ENGINE KNOCKING OR RATTLING

HINT:

- This troubleshooting procedure checks for knocking and rattling.
- Knocking is most likely to occur while the engine is idling.

CIRCUIT DESCRIPTION

MalfunctionCondition	Main Trouble Areas	Related Trouble Areas
• Knocking and abnormal sound due to extremely rich combustion • Abnormal sound due to friction between parts	(a) Injectormalfunctions • Injector sliding malfunction • Injector stuck closed • Injector stuck open • Deposits in injector • Injector circuit malfunction (b) Abnormal common rail pressure • Supply pump • Fuel pulsation sound • Air in fuel (c) Friction between parts (d) Compression pressure	• Injector compensation codes • Fuel leakage • Intake air system leakage • Intake air system blockage • EGR system • Throttle valve system • Fuel pressure sensor • Manifold absolute pressure sensor • Mass air flow meter • Atmosphere air pressure sensor (built into ECM) • Mass air flow meter • Vehiclemodifications • Low quality fuel • Lack of fuel • ECM

HINT:

- Specified values in the following troubleshooting flowchart are for reference only. Variations in the Data List result values may occur depending on the measuring conditions or the vehicle's age. Do not judge the vehicle to be normal even when the Data List values indicate a standard level. There are possibly some concealed factors of the malfunction.
- Check that the vehicle has not been modified in any way prior to the vehicle inspection.

INSPECTION PROCEDURE

1 CHECK SOUND AREA

(a) Find source of the abnormal sound using a mechanic's stethoscope.
Result:

Result	Proceed to
Sound from supply pump	A
Sound from parts other than supply pump	B

B → **REPAIR OR REPLACE**

A

2 CHECK WIRE HARNESS IN ENGINE ROOM

(a) Check the wire harness connections.
OK: Wire harness are connected securely.

NG → **REPAIR OR REPLACE HARNESS OR CONNECTOR**

OK

3 CHECK DTC OUTPUT (RELATING TO FUEL SYSTEM AND INTAKE SYSTEM)

HINT:
Drive the vehicle according to the driving pattern below to allow the ECM to set DTCs relating to malfunctions of the fuel system, EGR system and throttle valve. If any of the DTCs are set, problem areas can be identified.

(a) Enter CHECK MODE (see page 05–468).
(b) Fully warm up the engine.
(c) Allow the engine to idle for 5 minutes or more.
(d) Drive the vehicle at more than 40 km/h (25mph) for several tens of seconds.
(e) Decelerate and stop the vehicle.
(f) Repeat steps (f) and (g) 4 times or more.
(g) Stop the engine and wait for at least 10 seconds.
(h) Repeat steps (f) and (h) described above (to set DTCs relating to the throttle valve).
(i) Drive the vehicle at more than 70 km/h (43 mph) for at least 1 minute (to set DTCs relating to the supply pump).

NEXT

4 READ OUTPUT DTC (RELATING TO ENGINE)

(a) Enter the following menus: Powertrain / Engine / DTC.
(b) Read pending DTCs.

Result:

Display (DTC Output)	Proceed to
No DTCs (see page 05–477)	A
Engine related DTCs (see page 05–477)	B

B → **REPAIR OR REPLACE ENGINE CONTROL SYSTEM ACCORDING TO DTC OUTPUT (See page 05–477)**

A

5 PERFORM ACTIVE TEST (FUEL LEAK TEST)

HINT:
By performing this Active Test, engine speed is maintained at 2,000 rpm and the common rail internal fuel pressure is raised to the maximum operating pressure. As a result, a fuel leak check can be conducted while retaining the high common rail pressure.

(a) Connect the intelligent tester II to the DLC3.
(b) Start the engine and turn the intelligent tester II ON.
(c) Enter the following menus: Powertrain / Engine / Active Test / Test the Fuel Leak
(d) Visually check the supply pump, injector and fuel line located between the supply pump and common rail for fuel leaks and fuel pressure leaks. Also, perform the same check on the fuel line between the common rail and the injector (see page 11–46).

HINT:
There may be fuel leaks inside the components, such as the supply pump.

OK: No fuel leakage.

NG → **REPAIR OR REPLACE**

OK

6 READ DATA LIST (MAF, PIM, COMMON RAIL PRESSURE)

(a) Connect the intelligent tester II to the DLC3.
(b) Start the engine and warm it up and turn the intelligent tester II ON.
(c) Enter the following menus: Powertrain / Engine / Data List.
(d) Select the following menu items in order and read the values.
- MAP
- MAF
- Fuel Press

Standard:

Item	Engine Speed*1	Standard Range	Proceed to	Description
MAP	Ignition switch ON (engine stopped)	Same as atmospheric pressure	• A (standard range) • B (both PIM and MAF outside standard range) • C (only PIM outside standard range)	Intake manifold internal pressure detected by intake pressure sensor
	Idling	95 to 105 kPa		
	3,000 rpm (No engine load)	110 to 140 kPa		
	3,500 rpm (full throttle acceleration)	Min.: 180 kPa		
MAF*2	Ignition switch ON (engine stopped)	0 g/s	• A (standard range) • B (both PIM and MAF outside standard range) • D (only MAF outside standard range)	Intake air volume detected by mass air flow meter
	Idling	5 to 12 g/s		
	3,000 rpm (No engine load)	28 to 46 g/s		
	3,500 rpm (full throttle acceleration)	Min.: 150 g/s		
Fuel Press	Idling	30,000 to 40,000 kPa	• A (standard range) • E (common rail pressure outside standard range)	Common rail internal fuel pressure
	2,000 rpm (No engine load)	35,000 to 50,000 kPa		
	3,000 rpm (No engine load)	50,000 to 80,000 kPa		
	3,500 rpm (full throttle acceleration)	Min.: 150,000 kPa		

HINT:
*1: The A/C switch and all accessory switches should be OFF with a fully warm engine.
*2: When the MAF meter malfunctions, the MAF output value may deviate from the standard (referential) range when the engine idles and is accelerated from 3,000 to 4,000 rpm with full throttle acceleration.

B → **Go to step 11**

C → **GO TO DTC P0105/31, P0107/31 AND P0108/31 (RELATED TO MANIFOLD ABSOLUTE SENSOR) (See page 05–520)**

D → **GO TO DTC P0100/31, P0102/31 AND P0103/31 (RELATED TO MASS AIR FLOW METER) (See page 05–512)**

HINT:
A visual inspection of the MAF meter may be effective.

E → **Go to step 28**

A

7	READ DATA LIST (REVISED INJECTION VOLUME #1 TO #4, INJECTION VOLUME)

(a) Select the following menu items in order and read the values.
- Injection Feedback Vol #1, #2, #3 and #4
- Injection Volume

Standard:

Item	Engine Speed*	Standard Range	Proceed to	Description
Injection Feedback Vol #1	Idling	–3.0 to 3.0 mm^3	• A (standard range) • B (Revised Injection Volume and/or Injection Volume outside standard range)	Value of injector fuel injection volume compensates for differences in combustion condition of the cylinders • Positive values indicate control which corrects combustiondegradation • Negative values indicate control which corrects excessive combustion pressure • If problems exist, revised injection volume may deviate from –3.0 mm and 3.0 mm range
Injection Feedback Vol #2	Idling	–3.0 to 3.0 mm^3		
Injection Feedback Vol #3	Idling	–3.0 to 3.0 mm^3		
Injection Feedback Vol #4	Idling	–3.0 to 3.0 mm^3		
Injection Volume	Idling	3.0 to 12.0 mm^3		Fuel injection volume value controlled by the ECU • Controls NE signal, fuel temperature, engine coolant temperature, intake air temperature, boost pressure, atmospheric pressure, EGR volume, and MAF at target output level • If problems exist, injection volume may be outside standard range

HINT:

*: The A/C switch and all accessory switches should be OFF, and the engine should be fully warmed up.

B	Go to step 20

A

8	CHECK INJECTOR COMPENSATION CODE (See page 05–442)

HINT:

If the injector compensation code is not correctly registered, it may cause malfunctions (see page 05–419).

OK: Compensation codes of installed injector and ECM are same.

NG	REGISTER INJECTOR COMPENSATION CODE (See page 05–447)

OK

9	CLEAR BATTERY

(a) Disconnect the cable from the negative (–) battery terminal for at least 2 minutes.
(b) Reconnect the cable to the negative (–) battery terminal.
(c) Check whether the malfunction has been successfully repaired by performing a driving test using the freeze frame data recorded at the time the malfunction occurred.
OK: Malfunction has been repaired successfully.

OK	CHECK FOR INTERMITTENT PROBLEMS (See page 05–439)

NG

10	BASIC INSPECTION (See page 05–440)

(a) Check the fuel quality.
(b) Check the fuel for air.
(c) Check the fuel system for blockages.
(d) Check the air filter.
(e) Check the engine oil.
(f) Check the engine coolant.
(g) Check the engine idling speed and the maximum engine speed.
(h) Check the vacuum pump.
OK: Each inspection result is normal.

NG	REPAIR OR REPLACE

OK

11	CHECK INTAKE AND EXHAUST SYSTEM

(a) Check for air leakage and any blockage between the air cleaner and the turbocharger.
(b) Check for air leakage and any blockage between the turbocharger and the intake manifold.
OK: No air leakage or blockage.

NG	REPAIR OR REPLACE

OK

12	CHECK EGR VALVE ASSY (See page 12–20)

HINT:
In this inspection, measure the MAF rate while idling with the EGR valve fully closed.
(a) Make sure the engine is not in operation.
(b) Disconnect the E–VRV connector for EGR.
(c) Connect the intelligent tester II to the DLC3.
(d) Turn the ignition switch ON and turn the intelligent tester II ON.
(e) Start the engine.
(f) Enter the following menus: Powertrain / Engine / Data List / MAF.
(g) Measure the MAF rate while idling the engine.
Standard: MAF rate is between 5 to 12 g/s.

HINT:
With the E–VRV connector for EGR disconnected, a DTC is set when the ignition switch is turned ON. Therefore, clear the DTC upon completion of the above inspection (see page 05–466).

NG → **REPAIR OR REPLACE (See page 10–20)**

OK

13	INSPECT DIESEL THROTTLE BODY ASSY (SEE REPAIR MANUAL FOR VISUAL AND OPERATIONAL INSPECTIONS) (See page 10–17)

OK: No malfunction.

NG → **REPAIR OR REPLACE**

OK

14	CHECK COMBUSTION SOUND

(a) Confirm type of sound emitted.
Result:

Result	Proceed to
Knocking	A
Mechanical sound other than knocking	B

B → **Go to step 25**

A

15	PERFORM ACTIVE TEST (INJECTOR CUT FOR IDENTIFYING MALFUNCTIONING CYLINDER)

(a) Connect the intelligent tester II to the DLC3.
(b) Start the engine and turn the intelligent tester II ON.
(c) Enter the following menus: Powertrain / Engine / Active Test / Injector cut #1, #2, #3 and #4.
(d) Check the four cylinders in sequence to identify any faulty cylinders by performing the power–balance inspection.

HINT:

- While the engine is idling, if the idling stability variation is small despite cutting off the fuel injection, the cylinder is malfunctioning.
- With normal cylinders, the engine idles roughly when the fuel injection is cut off.

NEXT

16	CHECK CYLINDER COMPRESSION PRESSURE OF MALFUNCTION CYLINDER (See Pub. No. RM990E, page 14–186)

OK: Cylinder compression pressure is normal.

NG → **REPAIR OR REPLACE**

OK

17	CHECK MALFUNCTIONING CYLINDER INJECTION FOR DEPOSIT

HINT:
If an injector is contaminated with deposits, the fuel injection volume deviates from the standard range. This may cause malfunctions.

(a) Check the injector for any deposits.

Result:

Injector Condition	Proceed to
Deposits	A
No deposits	B

B → **REPLACE INJECTOR OF MALFUNCTIONING CYLINDER (See page 11–52)**

A

18	CLEAN INJECTOR

NEXT

19	READ DATA LIST (REVISED INJECTION VOLUME #1 TO #4, INJECTION VOLUME)

(a) Reinstall the injector to the cylinder head.
(b) Connect the intelligent tester II to the DLC3.
(c) Turn the ignition switch ON and turn the intelligent tester II ON.
(d) Start the engine and warm it up.
(e) Enter the following menus: Powertrain / Engine / Data List.
(f) Select the following menu items in order and read the values displayed on the intelligent tester II respectively.
- Injection Feedback Vol #1, #2, #3 and #4
- Injection Volume

Standard:

Item	Engine Speed*	Reference Value
Injection Feedback Vol #1 to #4	Idling	–3.0 to 3.0 mm^3
Injection Volume	Idling	3.0 to 12.0 mm^3

HINT:
*: The A/C switch and all accessory switches should be OFF, and the engine should be fully warmed up.
When the values are outside the standard range, deposits inside the injector may be causing the problem.

OK: Values are within standard range.

NG → **REPLACE INJECTOR OF MALFUNCTIONING CYLINDER (See page 11–52)**

OK

END

20 IDENTIFY MALFUNCTIONING CYLINDER INJECTOR

(a) Follow the instructions in the table below according to the check result when using the intelligent tester II.

HINT:

This operation is based on the premise that the common rail pressure is normal.

Standard:

Item	Engine Speed*	Reference Value
Injection Feedback Vol #1 to #4	Idling	–3.0 to 3.0 mm^3
Injection Volume	Idling	5.0 to 12.0 mm^3

HINT:

*: The A/C switch and all accessory switches should be OFF, and the engine should be fully warmed up.

Result:

Injection Volume / Injection Feedback Vol #1 to #4	Less than 3.0 mm^3	Between 3.0 to 12.0 mm^3 (Normal)	More than 12.0 mm^3
3.0 mm^3 or more, –3.0 mm^3 or less	A	B	B
Between –3.0 to 3.0 mm^3	—	Normal	C*

Proceed to	Inspection Areas	Descriptions
A	Inspect and repair cylinder injector with revised injection volume of less than –3.0 mm^3: Perform power balance inspection and identify malfunctioningcylinder. Replace the injector of malfunctioningcylinder	Abnormal value cylinder injector injects excessively large quantity of fuel
B	Identify malfunctioning cylinders by conducting power balance test: • Perform power balance inspection to identify malfunctioningcylinders • Clean malfunctioning cylinder injector, then check and repair it	Abnormal value cylinder injector injects excessively small quantity of fuel: • Fuel injection volume too low due to injector nozzle being blocked by deposits • Abnormal value cylinder injector compression decreases • Abnormal value cylinder injector injects excessively large quantity of fuel
C	Inspect and repair all cylinder injectors: Clean all cylinder injectors, and then inspect and repair them	All cylinder injectors inject excessively small quantity of fuel: Fuel injection volume too low due to all cylinder injector nozzles being blocked by deposits

HINT:

*: When the Injection Volume displayed on the intelligent tester II is large despite the Common Rail Pressure and Revised Injection Volume #1 to #4 in the Data List being normal, the injector may have a clogging malfunction. In this case, there may be deposits inside or outside the injector.

- Despite the injector functioning normally, the indicated Injection Feedback Vol #1 to #4 value may be outside the normal operating range due to compensation for other problems (such as low compression).
- Revised Injection Volume is the value used to correct the fuel injection volumes of each cylinder, in order to optimize (compensate for the unevenness between) all the cylinder combustion condition. If any of the cylinders malfunction, the fuel injection volumes for the normal cylinders are corrected simultaneously. As a result, the Revised Injection Volume may deviate from the standard range.

B	Go to step 17
C	Go to step 22

A

21	PERFORM ACTIVE TEST (INJECTOR CUT FOR IDENTIFYING MALFUNCTIONING CYLINDER)

(a) Connect the intelligent tester II to the DLC3.
(b) Start the engine and turn the intelligent tester II ON.
(c) Select the following menu items: Powertrain / Engine / Active Test / Injector cut #1, #2, #3 and #4.
(d) Check the four cylinders in sequence to identify any faulty cylinders by performing the power–balance inspection.

HINT:

- While the engine is idling, if the idling stability variation is small despite cutting off the fuel injection, the cylinder is malfunctioning.
- With normal cylinders, the engine idles roughly when the fuel injection is cut off.

NEXT

REPLACE INJECTOR OF MALFUNCTIONING CYLINDER (See page 11–52)

22	CHECK ALL CYLINDER INJECTORS FOR DEPOSIT

HINT:
If an injector is contaminated with deposits, the fuel injection volume deviates from the standard range. This may cause malfunctions.

(a) Check the injector for any deposits.
Result:

Injector Condition	Proceed to
Deposits	A
No deposits	B

B	REPLACE INJECTOR OF ALL CYLINDER (See page 11–52)

A

23	CLEAN INJECTOR

NEXT

24	READ DATA LIST (REVISED INJECTION VOLUME #1 TO #4 AND INJECTION VOLUME)

(a) Reinstall the injector to the cylinder head.
(b) Connect the intelligent tester II to the DLC3.
(c) Turn the ignition switch ON and turn the intelligent tester II ON.
(d) Start the engine and warm it up.
(e) Enter the following menus: Powertrain / Engine / Data List.
(f) Select the following menu items in order and read the values displayed on the intelligent tester II respectively.
- Injection Feedback Vol #1, #2, #3 and #4
- Injection Volume

Standard:

Item	Engine Speed*	Reference Value
Injection Feedback Vol #1 to #4	Idling	–3.0 to 3.0 mm^3
Injection Volume	Idling	3.0 to 12.0 mm^3

HINT:
*: The A/C switch and all accessory switches should be OFF, and the engine should be fully warmed up.
When the values are outside the standard range, deposits inside the injector may be causing the problem.

OK: Values are within the standard range.

NG → **REPLACE INJECTOR OF ALL CYLINDER (See page 11–52)**

OK

END

25	CHECK SOUND AREA

(a) Find source of the abnormal sound using a mechanic's stethoscope.

Result:

Result	Proceed to
Sound from supply pump	A
Sound from parts other than supply pump	B

B → **REPAIR OR REPLACE**

A

26	BLEED AIR FROM FUEL SYSTEM

(a) To bleed air from the priming pump, pump the priming pump until it becomes hard and cannot be pumped any more.

NEXT

27	CONFIRM WHETHER MALFUNCTION HAS BEEN SUCCESSFULLY REPAIRED

(a) Check whether the knocking has been successfully repaired by performing a driving test.
OK: Malfunction has been repaired successfully.

NEXT

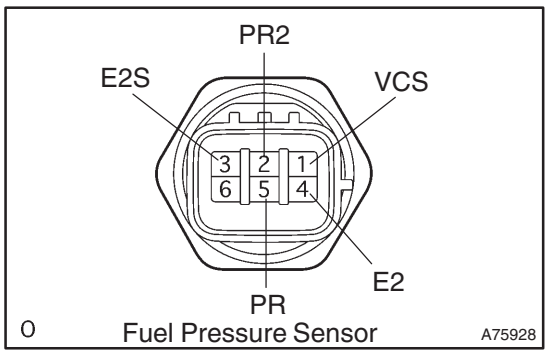
CONFIRM WHETHER KNOCKING HAS BEEN SUCCESSFULLY REPAIRED

28	INSPECT SUPPLY PUMP ASSY (See page 11–47)

NG → **REPLACE SUPPLY PUMP ASSY (See page 11–63)**

OK

29	INSPECT COMMON RAIL ASSY (FUEL PRESSURE SENSOR)



(a) Disconnect the F9 sensor connector.
(b) Measure the resistance of the sensor.
Standard:

Tester Connection	Specified Condition
F9–4 (E2) – F9–5 (PR)	3 kΩ or less
F9–3 (E2S) – F9–2 (PR2)	3 kΩ or less
F9–5 (PR) – F9–1 (VCS)	16.4 kΩ or less
F9–2 (PR2) – F9–1 (VCS)	16.4 kΩ or less

NG → **REPLACE COMMON RAIL ASSY (See page 11–67)**

OK

CONFIRM WHETHER KNOCKING HAS BEEN SUCCESSFULLY REPAIRED (PRESSURE DISCHARGE VALVE) (See page 11–47)