

## Engine

### External View



E44216

### GENERAL

The TdV6 engine is a 2.7 litre, direct injection, six-cylinder diesel engine having two banks of three cylinders, arranged at 60 degrees to each other. There are 4 valves per cylinder, which are operated by two overhead camshafts per cylinder bank. The engine emission comply with ECD3 (European Commission Directive) legislative requirements and employs two catalytic converters, electronic engine management control, positive crankcase ventilation and exhaust gas recirculation to limit the emission of pollutants. The unit is water cooled and turbo-charged. The fuel injection system features common rail technology.

The cylinder block is manufactured in Compacted Graphite Iron (CGI) and is coupled with a separate aluminium ladder frame to provide a lightweight, compact and very stiff bottom end of the engine. The cylinder heads are cast aluminium with a moulded plastic camshaft cover. The single-piece oil sump is formed from stamped steel. The cast iron exhaust manifolds are unique for each cylinder bank and a moulded plastic acoustic cover is fitted over the upper engine to reduce engine-generated noise.

### TECHNICAL FEATURES

The technical features include:

- 60 degree 'vee' 6 cylinder engine with a CGI cylinder block
- Plastic cylinder head cover

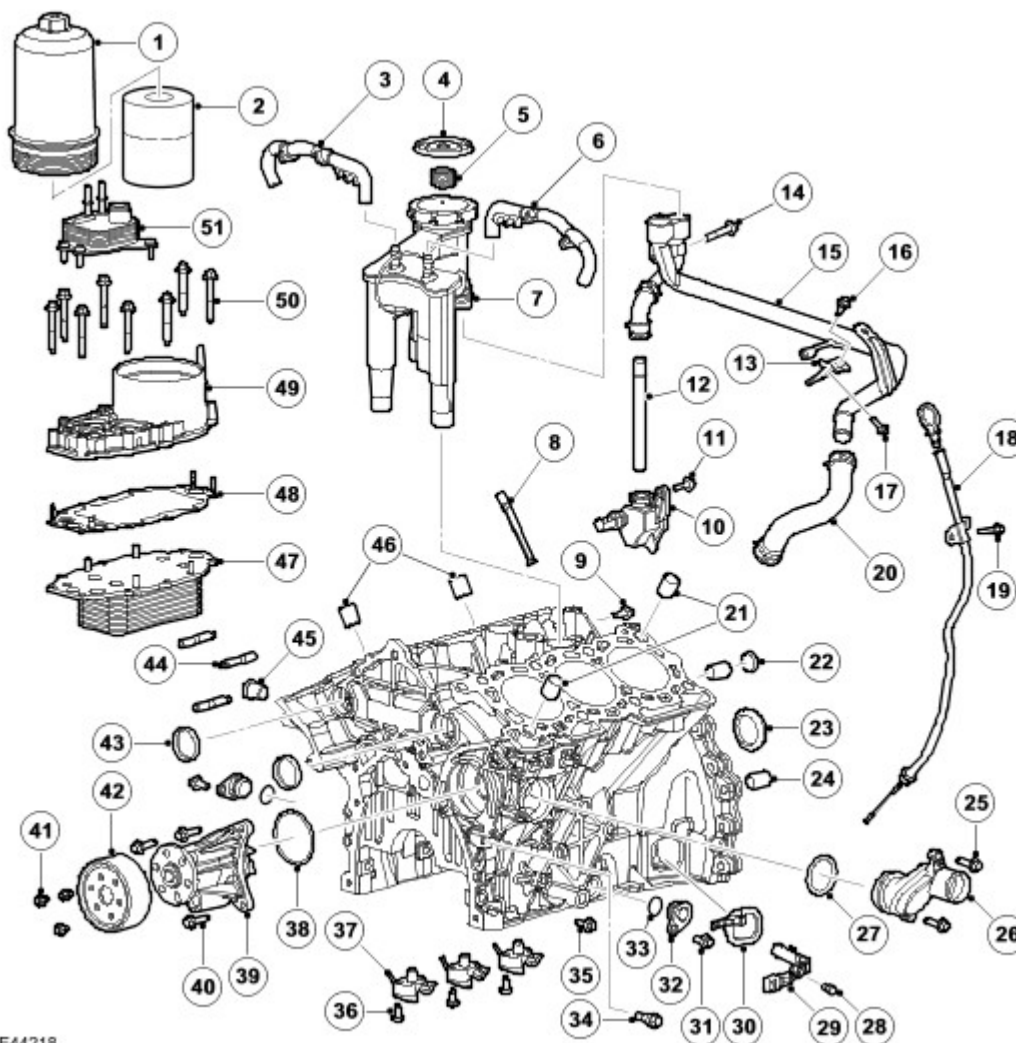
- Two light, high strength, aluminium cylinder heads
- 4-valve technology with centrally arranged fuel injectors
- Steel roller rockers with hydraulic lash adjusters
- Twin plenum intake system integrated with the camshaft cover
- Variable Geometry Turbocharger
- Common rail direct fuel injection system
- High pressure fuel pump
- Gallery cooled pistons with a central crown bowl
- Two electronically controlled Exhaust Gas Recirculation (EGR) valves
- Two EGR coolers
- Exhaust re-treatment by means of a diesel specific oxidation catalytic converter and primary catalytic converter
- Cooling fan with electro-viscous clutch drive.

## ENGINE DATA

The technical data is detailed below:

DESCRIPTION	TYPE
<b>Configuration</b>	60 degree V6
<b>Maximum power</b>	147 kW at 4000 rpm
<b>Maximum torque</b>	440 Nm at 1900 rpm
<b>Displacement</b>	2720cc
<b>Stroke/bore</b>	81mm/88mm
<b>Compression ratio</b>	17.3:1
<b>Firing order</b>	1 4 2 5 3 6
<b>Oil capacity</b>	6.55 litres (initial fill) 5.45 litres (service fill, includes oil filter)
<b>Engine weight (with oil)</b>	235kg (Automatic) 260kg (Manual, inc. clutch plate and cover)

## CYLINDER BLOCK COMPONENTS



E44218

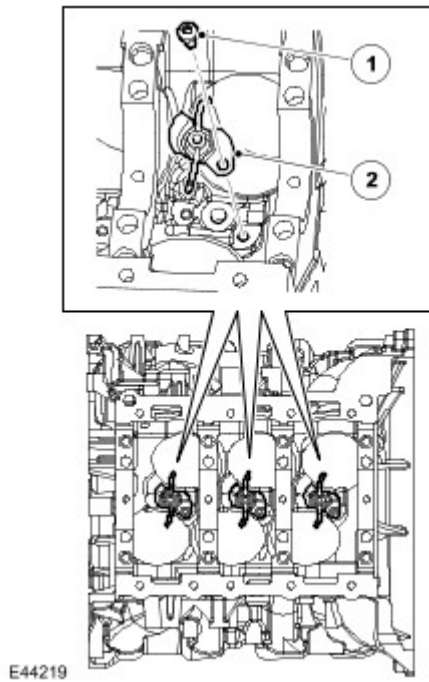
Item	Part Number	Description
1	-	Oil filter cap
2	-	Oil filter element
3	-	Scavenge pipe
4	-	Diaphragm
5	-	Spring
6	-	Scavenge pipe
7	-	Crankcase ventilation oil separator assembly
8	-	Turbocharger feed filter
9	-	Bolt
10	-	Crankcase ventilation drain reservoir assembly
11	-	Bolt
12	-	Crankcase ventilation oil return tube
13	-	Bracket
14	-	Bolt
15	-	Crankcase ventilation oil return assembly
16	-	Bolt
17	-	Bolt
18	-	Oil level gauge
19	-	Bolt
20	-	Crankcase ventilation return hose
21	-	Cylinder head locating dowels

22	-	Core plug
23	-	Seal
24	-	Transmission locating dowel
25	-	Bolt, 2 of
26	-	Water inlet connector assembly
27	-	O ring
28	-	Bolt
29	-	Crankshaft position (CKP) sensor
30	-	Cylinder block aperture cover
31	-	Bolt
32	-	Blanking plug
33	-	O ring
34	-	Crankshaft timing plug
35	-	Bolt
36	-	Bolt, 3 of
37	-	Piston cooling jets
38	-	O ring
39	-	Water pump
40	-	Bolt, 3 of
41	-	Bolt, 3 of
42	-	Water pump pulley
43	-	Core plug
44	-	Stud bolts, 3 of
45	-	Coolant drain plug
46	-	Cylinder head locating dowels
47	-	Lower oil filter and cooler assembly
48	-	Seal
49	-	Upper oil filter and cooler assembly
50	-	Bolt, 8 of
51	-	Fuel cooler

## Cylinder Block

The cylinders and crankcase are contained in the cylinder block, which is of single cast CGI construction with a hollow beam structure. With this type of construction less material is required than for a conventional cast iron block, therefore, reducing engine weight and length.

## Piston Cooling Jets



Item	Part Number	Description
1	-	Bolt
2	-	Piston cooling jet

Jets located in the cylinder block provide piston and gudgeon pin lubrication and cooling. These jets spray oil on to the inside of the piston, the oil then flows through two internal wave shaped channels to help cool each piston crown.

Lubrication oil is distributed through the cylinder block, via the main oil gallery and channels bored in the block, to all critical moving parts. These channels divert oil to the main and big-end bearings via holes machined into the crankshaft.

A tapping at the rear RH side of the cylinder block, below the RH cylinder head, connects a pipe to the turbocharger by means of a banjo connection. Oil is supplied, under pressure, via this tapping, from the oil pump to provide lubrication for the turbocharger bearings.

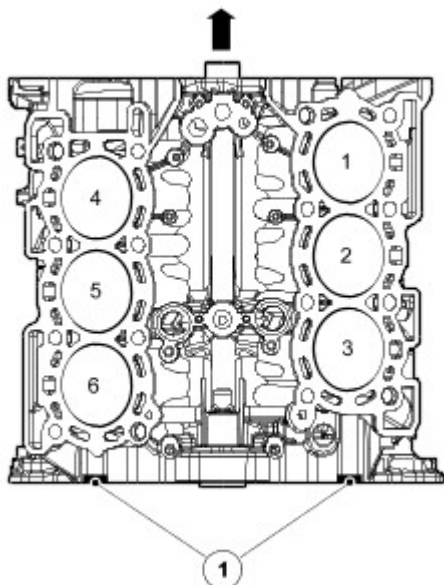
Cylinder cooling is achieved by coolant circulating through chambers in the cylinder block casting.

Two hollow metal dowels are used to locate the cylinder heads to the cylinder block, one on each side at the rear of the unit.

A port is included at the rear LH side of the ladder frame, below the turbocharger, to connect the turbocharger oil return pipe to the sump.

A plug sealing the lubrication cross-drilling gallery is located at the front RH side of the cylinder block. Plugs for the main lubrication gallery are included at the front and rear of the cylinder block.

## Engine Data Locations

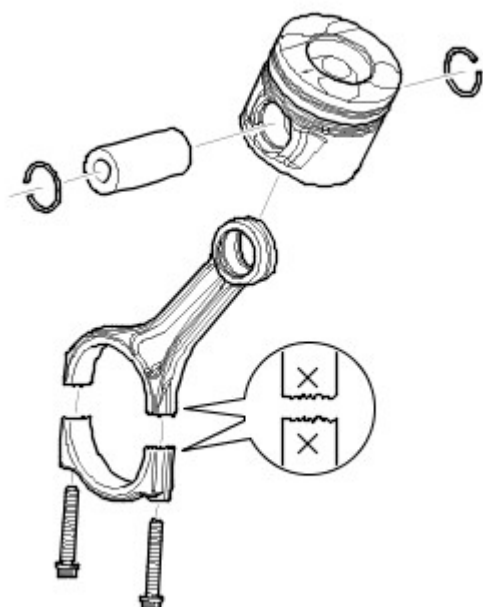


E44217

Item	Part Number	Description
1	-	Engine data locations

Engine data is marked at two locations at the back of the cylinder block. Component diameters are represented by alphabetical and numerical codes; keys to the codes are in the Service Repair Procedures (SRP) Manual.

### Connecting Rods and Pistons

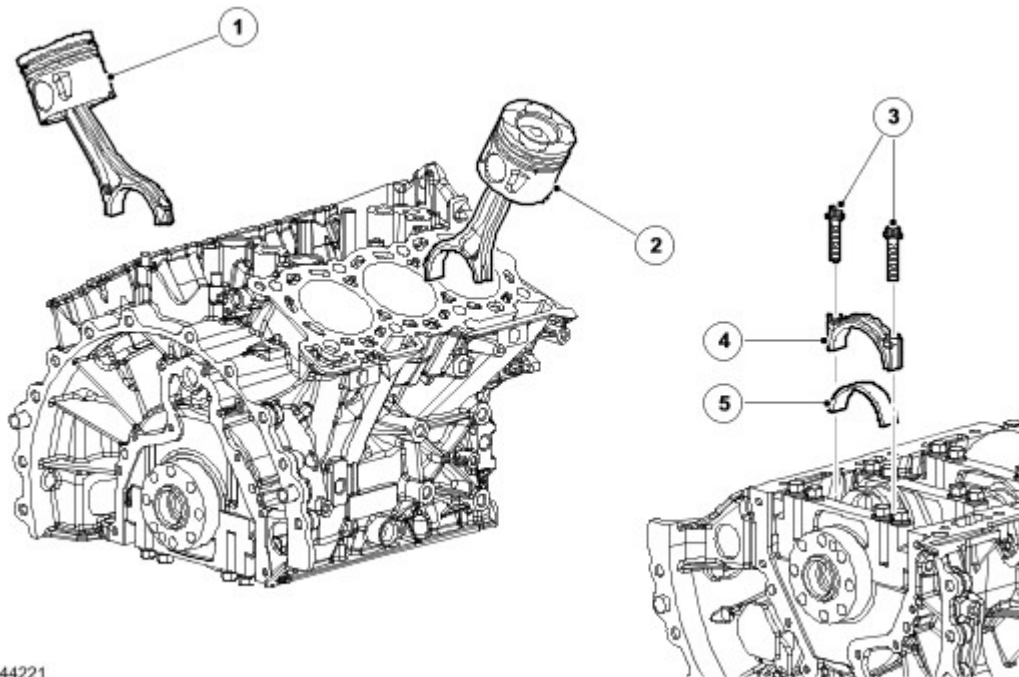


E44220

The connecting rods are manufactured from sinter-forged steel and have fracture-split bearing caps. The bearing caps are produced by fracturing the opposing sides of the connecting rod at the bearing horizontal centre-line. As well as being easier to manufacture, when reassembled the fractured surfaces interlock to form a strong seamless joint. The cylinder position is etched on adjoining sides of the joint to identify matching connecting rods and bearing caps. The selective connecting rod bearings are aluminium/tin split plain bearings. The connecting rod bearing is 'sputter coated', which is a manufacturing process that layers the bearing material to produce a higher load capacity for improved durability.

**NOTE :**

The connecting rods are not selective.

**Connecting Rod Installation**

E44221

Item	Part Number	Description
1	-	Piston and connecting rod assembly, cylinders 4-6
2	-	Piston and connecting rod assembly, cylinders 1-3
3	-	Bolts
4	-	Connecting rod bearing cap
5	-	Connecting rod lower bearing

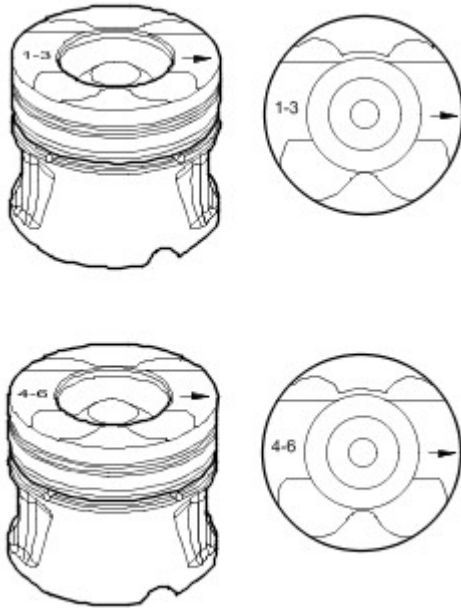
When installing a connecting rod, ensure the back of the connecting rod faces the centre of the 'vee'.

The pistons are made from aluminium alloy and are fitted with three rings. The piston crown incorporates a pronounced bowl; this forms the combustion chamber, which promotes swirl and turbulence necessary for good combustion and improved emissions. In addition, the piston skirt has a molybdenum-coated surface, which counteracts scoring of the cylinder bore and piston.

The piston also incorporates a double wave gallery within the piston crown to enhance piston cooling. The pistons are supplied oil by means of spray jets located in the cylinder block oil gallery. These jets ensure optimum piston cooling to counteract the high temperatures generated by the combustion process.

Each piston is installed on a wrist pin located in a aluminium/tin bushing in the connecting rod.

**Piston Installation**



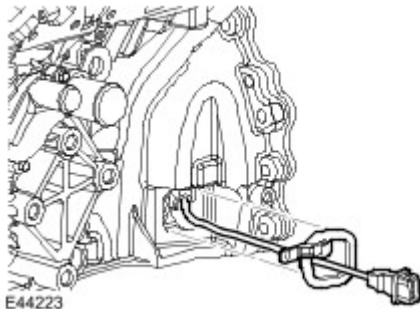
E44222

When installing pistons ensure the arrows on the piston crowns all point to the front of the engine and the pistons are located in the correct cylinder banks, i.e. cylinders 1, 2, 3 or cylinders 4, 5, 6.

**NOTE :**

All pistons are common single grade/single part number for all engines.

The piston top ring is a taper type and is fitted with the taper to the top of the piston. All rings marked 'top' are assembled with 'top' uppermost. All rings must be spaced evenly around the piston before installing. The circumference gap of the double bevelled oil control ring must be opposite the spiral control joint.

**Crankshaft Position Sensor**

E44223

The Crankshaft Position (CKP) sensor is located at the rear of the crankshaft, behind the flywheel in the LH side of the rear oil seal retainer. The sensor provides an input of engine crankshaft speed and position. The sensor works on the principle of the Hall effect and scans a trigger wheel (magnetic disc) on the crankshaft. An air gap of 0.4 to 1.5mm, between the trigger wheel and the CKP sensor, is achieved by the positional mounting of the sensor. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)

**Starter Motor**

The engine starter motor is installed at the rear RH side of the ladder frame, at the cylinder block to ladder frame split line. For additional information, refer to Starting System (303-06C Starting System - 2.7L Diesel)

**Coolant Drain Plug**

Two coolant drain plugs are installed in the cylinder block, one is fitted in the rear RH side, and the other is fitted in

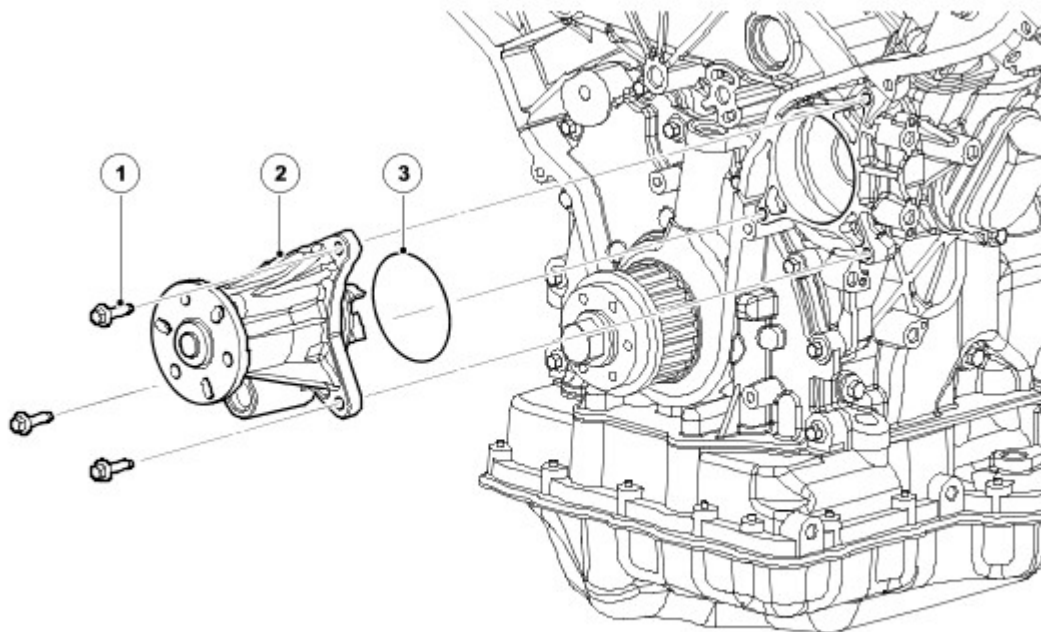


the middle of the cylinder block on the LH side.

### Cylinder Block Heater

On vehicles destined for cold climates, a cylinder block heater replaces a core plug in the middle of the cylinder block on the LH side.

### Coolant Pump

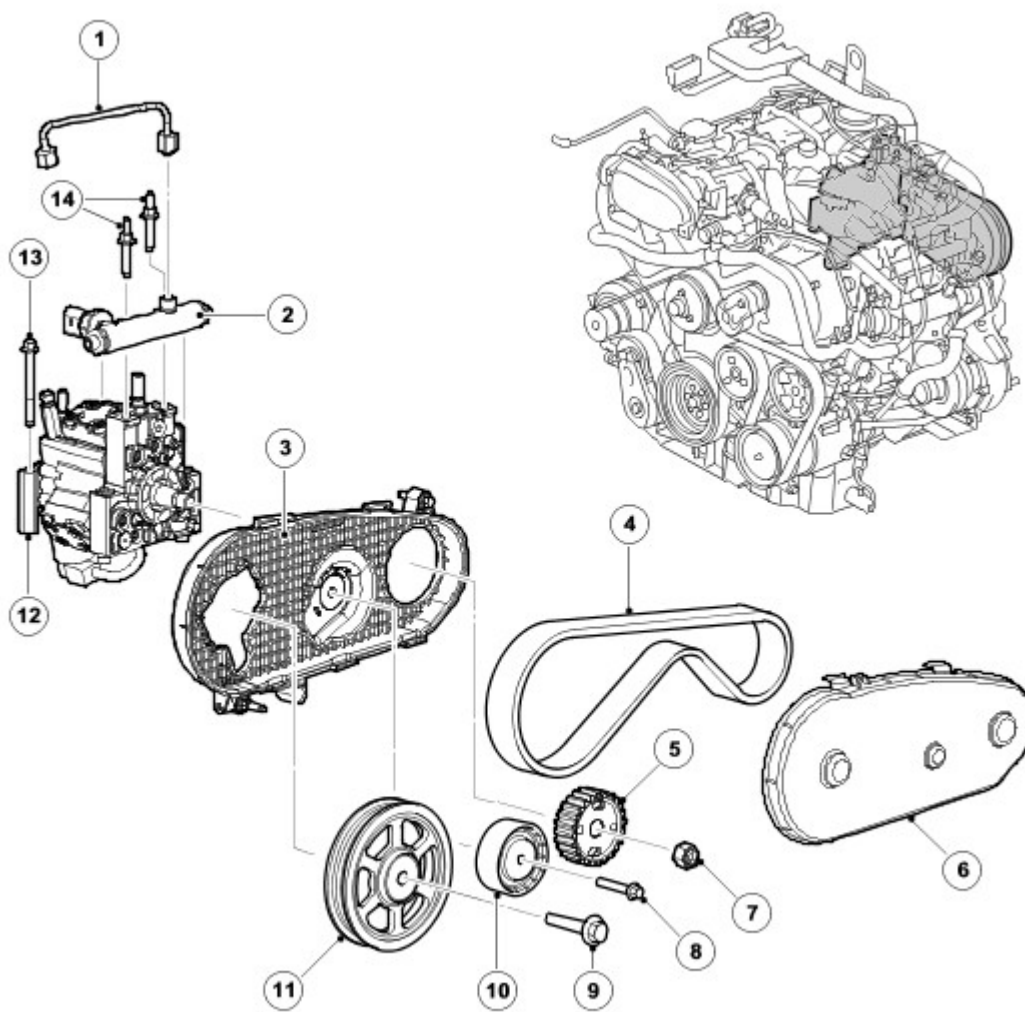


E44224

Item	Part Number	Description
1	-	Bolts
2	-	Water pump
3	-	'O' ring seal

The coolant pump is installed on the LH side of the cylinder block front face and is secured and sealed via three bolts and an 'O' ring. The coolant pump is driven by a poly-vee belt via the crankshaft.

### High-Pressure Fuel Pump



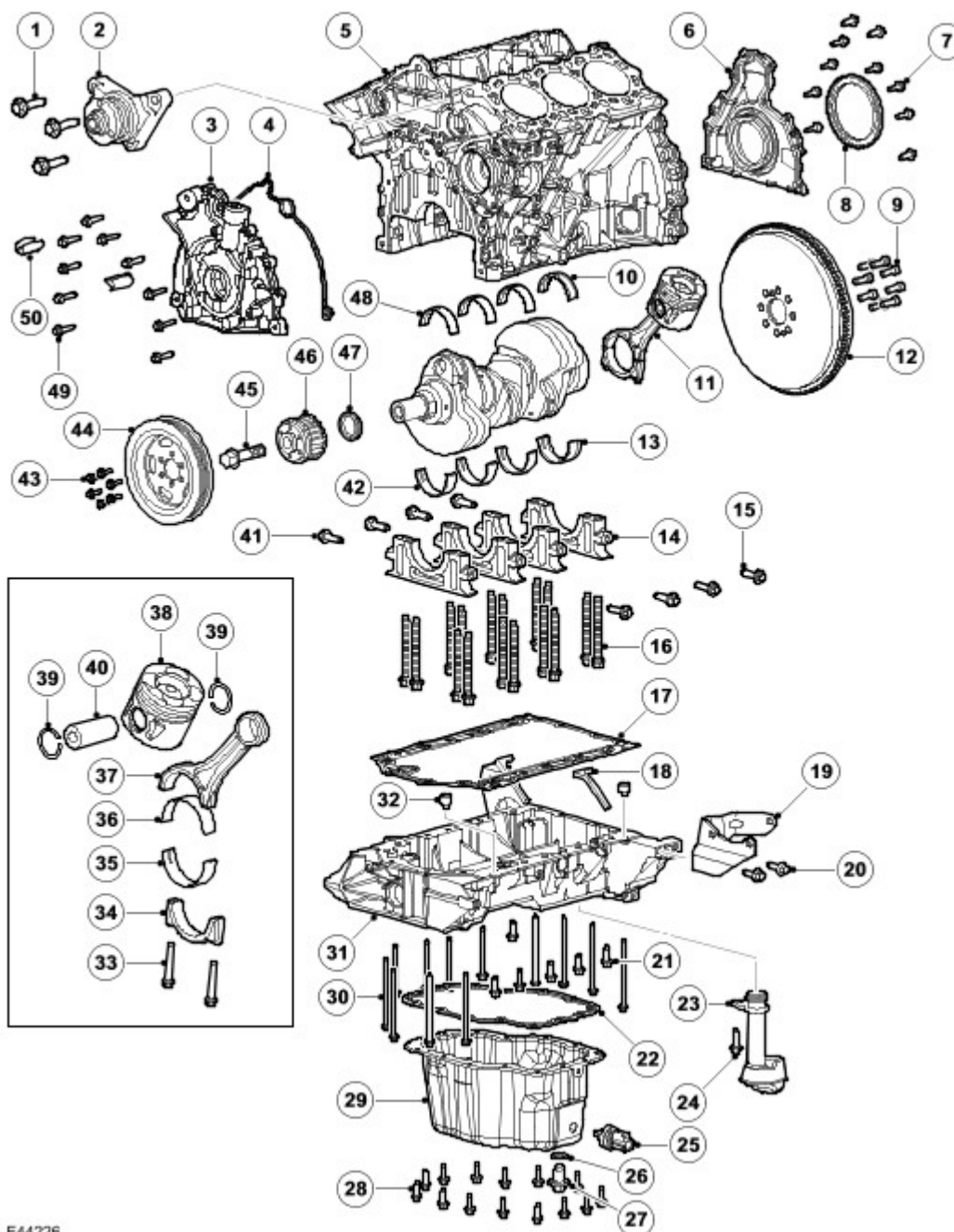
E44225

Item	Part Number	Description
1	-	Fuel pipe
2	-	Diverter rail assembly
3	-	Rear cover
4	-	Belt
5	-	Fuel pump pulley
6	-	Front cover
7	-	Nut
8	-	Bolt
9	-	Bolt
10	-	Tensioner
11	-	LH exhaust camshaft pulley
12	-	High pressure fuel pump
13	-	Bolt
14	-	Stud bolts

The high-pressure fuel pump supplies the common rail with fuel and is fixed to the rear of the cylinder block in the centre of the 'vee'. The pump is a 3 radial piston type controlled by the EMS and belt driven from the exhaust camshaft of the LH cylinder head. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)

For additional information, refer to Fuel Charging and Controls (303-04C Fuel Charging and Controls - 2.7L Diesel)

## CRANKSHAFT AND SUMP COMPONENTS



E44226

Item	Part Number	Description
1	-	Bolts, 3 of
2	-	Fan driver bracket
3	-	Oil pump
4	-	Seal
5	-	Cylinder block
6	-	Rear oil seal retainer
7	-	Bolts, 10 of
8	-	Crankshaft position sensor trigger wheel
9	-	Bolts, 8 of
10	-	Main thrust bearing, upper
11	-	Piston and connecting rod assembly
12	-	Flywheel
13	-	Lower main thrust bearing

14	-	Main bearing caps, 4 of
15	-	Cross bolts, 4 of
16	-	Main bearing cap bolts, 16 of
17	-	Gasket
18	-	Seal
19	-	Bracket
20	-	Bolts, 2 of
21	-	Bolts, 6 of
22	-	Gasket
23	-	Oil pick-up
24	-	Bolt
25	-	Oil temperature sensor
26	-	Seal
27	-	Drain plug
28	-	Bolts, 14 of
29	-	Oil pan assembly
30	-	Bolts, 12 of
31	-	Ladder frame
32	-	Dowel
33	-	Bolts, 2 of
34	-	Connecting rod cap
35	-	Connecting rod cap bearing
36	-	Connecting rod bearing
37	-	Connecting rod
38	-	Piston
39	-	Piston pin retainer
40	-	Piston pin
41	-	Cross bolts, 4 of
42	-	Lower main bearings
43	-	Bolts, 5 of
44	-	Crankshaft damper pulley
45	-	Bolt
46	-	Crankshaft drive pulley
47	-	Crankshaft front oil seal
48	-	Upper main bearings
49	-	Bolts, 10 of
50	-	Seal

## Crankshaft

The crankshaft is forged steel and fillet rolled with induction hardened journals, which run in four bearings with clamped two layer bearing shells.

The main bearing caps are double and cross-bolted, this adds to the strength and rigidity of the engine block.

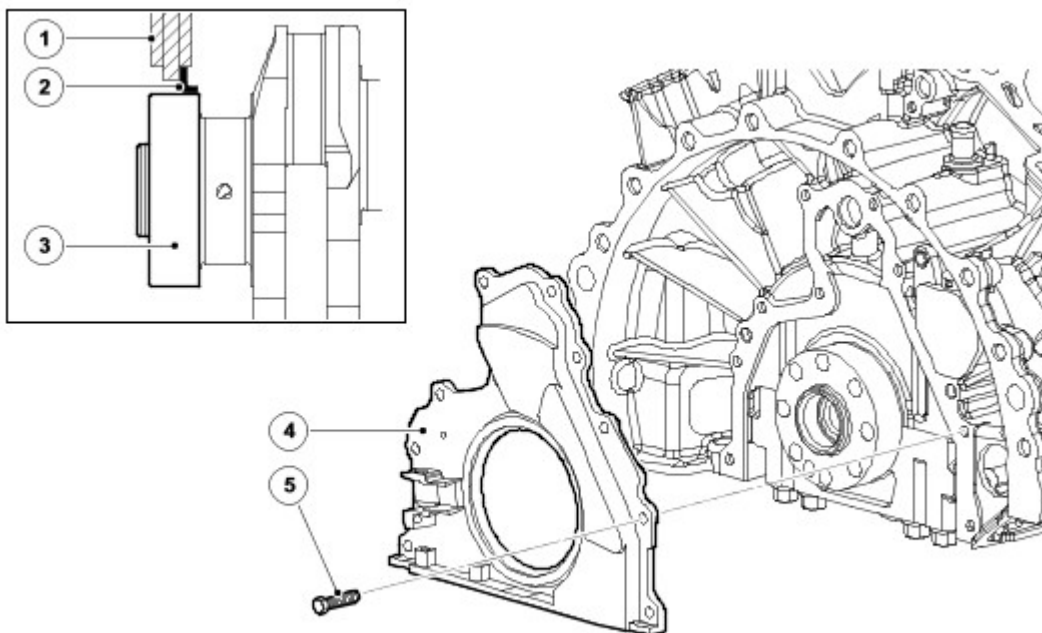
The crankshaft drive pulley is not keyed onto the crankshaft; it is secured to the crankshaft by a single bolt.

### NOTE :

Under no circumstances must the crankshaft pulley be tightened or loosened with the timing belt fitted.

### NOTE :

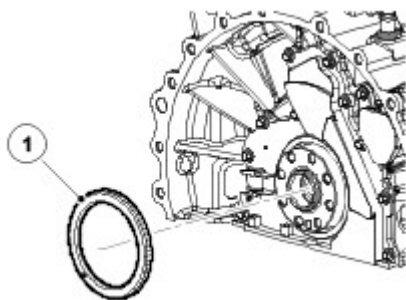
Do not attempt to remove the crankshaft drive pulley unless you have the correct special crankshaft-locking tool.



E44227

Item	Part Number	Description
1	-	Housing
2	-	Seal
3	-	Crankshaft
4	-	Rear oil seal retainer
5	-	Bolt

The crankshaft rear oil seal is a press fit in the rear oil seal retainer. The rear oil seal retainer also houses the CKP sensor.



E44228

Item	Part Number	Description
1	-	CKP sensor trigger wheel

The trigger wheel is located on the rear of the crankshaft. It is pressed onto the crankshaft using a special tool, which also precisely aligns the trigger wheel for crankshaft position and timing. The trigger wheel consists of 60 magnets, minus 2 for ECM crankshaft position reference and synchronisation. The magnets cannot be seen on the trigger-wheel; therefore, it can only be positioned using the special tool.

The CKP sensor air gap is 0.4mm to 0.5mm there is no adjustment. The sensor bolts into the rear oil seal retainer and the tolerance on the retainer and sensor gives an air gap within the specified range.

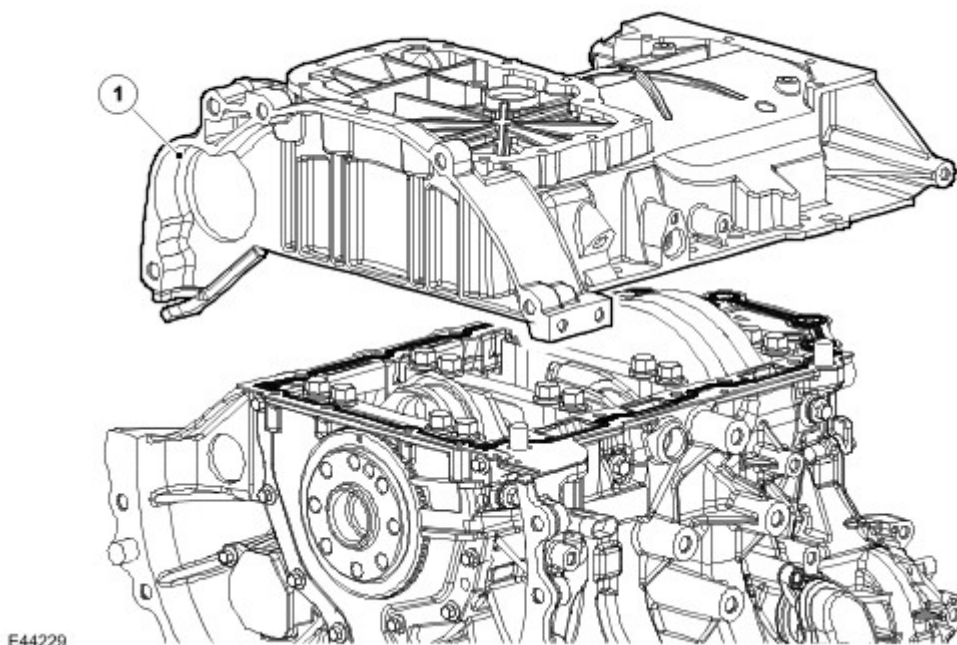
**NOTE :**

If the trigger wheel is removed for any reason, a new trigger wheel must be fitted. Do not reuse the old trigger wheel.

## Main Bearings

The main bearings are aluminium/tin split plain selective bearings. An oil groove in the top half of each bearing transfers oil into the crankshaft for lubrication of the connecting rod bearings. The upper and lower shells of bearing number four contain integral thrust washers, which limits the end float of the crankshaft.

## Ladder Frame



E44229

Item	Part Number	Description
1	-	Ladder frame

The ladder frame is fitted to the lower cylinder block to stiffen the base structure thus helping to reduce Noise, Vibration and Harshness (NVH). The frame is made of high-pressure die cast aluminium and also incorporates an oil baffle plate to reduce oil foaming and slosh.

The ladder frame is secured to the cylinder block with 2 dowels, 2 locator pins for the gasket and 18 retaining bolts; three different lengths of bolts are used:

- M6 x 20, 6 of
- M8 x 75, 4 of
- M6 x 105, 8 of

Iron inserts, cast into the main bearing supports of the ladder frame, minimise main bearing clearance changes due to heat expansion.

A gasket seals the joint between the ladder frame and the cylinder block.

A port for the oil level gauge tube is included in the casting on the LH side of the ladder frame.

An oil pick-up pipe with integral strainer locates in the front of the ladder frame to provide oil to the crankshaft driven oil pump.

## Sump

The sump consists of a pressed steel oil pan bolted to the aluminium alloy ladder frame with 14 M6 x 16 bolts. The engine oil drain plug and the oil temperature sensor are located at the rear left corner of the sump.

A reusable gasket seals the joint between the oil pan and the ladder frame; a bead of sealant seals the joint between the sump and the ladder frame.

## **Oil Temperature Sensor**

The engine oil temperature sensor is located at the rear left corner of the sump. The sensor provides the ECM and the instrument pack with the engine oil temperature status.

The sensor circuit consists of an internal voltage divider circuit which, incorporates an Negative Temperature Coefficient (NTC) thermistor. As the engine oil temperature rises the resistance through the sensor decreases and visa versa. The output from the sensor is the change in voltage, as the thermistor allows more current to pass to earth relative to the temperature of the oil. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)

## **Rear Oil Seal Retainer**

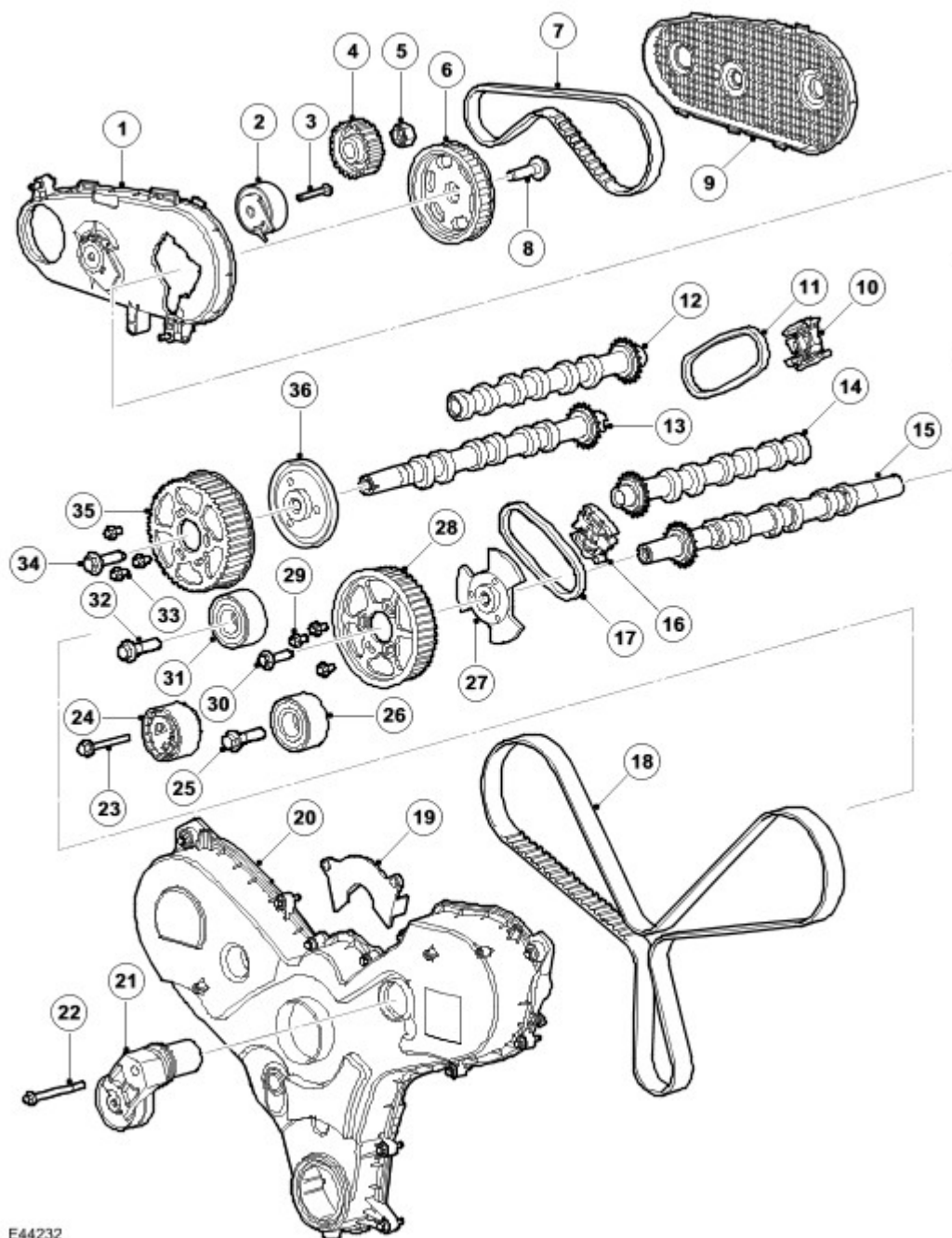
The crankshaft rear oil seal retainer is attached to the rear of the cylinder block by ten bolts and is sealed with a rubber seal. The retainer also houses the crankshaft position sensor.

## **Dual Mass Flywheel**

On vehicles with manual transmission, the dual mass flywheel is bolted on the rear of the crankshaft with eight bolts. A dowel on the crankshaft flange ensures that the flywheel is correctly located. A ring gear is fitted on the outer diameter of the flywheel. The ring gear is not serviceable.

The dual mass flywheel is used to insulate the gearbox from torsional and transient vibrations produced by the engine. For additional information, refer to Clutch (308-01 Clutch - 2.7L Diesel)

## **CAMSHAFT TIMING COMPONENTS**



E44232

Item	Part Number	Description
1	-	Rear Engine Accessory Drive (READ) rear cover
2	-	READ tensioner
3	-	Bolt
4	-	Fuel pump pulley
5	-	Nut
6	-	READ camshaft pulley
7	-	READ belt
8	-	Bolt
9	-	READ front cover
10	-	RH chain tensioner
11	-	RH timing chain
12	-	RH inlet camshaft
13	-	RH exhaust camshaft



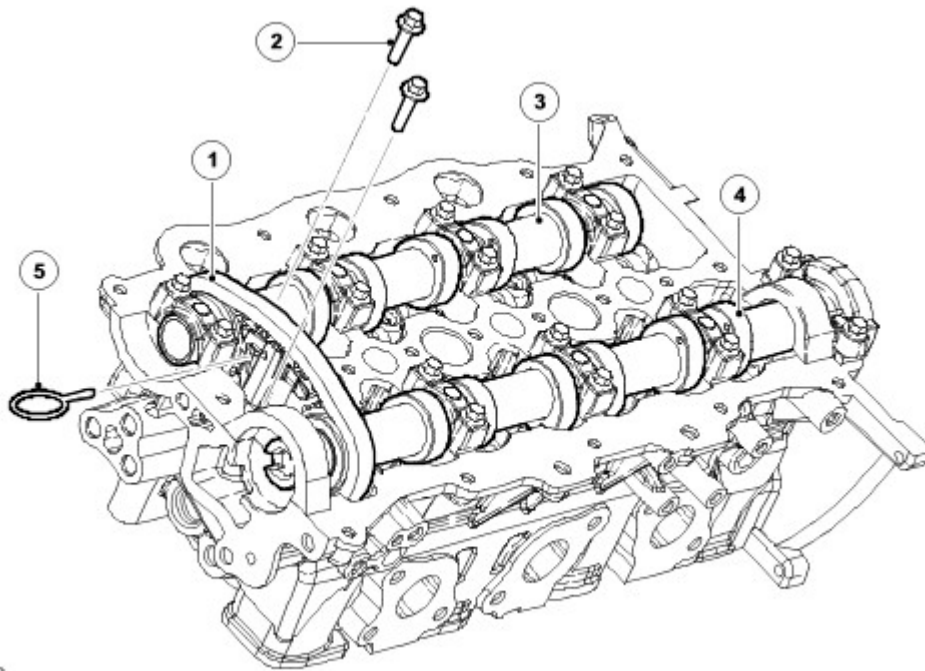
14	-	LH inlet camshaft
15	-	LH exhaust camshaft
16	-	LH chain tensioner
17	-	LH timing chain
18	-	Timing belt
19	-	Front cover bridge
20	-	Primary drive cover
21	-	Idler
22	-	Bolt
23	-	Bolt
24	-	Tensioner
25	-	Bolt
26	-	Idler
27	-	Camshaft hub
28	-	LH camshaft timing pulley
29	-	Bolt, 3 of
30	-	Bolt, 1 of
31	-	Idler
32	-	Bolt, 1 of
33	-	Bolt, 3 of
34	-	Bolt, 1 of
35	-	RH camshaft timing pulley
36	-	Camshaft hub

## Primary Drive

Primary drive is provided by a single toothed belt from the crankshaft to the exhaust camshaft gears of each cylinder bank via two idler pulleys and a tensioner.

Timing belt adjustment is carried out by an eccentric type tensioner mounted on the RH front face of the cylinder block.

## Secondary Drive



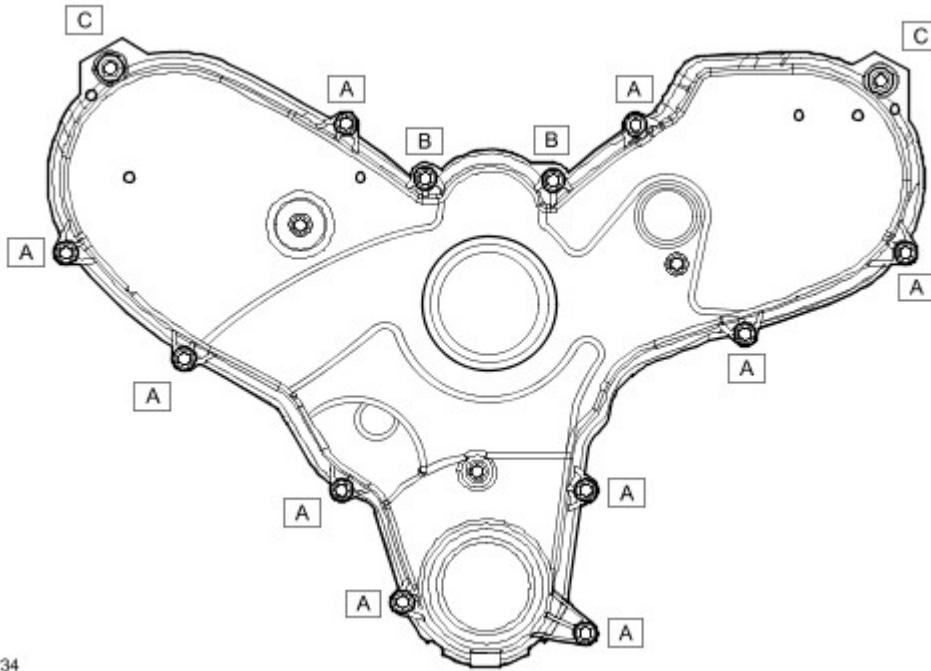
E44233

Item	Part Number	Description
1	-	Timing chain
2	-	Bolts
3	-	Inlet camshaft
4	-	Exhaust camshaft
5	-	Tensioner firing pin

Secondary drive is provided by two short crossover chains, which transfer drive from the exhaust camshaft gears to the inlet camshaft gears. The crossover drives are located at the rear of the RH cylinder bank and the front of the LH cylinder bank. This allows for a much shorter and simpler run for the main camshaft drive belt at the front of the engine.

Each crossover chain is tensioned via an automatic chain tensioner, which acts directly on the chains via a guide rail. The tensioners are located between the exhaust and inlet camshafts at the front or rear of the cylinder head, depending on the cylinder bank.

## Timing Cover

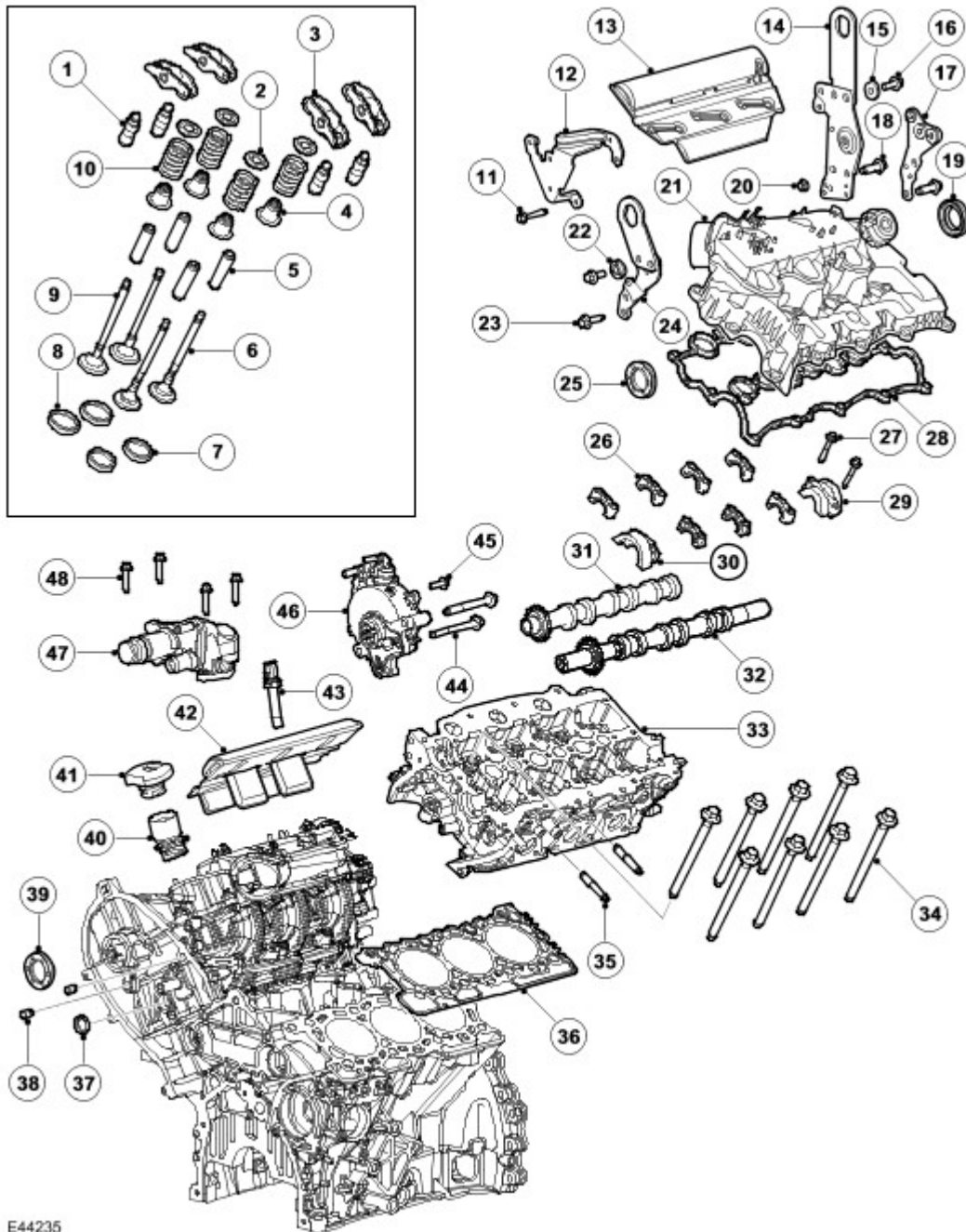


E44234

Item	Part Number	Description
A	-	Bolt (M6 x 32), 13 of
B	-	Bolt (M6 x 36), 2 of
C	-	Bolt (M6 x 30), 2 of

The plastic timing cover is bolted to the front of the cylinder block and cylinder heads with sixteen bolts and sealed with a rubber seal.

## CYLINDER HEAD COMPONENTS

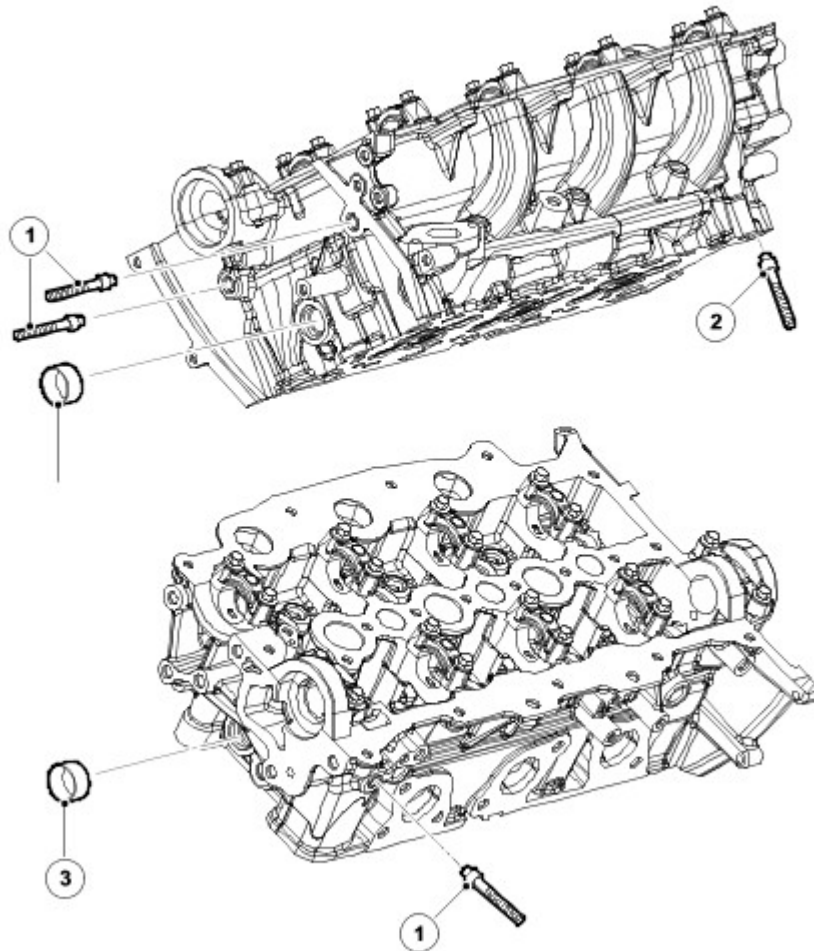


E44235

Item	Part Number	Description
1	-	Hydraulic lash adjusters
2	-	Valve spring retainers
3	-	Roller rockers
4	-	Valve stem seals
5	-	Valve guides
6	-	Exhaust valves
7	-	Intake valves
8	-	Exhaust valve seats
9	-	Intake valve seats
10	-	Valve springs
11	-	Bolt
12	-	Bracket
13	-	Cover

14	-	Lifting eye
15	-	Washer
16	-	Bolt
17	-	Bracket
18	-	Bolt
19	-	Seal
20	-	Cap
21	-	Inlet manifold cover assembly
22	-	Washer
23	-	Bolt
24	-	Lifting eye
25	-	Seal
26	-	Camshaft bearing caps
27	-	Bolts
28	-	Gasket
29	-	Camshaft bearing cap and seal housing
30	-	Camshaft bearing cap and seal housing
31	-	Inlet camshaft
32	-	Exhaust camshaft
33	-	LH cylinder head
34	-	Cylinder head bolts
35	-	Exhaust manifold studs
36	-	LH cylinder head gasket
37	-	Core plug
38	-	Plug
39	-	Seal
40	-	Oil filler tube
41	-	Oil filler cap
42	-	Cover
43	-	Injectors
44	-	Bolts
45	-	Bolt
46	-	Vacuum pump
47	-	Water outlet assembly
48	-	Bolts

## Cylinder Heads



E44236

The aluminium gravity die cast cylinder heads are unique to each cylinder bank. Eight deep-seated bolts, to reduce distortion, secure each cylinder head to the cylinder block. The cylinder head bolts are located beneath the camshafts, four under the inlet camshaft and four under the exhaust camshaft. Two hollow dowels align each cylinder head with the cylinder block.

**NOTE :**

The cylinder head bolts are not accessible with the camshafts fitted.

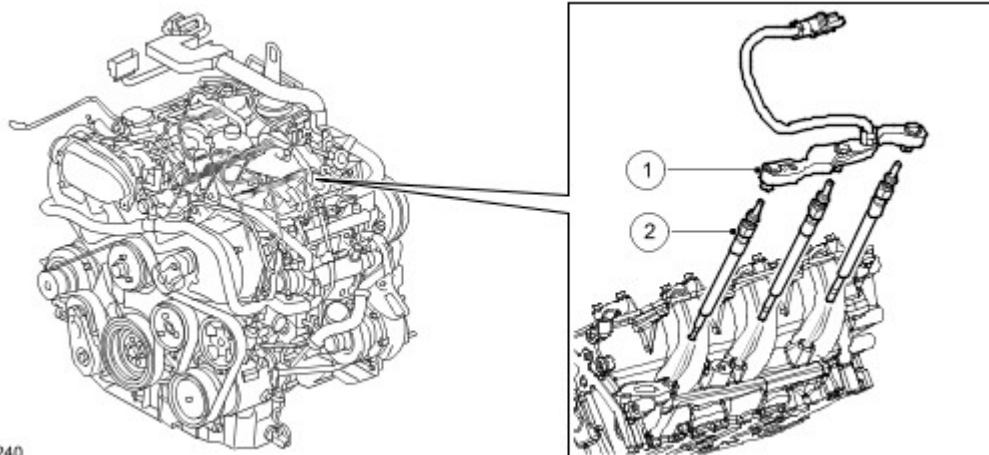
**NOTE :**

The cylinder head cannot be reworked.

The cylinder head has four ports machined at each cylinder location, two exhaust ports and two inlet ports. One of the inlet ports is helical and functions as a swirl port, the other is arranged laterally as a tangential port and functions as a charge port.

The six fuel injection nozzles are centrally mounted; one above each cylinder and each is fixed to the cylinder head by means of a clamp and two M6 x 35 bolts. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)

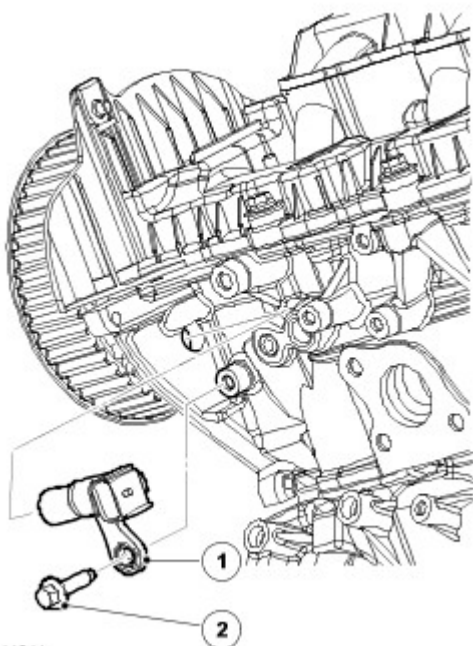
For additional information, refer to Fuel Charging and Controls (303-04C Fuel Charging and Controls - 2.7L Diesel)



E44240

Item	Part Number	Description
1	-	Harness connector
2	-	Glow plugs

The glow plugs are arranged centrally on the inlet side of the cylinder head, between the two inlet ports of each cylinder. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)



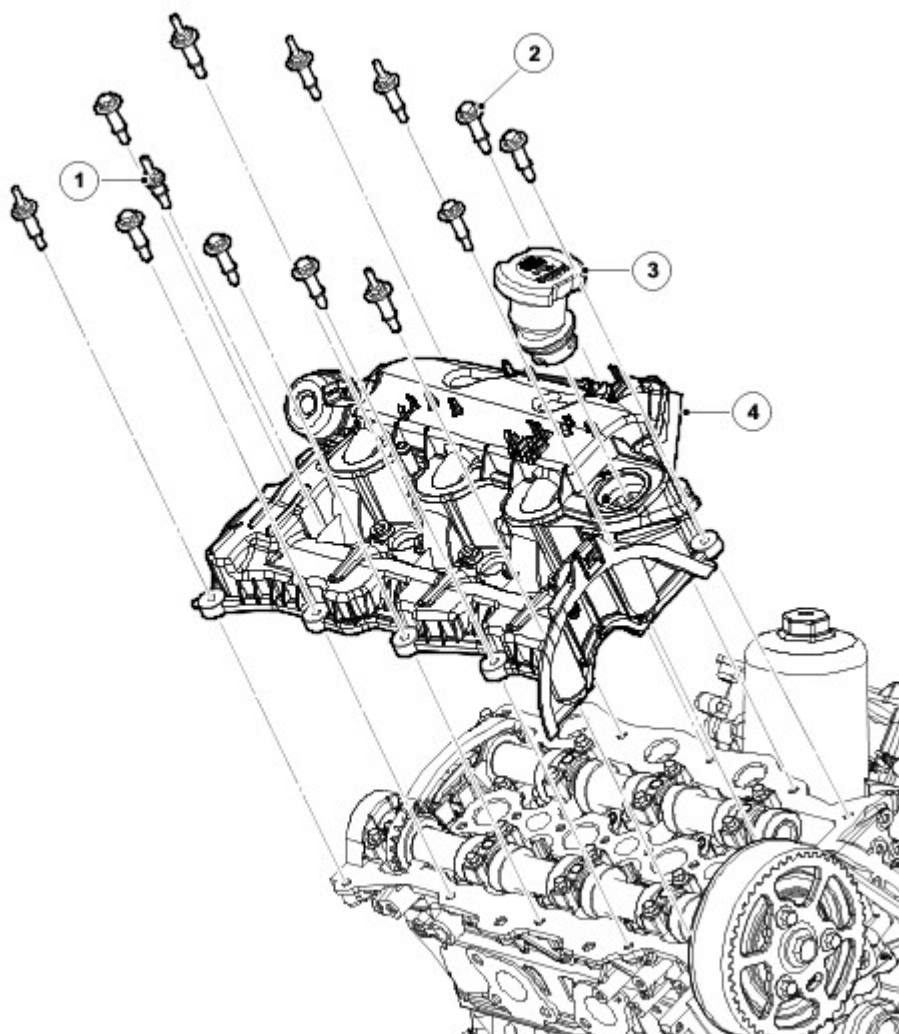
E44241

Item	Part Number	Description
1	-	Camshaft Position (CMP) sensor

The CMP sensor locates through a hole in a flange on the front LH side of the LH cylinder head. The exhaust camshaft gear of the LH cylinder head incorporates a trigger wheel, which is used in conjunction with the sensor to measure engine position. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel)

The engine lifting eyes are bolted to the cylinder head, one at the front and two at the rear, one per cylinder head.

### Camshaft Covers



E44237

Item	Part Number	Description
1	-	Stud bolt M6 x 40, 6 of
2	-	Bolt M6 x 40, 7 of
3	-	Oil filler aperture
4	-	RH camshaft cover assembly

The camshaft covers are manufactured from vinyl ester composite. The RH bank camshaft cover incorporates an outlet for the full load engine breather and the engine oil filler cap. The LH bank camshaft cover incorporates an outlet for the part load engine breather. For additional information, refer to Engine Emission Control (303-08C Engine Emission Control - 2.7L Diesel)

Silicon rubber in-groove gaskets seal the joints between the camshaft covers and the cylinder heads. Together with spacers and seals on the camshaft cover fasteners, they also isolate the covers from direct contact with the cylinder heads, to reduce noise.

### Cylinder Head Gasket

The cylinder head gasket is a three-layer, laminated steel type and is available in five different thickness. The choice of gasket thickness is dependent on the maximum piston protrusion. Gasket thickness is identified by serrations cut into the front end of the gasket.

### Gasket Selection Table

Piston Protrusion (mm)	Gasket Thickness (mm)	Identification
0.541 - 0.590	1.12	1



0.591 - 0.640	1.17	2
0.641 - 0.690	1.22	3
0.691 - 0.740	1.27	4
0.741 - 0.790	1.32	5

To calculate the correct cylinder head gasket thickness, each piston must be measured at two points, with an average of the two measurements taken to determine the piston protrusion. The highest of the three measurements will determine the gasket required for that particular cylinder head.

**NOTE :**

The difference between the maximum and minimum protrusion measurement in any one bank should not be greater than 0.1mm. It is permissible to have a different grade of gaskets between the LH and RH banks.

## Camshafts

The camshafts are of a hollow steel tube construction, with pressed on sintered lobes. Each camshaft is retained by aluminium alloy caps, five for the exhaust camshafts and four for the inlet camshafts. Location letters, A to I for the intake camshaft and R to Z for the exhaust camshaft, are marked on the outer faces of the caps for each cylinder head.

The LH cylinder bank exhaust camshaft is machined to accept a rear camshaft gear. The rear camshaft gear provides drive for High Pressure (HP) fuel pump, located centrally at the rear of the 'vee', via a short-toothed belt and tensioner pulley.

The RH cylinder head exhaust camshaft is machined at the rear end to provide a drive connection for the vacuum pump.

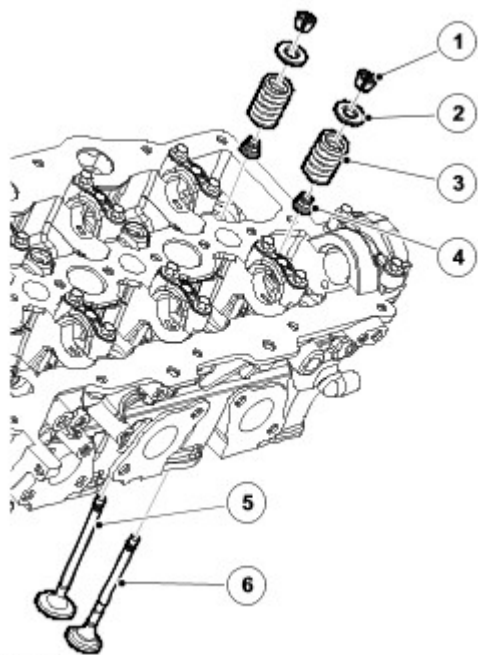
**NOTE :**

The camshaft drive sprockets also form the thrust faces for the camshaft endfloat. In production the endfloat is 0.065mm to 0.185mm. In service, if the endfloat is out of specification, the camshaft(s) or cylinder head(s) may have to be replaced.

## Camshaft Timing

Valve	Position
Inlet valve opens	8.5° BTDC
Inlet valve closes	35.5° ABDC
Exhaust valve opens	64° BBDC
Exhaust valve closes	12° ATDC

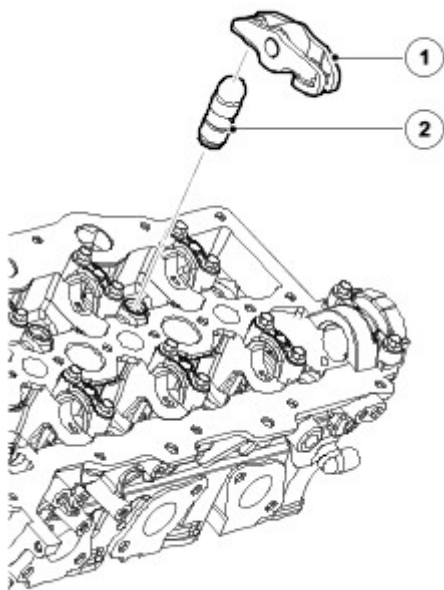
## Inlet and Exhaust Valves



E44239

Item	Part Number	Description
1	-	Valve spring collets
2	-	Valve spring retainer
3	-	Valve spring
4	-	Valve stem seal
5	-	Inlet valve
6	-	Exhaust valve

Each cylinder head incorporates two overhead camshafts operating four valves per cylinder via steel roller rockers with hydraulic lash adjusters.



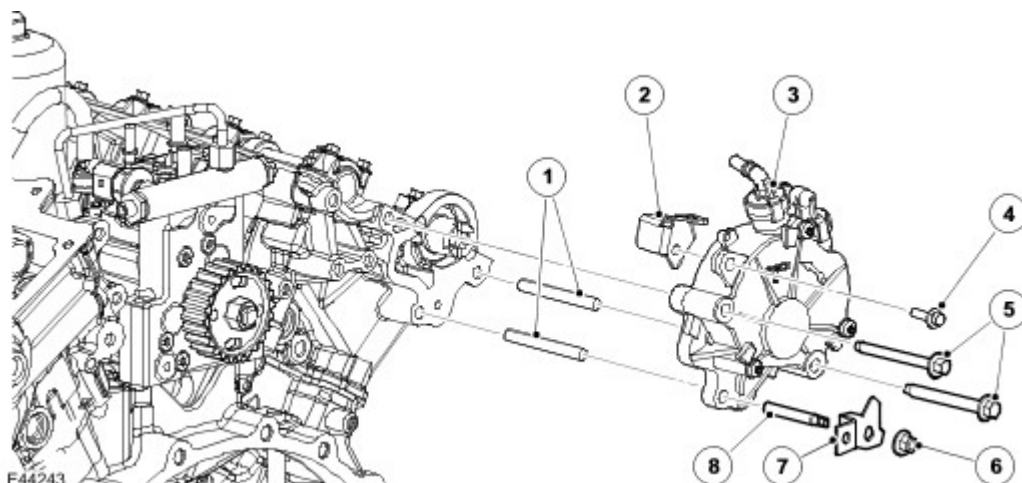
E44238

Item	Part Number	Description
1	-	Roller rocker

2 - Hydraulic lash adjuster

The lightweight valve gear provides good economy and noise levels. Valve head diameters are 31mm (1.220 in) for the exhaust and 35mm (1.378 in) for the intake. All valves have 5mm (0.197 in) diameter stems supported in sintered metal seats and guide inserts. Collets, valve collars and spring seats locate single valve springs on both intake and exhaust valves. Valve stem seals are integrated into the spring seats.

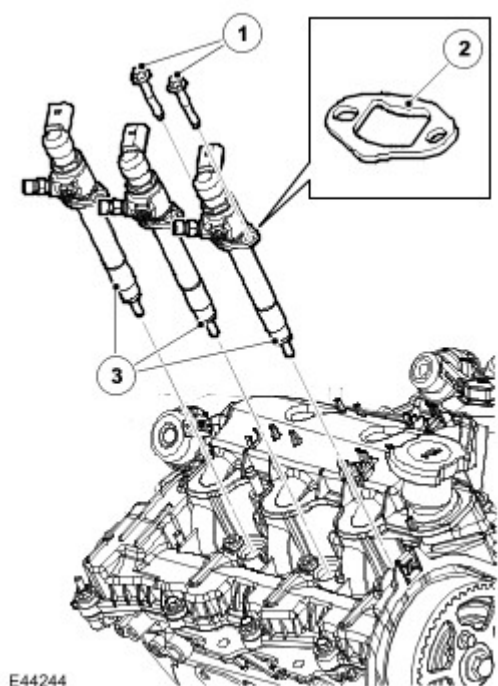
### Vacuum Pump



Item	Part Number	Description
1	-	Location dowels
2	-	Bracket
3	-	Vacuum pump
4	-	Bolt
5	-	Bolts
6	-	Nut
7	-	Bracket (transmission breather hose)
8	-	Stud

The vacuum pump is located at the rear of the RH side cylinder head and is driven from the exhaust camshaft.

### Fuel Injectors



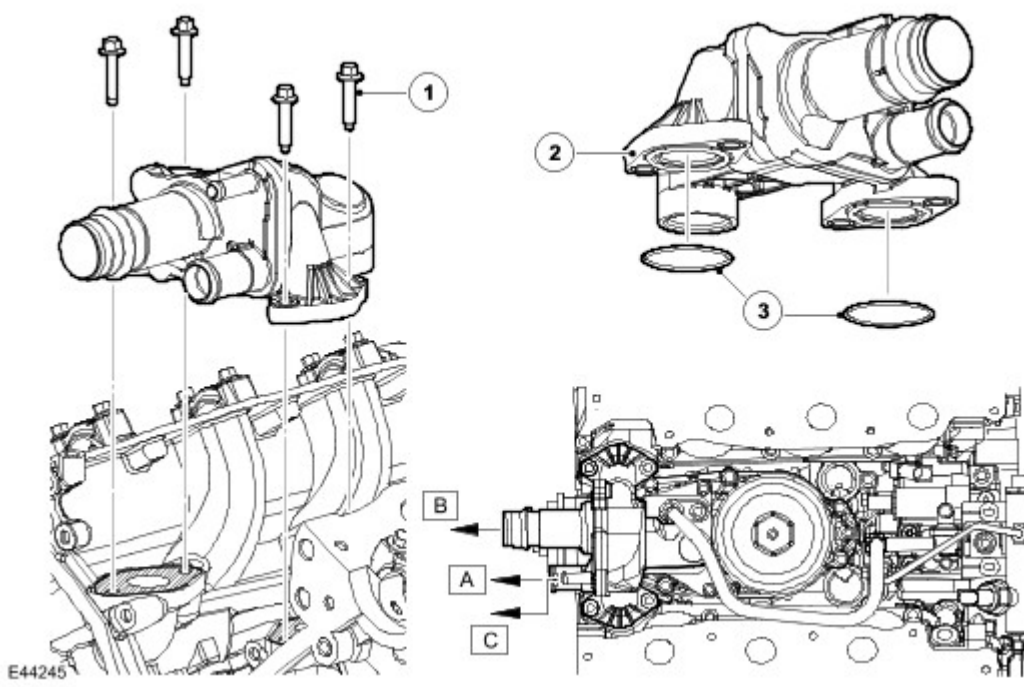
E44244

Item	Part Number	Description
1	-	Bolt, 2 per injector
2	-	Clamp
3	-	Injectors

The fuel injectors inject the quantity of fuel required for all the engine operating conditions into the combustion chambers. The quantity of fuel injected during each working cycle is composed of a noise-reducing pilot injection phase and a main injection phase.

The six, side fed, piezo electrically controlled fuel injectors are installed in the fuel rails. The start of fuel injection and the quantity of fuel injected is controlled directly by the ECM. Two O-rings seal each injector to the manifold interface. For additional information, refer to Electronic Engine Controls (303-14C Electronic Engine Controls - 2.7L Diesel) For additional information, refer to Fuel Charging and Controls (303-04C Fuel Charging and Controls - 2.7L Diesel)

### Water Outlet Assembly



Item	Part Number	Description
1	-	Bolt, 4 of
2	-	Water outlet assembly
3	-	Seals
A	-	Water outlet housing assembly, EGR outlet
B	-	Water outlet housing assembly, radiator outlet
C	-	Water outlet housing assembly, bleed valve

The water outlet assembly connects the cooling channels of the cylinder block to the cooling channels of the LH and RH cylinder heads and provides the coolant outlet for the EGR and coolant return.

## LUBRICATION SYSTEM

### General

Oil is drawn from the reservoir in the oil pan and pressurised by the oil pump. The output from the oil pump is then filtered and distributed through internal oil passageways.

All moving parts are lubricated by pressure or splash oil. Pressurised oil is also provided for operation of the hydraulic adjusters and the timing gear chain tensioners.

The engine is lubricated by a force-feed oil circulation system with a full flow oil filter. The oil cooler forms a unit with the oil filter and fuel cooler, which is mounted centrally in the middle of the cylinder block between the two banks of cylinders. The engine oil is cooled using the engine cooling system. This eliminates the need for an additional engine oil cooler remotely mounted.

The fuel cooler, which forms part of the oil filter body, is also cooled by engine coolant. In addition there is a further fuel cooler in the return line to the fuel tank.

The oil returns to the oil pan under gravity. Large drain holes through the cylinder heads and cylinder block ensure the quick return of the oil, reducing the volume of oil required and enabling an accurate check of the contents soon after the engine stops.

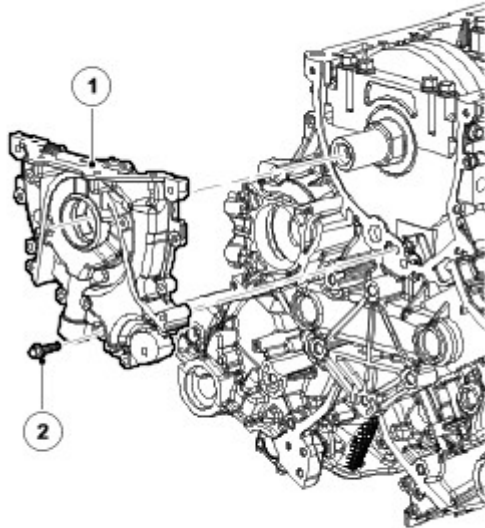
System replenishment is through the oil filler cap on the RH camshaft cover.

With the exception of the pump and level gauge, all oil system components are installed on the sump.

### Oil Pick-up

The moulded composite oil pick-up is immersed in the oil reservoir to provide a supply to the oil pump during all normal vehicle attitudes. The castellated inlet allows the supply to be maintained even if the sump pan is deformed (e.g. by 'grounding'). A mesh screen in the inlet prevents debris from entering the oil system.

## Oil Pump



E44230

Item	Part Number	Description
1	-	Oil pump
2	-	Bolt

The oil pump is a gear type pump and is bolted and dowelled to the front of the engine block. It is sealed by means of a rubber gasket, which is recessed into the oil pump housing. The pump inlet and outlet ports align with oil passages in the ladder frame.

The pumping element is an eccentric rotor, which is directly driven by flats on the crankshaft. An integral pressure relief valve regulates pump outlet pressure at 4.5 Bar (65.25 Psi).

The front crankshaft oil seal is housed in the oil pump casing and is fitted such that its front face is 1mm underflush with the machined front face of the oil pump.

### NOTE :

The seal is not to be pushed all the way into the bore as this will block the seal drains.

## Oil Filter

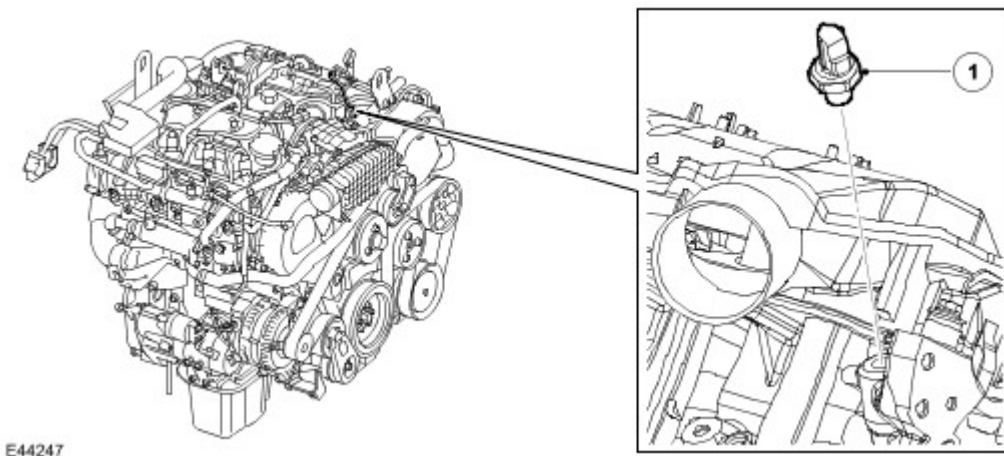
The oil filter is a replaceable cartridge installed on an adapter in the centre of the 'vee'. An internal bypass facility permits full flow bypass if the filter is blocked.

### NOTE :

In service care must be taken when removing the oil filter to minimise oil drips and spillage into the engine 'vee' and cam covers:

- Do not use air/power tools
- Unscrew oil filter cap 4-5 turns
- Leave for a minimum of 1 minute to allow to drain
- Remove cap, ensuring minimal oil spillage
- Replace oil filter element into the cap (can only be fitted in one direction)
- Replace cap and torque to specification.

### Oil Pressure Switch



E44247

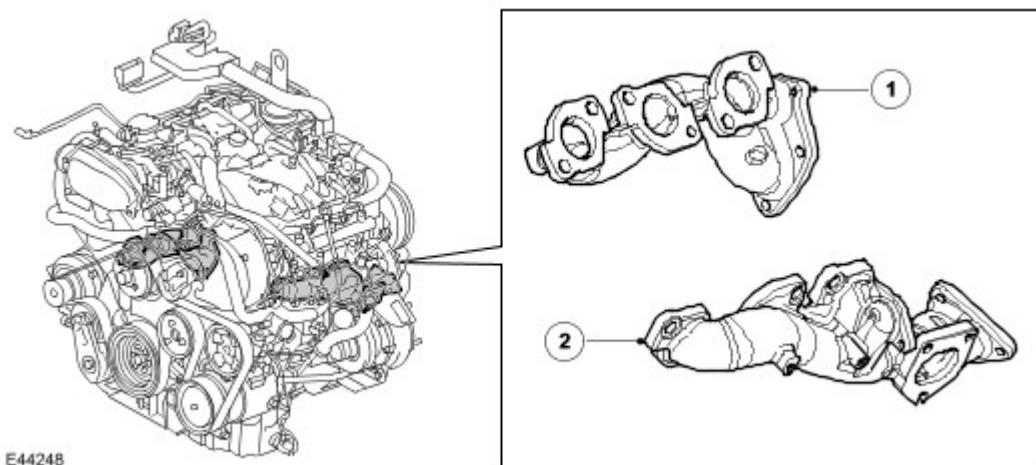
Item	Part Number	Description
1	-	Oil pressure switch

The oil pressure switch, located in the 'vee' at the front of the LH cylinder head, connects a ground input to the instrument cluster when oil pressure is present. The switch operates at a pressure of 0.15 to 0.41 Bar (2.2 to 5.9 Psi).

### Oil Level Gauge

The oil level gauge locates midway along the LH side of the oil pan, supported in a tube installed in the ladder frame. Two holes in the end of the gauge indicate the minimum and maximum oil levels. There is a difference of approximately 1 litre (1 US quart) between the two levels.

### EXHAUST MANIFOLD



E44248

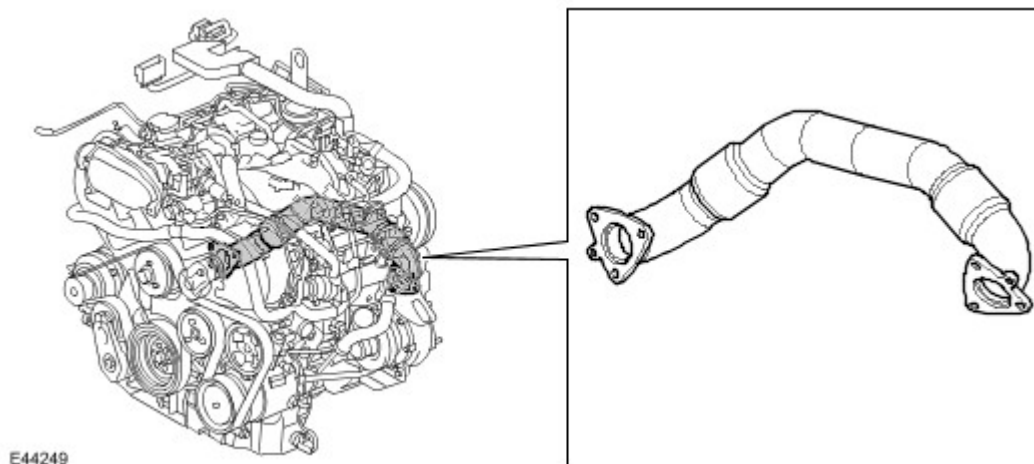
Item	Part Number	Description
1	-	LH exhaust manifold
2	-	RH exhaust manifold

The exhaust manifolds are cast from steel alloy and are unique for each cylinder bank. They are sealed to the cylinder head by means of a steel gasket. Sacrificial plastic sleeves are used to align the manifolds. These sleeves must be changed when refitting the manifolds. Spacers on the securing bolts allow the manifolds to expand and retract with changes of temperature while maintaining the clamping loads.

Each manifold has a connection for the EGR transfer pipe.

The engine is fitted with a Variable Geometry Turbocharger (VGT), which is fixed to the exhaust manifold by a three hole flange with a steel gasket.

## Crossover Pipe



E44249

A crossover pipe carries the exhaust gasses from the RH exhaust manifold to the turbocharger on the LH exhaust manifold. The crossover pipe is located at the rear of the engine and is routed across the top of the transmissions bell housing.