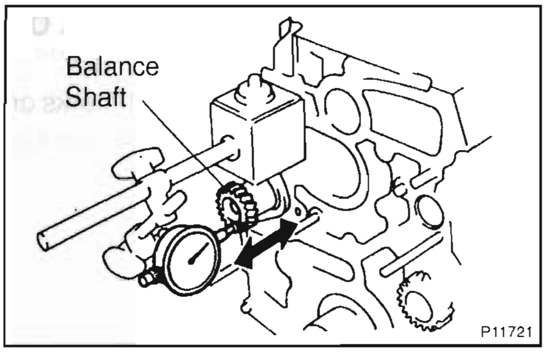
4. **INSTALL ENGINE TO ENGINE STAND FOR DISASSEMBLY**
5. **REMOVE TIMING BELT AND PULLEYS (See page EM–11)**
6. **REMOVE CYLINDER HEAD (See page EM–41)**
7. **REMOVE ALTERNATOR AND ALTERNATOR BRACKET (See page CO–5)**
8. **REMOVE WATER PUMP (See page CO–5)**
9. **REMOVE SUPPLY PUMP (See page FU–16)**
10. **REMOVE OIL COOLER (See page LU–19)**
11. **REMOVE TIMING GEARS (See page EM–21)**
12. **TIMING GEAR CASE (See page LU–7)**
13. **REMOVE WATER INLET AND THERMOSTAT (See page CO–11)**
14. **REMOVE WATER TEMPERATURE SENSOR**
15. **REMOVE ENGINE MOUNTING**
16. **REMOVE OIL PAN**
17. **REMOVE PLUG HOLE**



P11696

18. **REMOVE REAR OIL SEAL RETAINER**

Remove the 5 bolts and retainer.



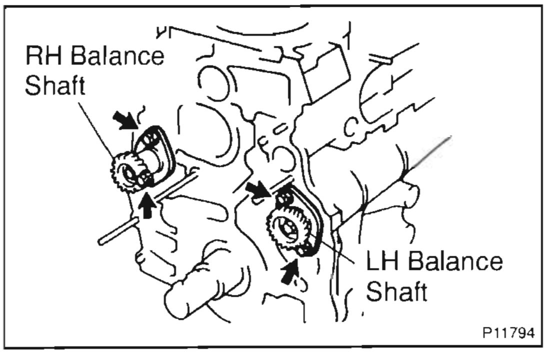
19. CHECK THRUST CLEARANCES OF RH AND LH BALANCE SHAFTS OF ENGINE BALANCER

Using a dial indicator, measure the thrust clearance while moving the balance shaft back and forth.

Standard thrust clearance:
0.065 – 0.140 mm (0.0026 – 0.0055 in.)
Maximum thrust clearance: 0.25 mm (0.0098 in.)

If the thrust clearance is greater than maximum, replace the balance shaft thrust washer.

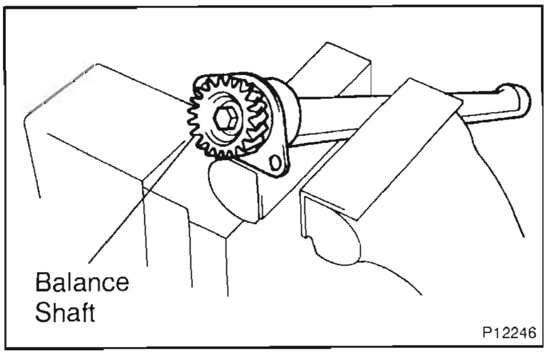
If necessary, replace the balance shaft.



20. REMOVE RH AND LH BALANCE SHAFTS

(a) Remove the 2 bolts and RH balance shaft.

(b) Remove the 2 bolts and LH balance shaft.

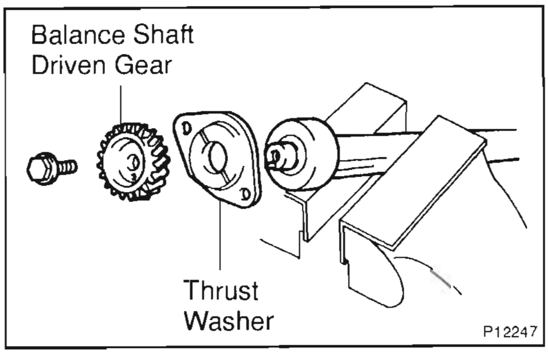


21. DISASSEMBLE RH AND LH BALANCE SHAFTS

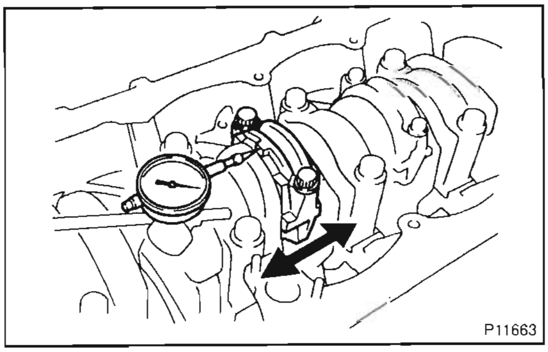
(a) Mount the weight of the balance shaft in a vise.

NOTICE:

Be careful not to damage the balance shaft.



(b) Remove the bolt, balance shaft driven gear and thrust washer.

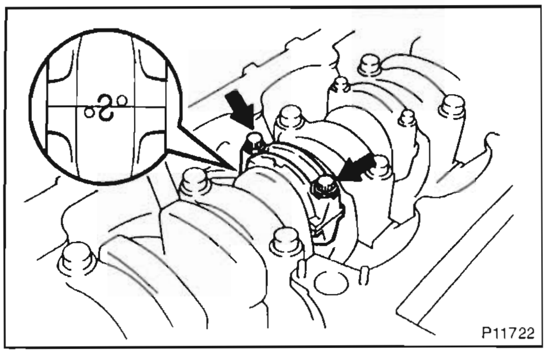


22. CHECK CONNECTING ROD THRUST CLEARANCE

Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

Standard thrust clearance:
0.10 – 0.30 mm (0.0039 – 0.0118 in.)
Maximum thrust clearance: 0.40 mm (0.0157 in.)

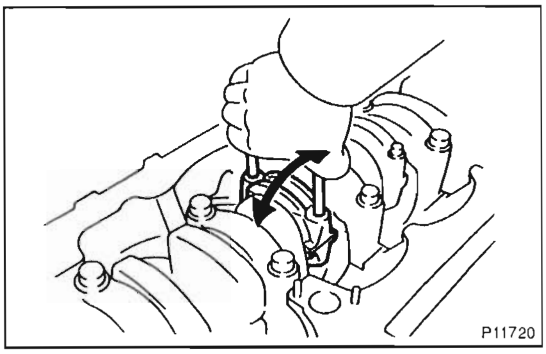
If the thrust clearance is greater than maximum, replace the connecting rod assembly. If necessary, replace the crankshaft.



23. REMOVE CONNECTING ROD CAPS AND CHECK OIL CLEARANCE

(a) Using a punch or numbering stamp, place matchmarks on the connecting rod and cap to ensure correct reassembly.

(b) Remove the connecting rod cap bolts.



(c) Using the 2 removed connecting rod bolts, pry the connecting rod cap back and forth, and remove the connecting cap.

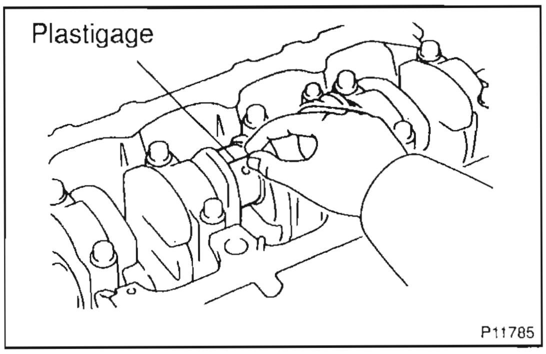
HINT:

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, grind or 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–83)

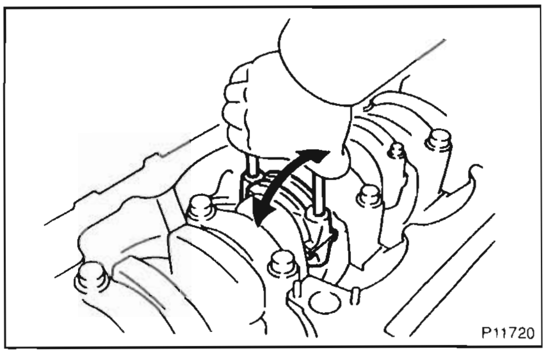
1st

Torque: 35 N·m (357 kgf·cm, 26 ft·lbf)

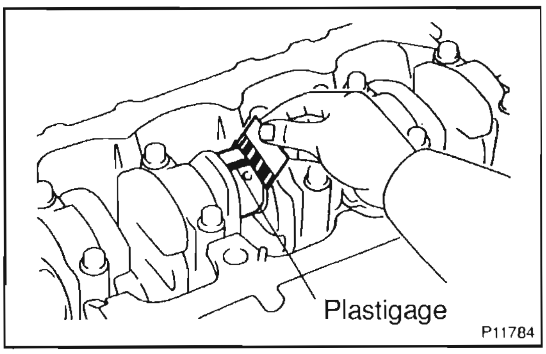
2nd Turn 90 °

NOTICE:

Do not turn the crankshaft.



(h) Remove the 2 bolts, connecting rod cap and lower bearing. (See procedure (b) and (c) above)



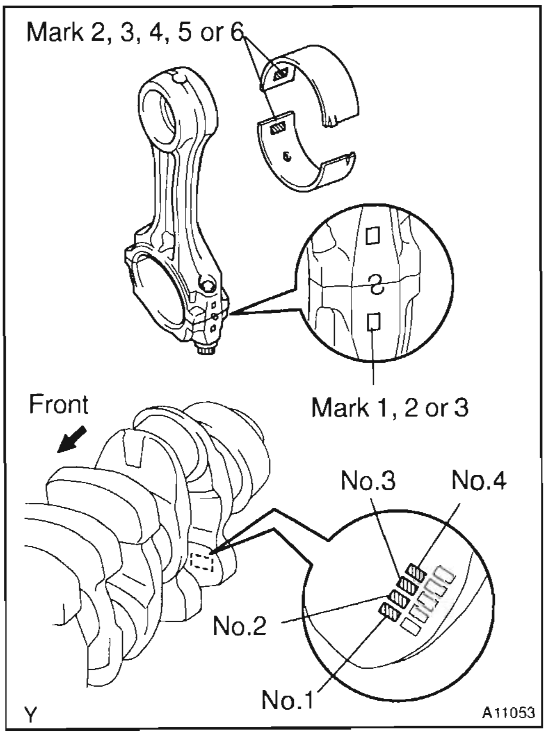
(i) Measure the Plastigage at its widest point.

Standard oil clearance:

STD: 0.036 – 0.054 mm (0.0014 – 0.0021 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or 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 inprinted on the crankshaft and connecting rod, then selecting the bearing with the same number as the total. There are 5 sizes of standard bearings, marked "2", "3", "4", "5" and "6" accordingly.



	Number Marked								
Cylinder block	1			2			3		
Crankshaft	1	2	3	1	2	3	1	2	3
Use bearing	2	3	4	3	4	5	4	5	6

EXAMPLE: Cylinder block "2" + crankshaft "1"
= Total number 3 (Use bearing "3")

Y A11054

Reference

Connecting rod big end inner diameter:

Mark "1"	62.014 – 62.020 mm (2.4415 – 2.4417 in.)
Mark "2"	62.020 – 62.026 mm (2.4417 – 2.4420 in.)
Mark "3"	62.026 – 62.032 mm (2.4420 – 2.4422 in.)

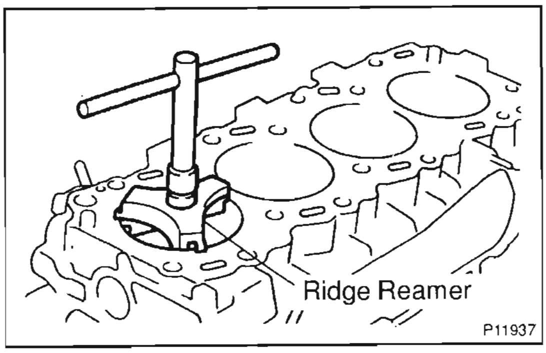
Crankshaft pin diameter:

Mark "1"	58.994 – 59.000 mm (2.3226 – 2.3228 in.)
Mark "2"	58.988 – 58.994 mm (2.3224 – 2.3226 in.)
Mark "3"	58.982 – 58.988 mm (2.3221 – 2.3224 in.)

Standard sized bearing center wall thickness:

Mark "2"	1.486 – 1.489 mm (0.0585 – 0.0586 in.)
Mark "3"	1.489 – 1.492 mm (0.0586 – 0.0587 in.)
Mark "4"	1.492 – 1.495 mm (0.0587 – 0.0589 in.)
Mark "5"	1.495 – 1.498 mm (0.0589 – 0.0590 in.)
Mark "6"	1.498 – 1.501 mm (0.0590 – 0.0591 in.)

(j) Completely remove the Plastigage.

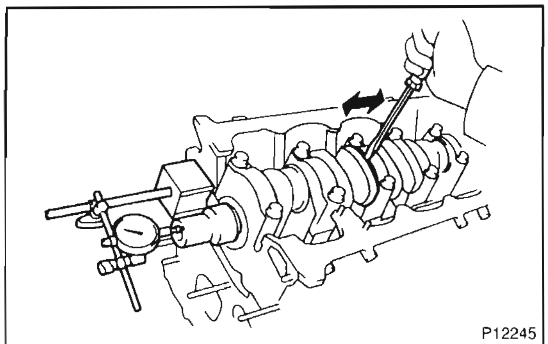


24. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

(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 correct order.


P12245

25. 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:

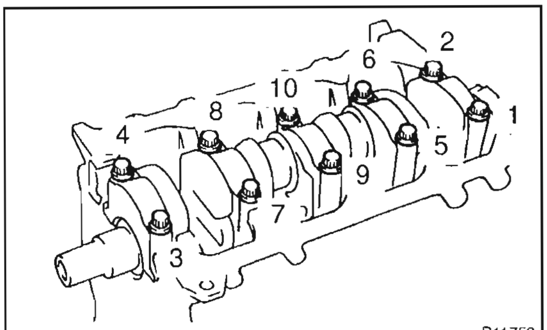
0.040 – 0.240 mm (0.0016 – 0.0094 in.)

Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is grater than maximum, replace the thrust washers as a set.

Thrust washer thickness:

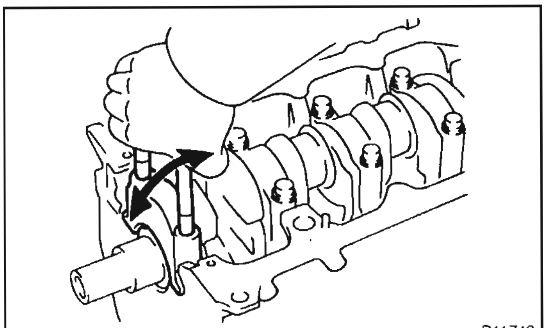
STD	2.430 – 2.480 mm (0.0957 – 0.0976 in.)
U/S 0.250	2.555 – 2.605 mm (0.1006 – 0.1026 in.)
U/S 0.125	2.493 – 2.543 mm (0.0981 – 0.1001 in.)



P11753

26. REMOVE MAIN BEARING CAPS AND CHECK OIL CLEARANCE

(a) Uniformly loosen and remove the main bearing cap bolts in several passes, in the sequence shown.


P11743

(b) Using the removed main bearing cap bolts, pry the main bearing cap back and forth, and remove the main bearing caps, lower bearings and lower thrust washers (No.5 main bearing cap only).

HINT:

- Keep the lower bearing and main bearing cap together.
- Arrange the main bearing caps and lower thrust washers in correct order.

(c) Lift out the crankshaft.

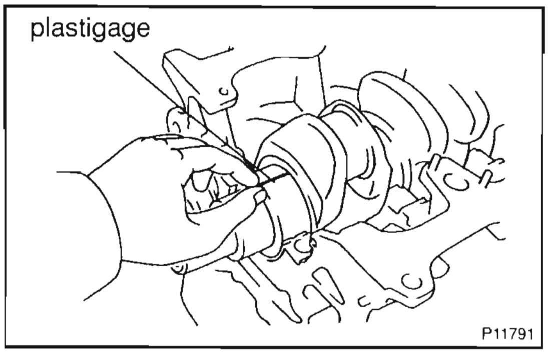
HINT:

Keep the upper bearings 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, grind or 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–83)

1st

Torque: 50 N·m (510 kgf·cm, 37 ft·lbf)

2nd Turn 90 °

NOTICE:

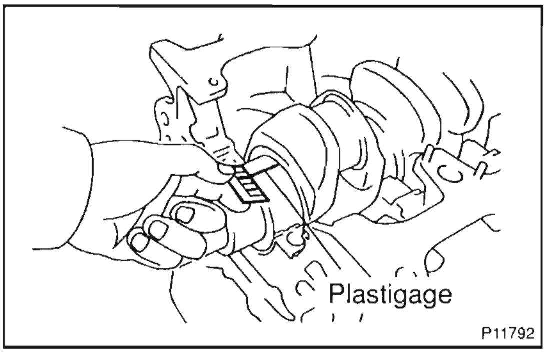
Do not turn the crankshaft.

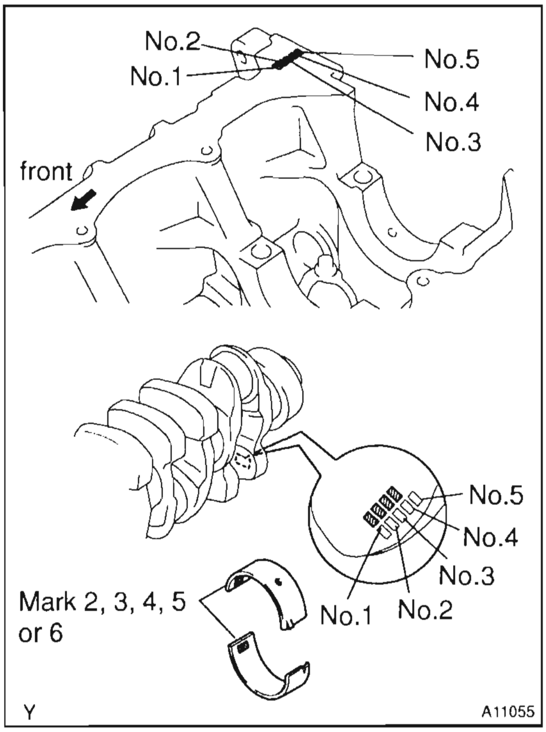
(i) Remove the main bearing caps. (See procedure (a) and (b) above)
(j) Measure the Plastigage at its widest point.

Standard clearance:

STD: 0.030 – 0.048 mm (0.00118 – 0.00189 in.)

Maximum clearance: 0.10 mm (0.0039 in.)





HINT:
If replacing the cylinder block subassembly, the bearing standard clearance will be:

0.030 – 0.048 mm (0.00118 – 0.00189 in.)

If the oil clearance is greater than maximum, replace the bearings. If necessary, grind or 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 "2", "3", "4", "5" and "6" accordingly.

	Number Marked								
Cylinder block	1			2			3		
Crankshaft	1	2	3	1	2	3	1	2	3
Use bearing	2	3	4	3	4	5	4	5	6

EXAMPLE: Cylinder block "2" + crankshaft "1"
= Total number 3 (Use bearing "3")

Y A11056

Reference

Cylinder block main journal bore diameter:

Mark "1"	75.000 – 75.006 mm (2.9528 – 2.9530 in.)
Mark "2"	75.006 – 75.012 mm (2.9530 – 2.9532 in.)
Mark "3"	75.012 – 75. 018 mm (2.9532 – 2.9535 in.)

Crankshaft journal diameter:

Mark "1"	69.994 – 70.000 mm (2.7557 – 2.7559 in.)
Mark "2"	69.988 – 69.994 mm (2.7554 – 2.7557 in.)
Mark "3"	69.982 – 69.988 mm (2.7552 – 2.7554 in.)

Standard sized bearing center wall thickness:

Mark "2"	2.482 – 2.485 mm (0.09772 – 0.09783 in.)
Mark "3"	2.485 – 2.488 mm (0.09783 – 0.09795 in.)
Mark "4"	2.488 – 2.491 mm (0.09795 – 0.09807 in.)
Mark "5"	2.491 – 2.494 mm (0.09807 – 0.09819 in.)
Mark "6"	2.494 – 2.497 mm (0.09819 – 0.09831 in.)

(k) Completely remove the Plastigage.

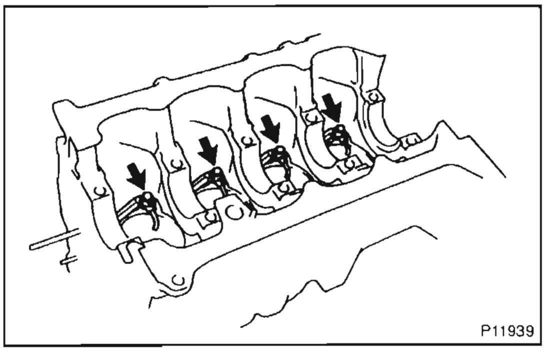
27. REMOVE CRANKSHAFT

(a) Lift out the crankshaft.

(b) Remove the upper bearings and upper thrust washers from the cylinder block.

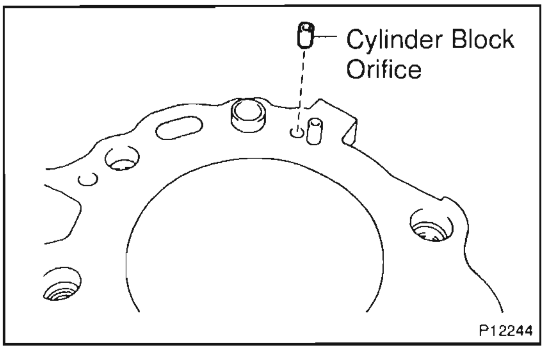
HINT:

Arrange the main bearing caps, bearings and thrust washers in correct order.


P11939

28. REMOVE CHECK VALVES AND OIL NOZZLES

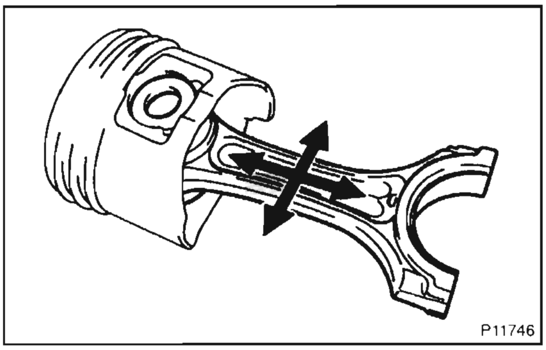
Remove the 4 check valves and oil nozzles.



P12244

29. REMOVE CYLINDER BLOCK ORIFICE

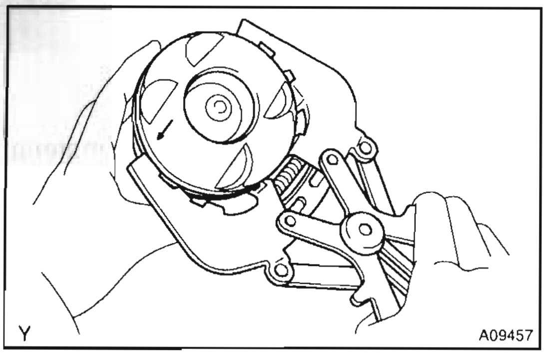
Remove the cylinder block orifice from the cylinder block.


P11746

30. 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.



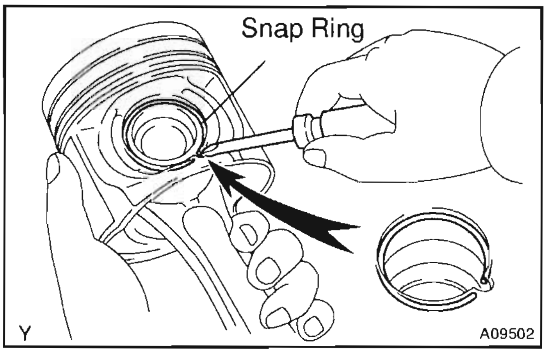
31. REMOVE PISTON RINGS

(a) Using a piston ring expander, remove the 2 compression rings and oil ring.

(b) Remove the coil by hand.

HINT:

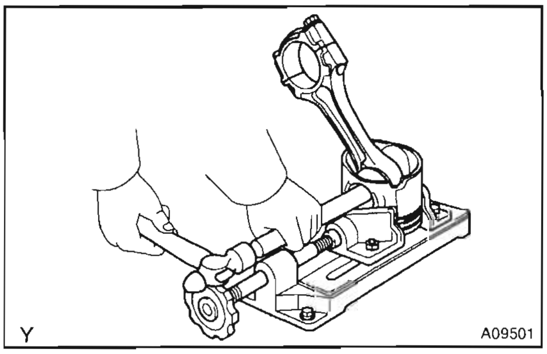
Arrange the rings in correct order only.



32. DISCONNECT CONNECTING ROD FROM PISTON

(a) Using a small screwdriver, pry off the snap ring form the piston.

(b) Gradually heat the piston to approx. 60°C (140°F).



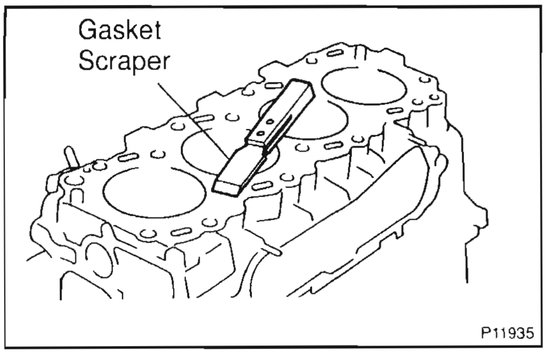
(c) Using a plastic–faced hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.

HINT:

- The piston pin are matched set.
- Arrange the pistons, pins, rings, connecting rods and bearings in correct order.

EM1SL–02

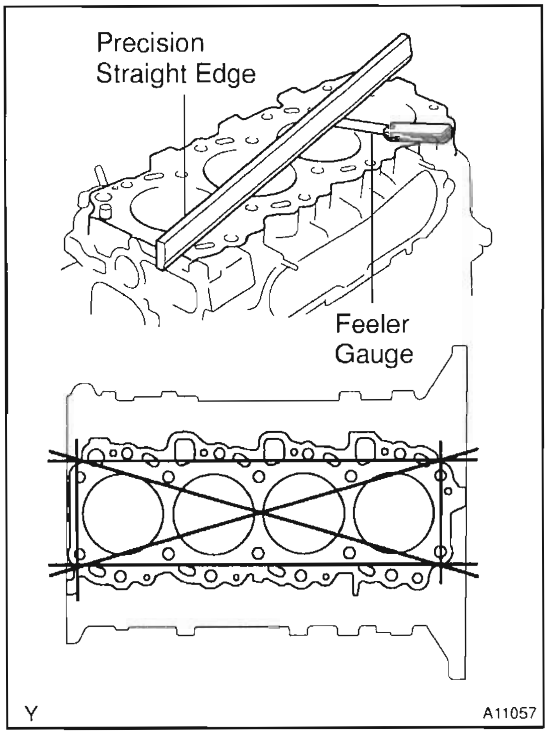
INSPECTION



1. CLEAN CYLINDER BLOCK

(a) Remove the gasket material.
Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

(b) Clean the cylinder block.
Using a soft brush and solvent, thoroughly clean the cylinder block.

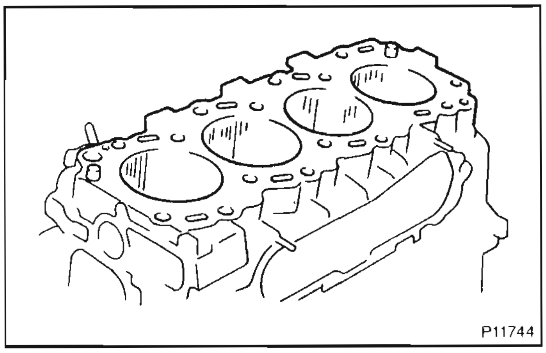


2. INSPECT TOP SURFACE OF CYLINDER BLOCK FOR FLATNESS

Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder head gasket for warpage.

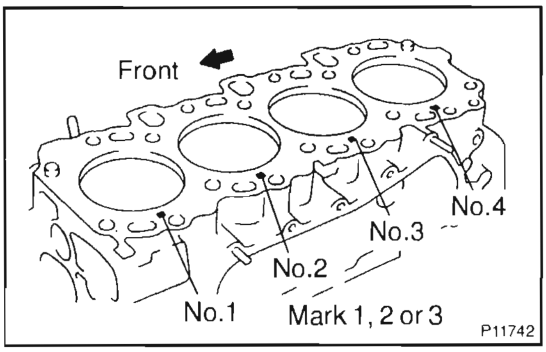
Maximum warpage: 0.10 mm (0.0039 in.)

If warpage is greater than maximum, replace the cylinder block.



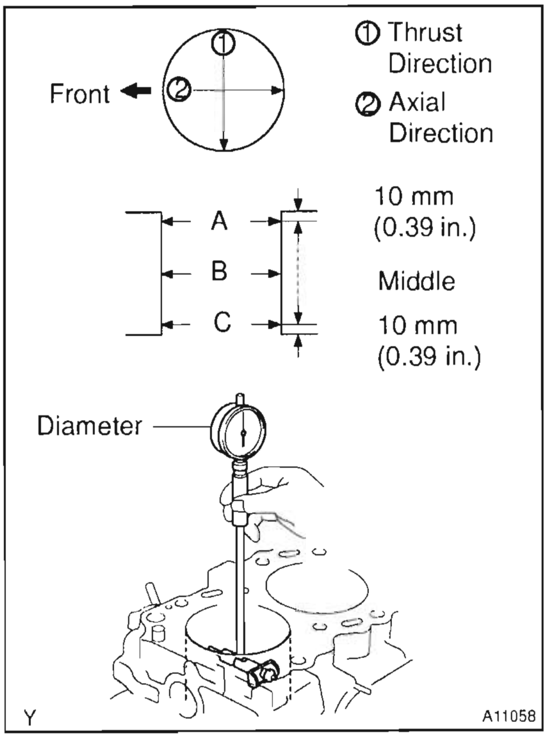
3. INSPECT CYLINDER FOR VERTICAL SCRATCHES

Visually check the cylinder for vertical scratches.
If deep scratches are present, rebore all the 4 cylinders. If necessary, replace the cylinder block.



4. INSPECT CYLINDER BORE DIAMETER

HINT:
There are 3 sizes of the standard cylinder bore diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the top of the cylinder block.



Using a cylinder gauge, measure the cylinder bore diameter at positions A, B and C in the thrust and axial directions.

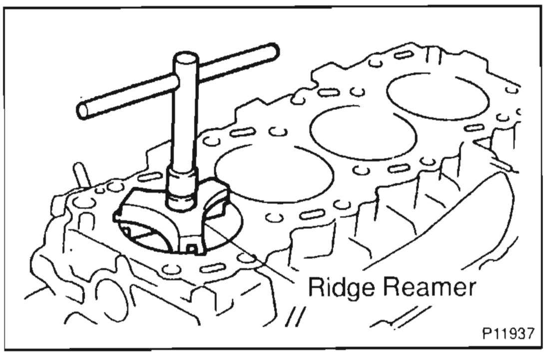
Standard diameter:

STD Mark	96.000 – 96.010 mm (3.7795 – 3.7799 in.)
STD Mark	96.010 – 96.020 mm (3.7799 – 3.7803 in.)
STD Mark	96.020 – 96.030 mm (3.7803 – 3.7807 in.)

Maximum diameter:

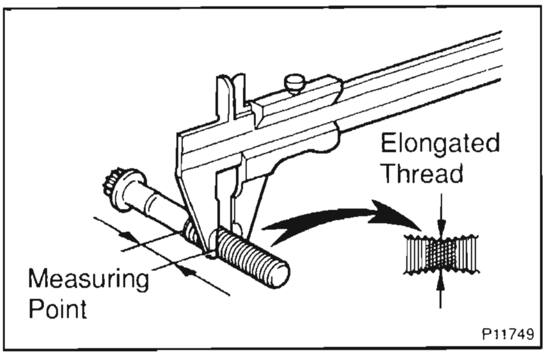
STD	96.23 mm (3.7886 in.)

If the diameter is greater than maximum, rebore all the 4 cylinders. If necessary, replace the cylinder block.



5. REMOVE CYLINDER RIDGE

If the wear is less than 0.2 mm (0.008 in.), using a ridge reamer, grind the top of the cylinder.



6. INSPECT MAIN BEARING CAP BOLTS

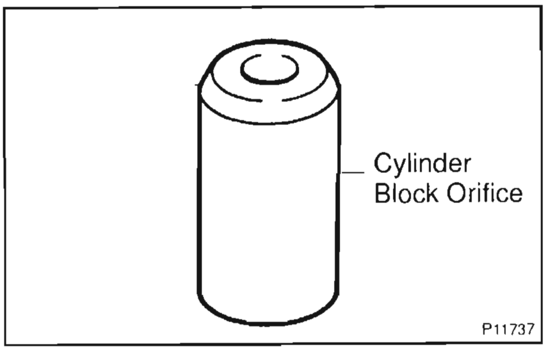
Using vernier calipers, measure the minimum diameter of the compressed thread at the measuring point.

Standard diameter:

13.500 – 14.000 mm (0.5315 – 0.5512 in.)

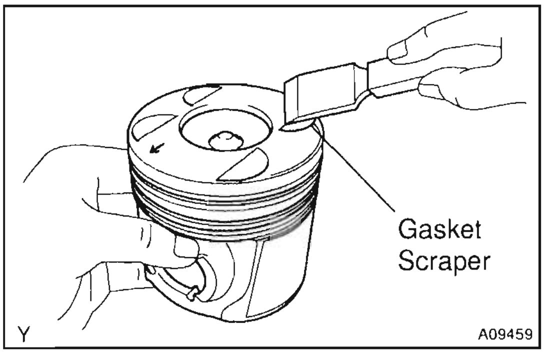
Minimum diameter: 12.60 mm (0.4961 in.)

If the diameter is less than minimum, replace the bolt.



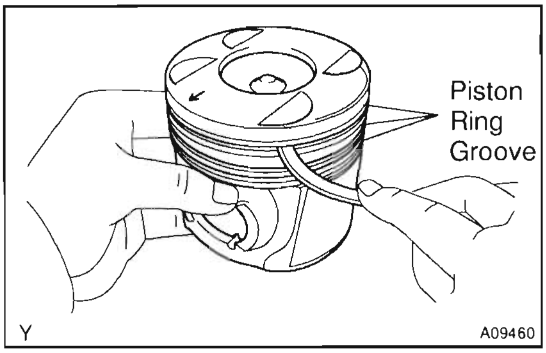
7. INSPECT CYLINDER BLOCK ORIFICE

Visually check that the orifice is not clogged.

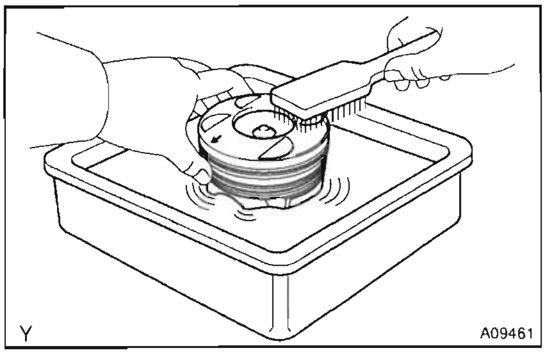


8. CLEAN PISTON

(a) Using a gasket scraper, remove the carbon from the piston top.



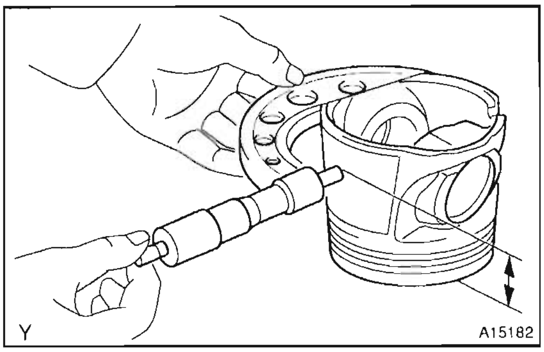
(b) Using a groove cleaning tool or broken ring, clean the piston ring grooves.



(c) Using solvent and a brush, thoroughly clean the piston.

NOTICE:

Do not use a wire brush.



9. INSPECT PISTON AND PISTON RING

(a) Inspect the piston oil clearance.

HINT:

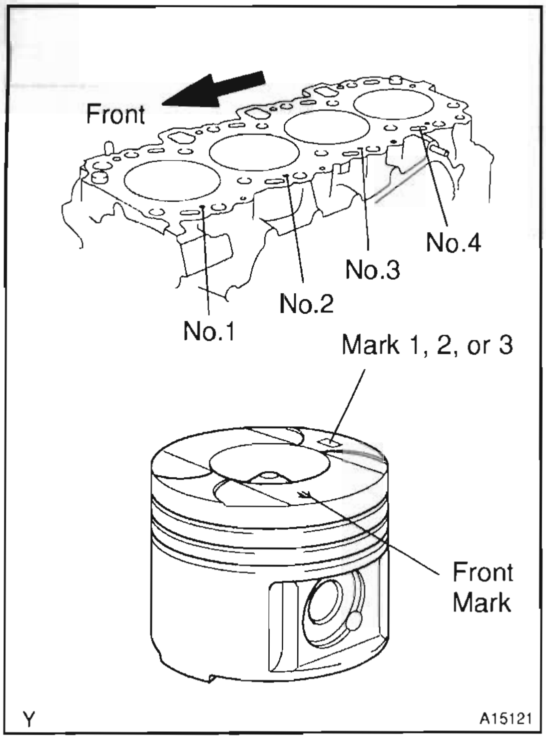
There are 3 sizes of the standard piston diameter, marked "1", "2" and "3" accordingly. The mark is stamped on the piston top.

(1) Using a micrometer, measure the piston diameter at right angles to the piston pin center line, 63.63 mm (2.5051 in.) from the piston head.

Piston diameter:

STD Mark 1	95.920 – 95.930 mm (3.77637 – 3.77676 in.)
STD Mark 2	95.930 – 95.940 mm (3.77676 – 3.77715 in.)
STD Mark 3	95.940 – 95.950 mm (3.77716 – 3.77755 in.)

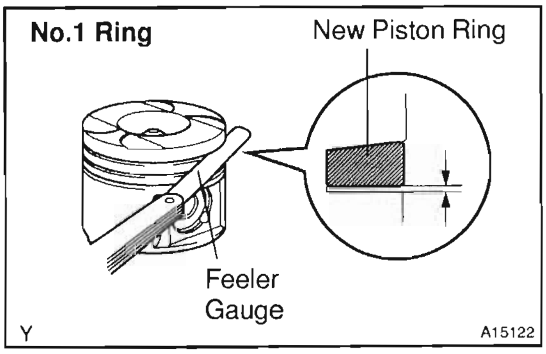
(2) Measure the cylinder bore diameter in the thrust directions. (See page EM–83)



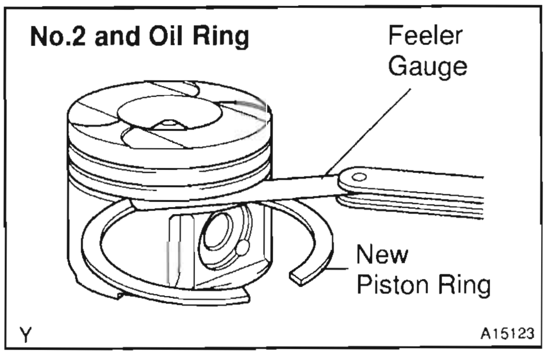
(3) Subtract the piston diameter measurement from the cylinder bore diameter measurement.
Standard oil clearance:
0.070 – 0.090 mm (0.00276 – 0.00354 in.)
Maximum oil clearance: 0.14 mm (0.0055 in.)

If the oil clearance is greater than maximum, replace all the 4 pistons and rebore all the 4 cylinders. If necessary, replace the cylinder block.

HINT:
(Use new cylinder block): Use a piston with the same number mark as the cylinder bore diameter marked on the cylinder block.



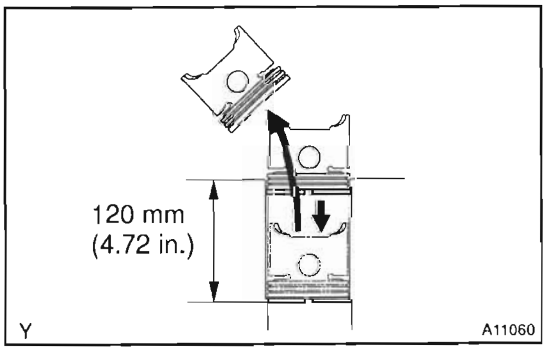
(b) Inspect the piston ring groove clearance.
(1) No.1 ring:
Install a new No.1 piston ring to the piston. Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.
Ring groove clearance (No.1):
0.091 – 0.135 mm (0.00358 – 0.00531 in.)



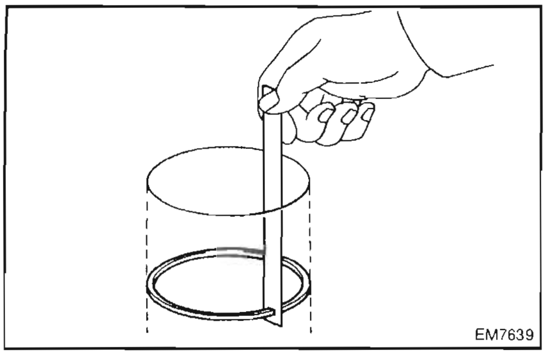
(2) No.2 and oil ring:
Using a feeler gauge, measure the clearance between the new piston ring and the wall of the ring groove.
Ring groove clearance (No.2 and oil ring):

No.2	0.090 – 0.130 mm (0.00358 – 0.00512 in.)
Oil	0.030 – 0.070 mm (0.00118 – 0.00276 in.)

If the clearance is greater than maximum, replace the piston.



(c) 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, 120 mm (4.72 in.) from the top of the cylinder block.



(3) Using a feeler gauge, measure the end gap.

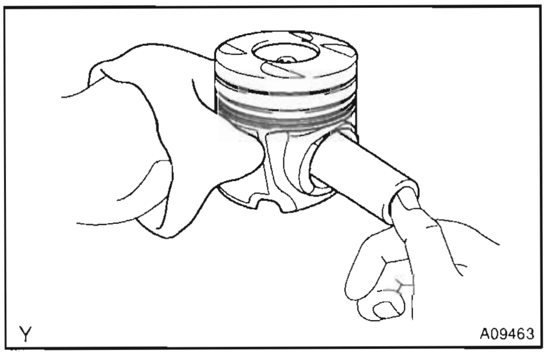
Standard end gap:

No.1	0.27 – 0.39 mm (0.0106 – 0.0154 in.)
No.2	0.47 – 0.57 mm (0.0185 – 0.0224 in.)
Oil	0.20 – 0.40 mm (0.0079 – 0.0157 in.)

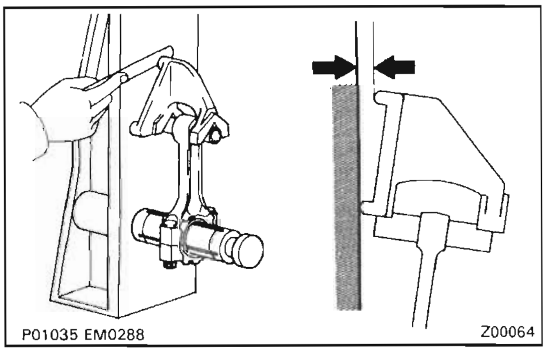
Maximum end gap:

No.1	0.85 mm (0.0335 in.)
No.2	1.07 mm (0.0421 in.)
Oil	0.77 mm (0.0303 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, rebore all the 4 cylinders or replace the cylinder block.



(d) Inspect the pistion pin fit.
At 80°C (176°F), you should be able to push the piston pin into the piston pin hole with your thumb.



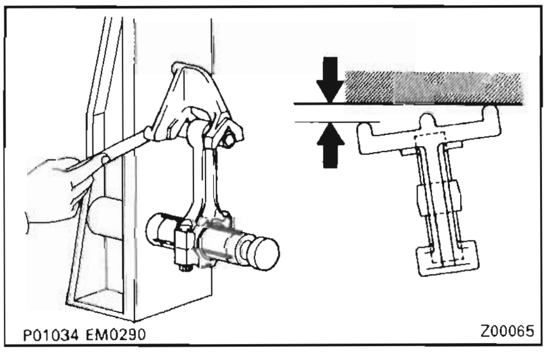
(e) Using a rod aligner and feeler gauge, check the connecting rod alignment.

(1) Check for bend.

Maximum bend:

0.03 mm (0.0012 in.) per 100 mm (3.94 in.)

If bend is greater than maximum, replace the connecting rod assembly.

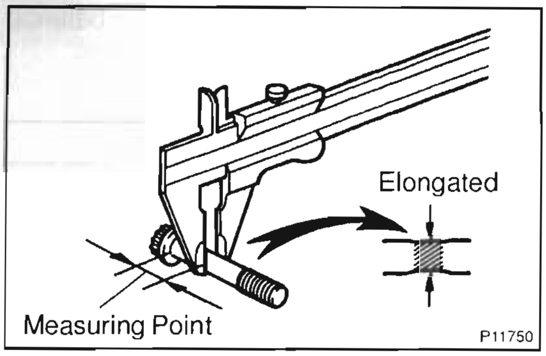


(2) Check for twist.

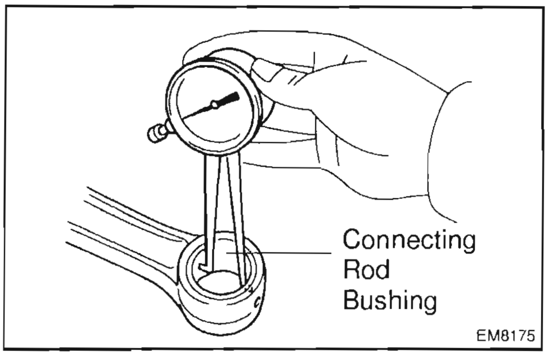
Maximum twist:

0.15 mm (0.0059 in.) per 100 mm (3.94 in.)

If twist is greater than maximum, replace the connecting rod assembly.

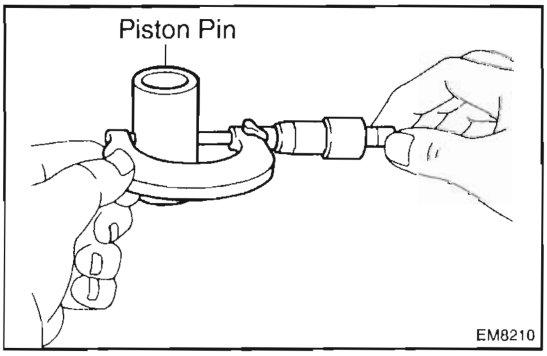


(f) Using vernier calipers, measure the minimum diameter of the compressed bolt at the measuring point.
Standard diameter:
8.500 – 8.600 mm (0.3346 – 0.3385 in.)
Minimum diameter: 8.30 mm (0.3268 in.)
If the diameter is less than minimum, replace the connecting rod bolt.



(g) Inspect the piston pin oil clearance.
(1) Using caliper gauge, measure the inside diameter of the connecting rod bushing.
Bushing inside diameter:

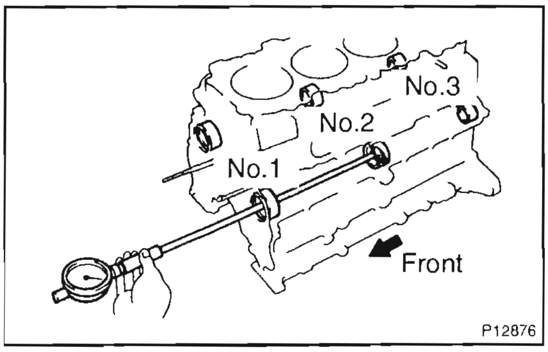
Mark A	34.012 – 34.016 mm (1.33905 – 1.33921 in.)
Mark B	34.016 – 34.020 mm (1.33921 – 1.33937 in.)
Mark C	34.020 – 34.024 mm (1.33937 – 1.33952 in.)



(2) Using a micrometer, measure the piston pin diameter.
Piston pin diameter:

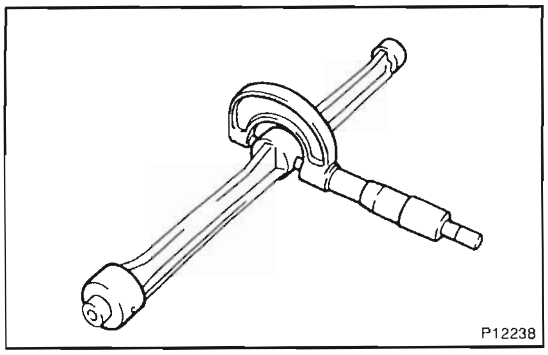
Mark A	33.996 – 34.000 mm (1.33842 – 1.33858 in.)
Mark B	34.000 – 34.004 mm (1.33858 – 1.33874 in.)
Mark C	34.004 – 34.008 mm (1.33874 – 1.33889 in.)

(3) Subtract the piston pin diameter measurement from the bushing inside diameter measurement.
Standard oil clearance:
0.012 – 0.020 mm (0.00047 – 0.00079 in.)
Maximum oil clearance: 0.03 mm (0.0012 in.)
If the oil clearance is greater than maximum, replace the bushing. If necessary, replace the piston and piston pin as a set.



10. INSPECT RH AND LH BALANCE SHAFT
(a) Using cylinder gauge, measure the inside diameter of the balance shaft bearing.
Bearing inside diameter (from front side):

No.1	42.000 – 42.020 mm (1.6535 – 1.6543 in.)
No.2	41.000 – 41.020 mm (1.6142 – 1.6150 in.)
No.3	32.000 – 32.020 mm (1.2598 – 1.2606 in.)


P12238

(b) Using a micrometer, measure the diameter of the balance shaft main journals.

Main journal diameter (from front side):

No.1	41.941 – 41.960 mm (1.6512 – 1.6520 in.)
No.2	40.931 – 40.950 mm (1.6115 – 1.6122 in.)
No.3	31.941 – 31.960 mm (1.2575 – 1.2583 in.)

(c) Subtract the balance shaft main journal diameter measurement from the balance shaft bearing inside diameter measurement.

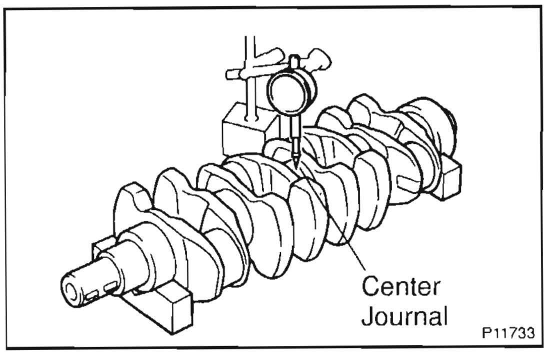
Standard oil clearance:

No.1	0.040 – 0.079 mm (0.0016 – 0.0031 in.)
No.2	0.040 – 0.079 mm (0.0016 – 0.0031 in.)
No.3	0.050 – 0.089 mm (0.0020 – 0.0035 in.)

Maximum oil clearance:

No.1	0.18 mm (0.0071 in.)
No.2	0.19 mm (0.0075 in.)
No.3	0.18 mm (0.0071 in.)

If the clearance is greater than maximum, replace the cylinder block and balance shaft.



P11733

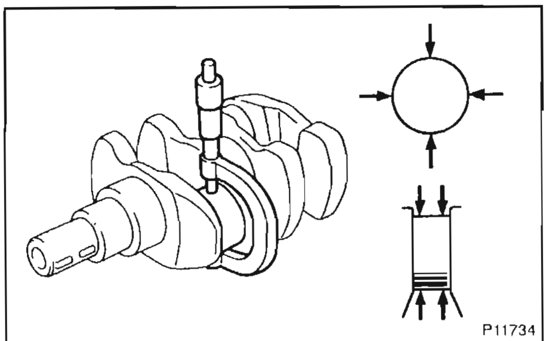
11. INSPECT CRANKSHAFT FOR RUNOUT

(a) Place the crankshaft on V–blocks.

(b) 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 crankshaft.


P11734

12. INSPECT MAIN JOURNALS AND CRANK PINS

(a) Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:

Mark 1	69.994 – 70.000 mm (2.75566 – 2.75590 in.)
Mark 2	69.988 – 69.994 mm (2.75543 – 2.75566 in.)
Mark 3	69.982 – 69.988 mm (2.75519 – 2.75543 in.)

Crank pin diameter:

Mark 1	58.994 – 59.000 mm (2.32259 – 2.32283 in.)
Mark 2	58.988 – 58.994 mm (2.32236 – 2.32259 in.)
Mark 3	58.982 – 58.988 mm (2.32212 – 2.32236 in.)

If the diameter is not as specified, check the oil clearance (See page EM–64). If necessary, grind or replace the crankshaft.

(b) Check each main journal and crank pin for taper and out–of–round as shown.

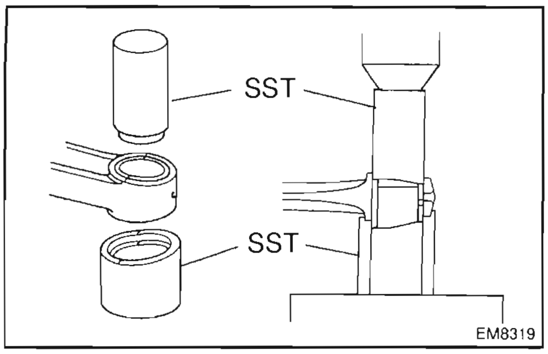
Maximum taper and out–of–round:
0.020 mm (0.0008 in.)

If the taper and out–of–round is greater than maximum, replace the crankshaft.

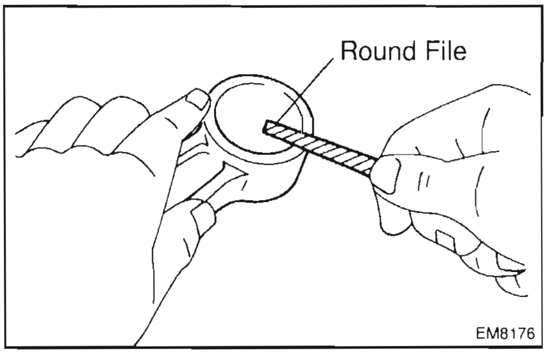
EM1M9-01

REPLACEMENT

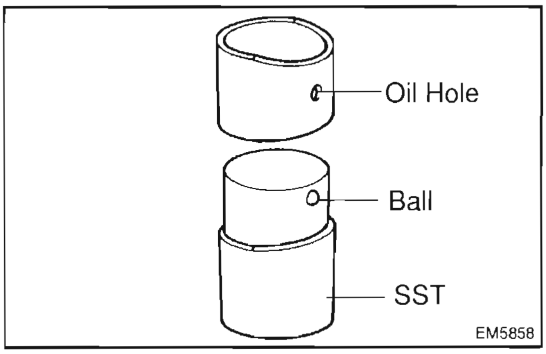
1. REPLACE CONNECTING ROD BUSHING



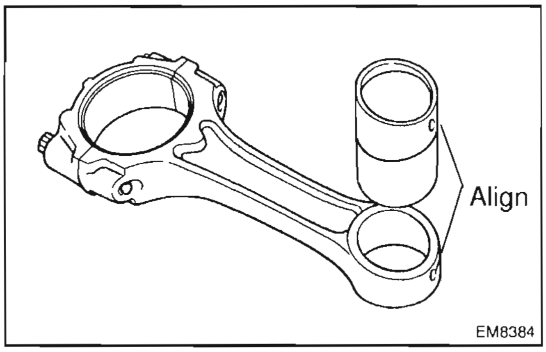
(a) Using SST and a press, press out the bushing.
SST 09222–67010 (09222–06010, 09222–06030)



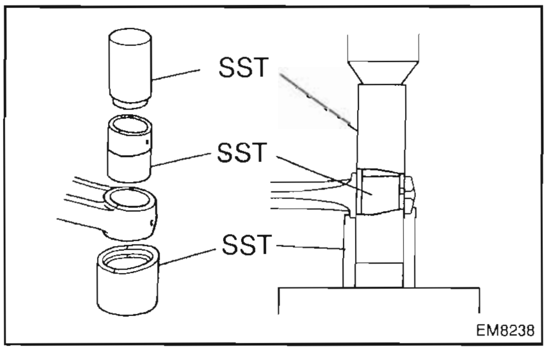
(b) Using a round file, lightly file off any roughness from the small end of the connecting rod.



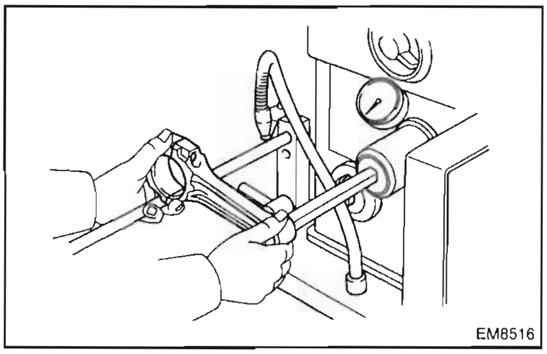
(c) Attach the bushing to SST with the ball of SST inside the oil hole of the bushing.
SST 09222–67010 (09222–06020)



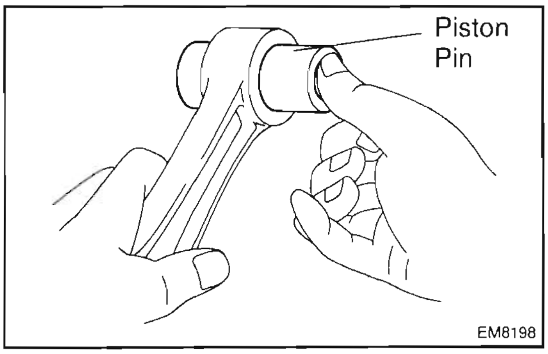
(d) Align the oil holes of a new bushing and the connecting rod.



(e) Using SST and a press, press in the bushing.
SST 09222–67010 (09222–06010, 09222–06020, 09222–06030)



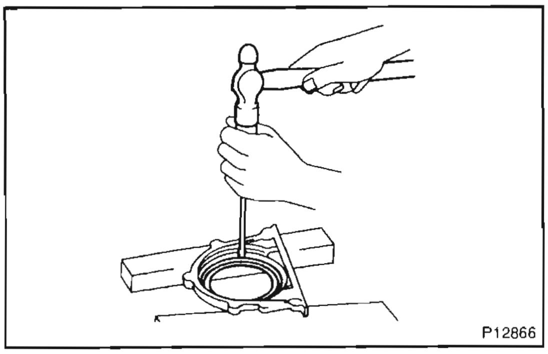
(f) Using a pin hole grinder, hone the bushing to obtain the standard specified clearance (See page EM–72) between the bushing and piston pin.



(g) Check 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.

2. GRIND AND HONE MAIN JOURNALS AND/OR CRANK PINS

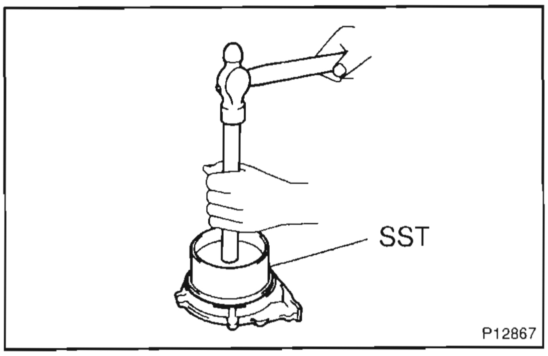
Grind and hone the main journals and/or crank pins to the finished undersized diameter (See page EM–72).
Install new main journal and/or crankshaft pin undersized bearings.



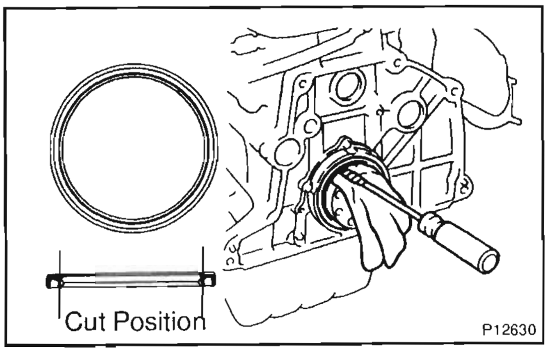
3. REPLACE CRANKSHAFT REAR OIL SEAL

HINT:
There are 2 methods (A and B) to replace the oil seal which are as follows.

(a) If the rear oil seal retainer is removed from the cylinder block:
  (1) Using a screwdriver and hammer, tap out the oil seal.

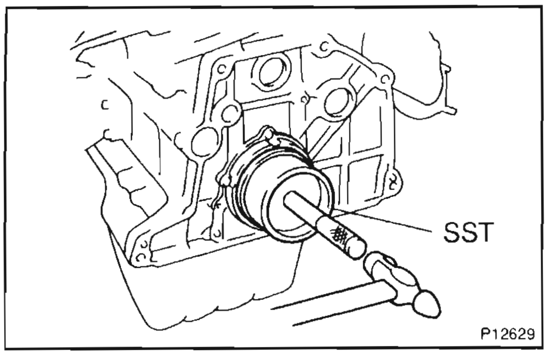


  (2) Using SST and a hammer, tap in a new oil seal until its surface is flush with the rear oil seal retainer edge.
  SST 09223–15030, 09252–10010
  (3) Apply MP grease to the oil seal lip.



(b) If the rear oil seal retainer 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) Apply MP grease to a new oil seal lip.

(4) 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, 09252–10010

EM1MA–01

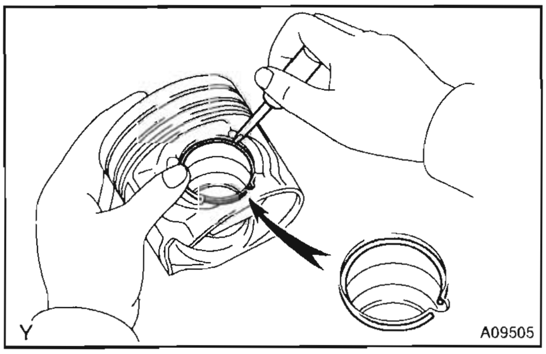
REASSEMBLY

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.**

HINT:

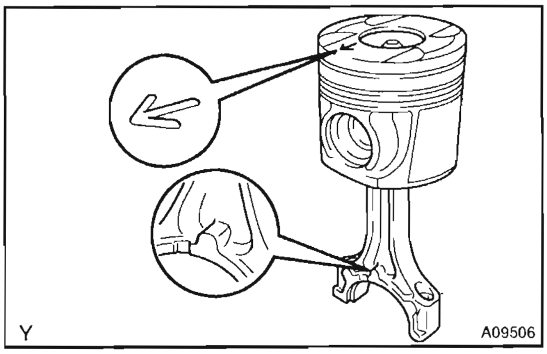
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O–rings and oil seals with new parts.



1. ASSEMBLE PISTON AND CONNECTING ROD

(a) Install a new snap ring on one side of the piston pin hole.

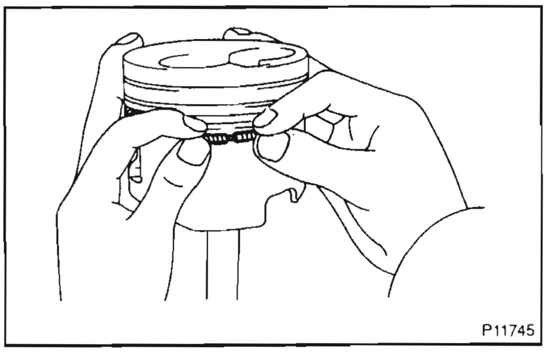
(b) Gradually heat the piston to 80°C (176°F).



(c) Coat the piston pin with engine oil.

(d) Align the front marks of the piston and connecting rod, and push in the piston pin with your thumb.

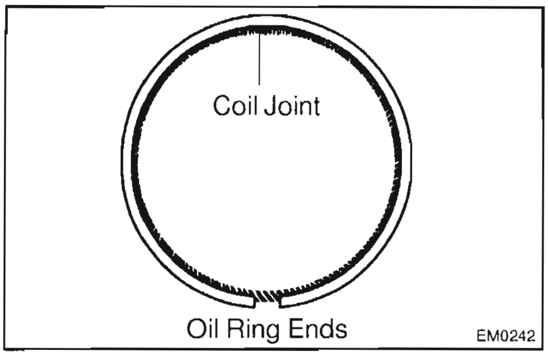
(e) Install a new snap ring on the other side of the piston pin hole.



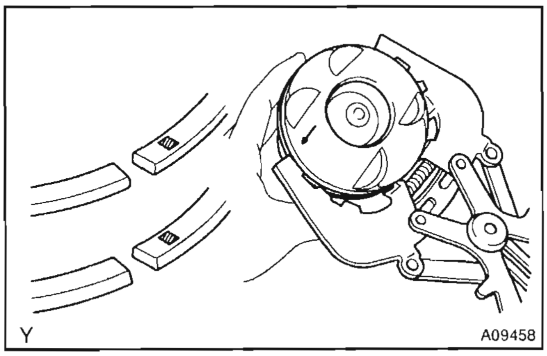
2. INSTALL PISTON RINGS

(a) Install the coil by hand.

(b) Install a piston ring expander, install the oil ring.

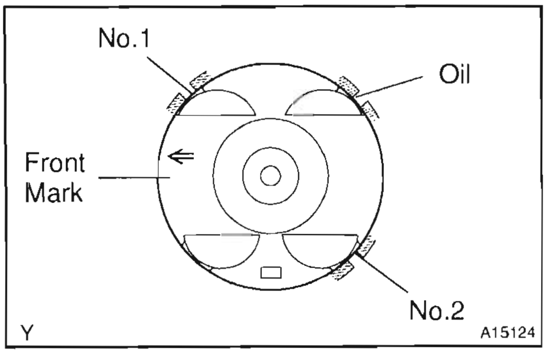


HINT:
Face the end gap of the oil ring in the opposite direction of coil joint.



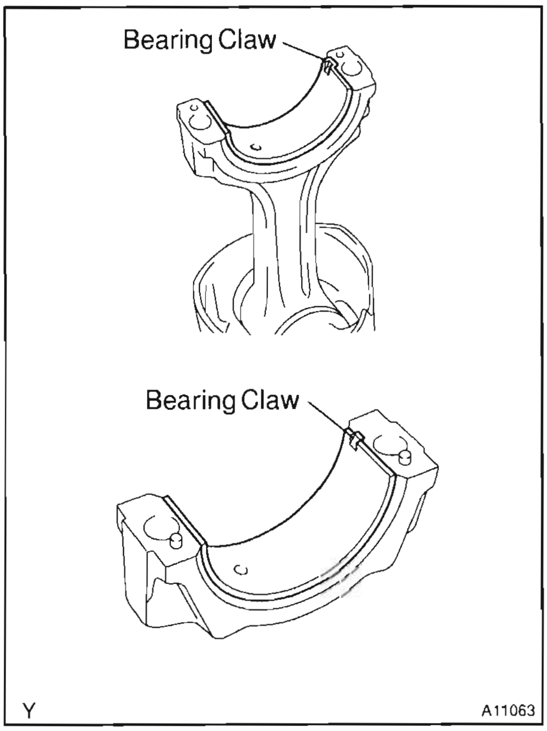
(c) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
Code mark:

No.1	NP
No.2	N



(d) Position the piston rings so that the ring ends are as shown.

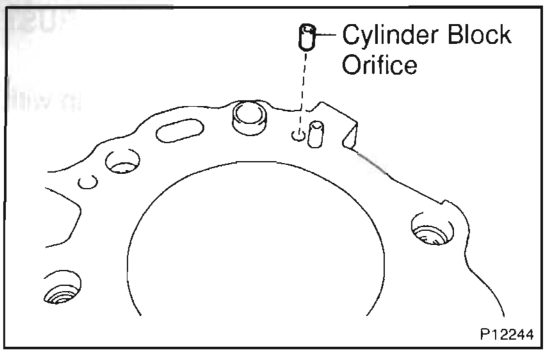
NOTICE:
Do not align the ring ends.



3. INSTALL BEARINGS

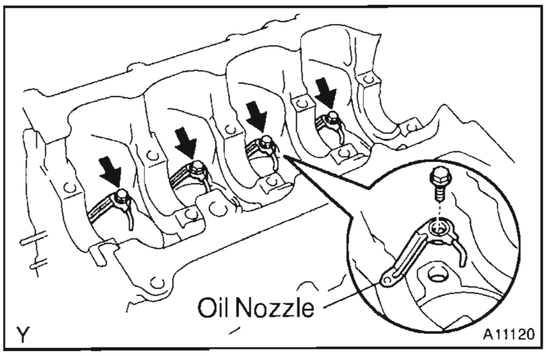
(a) Align the bearing claw with the groove of the connecting rod or connecting cap.

(b) Install the bearings in the connecting rod and connecting rod cap.



4. INSTALL CYLINDER BLOCK ORIFICE

Install the cylinder block orifice to the cylinder brock.

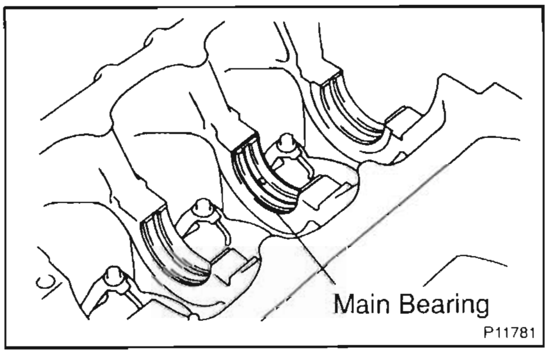


5. INSTALL OIL NOZZLES AND CHECK VALVES

(a) Align the pin of the oil nozzle with the pin hole of the cylinder block.

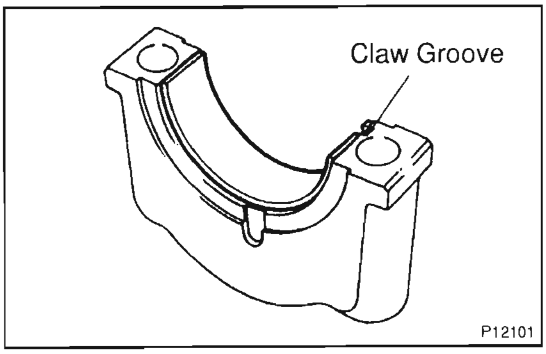
(b) Install the oil nozzle with the check valve. Install the 4 oil nozzles and check valves.

Torque: 25 N·m (260 kgf·cm, 19 ft·lbf)



6. INSTALL MAIN BEARINGS

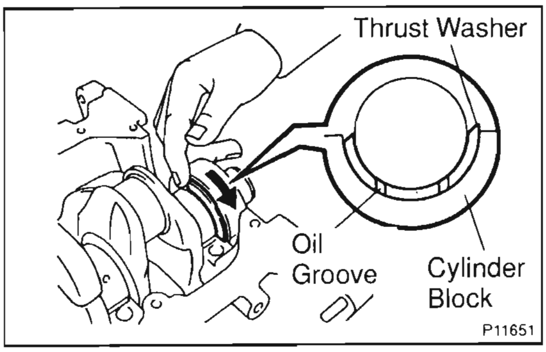
(a) Align the bearing claw with the claw groove of the cylinder block, and push in the 5 upper bearings.



(b) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

7. PLACE CRANKSHAFT ON CYLINDER BLOCK

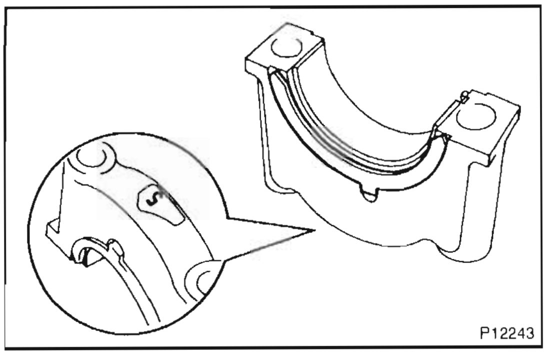
Place the crankshaft on the cylinder brock.



8. INSTALL UPPER THRUST WASHERS

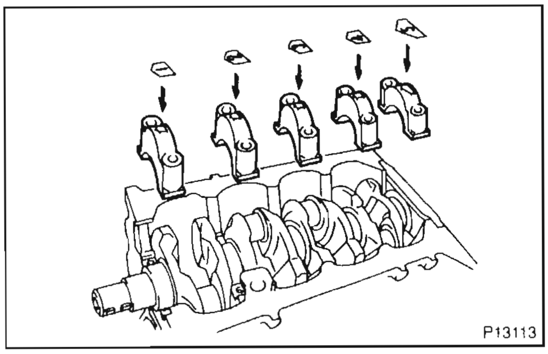
(a) Push the crankshaft toward the front (rear) side.

(b) Install the 2 thrust washers to the No.5 journal position of the cylinder block with the oil grooves facing outward.



9. PLACE MAIN BEARING CAP AND LOWER THRUST WASHERS ON CYLINDER BLOCK

(a) Install the 2 thrust washers on the No.5 bearing cap with the grooves facing outward.



(b) Install the 5 main bearing caps in their proper locations.

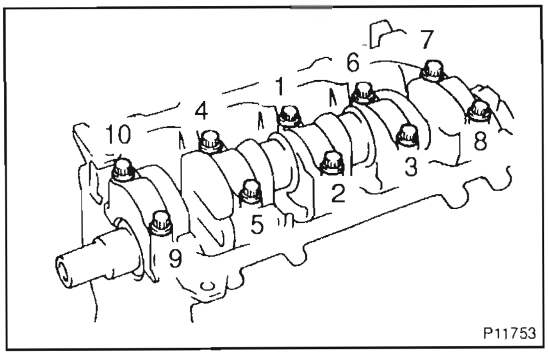
HINT:

Each bearing cap has a number and front mark.

10. INSTALL MAIN BEARING CAP BOLTS

HINT:

- The main bearing cap bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any one of the main bearing cap bolt is broken or deformed, replace it.



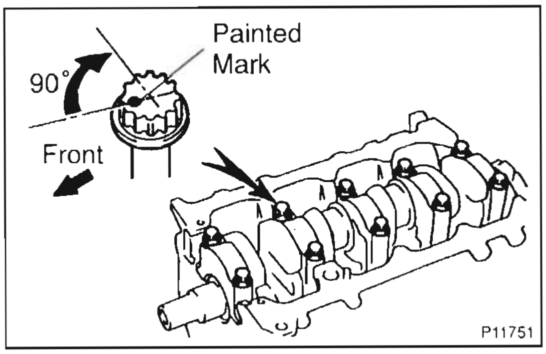
(a) Apply a light coat of engine oil on the threads and under the heads of the main bearing cap bolts.

(b) Install and uniformly tighten the 10 bolts of the main bearing caps in several passes, in the sequence shown.

Torque: 50 N·m (510 kgf·cm, 37 ft·lbf)

If any one of the main bearing cap bolts does not meet the torque specification, replace the main bearing cap bolt.

(c) Mark the front of the main bearing cap bolt with paint.

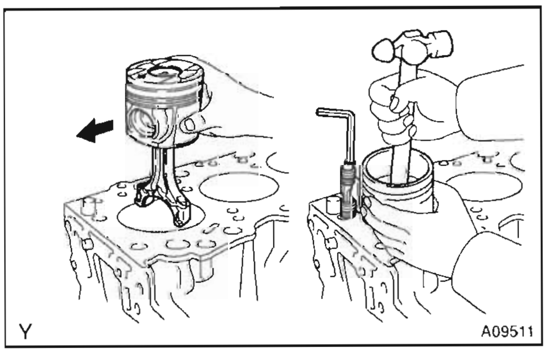


(1) Retighten the main bearing cap bolts 90 ° in the numerical order shown above.

(2) Check that the painted mark is now at a 90 ° angle to the front.

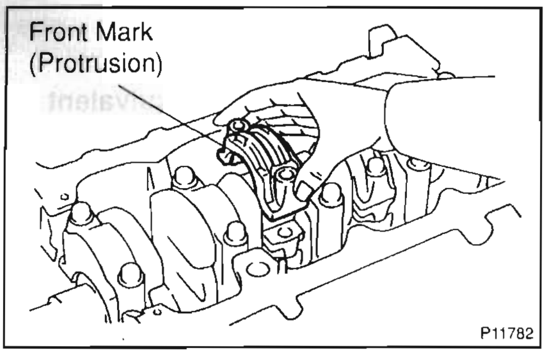
(3) Check that the crankshaft turns smoothly.

(4) Check the crankshaft thrust clearance(See page EM–80).



11. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES

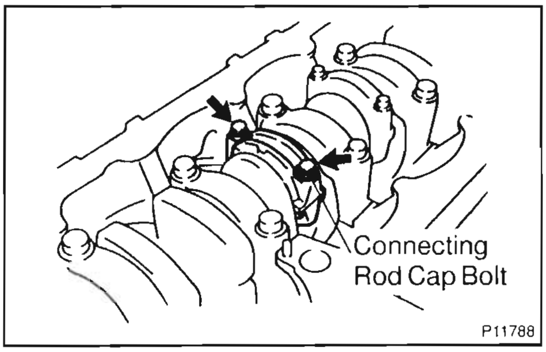
Using a piston ring compressor, push the correctly numbered piston and connecting rod assemblies into each cylinder with the front mark of the piston facing forward.



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.



(c) Install the connecting rod cap bolts.

HINT:

- The connecting rod bolts are tightened in 2 progressive steps (steps (b) and (d)).
- If any connecting rod bolt is broken or deformed, replace it.

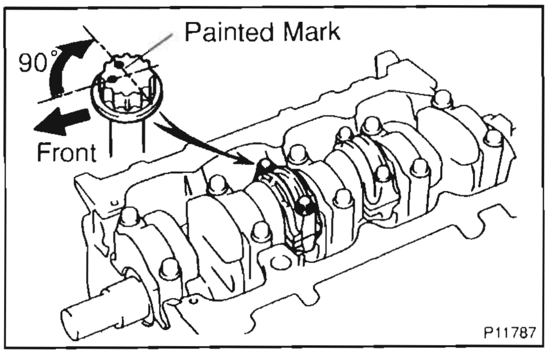
(d) Apply a light of engine oil on the threads and under the heads of the connecting rod cap bolts.

(e) Install and alternately tighten the bolts of the connecting rod cap in several passes.

Torque: 35 N·m (357 kgf·cm, 26 ft·lbf)

If any one of the connecting rod bolts does not meet the torque specification, replace the rod bolt.

(f) Mark the front of the connecting rod bolt with paint.



(g) Retighen the connecting rod cap bolts 90° as shown .

(h) Check that the painted mark is now at a 90° angle to the front.

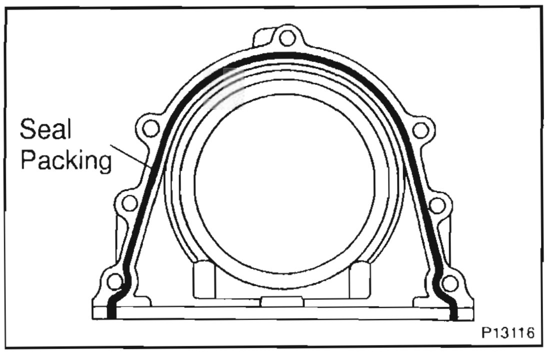
(i) Check that the crankshaft turns smoothly.

13. CHECK CONNECTING ROD THRUST CLEARANCE (See step EM–64)

14. 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 retainer 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.



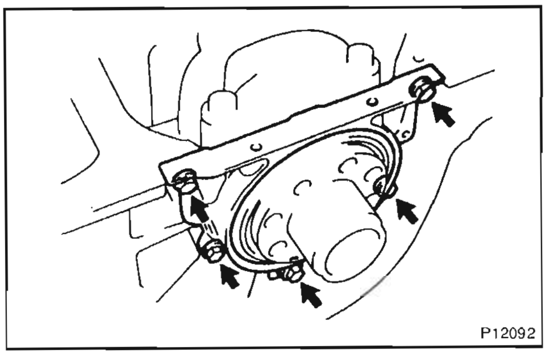
(b) Apply seal packing to the retainer as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent

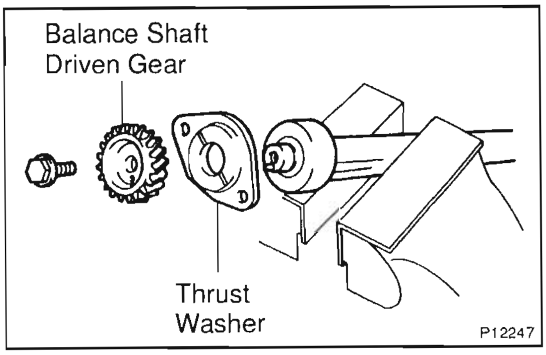
- Install a nozzle that has been cut to a 2 – 3 mm (0.08 – 0.12 in.) opening.

HINT:
Avoid applying an excessive amount to the surface.

- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



(c) Install the retainer with the 5 bolts.
Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)



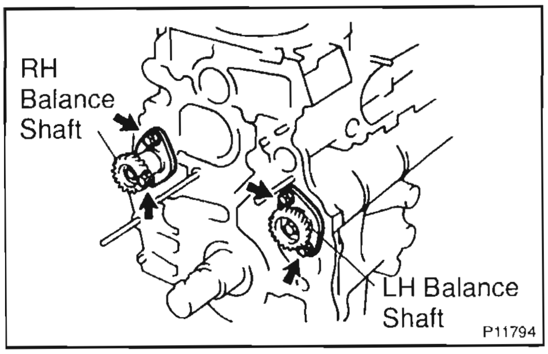
15. ASSEMBLY RH AND LH BALANCE SHAFTS

(a) Mount the weight of the balance shaft in a vise.

NOTICE:
Be careful not to damage the balance shafts.

(b) Align the balance shaft knock pin with the knock pin hole of the balance shaft driven gear, install the thrust washer and balance shaft driven gear.

(c) Install and torque the bolt.
Torque: 36 N·m (367 kgf·cm, 27 ft·lbf)



16. INSTALL RH AND LH BALANCE SHAFTS

(a) Install the RH balance shaft with the 2 bolts.

(b) Install the LH balance shaft with the 2 bolts.
Torque: 13 N·m (133 kgf·cm, 10 ft·lbf)

17. INSTALL PLUG HOLE

18. INSTALL ENGINE MOUNTING
Torque: 68 N·m (693 kgf·cm, 50 ft·lbf)

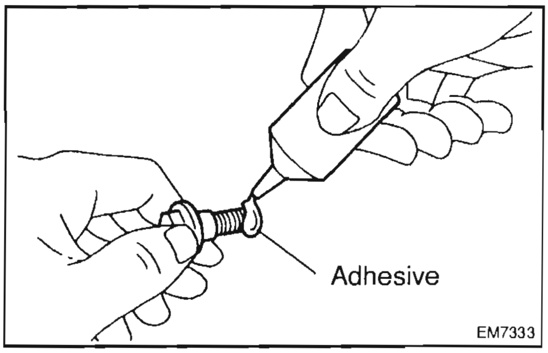
19. INSTALL WATER TEMPERATURE SENSOR

20. INSTALL WATER INLET AND THRMOSTAT
(See page CO–13)

21. **INSTALL OIL COOLER (See page LU–19)**
22. **INSTALL OIL PAN AND TIMING GEAR CASE (See page LU–12)**
23. **INSTALL SUPPLY PUMP (See page FU–18)**
24. **INSTALL TIMING GEARS (See page EM–31)**
25. **INSTALL WATER PUMP (See page CO–8)**
26. **INSTALL ALTERNATOR AND ALTERNATOR BRACKET (See page CO–8)**
27. **INSTALL CYLINDER HEAD (See page EM–56)**
28. **INSTALL TIMING BELT AND PULLEYS (See page EM–16)**
29. **DISCONNECT ENGINE FROM ENGINE STAND**
30. **INSTALL REAR END PLATE**

Install the rear end plate with the bolt.

Torque: 8.0 N·m (82 kgf·cm, 71 in.·lbf)



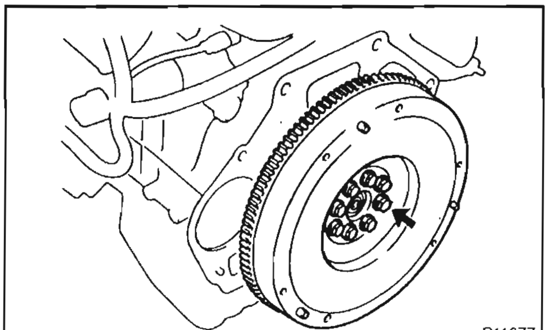
EM7333

31. **INSTALL FLYWHEEL (M/T) OR DRIVE PLATE (A/T)**

(a) Apply adhesive to 2 or 3 threads of the mounting bolt end.

Adhesive:

Part No. 08833–00070, THREE BOND 1324, or equivalent


P11677

(b) Install the flywheel or drive plate on the crankshaft.

(c) Install and uniformly tighten the mounting bolts in several passes, in the sequence shown.

Torque:

M/T: 145 N·m (1,479 kgf·cm, 107 ft·lbf)

A/T: 178 N·m (1,820 kgf·cm, 131 ft·lbf)

32. **M/T:**
INSTALL CLUTCH COVER AND DISC

TURBOCHARGING

TROUBLESHOOTING TC–1
TURBOCHARGER TC–2
INTERCOOLER TC–10

TROUBLESHOOTING

TC03A-01

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
1. Turbocharging pressure too low	Check turbocharging pressure.	TC–3
2. Restricted intake system	Check intake air system, and repair or replace parts as necessary.	EM–1 EM–41
3. Leak in intake air system	Check intake air system, and repair or replace parts as necessary.	EM–1 EM–41 TC–10
4. Restricted exhaust system	Check exhaust system, and repair or replace parts as necessary.	EM–41
5. Leak in exhaust system	Check exhaust system, and repair or replace parts as necessary.	EM–41
6. Erratic turbocharger operation	Check rotation of turbine shaft, and replace turbocharger if necessary. Check axial and radial plays of turbine shaft, and replace turbocharger if necessary. Check turbocharger operation, and replace turbocharger if necessary.	TC–7 TC–3

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–5
2. Erratic turbocharger operation	Check rotation of turbine shaft, and replace bearing housing if necessary. Check axial and radial plays of turbine shaft, and replace turbocharger if necessary.	TC–7

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 turbocharger if necessary.	TC–7

TURBOCHARGER

TC03B–01

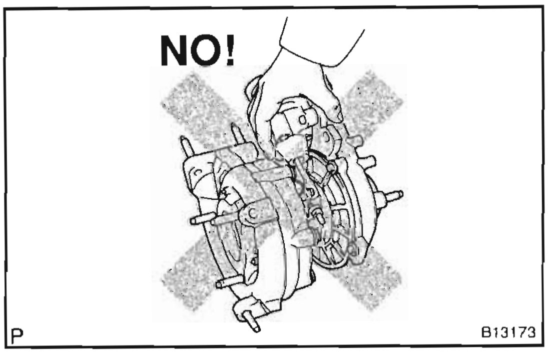
PRECAUTION

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.

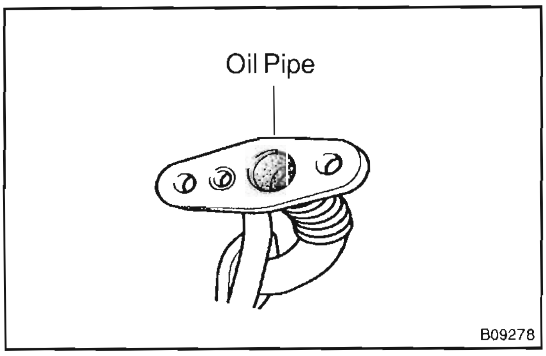
(b) Avoid sudden acceleration or racing immediately after starting a cold engine.

(c) If the turbocharger is found to be defective and must be replaced, check for the cause, and repair or replace the following 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, when moving it.

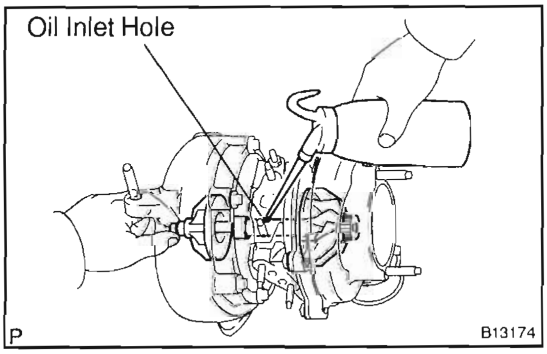
(e) Before removing the turbocharger, plug the intake and exhaust ports and oil inlet to prevent entry of dirt or other foreign material.



(f) If replacing the turbocharger, check for accumulation of sludge particles in the oil pipes, and if necessary, replace the oil pipes.

(g) Completely remove the gasket adhered to the lubrication oil pipe flange and turbocharger oil flange.

(h) When replacing 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 oil into the turbocharger oil inlet and turn the impeller 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) Do not run the engine with air cleaner removed, as this may cause foreign material to enter and damage the impeller wheel operating at high speed.

TC03C–01

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.

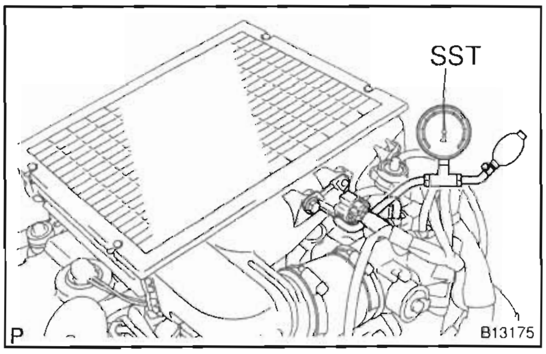
- Clogged air cleaner .... Clean or replace element
- Hoses collapsed or deformed .... Repair or replace
- Leakage from connections .... Check each connection and repair
- Cracks in components .... Check and replace

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

TC



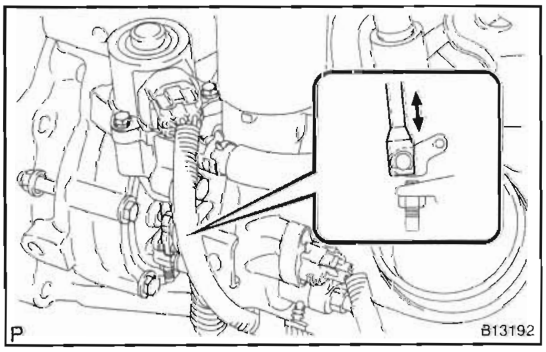
3. CHECK TURBOCHARGER PRESSURE

(a) Warm up engine.
(b) Using a 3–way connector, connect SST (turbocharger pressure gauge) to the hose leading to the intake manifold.
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 (approx. 4,600 rpm) .
Standard pressure:
205 kPa (2.1 kgf/cm^2, 15.6 psi)

If the pressure is not specification, check the intake air and exhaust systems for leakage.
If there is no leakage, check the turbocharger operation.

4. INSPECT TURBINE SHAFT ROTATION
(See page TC–7)

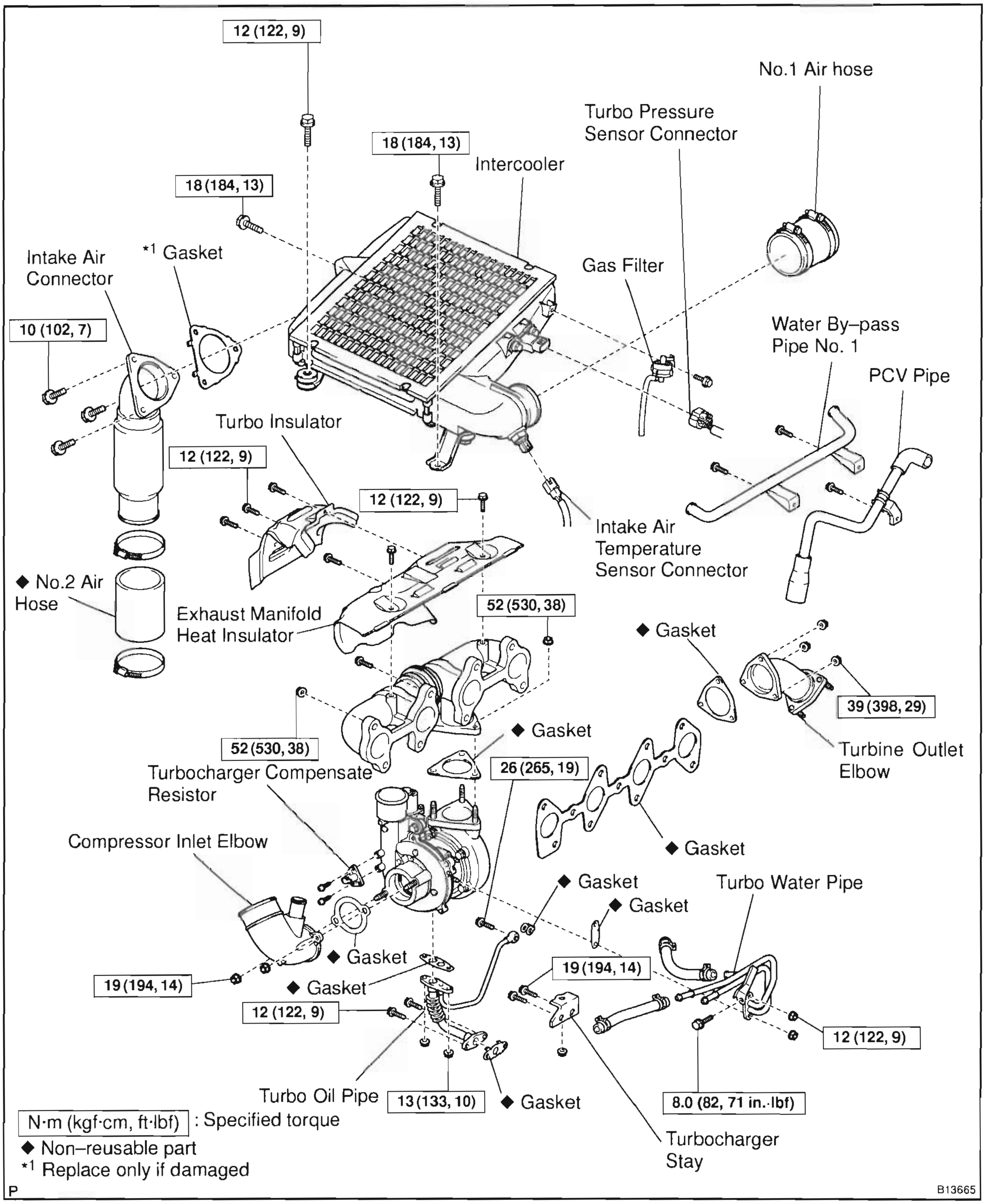
5. INSPECT TURBO PRESSURE SENSOR
(See page ED–15)



6. CHECK STEP MOTOR FOR TURBOCHARGER CONTROL OPERATION

(a) Warm up engine.
(b) Make sure that the connector is properly connected.
(c) Turn the IG switch OFF. Then turn the IG switch ON again.
(d) Start the engine and make it idle.
(e) At this time, check visually that the step motor rod strokes.
Reference:
Rod stroke range: 11 ± 0.03 mm (0.43 ± 0.0012 in.)

COMPONENTS


12 (122, 9)
No.1 Air hose
Turbo Pressure
Sensor Connector
18 (184, 13)
Intercooler
18 (184, 13)
Intake Air
Connector
*1 Gasket
Gas Filter
10 (102, 7)
Water By–pass
Pipe No. 1
PCV Pipe
Turbo Insulator
12 (122, 9)
12 (122, 9)
Intake Air
Temperature
Sensor Connector
◆ No.2 Air
Hose
Exhaust Manifold
Heat Insulator
52 (530, 38)
◆ Gasket
39 (398, 29)
◆ Gasket
52 (530, 38)
Turbine Outlet
Elbow
26 (265, 19)
Turbocharger Compensate
Resistor
◆ Gasket
Compressor Inlet Elbow
◆ Gasket
Turbo Water Pipe
◆ Gasket
◆ Gasket
19 (194, 14)
19 (194, 14)
◆ Gasket
12 (122, 9)
12 (122, 9)
Turbo Oil Pipe
13 (133, 10)
◆ Gasket
8.0 (82, 71 in.·lbf)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
*1 Replace only if damaged
Turbocharger
Stay
P
B13665

TC03E–01

REMOVAL

1. DRAIN ENGINE COOLANT

2. REMOVE INTERCOOLER (See page TC–11)

3. REMOVE PCV PIPE

(a) Remove the 2 bolts and disconnect the water by–pass pipe No. 1.

(b) Remove the bolt and PCV pipe.

4. REMOVE TURBO INSULATOR

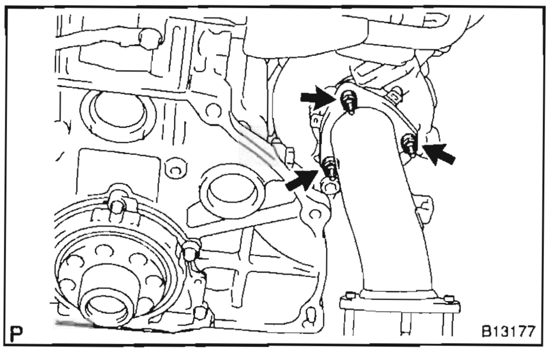
Remove the 3 bolts and turbo insulator.

5. REMOVE EXHAUST MANIFOLD HEAT INSULATOR

Remove the 3 bolts and exhaust manifold heat insulator.

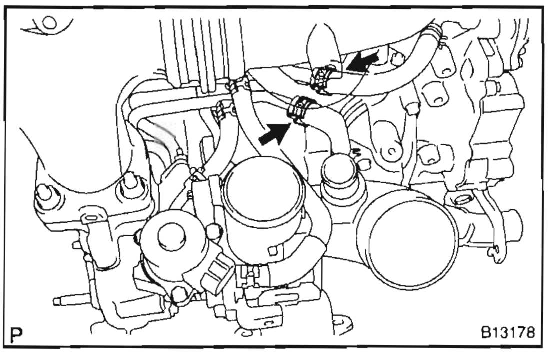
6. REMOVE OIL LEVEL GAUGE GUIDE

Remove the bolt, oil level gauge guide and O–ring.

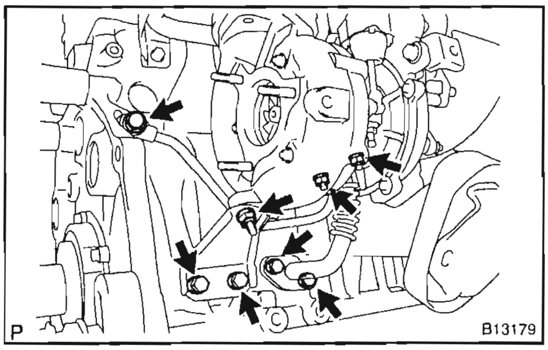


7. REMOVE TURBINE OUTLET ELBOW

Remove the 3 nuts, turbine outlet elbow and gasket.



8. DISCONNECT 2 WATER HOSES



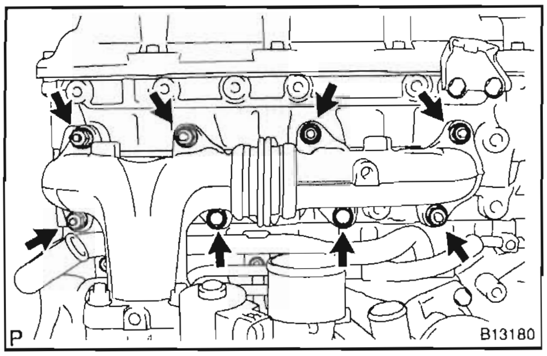
9. REMOVE TURBOCHARGER STAY

Remove the 2 bolts, nut and turbocharger stay.

10. REMOVE TURBO OIL PIPE

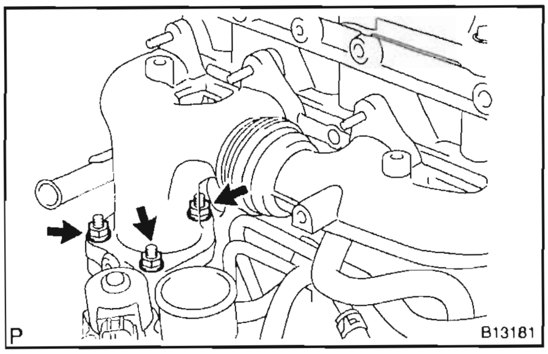
(a) Remove the 2 bolts and union bolt from the turbo oil.

(b) Remove the 2 nuts, turbo oil pipe and 3 gasket.



11. REMOVE TURBOCHARGER AND EXHAUST MANIFOLD ASSEMBLY

Remove the 6 nuts, plate washers, 2 bolts, turbocharger and exhaust manifold assembly and gasket.

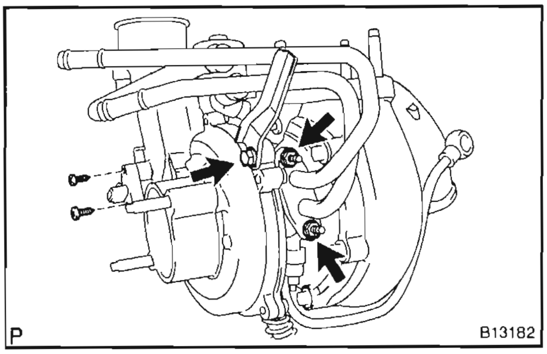


12. REMOVE EXHAUST MANIFOLD

Remove the 3 nuts, exhaust manifold and gasket from the turbocharger.

13. REMOVE COMPRESSOR INLET ELBOW

Remove the 2 nuts, compressor inlet elbow and gasket from the turbocharger.



14. REMOVE TURBO WATER PIPE

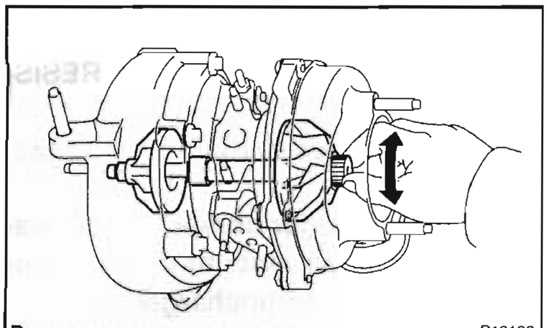
(a) Remove the 2 water hoses.

(b) Remove the 2 nuts, bolt, turbo water pipe and gasket.

15. REMOVE TURBOCHARGER COMPENSATE RESISTOR

Remove the 2 screws and turbocharger compensate resistor.

TC03F–01



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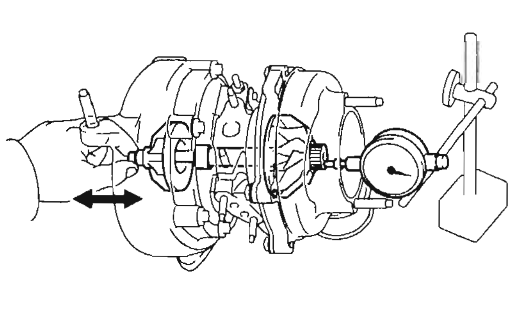
INSPECTION

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 does not turn or if it turn s with a heavy drag, replace the turbocharger.



P B13184

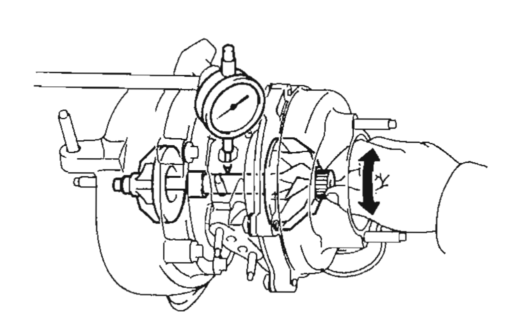
2. INSPECT AXIAL PLAY OF TURBINE SHAFT

(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 axial play: 0.15 mm (0.0063 in.)

If the axial play is greater than maximum, replace the turbocharger.



P B13185

3. INSPECT RADIAL PLAY OF TURBINE SHAFT

(a) Using 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.

(b) Move the turbine shaft in a radial direction, measure the radial play of the turbine shaft.

Maximum radial play: 0.13 mm (0.0051 in.)

If the radial play is greater than maximum, replace the turbocharger.

4. INSPECT TURBOCHARGER COMPENSATE RESISTOR

Using an Ohmmeter, measure the resistance between terminals.

Standard Resistance:

Mark	Resistance
1	214 – 228 Ω
2	285 – 303 Ω
3	372 – 394 Ω
4	472 – 502 Ω
5	600 – 638 Ω
6	763 – 811 Ω
7	989 – 1,051 Ω
8	1,290 – 1,370 Ω
9	1,727 – 1,833 Ω

If resistance is not specification, replace the turbocharger compensate resistor.

TC03G–01

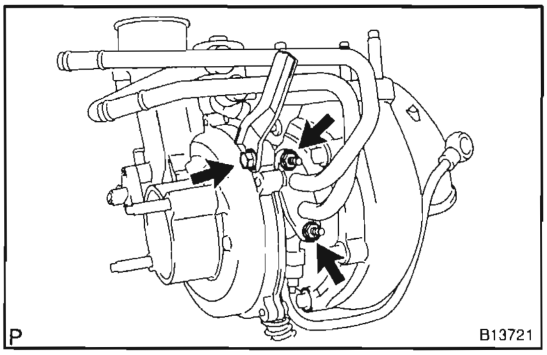
INSTALLATION

1. INSTALL TURBOCHARGER COMPENSATE RESISTOR

Install the turbocharger compensate resistor with the 2 screws.

NOTICE:

Use the same numbered turbocharger compensate resistor for replacement, because the air amount of the turbocharger is measured, to install the turbocharger compensate resistor with resistance value corresponding to the air amount.



2. INSTALL TURBO WATER PIPE

(a) Install a new gasket, turbo water pipe with the 2 nuts and bolt.

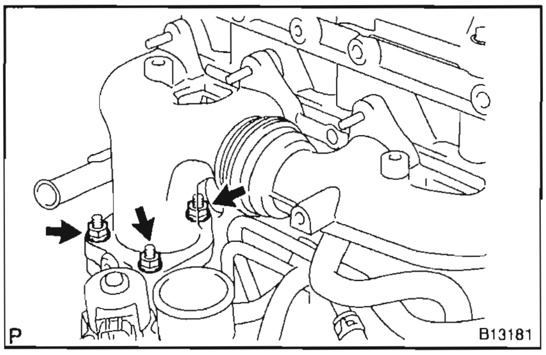
Torque:
Bolt: 8.0 N·m (82 kgf·cm, 71 in.·lbf)
Nut: 12 N·m (122 kgf·cm, 9 ft·lbf)

(b) Install the 2 water hoses.

3. INSTALL COMPRESSOR INLET ELBOW

Install a new gasket and compressor inlet elbow with the 2 nuts.

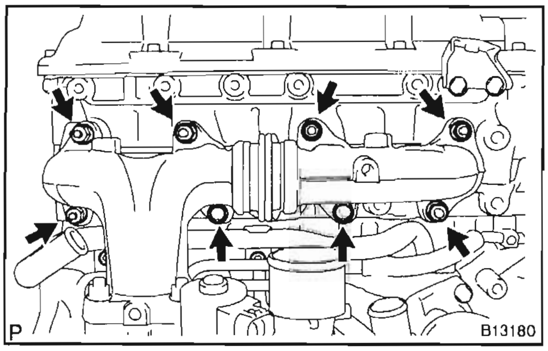
Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)



4. INSTALL EXHAUST MANIFOLD

Install a new gasket and exhaust manifold to the turbocharger with the 3 nuts.

Torque: 52 N·m (530 kgf·cm, 38 ft·lbf)



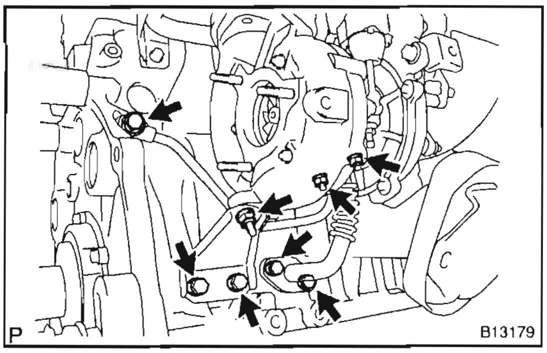
5. INSTALL TURBOCHARGER AND EXHAUST MANIFOLD ASSEMBLY

Install a new gasket and turbocharger and exhaust manifold assembly with the 6 nuts, plate washers and 2 bolts.

Torque: 52 N·m (530 kgf·cm, 38 ft·lbf)

6. INSTALL TURBO OIL PIPE

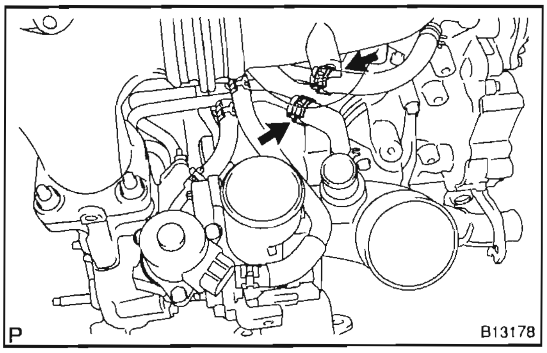
(a) Install new 2 gasket to the turbo oil pipe.



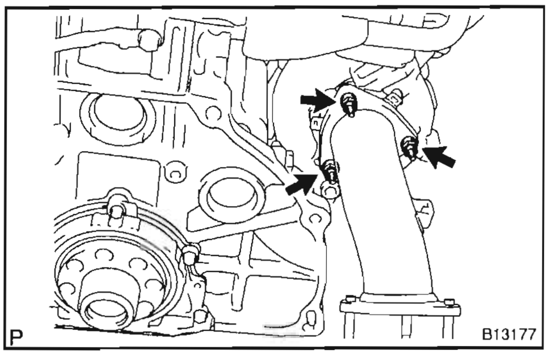
(b) Install a new gasket and turbo oil pipe with the 2 bolts, nuts and union bolt.
Torque:
Nut: 13 N·m (133 kgf·cm, 10 ft·lbf)
Bolt: 12 N·m (122 kgf·cm, 9 ft·lbf)
Union Bolt: 26 N·m (265 kgf·cm, 19 ft·lbf)

7. INSTALL TURBOCHARGER STAY

Install the turbocharger stay with the 2 bolts and nut.
Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)



8. CONNECT 2 WATER HOSES



9. INSTALL TURBINE OUTLET ELBOW

Install a new gasket and turbine outlet elbow with the 3 nuts.
Torque: 39 N·m (398 kgf·cm, 29 ft·lbf)

10. INSTALL OIL LEVEL GAUGE GUIDE

Install a new O–ring and oil level gauge guide with the bolt.
Torque: 8.0 N·m (82 kgf·cm, 71 in.·lbf)

11. INSTALL EXHAUST MANIFOLD HEAT INSULATOR

Install the exhaust manifold heat insulator with the 3 bolts.
Torque: 12 N·m (122 kgf·cm, 9 ft·lbf)

12. INSTALL TURBO INSULATOR

Install the turbo insulator with the 3 bolts.
Torque: 12 N·m (122 kgf·cm, 9 ft·lbf)

13. INSTALL PCV PIPE

(a) Install the PCV pipe with the bolt.
Torque: 20 N·m (204 kgf·cm, 15 ft·lbf)
(b) Install the No. 1 water by–pass pipe with the 2 bolts.
Torque: 18 N·m (184 kgf·cm, 13 ft·lbf)

14. INSTAL INTERCOOLER (See page TC–12)

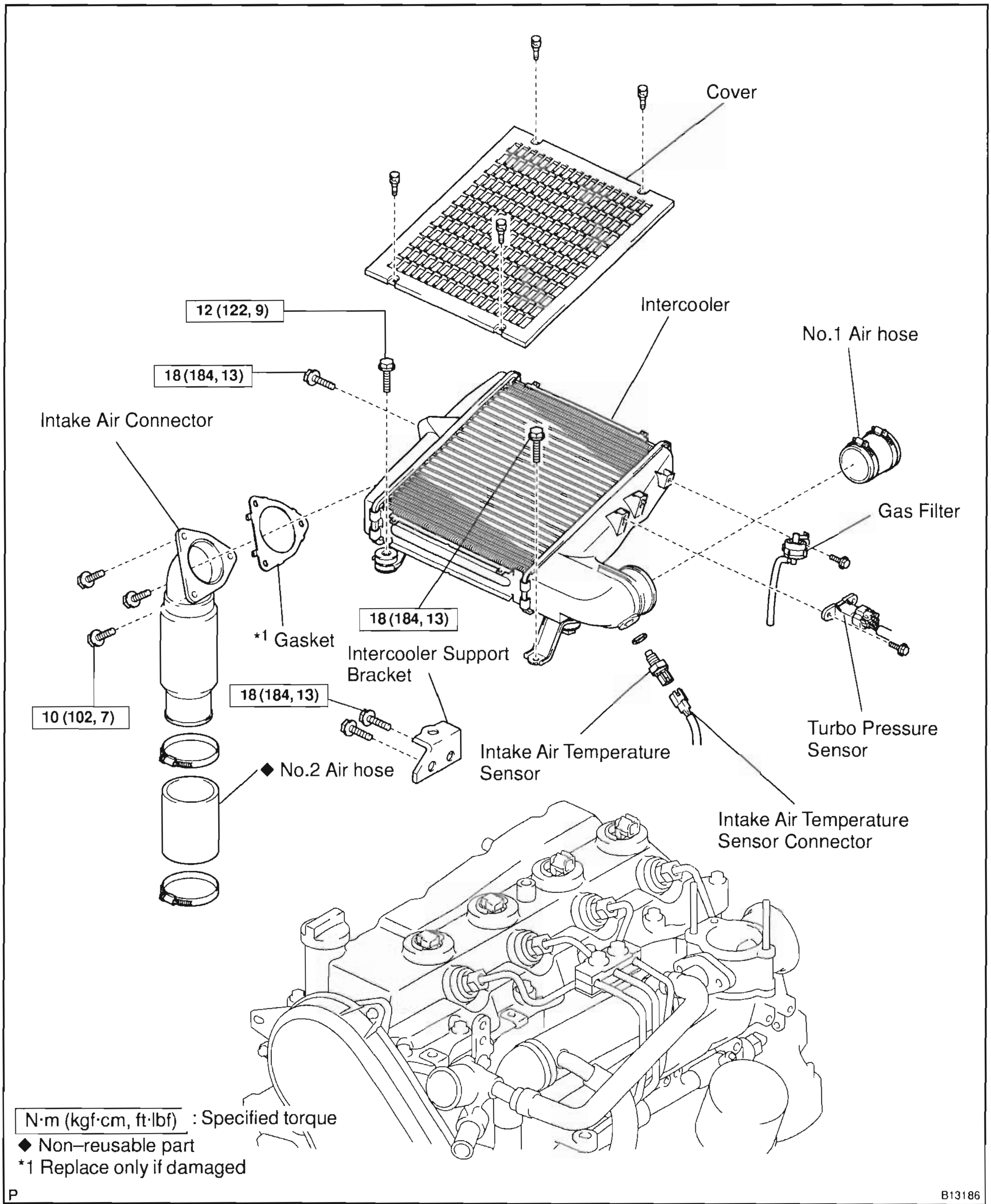
15. FILL WITH ENGINE COOLANT (See page CO–2)

16. START ENGINE AND CHECK FOR LEAKS.

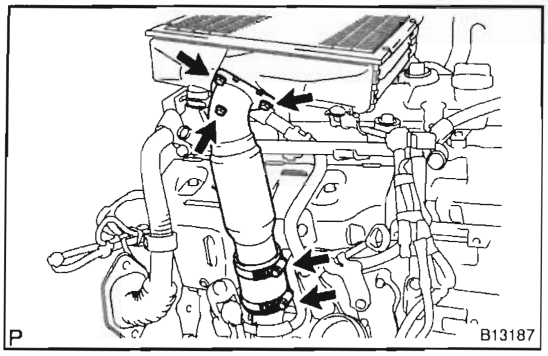
INTERCOOLER

COMPONENTS

TC03H–01



TC03I–01



REMOVAL

1. REMOVE INTAKE AIR CONNECTOR

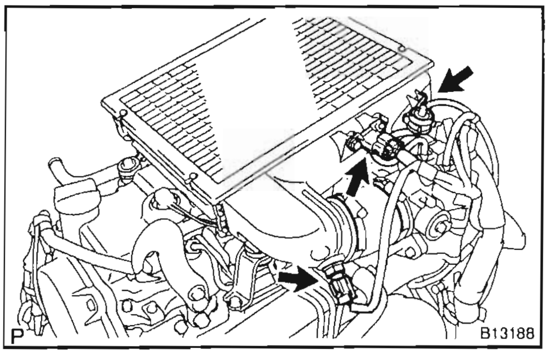
(a) Loosen the 2 clamp for No. 2 air hose.

(b) Remove the 3 bolts intake air connector and gasket.

(c) Remove the No. 2 air hose.

2. REMOVE NO. 1 AIR HOSE

Loosen the 2 clamp, and remove the No. 1 air hose.

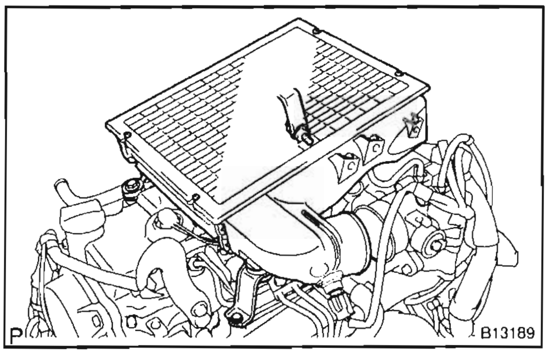


3. REMOVE INTERCOOLER

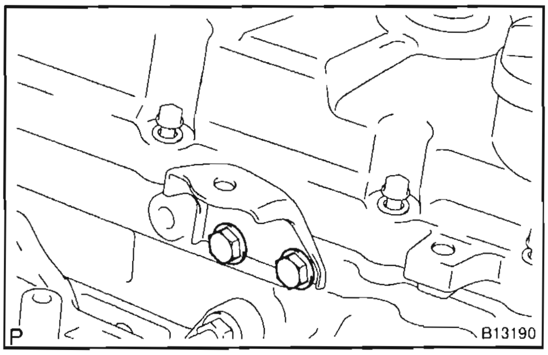
(a) Remove the bolt, and disconnect the turbo pressure sensor.

(b) Remove the bolt, and disconnect the gas filter.

(c) Disconnect the intake air temperature sensor connector and remove the intake air temperature sensor and gasket.

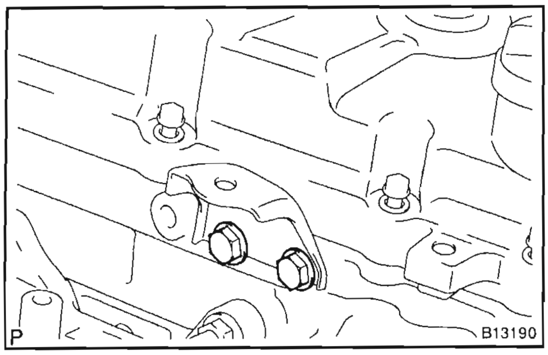


(d) Remove the 3 bolts and inter cooler.



(e) Remove the 2 bolts and intercooler support bracket.

(f) Remove the 4 clips and cover from the intercooler.



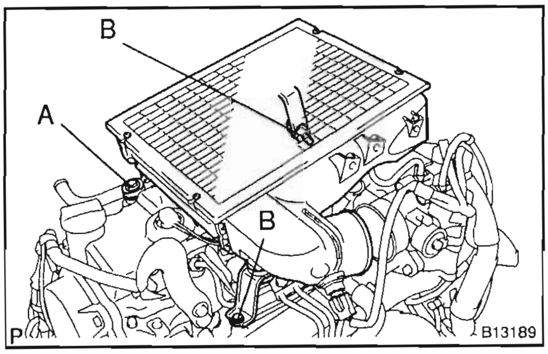
TC03J–01

INSTALLATION

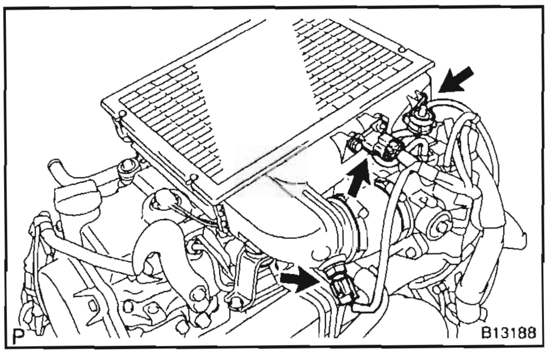
1. INSTALL INTERCOOLER

(a) Install the intercooler support bracket with the 2 bolts.
Torque: 18 N·m (184 kgf·cm, 13 ft·lbf)

(b) Install the cover with 4 clips.



(c) Install the intercooler with the 3 bolts.
Torque:
Bolt A: 12 N·m (122 kgf·cm, 9 ft·lbf)
Bolt B: 18 N·m (184 kgf·cm, 13 ft·lbf)



(d) Install a new gasket and intake air temperature sensor.
Torque: 29.4 N·m (300 kgf·cm, 22 ft·lbf)

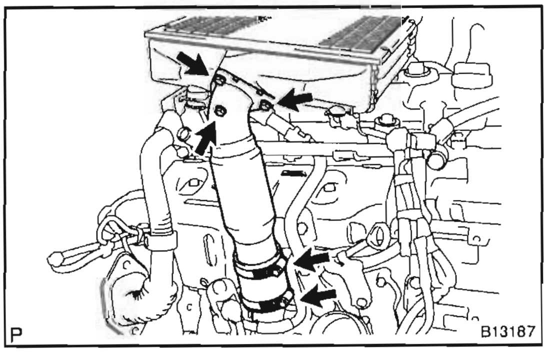
(e) Connect the intake air temperature sensor connector.

(f) Install the turbo pressure sensor with the bolt.

(g) Install the gas filter with the bolt.

2. INSTALL NO. 1 AIR HOSE

Install the No. 1 air hose, tighten the 2 clamps.



3. INSTALL INTAKE AIR CONNECTOR

(a) Install a new No. 2 air hose.

(b) Install the gasket and intake air connector with the 3 bolts.
Torque: 10 N·m (102 kgf·cm, 7 ft·lbf)

(c) Tighten the 2 clamps for No. 2 air hose.

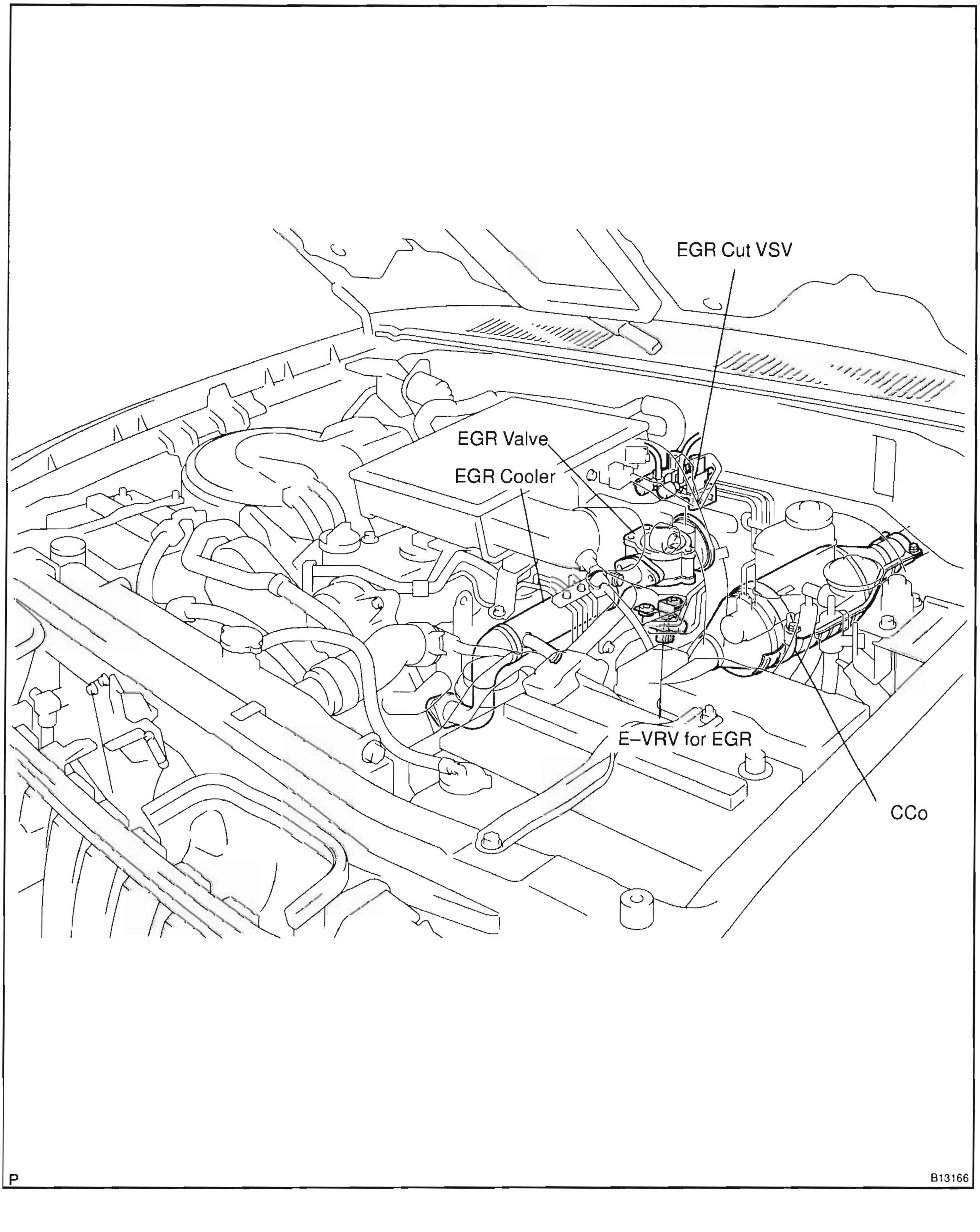
EMISSION CONTROL

PARTS LAYOUT AND SCHEMATIC DRAWING EC–1
POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM EC–3
EXHAUST GAS RECIRCULATION (EGR) SYSTEM EC–4
CATALYTIC CONVERTER FOR OXIDATION (CCo) SYSTEM EC–8

PARTS LAYOUT AND SCHEMATIC DRAWING

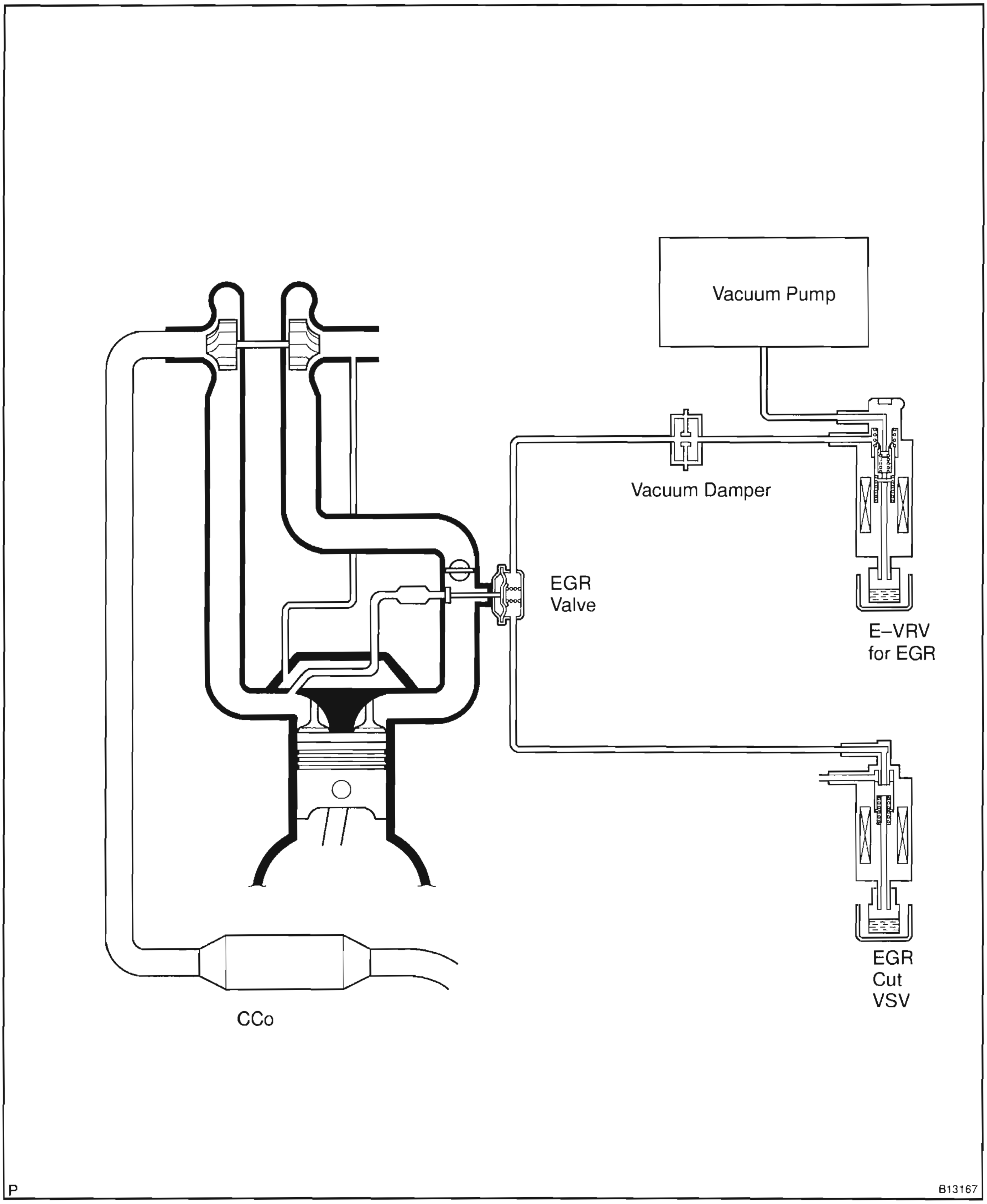
LOCATION

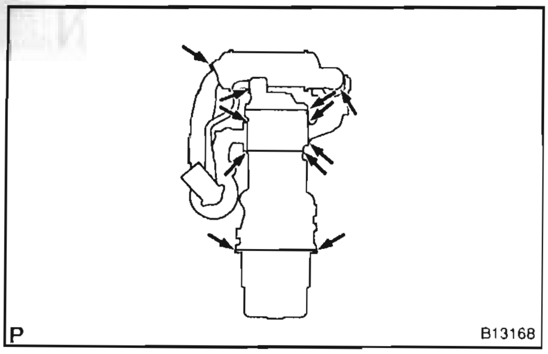
EC0CQ–03



ECOCR-02

DRAWING





POSITIVE CRANKCASE VENTILATION (PCV) SYSTEM

ECOCS-02

INSPECTION

VISUALLY INSPECT HOSE AND CONNECTION

Check for cracks, leaks or damage.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

ECOIV–01

ON–VEHICLE INSPECTION

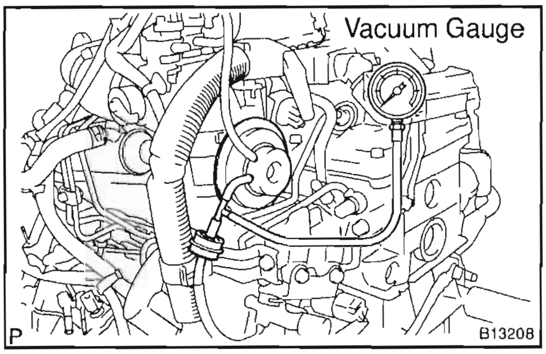
HINT:

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.

EC



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 15°C (59°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 75°C (109°F) and below 90°C (194°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 4,000 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**

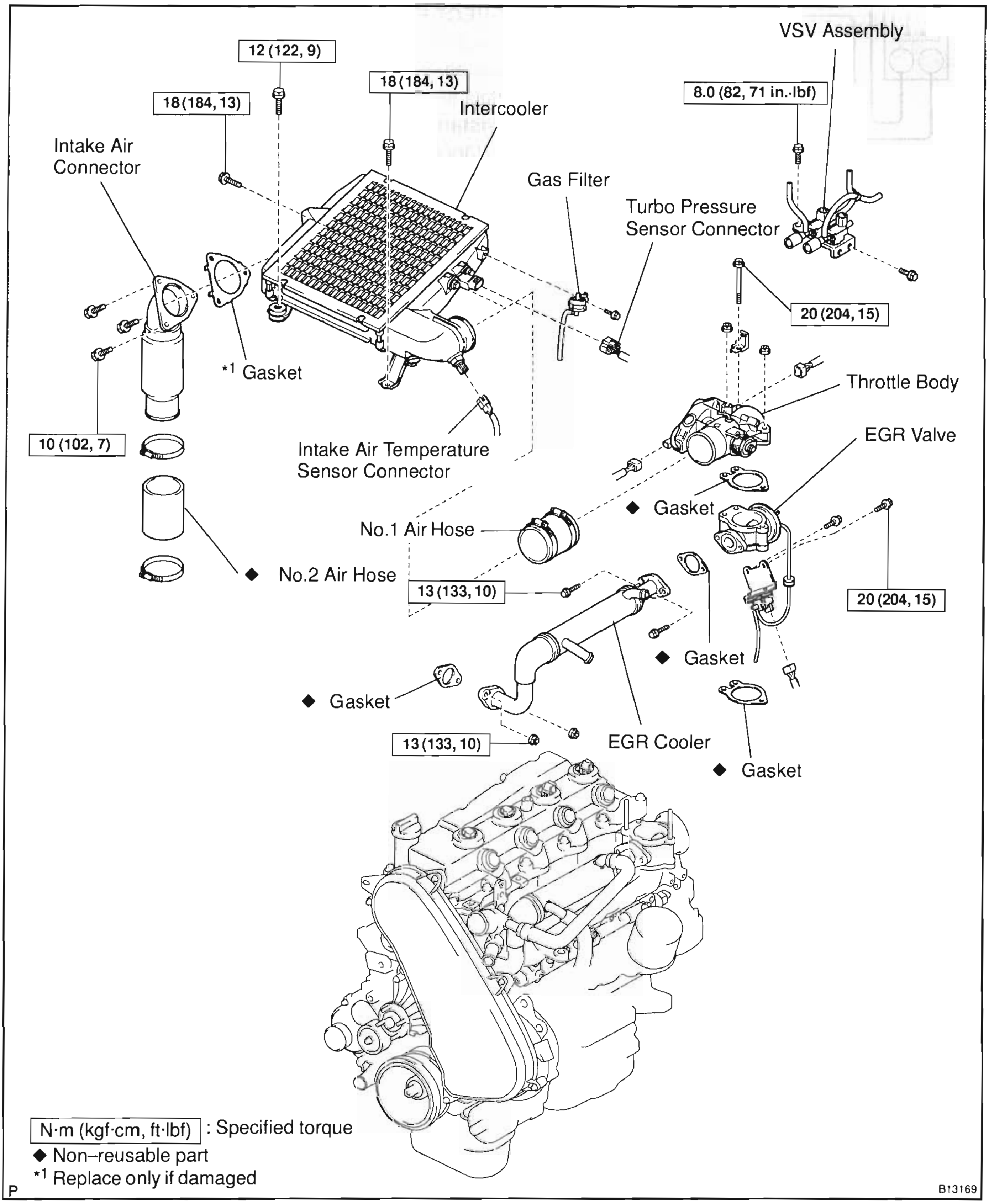
(a) Connect a vacuum gauge to the output pipe.

(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.

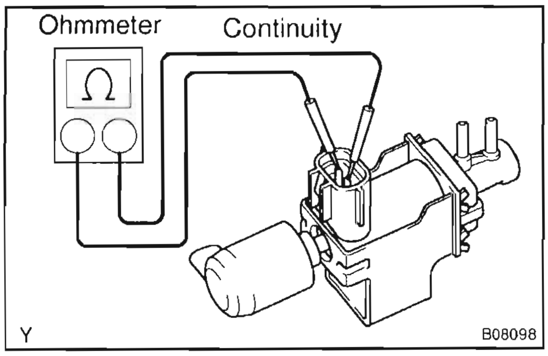
ECOCU–02

COMPONENTS



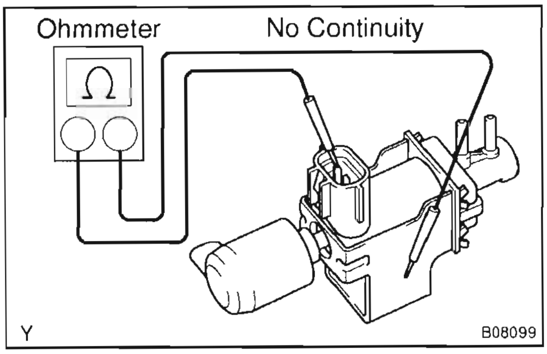
EC0CV–02

INSPECTION

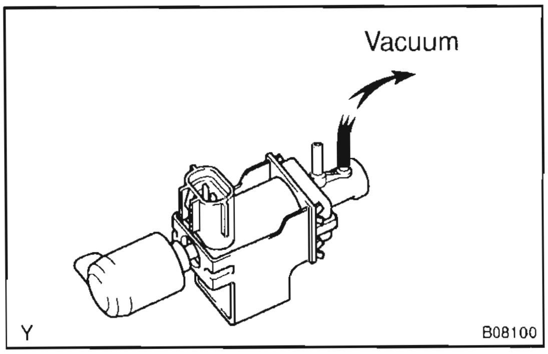


1. INSPECT E–VRV

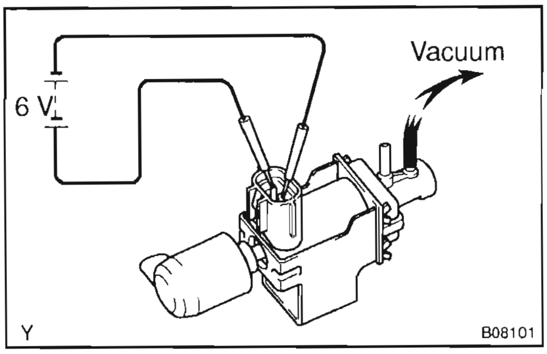
(a) Inspect the E–VRV for open circuit.
Using an ohmmeter, measure the resistance between terminals as shown.
Resistance: 11 – 13 Ω at 20°C (68°F)
If the resistance is not specified, replace the E–VRV.



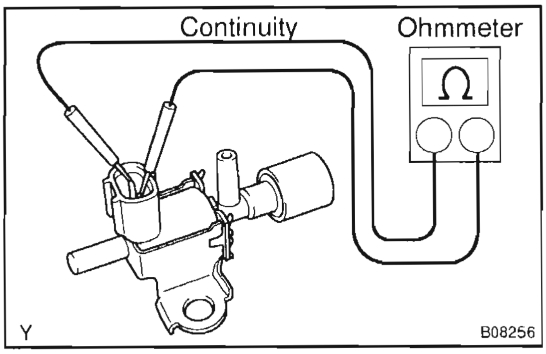
(b) Inspect the E–VRV for ground.
Using an ohmmeter, check that there is no continuity between terminals and E–VRV body.
If there is continuity, replace the E–VRV.



(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

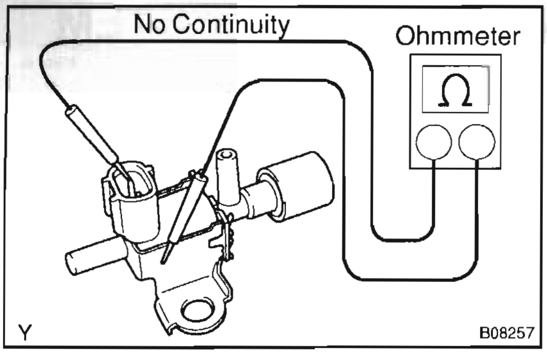


(d) Inspect the E–VRV operation.
(1) Apply about 6 V of DC power to the terminals.
(2) Check that when vacuum is applied to the vacuum outlet port shown, the need does not move.
If operation is not as specified, replace the E–VRV.



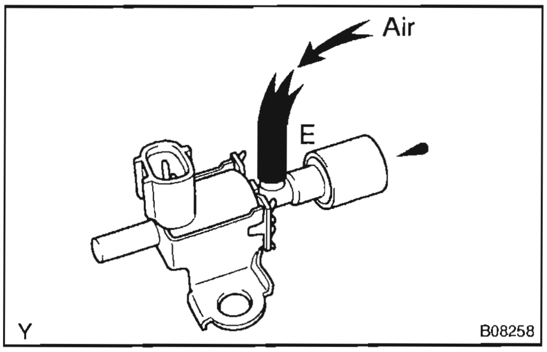
2. INSPECT VSV

(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

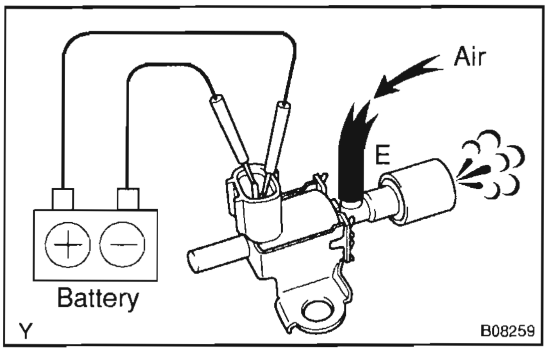


(b) Inspect the VSV for ground.
Using an ohmmeter, check that there is no *continuity* between terminals and body.

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.

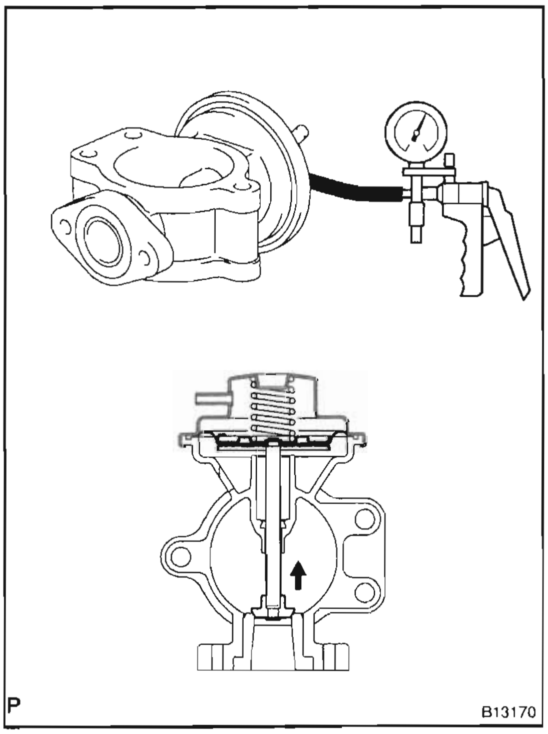


(2) Apply battery voltage across the terminals.
(3) Check that air flows from port E to filter.

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–28, DI–34 and ED–20)

5. INSPECT INTAKE AIR TEMPERATURE SENSOR (See page ED–13)

6. INSPECT WATER TEMPERATURE SENSOR (See page ED–11)

7. INSPECT CAMSHAFT POSITION SENSOR (See page ED–17)

8. INSPECT CRANKSHAFT POSITION SENSOR (See page ED–18)

9. INSPECT AIR FLOW METER (See page ED–3)

CATALYTIC CONVERTER FOR OXIDATION (CCo) SYSTEM

ECOCW-01

ON–VEHICLE INSPECTION

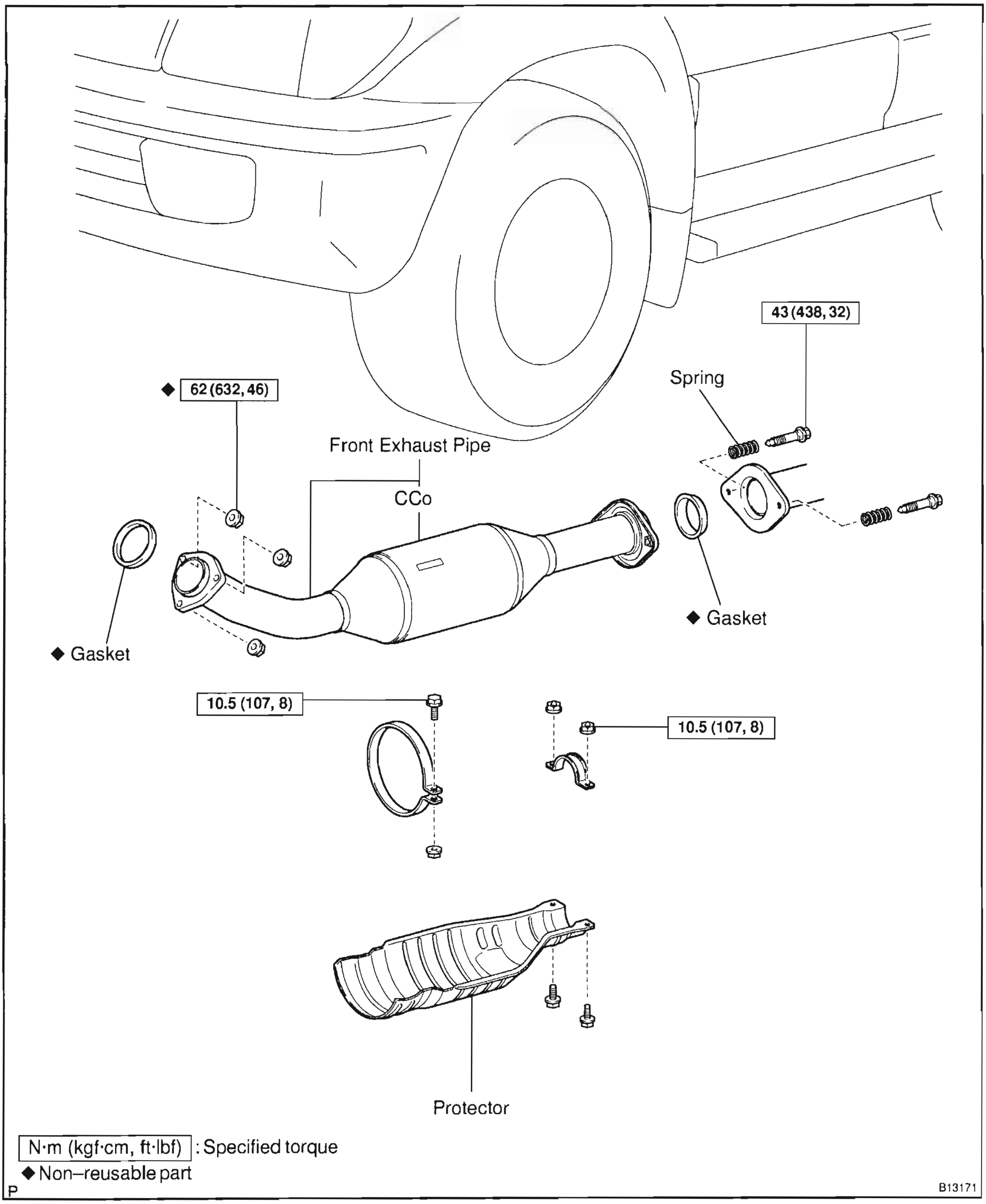
1. **CHECK CONNECTIONS FOR LOOSENESS OR DAMAGE**
2. **CHECK CLAMPS FOR WEAKNESS, CRACKS OR DAMAGE**
3. **CHECK FOR DENTS OR DAMAGE**

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**

EC0IU–01

COMPONENTS



EC

ELECTRONIC CONTROL DIESEL

ECD SYSTEM ED–1
AIR FLOW METER ED–3
THROTTLE BODY ED–4
EFI MAIN RELAY ED–8
ECD MAIN RELAY ED–9
VSV FOR TURBO PRESSURE SENSOR ... ED–10
WATER TEMPERATURE SENSOR ED–11
FUEL TEMPERATURE SENSOR ED–12
INTAKE AIR TEMPERATURE SENSOR ED–13
FUEL PRESSURE SENSOR ED–14
TURBO PRESSURE SENSOR ED–15
CAMSHAFT POSITION SENSOR ED–17
CRANKSHAFT POSITION SENSOR ED–18
ACCELERATOR PEDAL POSITION SENSOR ED–19
ELECTRONIC DRIVER UNIT (EDU) ED–21
ENGINE ECU ED–23

ECD SYSTEM

ED027-02

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.

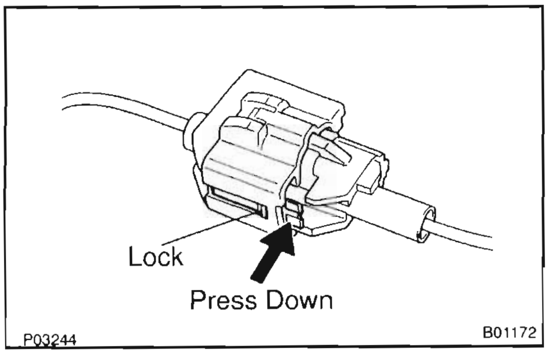
(c) Do not permit parts to receive a severe impact daring removal or installation. Handle all ECD parts carefully, especially the engine ECU.

(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.

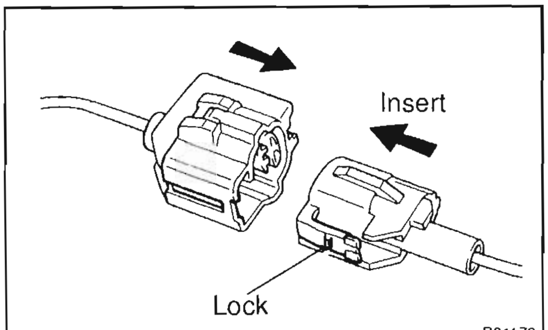
(g) Parts should be replaced as an assembly.



P03244 B01172

(h) Care is required when pulling out and inserting wiring connectors.

(1) Release the lock and pull out the connector, pulling on the connectors.



P03245 B01173

(2) Fully insert the connector and check that it locked.

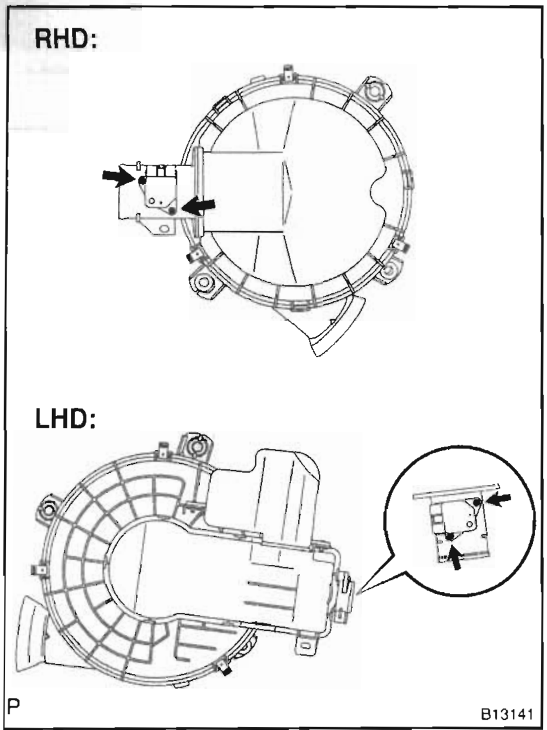
(i) When inspecting a connector with a volt/ohmmeter.

(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.



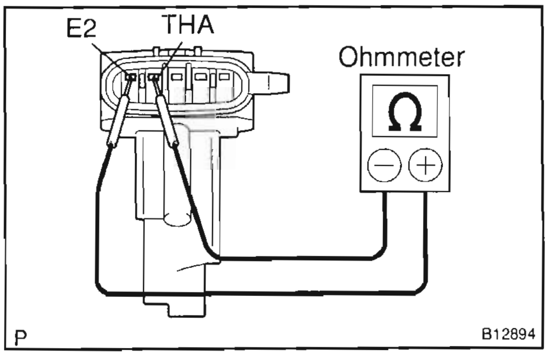
AIR FLOW METER

ED02L–03

INSPECTION

1. **DISCONNECT AIR FLOW METER CONNECTOR**
2. **REMOVE AIR FLOW METER**

Remove the 2 screws and air flow meter.

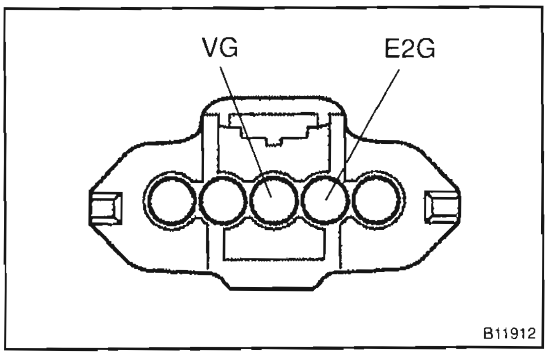


3. **INSPECT AIR FLOW METER**

(a) Using an ohmmeter, measure the resistance between terminals THA and E2.

Terminals	Resistance	Temperature
THA – E2	13.6 – 18.4 kΩ	–20°C (–4°F)
THA – E2	2.21 – 2.69 kΩ	20°C (68°F)
THA – E2	0.493 – 0.667 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.

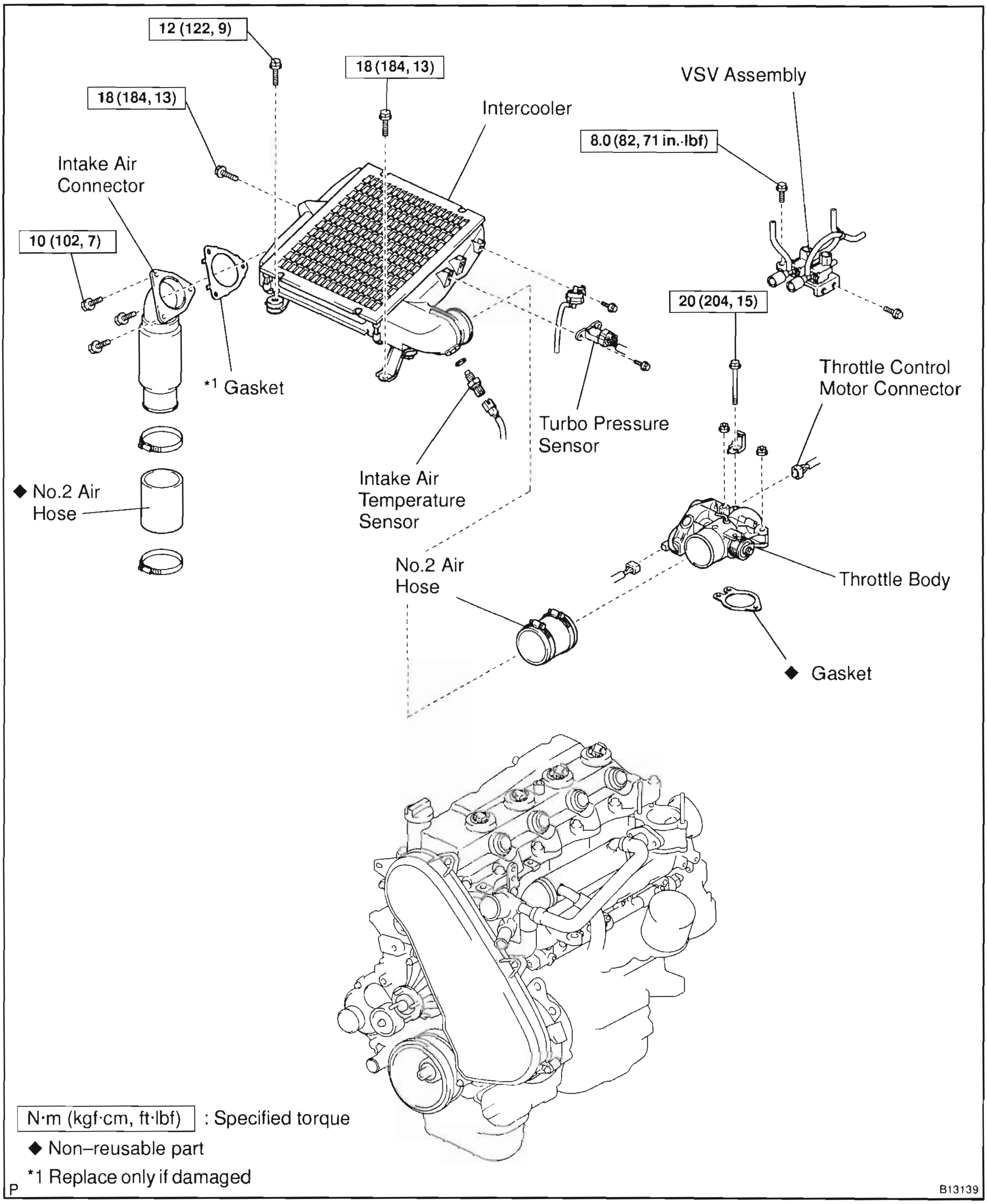
5. **RECONNECT AIR FLOW METER CONNECTOR**

ED

THROTTLE BODY

COMPONENTS

ED046–01



ED047-01

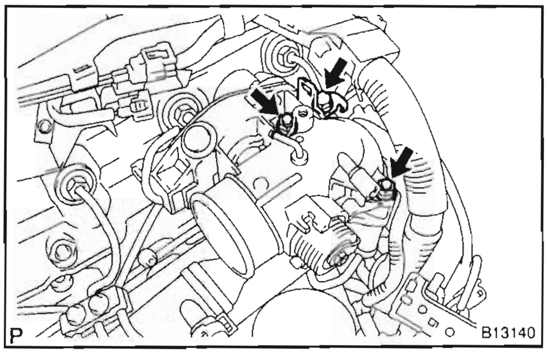
REMOVAL

1. **REMOVE INTERCOOLER (See page TC–10)**
2. **REMOVE DIESEL THROTTLE BODY**

(a) Remove the 2 bolts and VSV assembly.

(b) Disconnect the 2 connectors from the diesel throttle body.

(c) Disconnect the engine wire.



(d) Remove the 2 nuts, bolt, bracket, diesel throttle body and gasket.

Torque: 20 N·m (204 kgf·cm, 15 ft·lbf)

HINT:

At the time of installation, please refer to following item.

Place a new gasket.

ED048-01

INSPECTION

INSPECT DIESEL THROTTLE BODY (See page DI–26)

ED049–01

INSTALLATION

Installation is in the reverse order of removal (See page ED–5)

ED

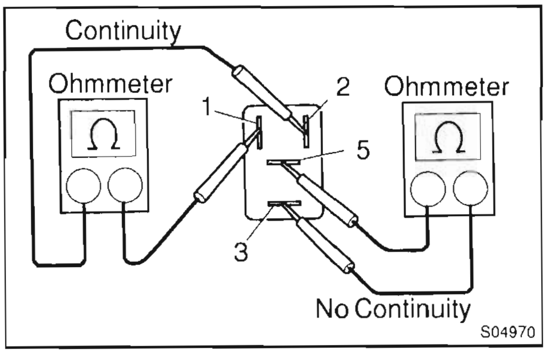
EFI MAIN RELAY

ED04G–01

INSPECTION

1. REMOVE NO.3 RELAY BOX COVER

2. REMOVE EFI MAIN RELAY (Marking: EFI)



3. INSPECT EFI MAIN RELAY

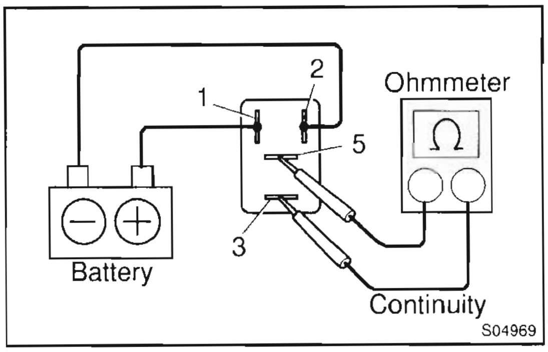
(a) Inspect the relay continuity.

(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.

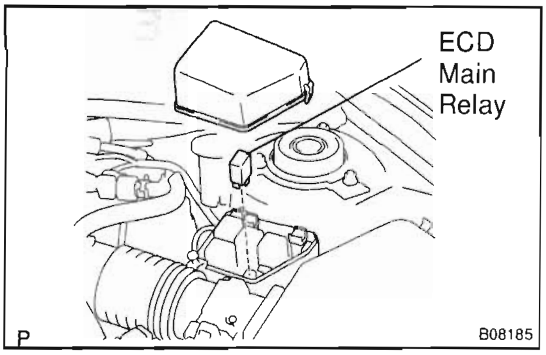
(2) Using an ohmmeter, check that there is continuity between terminals 3 and 5.

If there is no continuity, replace the relay.

4. REINSTALL EFI MAIN RELAY

5. REINSTALL RELAY BOX COVER

ED

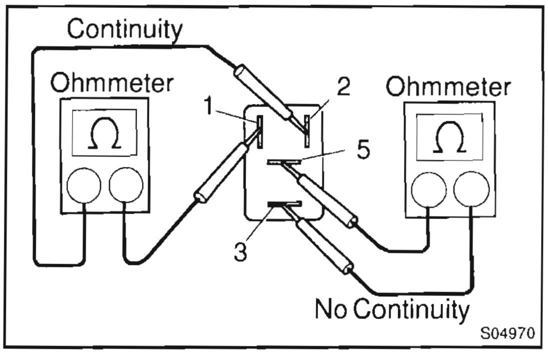


ECD MAIN RELAY

ED02C-02

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.

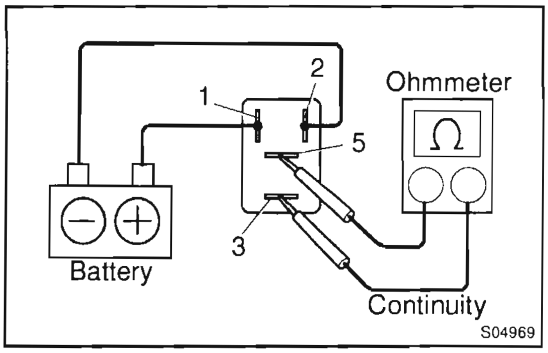
(1) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

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.

ED



(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.

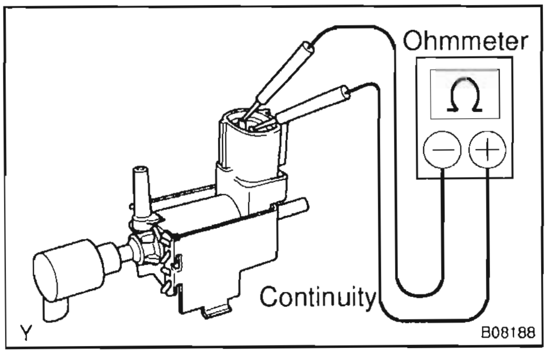
4. **REINSTALL ECD MAIN RELAY**
5. **REINSTALL RELAY BOX COVER**

VSV FOR TURBO PRESSURE SENSOR

INSPECTION

TC00X–03

1. REMOVE VSV

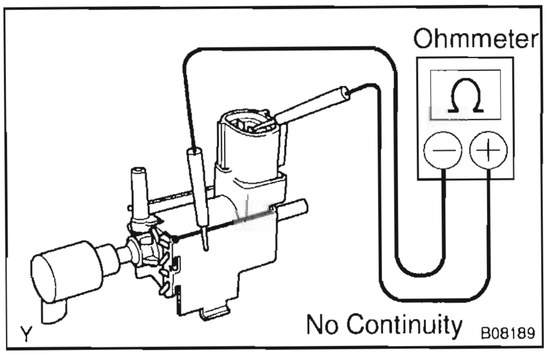


2. INSPECT VSV FOR OPEN CIRCUIT

Using an ohmmeter, check that the there is continuity between the terminals.

Resistance: 37 – 44 Ω at 20°C (68°F)

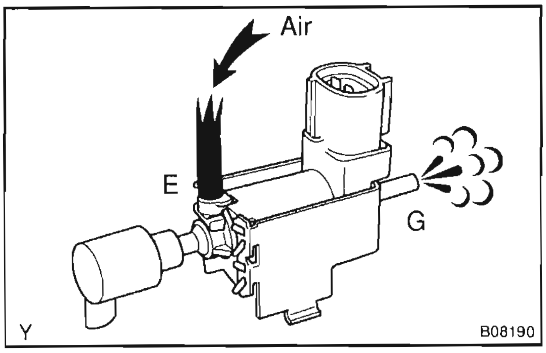
If there is no continuity, replace the VSV.



3. INSPECT VSV FOR GROUND

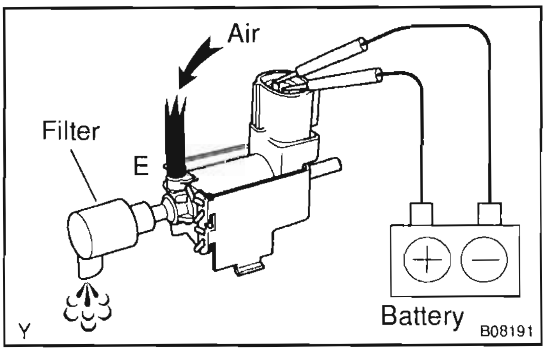
Using an ohmmeter, check that there is no continuity between each terminal and the body.

If there is continuity, replace the VSV.



4. INSPECT VSV OPERATION

(a) Check that air does not flow from port E to G.

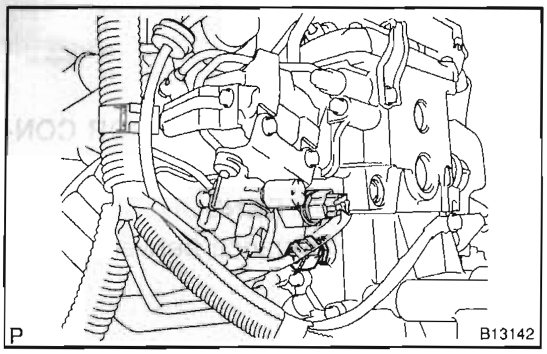


(b) Apply battery voltage across the terminals.

(c) Check that air flows from port E to filter.

If operation is not as specified, replace the VSV.

5. REINSTALL VSV



WATER TEMPERATURE SENSOR

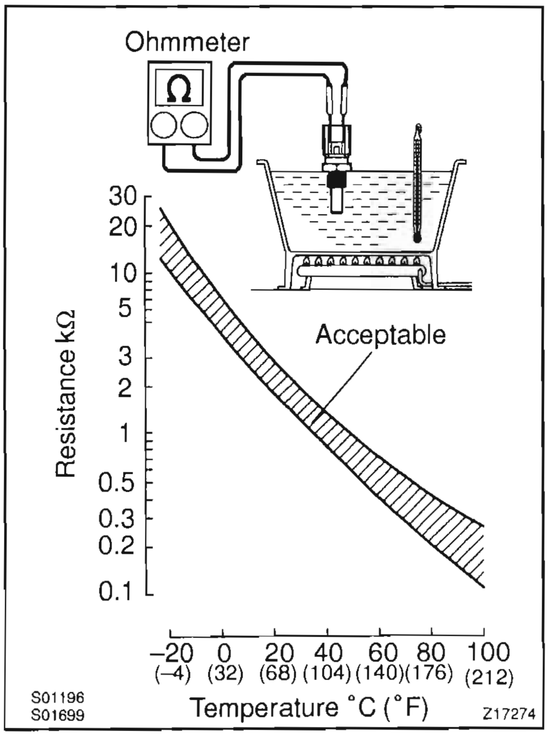
ED02D-02

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.

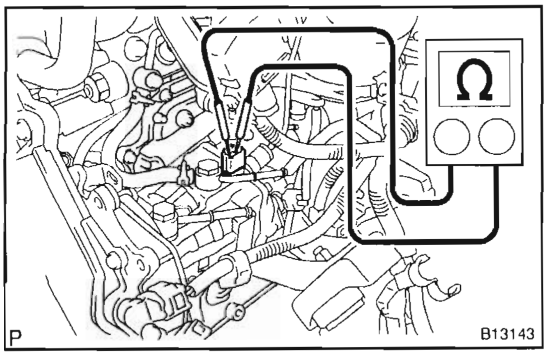
4. **REINSTALL WATER TEMPERATURE SENSOR**

(a) Using a 19 mm deep socket wrench, install a new gasket and the sensor.

Torque: 20 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–02

INSPECTION

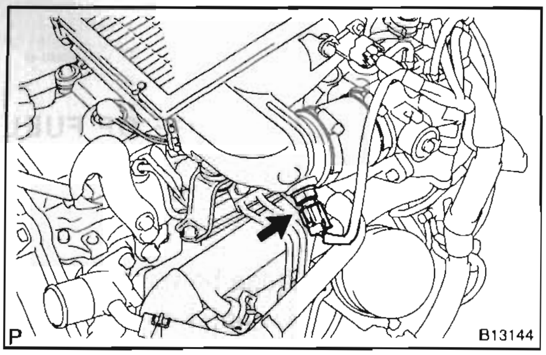
1. **DISCONNECT FUEL TEMPERATURE SENSOR CONNECTOR**
2. **INSPECT FUEL TEMPERATURE SENSOR**

Using an ohmmeter, measure the resistance between terminals.

Resistance:
2.21 – 2.79 kΩ at 20°C (68°F)
0.287 – 0.349 kΩ at 80°C (176°F)

If the resistance is not specified, replace the supply pump (See page FU–16).

3. **RECONNECT FUEL TEMPERATURE SENSOR CONNECTOR**



INTAKE AIR TEMPERATURE SENSOR

ED02E-02

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

Using an ohmmeter, measure the resistance between terminals.

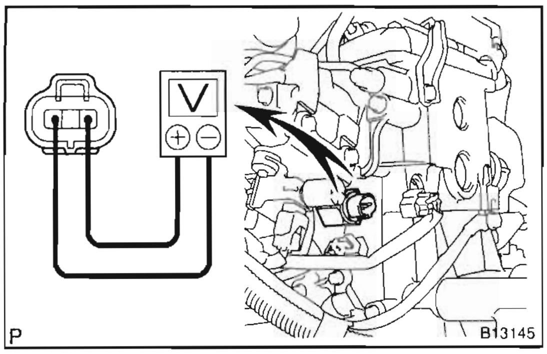
Resistance: 2.187 – 2.673 kΩ at 20°C (68°F)

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-02

INSPECTION

1. **INSPECT POWER SOURCE VOLTAGE OF FUEL PRESSURE SENSOR**

(a) Disconnect the sensor connector.

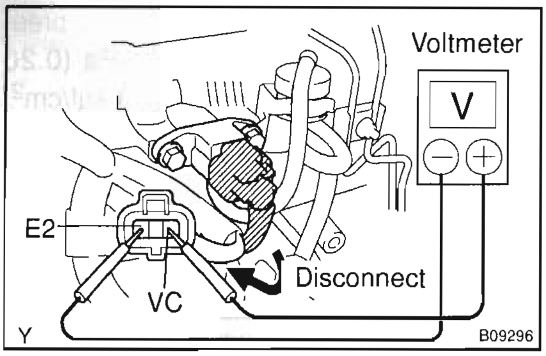
(b) Turn the ignition switch ON.

(c) Using a voltmeter, measure the voltage between connector terminals VCC and GND of the wiring harness side.
Voltage: 4.75 – 5.25 V

(d) Turn the ignition switch OFF.

(e) Reconnect the sensor connector.

2. **INSPECT VOLTAGE BETWEEN TERMINALS PCR AND E2 (See page DI–79)**



TURBO PRESSURE SENSOR

ED04B-01

INSPECTION

1. **INSPECT POWER SOURCE VOLTAGE OF TURBO PRESSURE SENSOR**

(a) Disconnect the turbo pressure sensor connector.

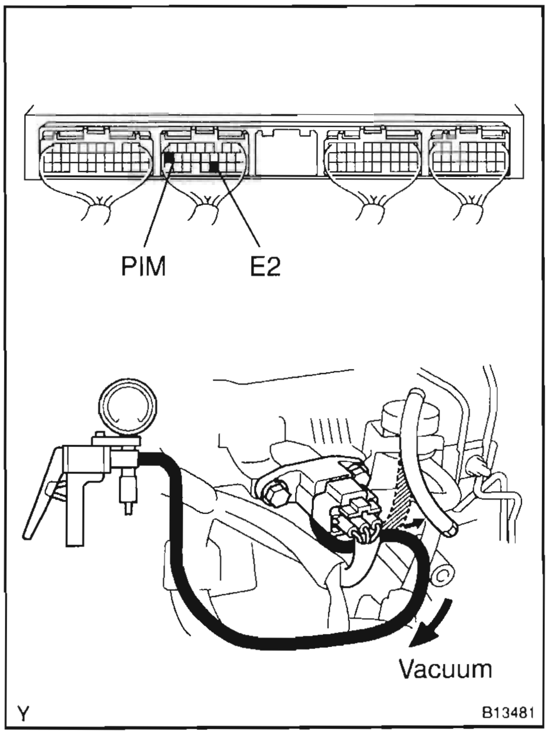
(b) Turn the ignition switch ON.

(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 form the turbo pressure sensor.

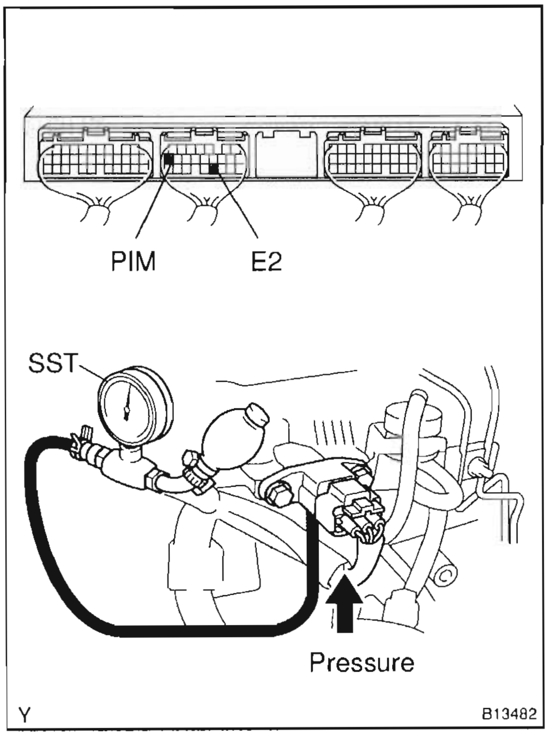
(c) Connect a voltmeter to terminals PIM and E2 of the engine ECU, and measure the output voltage under ambient atmospheric pressure.

(d) Apply vacuum to the turbo pressure sensor in 13.3 kPa (100 mmHg, 3.94 in.Hg) segments to 40.0 kPa (300 mmHg, 11.81 in.Hg).

(e) Measure the voltage drop from step (c) above for each segment.

Voltage drop:

Applied 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



(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

(h) Reconnect the vacuum hose to the turbo pressure sensor.

CAMSHAFT POSITION SENSOR

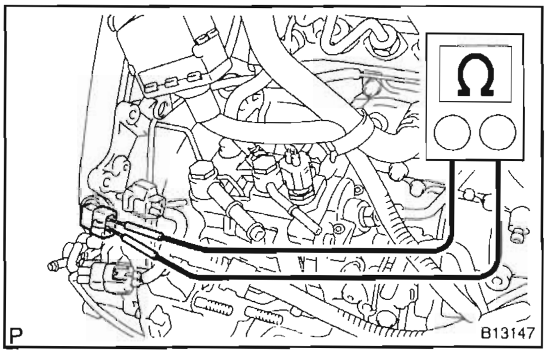
ED02I–02

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: 8.5 N·m (87 kgf·cm, 75 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

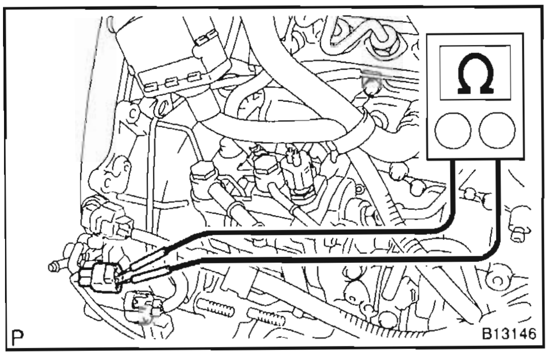
ED02J–02

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: 8.5 N·m (87 kgf·cm, 75 in.·lbf)

NOTICE:

Be careful not drop and shock the sensor.

HINT:

Apply engine oil to the O–ring.

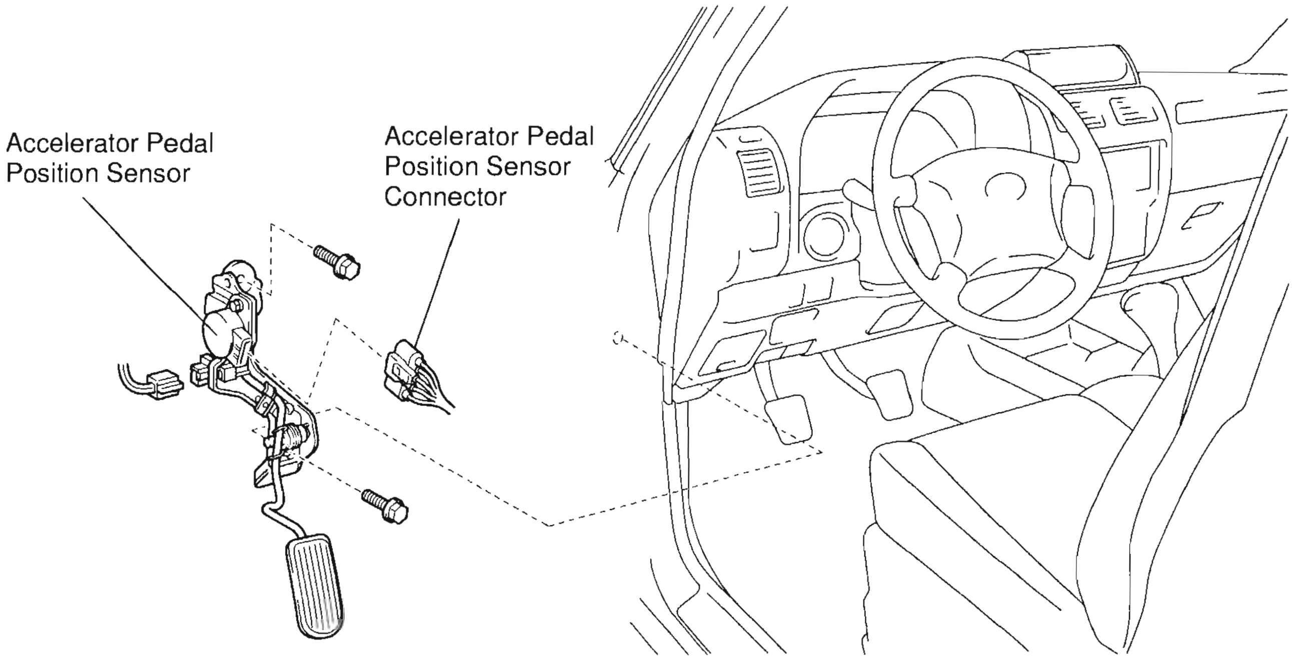
3. **RECONNECT CRANKSHAFT POSITION SENSOR CONNECTOR**

ACCELERATOR PEDAL POSITION SENSOR

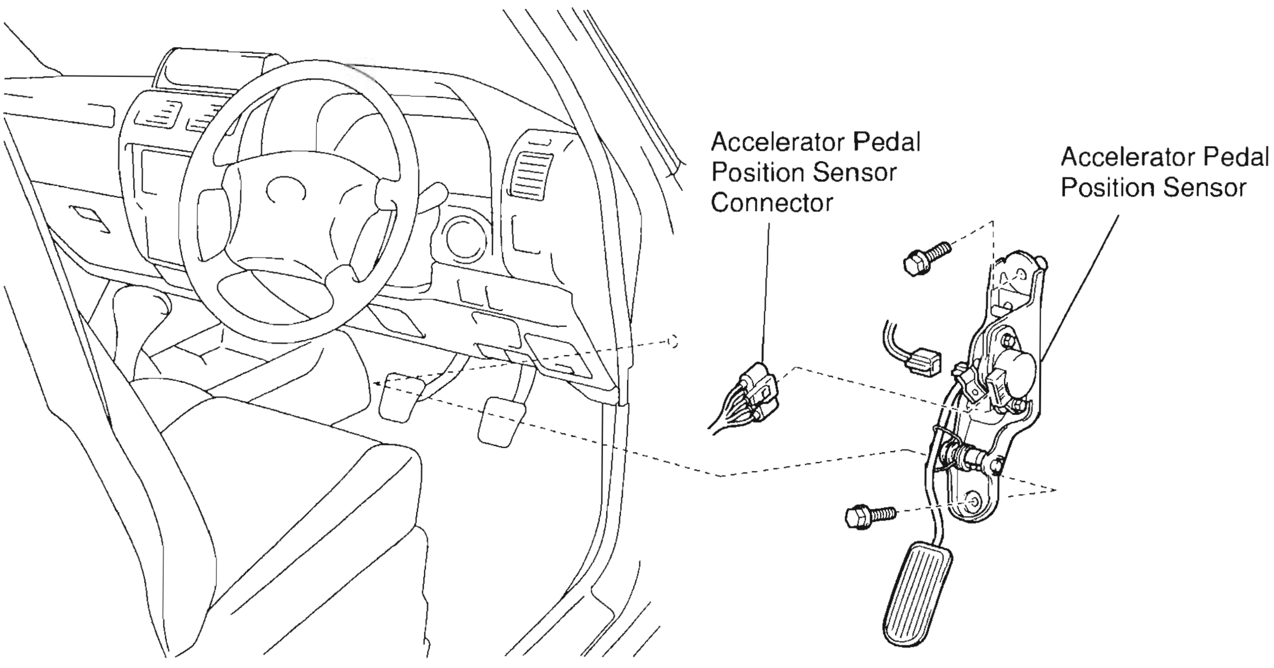
COMPONENTS

ED04C-01

LHD:



RHD:



P

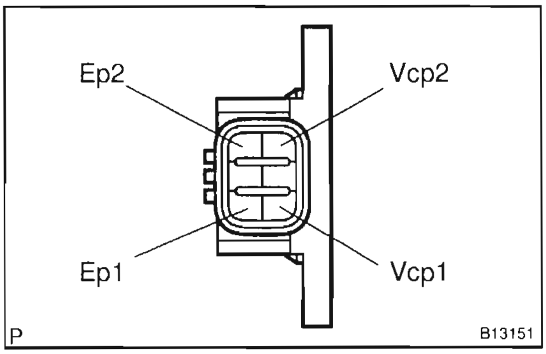
B13150

ED04D-01

INSPECTION

INSPECT ACCELERATOR PEDAL POSITION SENSOR

(a) Disconnect the accelerator pedal position sensor connector.



(b) Using an ohmmeter, measure the resistance between each terminals.

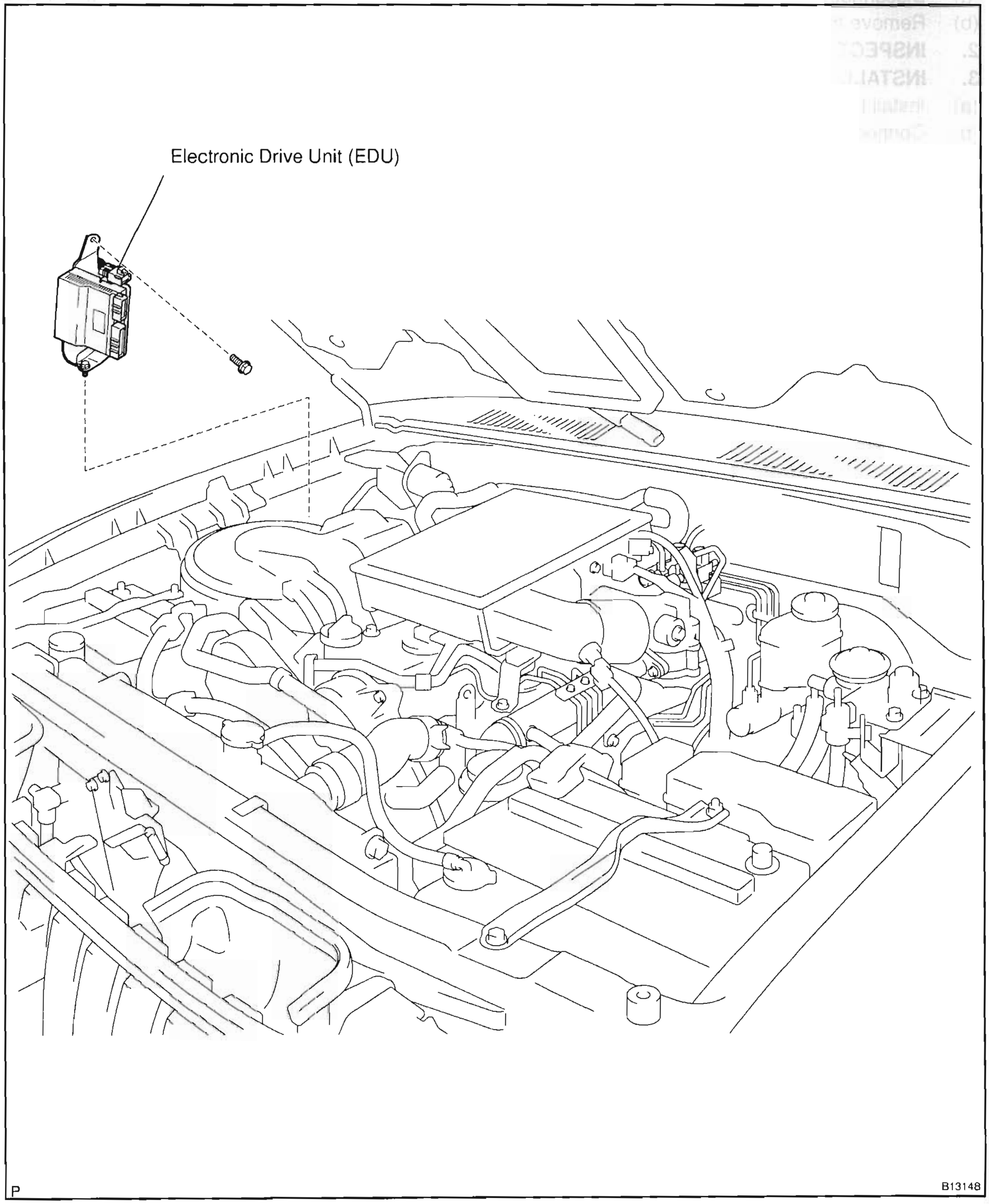
Resistance: at 20°C (68°F)

Terminals	Resistance
$V_{CP1} - E_{P1}$ $V_{CP2} - E_{P2}$	1.5 – 6.0 kΩ

ELECTRONIC DRIVER UNIT (EDU)

COMPONENTS

ED04E-01



ED04F–01

INSPECTION

1. REMOVE EDU

(a) Disconnect the 2 connectors.

(b) Remove the 2 bolts and EDU.

2. INSPECT EDU (See page DI–88)

3. INSTALL EDU

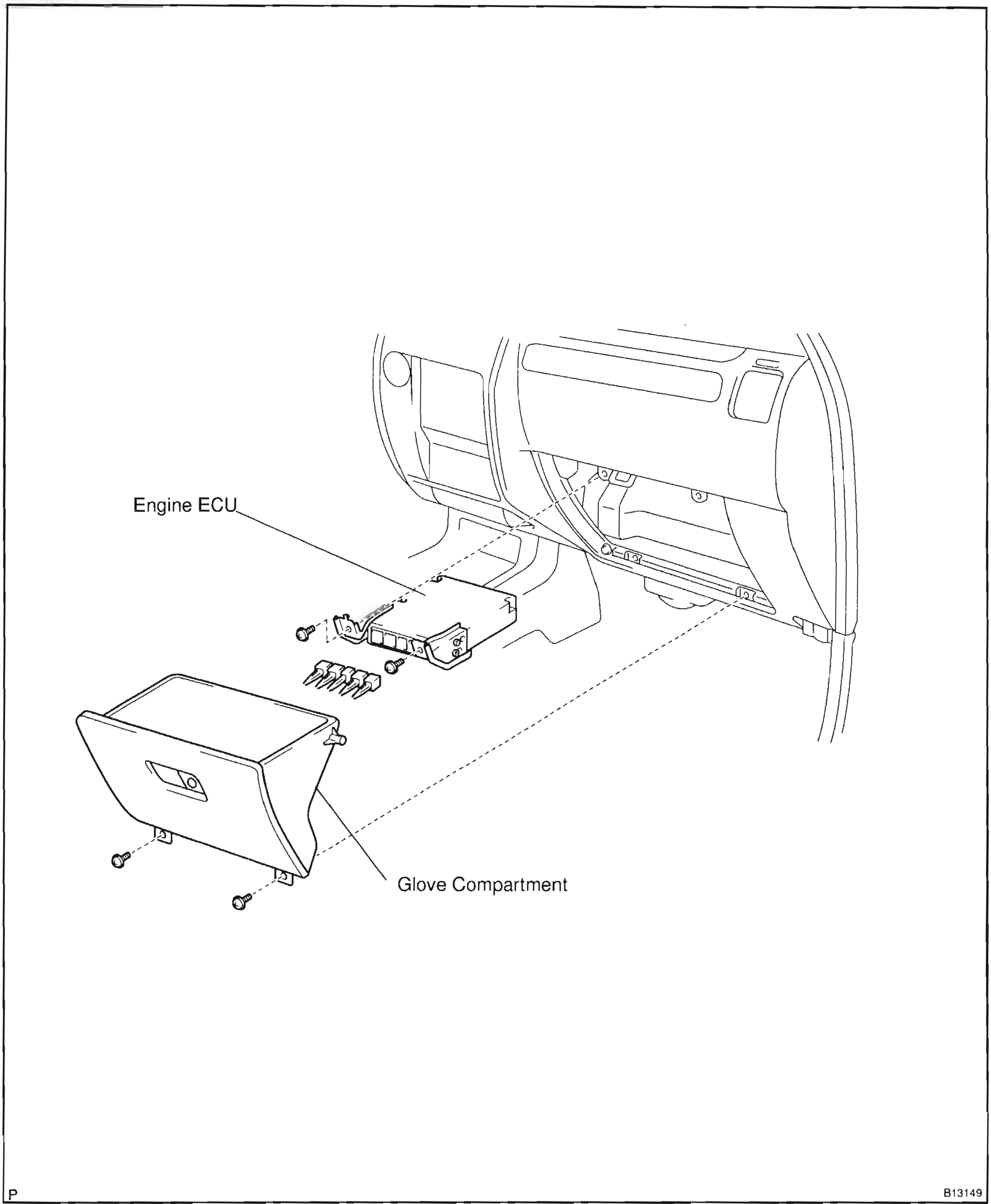
(a) Install the EDU with the 2 bolts.

(b) Connect the 2 connectors.

ENGINE ECU

COMPONENTS

ED02O–03

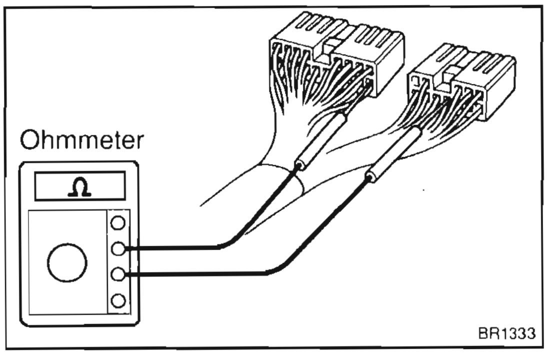


ED02P–03

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–16)



3. **INSPECT RESISTANCE OF ECD CIRCUITRY**

(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.**

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	80°C (176°F) – 0.287 – 0.349 k	10 or less
THW – E2	Coolant temp. 20°C (68°F)	2.59 – 2.32 k
THA – E2	Intake air temp. 20°C (68°F)	2.187 – 2.673 k
THF – E2	Fuel temp. 20°C (68°F)	2.21 – 2.79 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

ENGINE FUEL

FUEL FILTER FU–1
FUEL HEATER FU–3
INJECTOR FU–4
SUPPLY PUMP FU–13
COMMON RAIL FU–20
FUEL PRESSURE LIMITTER FU–23

FUEL FILTER

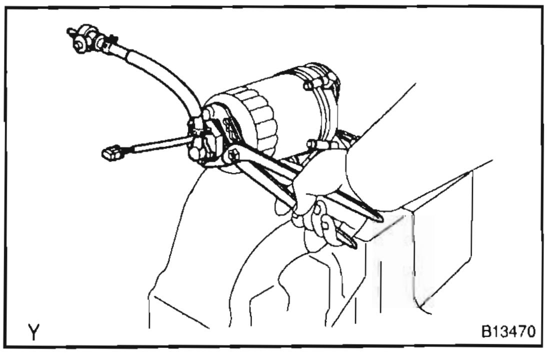
FU080–01

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.



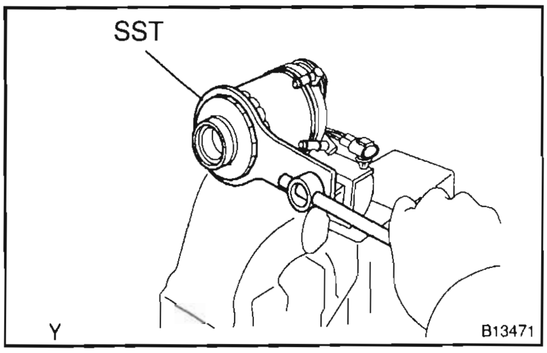
3. REMOVE FUEL FILTER WARNING SWITCH FROM FUEL FILTER

(a) Mount the fuel filter in a soft jaw vise.

(b) Using pliers, remove the warning switch and O–ring.

NOTICE:

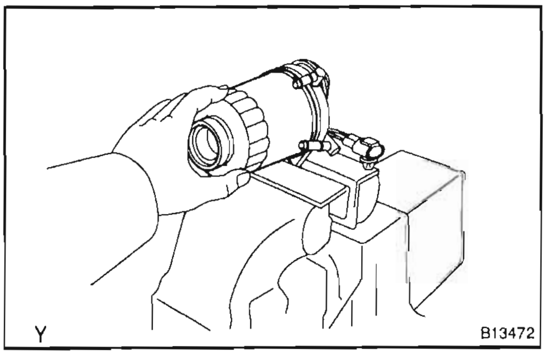
Be careful not to damage the warning switch.



4. REMOVE FUEL FILTER

Using SST, remove the fuel filter.

SST 09228–64010



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.

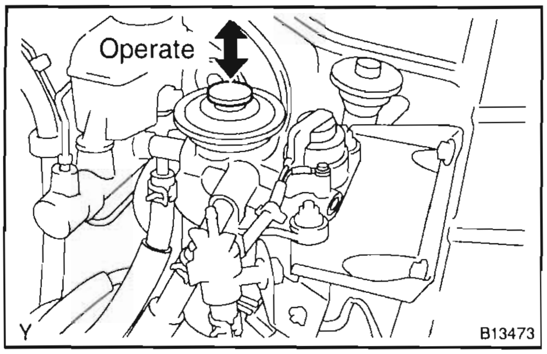
6. INSTALL FUEL FILTER WARNING SWITCH TO NEW FUEL FILTER

(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.

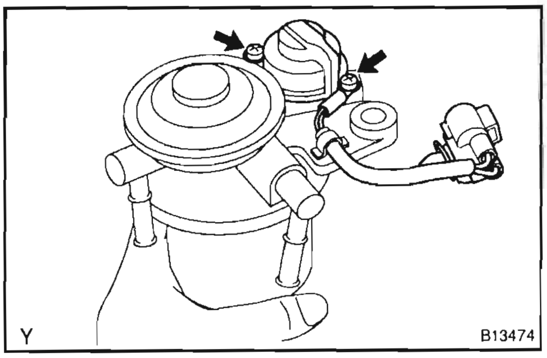
7. REINSTALL FUEL FILTER ASSEMBLY TO FUEL FILTER SUPPORT



8. REFILL FUEL FILTER WITH FUEL

Operate the hand pump until you feel more resistance.

9. START ENGINE AND CHECK FOR FUEL LEAK

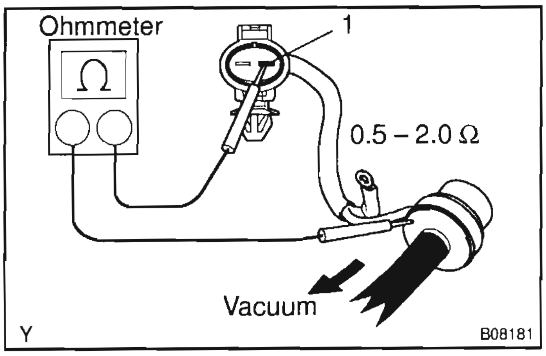


FUEL HEATER

FU08P–01

INSPECTION

1. REMOVE FUEL HEATER



2. INSPECT FUEL HEATER

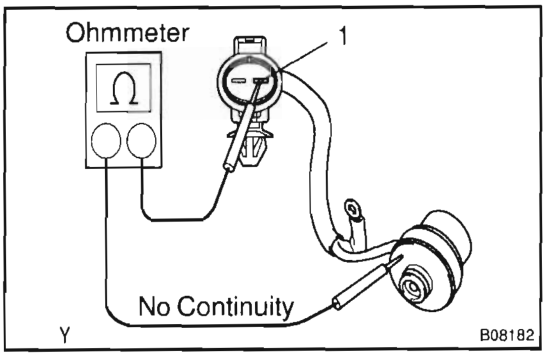
(a) Apply a vacuum of 34.7 ± 5.3 kPa (260 ± 40 mmHg, 10.24 ± 1.57 in.Hg) or more to the vacuum switch port.

(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.

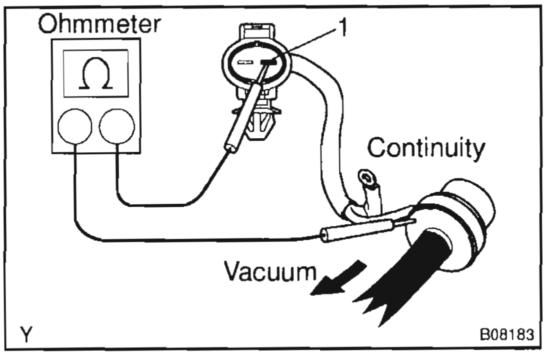
FU



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

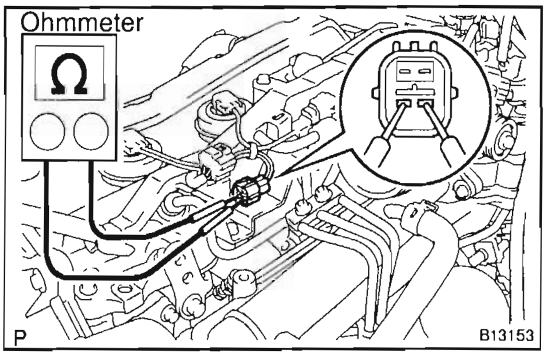
FU080–01

ON–VEHICLE INSPECTION

NOTICE:
In case of having the injectors replaced, must replace injection pipes, too.

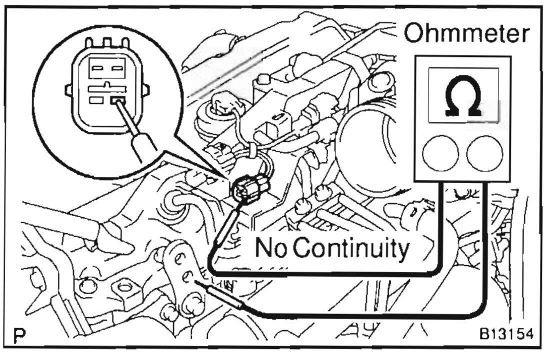
1. **REMOVE INTERCOOLER (See page TC–11)**
2. **INSPECT INJECTORS**

(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.

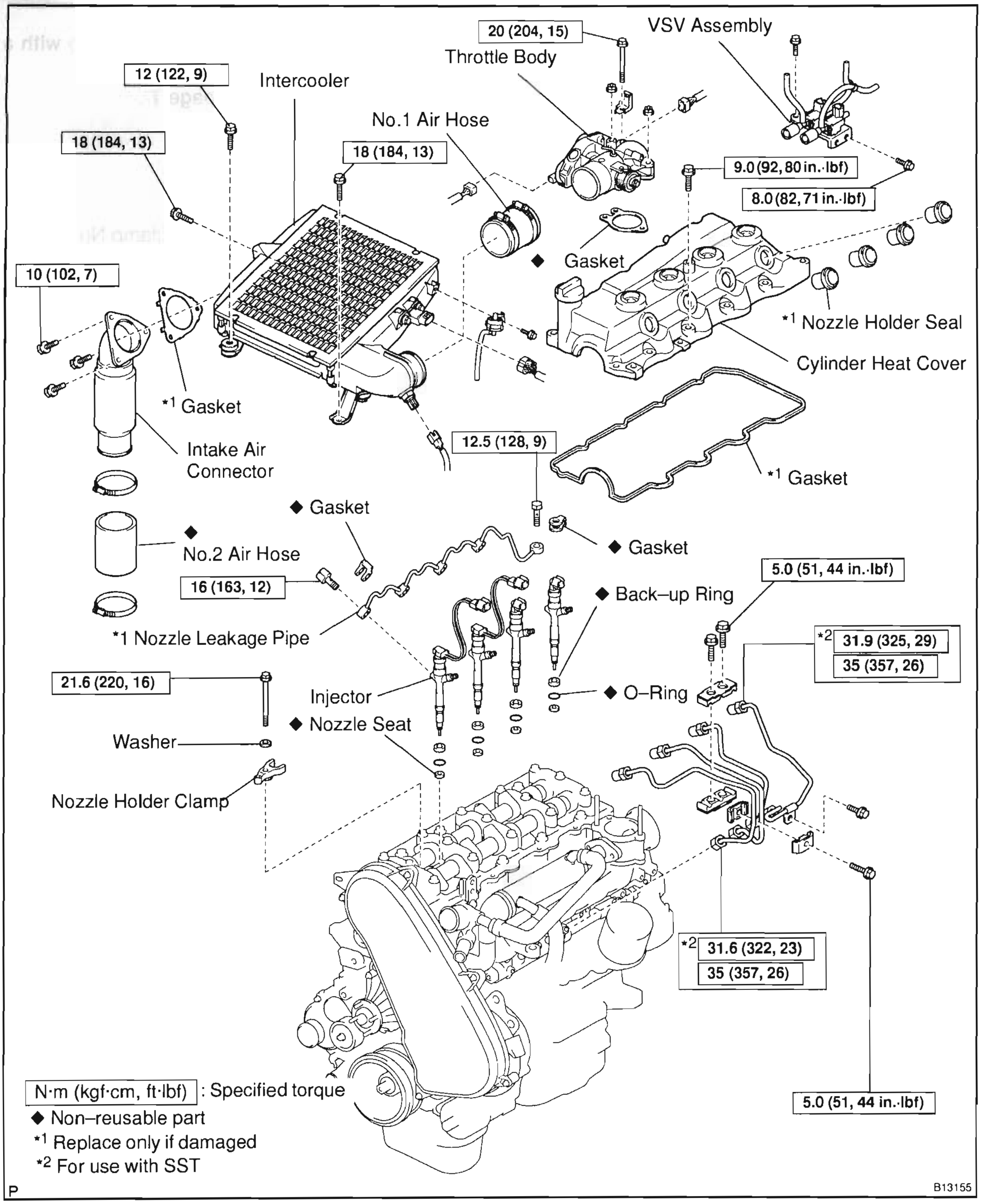
If there is continuity, replace the injector. (See page FU–6)

(d) Reconnect the 4 injector connectors.

3. **REINSTALL INTERCOOLER (See page TC–12)**

FU08R–01

COMPONENTS



FU

FU08S–01

REMOVAL

NOTICE:

When removing the injection pipes, clean them up with a brush and compressed air.

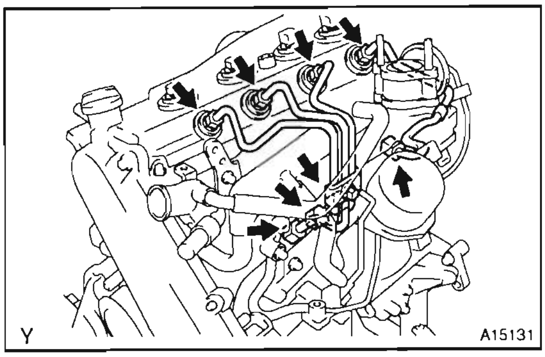
1. **REMOVE INTERCOOLER (See page TC–11)**
2. **DISCONNECT ENGINE WIRE**
3. **REMOVE DIESEL THROTTLE BODY (See page ED–5)**
4. **REMOVE INJECTION PIPE**

(a) Remove the 2 bolts and injection pipe clamp No. 3.

(b) Remove the bolt and injection pipe clamp No. 2

(c) Remove the bolt and injection pipe clamp.

FU



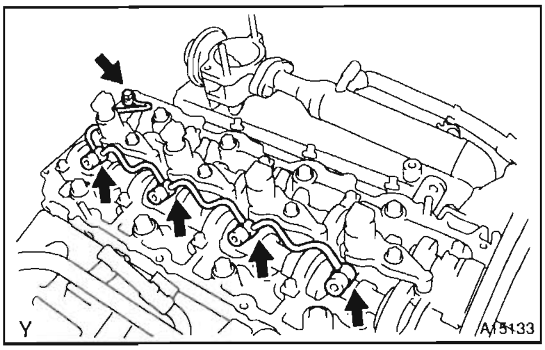
(d) Using SST, loosen the injection pipe unions of common rail side.
SST 09023–12900

(e) Using SST, loosen the injection pipe unions of 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.**

5. **REMOVE CYLINDER HEAD COVER (See Page EM–11)**



6. **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.**
- **Pay attention not to deform or scratch the union seal surface.**

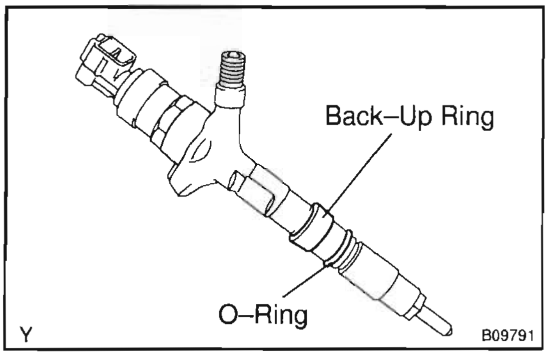
7. REMOVE INJECTORS

(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, clamps, washers and bolts in correct order.



(c) Remove the O–ring and back–up ring from each injector.

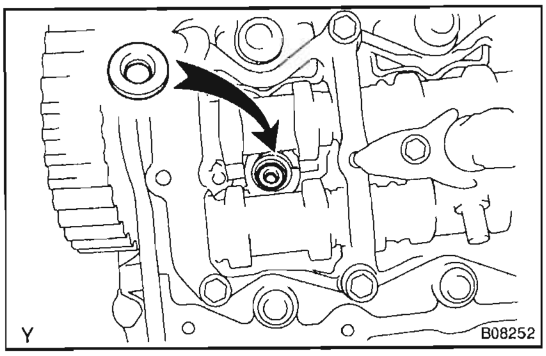
(d) Remove the 4 nozzle seats from the cylinder head.

FU08T–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

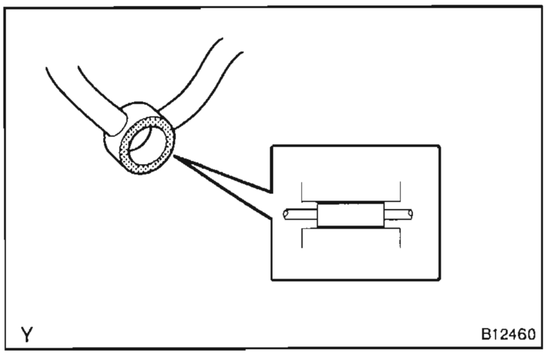
(a) Install 4 new nozzle seats to the cylinder head.
(b) Install a new back–up ring and O–ring to each injector.
(c) Apply a light coat of oil onto O–ring to each injector.
(d) Install the injector to cylinder head.

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.**

(e) Temporarily install the 4 injection pipes.

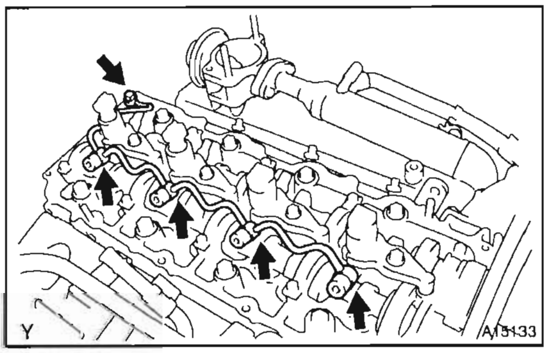
HINT:
For positioning of the infector, temporarily injection pipe.



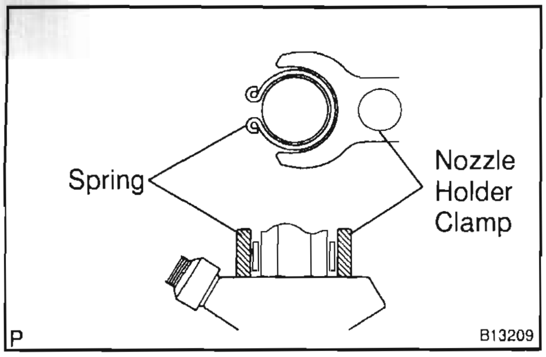
(f) Check before installing the nozzle leakage pipe using the straight edge that there is no scratch and deformation (dent) on the seal surface of the unions (at five positions).

In case of having any scratch of deformation, change it to a new one.

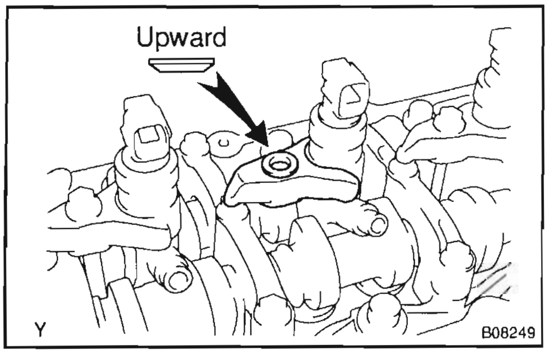
(g) Place the leakage pipe and 5 new gaskets.
(h) Apply a light coat of oil onto 4 hollow screws and union bolt.



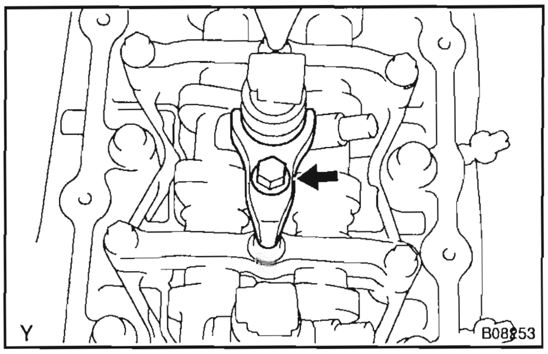
(i) Tighten the 4 hollow screws and union bolt by hand.



(j) Set the spring to each injector as shown in the illustration.



(k) Set the washer on the nozzle holder clamp as shown in the illustration.



(l) 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: 21.6 N·m (220 kgf·cm, 16 ft·lbf)

NOTICE:

- **Clip the infector at the fork portion with a clamp which is set on the head of the cam cap bolt. At this time, check that the clamp does not hold the infector at the part where the spring is attached.**
- **To torque the clamp bolt, temporally torque it with hand until the bearing surface of the bolt touches the washer, then tighten by the specified torque.**
- **In case of tighten by the specified torque, pay attention not to tilt the bolt and the clamp.**

(m) 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)

NOTICE:

In case of over–torque, the nozzle leakage pipe can not be reused, so change it to new one.

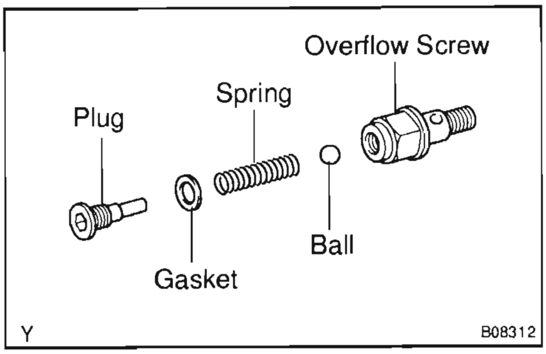
(n) Remove the 4 injection pipes.

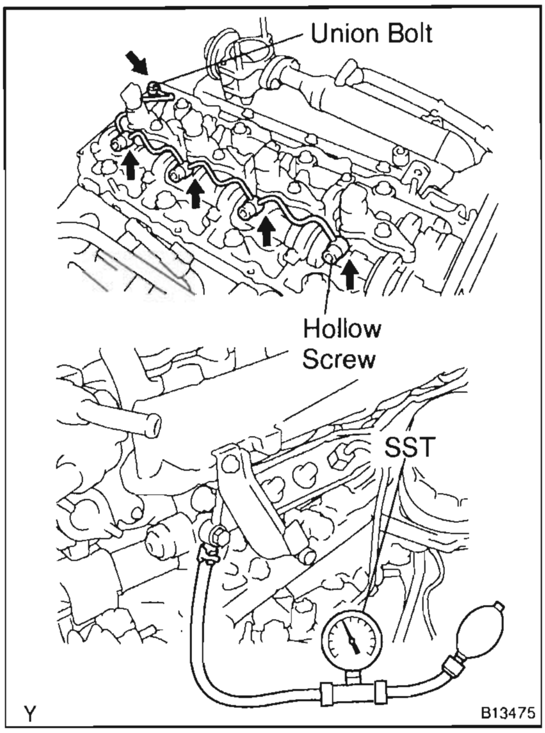
(o) Check that there are no leaks from nozzle leakage pipe connection.

(1) Remove the 2 bolts, union bolt, check valve, No. 2 nozzle leakage pipe and 2 gaskets.

FU

(2) Purchase 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 (1.0 kgf/cm^2, 14.5 psi) of pressure for 60 seconds to check that there are no bubbles from applying the soapy water place.

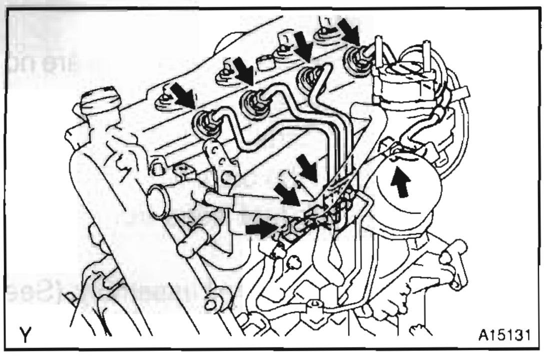
NOTICE:
When checking the leakage, be sure to remove the ball and spring in the check valve before operating.

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) Temporarily install the No. 2 nozzle leakage pipe and 2 new gaskets with the 2 bolts, union bolt and check valve.

HINT:
Never reinstall the disassembled check valve on the engine.

2. INSTALL CYLINDER HEAD COVER
(See page EM–16)



3. INSTALL INJECTION PIPE

(a) Temporarily install the 4 injection pipes.

(b) Install the injection pipe clamp with the bolt.
Torque: 5.0 N·m (51 kgf·cm, 44 in.·lbf)

(c) Install the injection pipe clamp No. 2 with the bolt.
Torque: 5.0 N·m (51 kgf·cm, 44 in.·lbf)

(d) Install the injection pipe clamp No. 3 with the 2 bolts.
Torque: 5.0 N·m (51 kgf·cm, 44 in.·lbf)

(e) Using SST, tighten the injection pipe union of common rail side.
SST 09023–12900
Torque:
31.6 N·m (322 kgf·cm, 23 ft·lbf) for use with SST
35 N·m (357 kgf·cm, 26 ft·lbf)

HINT:
Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

(f) Using SST, tighten the injection pipe union of injector side.
SST 09023–12700
Torque:
31.9 N·m (325 kgf·cm, 24 ft·lbf) for use with SST
35 N·m (357 kgf·cm, 26 ft·lbf)

HINT:
Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

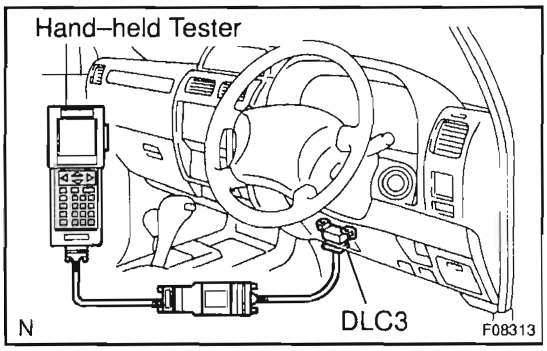
(g) Tighten the 2 bolts, union bolt and check valve for No. 2 nozzle leakage pipe.
Torque:
Bolt: 12.7 N·m (130 kgf·cm, 9 ft·lbf)
Union bolt: 12.7 N·m (130 kgf·cm, 9 ft·lbf)
Check valve: 21 N·m (214 kgf·cm, 15 ft·lbf)

4. INSTALL DIESEL THROTTLE BODY
(See page ED–7)

5. CONNECT ENGINE WIRE

NOTICE:
When installing a wire for infector No. 1 and No. 2, check theat the number of the wire agrees with that of the injector.

6. INSTALL INTERCOOLER (See page TC–12)



7. 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–21)

(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.

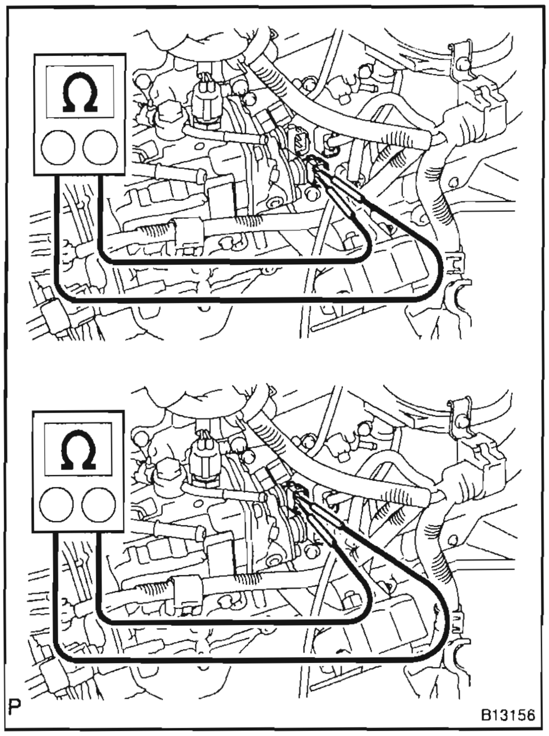
SUPPLY PUMP

FU08U–01

ON–VEHICLE INSPECTION

INSPECT SCV1 AND SCV2

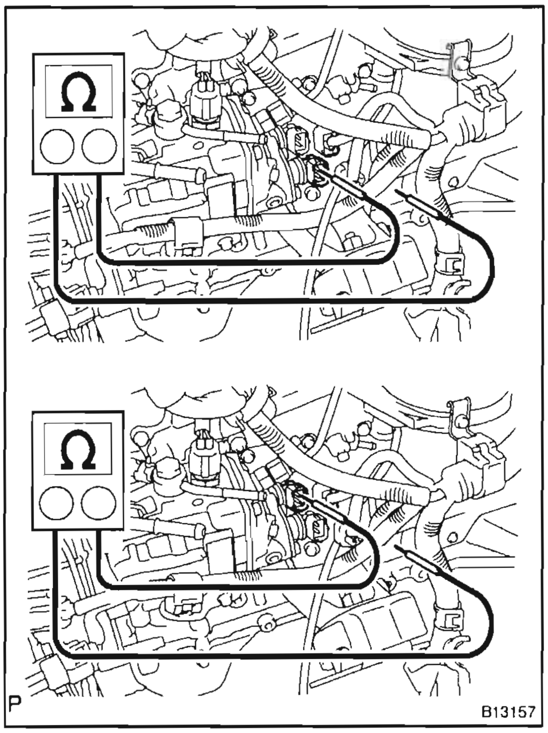
(a) Disconnect the SCV1 and SCV2 connectors.



(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–14).



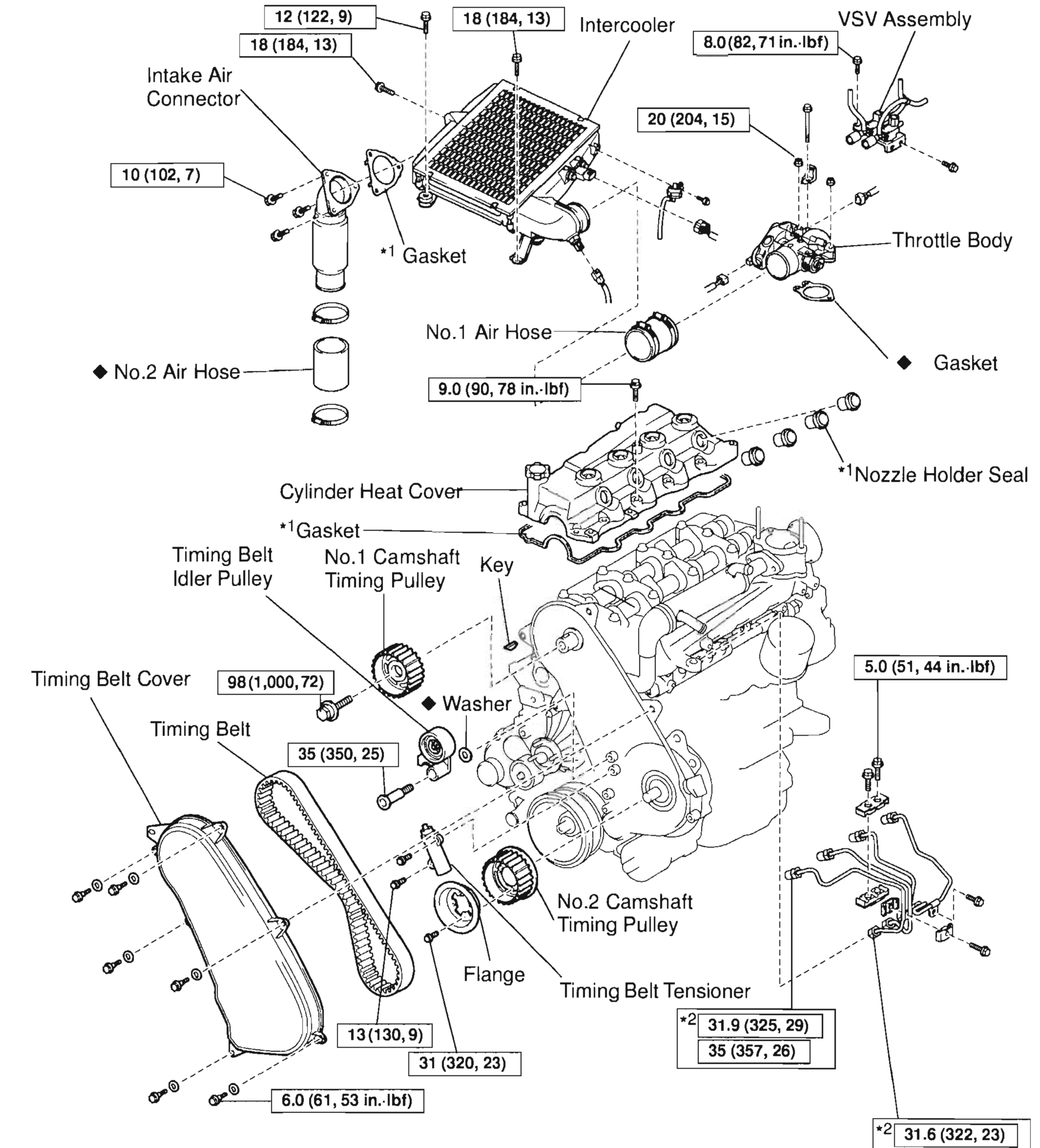
(c) Using an ohmmeter, check that there is no continuity between the terminal and ground as shown.

If there is continuity replace the pump (See page FU–14).

(d) Reconnect the SCV1 and SCV2 connectors.

FU08V–01

COMPONENTS



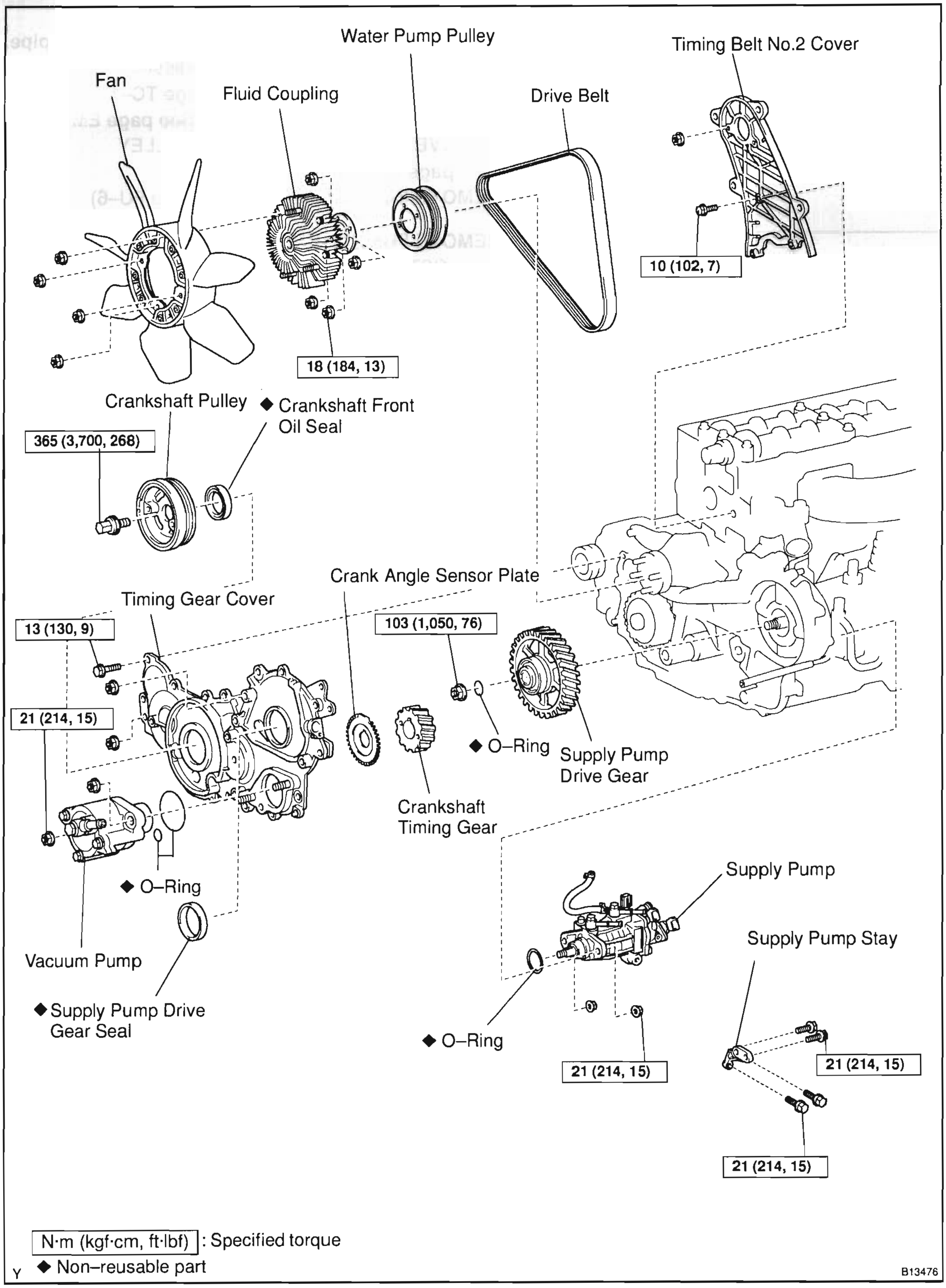
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

A15093


Water Pump Pulley
Timing Belt No.2 Cover
Fan
Fluid Coupling
Drive Belt
10 (102, 7)
18 (184, 13)
Crankshaft Pulley
◆ Crankshaft Front Oil Seal
365 (3,700, 268)
Crank Angle Sensor Plate
Timing Gear Cover
13 (130, 9)
103 (1,050, 76)
21 (214, 15)
◆ O–Ring
Supply Pump Drive Gear
Crankshaft Timing Gear
Supply Pump
◆ O–Ring
Supply Pump Stay
Vacuum Pump
◆ Supply Pump Drive Gear Seal
◆ O–Ring
21 (214, 15)
21 (214, 15)
21 (214, 15)
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
B13476

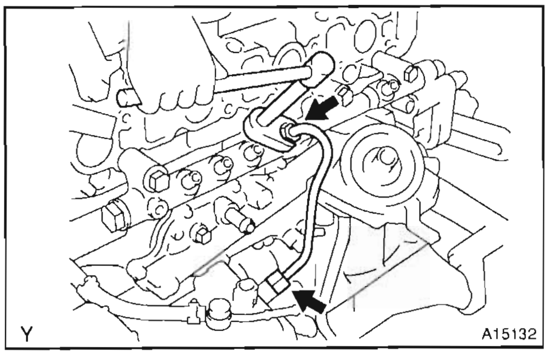
FU38W–01

REMOVAL

NOTICE:

When removing the injection pipes and fuel inlet pipe, clean them up with a brush and compressed air.

1. **REMOVE INTERCOOLER (See page TC–11)**
2. **REMOVE TIMING BELT COVER (See page EM–11)**
3. **REMOVE SUPPLY PUMP DRIVE PULLEY (See page EM–21)**
4. **REMOVE INJECTION PIPE (See page FU–6)**



5. **REMOVE FUEL INLET PIPE**

(a) Using SST, loosen the fuel inlet union of common rail side.

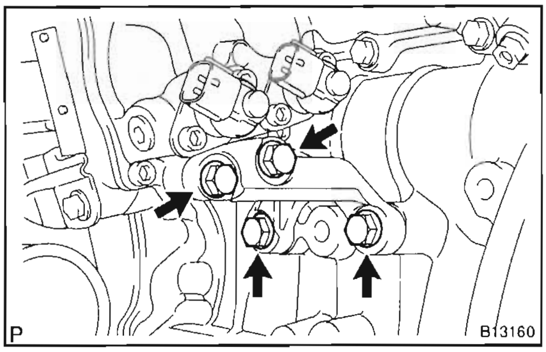
(b) Using SST, loosen the fuel inlet pipe union of pump side.
SST 09023–12700

(c) Remove the fuel inlet pipe.

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 SUPPLY PUMP DRIVE GEAR (See page EM–21)**

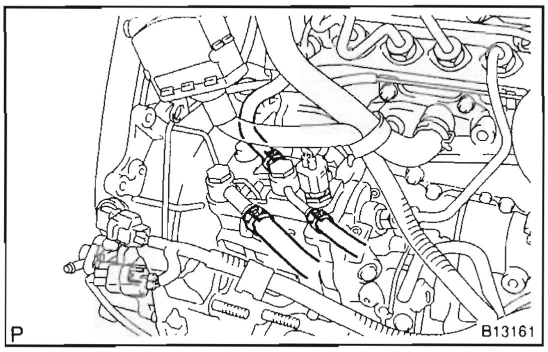


7. **REMOVE SUPPLY PUMP STAY**

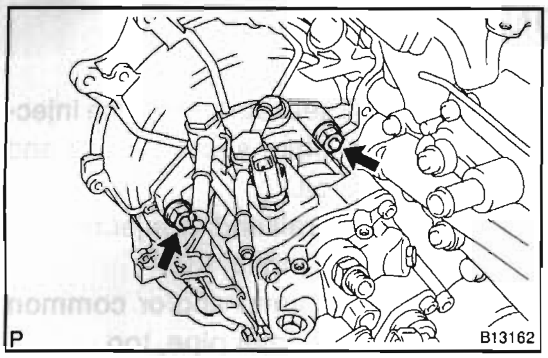
Remove the 4 bolts and supply pump stay.

8. **REMOVE SUPPLY PUMP**

(a) Disconnect the 3 connectors from the supply pump.



(b) Disconnect the 3 fuel hoses from the supply pump.



(c) Remove the 2 nuts and supply pump.

FU08X–01

INSTALLATION

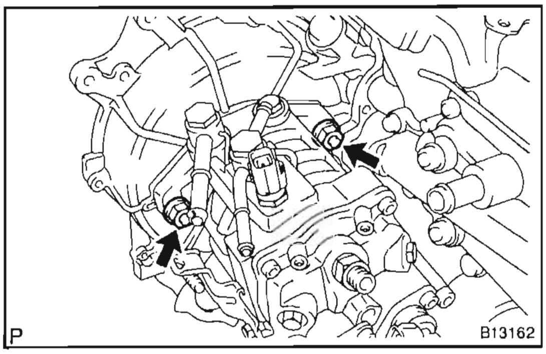
NOTICE:

- **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

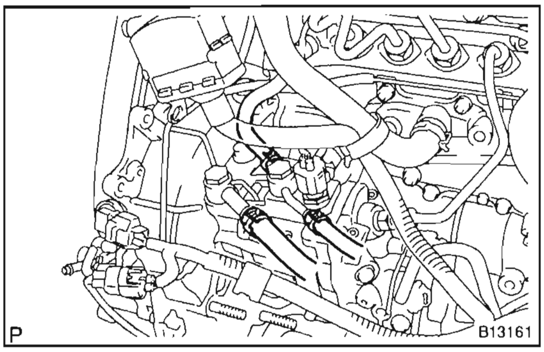
(a) Install a new O–ring to the supply pump.

(b) Align the key position with the match mark on the pump housing.



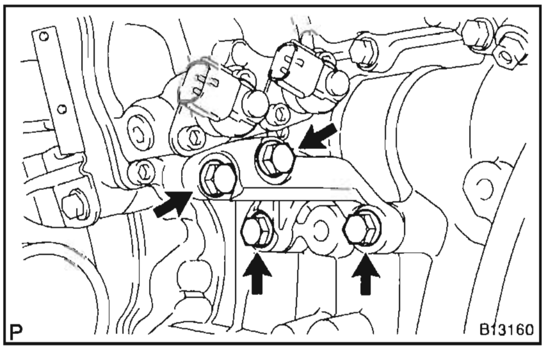
(c) Temporality Install the supply pump with the 2 nuts.

(d) Remove the gum tape from the fuel pipe.



(e) Connect the 3 fuel hoses to the supply pump.

2. INSTALL SUPPLY PUMP DRIVE GEAR
(See page EM–31)

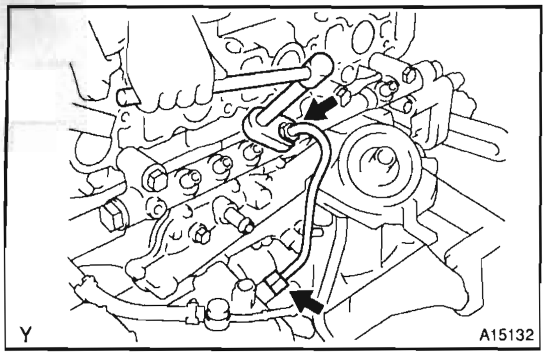


3. INSTALL SUPPLY PUMP STAY

(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 both sides.
Torque: 21 N·m (214 kgf·cm, 15 ft·lbf)

(c) Torque the supply pump.
Torque: 21 N·m (214 kgf·cm, 15 ft·lbf)



4. **INSTALL FUEL INLET PIPE**

(a) Temporarily install the fuel inlet pipe.

(b) Using SST, tighten the fuel inlet pipe union of common rail side.
SST 09023–12900
Torque:
31.6 N·m (322 kgf·cm, 23 ft·lbf) for use with SST
35 N·m (357 kgf·cm, 26 ft·lbf)

HINT:
Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

(c) Using SST, tighten the fuel inlet pipe union of supply pump side.
SST 09023–12700
Torque:
31.9 N·m (325 kgf·cm, 24 ft·lbf) for use with SST
35 N·m (357 kgf·cm, 26 ft·lbf)

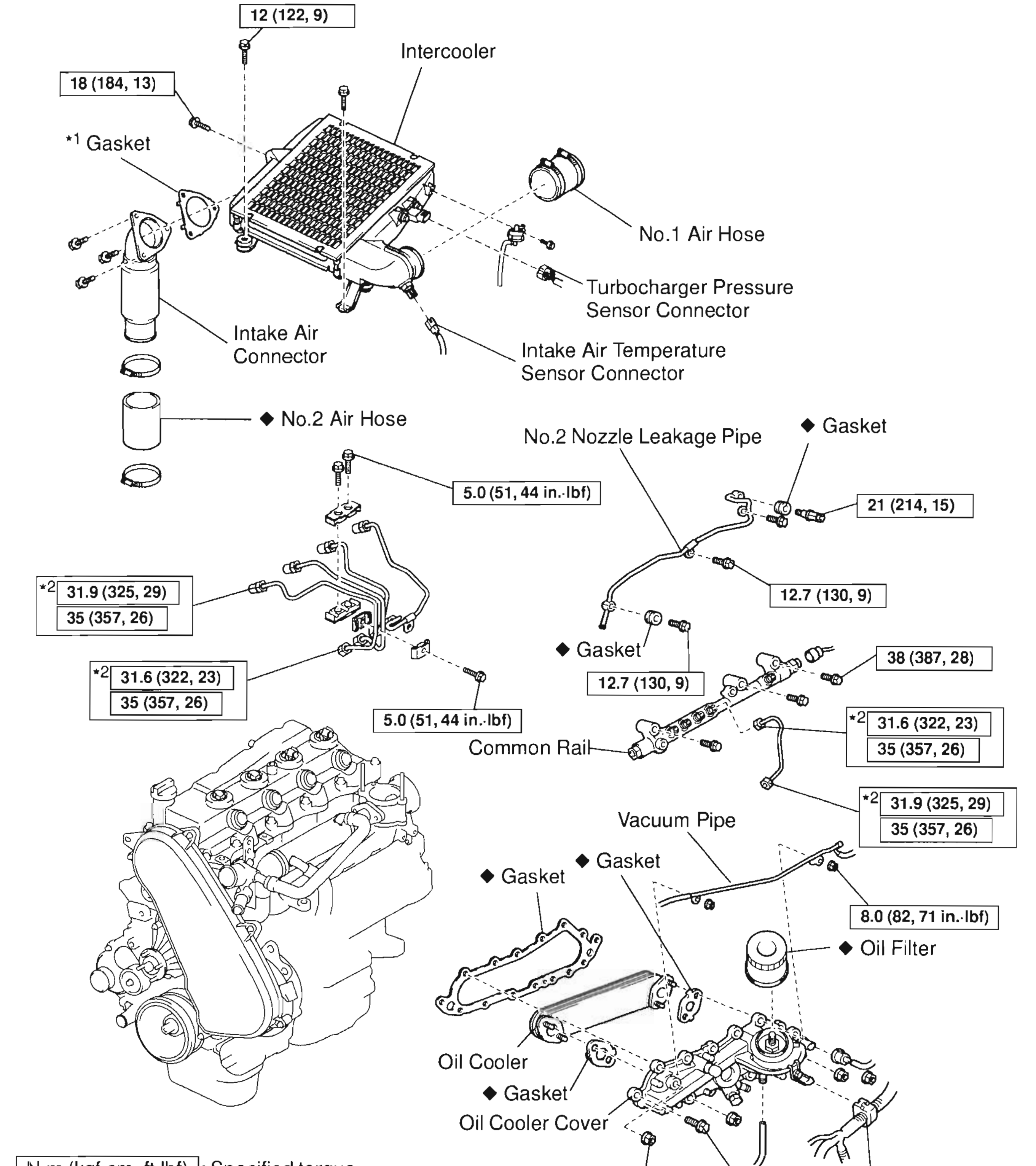
HINT:
Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

5. **INSTALL INJECTION PIPE (See page FU–8)**
6. **INSTALL SUPPLY PUMP DRIVE PULLEY (See page EM–31)**
7. **INSTALL INTERCOOLER (See page TC–12)**
8. **CHECK FUEL LEAK (See page FU–8)**

COMMON RAIL

COMPONENTS

FU08Y–01



N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

*1 Replace only if damaged

*2 For use with SST

P

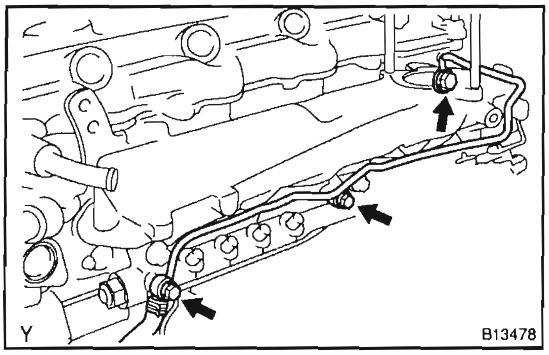
B13477

FU08Z–01

REMOVAL

NOTICE:
When removing the injection pipes and fuel inlet pipe, clean them up with a brush and compressed air.

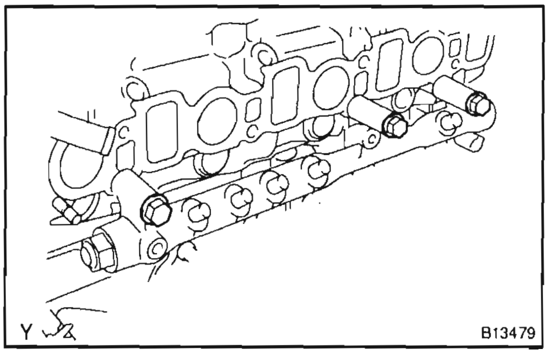
1. **REMOVE INJECTION PIPE (See page FU–6)**
2. **REMOVE FUEL INLET PIPE (See page FU–16)**



3. **REMOVE NO.2 NOZZLE LEAKAGE PIPE**

(a) Disconnect the fuel hose from the No. 2 nozzle leakage pipe.

(b) Remove the 2 bolts, union bolt, check calve, No. 2 nozzle leakage pipe and 2 gasket.



4. **REMOVE COMMON RAIL**

(a) Disconnect the fuel pressure sensor connector.

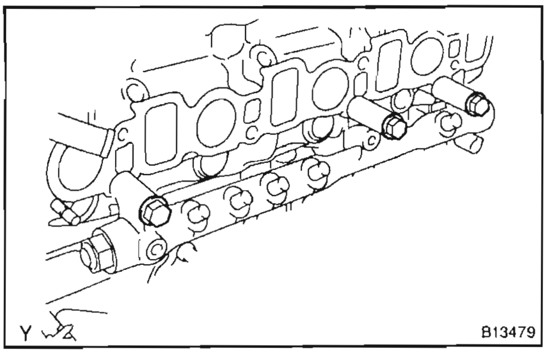
(b) Remove the 3 bolts and common rail.

NOTICE:

- **Do not remove the pressure limiter.**
- **Do not reuse the fuel pressure sensor.**

FU090–01

INSTALLATION



NOTICE:

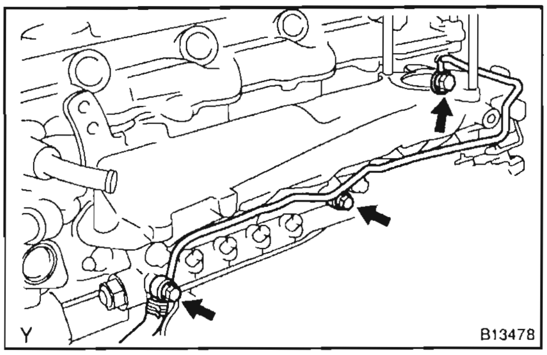
In case of having the common rail, must replace injection pipes and fuel inlet pipe, too.

1. **INSTALL COMMON RAIL**

(a) Install the common rail with the 3 bolts.

Torque: 38 N·m (387 kgf·cm, 28 ft·lbf)

(b) Connect the fuel pressure sensor connector.



2. **INSTALL NO. 2 NOZZLE LEAKAGE PIPE**

Torque:

Bolt: 12.7 N·m (130 kgf·cm, 9 ft·lbf)

Union bolt: 12.7 N·m (130 kgf·cm, 9 ft·lbf)

Check valve: 21 N·m (214 kgf·cm, 15 ft·lbf)

3. **INSTALL FUEL INLET PIPE (See page FU–18)**
4. **INSTALL INJECTION PIPE (See page FU–8)**
5. **CHECK FUEL LEAK (See page FU–8)**

FUEL PRESSURE LIMITTER

FU091–01

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.

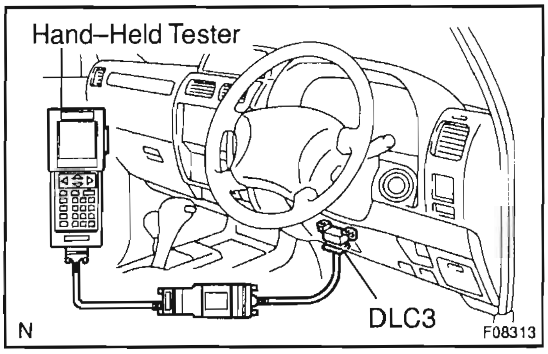
If there is fuel leakage, replace these parts.

(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–20)



(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 CO–1
WATER PUMP CO–3
THERMOSTAT CO–10
RADIATOR CO–14

COOLANT

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 "L" and "F" lines.

If low, check for leaks and add "Toyota Long Life Coolant" or equivalent up to between the "L" and "F" 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 while the engine and radiator are still hot, as fluid and steam can be blown out under pressure.

(b) There should not be 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.

C00NH–04

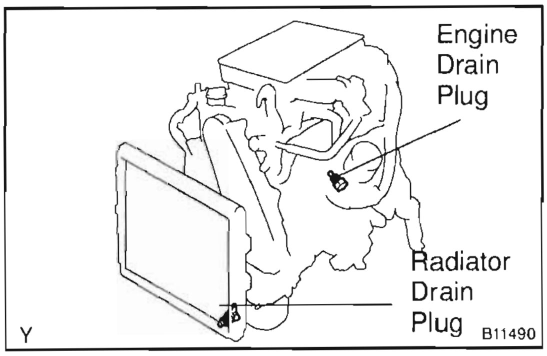
REPLACEMENT

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.

1. **DRAIN ENGINE COOLANT**

(a) Remove the radiator cap.



(b) Loosen the radiator drain plug (on the right side of the radiator lower tank) and engine drain plug (on the oil cooler cover), and drain the coolant.

(c) Close the drain plugs.

Torque: 8 N·m (80 kgf·cm, 69 in.·lbf) for Engine

2. **FILL ENGINE COOLANT**

(a) Slowly fill the system with coolant.

- 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/ Rear heater:
M/T 10.5 liters (11.1 US qts, 9.2 Imp. qts)
A/T 11.0 liters (11.6 US qts, 9.7 Imp. qts)
w/o Rear heater:
M/T 9.5 liters (10.0 US qts, 8.4 Imp. qts)
A/T 10.0 liters (10.6 US qts, 8.8 Imp. qts)

(b) Reinstall the radiator cap.

(c) Start the engine, and bleed the cooling system.

(d) Refill the radiator reservoir with coolant until it reaches the "F" line.

3. **CHECK ENGINE COOLANT FOR LEAKS**

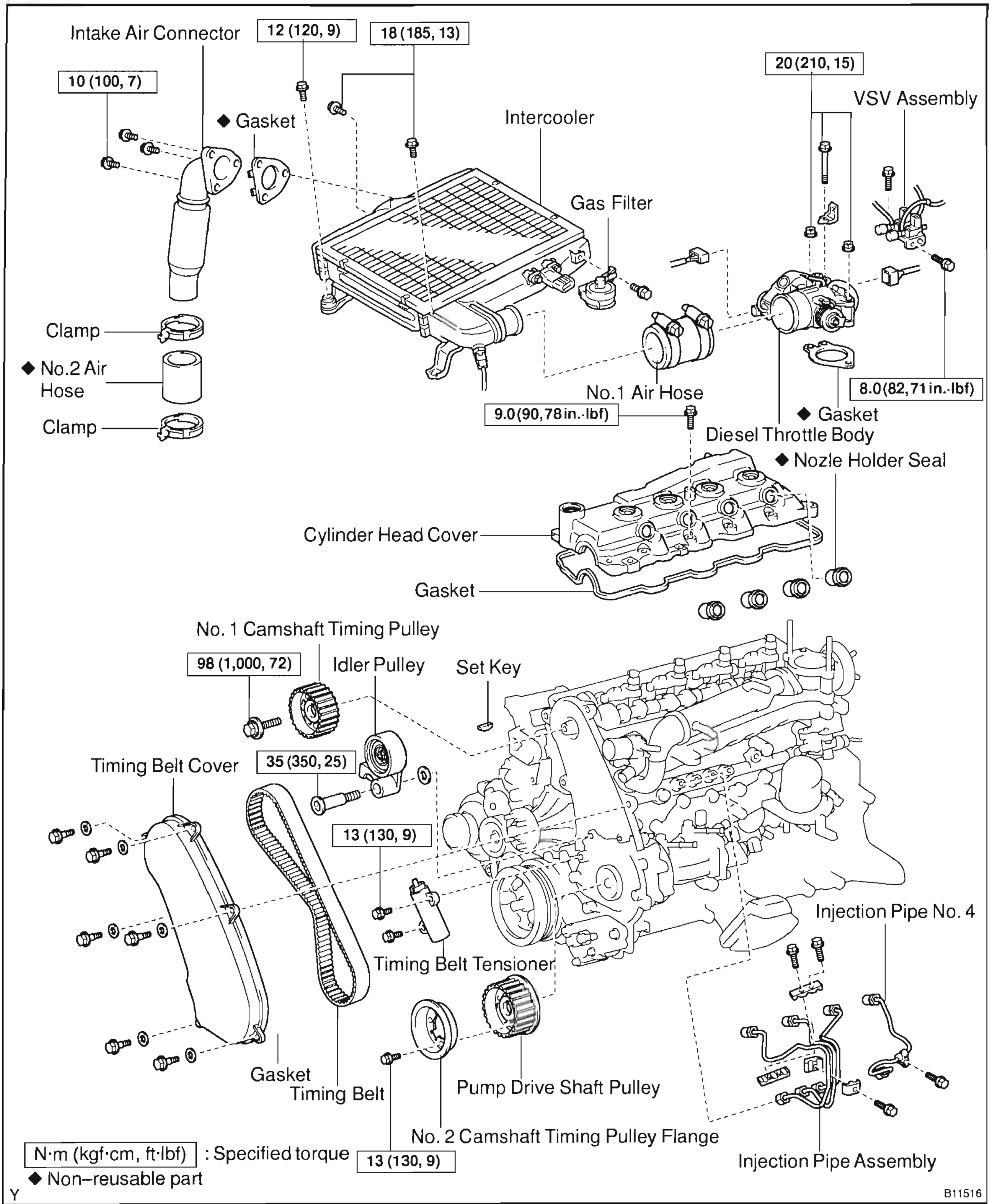
4. **CHECK ENGINE COOLANT SPECIFIC GRAVITY CORRECTLY**

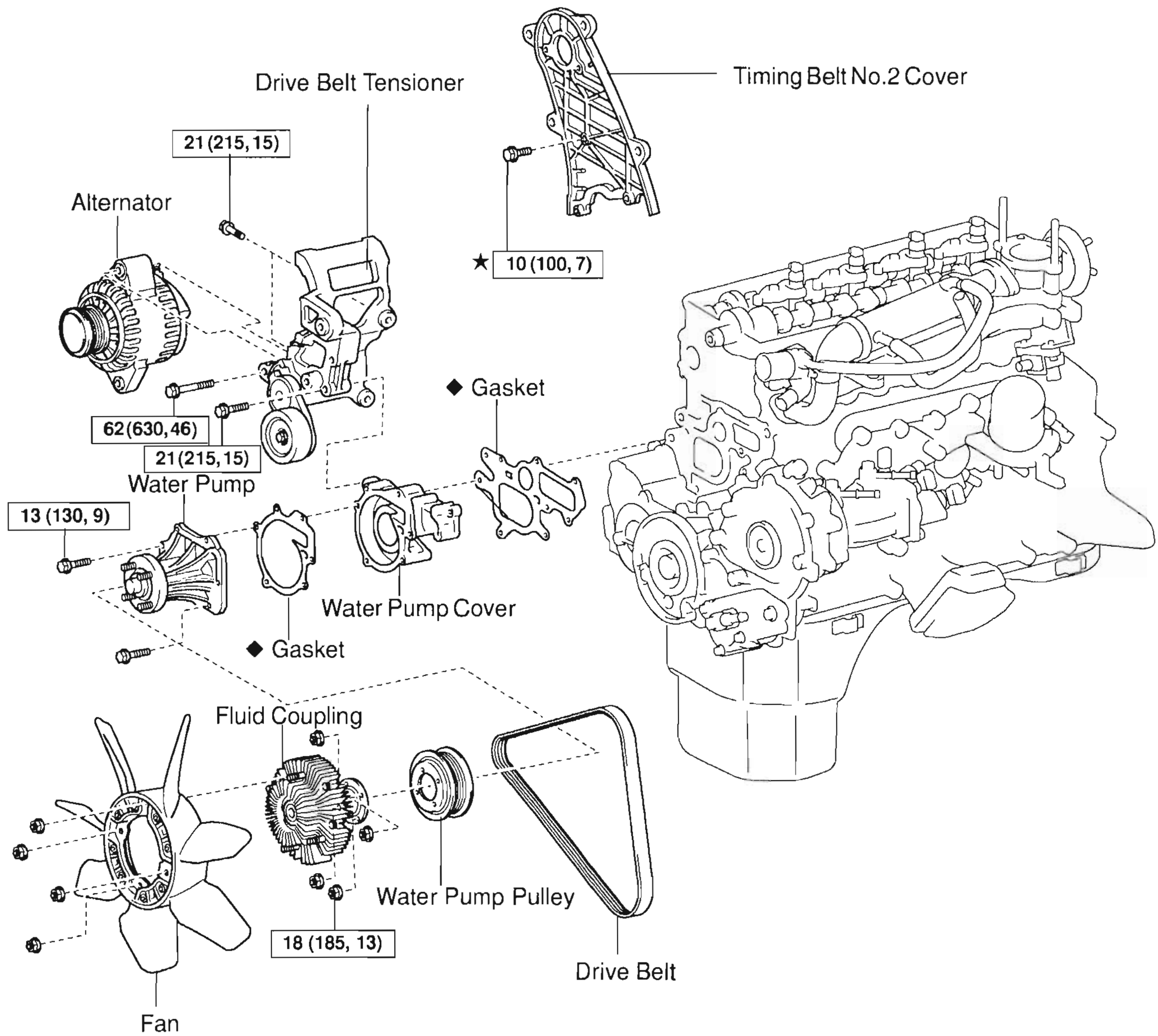
CO

WATER PUMP

COMPONENTS

C00WL-03



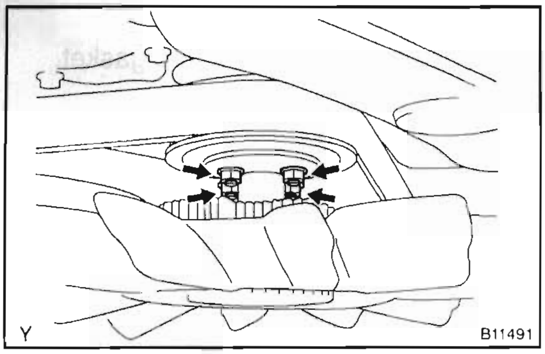


N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
★ Precoated part

B11517

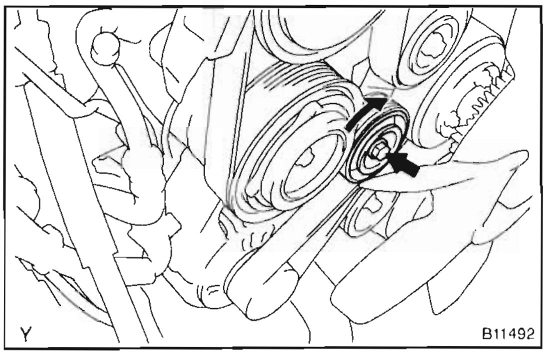
CO17K–01

REMOVAL



1. **DRAIN ENGINE COOLANT**
2. **REMOVE DRIVE BELT, FAN AND WATER PUMP PULLEY**

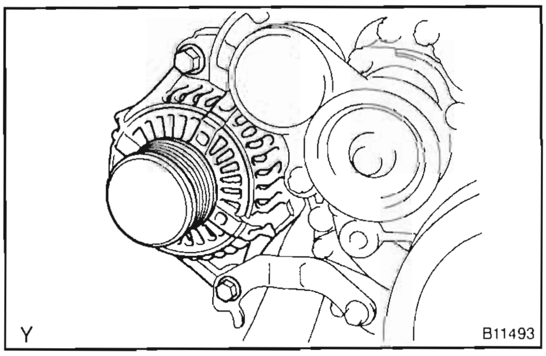
(a) Stretch the belt tight drive and loosen the 4 pump pulley set nuts.



(b) Turn the drive belt tensioner, and remove the drive belt.

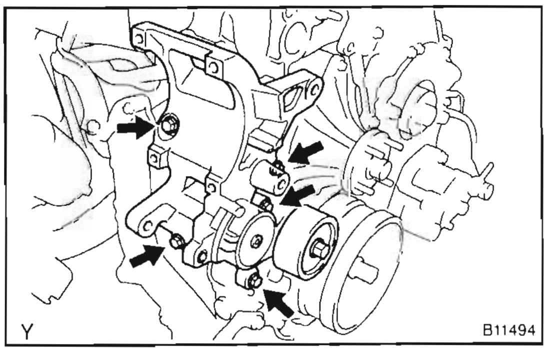
(c) Remove the 4 nuts, fan and fluid coupling assembly and pulley.

3. **REMOVE TIMING BELT AND IDLER PULLEY**
(See page EM–11)
4. **REMOVE NO.1 CAMSHAFT TIMING PULLEY**
(See page EM–11)
5. **REMOVE TIMING BELT NO. 2 COVER**
(See page EM–21)
6. **w/ A/C:**
REMOVE A/C COMPRESSOR

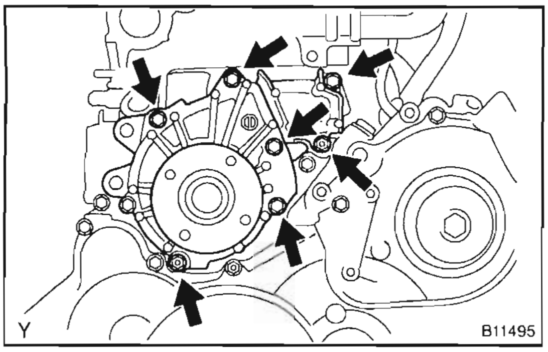


7. **REMOVE ALTERNATOR AND DRIVE BELT TENSIONER**

(a) Remove the 2 bolts and alternator.

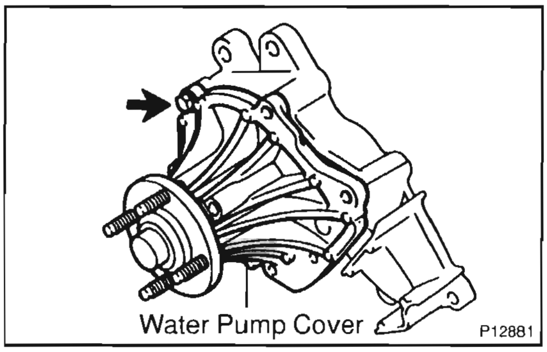


(b) Remove the 5 bolts and drive belt tensioner.



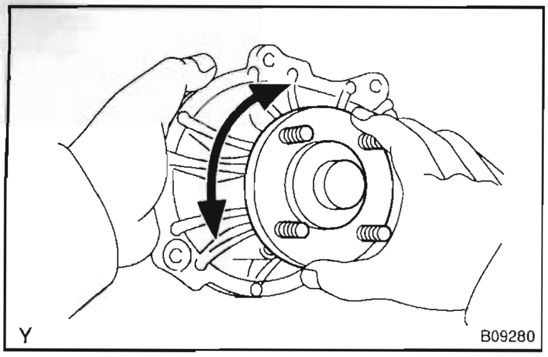
8. REMOVE WATER PUMP

(a) Remove the 5 bolts, 2 nuts, water pump and gasket.



(b) Remove the bolt, water pump cover and gasket.

C00WN-02



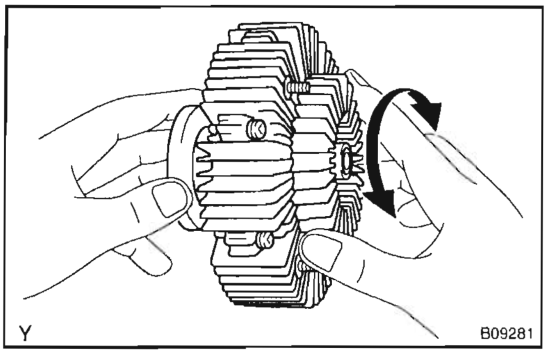
INSPECTION

1. INSPECT WATER PUMP

(a) Visually check the water 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.

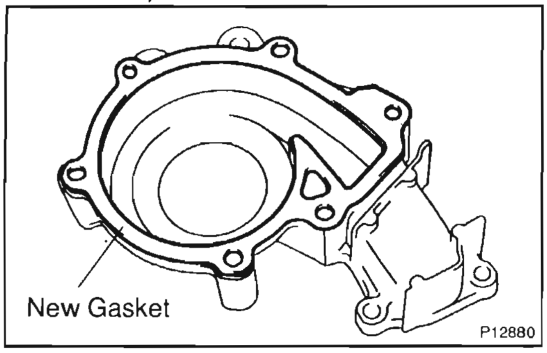


2. INSPECT FLUID COUPLING

Check the fluid coupling for damage and silicon oil leakage.
If necessary, replace the fluid coupling.

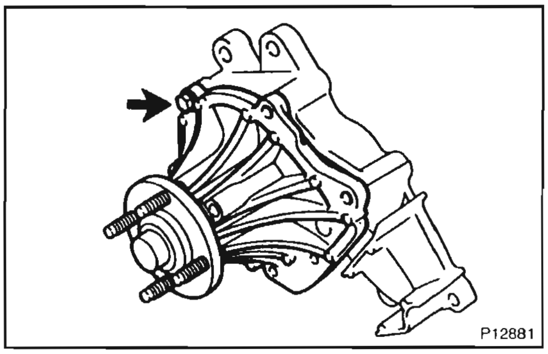
COOWO–02

INSTALLATION

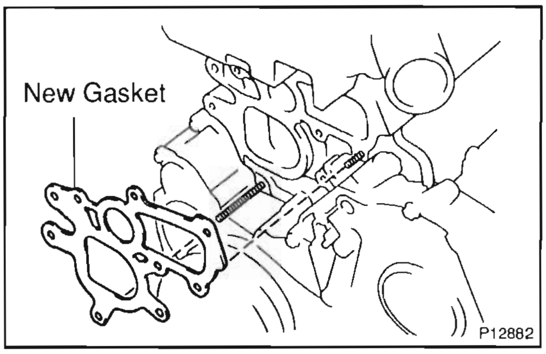


1. INSTALL WATER PUMP ASSEMBLY

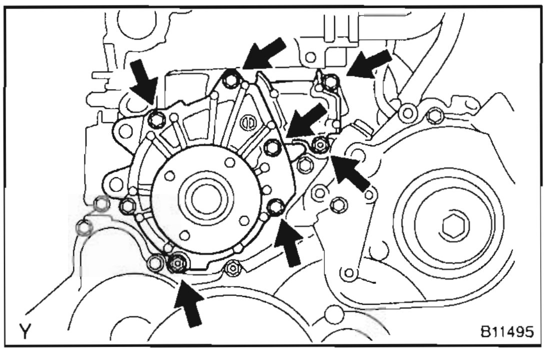
(a) Install a new gasket to the water pump cover.



(b) Temporarily install the water pump and water pump cover with the bolt.



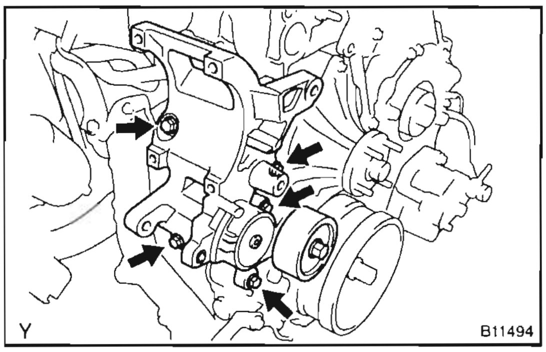
(c) Place a new gasket in position on the cylinder block.



(d) Temporarily install the water pump with the 5 bolts and 2 nuts.

(e) Tighten the bolts and nuts.

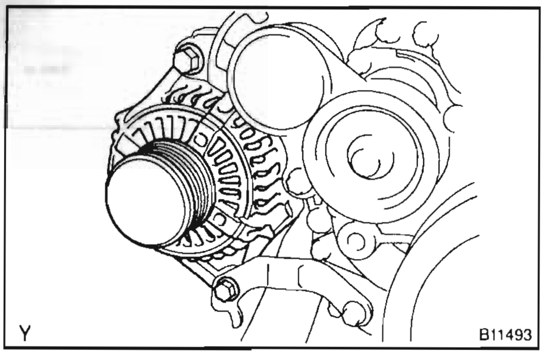
Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)



2. INSTALL DRIVE BELT TENSIONER AND ALTERNATOR

(a) Install the drive belt tensioner with the 5 bolts.

Torque: 21 N·m (210 kgf·cm, 15 ft·lbf)



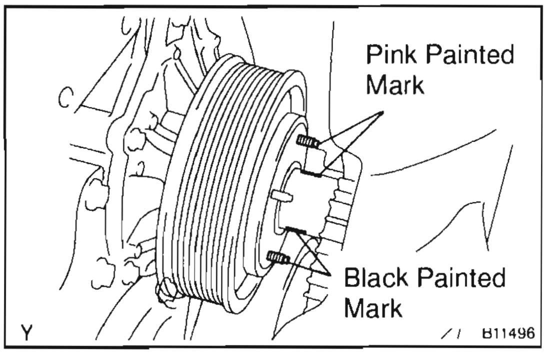
(b) Install the alternator with the 2 bolts.
Torque:
To Drive belt tensioner
62 N·m (630 kgf·cm, 46 ft·lbf)
To Alternator bracket
21 N·m (210 kgf·cm, 15 ft·lbf)

3. INSTALL TIMING BELT NO. 2 COVER
(See page EM–31)

4. INSTALL NO.1 CAMSHAFT TIMING PULLEY
(See page EM–16)

5. INSTALL IDLER PULLEY AND TIMING BELT
(See page EM–16)

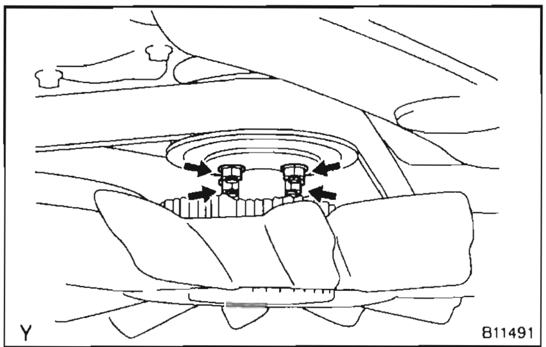
6. INSTALL WATER PUMP PULLEY, FAN AND DRIVE BELT



(a) Install the pump pulley, the fluid, fan and coupling assembly with the 4 nuts.

HINT:
When intalling the fluid coupling on the water pump, must intall it by making the marking color of the bolt of the water pump and the marking color of the fluid coupling meet.

(b) Install the drive belt tensioner.



(c) Stretch the belt tight and torque the 4 nuts.
Torque: 18 N·m (185 kgf·cm, 13 ft·lbf)

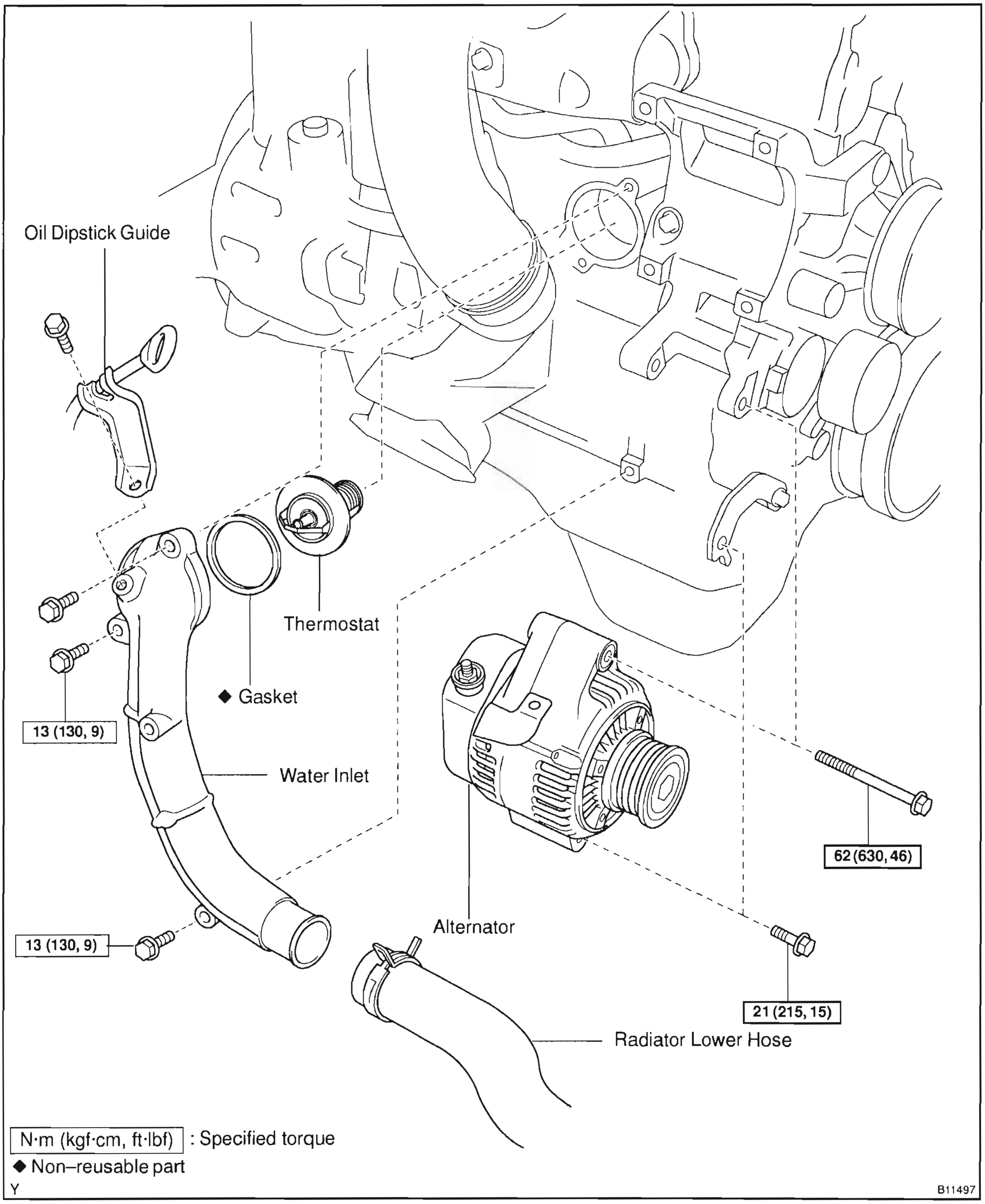
7. FILL WITH ENGINE COOLANT

8. START ENGINE AND CHECK FOR COOLANT LEAKS

THERMOSTAT

COMPONENTS

CO0NI–03



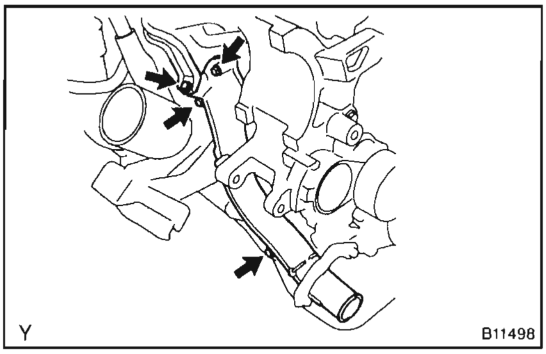
CO0WP–02

REMOVAL

HINT:

Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. **DRAIN ENGINE COOLANT**
2. **DISCONNECT RADIATOR LOWER HOSE**
3. **REMOVE ALTERNATOR**



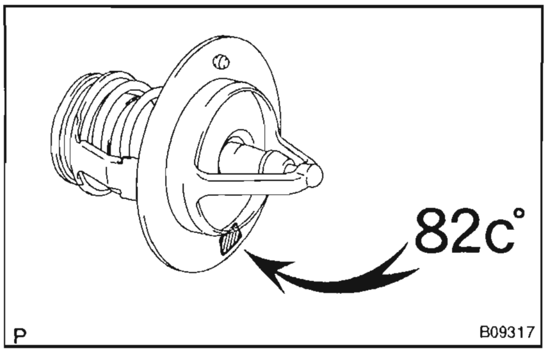
4. **REMOVE WATER INLET AND THERMOSTAT**

(a) Remove the bolt and oil dipstick guide.

(b) Remove the 3 bolts and water inlet from the cylinder block.

(c) Remove the thermostat.

(d) Remove the gasket from the thermostat.

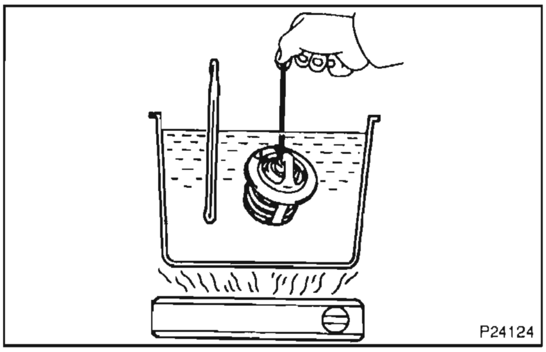


CO0NK–03

INSPECTION

INSPECT THERMOSTAT

HINT:
The thermostat is numbered with the valve opening temperature.

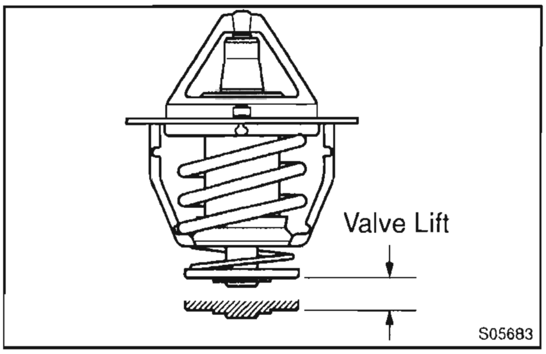


(a) Immerse the thermostat in water and gradually heat the water.

(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.



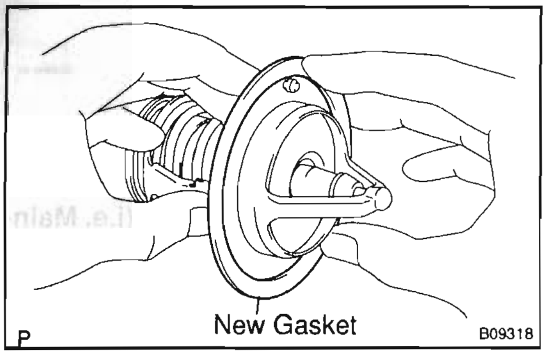
(c) Check the valve lift.

Valve lift: 10 mm (0.39 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 temperatures (below 40°C (104°F)).

If not closed, replace the thermostat.

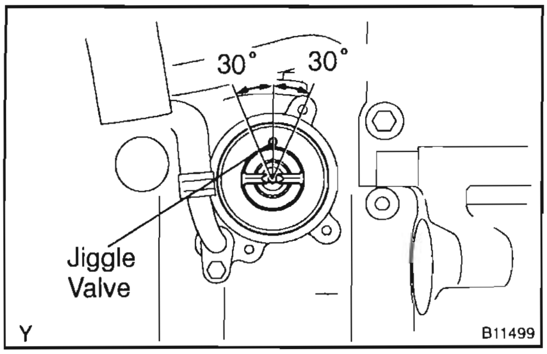


CO0NL–03

INSTALLATION

1. **PLACE THERMOSTAT IN CYLINDER BLOCK**

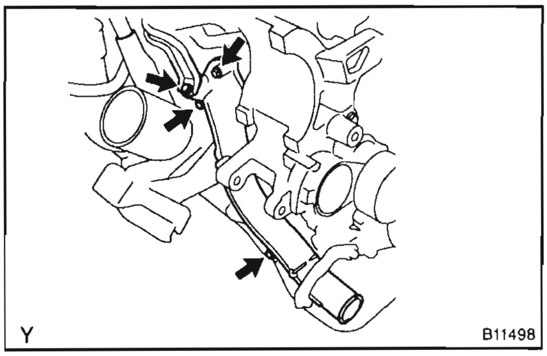
(a) Install a new gasket to the thermostat.



(b) Install the thermostat with the jiggle valve upward.

HINT:

The jiggle valve may be set within 30° of either side of the prescribed position.



2. **INSTALL WATER INLET TO CYLINDER BLOCK**

(a) Install the water inlet with the 3 bolts.

Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

NOTICE:

Torque the 2 upper bolts first.

(b) Install the oil dipstick guide with the bolt.

3. **CONNECT RADIATOR LOWER HOSE**
4. **INSTALL ALTERNATOR (See page CO–8)**
5. **FILL WITH ENGINE COOLANT**
6. **START ENGINE AND CHECK FOR COOLANT LEAKS**

RADIATOR

CO0WQ–01

ON–VEHICLE CLEANING

Using water or a steam cleaner, remove any mud and 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.)

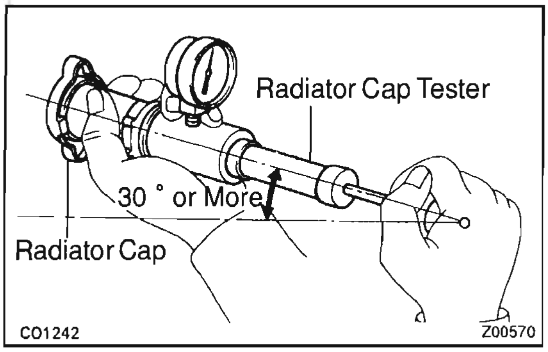
CO0WR–02

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.



C01242 Z00570

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 that air is coming form 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:

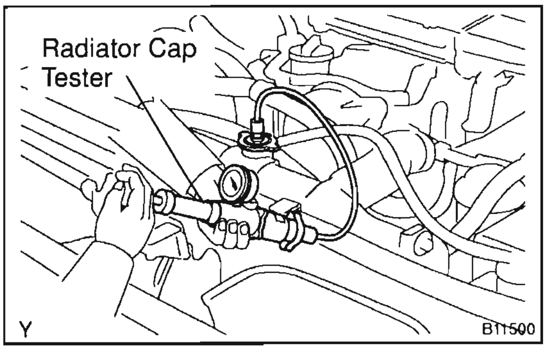
This pump speed is for the first pump only (in order to close the vacuum valve). After this, the pump speed can be reduced.

Standard opening pressure:
93 – 123 kPa (0.95 – 1.25 kgf/cm^2, 13.5 – 17.8 psi)
Minimum opening pressure:
79 kPa (0.8 kgf/cm^2, 11.5 psi)

HINT:

Use the tester's maximum reading as the opening pressure.

If the opening pressure is less than minimum, replace the radiator cap.



Y B11500

3. INSPECT COOLING SYSTEM FOR LEAKS

(a) Fill the radiator with coolant, and attach a radiator cap tester.

(b) Warm up the engine.

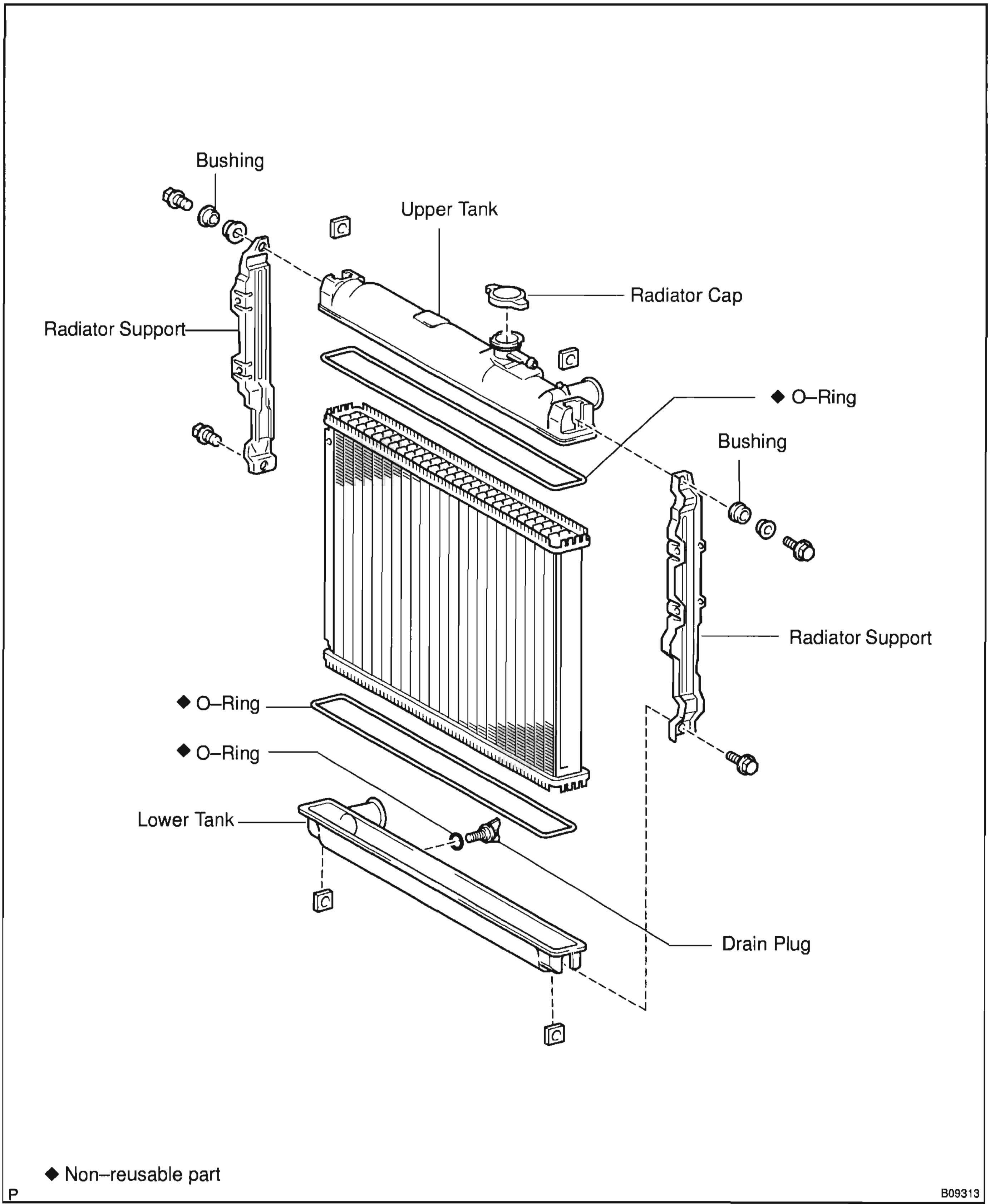
(c) Pump it to 118 kPa (1.2 kgf/cm^2, 17.1 psi), and check that the pressure does not drop.

If the pressure drops, check the hoses, radiator or water pump for leaks. If no external leaks is found, check the heater core, cylinder block and head.

4. REINSTALL RADIATOR CAP

CO0NM–03

COMPONENTS



CO0NN–03

DISASSEMBLY

1. REMOVE RADIATOR SUPPORTS

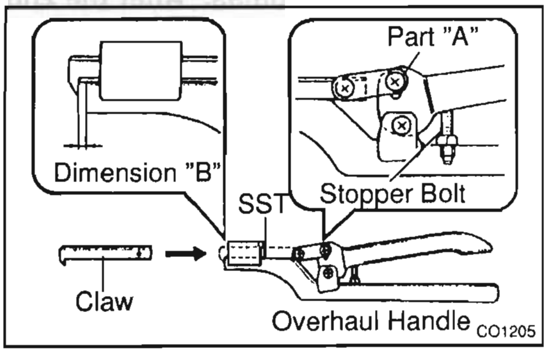
Remove the 2 bolts, nuts, pipe, bushing and radiator support. Remove the LH and RH supports.

2. REMOVE RADIATOR CAP

3. REMOVE DRAIN PLUG

(a) Remove the drain plug.

(b) Remove the O–ring.



CO1205

4. ASSEMBLE SST

SST 09230–01010

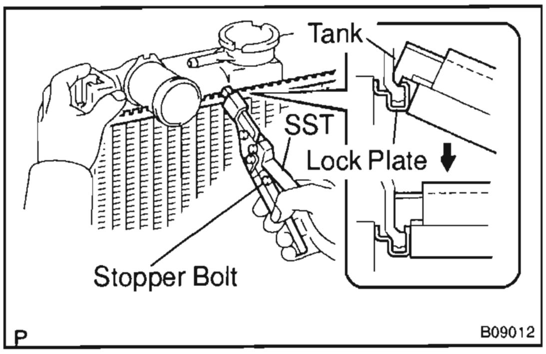
(a) Install the claw to the overhaul handle, inserting it in the hole in part "A" as shown in the diagram.

(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.

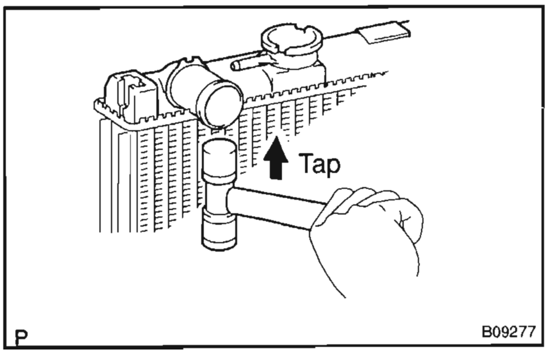


P B09012

5. UNCAULK LOCK PLATES

Using SST to release the caulking, squeeze the handle until stopped by the stopper bolt.

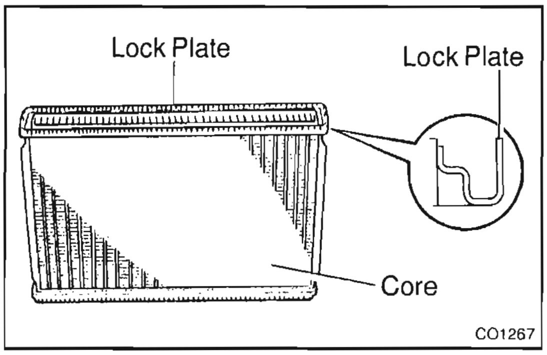
SST 09230–01010



P B09277

6. 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.



REASSEMBLY

CO0NO–03

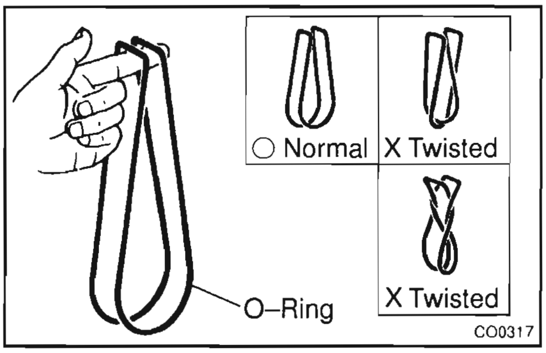
1. INSPECT LOCK PLATE FOR DAMAGE

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.

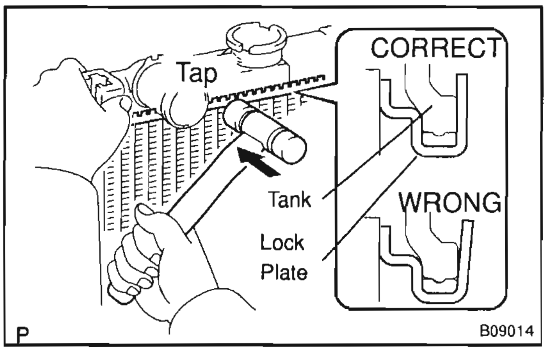


2. INSTALL NEW O–RINGS AND TANKS

(a) After checking that there are no foreign objects in the lock plate groove, install a new O–ring without twisting it.

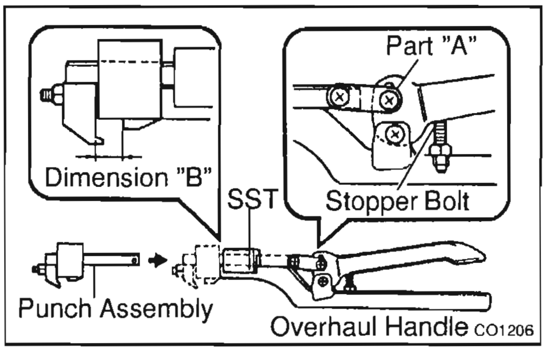
HINT:

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.



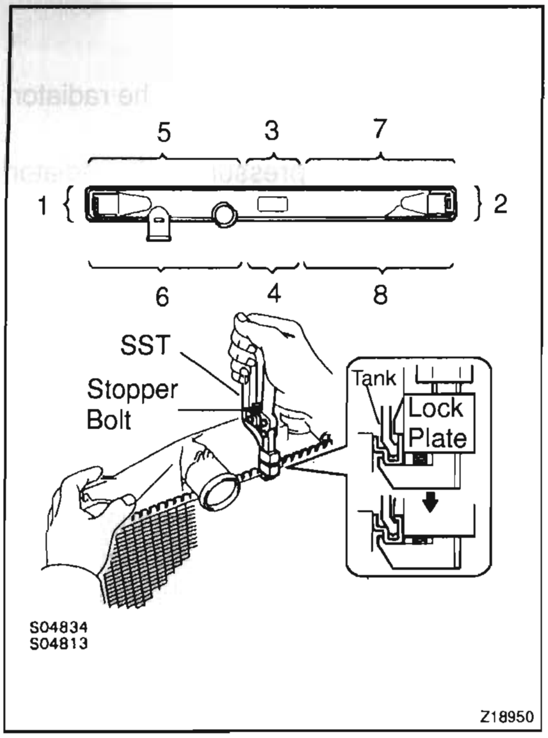
3. ASSEMBLE SST

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.

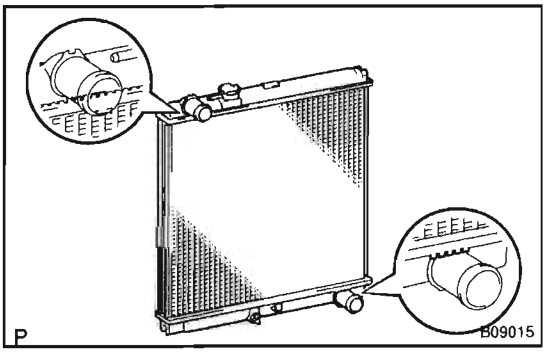
(b) While gripping the handle, adjust the stopper bolt so that dimension "B" is as shown in the illustration.

Dimension "B": 8.4 mm (0.331 in.)



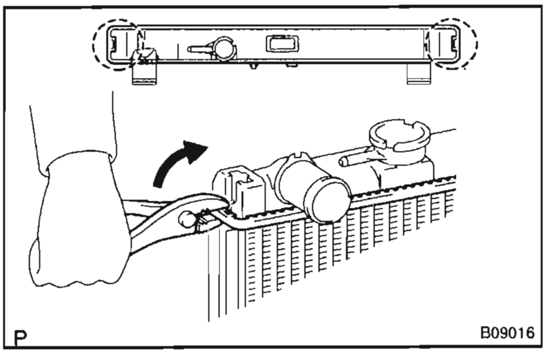
4. **CAULK LOCK PLATE**

(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 bolt.
SST 09230–01010

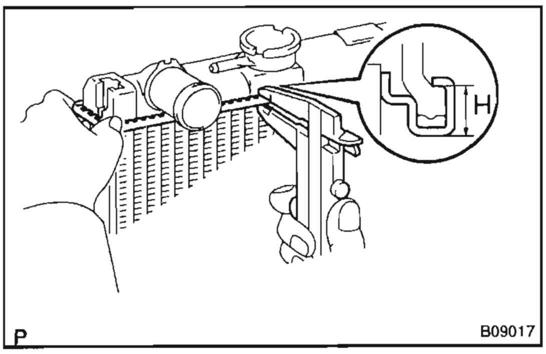


HINT:

- Do not stake the areas protruding around the ports.



- The points shown in the rib sides near here cannot be staked with SST. Use pliers similar object and be careful not to damage the core plates.

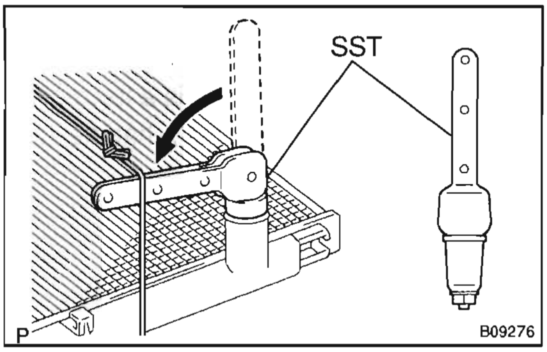


(b) Check the lock plate height (H) after completing the caluking.
Plate height (H):
7.40 – 7.80 mm (0.2913 – 0.3071 in.)

If not within the specified height, adjust the stopper bolt of the handle again and caulk again.

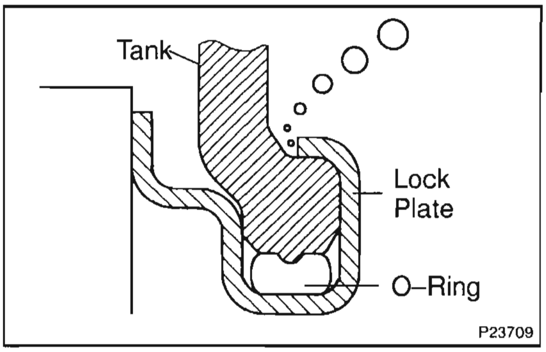
5. **INSTALL RADIATOR CAP**
6. **INSTALL DRAIN PLUG**

(a) Install a new O–ring to the drain plug.
(b) Install the drain plug.



7. CHECK FOR WATER LEAKS

(a) Tighten the drain plug.
(b) Using SST, plug the inlet and outlet pipes of the radiator.
SST 09230–01010
(c) Using a radiator cap tester, apply pressure to the radiator.
Test pressure: 147 kPa (1.8 kgf/cm^2, 26 psi)
(d) Submerge the radiator in water.



(e) Inspect for water leaks.

HINT:
On radiators with resin tanks, there is a clearance between the tank and lock plate where a minute amount of air will remain, giving the appearance of an air leak when the radiator is submerged in water. Therefore, before doing the water leak test, first swirl the radiator around in the water until all air bubbles disappear.

8. INSTALL RADIATOR SUPPORTS

Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

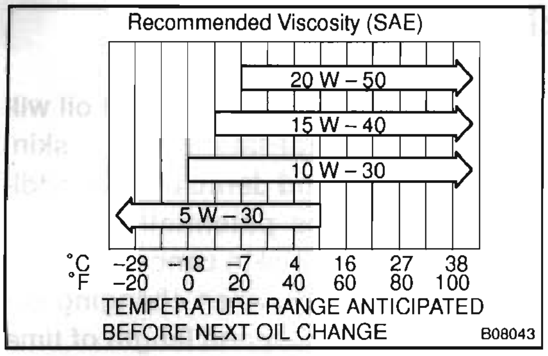
LUBRICATION

OIL AND FILTER LU–1
OIL PUMP LU–4
OIL COOLER LU–15
OIL NOZZLE LU–21

OIL AND FILTER

LU0BW–03

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 CF–4 or CF (You may also use API CE or CD)

If you use SAE 10W–30 or higher viscosity oil in extremely low temperatures, the engine may become difficult to start, so SAE 5W–30 engine oil is recommended.

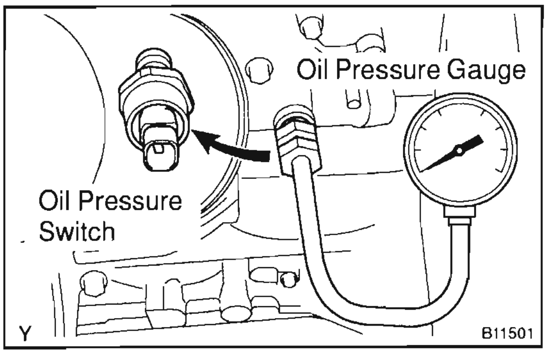
2. CHECK ENGINE OIL LEVEL

After warming up the engine and then 5 minutes after the engine stops, oil level should be between the "L" and "F" marks of the dipstick.

If low, check for leakage and add oil up to the "F" mark.

NOTICE:

Do not fill with engine oil above the "F" mark.



3. CHECK OIL PRESSURE

(a) Using a 24 mm deep socket wrench, remove the oil pressure switch.

(b) Install an oil pressure gauge.

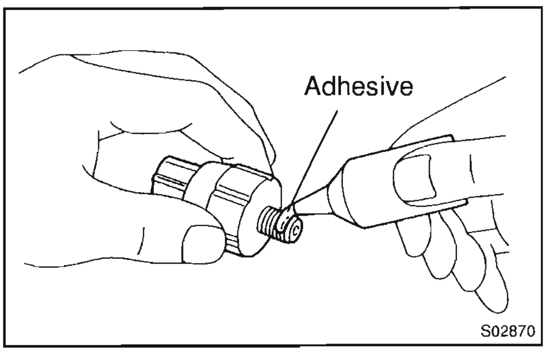
(c) Allow the engine to warm up to normal operating temperature.

(d) Check the oil pressure.

Oil pressure:

At idle	29 kPa (0.3 kgf/cm^2, 4.3 psi) or more
At 3,000 rpm	245 kPa (2.5 kgf/cm^2, 33 psi) or more

(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.

LU

LU0NH–01

REPLACEMENT

CAUTION:

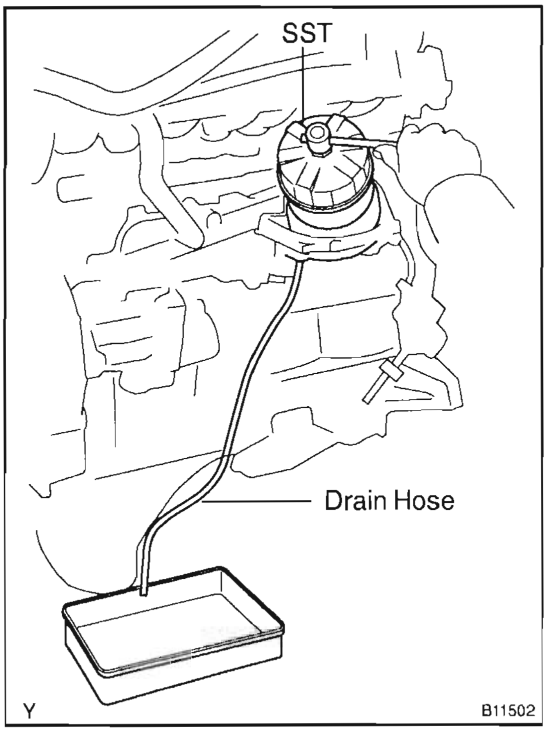
- **Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.**
- **Care should be taken, therefore, when 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 filter must be disposed of only at designated disposal sites.**

1. DRAIN ENGINE OIL

(a) Remove the oil filter cap.

(b) Remove the oil drain plug, and drain the oil into a container.

LU



2. REPLACE OIL FILTER

(a) Using SST, remove the oil filter.
SST 09228–10002

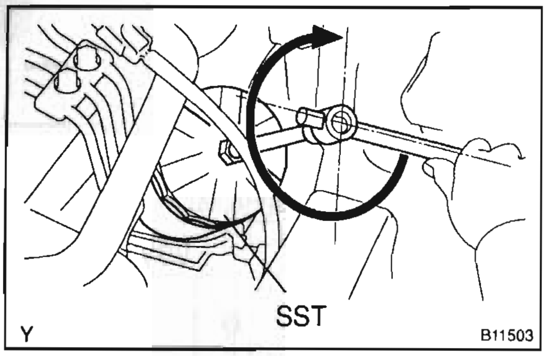
HINT:

As the oil in the filter flows out through the drain hose, place the drain oil container under the drain hose.

(b) Clean the oil filter contact surface on the oil filter mounting.

(c) Lubricate the filter rubber gasket with clean engine oil.

(d) Tighten the oil filter by hand until the rubber gasket contacts the seat of the filter mounting.



(e) Using SST, give it an additional 3/4 turn to seat the filter.
SST 09228–10002

3. **FILL WITH ENGINE OIL**

(a) Clean and install the oil drain plug with a new gasket.
Torque: 34 N·m (350 kgf·cm, 25 ft·lbf)

(b) Fill with fresh engine oil.
Capacity:

Drain and refill	w/ Oil filter change w/o Oil filter change	7.5 liters (7.9 US qts, 6.6 Imp. qts) 6.8 liters (7.2 US qts, 6.0 Imp. qts)
Dry fill		8.0 liters (8.5 US qts, 7.0 Imp. qts)

(c) Reinstall the oil filter cap.

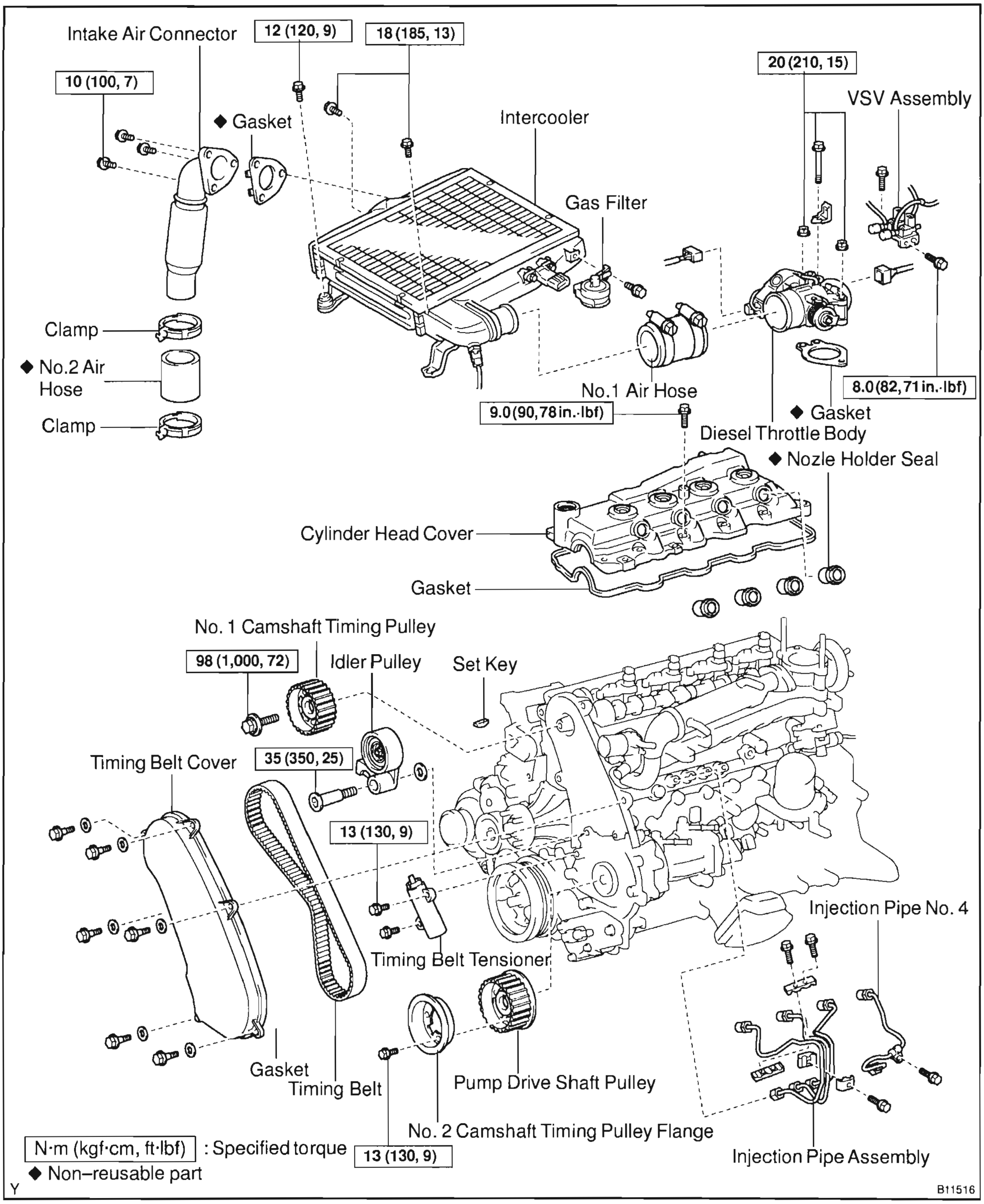
4. **START ENGINE AND CHECK FOR OIL LEAKS**

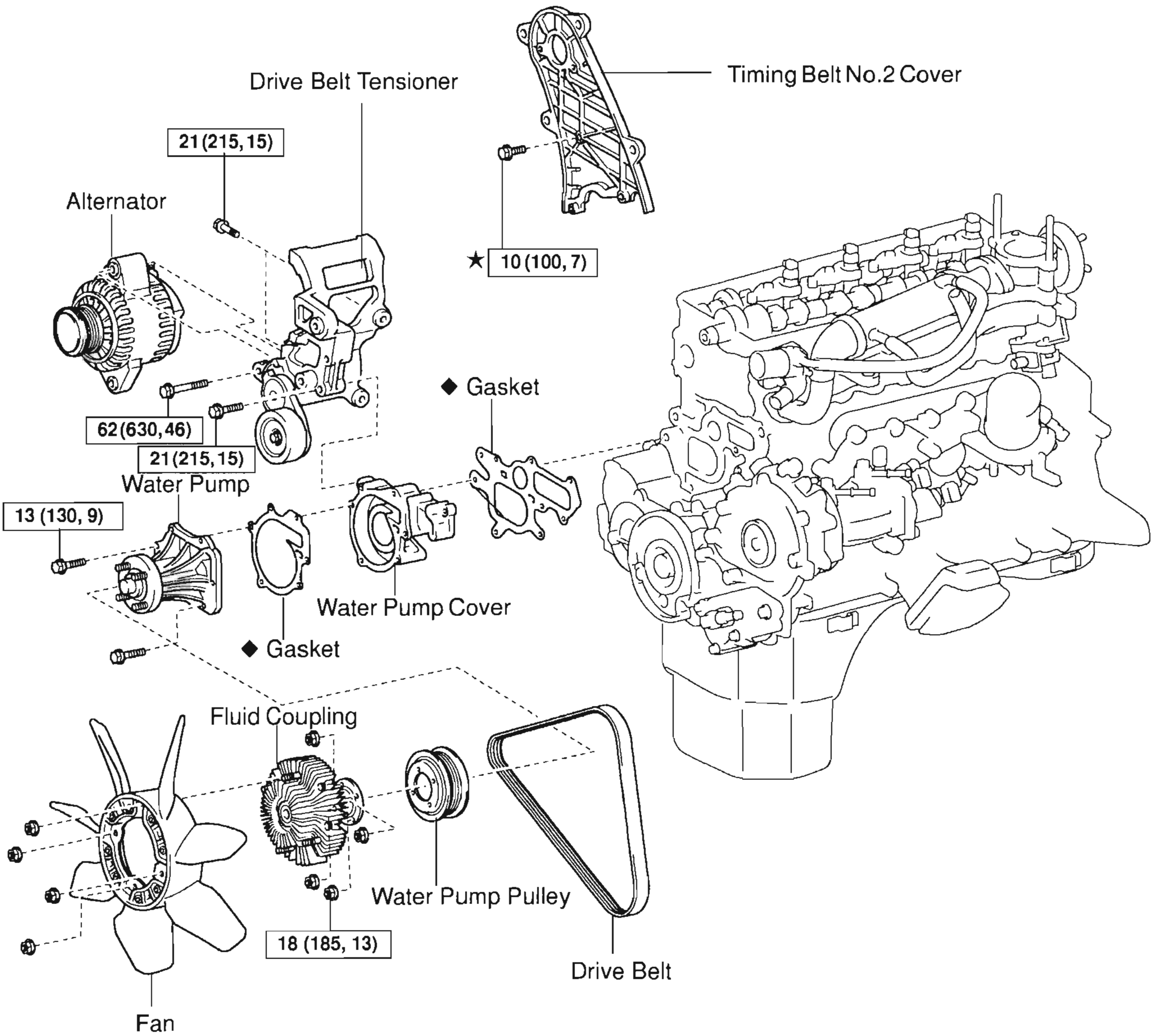
5. **RECHECK ENGINE OIL LEVEL**

OIL PUMP

COMPONENTS

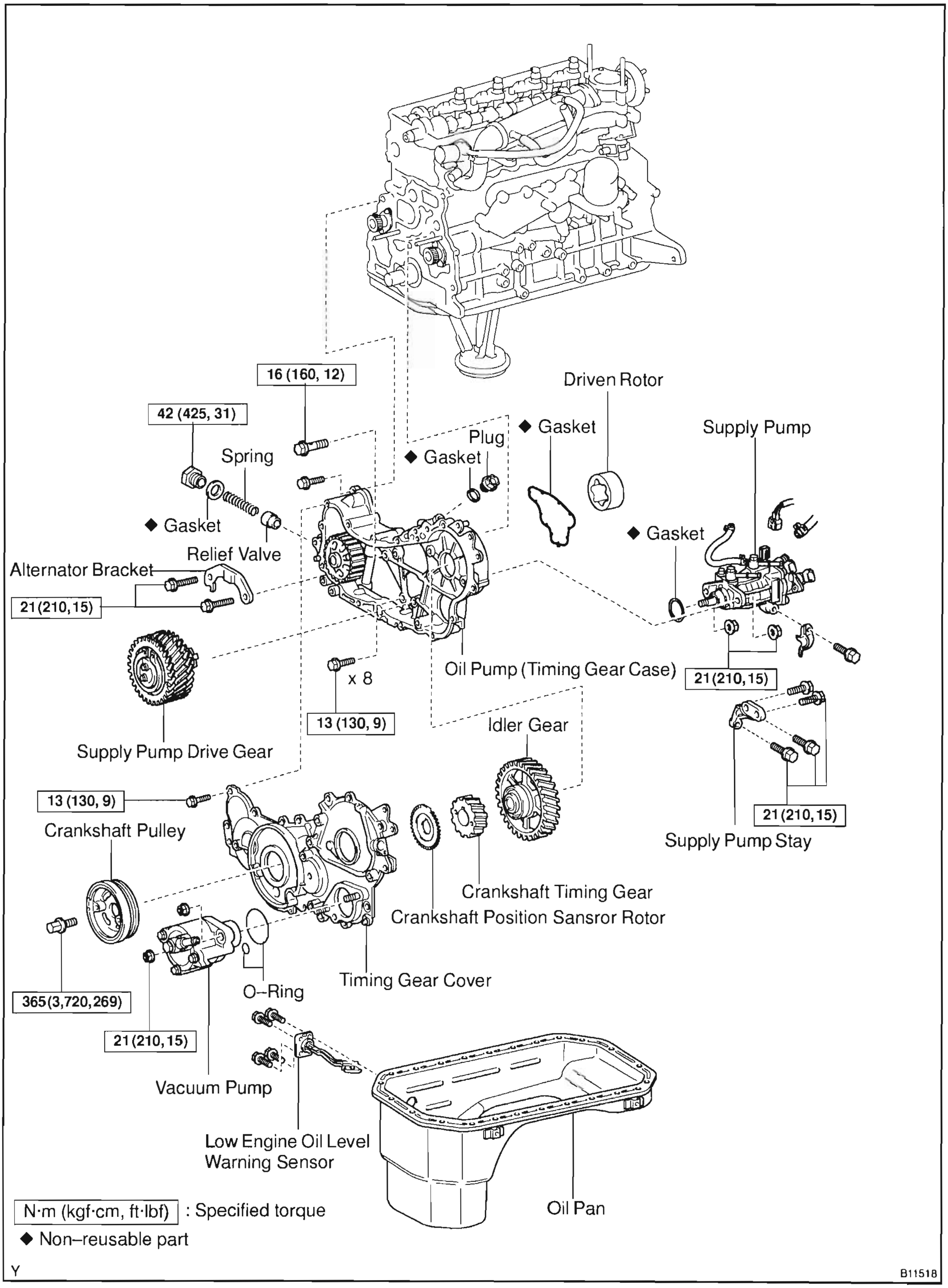
LU0HX–03





N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
★ Precoated part

B11517

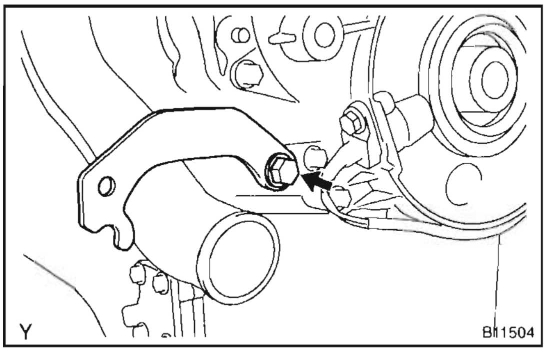

16 (160, 12)
42 (425, 31)
Driven Rotor
◆ Gasket
Supply Pump
Plug
Spring
◆ Gasket
◆ Gasket
◆ Gasket
Relief Valve
Alternator Bracket
21 (210, 15)
x 8
Oil Pump (Timing Gear Case)
21 (210, 15)
13 (130, 9)
Idler Gear
Supply Pump Drive Gear
13 (130, 9)
Crankshaft Pulley
21 (210, 15)
Supply Pump Stay
Crankshaft Timing Gear
Crankshaft Position Sansror Rotor
365 (3,720, 269)
O–Ring
Timing Gear Cover
21 (210, 15)
Vacuum Pump
Low Engine Oil Level
Warning Sensor
Oil Pan
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
Y
B11518

LU0NI–01

REMOVAL

HINT:
When repairing the oil pump, oil pan and strainer should be removed and cleaned.

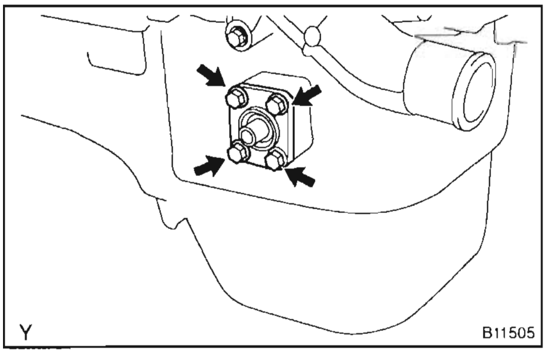
1. **DRAIN ENGINE COOLANT**
2. **DRAIN ENGINE OIL**
3. **REMOVE DRIVE BELT, FAN AND WATER PUMP PULLEY (See page CO–5)**
4. **REMOVE TIMING BELT (See page EM–11)**
5. **REMOVE TIMING GEARS (See page EM–21)**
6. **REMOVE ALTERNATOR AND DRIVE BELT TENSIONER (See page CO–5)**



7. **REMOVE ALTERNATOR ALTERNATOR BRACKET**

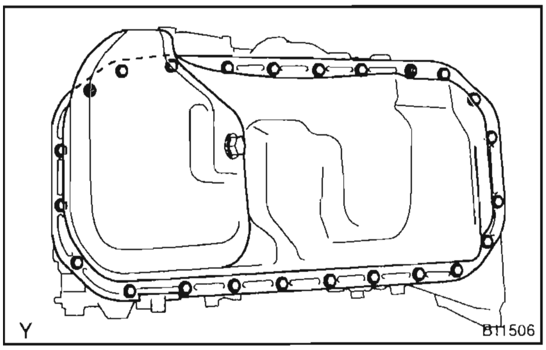
Remove the bolt and alternator bracket.

8. **REMOVE WATER PUMP (See page CO–5)**



9. **REMOVE OIL LEVEL SENSOR**

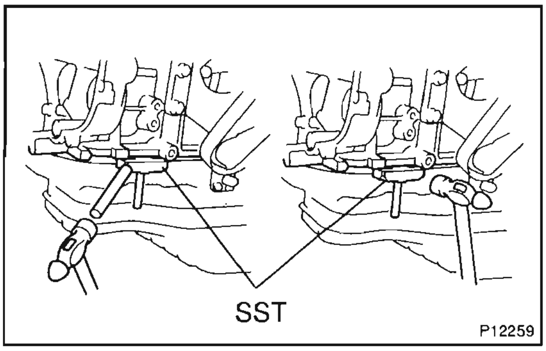
(a) Disconnect the oil level sensor connector.
(b) Remove the 4 bolts and oil level sensor.



10. **REMOVE OIL PAN**

(a) Remove the 22 bolts and 2 nuts.

LU

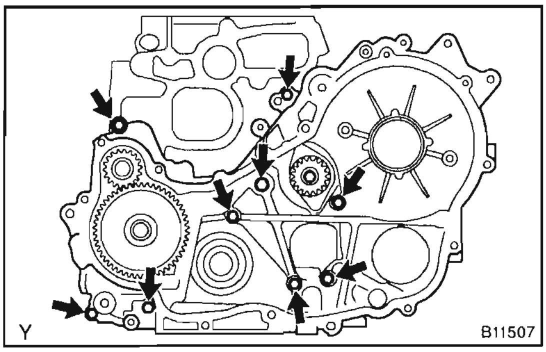


(b) Insert the blade of SST between the cylinder block and oil pan, and cut off applied sealer and remove the oil pan.
SST 09032–00100

NOTICE:
- **Do not use SST for the oil pump body side and rear oil seal retainer.**
- **Be careful not to damage the oil pan flange.**

11. REMOVE SUPPLY PUMP

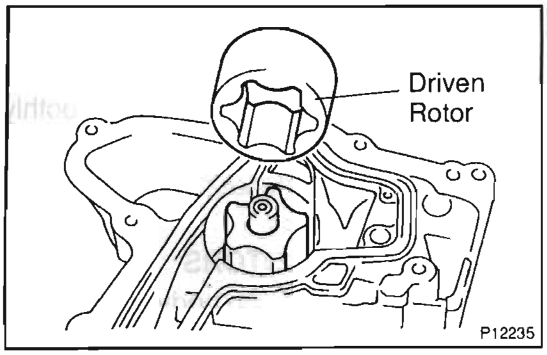
12. REMOVE OIL PUMP (TIMING GEAR CASE)



(a) Remove the 8 bolts and union bolt.
(b) Using a plastic–faced hammer, lightly tap out the timing gear case.
(c) Remove the 3 O–rings.

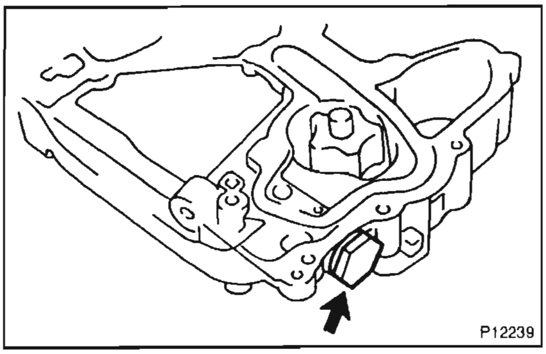
LU0IA–02

DISASSEMBLY



1. REMOVE DRIVE ROTOR

Pull out the driven rotor.

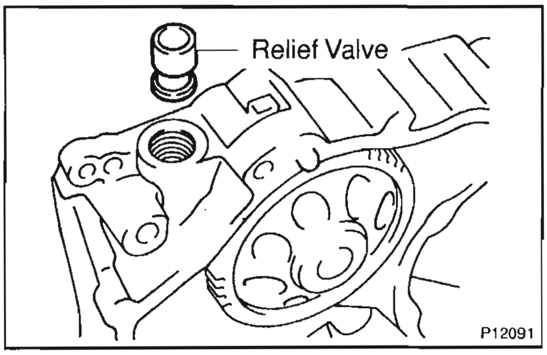


2. REMOVE RELIEF VALVE

Remove the plug, gasket, spring and relief valve.

LU0I0–02

INSPECTION



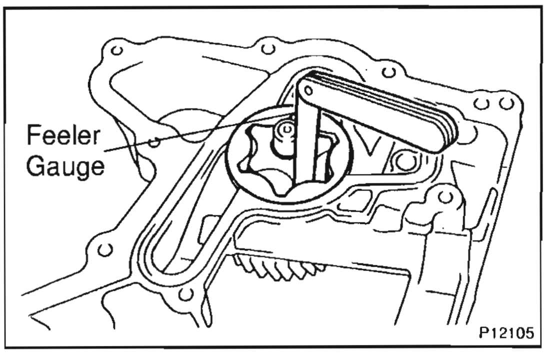
1. INSPECT RELIEF VALVE

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.



(b) Inspect the rotor tip clearance.

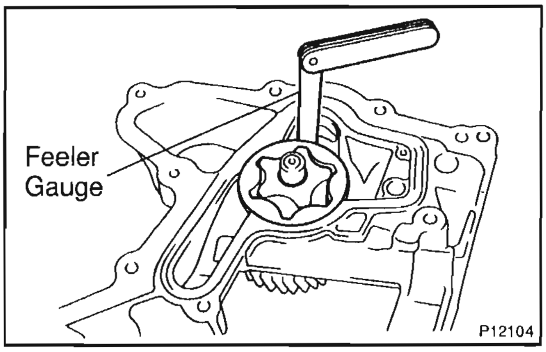
Using a feeler gauge, measure the clearance between the drive and driven rotor tips.

Standard tip clearance:

0.060 – 0.160 mm (0.0024 – 0.0063 in.)

Maximum tip clearance: 0.21 mm (0.0083 in.)

If the tip clearance is greater than maximum, replace the timing gear case.



(c) Inspect the rotor body clearance.

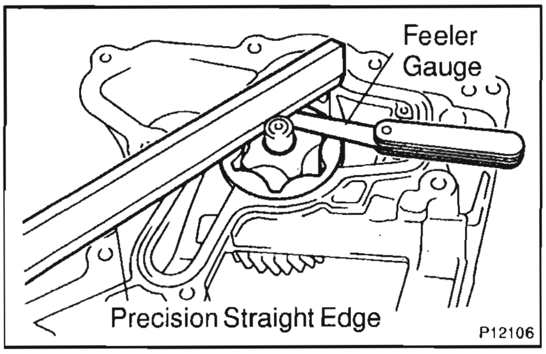
Using a feeler gauge, measure the clearance between the driven rotor and body.

Standard body clearance:

0.100 – 0.170 mm (0.0039 – 0.0067 in.)

Maximum body clearance: 0.20 mm (0.0079 in.)

If the body clearance is greater than maximum, replace the timing gear case.



(d) Inspect the rotor side clearance.

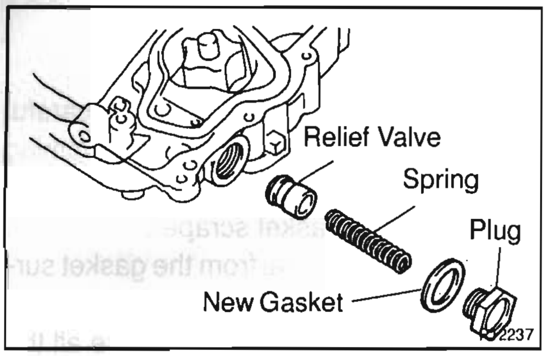
Using a feeler gauge and precision straight edge, measure the clearance between the rotors and precision straight edge.

Standard side clearance:

0.030 – 0.090 mm (0.0012 – 0.0035 in.)

Maximum side clearance: 0.15 mm (0.0059 in.)

If the side clearance is greater than maximum, replace the timing gear case.



LU0I1–02

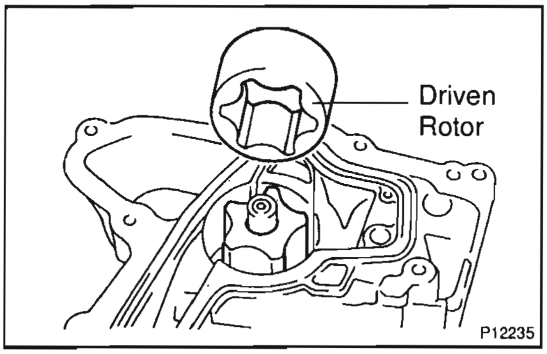
REASSEMBLY

1. INSTALL RELIEF VALVE

(a) Insert the relief valve and spring into the installation hole of the timing gear case.

(b) Install a new gasket and the plug.

Torque: 42 N·m (425 kgf·cm, 31 ft·lbf)



2. INSTALL DRIVE AND DRIVEN ROTORS

Install the driven rotor into the pump.

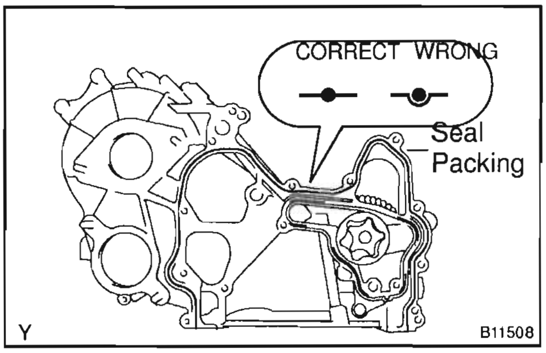
LU0NJ–01

INSTALLATION

1. INSTALL OIL PUMP (TIMING GEAR CASE)

(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the timing gear case 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.



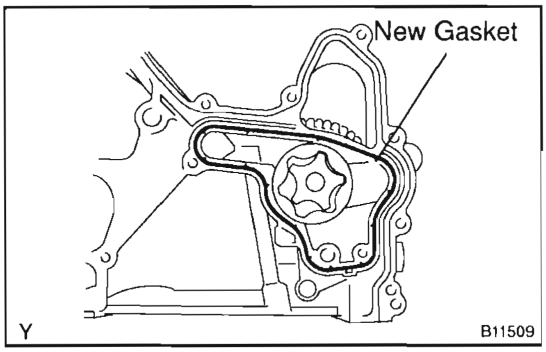
(b) Apply seal packing to the timing gear case as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent

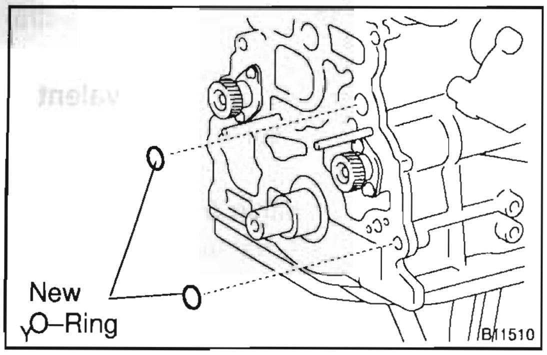
NOTICE:

Aroid applying an excessive amount to the surface.

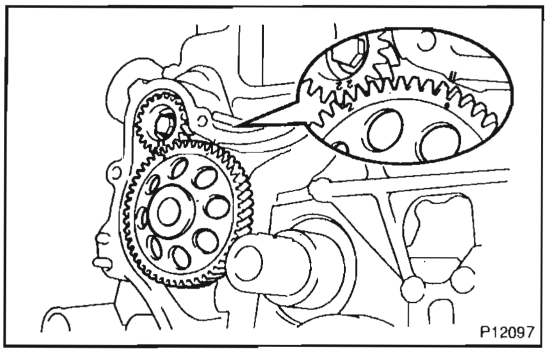
- Install a nozzle that has been cut to a 3 – 5 mm (0.12 – 0.20 in.) opening.
- Parts must be assembled within 5 minutes of application. Otherwise the material must be removed and reapplied.
- Immediately remove nozzle from the tube and reinstall cap.



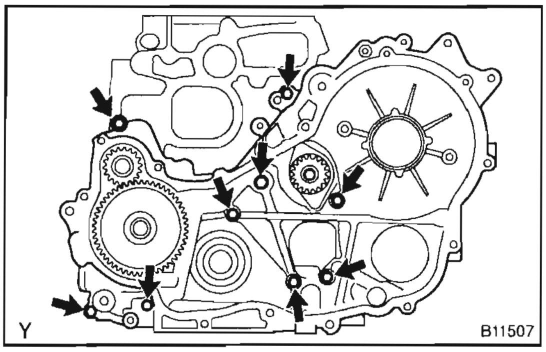
(c) Place a new gasket into the groove of the timing gear case as shown in the illustration.



(d) Install 2 new O–rings to the cylinder block.
(e) Install the timing gear case.

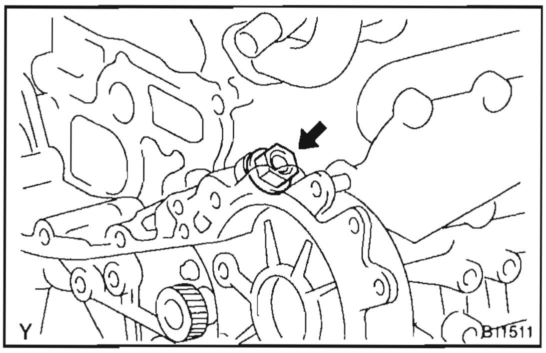


(f) The matchmark on the No.1 balance shaft driven gear should be aligned with the "2" mark.
(g) Align the mark on the oil pump drive gear with the mark on the timing gear case.



(h) Install the 8 bolts and union bolt.
Torque:
13 N·m (130 kgf·cm, 9 ft·lbf) for Bolt
16 N·m (160 kgf·cm, 12 ft·lbf) for Union bolt

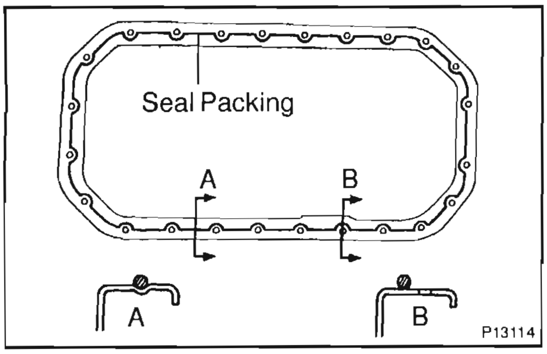
2. INSTALL SUPPLY PUMP



3. POUR ENGINE OIL INTO OIL PUMP
(a) Remove the plug and gasket.
(b) Pour in approx. 20 cc (0.12 cu in.) of engine oil into the oil pump.
(c) Install the plug with a new gasket.

4. INSTALL OIL PAN
(a) Remove any old packing (FIPG) material and be careful not to drop any oil on the contact surfaces of the oil pan 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.

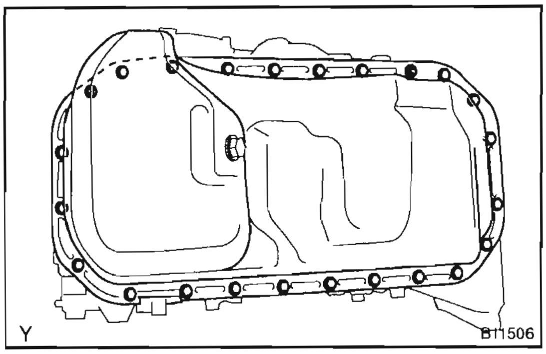
NOTICE:
Do not use a solvent which will affect the painted surfaces.



(b) Apply seal packing to the oil pan as shown in the illustration.

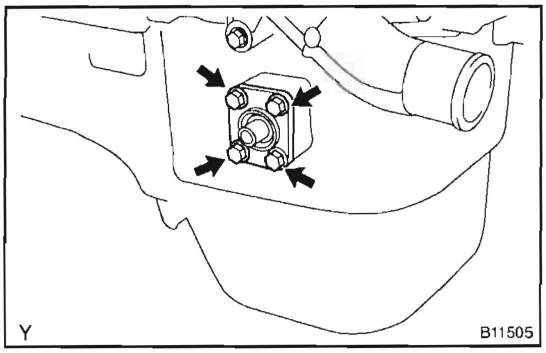
Seal packing: Part No. 08826 –00080 or equivalent

- Install a nozzle that has been cut to a 3 – 5 mm (0.12 – 0.20 in.) opening.
- Parts must be assembled within 5 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 22 bolts and 2 nuts.

Torque: 16 N·m (165 kgf·cm, 12 ft·lbf)



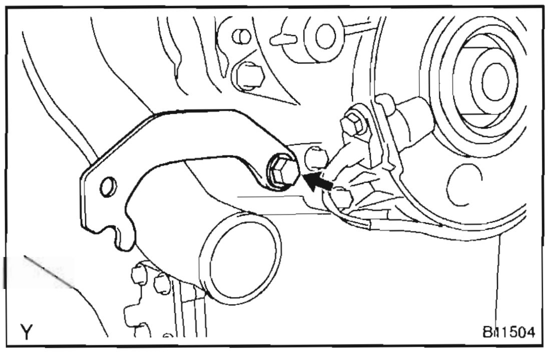
5. INSTALL OIL LEVEL SENSOR

(a) Install the oil level sensor with the 4 bolts.

(b) Connect the oil level sensor connector.

6. INSTALL WATER PUMP (See page CO–8)

7. INSTALL ALTERNATOR AND DRIVE BELT TENSIONER (See page CO–8)



8. INSTALL ALTERNATOR BRACKET

Install the bracket with the bolt.

Torque: 21 N·m (210 kgf·cm, 15 ft·lbf)

9. INSTALL TIMING GEARS (See page EM–31)

10. INSTALL TIMING BELT (See page EM–16)

11. INSTALL WATER PUMP PULLEY, FAN AND DRIVE BELT (See page CO–8)

12. FILL WITH ENGINE OIL

13. FILL WITH ENGINE COOLANT

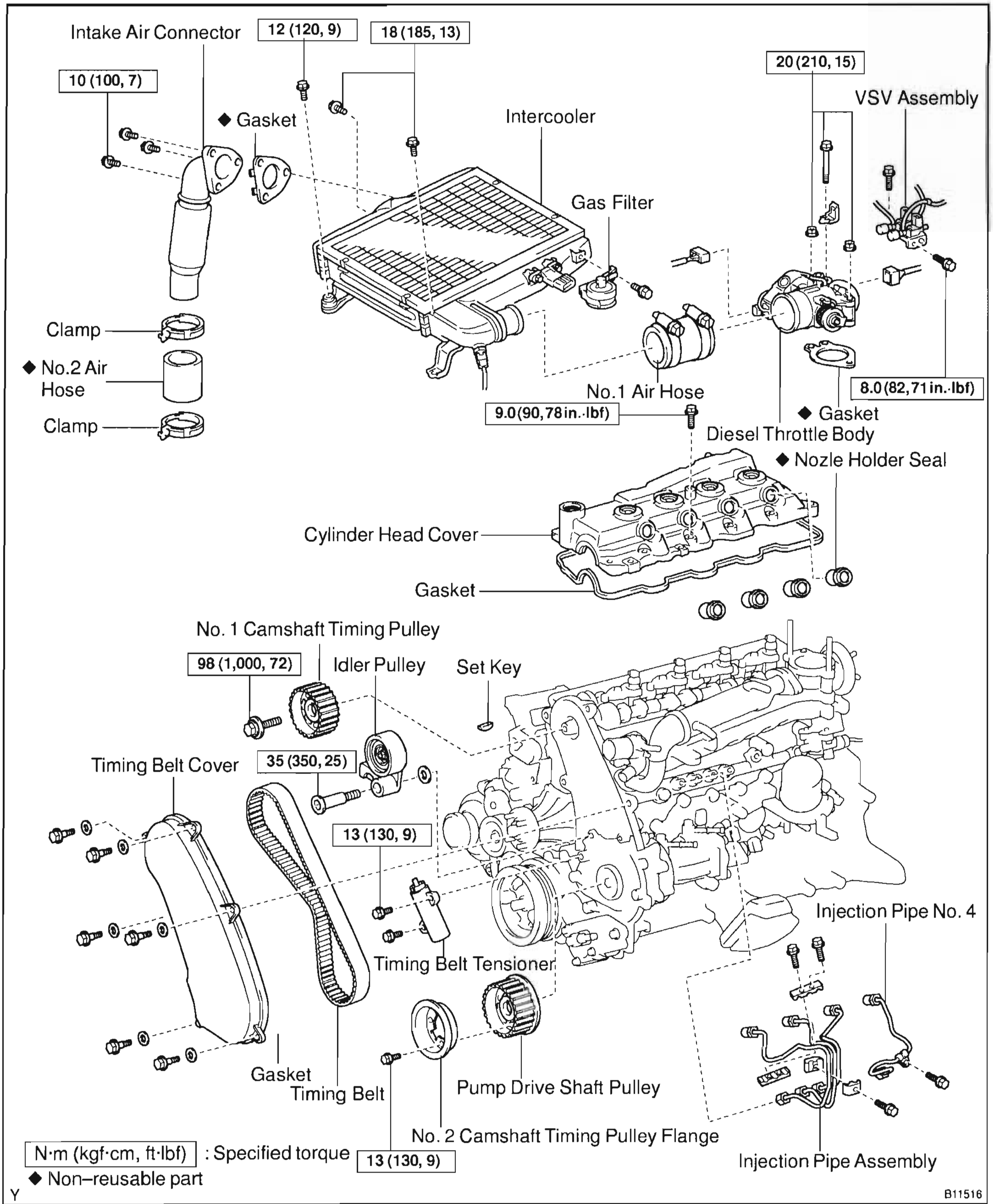
14. START ENGINE AND CHECK FOR OIL LEAKS

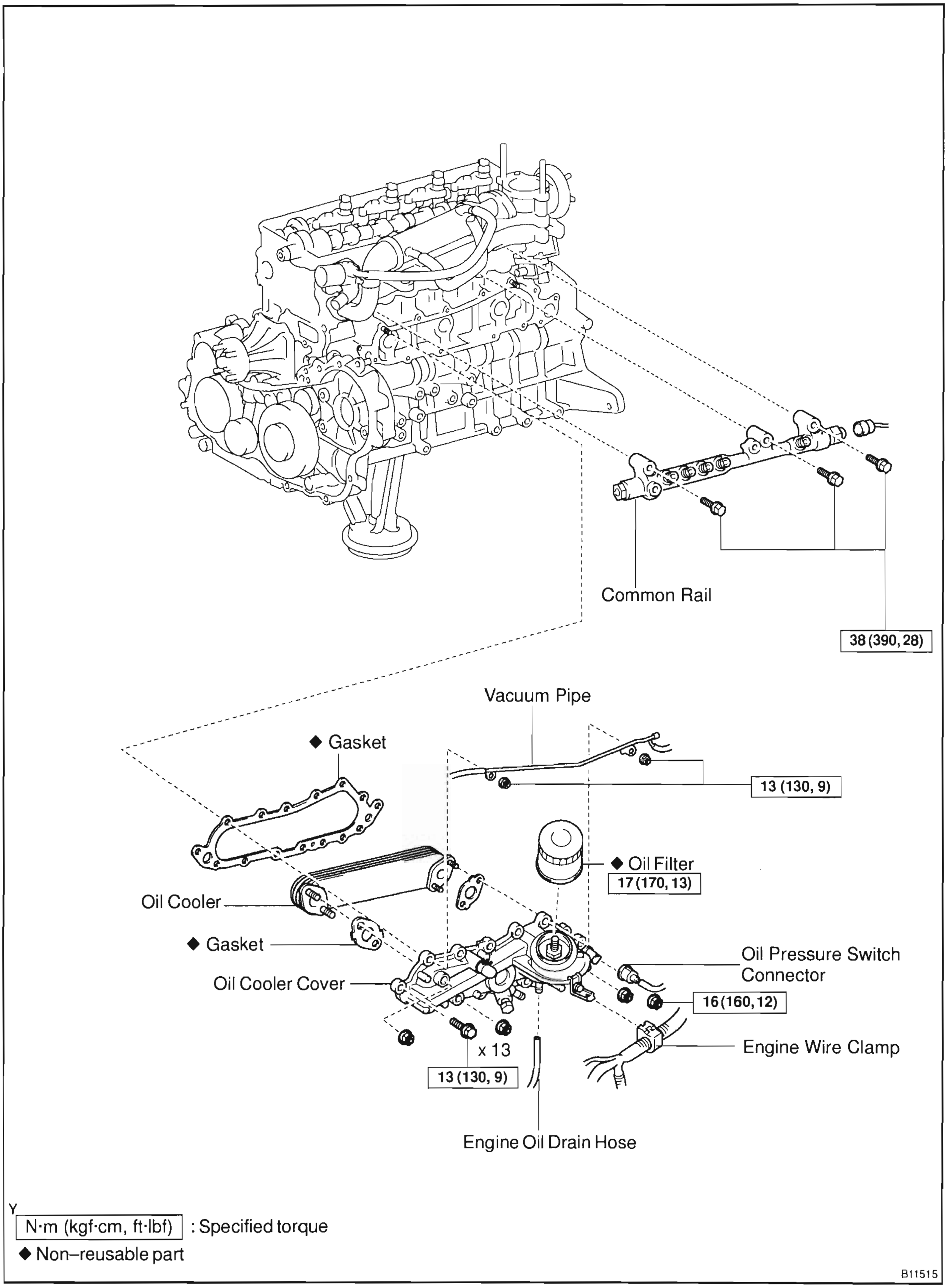
15. RECHECK ENGINE OIL LEVEL

OIL COOLER

COMPONENTS

LU0I3-02

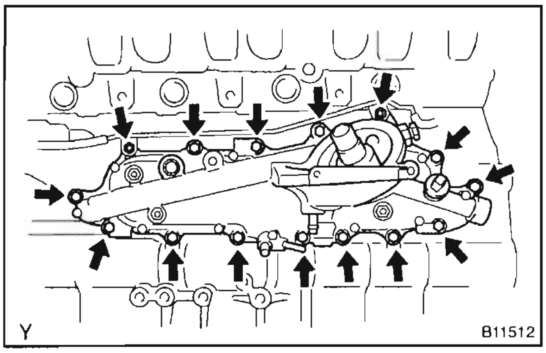



Common Rail
38 (390, 28)
Vacuum Pipe
◆ Gasket
13 (130, 9)
◆ Oil Filter
17 (170, 13)
Oil Cooler
◆ Gasket
Oil Pressure Switch Connector
Oil Cooler Cover
16 (160, 12)
x 13
Engine Wire Clamp
13 (130, 9)
Engine Oil Drain Hose
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
B11515

LU0NK–01

REMOVAL

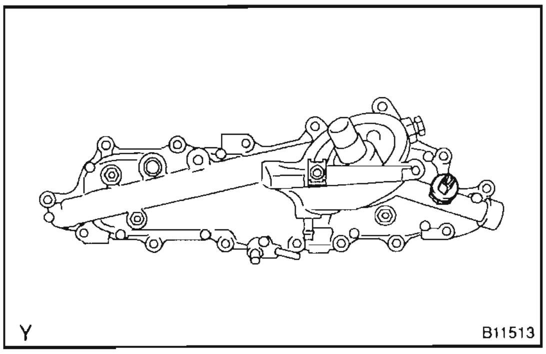
1. **DRAIN ENGINE COOLANT**
2. **REMOVE TIMING BELT (See page EM–11)**
3. **REMOVE SUPPLY PUMP (See page FU–16)**
4. **REMOVE OIL FILTER (See page LU–2)**
5. **REMOVE COMMON RAIL(See page FU–21)**



6. **REMOVE OIL COOLER AND OIL COOLER COVER ASSEMBLY**

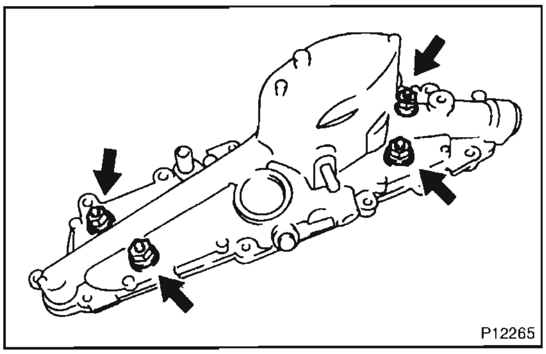
(a) Remove the 2 nuts and disconnect the vacuum pipe.

(b) Remove the 13 bolts, oil cooler, oil cooler cover assembly and gasket.



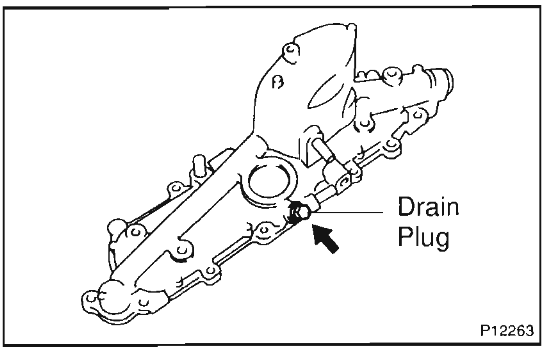
7. **REMOVE OIL PRESSURE SWITCH**

Remove the oil pressure switch from the oil cooler cover.



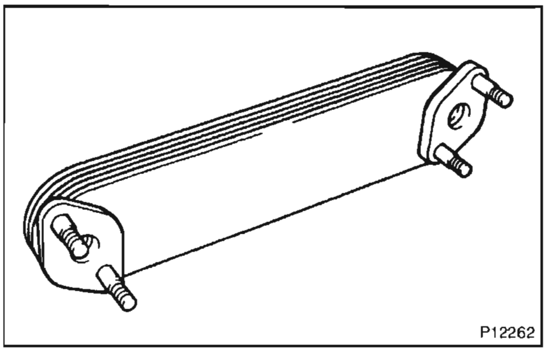
8. **SEPARATE OIL COOLER AND OIL COOLER COVER**

Remove the 4 nuts, oil cooler and 2 gaskets from the oil cooler cover.



9. **REMOVE DRAIN PLUG**

Remove the drain plug from the oil cooler cover.



P12262

LU0NL–01

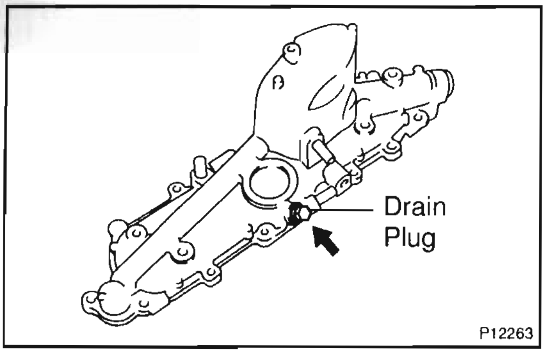
INSPECTION

INSPECT OIL COOLER

Check the oil cooler for damage or clogging.
If necessary, replace the oil cooler.

LU0NM–01

INSTALLATION

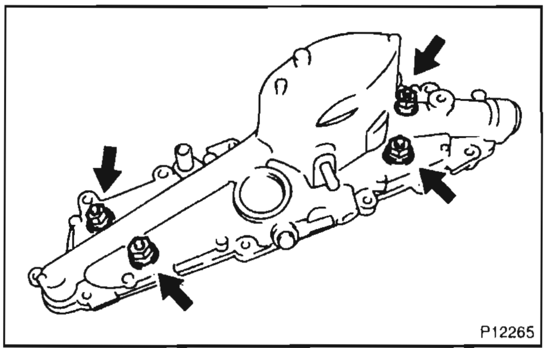


P12263

1. INSTALL ENGINE DRAIN PLUG

Install the engine drain plug to the oil cooler cover.

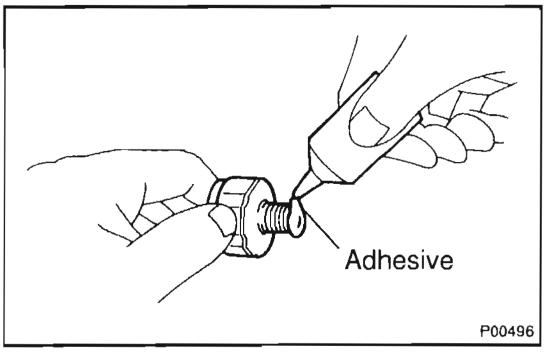
Torque: 8 N·m (80 kgf·cm, 69 in.·lbf)


P12265

2. ASSEMBLY OIL COOLER AND OIL COOLER COVER

Install 2 new gaskets and the oil cooler to the oil cooler cover with the 4 nuts.

Torque: 16 N·m (160 kgf·cm, 12 ft·lbf)



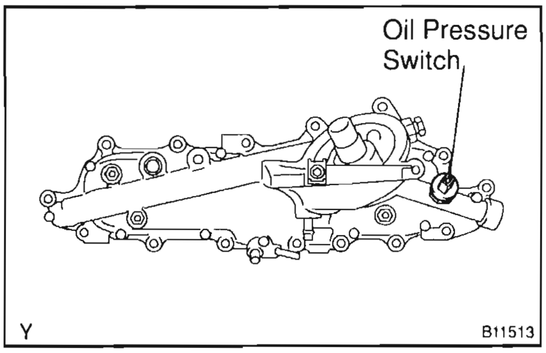
P00496

3. INSTALL OIL PRESSURE SWITCH

(a) Apply adhesive to 2 or 3 threads of the oil pressure switch.

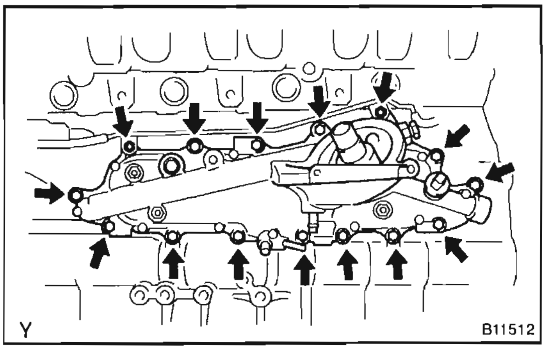
Adhesive:

Part No. 08833–00080, THREE BOND 1344, LOCTITE 242 or equivalent



B11513

(b) Install the oil pressure switch.



B11512

4. INSTALL OIL COOLER AND OIL COOLER COVER ASSEMBLY

Install a new gasket, the oil cooler and oil cooler cover assembly with the 13 bolts.

Torque: 13 N·m (130 kgf·cm, 9 ft·lbf)

5. INSTALL COMMON RAIL (See page FU–22)

6. INSTALL OIL FILTER (See page LU–2)

7. INSTALL SUPPLY PUMP (See page FU–18)

8. INSTALL TIMING BELT (See page EM–16)

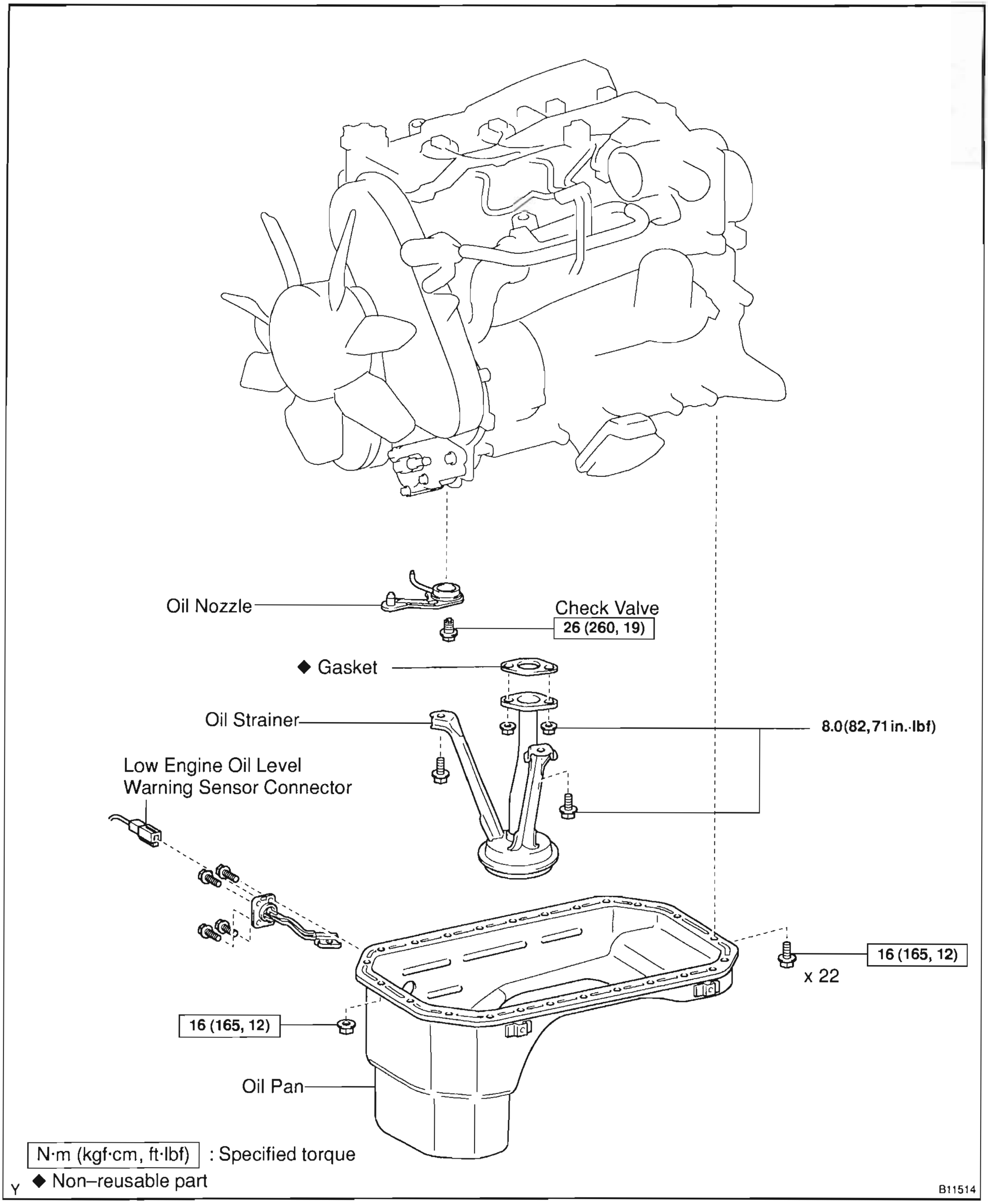
9. FILL WITH ENGINE COOLANT

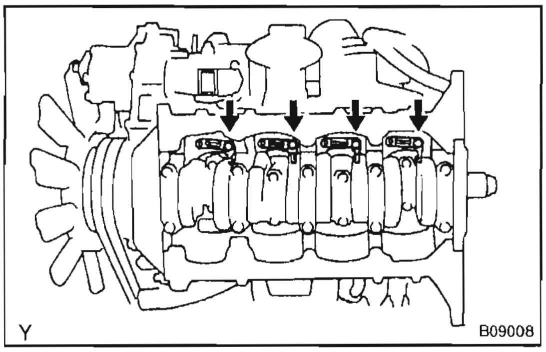
10. START ENGINE AND CHECK FOR LEAKS

11. CHECK ENGINE OIL LEVEL

OIL NOZZLE
COMPONENTS

LU0C0–03





LU0I7–02

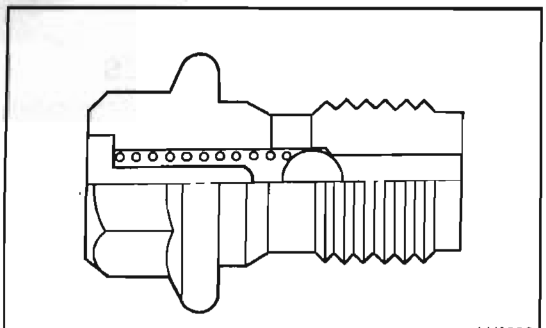
REMOVAL

1. **DRAIN ENGINE OIL**
2. **REMOVE OIL PAN (See page LU–7)**
3. **REMOVE OIL STRAINER**

Remove the 2 bolts, 2 nuts, gasket and oil strainer.

4. **REMOVE CHECK VALVE AND OIL NOZZLES**

Remove the 4 check valves and oil nozzles.


LU0338

LU018–02

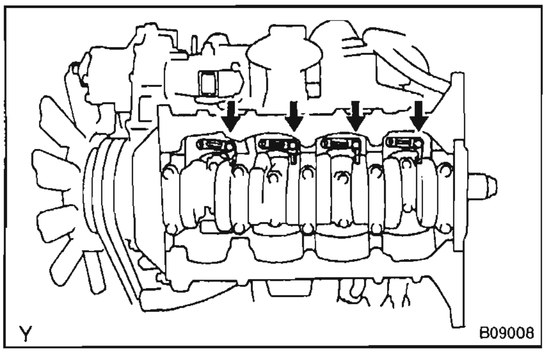
INSPECTION

1. INSPECT CHECK VALVES

Push the valve with a wooden stick to check if it is stuck.
If stuck, replace the check valve.

2. INSPECT OIL NOZZLES

Check the oil nozzles for damage or clogging. If necessary, replace the oil nozzle.



LU0I9–02

INSTALLATION

1. **INSTALL OIL NOZZLES AND CHECK VALVES**

(a) Align the pin of the oil nozzle with the pin hole of the cylinder block.

(b) Install the oil nozzle with the check valve. Install the 4 oil nozzles and check valves.

Torque: 26 N·m (260 kgf·cm, 19 ft·lbf)

2. **INSTALL OIL STRAINER**

Install the oil strainer and new gasket with the 2 bolts and 2 nuts.

Torque: 8.0 N·m (80 kgf·cm, 71 in.·lbf)

3. **INSTALL OIL PAN (See page LU–12)**
4. **FILL WITH ENGINE OIL**
5. **START ENGINE AND CHECK FOR LEAKS**

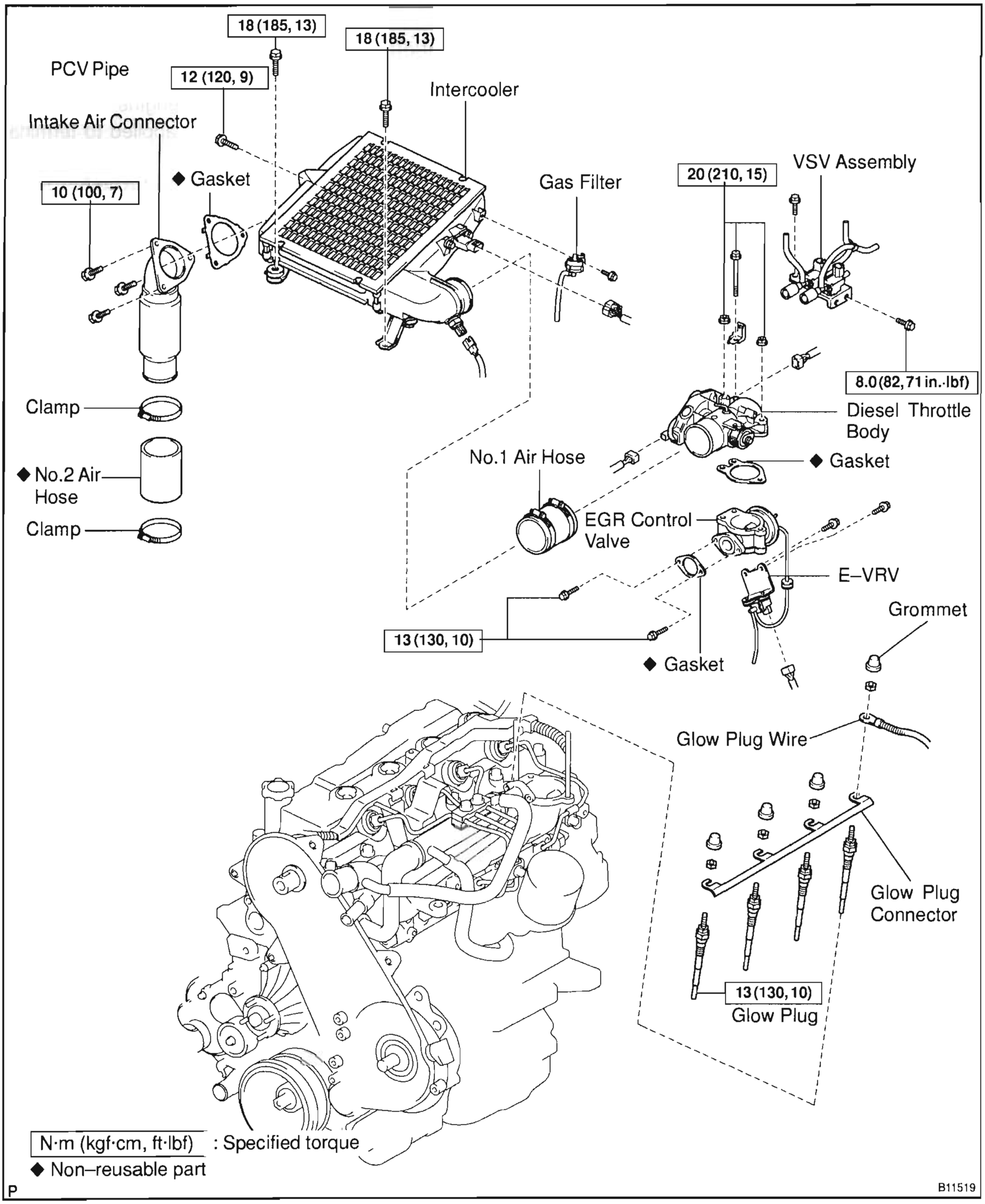
STARTING

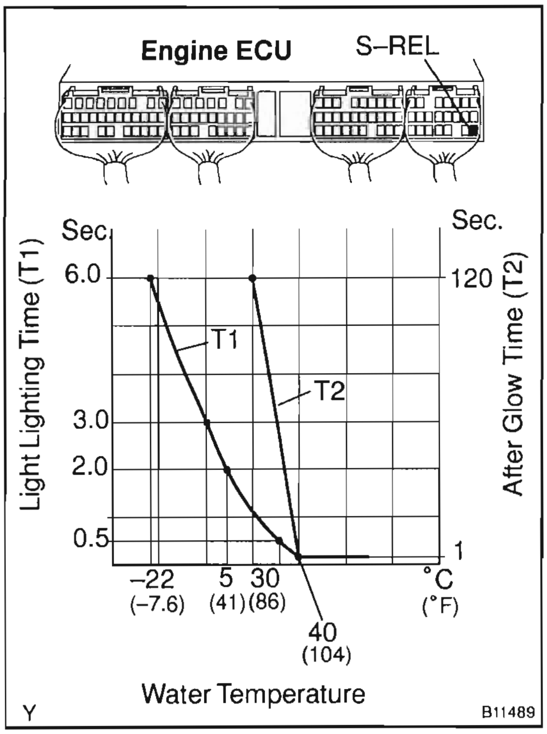
PRE–HEATING SYSTEM ST–1
STARTER ST–5
STARTER RELAY ST–20

PRE–HEATING SYSTEM

COMPONENTS

ST0HH–02





ST0HI–02

INSPECTION

1. INSPECT LIGHTING TIME OF GLOW INDICATOR LIGHT

Turn the ignition switch ON, and measure the lighting time.

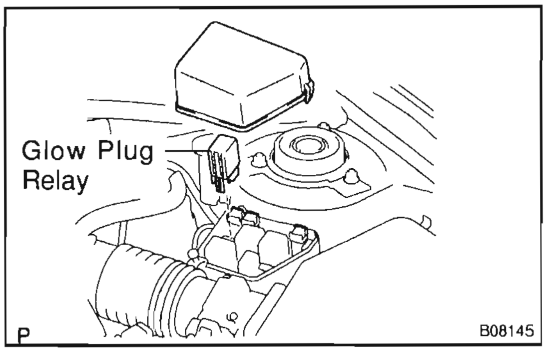
Light lighting time (T1): Refer to the chart graph

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

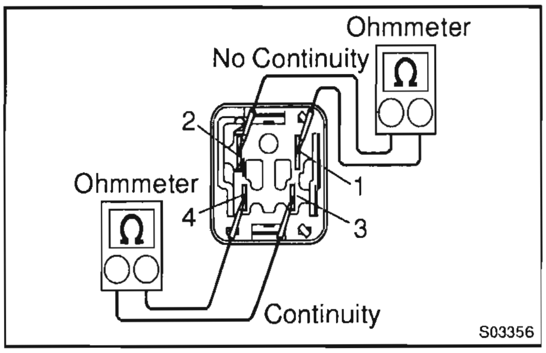
3. INSPECT ENGINE ECU (See page DI–119)



4. INSPECT GLOW PLUG RELAY (Making: GLOW)

(a) Remove the relay box cover.

(b) Remove the glow plug relay.



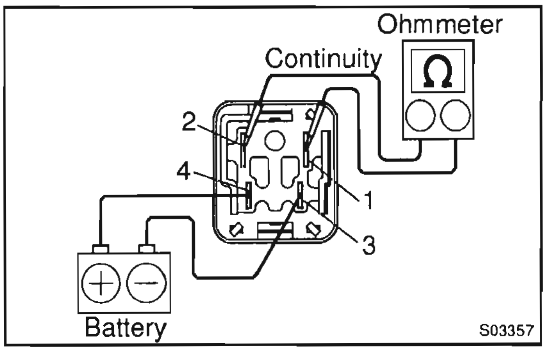
(c) Inspect the glow plug relay continuity.

(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.

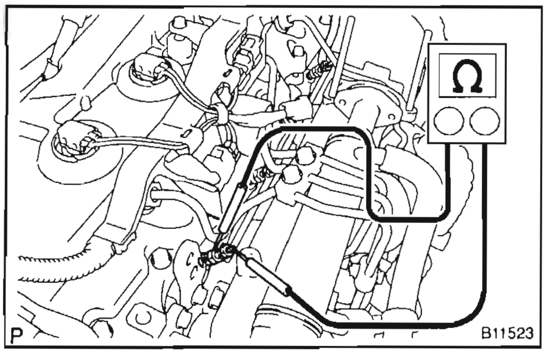
(2) Using an ohmmeter, check that there is continuity between terminals 1 and 2.

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–11)



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.**

ST0MP–01

REPLACEMENT

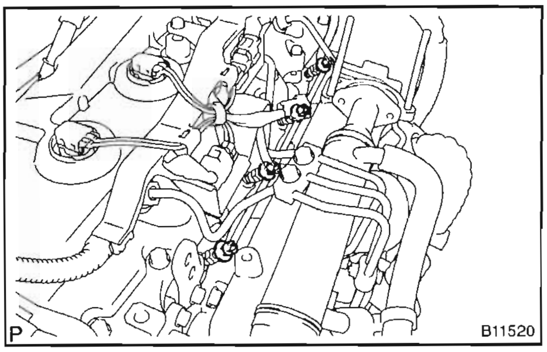
REPLACE GLOW PLUGS

NOTICE:

The cylinder head and glow plug hole can seize up with carbon deposits. And if the glow plug is forcefully twisted when you remove it, the torsion can crack the material. So keep removal of the glow plugs to a minimum.

(a) Remove the intercooler (See page EM–41).

(b) Remove the EGR valve (See page EC–5)

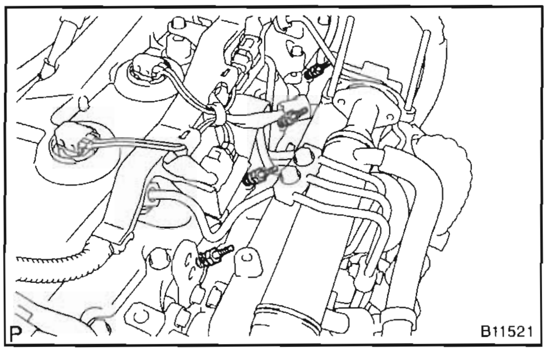


(c) Remove the glow plugs.

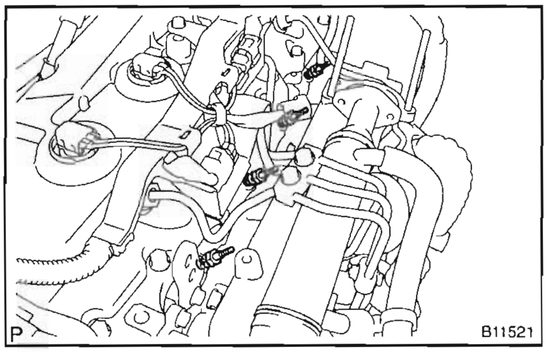
(1) Remove the 4 screw grommets from the glow plugs.

(2) Remove the ground wire from the glow plug.

(3) Remove the 4 nuts and glow plug connector from the glow plugs.



(4) Using a 12 mm deep socket wrench, remove the 4 glow plugs from the cylinder head.



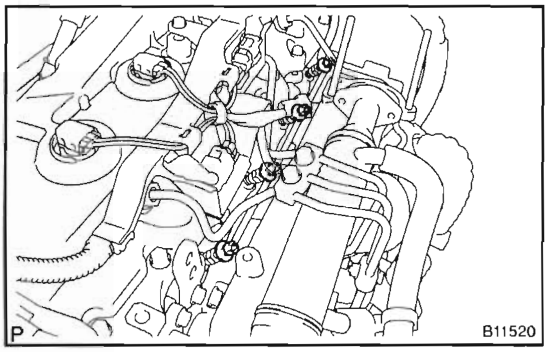
(d) Install the glow plugs.

(1) Using a 12 mm deep socket wrench, install the 4 glow plugs to the cylinder head.

Torque: 13 N·m (130 kgf·cm, 10 ft·lbf)

(2) Install the glow plug wire to the glow plug.

(3) Install the glow plug connector to the glow plugs with the 4 nuts.



(4) Install the 4 screw grommets to the glow plugs.

(e) Install the EGR valve (See page EC–5).

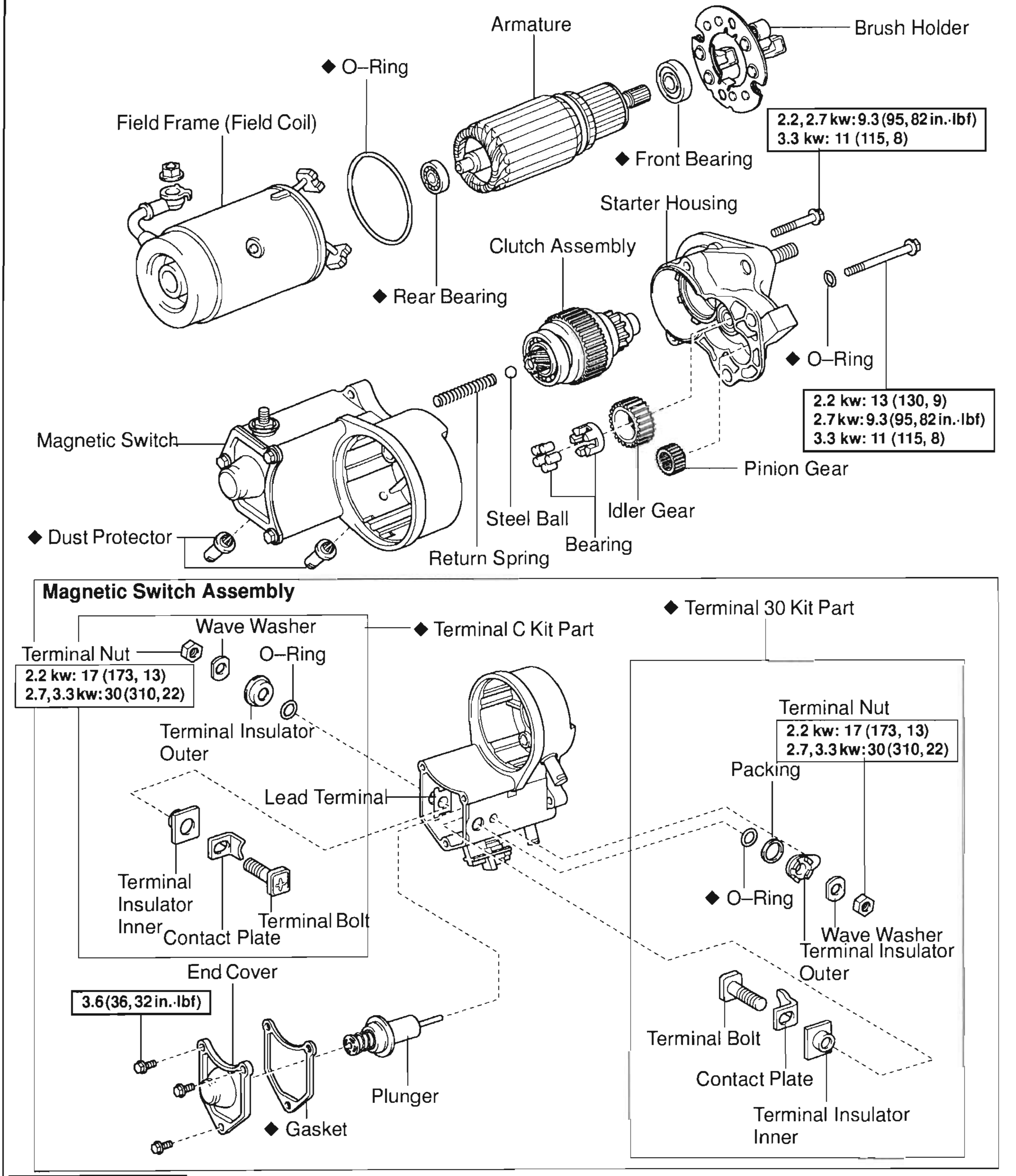
(f) Install the intercooler (See page EM–56).

ST

STARTER

COMPONENTS

ST0BK–03



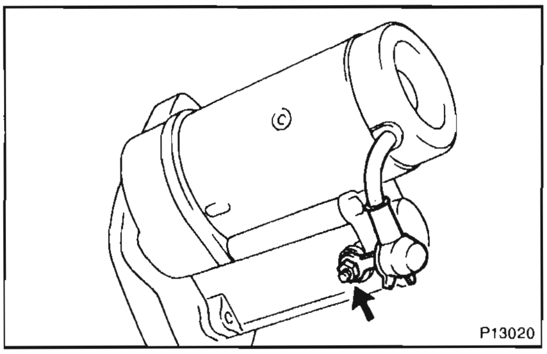
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

B11524

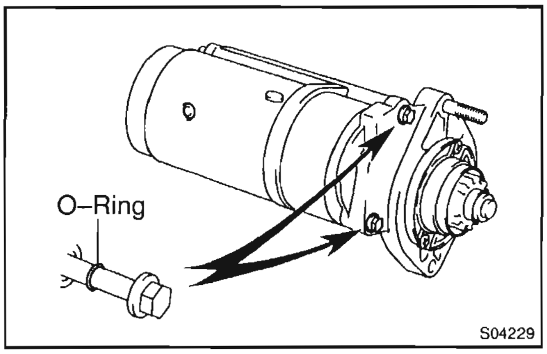
ST0BL–03

DISASSEMBLY



1. REMOVE FIELD FRAME AND ARMATURE

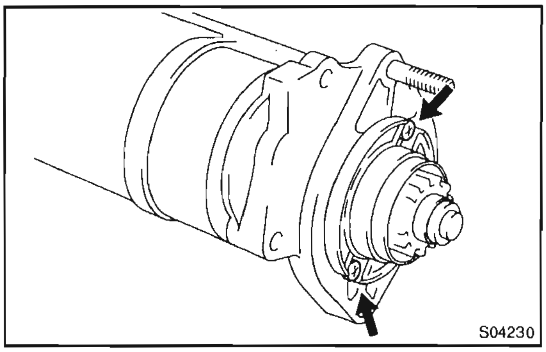
(a) Remove the nut, and disconnect the lead wire from the terminal C.



(b) Remove the 2 through bolts and O–rings.

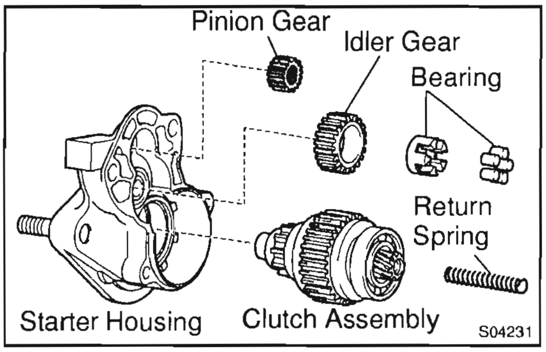
(c) Pull out the field frame with the armature from the magnetic switch assembly.

(d) Remove the O–ring from the field frame.

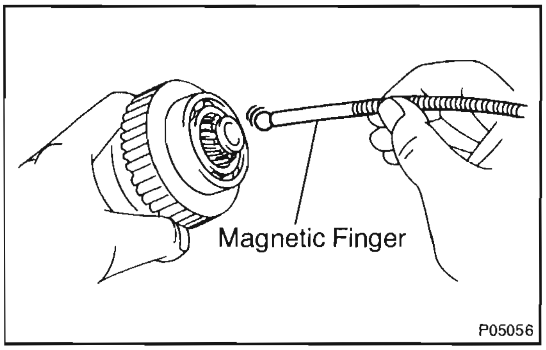


2. REMOVE STARTER HOUSING, CLUTCH ASSEMBLY AND GEARS

(a) Remove the 2 screws.



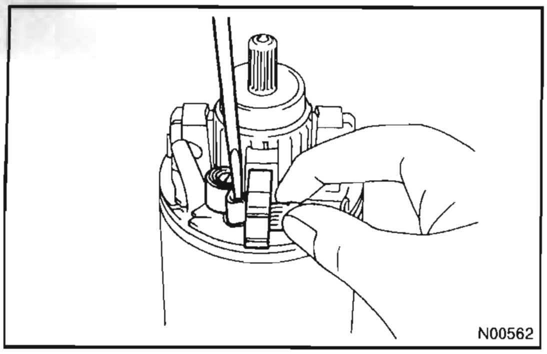
(b) Remove the starter housing, return spring, pinion gear, bearing, idler gear and clutch assembly from the magnetic switch assembly.



3. REMOVE STEEL BALL

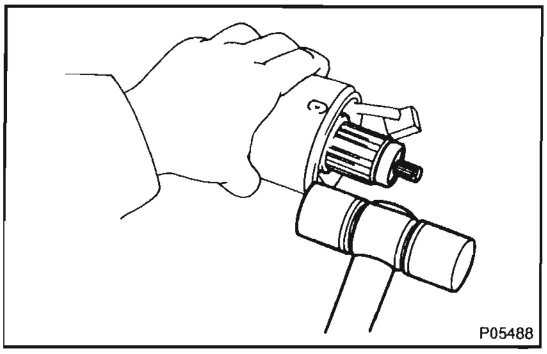
Using a magnetic finger, remove the steel ball from the clutch shaft hole.

ST



4. REMOVE BRUSH HOLDER

Using a screwdriver, hold the spring back and disconnect the brush from the brush holder. Disconnect the 4 brushes and remove the brush holder.



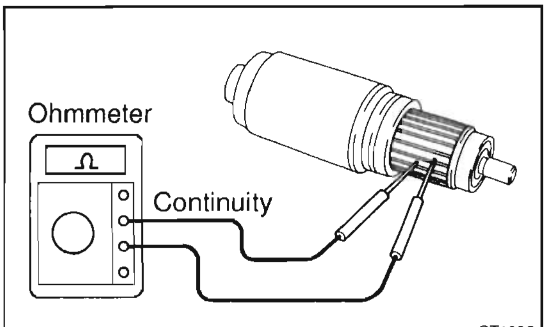
5. REMOVE ARMATURE FROM FIELD FRAME

Using a plastic hammer, tap the frame end to remove the armature from the field frame.

ST0HK–02

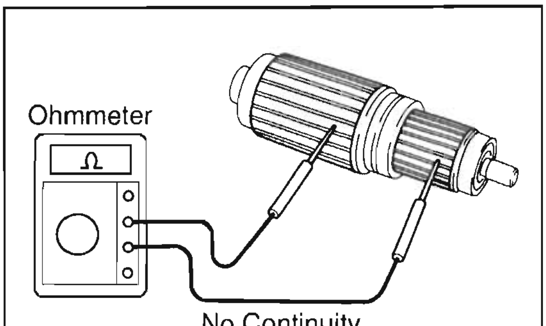
INSPECTION

1. INSPECT ARMATURE COIL



ST1098

(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 segment, replace the armature.

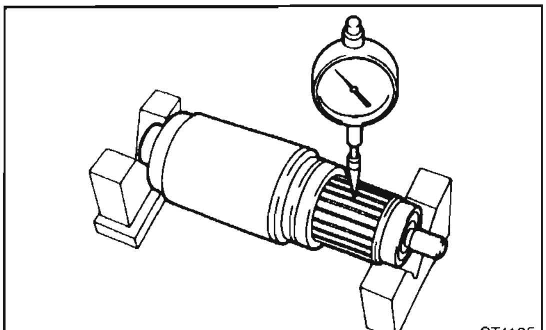


ST1099

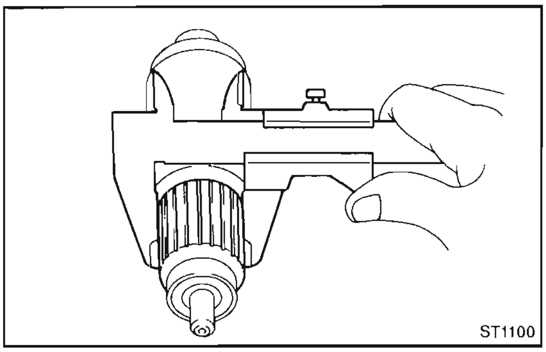
(b) Check the commutator for ground.
Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.
If there is continuity, replace the armature.

2. INSPECT COMMUTATOR

(a) Check the commutator for the dirty and burnt surfaces.
If the surface is dirty or burnt, correct it with sandpaper (No. 400) or on a lathe.

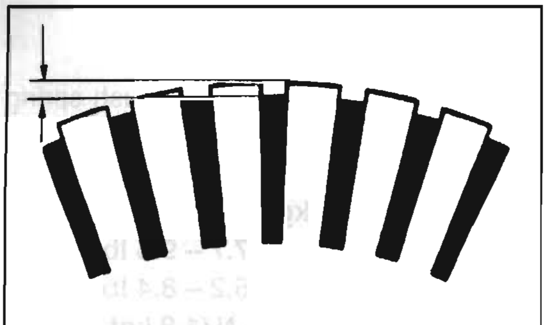

ST1125

(b) Check the commutator circle runout.
(1) Place the commutator on V–blocks.
(2) Using a dial gauge, measure the circle runout.
Maximum circle runout: 0.05 mm (0.0020 in.)
If the circle runout is greater than maximum, correct it on a lathe.


ST1100

(c) Using vernier calipers, measure the commutator diameter.
Standard diameter:
2.2 kw: 35 mm (1.38 in.)
2.7 kw: 36 mm (1.42 in.)
3.3 kw: 43 mm (1.69 in.)
Minimum diameter:
2.2 kw 34 mm (1.34 in.)
2.7 kw: 35 mm (1.38 in.)
3.3 kw: 42 mm (1.65 in.)
If the diameter is less than minimum, replace the armature.

ST

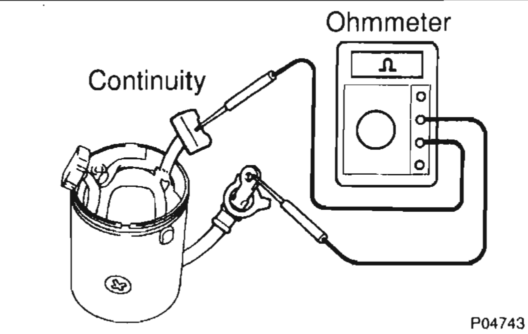

ST0040

(d) Check that the undercut depth is clean and free of foreign materials. Smooth out the edge.

Standard undercut depth: 0.7 mm (0.027 in.)

Minimum undercut depth: 0.2 mm (0.008 in.)

If the undercut depth is less than minimum, correct it with a hacksaw blade.



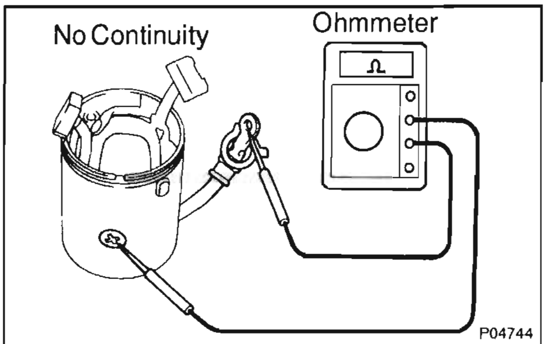
P04743

3. INSPECT FIELD FRAME

(a) Check the field coil for open circuit.

Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.

If there is no continuity, replace the field frame.



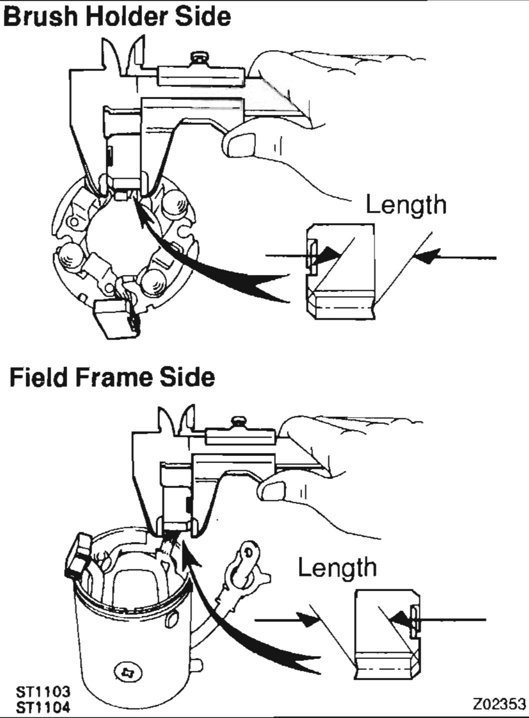
P04744

(b) Check the field coil for ground.

Using an ohmmeter, check that there is no continuity between the field coil end and field frame.

If there is continuity, repair or replace the field frame.

ST



ST1103
ST1104
Z02353

4. INSPECT BRUSHES

Check the brushes length.

Using vernier calipers, measure the brush length.

Standard length:

2.2 kw: 16.5 mm (0.650 in.)

2.7 kw: 20.5 mm (0.807 in.)

3.3 kw: 21.0 mm (0.827 in.)

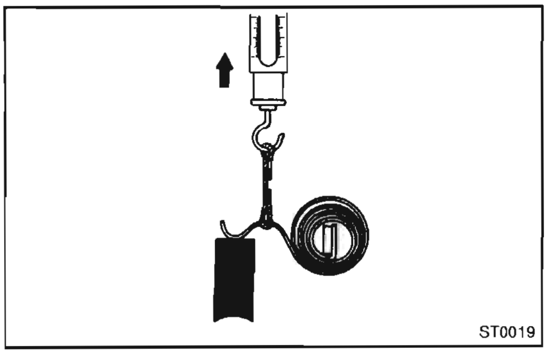
Minimum length:

2.2 kw: 9.0 mm (0.354 in.)

2.7 kw: 11.0 mm (0.439 in.)

2.2 kw: 12.0 mm (0.472 in.)

If the length is less than minimum, replace the brush holder and field frame.



ST0019

5. INSPECT BRUSH SPRINGS

Check the brush spring load.

Take the pull scale reading the instant the brush spring separates from the brush.

Standard spring installed load:

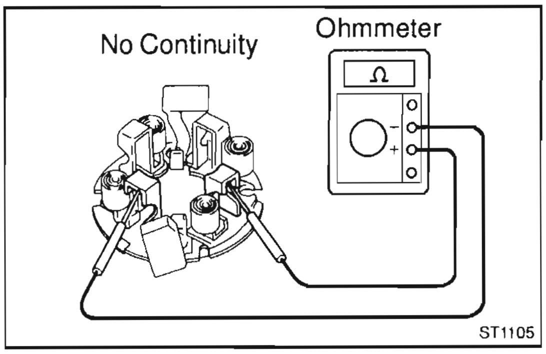
2.2 kw: 26.5 – 32.3 N (2.7 – 3.3 kgf, 5.9 – 7.3 lbf)

2.7 kw: 34.3 – 42.1 N (3.5 – 4.3 kgf, 7.7 – 9.5 lbf)

3.3 kw: 27.5 – 37.3 N (2.8 – 3.8 kgf, 6.2 – 8.4 lbf)

Minimum spring installed load: 17.6 N (1.8 kgf, 4.0 lbf)

If the installed load is less than minimum, replace the brush springs.



ST1105

ST

6. INSPECT BRUSH HOLDER

Check the brush holder insulation.

Using an ohmmeter, check that there is no continuity between the positive (+) and negative (–) brush holders.

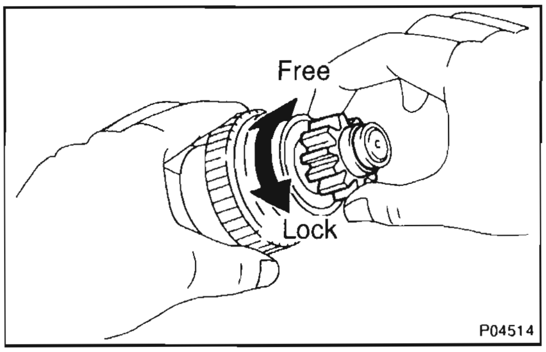
If there is continuity, repair or replace the brush holder.

7. INSPECT CLUTCH AND GEARS

(a) Check the gear teeth on the pinion gear, idle gear and clutch assembly for wear or damage.

If damaged, replace the gear or clutch assembly.

If damaged, also check the drive plate ring gear for wear or damage.



P04514

(b) Check the clutch pinion gear.

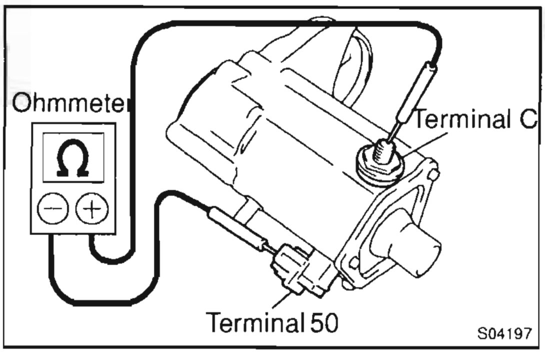
Hold the starter clutch and rotate the pinion gear clockwise, and check that it turns freely. Try to rotate the pinion gear counterclockwise and check that it locks.

If necessary, replace the clutch assembly.

8. INSPECT BEARINGS

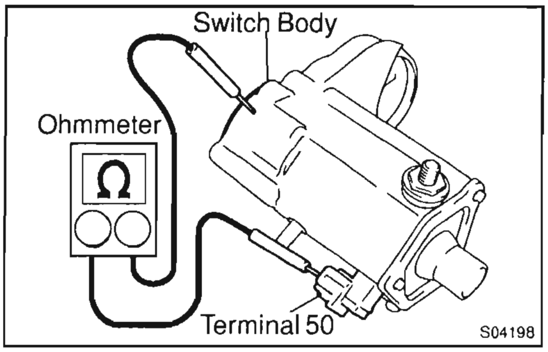
Turn the bearing by hand while applying inward force.

If resistance is felt or the bearing sticks, replace the bearing. (See page ST–12)



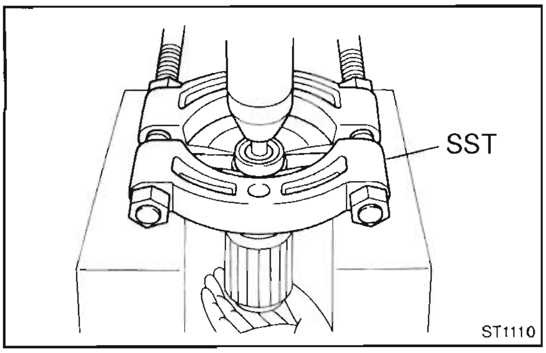
9. INSPECT MAGNETIC SWITCH

(a) 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.



(b) Check the holding 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.

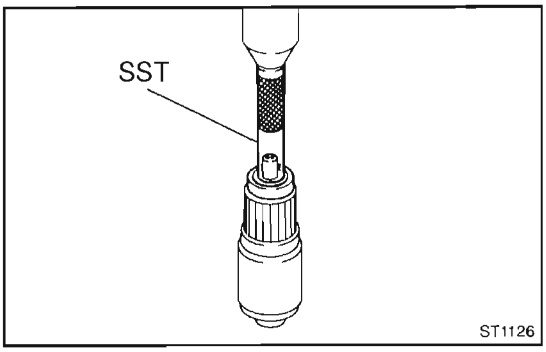
ST0HL–02



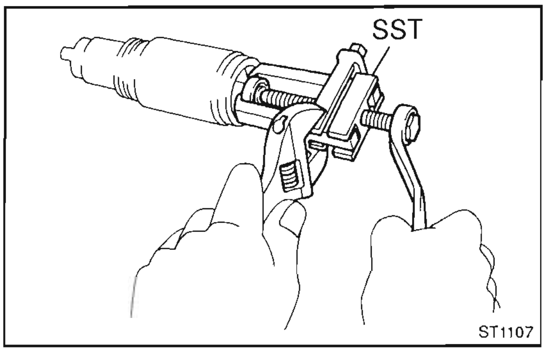
REPLACEMENT

1. REPLACE FRONT BEARING

(a) Using SST and a press, press out the bearing.
SST 09950–00020

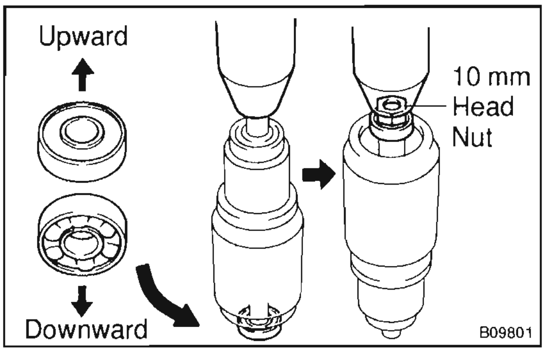


(b) Using SST and a press, press in a new bearing.
SST 09201–41020



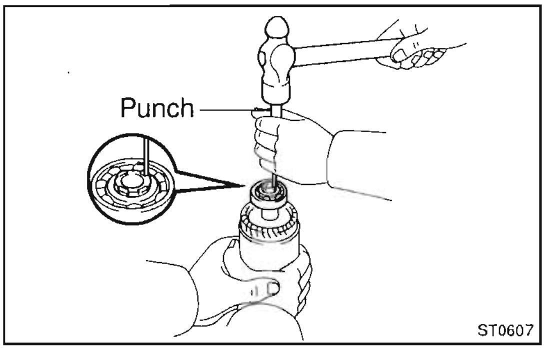
2. REPLACE REAR BEARING

(a) Using SST, remove the bearing.
SST 09286–46011



(b) Using a 10 mm (for thread diameter) nut and press, press in a new bearing.

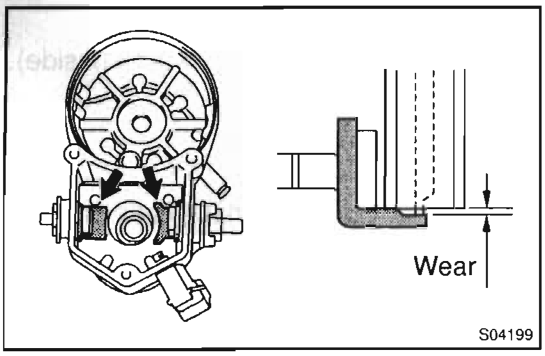
NOTICE:
Be careful of the bearing installation direction.



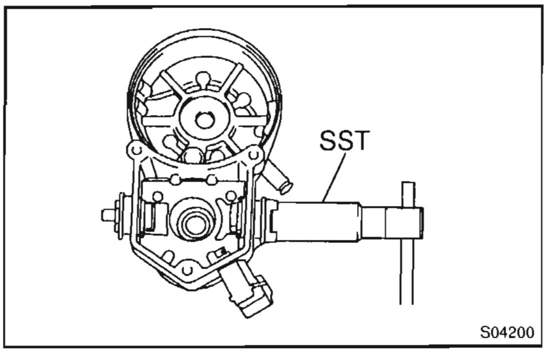
(c) Using a punch, stake the armature shaft.

3. REPLACE MAGNETIC SWITCH TERMINAL KIT PARTS

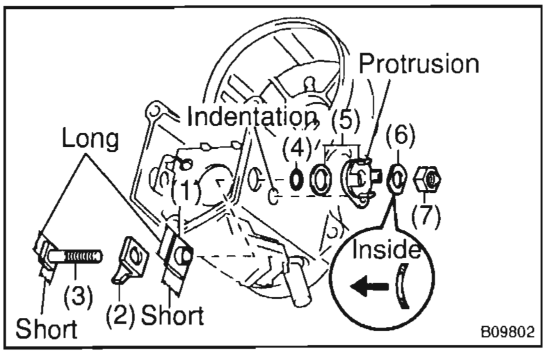
(a) Remove the 3 bolts, end cover, gasket and plunger.



(b) Inspect the contact plate for wear.
Using vernier calipers, measure the contact plate for depth of wear.
Maximum wear:
2.2 kw: 0.9 mm (0.035 in.)
2.7, 3.3 kw: 1.6 mm (0.063 in.)
If the depth of wear is greater than the maximum, replace the contact plate.



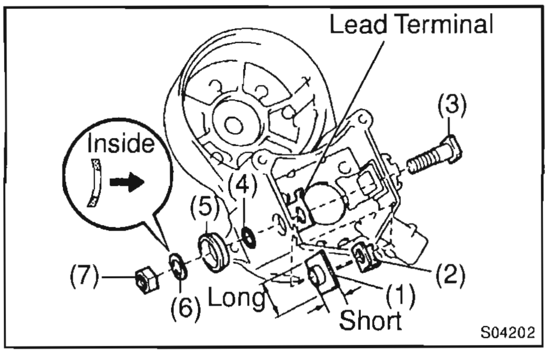
(c) Remove the terminal kit parts.
(1) Using SST, loosen the terminal nuts.
SST 09810–38140
(2) Terminal C:
Remove the terminal nut, wave washer, terminal insulator (outside), O–ring, terminal bolt, contact plate and terminal insulator (inside).
(3) Terminal 30:
Remove the terminal nut, wave washer, terminal insulator (outside), packing, O–ring, terminal bolt, contact plate and terminal insulator (inside).



(d) Install new terminal 30 kit parts.
(1) Temporarily install a new terminal insulator (inside).
(2) Temporarily install a new contact plate.
(3) Temporarily install a new terminal bolt.
(4) Temporarily install a new O–ring.
(5) Temporarily install a new packing and new terminal insulator (outside).

HINT:
Match the protrusion of the insulator with the indentation of the housing.
(6) Temporarily install a new wave washer.
(7) Temporarily install a new terminal nut.

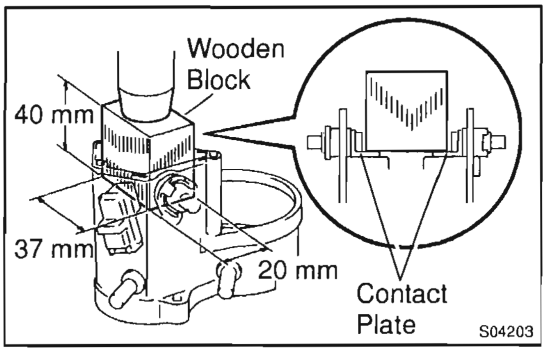
NOTICE:
Be careful to install the terminal insulators (inside) and wave washer and terminal bolt in the correct direction.



(e) Install new terminal C kit parts.
(1) Temporarily install a new terminal insulator (inside).
(2) Temporarily install a new contact plate.
(3) Temporarily install a new terminal bolt.
(4) Temporarily install a new O–ring.
(5) Temporarily install a new terminal insulator (outside).
(6) Temporarily install a new wave washer.
(7) Temporarily install a new terminal nut.

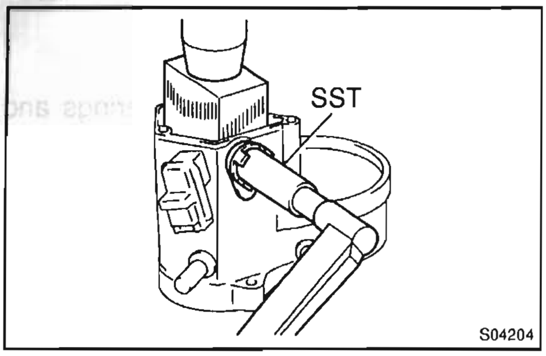
NOTICE:
Be careful to install the terminal insulators (inside) and wave washer in the correct direction.

(f) Temporarily tighten the terminal nuts.



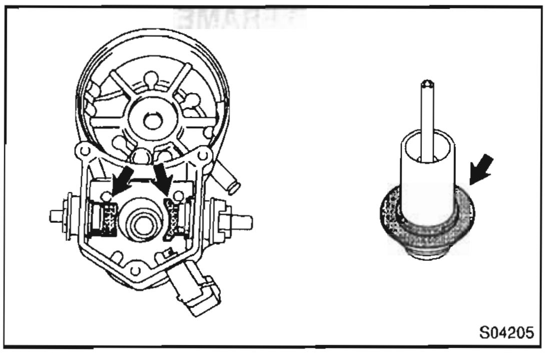
(g) Tighten the terminal nuts.
(1) Put a wood block on the contact plate and press it down with a hand press.
Dimensions of wood block:
20 x 37 x 40 mm (0.97 x 1.46 x 1.57 in.)
Press force: 981 N (100 kgf, 221 lbf)

NOTICE:
- **Check the diameter of the hand press ram. Then calculate the gauge pressure of the press when 981 N (100 kgf, 221 lbf) of force is applied.**
  Gauge pressure
  $$(\mathrm{kgf/cm^2}) = \frac{100\ \mathrm{kgf}}{\left(\frac{\text{Ram diameter (cm)}}{2}\right)^2 \times 3.14\ (\pi)}$$
  $$(\mathrm{psi}) = \frac{221\ \mathrm{lbf}}{\left(\frac{\text{Ram diameter (in.)}}{2}\right)^2 \times 3.14\ (\pi)}$$
  (kPa) = (kgf/cm^2) x 98.1
  (kPa) = (psi) x 6.9
- **If the contact plate is not pressed down with the specified pressure, the contact plate may tilt due to coil deformation or the tightening of the nut.**



(2) Using SST, tighten the nuts to the specified torque.
SST 09810–38140
Torque:
2.2 kw: 17 N·m (173 kgf·cm, 13 ft·lbf)
2.7, 3.3 kw: 30 N·m (310 kgf·cm, 22 ft·lbf)

NOTICE:
If the nut is over tightened, it may cause cracks on the inside of the insulator.



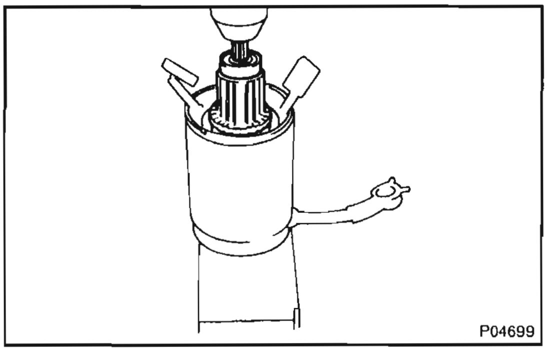
(h) Clean the contact surfaces of the remaining contact plate and plunger with a dry shop rag.

(i) Reinstall the plunger, a new gasket and end cover with the 3 bolts.
Torque: 3.6 N·m (36 kgf·cm, 32 in.·lbf)

ST080–03

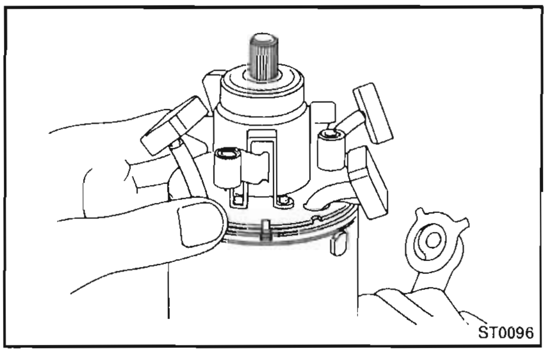
REASSEMBLY

HINT:
Use high–temperature grease to lubricate the bearings and gears when assembling the starter.



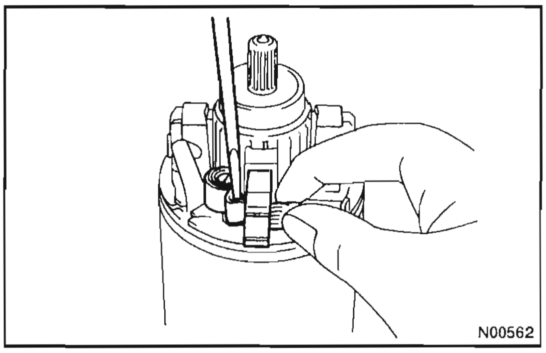
1. PLACE ARMATURE INTO FIELD FRAME

(a) Apply a grease to the armature bearings.
(b) Using a press, press the armature into the field frame.



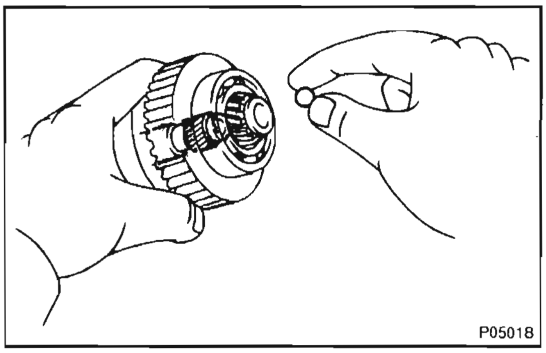
2. INSTALL BRUSH HOLDER

(a) Align the claw of the brush holder with the claw groove of the field frame.
(b) Place the brush holder on the field frame.



(c) Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Contact the 4 brushes.

NOTICE:
Check that the positive (+) lead wires are not grounded.

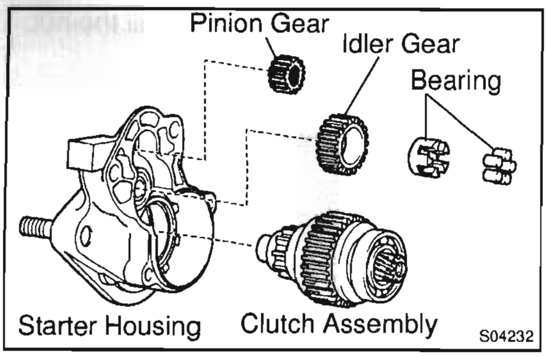


3. INSERT STEEL BALL INTO CLUTCH SHAFT HOLE

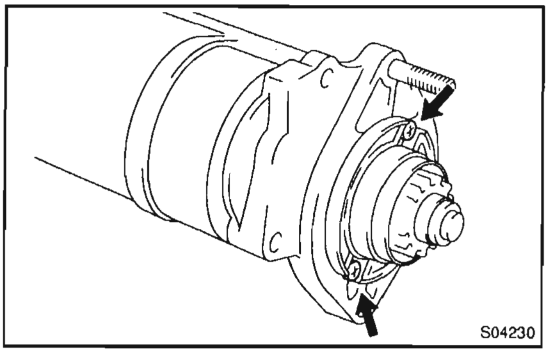
(a) Apply grease to the steel ball.
(b) Insert the steel ball into the clutch shaft hole.

4. INSTALL STARTER HOUSING, CLUTCH ASSEMBLY AND GEARS

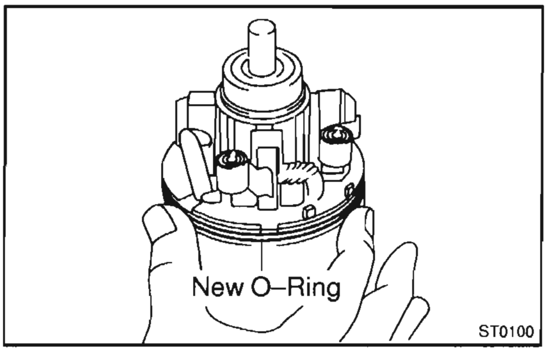
(a) Apply grease to the return spring.
(b) Insert the return spring into the magnetic switch hole.



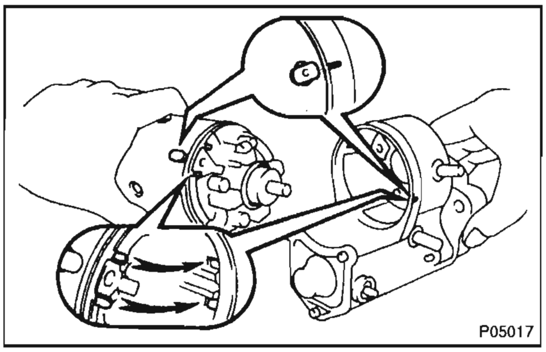
(c) Place the starter housing, pinion gear, bearing, idler gear and clutch assembly on the starter housing.



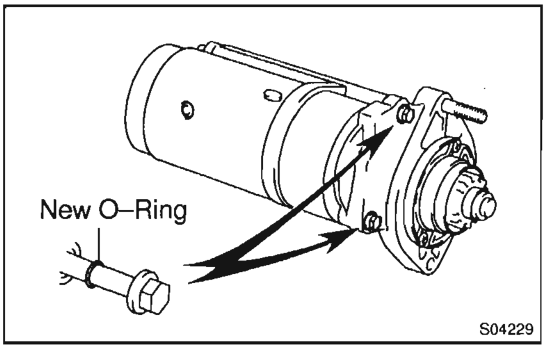
(d) Assemble the starter housing and magnetic switch assembly and install the 2 screws.
Torque:
2.2, 2.7 kw: 9.3 N·m (95 kgf·cm, 82 in.·lbf)
3.3 kw: 11 N·m (115 kgf·cm, 8 ft·lbf)



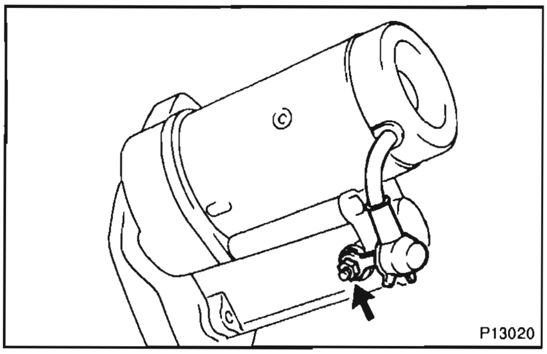
5. **INSTALL FIELD FRAME AND ARMATURE ASSEMBLY**
(a) Place a new O–ring in position on the field frame.



(b) Align the claws of the brush holder with the grooves of the magnetic switch, and install the field frame and armature shaft assembly.
(c) Align the punch mark of the field frame with the line of the magnet switch.

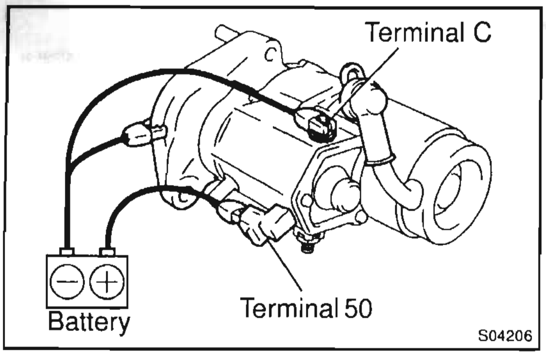


(d) Install a new O–rings to the through bolts.
(e) Install the field frame and armature assembly with the 2 through bolts.
Torque:
2.2 kw: 13 N·m (130 kgf·cm, 9 ft·lbf)
2.7 kw: 14 N·m (145 kgf·cm, 10 ft·lbf)
3.3 kw: 9.3 N·m (95 kgf·cm, 82 in.·lbf)



(f) Connect the lead wire to terminal C, and install the nut.
Torque:
2.2 kw: 5.9 N·m (60 kgf·cm, 52 in.·lbf)
2.7, 3.3 kw: 24 N·m (240 kgf·cm, 17 ft·lbf)

ST0BP–03



TEST

NOTICE:

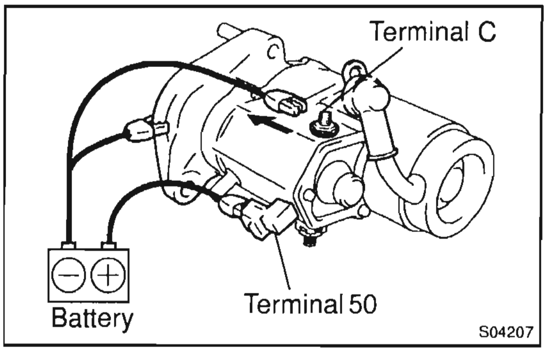
These tests must be performed within 3 to 5 seconds to avoid burning out the coil.

1. PERFORM PULL–IN TEST

(a) Disconnect the field coil lead wire from terminal C.

(b) Connect the battery to the magnetic switch as shown.
Check that the clutch pinion gear moves outward.

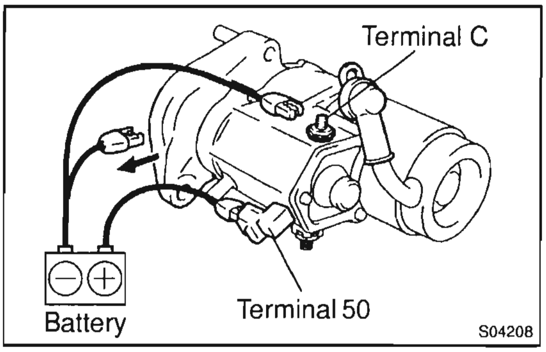
If the clutch pinion gear does not move, replace the magnetic switch assembly.



2. PERFORM HOLDING TEST

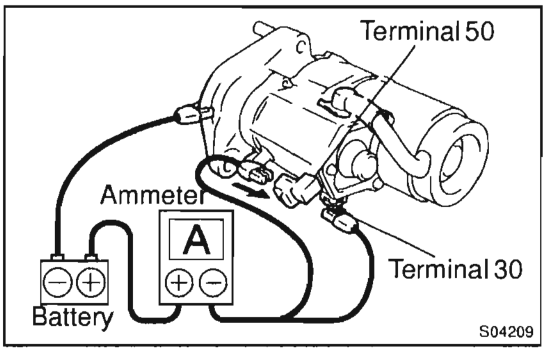
With battery connected as above with the clutch pinion gear out, disconnect the negative (–) lead from terminal C. Check that the pinion gear remains out.

If the clutch pinion gear returns inward, replace the magnetic switch assembly.



3. INSPECT CLUTCH PINION GEAR RETURN

Disconnect the negative (–) lead from the switch body.
Check that the clutch pinion gear returns inward.
If the clutch pinion gear does not return, replace the magnetic switch assembly.

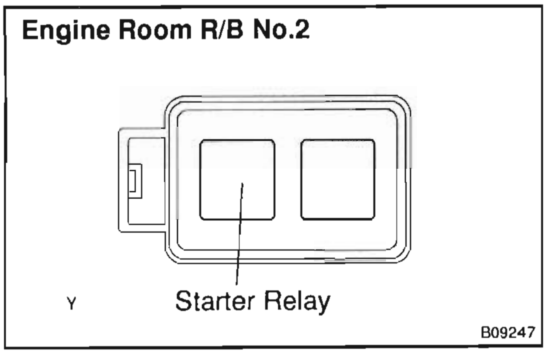


4. PERFORM NO–LOAD PERFORMANCE TEST

(a) Connect the battery and ammeter to the starter as shown.

(b) Check that the starter rotates smoothly and steadily with the pinion gear moving out. Check that the ammeter shows the specified current.

Specified current:
2.2 kw: 120 A or less at 11.5V
2.7 kw: 180 A or less at 11.0V
2.2 kw: 220 A or less at 11.0V



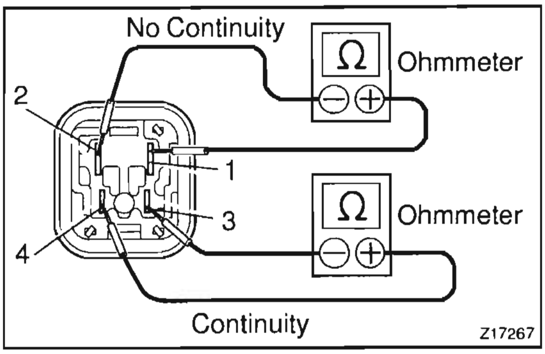
STARTER RELAY

ST0HM–02

INSPECTION

1. REMOVE STARTER RELAY

Remove the starter relay. (Marking: ST RLY)



2. INSPECT STARTER RELAY

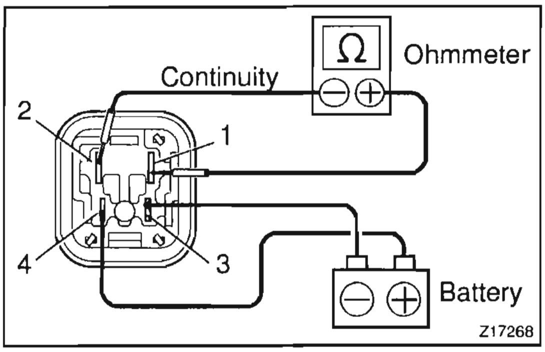
(a) Inspect the relay continuity.

(1) Using an ohmmeter, check that there is continuity between terminals 3 and 4.

If there is no continuity, replace the relay.

(2) Check that there is no continuity between terminal 1 and 2.

If there is continuity, replace the relay.



(b) Inspect the 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.

3. REINSTALL STARTER RELAY

CHARGING

CHARGING SYSTEM CH–1
ALTERNATOR CH–5

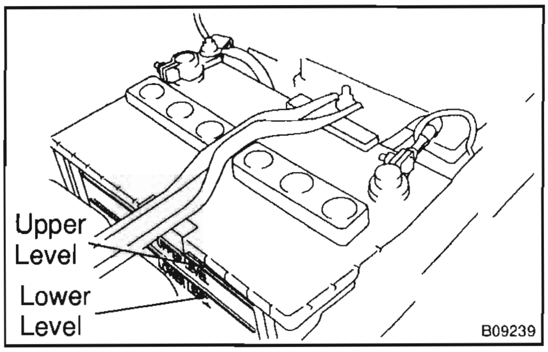
CHARGING SYSTEM

CH0C4–02

ON–VEHICLE INSPECTION

CAUTION:

- **Check that the battery cables are connected to the correct terminals.**
- **Disconnect the battery cables when the battery is given a quick charge.**
- **Do not perform tests with a high voltage insulation resistance tester.**
- **Never disconnect the battery while the engine is running.**



1. CHECK BATTERY ELECTROLYTE LEVEL

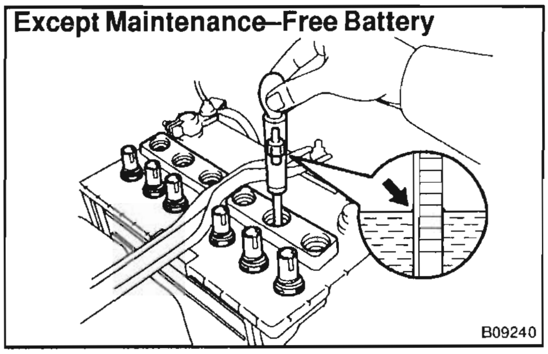
Check the electrolyte quantity of each cell.

Maintenance–Free Battery:

If under the lower level, replace the battery (or add distilled water if possible). Check the charging system.

Except maintenance–Free Battery:

If under the lower level, add distilled water.

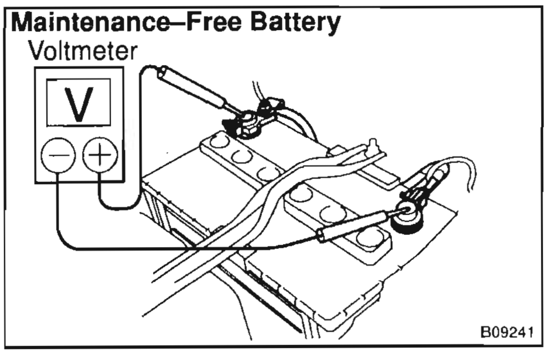


2. Except Maintenance–Free Battery: CHECK BATTERY SPECIFIC GRAVITY

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

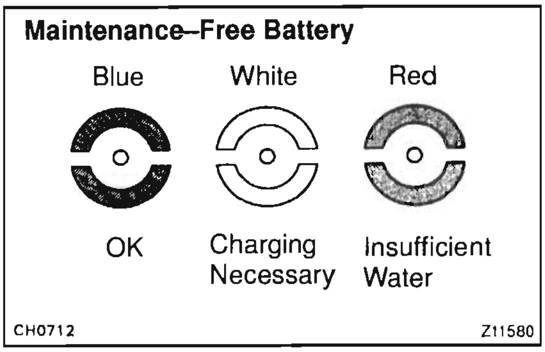
(a) After having driven the vehicle and in the case that 20 minutes have not passed after having stopped the engine, turn the ignition switch ON and turn on the electrical system (headlight, blower motor, rear defogger etc.) for 60 seconds to remove the surface charge.

(b) Turn the ignition switch OFF and turn off the electrical systems.

CH

(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.



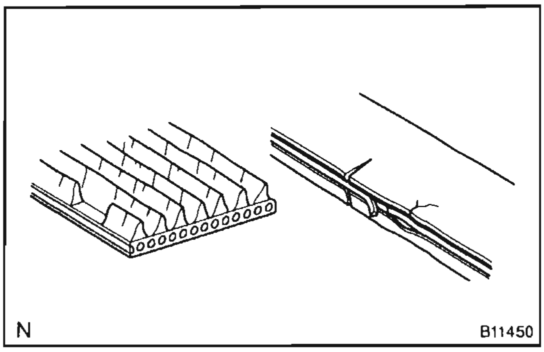
HINT:
Check the indicator as shown in the illustration.

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.

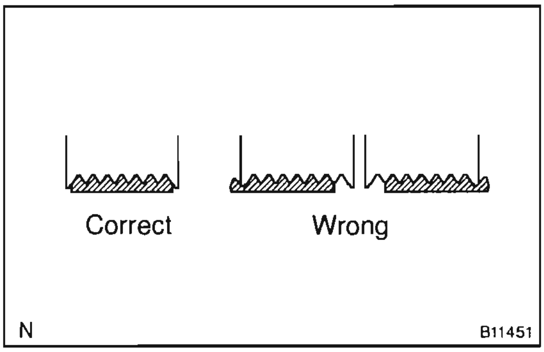


5. INSPECT DRIVE BELT

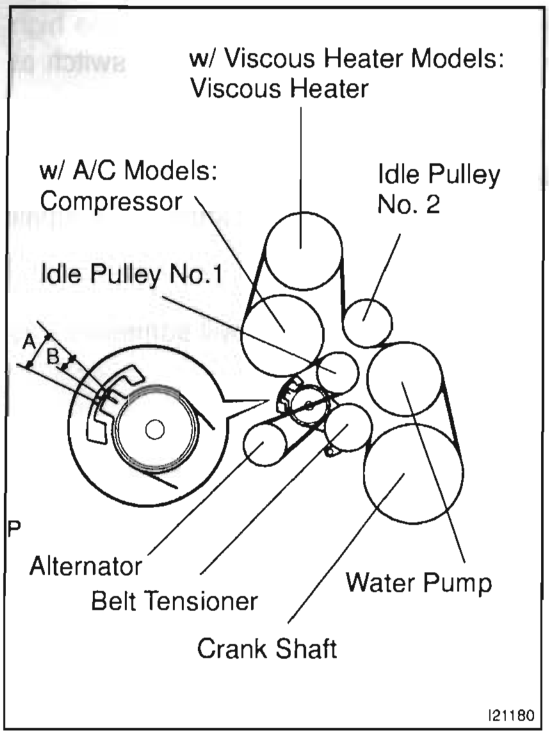
(a) Visually check the drive belt for excessive wear, frayed cords etc.

If any defect has been found, replace the drive belt.

HINT:
Cracks on the rib side of a drive belt are considered acceptable. If the drive belt has chunks missing from the ribs, it should be replaced.



(b) Check that the drive belt fits properly in the ribbed grooves.



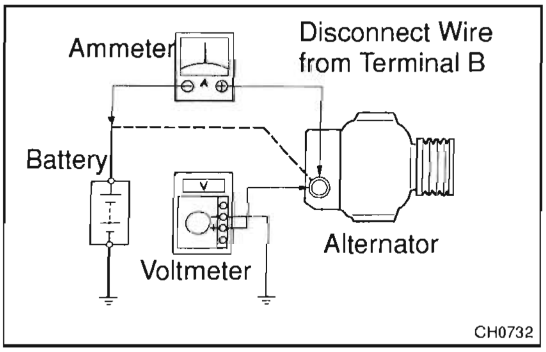
6. INSPECT DRIVE BELT TENSION

Check that the tension is within A range on the auto tensioner scale.

If the tension is not within the A range on the scale, replace the belt with a new one.

HINT:

When replacing the drive belt with a new one, the belt's tension should be within the B range on the belt tensioner scale.



7. INSPECT CHARGING CIRCUIT WITHOUT LOAD

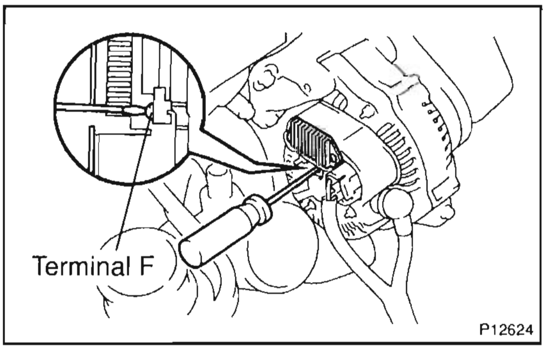
HINT:

If a battery / alternator tester is available, connect the tester to the charging circuit as per the 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 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 2,000 rpm, check the reading on the ammeter and voltmeter.
Standard amperage. 10 A or less
Standard voltage: 13.2 – 14.8 V

If the voltmeter reading is more than standard voltage, replace the IC regulator.



If the voltmeter reading is less than the standard voltage, check the IC regulator and alternator as follows:
- With terminal F grounded, start the engine and check the voltmeter reading of terminal B.
- If the voltmeter reading is more than standard voltage, replace the IC regulator,
- If the voltmeter reading is less than standard voltage, check the alternator.

8. 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 standard amperage, repair the alternator.

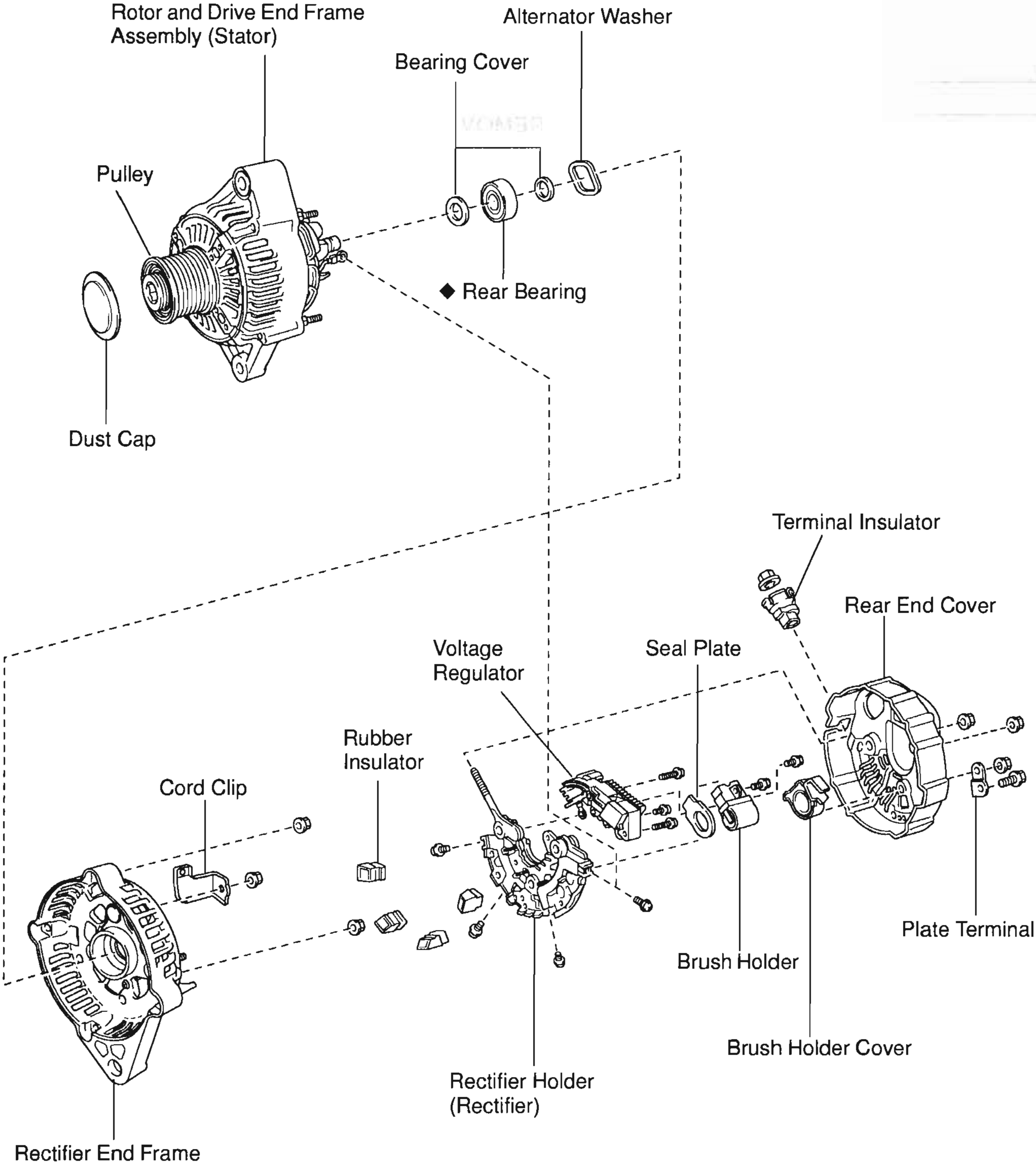
HINT:

If the battery is fully charged, the indication will sometimes be less than standard amperage.

ALTERNATOR

COMPONENTS

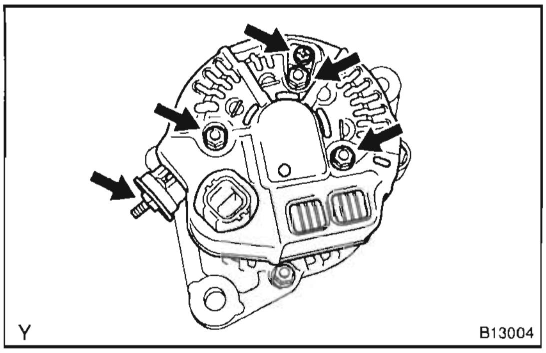
CH0GN–01



Y ◆ Non–reusable part

B13029

CH0GO–01

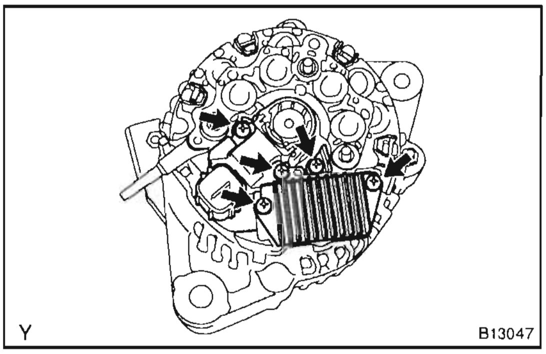


DISASSEMBLY

1. REMOVE REAR END COVER

(a) Remove the nut and terminal insulator.

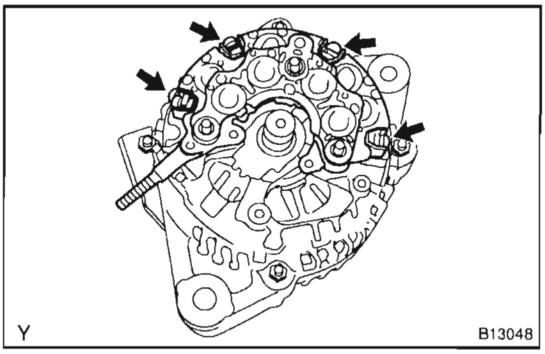
(b) Remove the bolt, 3 nuts, plate terminal, end cover and brush holder cover.



2. REMOVE BRUSH HOLDER AND VOLTAGE REGULATOR

(a) Remove the 5 screws, brush holder and voltage regulator.

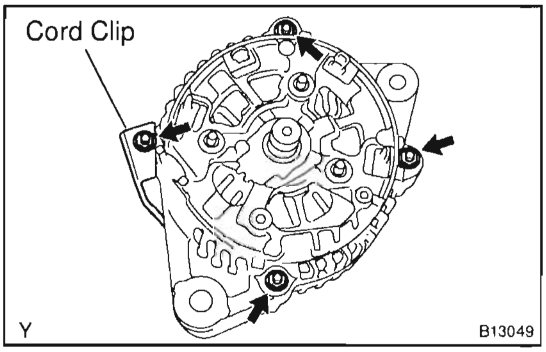
(b) Remove the seal plate from the rectifier end frame.



3. REMOVE RECTIFIER HOLDER

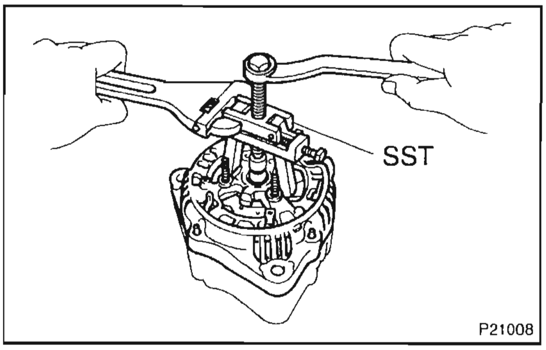
(a) Remove the 4 screws and rectifier holder.

(b) Remove the 4 rubber insulators.



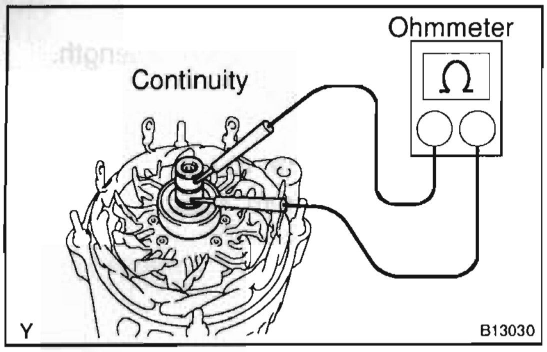
4. REMOVE RECTIFIER END FRAME

(a) Remove the 4 nuts and cord clip.



(b) Using SST, remove the rectifier end frame.
SST 09286–46011

(c) Remove the alternator washer from the rotor.

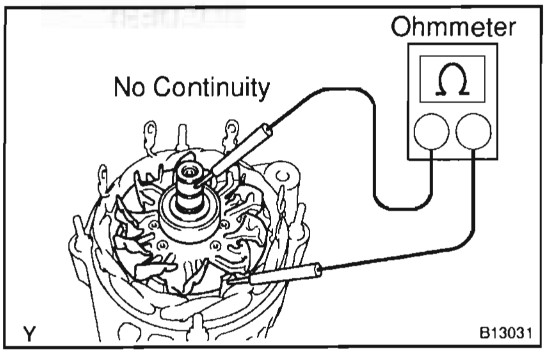


CH0GP-01

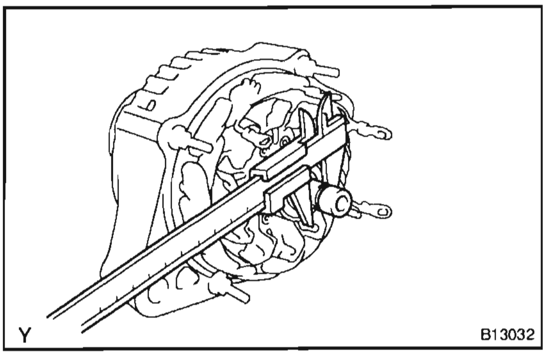
INSPECTION

1. INSPECT ROTOR

(a) Check the 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 alternator assembly.

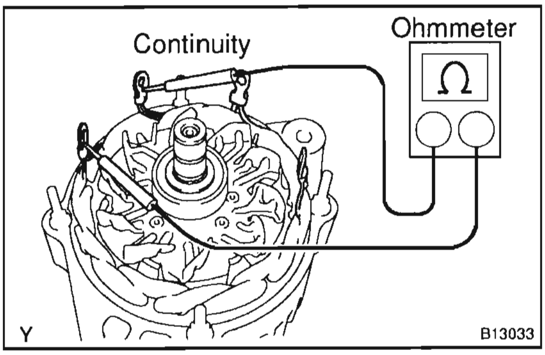


(b) Check the rotor for ground.
Using an ohmmeter, check that there is no continuity between the slip ring and rotor.
If there is continuity, replace the alternator assembly.



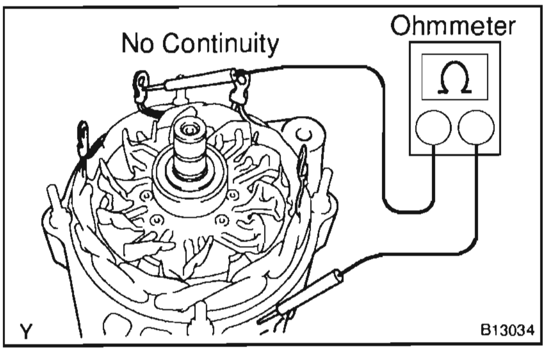
(c) Check that the slip rings are not rough or scored.
If rough or scored, replace the rotor.
(d) Using vernier calipers, measure the slip ring diameter.
Standard diameter: 14.2 – 14.4 mm (0.559 – 0.567 in.)
Minimum diameter: 12.8 mm (0.504 in.)
If the diameter is less than minimum, replace the alternator assembly.

CH

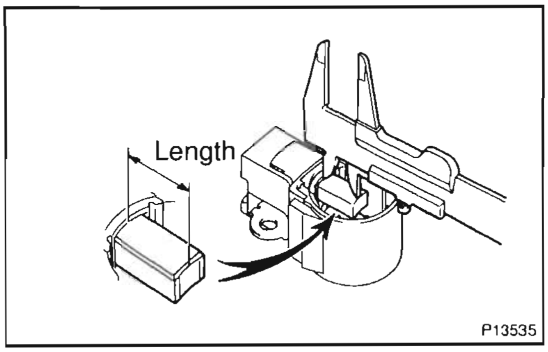


2. INSPECT STATOR (DRIVE END FRAME)

(a) Check the stator for open circuit.
Using an ohmmeter, check that there is continuity between the coil leads.
If there is no continuity, replace the alternator assembly.



(b) Check the 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 alternator assembly.



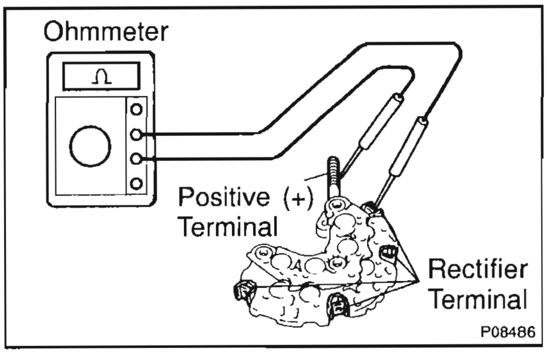
P13535

3. INSPECT BRUSHES

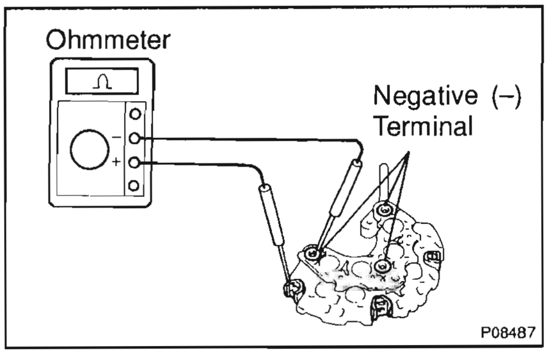
Using vernier calipers, measure the exposed brush length.

Standard exposed length:
9.5 – 11.5 mm (0.374 – 0.453 in.)
Minimum exposed length: 1.5 mm (0.059 in.)

If the exposed length is less than minimum, replace the brush holder assembly.



P08486



P08487

4. INSPECT RECTIFIERS (RECTIFIRE HOLDER)

(a) Check the positive (+) rectifire.
- (1) Using an ohmmeter, connect one tester probe to the positive (+) terminal and the other to each rectifier terminal.
- (2) Reverse the polarity of the tester probes and repeat step (a).
- (3) Check that one shows continuity and the other shows no continuity.

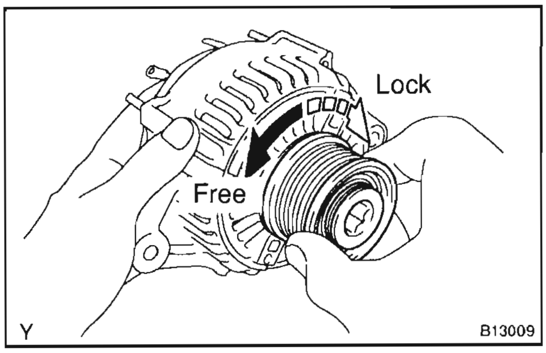
If continuity is not as specified, replace the rectifier holder.

(b) Check the negative (–) rectifire.
- (1) Using an ohmmeter, connect one tester probe to each negative (–) terminal and the other to each rectifier terminal.
- (2) Reverse the polarity of the tester probes and repeat step (a).
- (3) Check that one shows continuity and the other shows no continuity.

If continuity is not as specified, replace the rectifier holder.

5. INSPECT BEARINGS

Check the bearing is not rough or worn.
For rear bearing:
If necessary, replace the rear bearing. (See page CH–9)
For front bearing:
If necessary, replace the alternator assembly.



B13009

6. INSPECT PULLEY

(a) Temporarily install the rotor and pulley to the drive end frame.

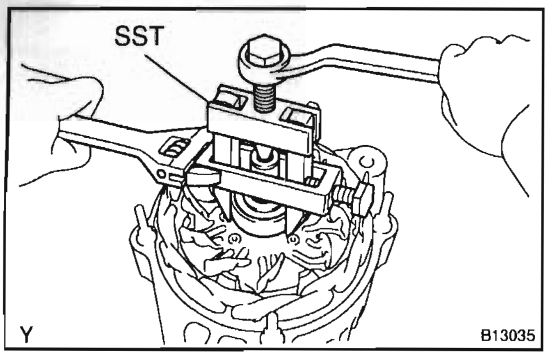
(b) Check the pulley operation.
Hold the rotor and rotate the pulley clockwise, and check that it locks. Try to rotate the pulley counterclockwise and check that it turned freely.

If necessary, replace the alternator assembly.

CH0GO–01

REPLACEMENT

REPLACE REAR BEARING

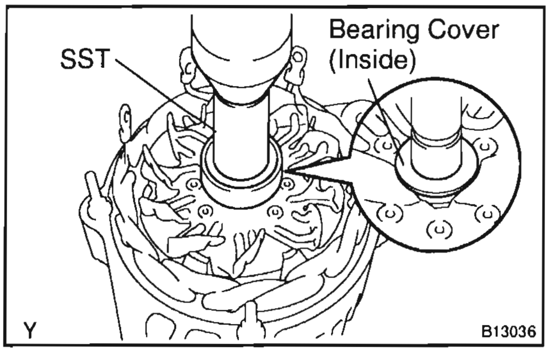


(a) Using SST, remove the bearing cover (outside) and bearing.
SST 09820–00021

NOTICE:

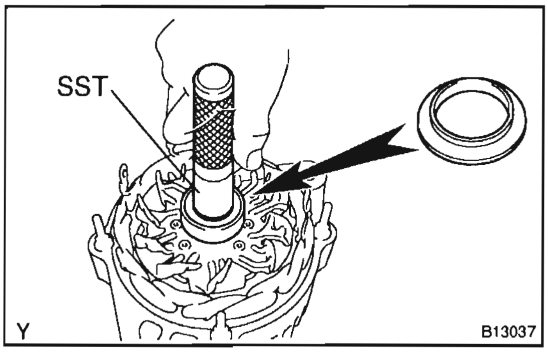
Be careful not to damage the fan.

(b) Remove the bearing cover (inside).



(c) Place the bearing cover (inside) on the rotor.

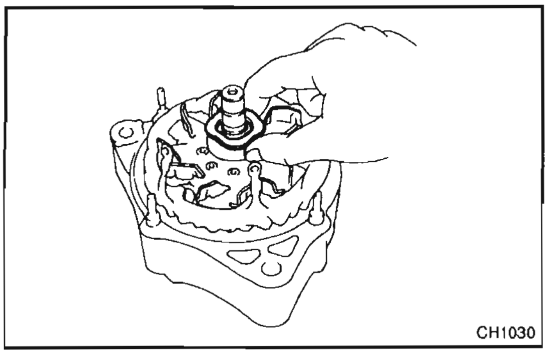
(d) Using SST and a press, press in a new bearing.
SST 09820–00030



(e) Using SST, push in the bearing cover (outside).
SST 09285–76010

CH0GR–01

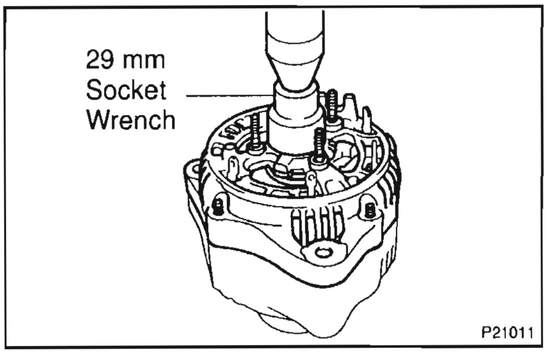
REASSEMBLY



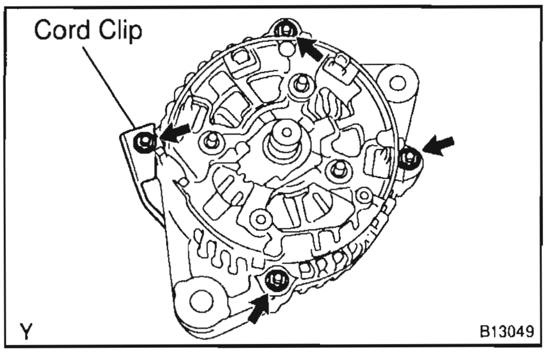
1. INSTALL RECTIFIER END FRAME

(a) Place the rectifier end frame on the rotor.

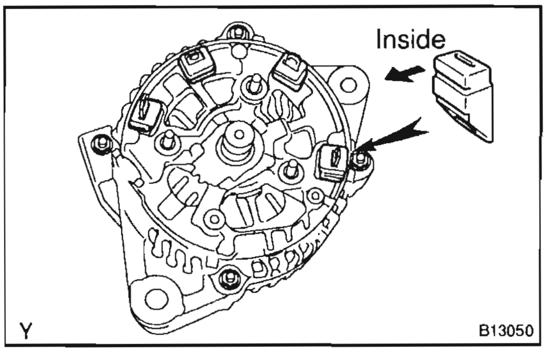
(b) Place the alternator washer on the rotor.



(c) Using a 29 mm socket wrench and press, slowly press in the rectifier end frame.



(d) Install the cord clip and 4 nuts, and temporarily tighten the 4 nuts.

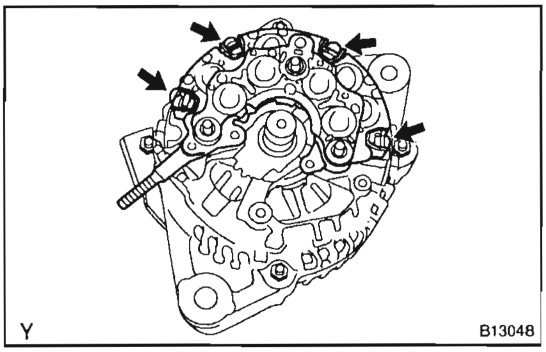


2. INSTALL RECTIFIER HOLDER

(a) Install the 4 rubber insulators on the lead wires.

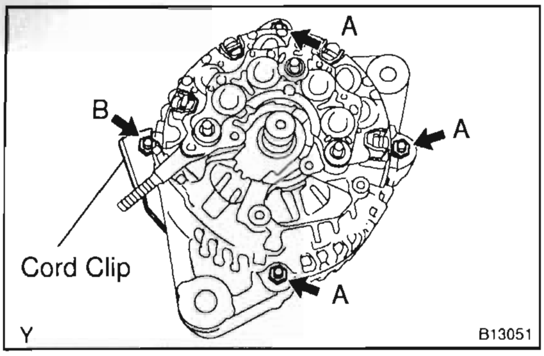
NOTICE:

Be careful of the rubber insulators installation direction.

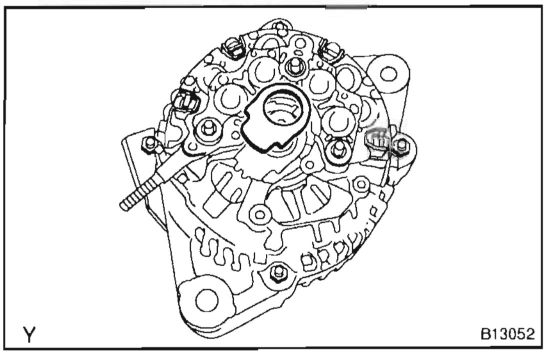


(b) Install the rectifier holder while pushing it with the 4 screws.

Torque: 2.94 N·m (30 kgf·cm, 26 in.·lbf)

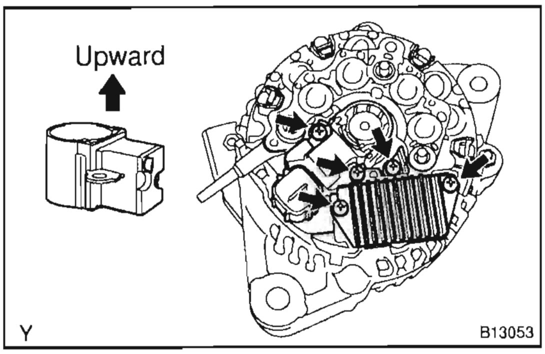


(c) Tighten the 4 nuts.
Torque:
4.5 N·m (46 kgf·cm, 40 in.·lbf) for A
5.4 N·m (55 kgf·cm, 48 in.·lbf) for B



3. INSTALL VOLTAGE REGULATOR AND BRUSH HOLDER

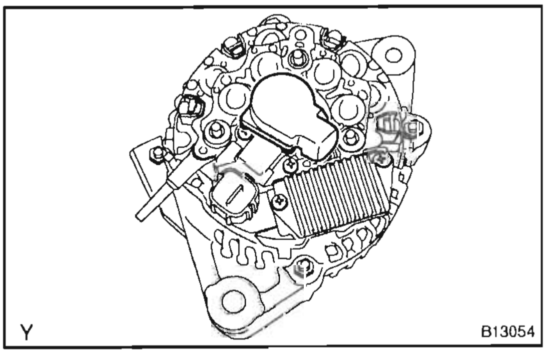
(a) Place the seal plate on the rectifier end frame.



(b) Place the voltage regulator and brush holder on the rectifier end frame.

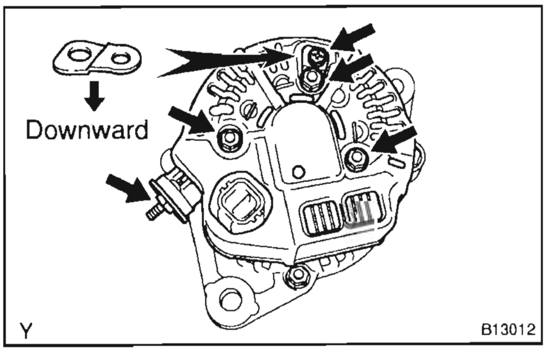
NOTICE:
Be careful of the holder installation direction.

(c) Install the 5 screws.
Torque: 2.0 N·m (20 kgf·cm, 18 in.·lbf)



4. INSTALL REAR END COVER

(a) Place the brush holder cover on the brush holder.



(b) Install the end cover and plate terminal with the bolt and 3 nuts.
Torque:
4.4 N·m (45 kgf·cm, 39 in.·lbf) for nut
3.8 N·m (39 kgf·cm, 34 in.·lbf) for bolt

(c) Install the terminal insulator with the nut.
Torque: 4.1 N·m (42 kgf·cm, 36 in.·lbf)

5. CHECK THAT ROTOR ROTATES SMOOTHLY

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