02- Engine

Mechanical System

Technical specifications

General specifications

Name		Specification
Cylinder pressure	Standard cylinder pressure	1.3MPa
	Minimal cylinder pressure	1.1MPa
	Maximum cylinder pressure	1.4MPa
	Maximum cylinder pressure difference	0.1MPa
Oil pressure	Idle speed	60~300kPa
	Calibrated speed	400~570kPa
Minimum diameter of exhaust cam timing sprocket		97.3mm
Minimum diameter of crankshaft timing sprocket		51.6mm
Maximum thickness of timing chain moving track		1.0mm
Cylinder head flatness	Cylinder block junction plane	0.05mm
	Intake side	0.10mm
	Exhaust side	0.10mm
Camshaft radial run-out		0.03mm
Intake and exhaust camshaft maximum lift	Intake camshaft	44.168~44.268
	Exhaust camshaft	43.705~43.805
Camshaft journal	No. 1 exhaust	34.449~34.465mm
	Others	22.949~22.965mm
Axial clearance of the camshaft	Standard axial play	0.085mm
	Maximum axial play	0.12mm
Valve spring	Free length	44.7~45.7mm
	Installation force	153~169Nom (33.88mm)
	Max. working force	335.3~370.7Nom (24.252mm)
Air valve spring verticality	Max. deviation	1.0mm
	Maximum deviation angle	2°
Valve edge thickness	Standard length	1.25 mm for intake, and 1.39 mm for exhaust
	Minimum length	1.05mm

Name			Specification
Valve length	Intake valve	Standard length	88.65mm
		Minimum length	88.35mm
	Exhaust valve	Standard length	88.69mm
		Minimum length	88.39mm
Valve stem diameter		Intake valve	5.470~5.485mm
		Exhaust valve	5.465~5.480mm
Valve seat contact width		Intake valve seat width	1.0~1.4mm
		Exhaust valve seat width	1.0~1.4mm
Valve guide inside diameter			5.510~5.530mm
Thickness of the top of the mechanical tappet			5.055~6.005
Valve oil clearance	Intake valve	Standard oil clearance	0.025~0.060mm
		Maximum oil clearance	0.08mm
	Exhaust valve	Standard oil clearance	0.030~0.065mm
		Maximum oil clearance	0.1mm
Valve guide mounting hole inside diameter			10.285~10.306mm
Valve guide designated pressing-in amount			8.7~9.1mm
Valve clearance (cold)		Intake valve	0.20~0.25mm
		Exhaust valve	0.30~0.35mm
Piston diameter standard value			82.442~82.458mm
Piston oil clearance		Standard oil clearance	0.042~0.073mm
		Maximum oil clearance	0.073mm
Piston pin mounting hole diameter			20.006~20.015mm
Piston pin top circle diameter			20.004~20.013mm
Connecting rod axial play		Standard axial play	0.16~0.34mm
		Maximum axial play	0.34mm
Connecting rod oil clearance		Standard oil clearance	0.030mm~0.054mm
		Maximum oil clearance	0.08mm
Piston pin oil film gap (piston pin mounting hole)		Standard oil clearance	0.002~0.011mm
		Maximum oil clearance	0.011mm
Connecting rod small end bore			20.012~20.021mm
Piston pin oil film gap (small hole of connecting rod)		Standard oil clearance	0.001~0.017mm
		Maximum oil clearance	0.017mm
Piston ring groove gap		First ring groove	0.035~0.075mm
		Second ring groove	0.035~0.075mm

Name			Specification
Piston ring notch clearance	Closed gap	First ring	0.20~0.35mm
		Second ring	0.40~0.60mm
		Film ring	0.20~0.70mm
	Maximum opening gap	First ring	10mm
		Second ring	11mm
		Film ring	1~4mm
Maximum twist of connecting rod			0.05mm/100mm
Maximum permissible straightness of connecting rod			0.05mm/100mm
Connecting rod bolt diameter		Nominal diameter	7.30~7.40mm
		Minimum diameter	7.20mm
Crankshaft maximum radial run-out			0.03mm
Crankshaft main journal diameter			47.982~48.000mm
Maximum taper and non-roundness of main crankshaft journal			0.02mm
Crankshaft connecting rod neck diameter			43.984~44.000mm
Crankshaft connecting rod neck taper and non-roundness			0.02mm
Crankshaft oil clearance		Standard oil clearance	0.014~0.032mm
		Maximum oil clearance	0.1mm
Cylinder block main bearing cap fixing bolt diameter		Nominal diameter	8.80~9.00mm
		Minimum diameter	8.70mm
Upper body warpage of cylinder block (maximum warpage)			0.05mm
Cylinder block cylinder hole diameter			82.5~82.015mm

Torque Specifications

Name	Torque range	
	Metric Nm	British Lb-ft
Oil sump drain bolt	44	32
Engine left suspension mounting bolt	88	65
Engine right suspension mounting bolt	88	65
Engine front suspension mounting bolt	88	65
Engine rear suspension mounting bolt	88	65
Power steering pump fixing bolt	45	33
Air conditioning compressor mounting bolts	25	18
Bolts and nuts for fixing electronic throttle body	11	8
Bolt for fixing intake manifold	30	22
Bolt for fixing outtake manifold	37	27
Bolts for fixing isolation shield on exhaust manifold	18	13
Bolts for fixing timing sprocket on exhaust camshaft	54	40
Bolts for fixing timing sprocket on intake camshaft	60	44
Set bolt of the flexible rail of timing chain	19	14
Timing chain fixed rail mounting bolts	13	10
Front enclosure mounting bolts	23	17
Tensioner hold-down nuts	11	8
Crankshaft pulley fixing bolts	138	102
Pump fixing bolt	11	8
Engine front suspension bracket mounting bolts	52	38
Bolts and nuts for fixing belt tension wheel	Bolt: 69 Nut: 29	Bolt: 51 Nut: 21
Generator fixing bolt	Short bolts: 25. Long bolts: 54.	Short bolts: 18. Long bolts: 40.
Cylinder head cover fixing bolt	11	8
Ignition coil fixing bolt	11	8
Spark plug	40	30
Bolts for fixing camshaft bearing cover	23	17
Other bolts for fixing camshaft bearing cover	13	10
Bolts for fixing cylinder head (fastening it for two times)	First time 49, Second time 90	First time 36,Second time 66
Fuel rail fixing bolt	11	8
Connecting rod cap fixing bolt	50	37
Cylinder drain bolts	23	17

Name	Torque range	
	Metric Nm	British Lb-ft
Oil filter	28	21
Oil strainer set bolt	25	18
Oil sump fixing bolt	10	7
Bolts for fixing main bearing cover on crankshaft (fastening it for two times)	First time 40, Second time 60	First time 30, Second time 44
Bolts for fixing upper and lower cylinder block	18	13
Bolts for fixing flywheel	88	65
Oil pressure sensor torque	15	11
Bolts for fixing cooling nozzle	33	24

Precautions

Precautions

1. Allow the engine to cool down before discharging the engine coolant.
2. When disconnecting the fuel lines, keep away from the source of ignition and kids as much as possible.
3. After removing the oil pipes, seal all the oil pipe joints to prevent the piple plugging or fuel leak.
4. Take special care when removing the engine and do not damage the fitting face and slipping face.
5. When removing the engine, seal the engine openings with the tape or equivalent materials to prevent the foreign matters entering the engine.
6. During the removal, identify and arrange all the disassembled parts to facilitate the troubleshooting and reassembly.
7. Clean and check all the parts thoroughly before the repair or replacement.
8. For the assembly of engine, the basic principles for tightening bolts and nuts are to tighten the middle bolt or nut first and then those on the diagonal position to the same torque in several steps. Follow the designated sequence if any.
9. Replace the new gasket, oil seal and seal ring during the assembly of engine.
10. Apply the sealant uniform and install the bonding components in the specified time after the sealant application.
11. During the assembly of engine, carefully check the engine oil lines and vacuum lines for clogging.
12. When connecting the sensor connectors, ensure to hear a silvery click before stopping the installation.
13. After repairing and assembling the engine, start the engine and increase the engine speed to check the engine coolant, fuel, engine oil and exhaust gas for leak.

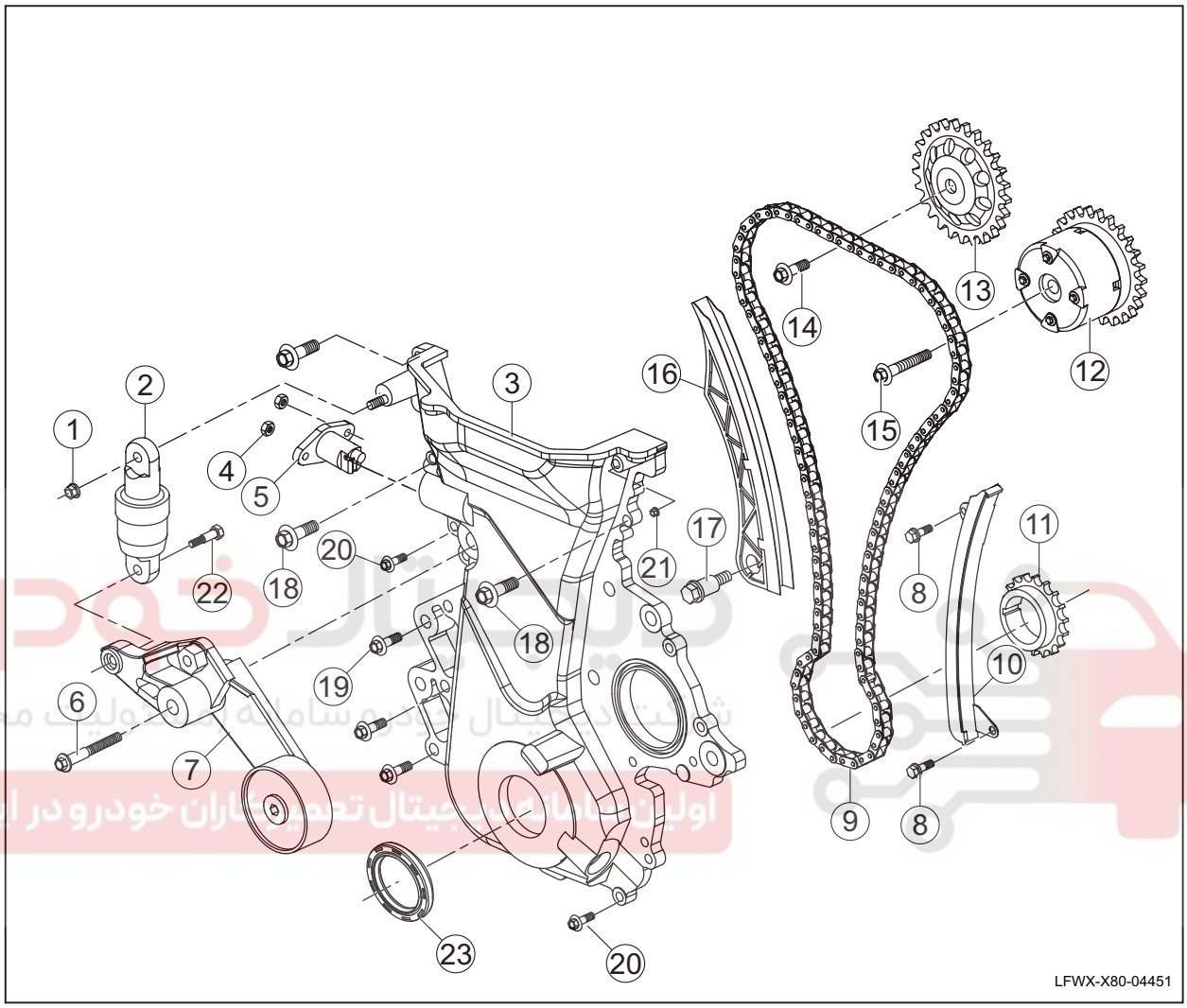
Preparation

Special maintenance tools

Structure and installation location

Component Location Plan

Timing sprocket



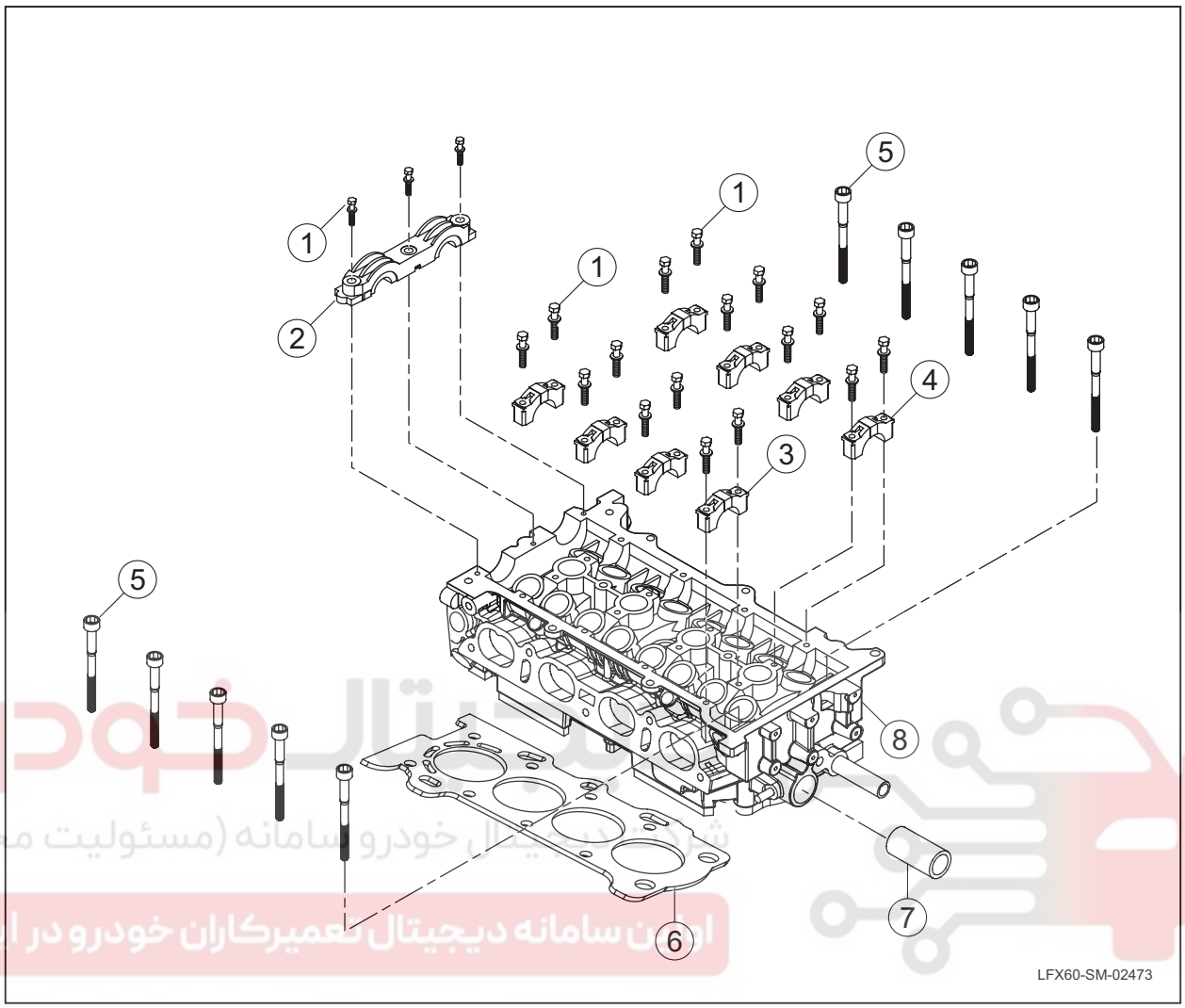
No.	Part name
1	Hex flange nut
2	Shock absorber
3	Timing cap
4	Hex flange nut
5	Timing chain tensioner
6	Tensioner bolt
7	Tensioner assembly
8	Hexagon head bolt and plain washer assembly
9	Timing chain

No.	Part name
13	Exhaust timing sprocket
14	Exhaust timing sprocket bolt
15	Phaser bolt
16	Timing chain rail components
17	Slide rail positioning bolt
18	Hexagon flange bolt
19	Hexagon flange bolt
20	Hexagon flange bolt
21	Hex flange nut

No.	Part name
10	Orbit determination components of timing chain
11	Crankshaft timing sprocket
12	Air intake phaser (CVVT or VVT) assembly

No.	Part name
22	Hexagon flange bolt
23	Front crankshaft oil seal

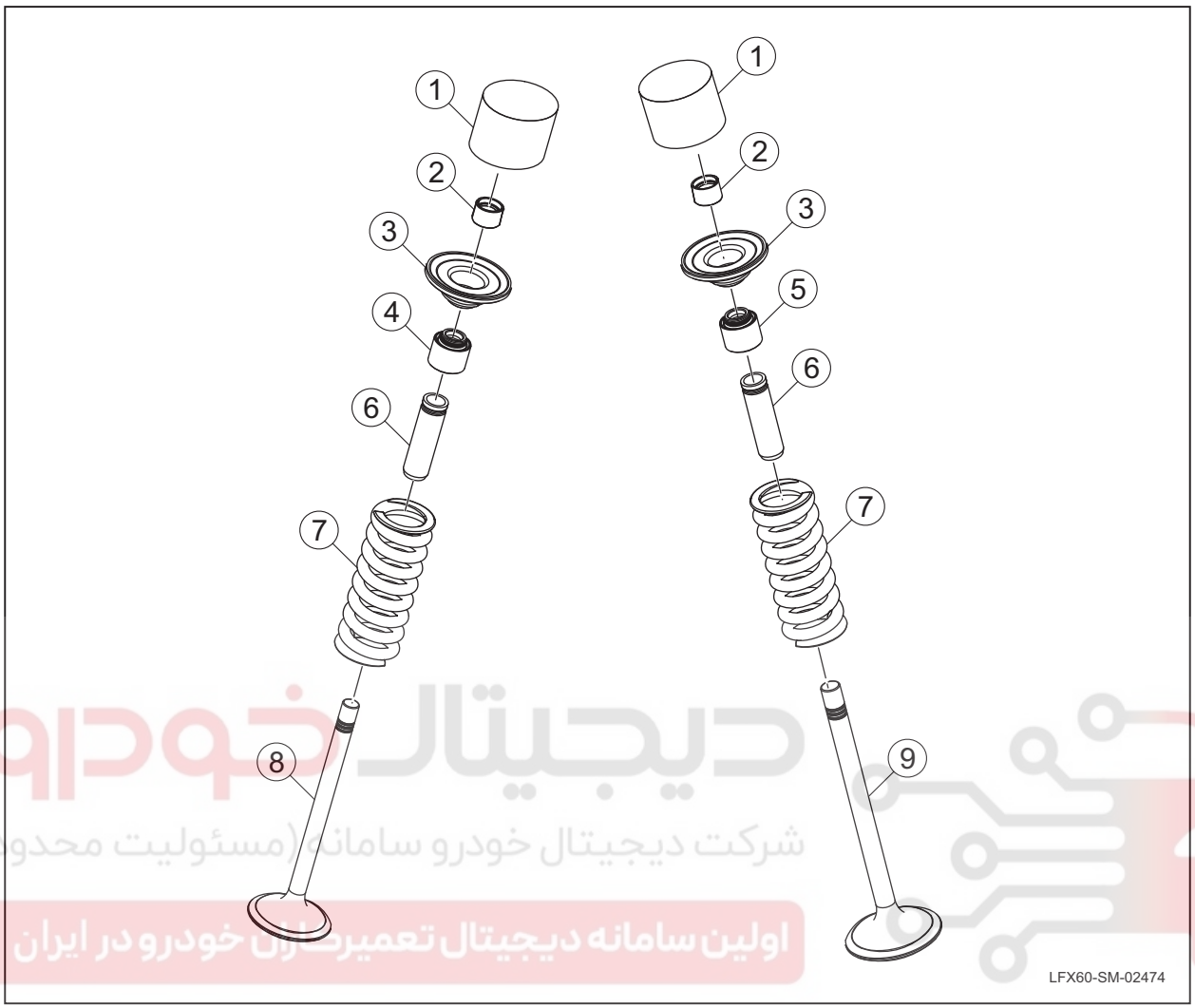
Cylinder head



No.	Part name
1	Camshaft cover bolt
2	1st camshaft bearing cap
3	Intake camshaft cap
4	Exhaust camshaft cover

No.	Part name
5	Cylinder head bolt
6	Cylinder head gasket
7	Water outlet pipe
8	Cylinder head assembly

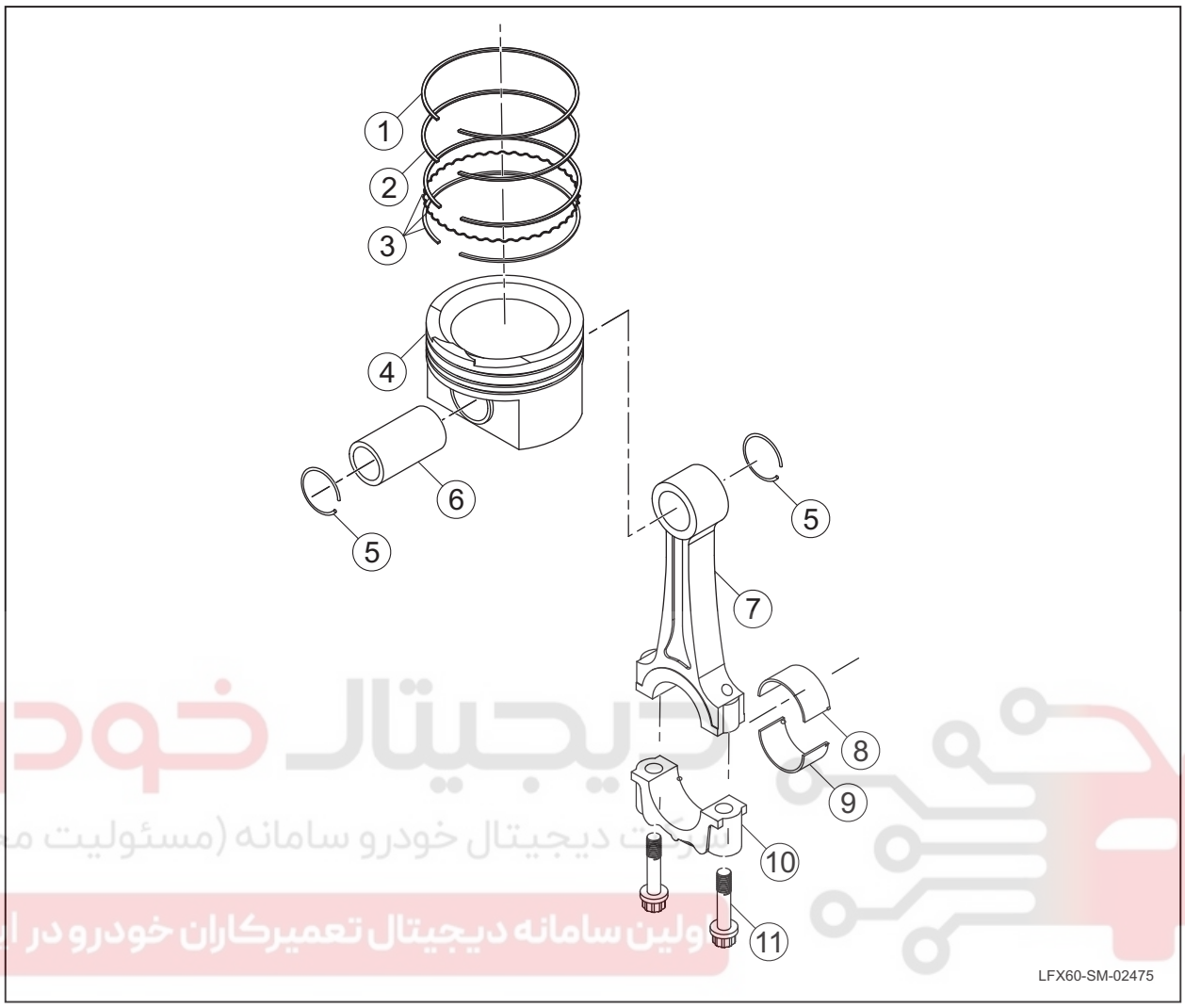
Valve



No.	Part name
1	Tappet
2	Valve collet
3	"Seat, spring, valve"
4	Oil seal of exhaust valve
5	Oil seal of Intake valve

No.	Part name
6	Valve guide
7	Valve spring
8	Exhaust valve
9	Intake valve

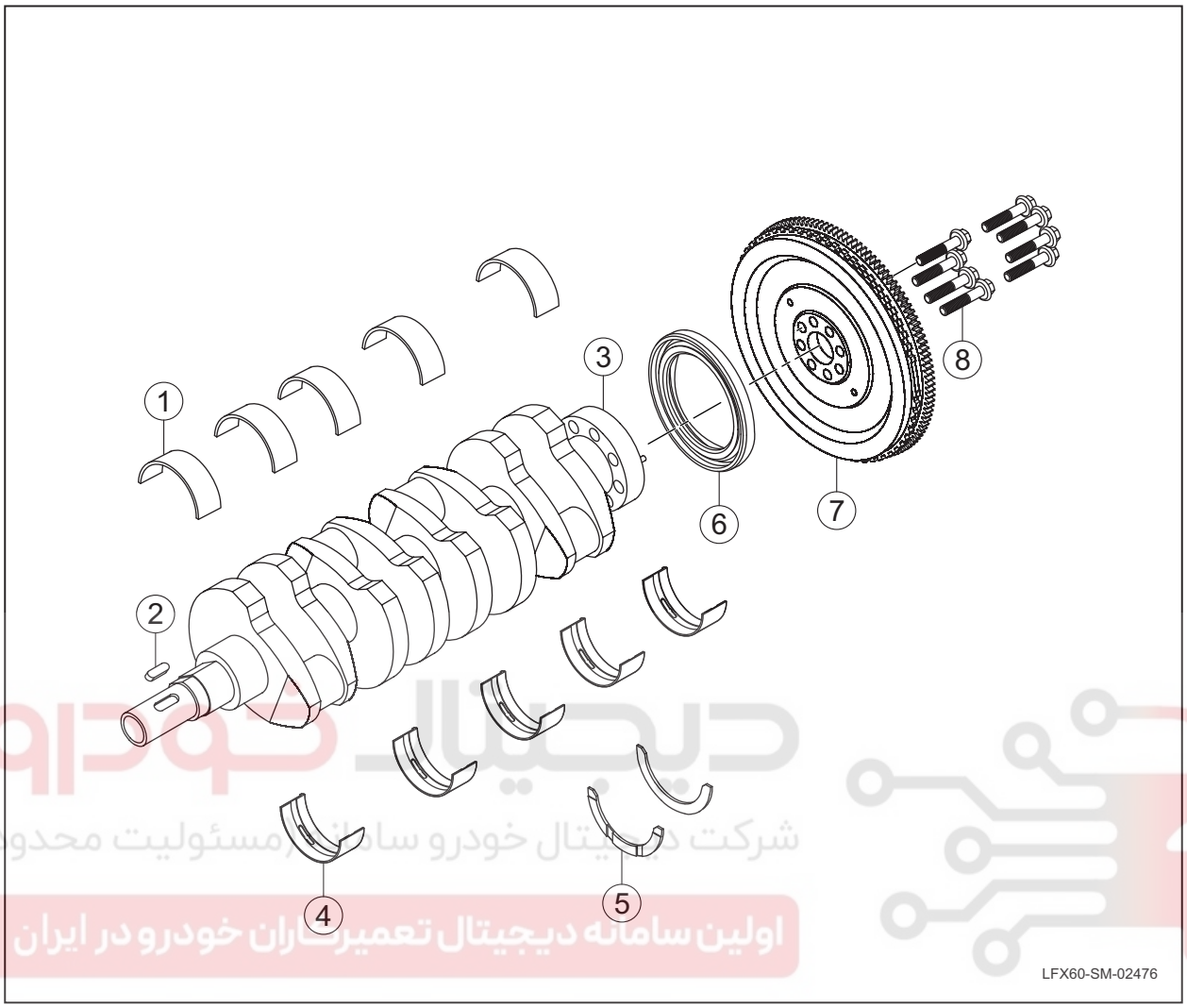
Piston and connecting rod



No.	Part name
1	1st piston ring
2	2st piston ring
3	Combination oil ring
4	Piston
5	Snap ring, piston pin
6	Piston pin

No.	Part name
7	Linking rod body
8	Upper connecting rod lining
9	Lower connecting rod lining
10	Connecting rod cap
11	Connecting rod bolt

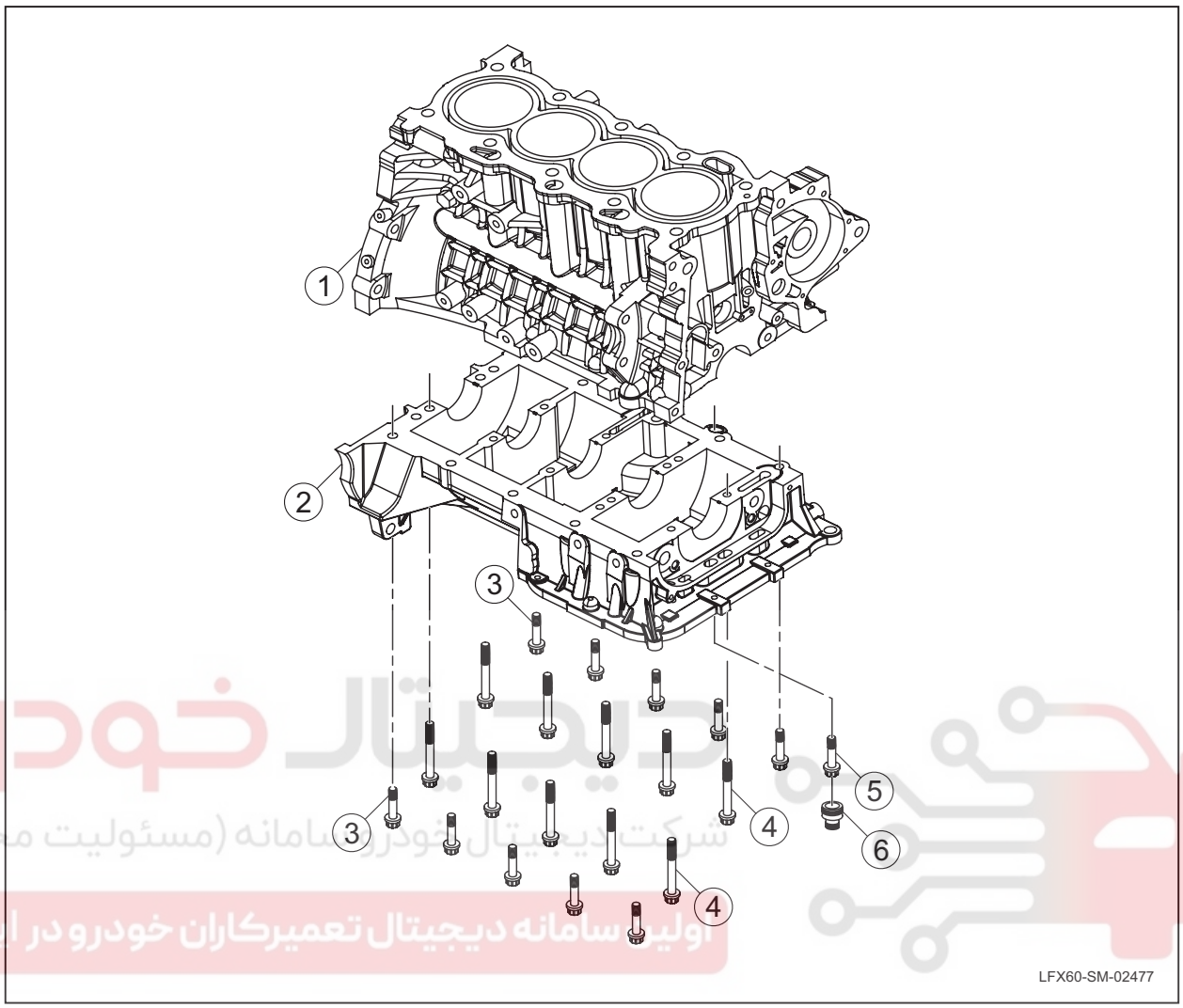
Crankshaft and flywheel



No.	Part name
1	Upper main bearing shell
2	Woodruff key
3	Crankshaft
4	Lower main bearing shell

No.	Part name
5	Upper thrust plate
6	Crankshaft rear oil seal
7	Flywheel assembly
8	Flywheel bolt

Cylinder block



No.	Part name
1	Upper cylinder body
2	Lower cylinder body
3	Cylinder fixing bolt

No.	Part name
4	Bearing cap fixing bolt
5	Cylinder fixing bolt
6	Oil filter connecting nut

General Inspection

Check the engine coolant

a. Check whether the engine coolant leaks.

- Add coolant into the radiator assembly.
- Connect the radiator cover detector, adjust the radiator to the standard pressure, and then observe whether the pressure value drops.

Standard pressure of radiator:
94.2~115.8kPa (exhaust)
4.9kPa (intake)
180kPa (sealed)

Note:

- **If the pressure drops, check whether the hose, the radiator assembly and the water pump for leaks.**
- **If there is not any coolant leak outside of the engine, check the heater core, the cylinder block and the cylinder head.**

Check the air filter element

a. Remove the upper cover of air filter.
b. Take off the air filter element.
c. Visually inspect whether there is any dirt or damage on the air filter element. If any, clean or replace it.

Install the driving belt

a. Check whether there is any oil trace on drive belt. If any, clean it.
b. Check whether the drive belt is aged, cracked or worn. If any, replace it.

Check the cylinder pressure

a. Preheat the engine, and then stop it.

Note:

After preheating the engine, turn the transmission shift level in the Neutral position, and enable the parking brake.

b. Disconnect each ignition coil connector.
c. Disconnect each injector connector.
d. Remove each ignition coil retaining bolt, and then remove four ignition coils.
e. Use a sleeve and an extension level to remove all spark plugs.

Note:

- **Do not damage the insulations of the ignition coil.**
- **During the removal, identify the ignition coil of each cylinder to facilitate the subsequent installation.**

f. Install a pressure gauge into a spark mounting hole.
g. Start the engine, and read out the value on the pressure gauge.

Standard cylinder pressure: 1.2MPa
Minimal cylinder pressure: 1.0MPa
Maximum cylinder pressure: 1.3MPa

Note:

Before starting, must check whether the battery is fully charged; otherwise, the battery should be charged or replaced.

h. Test the pressure of other cylinders with the same method, and calculate the maximum pressure difference among cylinders.

Maximum cylinder pressure difference:
0.1MPa

Note:

All tests must be completed within a short period (about 15s) to avoid damage to the starter.

Diagnostic Information and Procedures

Diagnosis Instructions

Before diagnose the mechanical system failure in an engine, understand and familiarize the operating principle of the mechanical system in the engine, and then begin to diagnose the mechanical system in the engine. This helps to determine the correct troubleshooting procedures in the event of a failure. And most importantly, it helps to determine whether a customer's description belongs to a normal operation.

Any failure diagnosis on mechanical system in engine should be based on the inspection of mechanical system in engine to guide the maintenance staff to take next logical procedures and carry out troubleshooting. Comprehend and correctly use the diagnostic flow chart to shorten the diagnosis time and avoid the misjudgement.

General equipment

Digital multimeter
Diagnostic equipment of vehicle
Oil manometer
Cylinder compression pressure gauge
Sound scope

Visual Inspection

1. Confirm the problem of the customer.
2. Visually check whether there is any obvious mechanical or electrical damage sign.

Visual inspection table

Mechanical
• Coolant leak • Oil leak • Fuel leak • Nut or bolt is loosened or dropped • Part is damaged or worn obviously • Accessory belt is damaged obviously • Tension wheel is damaged obviously • Pulley is damaged obviously

3. If the observed or proposed problem is obvious and its cause is identified, rectify the cause before proceeding with next step.
4. If for the problem, there are no obvious findings, then confirm the fault and refer to the symptom table.

List of fault symptoms

If the vehicle fails, no trouble code is detected by the engine control module (ECM), and no significant fault location is found after visual inspection and general inspection, it is recommended that troubleshooting should be carried out according to diagnostic ideas and processes of the table below.

Symptom	Possible Cause	Recommended Measures
Accessory belt noise	• Attachment belt	**Refer to: Accessory belt noise diagnosis process**
	• Related fasteners	
	• Crankshaft pulley	
	• Generator	
	• Water pump	
	• Air conditioning compressor	
	• Booster pump	
There is an abnormal noise below the engine	• Deformation of oil pan	**Refer to: Abnormal noise diagnosis process is under the engine**
	• Filter screen is deformed or damaged	
	• The oil pressure is too low	
	• The fitting clearance between the crankshaft and bearing is too big	
	• The axial clearance of the crankshaft is too big	
Engine tempering	• Electric control system fault	**Refer to: Engine tempering diagnosis process**
	• Engine timing	
	• The mixture is too thick	
	• Exhaust valve components	
	• Exhaust system blocked	
	• ECM	
Engine firing **Note:** **ℹ The fuel in the exhaust system is ignited to produce a severe bust noise.**	• Electric control system fault	**Refer to: Engine blasting diagnosis process**
	• Engine timing	
	• The ignition is too late	
	• The mixture is too thick	
	• Exhaust valve components	
	• Exhaust system leaks	
	• ECM	
Exhaust abnormity (blue smoke)	• Burn oil	**Refer to: Exhaust abnormality (blue smoke) diagnosis process**
Exhaust abnormity (black smoke)	• Fuel and gas mixture is too concentrated	**Refer to:Exhaust abnormality (black smoke) diagnosis process**

Symptom	Possible Cause	Recommended Measures
Connecting rod and connecting rod bearing noise	• Oil pump pressure is too low • Side clearance at the large end of connecting rod is overrun • Tightening torque of connecting rod bolt • Twist/bend overrun of connecting rod • Crank roundness/taper overrun • Connecting rod bearing overrun	**Refer to: Diagnostic process of noise in connecting rod and connecting rod bearing**
Piston and piston pin noise	• Oil pump pressure is too low	**Refer to: Diagnosis process of piston and piston pin noise**
	• The big end clearance of the connecting rod is beyond the scope	
	• Connecting rod distortion/bend overrun	
	• The piston pin clearance is too big	
	• The clearance between the piston and cylinder wall is too big	
	• The piston ring groove clearance is too big	
Valve train group noise	• Bucket tappet is blocked	**Refer to: Diagnostic procedure of valve train group noise**
	• The oil pump pressure is too low	
	• The cam angle is damaged	
	• The camshaft journal clearance is too big	
	• Camshaft axial clearance is too large	
	• The valve spring is too soft	
	• The valve is stuck	
	• Clearance between valve rod and valve guide pipe is too large	
	• The valve seat is loosened	
Engine can not be started - the crankshaft can not be rotated freely	• Parts in accessory drive system are jammed	**Refer to: Engine non-starting – crankshaft non-rotating diagnosis process**
	• The cylinder is stuck due to the hydraulic reason.	
	• The camshaft is stuck or broken	
	• Components in valve system are stuck or broken	
	• There is a foreign object in the cylinder.	
	• The crankshaft and connecting rod bearing is stuck	
	• The connecting rod is bent or broken	
	• The crankshaft is broken.	

Accessory belt noise diagnosis process

Note:

- **The accessory belt includes a compressor belt and a pump belt.**
- **Be sure to use a correct accessory belt.**
- **Using a stethoscope will help determine the location where the engine noise is generated.**
- **The flatness (the unevenness of crank pulley and associated accessory pulleys) may cause abnormal wear of accessory belt, abnormal noise, fall-off and others.**
- **Sudden increase of large load may cause the belt to slip and make noise. For example, compressor is started in air conditioning system, and throttle is opened quickly when engine is running, etc.**
- **Excessive load may cause abnormal belt noise, such as excessive filling in air conditioning system.**

Test condition	Details/results/measures
1. Check the attachment belt.	
	A. Check whether the correct accessory belt is installed. B. Check whether the accessory belt appearance is normal. Is it OK after checking? →**Yes** To step 2. →**No** Replace the accessory belt. Refer to: Accessories belt replacement.
2. Check the related fasteners.	
	A. Check whether all fasteners associated with the accessory belt are loose or peel off. B. Check whether they are loose or peel off. →**Yes** Tighten or replace it. →**No** To step 3.
3. Check the tensioner assembly.	
	A. Remove the accessory belt. B. Rotate the tension wheel assembly. The bearing can not appear stuck, loose or others. C. Rotate the tension wheel assembly. The bearing can not appear any abnormal sound. D. The tensioner can not displaced, bent, distorted and cracked. E. There should be abnormal scratches, edges and corners and other abnormalities on the tensioner surface. F. Whether to meet the requirements above? →**No** Clean it. →**Yes** To step 4.

Test condition	Details/results/measures
4. Check the crankshaft pulley and pulleys of related accessories.	
	A. The pulley can not be displaced, bent, distorted, cracked or loosened. B. There should be abnormal scratches, edges and corners and other abnormalities on the pulley surface. C. There should be no foreign body in pulley groove. Can it meet the above requirements? →**No** Clean the foreign bodies, fasten or replace the part. →**Yes** To step 5.
5. Check water pumps, generators, air conditioning compressor bearings, and steering power pump one by one.	
	A. Check whether pumps, generators, steering power pump, air conditioning compressor can rotate normally. The bearing can not appear stuck, loose or others. B. Turn the bearings, there should be no abnormal noise. Whether to meet the requirements above? →**No** Carry out the part replacement. →**Yes** Confirm that the fault has been ruled out.

Abnormal noise diagnosis process is under the engine

Note:

- **Remove the accessory belt to eliminate the noise caused by these devices.**
- **Using a stethoscope will help determine the location where the engine noise is generated.**

Test condition	Details/results/measures
1. Check the oil sump.	
	A. Check the oil sump. Whether is the oil pan deformed? →**Yes** Repair or replace it, and then go to Step 2. →**No** To step 2.
2. Check the oil filter screen.	
	A. Check the oil filter screen. Whether the oil filter screen is deformed or damaged? →**Yes** Repair or replace it. →**No** To step 3.
3. Check the oil pressure.	
	A. Check and test the oil pressure. B. Is the oil pressure too low? →**Yes** To step 4. →**No** To step 5.
4. Check the oil pump.	
	A. Remove the oil pump. B. Check the oil pump. Is the oil pump normal? → **No** Replace the oil pump. **Refer to: oil pump replacement** →**Yes** To step 5.

Test condition	Details/results/measures
5. Check the shaft tile fitting clearance and the crankshaft axial clearance	
	A. Decompose the main shaft tiles and the connecting rod shaft tiles. B. Check the fitting gap between main engine bearing brush and connecting rod bearing brush as well as whether there is any wear on crankshaft thrust plate. Are the fitting clearances and the crankshaft axial clearance normal? →**No** Maintain the main engine bearing brush, the fitting gap of connecting rod bearing brush, and the axial clearance of crankshaft to a normal value. →**Yes** Confirm that the fault has been ruled out.

Engine misfire diagnosis procedure

Test condition	Details/results/measures
1. Check the engine DTC.	
	A. Read and see if there is a DTC in the engine control system by using automotive diagnostic equipment. Is there a DTC? →**Yes** **Refer to:Diagnostic trouble code (DTC) list. Perform DTC diagnostic procedure.** →**No** To step 2.
2. Check the vacuum degree of air intake system.	
	A. Check the intake system vacuum and determine whether the intake system leaks. Whether does the intake system leak? →**Yes** Repair it. **Refer to:Air intake leak diagnosis process** →No To step 3.
3. Check the engine timing.	
	A. Intake leakage diagnosis procedure. Is it OK after checking? →**No** Carry out adjusting and repairing. →**Yes** To step 4.
4. Check the fuel pressure.	
	A. Check the fuel pressure. Is the fuel pressure too low? →**Yes** Implement the measures for symptoms. **Refer to: Diagnostic process of low fuel pressure** →**No** To step 5.
5. Check the fuel injector.	
	A. Check the fuel injector. Is the injector jammed? →**Yes** Clean or replace it. →**No** To step 6.

Test condition	Details/results/measures
6. Test the spark plug.	
	A. Test the spark plug. Is the test normal? →**No** Clean or replace it. →**Yes** To step 7.
7. Check the cylinder pressure.	
	A. Check the cylinder pressure. **Refer to: Cylinder compression pressure check** Is it within the standard scope? →**Yes** To step 8. →**No** Repair it.
8. Check the exhaust system.	
	A. Test the exhaust back pressure, to check whether the exhaust system is clogged. If is it clogged? →**Yes** Implement the exhaust system clogging diagnosis procedure. →**No** To step 9.
9. Check ECM.	
	A. Replace ECM. **Refer to: ECM** ECM confirms that the troubleshooting is successful.

Engine blasting diagnosis process

Test condition	Details/results/measures
1. Check the engine DTC.	
	A. Read and see if there is a DTC in the engine control system by using automotive diagnostic equipment. Is there a DTC? →**Yes** **Refer to: Diagnostic trouble code (DTC) list. Perform DTC diagnostic procedure.** →No To step 2.
2. Check the engine timing.	
	A. Check the engine timing. Is it OK after checking? →**No** Repair it. →**Yes** To step 3.
3. Check the fuel pressure.	
	A. Check the fuel pressure. Is the fuel pressure too low? →**Yes** Implement the measures for symptoms. **Refer to: Diagnostic process of low engine fuel pressure** →**No** To step 4.
4. Check the fuel injector.	
	A. Check the fuel injector. Is the injector jammed? →**Yes** Clean or replace it. →**No** To step 5.
5. Test the spark plug.	
	A. Test the spark plug. Check whether it is normal? →**No** Clean or replace it. →**Yes** To step 6.

Test condition	Details/results/measures
6. Check the cylinder pressure.	
	A. Check the cylinder pressure. **Refer to: Cylinder compression pressure check** If is it clogged? →**Yes** To step 7. →**No** Repair it.
7. Check the exhaust system.	
	A. Test the exhaust back pressure, to check whether the exhaust system is clogged. Whether is the exhaust system blocked? →**Yes** Implement the exhaust system clogging diagnosis procedure. →**No** To step 8.
8. Check ECM.	
	A. Replace ECM. **Refer to: ECM** ECM confirms that the troubleshooting is successful.

Exhaust abnormality (blue smoke) diagnosis process

Note:
- **Use the oil meeting the specifications.**
- **It is accompanied usually with spark plug fouling.**

Test condition	Details/results/measures
1. Check the engine oil level.	
	A. Check the level of engine oil. Whether is the oil level too high? **→Yes** Restore the correct oil level. **→No** To step 2.
2. Check the spark plug.	
	A. Check the spark plug. Whether there is any spark plug fouling? **→Yes** Clean or replace it. **→No** To step 2.
3. Check the oil-gas separator.	
	A. Check the oil-gas separator. Is it OK after checking? **→No** Replace the oil-gas separator. **→Yes** To step 4.
4. Check the piston rings or valve for fault.	
	A. Check the piston rings or valve for fault. **Refer to: Cylinder compression pressure check** **Standard cylinder pressure: 1.2MPa** **Minimal cylinder pressure: 1.0MPa** **Maximum cylinder pressure: 1.3MPa** **Maximum cylinder pressure difference: 0.1MPa** If is it clogged? **→Yes** To step 6. **→No** To step 5.

Test condition	Details/results/measures
5. Check the piston rings or valve for fault.	
	A. After add a proper amount of oil into the cylinder. The cylinder pressure is increased significantly. Check the piston ring. The cylinder pressure is not increased significantly. Check the valve.
6. Check the carbon deposition in the combustion chamber.	
	A. Check the combustion chamber. If is there some carbons? →**Yes** Clean it. →**No** To step 7.
7. Check the valve seal.	
	A. Check the valve seal. Whether is the valve oil seal leaking? →**Yes** Clean it. →**No** Confirm that the fault has been ruled out.

Exhaust abnormality (black smoke) diagnosis process

Test condition	Details/results/measures
1. Check the engine DTC.	
	A. Read the engine control system with an automobile diagnostic device to determine whether there is any DTC. Is there a DTC? →**Yes** **Refer to:Diagnostic trouble code (DTC) list. Perform DTC diagnostic procedure.** →**No** To step 2.
2. Check the fuel pressure.	
	A. Check the fuel pressure. Whether is the fuel pressure too high? →**Yes** Check fuel pipelines and fuel pumps. →**No** To step 3.
3. Check the fuel injector.	
	A. Check the fuel injector. Whether is the injector leaking? →**Yes** Clean or replace it. →**No** To step 4.
4. Test the spark plug.	
	A. Test the spark plug. Is the test normal? →**No** Clean or replace it. →**Yes** To step 5.
5. Check the carbon canister solenoid valve.	
	A. Check the carbon canister solenoid valve. Whether is the carbon canister solenoid valve operating normally? →**No** Replace the canister solenoid valve. →**Yes** To step 6.

Test condition	Details/results/measures
5. Check ECM.	
	A. Replace ECM. **Refer to: ECM** Confirm that the fault has been ruled out.

Diagnostic process of noise in connecting rod and connecting rod bearing

Note:

- **Remove the accessories belt to remove the noise caused by the accessories device.**
- **Remove the accessories belt. Strictly limit the engine running time. Otherwise, high temperature damage to the engine can be caused.**
- **Using a stethoscope will help determine the location where the engine noise is generated.**
- **The noise can be isolated sometimes by removing an injector harness connector at one time. If the noise volume is reduced or disappears, the noise is related to the cylinder in which it is located.**
- **Excessive connecting rod clearance will cause the engine with a percussion noise at a variety of speeds, and low oil pressure will also be accompanied by this situation.**

Test condition	Details/results/measures
1. Confirm that the fault is not caused by the attachments.	
	A. Remove the attachment belt. **Refer to: Accessories belt replacement.** Does the noise exist? **→No** Noise generated by accessories. Check the accessories. **→Yes** To step 2.
2. Check the oil.	
	A. Check whether the oil status is normal. B. Check whether the oil level is normal. Is it OK after checking? **→Yes** To step 3 **→No** Replace the oil or restore the oil level.
3. Check the oil pump pressure.	
	A. Check the oil pump pressure. Is the oil pump pressure too low? **→Yes** Repair it. **→No** To step 4.
4. Broken cylinder inspection.	
	A. Perform an off-cylinder test by removing the injector harness connector. Confirm which engine cylinder is associated with noise. Is there a cylinder working abnormally? **→Yes** Repair it. **→No** To step 5.

Test condition	Details/results/measures
5. Check the big end clearance of the connecting rod.	
	A. Check the big end clearance of the connecting rod. If is there a leakage? →**No** Replace the connecting rod. **Refer to: Replacement of the piston, piston ring, and connecting rod assembly.** →**Yes** To step 6.
6. Check the connecting rod bolt tightening torque.	
	A. Check the connecting rod bolt tightening torque. If is there a leakage? →**No** Replace connecting rod bolts, and fasten them according to the standard torque. →**Yes** To step 7.
7. Check the twist/bend of connecting rods.	
	A. Check the twist/bend of connecting rods. If does it meet the requirement? →**No** Replace the connecting rod. **Refer to: Replacement of the piston, piston ring, and connecting rod assembly.** →**Yes** To step 8.
8. Check the crankshaft roundness and taper.	
	A. Check the crankshaft roundness and taper. If is there a leakage? →**No** Repair or replace the crankshaft. →**Yes** To step 9.
9. Check the clearance between the connecting rod and the crankshaft.	
	A. Check the clearance between the connecting rod and the crankshaft. If is there a leakage? →**No** Repair it to meet the specifcation requirements. →**Yes** Confirm that the fault has been ruled out.

Diagnosis process of piston and piston pin noise

Note:

- **Remove the accessory drive belt to eliminate the noise caused by these accessory devices.**
- **Remove the accessory belt. Strictly limit the engine running time. otherwise, it will lead to a high temperature damage to the engine.**
- **Using a stethoscope will help determine the location where the engine noise is generated.**
- **The percussion noise caused by the excessive gap between piston and cylinder wall can be heard usually when the engine is idling in operation. If the fuel r injector wiring harness plug on the cylinder is removed, the knock sound may be changed obviously.**

Test condition	Details/results/measures
1. Confirm that the noise is not caused by accessories devices.	
	A. Remove the attachment belt. **Reference: Attachment** If is there a noise? **→No** Noise generated by accessories. Check the accessories. **→Yes** To step 2.
2. Check the oil.	
	A. Check whether the oil status is normal. B. Check whether the oil level is normal. Is it OK after checking? **→Yes** To step 3. **→No** Replace the oil or restore the oil level.
3. Check the oil pressure.	
	A. Check the oil pressure. Is the oil pressure too low? **→Yes** Repair it. **Reference: Oil pump** **→No** To step 4.
4. Broken cylinder inspection.	
	A. Use the cylinder disconnection test with removal of the fuel injector wiring harness plug, to confirm the engine cylinder associated with the noise. Is there a cylinder working abnormally? **→Yes** Repair it. **→No** To step 5.

Test condition	Details/results/measures
5. Check the installation of the connecting rod and the piston.	
	A. Check the installation of the connecting rod and the piston. If is there a leakage? →**No** Reinstall it. **Refer to: Replacement of the piston, piston ring, and connecting rod assembly.** →**Yes** To step 6.
6. Check the connecting rod tortion/bending degree.	
	A. Check the connecting rod torsion/bending degree. If is there a leakage? →**No** Replace the connecting rod. **Refer to: Replacement of the piston, piston ring, and connecting rod assembly.** →**Yes** To step 7.
7. Check the piston pin clearance.	
	A. Check whether the piston pin clearance is within the range specified in the specification. If is there a leakage? →**No** Repair it. **Refer to: Replacement of the piston, piston ring, and connecting rod assembly.** →**Yes** To step 8.
8. Check the piston ring groove clearance.	
	A. Check the piston ring groove clearance. If is there a leakage? →**No** Repair it to meet the requirement. →**Yes** To step 9.
9. Check the clearance between piston and cylinder wall.	
	A. Check the clearance between the piston and the cylinder wall. If is there a leakage? →**No** Repair it to meet the requirement. →**Yes** Confirm that the fault has been ruled out.

Diagnostic procedure of valve train group noise

Note:

- **Remove the accessories belt to remove the noise caused by the accessories device.**
- **Remove the accessories belt. Strictly limit the engine running time. Otherwise, high temperature damage to the engine can be caused.**
- **Using a stethoscope will help determine the location where the engine noise is generated.**

Test condition	Details/results/measures
1. Confirm that the noise is not caused by accessories devices.	
	A. Remove the attachment belt. **Refer to: Accessories belt replacement.** If is there a noise? **→No** Noise generated by accessories. Check the accessories. **→Yes** To step 2.
2. Check the oil.	
	A. Check whether the oil status is normal. B. Check whether the oil level is normal. Is it OK after checking? **→Yes** To step 3. **→No** Replace the oil or restore the oil level.
3. Check the oil pressure.	
	A. Check the oil pressure. Is the oil pressure too low? **→Yes** Repair it. **Refer to: oil pump replacement** **→No** To step 4.
4. Check the hydraulic rocker component.	
	A. Check the hydraulic rocker assembly. Can they meet the requirements? **→No** Replace and repair it. **Refer to: Replacement of the camshaft and hydraulic rocker arm assembly** **→Yes** To step 5.

Test condition	Details/results/measures
5. Check the camshaft cam height.	
	A. Check the camshaft cam height. If is there a leakage? →**No** Replace the camshaft **Refer to: Replacement of the camshaft and hydraulic rocker arm assembly** →**Yes** To step 6.
6. Check the camshaft journal clearance	
	A. Check the camshaft journal clearance If is there a leakage? →**No** Repair it. →**Yes** To step 7.
7. Check the camshaft axial clearance.	
	A. Check the camshaft axial clearance. If is there a leakage? →**No** Repair it. →**Yes** To step 8.
8. Check the valve spring.	
	A. Check whether the valve spring can meet the specification requirements. If is there a leakage? →**No** Replace the valve spring. **Refer to: Replace the cylinder head assembly and the valve assembly.** →**Yes** To step 9.
9. Check whether the air valve.	
	A. Check whether the valve is stuck. Whether is the valve stuck? →**Yes** Repair or replace relevant parts. →**No** To step 10.

Test condition	Details/results/measures
10. Check the clearance between the valve stem and the valve duct.	
	A. Check the clearance between the valve stem and the valve duct. If is there a leakage? →**No** Repair or replace relevant parts. →**Yes** To step 11.
11. Check whether the valve seat is loosened.	
	A. Check whether the valve seat is loosened. Whether is the valve seat loose? →**No** Repair or replace relevant parts. →**Yes** Confirm that the fault has been ruled out.

Engine non-starting – crankshaft non-rotating diagnosis process

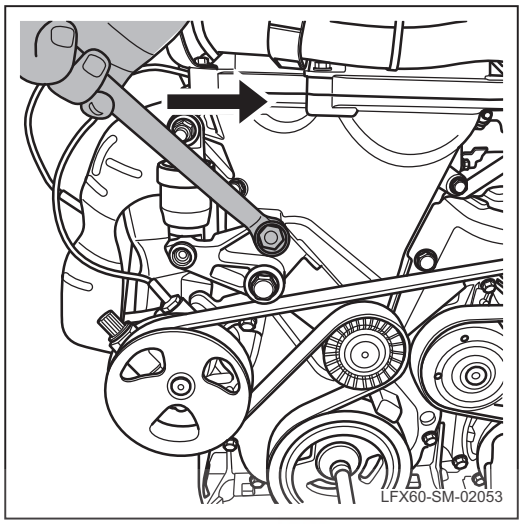
Test condition	Details/results/measures
1. Check the accessory drive system components.	
	A. Remove the accessory belt, and try to rotate the crankshaft with a wrench. **Reference: Attachment** Is the crankshaft rotated freely? → **Yes** Repair or replace the accessory drive system components. →**No** To step 2.
2. Check whether the cylinder is stuck due to the hydraulic pressure.	
	A. Remove all spark plugs and check whether there is water/oil/antifreeze attached on them. If is there a leakage? →**Yes** Check whether there is any crack on cylinder block, cylinder head and cylinder seal gasket to carry out inspection or repair. →**No** To step 3.
3. Check the cylinder head assembly.	
	A. Remove the timing mechanism. B. Check the cylinder head. - The camshaft is stuck or broken - The valve rocker is stuck or broken. - The valve or valve spring is stuck or broken. If are there the above circs? → **Yes** Repair or replace it. → **No** To step 4.
4. Check the cylinder block assembly.	
	A. Check the cylinder block assembly. - The piston is broken. - There is the foreign body in the cylinder - The crankshaft is broken. - The connecting rod is bent or broken If are there the above circs? → **Yes** Repair or replace it. → **No** Confirm that the fault has been ruled out.

Removal and Installation

Attachment belt

Removal

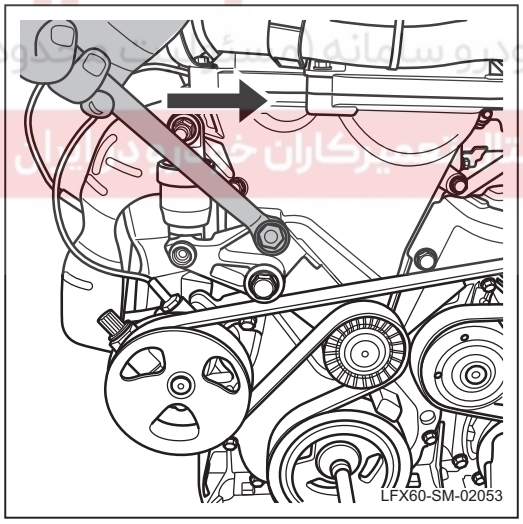
1. Remove the accessory belt.



(a). Turn the tensioning wheel assembly clockwise by using a tool.
(b). Remove the accessory belt.

Installation

1. Install the accessory belt.



(a). Turn the tensioning wheel assembly clockwise by using a tool.
(b). Install the accessory belt.

⚠Warning:

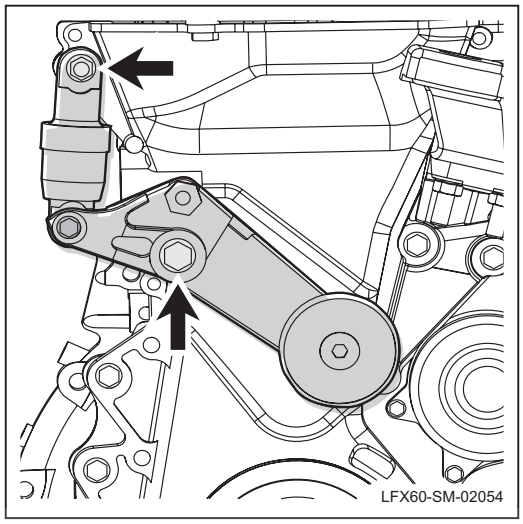
- **When installing the accessory belt, please ensure that it is combined correctly with the pulley groove.**
- **Do not allow the engine oil or the engine coolant to attach on the accessory belt.**
- **Do not excessively twist or bend the accessory belt.**

Tensioner assembly

Removal

1. Remove the tensioner assembly.

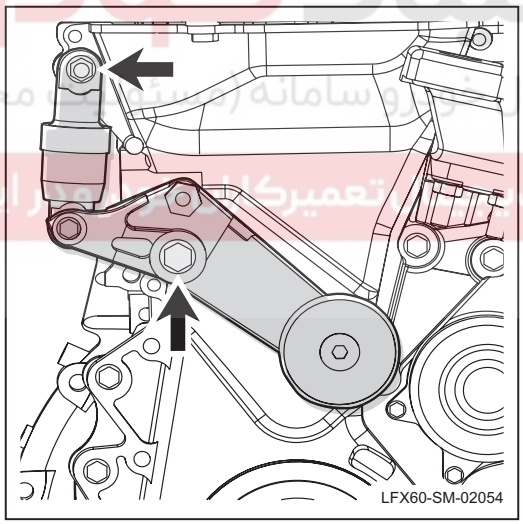
(a). Remove the accessory belt. **Refer to: Accessories belt replacement.**



(b). Remove the tensioning wheel assembly, retaining bolts and nuts as well as take off the tensioning wheel assembly.

Installation

1. Install the tensioner assembly.



(a). Install the tensioning wheel assembly on the engine. Install and tighten retaining bolts and nuts on the tensioning wheel assembly.
Torque: 29 Nm (Nut)
Torque: 69 Nm (bolt)

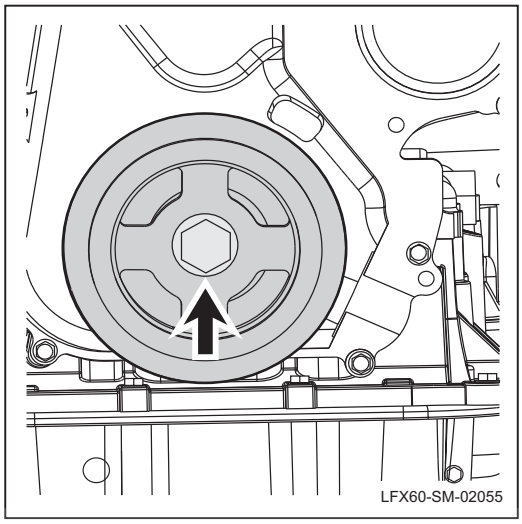
(b). Install the accessories belt.**Refer to: Accessories belt replacement.**

Crankshaft front oil seal

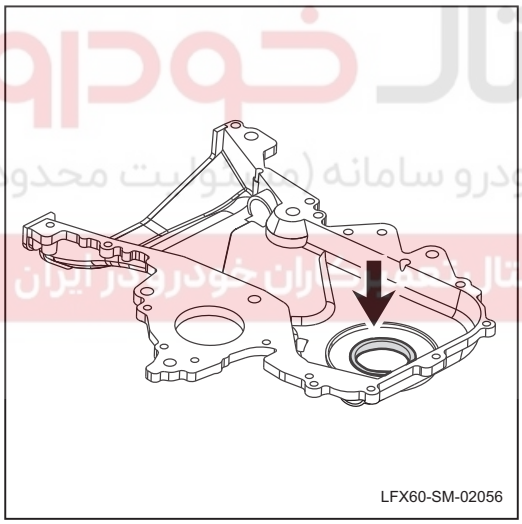
Removal

1. Tensioner bracket

(a). Remove the accessory belt. **Refer to: Accessories belt replacement.**



(b). Remove retaining bolts from the crankshaft pulley, and take off the crankshaft pulley.



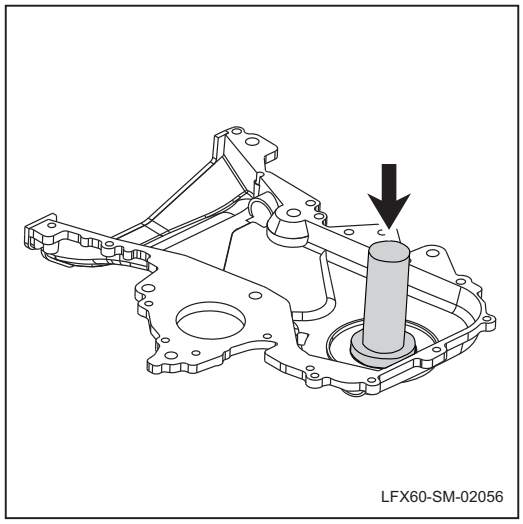
(b). Remove the front seal from the crankshaft with a proper tool.

Note:

The removed oil seal can not be used again; when installation, please replace the new oil seal.

Installation

1. Install the front crankshaft oil seal.



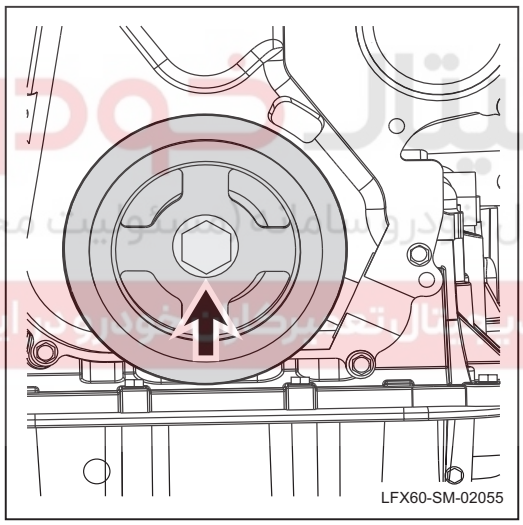
(a). Install the front oil seal with an oil seal tool on the crankshaft.

△ **Tips:**

Before installation, coat a layer of clean oil on the oil seal lip.

Note:

Vertically install the oil seal; do not install it aslant.



(b). Install the crankshaft pulley, install and fasten retaining bolts on the crankshaft pulley.
Torque: 138 Nm

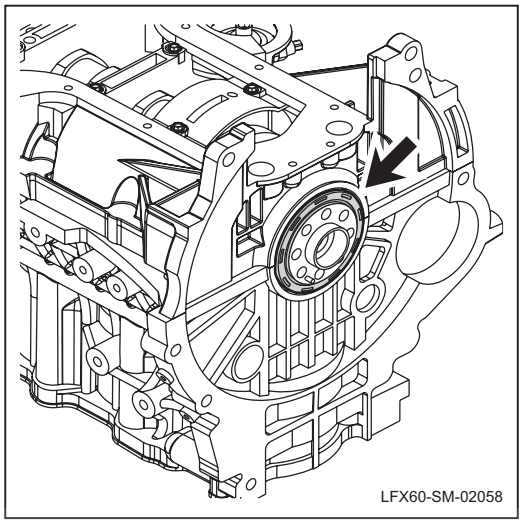
(c). Install the accessories belt，**Refer to: Accessories belt replacement.**

Crankshaft rear oil seal

Removal

1. Remove the rear crankshaft oil seal.

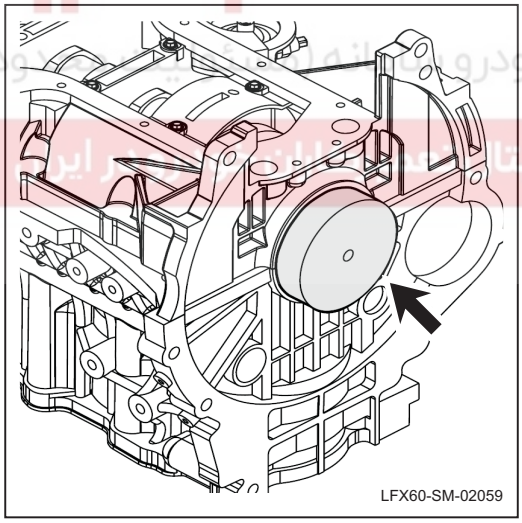
(a). Remove the flywheel. **Refer to: Flywheel replacement.**



(b). Remove the rear oil seal from the crankshaft.

Installation

1. Install the rear crankshaft oil seal.



(a). Use the oil seal tool to install the rear crankshaft oil seal.

(b). Install the flywheel. **Refer to: Flywheel replacement.**

Replacement of timing chain and sprocket assembly

Removal

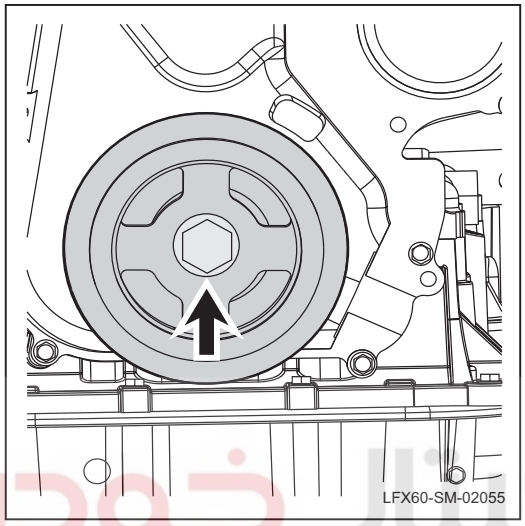
1. Remove the timing chain and sprocket components.

(a). Remove the accessory belt. **Refer to the replacement of accessory belt.**

(b). Remove the camshaft cover. **Refer to: Replacement of the camshaft cover.**

(c). Remove the tensioning wheel assembly. **Refer to the replacement of tensioning wheel assembly.**

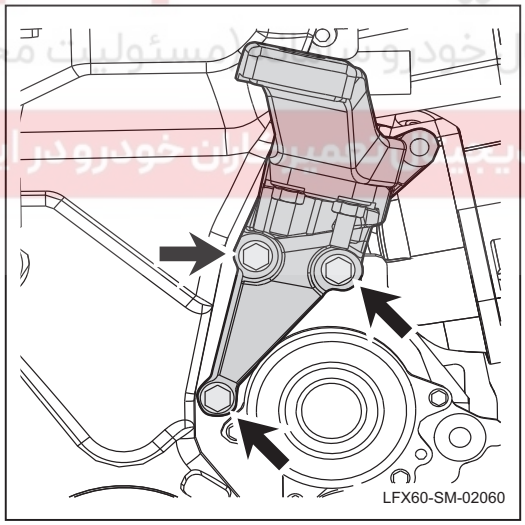
(d). Remove the water pump assembly. **Refer to the replacement of water pump assembly.**



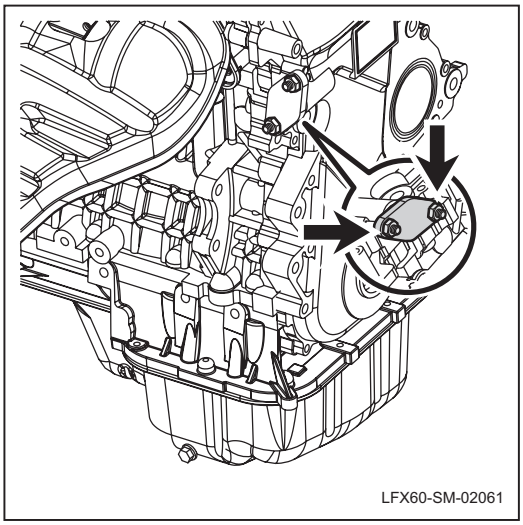
(e). Remove retaining bolts from the crankshaft pulley, and take off the crankshaft pulley.

△**Tips:**

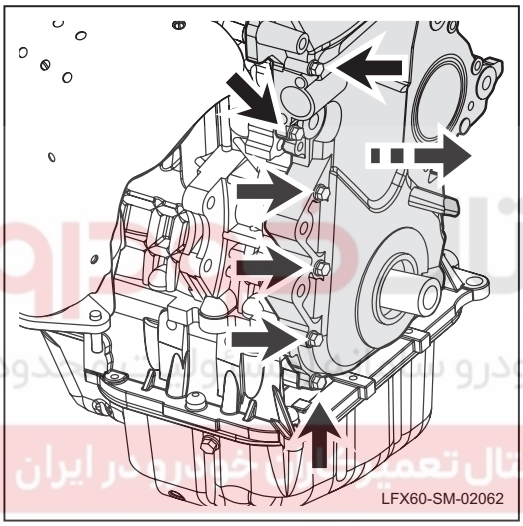
To prevent any rotation when removing the crankshaft pulley, it can be fixed before removal.



(f). Remove retaining bolts from the right engine mounting bracket.



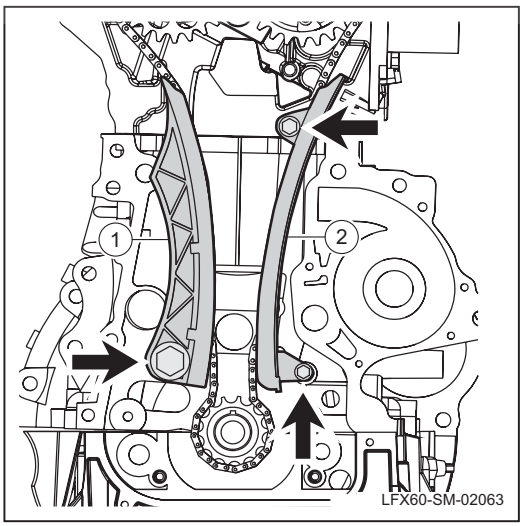
(g). Remove mounting nuts from the timing chain tensioner, and take off the timing chain tensioner.



(h). Remove retaining bolts from the timing cover in the order shown in the illustration, and take off the timing cover.

Note:

The timing cover is difficult to remove due to the sealant; it should be tapped with a rubber hammer to remove it.



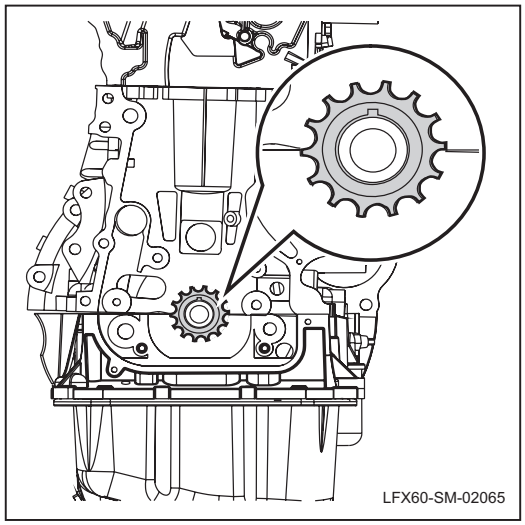
(i). Remove the timing chain rail assembly ① and the orbit determination assembly ② .

Note:

To prevent that the valve tappets or other parts withstand the piston due to the camshaft or crankshaft rotation when removing the timing part, before removal, rotate the crankshaft to allow that the piston is not in TDC or BDC position.

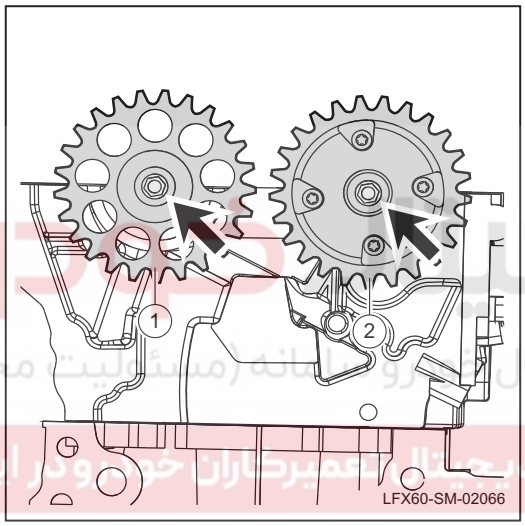
(j). Remove the timing chain.

(k). Take out the timing sprocket.

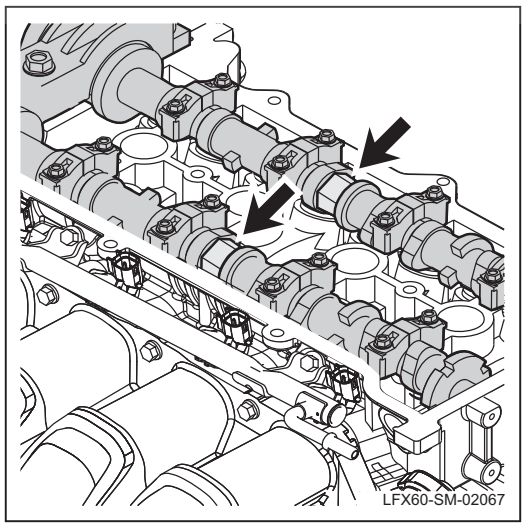


(l). Remove the crankshaft timing sprocket ring.
(m). Remove the crankshaft sprocket and the semicircle key.

△**Tips:**
After the semi-circular key is embedded in the pin groove, it is not easy to remove; if it is removed in this step, do not miss it in the installation.



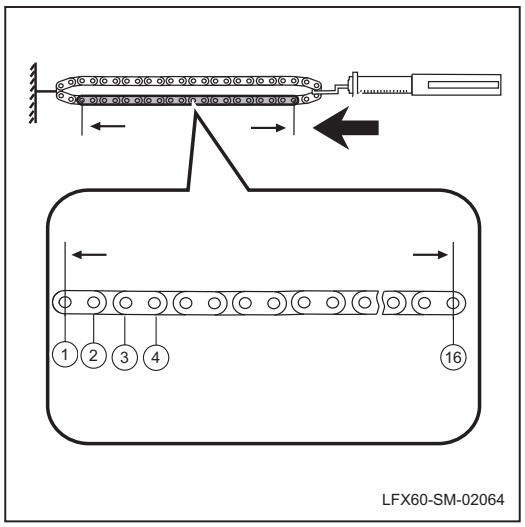
(n). Remove bolts from the exhaust timing sprocket, and take off the exhaust timing sprocket ① .
(o). Remove bolts from the intake phase shifter and take off the intake phase shifter ② .



Note:
To prevent the camshaft rotation during disassembly, must apply an opposite force on the camshaft with a wrench (apply the force on the position as shown on the left figure).

Inspection

1. Check the timing chain.



LFX60-SM-02064

(a). Check the timing chain for damage; if any, replace it.

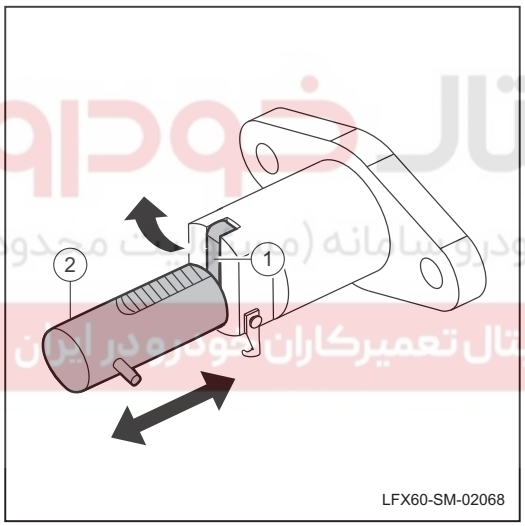
(b). As shown, apply a force of 140N onto the timing chain with a spring pressure gauge and then measure the length of the chain with a vernier caliper. If the maximum elongation of the chain is exceeded, replace the chain.

Maximum elongation of the chain: 13mm

△Tips:

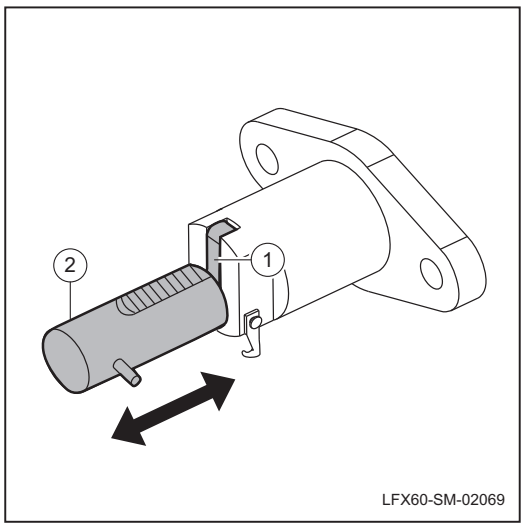
Randomly select 3 or more points for the chain length check with the method as shown in the left figure.

2. Check the timing chain tensioner.



LFX60-SM-02068

(a). Lift the tensioning shaft lock sheet ① , check whether the tensioning shaft can ② carry out a telescopic movement. If not, replace the tensioner.



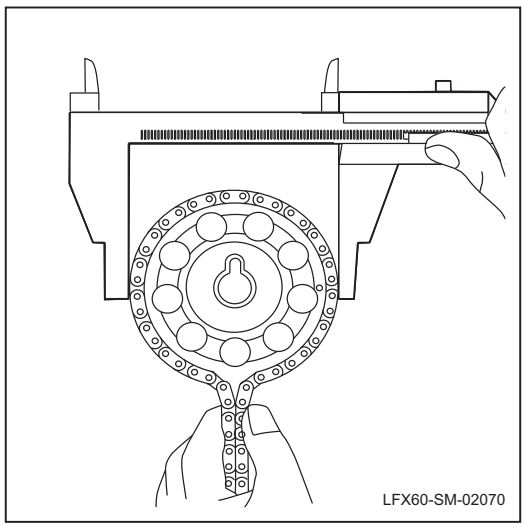
LFX60-SM-02069

(b). Lock the tensioning shaft with a lock sheet ① , check whether the tensioning shaft ② can carry out a telescopic movement. If yes, replace the tensioner.

❶Note:

At this point, the tensioner shaft can be only retracted inside and can not be stretched outside.

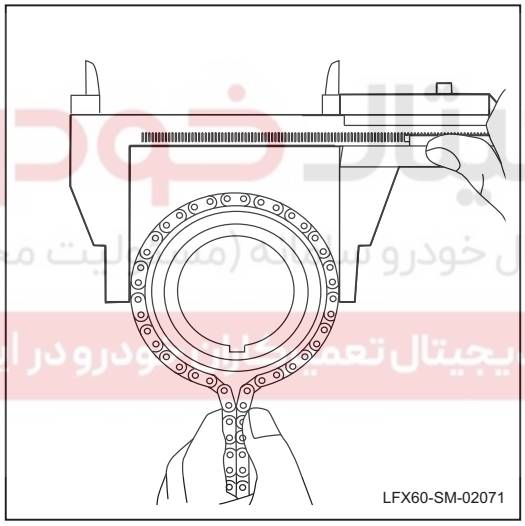
3. Check the exhaust timing sprocket.



(a). Install the chain onto the exhaust timing sprocket.
(b). Use a vernier caliper to measure the exhaust timing sprocket diameter with the timing chain. If it is less than the specified value, replace the exhaust timing sprocket.
Minimum diameter: 97.3mm

Note:
In measurement, the two measuring points of the vernier caliper must be contacted with the chain roller.

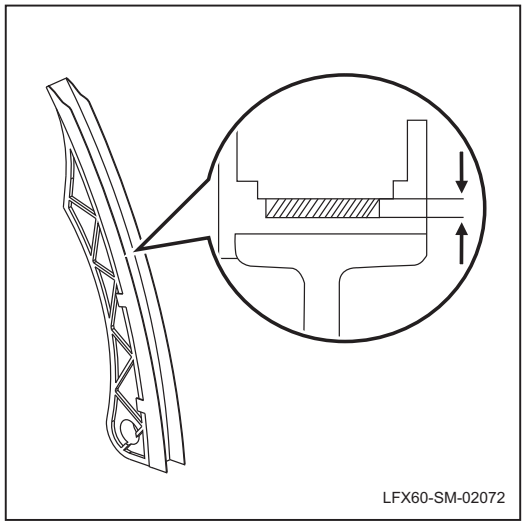
4. Check the crankshaft timing sprocket.



(a). As shown, install the chain onto the crankshaft timing sprocket.
(b). Use a vernier caliper to measure the crankshaft timing sprocket diameter with the timing chain. If it is less than the specified value, replace the crankshaft sprocket.
Minimum diameter: 51.6mm

Note:
In measurement, the two measuring points of the vernier caliper must be contacted with the chain roller.

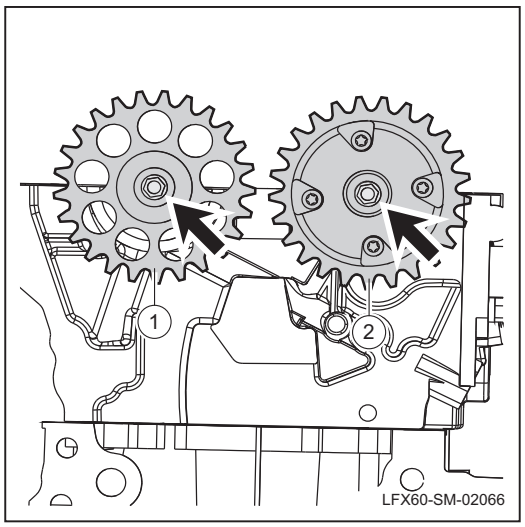
5. Check the timing chain rail assembly.



(a). Use a vernier caliper to measure the thickness of the timing chain moving rail. If the rail thickness is greater than the maximum thickness, replace the timing chain drive rail assembly.
Maximum thickness: 1.0 mm.

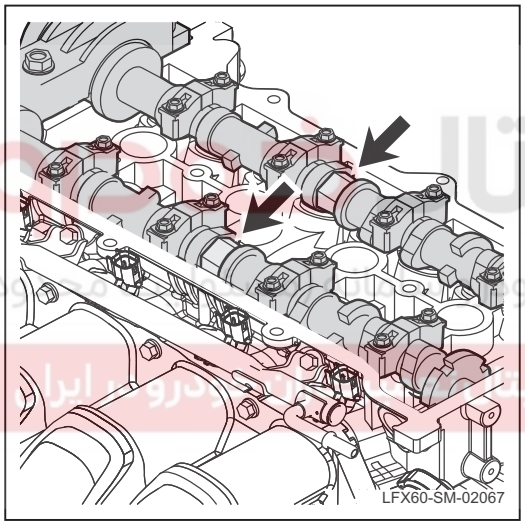
Installation

1. Install the timing chain and sprocket components.

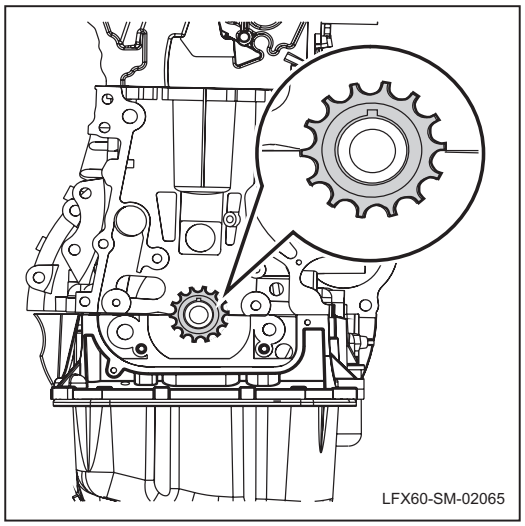


(a). Install the exhaust timing sprocket ① to the mounting position, install mounting bolts, and tighten them.
Torque: 54Nm

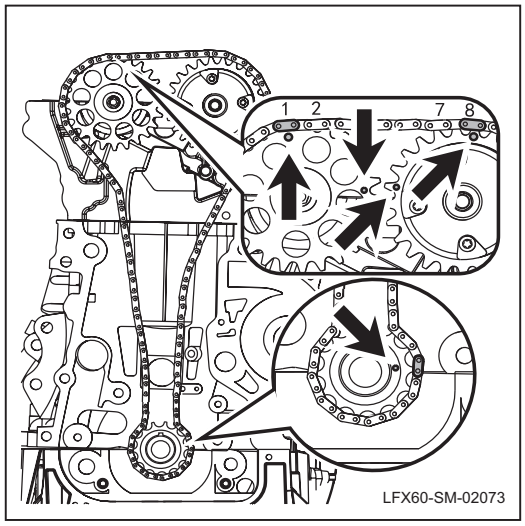
(b). Install the intake phase shifter assembly ② to the mounting position, install the phase shifter bolts, and tighten them.
Torque: 60Nm



ℹNote:
To prevent the crankshaft from rotating during the disassembly period, apply an opposite force with a wrench on the camshaft (apply a force on the diagram in the left figure).



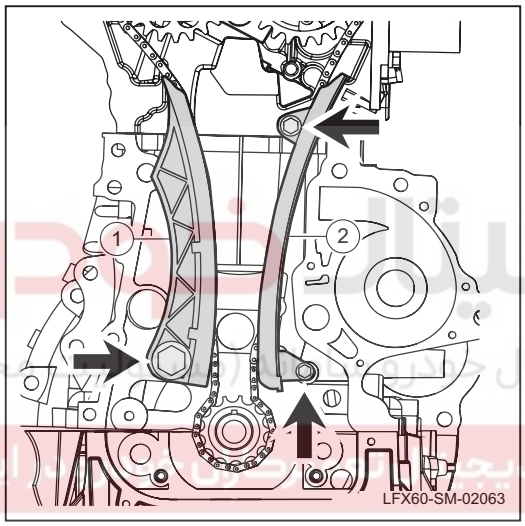
(c). Install the crankshaft timing sprocket.



(d). Install the timing chain.

Note:

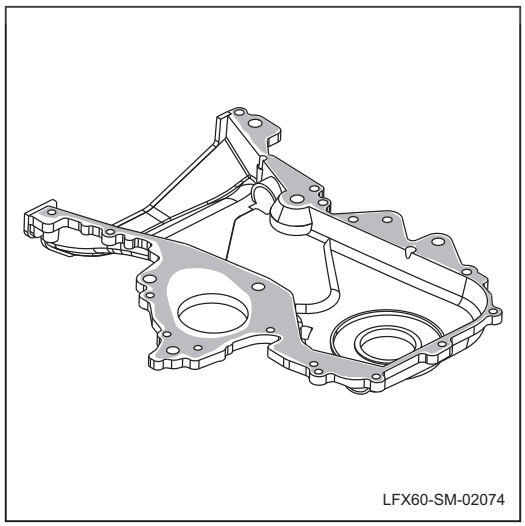
As shown, the markings should be aligned when installing the timing chain.



(e). Install the timing chain rail assembly ① and the orbit determination assembly ② .

Torque: 19 Nm (dynamic rail mounting bolts).

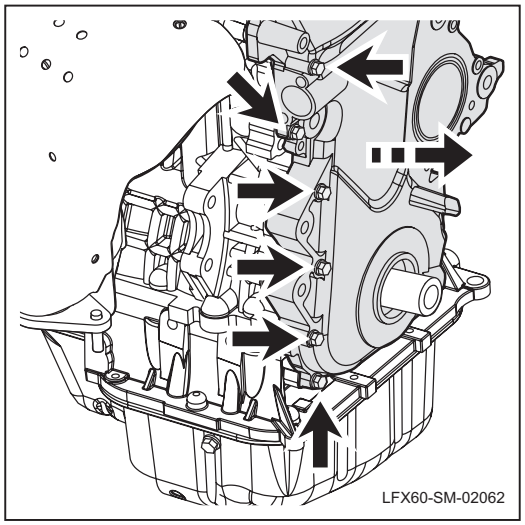
Torque: 13 Nm (orbit determination bolts).



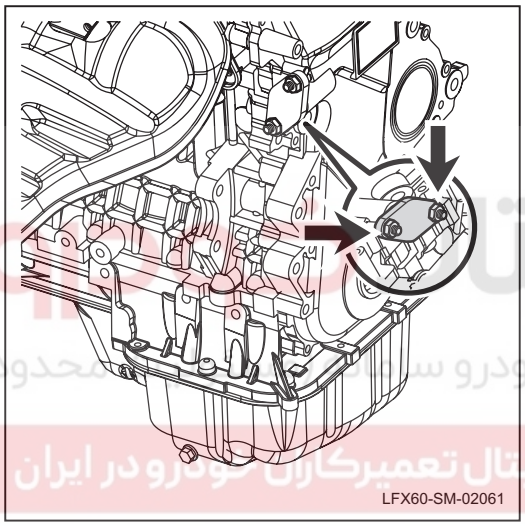
(f). Apply sealant evenly to the mating surface of the timing cover.

Note:

Be sure to clean the old sealant before applying the new one.



(g). Install the timing cover on the engine, install mounting bolts, and tighten them.
Torque: 23 Nm

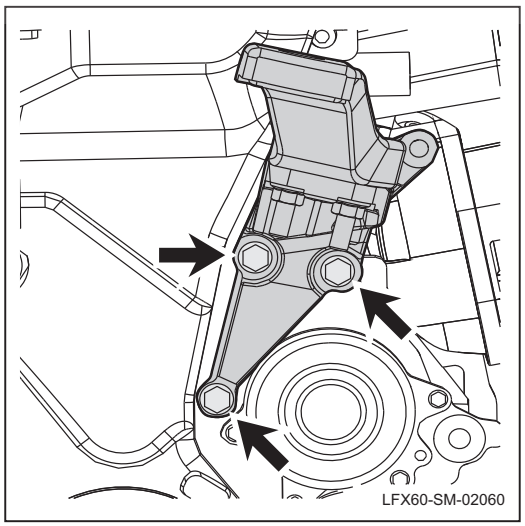


(h). Install the timing chain tensioner to the mounting position, install mounting nuts, and tighten them.
Torque: 11 Nm

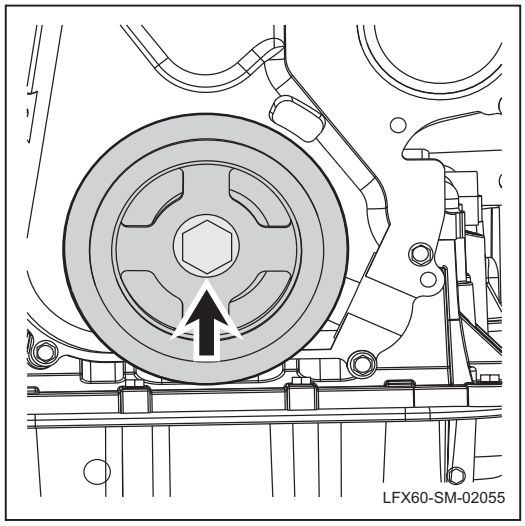
△**Tips:**

Be sure to lock the tensioner plunger with the locking piece before installing the timing chain tensioner. After installing the tensioner fastening bolts, turn the crankshaft counterclockwise to release the locking piece.

(i). Turn the crankshaft clockwise to check whether the timing chain tensioner is installed properly.



(j). Install the right generator mounting assembly to the installation position, install retaining bolts, and tighten them.
Torque: 75 Nm



(k). Install the crankshaft pulley onto the mounting position and install and tighten the bolt components.
Torque: 138 Nm
△Tips:
When installing the crankshaft pulley bolt assembly, fasten the flywheel to prevent any crankshaft rotation.

(l). Install the water pump assembly. **Refer to the replacement of water pump assembly.**

(m). Install the tensioning wheel assembly. **Refer to the replacement of tensioning wheel assembly.**

(n). Install the camshaft cover. **Refer to the replacement of camshaft cover.**

(o). Install the accessories belt.**Refer to: Accessories belt replacement.**

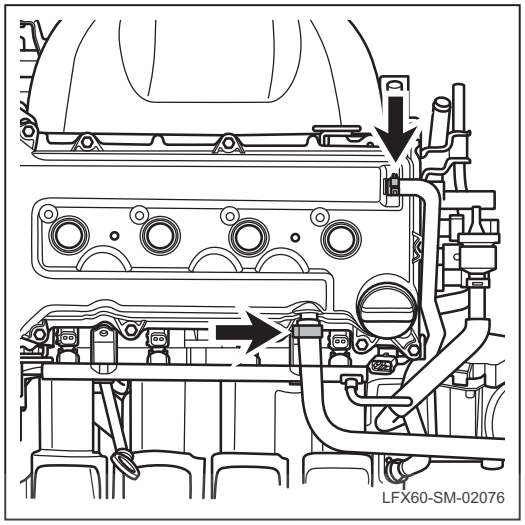
Replacement of cylinder head cover

Removal

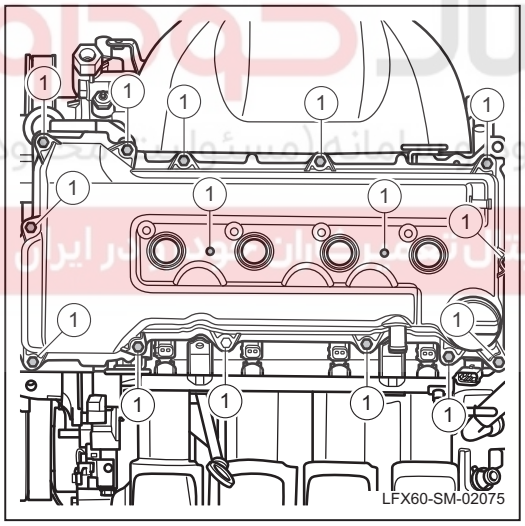
1. Remove the cylinder head cover.

(a). Remove ignition coils. **Refer to the replacement of ignition coils.**

(b). Remove spark plugs. **Refer to the replacement of spark plug.**



(c). Remove clamps, and disengage the upper pipeline from the cylinder head cover.



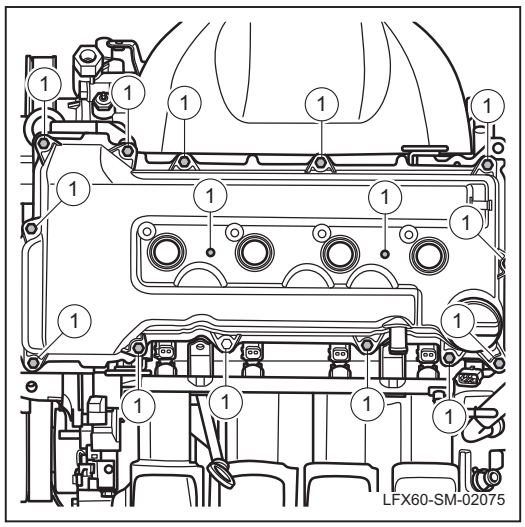
(d). Remove the cylinder head cover fixing bolts and remove the cylinder head cover.

Note:

- **The cylinder head cover tightening bolts must be removed evenly.**
- **The cylinder head cover assembly is difficult to remove due to the sealant, and be sure to use a suitable tool to remove it.**

Installation

1. Install the cylinder head cover assembly.

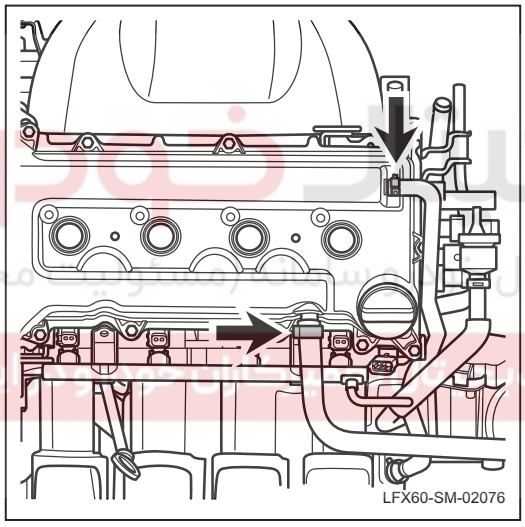


(a). Install the cylinder cover.

Note:

Before installing, apply sealant evenly to the cylinder head cover.

Torque: 11 Nm



(b). Install the upper pipeline of the cylinder head cover.

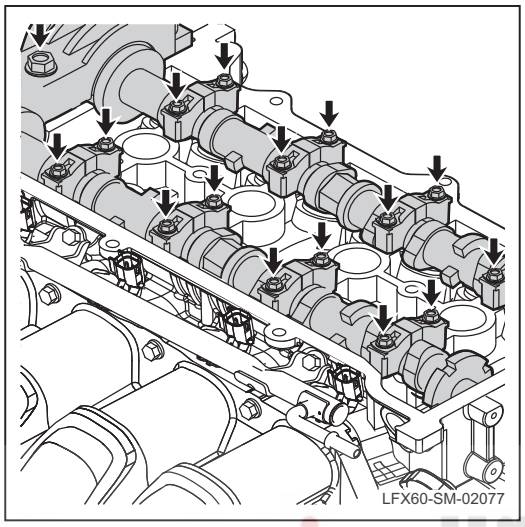
Camshaft replacement.

Removal

1. Remove camshaft

(a). Remove the cylinder head cover. **Refer to the replacement of cylinder head cover.**

(b). Remove the valve cover assembly, **Reference: Timing chain and sprocket assembly removal and replacement.**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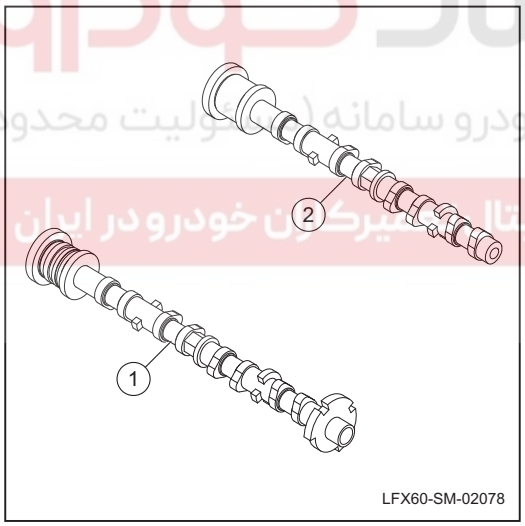
(c). Remove the camshaft cover bolts and remove all camshaft covers.

ⓘNote:

- **Remove the camshafts fixing bolts in pairs.**
- **Place the removed camshaft head cover in order. Pay attention to distinguishing the intake and exhaust camshaft covers.**

(d). Take off the intake and exhaust camshafts.



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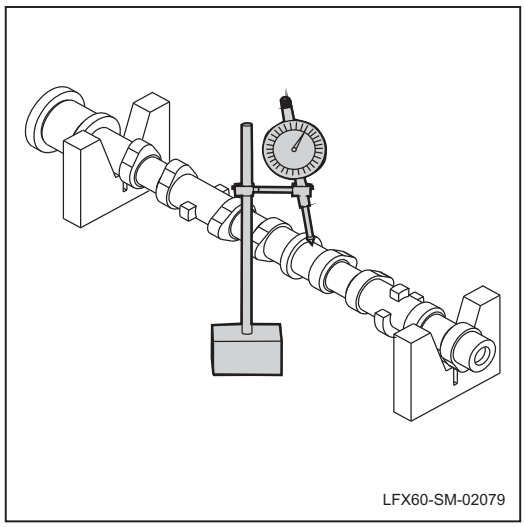
ⓘNote:

Pay attention to distinguishing intake and exhaust camshafts such as (1) intake camshaft assembly and (2) exhaust camshaft assembly.

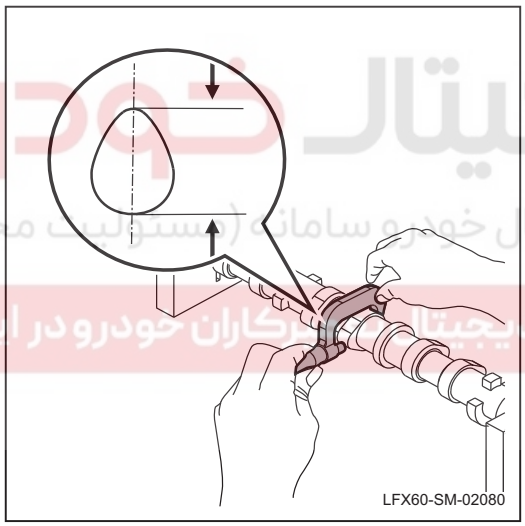
Inspection

1. Check the camshaft rocker runout.



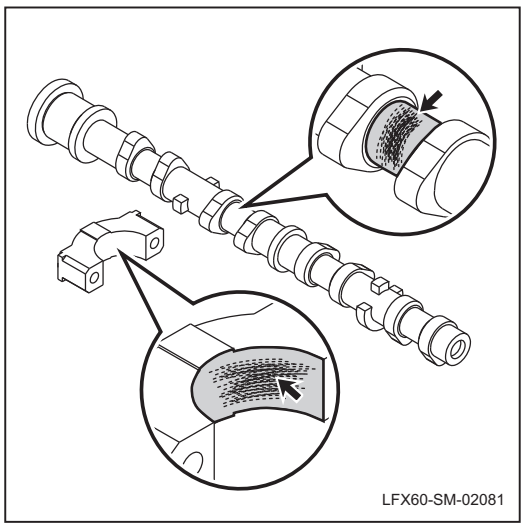
(a). Put the camshaft on a V-shaped block, use a dial indicator to measure the circular rocker runout at the middle shaft journal. If the rocker runout is greater than the maximum value, must replace the camshaft.
Maximum value: 0.03 mm

2. Check the maximum strokes of the inlet and exhaust camshafts.

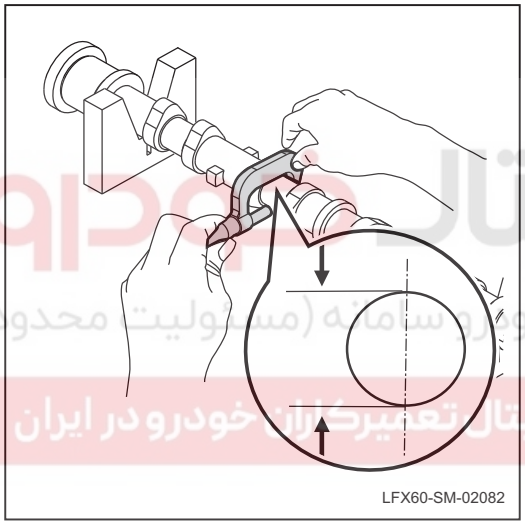


(a). As shown in the figure, measure the maximum lift of intake and exhaust camshafts with a screw-thread micrometer. If the values are beyond the scope, replace them.
Intake: 44.168~44.268
Exhaust: 43.705~43.805

3. Check the camshaft journal.

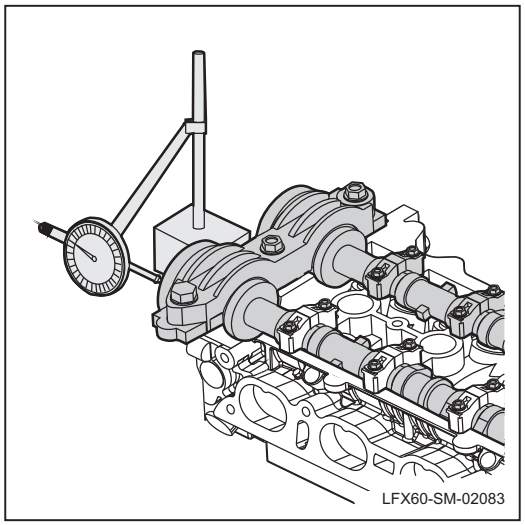


(a). Check the camshaft journal and the bearing cap for rust, abrasion, or other damage; if any, replace it; if necessary, replace the cylinder head assembly.



(b). Measure the camshaft journal with a spiral micrometer; if it can meet the requirement, check the oil film clearance.
No. 1 exhaust: 34.449~34.465 mm
Others: 22.949~22.965mm

4. Check the camshaft axial clearance.

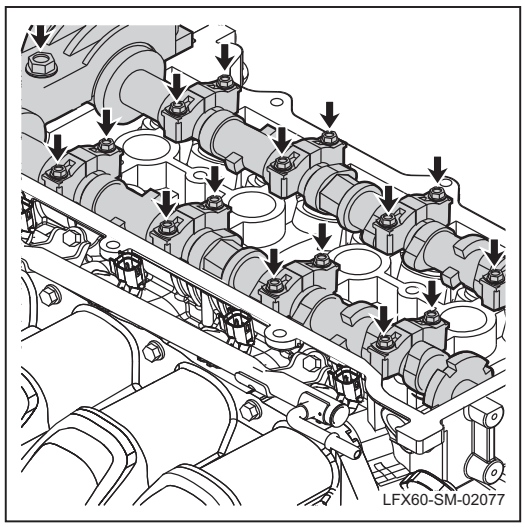


(c). Install the intake and exhaust camshafts onto the cylinder head cover.

(d). Make the camshaft in a reciprocation motion. Check the axial clearance of the camshaft with a dial indicator. If not meet the requirements, replace the camshaft. If necessary, replace the cylinder head cover.
Standard axial clearance: 0.085 mm
Maximum axial clearance: 0.12 mm

Installation

1. Install the camshaft.



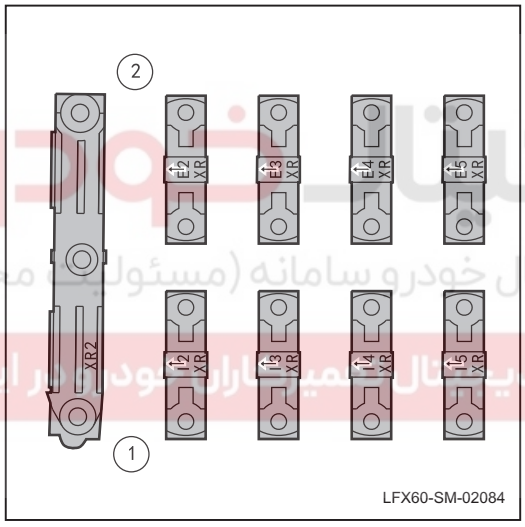
(a). Install the intake and exhaust camshafts onto the cylinder head.

Note:

- **Apply clean oil evenly on each contact surface of the camshaft.**
- **Pay attention to distinguishing intake and exhaust camshafts.**

(b). Install the camshaft cap onto the mounting position, and install and tighten the mounting bolts.

Torque of mounting bolt for No. 1 camshaft cover: 23 Nm.
Other torques: 13 Nm.



(c). Install the intake and exhaust camshaft assembly onto the cylinder head cover.

Note:

- **As shown in the figure, pay attention to distinguishing the bearing cover sequence of intake and exhaust camshaft bearing covers. Do not mix them.**
- **1 is the intake side (identification letter I), 2 is the exhaust side (identification letter E).**
- **Fasten mounting bolts in pairs on the camshaft bearing cover.**
- **After fastening bolts on the camshaft bearing cover, rotate the camshaft flexibly. Do not allow any jamming.**

(d). Install the cylinder head cover. **Refer to the replacement of cylinder head cover.**

(e). Install the timing chain and the sprocket assembly. **Refer to the replacement of the chain and the sprocket assembly.**

Replace the cylinder head assembly and the valve assembly.

Removal

1. **Remove the cylinder head assembly and the valve components.**

(a). Remove the intake manifold. **Refer to the replacement of the intake manifold assembly.**

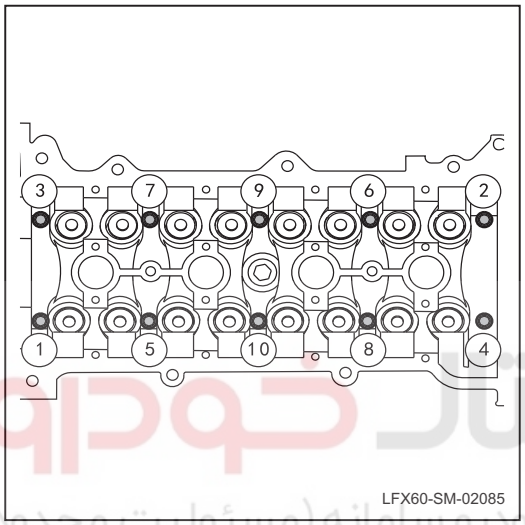
(b). Remove the exhaust manifold. **Refer to the replacement of the exhaust manifold assembly.**

(c). Remove the injector assembly. **Refer to the replacement of injector assembly.**

(d). Remove the cylinder head cover. **Refer to the replacement of cylinder head cover.**

(e). Remove the timing chain and the sprocket assembly. **Refer to the replacement of the chain and the sprocket assembly.**

(f). Remove the camshaft. **Refer to the replacement of camshaft.**



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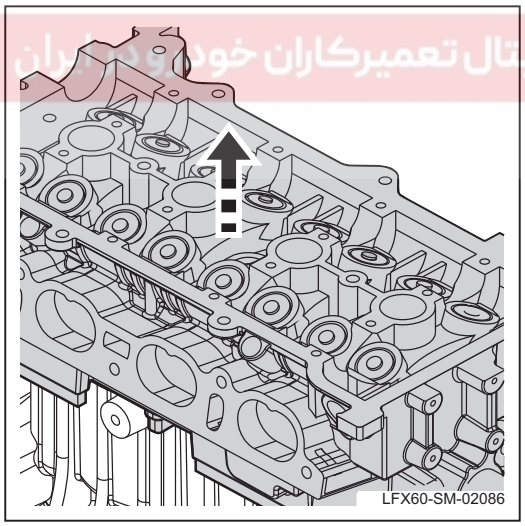
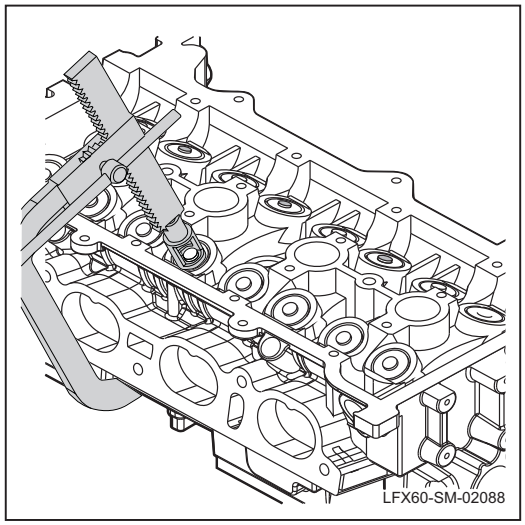
(g). Loosen and remove bolts from the cylinder head in the order shown in the figure.


LFX60-SM-02086

(h). Remove the cylinder head and the cylinder gasket.

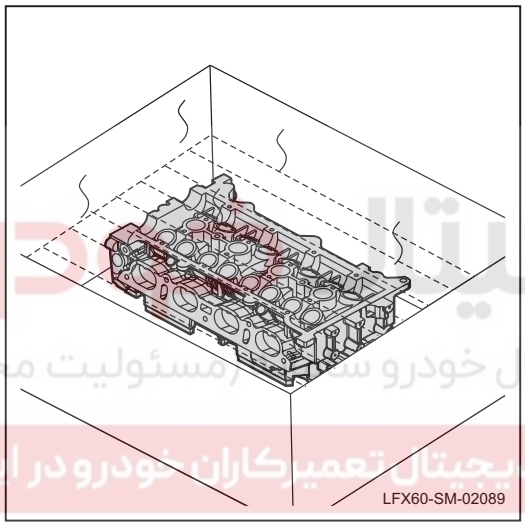


(i). Remove all mechanical tappets in turn.

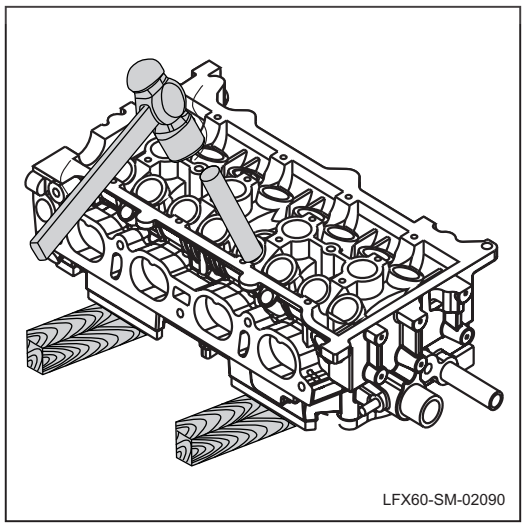
Note:

Remove the mechanical tappets and place them in the installation location order for subsequent installation.

(j). Remove the valve spring with a special tool.



(k). Heat the cylinder head to 80~100 °C.



(l). Place the cylinder head on a wooden plate, and take off the valve guide pipe from the cylinder head with a special tool.

Note:

- **The removed air valve duct can not be used again.**
- **Because there is an interference fit between the valve duct and the cylinder head, when installing a new duct, must increase the size.**

Inspection

1. Check the cylinder head.

(a). Clean the sealant and the oil on the cylinder head.

(b). Clean the carbon deposition in the combustion chamber of the cylinder head.

Note:

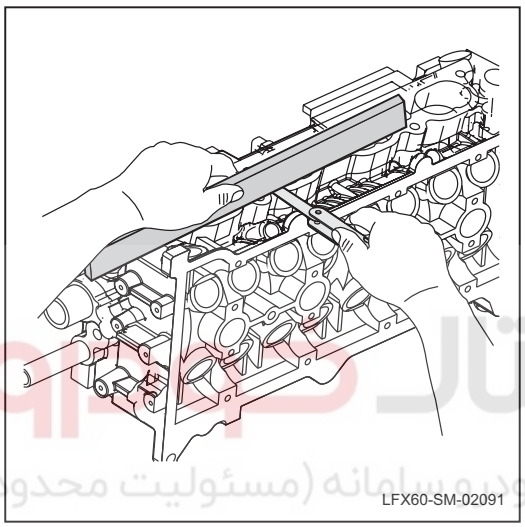
Do not allow scraping carbons with any sharp tool. When removing carbon deposits, pay attention not to scratching or damaging to the metal surface.

(c). Use a high pressure water jet to clean the cylinder head, especially, the water duct and the oil duct.

(d). Use compressed air to dry the cylinder head.

Note:

When using compressed air, it is suggested to wear goggles and protective mask, to avoid any injury from flying debris or dirt.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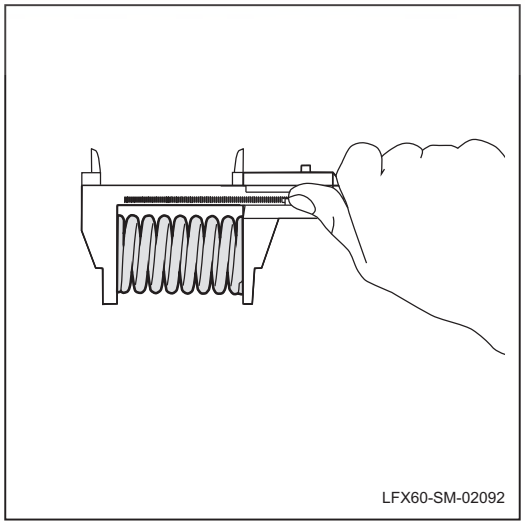
(e). Check the cylinder head bolts for any damage; if necessary, replace them.

(f). Check the cylinder head joint surface and the flatness at the intake and exhaust sides with a ruler and a thickness gauge. If the flatness exceeds the maximum value, replace the cylinder head.

Flatness of cylinder head:0.04 mm

Flatness at intake and exhaust sides: 0.04 mm

2. Check the air valve components.

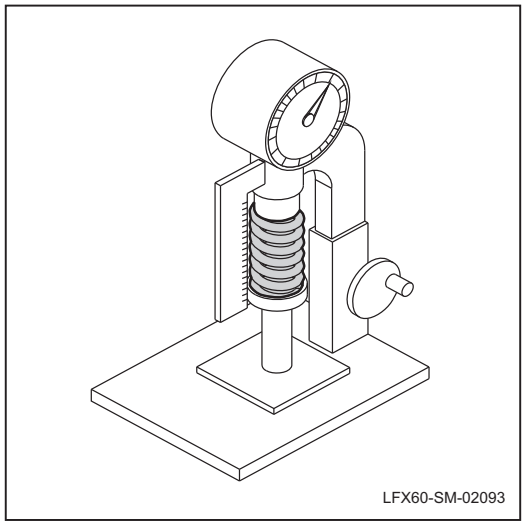

LFX60-SM-02092

(a). Check whether the valve lock sheet is cracked or damaged. If yes, replace it.

(b). Use a vernier caliper to measure the valve spring length under the free status;, if it is beyond the scope, replace it.

Intake valve spring: 44.7 mm

Exhaust valve spring: 45.7 mm


LFX60-SM-02093

(c). Use a spring dynamometer to measure the spring force under the standard compression length of elasticity; if it can not meet the requirements, replace it.

Installation spring force: 153~169 Nm(33.88mm)

Maximum working force: 335.3~370.7 Nm(24.252mm)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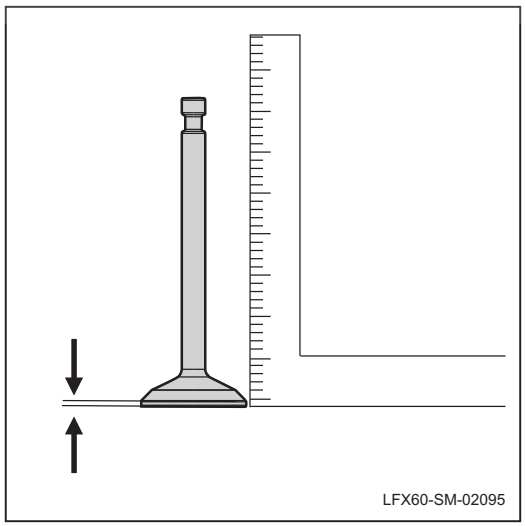
(d). Use a ruler and tablet to check the spring verticality based on the clearance between the air valve spring end and the ruler; if it is beyond the specified value, replace it.

Verticality: 1.0 mm (maximum deviation).

Verticality: 2°(The maximum deviation angle)

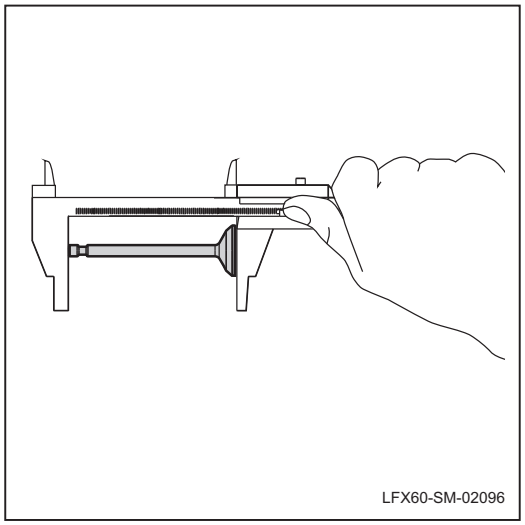
(e). Remove all carbon deposits from the valve. Check whether there is any wear, ablation or deformation on each valve operating surface and each valve stem. If yes, repair it. If necessary, replace the valve.


LFX60-SM-02095

(f). Use a square angle ruler to measure the air valve edge thickness; if the measured value is less than the minimum value, replace the air valve.

Standard thickness: 1.25 mm for intake, and 1.39 mm for exhaust.

Minimum thickness: 1.05 mm

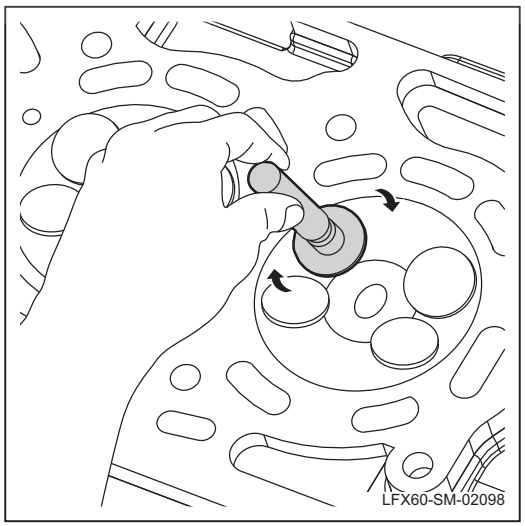


(g). Use a vernier caliper to measure the air valve length, if it can not meet the requirement, replace it.

Standard length:
Intake valve: 88.65mm
Exhaust valve: 88.69mm
Minimum length:
Intake valve: 88.35mm
Exhaust valve: 88.39mm

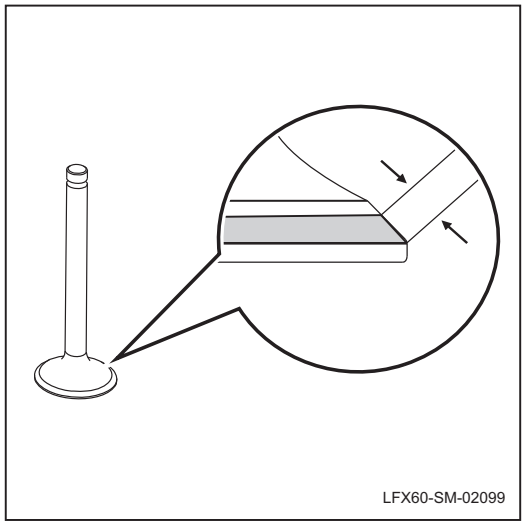
(h). Use a micrometer to measure the air valve stem diameter, if it can not the requirement, replace it.

Intake valve: 5.470mm ~ 5.485mm
Exhaust valve: 5.465mm ~ 5.480mm



(i). Check the air valve seat contact width.

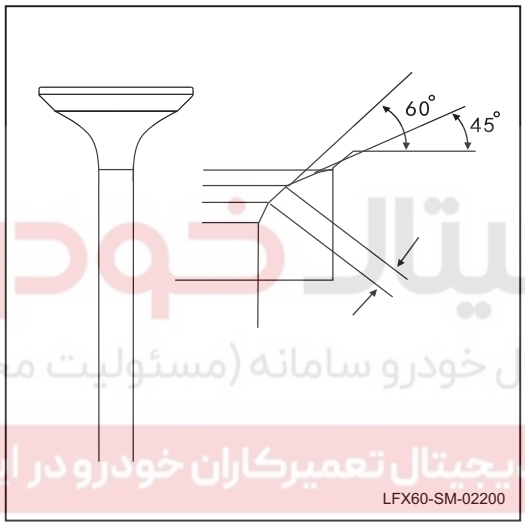
Note:
Coat a layer of the marking membrane on the air valve seat, and then install the air valve on the cylinder head. Use the air valve grinding tool to rotate the air valve 1/4 turns several times, and then remove the air valve.


LFX60-SM-02099

Note:

The marking produced on the air valve mating surface must be a continuous closed trace, and its width must be within the prescribed scope. If the marking is uneven, or the mark width is beyond the specified scope, must grind and fine grind and polish the air valve seat.

Width of valve block contact surface: 1.0~1.4 mm



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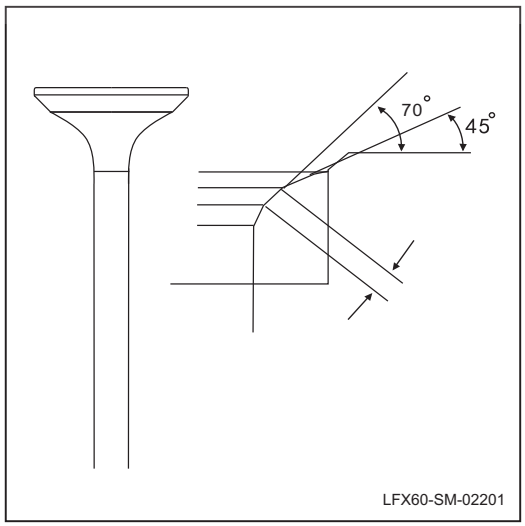
(j). Intake valve block: repair it with a valve block reamer for two times. Must use two reamers to repair it: the first reamer has an angle of 15°, and the second reamer has an angle of 45°. In the second repair, must achieve the required air valve seat width.

Intake valve holder width: 1.0~1.4mm



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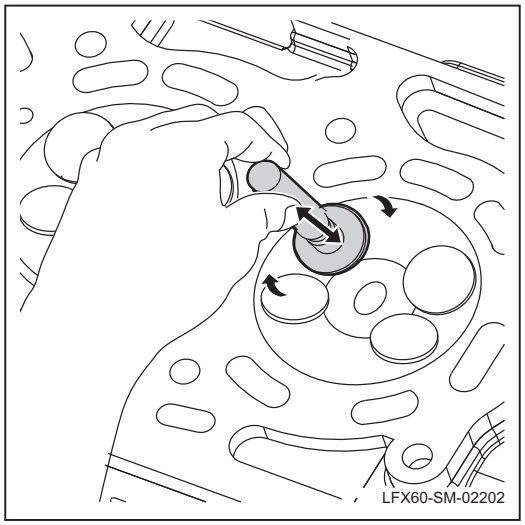
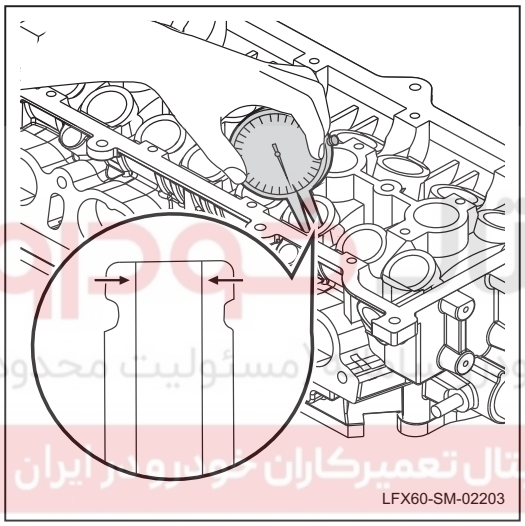
(k). Exhaust valve block: the repair procedures are same as those of intake valve block.

Exhaust valve seat width: 1.0~1.4mm



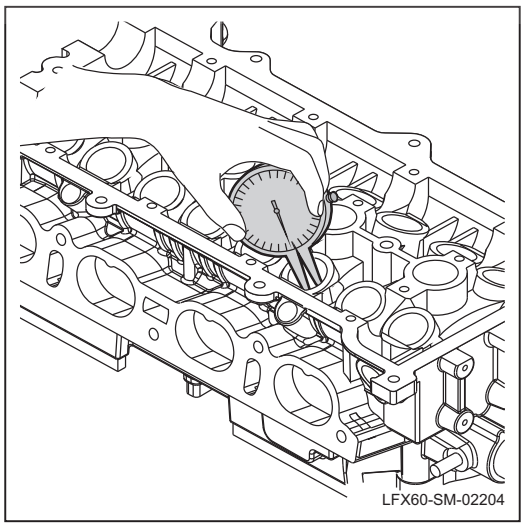
(l). Grind the valve. Firstly, apply the rough grinding paste on the valve block surface to grind the valve with a grinding tool. Then, grind with a fine grinding paste until that the valve is matched perfectly with the valve block.

(m). Clean the valve and the valve block thoroughly after grinding.

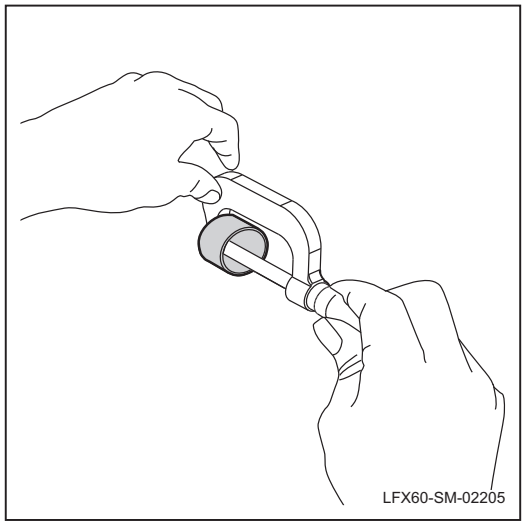


(n). Measure the inner diameter of valve guide tube with an inner diameter micrometer.
Air valve duct inner diameter: 5.510~5.530mm

(o). Minus the valve stem diameter from the inner diameter of the valve guide tube to get the oil clearance of valve guide tube. If the oil clearance value is greater than the maximum value, replace the air valve and the air valve duct.
Standard oil clearance:
Intake valve: 0.025~0.060mm
Exhaust valve: 0.030~0.065mm
Maximum oil clearance:
Intake valve: 0.08mm
Exhaust valve: 0.10mm



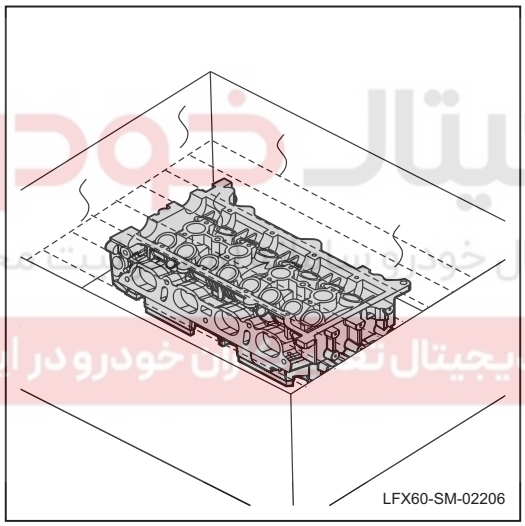
(p). Measure the inner installation diameter of valve guide tube with an inner diameter micrometer.
Inner diameter of installation hole on valve guide tube: 10.285~10.306 mm


LFX60-SM-02205

(q). Measure the top thickness of the mechanical tappet. If not meeting the requirements, replace it.
Top thickness of mechanical tappet: 5.055mm~6.005 mm.

Installation

1. Install the cylinder head assembly and the valve components.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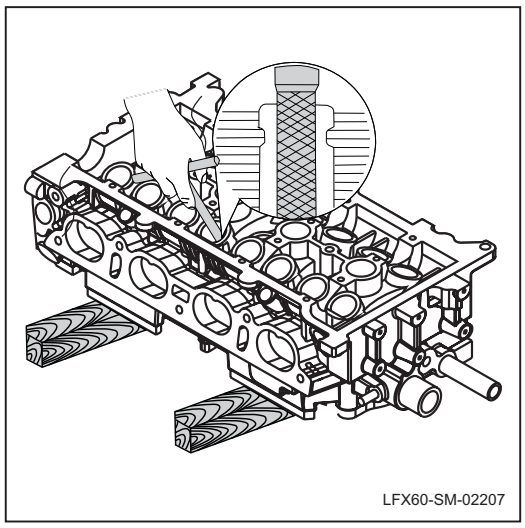
(a). Heat the cylinder head to 80 ~ 100°C.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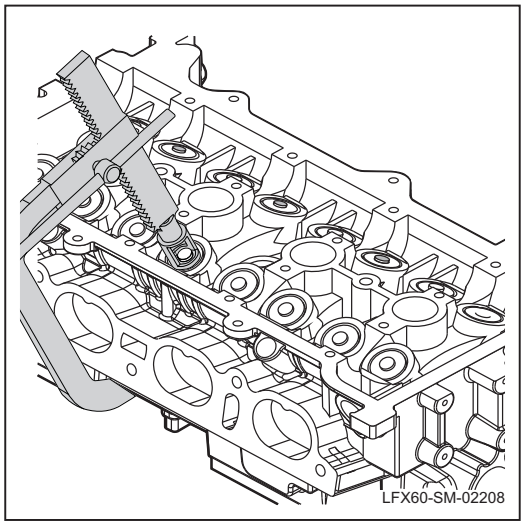
(b). Remove the cylinder head and place it on a wooden board, use the special tool to press the new valve duct to the specified value into the duct hole, until the special tool is contacted with cylinder head.
Specific press amount: 8.7~9.1 mm.

ℹNote:
Hinge the guide hole with a tool (with a 11 mm reamer) to remove the burr.

(c). Use the special tool (5.5 mm reamer), to ream the air valve duct hole to achieve the standard oil clearance.
Standard oil clearance:
Intake valve: 0.025~0.060mm
Exhaust valve: 0.030~0.065mm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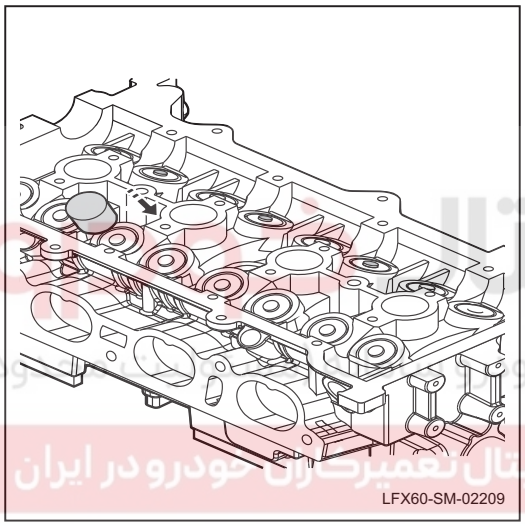
(d). Install valve oil seal, valve, valve spring, valve spring block, and valve lock plate in turn with a special tool.

Note:

- **The removed air valve seal can not be used again; must use the new oil seal during installation.**
- **In installation, it is prohibited to use a hammer or other objects to tap the special tool; when installing the oil seal onto the duct, only manually press the special tool, the tapping on the special tool may cause the air valve seal damage or deformation.**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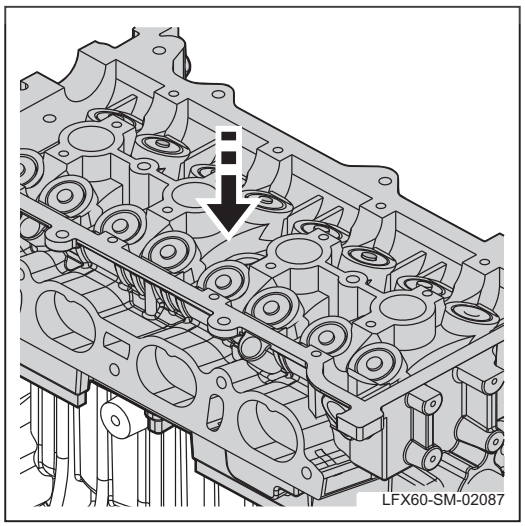
(e). Install mechanical tappets on the cylinder head.

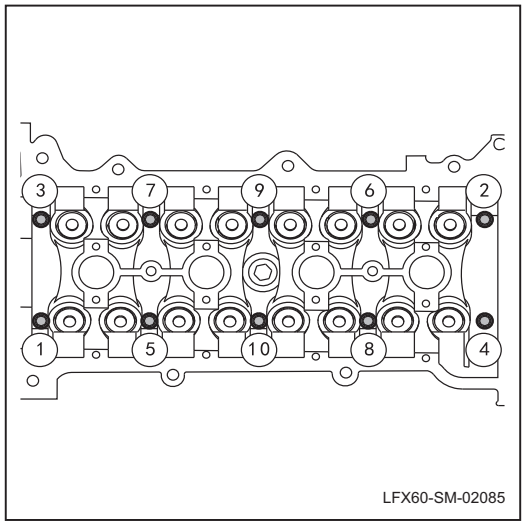

LFX60-SM-02087

(f). Wipe the upper cylinder end clearly with a wiping paper to ensure there is not any oil when installing a cylinder pad.

Note:

The marked surface should be upward; the positioning pin hole position should be noticed.

(g). Install the cylinder head onto the cylinder head.



Note:

- **Apply a proper amount of clean oil to the threads of cylinder head bolt.**
- **In case of tightening the cylinder head bolt, tighten it twice in the shown sequence.**

  The first torque: 49 Nm

  The second torque:90 Nm

(h). Install the camshaft. **Refer to "Replacement of Camshaft".**

(i). Install the timing chain and sprocket assembly. **Refer to "Replacement of Timing Chain or Sprocket Assembly"**.

(j). Install the cylinder head cover. **Refer to "Replacement of Cylinder Head Cover"**.

(k). Install the oil injector assembly. **Refer to "Replacement of Oil Injector Assembly"**.

(l). Install the exhaust manifold. **Refer to "Replacement of Exhaust Manifold Assembly"**.

(m). Install the intake manifold. **Refer to "Replacement of Intake Manifold Assembly"**.

Piston, piston ring, and connecting rod assembly

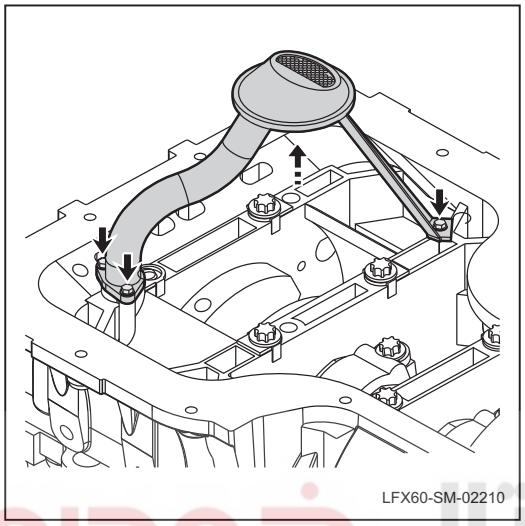
Removal

1. Removal piston, piston ring, and connecting rod assembly

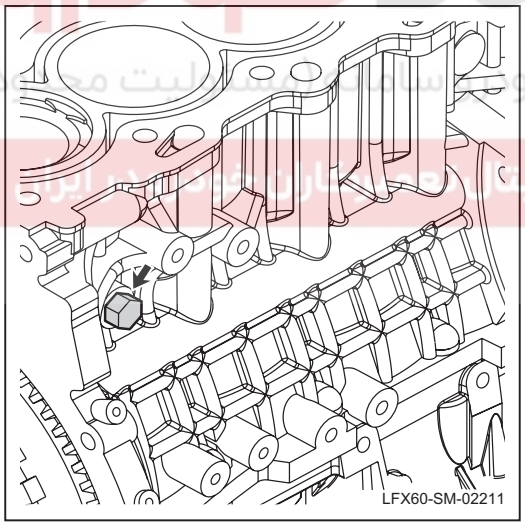
(a). Remove the cylinder cover assembly and valve assembly. **Refer to "Replacement of Cylinder Cover Assembly and Valve Assembly".**

(b). Remove the oil sump. **Refer to "Replacement of Oil Sump".**

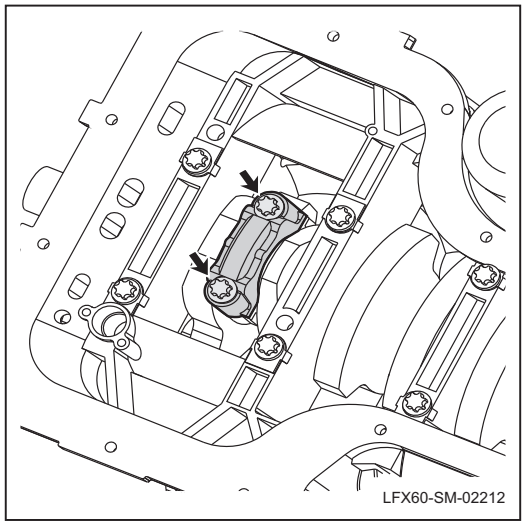
(c). Remove the oil pump. **Refer to "Replacement of Oil Pump".**



(d). Remove the engine oil suction filter fixing bolts to take out the filter.



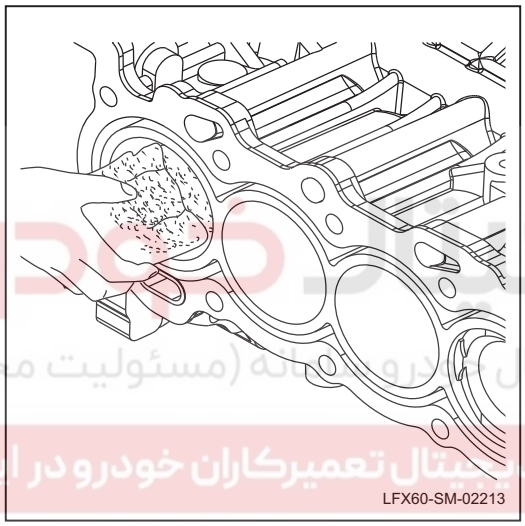
(e). Remove the drain bolt and tilt the cylinder to drain the coolant.


LFX60-SM-02212

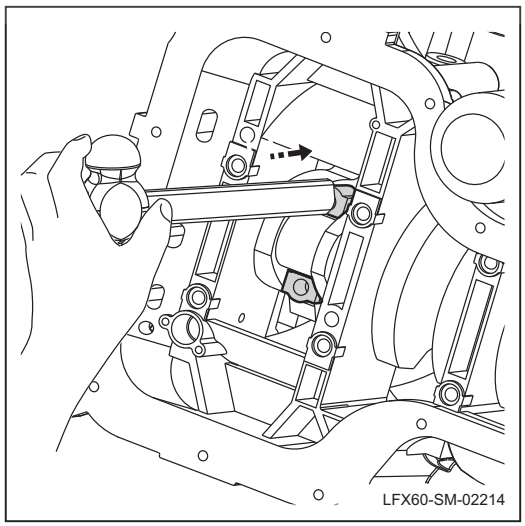
(f). Rotate the crankshaft to bring the piston of cylinder 1 and 4 to the BDC (namely, the connecting rod cap is revealed vertically).

(g). Remove the connecting rod bolt and take out the connecting rod cap and bearing bush.

(h). Remove the other connecting rod caps and bearing bushes in the same way.


LFX60-SM-02213

(i). Clean up all carbon deposits on top of the cylinder.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(j). Remove the piston assembly.

Note:

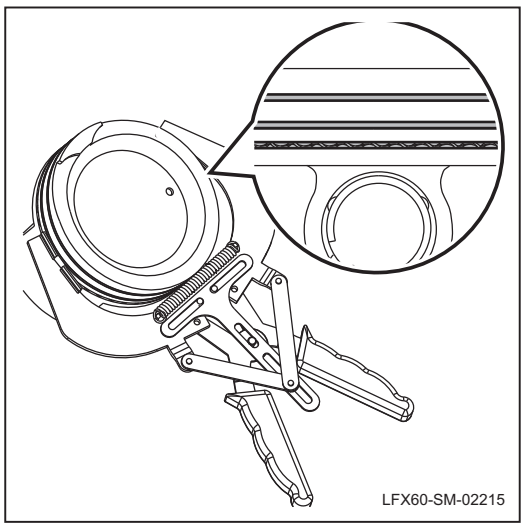
Use a wood or rubber object to push out the piston, do not use any metal object, to avoid damage to the connecting rod end surface.

(k). Take out the piston assembly from the other side.

Note:

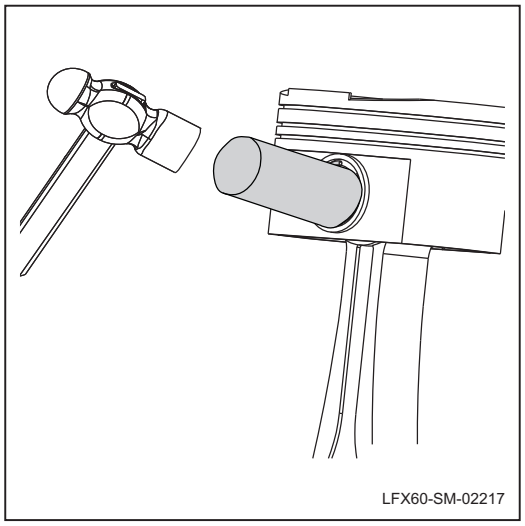
Place the piston and connecting rod components in the correct order, don't mix them.

2. Disassemble the piston and connecting rod assembly



(a). Use the piston ring expander to remove the piston ring I, the piston ring II and the combination oil ring.

(b). Remove two piston ring lock rings with ring pliers.



(c). Punch out the piston pin with a punching rod.