

# SECTION 303-01A: Engine - I6

## VEHICLE APPLICATION: 2008.0 Falcon

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## SPECIFICATIONS

### Lubricants and Sealants

Description	Specification
Engine Oil 5W-30 ILSAC - GF4/ GF5	WSS-M2C929-A/ WSS-M2C946-A (I6 DOHC VCT)
Silicone Sealant (Loctite 5900)	WSS M4G323 A7
Anti Seize compound (Loctite 767 or similar)	ESE FM99C100 A
Rubber Grease	ESZ M1C223 A

### General Specifications

Description	Specification
Displacement	3983cc
Number of cylinders	In line 6
Compression Ratio	
DOHC VCT	10.3:1
Power at specified rpm(DIN) on 95 RON	
DOHC VCT	198 kW @ 5000
Torque at specified rpm(DIN) on 95 RON	
DOHC VCT	409 Nm @ 3250
Bore/Stroke	92.25mm / 99.31mm
Firing Order	1-5-3-6-2-4
Oil Pressure - 2000 rpm @ 80°C (normal operating temperature)	300kPa minimum
Oil Pressure - 700 rpm (idle) @ 80°C (normal operating temperature)	120kPa minimum
Spark Plug - I6	
DOHC VCT	AGSP 22Z13
Compression Pressure at Maximum cranking speed	
DOHC VCT	1010 kPa
Idle Speed	
Auto trans in Neutral	
DOHC VCT	700 ± 50 rpm
Auto trans in Drive	
DOHC VCT	530 ± 50 rpm
Intake Manifold Vacuum @ Idle rpm	
DOHC VCT	60 kPa @ Drive

### Cylinder Head/Valve Train

Combustion Chamber Volume	63.25 - 65.75cc
Joint face flatness	0.08mm in 150mm or 0.18mm overall
Cylinder head joint face surface finish	2.5 Rz (Din) @2.5 cut-off, Wt <10.0, Mr 68% min @ 2.0 um
Minimum Cylinder head deck height	Std - 0.3 mm
Valve seat width- Intake	1.0mm - 1.4mm
Valve seat width-Exhaust	1.25mm - 1.75mm
Valve seat angle	44.75°
Valve seat runout	0.04mm
Valve stem to guide clearance	0.020mm - 0.069mm
Valve guide parent bore diameter	9.975mm - 10.025mm
Valve guide outside diameter	10.028mm - 10.039mm
Valve guide inside diameter	6.015mm - 6.044mm
Valve head diameter-intake	35mm
Valve head diameter - exhaust	32mm
Gauge Diameters	
Valve face runout	0.05mm
Valve face angle	45.5°
Valve stem diameter (In & Ex)	5.975mm - 5.995mm
Valve seat insert recess diameter (In)	35.07mm - 35.12mm
Valve seat insert recess diameter (Ex)	32.37mm - 32.42mm
Valve seat insert outer diameter (In)	35.192mm - 35.208mm
Valve seat insert outer diameter (Ex)	32.492mm - 32.508mm
Valve spring free length	50.0 mm
Valve spring installed load/length	280N / 37.8 mm
Valve spring compressed load/length	550N / 26.8mm
Valve spring allowable load loss	30N @ 37.8mm
Valve spring - out of square	2°
Rocker arm ratio	2.04
Hydraulic Lash Adjuster diameter	13.972mm - 13.984mm
Lash adjuster bore in cylinder head	13.990mm - 14.007mm
Collapsed Lash adjuster clearance at cam	0.5mm - 1.1mm (desired)



## SPECIFICATIONS (Continued)

Description	Specification	
<b>Camshaft</b>		
Lobe lift (In & Ex)	5.39mm	
Valve lift (In & Ex)	11.00mm	
Camshaft end play	0.1mm - 0.3mm	
Camshaft journal diameter	34.928mm - 34.968mm - Front  29.928mm - 29.968mm - Remainder	
Camshaft Journal max out of round	0.015mm	
Cylinder head bearing diameter	34.987mm - 35.012mm - Front  29.987mm - 30.012mm - Remainder	
Journal to bearing clearance	0.019mm - 0.084mm	
Service Limit	0.120mm	
Valve Timing	Engine Stopped, VCT Phasers Fully Advanced & VCT Locking Pins Engaged	
Intake Opens	27.5° BTDC	
Intake Closes	48.5° ABDC	
Exhaust Opens	78.5° BBDC	
Exhaust Closes	2.5° BTDC	
Intake Cam Centre-line (Maximum Lift)	99.5° ATDC	
Exhaust Cam Centre-line (Maximum Lift)	131.5° BTDC	
Timing Chain Maximum Elongation	0.35 %	
<b>Cylinder Block</b>		
Head gasket thickness	0.25mm at body, 0.37mm at cylinder bore	
Main bearing bore diameter	71.517mm - 71.541mm	
Cylinder bore diameter	92.24mm - 92.26mm Std  92.79mm - 92.31mm (0.05mm O/S)  93.74mm - 92.76mm (0.5mm O/S)  93.24mm - 93.26mm (1.0mm O/S)	
Out of round limit	0.015mm	
Out of round service limit	0.125mm	
Taper service limit	0.25mm	
<b>Crankshaft</b>		
Main bearing journal diameter	67.481mm - 67.505mm	
Connecting rod journal diameter	53.93mm - 53.95mm	
Crankshaft free end play	0.10mm - 0.20mm	
Service Limit	0.30mm	
Connecting rod bearings- clearance to crankshaft- desired	0.025mm - 0.04mm	
Connecting rod bearings- clearance to crankshaft- service limit	0.06mm	
Main bearings- clearance to crankshaft-desired	0.02mm - 0.04mm	
Main bearings- clearance to crankshaft- service limit	0.06mm	
<b>Connecting Rod</b>		
Small end bore diameter	23.104mm - 23.144mm	
Fixed Pin (Without Bushing)		
Big end bore diameter	56.871mm - 56.889mm	
Length (centre to centre)	153.78mm - 153.92mm	
Alignment ( bore to bore- max difference)Twist	0.20mm Service Limit	
Bend	0.10mm Service Limit	
Side clearance (assembled to crank) Standard	0.09mm - 0.27mm	
Side clearance Service limit	0.36mm	



**SPECIFICATIONS (Continued)**

<b>Description</b>		<b>Specification</b>			
Bore Diameter			92.24	92.25	92.26
Installed piston ring gap - Top Compression - New	TBA	Top Ring Installed Gap	0.267mm ~ 0.417mm	0.299mm ~ 0.449mm	0.330mm ~ 0.480mm
Installed piston ring gap - 2nd Ring - New	TBA	2nd Ring Installed Gap	0.287mm ~ 0.447mm	0.319mm ~ 0.479mm	0.350mm ~ 0.510mm
Oil Ring (Rail) Gap - New	0.15mm - 0.75mm	Oil Ring Installed Gap	0.087mm ~ 0.687mm	0.119mm ~ 0.719mm	0.150mm ~ 0.750mm
Oil Ring (Rail) Gap - Service Limit	1.0mm				

<b>Description</b>	<b>Specification</b>
<b>Piston</b>	
Piston diameter (STD) (Measured at 12.5 up from Piston Skirt)	92.201mm-92.215mm (Without Skirt Coating) 92.211mm-92.235mm (With Skirt Coating)
Piston to bore clearance (new)	0.025mm-0.059mm 0.005mm-0.049mm
Piston Pin bore diameter (Fixed Pin)  Note the "Pin to Piston Clearance" required below	23.169mm - 23.174mm
Ring groove width - Top Compression	1.23mm - 1.25mm
Ring groove width - Lower Compression	1.52mm - 1.54mm
Ring groove width - Oil Ring	2.99mm - 3.01mm
Piston pin length	65.10mm - 65.30mm
Piston pin diameter (Fixed Pin)  Note the "Pin to Piston Clearance" required below.	23.157mm - 23.162mm
Pin to piston clearance	0.010mm-0.015mm
Ring groove clearance- Top Compression New	0.04mm - 0.080mm
Ring groove clearance- Top Compression Service limit	0.15mm
Ring groove clearance- 2nd Ring New	0.03mm - 0.075mm
Ring groove clearance - 2nd Ring Service limit	0.15mm
Oil ring groove clearance - new	0.028mm - 0.17mm
Oil ring groove clearance - service limit	0.20mm

<b>Lubrication system</b>	
Oil capacity - Initial Fill (Dry engine)	7.0L
Oil Change without Filter	5.8L
Oil Change with Filter	6.8L

**Torque Specifications**

Oil threads with engine oil. Do not oil threads that require thread sealant or thread locker.

<b>Description</b>	<b>Nm</b>
Main Bearing Cap bolts	85
Cylinder Head Bolts (except front and rear)	Step 1: 40 Nm Step 2: Rotate 120° clockwise
Front and Rear Cylinder Head Bolts (X4 Bolts)	Step 1: 30 Nm Step 2: Rotate 90° clockwise
Oil Pan to Cylinder block/front cover	10
Oil Pan to main bearing cross bolts	58 (Apply thread sealant)
Oil Pan Rear Face	Flush or 0.25mm forward of rear face of block
Oil Pan Drain Plug	26
Intake Manifold - Cylinder Head	17-24
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To Cylinder Head	8-12
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To Manifold	17-24
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Fuel Rail to Intake Manifold	8-12
Intake Manifold ETB	8-12



**SPECIFICATIONS (Continued)**

<b>Description</b>	<b>Nm</b>	<b>Description</b>	<b>Nm</b>
Intake Manifold MTV	4.5-5.5	Engine Mount Bracket to Cylinder Block	50 (Apply thread locker)
Intake Manifold Pressure/Temperature Sensor	2	Engine Mount to Engine Mount Bracket	102
Intake Manifold Dip Stick Tube	10	Alternator Bracket(rear) to Cylinder Block	25
Exhaust Manifold to Cylinder Head	27	Spark Plugs	17
Exhaust Manifold Heat Shield - Lower	20	Variable Cam Timing Unit to Camshaft	Step 1: 20 Nm Step 2: Rotate 40° clockwise
Exhaust Manifold Slip Joint		Spark Plug Cover to Rocker Cover	7
Stud	16	Ignition Coil to Rocker Cover	24
Nut	23	Cam Cover to Cylinder Head - Front two long bolts	13
Flywheel to Crankshaft (Manual)	90	Cam Cover to Cylinder Head - Six short bolts	10 (Apply thread locker)
Flywheel to Crankshaft (Auto)	70	Oil Control Valve Seals to Cam Cover	7
Manual Flywheel Housing to Block	50	Cam Caps to Cylinder Head	10
Oil Pump to Cylinder Block	10	Camshaft position sensor to cylinder head	9
Oil Pump Pickup Tube to Oil Pump	10	Cylinder Head Temperature sensor to Cylinder Head	15
Oil Pump Pickup Tube to Main Bearing Bolt	20	Timing Chain Fixed Chain Guide to Cylinder Block and Cylinder Head	20
Oil Filter Adaptor to Cylinder Block	17	Timing Chain Tensioner to Cylinder Head	9
Oil Filter to Cylinder block	With oiled gasket, hand tighten until gasket contacts block face, tighten a further ¾ turn	Timing Chain Guide Pivot Bolt to Oil Pump	47
Oil Pressure Sensor	20 (Apply thread sealant)	Timing Chain Guide Pivot Nut	9
Oil Temperature Sensor	20 (Apply thread sealant)	Crankshaft Vibration Damper/Front Pulley to Crankshaft	145
Knock Sensor to Cylinder Block	20-25 (Apply thread sealant)	Connecting Rod Cap to Connecting rod	Step 1: 25 Nm Step 2: 90° clockwise.
Timing Cover to Cylinder Block	28 (Apply thread sealant)		
Crankshaft Position Sensor to Timing Cover	10-12		
Thermostat Housing to Cylinder Head	20 (Apply thread locker)		
Water Outlet to Thermostat Housing	20		
Heater Tube to Thermostat Housing	20		
Heater Tube to Block (Exhaust side)	27		
Water Pump to Cylinder Block	20		



## DESCRIPTION AND OPERATION

### Engine - I6

The 4.0L I6 is a four valve per cylinder, Dual Overhead Camshaft Engine with individual intake and exhaust variable cam timing units. A distributorless ignition system with individual coils mounted above the spark plugs is used. The cylinder block is cast iron, and is attached to an aluminium oil pan with cross-bolted main bearing caps to increase rigidity. The oil pump is mounted on the nose of the crankshaft, and a single stage roller chain drives the hollow camshafts. Hydraulic lash adjusters and roller finger followers activate the valves. An electronic throttle body is employed together with a variable length intake manifold. Petrol version only is available.

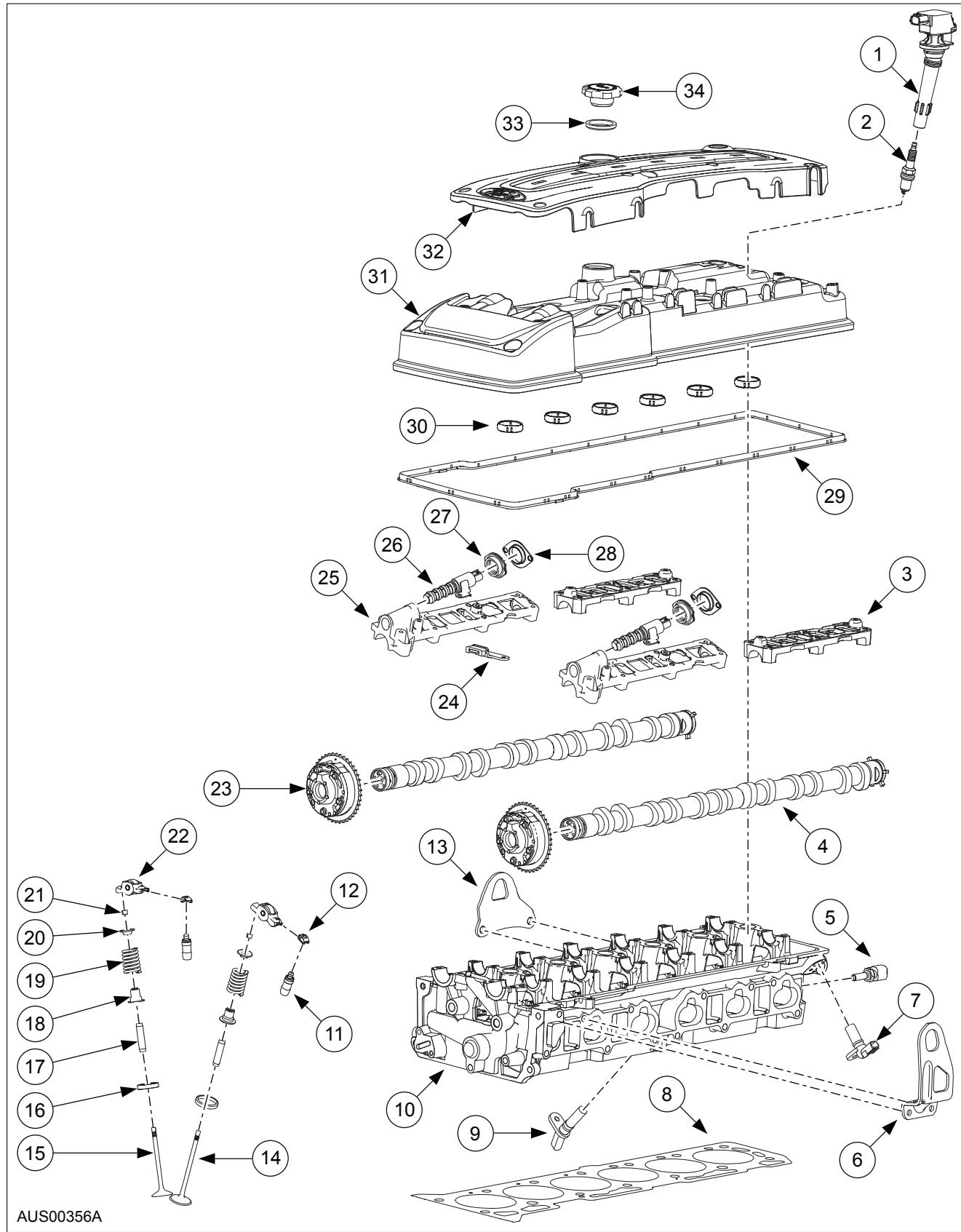
#### WARNING

 Engines with plastic inlet manifolds are not suitable for conversion to LPG. The plastic inlet manifold is only designed to work with petrol engines - it is dangerous to try to use this type of manifold with vapour based LPG fuel systems.



## DESCRIPTION AND OPERATION (Continued)

### Upper Engine Components



## DESCRIPTION AND OPERATION (Continued)

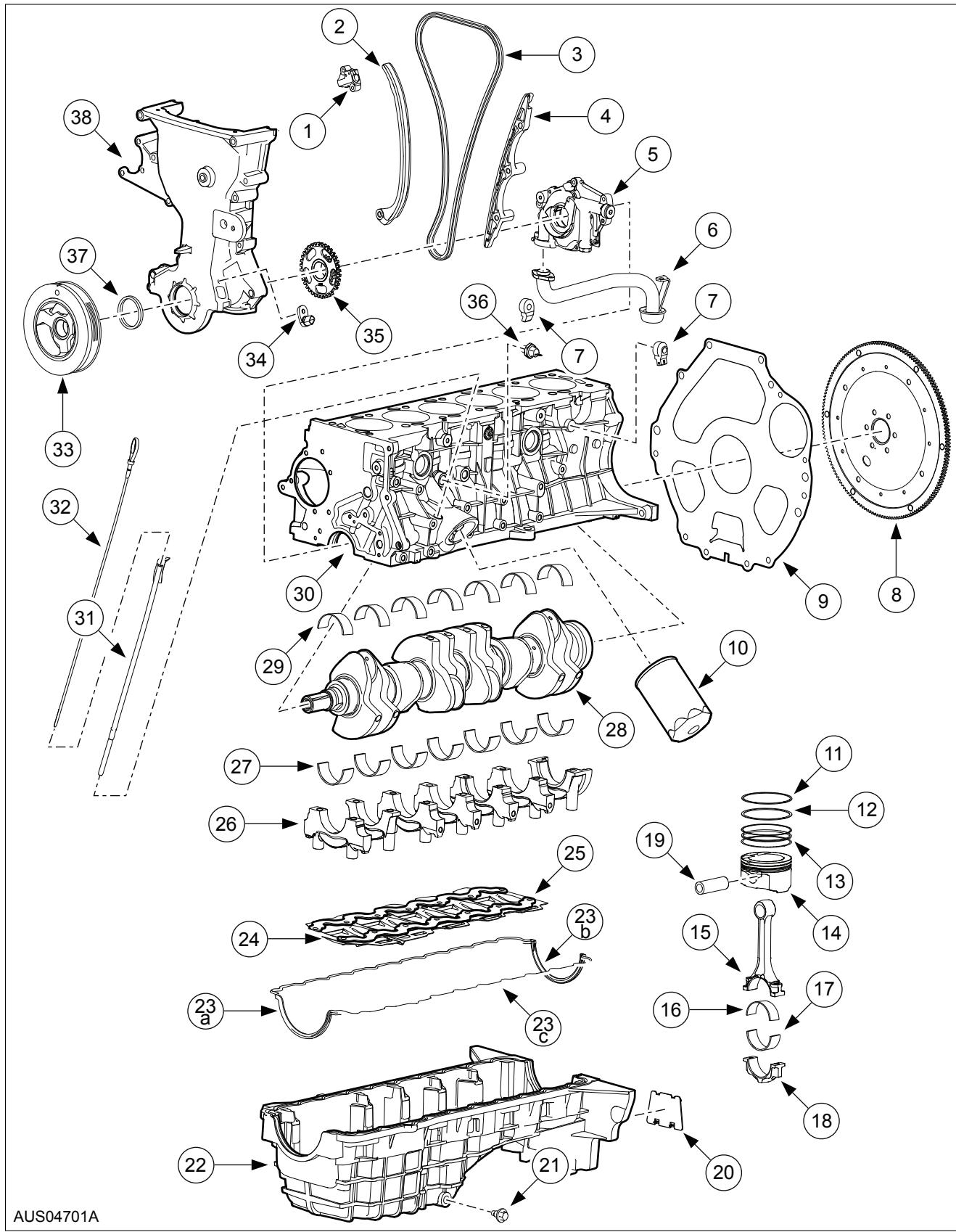
### Upper Engine Components

Item	Description
1	Coil and Boot Assembly
2	Spark Plug
3	Cap - Camshaft intake bridge - Rear
4	Camshaft - Intake
5	Cylinder head temperature sensor
6	Engine lifting eye, LH, FRT
7	Sensor Assembly camshaft timing
8	Head gasket
9	Sensor Assembly camshaft timing
10	Cylinder head
11	Lash adjuster assembly
12	Clip
13	Engine lifting eye, RH, RR
14	Valve - Inlet
15	Valve - Exhaust
16	Insert - Cylinder Head
17	Bushing - Valve guide
18	Seal - Valve stem
19	Spring - Valve
20	Retainer - Valve spring
21	Key - Valve spring retainer
22	Rocker arm
23	Cam timing assembly - Engine variable
24	Top timing chain guide
25	Cap - Camshaft exhaust bridge, FRT
26	Housing and Valve assembly camshaft variable timing
27	Gasket - Valve rocker arm cover
28	Seal - Gasket valve rocker arm cover
29	Gasket - Rocker arm cover
30	Gasket - Spark plug
31	Cover - Valve rocker arm
32	Spark plug cover assembly
33	Oil filler cap gasket
34	Oil filler cap



## **DESCRIPTION AND OPERATION (Continued)**

## **Lower Engine Components**



## DESCRIPTION AND OPERATION (Continued)

### Lower Engine Components

Item	Description
1	Timing Chain Tensioner
2	Lever arm assembly - Timing chain tensioner
3	Timing chain
4	Guide assembly - Timing chain
5	Oil pump
6	Oil pump pick-up/ Screen
7	Sensor Assembly Engine Spark intensity (knock sensors)
8	Driveplate/ Flexplate
9	Cover - Flywheel housing
10	Filter assembly - Oil
11	Piston compression ring, Upper
12	Piston compression ring, Lower
13	Piston Oil control, Ring
14	Piston
15	Connecting rod
16	Bearing upper - Connecting rod (Big End)
17	Bearing lower - Connecting rod (Big End)
18	Cap - Connecting Rod
19	Pin - Piston
20	Cover - Flywheel
21	Plug - Oil Pan drain
22	Pan - Oil pan
23a	Front Half Moon Seal - Oil Pan
23b	Front Half Moon Seal - Oil Pan
23c	FIP Gasket (Silicon RTV) - Oil Pan
24	Crank windage oil baffle
25	Brace - Main bearing cap support
26	Crankshaft main bearing caps
27	Crankshaft main bearing - Lower
28	Crankshaft
29	Crankshaft main bearings - Upper
30	Cylinder block
31	Tube - Oil lever indicator
32	Oil lever indicator
33	Damper assembly - Crankshaft
34	Crank sensor
35	Crankshaft sprocket / Tone wheel
36	Switch assembly - Oil pressure
37	Seal - Oil, Cylinder front cover
38	Cover - Cylinder front



## DIAGNOSIS AND TESTING

### Engine

#### Inspection and Verification

Since diagnosis and testing actually begins when repairs are taken on, the following procedure is recommended.

1. Verify the customer concern by operating the system.
2. Visually inspect for obvious signs of mechanical damage or electrical damage. If the concern cannot be reproduced, carry out a road test and/or visual check with the aid of the following table.

#### Visual Inspection Chart

Mechanical
<ul style="list-style-type: none"><li>• Coolant leaks</li><li>• Oil leaks</li><li>• Leaks in the fuel system</li><li>• Visibly damaged or worn parts</li><li>• Loose or missing nuts or bolts</li></ul>

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. If the concern is not visually evident, verify the symptom and refer to the Symptom Chart.



## DIAGNOSIS AND TESTING (Continued)

### Symptom Chart

Condition	Possible Sources	Action
Engine will not crank	• Faulty Starter System.	• Refer to Section 303-06 Starting System.
	• Transmission lever not in P or N.	• Place in P.
	• Seized engine.	• Replace engine.
	• Coolant in cylinders.	• Replace engine.
Engine cranks but will not start	• Ignition system inoperative.	• Refer to Section 303-06 Starting System.
	• Fuel system inoperative.	• Refer to Section 303-04.
Engine slow/difficult to start	• Variable Cam Timing (VCT) unit lock pin not engaged at start. • VCT unit Oil Control Valve jammed.	• Clean Oil Control Valve. Refer to Valve Cover Section.
Engine misfires	• Fail Safe Cooling in operation.	• Repair coolant system.
	• Ignition system faulty.	• Refer to Section 303-06.
	• Fuel system faulty.	• Refer to Section 303-04.
	• Restricted exhaust system.	• Inspect Exhaust system.
	• Intake vacuum leak.	• Carry out Intake Manifold Vacuum test in this section.
	• Burned valve/poor seating.	• Perform a compression check.
	• Broken valve spring.	• Inspect valve springs.
	• Head gasket leakage.	• Inspect head gasket.
	• Piston damage.	• Perform cylinder compression check.
Rough - Rolling Idle	• Faulty intake Oil Control Valve (OCV)	• Replace intake OCV only
	• Low idle oil pressure	• Measure minimum idle oil pressure and repair. Refer relevant section.
	• Incorrect spark plug gap	• Re-gap spark plug to specification. Refer Section 303-06
Insufficient Power	• Dual Plenum Intake Manifold not operative.	• Check switching occurs at 3700 rpm- refer to Section 303-14.
	• VCT unit(s) not operative.	• Refer to Section 303-14.
	• Electronic Throttle Control Unit faulty.	• Refer to Section 303-14.
Excessive Fuel Consumption	• Green(low mileage) engine/ vehicle. City/stop-start driving.	• Establish accurate fuel consumption using full-to-full method.
	• Faulty Fuel System.	• Refer to Section 303-04.
	• Green engine.	• Recheck at 15,000 km.
	• Valve stem seal damaged or missing.	• Inspect the seals.
	• Oil leakage.	• Repair oil leakage.
	• Incorrect Oil viscosity.	• Drain and fill with correct oil.
	• Piston/rings/cylinder worn or damaged.	• Repair. Refer to Section 303-00.



## DIAGNOSIS AND TESTING (Continued)

Condition	Possible Sources	Action
Excessive Oil Consumption	<ul style="list-style-type: none"> <li>• Diluted oil</li> <li>• Crankcase overfilled.</li> <li>• Faulty PCV Valve.</li> </ul>	<ul style="list-style-type: none"> <li>• Determine the cause. Correct. Drain and refill oil.</li> <li>• Adjust oil level.</li> <li>• Check and replace.</li> </ul>
Engine leaks oil	<ul style="list-style-type: none"> <li>• Joint fasteners loose.</li> <li>• Out of position or damaged seal/RTV sealant omitted/inadequate.</li> <li>• Worn/out of position crank rotary seal.</li> <li>• Porous casting.</li> <li>• Sealant in Crank Damper keyway omitted or inadequate.</li> <li>• Sealant between Rear Main Cap and block omitted or inadequate.</li> </ul>	<ul style="list-style-type: none"> <li>• Tighten to specification.</li> <li>• Pressurise crankcase to 35kPa. Apply soapy water, check for leak. Inspect and replace.</li> <li>• Inspect and replace.</li> <li>• Clean suspect area, Perform pressurized crankcase check. Run engine, check for leak. Replace casting.</li> <li>• Replace sealant.</li> <li>• Perform pressurized crankcase leak check. Repair.</li> </ul>
Engine Noise	<ul style="list-style-type: none"> <li>• Excessive Crankshaft Main bearing or big end clearance.</li> <li>• Excessive Crankshaft end play.</li> <li>• Excessive camshaft end play.</li> <li>• Excessive piston to cylinder bore clearance/damaged piston/bent connecting rod.</li> <li>• Excessive piston pin to piston pin bore clearance.</li> <li>• Excessive hydraulic valve adjuster clearance.</li> <li>• Worn cam lobe or roller finger follower.</li> <li>• Excessive valve guide clearance.</li> <li>• Broken valve spring.</li> <li>• Loose timing chain.</li> <li>• Loose crank damper.</li> <li>• Worn/noisy Front End Accessory Drive Belt.</li> <li>• Worn/noisy tensioner/idler pulley.</li> <li>• Exhaust gas leakage.</li> </ul>	<ul style="list-style-type: none"> <li>• Inspect and repair. Refer relevant Section.</li> </ul>
	<ul style="list-style-type: none"> <li>• Soft or spongy lash adjusters.</li> </ul>	<ul style="list-style-type: none"> <li>• Check for excessively low or high oil level. Air leak in suction side of oil pump.</li> </ul>
	<ul style="list-style-type: none"> <li>• Carbon in combustion chamber/top land of piston.</li> </ul>	<ul style="list-style-type: none"> <li>• Remove carbon using proprietary carbon removal treatment.</li> </ul>



## DIAGNOSIS AND TESTING (Continued)

### Component Tests

#### Engine Oil Leaks

**Note:** Before installing new gaskets or oil seals, make sure that the fault is clearly established. If the oil leak cannot be identified clearly by a visual inspection, carry out a pressurized crankcase leak check.

#### Pressurised leak check

1. Clean the engine with a suitable cleaning fluid to remove all traces of oil.
2. Block off the line to the PCV valve.
3. Apply a regulated air supply line to the fresh air makeup point on the rocker cover.
4. Pressurise the crankcase to 35 kPa.
5. Check for air leaks by washing the suspect area with a solution of soapy water and watching for bubbles.
6. Repair all leaks as necessary.

#### General Remarks

**Note:** Removing fuses and disconnecting electrical components causes the powertrain control module (PCM) to log an error message. After the measurements have been carried out this error message should be cleared from memory by connecting to IDS.

The compression pressure should be checked with the engine at operating temperature.

#### Check The Compression Pressure

##### WARNING

 On automatic transmission vehicles, select "P". Failure to follow these instructions may result in personal injury.

1. Remove the fuel pump relay.
2. Start the engine and run for a few seconds, then stall.
3. Remove the spark plugs.
4. Install an adaptor and compression tester.
5. Install an auxiliary starter switch in the starting circuit. With the ignition switch OFF, use the auxiliary starter switch to crank the engine a minimum of five compression strokes, and record the highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
6. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes.
7. Install the components in reverse order, observing the specified tightening torques.
8. Reset the PCM fault memory.

### Interpretation of the Results

The indicated compression pressure is considered to be within specification if the lowest reading cylinder is within 75% of the highest reading.

#### CAUTION

 If engine oil is sprayed into the combustion chamber, run the engine at 2000rpm for about 15 minutes (in order to burn the oil and prevent damage to the catalytic converter) after carrying out the measurement.

If the measurement on one or more cylinders is significantly lower than the specified value, spray some engine oil into the combustion chamber and repeat the compression measurement.

If the reading greatly improves, the piston rings are damaged.

If the reading stays the same, the cause is either damaged valves or valve seats.

If the measurements for two adjacent cylinders are both too low, then it is very likely that the cylinder head gasket between the cylinder is burnt through. This can also be recognized by traces of engine oil in the coolant and/or coolant in the engine oil.

#### Excessive Engine Oil Consumption

The amount of oil an engine uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation. This is especially true during the first 15,000 km when a new engine is being broken in or until certain internal components become conditioned. Vehicles used in heavy-duty operation may use more oil. The following are examples of heavy-duty operation:

- Trailer towing applications
- Severe loading applications
- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Cylinder block cylinder walls
- Pistons and piston rings
- Intake and exhaust valve stems
- Intake and exhaust valve guides
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. As the vehicle is operated, some oil is also drawn into the combustion chambers past the intake and exhaust valve stem seals and burned.



## DIAGNOSIS AND TESTING (Continued)

The following is a partial list of conditions that can affect oil consumption rates:

- Engine size
- Operator driving habits
- Ambient temperatures
- Quality and viscosity of oil

Operation under varying conditions can frequently be misleading. A vehicle that has been run for several thousand kilometres on short trips or in cold ambient temperatures may have consumed a "normal" amount of oil. However, when checking the engine oil level, it may measure up to the full mark on the oil level indicator due to dilution (condensation and fuel) in the engine crankcase. If the vehicle is then driven at high speeds on a highway where the condensation and fuel boil off, the next time the engine oil is checked it may appear that a litre of oil was used in a relatively short distance.

Make sure the selected engine oil meets the Ford specification and the recommended API performance category "SJ/CF" and SAE viscosity grade as shown in the vehicle's Owner's Manual. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions.

### Oil Consumption Test

The following diagnostic procedure is used to determine the source of excessive oil consumption.

**Note:** Oil use is normally greater during the first 15,000 km of service. As mileage increases, oil use decreases. High speed driving, towing, high ambient temperature and other factors may result in greater oil use.

1. Define excessive consumption such as the number of kilometres driven per litre of oil used. Also determine customer's driving habits, such as sustained high speed operation, towing, extended idle and other considerations.
2. Verify that the engine has no external oil leaks as described in the Engine Oil Leaks section.
3. Verify that the engine has the correct oil level.
4. Verify that the engine is not being run in an overfilled condition. Check the oil level at least five minutes after a hot shutdown with the vehicle parked on a level surface.
5. Carry out an Oil Consumption Test:
  1. For a 4.0L I6 engine, drain the engine oil and refill the engine. Run for 10 minutes, and allow the engine to stand for 5 minutes to allow the oil to drain to the crankcase.
  2. Top up the oil level exactly to the full mark. Allow to stand for 5 minutes and re-check.

**Note:** For engines other than the 4.0L I6, refill the engine with one litre less oil than specified.

Run the engine for 10 minutes and allow to stand for 5 minutes. Clean the dipstick and scribe a line on the back face of the dipstick blade corresponding with this level, then reinsert. Add exactly 1 litre of oil to the engine. Run for 5 minutes and allow to stand for 5 minutes. Mark the new level on the back of the dipstick. This should correspond closely to the FULL mark.

3. Record the vehicle's odometer reading.
4. Instruct the customer to drive the vehicle as usual and:
  - Check the oil level regularly at intervals of 250 km.
  - Return to the service point when the oil level drops below the ADD mark on the oil dipstick.
  - Add only full litres of the same oil in an emergency. Note the mileage at which the oil is added.
5. Check the oil level under the same conditions and at the same location as in steps 1-3.
6. Measure the distance from the full mark to the current oil level on the oil dipstick and calculate the oil usage based on a volume of 1.0 litres used for 10mm distance below the FULL mark for the 4.0L I6 engines. For engines employing the alternate method of marking the dipstick with levels corresponding to a volume difference of 1 litre, note the distance the new oil level is below the Top scribed mark and divide this by the distance between the original two scribed marks. This gives the volume of oil in litres used during the test.
7. Divide the distance travelled (kilometres) during the test by the amount of oil used (litres) to produce the oil consumption in kilometres per litre.
8. If the oil consumption is unacceptable go to Step 9.
9. Check the positive crankcase ventilation (PCV) system. Make sure the system is not plugged.
7. Check for plugged oil drain-back holes in the cylinder head and cylinder block.
8. If the condition still exists after carrying out the above tests go to Step 9.
9. Carry out a cylinder compression test as outlined in the Compression Test section. This can help determine the source of oil consumption such as valves, piston rings or other areas.
10. Check valve guides for excessive guide clearance. Install new valve stem seals if required.



## DIAGNOSIS AND TESTING (Continued)

11. Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on the tips of the spark plugs can be a clue to internal oil consumption.

### Intake Manifold Vacuum Test

Bring the engine to normal operating temperature. Connect a vacuum gauge or equivalent to the intake manifold. Run the engine at the specified idle speed.

The vacuum gauge should read between 51-74 kPa depending upon the engine condition and the altitude at which the test is carried out. Subtract 4.0 kPa from the specified reading for every 300m of elevation above sea level.

The reading should be steady. Adjust the gauge damper control (where used) if the needle is fluttering rapidly. Adjust damper until needle moves easily without excessive flutter.



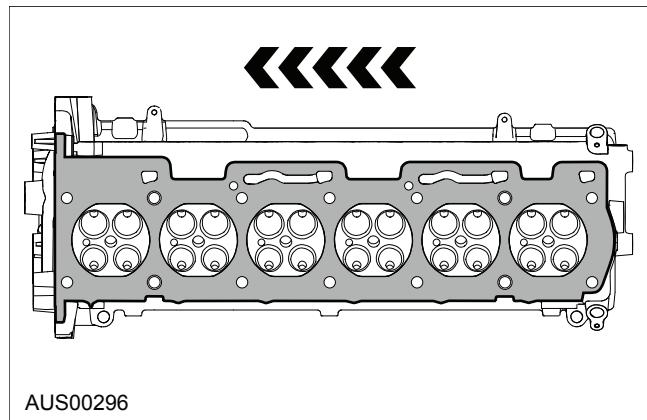
## GENERAL PROCEDURES

### Cylinder Head Inspection

#### WARNING

 Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.

- Conduct a dye penetrant (or similar) crack test. Replace the cylinder head if necessary.
- Inspect for the following and repair if necessary.
  - Sunken valve seats
  - Excessive camshaft bearing clearance and end play
  - Excessive lash adjuster bore size
- Measure the cylinder head for distortion. This can be achieved by using a straight edge and feeler gauge along the horizontal and vertically aligned bolt holes on the shaded surface.
- Repeat the procedure along the diagonal from the top left bolt hole to the bottom right bolt hole and along the diagonal from the top right bolt hole to the bottom left bolt hole.

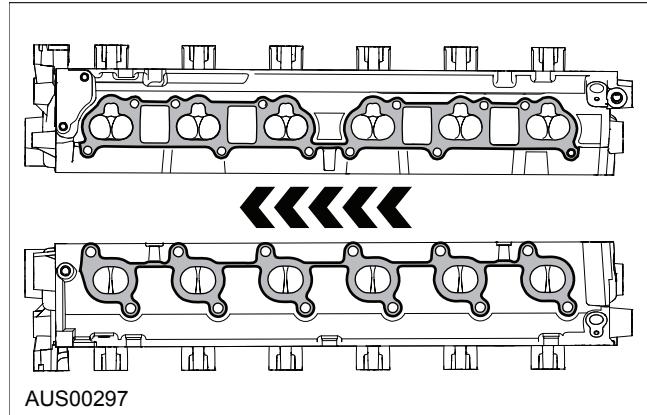


<b>Maximum distortion</b>	0.18mm lengthways or 0.075mm in 150mm transversely
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- If the cylinder head distortion exceeds the maximum, repair by grinding the joint face or replace the cylinder head.

<b>Maximum joint face machining</b>	0.3mm
<b>Minimum surface combustion chamber volume</b>	64.0cc

- Measure the manifold contact surface distortion as shown.



<b>Maximum distortion</b>	0.15mm
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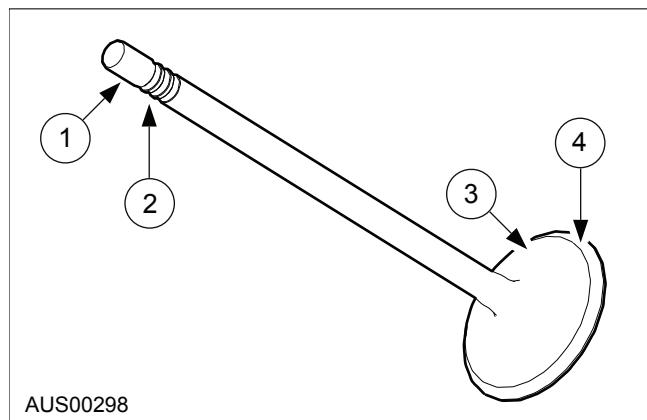
- If the distortion exceeds the specification, grind the surface.

<b>Maximum grinding</b>	0.20mm
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### Valve Inspection

Inspect the following valve areas:

- The valve tip, for pitting and wear.
- The keeper grooves, for burns and wear.
- The stem, for wear, scuffing and bending.
- The valve head, for burning, cracks and pitting of the seat.
- The valve head thickness.



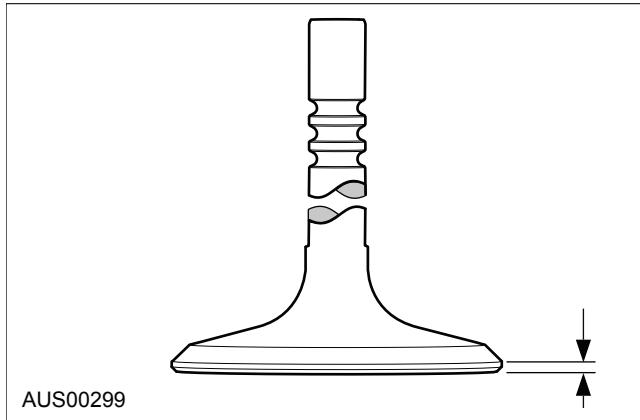
Item	Description
1	Valve tip
2	Keeper grooves
3	Stem
4	Valve head
5	Valve head thickness



## GENERAL PROCEDURES (Continued)

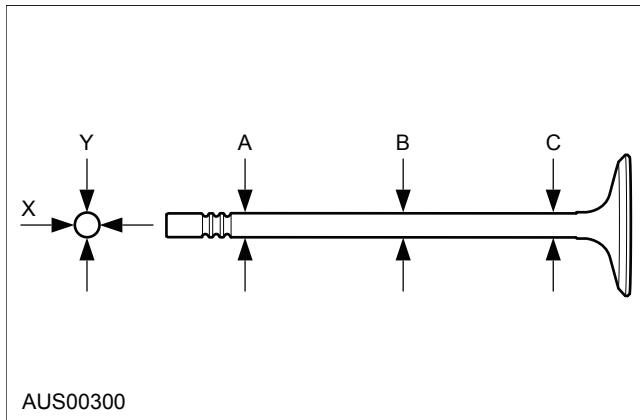
### Valve Measurement

- Measure the valve head margin thickness of each valve. Replace the valve if necessary.



<b>Margin thickness (min)</b>	IN: 1.1mm EX: 1.1mm
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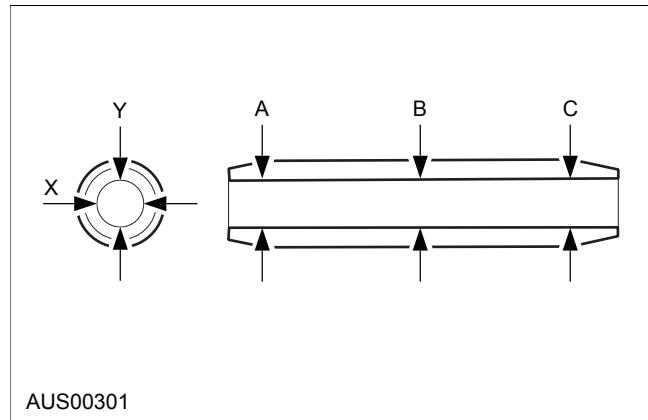
- Measure the stem diameter of each valve in X and Y directions at the three points (A, B, and C) shown. Replace the valve if necessary.



<b>Standard Diameter (IN and EX)</b>	5.975 - 5.995mm
<b>Minimum Diameter</b>	5.950mm

### Valve Guide Inspection

Measure the inner diameter of each valve guide in X and Y directions at the three points (A, B, and C) shown.



<b>Standard Inner Diameter</b>	6.015 - 6.044 mm
<b>Maximum diameter</b>	6.070mm

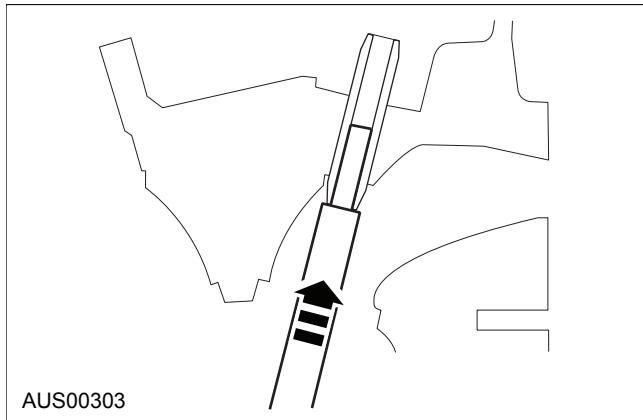


## GENERAL PROCEDURES (Continued)

### Valve Guide Replacement

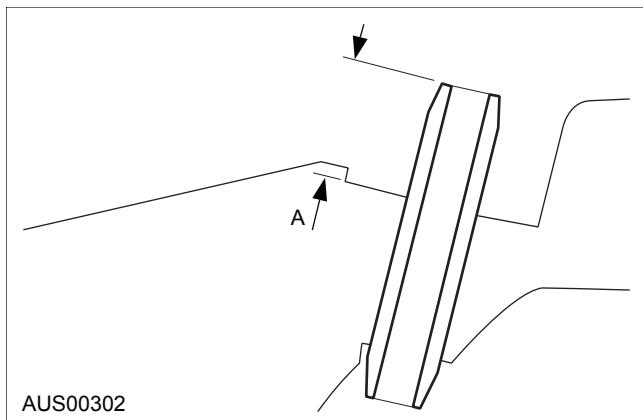
#### Removal

1. Remove the valve guide from the combustion chamber side by using a drift.



#### Installation

1. Install the guide using a drift so the protrusion (A) is as specified.



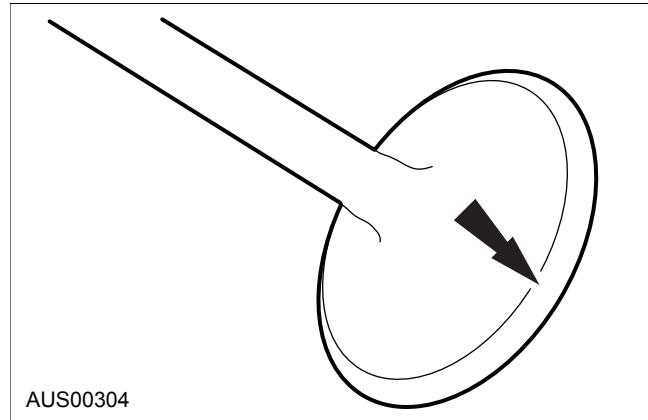
<b>Protrusion A</b>	13.5 - 14.1 mm
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2. Ream the guide to size.

<b>Diameter</b>	6.015 - 6.044 mm
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### Valve Seat Inspection/Repair

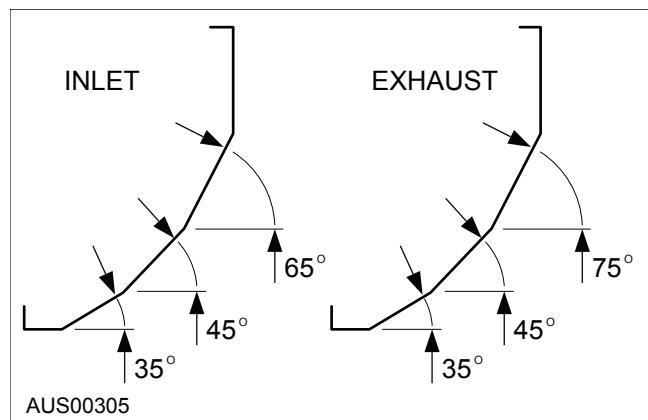
1. Measure the seat contact width. If necessary, resurface the valve seat using a 45° valve seat cutter and/or resurface the valve face.



<b>Intake</b>	1.0 - 1.4 mm
<b>Exhaust</b>	1.25 - 1.75 mm

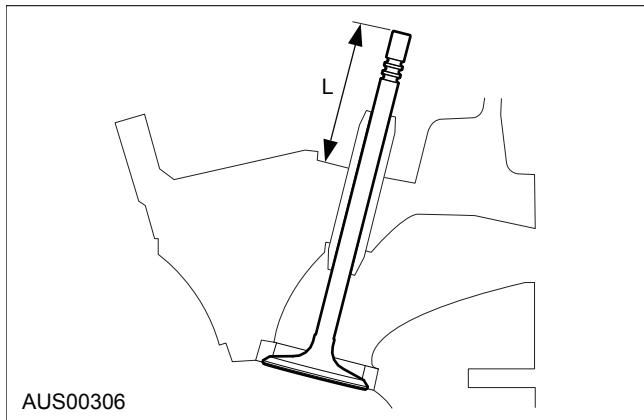
**Note:** After resurfacing valves or seats, check collapsed lash adjuster clearance.

2. Verify that the seating position is at the centre of the valve face.
  - If the seating position is too high, correct the valve seat using a 65° (IN) or 75° (EX) cutter, and a 45° cutter.
  - If the seating position is too low, correct the valve seat using a 35° cutter, and a 45° cutter.



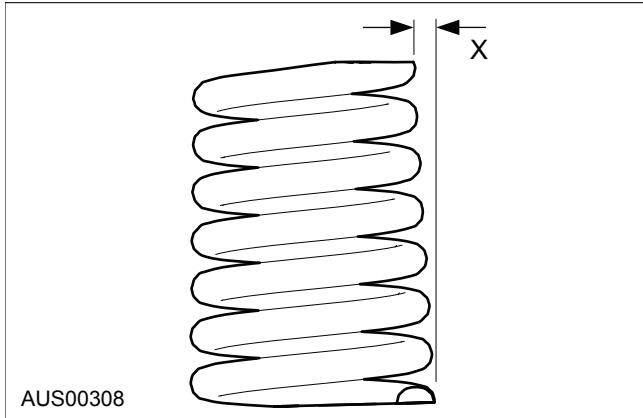
## GENERAL PROCEDURES (Continued)

3. Measure the protruding length (L) of the valve stem. Replace the valve or valve seat if necessary.



AUS00306

2. Measure the out-of-square of the valve spring. Replace the valve spring if necessary.



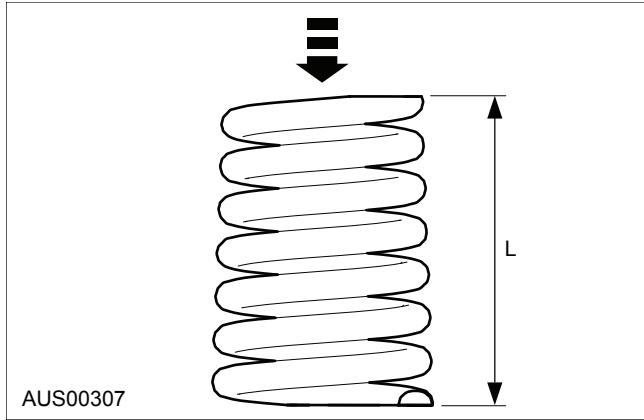
AUS00308

<b>Standard dimension L</b>	IN: 50.00 EX: 47.92
<b>Maximum dimension L</b>	IN: 51.0 EX: 48.9

**Maximum valve spring out-of-square** 1.75mm

### Valve Spring Inspection

1. Check the valve spring load at set length



AUS00307

<b>Minimum Load</b>	250N at 37.8 mm
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### Camshaft End Play Inspection

1. Remove the roller followers. For additional information, refer section 303-00 of the 2008.0 Falcon Workshop Manual.
2. Use a Dial Indicator with basketry to measure camshaft end play.
3. Position the camshaft to the rear of the cylinder head.
4. Zero the indicator.
5. Move the camshaft to the front of the cylinder head. Note and record the camshaft end play.
  - If camshaft end play exceeds specifications, install new camshaft and recheck end play.
  - If camshaft end play exceeds specification after camshaft installation, install a new cylinder head.

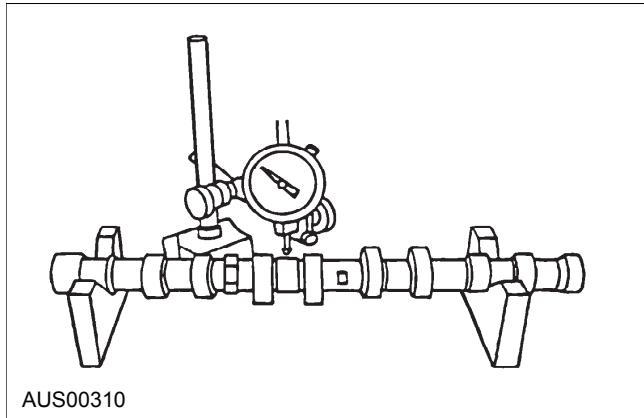
<b>Standard end play</b>	0.1 - 0.3 mm
<b>Maximum end play</b>	0.4 mm



## GENERAL PROCEDURES (Continued)

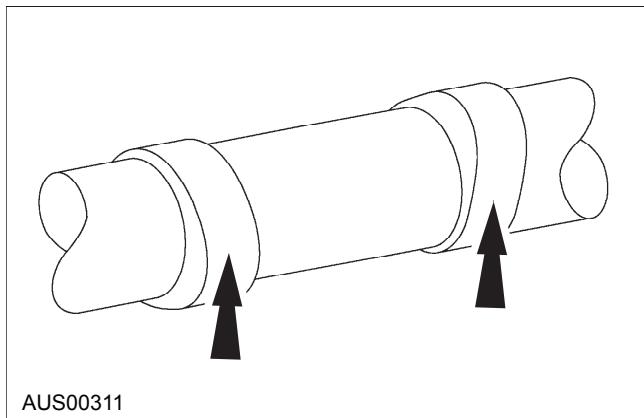
### Camshaft Inspection

- Set the No.1 and No.7 journals on V-blocks. Measure the camshaft runout. Replace the camshaft if necessary.

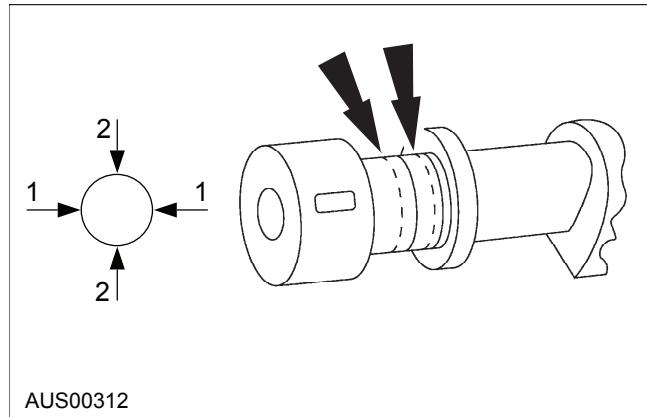


<b>Maximum runout</b>	0.1mm
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- Check the cam lobe for cracks and pitting. Minor indentations are acceptable. Replace if necessary.



- Measure the journal diameter in 2 directions. Replace the camshaft if necessary.



#### Standard diameter

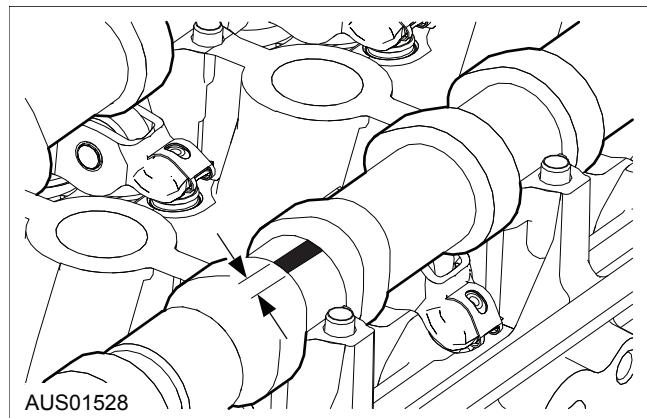
<b>Journal 1</b>	34.928 - 34.968 mm
<b>Journal 2 - 7</b>	29.928 - 29.968 mm

#### Minimum diameter

<b>Journal 1</b>	34.900 mm
<b>Journal 2 - 7</b>	29.900 mm

### Camshaft Journal Clearance - Plastigauge Method

- Remove the camshaft bearing cap and lay the plastigauge across the surface.
- Reinstall the camshaft bearing cap - DO NOT rotate the camshaft.
- Remove the camshaft bearing cap and measure the width of the plastigauge with the scale provided to determine the clearance. Replace the components as required if necessary.



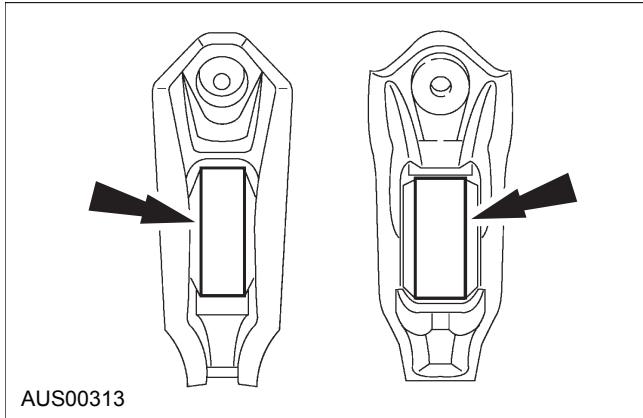
<b>Standard clearance</b>	0.019 - 0.084 mm
<b>Maximum clearance</b>	0.100 mm



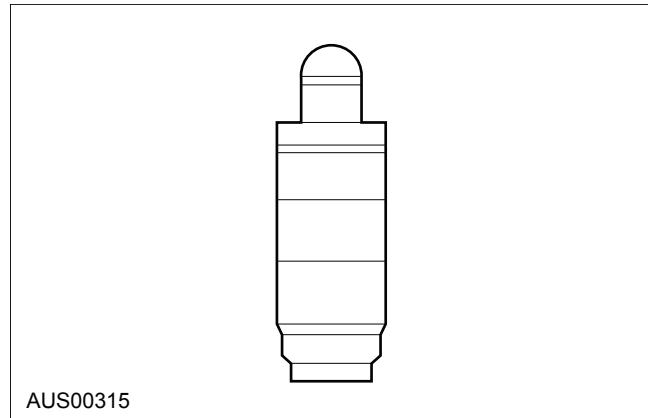
## GENERAL PROCEDURES (Continued)

### Roller Follower Inspection

1. Inspect the roller for flat spots or scoring.
2. Check the ball socket and valve pad for scuffing and wear.

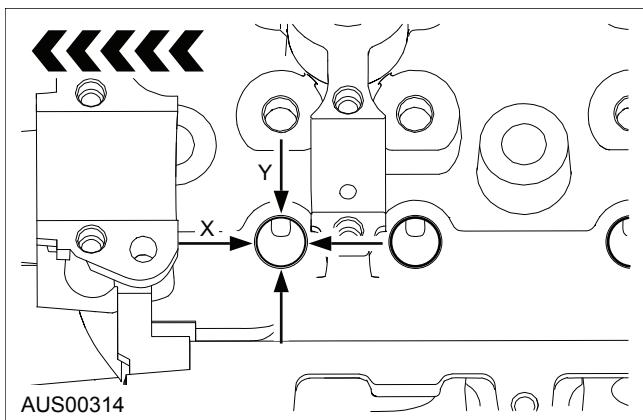


3. Calculate the clearance between the lash adjuster and the related lash adjuster bore. Replace the lash adjuster or cylinder head if necessary.



### Lash Adjuster Bore Inspection

1. Measure the diameter of each lash adjuster bore



<b>Standard clearance</b>	0.006 - 0.035 mm
<b>Maximum clearance</b>	0.050 mm

<b>Standard diameter</b>	13.990 - 14.007 mm
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2. Measure the diameter of each lash adjuster.

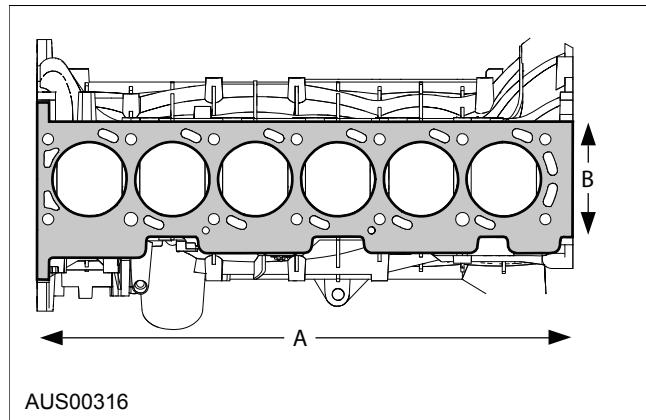
<b>Standard diameter</b>	13.972 - 13.984 mm
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## GENERAL PROCEDURES (Continued)

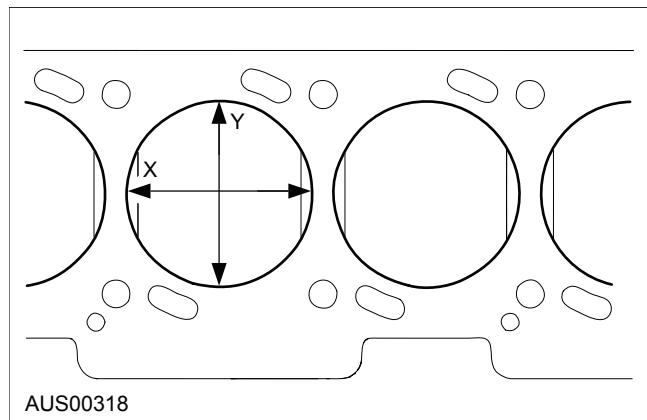
### Cylinder Block Inspection/Repair

Measure the distortion of the cylinder block top surface in the two directions as shown. Repair by grinding or replace if necessary.



### Cylinder Bore - Out-of-Round

Measure the cylinder bore in two directions. The difference is the out-of-round. Verify the out-of-round is within the wear limit and bore the cylinder to the next oversize limit.

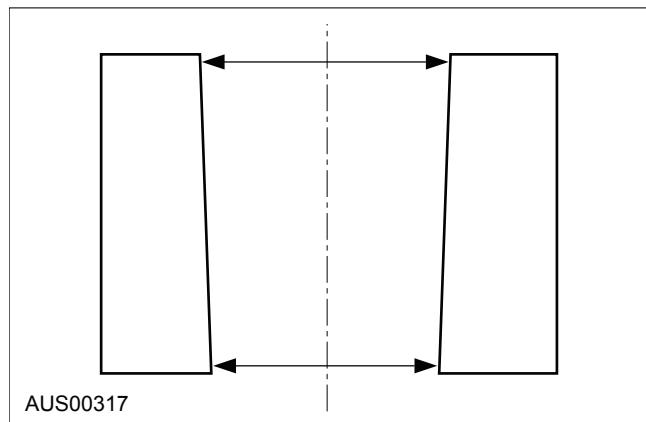


#### Maximum cylinder block distortion

<b>Direction A</b>	0.15 mm
<b>Direction B</b>	0.05 mm
<b>Maximum grinding</b>	0.20 mm
<b>Minimum Piston-Deck</b>	0.50 mm
<b>Maximum Surface finish Rz</b>	13.5

### Cylinder Bore - Taper

Measure the cylinder bore at the top and bottom. Verify the cylinder bore is within the wear limit. The difference indicates the cylinder bore taper. Bore the cylinder to the next oversize.



#### Service limit

0.125 mm

#### Cylinder bore - Reboring sizes

<b>Size</b>	<b>Diameter (mm)</b>
<b>Standard</b>	92.24 - 92.26
<b>0.5 oversize</b>	92.74 - 92.76
<b>1.0 oversize</b>	93.24 - 93.26

#### Service limit

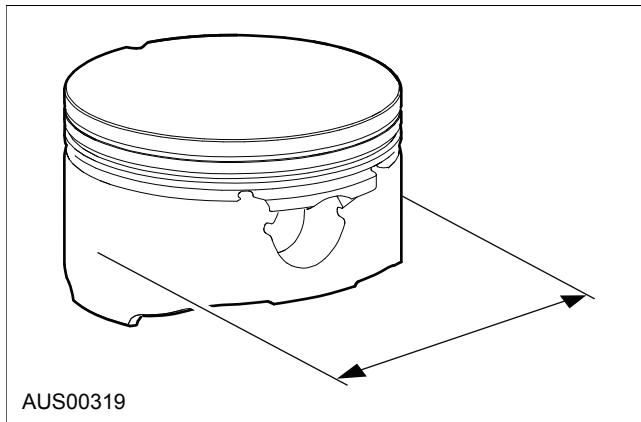
0.25 mm



## GENERAL PROCEDURES (Continued)

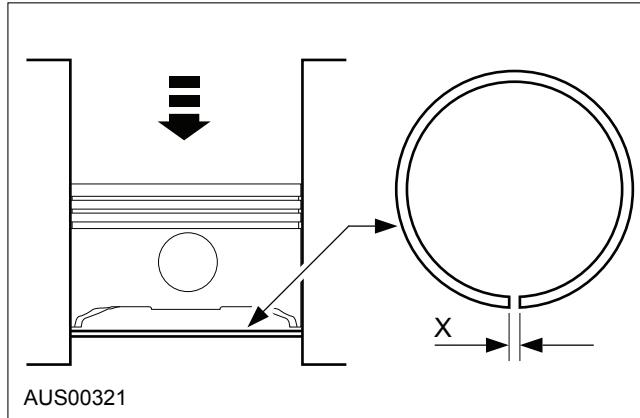
### Piston Inspection

Measure the outer diameter of each piston at a right angle ( $90^\circ$ ) to the piston pin, 44.5mm below the crown.



Service Limit	
<b>Top</b>	0.15 mm
<b>Second</b>	0.15 mm
<b>Oil</b>	0.20 mm

- Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.
- Measure each piston ring end gap using a feeler gauge. Replace the piston ring if necessary.



### Piston Clearance Inspection/ Repair

- Calculate the piston-to-cylinder clearance. Replace the piston or re bore the cylinders to fit oversize piston if necessary.

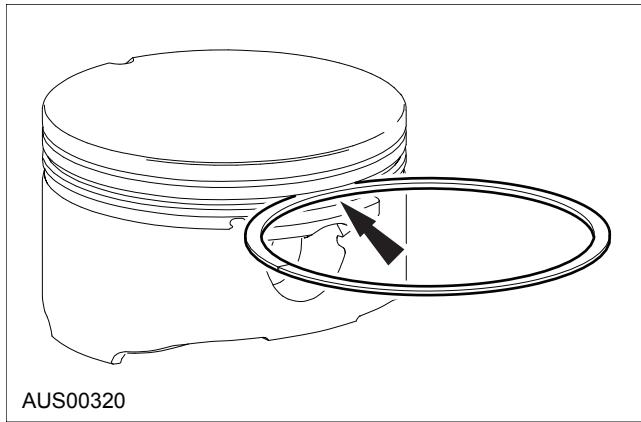
<b>Standard Clearance</b>	0.030 mm interference to 0.025 mm clearance
<b>Service limit</b>	0.09 mm clearance

- If the piston is replaced, the piston rings must also be replaced.

### Piston Ring Clearance Inspection

- Measure the piston ring-to-ring land clearance around the entire circumference. Replace the piston ring if necessary.

Standard Limit	
<b>Top</b>	0.04 - 0.08 mm
<b>Second</b>	0.03 - 0.075 mm
<b>Oil</b>	0.028 - 0.170 mm



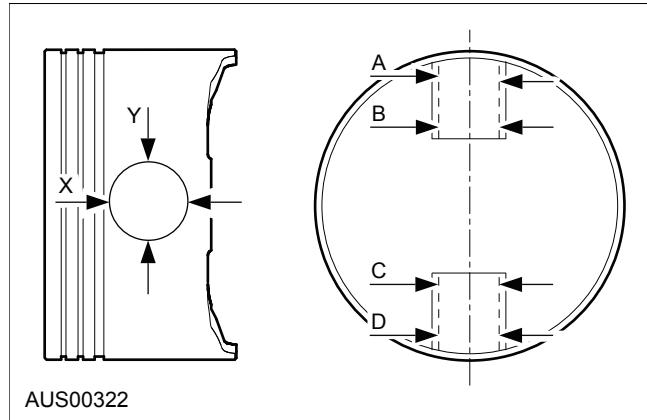
Standard End Gap	
<b>Top</b>	TBA
<b>Second</b>	TBA
<b>Oil</b>	0.15 - 0.75 mm
Maximum End Gap	
<b>Top</b>	0.45 mm
<b>Second</b>	0.60 mm
<b>Oil</b>	1.0 mm



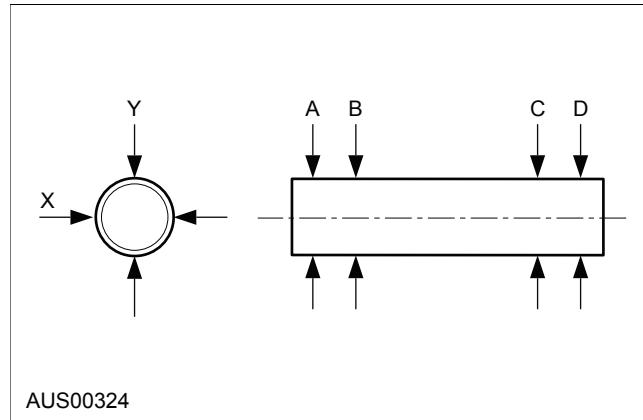
## GENERAL PROCEDURES (Continued)

### Piston Ring Clearance Inspection

1. Measure each piston pin hole diameter in X and Y directions at the four points (A, B, C and D) as shown.



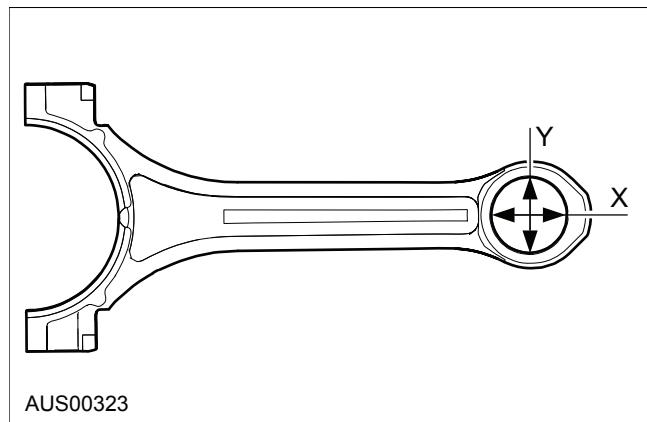
3. Measure each piston pin diameter in X and Y directions at the four points (A, B, C and D) as shown.



#### Standard Diameter

<b>DOHC VCT</b>	23.169 - 23.174 mm
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2. Measure each connecting rod small end inner diameter in X and Y directions as shown.



#### Standard Diameter

<b>DOHC VCT</b>	23.132 - 23.144 mm
-----------------	--------------------

#### Standard Diameter

<b>DOHC VCT</b>	23.157 - 23.162 mm
-----------------	--------------------

4. Calculate the piston pin to piston - pin bore clearance. Replace the piston and/or piston pin if necessary.

#### Standard Clearance

<b>DOHC VCT</b>	TBA
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5. Connecting rod bush as required.

#### Standard Interference

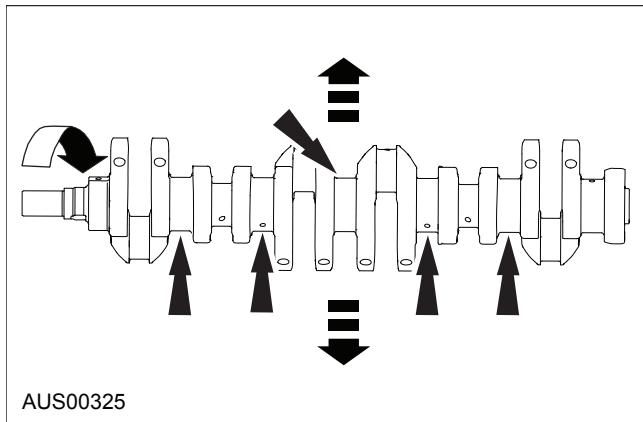
<b>DOHC VCT</b>	0.013 - 0.030 mm
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## GENERAL PROCEDURES (Continued)

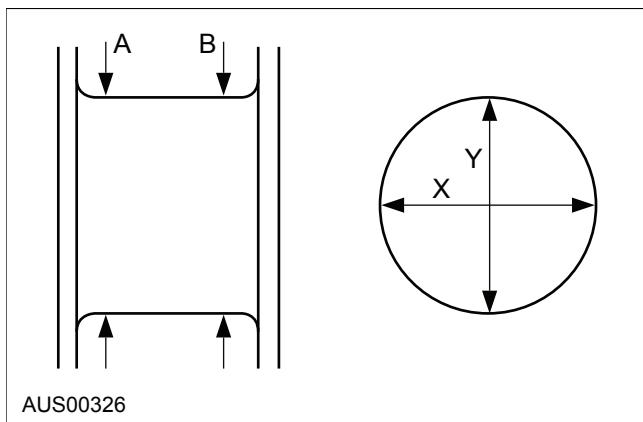
### Crankshaft Inspection

- Measure the crankshaft runout. Replace the crankshaft if necessary.



Standard End Gap	
Maximum runout - between adjacent journals	0.05 mm
Maximum runout - between any journals	0.08 mm

- Measure the journal diameter in X and Y direction at the two points (A and B) as shown. Replace the crankshaft or grind the journal and install the undersize bearing if necessary.

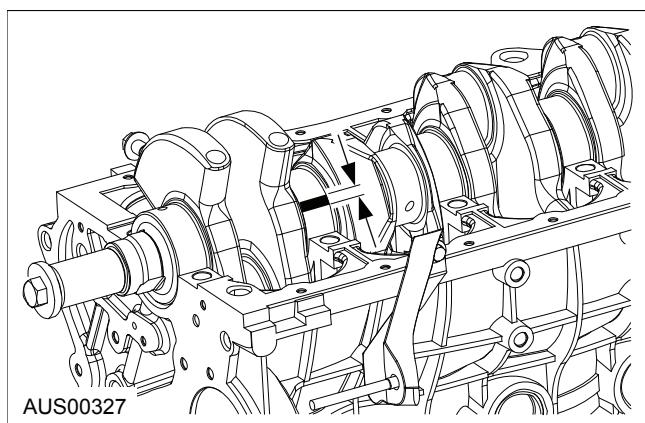


Main Journal	
Bearing Diameter	67.481 - 67.505 mm
Out-of-round	0.006 mm
Taper	0.008 mm

Crank Pin	
Bearing Diameter	53.93 - 53.95 mm
Out-of-round	0.006 mm
Taper	0.008 mm (max)

### Crankshaft Main Bearing Clearance

- Position a plastigauge on top of the journals in the axial direction.
- Install the main bearing cap. DO NOT rotate the crankshaft.
- Remove the main bearing cap.
- Measure the main journal clearance. If the clearance exceeds the maximum, replace the main bearing or grind the main journal and install the undersize bearings so that the specified clearance is obtained.



Standard Clearance	0.025 - 0.04 mm
Maximum Clearance	0.06mm

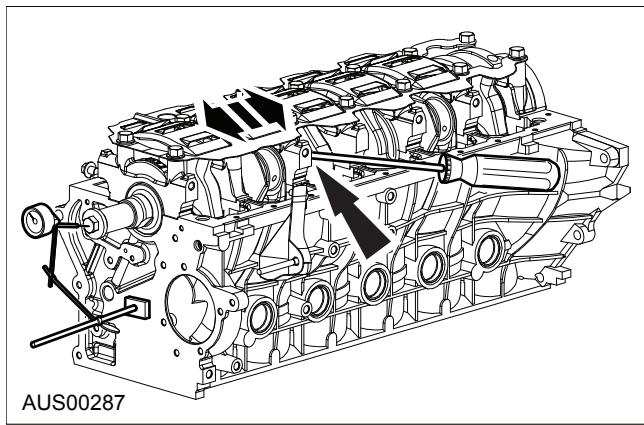
Bearing size	Bearing thickness
Standard	1.996 - 2.000 mm
0.250 mm undersize	2.118 - 2.128 mm
0.508 mm undersize	2.245 - 2.255 mm
1.016 mm undersize	2.499 - 2.509 mm



## GENERAL PROCEDURES (Continued)

### Crankshaft End Play Inspection/Repair

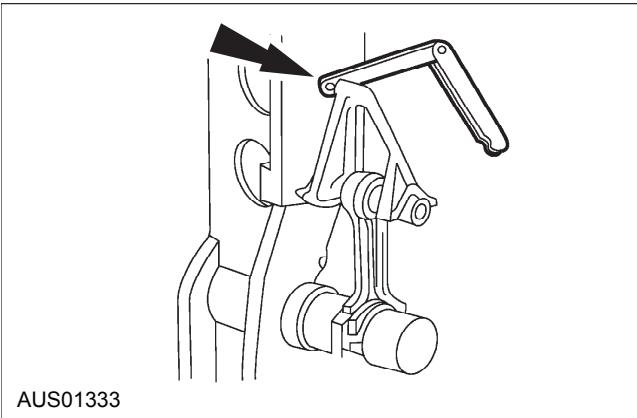
1. Install the thrust main bearing and cap.
2. Measure the crankshaft end play. Use a dial indicator with bracketry to measure crankshaft end play.
3. Position the crankshaft to the rear of the cylinder block.
4. Zero the indicator.
5. Move the crankshaft to the front of the cylinder block. Note and record the crankshaft end play.
  - If the crankshaft end play exceeds specifications, install a new crankshaft thrust washer or crankshaft thrust main bearing.



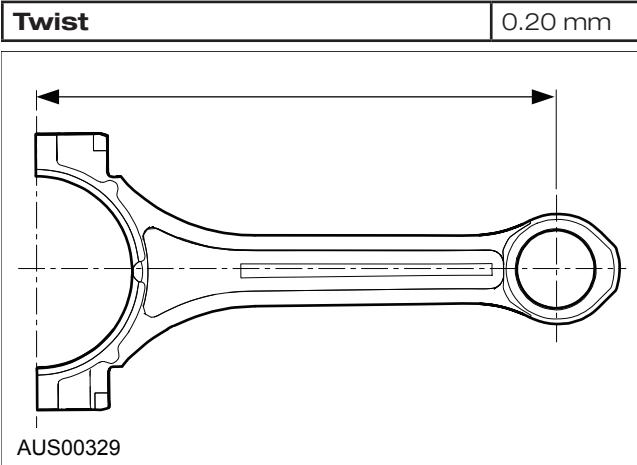
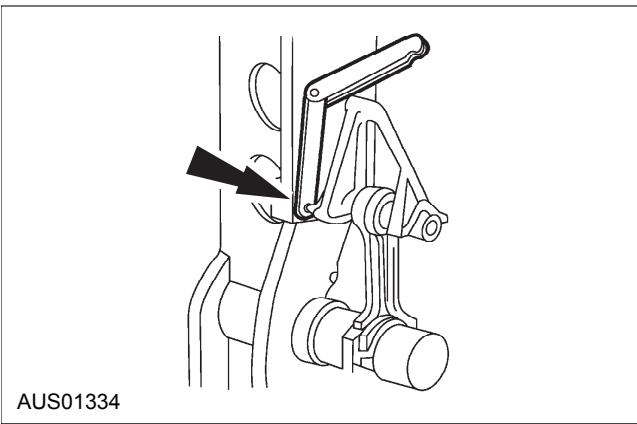
<b>Standard end play</b>	0.10 - 0.20 mm
<b>Maximum end play</b>	0.30 mm

### Connecting Rod Inspection

1. Measure each connecting rod for bending and twist. Replace the connecting rod if necessary.



<b>Bending</b>	0.10 mm
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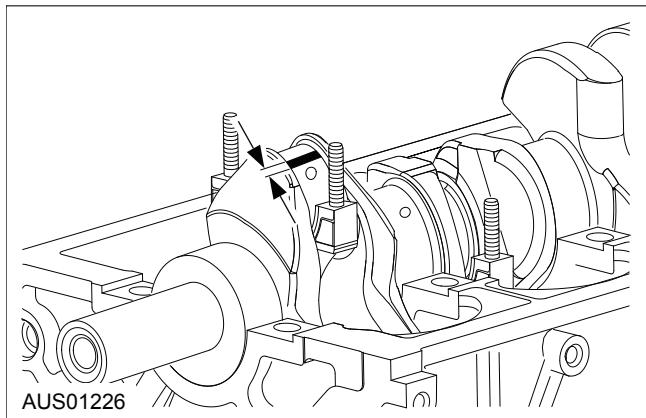
<b>Centre-to-centre distance</b>	153.82 - 153.89 mm
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## GENERAL PROCEDURES (Continued)

### Connecting Rod Big End Bearing Clearance

- Position a plastigauge on top of the journals in the axial direction.
- Install the connecting rod cap.
- Remove the connecting rod cap.
- Measure the crankpin clearance. If the clearance exceeds the maximum, replace the connecting rod bearing or grind the crankpin and use undersize bearing so that the specified clearance is obtained.

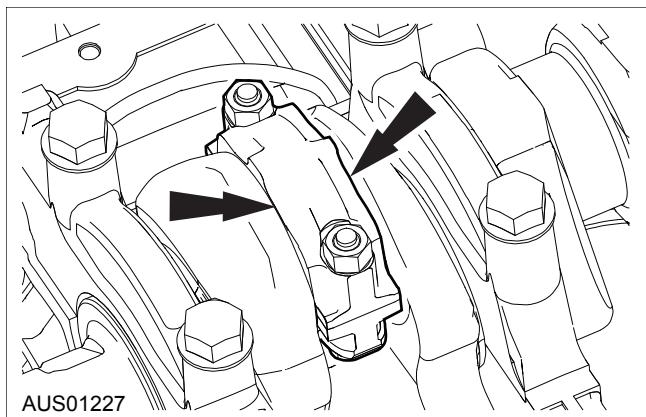


<b>Standard Clearance</b>	0.025 - 0.04 mm
<b>Maximum Clearance</b>	0.06mm

Bearing size	Bearing thickness
<b>Standard</b>	1.445 - 1.458 mm
<b>0.051 mm undersize</b>	1.470 - 1.483 mm
<b>0.254 mm undersize</b>	1.572 - 1.585 mm
<b>0.508 mm undersize</b>	1.699 - 1.712 mm

### Connecting Rod Side Clearance Inspection

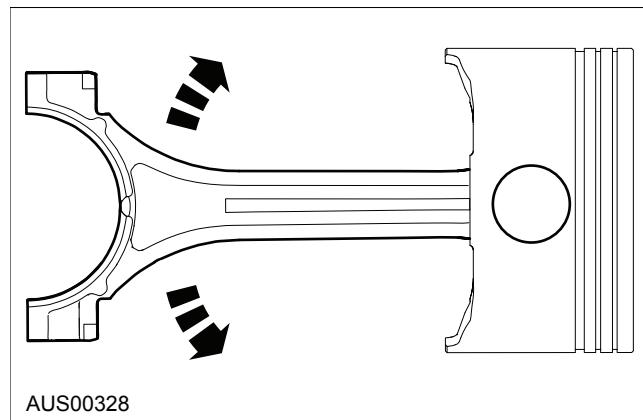
- Install the connecting rod cap.
- Measure the connecting rod big end side clearance.



<b>Standard Clearance</b>	0.09 - 0.27 mm
<b>Maximum Clearance</b>	0.36mm

### Piston and Connecting Rod Inspection

Check the oscillation torque as shown. If the large end does not drop by its own weight, replace the piston or the piston pin.



### Timing Chain Elongation

To establish the percentage elongation of the Timing chain:

- Hang the chain vertically over a suitable pin & hook a weight to the free end.
- Measure the length (from pin O.D. to pin O.D) over the maximum number of chain pins possible using vernier callipers. Note the number of pins measured.
- Repeat the measurement across three separate lengths of the chain and average the results.
- Measure the O.D of one chain pin with verniers.
- Calculate the theoretical chain length =  $(\text{measured number of pins} - 1) \times 8.0 \text{ mm pitch} + \text{measured pin O.D.}$
- Compare the actual length measured with the theoretical length: maximum elongation permissible = 0.35 %.

Alternatively measure the actual length of a new chain (as above) and compare with the original chain and compare as a percentage of the new chain length.

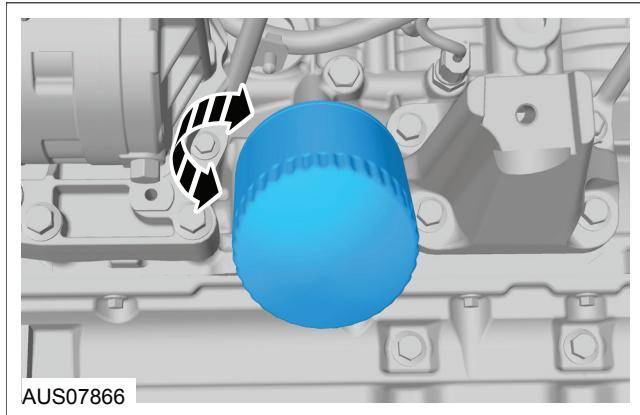


## IN-VEHICLE REPAIR

### Oil Filter

#### Removal

- Unscrew filter using a filter wrench.



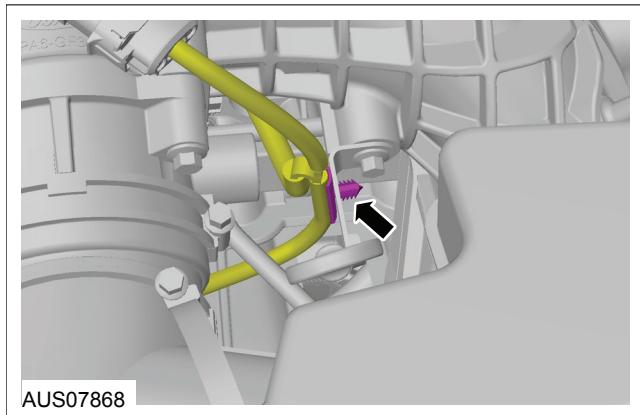
#### Installation

- Install as indicated.
- Lubricate the seal with engine oil prior to installation.

### Oil Level Indicator & Tube

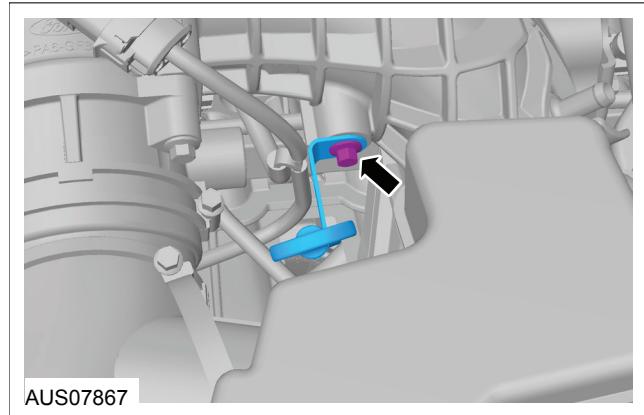
#### Removal

- Remove the Oil Level indicator from the Oil Level Tube.
- Detach the wiring retainer and position aside the wiring harness.



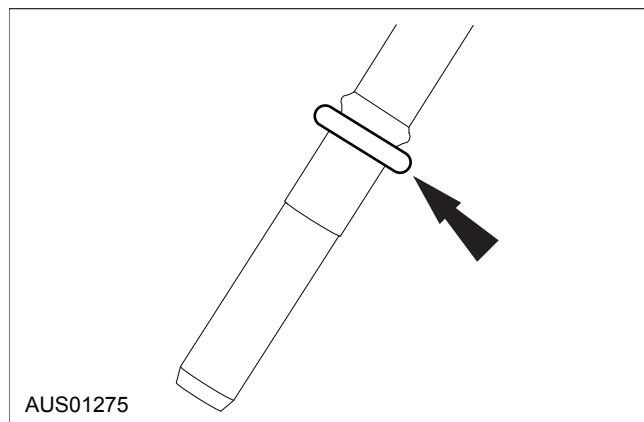
- Unscrew retaining bolt.

- Remove Oil Level Tube.

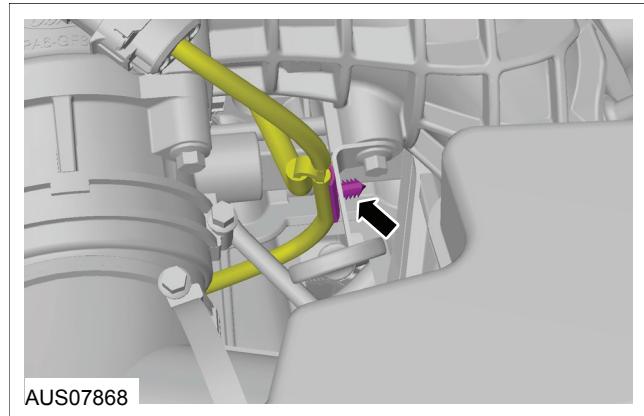


#### Installation

- Inspect the O-ring at the base of the tube for damage and renew if necessary. Lubricate with engine oil prior to reinstallation of the tube.
- Insert the Oil Level Tube and secure with retaining screw.
- With the tube reinstalled in the block, ensure the O-ring is fully seated in the block counterbore.



- Insert the Oil Level Indicator and attach the wiring harness retainer on the bracket.

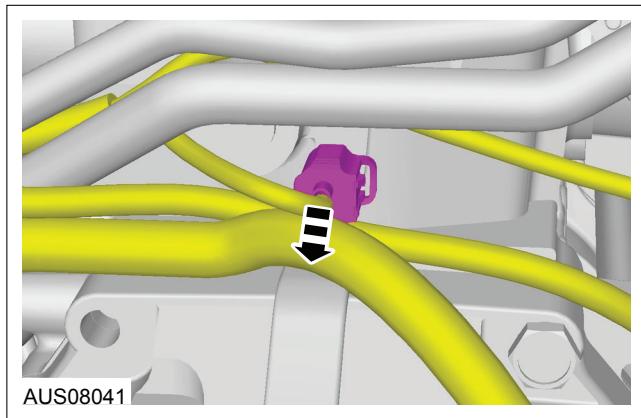


## IN-VEHICLE REPAIR (Continued)

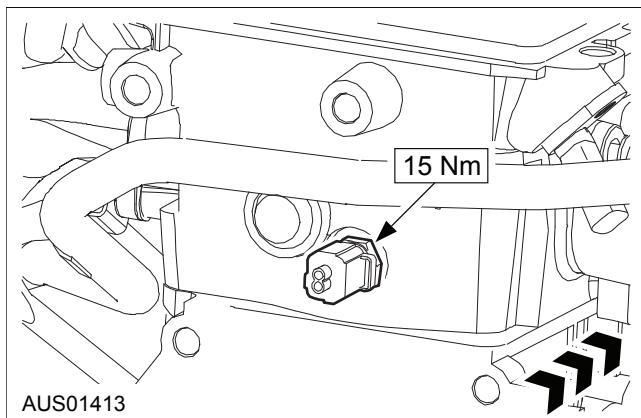
### Cylinder Head Temperature Sensor

#### Removal

1. The cylinder head tapped hole is blind.
2. Disconnect the electrical connector from Cylinder Head Temperature Sensor.



3. Unscrew and remove the sensor from Cylinder Head.



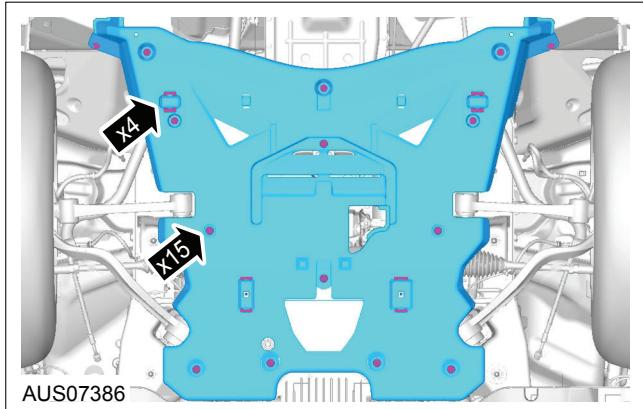
#### Installation

1. Installation is reversal of the removal procedure.
2. Do not use thread sealant/locker.

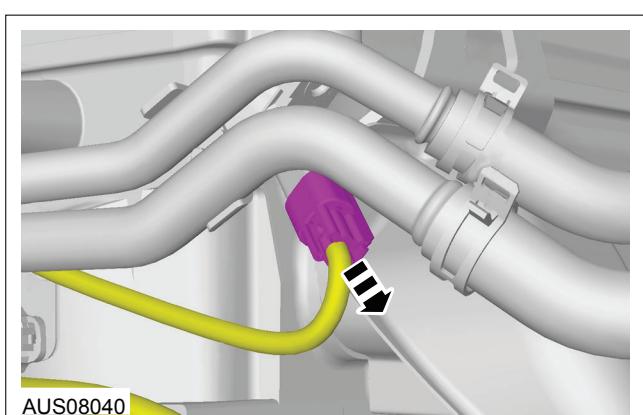
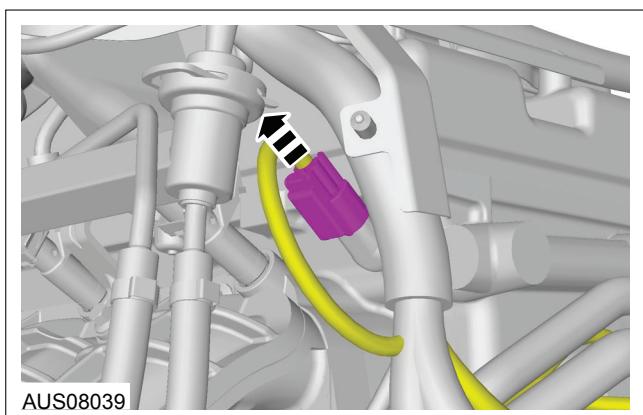
### Cam Position Sensor

#### Removal and Installation

1. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
2. Remove the "NVH Engine Undertray".



3. Disconnect Cam Position Sensor electrical connectors.

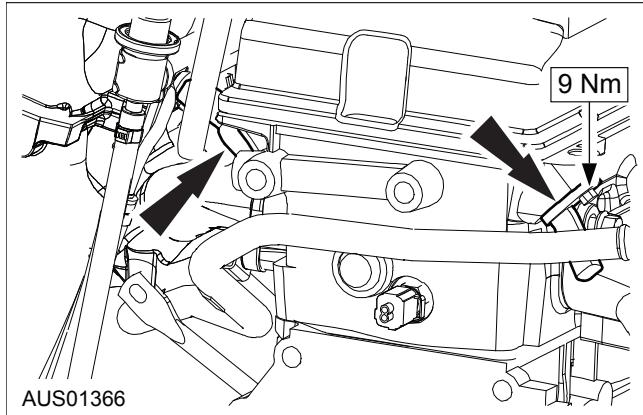


4. Unscrew retaining bolt & remove Cam Position Sensor.
5. Check the condition of the O-ring prior to installation.



## IN-VEHICLE REPAIR (Continued)

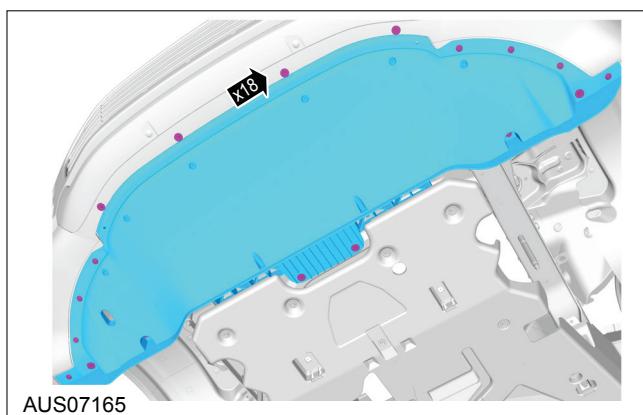
- Lubricate the O-ring with engine oil prior to installation.



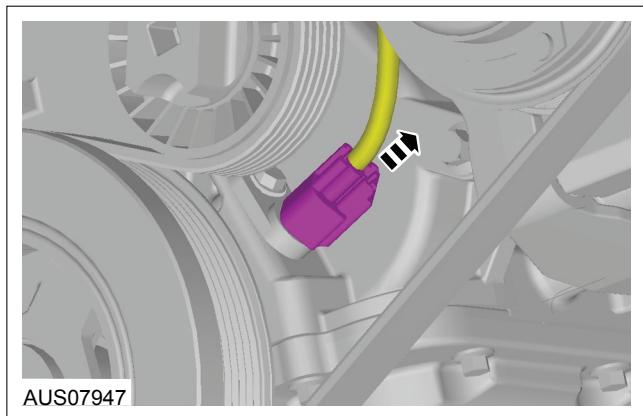
### Crankshaft Position Sensor

#### Removal and Installation

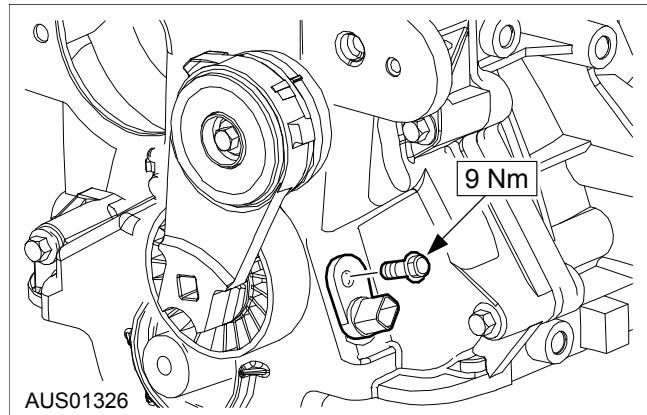
- Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
- Remove the lower air deflector.



- Remove Accessory Drive Belt. For additional information, refer to section 303-05A of the 2008 Falcon Workshop Manual
- Disconnect the electrical connector to the crankshaft position sensor.



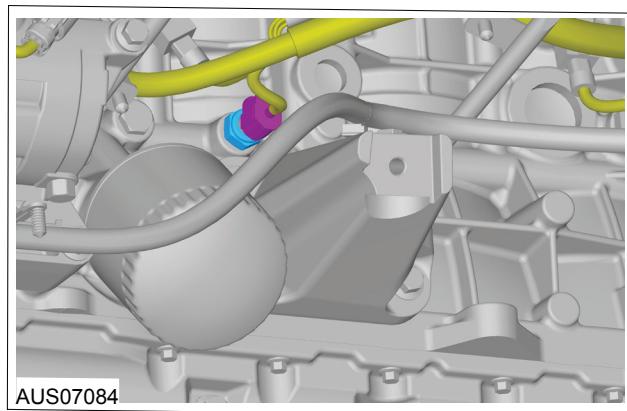
- Unscrew retaining bolt & remove Crankshaft Position Sensor.
- Check the condition of the O-ring prior to installation.
- Lubricate the O-ring with engine oil prior to installation.



### Oil Pressure & Oil Temperature Sensor

#### Removal and Installation

- Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
- When re-installing the original sensor, coat the threads with Loctite 567 (or similar) thread sealant. New replacement sensors are pre-coated. Tighten the oil temperature sensor (not shown in this illustration) to 18-25Nm. Tighten the oil pressure sensor (directly left of the pressure sensor, shown in this illustration) to 24Nm.

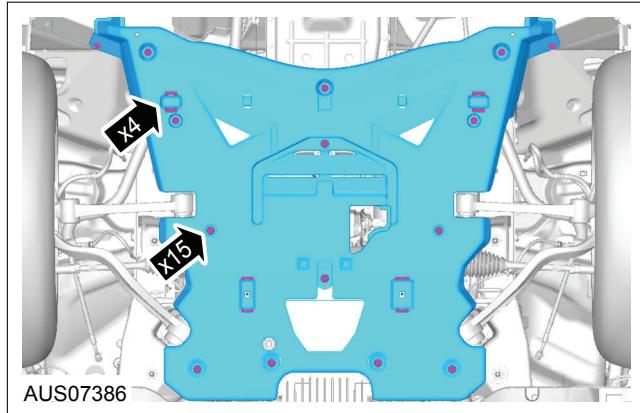


## IN-VEHICLE REPAIR (Continued)

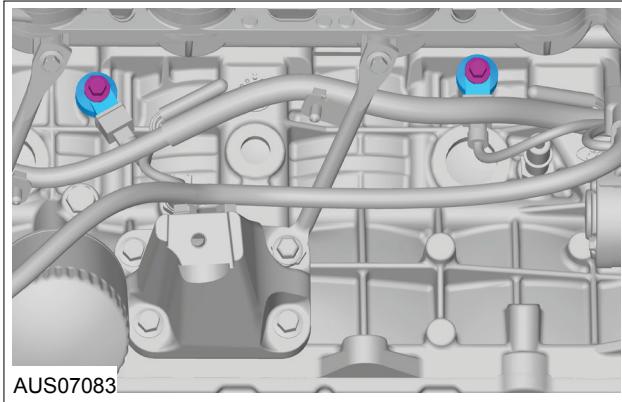
### Combustion Knock Sensors

#### Removal and Installation

1. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
2. Remove the "NVH Engine Undertray".



3. Unscrew retaining bolt & remove the 2 Combustion Knock Sensor

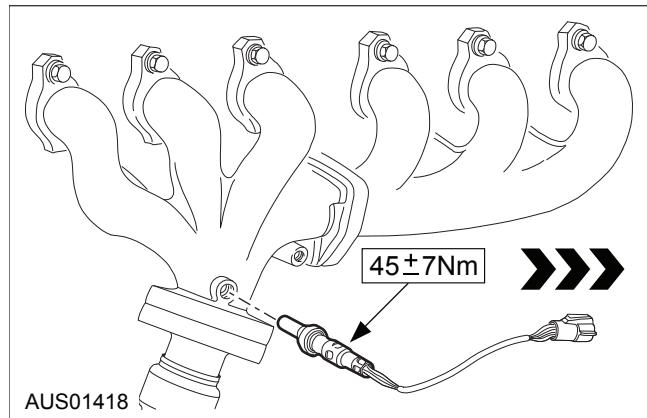


4. When re-installing the Knock sensor, coat the threads with Loctite 242 (or similar) thread locker.

### Exhaust Gas Oxygen Sensor (Pre Catalytic Convertor)

#### Removal and Installation

1. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
2. Disconnect the electrical connector.
3. Unscrew and remove the Exhaust Gas Oxygen Sensor from the vehicle.
4. Coat the threads with a Nickel Anti- Seize compound (Loctite 767 or similar) per ESE-FM99C100-A.



### Exhaust Gas Oxygen Sensor (Post Catalytic Convertor)

#### Removal and Installation

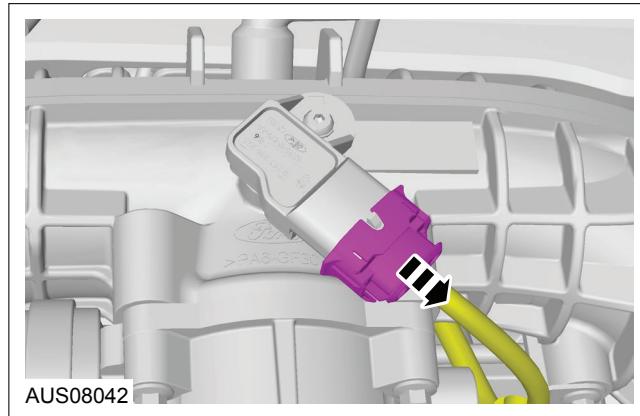
1. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
2. Disconnect the electrical connector.
3. Unscrew and remove the Exhaust Gas Oxygen Sensor from the vehicle.
4. Coat the threads with a Nickel Anti- Seize compound (Loctite 767 or similar) per ESE-FM99C100-A.



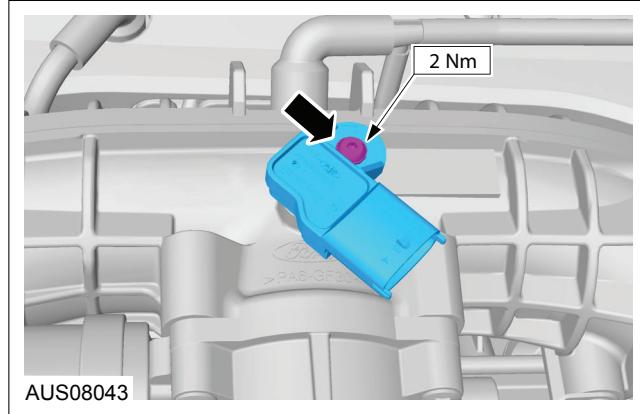
## IN-VEHICLE REPAIR (Continued)

### Temperature - Manifold Air Pressure Sensor

1. Disconnect the electrical connector.



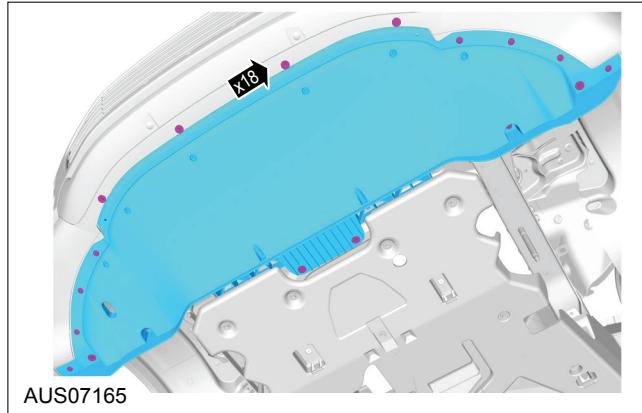
2. Unscrew the retaining screw and remove the Manifold Air Pressure Sensor.



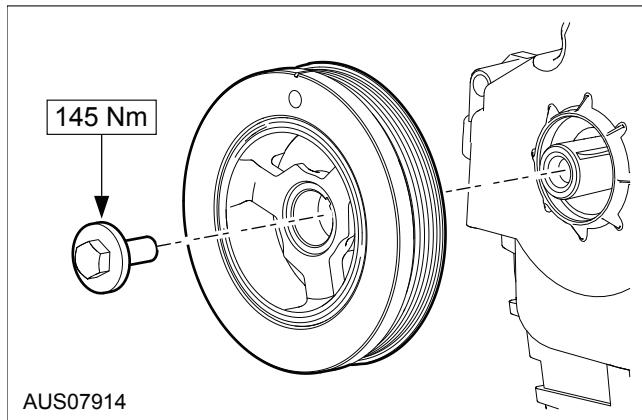
3. Inspect the condition of the O-ring prior to installation.
4. When replacing the fastening screw in the normally aspirated inlet manifold, be careful not to exceed 2Nm of torque. Excessive torque will strip the thread in the plastic material.

### Crankshaft Vibration Damper Removal

1. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual
2. Remove the lower air deflector.



3. Remove the Accessory Drive belt. For additional information, refer to section 303-05A of the 2008 Falcon Workshop Manual
4. Remove the Retaining Bolt.
5. Use SST 303-642 to remove the damper.
6. Remove key.



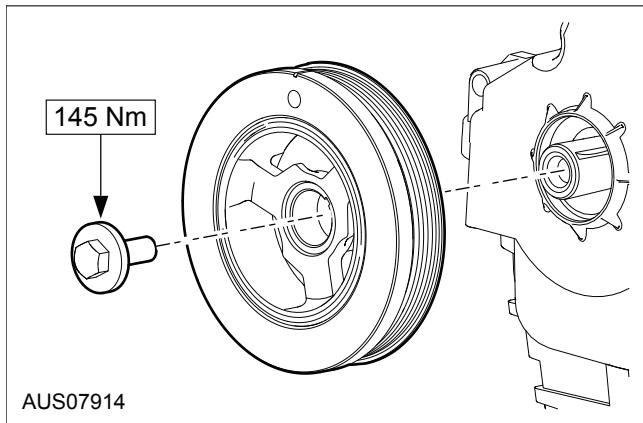
### Installation

1. Apply sealer in the keyway as shown.
2. Lubricate the seal rubbing area with engine oil.
3. Use SST 303-642 to install the damper.

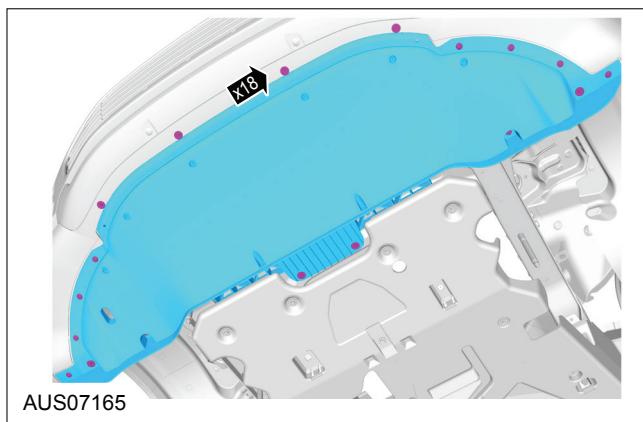


## IN-VEHICLE REPAIR (Continued)

4. Inspect key for damage. Replace if necessary.



5. Install the Retaining bolt.  
6. Install the Accessory Drive belt. For additional information, refer to section 303-05A of the 2008 Falcon Workshop Manual  
7. Install the lower air deflector.



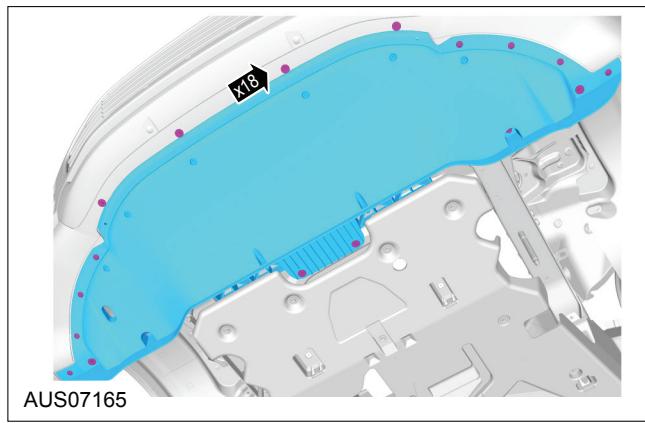
8. Lower the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual

### Crankshaft Front Oil Seal

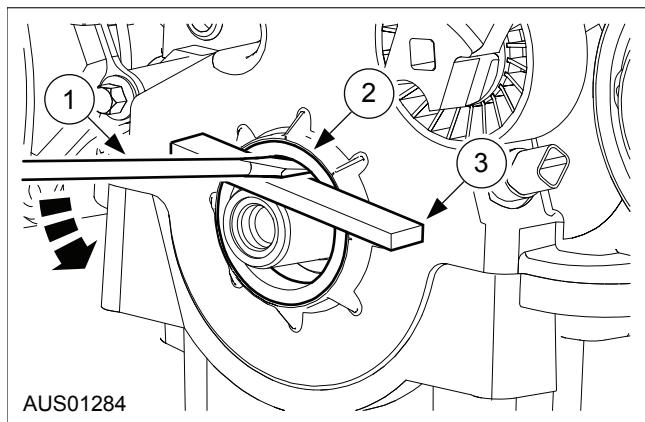
#### Removal

1. Disconnect the battery ground cable. For additional information, refer to section 414-01 of the 2008 Falcon Workshop Manual
2. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008 Falcon Workshop Manual

3. Remove the lower air deflector.



4. Remove the radiator cooling fan assembly. For additional information, refer to section 303-03A of the 2008 Falcon Workshop Manual
5. Remove the radiator. For additional information, refer to section 303-03A of the 2008 Falcon Workshop Manual
6. Remove the front end accessory drive belt. For additional information, refer to section 303-05A of the 2008 Falcon Workshop Manual
7. Remove the Crankshaft Vibration Damper. For additional information, refer Crankshaft Vibration Damper procedure in this section.
8. Protect the crankshaft with a piece of soft metal or plastic, and use a screwdriver to lever out the oil seal.



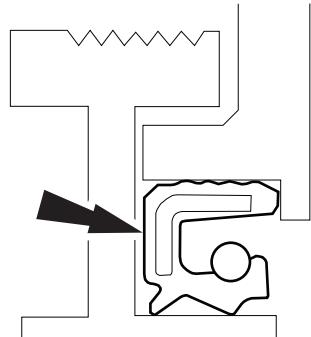
Item	Description
1	Screwdriver (flathead)
2	Crankshaft Front Oil Seal
3	Soft Metal or Plastic (shim)



## IN-VEHICLE REPAIR (Continued)

### Installation

1. Clean the front cover recess and tap in the seal until it is fully seated.
2. Lubricate the lip of the seal with engine oil.



AUS01285

3. Install the Crankshaft Vibration Damper.

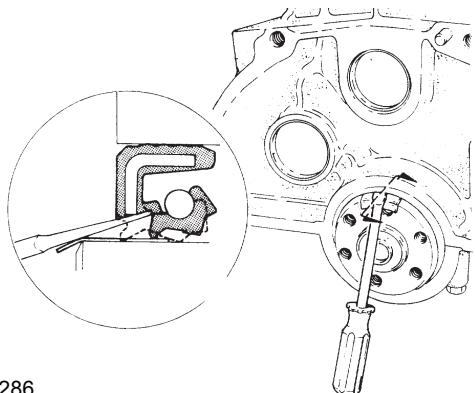
### Crankshaft Rear Oil Seal

#### Removal

1. Remove the transmission. For additional information, refer to section 307-01A of the 2008 Falcon Workshop Manual.
2. Remove the flexplate/ drive plate. For additional information, refer to section 307-01A of the 2008 Falcon Workshop Manual

**Note:** Other potential sources of oil leak should be eliminated prior to replacing the seal.

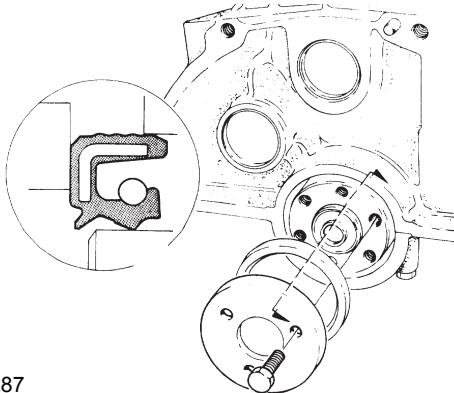
3. Insert a suitable brass strip between the seal and the crankshaft to protect the crankshaft seal surface.
4. Insert a screwdriver between the seal and the protection strip and lever out the seal.



AUS01286

### Installation

1. Clean the seal recess in the block.
2. Oil the lip of the seal and the shaft.
3. Install the seal evenly using the SST E9312.



AUS01287

### Flexplate/ Drive Plate

#### Removal and Installation

1. Remove the transmission. For additional information, refer to section 307-01A of the 2008 Falcon Workshop Manual.
2. Remove the flexplate/ drive plate. For additional information, refer to section 307-01A of the 2008 Falcon Workshop Manual

### Water Pump

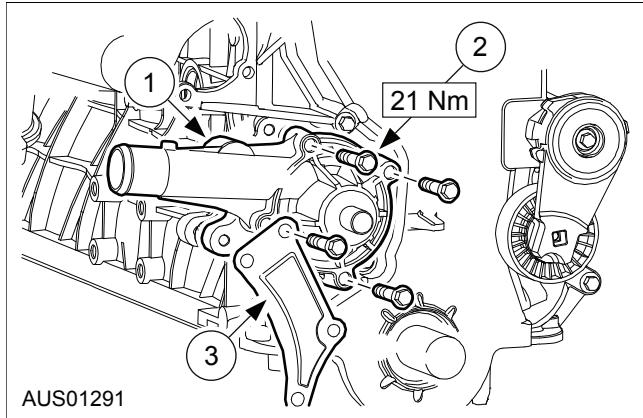
#### Removal

1. Remove the radiator cooling fan assembly. For additional information, refer to section 303-03A of the 2008 Falcon Workshop Manual
2. Remove the front end accessory drive belt. For additional information, refer to section 303-05A of the 2008 Falcon Workshop Manual
3. Remove the water pump pulley. For additional information, refer to section 303-03A of the 2008 Falcon Workshop Manual
4. Remove the alternator and brace. For additional information, refer to section 414-02 of the 2008 Falcon Workshop Manual



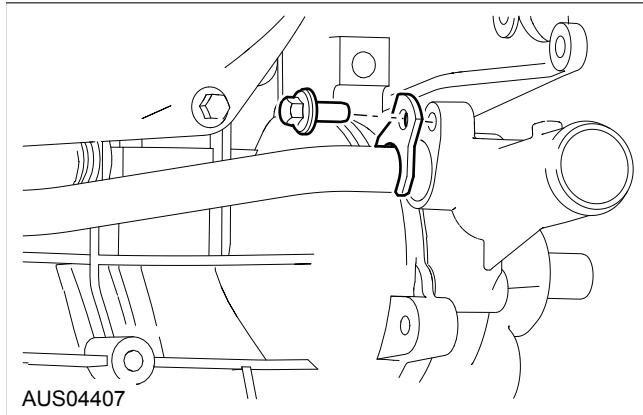
## IN-VEHICLE REPAIR (Continued)

5. Remove the radiator lower hose (and coolant). For additional information, refer to section 303-03A of the 2008 Falcon Workshop Manual



Item	Description
1	Water Pump
2	Bolt (x4)
3	Alternator Brace

6. Unscrew heater pipe Y-clamp on rear of water pump housing.



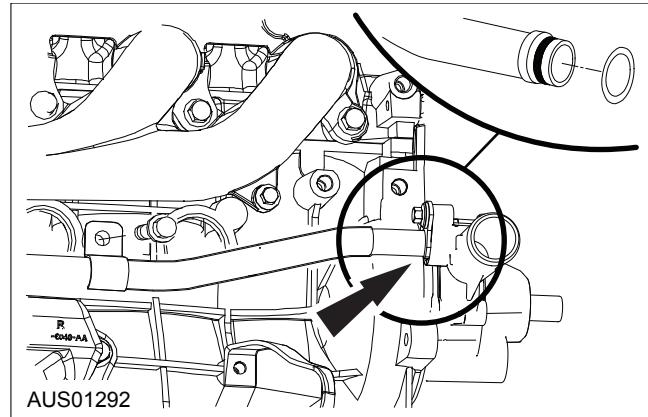
**Note:** Weeping and staining of coolant from the water pump drain reservoir can happen under extreme circumstances. When the water pump is suspected of leaking, this should be confirmed with a cooling system pressure test.

**Note:** The pump is a sealed unit, and should be replaced complete if faulty.

### Installation

To install, reverse the removal procedure with special consideration given to the following.

- Check the condition of the heater pipe recess in the rear of the water pump.
- Check the condition of the O-ring on the end of the heater pipe and renew if damaged.
- Lubricate the O-ring to assist assembly.



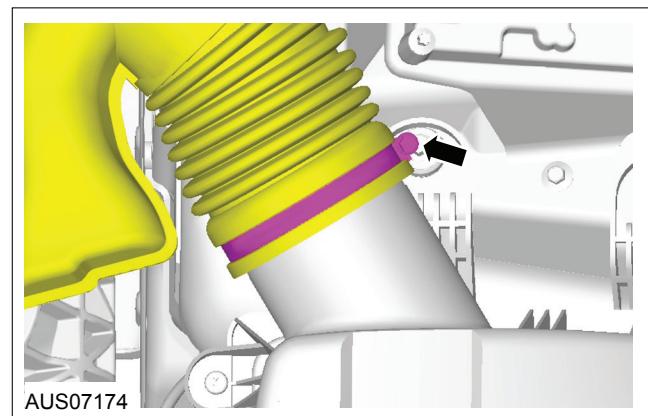
## Electronic Throttle Body and Intake Manifold

### WARNING

 Engines with plastic inlet manifolds are not suitable for conversion to LPG. The plastic inlet manifold is only designed to work with petrol engines - it is dangerous to try to use this type of manifold with LPG fuel.

### Removal

- Back off the air cleaner lid worm drive clamp until loose on its collar.

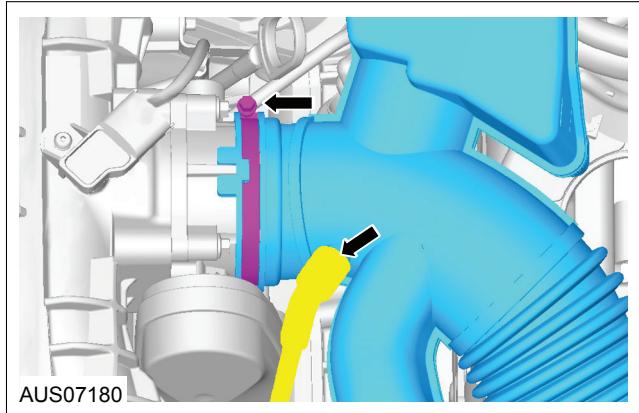


- Detach the Positive Crankcase Ventilation (PCV) hose from the duct & back off the throttle body

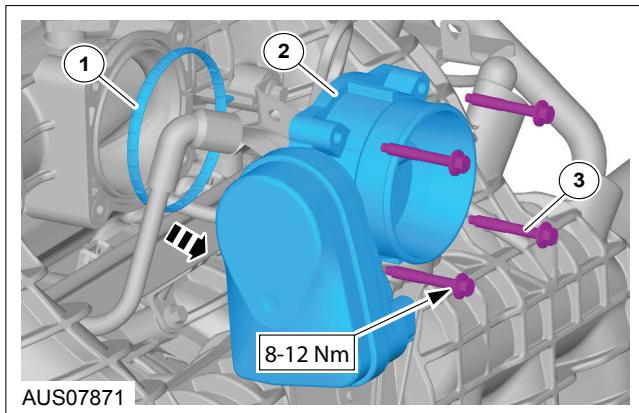
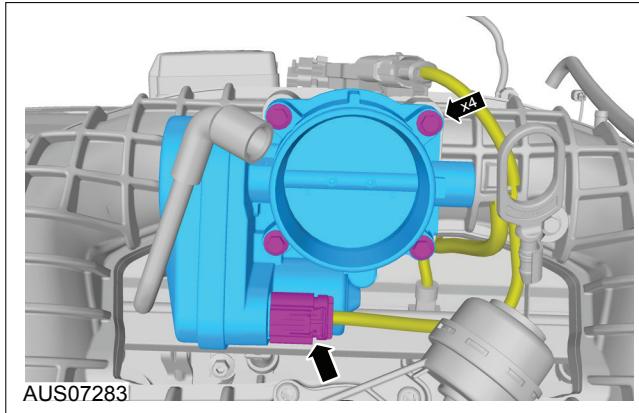


## IN-VEHICLE REPAIR (Continued)

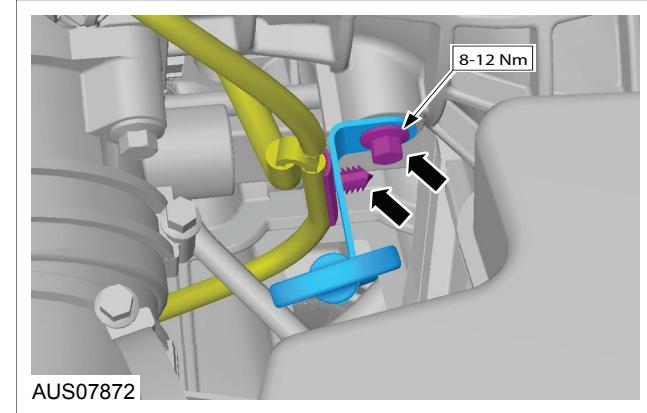
worm drive clamp until loose on its collar



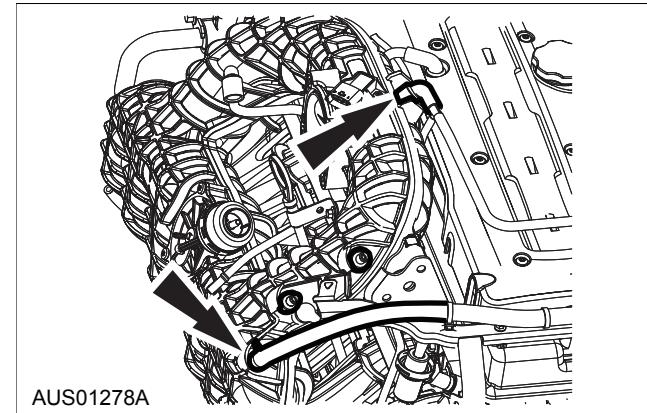
- Disconnect the electrical connector and remove the ETB.



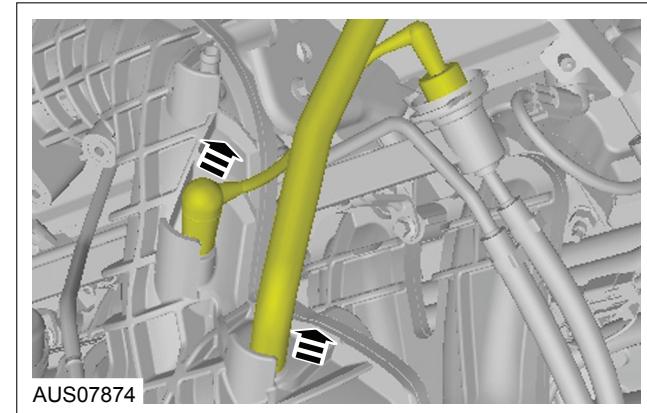
- Remove dipstick and tube.



- Disconnect the brake booster vacuum hose, disconnect the hose to vacuum reservoir from intake manifold, fuel pressure regulator hose, PCV hose, and the MTV vacuum hose from the manifold, manifold absolute pressure and temperature sensor.



- Detach canister vacuum hose and hose to vacuum reservoir from intake manifold.

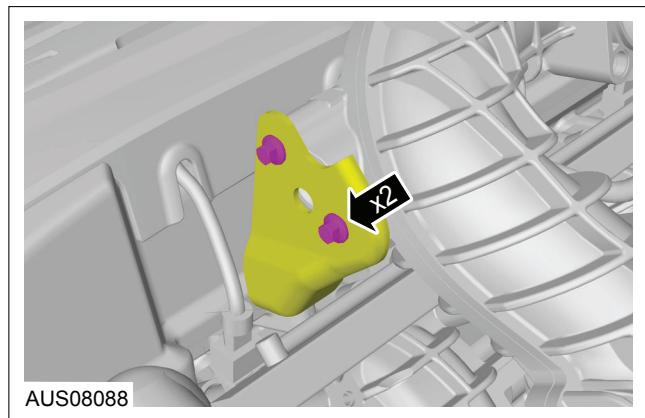


- Remove the 2 upper cylinder head to manifold brackets from the front end of the intake

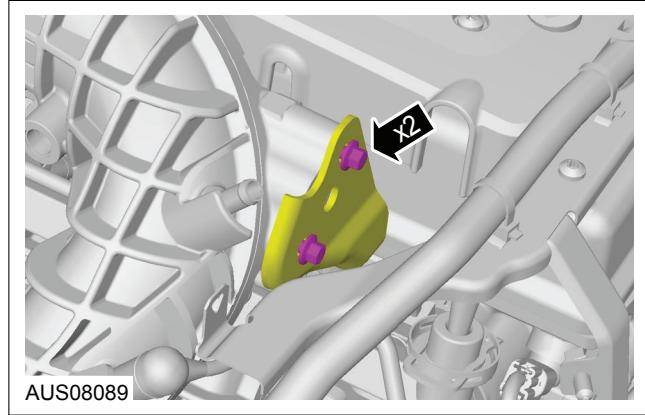


## IN-VEHICLE REPAIR (Continued)

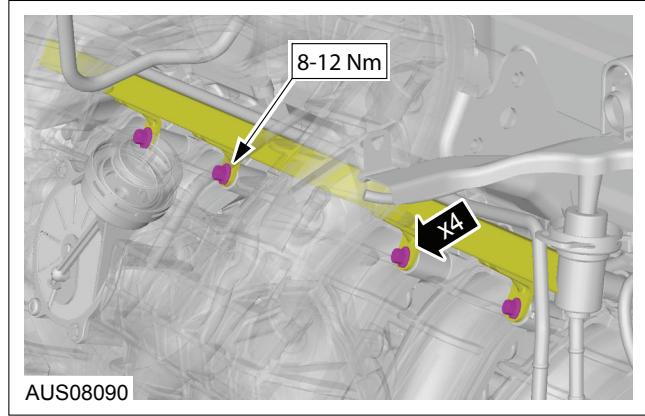
manifold.



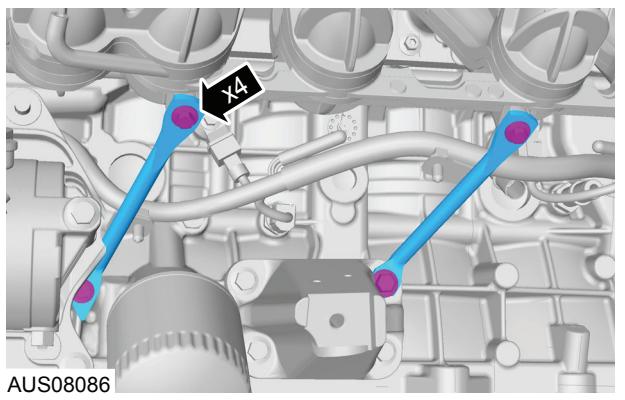
- Remove the 2 upper cylinder head to manifold brackets from the rear end of the intake manifold.



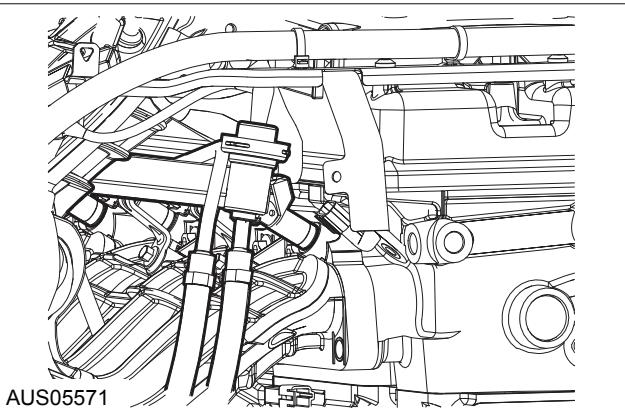
- Remove the 4 fuel rail mounting bolts.



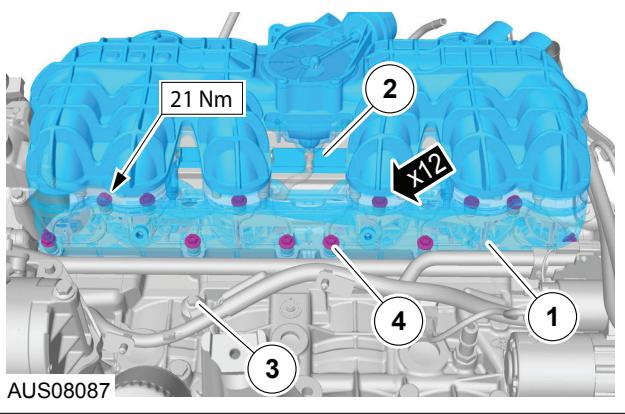
- Remove the 2 lower cylinder block to manifold pencil struts.



- Depressurise and drain the fuel system and fuel rail. For additional information, refer to section 310-00 of the 2008 Falcon Workshop Manual. Disconnect the return and supply lines on the fuel rail from the vehicle lines. Remove the fuel rail and injectors as an assembly.



- Remove the intake manifold.



Item	Description
1	Fuel rail
2	Support bracket
3	Knock sensor
4	M8 Bolts

**Note:** The Electronic Throttle Body is a nonadjustable item. The set screw is permanently set.



## IN-VEHICLE REPAIR (Continued)

into the housing. For additional information, refer to section 303-14 of the 2008 Falcon Workshop Manual

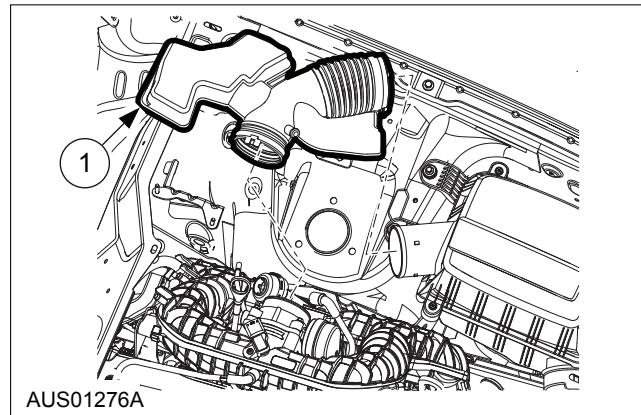
### Installation

1. When reinstalling the intake manifold bolts to the cylinder head ensure that the axi-rads for the cylinder head bolts are present. If the axi-rads appear to be worn or damaged, they should be replaced.
2. Torque the M8 bolts to 17-24Nm.
3. Replace the seals between the cylinder head and the mounting flange of the intake manifold.
4. When reinstalling the ETB to the intake manifold, use a new gasket and new bolts or apply Loctite 242 (or similar) thread locker to the threads.
5. Torque the ETB M6 bolts to 8-12Nm.
6. When reinstalling the fuel rail to the intake manifold, replace the O-Ring seals on each injector.
7. Torque the fuel rail M6 bolts to 8-12Nm.
8. When reinstalling the dipstick tube and a new bolt or apply Loctite 242 (or similar) thread locker to the thread. Torque the M6 bolt to 8-12Nm.
9. The intake manifold tuning valve (IMTV) position is set in the factory and should not be touched, unless the IMTV is to be serviced.

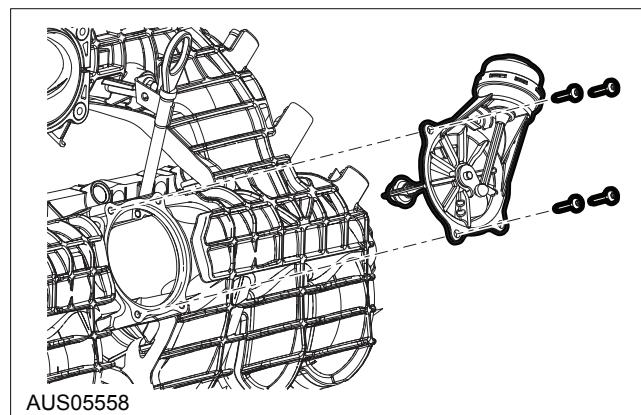
### Intake Manifold Tuning Valve (IMTV)

#### Removal

1. Remove the air duct assembly. For additional information, refer to section 303-12A of the 2008.0 Falcon Workshop Manual.



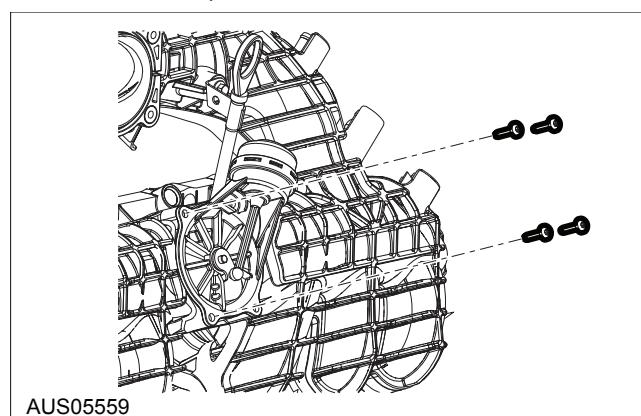
2. Detach the hose from the IMTV.
3. Unscrew the retaining screws.



4. Remove the IMTV.

#### Installation

1. Insert the IMTV cartridge into the manifold while taking care not to pinch the O-ring. Orient it into the correct position.
2. Taking care not to cross thread or strip the threads in the manifold for the self forming screws. Torque the M6 screws to 4.5-5.5Nm.

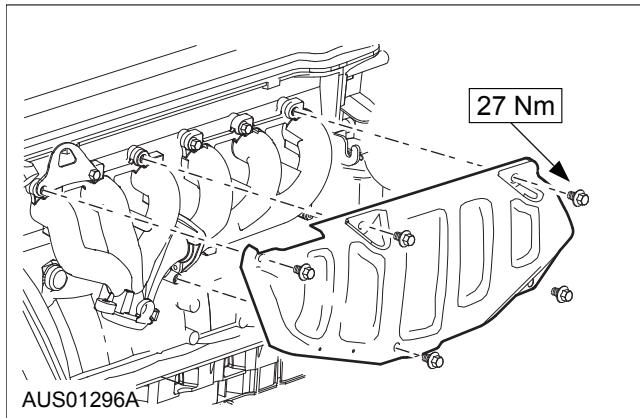


## IN-VEHICLE REPAIR (Continued)

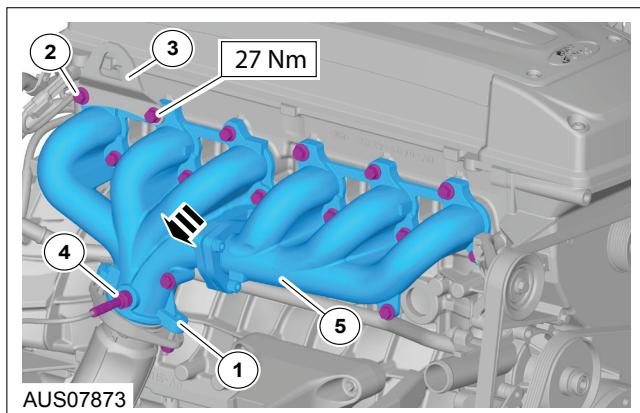
### Exhaust Manifold Assembly

#### Removal

1. Remove the heat shield by unscrewing the retaining bolts.



2. Disassemble the items in the following order.



Item	Description
1	Catalytic Converter Inlet Pipe
2	Lifting Eye
3	Retaining Bolt
4	Heated Exhaust Gas Oxygen (HEGO) Sensor
5	Exhaust Manifold Assembly

#### Installation

1. Fit 2 M10 x 1.5 bolts with heads removed as guide pins.
2. Fit a new gasket and loosely assembled manifold onto guide pins.

#### WARNING



Do not fit a used gasket, throw away any old gaskets. Always fit a new gasket.

Do not install used studs and nuts, throw away all old studs and nuts. Always use new fasteners.

3. Install lower manifold to head studs, and nip up the nuts.
4. Remove guide pins, install remainder of studs and nuts excluding the bolts those used to attach the heat shield.
5. Tighten the nuts progressively to specification.
6. Tighten the front to rear manifold joint nuts to specification.
7. Install the catalytic convertor inlet pipe with the exhaust manifold. Torque the studs and nuts to specifications.

#### WARNING



Do not fit a used gasket, throw away any old gaskets. Always fit a new gasket.

Do not install used studs and nuts, throw away all old studs and nuts. Always use new fasteners.

8. Lubricate the HEGO sensor thread with Loctite 767 (or similar) anti-seize compound per ESE-FM99C100-A.
9. Install the lifting eye and the retaining bolt.

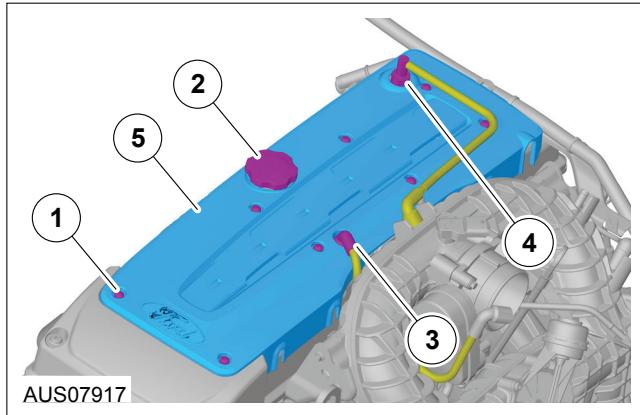


## IN-VEHICLE REPAIR (Continued)

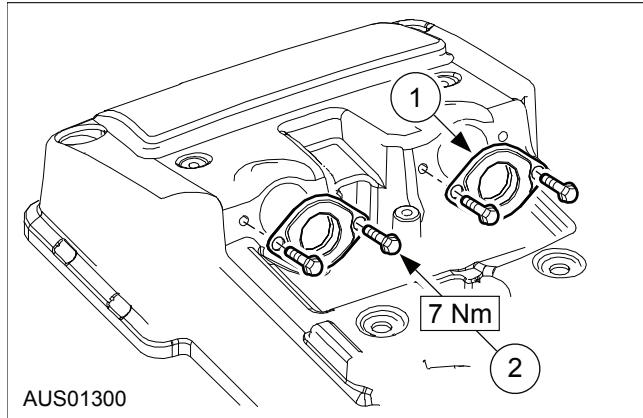
### Oil Control Valve Seal

#### Removal

1. Remove the Spark Plug cover. For additional information, refer the Valve Cover procedure in this section.

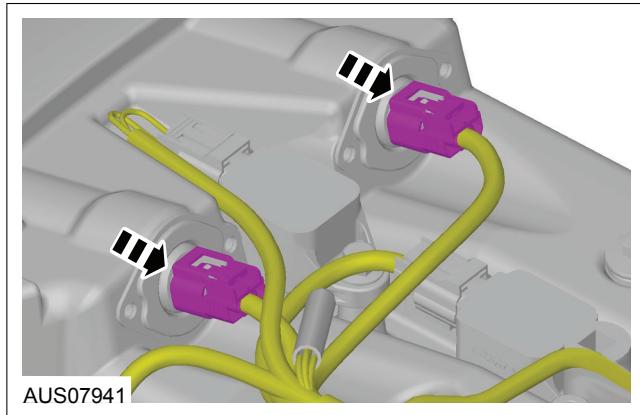


3. Check metal garter band is still in place on the seal.



Item	Description
1	Bolt (X8)
2	Oil filler cap
3	PCV hose connector (front)
4	PCV hose connector (rear)
5	Spark plug cover

2. Disconnect the electrical connectors for the camshaft variable timing sensor.



#### Item | Description

1	Plate - Gasket valve rocker arm cover
2	Bolt

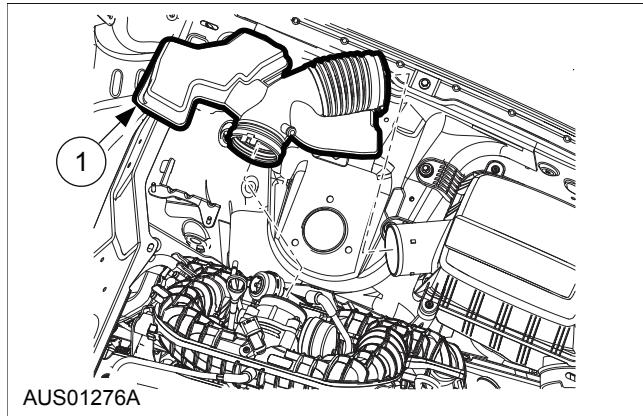
#### Installation

1. After tightening the Valve Cover retaining bolts, insert the Oil Control Valve seals into the Valve Cover without displacing the metal garter band, and tighten the seal retaining bolts.

### Valve Cover

#### Removal

1. Remove the air duct assembly. For additional information, refer to section 303-12A of the 2008.0 Falcon Workshop Manual.



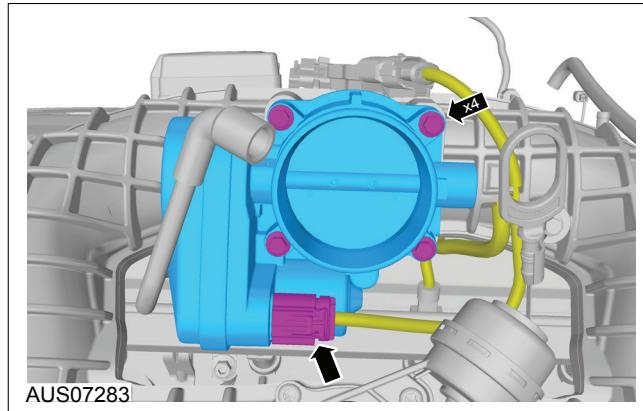
#### Item | Description

1	Air duct
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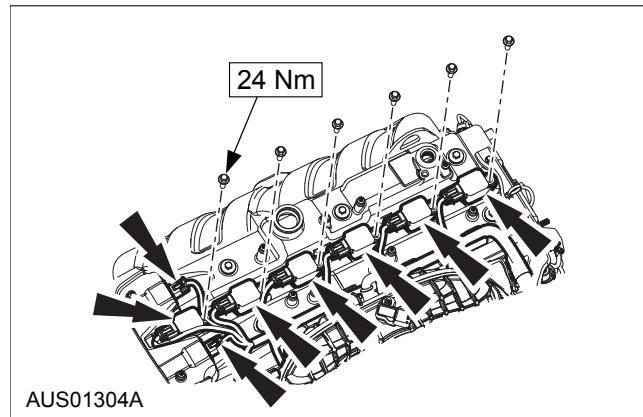


## IN-VEHICLE REPAIR (Continued)

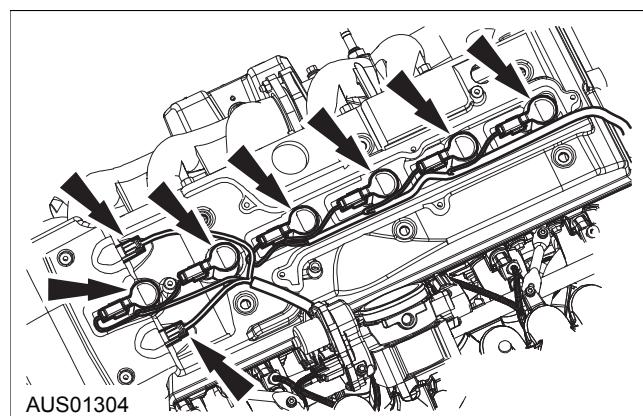
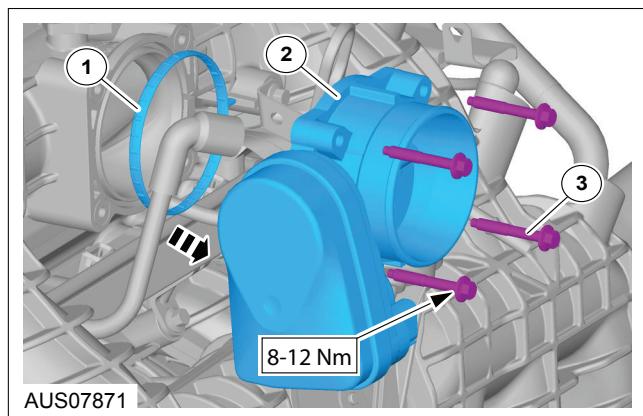
2. Disconnect the electrical connector and remove the ETB.



4. Remove the 6 Ignition Coil retaining bolts.

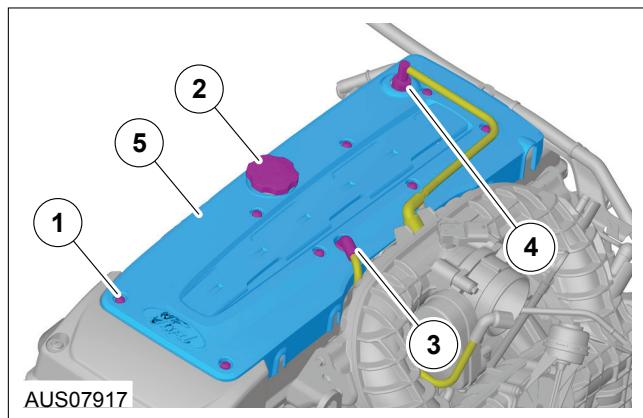


5. Disconnect the Ignition Coil electrical connectors.



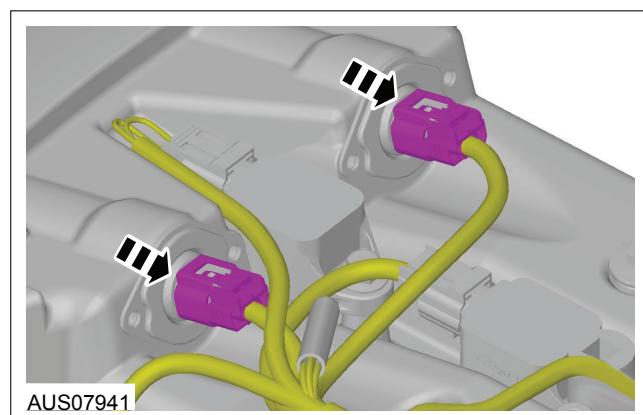
Item	Description
1	Gasket - Throttle body
2	Throttle body
3	M6 screw (x4)

3. Remove the Spark Plug Cover.



6. Remove the ignition coils.

7. Disconnect the electrical connectors for the camshaft variable timing sensor.

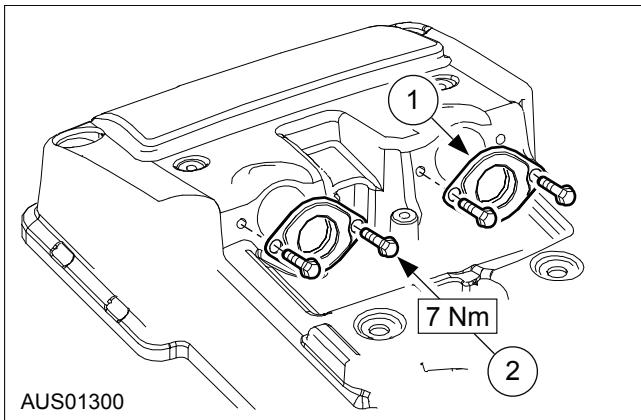


Item	Description
1	Bolt (X8)
2	Oil filler cap
3	PCV hose connector (front)
4	PCV hose connector (rear)
5	Spark plug cover



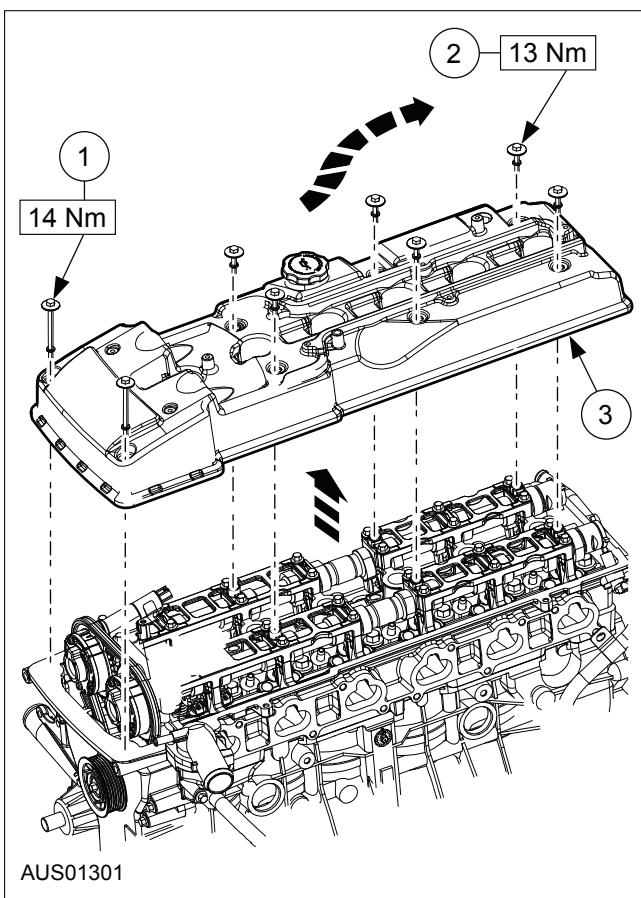
## IN-VEHICLE REPAIR (Continued)

8. Remove the Oil control valve seals retaining bolts. Check metal garter band is still in place on the seal.



Item	Description
1	Plate - Gasket valve rocker arm cover
2	Bolt

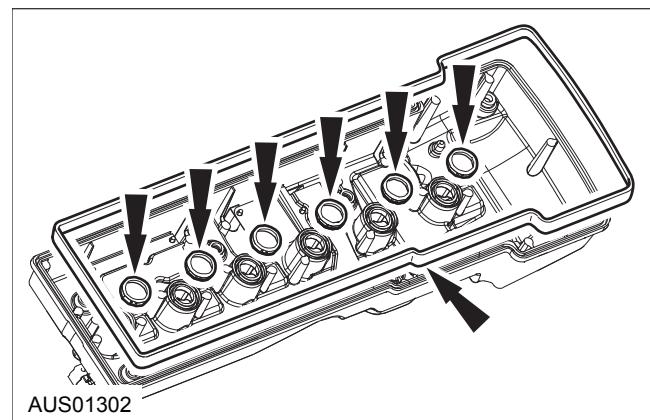
9. Remove valve cover retaining bolts (8).  
10. Remove the valve cover.



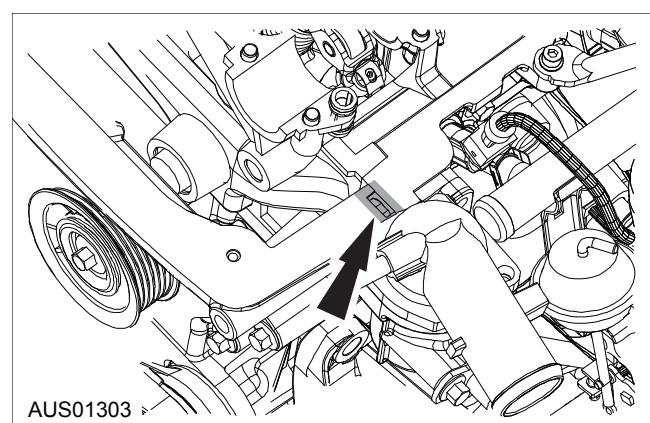
Item	Description
1	Bolt and washer
2	Bolt and washer
3	Valve cover

### Installation

1. Clean the cover including PCV and fresh air chambers, and seal grooves. Fit new seals.



2. Apply sealer WSS-M4G323 A7 in 2 places on the Valve Cover to cylinder head/front cover joints as shown, refit the cover, check the peripheral seal is not displaced out of the groove using a mirror for the rear of the engine.  
3. When re-installing the 8 short bolts which retain the Valve Cover to the cylinder head assembly, coat the threads with Loctite 242 (or similar) thread locker.



4. Connect the camshaft variable timing sensor electrical connectors.  
5. Check the Oil Control Valve Seals, replace if necessary and refit after the Valve Cover is tightened down.  
6. Connect the ignition coil electrical connectors.  
7. Install the Ignition Coils and its retaining bolts.  
8. Install the spark plug cover.  
9. Reinstall the Electronic Throttle Body (ETB). For additional information, refer the Electronic Throttle Body procedure in this section.  
10. Refit the air duct assembly. For additional information, refer to section 303-12A of the 2008.0 Falcon Workshop Manual.

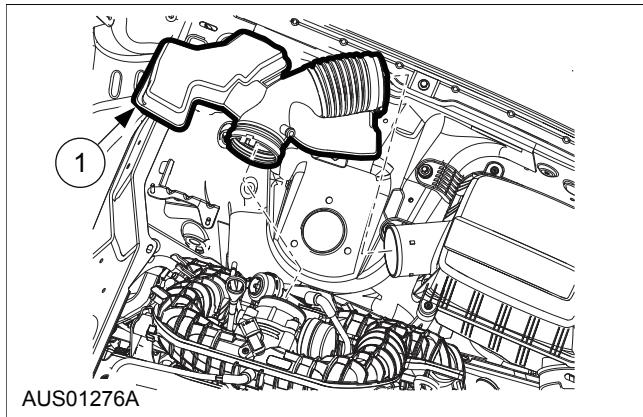


## IN-VEHICLE REPAIR (Continued)

### Ignition Coils/Wiring Loom

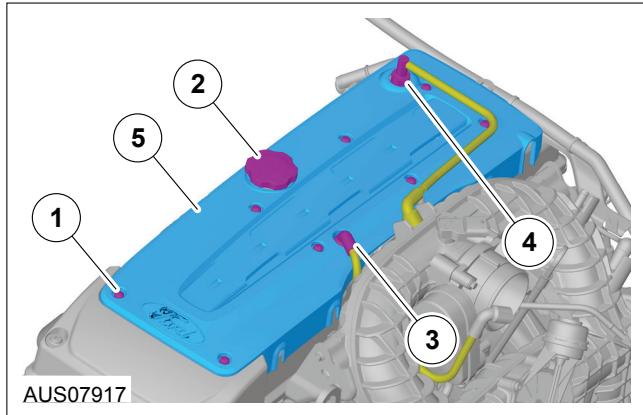
#### Removal

1. Remove the air duct assembly. For additional information, refer to section 303-12A of the 2008.0 Falcon Workshop Manual.



Item	Description
1	Air intake tube assembly
2	Bolt

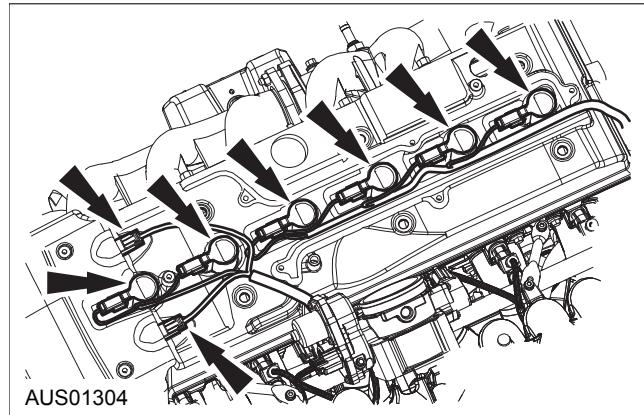
2. Remove the Electronic Throttle Body (ETB). For additional information, refer to the Electronic Throttle Body procedure in this section.
3. Remove the oil filler cap, PCV valve and PCV hoses.
4. Remove the Spark Plug Cover.



Item	Description
1	Bolt (X8)
2	Oil filler cap
3	PCV hose connector (front)
4	PCV hose connector (rear)
5	Spark plug cover

5. Remove the Ignition Coil retaining bolts.

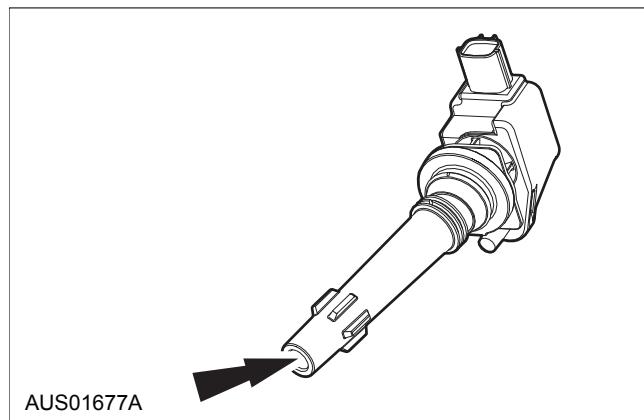
6. Disconnect the Ignition Coil electrical connectors.



7. Remove the Ignition Coils.

#### Installation

1. Every time the Ignition Coils are removed, apply 2 grams of synthetic grease ESF-M1C229-A (Dupont Krytox) using a suitable applicator (cotton bud) to the inside of the tapered section of the coil boot, smearing it evenly over the surface.



2. Refit the ignition coils and reconnect the wiring loom to the coils & oil control valves. Install coil securing bolts and torque to specification (24Nm).

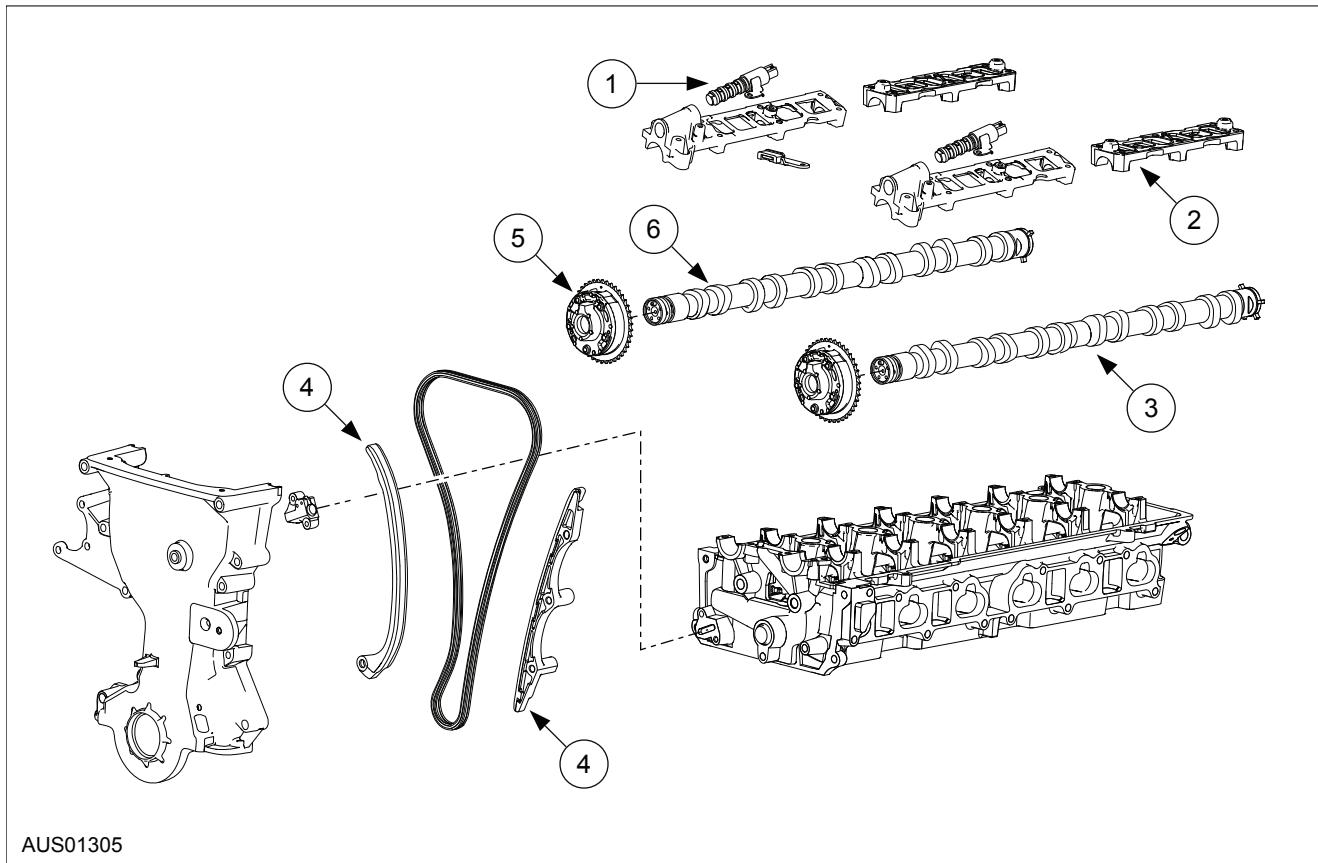
**Note:** The short lead is attached to the intake oil control valve and the long lead is connected to the exhaust oil control valve.

3. Ensure all of the wiring is clear of the Spark Plug Cover seal surfaces, and that the wiring does not obstruct any hardware mounting points.
4. Ensure that the wiring is located correctly in the grooves in the Valve Cover where it exits the Spark Plug Cover when refitting the Spark Plug Cover.



## IN-VEHICLE REPAIR (Continued)

### Camshafts, VCT Phaser, Oil Control Valves, & OCV Filters



AUS01305

Item	Description
1	VCT Oil Control Valve
2	Camshaft Bearing caps
3	Camshaft - Intake
4	Chain Guide
5	Variable Cam Timing (VCT) unit
6	Camshaft - exhaust



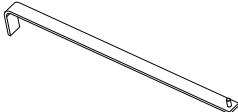
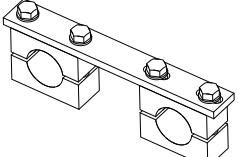
## IN-VEHICLE REPAIR (Continued)

### Camshaft Removal

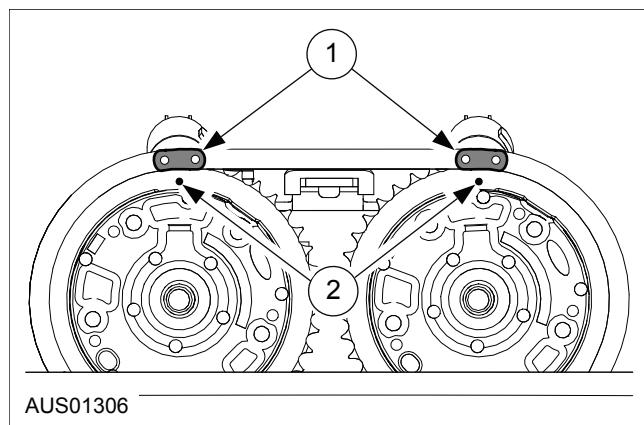
#### Removal

- Remove valve cover. For additional information, refer to Valve Cover procedure in this section.

### Camshaft and VCT Phasers

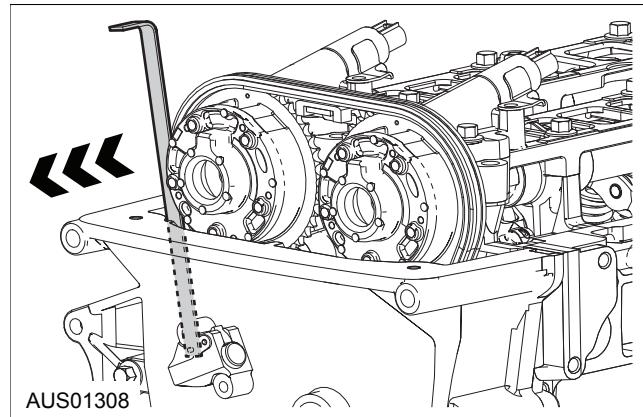
Special Tool(s)	
	Timing chain tensioner special service tool 303-777
	Camshaft holding tool 303-778

- Rotate the crankshaft so the VCT timing marks (on the sprocket) are vertically upwards and the crankshaft at Top Dead Centre.
- Mark the two timing chain links above the timing marks with a marker pen.

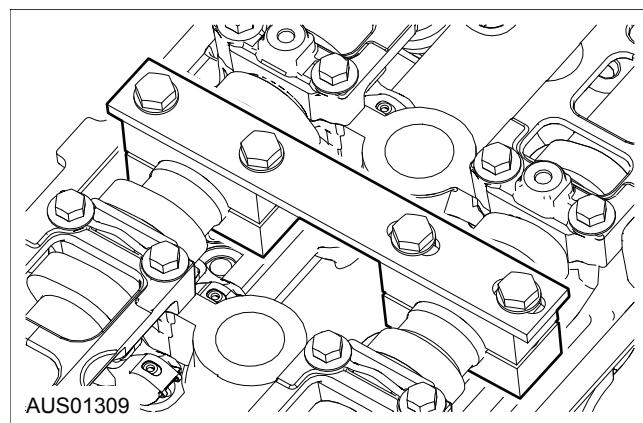


**Note:** The yellow and orange coloured links used for original assembly, and assembly with the front cover removed, are only synchronized with the timing marks once every 38 crankshaft revolutions, and should be ignored when working with the front cover in place (unless synchronized).

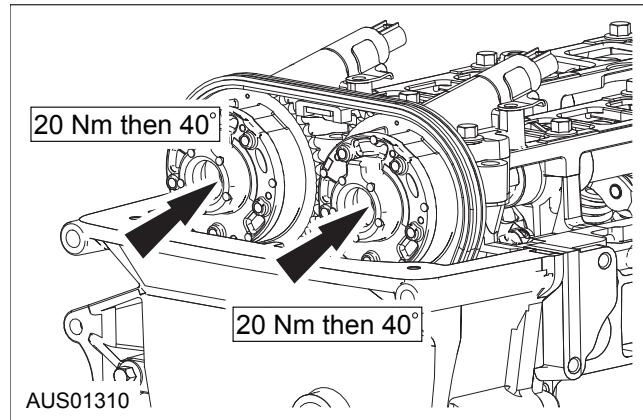
- Release the timing chain tension by compressing the tensioner using SST 303-777. For additional information, refer to Timing Chain Tensioner procedure in this section.



- Fit the SST 303-778 to the camshafts in the central position between the caps and tighten to prevent rotation.



- Loosen the bolt attaching the VCT units to the camshafts.
- Do not use the chain to prevent rotation when loosening the central bolt as this load will be transmitted through the locked phaser mechanism and could cause damage.

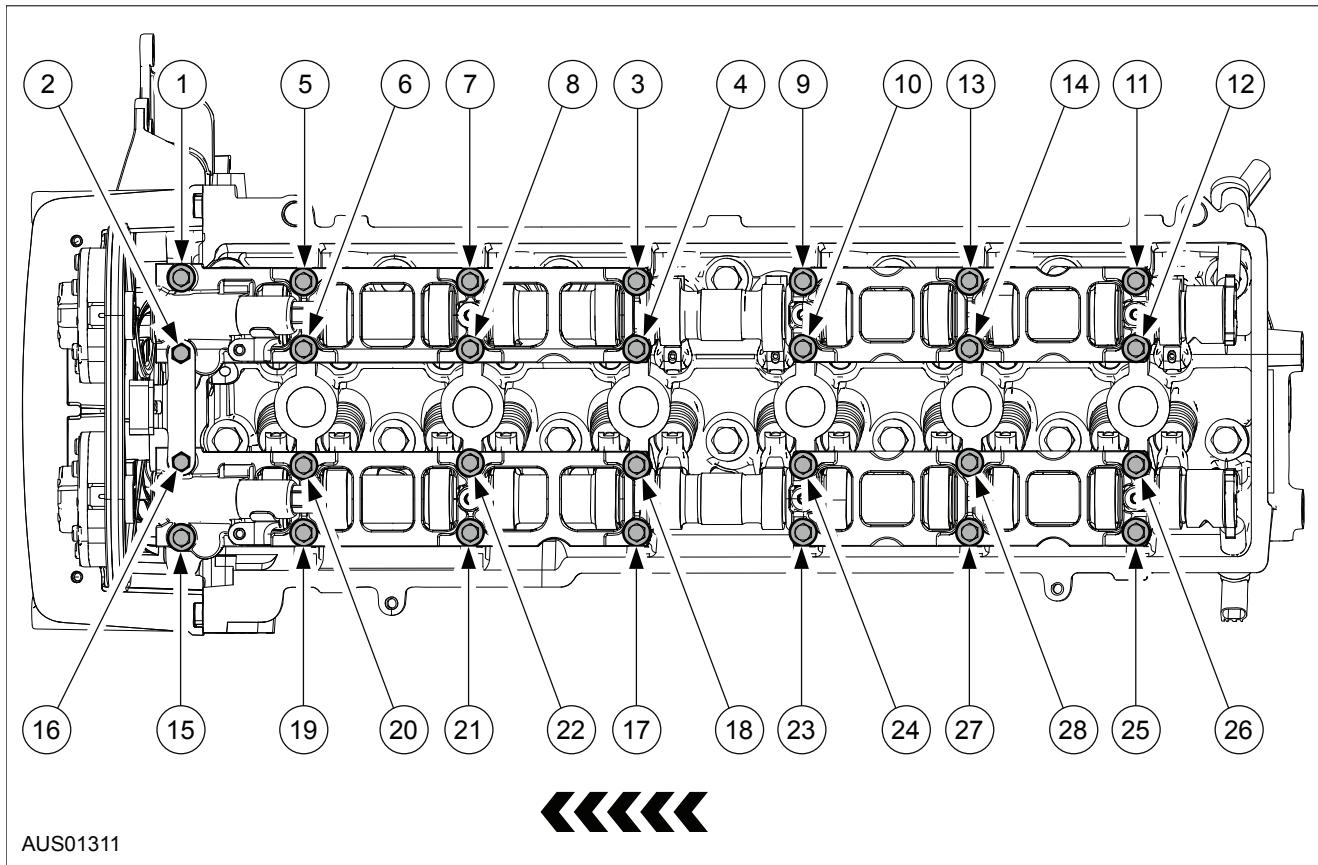


## IN-VEHICLE REPAIR (Continued)

- Whilst holding the VCT phaser and timing chain, slide the VCT phaser forward off the camshafts and rest on top of the timing cover.

**Note:** Do not remove the timing chain from the VCT phasers.

- Remove the tool.
- Loosen the camshaft cap bolts 2 turns at a time in the order shown below.



- Remove camshaft caps.
- Remove inlet & exhaust camshaft.

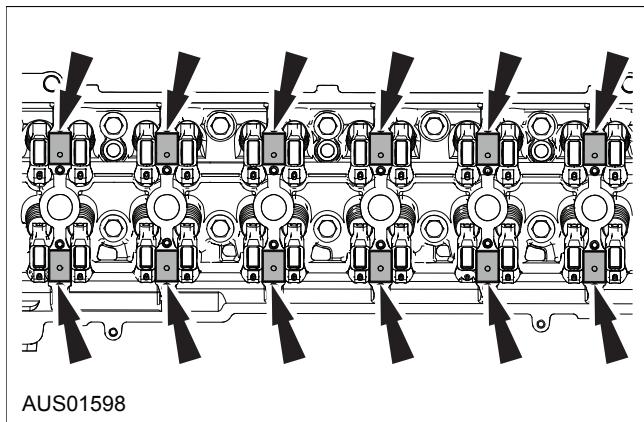


## IN-VEHICLE REPAIR (Continued)

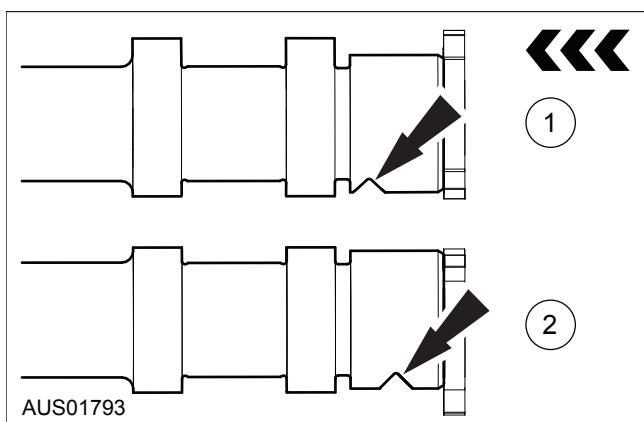
### Camshaft Installation

#### Installation

- Check the camshaft journal clearance.
- Lubricate the head-cam bearing surfaces with engine oil.

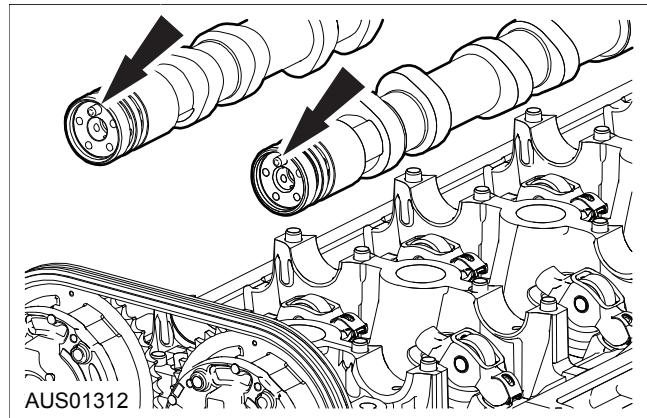


**Note:** Use the following illustration to identify the Exhaust and Inlet camshafts.



Item	Description
1	Exhaust
2	Inlet

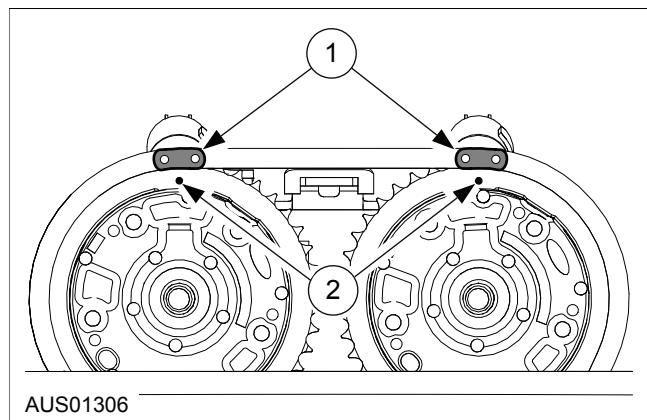
- Fit the respective Intake and Exhaust camshafts with the timing pin positioned vertically upwards. Take care not to damage the thrust surfaces on journal #2.



- Check for burrs and damage on the cap-to-head joints and the cam-to-VCT phaser joint. Tighten bolts 2 turns at a time in the same order shown in the removal section.

**Note:** The cam-cap oil passage must be absolutely clean.

- Rotate the crankshaft so the VCT timing marks (on the sprocket) are vertically upwards and the crankshaft at Top Dead Centre.
- Align the marked the two timing chain links with the VCT timing marks sprocket.



**Note:** The yellow and orange coloured links used for original assembly, and assembly with the front cover removed, are only synchronized with the timing marks once every 38 crankshaft revolutions, and should be ignored when working with the front cover in place (unless synchronized).

**Note:** If a camshaft timing error is suspected, and it is necessary to check the basic cam timing using the valve lift loss method, then the cams must be fully advanced and both VCT Phaser locking pins engaged.



## IN-VEHICLE REPAIR (Continued)

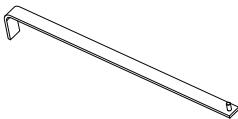
7. Check that the cams are fully advanced and the locking pins engaged by gripping each camshaft between the journals numbers 4 & 5 with a suitable wrench using soft protective pads, and attempt to rotate the camshaft backwards and forwards relative to the VCT Phaser.
8. Establish the point of maximum lift on a No. 1 cylinder intake cam lobe by determining the positions where the lift is reduced by 0.25 mm either side of maximum lift. Note the crankshaft angles while rotating the crankshaft in a clockwise direction only.
9. Average the two crankshaft angles to give the point of maximum lift.
10. Repeat this procedure for the No.1 cylinder exhaust cam lobe.
11. Check the piston TDC in a similar way by fitting an adaptor in the spark plug hole in cylinder No. 1 with an adjustable length pin protruding into the cylinder so that it just prevents the piston from reaching TDC. Lock the adjustment using a suitable locknut.
12. Rotate the engine clockwise until the piston touches the pin and noting the crankshaft angle, and then rotating it anti-clockwise, and again note the angle.
13. Average the two crankshaft angles to give TDC, and compare it to the timing mark on the Crankshaft Vibration Damper to ensure that the Damper outside element has not rotated. If there is a significant discrepancy, replace the Damper. Refer to Crankshaft Vibration Damper in this section.

Standard Intake Cam Timing	Maximum lift @ 99.5° ATDC
Standard Exhaust Cam Timing	Maximum lift @ 131.5° BTDC

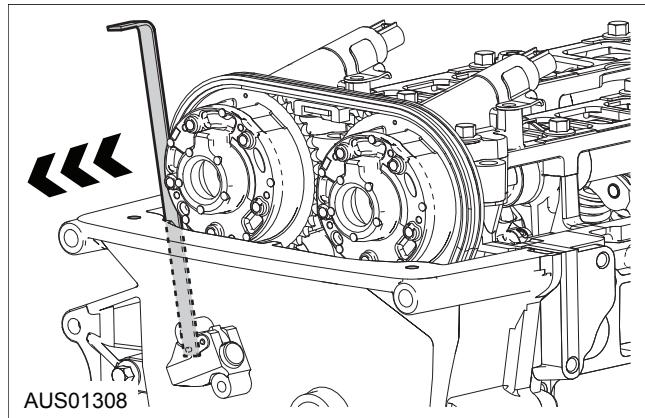


## IN-VEHICLE REPAIR (Continued)

### Timing Chain Tensioner

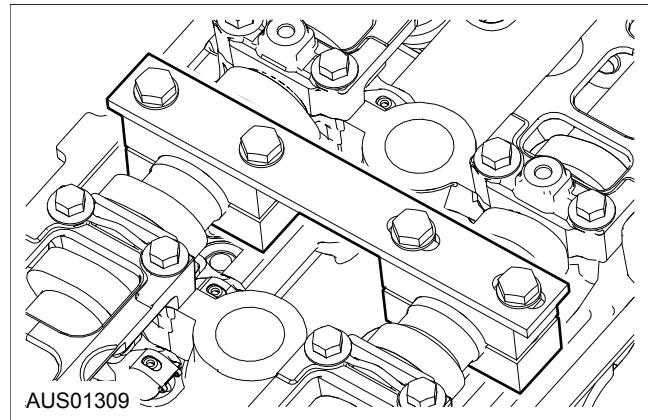
Special Tool(s)	
	Timing chain tensioner special service tool 303-777  SST303-777

1. Release the timing chain tension by compressing the tensioner. Refer this section.

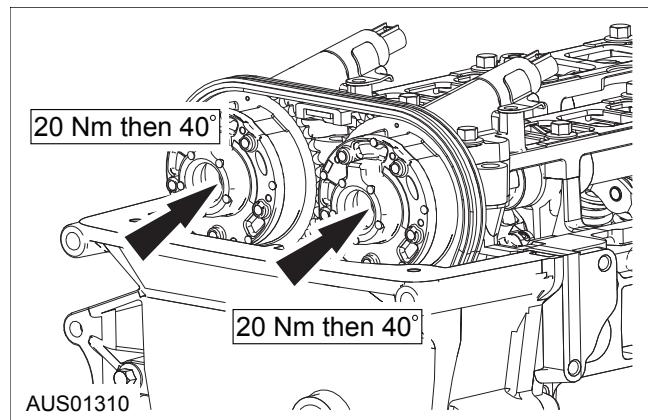


### Removal

1. Remove valve cover. For additional information, refer to Valve Cover procedure in this section.
2. Fit the SST 303-778 to the camshafts in the central position between caps and tighten to prevent rotation.



3. Loosen the bolt attaching the VCT units to the camshafts.
4. Do not use the chain to prevent rotation when loosening the central bolt as this load will be transmitted through the locked phaser mechanism and could cause damage.



5. Whilst holding the VCT phaser and timing chain, slide the VCT phaser forward off the camshafts and rest on top of the timing cover.

**Note:** Do not remove the timing chain from the VCT phasers.

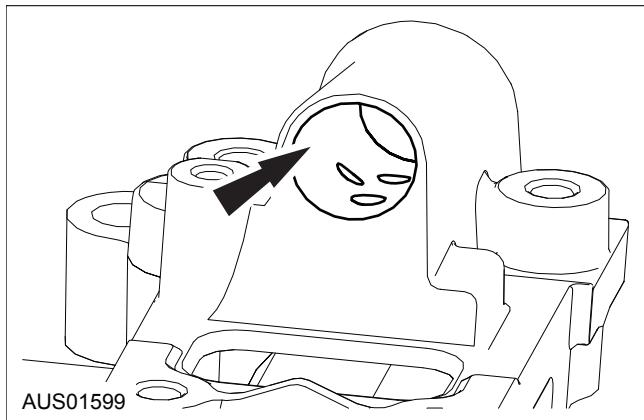
6. Remove the tool.



## IN-VEHICLE REPAIR (Continued)

### Installation

1. To install, reverse the removal procedure.
2. The oil control valves & cam cap bores must be absolutely clean.

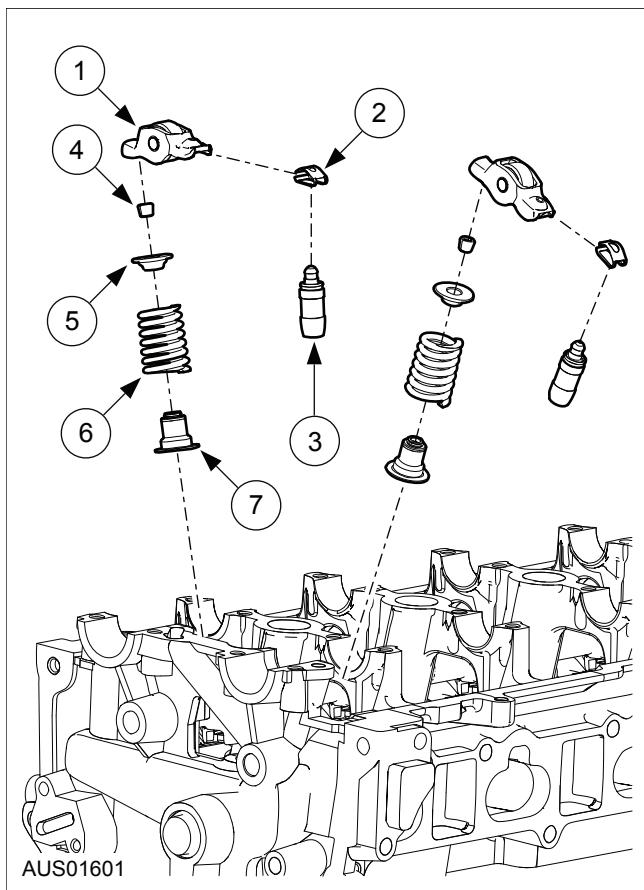


Item	Description
1	Cam follower
2	Lash adjuster retaining clip
3	Lash adjuster
4	Valve spring retainers
5	Valve spring retainer keys
6	Valve spring
7	Valve stem seal

3. The cam cap oil passages must be absolutely clean.

### Rocker Arm, Lash Adjuster, Valve Spring and Valve Stem Seal

1. Disassemble in the order indicated in the table.



## IN-VEHICLE REPAIR (Continued)

### Rocker Arm and Lash Adjuster

The rocker arm and lash adjuster are clipped together to prevent rocker displacement under extraordinary start up conditions.

Care should be taken when removing the assembly, so as not to strain the clip.

Do not remove the clip unless either the rocker arm or lash adjuster are to be replaced and fit a new clip.

If the clip is loose on the rocker arm it should be replaced when the rocker and lash adjuster assembly is removed from the cylinder head.

#### Removal

1. Remove the camshaft. For additional information, refer to the Camshaft procedure in this section.
2. Disengage the rocker arm from the valve tip.
3. The rocker arm & lash adjuster assembly can be raised and the lash adjuster removed from the cylinder head.

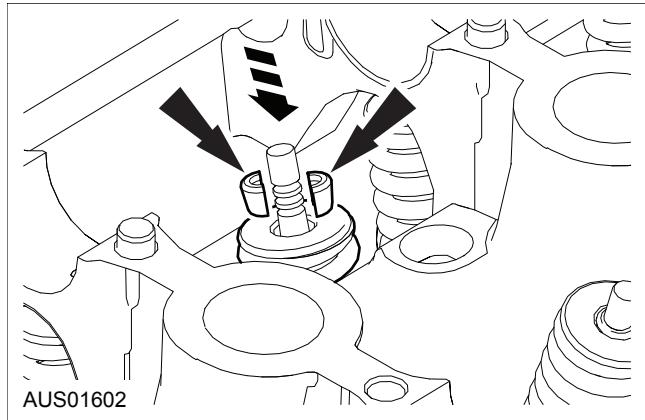
#### Installation

1. To install, reverse the removal procedure.

### Valve spring and Valve Stem Seal

#### Removal

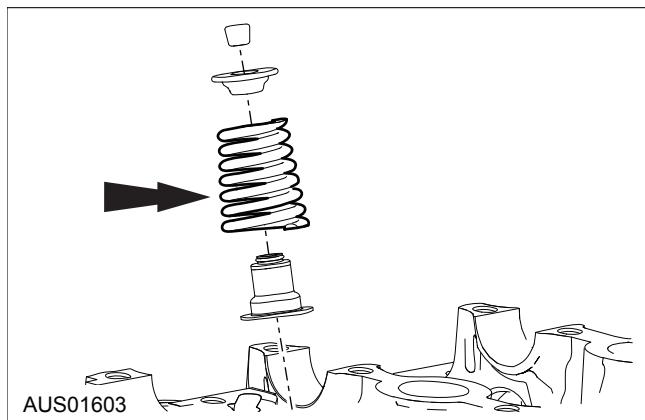
1. Remove the appropriate spark plug, and pressurise the cylinder via an air line and adaptor. DO NOT exceed 800 kPa.
2. Remove the keys, retainers and valve spring using a suitable valve spring compressor.



3. Remove the valve stem seal/spring seat assembly with pliers or multi-grips, being careful not to mark the valve stem.

#### Installation

1. Pressurise the cylinder via an air line and adaptor. Do not exceed 800 kPa.
2. Use an 18mm inside diameter tube to gently seat the valve stem seal.
3. Reassemble in the reverse order to the procedure above.

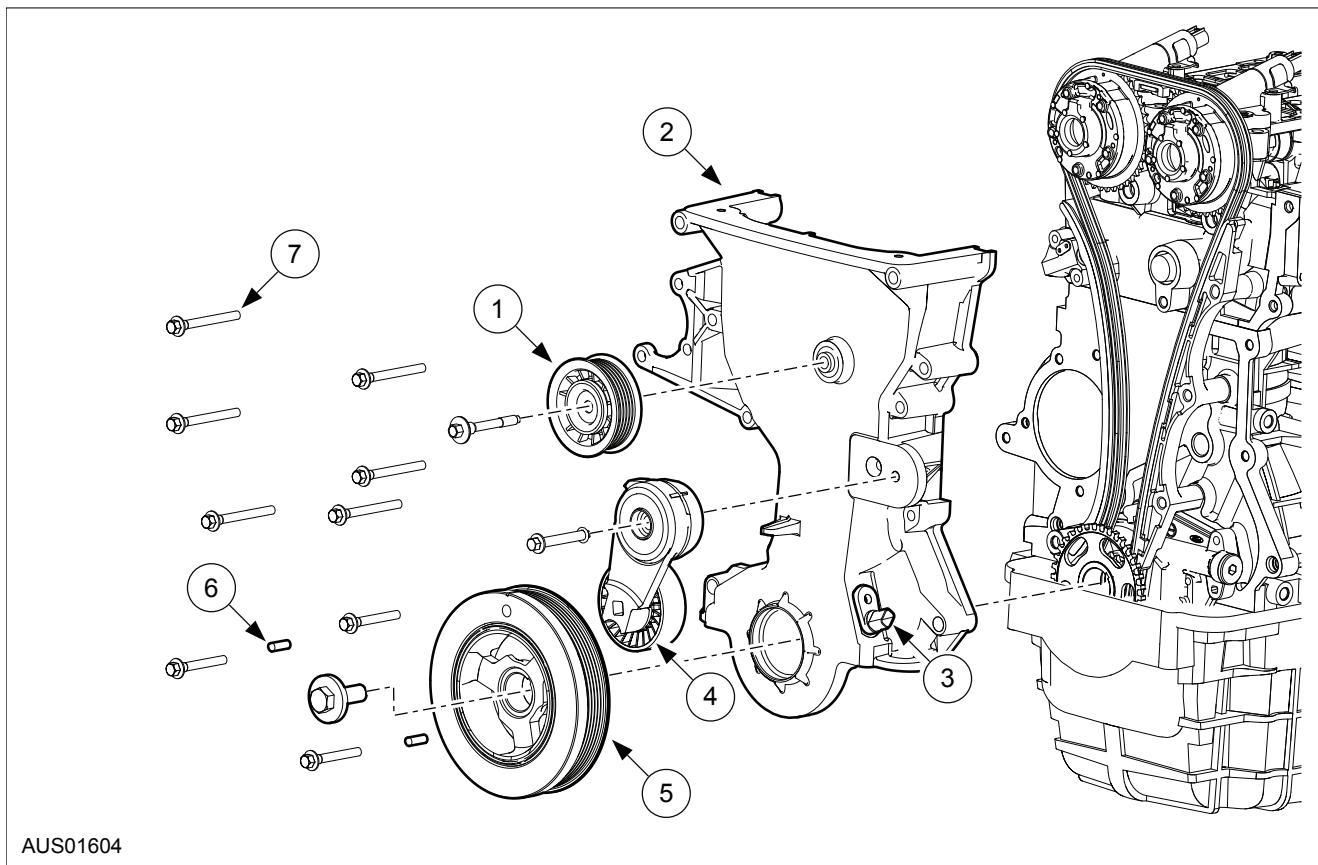


**Note:** The valve spring must be fitted with the smaller diameter end upwards.



## IN-VEHICLE REPAIR (Continued)

### Front Cover



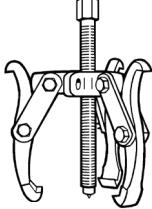
Item	Description
1	Idle pulley
2	Front cover
3	Crankshaft sensor
4	Drive belt tensioner assembly
5	Crankshaft vibration damper
6	Dowel front cover location
7	Bolt - Front cover



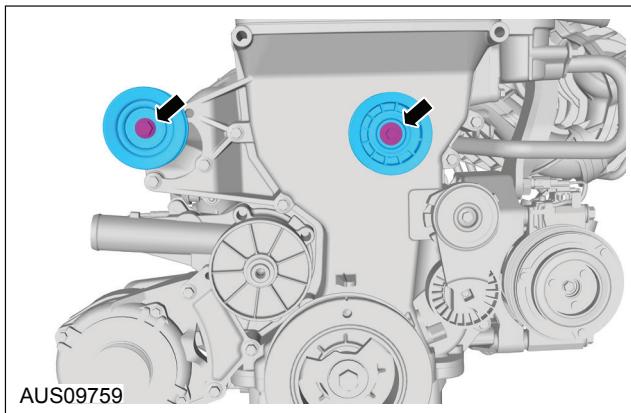
## IN-VEHICLE REPAIR (Continued)

### Front cover

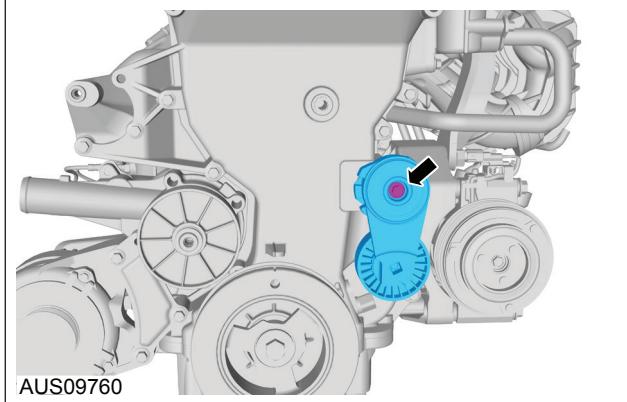
#### Removal

Special tool	
	Harmonic balancer strap wrench holding tool, SST 303-D055 or an equivalent suitable holding tool.
 SST303-642	special service tool SST 303-642

1. Raise and support the vehicle. For additional information, refer to section 100-02 of the 2008.0 Falcon Workshop Manual.
2. Disconnect the battery ground cable. For additional information, refer to section 414-01 of the 2008.0 Falcon Workshop Manual.
3. Remove the cooling fan motor and shroud assembly. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
4. Remove the accessory drive belt. For additional information, refer to section 303-05A of the 2008.0 Falcon Workshop Manual.
5. Remove the two idler pulleys retaining bolts and remove the idler pulleys.

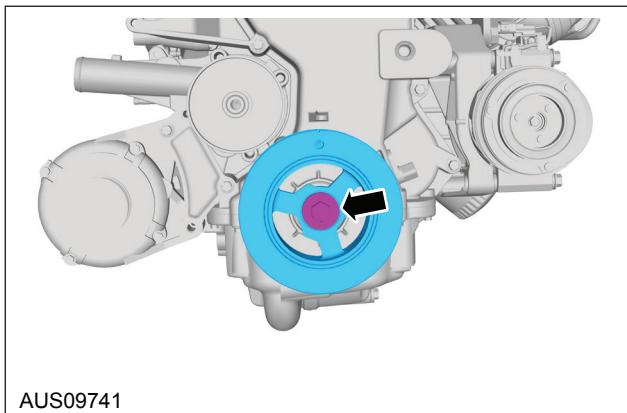


6. Remove the accessory drive belt tensioner pulley retaining bolt and the tensioner pulley.



7. Remove the crankshaft pulley retaining bolt and washer.

- Install the special service tool 303-D055 or equivalent to hold the crankshaft pulley.



8. Install the special service tool SST 303-642 to remove the crankshaft pulley.

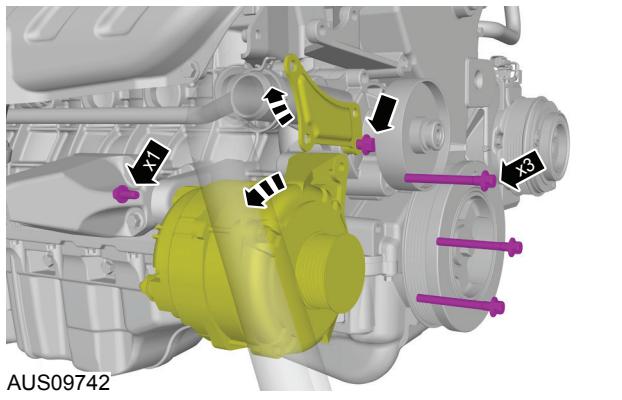
9. Clean the sealant (silastic) from the crankshaft key way and crankshaft pulley.



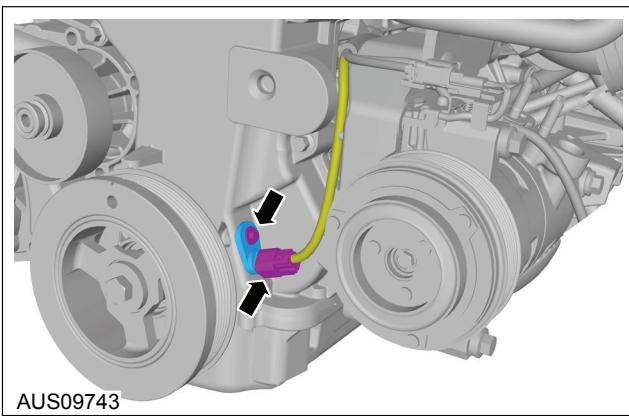
## IN-VEHICLE REPAIR (Continued)

10. Reposition the alternator.

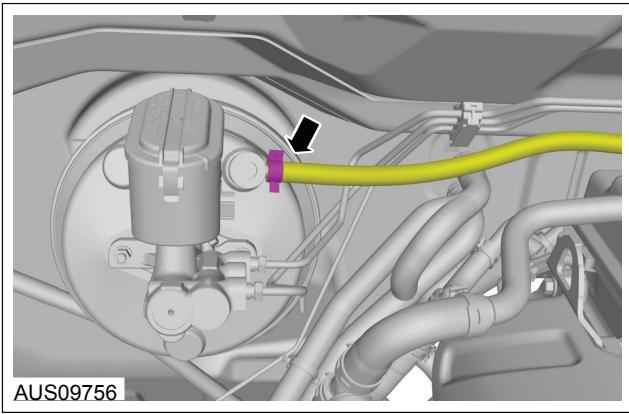
- Remove the alternator retaining bolts x3.
- Loosen the water pump to alternator bracket retaining bolt and position the bracket aside
- Remove the rear alternator mounting bolt x1 and position aside the alternator.



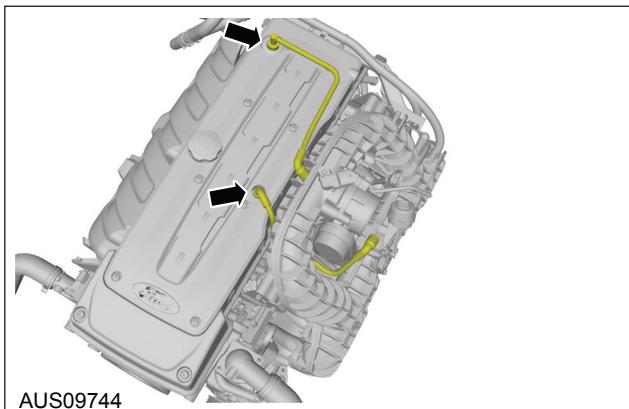
11. Disconnect the crankshaft sensor electrical connector and remove the crankshaft sensor.



12. Disconnect the vacuum hose from the brake booster.

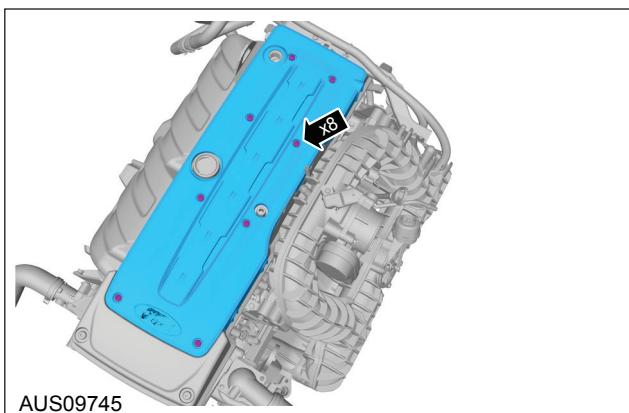


13. Disconnect the PCV and engine breather hoses x2.

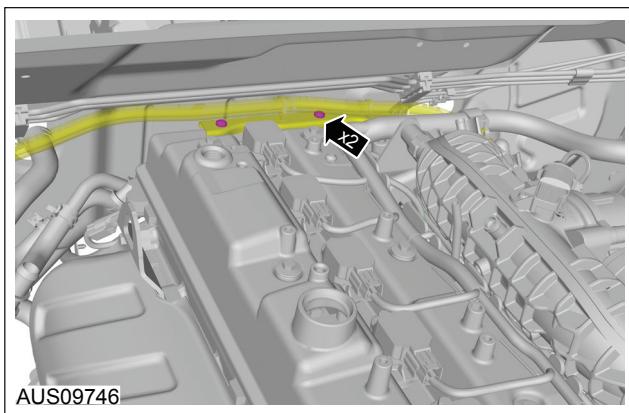


14. Remove the engine oil filler cap.

15. Remove the ignition coil cover retaining torque screws x8.



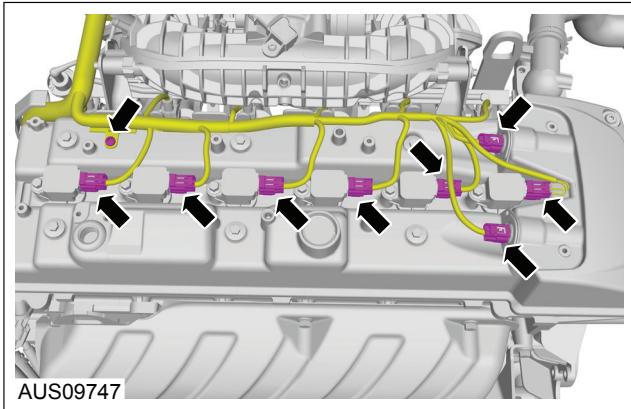
16. Remove the brake booster vacuum hose bracket retaining screws x2 and re-position the bracket and hose.



## IN-VEHICLE REPAIR (Continued)

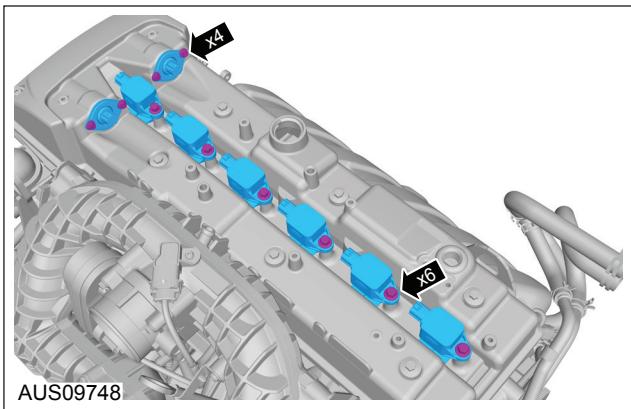
17. Remove the ignition coil and VCT solenoid wiring harness.

- Remove the wiring harness retaining screw x1.
- Disconnect the VCT solenoid electrical connectors x2.
- Disconnect the ignition coil electrical connectors x6.

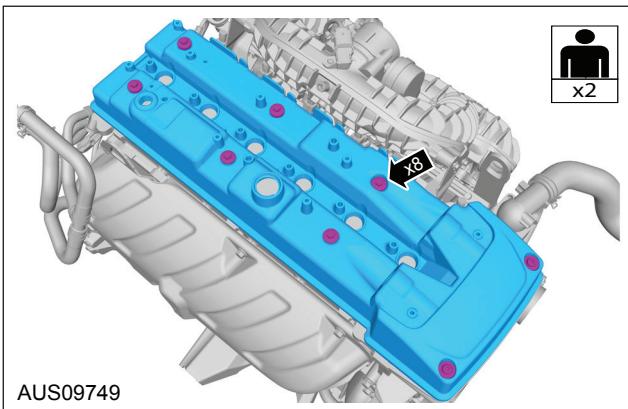


18. Remove the ignition coil and VCT solenoids.

- Remove the ignition coil retaining bolts x6 and remove the ignition coils.
- Remove the VCT solenoid retaining bolts x4 and remove the VCT solenoids with retainers.

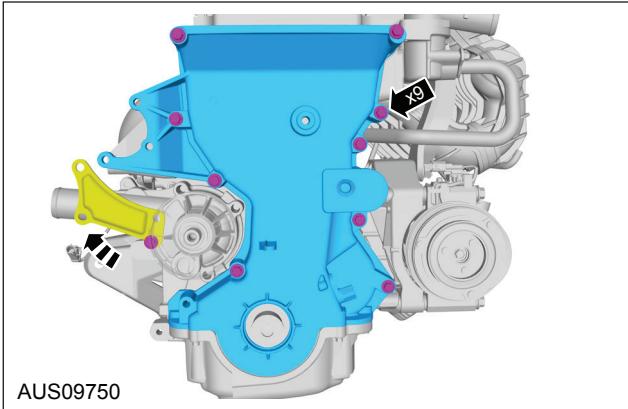


19. Remove the valve cover fasteners and remove the valve cover.



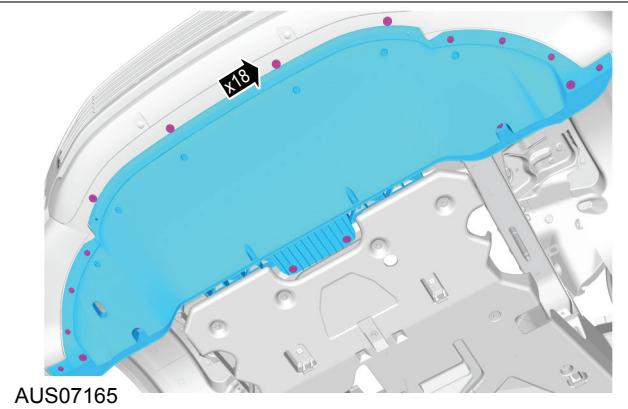
20. Clean the valve cover and the cylinder head surface.

21. Remove the front cover retaining bolts x9



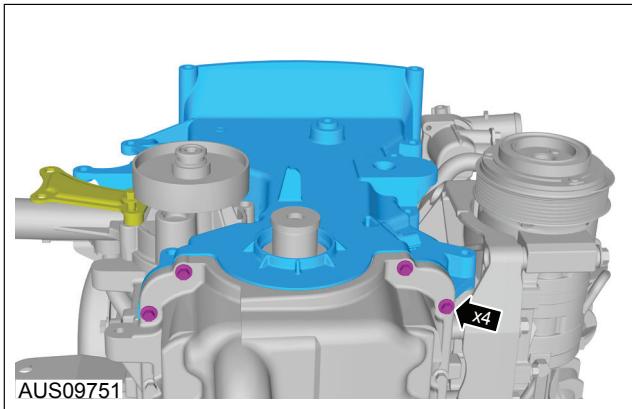
22. Raise the vehicle.

23. Remove the air deflector retaining screws x18 and remove the air deflector.



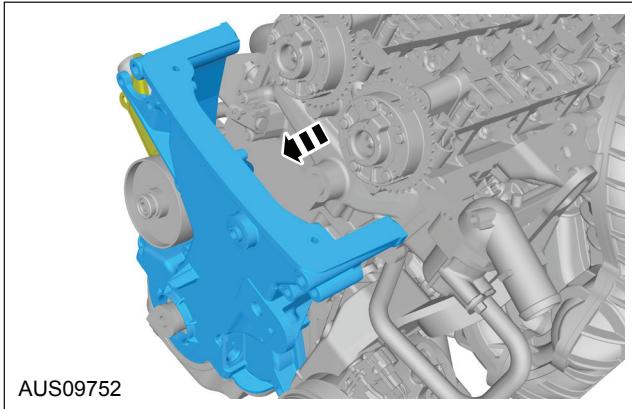
## IN-VEHICLE REPAIR (Continued)

24. Remove the front sump retaining bolts x4.



25. Lower the vehicle.

26. Carefully separate the engine front cover from the block.



### CAUTION

Place suitable covering to exposed internal engine components. (To avoid foreign debris entering into the engine while cleaning the front cover to the engine block area).

27. Remove the front cover dowels x2 from the front cover.



### Inspection

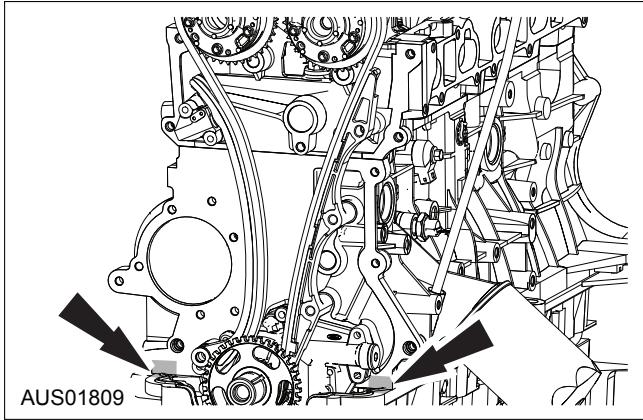
- Remove any sealant from the front cover to the block surface and the front cover to the oil pan surface.
- Check the condition of the oil pan, front cover to block and crankshaft rotary seals and replace if required.
- Ensure the joint surfaces are clean and free of oil.



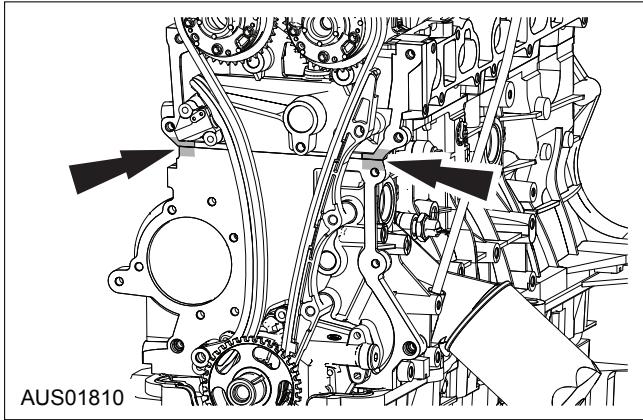
## IN-VEHICLE REPAIR (Continued)

### Installation

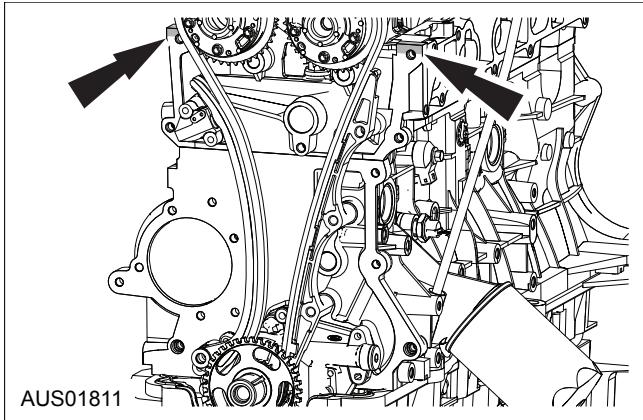
1. Apply a small bead of Loctite 5900 to the oil pan to block the front cover joint in 2 places as shown.



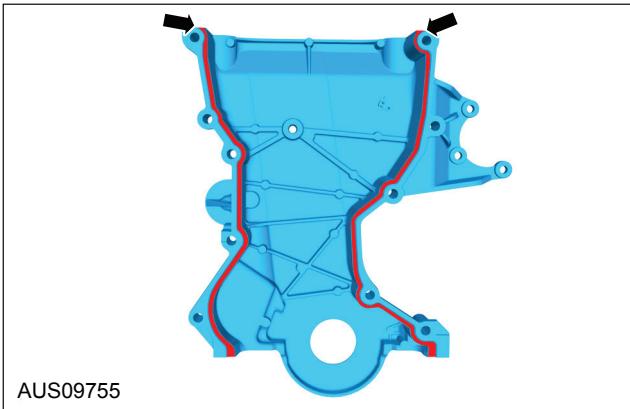
2. Apply a small bead of Loctite 5900 to the front face joint between the cylinder head and cylinder block in 2 places as shown.



3. Apply a small bead of Loctite 5900 to the front face joint between the cylinder head and cylinder block in 2 places as shown.



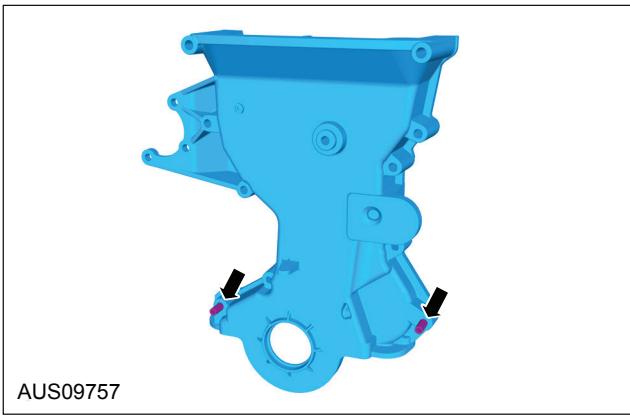
4. Apply a continuous bead of Loctite 5900 around the front cover at top of ridge, not bottom.



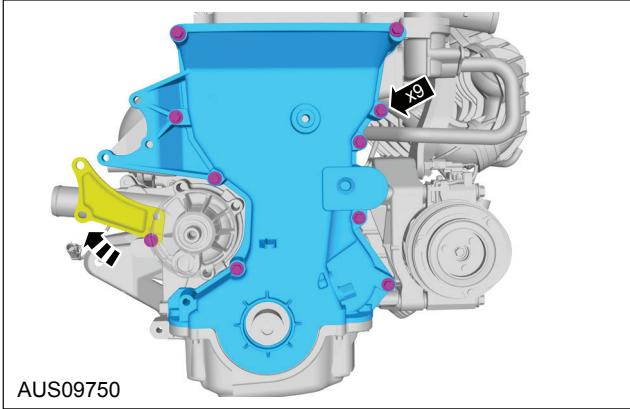
### CAUTION

**!** Place the front cover against the cylinder block, using two cross head type screwdrivers or similar through two bolt holes in the front cover and into the cylinder head to position the front cover.

5. Fit the two lower dowels into the front cover and into the cylinder block.

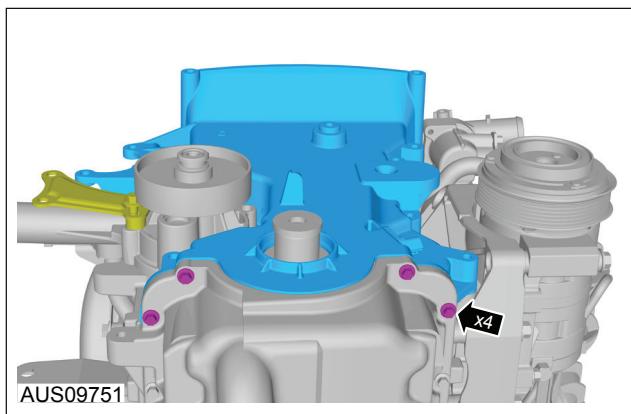


6. Insert the retaining bolts and apply thread sealant into the front cover to hold it in position, tighten the front cover retaining bolts x9 to 28 Nm.

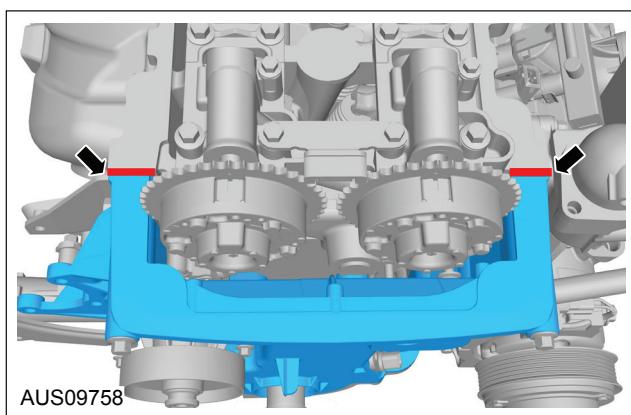


## IN-VEHICLE REPAIR (Continued)

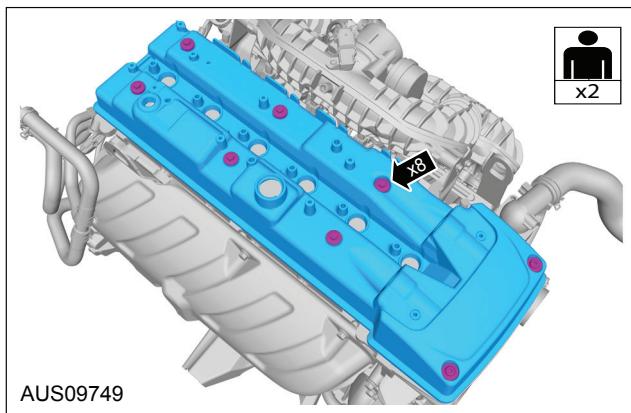
7. Raise the vehicle
8. Install the front sump retaining bolts x4.



9. Lower the vehicle
10. Replace the valve cover gasket and sparkplug seals.
11. Apply Loctite 5900 to the front cover to the block area.

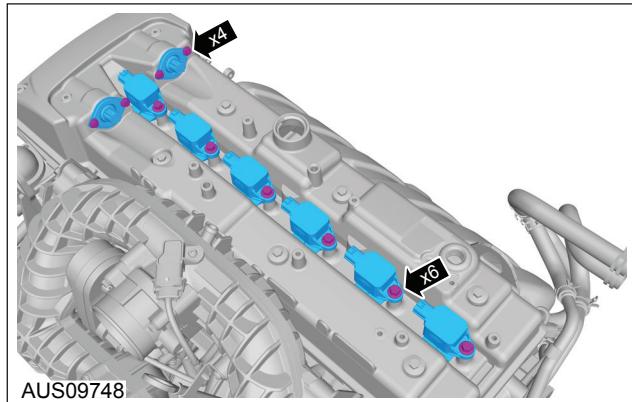


12. Install the valve cover.
- Loosely start all the valve cover fasteners.
- Inspect the valve cover gasket for correct fitment.
- Tighten the valve cover fasteners.



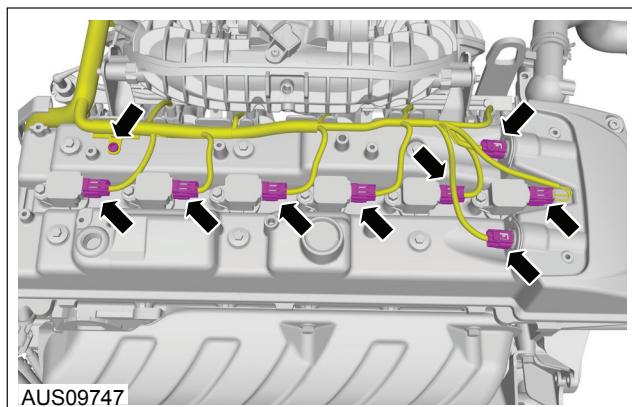
13. Install the ignition coil and the VCT solenoids.

- Install the ignition coil and tighten the retaining bolts x6.
- Install the VCT solenoid and tighten the retaining bolts x4.



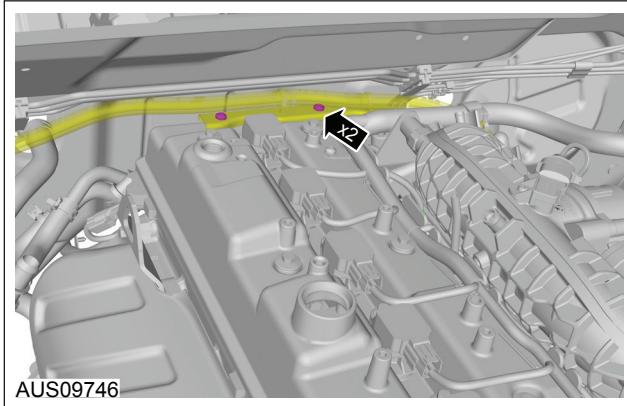
14. Install the ignition coil and the VCT solenoid wiring harness.

- Connect the ignition coil electrical connectors x6.
- Connect the VCT solenoid electrical connectors x2.
- Install the harness retaining screw x1 and tighten.

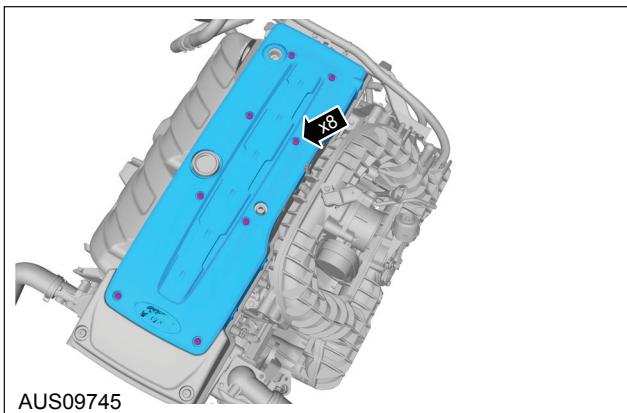


## IN-VEHICLE REPAIR (Continued)

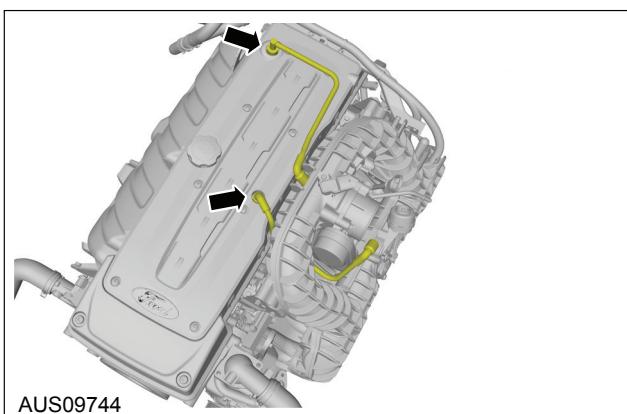
15. Position the bracket and the vacuum supply hose back to the original place and install the brake booster vacuum hose bracket retaining screws x2 and tighten.



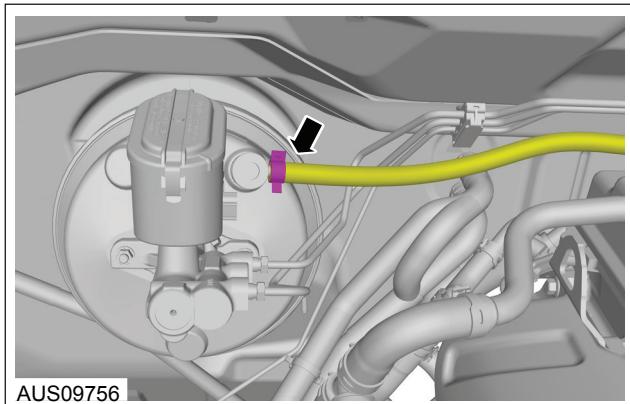
16. Install the coil cover and tighten the retaining torque screws x8



17. Connect the PCV and the engine breather hoses x2

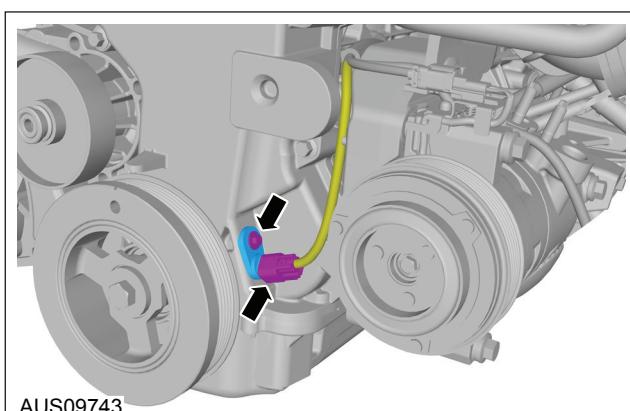


18. Connect the vacuum supply hose to the brake booster.



19. Install the crankshaft sensor.

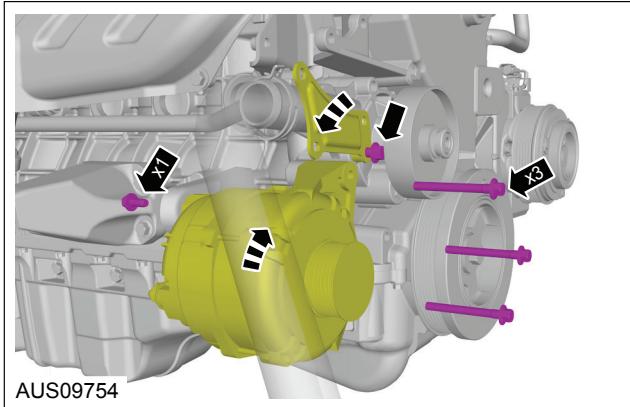
- Install the crankshaft sensor retaining bolt x1 and tighten.
- Connect the crankshaft electrical connector.



## IN-VEHICLE REPAIR (Continued)

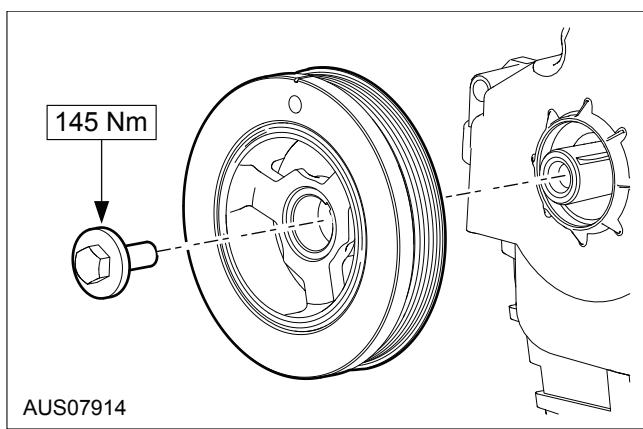
20. Position the alternator back to original place.

- Position the alternator to original place and loosely install the alternator retaining x3.
- Loosely install the rear alternator mounting bolt x1.
- Position the water pump to alternator bracket to original position.
- Tighten all the retaining bolts.

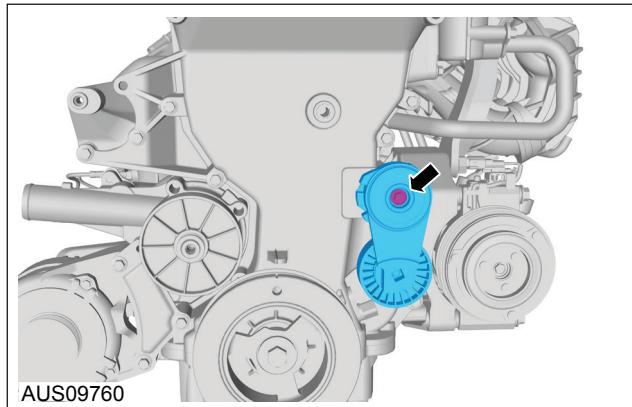


21. Position the harmonic balancer onto the crankshaft and install the special service tool 303-D055 or equivalent to hold the crankshaft pulley.

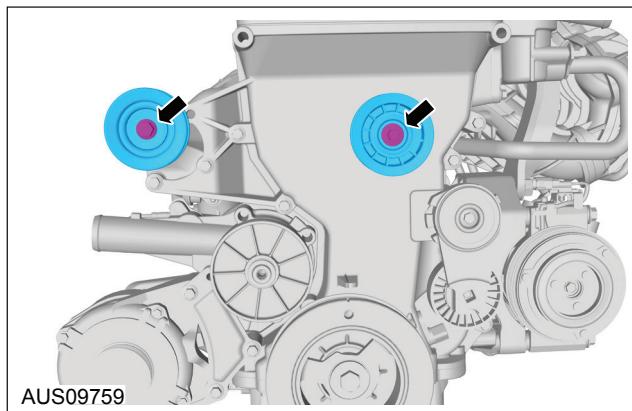
- Apply sealant to the harmonic balancer and to the crankshaft key way.
- Install the harmonic balancer retaining bolt x1.
- Torque the bolt to the specification.



22. Install the drive belt tensioner and tighten the retaining bolt to the specifications.



23. Install the two idler pulleys and tighten the retaining bolts to the specifications.



24. Install the accessory drive belt. For additional information, refer to section 303-05A of the 2008.0 Falcon Workshop Manual.

25. Install the engine cooling fan motor and shroud assembly. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.

26. Check engine oil level, top up as required.

27. Connect the battery. For additional information, refer to section 414-01 of the 2008.0 Falcon Workshop Manual.

### CAUTION

**Allow 2 hours for sealant to cure**

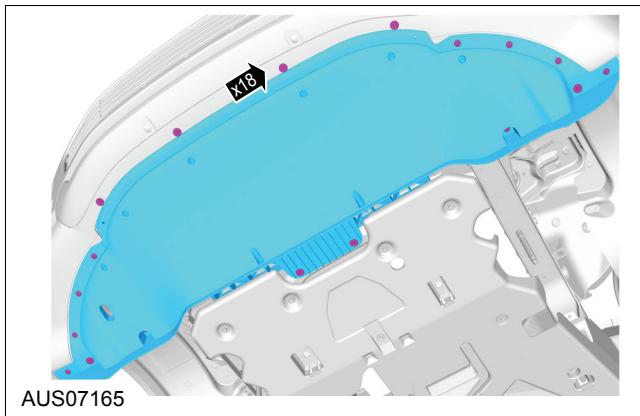
28. Start the engine.

29. Raise the vehicle.



**IN-VEHICLE REPAIR (Continued)**

30. Inspect the engine for oil leaks.
31. Install the air deflector shield x18 screws.

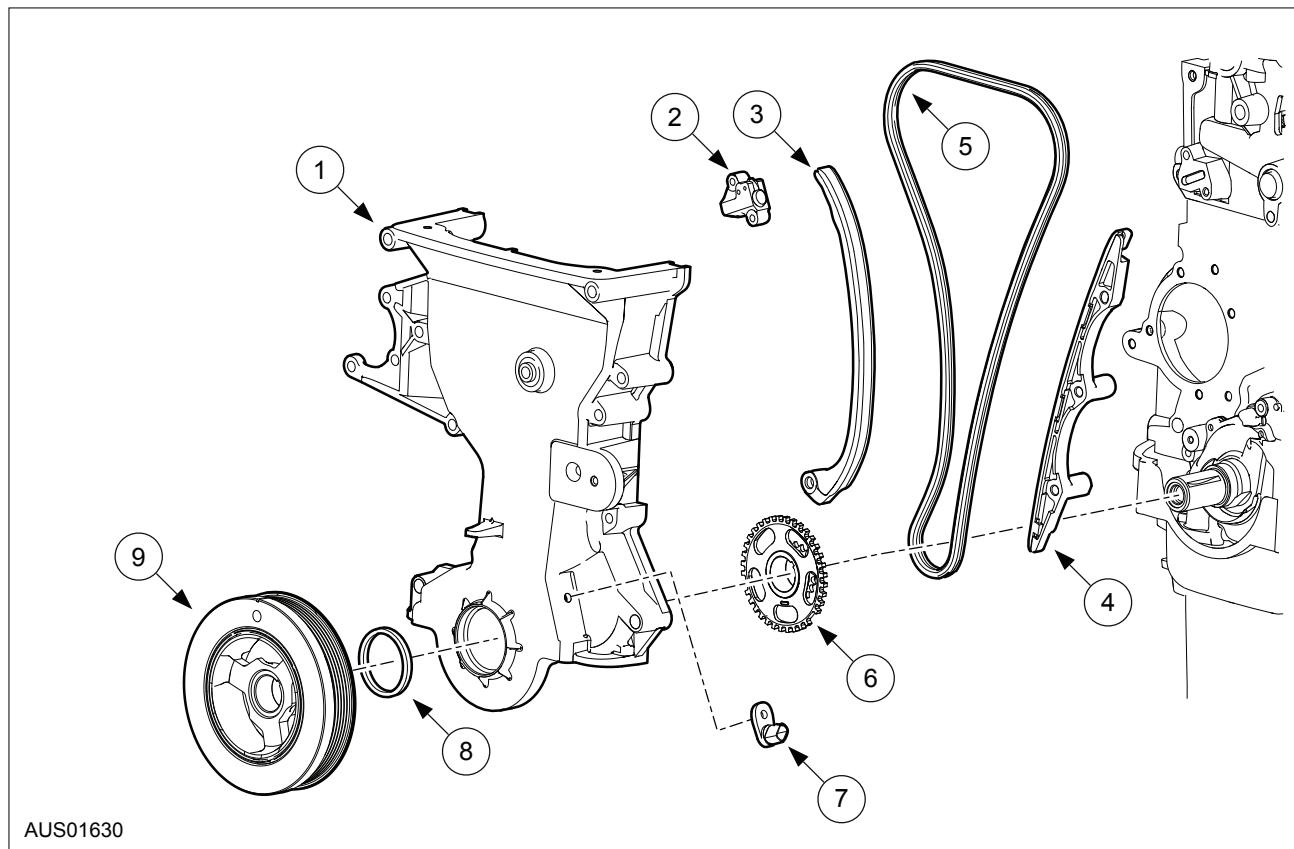


32. Lower the vehicle.



## IN-VEHICLE REPAIR (Continued)

### Camshaft Drive



Item	Description
1	Front cover
2	Gasket - Front cover
3	Tensioner assembly timing chain
4	Timing chain guide tension
5	Timing chain guide fixed
6	Timing chain
7	Crankshaft tone wheel
8	Crankshaft sensor
9	Front seal
10	Crankshaft vibration damper

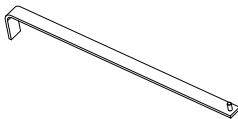
#### Removal

1. Remove the front cover. For additional information, refer the Front Cover procedure in this section.
2. Remove the tensioner. For additional information, refer the Tensioner procedure in this section.
3. Remove the timing chain.
4. Remove the crank sprocket/timing wheel.
5. Remove the moving chain guide.
6. Remove the fixed chain guide.
7. Remove the chain guide (top run).



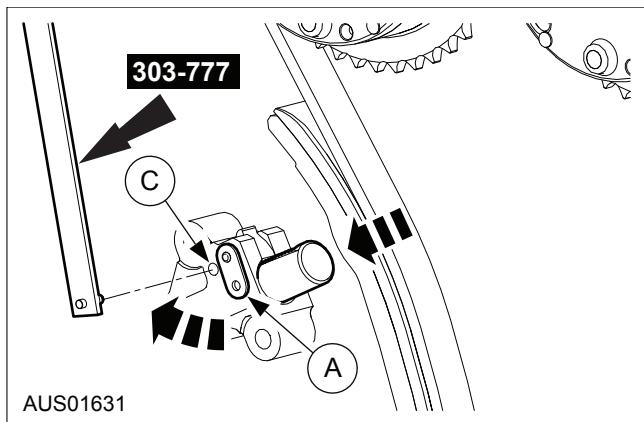
## IN-VEHICLE REPAIR (Continued)

### Timing Chain Tensioner Release

Special Tool(s)	
 SST303-777	Timing chain tensioner special service tool 303-777

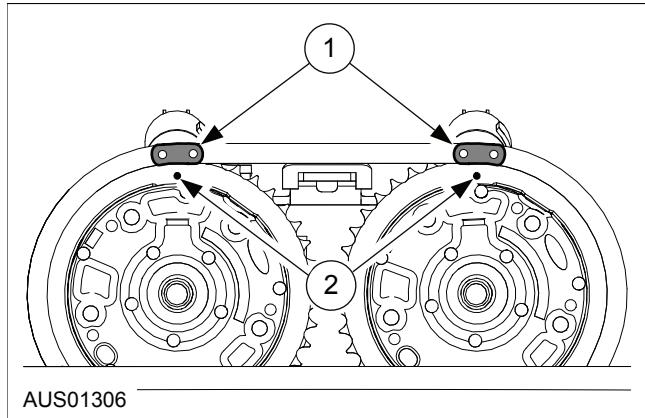
#### Removal

1. Rotate Lever A anti clockwise by engaging pin of SST 303-777 into hole in lever.
2. Push in plunger until 3-4mm is visible.
3. Release load from Lever A so ratchet teeth engage with 1st teeth on plunger.
4. Push in plunger slightly so hole in A aligns with hole C and is locked with SST.



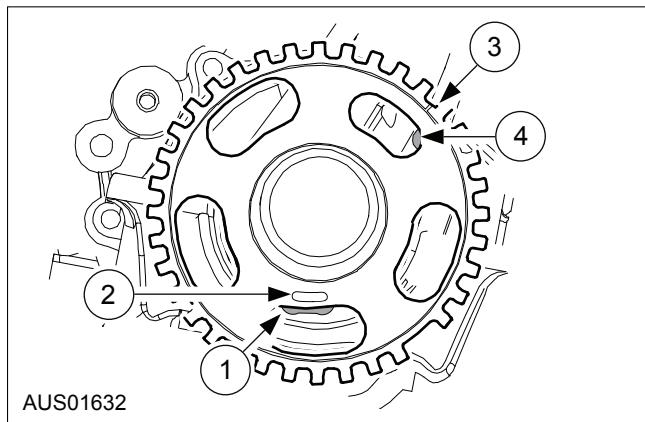
#### Installation

1. Set the crankshaft position to Top Dead Centre: Cylinder #1 Firing (both VCT phaser timing marks vertically upwards).



Item	Description
1	Yellow links
2	Timing dot on VCT

2. Align yellow link at 6 o'clock with its position indicator. Align orange link at 1 o'clock with the timing indicator on tone wheel. The orange link should be half visible within the tone wheel cut away hole.



Item	Description
1	Yellow link
2	Yellow link position indicator
3	Timing indent on tone wheel
4	Orange link

3. Remove the SST 303-777 to release the tensioner.
4. Rotate crankshaft back and forwards to check that the slack is removed from chain.
5. Reverse removal procedure for camshaft drive components.

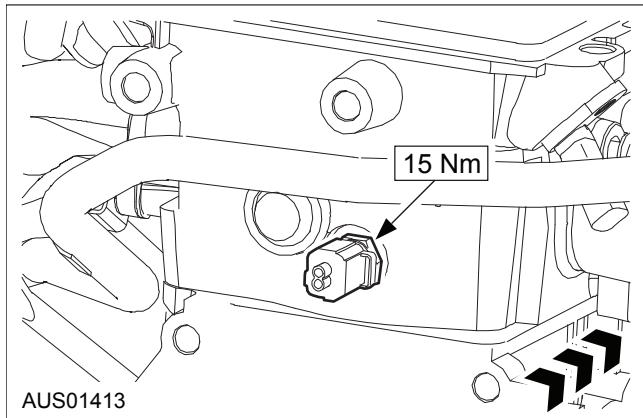


## IN-VEHICLE REPAIR (Continued)

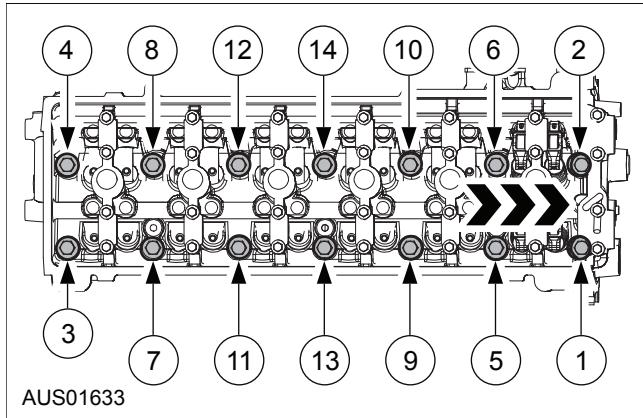
### Cylinder Head

#### Removal

1. Remove the radiator cooling fan assembly. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
2. Remove the radiator. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
3. Remove the valve cover. For additional information, refer to Valve Cover procedure in this section.
4. Remove timing chain.
5. Remove camshafts. For additional information, refer to camshafts procedure in this section.
6. Remove intake manifold. For additional information, refer to Intake Manifold procedure in this section.
7. Remove exhaust manifold. For additional information, refer to exhaust manifold procedure in this section.
8. Disconnect the Cylinder Head Temperature Sensor, and two camshaft position sensors from rear of cylinder head.



9. Loosen the cylinder head bolts in the sequence shown.

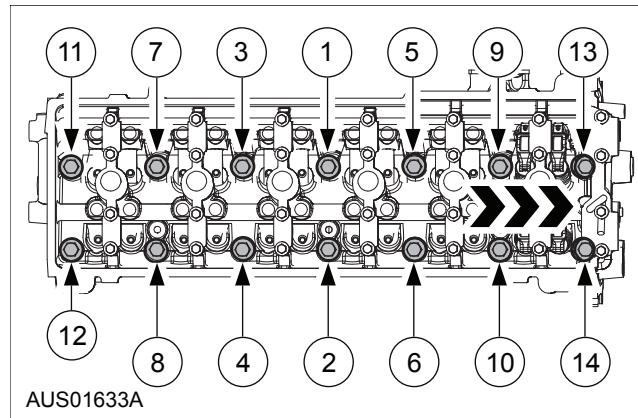


#### Installation

1. Ensure all joint surfaces are clean and free of oil and grease.

**Note:** A new cylinder head gasket must be used.

2. Lightly lubricate the bolt threads and washer surfaces with engine oil.
3. Rundown all bolts to 30 Nm in the tightening sequence shown.



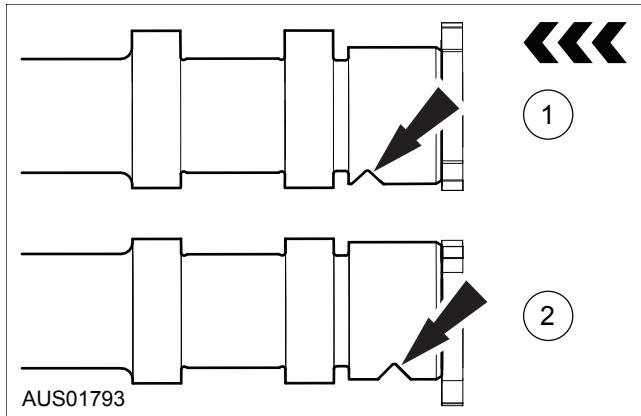
4. Tighten all bolts to 90 Nm in the tightening sequence shown.
5. Back off all bolts until loose, using the bolt loosening sequence. For additional information, refer Cylinder Head-Removal procedure in this section.
6. Tighten inner bolts (#1 to #10) to 40 Nm using the tightening sequence shown.
7. Tighten outer bolts (#11 to #14) to 30 Nm using the tightening sequence shown.
8. Rotate bolts (#1 to #10) an additional  $120^\circ \pm 5^\circ$  using the tightening sequence shown.
9. Rotate bolts (#11 to #14) an additional  $90^\circ \pm 5^\circ$  using the tightening sequence shown.



## IN-VEHICLE REPAIR (Continued)

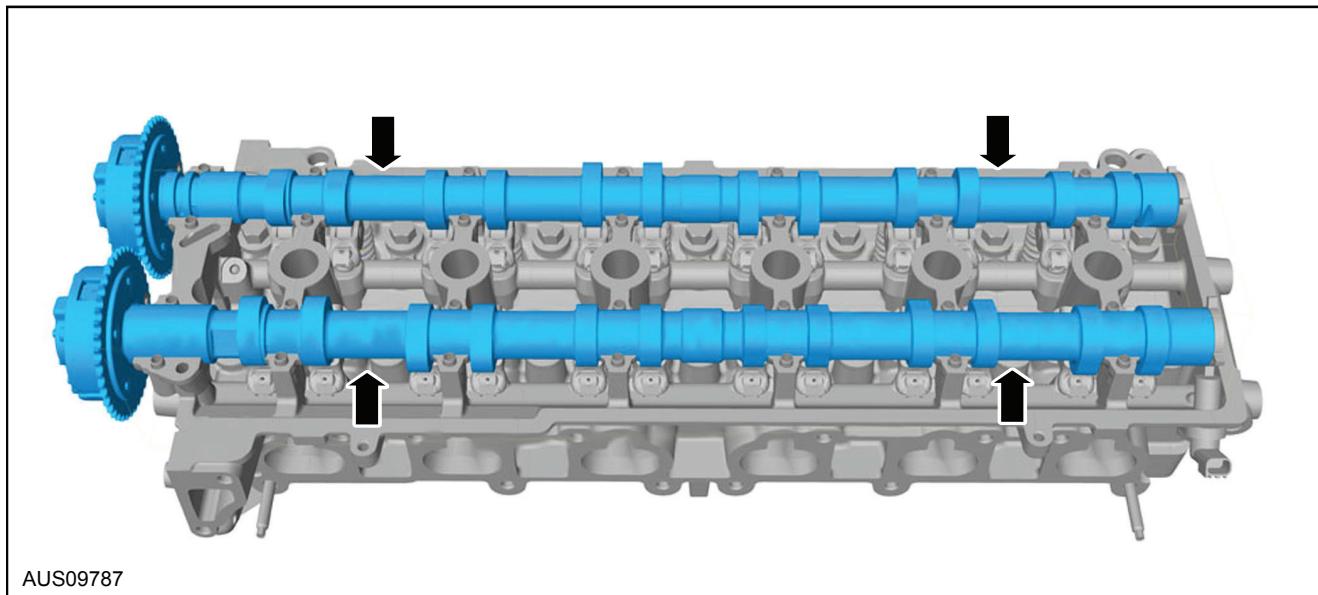
10. Lubricate the head-cam bearing surfaces with engine oil.

**Note:** Use the following illustration to identify the Exhaust and Inlet camshafts.



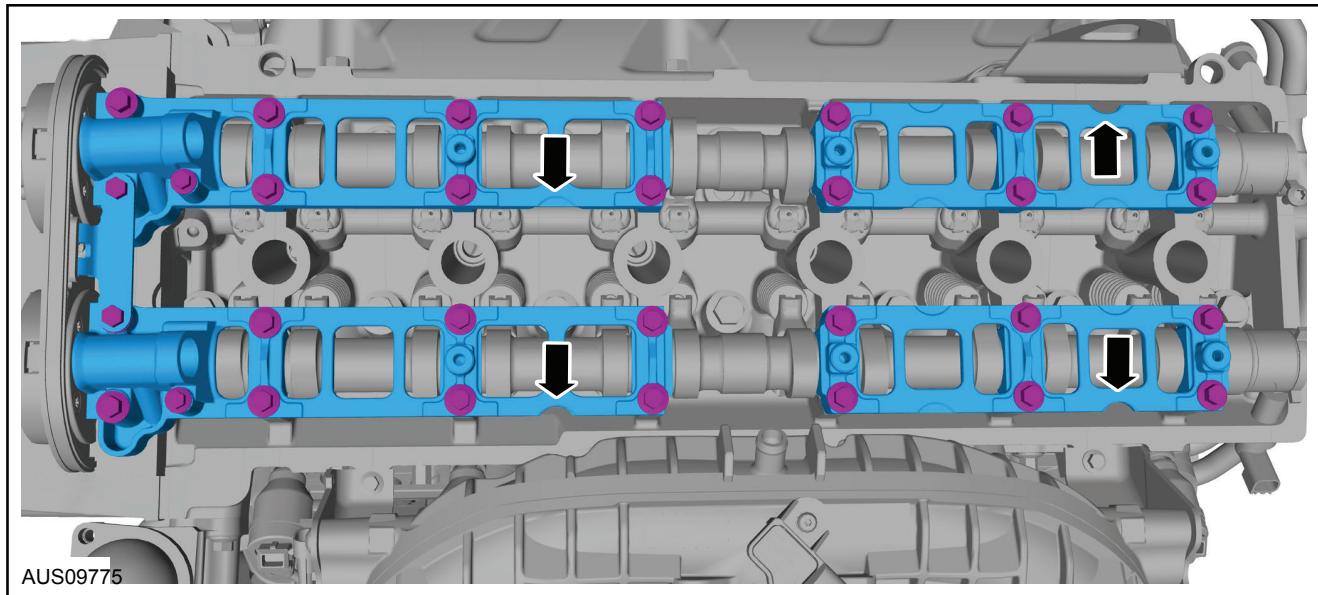
Item	Description
1	Exhaust
2	Inlet

1. Install the camshafts.

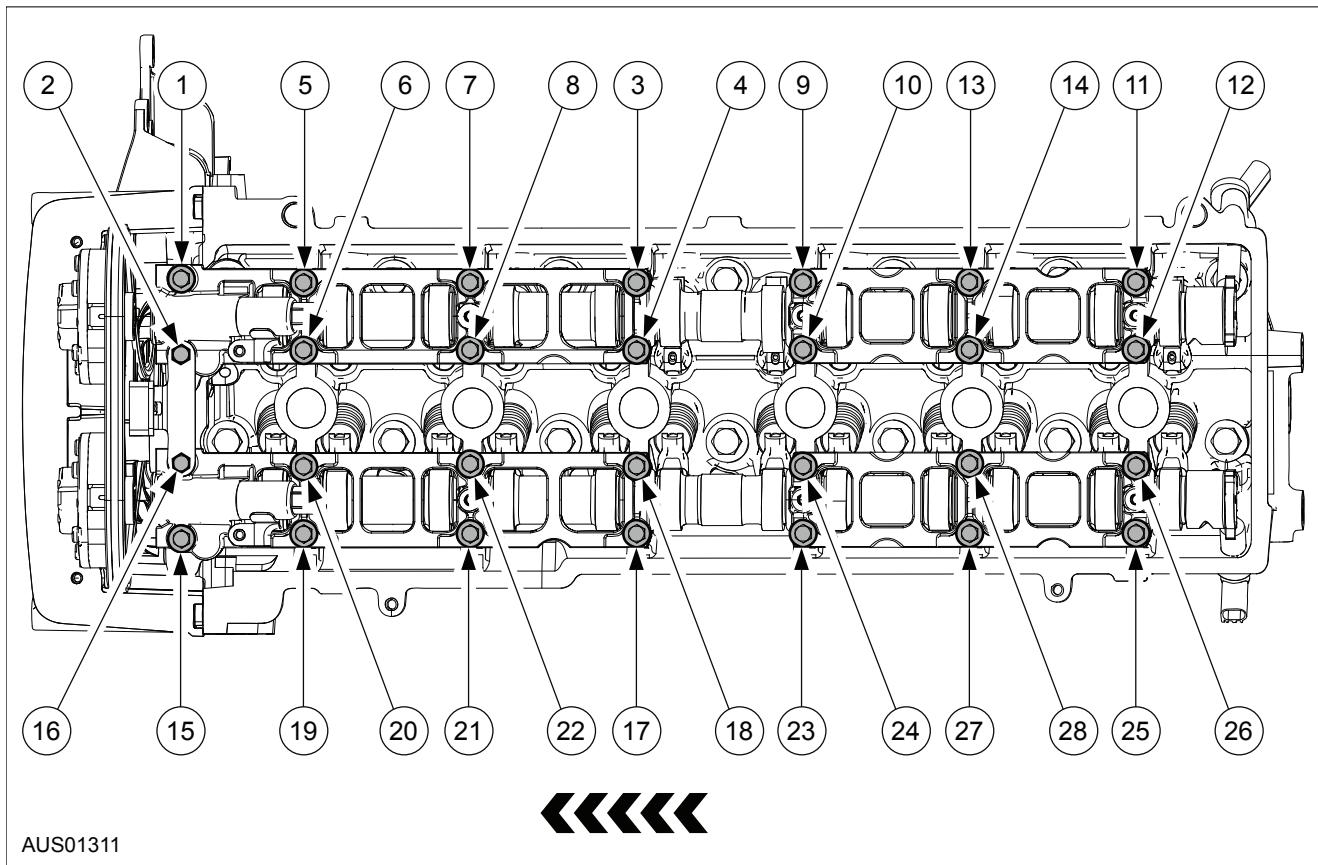


## IN-VEHICLE REPAIR (Continued)

**Note:** Install the camshaft caps as per the illustration shown below, failure to follow instructions may result in damage to the engine.



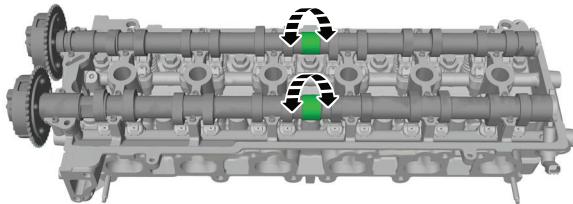
2. Tighten the camshaft cap retaining bolts two turns at a time in the order shown below.



3. Using a suitable tool rotate the camshafts to align the timing dot on the VCT phasers (both camshafts at the 12 o'clock position).

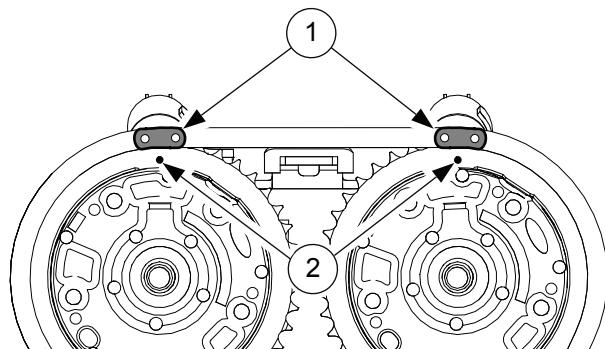


## IN-VEHICLE REPAIR (Continued)



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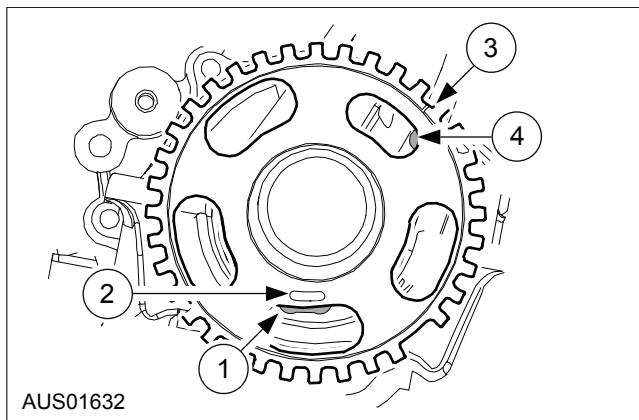
4. Install the timing chain.



AUS01306

Item	Description
1	Yellow links
2	Timing dot on VCT

5. Align yellow link at 6 o'clock with its position indicator. Align orange link at 1 o'clock with the timing indicator on tone wheel. The orange link should be half visible within the tone wheel cut away hole.

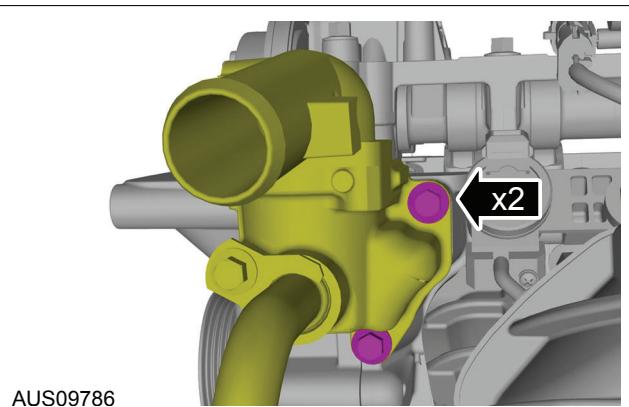


6. Remove the SST 303-777 to release the tensioner.  
7. Rotate the crankshaft to check that the slack is removed from the chain.

8. Recheck all the timing marks.
9. Install the front engine cover. For additional information, refer to the Front Engine Cover removal and installation procedure in this section.
10. Install the valve cover. For additional information, refer to the Valve Cover removal and installation procedure in this section.
11. Install the exhaust manifold. For additional information, refer to the exhaust manifold removal and installation procedure in this section.
12. Install the inlet manifold.
13. Install the electronic throttle body. For additional information, refer to the Electronic Throttle Body removal and installation procedure in this section.
14. Install the air cleaner body. For additional information, refer to section: 303-12 Intake Air Distribution and Filtering of the 2008.0 FG Falcon Workshop Manual.

**Note:** Install a new thermostat housing gasket.

15. Install the thermostat housing to the cylinder head x2 retaining bolts.



AUS09786

16. Install the air deflector retaining screws x18.
17. Install the radiator cooling fan assembly. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
18. Connect the battery. For additional information, refer to section 414-01 of the 2008.0 Falcon Workshop Manual.
19. Check the engine oil level, top up engine oil level as required.
20. Fill and bleed the cooling system For additional information, refer to section: 303-03A Engine Cooling of the 2008.0 FG Falcon Workshop Manual.

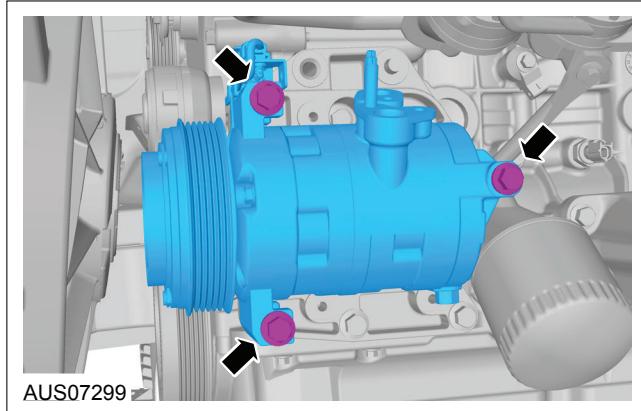


## IN-VEHICLE REPAIR (Continued)

### Engine

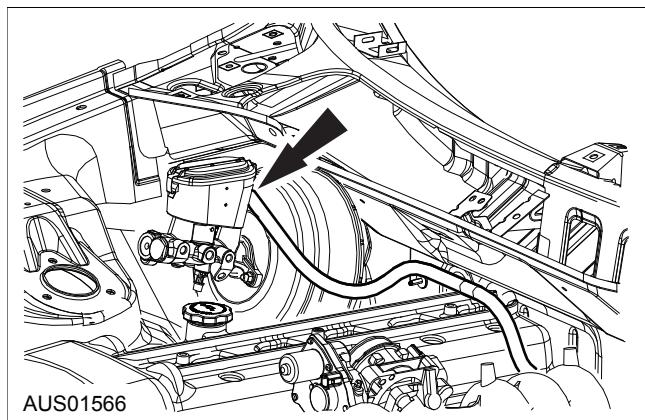
#### Removal

1. Disconnect Hood struts and securely tie back Engine Hood, or remove bonnet.
2. Recover the A/C gas. For additional information, refer to Section 412-03 of the 2008.0 Falcon Workshop Manual.
3. Disconnect battery leads and remove battery. For additional information, refer to section 414-01 of the 2008.0 Falcon Workshop Manual.
4. Remove Air Cleaner assembly and induction tubes. For additional information, refer to section 303-12A of the 2008.0 Falcon Workshop Manual.
5. Raise the vehicle. For additional information, refer to section 100-02 of the 2008.0 Falcon Workshop Manual.
6. Drain engine coolant from radiator tap. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
7. Remove the radiator and cooling fan assembly. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
8. Remove the A/C condensor. For additional information, refer to section 412-03A of the 2008.0 Falcon Workshop Manual.
9. Remove the intake manifold tuning valve (IMTV) vacuum hose.
10. Detach the vacuum reservoir supply hose.
11. Detach the activated charcoal canister pipe connectors in the vicinity of the throttle body.
12. Disconnect the alternator positive supply, the alternator harness connector and harness retainer.
13. Detach 2 connectors on the LHS engine mounting.
14. Remove the 2 the air conditioning compressor hoses and disconnect the electronic connector. Do not remove the compressor.

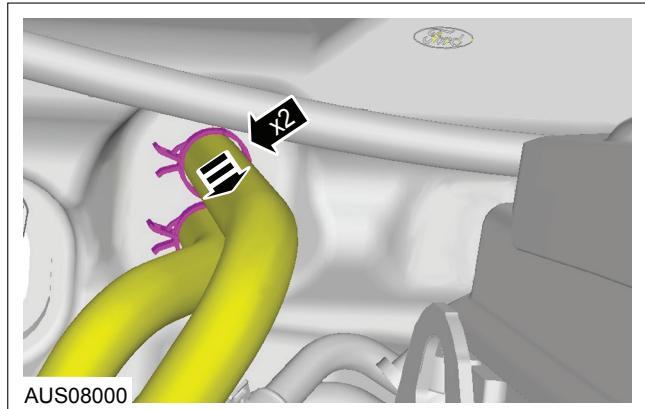


15. Disconnect vacuum hose from vacuum check

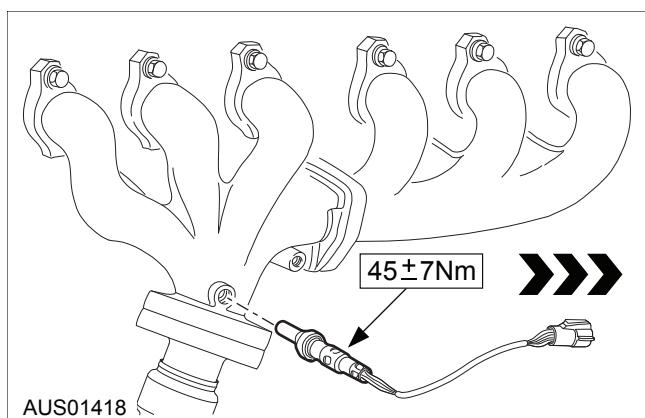
valve.



16. Detach the coolant pipes at the heater core inlet and outlet pipes at the firewall.



17. Remove PCM module. For additional information, refer to section 303-14A of the 2008.0 Falcon Workshop Manual.
18. Disconnect the Hego sensor electrical connector.

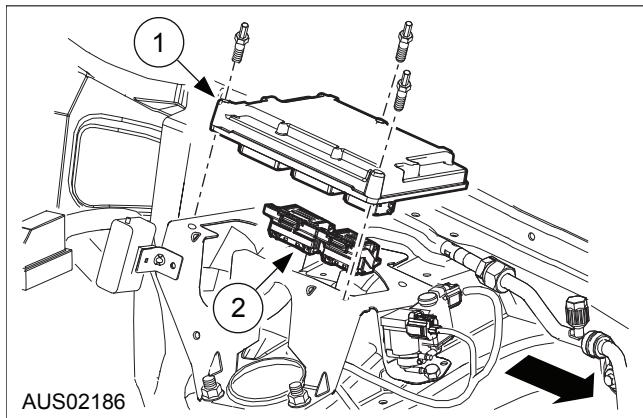


19. Disconnect the engine loom wiring plugs from



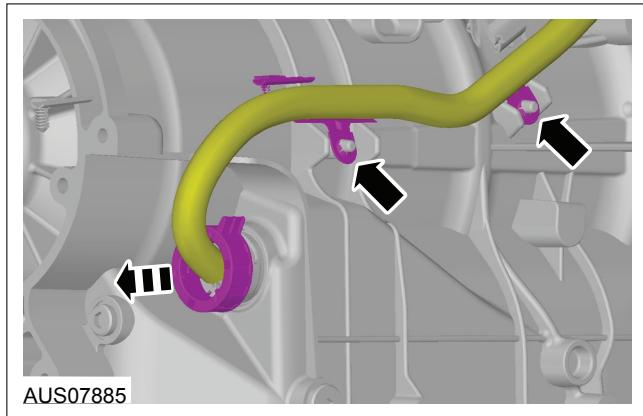
## IN-VEHICLE REPAIR (Continued)

the underside of PCM.

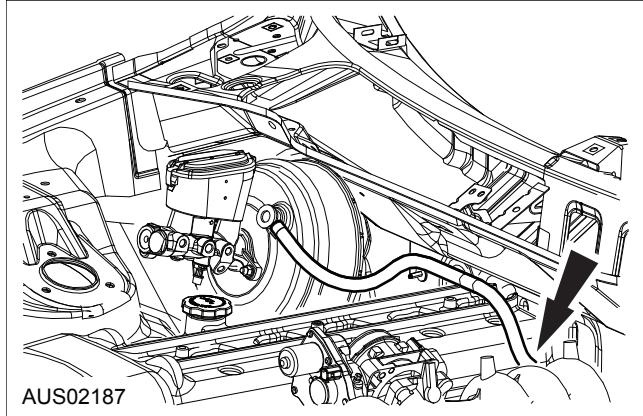


Item	Description
1	PCM Module
2	Engine electrical connectors

20. Detach transmission multiplug and transmission wiring harness retainers from the transmission.

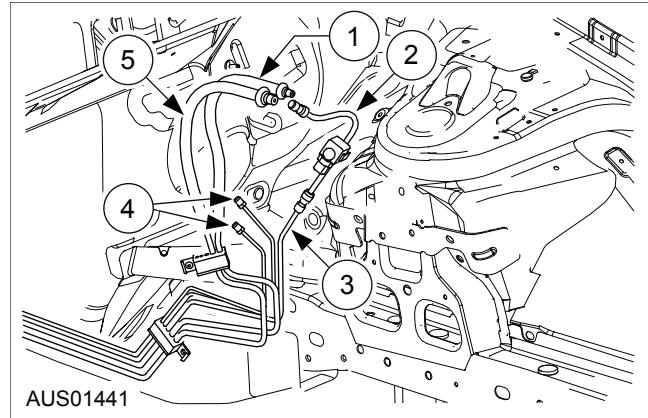


21. Disconnect vacuum hoses from intake manifold.



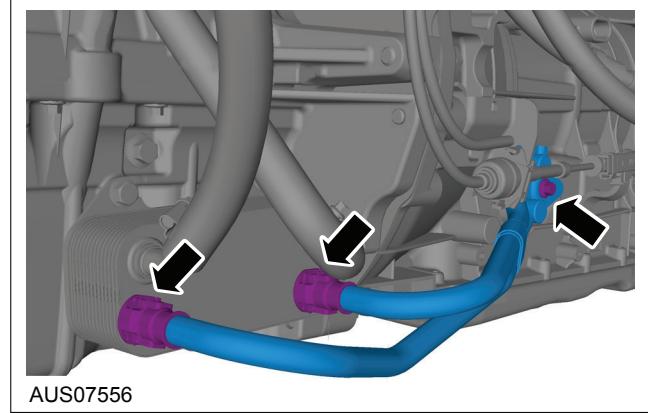
22. Disconnect Fuel lines at the quick release

connectors below left hand side of firewall.



Item	Description
1	Fuel Tube Supply
2	Fuel Vapour Hose
3	Fuel Tank to Vapour Hose
4	Rear Brake Lines
5	Fuel Tube Return

23. Remove the catalytic convertor. For additional information, refer to section 309-00A of the 2008.0 Falcon Workshop Manual.
24. Remove the starter motor. For additional information, refer to section 303-06A of the 2008.0 Falcon Workshop Manual.
25. Remove the 4 bolts from convertor to flexplate through the starter hole in the bell housing. For additional information, refer to section 307-01A of the 2008.0 Falcon Workshop Manual.
26. Remove the transmission to engine bolts. For additional information, refer to section 307-01A of the 2008.0 Falcon Workshop Manual.
27. Disconnect the transmission cooler pipes from the transmission cooler, located on the LHS of the engine oil sump.

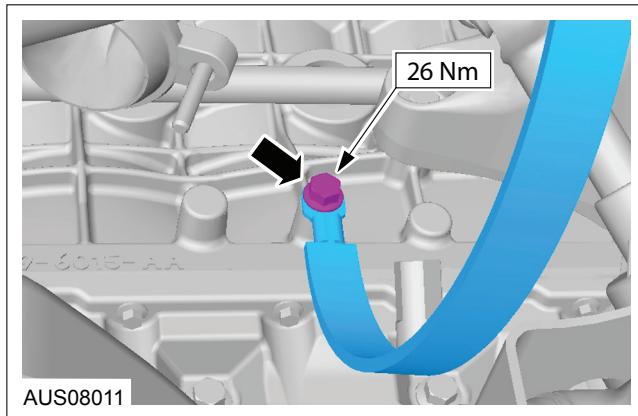


28. Remove the engine mounting to chassis nuts.
29. Remove the earth wiring cable from the RHS of

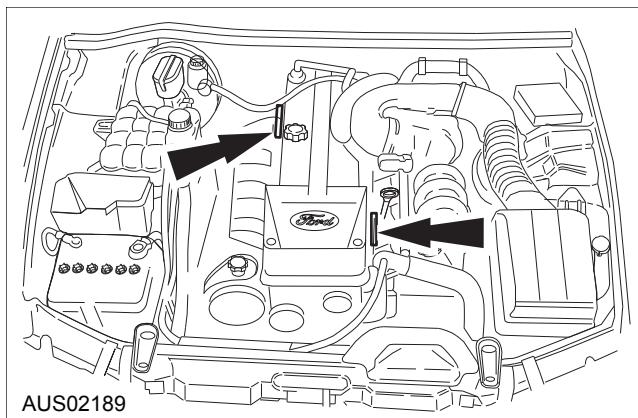


## IN-VEHICLE REPAIR (Continued)

the cylinder block.

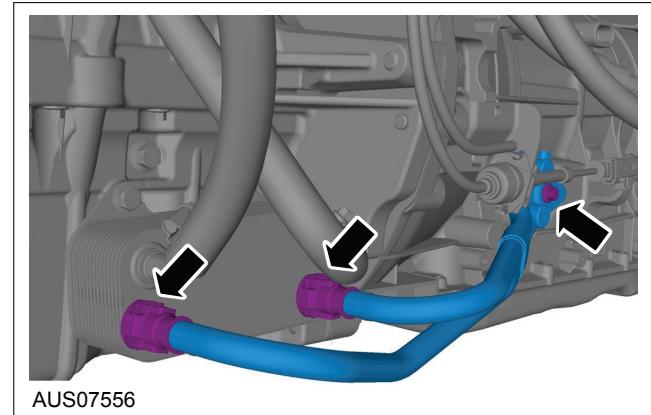


30. Install the special tool 'lifting eye'.
31. Install an appropriate lifting crane to the engine.
32. Connect suitable engine lifter to the lift brackets supplied and carefully remove engine assembly. On base models only, install front lifting eye and bolt to  $40\pm6$  Nm.



### Installation

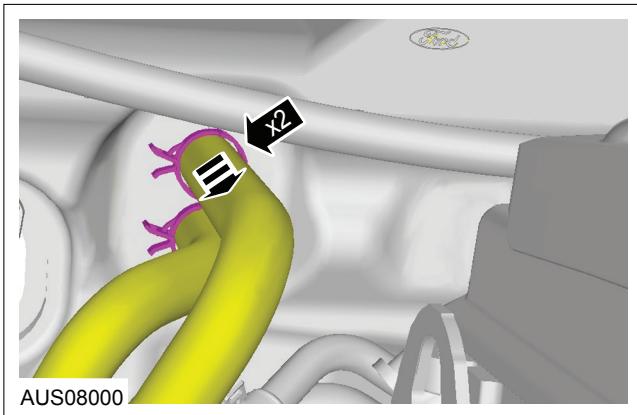
1. Install engine lifting crane.
2. Install the engine.
3. Install transmission to engine bolts. For additional information, refer to section 307-01A of the 2008.0 Falcon Workshop Manual.
4. Install engine mounting to chassis nuts.
5. Install the (4) torque converter to drive plate bolts through the starter motor opening in the bell housing. For additional information, refer to section 307-01A of the 2008.0 Falcon Workshop Manual.
6. Install the starter motor. For additional information, refer to section 303-06A of the 2008.0 Falcon Workshop Manual.
7. Install the catalytic converter. For additional information, refer to section 309-00A of the 2008.0 Falcon Workshop Manual.
8. Install the transmission multiplug and transmission wiring harness retainers to the transmission.
9. Install the earth wiring cable to the RHS of the cylinder block.
10. Connect the fuel lines at the quick release connectors below the LHS firewall.
11. Connect the transmission cooler pipes to the transmission cooler. Transmission cooler is located on the LHS of the engine oil sump. For additional information, refer to section 412-03 of the 2008.0 Falcon Workshop Manual.



12. Connect the Hego sensor electrical connector. (Hego sensor is located on the exhaust manifold).
13. Install the vacuum hose at the tandem booster.
14. Remove the special tool 'lifting eye'.
15. Install the coolant pipes at the heater core inlet and outlet pipes at the firewall.



## IN-VEHICLE REPAIR (Continued)



16. Install the PCM module. For additional information, refer to section 303-14A of the 2008.0 Falcon Workshop Manual.
17. Install the discharge and suction pipes at the A/C compressor. For additional information, refer to section 412-03 of the 2008.0 Falcon Workshop Manual.
18. Install the two harness retainers on the LHS engine mounting.
19. Connect the alternator positive supply, the alternator harness connector and harness retainer.
20. Attach the intake manifold tuning valve (IMTV) vacuum hose.
21. Attach the activated charcoal canister pipe connector in the vicinity of the throttle body.
22. Attach the vacuum reservoir supply hose.
23. Install the A/C condenser. For additional information, refer to section 412-03 of the 2008.0 Falcon Workshop Manual.
24. Install the radiator and cooling fan assembly. For additional information, refer to section 303-03A of the 2008.0 Falcon Workshop Manual.
25. Fill the engine coolant system. For additional information, refer to Section 303-03A of the 2008.0 Falcon Workshop Manual.
26. Install the air induction pipes with the air cleaner assembly. For additional information, refer to section 303-12A of the 2008.0 Falcon Workshop Manual.
27. Install the battery. For additional information, refer to section 414-01 of the 2008.0 Falcon Workshop Manual.
28. Fill the A/C system. For additional information, refer to section 412-03 of the 2008.0 Falcon Workshop Manual.
29. Install the engine hood and attach the hood struts.



## IN-VEHICLE REPAIR (Continued)

### Engine Mounting

- Mount the engine on an engine rollover stand.

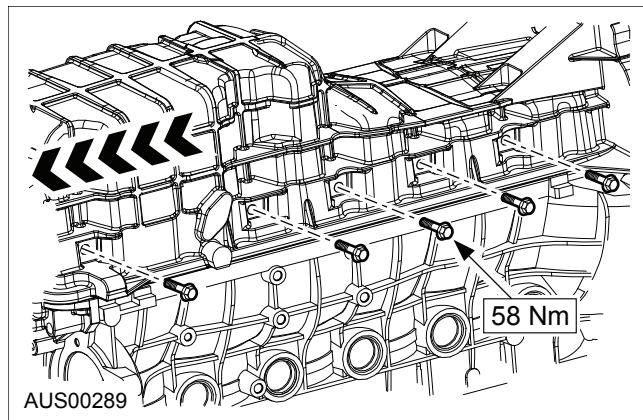
#### WARNING

 Self-locking brake system of the engine stand may not be effective when the engine is held in an unbalanced position. This could lead to sudden, rapid movement of the engine and mounting stand handle and cause serious injury. Never keep the engine in an unbalanced position, and always hold the rotating handle firmly when turning the engine.

### Engine Oil Pan

#### Removal

- Raise the vehicle. For additional information, refer to section 100-02 of the 2008.0 Falcon Workshop Manual.
- Remove the main bearing cross bolts.



**Note:** There are 5 main bearing cross bolts on the right hand side and 4 on the left hand side of the oil pan.

- Remove the oil pan flange bolts.

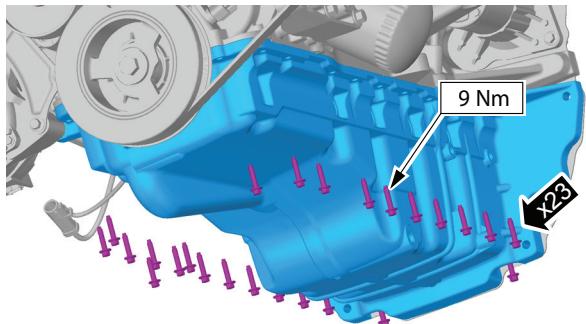
**Note:** The 23 oil pan flange bolts are slightly longer than the bearing cross bolts. Store them separately when removed.

**Note:** Only 12 right hand side pan flange bolts are shown. There are a further 11 on left hand side.

- Remove the oil pan seal. To do so use a suitable tool to lever out each corner of the oil pan to break the seal.

Note: Take care not to damage the sealing surface of the oil pan.

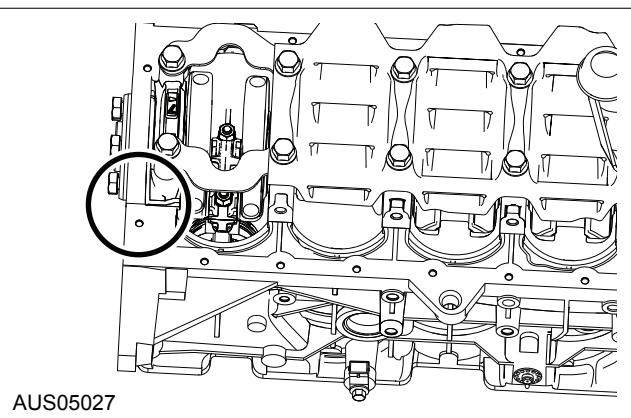
- Remove the oil pan.



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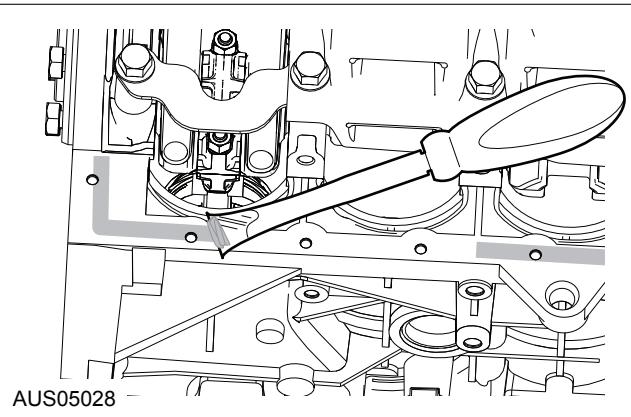
#### Installation

- Clean block and sump contact surfaces. To do so wipe off excess oil. (Particular note should be given to the area circled in red to the left).



AUS05027

- Use a scraper to remove the bulk of the silicon material, ensure none of this material enters the engine.

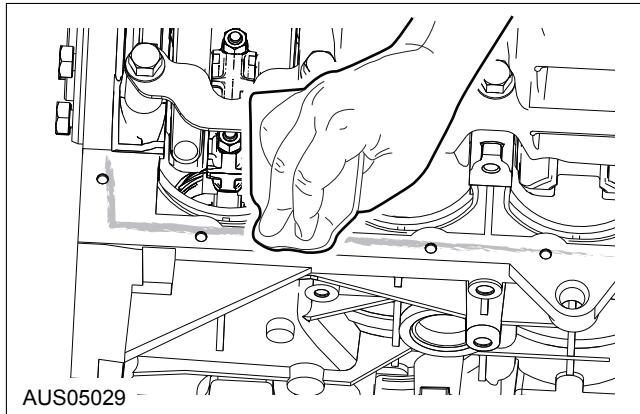


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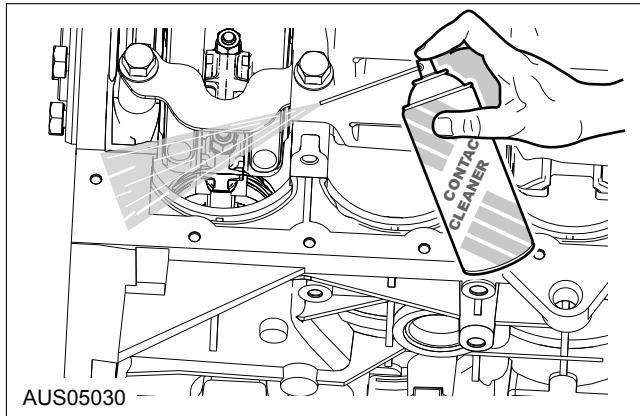


## IN-VEHICLE REPAIR (Continued)

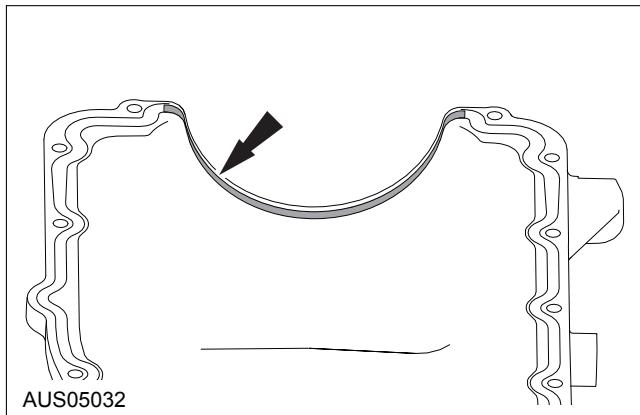
3. Use a Scotchbrite or a similar pad to remove the rest of the silicon material.



4. Use contact cleaner to ensure no oil is left on the surfaces.

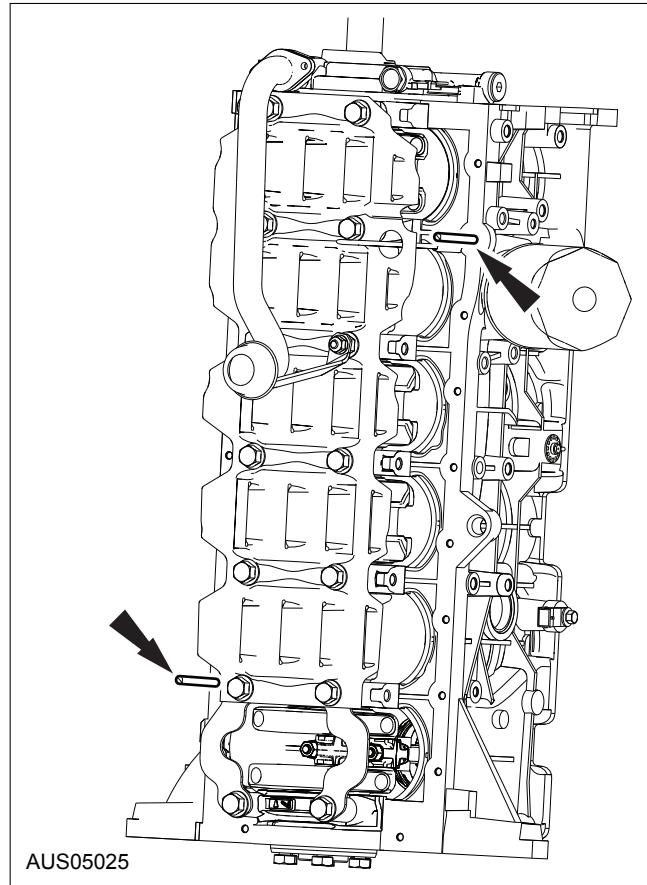


5. Check the oil pan baffle plates for cracks and loose rivets.  
6. Fit a new half moon seal, ensuring that it fits into the groove.

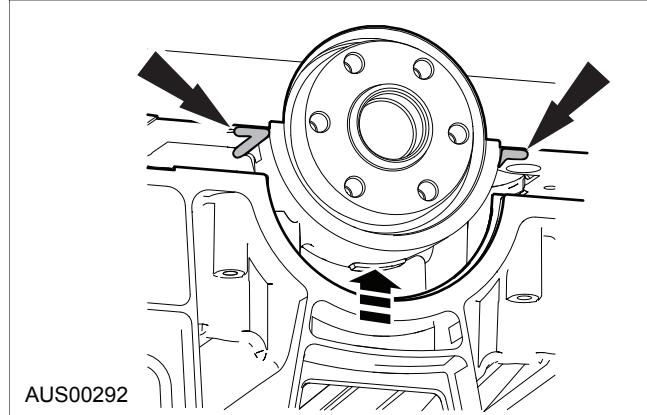


7. Fit a new rear half moon seal, ensuring that it fits into the groove.

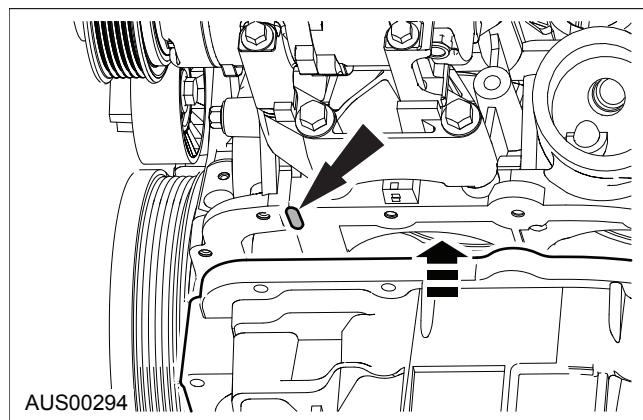
8. Insert dowels in block as shown to guide the sump into the correct position.



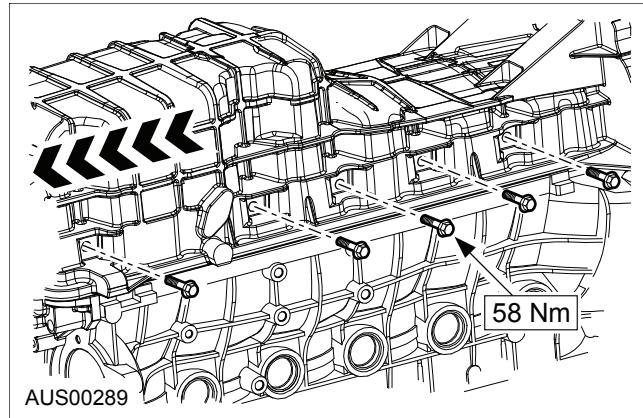
9. Apply a continuous bead of Loctite 5900 around the sump. The bead should be positioned on the top ridge, not on the bottom area.  
10. At the 4 locations shown, apply additional Loctite 5900 (or similar).  
11. Apply a bead of sealant Loctite 5900 (or similar) at the front cover to block joint (2 places), and the rear main bearing cap to block joint (2 places).



## IN-VEHICLE REPAIR (Continued)



12. Place sump on block and insert flange bolts.
13. Replace dowels with flange bolts.
14. Coat the main bearing cross bolt threads with Loctite 567 (or similar) thread sealant.

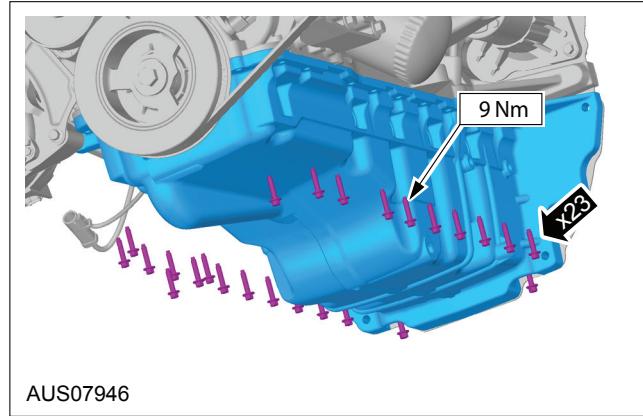


15. Install oil pan flange bolts to specified torque.

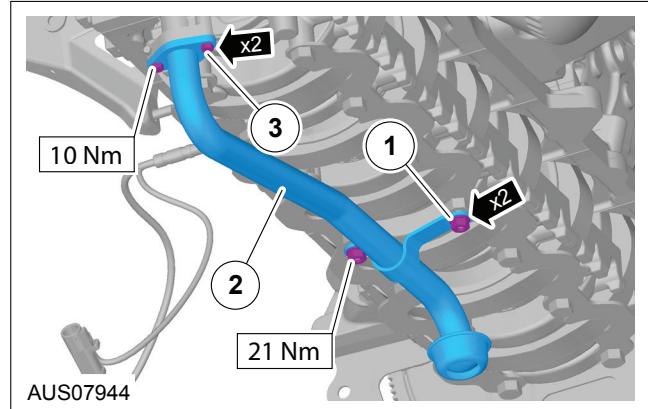
### Oil Pump Pickup Tube

#### Removal

1. Remove the oil pan. For additional information, refer the oil pan procedure in this section.



2. Remove the pickup tube attachment bolts to oil pump.



Item	Description
1	Nut
2	Pickup tube
3	Bolt

3. Remove the oil pump pickup tube.

#### Installation

1. Inspect the intake flanges on the oil pump and pickup tube for signs of damage.
2. Fit a new O-ring to this joint
3. Tighten the pickup tube to oil pump bolts and check that the mounting bracket is sitting lightly on the head of the main bearing bolt, or just clear by up to 1 mm, before fitting the nut.

**Note:** Heavy bearing, or a large gap could cause an air leak and should be corrected by adjusting the bracket.

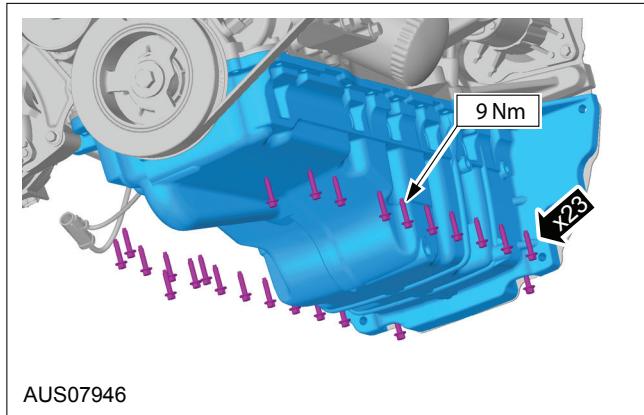


## IN-VEHICLE REPAIR (Continued)

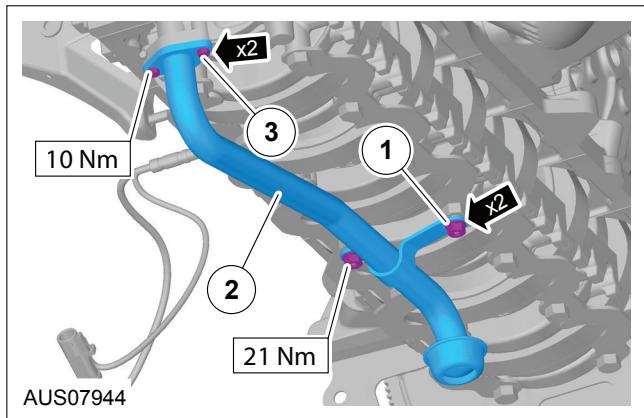
### Oil pump

#### Removal

1. Remove the oil pan. For additional information, refer the oil pan procedure in this section.



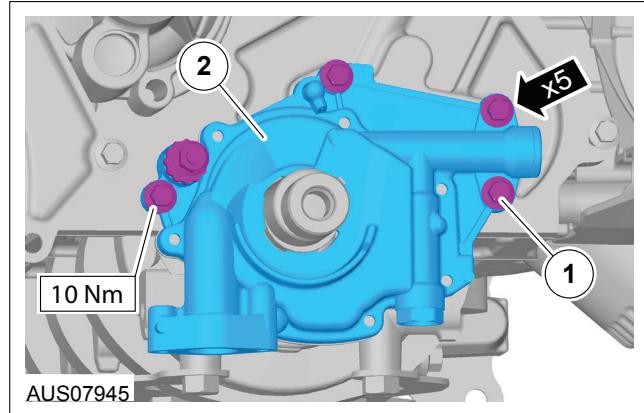
2. Remove the Front Cover. For additional information, refer the front cover procedure in this section.
3. Remove the pickup tube mounting bracket nut (attached to main bearing bolt stud).



Item	Description
1	Nut
2	Pickup tube
3	Bolt

4. Remove the oil pick up tube. For additional information, refer the oil pick up tube procedure in this section.

5. Remove the oil pump to block mounting bolts.



Item	Description
1	Bolt
2	Oil pump

6. Remove the oil pump.

**Note:** The oil pump is a non-repairable item and should be replaced if damaged.

#### Installation

1. Engage the drive flats in the oil pump rotor bore with the two flats on the crankshaft.
  2. Gently push the oil pump into position against the cylinder block.
- Note:** Rotating the oil pump body and gently rocking it fore and aft will assist assembly.
3. DO NOT use force.



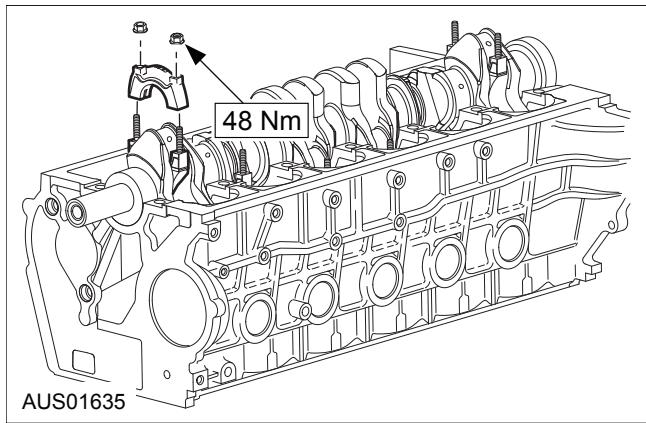
## IN-VEHICLE REPAIR (Continued)

### Piston and Rod Assembly

#### Removal

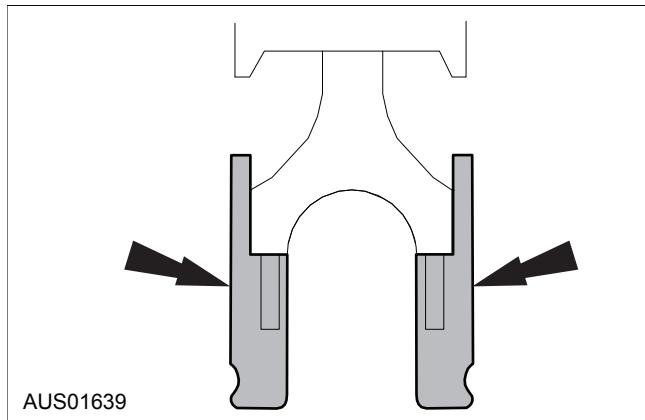
Place the engine on a rollover stand and invert before performing this procedure.

1. Remove the main bearing bolts.
2. Remove the windage baffle.
3. Remove the main bearing caps and lower main bearings.
4. Rotate the crankshaft to Bottom Dead Centre on the respective cylinders to improve access to the connecting rod bolts.
5. Fit Connecting rod bolt protectors prior to disengaging the connecting rod from the crankshaft.



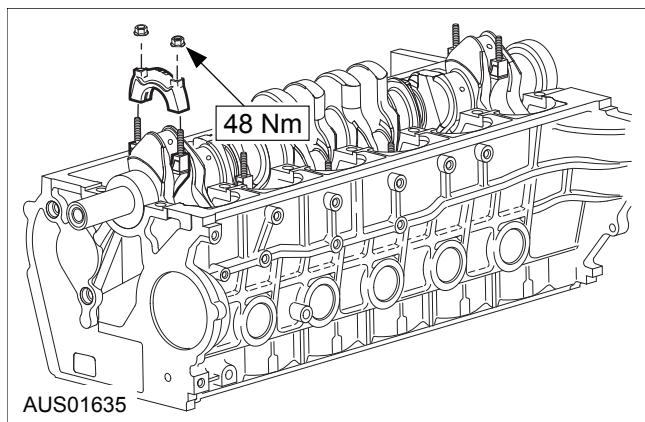
#### Installation

1. Use bolt protectors when installing the assembly.



**Note:** Ensure new connecting rod bolts have been fitted, as the 'Torque to Yield' bolts are not reusable.

2. Ensure the cap and the connecting rod carry the same cylinder number marking on the same side of the rod.
3. Tighten each pair of bolts to 25Nm, then a further 90 degrees.



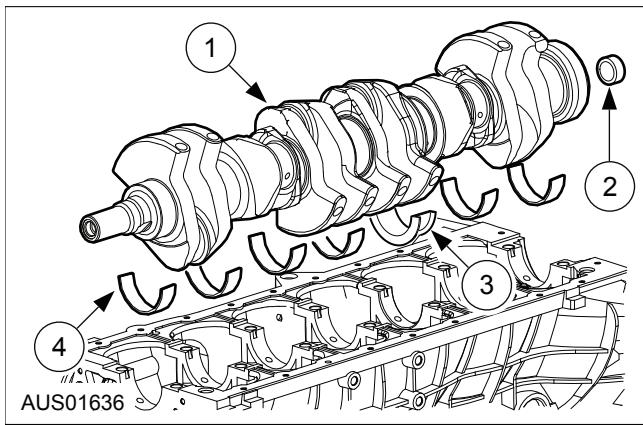
## IN-VEHICLE REPAIR (Continued)

### Main bearings/Crankshaft

Place the engine on a rollover stand and invert before performing this procedure.

#### Removal

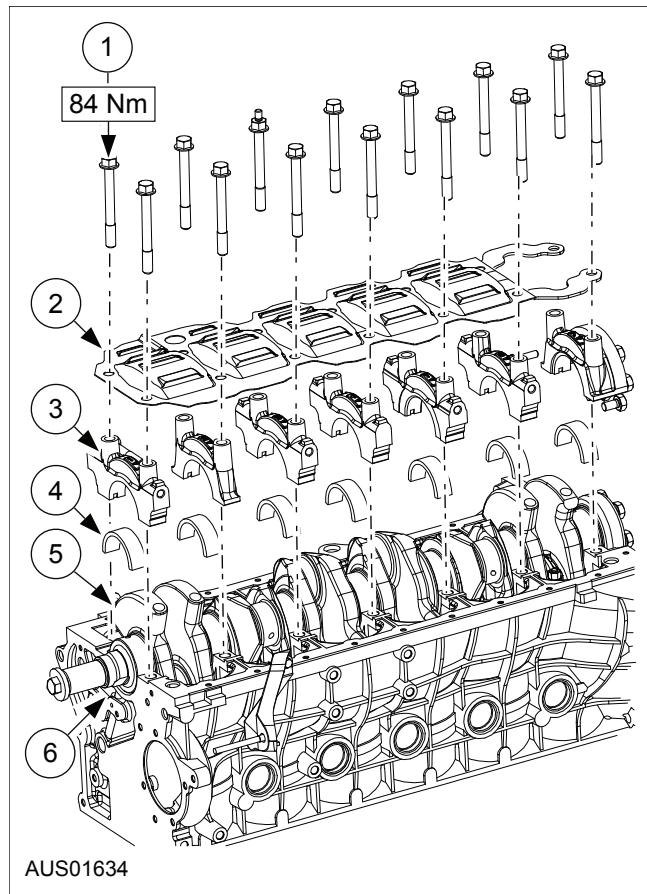
1. Remove the main bearing bolts.
2. Remove the windage baffle.
3. Remove the main bearing caps and lower main bearings.
4. Remove the connecting rod caps, upper and lower connecting rod bearings, and piston & rod assemblies. For additional information, Refer to Piston and Rod Assembly procedure in this section.
5. Remove the crankshaft.
6. Remove the upper main bearings.



Item	Description
1	Crankshaft
2	Pivot bearing (Manual transmission only)
3	Upper main crankshaft thrust bearing
4	Upper main crankshaft bearings

#### Installation

1. For installation reverse the removal procedure.



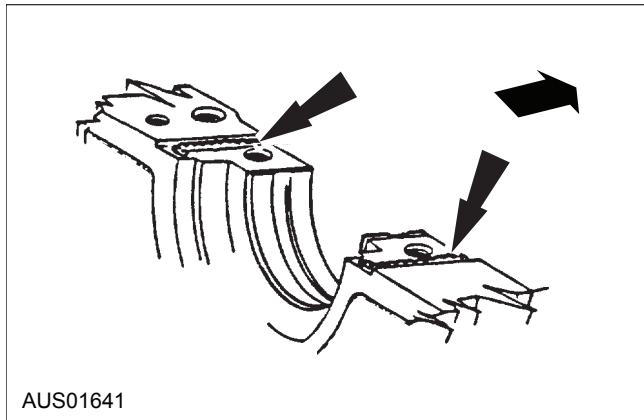
Item	Description
1	Main bearing bolts
2	Windage baffle
3	Main bearing caps
4	Lower main crankshaft bearings
5	Crankshaft
6	Upper main crankshaft bearings



## IN-VEHICLE REPAIR (Continued)

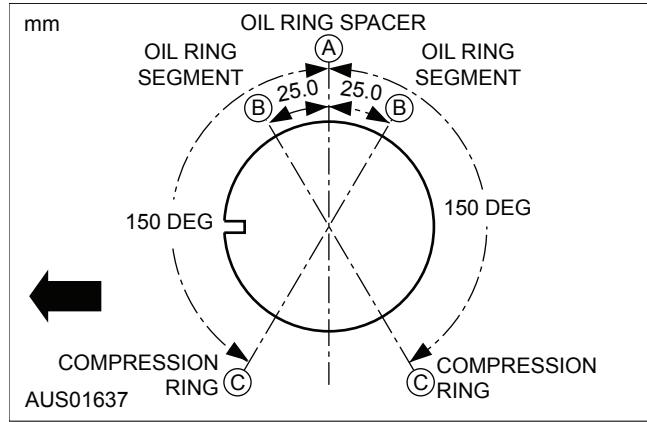
### Rear Main Bearing Cap Assembly

1. Apply silicone sealant Loctite 5900 (or a sealant which meets the Ford specification WSS-M4G323-A7) to the rear main bearing cap to block joint as shown.
2. Fit the rear main bearing cap and tighten within 5 minutes of application of the sealant.
3. Reverse the removal procedure.

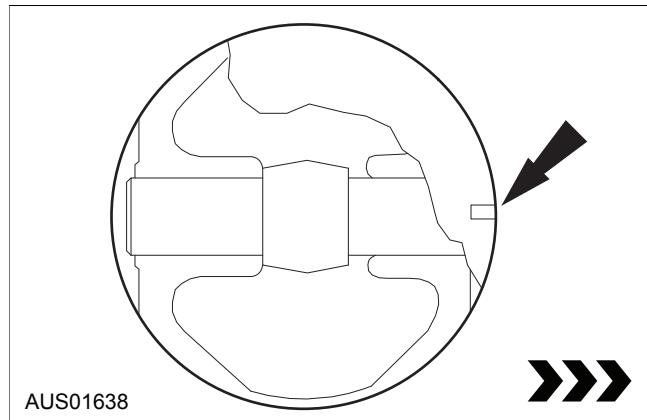


### Piston Ring Installation

1. Verify the second piston ring is installed with the dot upwards.
2. Position the end gaps of the piston rings as shown.



3. Ensure the notch on the piston is facing the front of the engine, the valve cut-outs are on the exhaust side, and the connecting rod oil squirt hole is on the exhaust side of the engine.

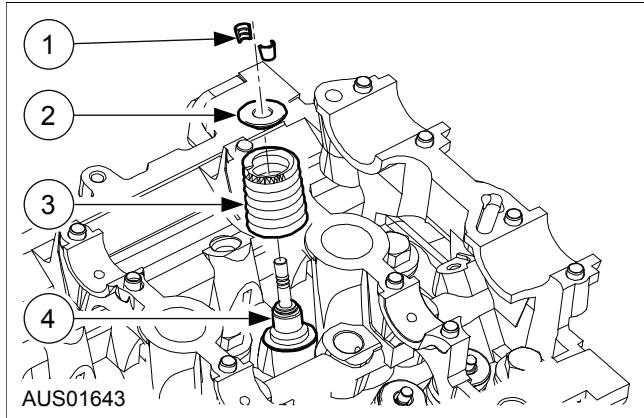


## DISASSEMBLY AND ASSEMBLY

### Key Retainer - Valve Spring

#### Disassembly

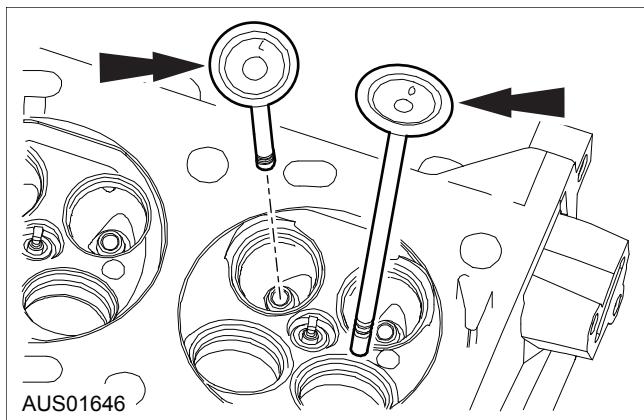
1. Remove the keys using a valve spring compressor.
2. Remove the valve spring retainer.
3. Remove the valve spring.
4. Remove the valve stem seal.



Item	Description
1	Key - Valve spring retainer
2	Valve spring retainer
3	Valve spring
4	Valve stem seal

#### Assembly

To assemble Reverse the disassemble procedure.



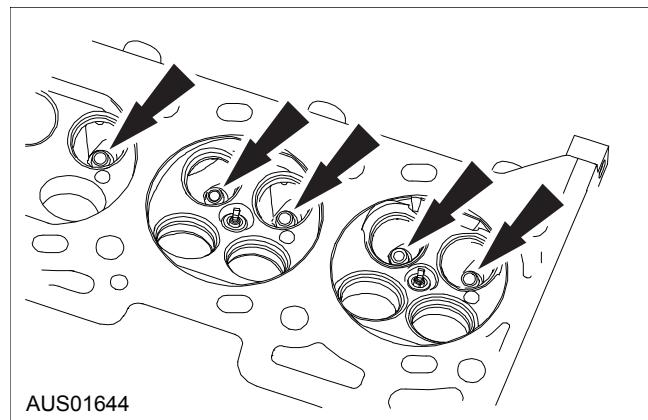
### Valve Stem Seal

#### Disassembly

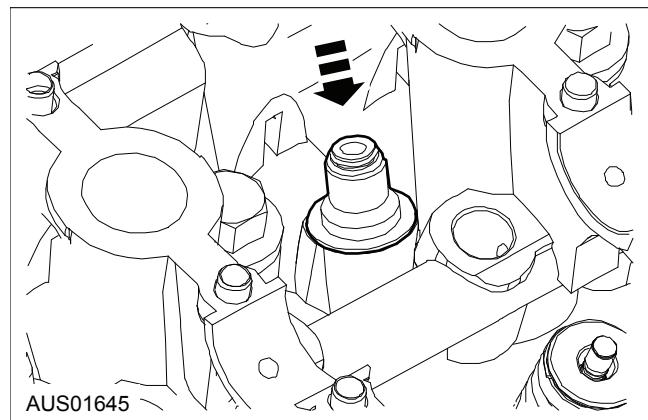
1. Remove the seal using a pair of pliers.

#### Assembly

1. Ensure the cylinder head is clean.
2. Ensure the cylinder head joint face is free from scratches and nicks in the sealing areas around the cylinder bore and oil and waterways.
3. Lubricate the valve guides with engine oil.

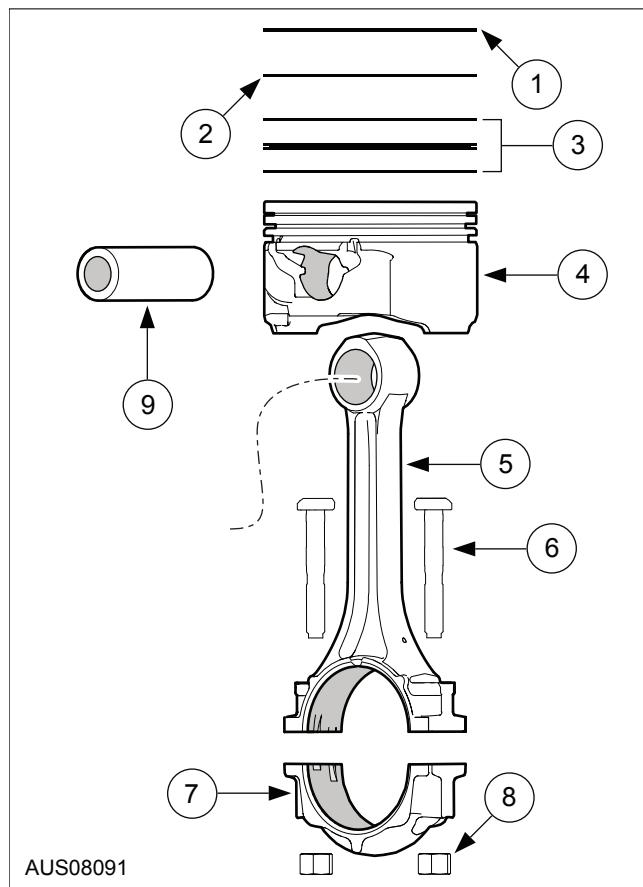


4. Fit new seals using an 18 mm inside diameter drift.



## DISASSEMBLY AND ASSEMBLY (Continued)

### Piston and Connecting Rod Assembly Assembly

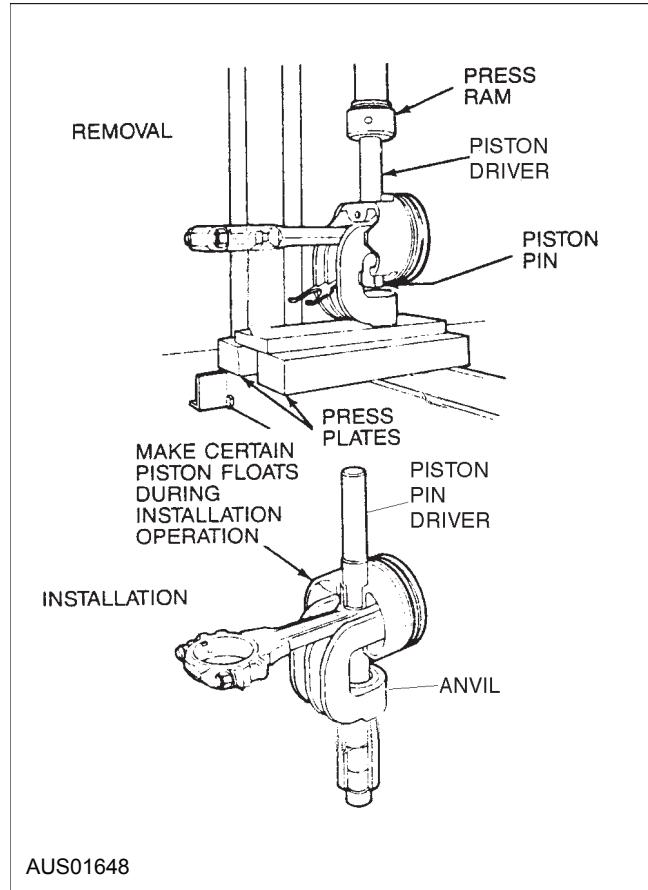


Item	Description
1	Compression ring upper
2	Compression ring lower
3	Oil rings
4	Piston
5	Connecting rod
6	Connecting rod bolt
7	Connecting rod cap
8	Connecting rod nut
9	Gudgeon Pin

### Piston and Connecting Rod Disassembly and Assembly

#### Assembly

1. Use SST 303-D034 to remove and install the piston from the connecting rod assembly.



**Note:** Do not separate the piston and rod unless the rod, pin or piston is to be replaced.

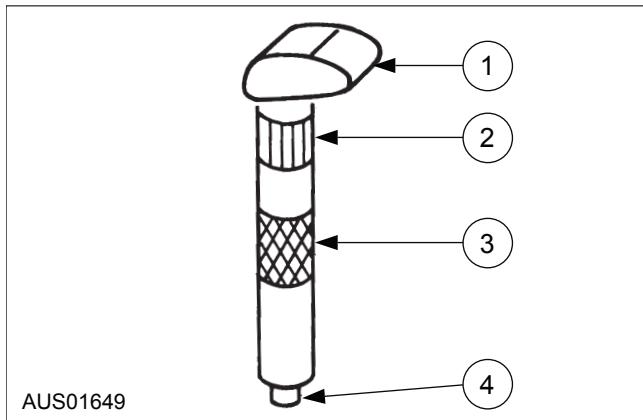


## DISASSEMBLY AND ASSEMBLY (Continued)

### Connecting Rod Bolt

The connecting rod bolts are permanently stretched each time they are tightened and should only be used once.

Replace the connecting rod bolts prior to rebuilding the engine. The old bolts can be used to establish bearing clearances. The correct level bolts are marked WR/AB.



Item	Description
1	WR/AA marking
2	Straight knurl
3	Diamond knurl
4	Pilot point

