

## Basic Inspection Procedure

Follow the under inspection procedure, when the problem vehicle comes workshop.

Step	Inspection point	Inspection result	YES	NO
1	Check the check engine lamp	Is the check engine lamp turn ON ?	Go to section 6E "On Board Diagnostic (OBD) System Check"	Go to Step 2
2	The battery fluid level and the gravity	Was the problem found?	Re-charge the battery or replace the battery	Go to Step 3
3	The engine coolant capacity	Was the problem found?	Replenish the engine coolant	Go to Step 4
4	The engine oil level	Was the problem found?	Replenish the engine oil	Go to Step 5
5	The air cleaner element	Was the problem found?	Clean or replace	Go to Step 6
6	The piping fixing condition (oil, vacuum and fuel piping)	Was the problem found?	Return normal condition	Go to Step 7
7	The drive belt tension and break	Was the problem found?	Re-adjust the tension or replace	Go to Step 8
8	Go to section 6E "On Board Diagnostic (OBD) System Check"	Was the problem found?	Verify repair	Go to Step 9
9	Go to mechanical troubleshooting chart	Was the problem found?	Verify repair	—

## 2. Unstable Idling

Step	Action	Value(s)	Yes	No
1	Was the fuel line air bled completely?	—	Go to <i>Step 3</i>	Bleed the air
2	Was the fuel line leakage or blockage found?	—	Repair or replace relation parts.	Go to <i>Step 4</i>
3	Was the water contained in the fuel?	—	Replace the fuel	Go to <i>Step 5</i>
4	Was the fuel filter element clogged?	—	Replace the fuel filter element	Go to <i>Step 6</i>
5	Was the injection starting pressure or the injection spray condition OK?	(See below)	Go to <i>Step 7</i>	Replace the injection nozzle
6	Was the injection nozzle sticking?	See <i>Step 6</i>	Replace the injection nozzle	Go to <i>Step 8</i>
7	Check the throttle valve condition. Was the idling port clogged in the throttle valve?	—	Repair or replace the throttle valve	Go to <i>Step 9</i>
8	Was the valve clearance improper adjusted?	0.4 mm (0.016 in) both intake and exhaust valves	Adjust the valve clearance	Go to <i>Step 10</i>
9	Was the compression pressure OK?	3.0MPa (31.0 kg/cm <sup>2</sup> , 441 psi) at 200rpm	Go to <i>Step 11</i>	Readjust the valve clearance or replace the cylinder head gasket or cylinder liner or piston or piston ring or valve and valve seat
10	Are any DTC stored?	—	Go to <i>indicated DTC</i>	Solved

Injection nozzle opening pressure  
1st = 19.5 MPa (199 kg/cm<sup>2</sup>, 2828 psi)

## 10. Abnormal Engine Noise

### 10-1 Engine knocking

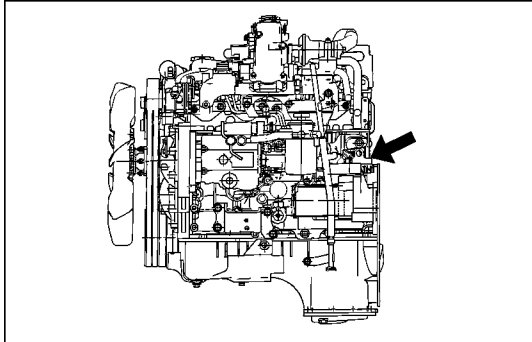
Step	Action	Value(s)	Yes	No
1	Was the injection nozzle pressure or injection spray pattern OK?	—	Go to <i>Step 2</i>	Replace the injection nozzle
2	Was the compression pressure OK?	3.0 MPa (31.0 kg/cm <sup>2</sup> , 441 psi) at 200 rpm	Go to <i>Step 3</i>	Replace the cylinder head gasket or piston ring
3	Are any DTC stored?	—	Go to <i>indicated DTC</i>	Solved

### 10-2 Gas leakage noise

Step	Action	Value(s)	Yes	No
1	Was the exhaust pipe loose or broken?	—	Retighten or replace the exhaust pipe	Go to <i>Step 2</i>
2	Was the exhaust manifold loose?	—	Retighten or replace the exhaust manifold. Or replace the exhaust manifold gasket	Go to <i>Step 3</i>
3	Was the injection nozzle loose?	—	Retighten or replace the injection nozzle fixing bolt	Go to <i>Step 4</i>
4	Was the cylinder head gasket broken?	—	Replace the cylinder head gasket	Go to <i>Step 5</i>
5	Are any DTC stored?	—	Go to <i>indicated DTC</i>	Solved

## SERVICING

Servicing refers to general maintenance procedures to be performed by qualified service personnel.



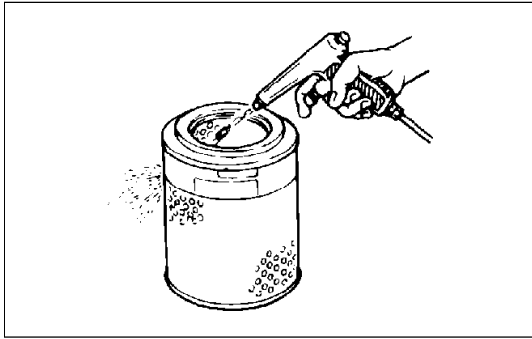
RTW36ASH000401

### MODEL IDENTIFICATION

#### Engine Serial Number

The engine number is stamped on the rear left hand side of the cylinder body.

The engine number is stamped in the plate in front of the engine room as well.



130RY00003

### AIR CLEANER

Element cleaning procedures will vary according to the condition of the element.

#### Dust Fouled Element (Except wet type element)

Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

Compressed air pressure	kPa (kg/cm <sup>2</sup> /psi)
392 – 490 (4 – 5/57 – 71)	

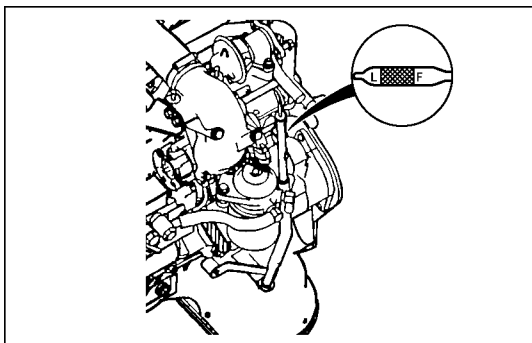


6A-6

### LUBRICATING SYSTEM

#### Main Oil Filter (Cartridge Type Paper Element) Replacement Procedure

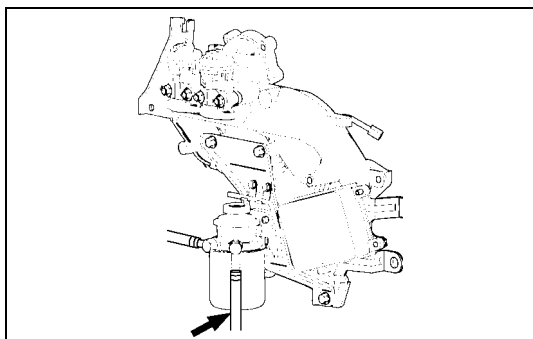
1. Drain the engine oil.
2. Retighten the drain plug.
3. Loosen the used oil filter by turning it counterclockwise with a filter wrench.  
Filter Wrench: 5-8840-0203-1



RTW36ASH000101



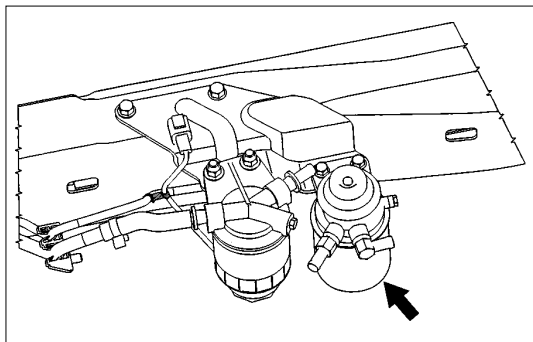
4. Clean the oil cooler fitting face. This will allow the new oil filter to seat properly.
5. Apply a light coat of engine oil to the filter O-ring.
6. Turn in the new oil filter until the filter O-ring is fitted against the sealing face.
7. Use the filter wrench to turn in the filter an additional 2/3 turns.  
Filter Wrench: 5-8840-0203-1
8. Check the engine oil level and replenish to the specified level if required.



140R300001

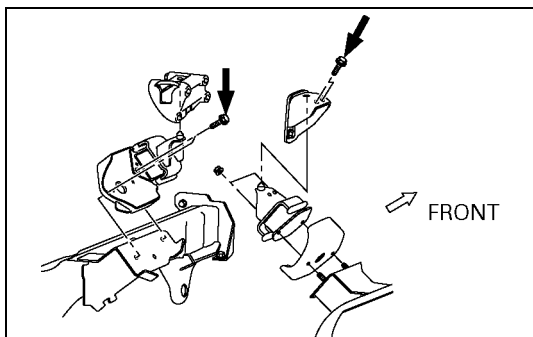
### 26. Fuel Hose

Remove the fuel hose from the fuel filter (Except EURO III).



RTW46ASH000501

Remove the fuel hose from injection pump (EURO III only).



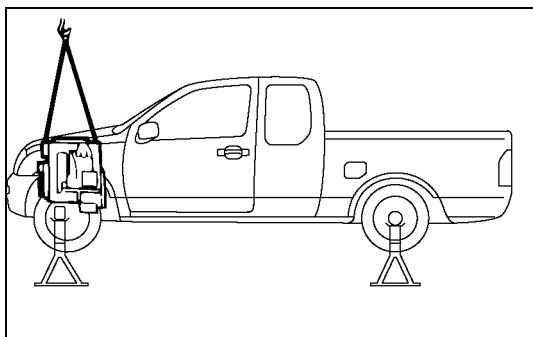
022R300002

### 27. Exhaust Pipe

Remove the front exhaust pipe bolts and separate the exhaust manifold and the front exhaust pipe.

### 28. Engine Assembly

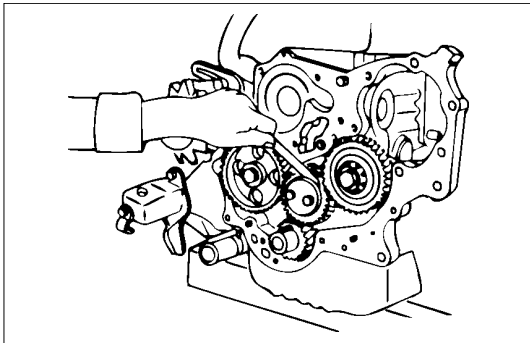
- 1) Remove two right side engine foot bolts.
- 2) Remove two left side engine mount bolts.
- 3) Use the hoist to lift the engine from the engine compartment.



F06R300008

### Installation

To reassemble, follow the removal steps in the reverse order.



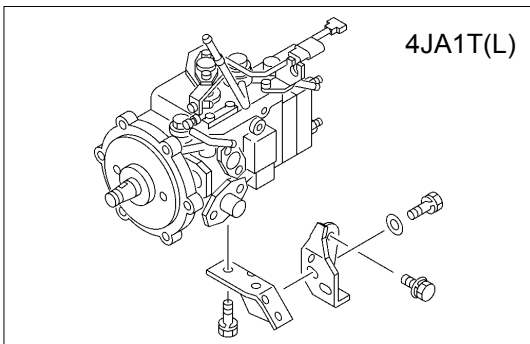
RTW36ASH000801

### Idler Gear "A" End Play Measurement

Insert a feeler gauge between the idler gear and the thrust collar to measure the gap and determine the idler gear end play.

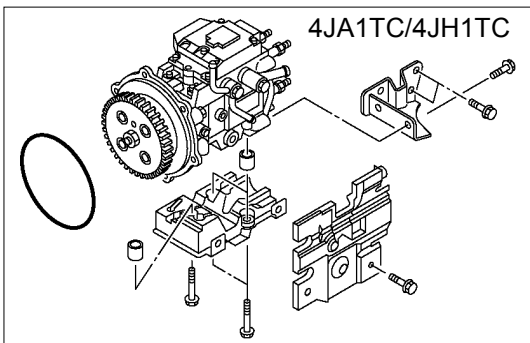
If the measured value exceeds the specified limit, the thrust collar must be replaced.

Idler Gear End Play		mm (in)
Standard		Limit
0.07 (0.0028)		0.2 (0.0079)



RTW86ASH002301

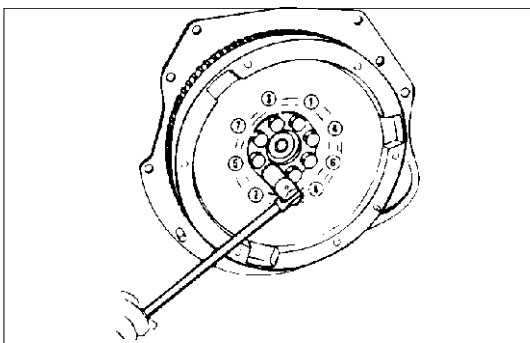
- 14. Idle Gear Shaft
- 15. Crankshaft Timing Gear



RTW36ASH001301

- 16. Injection Pump
  1. Remove the injection pump cover (4JA1TC/4JH1TC only).
  2. Remove the injection pump bracket.
  3. Pull the injection pump along with the injection pump timing gear free toward the rear of the engine.

**NOTE:**  
**Plug the injection pump delivery ports with the caps to prevent the entry of foreign material.**



015RY00001



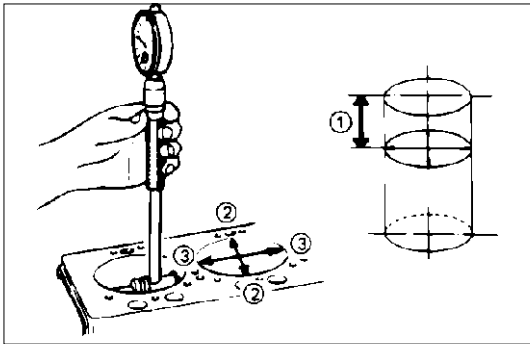
- 17. Flywheel
 

Loosen the flywheel bolts in numerical order a little at a time.

Use the gear stoper to stop the flywheel gear.

Gear stoper: 5-8840-0214-0

- 18. Crank Case
- 19. Oil Pump With Oil Pipe



012RY00010

### Cylinder Liner Bore Measurement

Use a cylinder indicator to measure the cylinder bore at measuring point (1) in the thrust (2-2) and axial (3-3) directions of the crankshaft.

Measuring Point (1): 20 mm (0.79 in)

If the measured value exceeds the specified limit, the cylinder liner must be replaced.

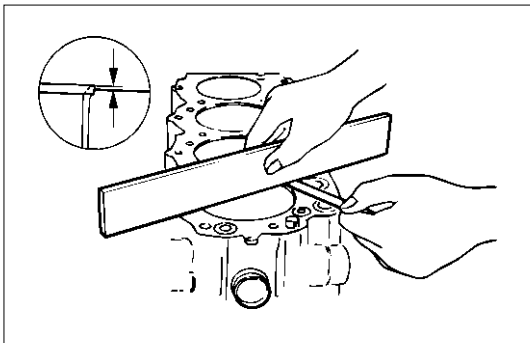


Cylinder Liner Bore	mm (in)	
	Standard	Limit
4JA1T(L), 4JA1TC	93.00 (3.6614)	93.08 (3.6646)
4JH1TC	95.40 (3.7559)	95.48 (3.7590)

**NOTE:**

The inside of the dry type cylinder liner is chrome plated. It cannot be rebored or honed.

If the inside of the cylinder liner is scored or scorched, the cylinder liner must be replaced.



012LX016

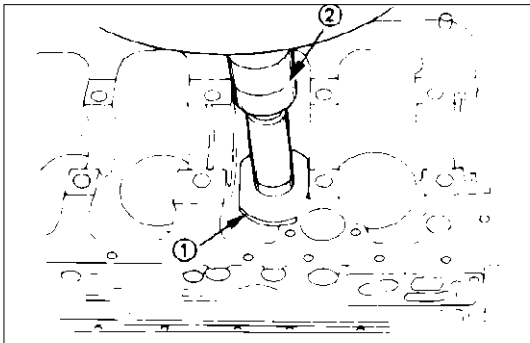
### Cylinder Liner Projection Inspection

1. Hold a straight edge along the top edge of the cylinder liner to be measured.
2. Use a feeler gauge to measure each cylinder liner projection.



Cylinder Liner Projection	mm (in)
	Standard
	0-0.1 (0-0.004)

The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 mm (0.0012 in).



012RY00012

### Cylinder Liner Replacement



#### Cylinder Liner Removal

1. Insert the cylinder liner remover (1) into the cylinder body (from the lower side of the cylinder body) until it makes firm contact with the cylinder liner.



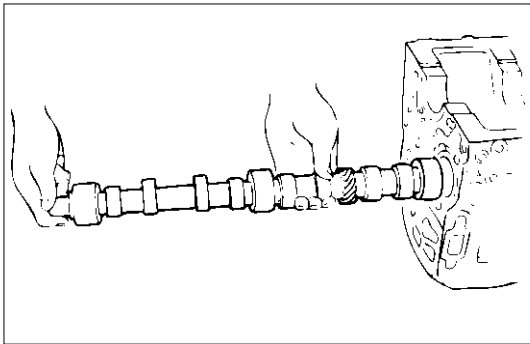
Cylinder Liner Remover : 5-8840-2039-0 (4JA1L/TC)  
: 5-8840-2304-0 (4JH1TC)

2. Use a bench press (2) to slowly force the cylinder liner from the cylinder body.

**NOTE:**

Take care not to damage the cylinder body upper face during the cylinder liner removal procedure.

3. Measure the cylinder body upper face warpage. Refer to "Cylinder Body Upper Face Warpage".

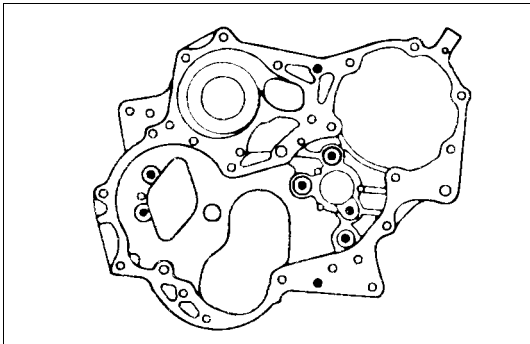


014RY00019

**7. Camshaft**



1. Apply a coat of engine oil to the camshaft and the camshaft bearings.
2. Install the camshaft to the cylinder body.  
Take care not to damage the camshaft bearings.



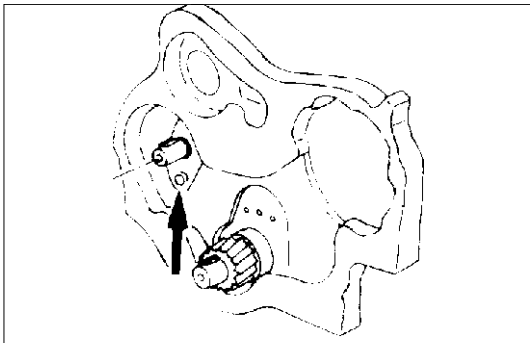
020R300003

**8. Timing Gear Case**

Tighten the timing gear case with timing gear case gasket to the specified torque.



Timing Gear Case Bolt Torque	N·m(kg·m/lbft)
	19 (1.9/14)



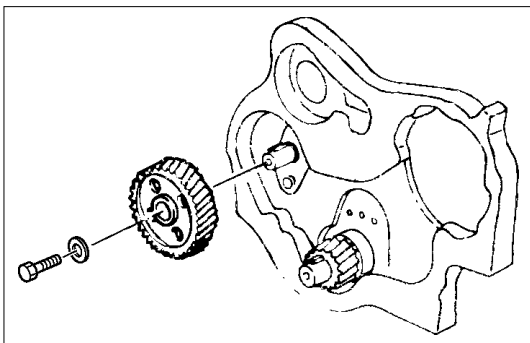
020RY00032

**9. Camshaft Thrust Plate**

Install the thrust plate to the cylinder body and tighten the thrust plate bolts to the specified torque.



Thrust Plate Bolt Torque	N·m(kg·m/lbft)
	19 (1.9/14)



RTW36ASH000901



**10. Camshaft Timing Gear**

1. Install the camshaft timing gear to the camshaft. The timing gear mark must be facing outward.
2. Tighten the timing gear to the specified torque.

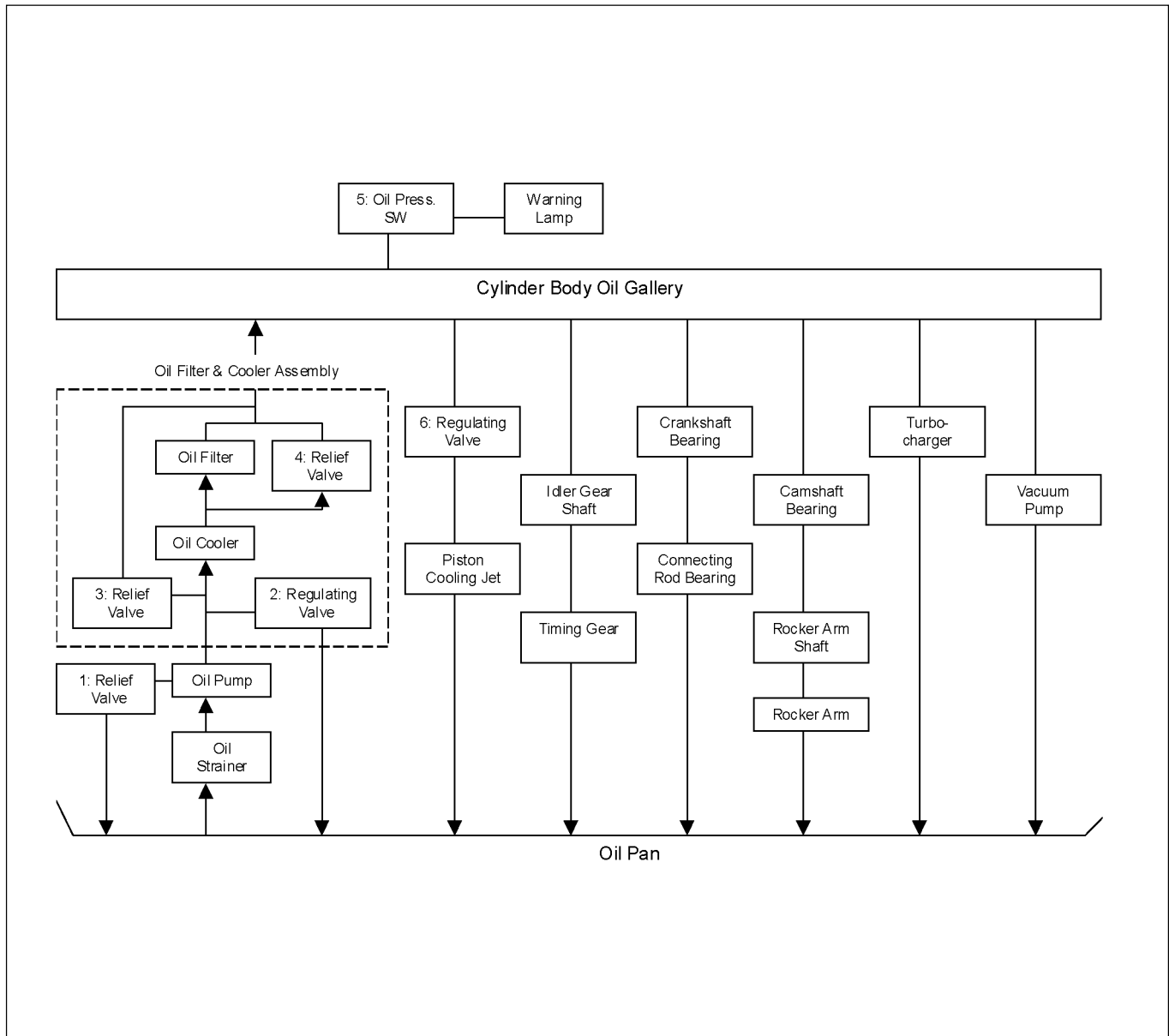


Timing Gear Bolt Torque	N·m(kg·m/lbft)
	110 (11.2/82)



## LUBRICATION SYSTEM

### LUBRICATING OIL FLOW



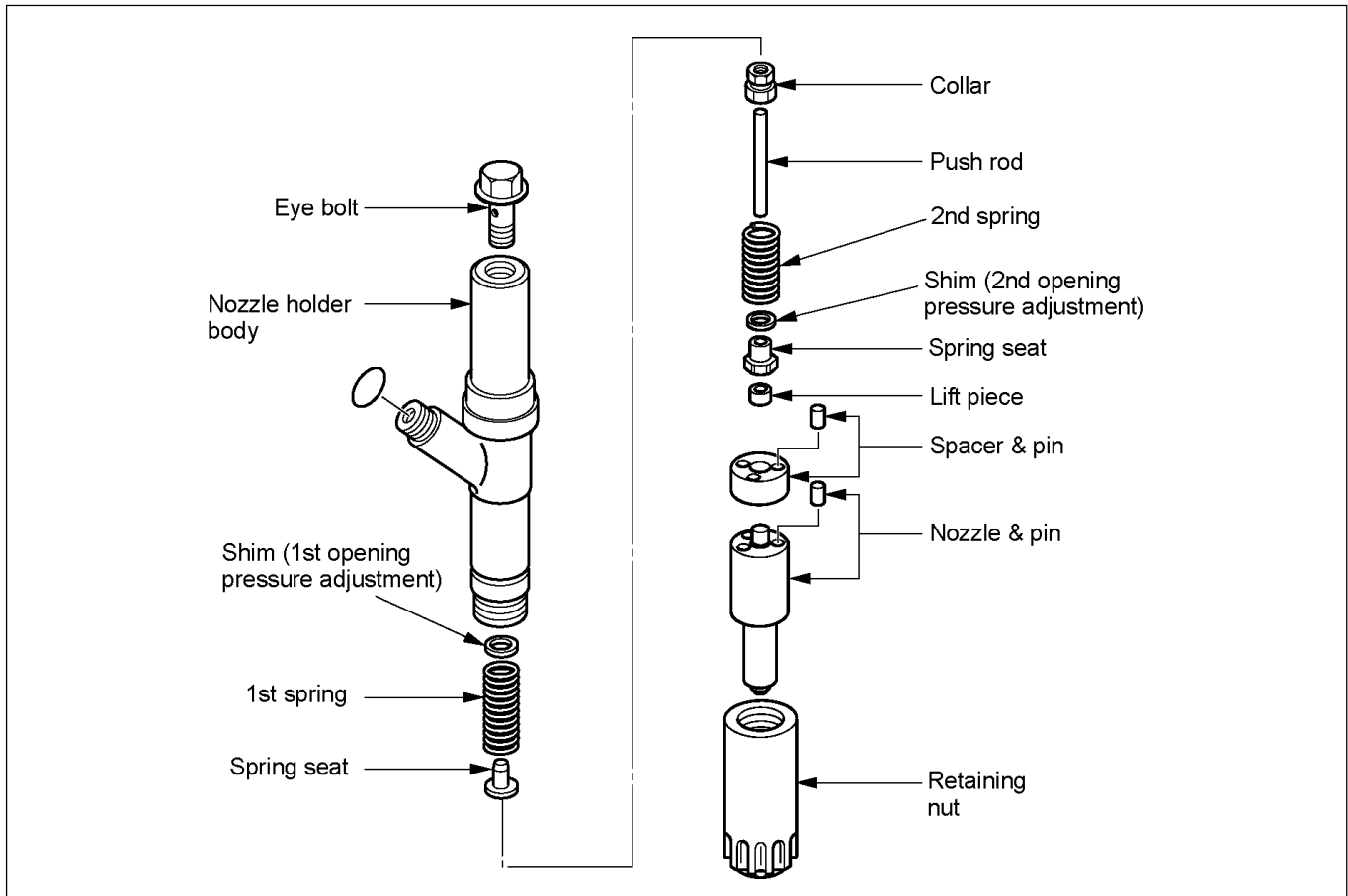
1. Oil Pump Relief Valve Operating Pressure: 6.2 - 7.8 kg/cm<sup>2</sup> (608 – 764 kPa)
2. Regulating Valve Operating Pressure: 5.7 - 6.3 kg/cm<sup>2</sup> (558.6 - 617.4 kPa)
3. Oil Cooler Relief Valve Opening Pressure: 2.8 - 3.4 kg/cm<sup>2</sup> (270 – 330 kPa)
4. Oil Filter Relief Valve Opening Pressure: 0.8 - 1.2 kg/cm<sup>2</sup> (78.4 - 117.6 kPa)
5. Oil Pressure Switch Operating Pressure: 0.3 - 0.5 kg/cm<sup>2</sup> (29.4 - 49.0 kPa)
6. Regulating Valve: 1.8 - 2.2 kg/cm<sup>2</sup> (176 – 216 kPa)

The 4J series engine has a full flow type lubricating system.

Lubricating oil is pumped from the oil pump to the cylinder body oil gallery through the oil cooler and the oil filter. It is then delivered to the vital parts of the engine from the cylinder body oil gallery.

Oiling jets installed on the cylinder body spray engine oil to the piston backside faces to achieve maximum piston cooling effect.

## INJECTION NOZZLE (4JA1L)



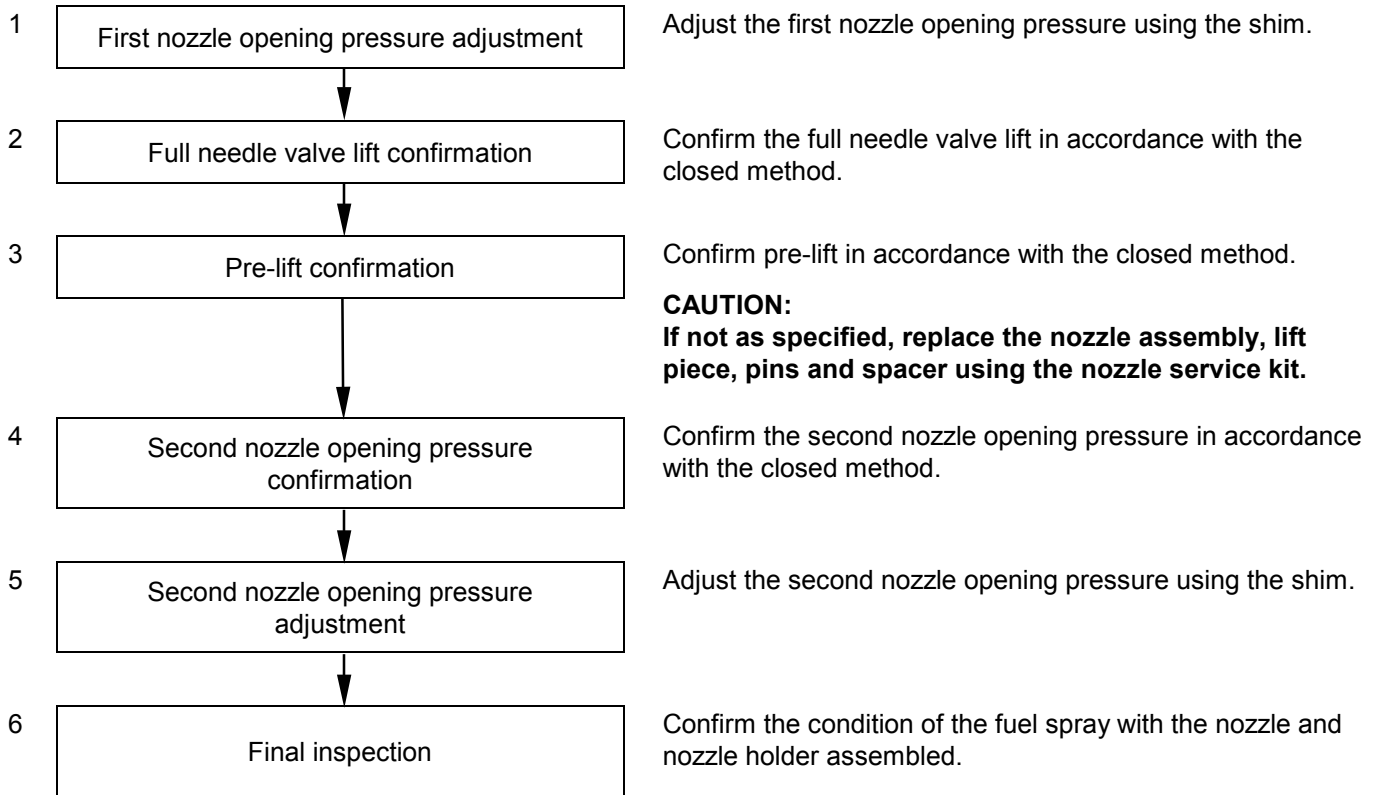
RTW76CMF000301

**NOTE:**

- Injection nozzle adjustment is possible only on the 4JA1L engine.

A hole (with 5 orifices) type injection nozzle. It consists of the nozzle body and the needle valve assembly. The injection nozzle assembly sprays pressurized fuel from the injection pump into the combustion chamber through the nozzle body injection orifice.

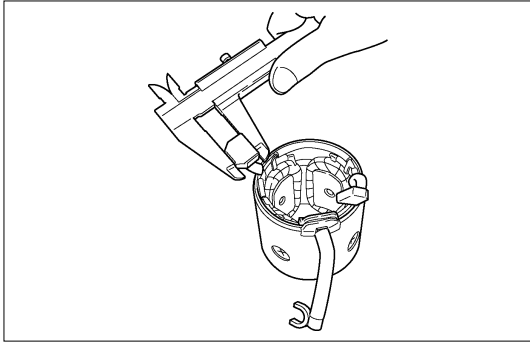
**REASSEMBLY AND ADJUSTMENT PROCEDURE**



**First nozzle opening pressure adjustment**

Nozzle needle valve full-lift	0.25 mm (0.0098 in)
Nozzle needle valve pre-lift	0.04 mm(0.0016 in) at 20 MPa (2901 psi, 204 kg/cm <sup>2</sup> )
Nozzle pressure	
4JA1T(L)    1st Stage	19.1 MPa (2759 psi, 194 kg/cm <sup>2</sup> )
2nd Stage	25.5-27.0 MPa (3768-3911 psi, 260-275 kg/cm <sup>2</sup> )

NOTE: Only 4JA1L can perform adjustment of a nozzle.



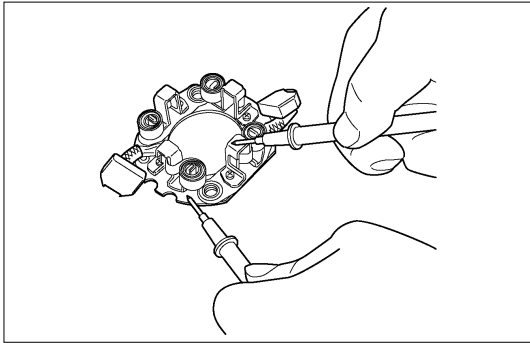
RTW46DSH004001

## BRUSH AND BRUSH HOLDER

1. Use a vernier caliper to measure the brush length (four brushes).  
Replace the brushes as a set if one or more of the brush lengths is less than the specified limit.



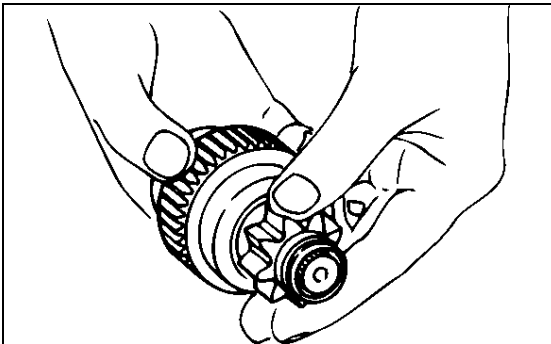
Brush Length		mm (in)
Standard	Limit	
15 (0.59)	12 (0.47)	



RTW46DSH004101

2. Use a circuit tester to check the brush holder insulation.  
Touch one probe to the holder plate and the other probe to the positive brush holder.  
There should be no continuity.

3. Inspect the brushes for excessive wear.  
If the negative brushes have excessive wear, the entire brush holder assembly must be replaced.  
If the positive brushes have excessive wear, the entire yoke must be replaced.

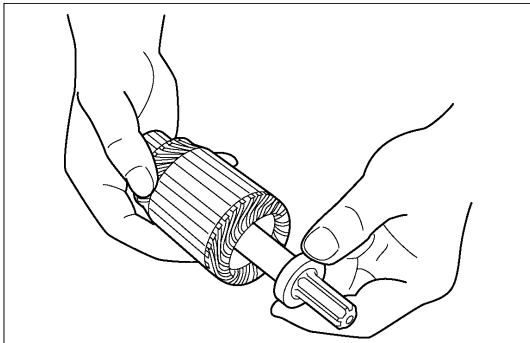


065RY00035



## OVERRUNNING CLUTCH

1. Inspect the overrunning clutch gear teeth for excessive wear and damage.  
Replace the overrunning clutch if necessary.
2. Rotate the pinion clockwise.  
It should turn smoothly.
3. Try to rotate the pinion in the opposite direction.  
The pinion should lock.



RTW46DSH004401



## BEARING

Inspect the bearings for excessive wear and damage.  
Replace the bearings if necessary.

**DTC P0215 (Symptom Code B) (Flash Code 52)**

**Circuit Description**

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.

The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running. If the PCU detects that the ESO solenoid valve control circuit voltage level from the ECM to PCU is high, this DTC will set.

**Condition for Running the DTC**

- The ignition switch is ON.

**Condition for Setting the DTC**

- The PCU detects high voltage condition on the ESO solenoid valve control circuit for longer than 1 second when the ECM does not command shutoff.

**Action Taken When the DTC Sets**

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

**Condition for Clearing the MIL/DTC**

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the scan tool.

**Diagnostic Aids**

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

**Notice:**

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.
- If this DTC is present, engine will not start.

**DTC P0215 (Symptom Code B) (Flash Code 52)**

**Schematic Reference:** Engine Controls Schematics

**Connector End View Reference:** Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check-Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check-Engine Controls
2	1. Install the scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If the engine does not start, crank over the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Connect a test lamp between the engine shutoff (ESO) solenoid valve control signal circuit (pin 5 of E-6 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 4

## DTC P0381 (Symptom Code 8) (Flash Code 67)

### Circuit Description

The glow indicator lamp is located on the instrument panel (IP) cluster. The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. If the ignition switch is turned ON when the engine coolant temperature is low, the engine control module (ECM) illuminates the glow indicator lamp and turns ON the glow plugs. After a fixed time passes, the ECM turns OFF the glow indicator lamp and the glow plugs. The ECM monitors the glow indicator lamp control circuit for conditions that are incorrect for the commanded state of the glow indicator lamp. If the ECM detects a short to battery or ignition voltage on the glow indicator control circuit, this DTC will set.

### Condition for Running the DTC

- The ignition switch is ON.

### Condition for Setting the DTC

- The ECM detects that the high voltage condition on the glow indicator lamp control circuit for longer than 1 second when the lamp is commanded ON.

### Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

### Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the scan tool.

### Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

### Notice:

- The glow indicator lamp is commanded OFF with the ignition ON and engine OFF when the engine coolant temperature is reached at 30°C (86°F).

### Test Description

The number below refers to the step number on the diagnostic table.

3. If the control circuit of the glow indicator lamp between the ECM and the IP cluster is normal, the control circuit voltage low DTC P0381 (Symptom Code 4) will set.

### DTC P0381 (Symptom Code 8) (Flash Code 67)

**Schematic Reference:** Engine Controls Schematics

**Connector End View Reference:** Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check-Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check-Engine Controls
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Glow Indicator test with the scan tool. 4. Command the Glow Indicator ON with the scan tool. Does the glow indicator lamp turn ON when commanded ON with the scan tool?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Remove the instrument panel (IP) cluster in order to disconnect the IP cluster harness B-23 connector. 3. Disconnect the IP cluster harness B-23 connector. 4. Turn ON the ignition for 30 seconds, with the engine OFF. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the scan tool. Does DTC P0381 (Symptom Code 4) set, but not DTC P0381 (Symptom Code 8)?	—	Go to Step 5	Go to Step 4

**DTC P1651 (Symptom Code A, B) (Flash Code 45)****Circuit Description**

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.

The ECM monitors CAN operational status by expecting a constant flow of messages from the PCU. If the ECM fails to receive an expected message from the PCU, this will set depending on what communication is lost.

**Condition for Setting the DTC**

- The ECM detects that the PCU does not receive the CAN messages from the ECM. (Symptom Code A)

- The ECM does not receive the CAN messages from the PCU. (Symptom Code B)

**Action Taken When the DTC Sets**

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

The ECM cuts the fuel injection.

**Condition for Clearing the MIL/DTC**

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the scan tool.

**Diagnostic Aids**

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

**DTC P1651 (Symptom Code A, B) (Flash Code 45)**

**Schematic Reference:** Engine Controls Schematics

**Connector End View Reference:** Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check-Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check-Engine Controls
2	1. Install the scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the scan tool. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Connect a DMM across the controller area network (CAN) harness (pins 1 and 2 of E-6 connector). 4. Measure the resistance across the CAN terminals. Is the resistance within the specified value?	110-130 $\Omega$	Go to Step 4	Go to Step 9
4	1. Connect a DMM between the CAN Low signal circuit (pin 1 of E-6 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage within the specified value?	1.5 – 2.5 volts	Go to Step 5	Go to Step 10
5	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a DMM between the CAN High signal circuit (pin 2 of E-6 connector) and a known good ground. Is the DMM voltage within the specified value?	3.0 – 4.0 volts	Go to Step 6	Go to Step 11