SECTION 6A3 - ENGINE MECHANICAL - GEN III V8 ENGINE

IMPORTANT

Before performing any Service Operation or other procedure described in this Section, refer to Section 00 CAUTIONS AND NOTES for correct workshop practices with regard to safety and/or property damage.

CONTENTS

1. GENERAL DESCRIPTION

The 2003 Model Year 5.7 litre, GEN III, V8 engine (production option LS1), carries over from earlier build engines, except for minor changes, detailed here. Minor changes to some service operations have also been made, that reflect a modified approach to various tasks. As a result, the procedures contained in this Section have been reproduced in full and should be followed when service operations are carried out on MY 2003 GEN III V8 engines.

Note that some vehicle specifications may include manual transmission and/or automatic transmission fitment, in addition to left and right hand drive. Unless noted otherwise, the information contained within this Section is appropriate for all vehicle specifications.

1.1 SERVICE INFORMATION

In summary, the following reflects changes that have been introduced with the 2001 Model Year release of the GEN III V8 engine.

1. The engine accessory drive belt, coolant pump pulley is an integral part of the coolant pump and is not serviced separately.
2. The pistons and piston rings have been through several changes, involving different piston skirt treatments and the second compression piston ring design has also changed. For these reasons, it is vital that only parts listed in the current PartFinder® CD are fitted to this engine.
3. The cylinder head gasket material has changed from a graphite layered design to a laminated steel type.

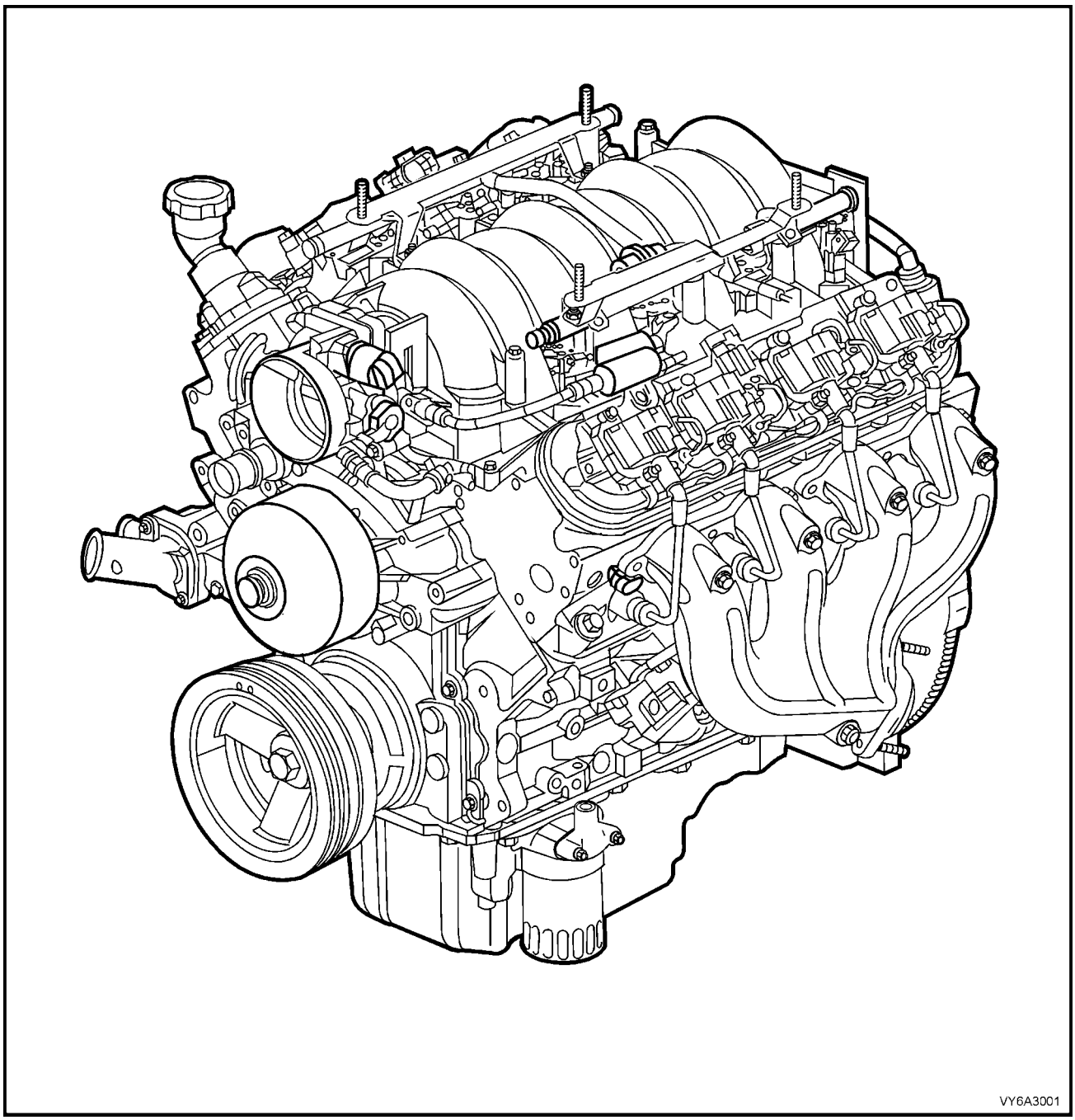

Figure 6C3-1-1 GEN III V8 Engine View Left Hand Side
(Power Steering Pump and Air Conditioning Compressor Not Shown)

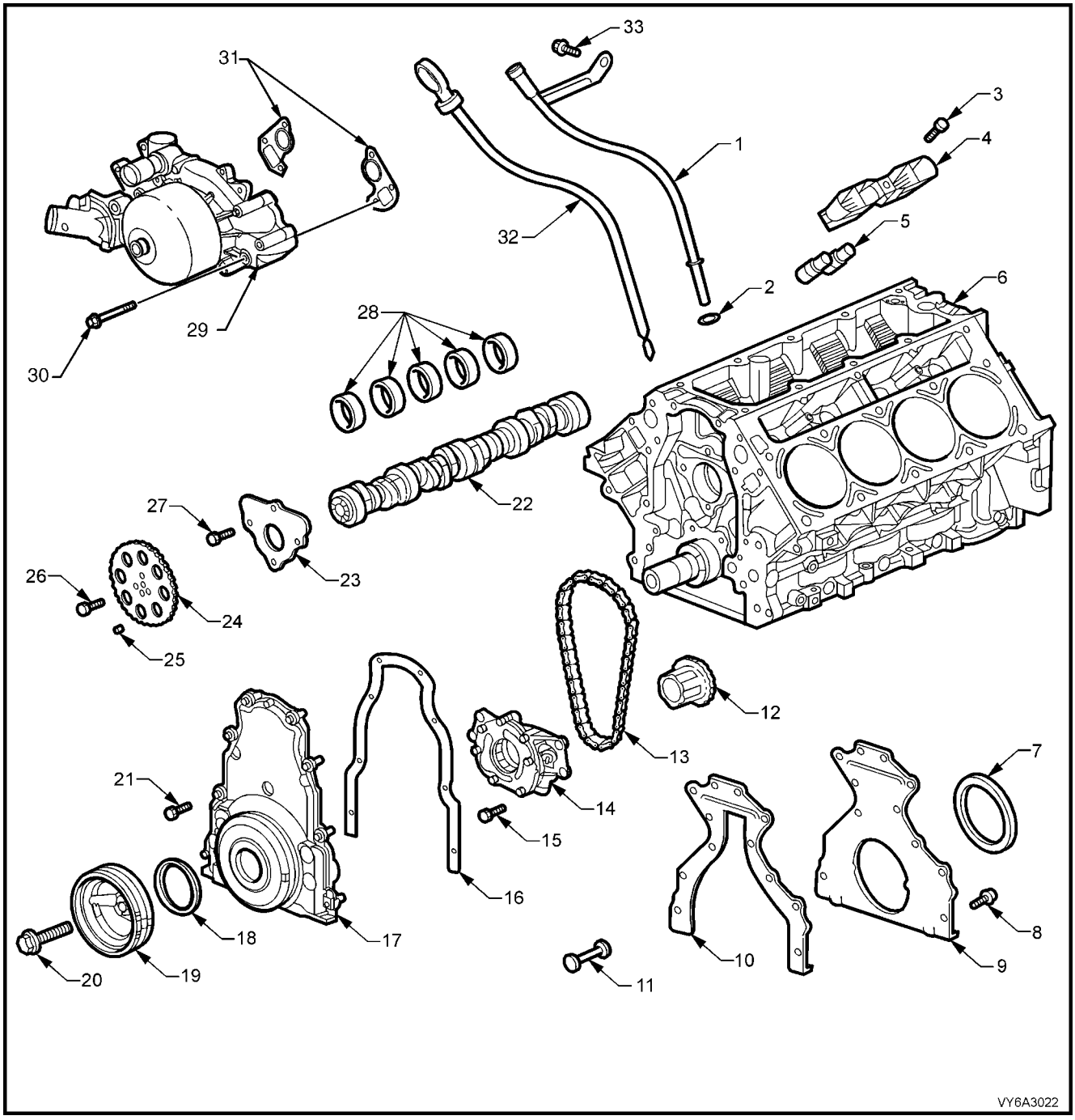

Figure 6A3-2 - Lower Front of Engine

Legend

1. Tube – Oil Level Indicator
2. O-ring Seal – Oil Lever Indicator Tube
3. Bolt – Valve Lifter Guide
4. Guide – Valve Lifter
5. Lifter – Valve
6. Engine Block
7. Oil Seal – Crankshaft Rear
8. Bolt – Engine Rear Cover
9. Cover – Engine Rear
10. Gasket – Engine Rear Cover
11. Plug – Engine Block Rear Oil Gallery
12. Crankshaft Sprocket
13. Chain – Camshaft Timing
14. Oil Pump Assembly
15. Bolt – Oil Pump Assembly
16. Gasket – Engine Front Cover
17. Engine Front Cover
18. Oil Seal – Crankshaft Front
19. Balancer – Crankshaft
20. Bolt – Crankshaft Balancer
21. Bolt – Engine Front Cover
22. Camshaft
23. Retainer – Camshaft
24. Sprocket – Camshaft
25. Locating Pin – Camshaft Sprocket
26. Bolt – Camshaft Sprocket
27. Bolt – Camshaft Retainer
28. Bearings – Camshaft
29. Coolant Pump
30. Bolt – Coolant Pump
31. Carrier Gaskets – Coolant Pump
32. Indicator – Oil Level
33. Bolt – Oil Level Indicator Tube

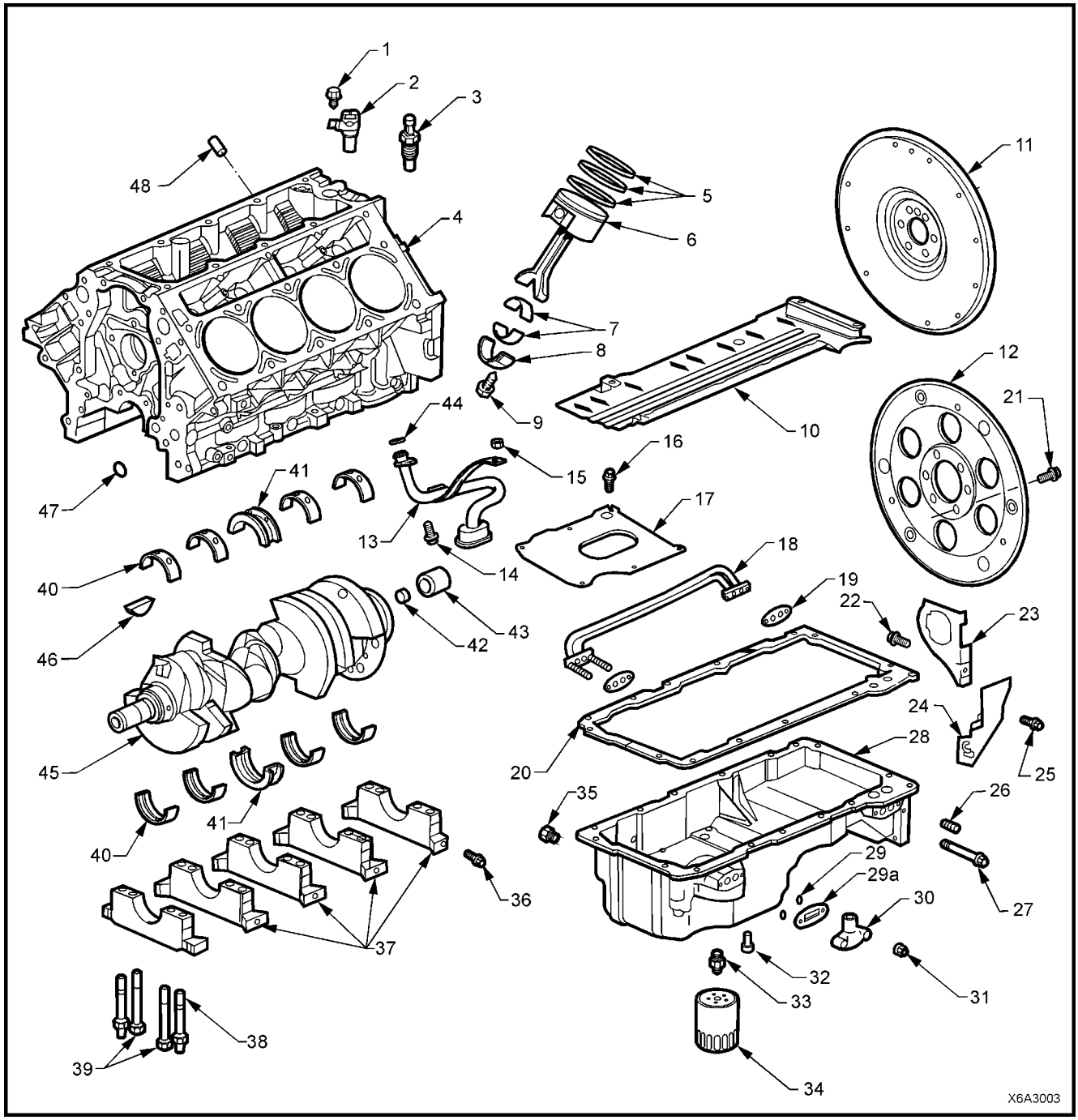

Figure 6A3-3 - Lower Engine Assembly

Legend

1. Bolt – Camshaft Position Sensor
2. Camshaft Position Sensor
3. Oil Pressure Sensor
4. Engine Cylinder Block
5. Piston Rings
6. Piston and Connecting Rod Assembly
7. Connecting Rod Bearings
8. Connecting Rod Cap
9. Bolt – Connecting Rod
10. Crankshaft Oil Deflector
11. Engine Flywheel – Manual Trans.
12. Engine Flexplate – Automatic Trans.
13. Screen and Pipe – Oil Pump Pick-up
14. Screw – Oil Pump Pick-up to Pump
15. Nut – Oil Deflector and Oil Pump Pick-up
16. Bolt – Oil Pan Baffle
17. Baffle – Oil Pan
18. Tube – Oil Transfer
19. Gasket – Oil Transfer Tube
20. Gasket – Oil Pan
21. Bolt – Engine Flexplate
22. Screw – Oil Pan Closeout Cover (RHS)
23. Cover – Oil Pan Closeout (RHS)
24. Cover – Oil Pan Closeout (LHS)
25. Screw – Oil Pan Closeout Cover (LHS)
26. Plug – Oil Pan Gallery
27. Bolt – Oil Pan Transfer Tube
28. Oil Pan
29. O-Ring Seal – Oil Transfer Cover Stud

29a. Gasket – Oil Transfer Cover

30. Cover – Oil Transfer
31. Nut – Oil Transfer Cover
32. Valve – Oil Bypass
33. Adaptor – Oil Filter
34. Oil Filter
35. Plug – Oil Drain
36. Bolt – Crankshaft Bearing Cap Side
37. Caps – Crankshaft Main Bearing
38. Stud – Main Bearing Cap
39. Bolt – Main Bearing Cap
40. Bearings – Crankshaft Main
41. Bearings – Crankshaft Main Thrust
42. Plug – Rear Crankshaft
43. Bush – Manual Transmission Spigot
44. O-Ring Seal – Oil Pump Pick-up
45. Crankshaft
46. Key – Crankshaft Sprocket
47. Plug – Engine Block Front Oil Gallery
48. Plug – Cylinder Block in Unused Hole

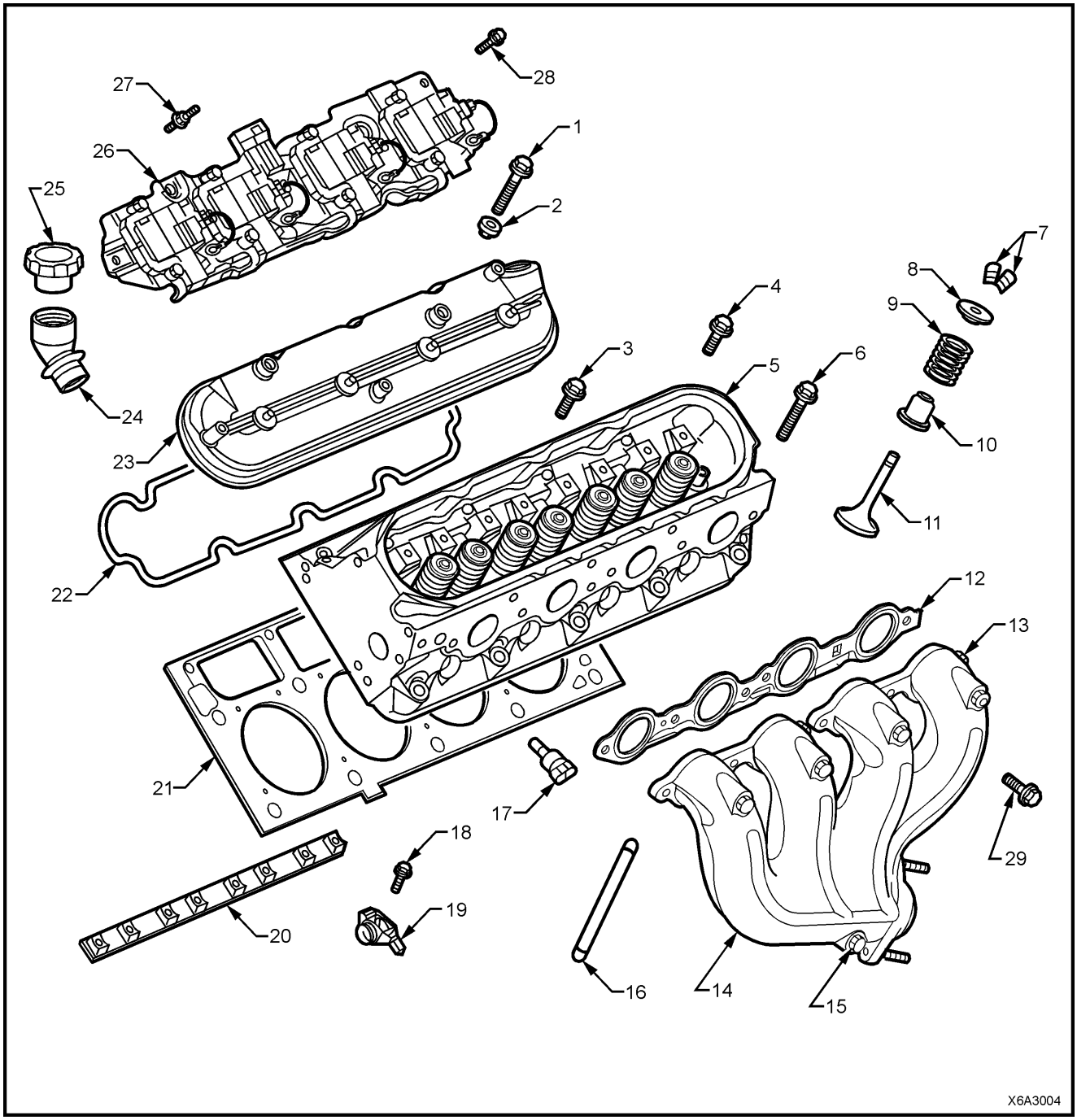

Figure 6A3-4 - Cylinder Head/Upper Engine

Legend

1. Bolt – Valve Rocker Arm Cover
2. Grommet – Valve Rocker Arm Cover
3. Bolt – Cylinder Head (Short)
4. Bolt – Cylinder Head (Medium)
5. Cylinder Head
6. Bolt – Cylinder Head (Long)
7. Collets – Valve Stem Keys
8. Cap – Valve Spring
9. Spring – Valve
10. Oil Seal/Valve Spring Shim – Valve Stem
11. Valve
12. Gasket – Exhaust Manifold
13. Manifold – Exhaust
14. Heat Shield – Exhaust Manifold
15. Bolt – Exhaust Manifold Heat Shield
16. Pushrod
17. Sensor – Coolant Temperature
18. Bolt – Valve Rocker Arm
19. Arm – Valve Rocker
20. Support – Valve Rocker Arm Pivot
21. Gasket – Cylinder Head
22. Gasket – Valve Rocker Arm Cover
23. Cap – Oil Fill Tube
24. Cover – Valve Rocker Arm
25. Tube – Oil Fill
26. Assembly – Ignition Coil and Bracket
27. Stud – Ignition Coil Bracket Assembly
28. Screw – Ignition Coil Bracket Assembly. Rear on each side
29. Bolt – Exhaust Manifold

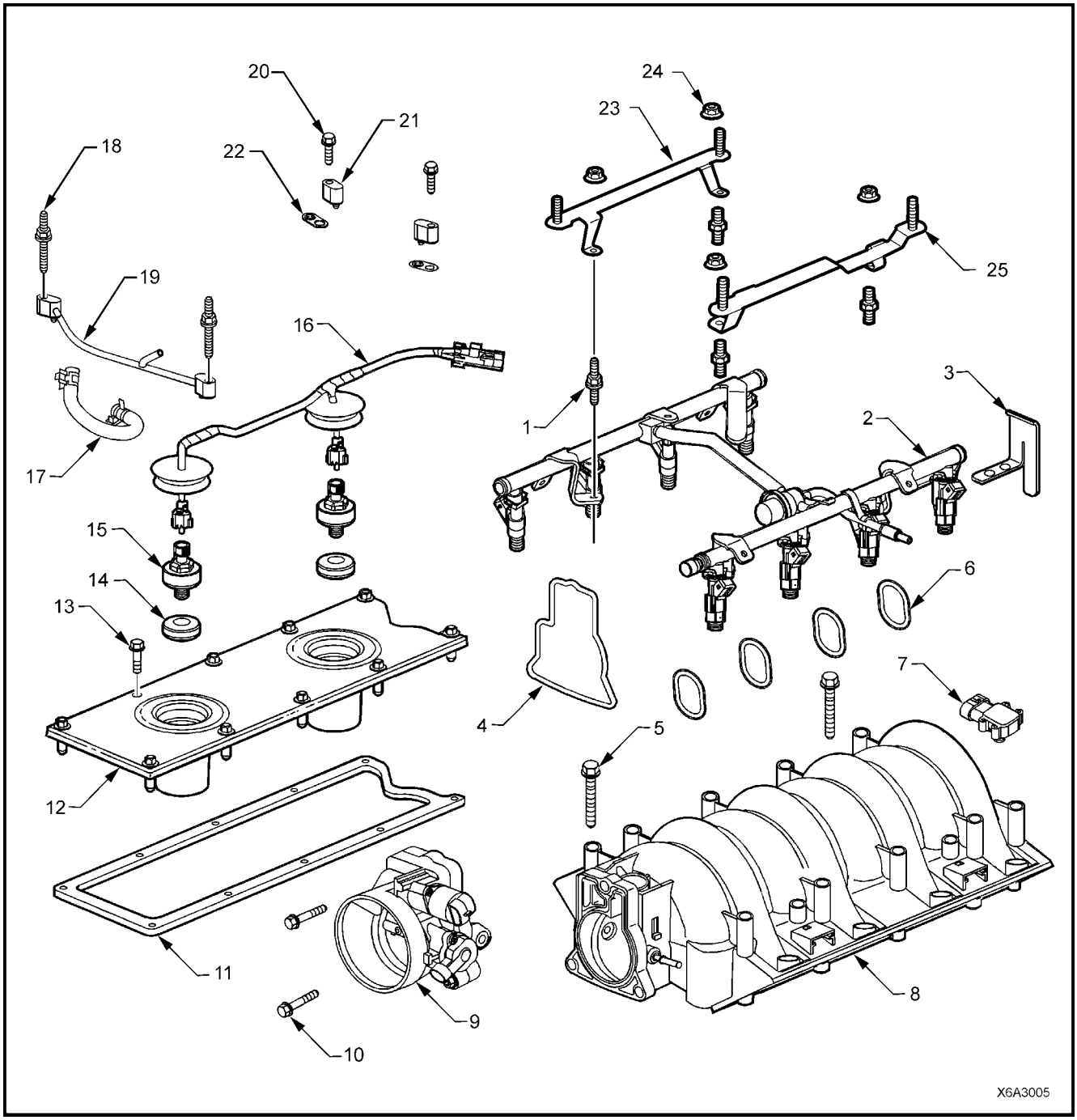

Figure 6A3-5 - Intake Manifold/Upper Engine

Legend

1. Stud – Fuel Rail to Intake Manifold (4 places)
2. Fuel Rail (with Injectors)
3. Bracket – Fuel Rail Stop
4. Gasket – Throttle Body
5. Bolt – Intake Manifold (10 places)
6. Gaskets – Intake Manifold (8 places)
7. Sensor – Manifold Absolute Pressure (MAP)
8. Intake Manifold
9. Throttle Body
10. Bolt – Throttle Body (3 places)
11. Gasket – Valley Cover
12. Valley Cover
13. Bolt – Valley Cover (10 places)
14. Oil Seal – Knock Sensor (2 places)
15. Knock Sensor (2 places)
16. Knock Sensor Wire Harness
17. Hose – Vapour Vent Tube
18. Stud – Vapour Vent Tube (2 places)
19. Vapour Vent Tube
20. Bolt – Vapour Vent Tube
21. Cover – Vapour Vent (2 places)
22. Gasket – Vapour Vent Tube (4 places)
23. Bracket – Engine Dress Cover, Right Hand Side
24. Nut – Engine Dress Cover Bracket
25. Bracket – Engine Dress Cover, Left Hand Side

1.2 ENGINE SERIAL NUMBER

The engine number is stamped on the right hand side front of the engine cylinder block, as shown. The number is prefixed by the letters 'VF'.

A breakdown of the engine numbering system, using and example of 'VF031904500', is;

- First two numbers ('03' = 2003) indicates the engine model year.
- Next three numbers ('190') is the Julian date (day of the year), the engine was manufactured.
- Next four numbers are the daily, sequential build number.

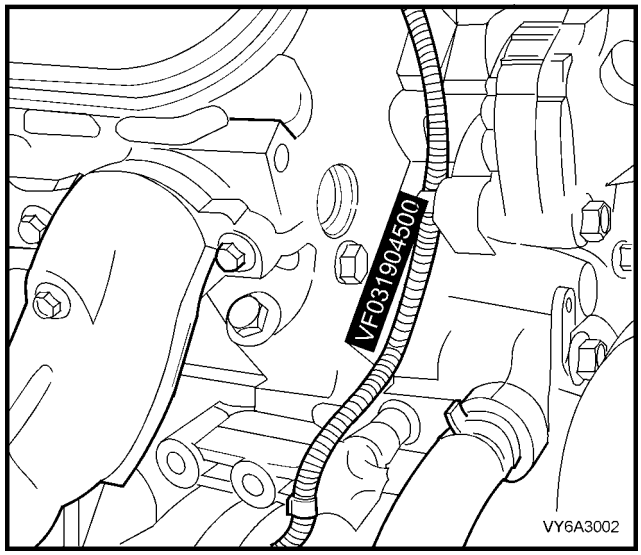

Figure 6A3-6

1.3 ENGINE CONSTRUCTION

CYLINDER BLOCK

The engine cylinder block is a cam-in-block, deep skirt, 90° 'V' configuration with five crankshaft bearing caps, manufactured from forged powdered metal. The engine block is aluminium with cast in place, cast iron cylinder bore liners. The five cross-bolted crankshaft bearing caps each have four vertical M10 (2, 3, 4, and 5) and two horizontal M8 (1 and 6) mounting bolts. Only cylinder honing is permitted.

The crankcase skirt length, bearing cap width, deck width and upper rails have been optimised for strength, using finite element analysis.

The camshaft is supported by five camshaft bearings pressed into the block.

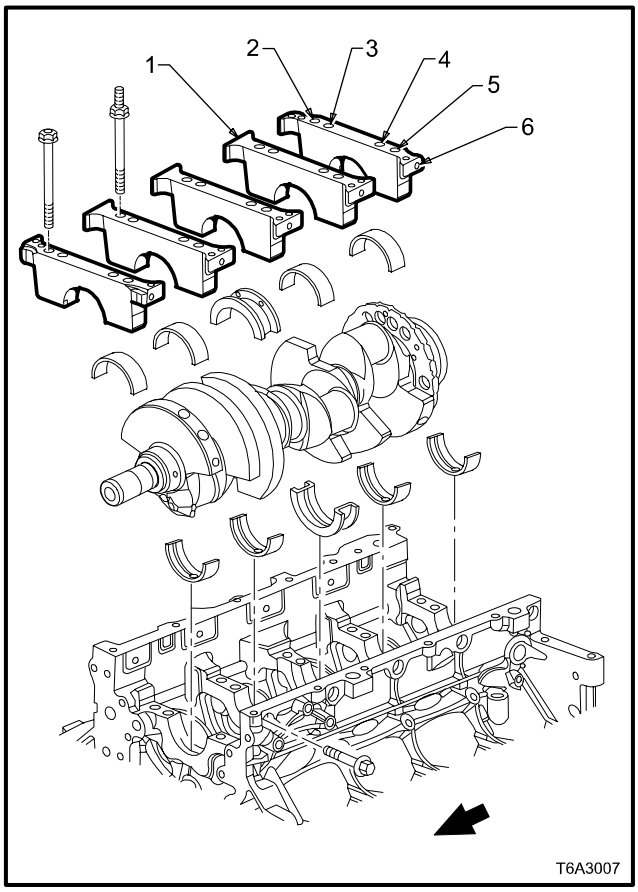

Figure 6A3-7

The cylinder block incorporates enclosed valve lifter bores (2) under each cylinder head, that results in a more stiff structure with quiet operation.

Utilising a structural die cast aluminium valley cover (1), ties both cylinder banks together, increasing the block's torsional and bending frequencies. Having a closed valley area also prevents hot oil from contacting the lower surface of the intake manifold, allowing cooler air to enter the cylinders.

Overall, the cylinder block construction weighs 48% less than an equivalent cast iron block and the structural design features, coupled with the inherently light cylinder heads, combine into an engine with unique stiffness and light weight.

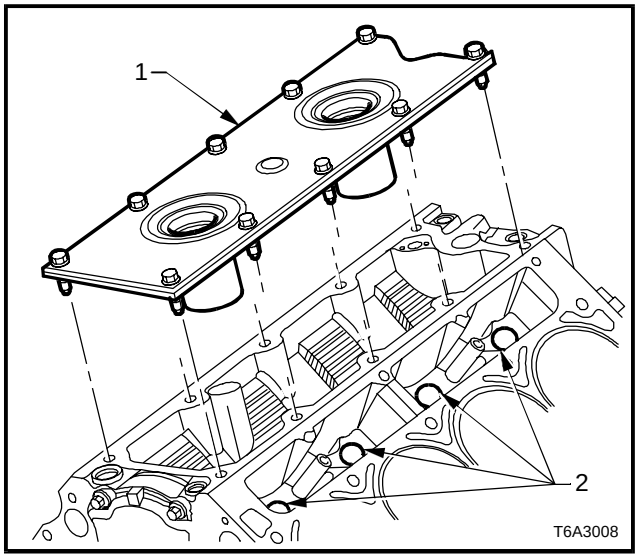

Figure 6A3-8

CYLINDER HEADS

The cylinder head assemblies are cast aluminium and have pressed in place, powdered metal valve guides and valve seats.

Intake and exhaust ports are identical for each cylinder, ensuring a balanced air-flow distribution for balanced combustion, resulting in a smoother running engine.

The cylinder head is attached using a four bolt per cylinder, deep threaded arrangement for minimal bore distortion, allowing low friction pistons and rings for reduced fuel consumption.

Cylinder head gaskets are now a laminated steel type and feature stainless steel PTFE coated flanges and lacing. The revised material gaskets are now common for both right and left hand sides.

Legend

1. Cylinder Head
2. Valve Stem Collets
3. Valve Spring Cap
4. Valve Spring
5. Valve Stem Oil Seal/Shim Combination
6. Cylinder Head Core Plugs
7. Exhaust Valve
8. Intake Valve

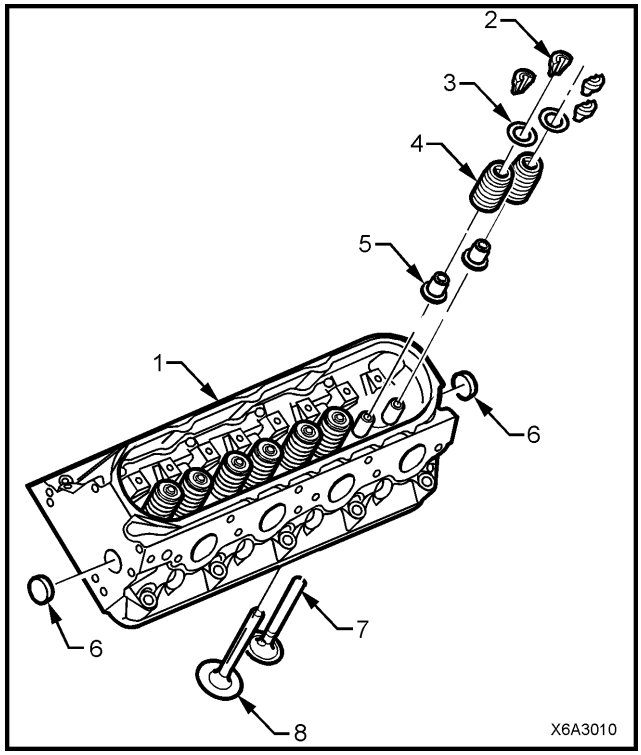

Figure 6A3-9

The intake ports are very tall, which enhances fuel injector targeting. As air flows down to the valve guide, it widens and shortens to the size of the intake valve seat.

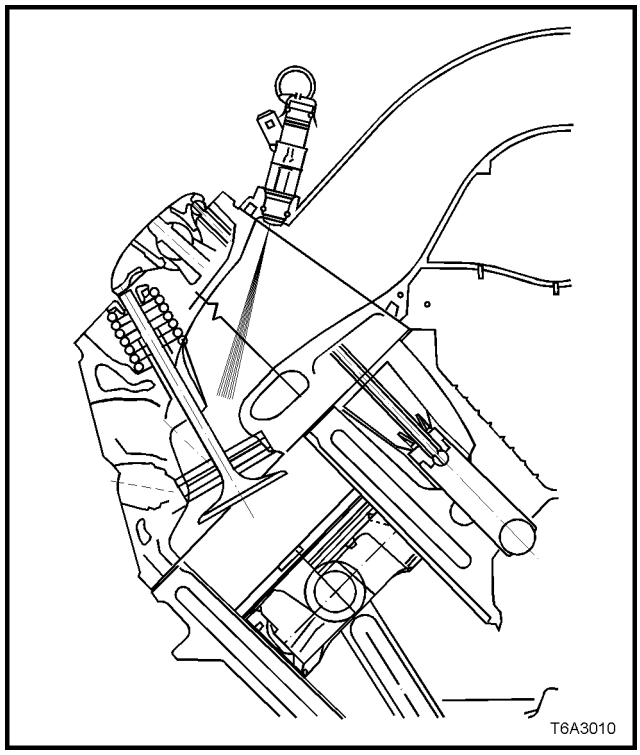

Figure 6A3-10

VALVE TRAIN

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the rocker arms. The valve lifter guides position and retain the roller hydraulic valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals (pivot supports). Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is adjusted automatically each cycle by the hydraulic valve lifters.

Both valves are angled at 15° to the cylinder bore centreline, which creates a shallow combustion chamber and a flat top piston, creating a compression ratio of 10.1:1.

Both the exhaust and intake valve seat angles are 45° with an intake valve head diameter of 50.8 mm and exhaust of 39.4 mm.

Valve springs are conical or 'beehive' in shape and made from chromium Silicone wire. The springs are double shot peened to provide maximum reliability. The reduced diameter end coils allows a smaller diameter, lower mass, steel spring retainer to be used, with single bead, valve stem keys. This spring design also reduces spring mass and, coupled with the increased stiffness in the valve train, results in a reduction in the valve spring pre-load, thereby reducing friction and valve train noise.

The rocker arms are made of investment cast steel and have a ratio of 1.7:1, that allows a lower cam lobe lift, resulting in lower valve train loading and less noise.

The valve rocker arm covers are cast aluminium and use a pre-moulded silicone gasket for sealing. Mounted to each rocker cover are four individual ignition coils. Incorporated into the covers are the oil fill tube, the Positive Crankcase Ventilation (PCV) system passages, and the engine fresh air passages.

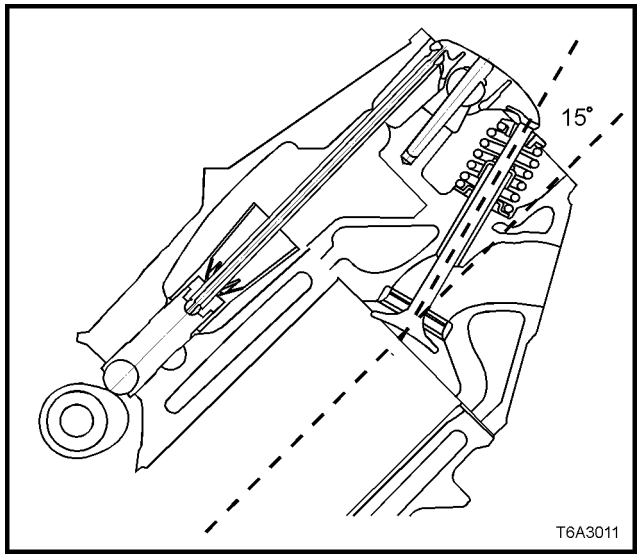

Figure 6A3-11

CRANKSHAFT

Manufactured from cast nodular iron, the crankshaft (1) is supported by five crankshaft bearings and are retained by 6 bolt crankshaft bearing caps. The main bearing caps are machined with the engine block for the proper alignment and clearance.

A 24X crankshaft position reluctor ring (2) is mounted at the rear of the number eight crankshaft counter weight. The reluctor ring is not serviced separately.

Crankshaft thrust is taken by the centre (No. 3) main bearing. This location is used to reduce the expansion differences between the cast iron crankshaft and the aluminium cylinder block.

By adopting a firing order of 1, 8, 7, 2, 6, 5, 4, 3, crank throw stresses are reduced and main bearing performance is improved.

The crankshaft has a drilled 25.4 mm hole through the centre of main journals 2, 3, 4 and 5. Apart from a reduction in crankshaft weight, this also achieves engine breathing enhancement at low speeds.

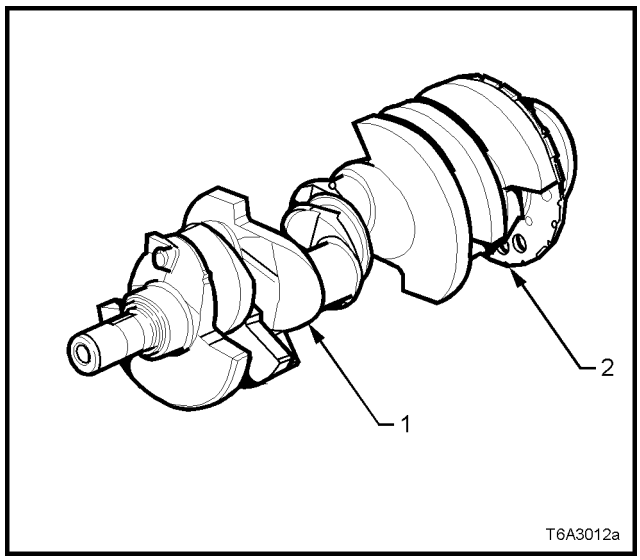

Figure 6A3-12

A variable radii undercut increases the effective bearing widths by 0.4 mm each side (A), compared to a uniform undercut and rolled fillets are utilised for improved fatigue strength.

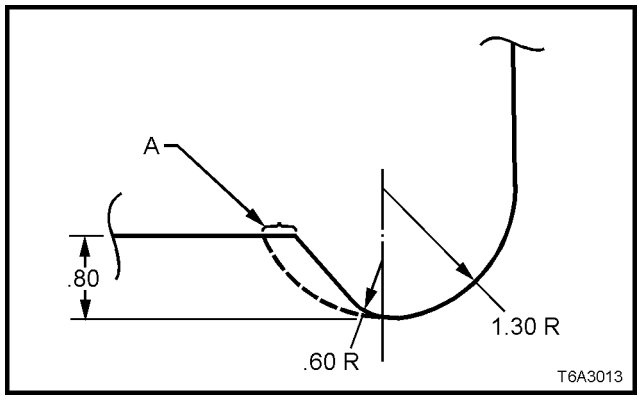

Figure 6A3-13

PISTONS AND CONNECTING RODS

The pistons are cast aluminium and have two compression rings and one oil control ring assembly fitted. Piston rings are of a thin, low friction design, with the top ring located close to the top of the piston crown to reduce hydrocarbon emissions. The piston is a low friction, lightweight design with a flat top and barrel shaped skirt.

Piston pins are chromium steel and are a floating fit in the piston and a press fit in the connecting rod.

The connecting rods are forged powdered metal. The connecting rod cap is separated during the manufacturing process, using the ‘fracture’ method. This creates a stronger, visually seamless rod to cap union. The reassembled rod is then machined for the proper clearance.

A 0.25 mm oversize piston and piston ring set are available for service, should cylinder honing be required.

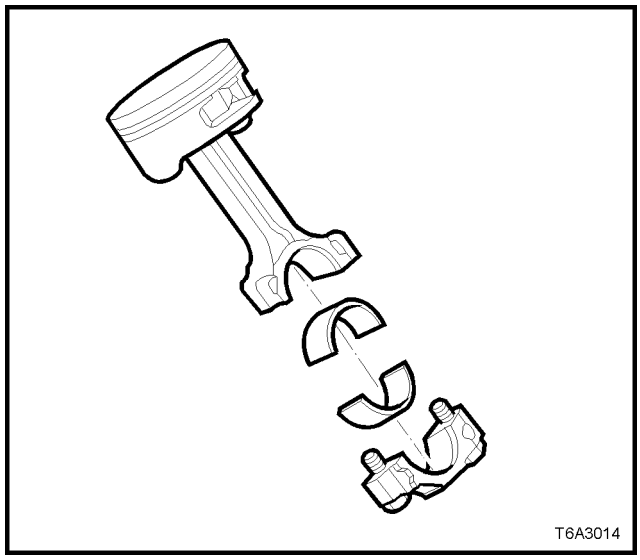

Figure 6A3-14

CAMSHAFT AND DRIVE

A billet steel, one piece camshaft is supported by five bearings pressed into the engine block. The camshaft has a machined camshaft sensor reluctor ring incorporated between the fourth and fifth bearing journals. To reduce valve train noise, both the intake and exhaust cam lobes have slow closing velocity ramps.

To reduce weight, the camshaft has a 17 mm gun-drilled hole down its length.

The camshaft (1) is driven by a traditional 9.52 mm pitch roller chain (2) and powdered metal timing sprockets mounted to the front of the camshaft (3) and crankshaft (4). The crankshaft sprocket (4) is splined and drives the oil pump driven gear. A retaining plate (5) mounted to the front of the engine block maintains the camshaft location. No chain tensioner is required.

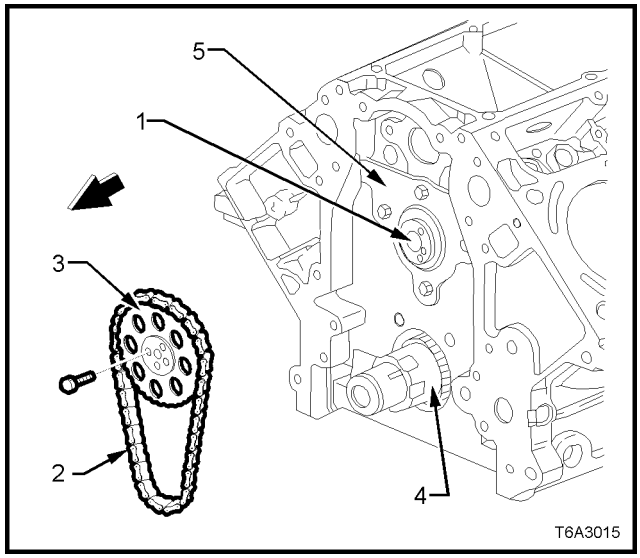

Figure 6A3-15

INTAKE MANIFOLD

The intake manifold (1) is a one piece composite design that incorporates metal threaded inserts for mounting the fuel rail (2), throttle cable bracket, and throttle body.

The intake manifold is sealed to the cylinder heads by eight separate non-reusable silicone sealing gaskets which press into the grooves of the intake housing.

The cable-actuated throttle body assembly bolts to the front of the intake manifold (A). The throttle body is sealed to the intake manifold by a one piece, push-in-place silicone gasket.

The fuel rail assembly (2) with eight separate fuel injectors (3) is retained to the intake manifold by four bolts (4). The injectors are seated in their individual manifold bores with O-ring seals to provide sealing. The fuel pulsation damper (5) is incorporated into the fuel rail design. A fuel rail stop bracket is retained at the rear of the left fuel rail by the intake manifold mounting bolts (not shown).

The Manifold Absolute Pressure (MAP) sensor is installed in the snap fit MAP sensor housing that is mounted at the rear of the manifold and sealed by an O-ring seal (not shown).

There are no coolant passages within the intake manifold.

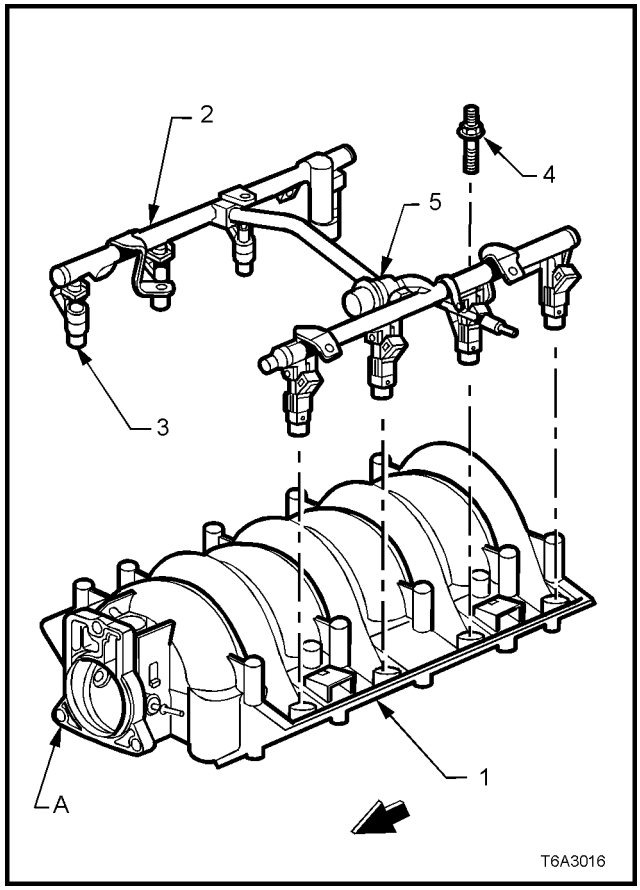

Figure 6A3-16

EXHAUST MANIFOLD

The exhaust manifolds are one piece, of high temperature silicone molybdenum cast iron and direct exhaust gases from the combustion chambers to the exhaust system.

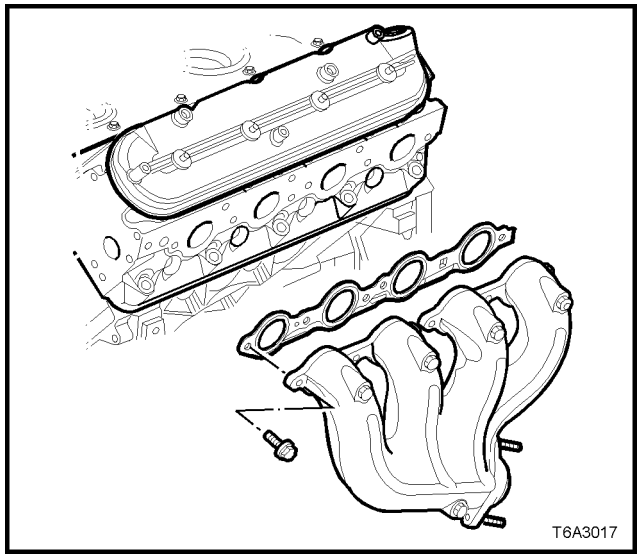

Figure 6A3-17

Each manifold (1) also has an externally mounted dual wall heat shield (2) attached, that is made of aluminiumised steel and attached by five screws (3).

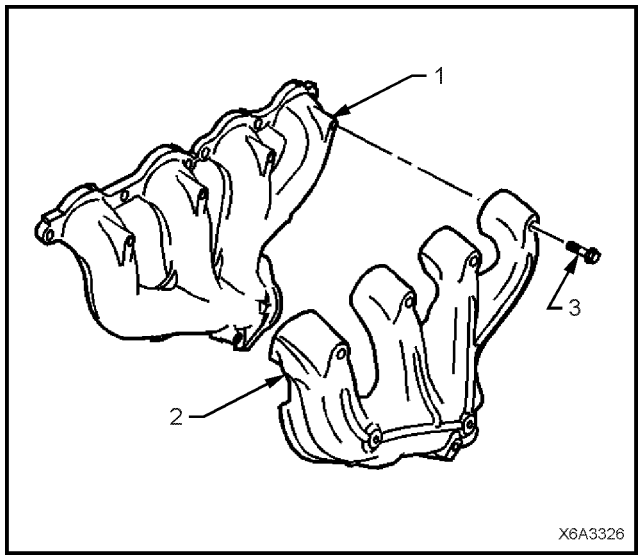

Figure 6A3-18

ACCESSORY DRIVE

The engine accessory drive consists of dual serpentine belts, that decouple the generator and air conditioning compressor for improved noise isolation. Using dual belts also provides design flexibility to optimise structural stiffness of support brackets.

The system includes two automatic belt tensioners with a low static tension for increased belt and bearing life.

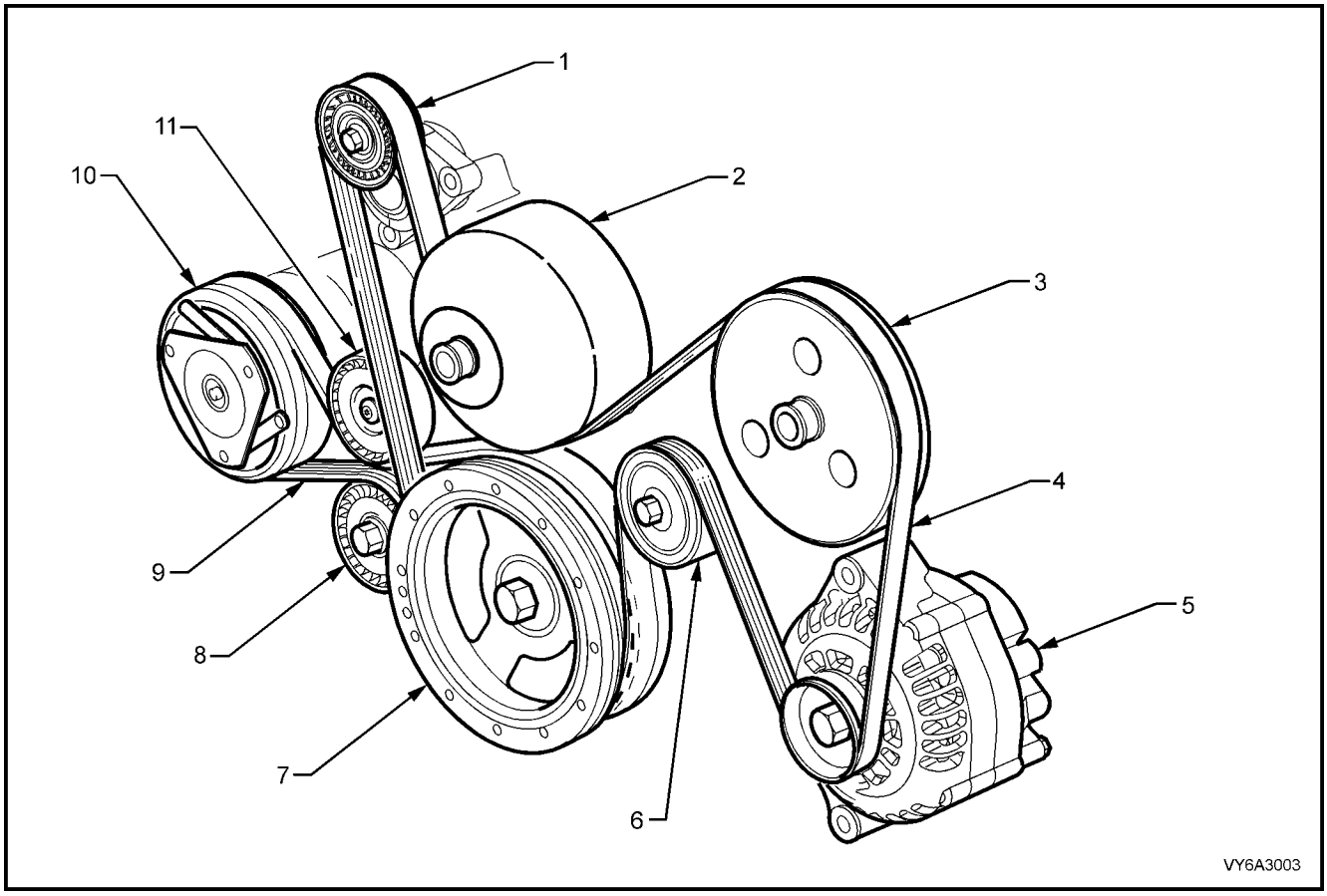

Figure 6A3-19

Legend

1. Accessory Drive Belt, Automatic Tensioner
2. Water Pump Pulley
3. Power Steering Pump Pulley
4. Engine Accessory Drive Belt
5. AC Generator
6. Accessory Drive Belt, Idler Pulley
7. Crankshaft Balancer Pulley
8. Air Conditioning Compressor Drive Belt Automatic Tensioner
9. Air Conditioning Compressor Drive Belt
10. Air Conditioning Compressor
11. Air Conditioning Compressor Drive Belt, Idler Pulley

OIL PAN

The oil pan (1) is cast aluminium and forms a structural part of the powertrain, by providing a 360° mounting for the transmission, whether it be Manual or Automatic.

Cast-in dams incorporated into the oil pan design, minimise oil migration during braking and cornering manoeuvres and oil is guided to the pick-up screen (2), via strategically placed openings in the dam walls.

Incorporated into the design are the oil filter mounting boss (3), an opening for the drain plug (4), and a stamped, oil pan baffle (6).

The oil pan baffle (6), maintains an area around the pick-up screen to prevent oil starvation/aeration.

A crankshaft oil deflector (7) mounted to the main bearing caps controls windage, scrapes oil from the crankshaft, facilitates drainback and reduces aeration.

The oil pan gasket (8), is a controlled compression aluminium carrier gasket with silicone used as the sealing agent.

Two O-ring seals (9) were introduced as a running change to stop oil wicking along the studs, resulting in an oil leak from this area. As the oil pan requires chamfers to be machined around each of the two stud holes, fitment of the O-rings to earlier build engines without the machined chamfers, is not possible without also changing the oil pan.

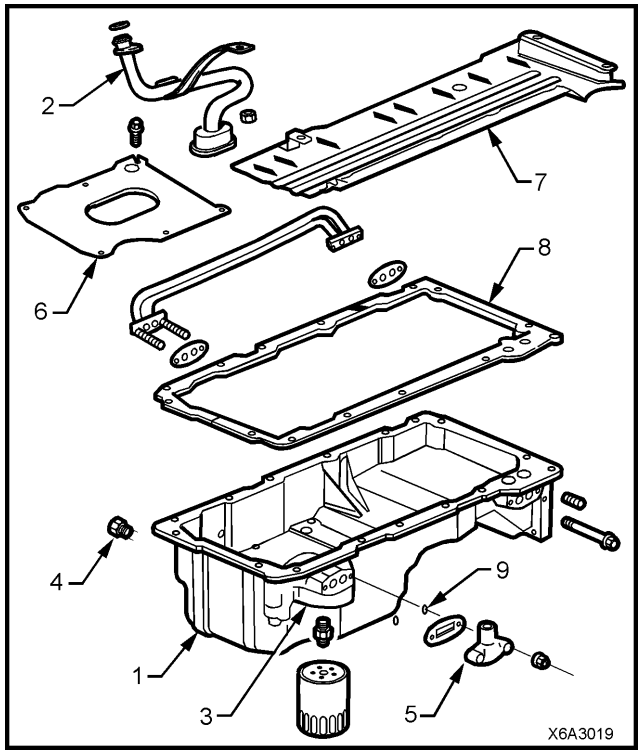

Figure 6A3-20

1.4 ENGINE LUBRICATION SYSTEM

OIL PUMP

Engine lubrication is supplied by a “Gerotor” type oil pump assembly. The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurised as it passes through the pump and is sent through the engine block oil galleries.

Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range. Pressurised oil is directed through the lower gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter that still allows oil to flow in the event that the filter becomes blocked.

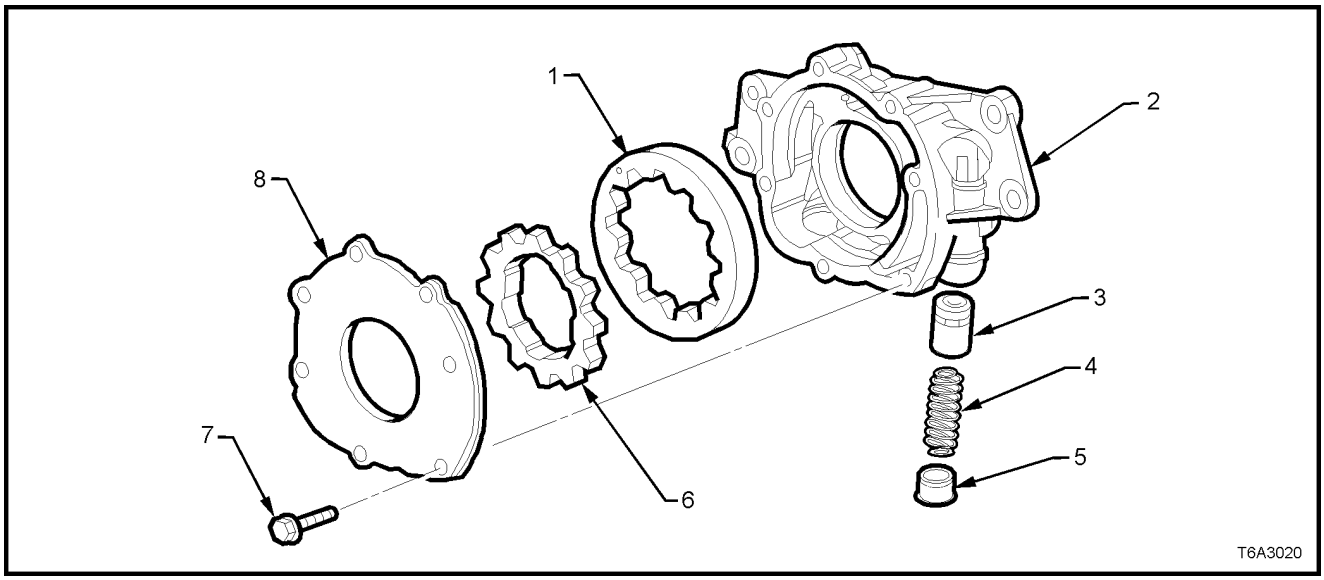

Figure 6A3-21 - Oil Pump Assembly

Legend

1. Driven Gear
2. Oil Pump Housing
3. Pressure Relief Valve
4. Spring – Pressure Relief Valve
5. Plug
6. Drive Gear
7. Bolt – Cover
8. Cover

At the rear of the block, oil is directed to the upper main oil galleries which are drilled just above the camshaft assembly. From there, oil is then directed to the crankshaft and camshaft bearings. Oil that has entered the upper main oil galleries also pressurises the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems.

Oil returning to the pan is directed by the crankshaft oil deflector.

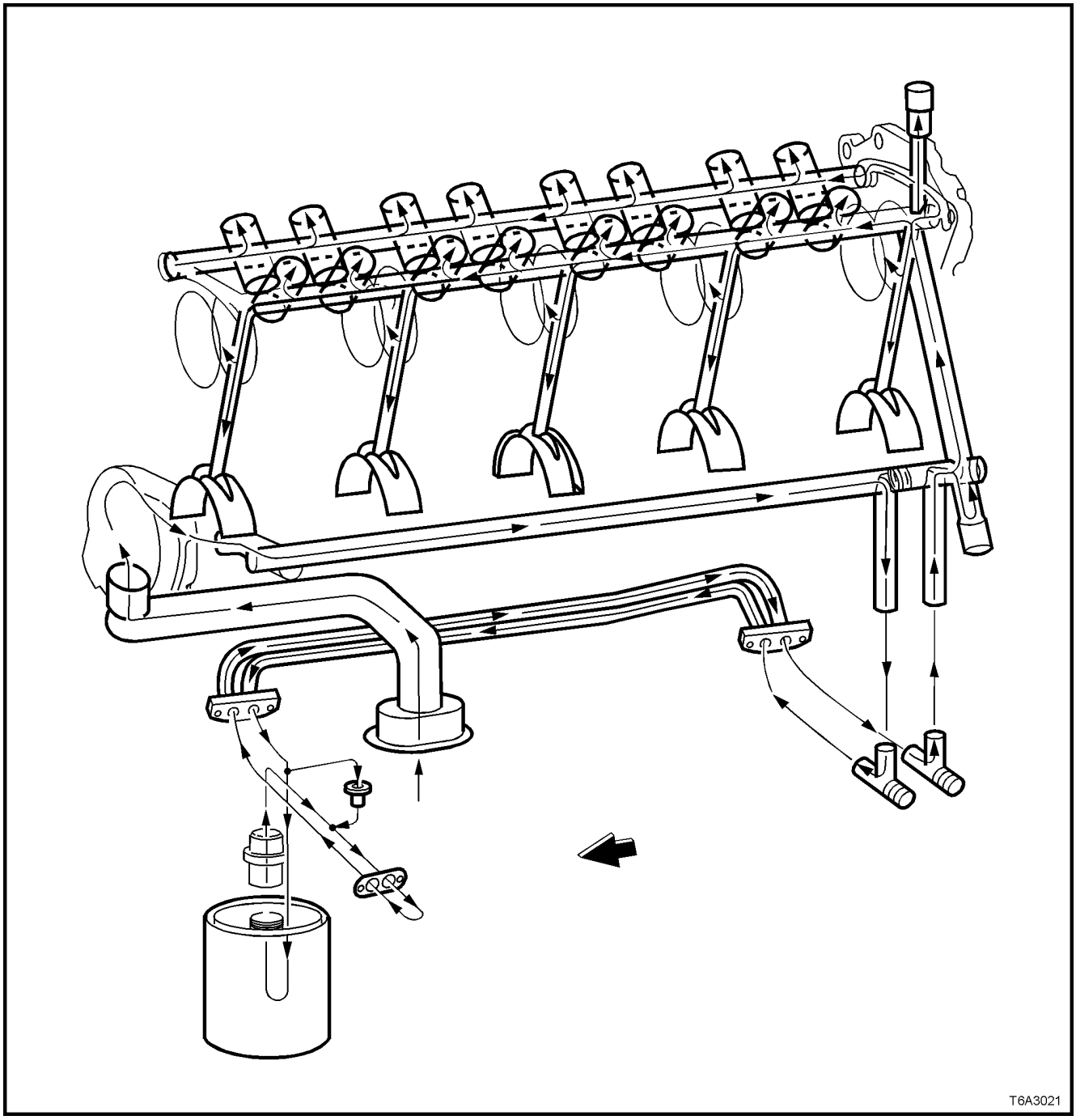

Figure 6A3-22 - Lubrication Flow Schematic

CRANKSHAFT OIL SEALS

The GEN III V8 engine uses a multiple lip crankshaft rear main oil seal, designed for long life operation.

The seal includes a PTFE (Teflon®) centre lip (1) to minimise a major cause of rear main oil seal leaks. The anti-friction properties of the PTFE reduces the chances of “choking” or build-up of degraded oil on the lip (causing the lip to lift off the shaft), resulting in a leak.

Like the rear main oil seal, the front crankshaft oil seal also incorporates a PTFE lip.

Service implications for this seal material are that **no** lubricant is to be added to the seal lip on installation, as this will prevent correct ‘break-in’ of the seal. The PTFE is actually deposited on the **dry** crankshaft seal surface during initial operation by the heat generated from the rotating shaft.

The outside of the seal may be lubricated sparingly to ease installation.

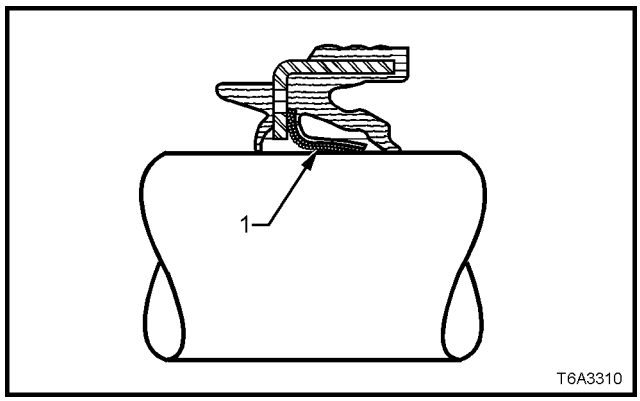

Figure 6A3-23

POSITIVE CRANKCASE VENTILATION SYSTEM

The engine ventilation system was developed to minimise oil consumption and ensure that oil ingestion could not occur during severe vehicle handling manoeuvres.

Filtered fresh air is routed from upstream of the throttle blade to the front of the right rocker cover via a formed rubber hose (2). To reduce the potential of oil pullover into the throttle bore area due to back flow of the ventilation system, the fitting in the right side rocker cover is located in a “quiet” area located between, and shielded from, the rocker arms. Crankcase blowby gases are routed from the rear of both rocker covers, through moulded nylon lines to a tee fitting, located on the centreline of the engine at the rear of the intake manifold (4). From there, a single hose carries crankcase vapours through an externally mounted, horizontal PCV valve (3) and enters the intake manifold behind the throttle body (1).

The hoses are foam insulated and the PCV valve (3) is conduction-heated from the cylinder block.

This “dual draw system” was developed to meet high ‘g’ forces (bold arrow) incurred during severe cornering manoeuvres. During sustained maximum lateral accelerations, the outboard rocker cover (1) may fill with oil.

The “dual draw” system “passively switches”, allowing the PCV valve to draw on the rocker cover with the least resistance. This results in the system drawing on the air filled, or inboard, rocker cover (2) and eliminates oil pullover that would result from drawing on the oil filled outboard rocker cover.

Sectioned view shown is looking rearward from the engine front.

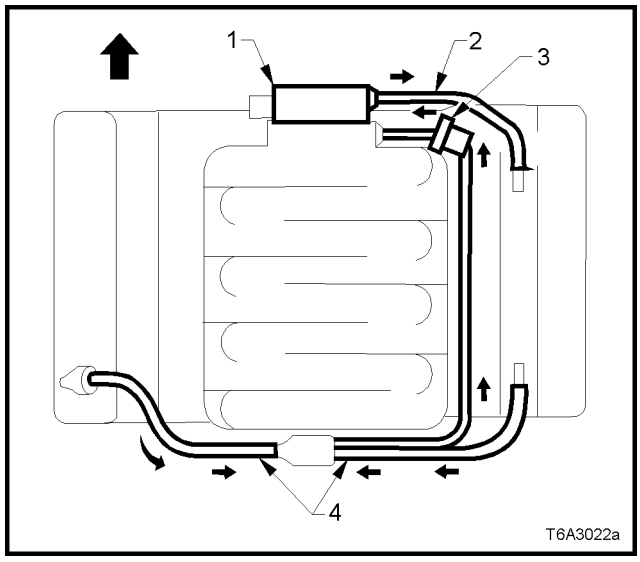

Figure 6A3-24

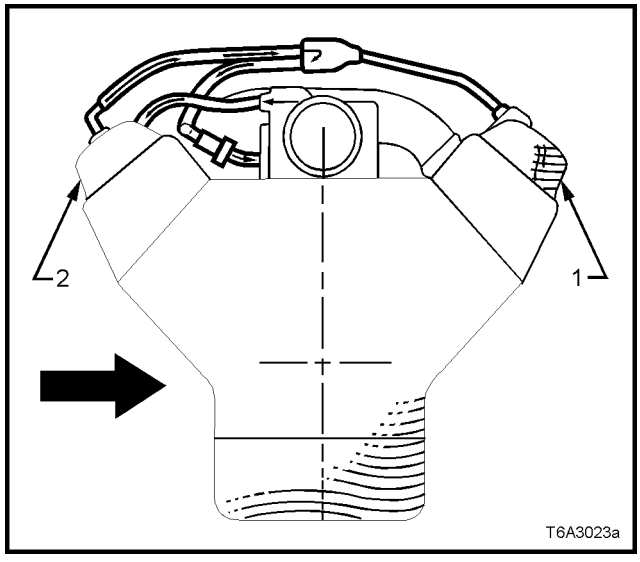

Figure 6A3-25

1.5 SERVICE NOTES

CLEANLINESS AND CARE

- Throughout this Section, it must be understood that proper cleaning and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard Workshop practice, even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organised or retained in a specific order for reassembly. Refer to **Separating Parts**.
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- Any engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in hundredths of millimetres. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly, as proper lubrication will protect and lubricate friction surfaces during the initial engine start-up.

REPLACING ENGINE GASKETS

- Re-using gaskets and applying sealants.
  - Do not reuse any gasket unless specified.
  - Gaskets that can be reused will be identified in the service procedure.
  - Do not apply sealant to any gasket or sealing surface unless called out in the service information.
- Separating components
  - Use a rubber mallet to separate components.
  - Bump the part sideways to loosen the components.
  - Bumping should be done at bends or reinforced areas to prevent distortion of parts.
- Cleaning gasket surfaces
  - Remove all gasket and sealing material from the part using a plastic or wood scraper (if required).
  - Care must be used to avoid gouging or scraping the sealing surfaces.
  - Do not use any other method or technique to remove sealant or gasket material from a part.
  - Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
    - These methods of cleaning can cause damage to the component sealing surfaces.
    - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
    - This grit is abrasive and has been known to cause internal engine damage.
- Assembling components
  - When assembling components, use only the sealant specified or equivalent in the service procedure.
  - Sealing surfaces should be clean and free of debris or oil.
  - Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
  - Components requiring lubrication will be identified in the service procedure.
  - When applying sealant to a component, apply the amount specified in the service procedure.
  - Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
  - Only ever tighten bolts to specifications. Do not overtighten.

USE OF RTV AND ANAEROBIC SEALER

IMPORTANT: A number of sealant types are commonly used in engines. Examples are; Room Temperature Vulcanising (RTV) sealer, anaerobic gasket eliminator sealer, anaerobic thread sealant and pipe joint compound. The correct sealant and amount must be used in the specified location to prevent oil leaks. DO NOT interchange the different types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

Pipe Joint Compound

- Pipe joint compound is a pliable sealer that does not completely harden. This type of sealer is used where two non-rigid parts (such as pressed steel and machined surfaces) are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.
- To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets** in this Section.
- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any boltholes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when the bolt is tightened.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

Examples of locations where a pipe sealant type material such as Loctite 565 (or other commercial equivalent) is to be used, are:

- Engine block coolant and oil gallery plugs.
- Oil pressure sensor threads.
- Engine block oil pan surface.

RTV Sealer

- Room Temperature Vulcanising (RTV) sealant hardens when exposed to air. This type of sealer is used where two non-rigid parts (such as the intake manifold and the engine block) are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are experienced. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.
- To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.
- Apply RTV to a clean surface. Use a bead size as specified in the service procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when the bolt is tightened.
- Assemble components while RTV is still wet (within 3 minutes). Do not wait for RTV to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator or thread sealant, hardens in the absence of air. This type sealer is used where two rigid parts (such as castings) are assembled together or where fasteners are subjected to vibration or where the holes are not blind. When two rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.
- To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets** in this Section.
- Apply a continuous bead of gasket eliminator to one flange or on the bolt/stud thread. All surfaces must be clean and dry.
- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.
- Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when tightened.

  IMPORTANT: Anaerobic sealed joints that are partially torqued and allowed to cure more than five minutes may result in incorrect shimming and sealing of the joint.
- Only ever tighten bolts to specification. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

Examples where thread locking sealants such as Loctite 242 or Loctite 272 (or other commercial equivalents) are to be used, are the fasteners for:

- Fuel rail. ..... '242'
- Intake manifold..... '242'
- Cylinder head M8..... '242'
- Exhaust manifold. ..... '272'

SEPARATING PARTS

IMPORTANT: Many internal engine components will develop specific wear patterns on their friction surfaces. So, when disassembling the engine, internal components MUST be separated, marked, or organised in a way to ensure reinstallation to their original location and position.

Separate, mark, or organise the following components:

- Piston and the piston pin.
- Piston to the specific cylinder bore.
- Piston rings to the specific piston.
- Connecting rod to the crankshaft journal.
- Connecting rod to the bearing cap.
- Crankshaft main and connecting rod bearings.
- Camshaft and valve lifters.
- Valve lifters, guides, pushrods, pivot supports and rocker arms.
- Valve to the valve guide.
- Valve spring and shim to the cylinder head location.
- Engine block main bearing cap location and direction.
- Oil pump drive and driven gears.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this Section with a complete listing at the end of the Section. These tools (or their equivalents) are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimise possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and torque angle tools are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves.
- A clean, well-lit, work area.
- A suitable parts cleaning tank.
- A compressed air supply.
- Trays or storage containers to keep parts and fasteners organised.
- An adequate set of hand tools.
- Approved engine repair stand.
- An approved engine lifting device that will adequately support the weight of the components.

FASTENERS

Fasteners are central to the reliable operation of any engine and the GEN III V8 engine is no exception.

Whenever any bolt or any other threaded component is removed from the engine, it is necessary to first allow the engine to cool (inset 'B') before attempting fastener removal.

Because of the greater thermal expansion of aluminium, bolt threads will change dimension to a greater extent when hot with this material (inset 'A') when compared to cast iron.

If a bolt or other threaded component is removed before the engine is allowed to cool to at least 50° C, threads could be pulled from the cylinder block or cylinder head.

Also, DO NOT use impact tools to remove bolts during engine disassembly. While this may be common practice with cast iron engine components, use of these tools is more likely to pull the aluminium threads in the cylinder block or head of this engine.

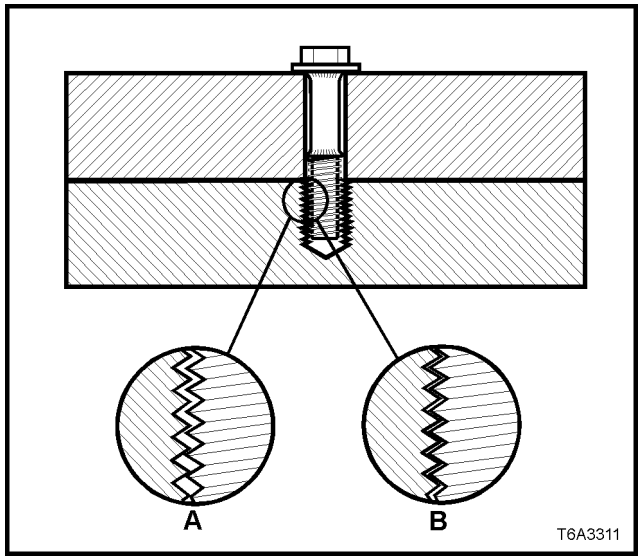

Figure 6A3-26

Clamp Load

When torque is applied to a fastener, the fastener stretches and the joint compresses. The force developed in the fastener due to its stretch is called tension ('C'), while the force applied to the joint is called "clamp load" ('B').

As shown, only a small portion of the applied torque ('A') is transferred to the clamp load (inset '1'). Friction under the bolt head (inset '3') and in the threads (inset '2') absorbs much of the applied torque ('A'). Typically, only 10% (inset '1') of the torque is available to develop stretch (or tension) in the fastener and clamp load in the joint.

Therefore, a slight variation in friction in the thread or under the bolt head, results in a wide variation in the clamp load applied to the joint.

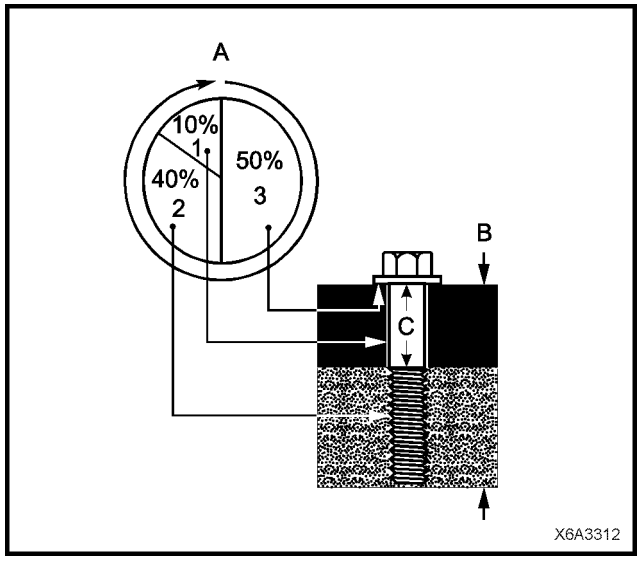

Figure 6A3-27

Torque Angle and Torque to Yield Fasteners

The torque angle method of applying torque to a fastener has been developed to overcome the effects of friction variation in fastener applications.

The application of the torque angle method does not always mean that the fastener has to be replaced after loosening. It is only when the fastener has been angle tightened to the extent that the "yield" point has been exceeded, that the fastener must be replaced.

Examples in the GEN III V8 engine are the main bearing caps that are angle tightened but the bolts can be re-used, whereas the M11 cylinder head bolts that are "Torque to Yield" fasteners, MUST be replaced after loosening.

2. MINOR SERVICE OPERATIONS

2.1 ENGINE OIL LEVEL CHECK

1. Engine must be at normal operating temperature (drive the vehicle for 15 minutes).
2. Park vehicle on level surface (as this will affect the accuracy indicated on dipstick:- this is a critical requirement).
3. Do not check oil level for at least 10 minutes after engine shut down to allow oil to drain back into the oil pan.
4. Remove dipstick and wipe clean.
5. Reinstall dipstick, with the “ADD/FULL” marks facing towards the centre of the engine, ensuring that it is fully seated. After leaving for several seconds, slowly remove to avoid smearing, then hold horizontally to avoid oil running along dipstick.
6. Observe the oil level where it passes over the centre line of the dipstick.
7. When topping up the engine oil, allow approximately 15 minutes for the oil added to fully drain into the oil pan. Alternatively, add 55 ml of oil for each millimetre below the “FULL” mark on the dipstick.

2.2 ENGINE OIL - CHANGE

NOTE 1: Quicker and more complete draining will occur if the engine oil is at operating temperature. However, care must be taken to avoid scalding from the hot oil.

NOTE 2: While the oil pan is aluminium, it is fitted with a steel thread insert to increase durability of the thread and to avoid thread tearing when the drain plug is removed from a hot engine

NOTE 3: It is also recommended that the oil filter is changed at each engine oil change, refer **2.3 ENGINE OIL FILTER & ADAPTOR**, in this Section.

1. Raise the engine hood and remove the oil fill cap.
2. Raise the vehicle front and rear to maintain a level attitude and support with safety stands. This is to ensure complete draining. Refer to **Section 0A GENERAL INFORMATION**.
3. Remove the four bolts securing the oil pan under-tray.
4. Clean any foreign material from around the oil pan drain plug.
5. Place an oil drain tray beneath the engine.
6. Using a 15 mm ring spanner, remove the drain plug, taking care to avoid scalding with the hot waste oil.
7. When the oil has drained sufficiently, reinstall the drain plug, after inspecting and cleaning the threads and inspecting the magnetic plug end for ferrous material. The drain plug O-ring seal may be re-used if not cut or damaged. Tighten the drain plug to the correct torque specification.

ENGINE OIL PAN DRAIN PLUG TORQUE SPECIFICATION	25 Nm

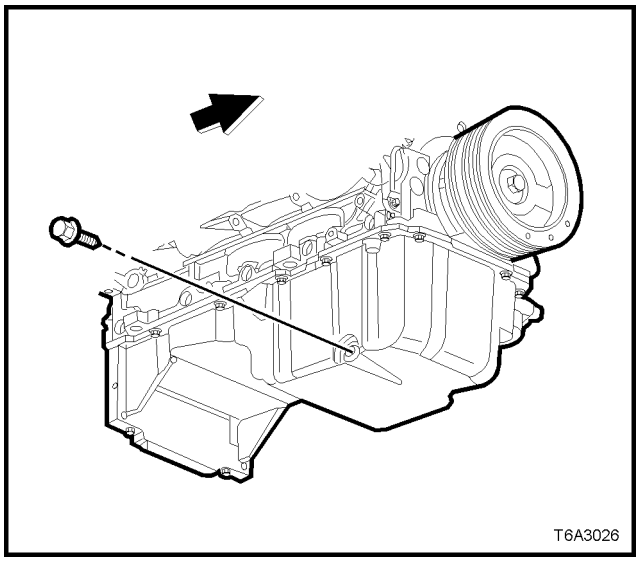

Figure 6A3-28

8. Reinstall the oil pan under-tray and tighten the four bolts to the correct torque specification.

OIL PAN UNDER-TRAY BOLT TORQUE SPECIFICATION	32 Nm

9. Lower the vehicle and fill the crankcase with the required amount of 10W30 SJ ILSAC GF2 engine oil.

NOTE: If this oil is unavailable, a 20W50 SJ or 15W/40 SJ engine oil should be used.

ENGINE OIL CAPACITY	
Without Oil Filter Change	5.2 litres
With Oil Filter Change	5.7 litres

NOTE: Synthetic oils of this viscosity are also an acceptable engine lubricant.

10. Start the engine and check for oil leaks.

2.3 ENGINE OIL FILTER & ADAPTOR

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NOTE: The oil filter should be replaced at the time or distance intervals, specified in the Owner's Handbook or whenever the engine oil is changed.

REPLACE

1. Raise the engine hood and remove the oil fill cap.
2. Raise the vehicle front and rear to maintain a level attitude and support with safety stands. This is to ensure complete draining. Refer to **Section 0A GENERAL INFORMATION**.
3. Remove the four bolts securing the oil pan under-tray.
4. Drain the engine oil as detailed in **2.2 ENGINE OIL - CHANGE**, in this Section.
5. Remove the oil filter (1), using a commercially available tool, taking care to avoid being scalded with the hot waste oil.
6. Should it be required, remove the oil filter adaptor (2) from the oil pan filter mounting flange, using a suitable socket.
7. After checking that the filter seal has not adhered to the oil pan flange, inspect the oil filter sealing surface for scratches or other damage and check the oil filter adaptor threads for damage.
8. If removed, reinstall the oil filter adaptor and tighten to the correct torque specification.

OIL FILTER ADAPTOR TORQUE SPECIFICATION	55 Nm

9. Smear some new engine oil onto the new filter seal, then install filter assembly to engine.
10. Tighten oil filter to the correct torque specification.

ENGINE OIL FILTER TORQUE SPECIFICATION	30 Nm

11. Reinstall the oil pan under-tray and tighten the four bolts to the correct torque specification.

OIL PAN UNDER-TRAY BOLT TORQUE SPECIFICATION	30 Nm

12. Lower the vehicle and fill the crankcase with the required amount of recommended, new lubricant. Refer to **2.2 ENGINE OIL – CHANGE**, in this Section for the recommended procedure.
13. Start the engine and check for oil leaks.

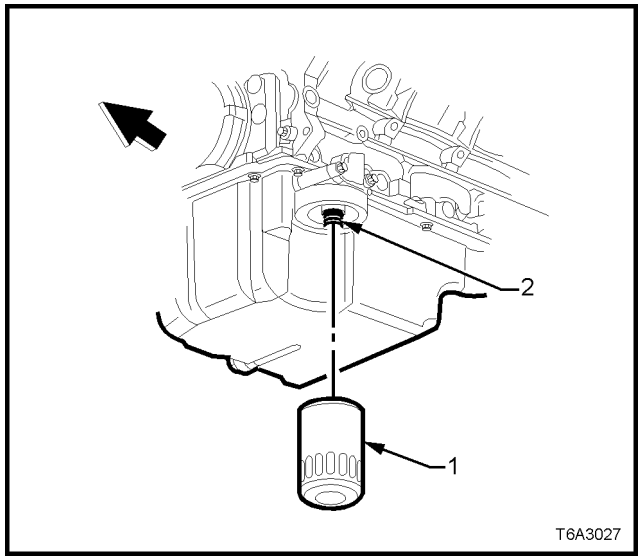


Figure 6A3-29

2.4 ENGINE OIL PRESSURE - CHECK

1. Ensure that engine is at operating temperature. Driving a cold vehicle for 15 minutes, should be sufficient to normalise the temperature.
2. Remove oil filter; refer **2.3 ENGINE OIL FILTER & ADAPTOR**, in this Section.
3. Install adaptor J 42907 to the oil filter adaptor.
4. On a level surface, check engine oil level and top up as required. Refer to **2.2 ENGINE OIL – CHANGE**, in this Section.
5. Install commercially available, accurate oil pressure gauge (capable of reading 800 kPa or higher) and suitably rated pressure hose, to adaptor J 42907.
6. Start the engine and check the oil pressure with the engine running with no load.
7. Check that the oil pressure is within the following specifications.

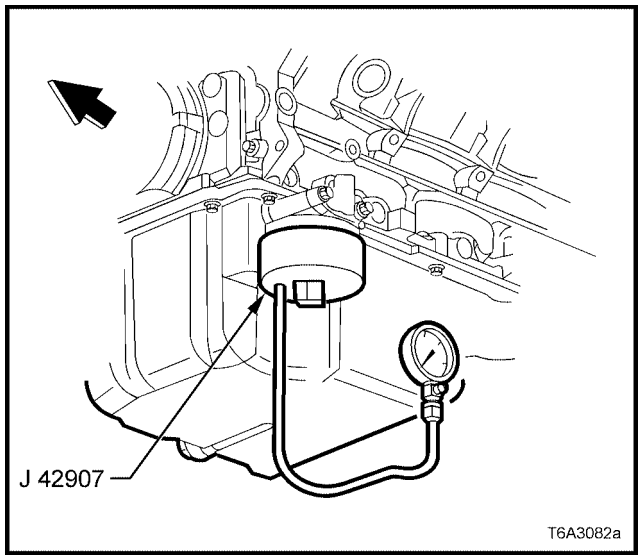


Figure 6A3-30

ENGINE OIL PRESSURE SPECIFICATION	
ENGINE SPEED	OIL PRESSURE READING
1,000 rpm	90 kPa (Minimum, Hot)
2,000 rpm	125 kPa (Minimum, Hot)
4,000 rpm	165 kPa (Minimum, Hot)

NOTE: If the oil pressure check indicates that the oil pressure is not to specification, then refer to **4.5 OIL PRESSURE DIAGNOSIS**, in this Section.

8. After completing the pressure check, stop the engine and remove the oil pressure gauge and adaptor assembly.
9. Install the oil filter. Refer **2.3 ENGINE OIL FILTER & ADAPTOR**, in this Section.
10. Top up engine oil level as required.

2.5 COMPRESSION CHECK

1. Before conducting this check, ensure that the:

a. Battery is at or near a full state of charge.

c. Spark plugs are all removed.

d. Throttle plate is held wide open.

2. With the ignition switched OFF, disable the ignition system and fuel injectors, by removing the Engine Control (EFI) relay X4, located in the underhood electrical centre.
3. Install a suitable, commercially available and accurate, compression tester, that has been reset to zero.
4. Crank the engine through approximately four compression strokes (four 'puffs'). Record the reading.
5. Repeat this compression check for each cylinder. Again, record each reading.
6. If a cylinder has low compression, inject about 15 ml (one tablespoon) of engine oil into the combustion chamber through the spark plug hole.
7. Recheck the compression and record the reading.

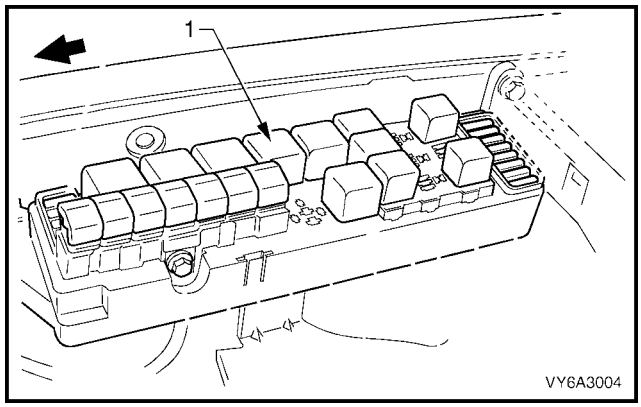


Figure 6A3-31

INTERPRETING COMPRESSION READINGS

The minimum compression in any one cylinder should not be less than 70% of the highest cylinder. No cylinder should read less than 690 kPa. For example, if the highest pressure in any one cylinder is 1035 kPa, the lowest allowable pressure for any other cylinder would be 725 kPa. (1,035 x 70% = 725).

NORMAL - Compression builds up quickly and evenly to the specified compression for each cylinder.

PISTON RINGS LEAKING - Compression is low on the first stroke. Compression then builds up with the following strokes but does not reach normal. Compression improves considerably when you add oil.

VALVES LEAKING - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.

CYLINDER HEAD GASKET LEAKING - If two adjacent cylinders have lower than normal compression and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

2.6 ENGINE DRIVE BELTS – REPLACE

LT Section No. – 01-003

1. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
2. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake hose (4) to the MAF sensor and the throttle body. Remove the hose (4) from the engine.

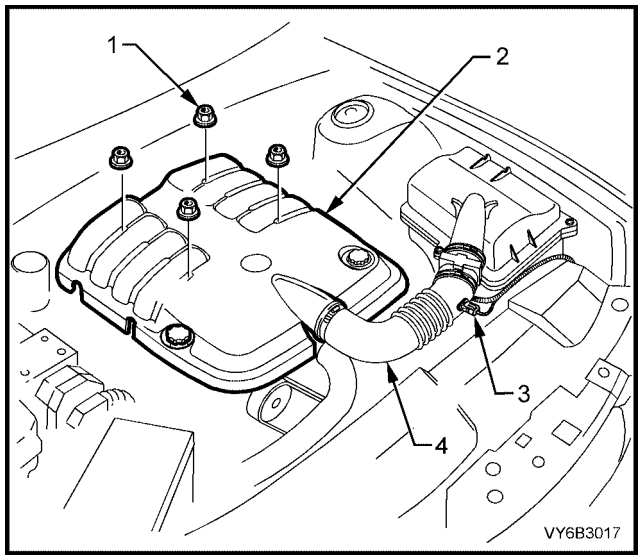


Figure 6A3-32

ENGINE ACCESSORY DRIVE BELT

1. Using a 15 mm ring spanner, rotate the accessory automatic drive belt tensioner (1), in the direction indicated, to reduce belt tension.
2. While holding the tensioner in the reduced tension position, remove the accessory drive belt (2), taking note of the belt routing.

NOTE: Use an assistant to maintain the tensioner in the required position.

3. Clean the accessory drive belt running surfaces and inspect the belt for damage.
4. While rotating the accessory drive belt tensioner (1) in the direction indicated, install the drive belt (2) over the pulleys, routing the belt correctly, as shown.
5. Inspect the installation to ensure that the belt is correctly aligned on all pulleys.
6. Reinstall the engine dress cover, securing with the four decorative nuts and tightening to the correct torque specification.

ENGINE DRESS COVER NUT TORQUE SPECIFICATION	10 Nm

7. Start the engine to ensure correct operation.

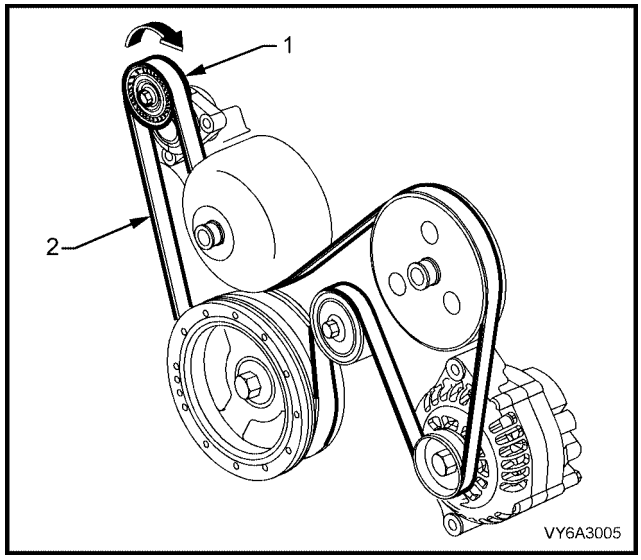


Figure 6A3-33

AIR CONDITIONING COMPRESSOR BELT

NOTE: The accessory drive belt must be removed first to allow access to this belt. Refer to the previous operation for details.

1. Raise the vehicle and support with safety stands. Refer to **Section 0A GENERAL INFORMATION**.
2. Remove the four bolts securing the oil pan under-tray.
3. From under the vehicle, rotate the A/C drive belt tensioner in the direction shown, using a 15 mm set spanner, to relieve belt tension.
4. While using an assistant to maintain the tensioner in the required position, remove the drive belt from the pulleys.

NOTE: An alternative to using an assistant, would be to secure the spanner using tie wire.

5. Clean the A/C drive belt running surfaces and inspect the belt for damage.
6. While holding the A/C drive belt tensioner in the direction indicated, install the drive belt over the pulleys, routing the belt correctly, as shown.
7. Inspect the installation to ensure that the belt is correctly aligned on all pulleys.
8. Reinstall the accessory drive belt as described in the previous operation.
9. Start the engine to ensure correct operation.
10. Reinstall the oil pan under-tray and tighten the bolts to the correct torque specification.

OIL PAN UNDER-TRAY BOLT TORQUE SPECIFICATION	30 Nm

11. Lower the vehicle and test for correct operation.

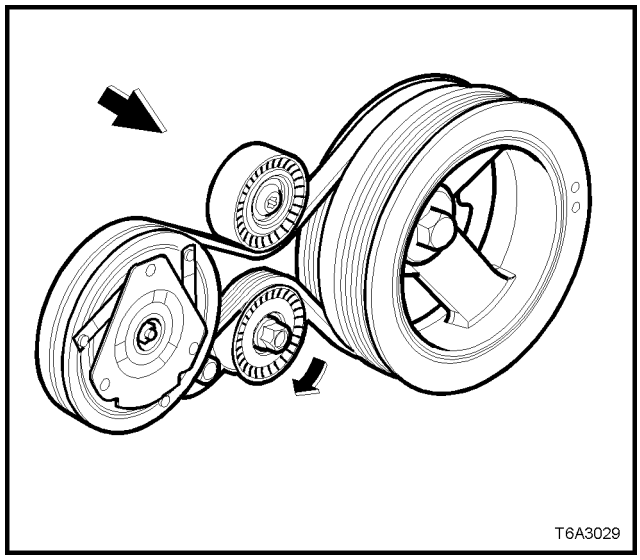


Figure 6A3-34

2.7 ACCESSORY BELT IDLER PULLEY

LT Section No. – 01-020

REPLACE

1. Remove the engine accessory drive belt. Refer to **2.6 ENGINE DRIVE BELTS – REPLACE**, in this Section for the necessary procedure.
2. Remove the idler pulley retaining bolt, then remove the pulley from its mounting boss, on the generator mounting bracket.
3. Install the idler pulley to its mounting boss.
4. Install the idler pulley retaining bolt and tighten to the correct torque specification.

ACCESSORY BELT IDLER PULLEY TORQUE SPECIFICATION	50 Nm

5. Install the engine accessory drive belt. Refer to **2.6 ENGINE DRIVE BELTS – REPLACE**, in this Section for the necessary procedure.

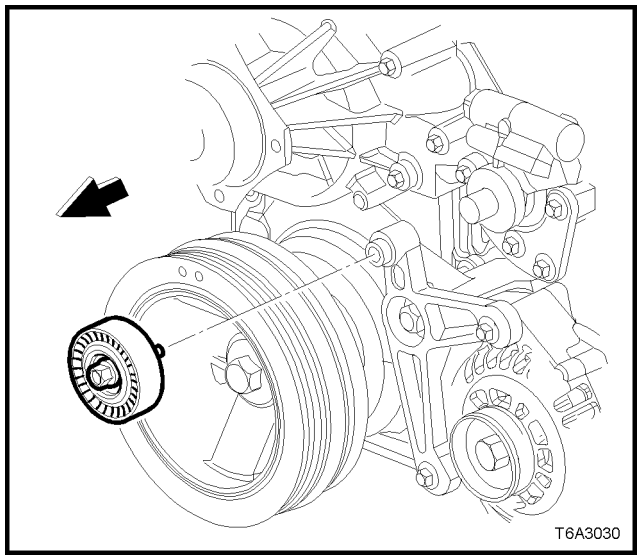


Figure 6A3-35

2.8 A/C BELT IDLER PULLEY

LT Section No. – 01-020

REPLACE

1. Raise the vehicle and support with safety stands. Refer to **Section 0A GENERAL INFORMATION**.
2. Remove the four bolts securing the oil pan under-tray.
3. From under the vehicle, rotate the A/C drive belt tensioner in the direction shown in Figure 6A3-34, using a 15 mm set spanner, to relieve belt tension.
4. While using an assistant to maintain the tensioner in the required position, remove the drive belt from the pulleys but leave hanging on the crankshaft pulley.

NOTE: An alternative to using an assistant, would be to secure the spanner using tie wire.

5. Using a commercially available Torx bit T50, remove the bolt securing the A/C compressor drive belt idler pulley to its mounting boss on the coolant pump housing, then remove the pulley assembly.
6. Install the idler pulley to its mounting boss.
7. Install the idler pulley retaining bolt and tighten to the correct torque specification.

A/C COMPRESSOR BELT IDLER PULLEY BOLT TORQUE SPECIFICATION	50 Nm

8. Install the A/C compressor drive belt. Refer to **2.6 ENGINE DRIVE BELTS – REPLACE**, in this Section for the necessary procedure.
9. Reinstall the oil pan under-tray and tighten the bolts to the correct torque specification.

OIL PAN UNDER-TRAY BOLT TORQUE SPECIFICATION	30 Nm

10. Lower the vehicle and test for correct operation.

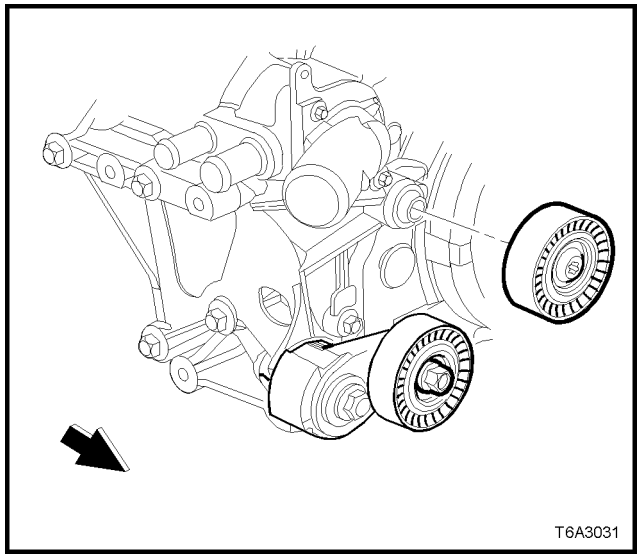


Figure 6A3-36

2.9 ACCESSORY BELT TENSIONER

LT Section No. – 01-020

REPLACE

1. Remove the engine accessory drive belt. Refer to **2.6 ENGINE DRIVE BELTS – REPLACE**, in this Section for the necessary procedure.
2. Remove the tensioner pulley bracket retaining bolts (1), then remove the assembly (2).
3. Install the tensioner assembly (2) and the two mounting bolts.
4. Tighten both mounting bolts (1) to the correct torque specification.

ACCESSORY BELT TENSIONER BOLT TORQUE SPECIFICATION	50 Nm

5. Install the engine accessory drive belt. Refer to **2.6 ENGINE DRIVE BELTS – REPLACE**, in this Section for the necessary procedure.

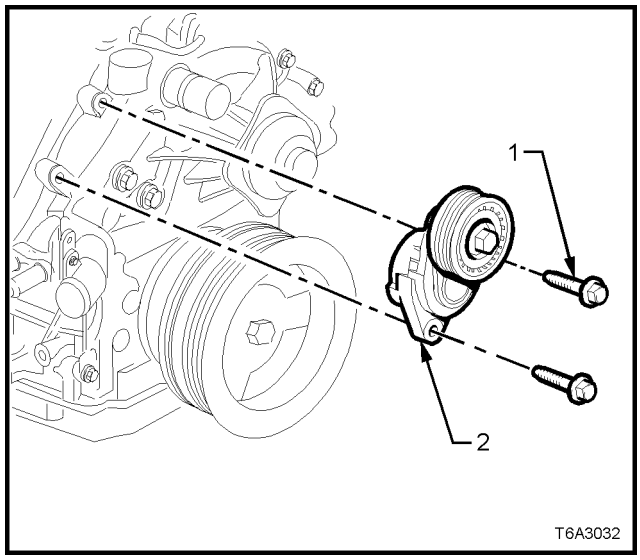


Figure 6A3-37

2.10 A/C BELT TENSIONER

LT Section No. – 01-020

REPLACE

1. From under the vehicle, rotate the A/C drive belt tensioner in the direction shown in Figure 6A3-34, using a 15 mm set spanner, to relieve belt tension.
2. While using an assistant to maintain the tensioner in the required position, remove the drive belt from the pulleys but leave hanging on the crankshaft pulley.

NOTE: An alternative to using an assistant, would be to secure the spanner using tie wire.

3. Remove the bolt (1) securing the A/C compressor drive belt tensioner, then remove the assembly.
4. Install the tensioner assembly and the mounting bolt.
5. Tighten the tensioner mounting bolt to the correct torque specification.

A/C COMPRESSOR BELT TENSIONER BOLT TORQUE SPECIFICATION	25 Nm

6. Install the A/C compressor drive belt. Refer to **2.6 ENGINE DRIVE BELTS – REPLACE** in this Section for the necessary procedure.

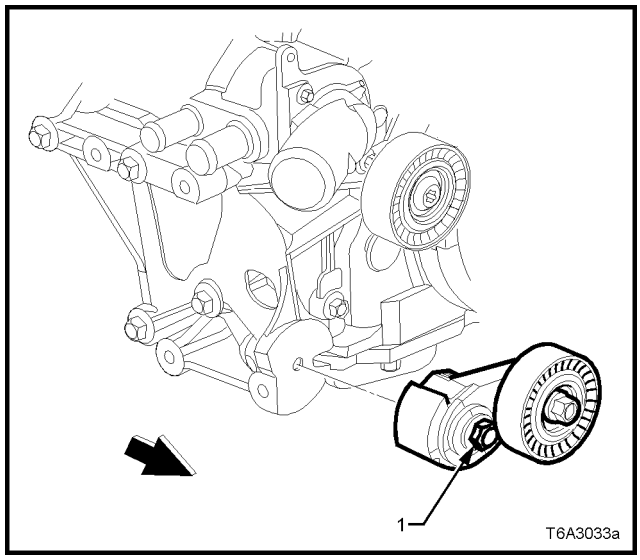


Figure 6A3-38

2.11 OIL PRESSURE SENSOR

LT Section No. – 02-000

REPLACE

1. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.

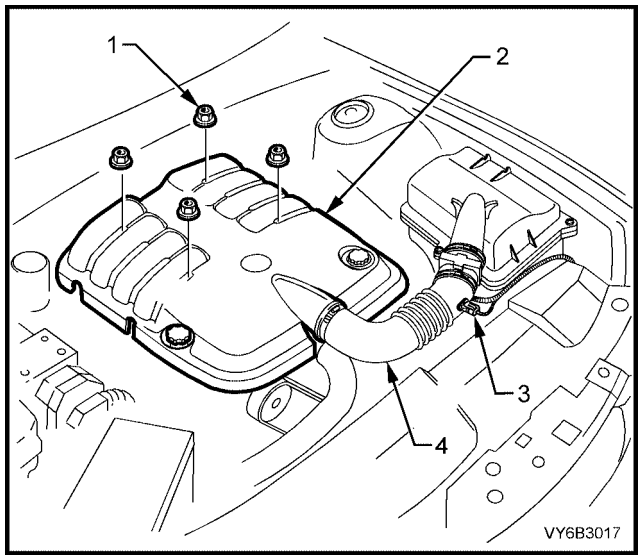


Figure 6A3-39

2. Release the wiring harness connector locking tang from the oil pressure sensor, then remove the connector (2) from the sensor.

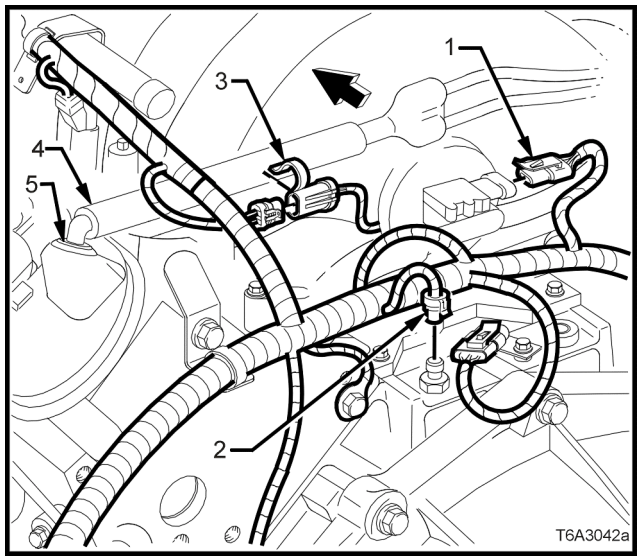


Figure 6A3-40

3. Using Tool No. J 41712 and suitable 3/8” drive socket equipment, remove oil pressure sensor (1) from the left hand rear of the engine cylinder block.
4. Prior to reinstallation apply Loctite 565 sealant (or equivalent) to the cleaned oil pressure sensor threads.
5. Reinstall the oil pressure sensor (1) and tighten with Tool No. J 41712 and suitable 3/8” drive socket equipment, to the correct torque specification.

OIL PRESSURE SENSOR TORQUE SPECIFICATION	20 Nm

6. Reinstall the engine dress cover, securing with the four decorative nuts and tightening to the correct torque specification.

ENGINE DRESS COVER NUT TORQUE SPECIFICATION	10 Nm

7. Start the engine to ensure correct operation.

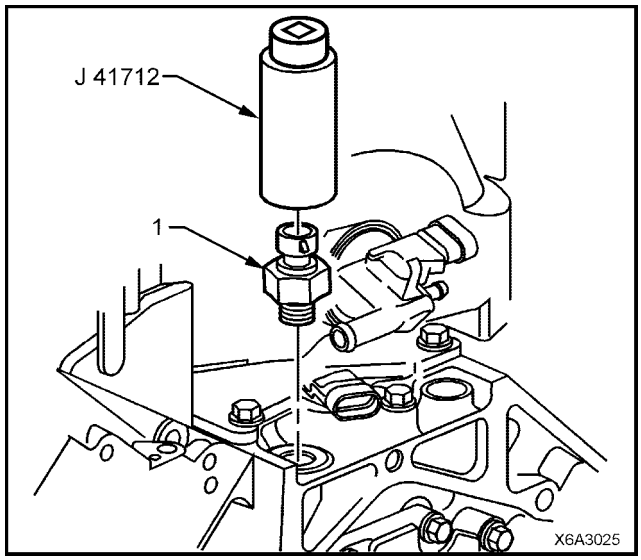


Figure 6A3-41

2.12 MANIFOLD ABSOLUTE PRESSURE SENSOR

LT Section No. – 02-000

REPLACE

1. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.

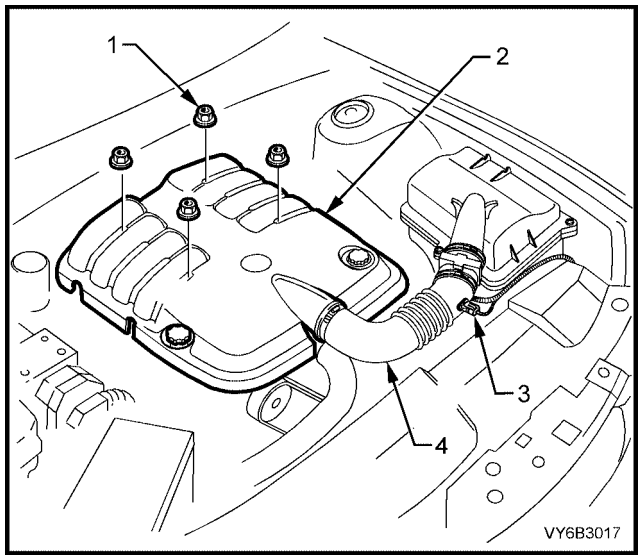


Figure 6A3-42

2. Release the wiring harness connector locking tang (1) from the manifold absolute pressure (MAP) sensor, then remove the connector from the sensor.

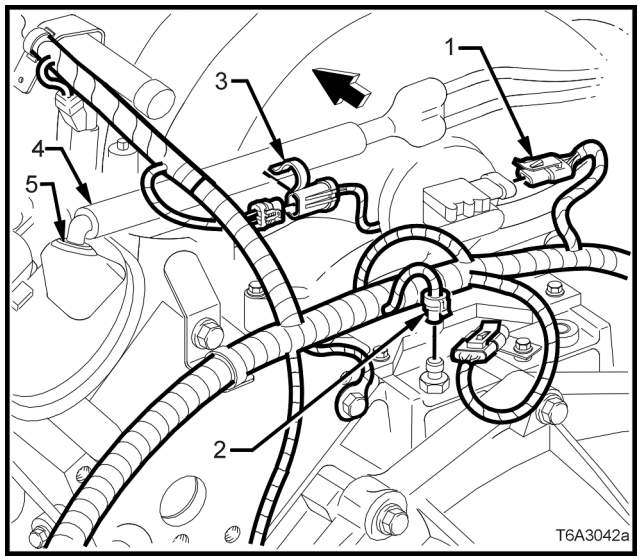


Figure 6A3-43

3. Grasp the MAP sensor (1) at the rear of the intake manifold and twist back and forth while pulling upward, to remove.
4. Check the silicone rubber seal (2) on the MAP sensor to ensure it is not torn or damaged.
5. Reinstall the MAP sensor by pushing it down, into the fitting at the rear of the intake manifold.
6. Reinstall the wiring harness connector to the MAP sensor, ensuring that the locking tab is in place.
7. Reinstall the engine dress cover, securing with the four decorative nuts and tighten to the correct torque specification.

ENGINE DRESS COVER NUT TORQUE SPECIFICATION	10 Nm

8. Start the engine to ensure correct operation.

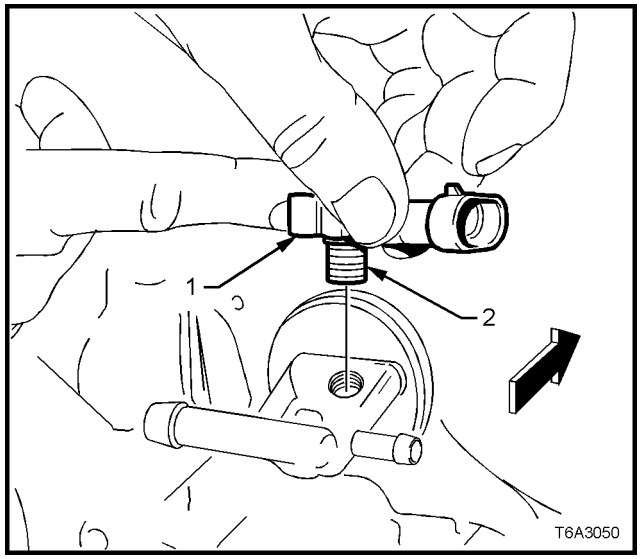


Figure 6A3-44

2.13 FUEL SYSTEM PRESSURE RELIEF

1. After removing the cover from the underhood electrical centre, remove the fuel pump relay, X16 (1).
2. With the throttle closed, crank the engine.

NOTE: The engine may start and run until the fuel supply remaining in the fuel delivery system is burned.

3. When the engine stops, re-engage the starter motor for 10 seconds to ensure that the line pressure has been fully relieved.
4. Reinstall the fuel pump relay, taking care that the wiring harness relay connector is not dislodged and that the relay is fully installed.

CAUTION: Unless this procedure is followed before servicing the fuel lines or fuel connections, fuel spray into the engine compartment could occur!

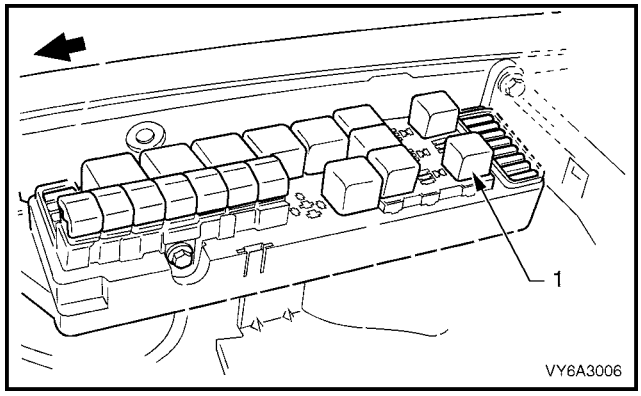


Figure 6A3-45

2.14 INTAKE MANIFOLD

LT Section No. – 00-375

REMOVE

NOTE: Unless components such as the throttle body, fuel injection rail and/or injectors are to be removed individually, then it is recommended that the complete intake manifold assembly be removed, as described in this service operation.

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Drain the cooling system. Refer to **Section 6B3 ENGINE COOLING - GEN III V8 ENGINE**.
3. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
4. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
5. De-pressurise fuel rail. Refer to **2.13 FUEL SYSTEM PRESSURE RELIEF**, in this Section.

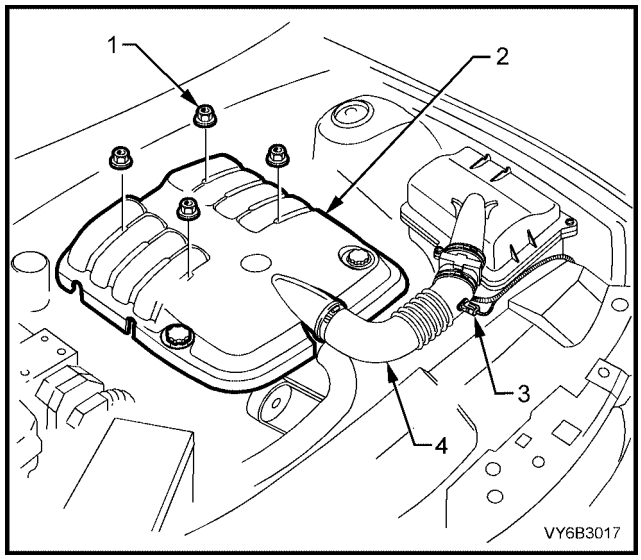


Figure 6A3-46

6. Using quick connect release Tool No. 7371 (not shown in Figure 6A3-47), install over fuel line .
7. While holding the fuel line quick connect (1), push on Tool 7371 to release the quick connect fitting (1) from the fuel rail. Pull back on the quick connect and remove.
8. Disconnect the vapour line connector (2) from the EVAP purge valve (3).

IMPORTANT: Cap the fuel line fittings and plug the holes after separating the fuel lines to prevent fuel leaking and/or dirt and other contaminants from entering the fuel system.

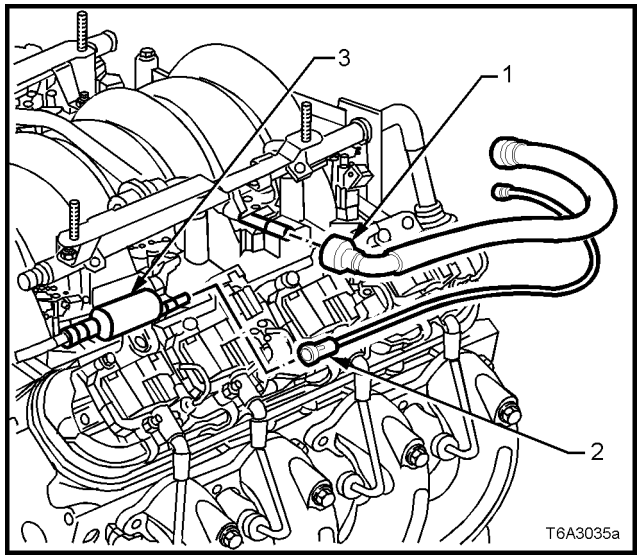


Figure 6A3-47

9. Disconnect wiring harness connector (1) from the Intake Air Control (IAC) motor, at the throttle body (3).
10. Disconnect the wiring harness connector (2) from the Throttle Position (TP) sensor at the throttle body (3).

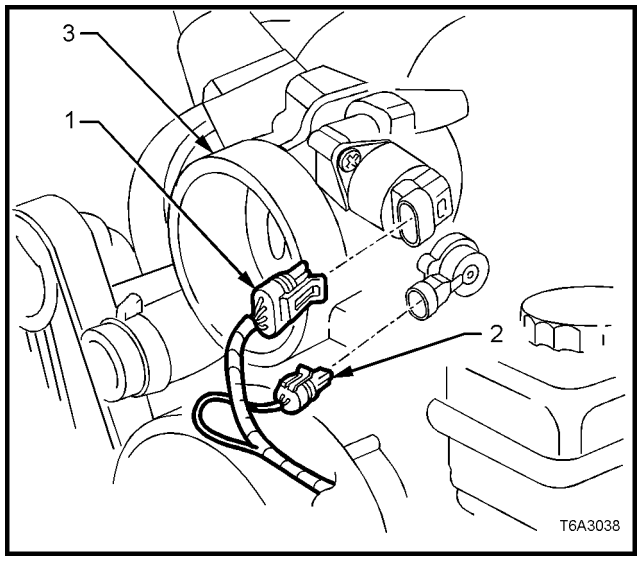


Figure 6A3-48

11. Disconnect the cruise control cable (1) (if fitted) from the stud (2) on the throttle body valve lever (3), then remove the outer cable (8) from the retainer bracket (4). Refer Figure 6A3-49.
12. Lift the throttle cable (5) from the clip at the fuel rail crossover pipe (6), then lift the cable (5) from the retainer bracket (4).
13. Remove the inner throttle cable (7) from the throttle body valve lever (3).
14. Set the cable/s to one side.

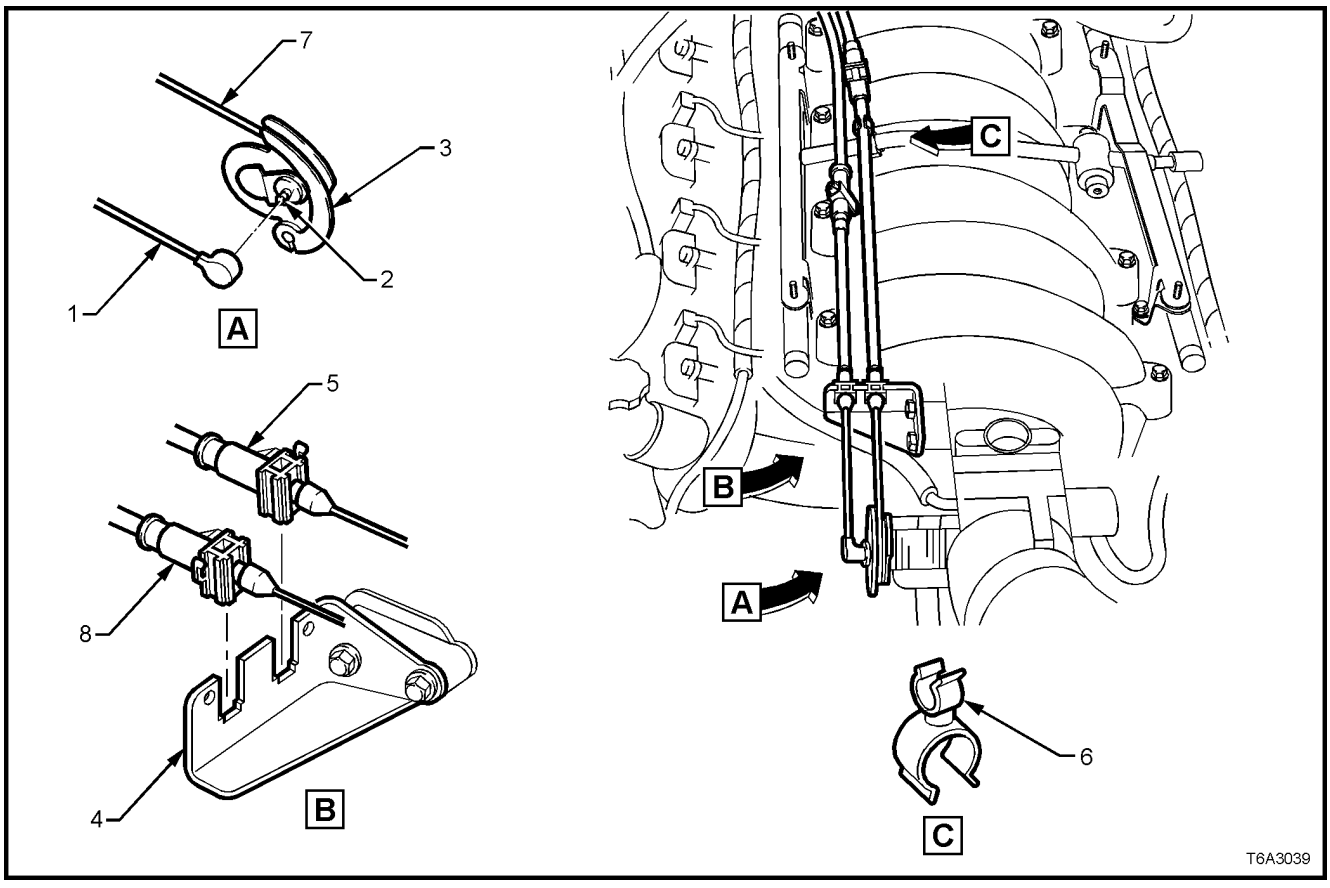


Figure 6A3-49 – (RHD Shown, LHD Similar)

15. Disconnect the fuel injector wiring harness connectors (1) from the right bank of fuel injectors (4 places).
16. Remove the CPA lock (2) from the ignition coil main connector (3) on the right hand side, remove the connector (3), then the harness securing clips from the fuel rail brackets (4) and set the harness to one side.

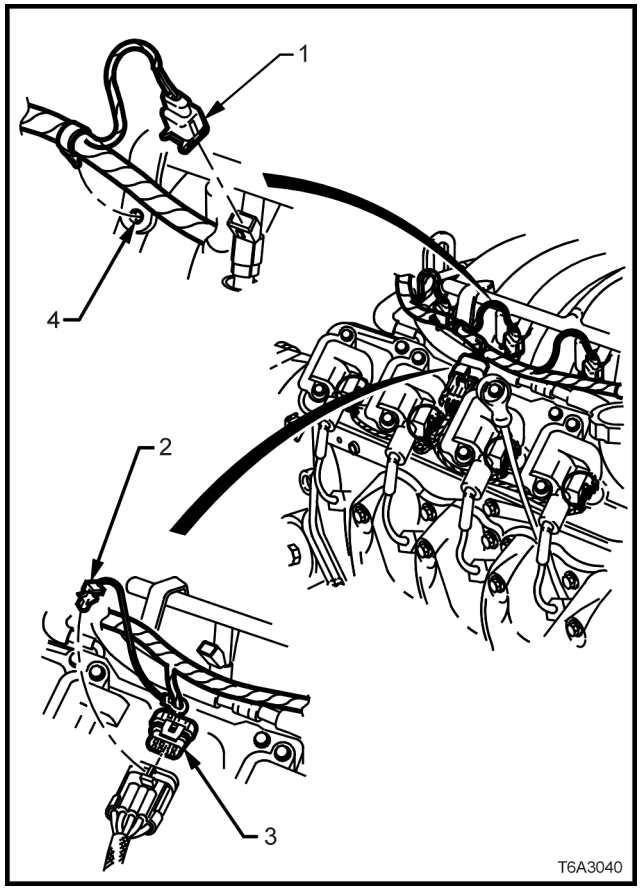


Figure 6A3-50

17. Disconnect the fuel injector wiring harness connectors (1) from the left bank of fuel injectors (4 places).
18. Remove the CPA lock (2) from the ignition coil main connector (3) on the left hand side, then remove the wiring harness connector (3).
19. Remove the wiring harness connector from the canister purge valve (4).
20. Remove the harness securing clips from the fuel rail brackets (5) and set the harness to one side.

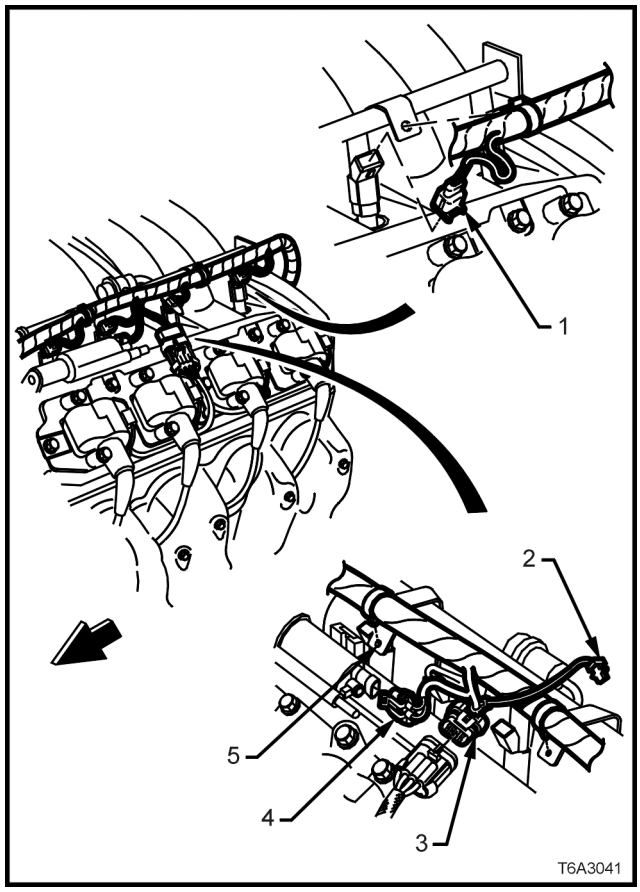


Figure 6A3-51

21. Disconnect the wiring harness connector (1) from the MAP sensor, located at the rear of the intake manifold.
22. Remove the knock sensor patch harness connector retaining clip (3) from the PCV hose and disconnect the wiring harness connector.
23. Remove the PCV hose (4) from the PCV vent valve grommet (5) (left bank).

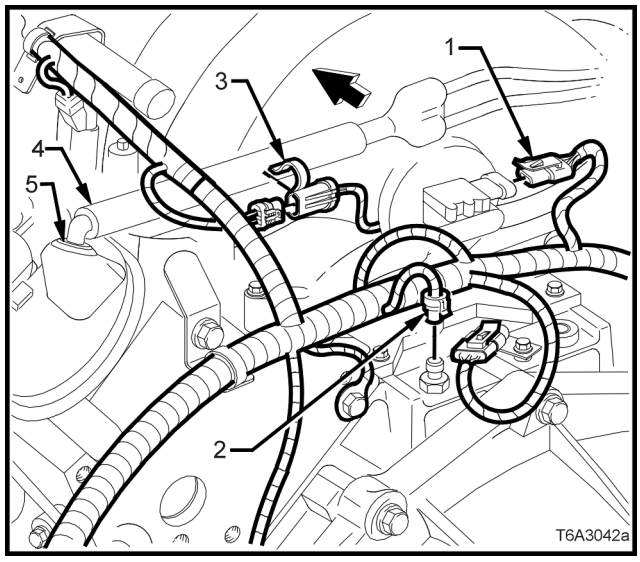


Figure 6A3-52

24. Remove the fresh air hose from the front fitting of the rocker cover and the throttle body.

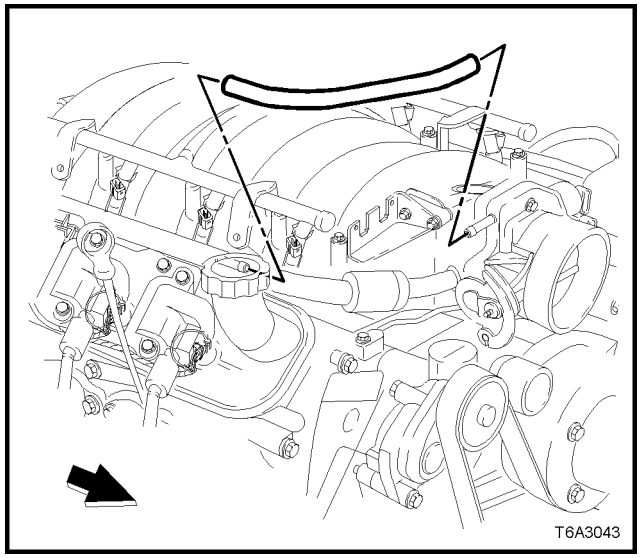


Figure 6A3-53

25. Remove the nut (1) securing the PCV valve, heat conducting strap (2) from the front right hand vapour pipe screw (3).
26. Remove the PCV valve hose from the throttle body and right hand rocker cover, rear fitting.
27. Remove the PCV valve and hose assembly from the left hand rocker cover clip, then lift hoses and valve assembly from the engine.

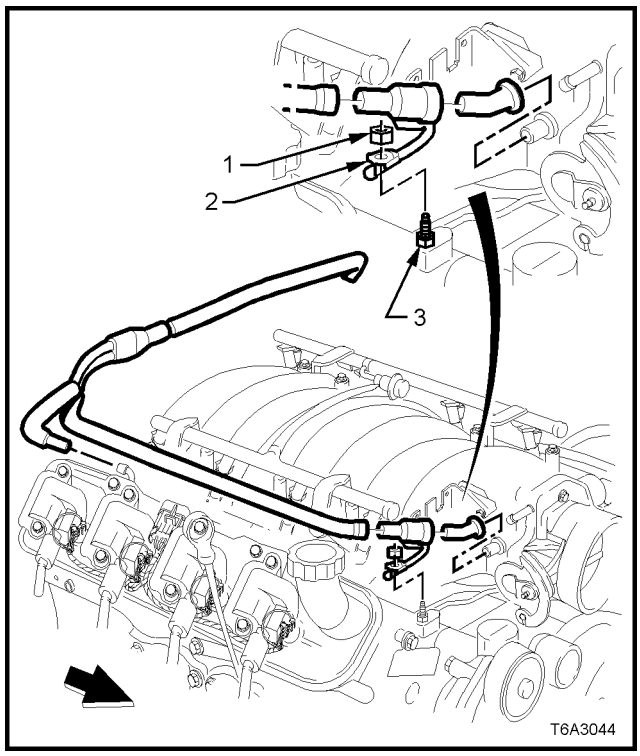


Figure 6A3-54

28. Remove the engine coolant, vapour vent hose from the throttle body and the vapour vent pipe.

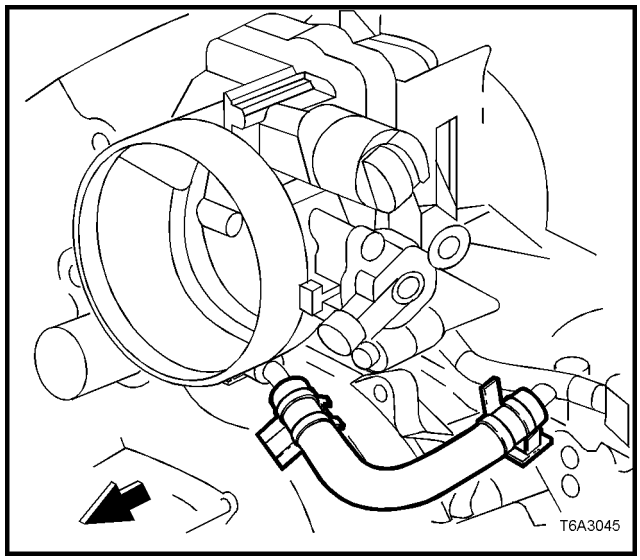


Figure 6A3-55

29. Remove the engine coolant vapour vent outlet hose (1) from the throttle body and left hand radiator tank.

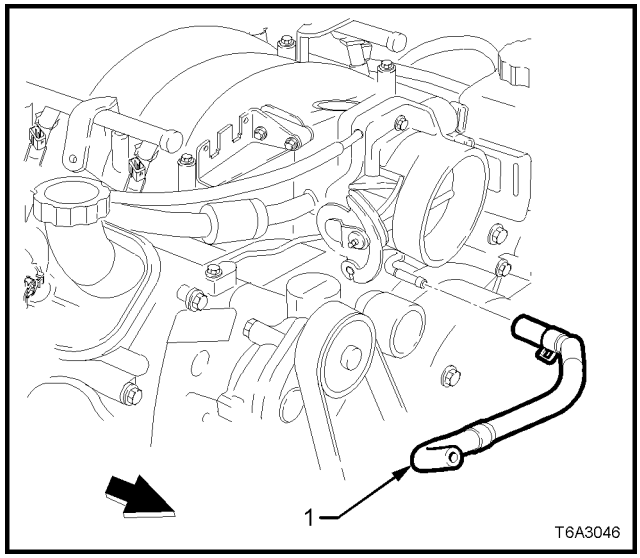


Figure 6A3-56

30. Remove the evaporative (EVAP) canister purge valve tube from the purge valve and the throttle body.

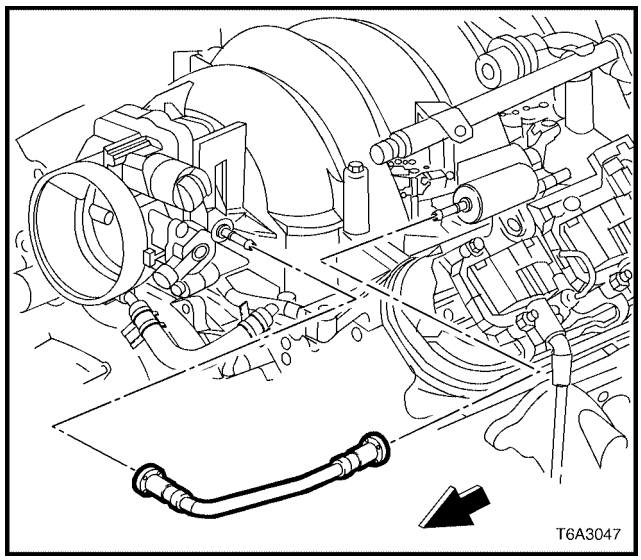


Figure 6A3-57

31. Remove the EVAP canister purge valve and bracket from the intake manifold.

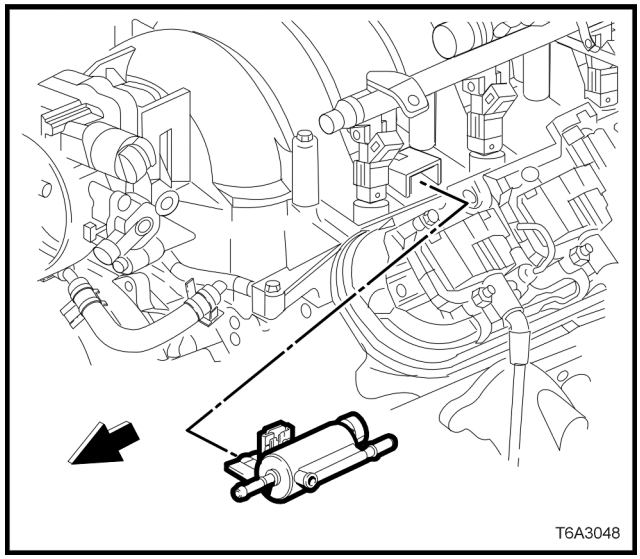


Figure 6A3-58

32. Progressively loosen the 10 intake manifold retaining bolts (1), working diagonally from outside to inside.
33. Remove the fuel rail stop bracket (2) with the two, left rear bolts and set to one side.

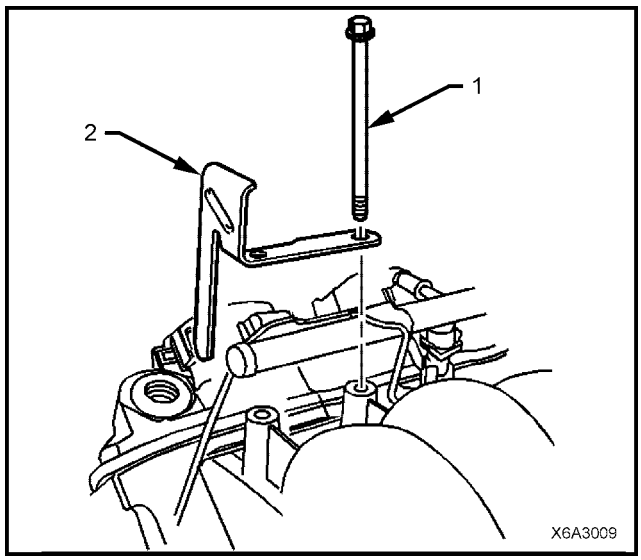


Figure 6A3-59

34. Carefully bump the intake manifold assembly (1) to break the gasket seal, then lift from the engine.

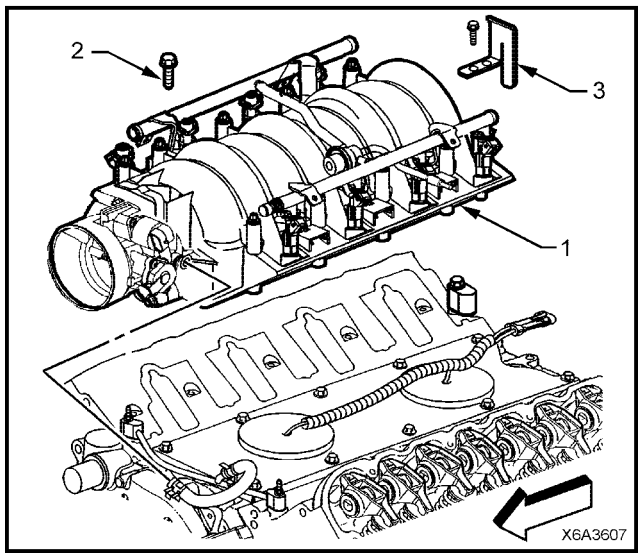


Figure 6A3-60

35. Remove the intake manifold to cylinder head gaskets (1) and discard.

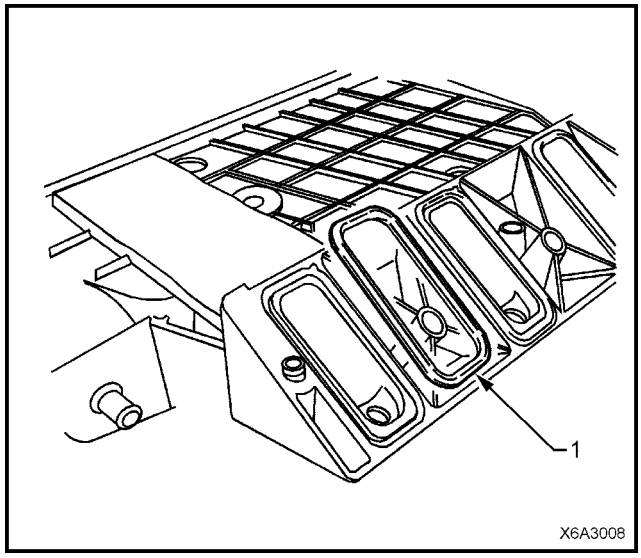


Figure 6A3-61

DISASSEMBLE

If required, the following components can be removed from the intake manifold:

1. Remove the Manifold Absolute Pressure (MAP) sensor (1) from the fitting at the rear of the intake manifold by twisting back and forth while pulling on the sensor.
2. Check the silicone rubber seal (2) on the MAP sensor to ensure that it is not torn or damaged.

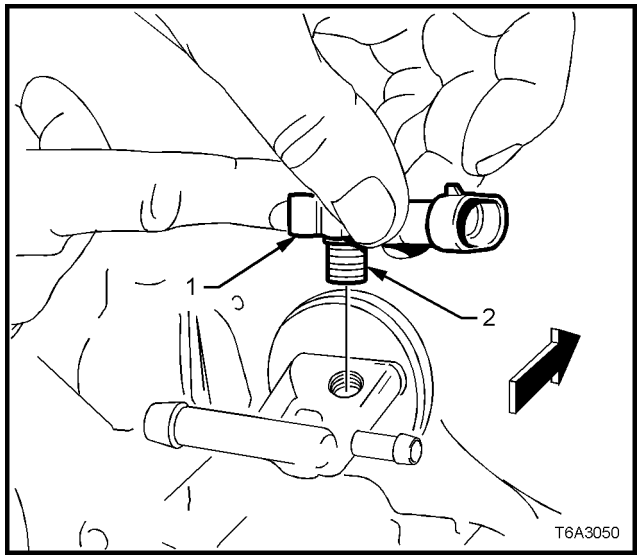


Figure 6A3-62

3. Remove the throttle body retaining bolts, then the throttle body and gasket. Discard the gasket.

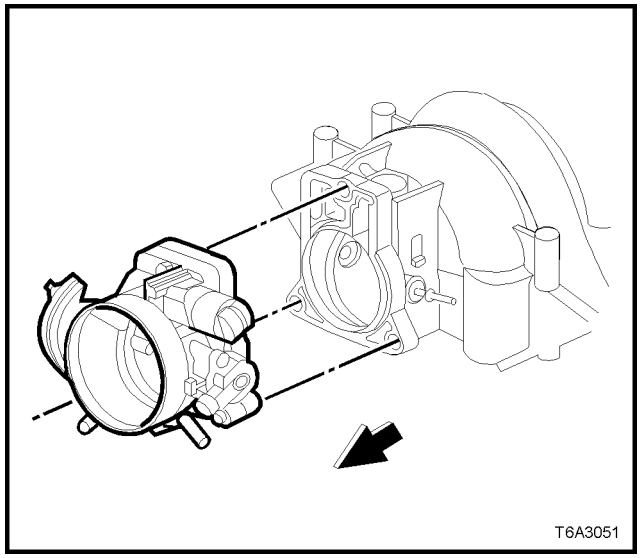


Figure 6A3-63

4. Remove the O-ring seal and discard.

NOTE: Do not re-use this O-ring seal.

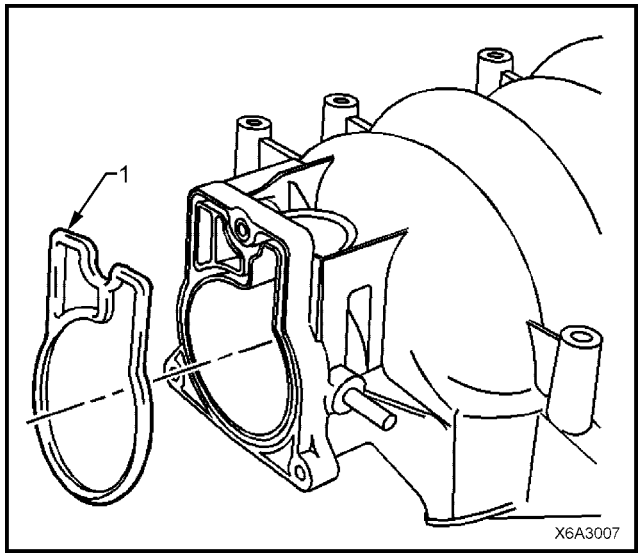


Figure 6A3-64

5. Remove the four nuts (1) securing the engine dress cover brackets (2) to the fuel rail (3), then lift the two brackets from the fuel rail.
6. Remove the studs (4) securing the fuel rail and injectors to the intake manifold, then carefully remove the fuel rail and injectors as an assembly.

Should further disassembly of the fuel injectors be required, refer to **Section 6C3-3 SERVICE OPERATIONS – GEN III V8 ENGINE**.

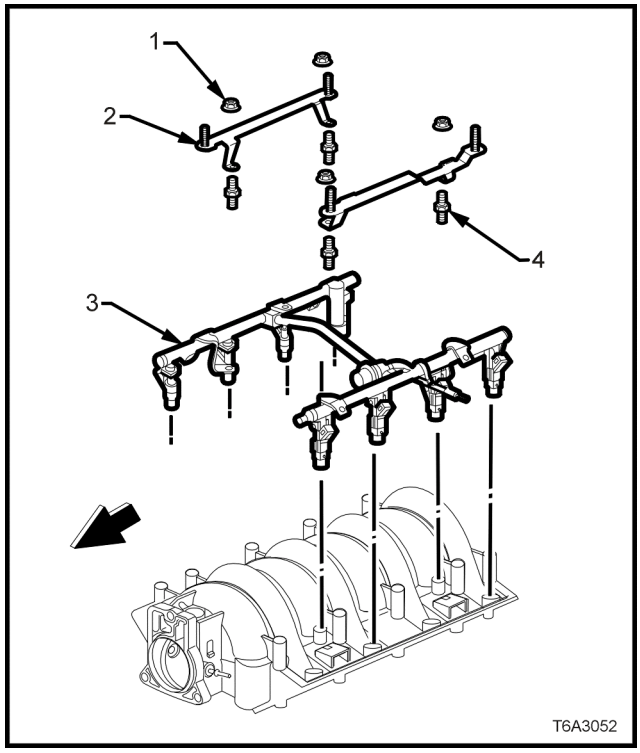


Figure 6A3-65

CLEAN AND INSPECT

1. After cleaning the intake manifold in a suitable solvent, dry off using compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Ensure that the intake manifold gasket grooves and vacuum passages in the rear of the intake manifold are all clean and clear.
3. Inspect throttle body and fuel rail bolt inserts in the composite intake manifold, for looseness and/or damaged threads.
4. Inspect the intake manifold for cracks or damage, including the areas between the intake runners.
5. Inspect the fuel injector bores for excessive scoring or damage.
6. Inspect the intake manifold to cylinder head faces for warpage, as follows:
   a. Locate a straight edge across each of the two surfaces and check for warpage, using feeler gauges.
   b. An intake manifold with warpage in excess of 0.5 mm, must be replaced.

REASSEMBLE

Manifold Absolute Pressure (MAP) Sensor

If removed, install the MAP sensor as follows:

1. Check the MAP sensor seal (2) to ensure it is seated correctly on the sensor.
2. Install the Manifold Absolute Pressure (MAP) sensor (1) into the fitting at the rear of the intake manifold by pushing the sensor into the fitting. If necessary apply a smear of petroleum jelly (Vaseline™ or equivalent).

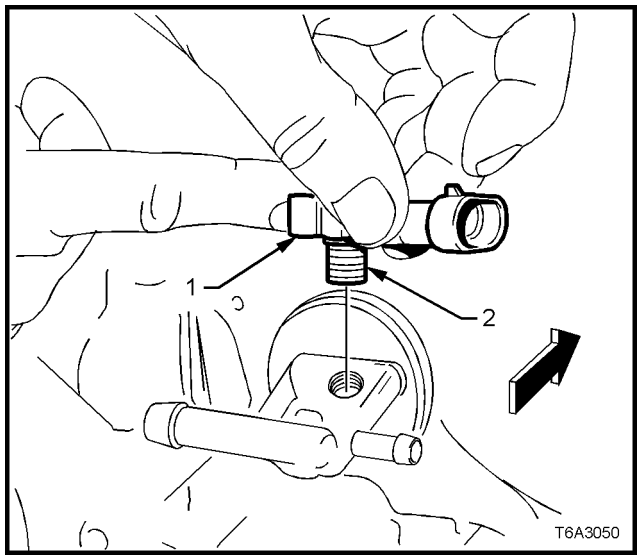


Figure 6A3-66

Fuel Rail and Injectors

1. Lubricate NEW injector O-ring seals with clean engine oil.
2. Install the NEW O-rings to the fuel injectors.
3. Install the fuel rail (with injectors) into the intake manifold, pressing evenly on each side until the injectors are all seated in their bores.
4. Apply a 5 mm band of thread sealant such as Loctite 242 (or other commercial equivalent) to the cleaned threads of the fuel rail attaching studs (4) and install, tightening to the correct torque specification.

FUEL RAIL ATTACHING BOLTS TORQUE SPECIFICATION	10 Nm

5. Install the engine dress cover attaching brackets (2) to the fuel rail attaching studs (4), fit the retaining nuts (1) and tighten to the correct torque specification.

ENGINE DRESS COVER BRACKET STUDS TORQUE SPECIFICATION	5 Nm

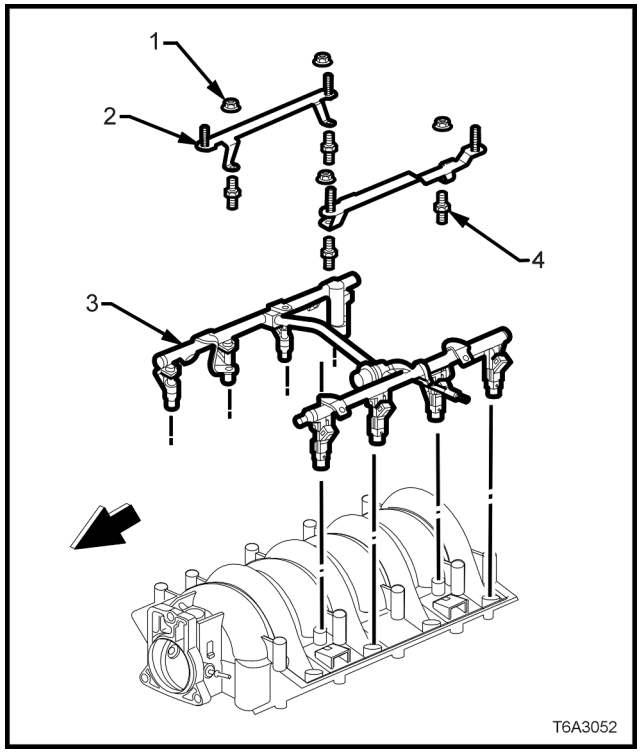


Figure 6A3-67

Throttle Body

1. Install a NEW throttle body O-ring seal (1) to the intake manifold.

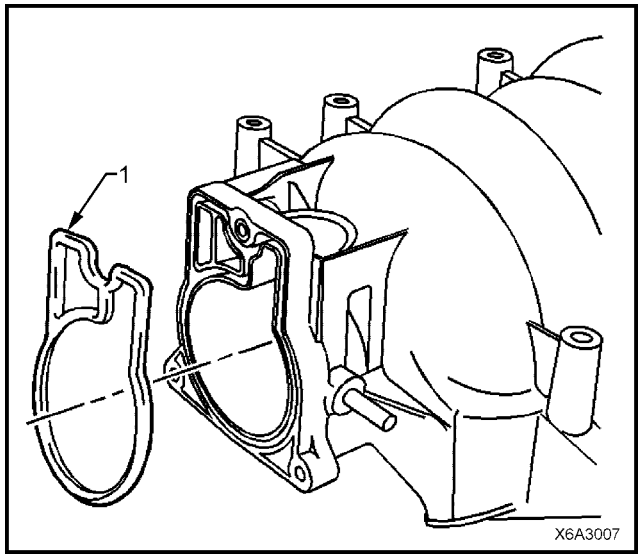


Figure 6A3-68

2. Install the throttle body and bolts to the intake manifold.
3. Tighten the throttle body bolts to the correct torque specification.

THROTTLE BODY BOLT TORQUE SPECIFICATION	12 Nm

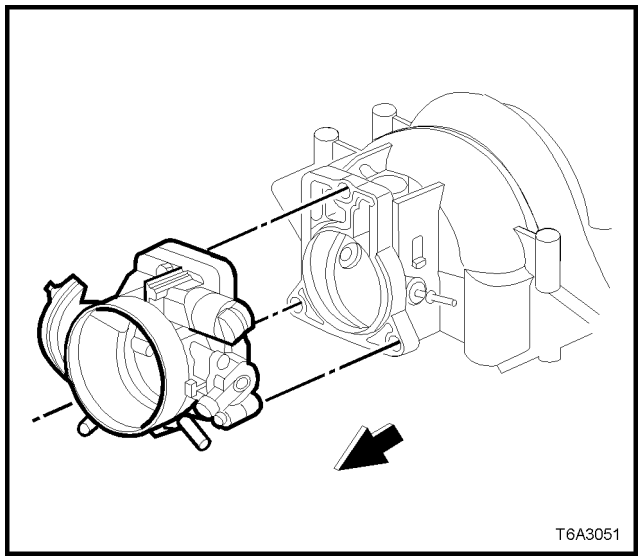


Figure 6A3-69

REINSTALL

1. Install NEW intake manifold to cylinder head gaskets, then install the intake manifold assembly (1).
2. Apply a 5 mm band of thread sealant such as Loctite 242 (or equivalent), to the cleaned threads of the 10 intake manifold attaching bolts (2).
3. Install all intake manifold bolts (2), including the two at the left hand rear, also securing the fuel rail stop bracket (3).

CAUTION: Do not overlook installing the fuel stop bracket (3). The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal collision. If the fuel stop bracket is not installed and the vehicle is involved in a collision, fuel could be sprayed, possibly causing a fire and personal injury from burns.

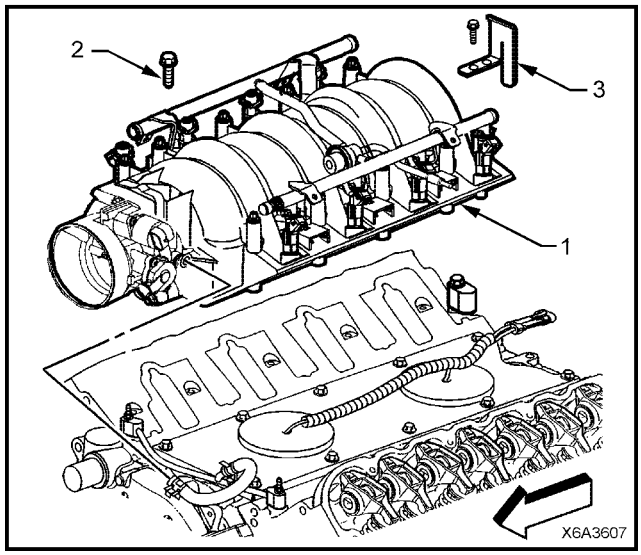


Figure 6A3-70

4. Tighten the intake manifold bolts in two stages, in the sequence shown, to the correct torque specification.

INTAKE MANIFOLD BOLTS TORQUE SPECIFICATION	Stage 1 – 5 Nm Stage 2 – 10 Nm

NOTE: The fuel stop bracket is secured by bolts '3' and '9'.

The remainder of the installation process is the reverse of the removal operations, except for the following;

5. Install Positive Crankcase Ventilation (PCV) System heat conducting strap to the vapour vent pipe stud at the front right of the engine, install the retaining nut and tighten to the correct torque specification.

PCV VALVE HEAT STRAP RETAINING NUT TORQUE SPECIFICATION	12 Nm

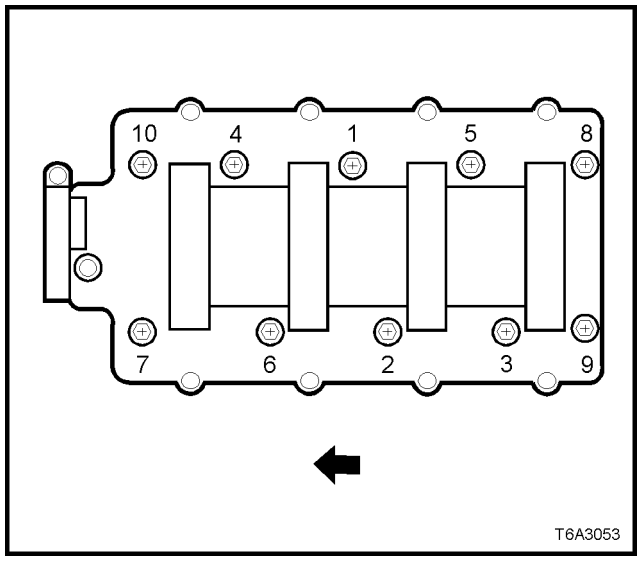


Figure 6A3-71

6. After installation, the throttle cable is to be adjusted, as detailed:

a. Attach all cable fittings.

b. With the outer cable adjuster unlocked, apply a tension to the adjuster, until the throttle cam (1) begins to move.

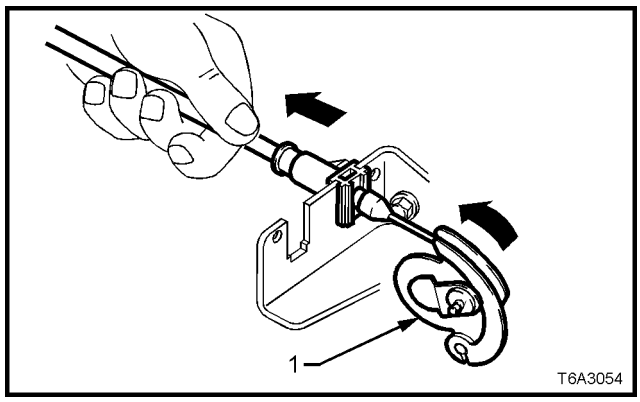


Figure 6A3-72

c. Release the tension on the adjuster until the throttle cam is back at rest (1), then slightly compress the adjuster (2) about 1 mm to lock.

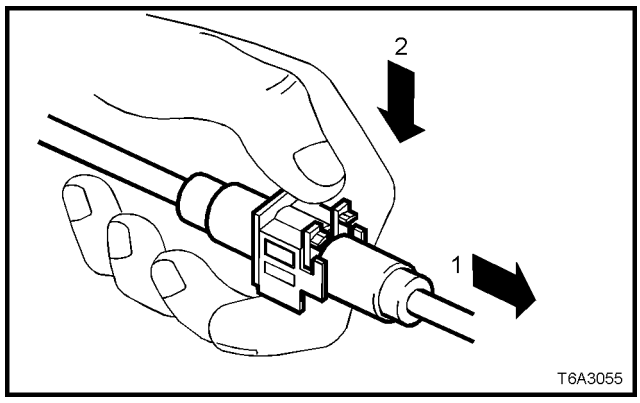


Figure 6A3-73

7. If fitted, the cruise control cable must be adjusted, as follows:
   a. Connect the inner cable (1) to the stud (2) on the throttle cam (3), then slide the outer cable into position in the throttle cable bracket (4).

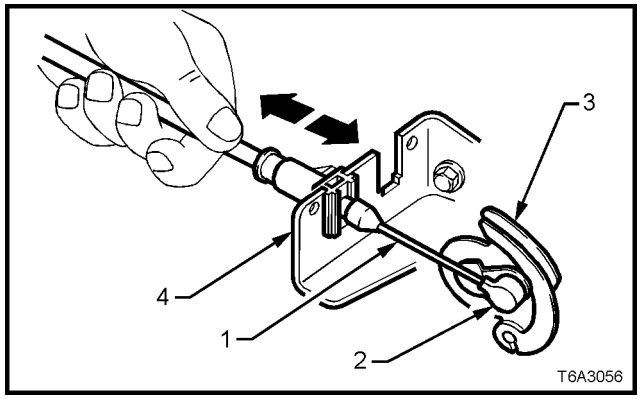


Figure 6A3-74

   b. Unlock the adjustment locking lever (1).
   c. Ensure that the throttle is fully closed, then adjust the outer cruise control cable (2), to achieve minimum slack in the inner cable.
   d. Flip the adjustment lever (1) to lock the outer cable (2) into position.

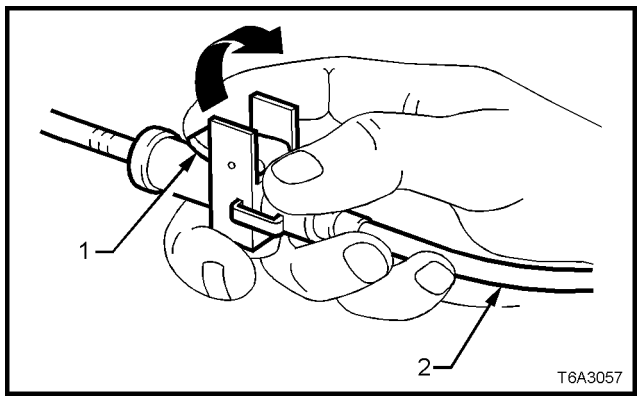


Figure 6A3-75

8. Install engine dress cover and the four retaining nuts and tighten to the correct torque specification.

ENGINE DRESS COVER DOME TORQUE SPECIFICATION	10 Nm

9. Fill the cooling system. Refer to **Section 6B3 ENGINE COOLING - GEN III V8 ENGINE**.
10. Start engine, check for leaks and normal operation.

2.15 VAPOUR VENT PIPE

LT Section No. – 00-249

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Drain the cooling system. Refer to **Section 6B3 ENGINE COOLING - GEN III V8 ENGINE**.
3. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
4. De-pressurise fuel rail. Refer to **2.13 FUEL SYSTEM PRESSURE RELIEF**, in this Section.
5. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.

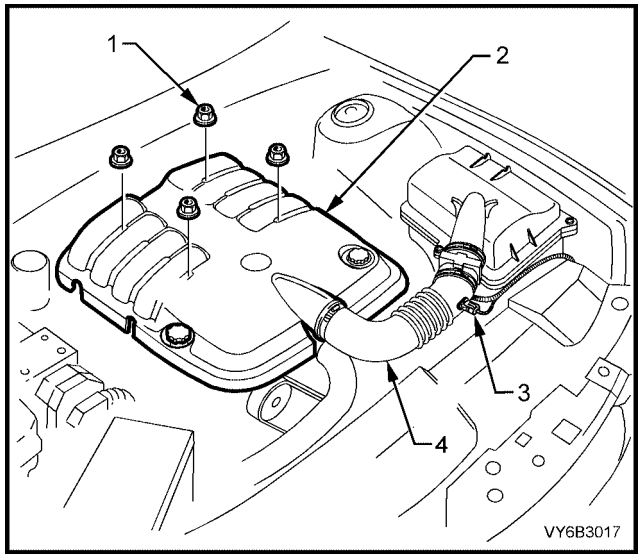


Figure 6A3-76

6. Remove intake manifold. Refer **2.14 INTAKE MANIFOLD,** in this Section.
7. Remove the wiring harness connector (1) from the knock sensor patch harness (2).

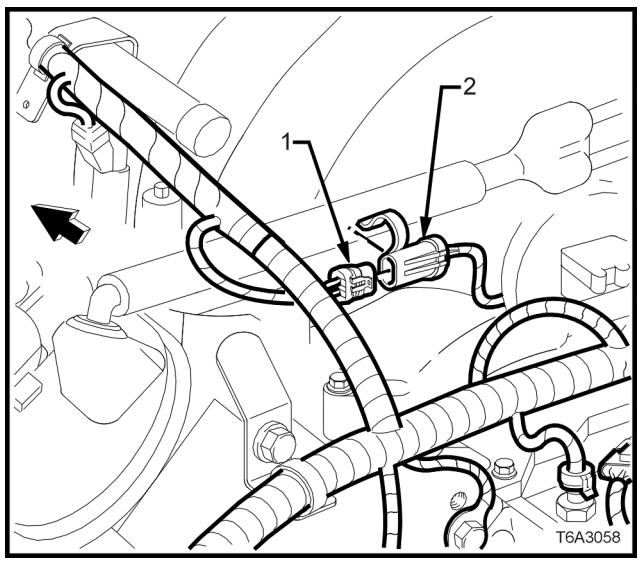


Figure 6A3-77

8. If required, remove the retaining bolts (1) from the rear engine coolant vapour bleed vent covers (2). Remove covers and gaskets (3). Discard the gaskets.
9. Remove the vapour vent pipe retaining studs (4) and the front engine coolant vapour bleed pipe (5), together with both gaskets (6). Discard the gaskets.

NOTE: Both front studs are double sided, with the right hand one (bold arrow) being used to secure the PCV valve braided strap, disconnected during the intake manifold removal operation.

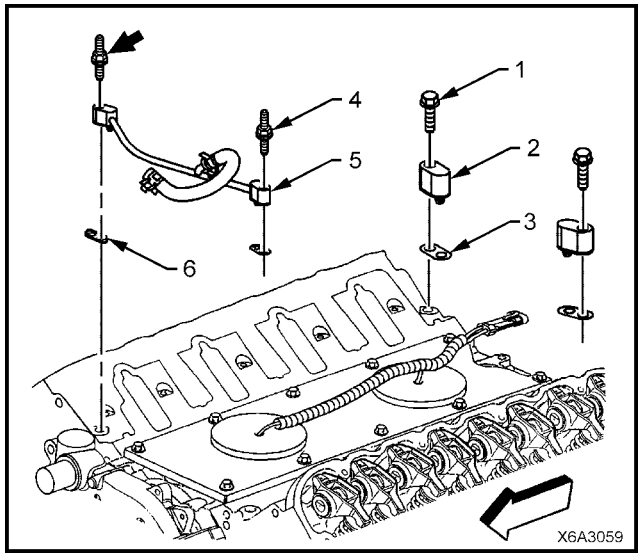


Figure 6A3-78

10. If required, loosen the engine coolant to vent pipe clamp, then remove the hose (2) from the vent pipe (1).

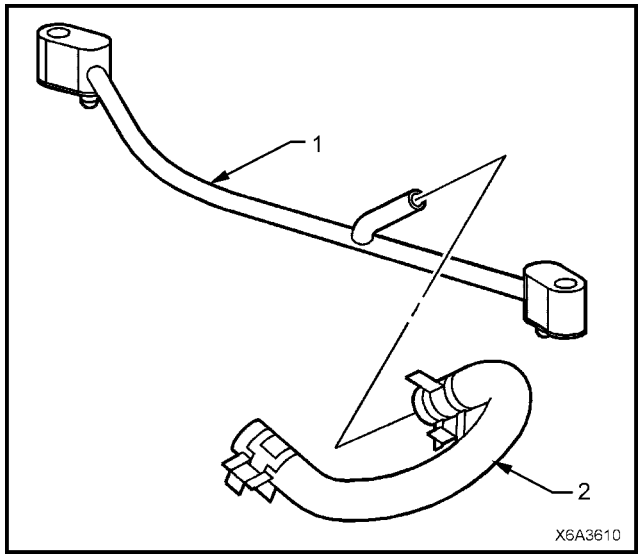


Figure 6A3-79

REINSTALL

1. Correctly install NEW vapour pipe gaskets by fitting the O-ring seal part, over the pipe fitting nipple, as shown.

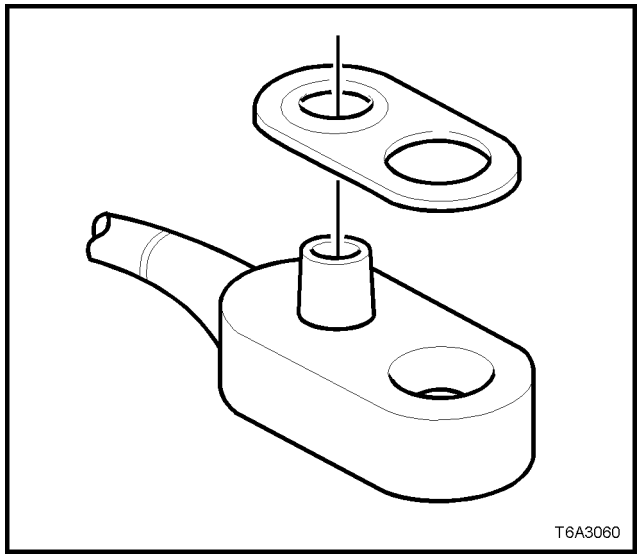


Figure 6A3-80

2. Install the vapour vent pipe (5), vapour vent covers (2) and gaskets (‘6’ and ‘3’) to the cylinder heads.
3. Install the vapour vent pipe bolts/studs (‘1’ and ‘4’) and tighten to the correct torque specification.

VAPOUR VENT PIPE BOLT/STUD TORQUE SPECIFICATION	12 Nm

4. Install the intake manifold, as described in **2.14 INTAKE MANIFOLD - REINSTALL**, in this Section.
5. Install the vapour vent hose to the throttle body and install the hose clamp securely.

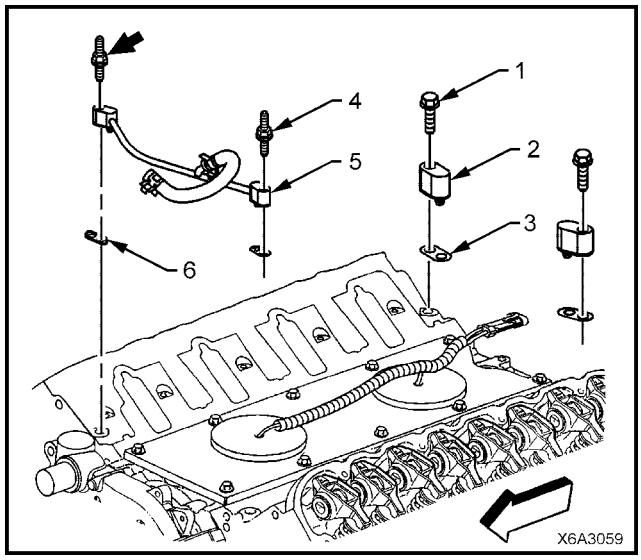


Figure 6A3-81

2.16 ENGINE VALLEY COVER

LT Section No. – 02-000

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Drain the cooling system. Refer to **Section 6B3 ENGINE COOLING - GEN III V8 ENGINE**.
3. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
4. De-pressurise fuel rail. Refer to **2.13 FUEL SYSTEM PRESSURE RELIEF**, in this Section.
5. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
6. Remove intake manifold. Refer **2.14 INTAKE MANIFOLD**.
7. Remove vapour vent pipe. Refer **2.15 VAPOUR VENT PIPE**.

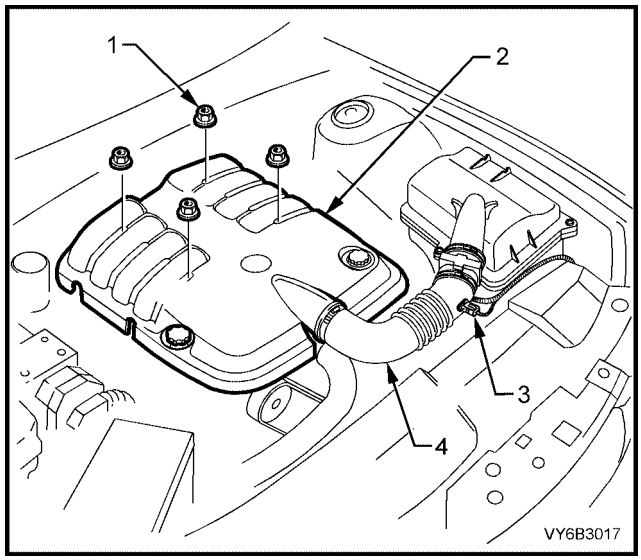


Figure 6A3-82

8. To remove the knock sensor wiring harness, carefully lift each sealing plug from the valley cover, release each knock sensor harness connector locking tab, then remove each connector. Lift the knock sensor wiring harness from the engine.

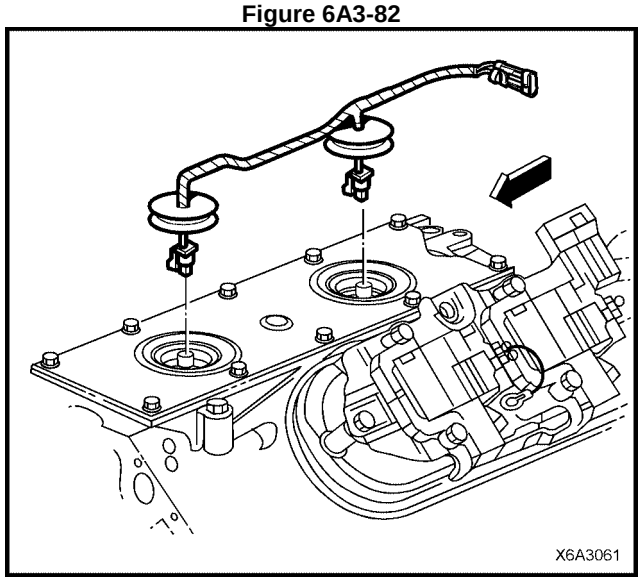


Figure 6A3-83

9. Remove both knock sensors, using a commercially available, 22 mm deep socket.

NOTE: Unless a deep socket is used, damage to the sensor connector will result.

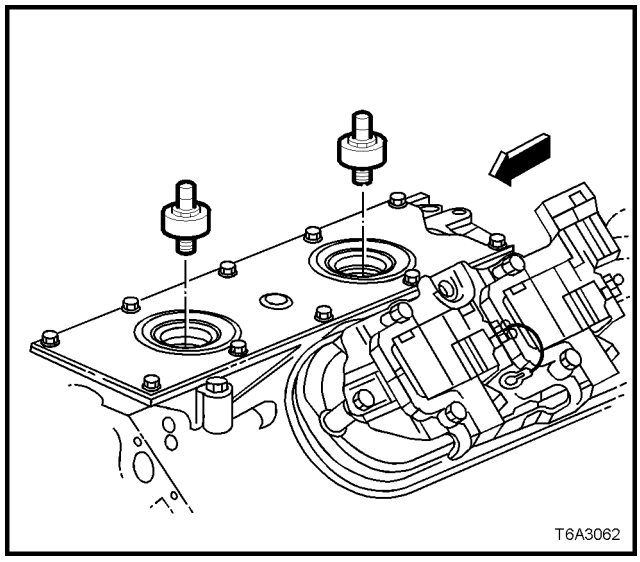


Figure 6A3-84

10. Remove the valley cover retaining bolts.
11. Remove the valley cover and gasket from the cylinder block. Discard the gasket.

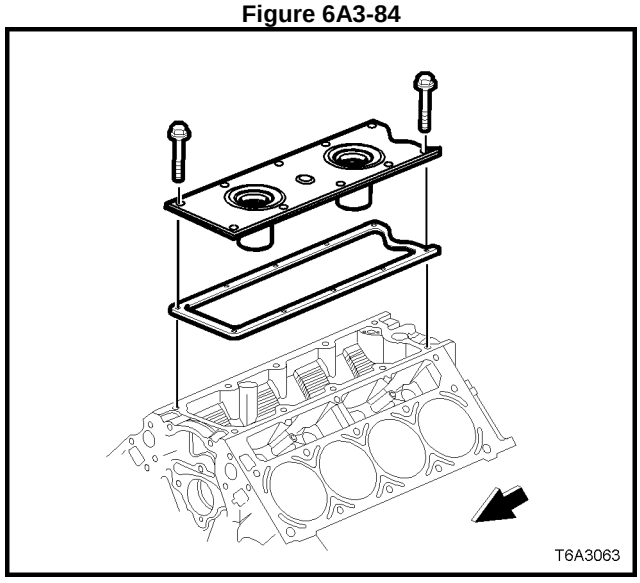


Figure 6A3-85

CLEAN AND INSPECT

1. Remove both knock sensor oil seals (1) from the valley cover (2).
2. Clean the valley cover in suitable solvent and dry off with compressed air

CAUTION: Wear safety glasses to avoid eye injury.

3. Inspect the valley cover sealing surfaces and oil seal bores for excessive scratches or other damage.

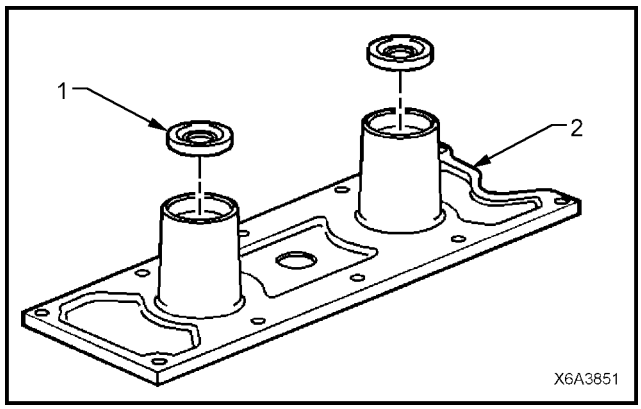


Figure 6A3-86

REINSTALL

Reinstallation is the reverse of removal operations, except for the following items.

1. Install NEW knock sensor oil seals into the valley cover and lubricate with clean engine oil (refer '1' in Figure 6A3-86).
2. Fit a NEW gasket to the valley cover and install cover to the engine (refer to Figure 6A3-85).
3. Install valley cover bolts and tighten to the correct torque specification.

ENGINE VALLEY COVER BOLT TORQUE SPECIFICATION	25 Nm

4. Install the knock sensors and tighten to the correct torque specification.

KNOCK SENSOR TORQUE SPECIFICATION	20 Nm

2.17 VALVE ROCKER ARM COVER

LT Section No. – 00-050

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.

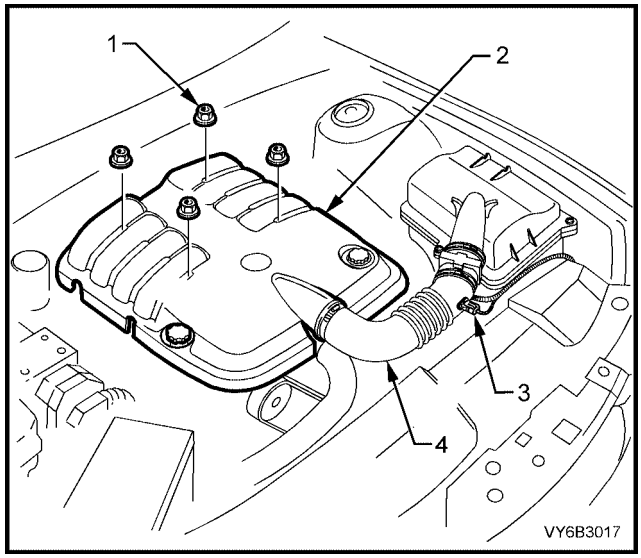


Figure 6A3-87

3. For the right hand rocker cover, remove the fresh air hose from the front fitting of the rocker cover and from the throttle body.

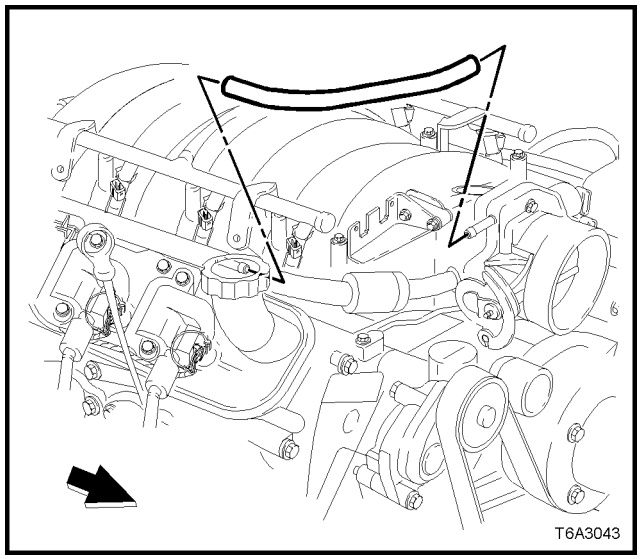


Figure 6A3-88

4. Remove the PCV hose connection from the rear fitting at the end of the rocker cover, being removed.

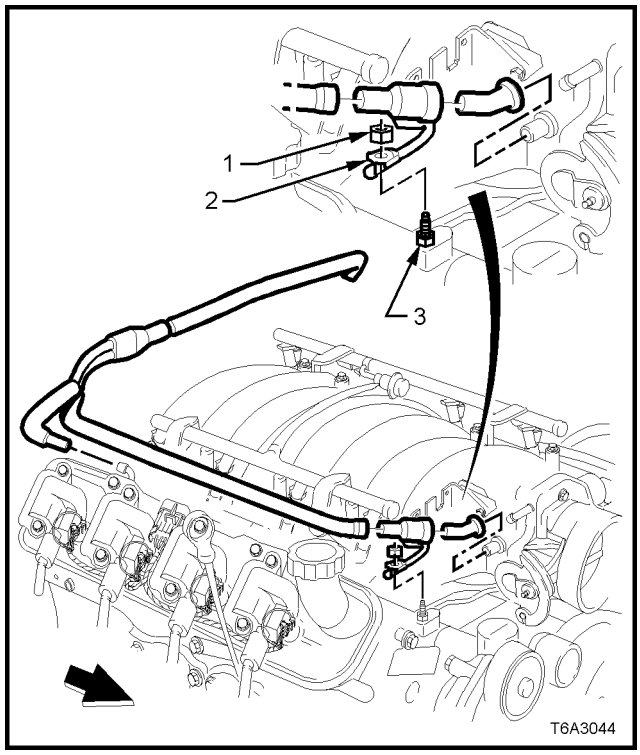


Figure 6A3-89

5. Using quick connect release Tool No. 7371 (not shown in Figure 6A3-90), install over fuel line.
6. While holding the fuel line quick connect (1), push on Tool 7371 to release the quick connect fitting (1) from the fuel rail. Pull back on the quick connect and remove.
7. Disconnect the vapour line connector (2) from the EVAP purge valve (3).

IMPORTANT: Cap the fuel line fittings and plug the holes after separating the fuel lines to prevent fuel leaking and/or dirt and other contaminants from entering the fuel system.

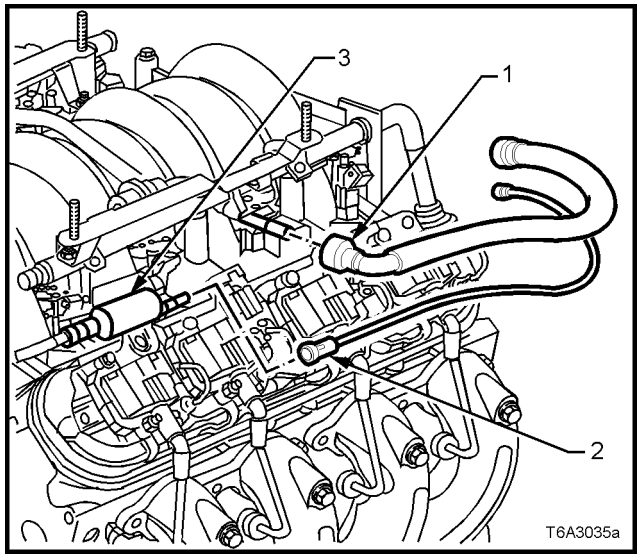


Figure 6A3-90

8. Remove the spark plug leads.

NOTE: Handle the boot only. DO NOT pull on the lead. Twist the boot first to break the seal, then pull to remove.

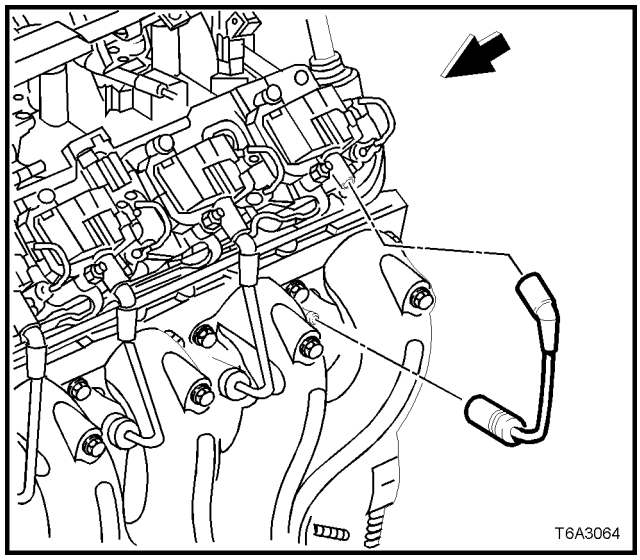


Figure 6A3-91

9. Remove the CPA lock (4) from the ignition coil main connector on the rocker cover being removed, then remove the wiring harness connector (3).
10. Remove the 4 studs (1) and one screw securing the ignition coil mounting bracket (2) to the rocker cover being removed, then lift the ignition coils, wiring and bracket from the engine.

NOTE: The rear attaching bolt on each coil assembly (arrow) is a conventional screw and not a stepped stud. Fitment of this screw in the correct position on reassembly is important to avoid possible chaffing.

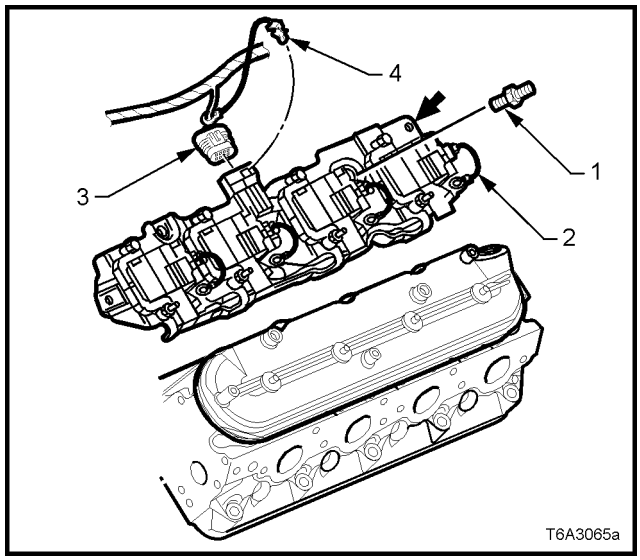


Figure 6A3-92

11. Remove the 4 valve rocker cover bolts, then remove the cover and gasket from the cylinder head.

NOTE: Do not remove the oil fill tube from the right hand rocker cover unless replacement is required.

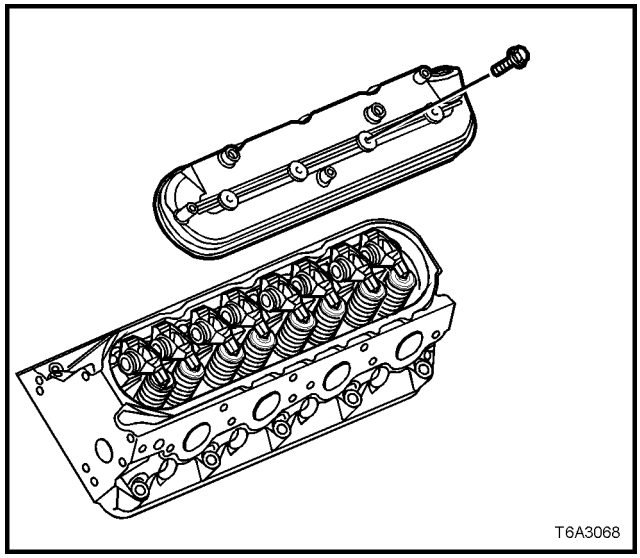


Figure 6A3-93

12. Remove the gasket (1) from the cover and discard.

NOTE: The cover securing bolt grommets may be re-used if not damaged.

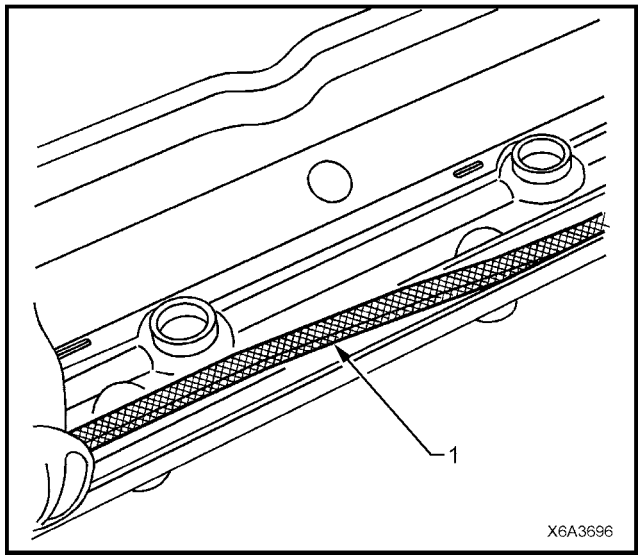


Figure 6A3-94

13. If required, remove the oil fill cap(1) and/or fill tube (2) from the right hand rocker cover (3). Discard the oil fill tube (2), as permanent damage will occur on removal.

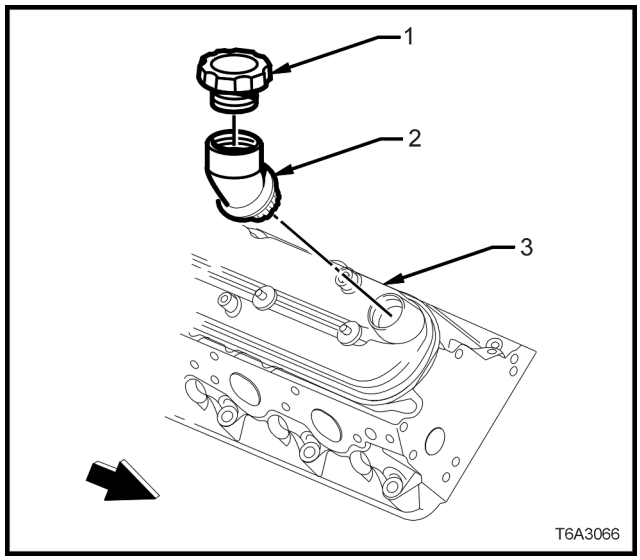


Figure 6A3-95

14. If required, remove the bolts securing the ignition coils to the mounting bracket and remove the coils and wiring harness.

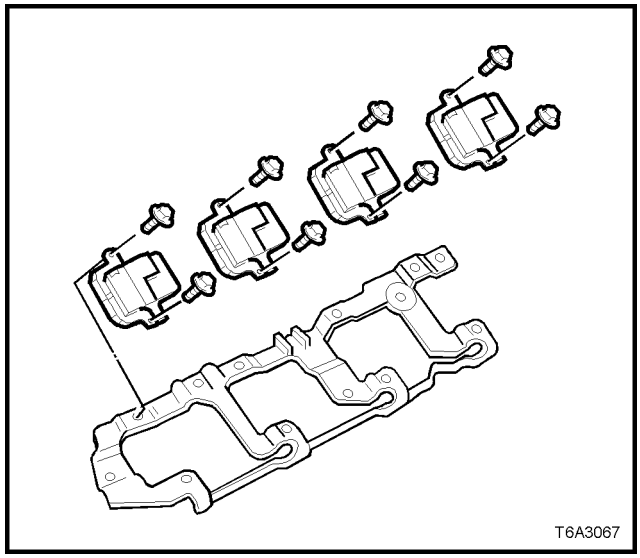


Figure 6A3-96

CLEAN AND INSPECT

1. Clean the rocker cover in a suitable solvent and dry off with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect the ventilation system passages for restriction.
3. Inspect the rocker cover gasket groove for damage.
4. Inspect the ignition coil mounting boss threads for damage.

REINSTALL

Reinstallation of the rocker cover is the reverse to the removal procedure except for the following items.

1. If the oil fill tube (2) was removed from the right hand rocker cover (3), it must be replaced with a NEW part (when installed, it is permanent).
2. Lubricate the O-ring seal of the NEW oil fill tube (2) with clean engine oil.
3. Install the oil fill tube into the rocker cover (3), rotating the tube clockwise until locked into the correct position.
4. Install the oil fill cap (1), rotating clockwise until locked into place.

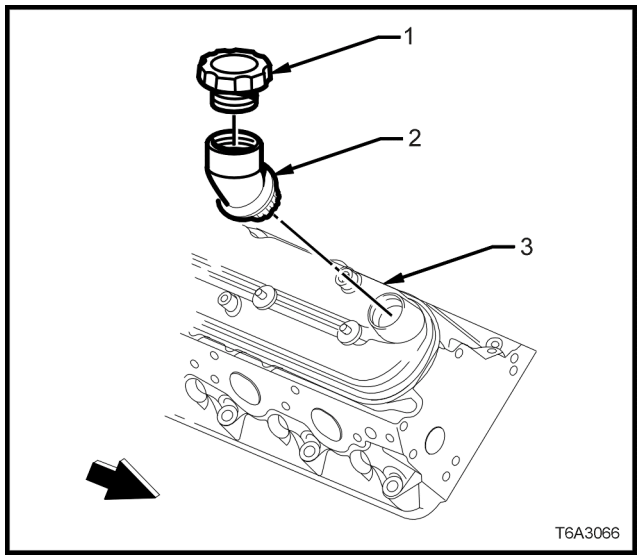


Figure 6A3-97

5. Install a NEW gasket to the rocker cover.
6. Install the rocker cover bolts.
7. Install the rocker cover onto the cylinder head and tighten the rocker cover studs to the correct torque specification.

ROCKER COVER BOLT TORQUE SPECIFICATION	12 Nm

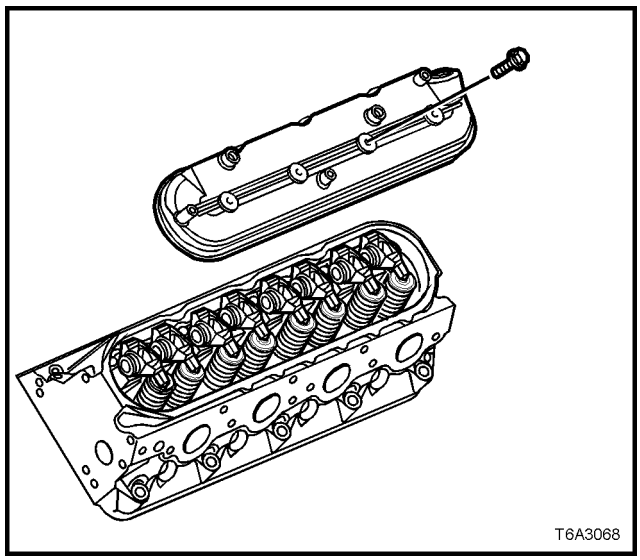


Figure 6A3-98

8. Install the ignition coils and coil wiring harness to the mounting bracket and tighten the to the correct torque specification.

IGNITION COIL SCREW TORQUE SPECIFICATION	12 Nm

9. Install the ignition coils and bracket assembly to the rocker cover, and tighten the studs and screw to the correct torque specification.

IGNITION COIL BRACKET STUD/ SCREW TORQUE SPECIFICATION	12 Nm

NOTE: The rear, left hand coil bracket fastener is a plain screw and not a stepped stud as are the others. Fitment of this screw in the correct position is important to avoid fuel/vapour line chaffing.

10. After installation of the ignition coil main harness connector, install the CPA lock, ensuring it is fitted securely.

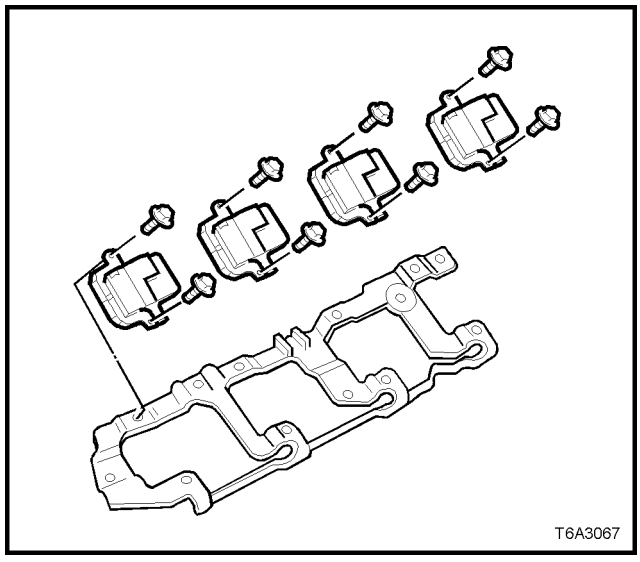


Figure 6A3-99

2.18 VALVE ROCKER ARMS AND PUSH RODS

LT Section No. – 00-050

NOTE: The following fasteners MUST be replaced (■) when performing this operation:

■ Rocker arm retaining bolts.

REMOVE

NOTE: While some views may show a cylinder head that is not specific to the one required, unless noted, it can be assumed that the operation is the same for either cylinder head.

1. Remove the valve rocker arm cover/s. refer to **2.17 VALVE ROCKER ARM COVER**, in this Section.

IMPORTANT: Store all removed valve operating mechanism components in a suitable rack to avoid being mixed. This will ensure that parts reinstalled will be in the same relationship as on removal.

2. Remove all the rocker arm bolts on the specific cylinder head.
3. Remove associated valve rockers arms.

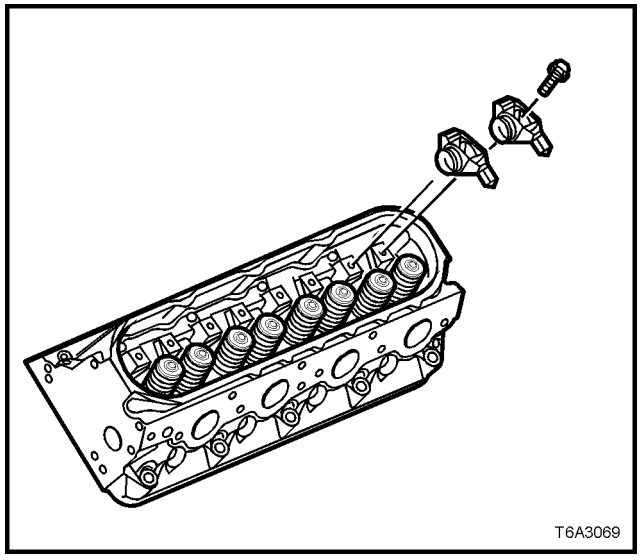


Figure 6A3-100

4. Remove the valve rocker arm pivot support.

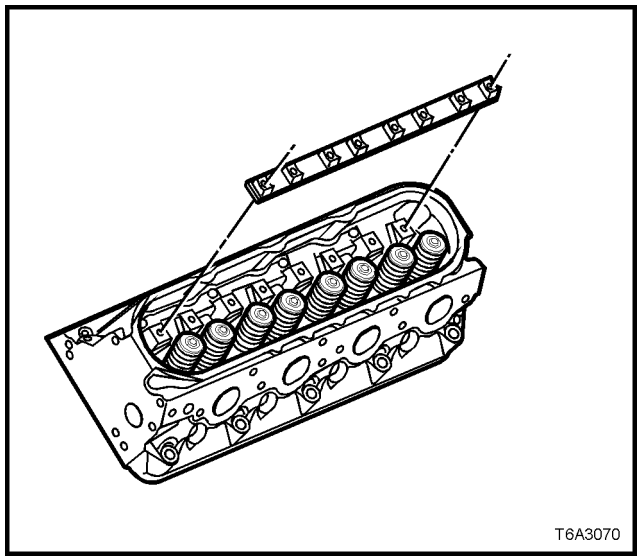


Figure 6A3-101

5. Remove the push rods.

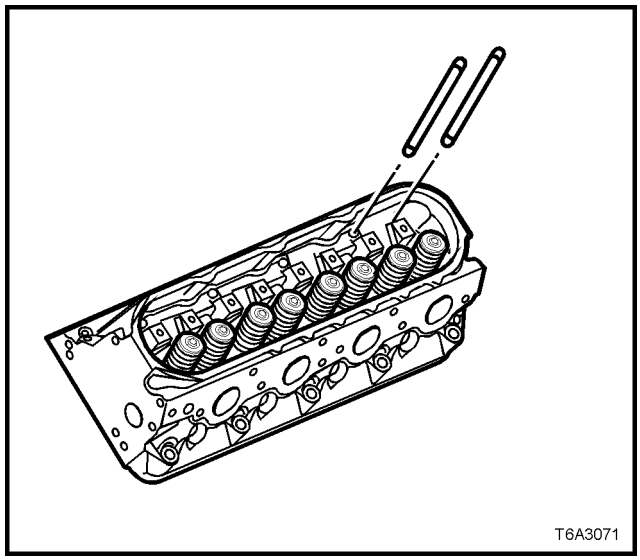


Figure 6A3-102

CLEAN AND INSPECT

1. Mark, sort or organise removed parts to retain in order removed.
2. Clean parts in a suitable solvent, then dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

3. Inspect parts, as follows:
   a. Valve rocker arm bearings for binding or roughness.
   b. Valve rocker arm push rod sockets and valve stem mating surfaces for wear and/or roughness.
   c. Pushrods for worn or scored ends.
   d. Also check for bent pushrods by rolling on a flat surface.
   e. Pushrod oil passages for restrictions.
   f. Pivot supports for cracks, wear or other damage.

REINSTALL

While the reinstallation process is the reverse of the removal procedure, there are some specific operations that must be complied with, and are detailed here.

1. To reduce the effort required to turn the engine over by hand, remove the spark plugs, taking note of the following;

a. The engine coolant is to be 50° C or less. If not, then the spark plug and cylinder head threads may bind, causing the cylinder head threads to be torn.

b. When removing spark plug leads, only handle the boot on each lead, twist to break the seal, them pull to remove. DO NOT pull on the lead itself.

c. Loosen the spark plug/s, then re-tighten to break away any carbon deposits on the threads.

d. Loosen the spark plug/s once again but, this time, only one or two turns. Then use compressed air to remove any foreign material that may otherwise enter the combustion chamber.

CAUTION: Wear eye protection to avoid injury.

e. Continue to remove the spark plug/s.

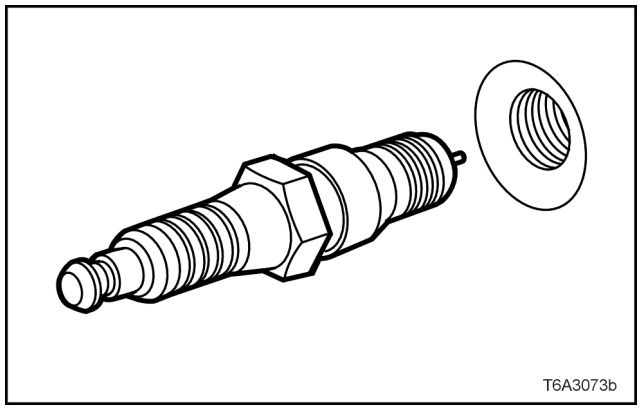


Figure 9A-103

2. Lubricate the following parts in clean engine oil before installation:
   a. All valve rocker arms and pushrods.
   b. The flanges of all rocker arm bolts.
3. Install all push rods, checking that each seats correctly to the hydraulic valve lifter sockets.
4. Install all rocker arms, bearings and NEW retaining bolts but DO NOT TIGHTEN fully at this time.
5. Rotate the crankshaft until No. 1 piston is at Top Dead Centre (TDC), on the compression stroke.

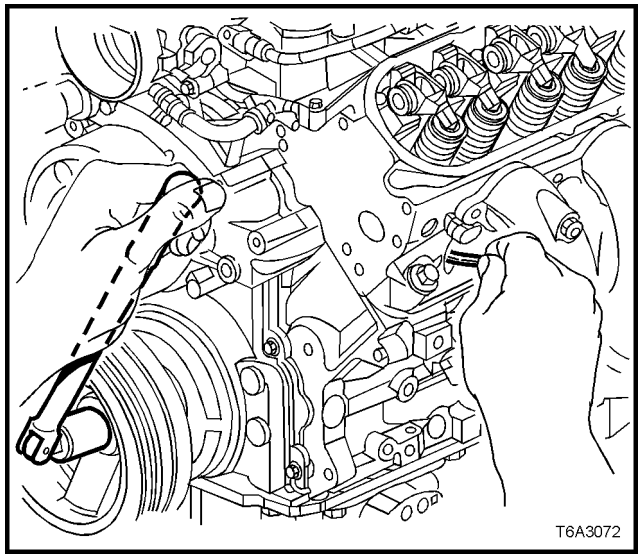


Figure 6A3-104

NOTE 1: Inserting a finger into the spark plug hole will determine if the piston is rising on the compression stroke, by the compressed air escaping. Finally, a suitable piece of wire can be used as shown, to determine when the piston is at TDC.

NOTE 2: The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3 and cylinder numbers are 1, 3, 5, 7, on the left bank and 2, 4, 6, 8, are on the right bank.

6. With No. 1 piston on TDC compression stroke, tighten the following rocker arm bolts to the correct torque specification:

ROCKER ARM BOLT TORQUE SPECIFICATION
Exhaust Valve, Cylinder No.1, 2, 7 and 8, to 30 Nm
Intake Valve, Cylinder No. 1, 3, 4 and 5, to 30 Nm

7. Rotate the crankshaft 360°.
8. Tighten the following rocker arm bolts to the correct torque specification:

ROCKER ARM BOLT TORQUE SPECIFICATION
Exhaust Valve, Cylinder No.3, 4, 5 and 6, to 30 Nm
Intake Valve, Cylinder No. 2, 6, 7 and 8, to 30 Nm

9. Reinstall the rocker cover/s. Refer **2.17 VALVE ROCKER ARM COVER**, in this Section, for the necessary procedure.

2.19 VALVE SPRING AND/OR VALVE STEM OIL SEAL

LT Section No. – 00-075

REPLACE

1. Remove the spark plugs from the cylinder/s being serviced, taking note of the following;

a. The engine coolant is to be at 50° C or less. If not, then the spark plug and cylinder head threads may bind, causing the cylinder head threads to be torn.

b. When removing spark plug leads, only handle the boot on each lead, twist to break the seal, them pull to remove. DO NOT pull on the lead itself.

c. Loosen the spark plug/s, then re-tighten to break away any carbon deposits on the threads.

d. Loosen the spark plug/s once again but, this time, only one or two turns. Then use compressed air to remove any foreign material that may otherwise enter the combustion chamber.

CAUTION: Wear eye protection to avoid injury.

e. Continue to remove the spark plug/s.

2. Remove the valve rocker arms, valve rocker arm pivot support, and valve pushrods. Refer to **2.18 VALVE ROCKER ARMS & PUSH RODS**.

3. Insert a suitable piece of wire into the spark plug hole and turn the crankshaft balancer bolt until the piston is at or near Top Dead Centre (TDC).

4. Install Spark Plug Port Adaptor Tool J 22794 or a commercial equivalent to the spark plug hole of the cylinder being serviced.

5. Using suitable adaptors, attach a compressed air line to J 22794 and apply a constant supply of compressed air to the cylinder being serviced.

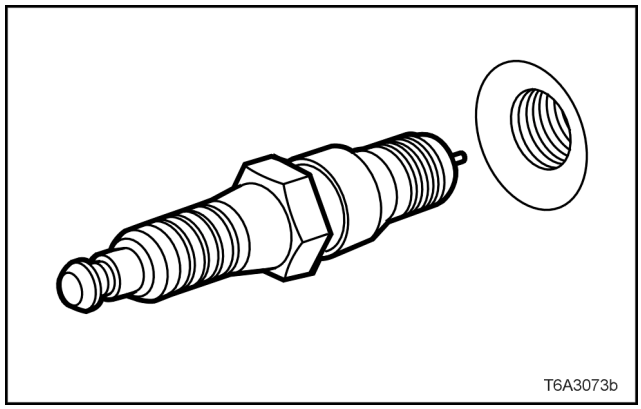


Figure 6A3-105

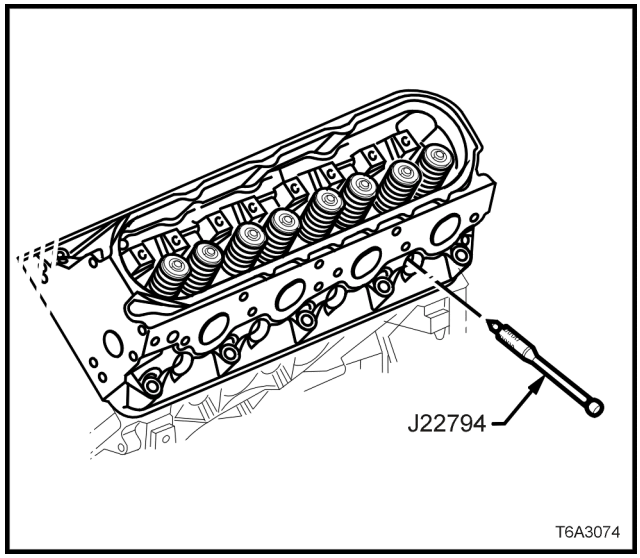


Figure 6A3-106

6. Compress one of the valve springs, using valve spring compressor, KD2078.

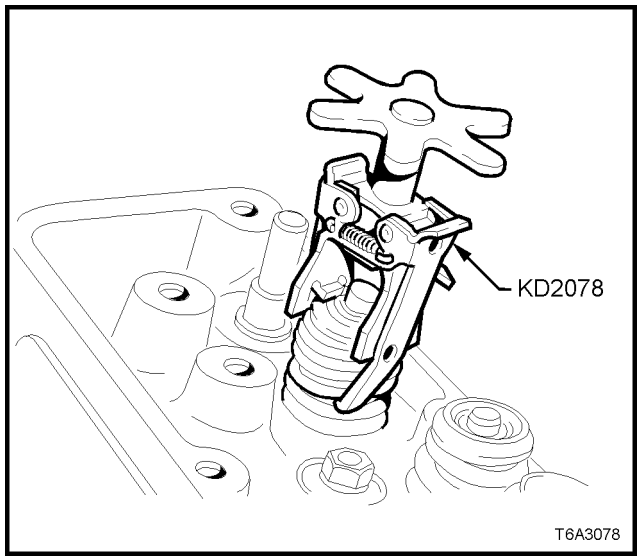


Figure 6A3-107

7. Remove valve stem collets (2).
8. Release the valve spring compressor and remove:
a. Valve spring cap (3).
b. Valve spring (4).
c. Valve spring oil seal and spring shim combination (5) (if being replaced).
9. Install a new valve stem oil seal and shim assembly (second design) to the valve guide, by hand, until the shim seats against the cylinder head. No special tools are required for this operation.

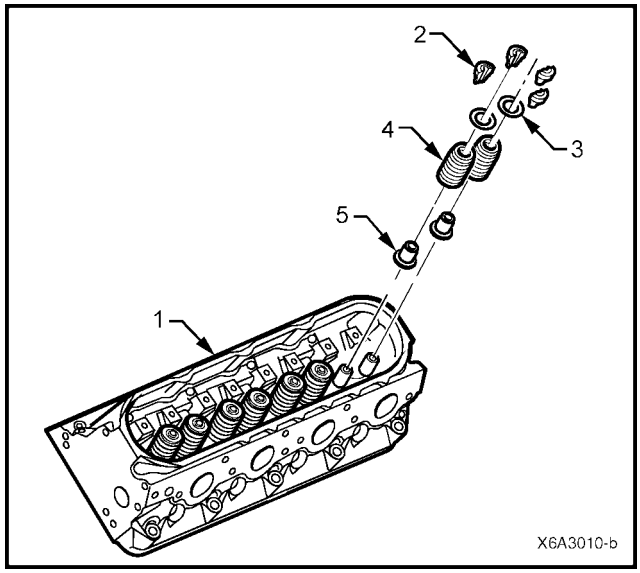


Figure 6A3-108

10. Install the valve spring with the smaller wound coils facing up, then install the spring cap.
11. Compress the spring using Tool No. KD2078 until sufficient space is allowed for the valve collets to be installed.
12. Install both valve stem collets, using clean grease or petroleum jelly to retain.
13. Release the valve spring compressor, checking that both valve stem collets are seated correctly.
14. Lightly tap the valve stem with a soft faced hammer to 'seat' the valve stem collets.
15. Remove the compressed air supply.
16. Remove the spark plug adaptor, Tool J22794.
17. Install the spark plug, tightening to the correct torque specification.

SPARK PLUG TORQUE SPECIFICATION	15 Nm

18. Reverse the removal procedure to complete this operation.

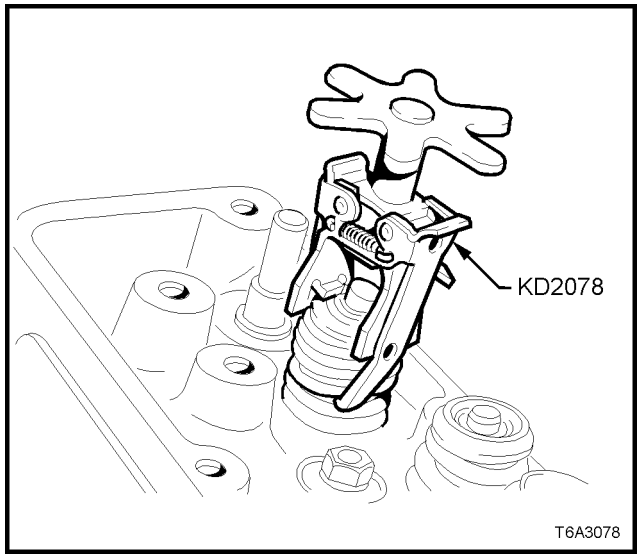


Figure 6A3-109

2.20 OIL LEVEL INDICATOR AND TUBE

LT Section No. – 00-580

REPLACE

1. Remove the oil level indicator from the tube.
2. Remove the oil level indicator tube bracket bolt from the right hand exhaust manifold
3. Remove the tube from the engine, then remove the O-ring.

NOTE: If the tube is not to be reinstalled immediately, plug the opening to prevent dirt entry.

4. After cleaning the tube, inspect the O-ring, which can be re-used if undamaged. Install O-ring to the lower end of the tube
5. Install the tube to the engine and rotate to the correct position.
6. Install the oil level indicator tube bracket bolt and tighten in two stages, to the correct torque specification.

OIL LEVEL TUBE RETAINING BOLT TORQUE SPECIFICATION	25 Nm

7. Install the oil level indicator to the tube.

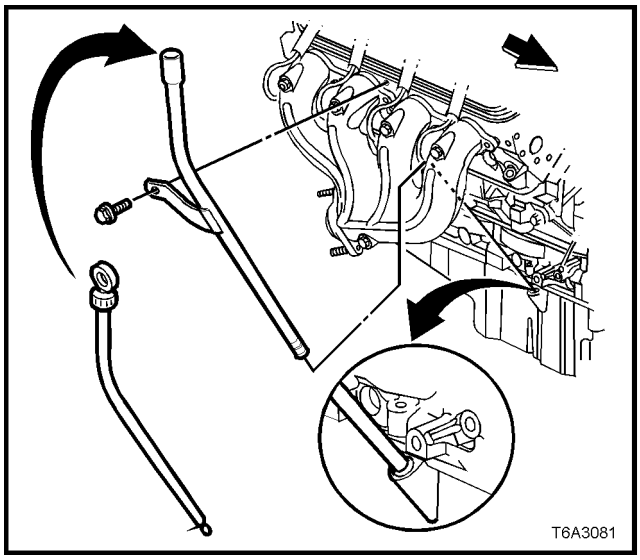


Figure 6A3-110

2.21 EXHAUST MANIFOLD

LT Section No. – 00-450

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
3. De-pressurise fuel rail. Refer to **2.13 FUEL SYSTEM PRESSURE RELIEF**, in this Section.
4. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
   a.

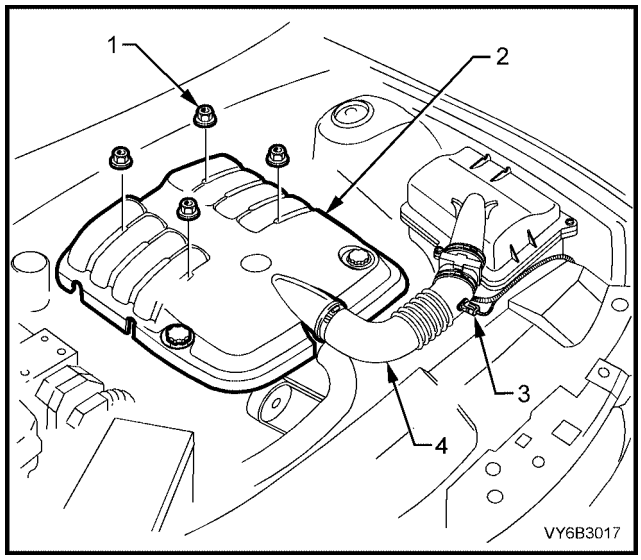


Figure 6A3-111

5. For the right hand side exhaust manifold:
   a. Remove the engine oil level indicator and tube. Refer to **2.20 OIL LEVEL INDICATOR AND TUBE**, in this Section.
   b. Plug the opening in the cylinder block to prevent entry of foreign matter.
6. For the left hand side exhaust manifold:
   a. Remove the engine coolant temperature sensor (1) from the cylinder head to avoid possible damage during exhaust manifold removal.
7. Raise the front of the vehicle and place on safety stands. Refer to **Section 0A GENERAL INFORMATION** for location of jacking and support points.

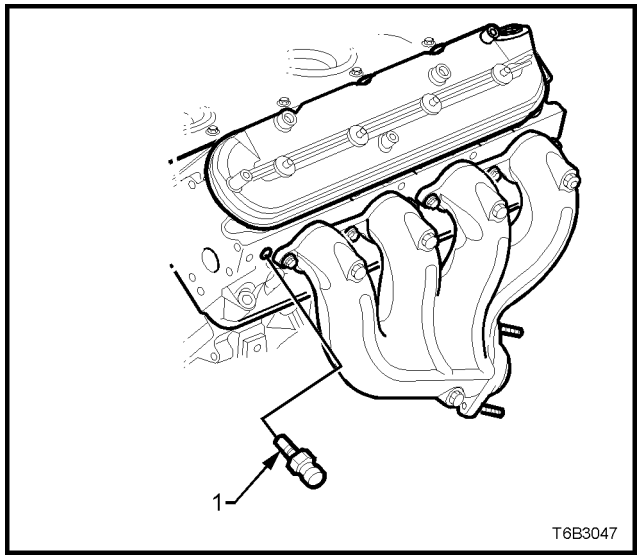


Figure 6A3-112

8. While not essential, it is recommended that the oxygen sensor/s (1) are removed from the exhaust pipe/s, to avoid accidental damage.

a. Disconnect the wiring harness connector/s from the oxygen sensor/s.

b. Remove the oxygen sensor/s from the exhaust pipe/s.

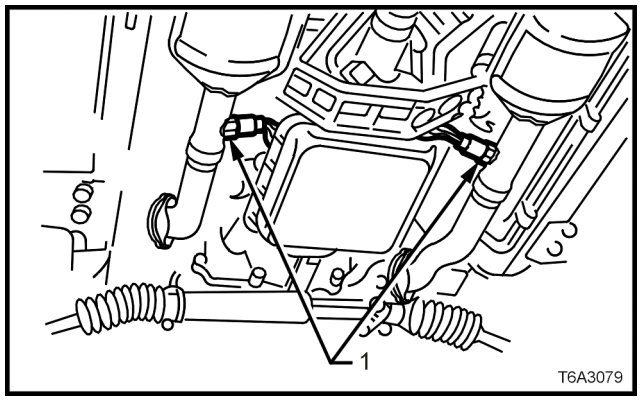


Figure 6A3-113

9. Remove the exhaust manifold to exhaust pipe flange nuts.
10. Lower vehicle to the ground.
11. Remove the spark plugs from the cylinder head on the exhaust manifold side being removed, taking note of the following;

a. The engine coolant is to be at 50° C or less. If not, then the spark plug and cylinder head threads may bind, causing the cylinder head threads to be torn.

b. When removing spark plug leads, only handle the boot on each lead, twist to break the seal, them pull to remove. DO NOT pull on the lead itself.

c. Loosen the spark plug/s, then re-tighten to break away any carbon deposits on the threads.

d. Loosen the spark plugs once again but, this time, only one or two turns. Then use compressed air to remove any foreign material that may otherwise enter the combustion chamber.

CAUTION: Wear eye protection to avoid injury.

e. Continue to remove the spark plugs.

12. Progressively loosen, then remove exhaust manifold bolts, working from the outside in to the centre.
13. Remove exhaust manifold and gasket from the cylinder head.

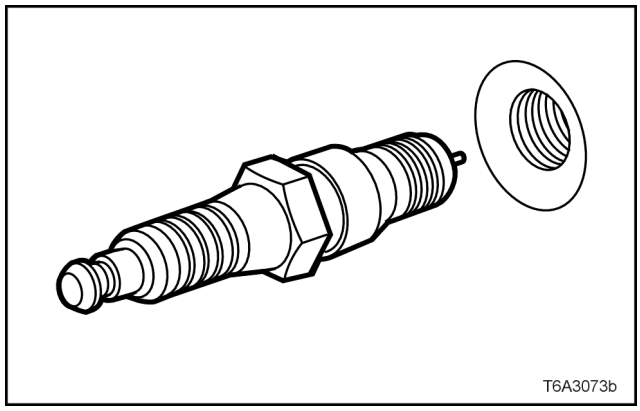


Figure 6A3-114

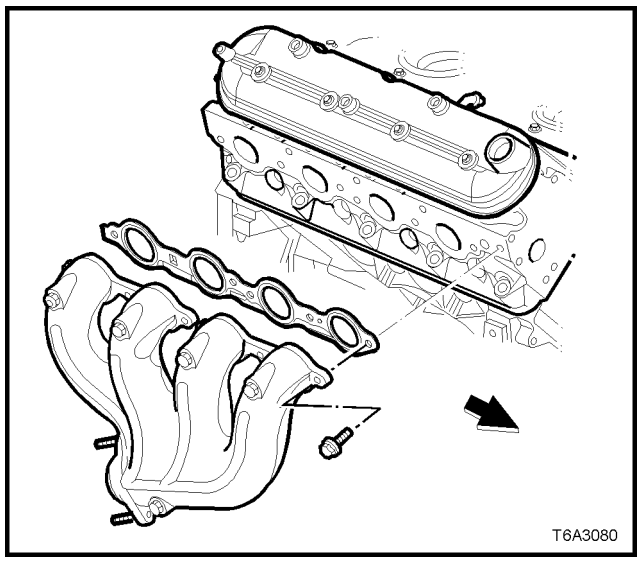


Figure 6A3-115

14. If required, remove the heat shield retaining bolts (1) and the heat shield (2) from the exhaust manifold (3).

NOTE: While the right hand side exhaust manifold is shown, the left hand side arrangement is similar.

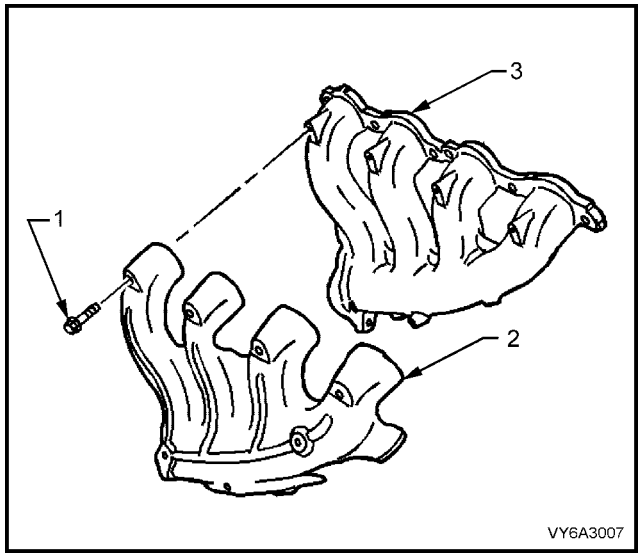


Figure 6A3-116

INSPECT

1. Inspect for a loose or damaged heat shield.
2. Inspect the exhaust pipe flange stud threads for damage.
3. Inspect the exhaust pipe flange stud threads for damage.
4. Inspect exhaust manifold to cylinder head mounting surface for scratches or damage.
5. Using a straight edge and feeler gauges, check that the cylinder head mounting face of the exhaust manifold does not exceed the maximum distortion specification of 0.25 mm.

   An exhaust manifold exceeding this maximum, must be machined to correct the misalignment.

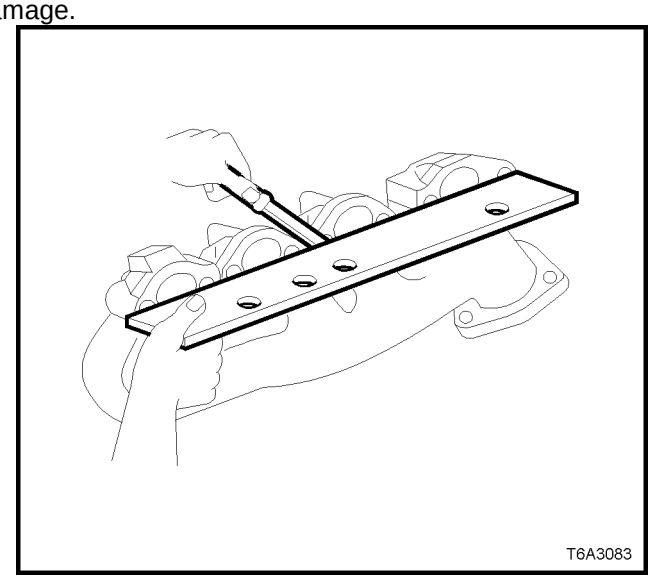


Figure 6A3-117

REINSTALL

The reinstallation procedure is the reverse of the removal operation, except for the following items:

NOTE 1: Correct installation of the exhaust manifold gaskets and the adherence to the specified tightening sequence and torque applied to the exhaust manifold attaching bolts is critical to ensure a gas tight seal and compliance with emission regulations.

NOTE 2: The exhaust manifold bolt hole threads must be clean and free of debris or threadlocking compound.

NOTE 3: All gaskets, O-rings and seals must be replaced with new parts on assembly.

NOTE 4: Do not apply thread sealant to the first three threads of any exhaust manifold mounting bolt.

1. If the heat shield was removed, apply an anti-seize compound such as Caltex Kopr-Kote (or equivalent) to the cleaned heat shield bolt threads, reinstall the heat shield and bolts to the exhaust manifold and tighten the retaining bolts to the correct torque specification.

EXHAUST MANIFOLD HEAT SHIELD BOLT TORQUE SPECIFICATION	9 Nm

2. Apply a 5 mm wide band of Loctite 272 thread sealant (or equivalent), to the threads of the exhaust manifold mounting bolts.

3. Install a NEW exhaust manifold to cylinder head gasket, install the manifold and bolts.
4. Tighten the exhaust manifold bolts to the specified, two stage torque specification, beginning with the centre two bolts, then alternate from side to side, to the outside bolts.

EXHAUST MANIFOLD BOLT TORQUE SPECIFICATION	Stage 1 – 15 Nm Stage 2 – 25 Nm

5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the front of the right hand cylinder head and the rear of the left hand cylinder head.
6. If removed, install the oxygen sensor/s into the exhaust pipe/s.

IMPORTANT: A special anti-seize compound is used on the oxygen sensor threads. New or service sensors will already have the compound applied to the threads. If an oxygen sensor is removed and is to be reinstalled, then the threads must have the specified anti-seize compound applied before reinstallation.

This specific anti-seize compound is available through Service Parts Operations, as Part Number 5613695 and is to be applied to the cleaned threads of the oxygen sensor.

7. Tighten the oxygen sensor/s to the correct torque specification.

OXYGEN SENSOR TORQUE SPECIFICATION	41 Nm

8. Apply an anti-seize compound such as Caltex Kopr-Kote (or equivalent) to the cleaned exhaust pipe flange stud threads.
9. Install and tighten the exhaust pipe to manifold flange nuts to the correct torque specification.

EXHAUST PIPE FLANGE NUT TORQUE SPECIFICATION	28 Nm

10. Apply thread sealant such as Loctite 565 (or equivalent), to the cleaned threads of the coolant temperature sensor (1).
11. Install and tighten the coolant temperature sensor (1) to the correct torque specification.

COOLANT TEMPERATURE TORQUE SPECIFICATION	20 Nm

12. Reinstall spark plugs tightening to the correct torque specification, then reinstall the spark plug leads.

SPARK PLUG TORQUE SPECIFICATION	15 Nm

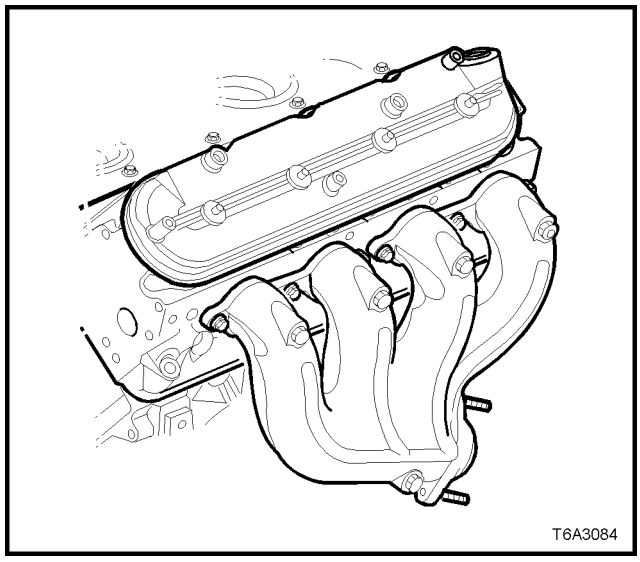


Figure 6A3-118

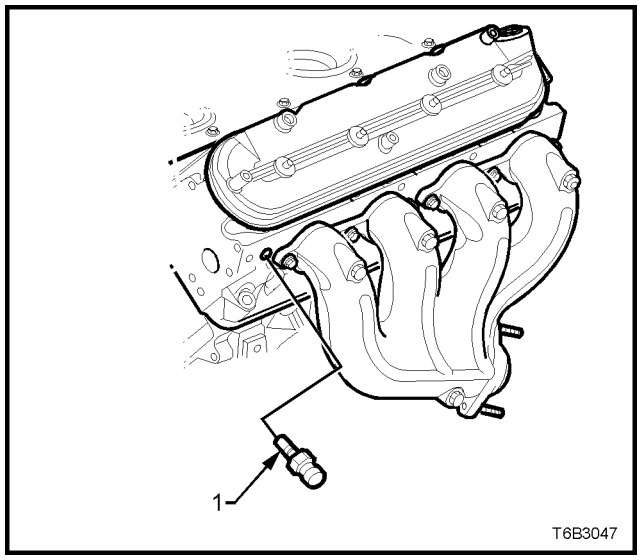


Figure 6A3-119

2.22 CYLINDER HEAD

LT Section No. – 00-075

NOTE: The following fasteners MUST be replaced (■) when performing this operation or have either micro encapsulation or incorporate a mechanical thread lock (♦) and should only be used once. If in doubt, replacement is recommended:

- ■ All M11 cylinder head bolts.
- ♦ Threads of the M8 bolts.

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
3. De-pressurise fuel rail. Refer to **2.13 FUEL SYSTEM PRESSURE RELIEF**, in this Section.
4. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
5. Remove the engine accessory drive belt. Refer to **2.6 ENGINE DRIVE BELTS**, in this Section.
6. Remove intake manifold. Refer to **2.14 INTAKE MANIFOLD**, in this Section.
7. Remove vapour vent pipe. Refer to **2.15 VAPOUR VENT PIPE**, in this Section.
8. Remove valve rocker arm cover on the cylinder head to be removed. Refer to **2.17 VALVE ROCKER ARM COVER**, in this Section.
9. Remove valve rocker arms and push rods on the cylinder head to be removed. Refer to **2.18 VALVE ROCKER ARMS AND PUSH RODS**, in this Section.
10. Remove the spark plugs from the cylinder head being removed, noting the following:

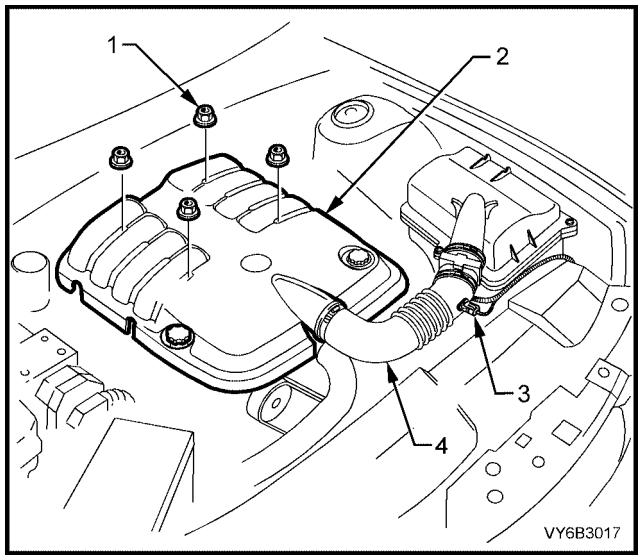


Figure 6A3-120

a. The engine coolant is to be at 50° C or less. If not, then the spark plug and cylinder head threads may bind, causing the cylinder head threads to be torn.

b. When removing spark plug leads, only handle the boot on each lead, twist to break the seal, them pull to remove. DO NOT pull on the lead itself.

c. Loosen the spark plug/s, then re-tighten to break away any carbon deposits on the threads.

   a. Loosen the spark plug/s once again but, this time, only one or two turns. Then use compressed air to remove any foreign material that may otherwise enter the combustion chamber.

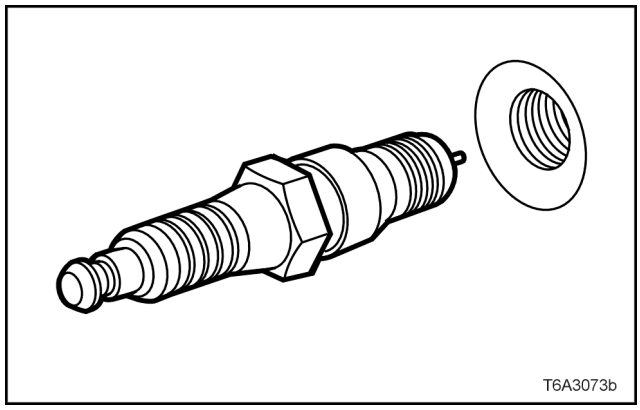


Figure 6A3-121

CAUTION: Wear eye protection to avoid injury.

   e. Continue to remove the spark plug/s.

11. For the right hand side cylinder head, first remove the engine oil level indicator and tube. Refer to **2.20 OIL LEVEL INDICATOR AND TUBE**, in this Section.
12. Remove the exhaust manifold on the cylinder head to be removed. Refer to **2.21 EXHAUST MANIFOLD**, in this Section.
13. For the right hand cylinder head:
    a. Remove the bolt securing the automatic transmission dipstick tube bracket bolt (if fitted).from the rear of the cylinder head

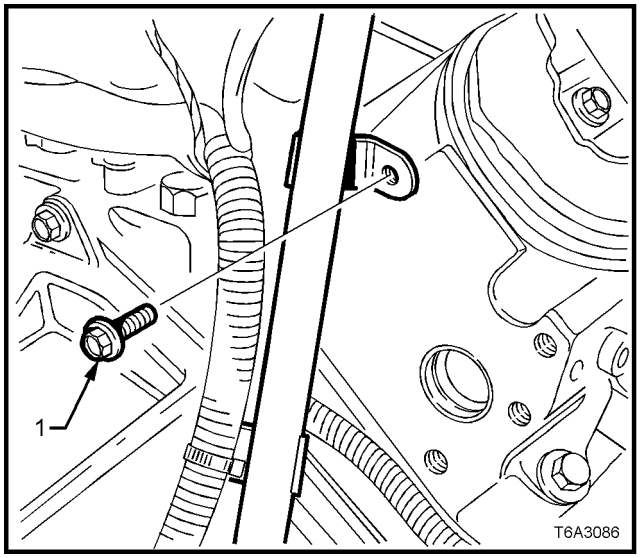


Figure 6A3-122

    b. Remove the bolt securing the powertrain harness ground strap from the front of the right hand cylinder head.

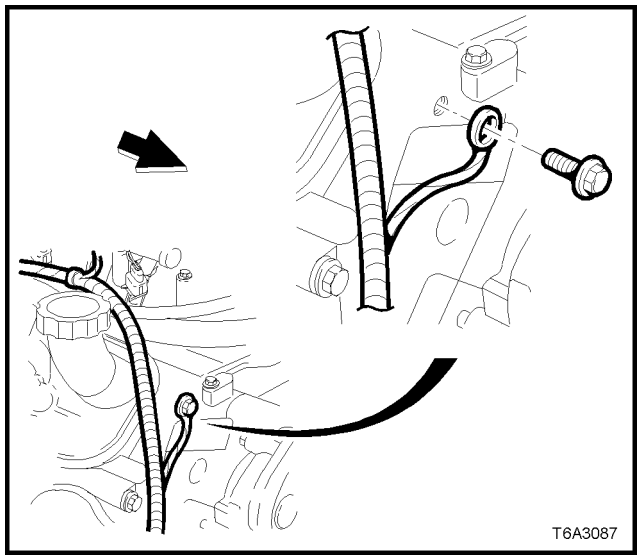


Figure 6A3-123

14. For the left hand cylinder head:
    a. Place a drain tray beneath power steering pump assembly.
    b. Remove the power steering fluid reservoir from its bracket by levering the bracket locking tab with a screwdriver or similar lever, to release the reservoir. Refer to **Section 9A STEERING**.
    c. Loosen and remove high pressure line flare nut (1) and O-ring (2) from pump outlet fitting, using a back-up spanner on the pump outlet fitting.

    NOTE: Fluid will drain from the reservoir so have a suitable container available.

    d. Loosen low pressure hose clamp (3) and remove hose from pump inlet fitting.

    NOTE: Plug or tape the pump and hose fittings to prevent dirt entry.

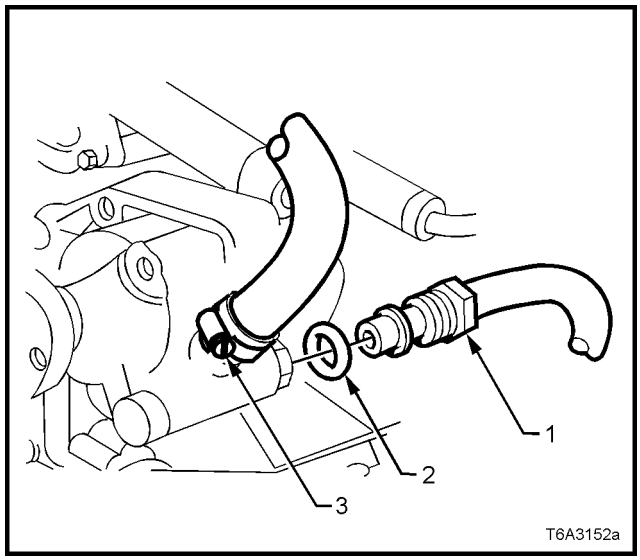


Figure 6A3-124

d. Remove both bolts (2) securing the power steering pump (1) to the front of the left hand cylinder head.

NOTE: Access to the two bolts can be made through the pulley holes, using a suitable socket and extension.

e. Secure the reservoir and pump to one side, using tie wire or similar.

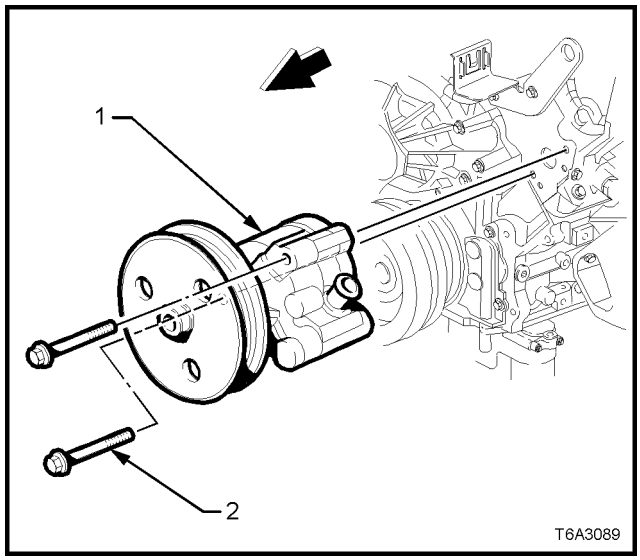


Figure 6A3-125

c. Remove the powertrain wiring harness strap (1) from the bracket at the rear of the cylinder head.

d. Remove the bolt (2) securing the powertrain harness ground cable at the rear of the cylinder head.

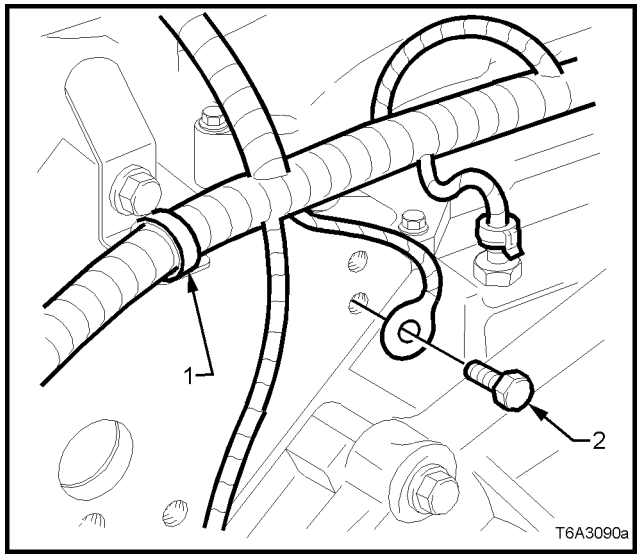


Figure 6A3-126

e. Remove the coolant temperature sensor (1).

NOTE: This step is necessary to allow the lower left cylinder head bolt to be removed and to avoid the risk of accidental damage to the sensor.

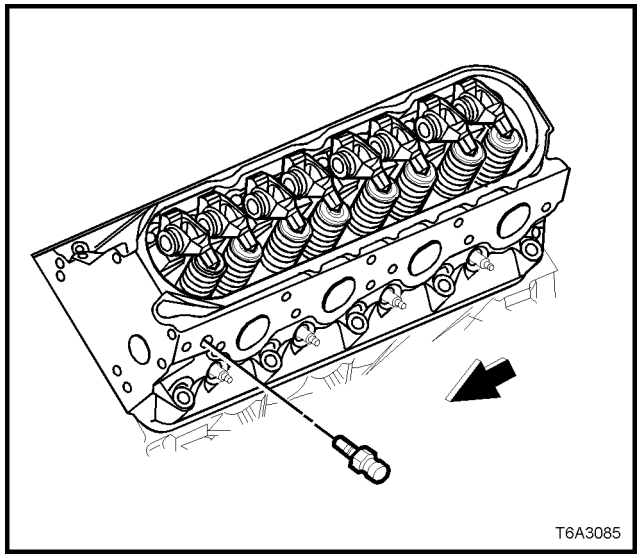


Figure 6A3-127

15. Progressively loosen cylinder head bolts starting with the M8 bolts (3) first, working from the outside to the centre.

NOTE: Discard all M11 bolts (1 and 2) after removal, as these are 'torque to yield' bolts. Also note the location of the two shorter, M11 bolts (2). The M8 bolts (3) can be re-used.

16. Remove the cylinder head from the cylinder block and place on two blocks of wood. This is most important to avoid scratching the machined surface.

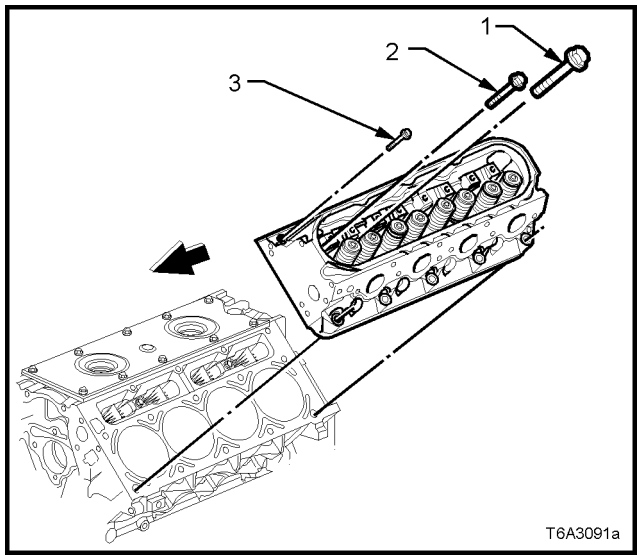


Figure 6A3-128

17. Remove and discard the cylinder head gasket.

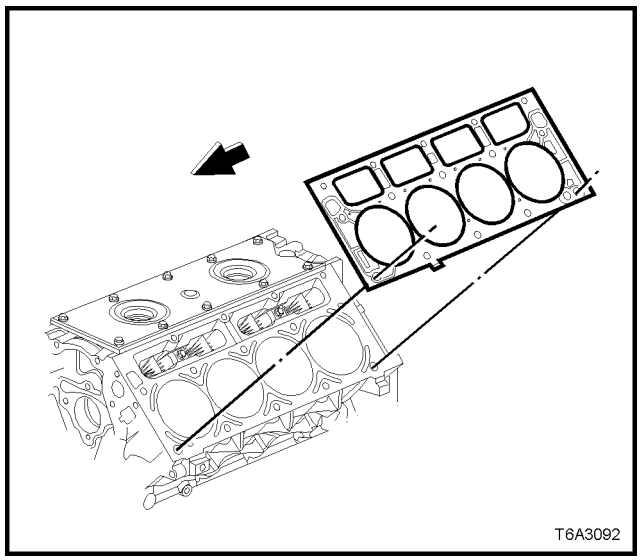


Figure 6A3-129

DISASSEMBLE

NOTE: Do not mix removed components. Organise all parts in the order removed, to ensure that parts reinstalled are fitted to their original locations.

1. Use a commercially available valve spring compressor to compress the valve spring.

NOTE: It may be necessary to tap the valve spring end of the compressor with a plastic faced hammer to loosen jammed valve collets.

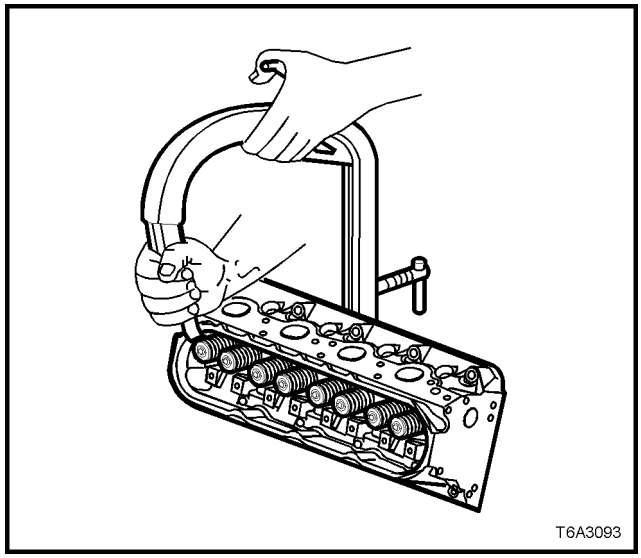


Figure 6A3-130

2. Remove the following components from the cylinder head (1):
   a. Valve stem collets (2).
   b. Valve spring cap (3).
   c. Valve spring (4).
   d. Valves (7, 8).
   e. Valve stem oil seal and shim assembly (5).

NOTE: Do not remove coolant core plugs (8) unless servicing is required.

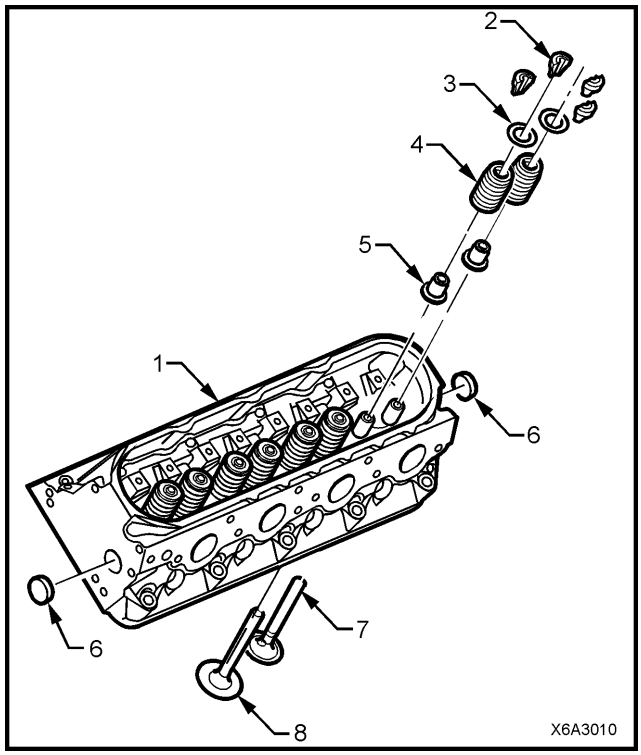


Figure 6A3-131

CLEAN

1. Use a commercially available rotary wire brush, clean all carbon deposits from the combustion chambers and valve ports, taking care not to scuff or damage the aluminium cylinder head surfaces.

CAUTION: Wear safety glasses to avoid eye injury.

2. Clean carbon deposits from valve stems and heads on a buffing wheel.
3. Check all bolt threads for damage and remove all threadlocking compound from both the threaded holes and bolts.

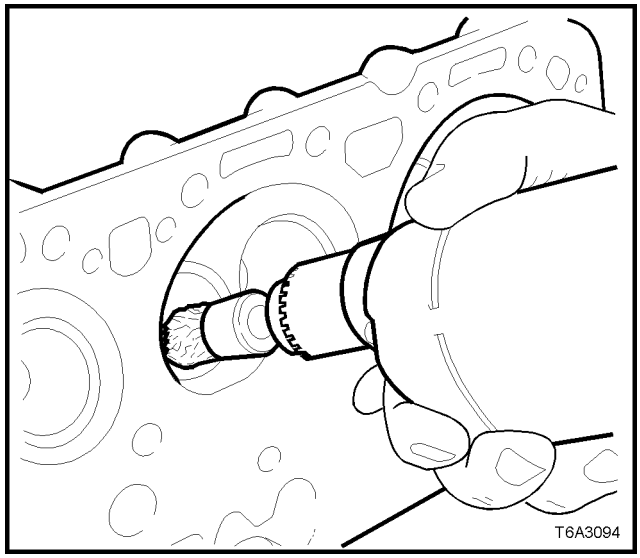


Figure 6A3-132

INSPECT

Cylinder Head

1. Check cylinder head deck, inlet and exhaust manifold mating surfaces for distortion, using a straight edge (2) and feeler gauges (1). Check lengthwise, diagonally and crosswise, as shown by the alphabetical order, in Figure 6A3-133.
2. Check the cylinder head deck to exhaust manifold the cylinder head deck to intake manifold surfaces for flatness.

CYLINDER HEAD FLATNESS SPECIFICATION (Measured Over the Cylinder Head Length)	
CYLINDER HEAD, ENGINE BLOCK DECK	0.22 mm
CYLINDER HEAD, EXHAUST MANIFOLD DECK	0.22 mm
CYLINDER HEAD, INTAKE MANIFOLD DECK	0.22 mm

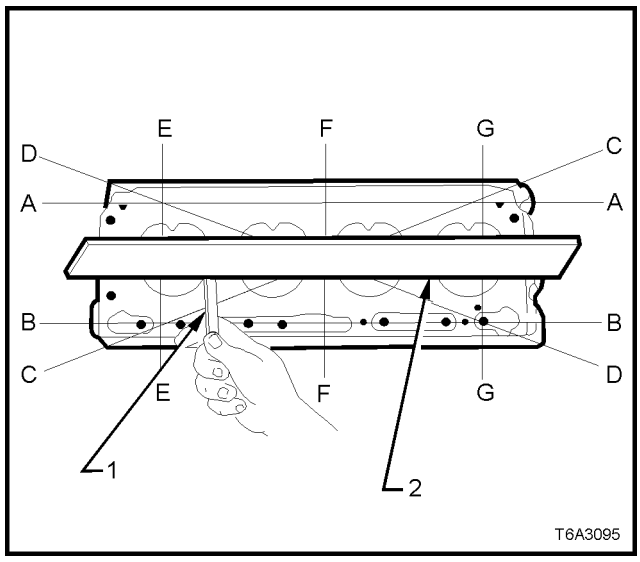


Figure 6A3-133

NOTE: If any of these surfaces are outside specification, the cylinder head may be machined, provided the minimum overall height of 120.2 mm (dimension 'A') is not exceeded.

3. Inspect all threaded holes for damage, repairing as required with suitable thread inserts. Refer to **3.16 THREAD REPAIR**, in this Section for more information.
4. Clean any residue of cylinder head bolt thread sealant from the cylinder block threads, using installer, Tool No. J-42385-107 (this tool is part of the thread repair kit, J-42385).

IMPORTANT: Do not use anything but this thread tool to clean the cylinder head threads in the cylinder block.

5. Use compressed air to clean all residue from bolt holes.

CAUTION: Wear eye protection to prevent injury.

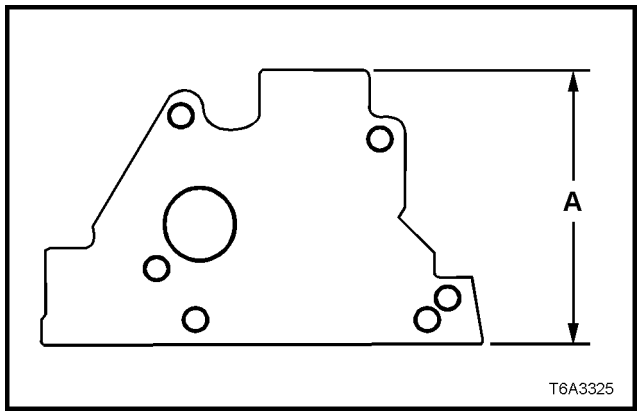


Figure 6B3-134

6. Inspect coolant jacket expansion plugs for signs of corrosion, replace plugs as necessary.

NOTE: If replacing expansion plugs, apply a coating of Loctite 242 or equivalent around plug sealing surface.

7. Inspect cylinder head for cracks, especially between valve seats or exhaust ports.
8. Inspect cylinder block deck surface for distortion, refer to **3.15 CYLINDER BLOCK**.
9. Clean the M8 cylinder head bolt threads, replacing any bolt that has suspect threads, stretched or damaged heads caused by improper use of tools.

NOTE: Discard all M11 bolts after removal, as these are “torque to yield” bolts.

Valve Springs

1. Check all valve springs for distortion. There should be no more than 1.6 mm variance (distance ‘1’) of the spring end, while the spring is being rotated on a flat surface. Replace springs that exceed this specification.

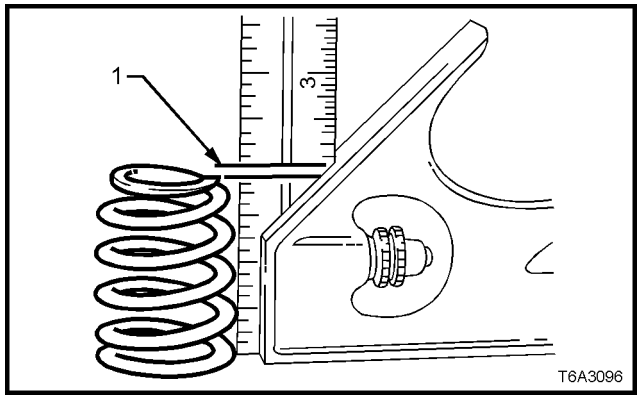


Figure 6A3-135

2. Use a commercially available valve spring tester to measure each valve spring free height and tension.
3. Discard any spring that does not conform to specification.

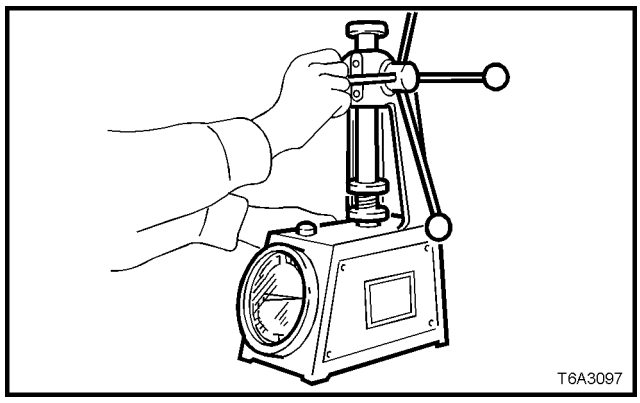


Figure 6A3-136

VALVE SPRING SPECIFICATIONS	
VALVE SPRING FREE HEIGHT (INTAKE and EXHAUST	52.9 mm
VALVE SPRING TENSION SPECIFICATION	310 N at 45.75 mm (Closed Valve, Minimum)
VALVE SPRING TENSION SPECIFICATION	980 N at 33.55 mm (Open Valve, Minimum)

Valves

1. Inspect valve stems for burrs and scratches. If minor, these can be removed with an oil stone.

   Valves with excessive stem wear or that are warped (1 and 2), should be replaced.

   Inspect the valve stem end (4) for wear. If required wear can be corrected by grinding, provided the stem end is ground at right angles to the valve stem.
2. Inspect valve stem collet groove (3) for wear or damage.

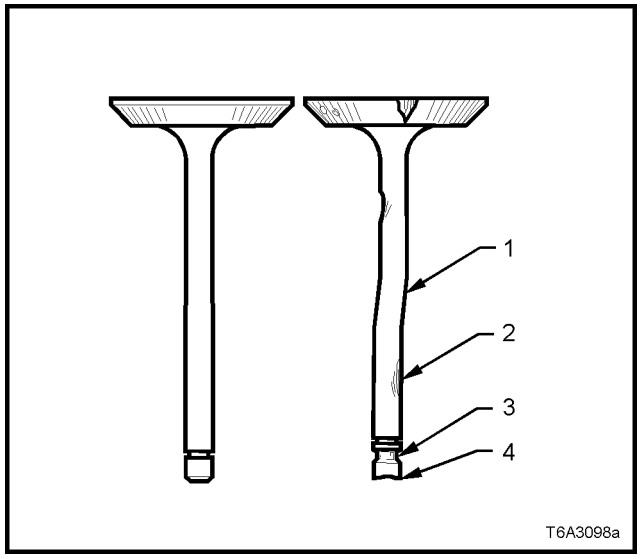


Figure 6A3-137

3. Check valve face for the following:

   Either no margin (1) or less than 1.25 mm after grinding (4).

   Excessive pitting (2).

   Burnt or corroded areas (3).

4. If an exhaust valve is to be reconditioned, the face can be ground, using a valve refacing machine. The valve seat angle is 45°.

   The equipment manufacturer's recommendations must be carefully followed to achieve the required standard of finish.

NOTE: If an exhaust valve face is reground, it may be necessary to shim the valve spring to achieve the correct spring installed height. Refer to **Cylinder Head Reassemble** in this Section, for details.

IMPORTANT: Intake valve faces must not be refaced. Intake valves that are worn or have face damage MUST be replaced.

5. Measure the valve stem diameter. A valve stem diameter of less than 7.95 mm must be replaced

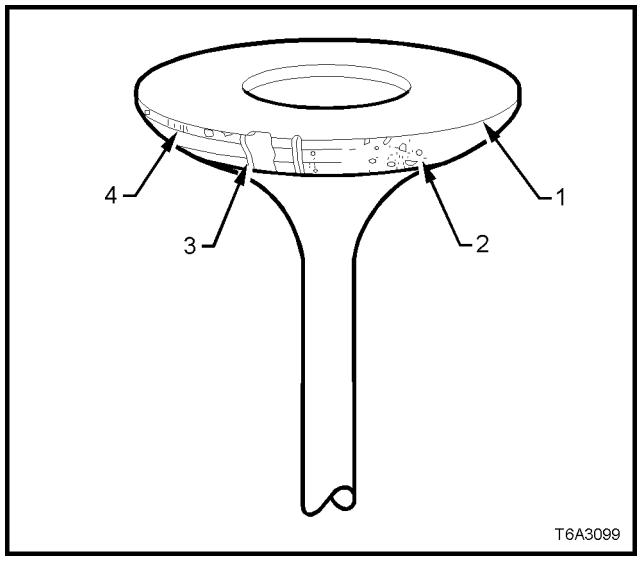


Figure 6A3-138

Valve Guides

Excessive valve stem to guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage and/or excessive oil consumption.

Insufficient valve stem to guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

Measure clearance as outlined in the following steps.

1. Insert valve into its guide.
2. Clamp a dial indicator to a valve rocker arm bolt that has been temporarily installed, in a position where sideways movement of the valve stem will cause movement of the indicator needle.
   To obtain a correct indication of wear, the indicator stem must contact the side of the valve stem, from 8 - 12 mm above top of valve guide.
3. With the valve head dropped approximately 2 mm off its seat, move the stem of the valve side to side against the dial indicator using light force, to obtain a clearance reading.

NOTE: Provided the valve stem diameter is within specifications but the valve stem to guide clearance exceed 0.093 mm (either intake or exhaust), the clearance must be corrected or the cylinder head replaced.

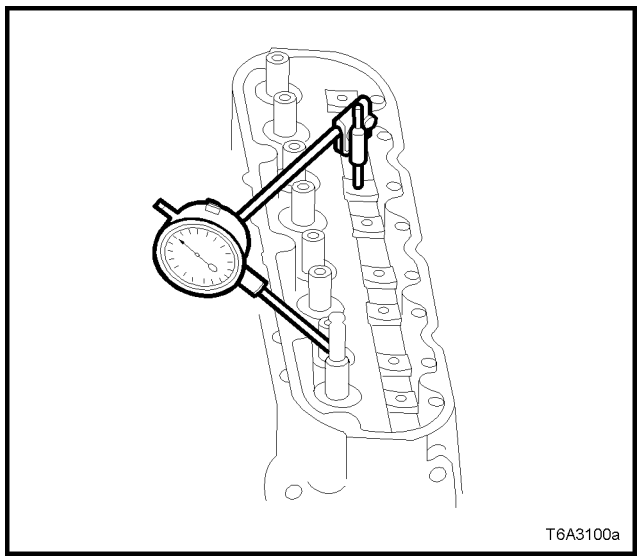


Figure 6A3-139

4. Ream the valve guide using Tool J 37378-1.
5. Clean the valve guide bore of all metal shavings and debris.

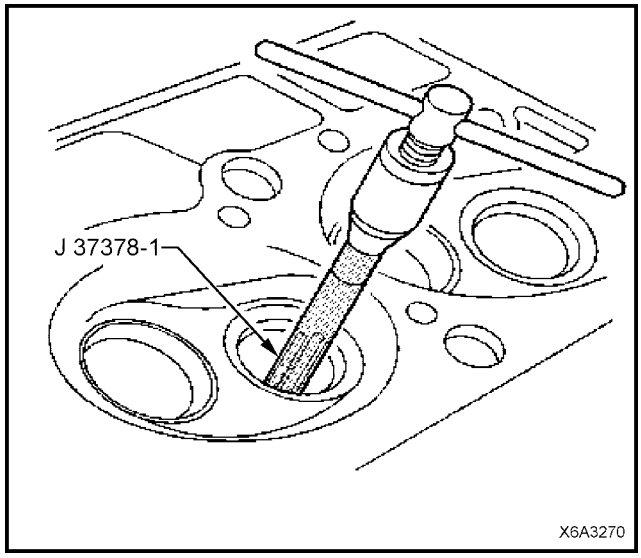


Figure 6A3-140

6. Install the oversize valve (2) into the reamed valve guide.
7. The valve should slide freely without resistance or drag. The clearance must also not exceed specification.

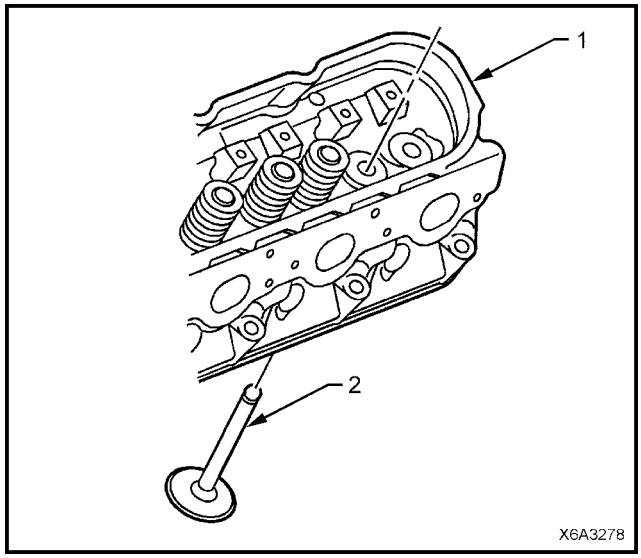


Figure 6A3-141

Valve Seats

Reconditioning the valve seats is very important because the seating of the valves must be precise for the engine to deliver the power and performance built into it.

Another important factor is the cooling of the valve head. Good contact between each valve and its seat in the head is imperative to ensure that the heat in the valve head will be transferred efficiently.

Several different types of equipment are available for reconditioning valve seats with an oscillating type valve seat grinder being preferred. The recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.

1. Check valve seats for any evidence of pitting or damage at valve contact surface. If pitting is evident, the valve seats will need to be reconditioned.

NOTE: Since the valve guide serves to support and centre the valve seat grinder, it is essential that valve guide wear is checked, as detailed in the previous operation.

Both the intake and exhaust valve seat angles are 46° and seat width should not exceed specification.

VALVE SEAT WIDTH SPECIFICATION	
INTAKE	1.02 mm maximum
EXHAUST	1.78 mm maximum

If valve seats are reconditioned and the exhaust valve faces ground, then light lapping will ensure a gas tight seal when closed.

NOTE: New valves must not be lapped, as this will destroy the protective coating on the valve face.

After refacing an existing valve or installing a new valve, correct seating must be checked as follows:

a. Lightly coat valve face with bearing (Prussian) blue.
b. Insert the valve and rotate about 1/6th of a turn.

c. Remove valve and check its contact with the seat.

d. If full contact is indicated, valve and seat are acceptable.

   However, if only partial contact is shown, reinstall the valve and rotate for one full turn. If blue now indicates a full contact then the valve must be refaced or replaced. If the blue contact still only shows partial contact then regrind the valve seat.

e. Clean all traces of blue from the valves and seats, then clean thoroughly before applying clean engine oil to both surfaces to protect from rusting.

REASSEMBLE

NOTE: Ensure that all re-used parts are reinstalled to their original locations.

1. Lubricate all valve stems, guides and valve faces with clean engine oil, then install valves (7, 8) to their correct ports.
2. Install a new valve stem oil seal and shim assembly by hand, until the shim seats against the cylinder head. No special tools are required for this operation.

IMPORTANT: The valve stem oil seal alignment and position on the valve stem is critical. An improperly installed valve stem oil seal will lead to excessive oil consumption and increased exhaust emissions.

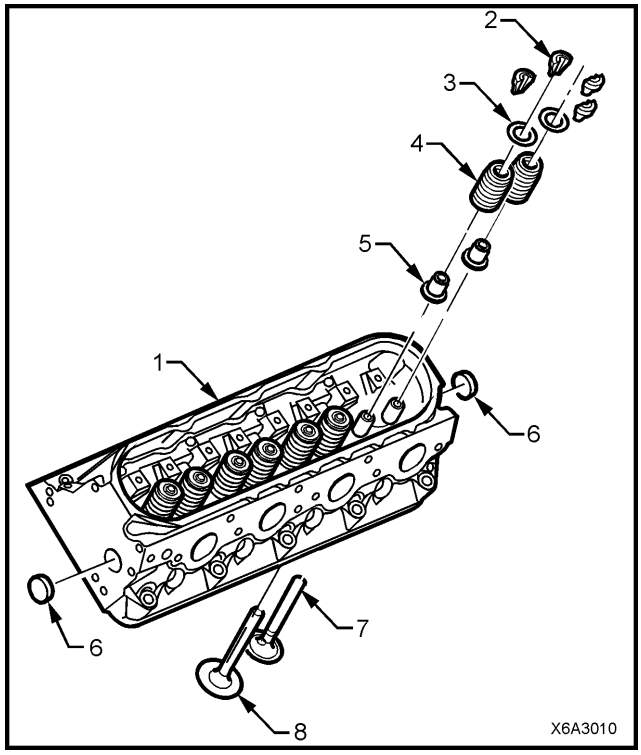


Figure 6A3-142

3. Install the valve springs and caps to each valve stem.
4. Use a commercially available valve spring compressor to compress the valve spring.
5. Install valve stem collets, retaining with petroleum jelly if required.
6. Ensure that the both collets are correctly located before releasing the valve spring compressor.
7. Tap the end of each installed valve stem, with a plastic faced hammer to seat the collets.

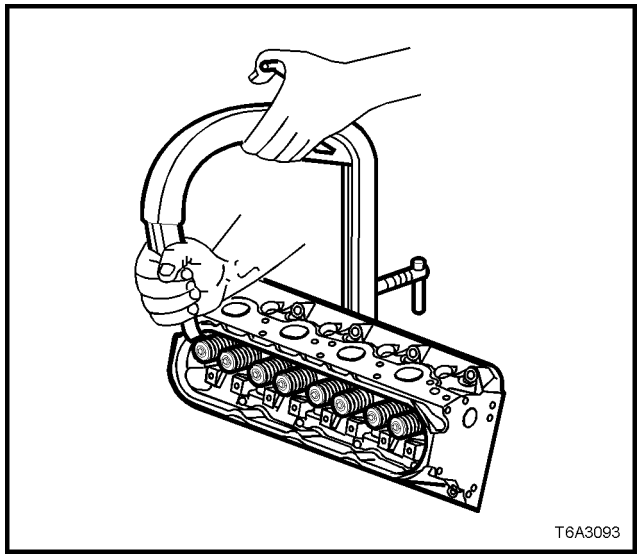


Figure 6A3-143

8. Measure the valve spring installed height using a ruler or vernier calipers. Measurement is to be taken from the base of the valve spring to the top.
9. If the measurement exceeds 46.25 mm, a commercially available, stainless steel shim must be installed between the valve stem oil seal/shim combination and the cylinder head, to achieve the required spring height.

NOTE 1: Do not shim the valve spring to obtain less than the specified height.

NOTE 2: When replacing valve stem oil seals, only use the later design that combines the oil seal and the valve spring shim.

10. Install the remaining valves, springs and other components, checking each spring height as it is assembled.
11. If the cylinder head core plugs were removed, install with sealant such as Loctite 565 (or equivalent) before plug installation.

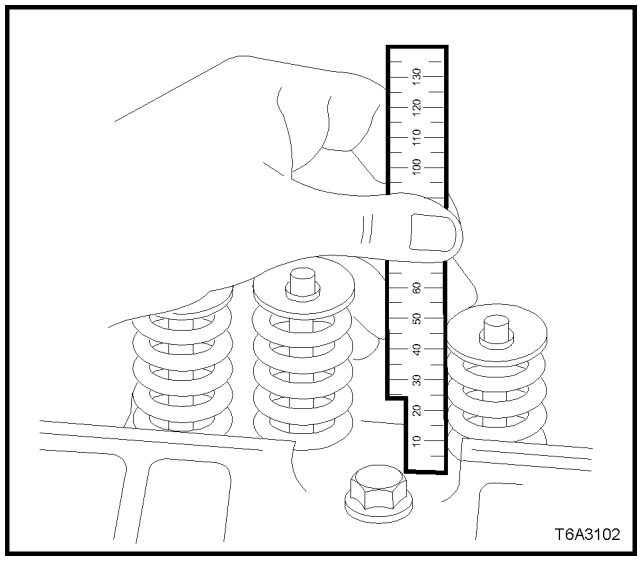


Figure 6A3-144

REINSTALL

Reinstallation of either or both cylinder heads is the reverse to the removal procedure, except for the following points.

NOTE 1: Do not refit removed M11 cylinder head bolts. Always use NEW bolts when installing a cylinder head.

NOTE 2: Do not use any sealant on the cylinder head gasket, nor threadlock compound on the M11 cylinder head bolts.

1. Check the cylinder head locating sleeves for correct installation. Dimension ‘A’ is to be 8.3 mm, when the revised design cylinder head gasket is used.

NOTE: When the earlier design cylinder head gaskets were used, this dimension was 6 mm.

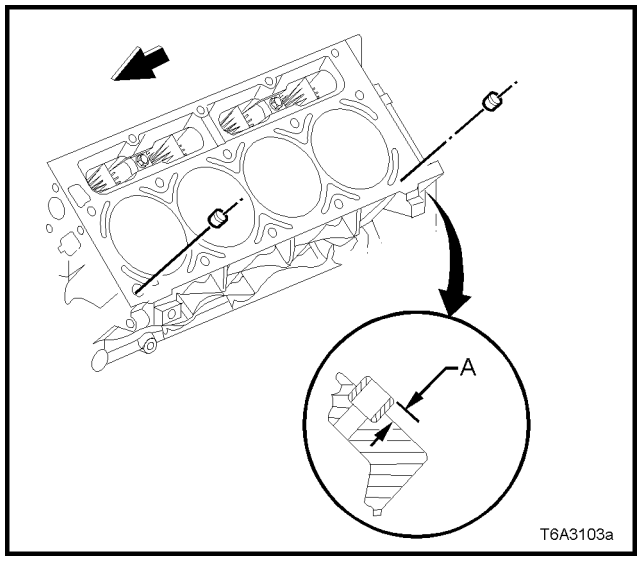


Figure 6A3-145

2. Install a NEW cylinder head gasket correctly over the locating sleeves.

NOTE 1: When correctly installed, the tab (arrow) on the cylinder head gasket will be located to the front half point (small arrow). This applies with either cylinder head gasket.

NOTE 2: The cylinder head gaskets will fit on either side. The only condition is that the word 'FRONT' stamped on the gasket must face the engine front. The tab should also have "5.7" imprinted on it.

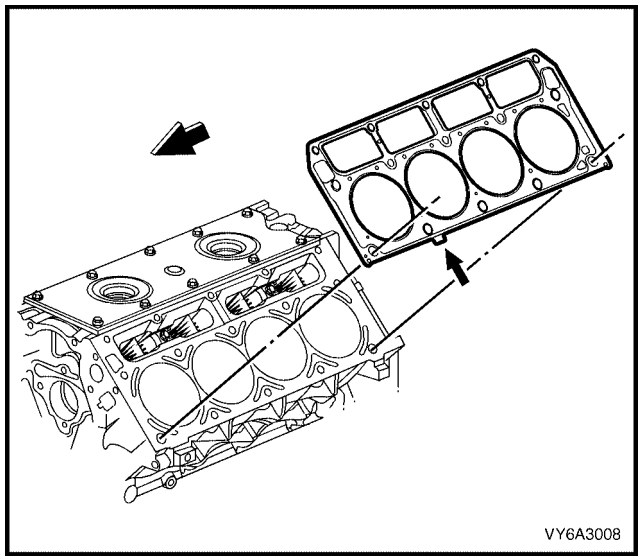


Figure 6A3-146

3. Install the cylinder head over the locating sleeves and the previously installed gasket.
4. Apply a 5 mm band of threadlock such as Loctite 242, ONLY to the threads of the M8 bolts (3).
5. Install the M8 cylinder head bolts (3), then loosely install NEW M11 bolts (1 and 2).

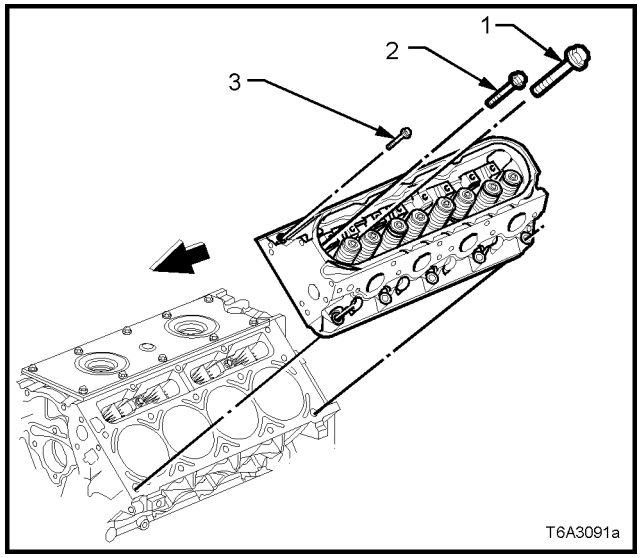


Figure 6A3-147

6. Tighten the cylinder head bolts in the sequence shown and to the correct torque specification.

NOTE 1: Use a torque angle meter such as E 7115 to achieve an accurate turn angle reading.

NOTE 2: Bolt numbers 1 to 10 inclusive are the M11 bolts, while bolts 11 to 15 are the M8 bolts.

CYLINDER HEAD BOLT TORQUE SPECIFICATION		
Stage 1	(All M11 and M8 Bolts)	30 Nm
Stage 2	(All M11 Bolts only)	90° turn angle
Stage 3	(M11 Bolts 1 to 8 only)	90° turn angle
	(M11 Bolts 9 and 10 only)	50° turn angle

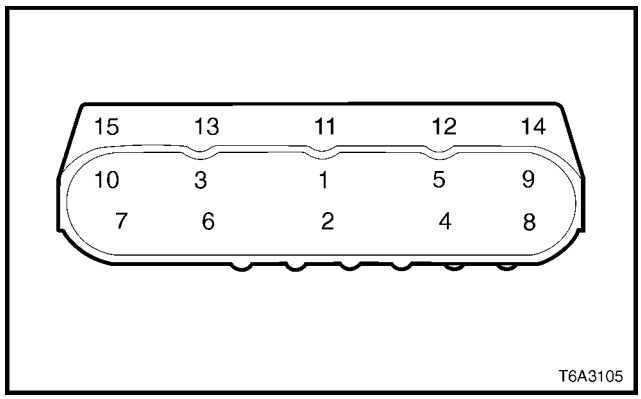


Figure 6A3-148

For the remainder of reinstallation process, refer to the following procedures, in the order listed:

2.18 VALVE ROCKER ARMS AND PUSH RODS.

2.17 VALVE ROCKER ARM COVER.

2.15 VAPOUR VENT PIPE.

2.14 INTAKE MANIFOLD.

2.21 EXHAUST MANIFOLD/S.

NOTE: If a cylinder head is replaced, the initial spark plug torque specification, must be amended to:

SPARK PLUG TORQUE SPECIFICATION	
(NEW CYLINDER HEAD)	20 Nm

2.20 OIL LEVEL INDICATOR AND TUBE.

2.23 VALVE LIFTERS

LT Section No. – 00-050

REMOVE

NOTE: Ensure that all valve train components are kept in order so they may be reinstalled, if required, in their original locations.

1. Remove the cylinder head on the side requiring hydraulic lifter removal. Refer **2.22 CYLINDER HEAD - REMOVE**, in this Section.
2. Remove both valve lifter guide retaining bolts.
3. Remove valve lifters and guides.

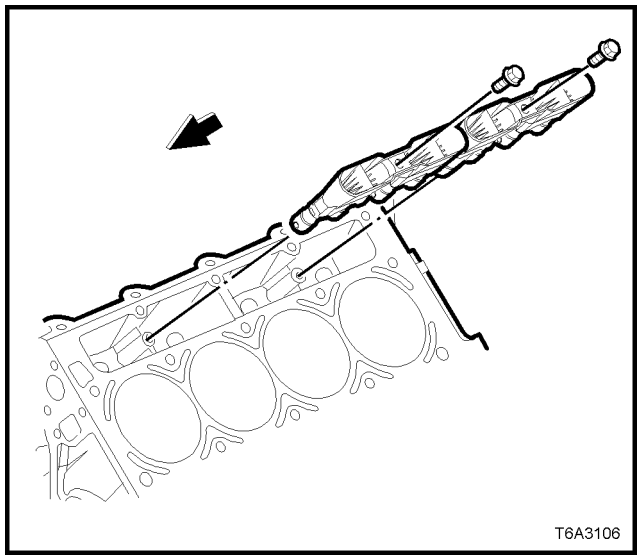


Figure 6A3-149

4. Remove the valve lifters from the guide/s.

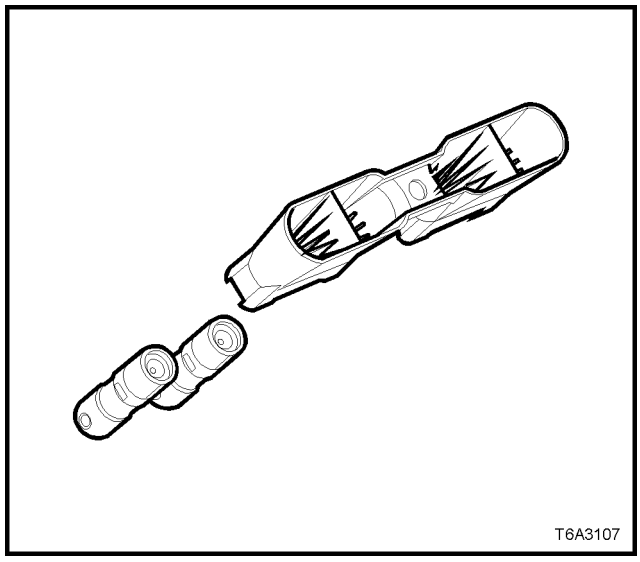


Figure 6A3-150

DISASSEMBLE

1. Using a small, fine bladed screwdriver, remove push rod seat retaining clip (10).
2. Remove push rod seat (9), oil metering valve (8), plunger assembly (7) and plunger spring (3) from lifter body (2).

NOTE: If the plunger is stuck in the lifter body, turn lifter body upside down and tap lifter body on a block of wood. If this is not effective, soak lifter assembly in a suitable cleaning fluid.

Legend:

1. Roller.
2. Lifter Body.
3. Plunger Spring.
4. Ball Check Retainer.
5. Ball Check Spring.
6. Ball Check.
7. Plunger.
8. Oil Metering Valve.
9. Push Rod Seat.
10. Push Rod Seat Retaining Clip.

3. Remove ball check retainer (4), ball check spring (5) and ball (6) from the plunger (7).

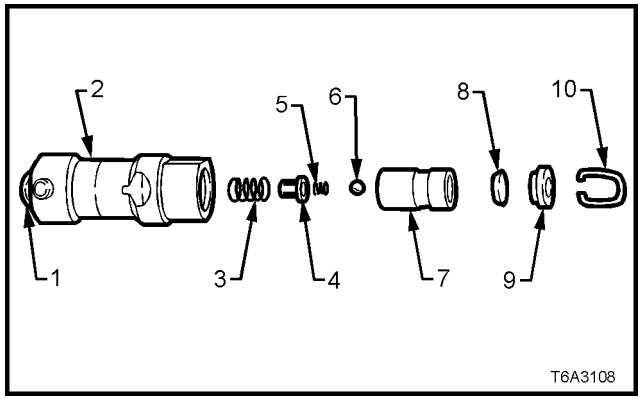


Figure 6A3-151

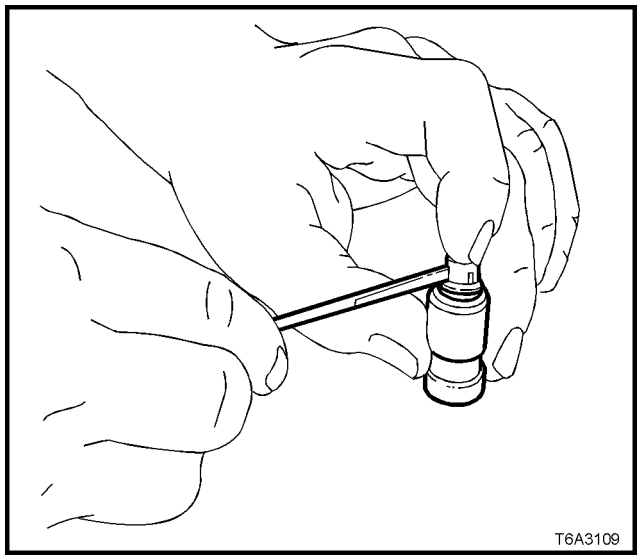


Figure 6A3-152

CLEAN AND INSPECT

1. Thoroughly clean all parts in a suitable cleaning fluid. Blow all parts dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect valve lifters for:
   a. Bent or broken clip (1).
   b. Worn pushrod socket (2). If the seat is worn, inspect the matching push rod. Replace the push rod if worn.
   c. Scuffed or worn lifter body (3). Also inspect lifter bore in the cylinder block.
   d. Flat spots on roller (4). Replace lifter if the roller is worn.
   e. Loose or damaged pin (5).
   f. Partially blocked oil hole (6).
   g. Worn or damaged roller bearing. Replace lifter if roller binds or roughness can be felt.
3. Inspect valve lifter guides for;
   a. Cracks or damage.
   b. Excessive wear in the lifter mounting bores.

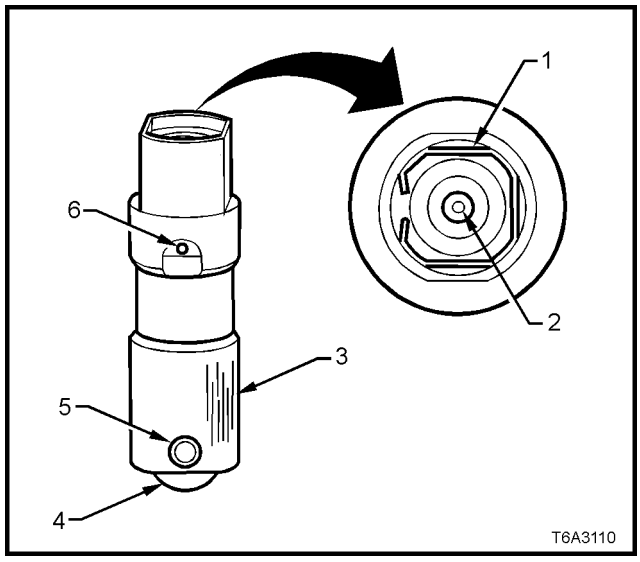


Figure 6A3-153

REASSEMBLE

NOTE 1: Do not attempt to recondition a lifter by taking parts from other unserviceable lifters.

NOTE 2: Cleanliness is extremely important when handling valve lifters. Lint or dirt can result in a failed lifter.

1. Place check ball (3) on the small hole in the plunger (4).

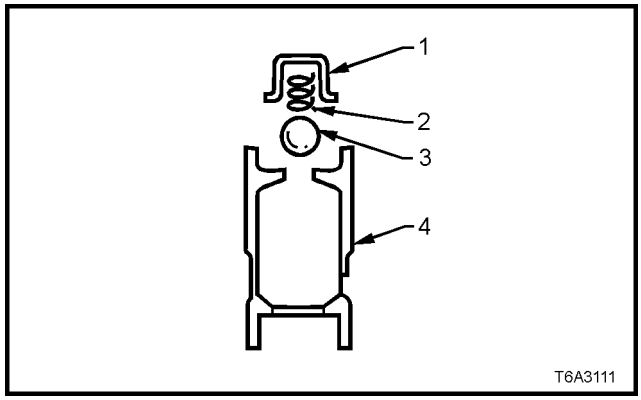


Figure 6A3-154

2. Carefully place check ball spring and retainer over ball and press retainer into position in the plunger with a small bladed screwdriver.
3. Half fill valve lifter body with test fluid No. E1151.

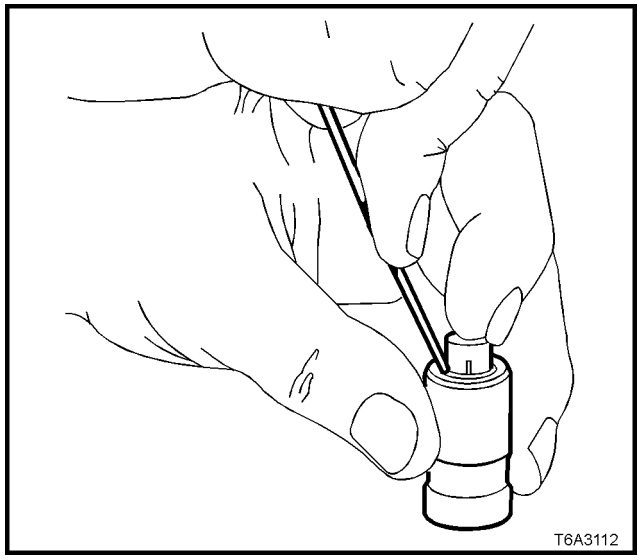


Figure 6A3-155

4. Reinstall plunger spring into the lifter body.
5. Install plunger assembly in body, taking care to align oil feed holes
6. Using a 1 mm diameter pin punch or similar, unseat the check ball (2) in the plunger, then push plunger down to the full extent of its travel.
7. Use Tool 6A24 (or a suitable sized pin punch) to align the oil feed holes (1) in the body and plunger.
8. Fill the lifter with test fluid.
9. Reinstall the oil metering valve, push rod seat (cup side facing out) and the retaining clip.

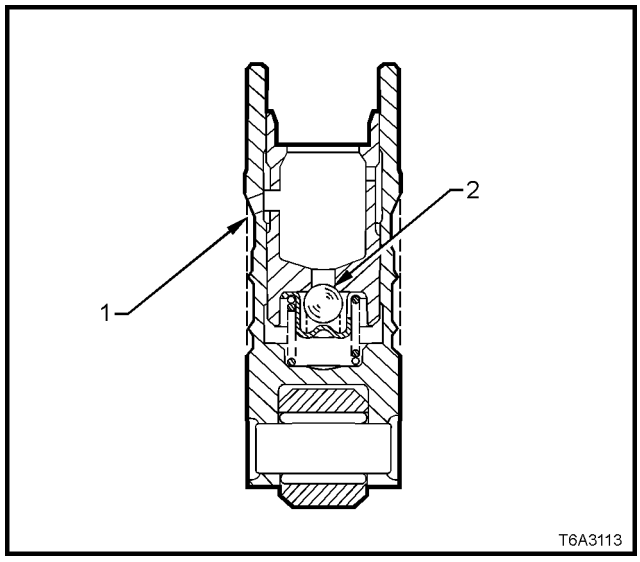


Figure 6A3-156

TESTING LIFTER LEAKDOWN RATE

After an hydraulic lifter has been cleaned, inspected and reassembled, it must be tested before being reinstalled. Lifter test fixture, Tool No 6A23 has been designed to test the leakdown rate of the lifter, to ensure that the lifter will operate as intended, when reinstalled.

1. Ensure the test cup is clean. Install the cup on the fixture and place the lifter in the cup.

NOTE: Some versions of Tool No. 6A23 may require modification to hold the base of the lifter inside the tester cup.

2. Add test fluid, No. E1151 to completely cover the lifter.
3. Place ball bearing supplied with test fixture in the push rod seat of the lifter.
4. Lower test fixture ram to rest on ball bearing.
5. Operate lifter plunger through its maximum travel to force all air out of lifter by using a vigorous pumping action on test fixture weight arm. Continue pumping action until considerable resistance is built up in lifter and lifter becomes solid.
6. Raise weight arm to allow lifter plunger to come up to its retainer, then lower arm to rest on ram.
7. Use a stop watch to measure the time required for the indicator needle on the tester to travel from 'START' to the 0.125" position on the scale.
8. The leak down rate (time between 'Start' and the 0.125" position) must be between 10 to 30 seconds to assure satisfactory lifter operation.

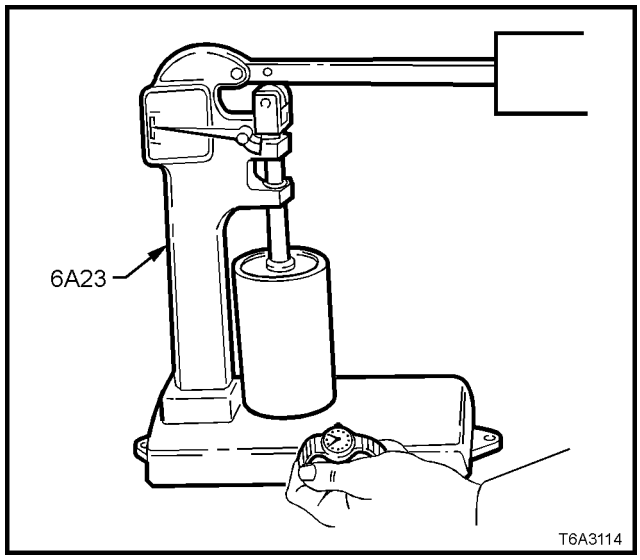


Figure 6A3-157

NOTE 1: A doubtful lifter should be tested several times before being discarded.

NOTE 2: Clean cup and refill with fresh test fluid after several lifters have been tested.

9. Stand tested lifters upright so that fluid does not drain from oil holes.
10. After all lifters have been tested, place a cover over the test fixture to keep dirt and dust from the cup.

REINSTALL

NOTE: Ensure that reinstalled lifters are fitted to the original locations.

1. Check that all valve lifter bores and adjacent areas are clean.
2. Lubricate valve lifter bodies and their bores with Lubrizol 6612 (or equivalent), then install lifters.
3. Install valve lifters into the guides, aligning the flat area at the top of the lifter with the flats in the lifter guide bore. Push the lifter completely into the guide bore
4. Install the valve lifters and guide assembly into the engine block.
5. Install each valve lifter guide retaining bolt/s and tighten to the correct torque specification.

VALVE LIFTER GUIDE BOLT TORQUE SPECIFICATION	12 Nm

6. Reinstall the cylinder head/s. Refer to **2.22 CYLINDER HEAD - REINSTALL** in this Section.

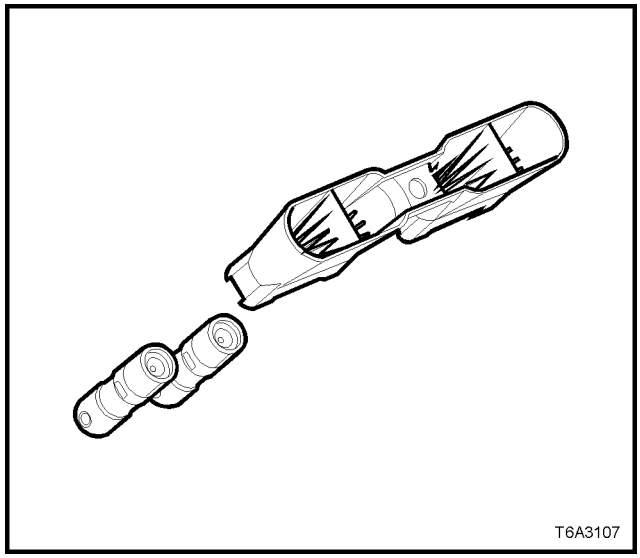


Figure 6A3-158

2.24 CRANKSHAFT BALANCER

LT Section No. – 00-540

NOTE: The following fasteners MUST be replaced (■) when performing this operation:

- ■ Crankshaft balancer bolt.

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Remove radiator, refer **Section 6B3 ENGINE COOLING – GEN III V8 ENGINE**.
3. Remove the engine accessory and air conditioning compressor drive belts. Refer **2.6 ENGINE DRIVE BELTS - REPLACE**, in this Section.
4. Remove the starter motor. Refer to **Section 6D3-2 STARTING SYSTEM**.
5. Remove the right hand side close-out cover retaining bolt, then the cover.

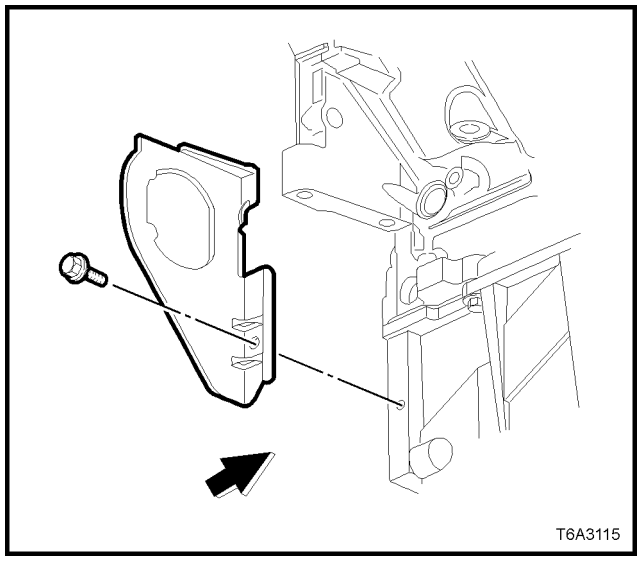


Figure 6A3-159

6. Using the two starter motor bolts, install ring gear holding Tool No. J 42386-A and tighten fasteners to 50 Nm.

NOTE: Ensure that the teeth of the holding tool engage correctly with the ring gear, before tightening the fasteners.

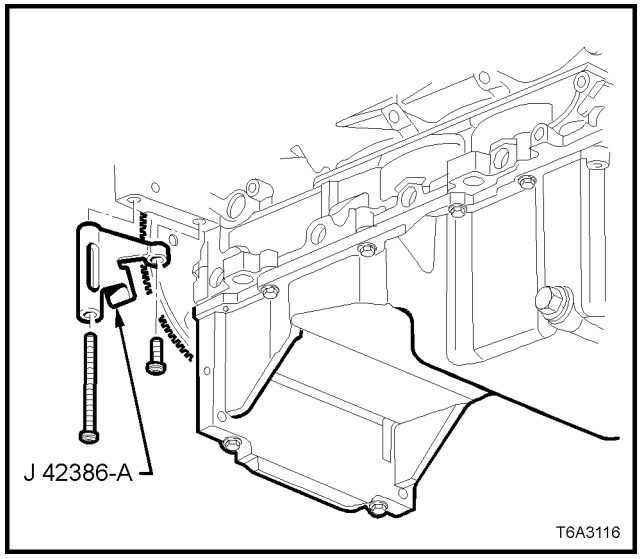


Figure 6A3-160

7. Remove the crankshaft balancer bolt. Do not discard bolt as it will be required for the reinstallation process.

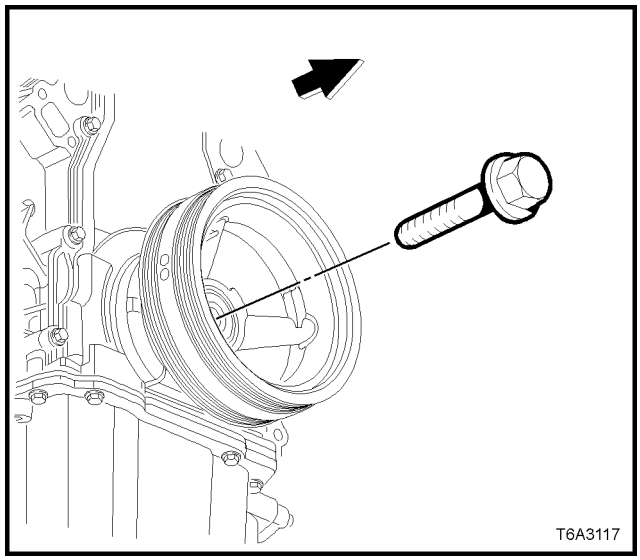


Figure 6A3-161

8. Use crankshaft end protector J 41816-2 and puller J41816 (or three legged commercial equivalent), to remove the crankshaft balancer.

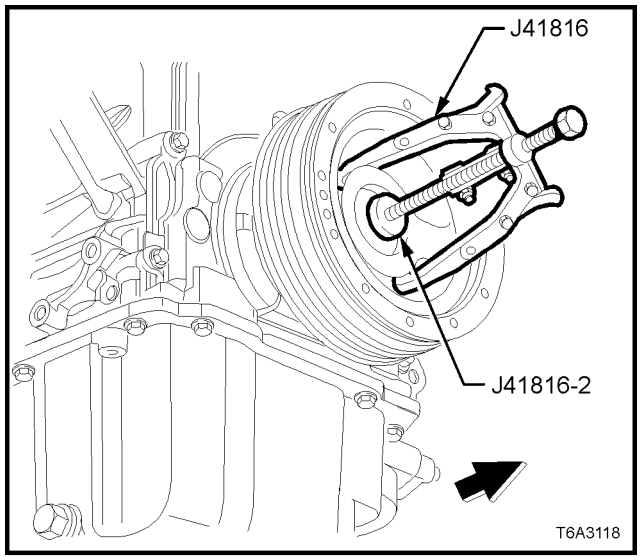


Figure 6A3-162

CLEAN AND INSPECT

1. Clean the crankshaft balancer in suitable solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following:
   - Worn, grooved, or damaged hub seal surface.
   - A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.
   - Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.
   - Dirty or damaged belt grooves.
   - The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

     IMPORTANT: For the belt to track properly, the belt grooves should be free of all dirt or debris.
   - Minor imperfections may be removed with a fine file.
   - Worn, chunking or deteriorated rubber between the hub and pulley.

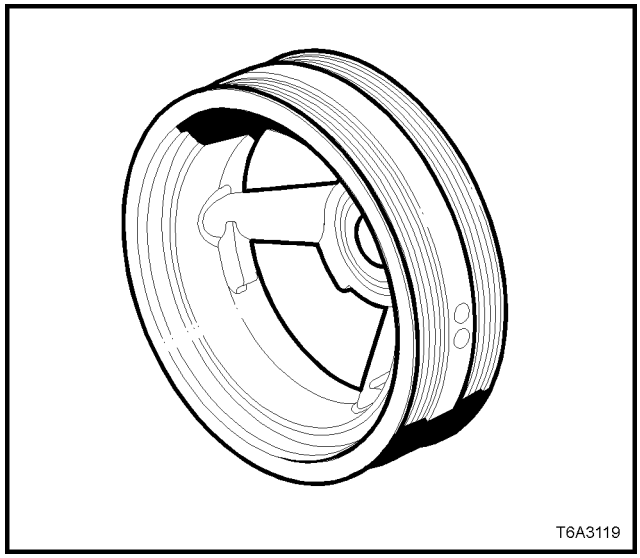


Figure 6A3-163

REINSTALL

IMPORTANT: The crankshaft balancer reinstallation and bolt tightening involves a multi-stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The remaining passes tighten the new bolt to the proper torque.

The used crankshaft balancer bolt will be used only during the first pass of the balancer installation procedure. **Only** install a NEW crankshaft balancer bolt and tighten as described in the remaining passes of the balancer bolt tightening procedure.

1. Ensure that the teeth of the ring gear locking Tool No. J 42386-A are correctly engaged.
2. Apply a smear of clean engine oil onto the seal surface of the balancer, then install the balancer onto the end of the crankshaft.

IMPORTANT: The balancer should be positioned onto the end of the crankshaft as straight as possible, before to tool installation.

3. Use installer, Tool No. J 41665 to install the crankshaft balancer, as follows:
   a. Select the threaded rod, nut, washer and installer, from tool J 41478.
   b. Insert the installer sleeve, J 41665-1 into the front of the balancer and back up with the plate, J 41665-2.

   NOTE: Insert the stepped end of sleeve J 41665-1 into the balancer, in this initial stage.

   c. Use a set spanner (1) to hold the hexagonal end of the threaded rod.
   d. Use a second spanner (2) to rotate the installation tool nut clockwise until the balancer is started onto crankshaft.
   e. Remove the stepped sleeve of J 41665-1 and reverse it, so that the larger end of the installer is against the front of the balancer.
   f. Repeat steps ‘a.’ through ‘d.’ above, until the balancer is installed onto the crankshaft.
   g. Remove the balancer installation tool.
4. Install the used crankshaft balancer bolt and tighten to the specified torque.

CRANKSHAFT BALANCER INSTALLATION TORQUE SPECIFICATION	330 Nm

5. Remove the used balancer bolt and discard.
6. Measure the distance the balancer protrudes from the crankshaft nose and check that dimension ‘A’ is to specification.

DISTANCE ‘A’	2.40 - 4.48 mm

7. If the dimension is not correct, reinstall Tool J 41665 and repeat the installation procedure.

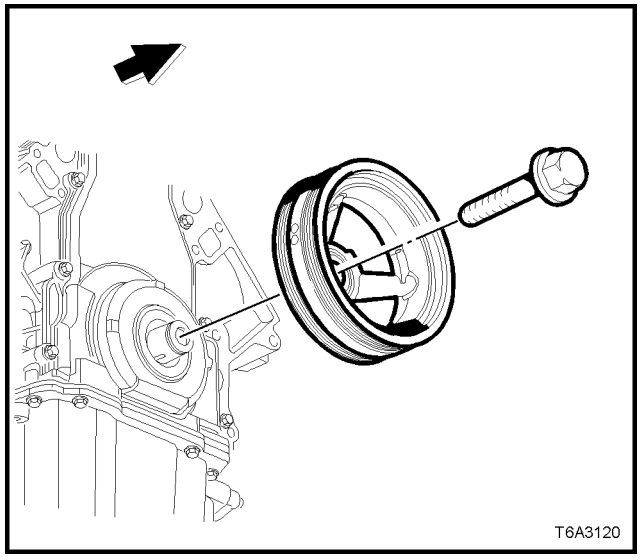


Figure 6A3-164

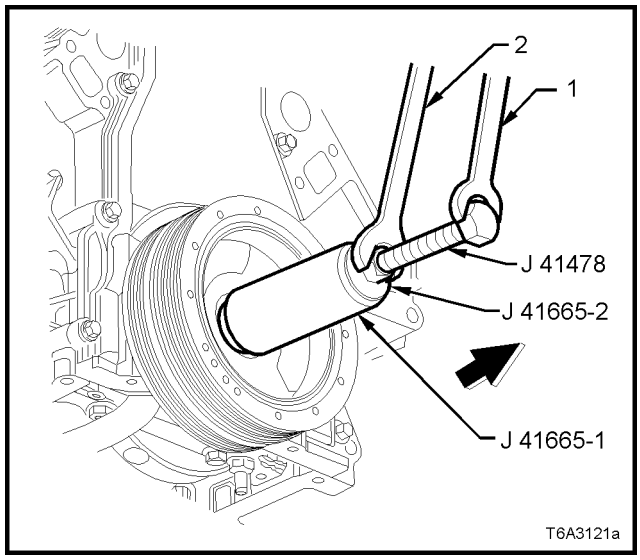


Figure 6A3-165

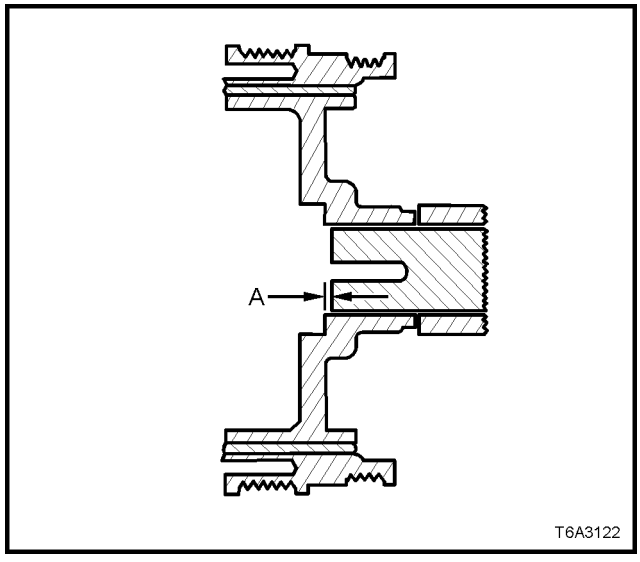


Figure 6A3-166

8. Install a NEW crankshaft balancer bolt.
9. Tighten the crankshaft balancer bolt to the correct torque specification, in two stages.

CRANKSHAFT BALANCER BOLT TORQUE SPECIFICATION	Stage 1:	50 Nm
	Stage 2:	140° Turn angle

10. Remove the ring gear locking tool No. J 42386-A.
11. Reinstall the close-out cover and tighten the bolt to the correct torque specification.

RIGHT HAND CLOSE-OUT COVER SCREW TORQUE SPECIFICATION	10 Nm

12. Install the starter motor. Refer to **Section 6D3-2 STARTING SYSTEM** and tighten the mounting bolts to the correct torque specification.

STARTER MOTOR MOUNTING BOLT TORQUE SPECIFICATION	50 Nm

13. Reinstall the radiator, refer **Section 6B3 ENGINE COOLING – GEN III V8 ENGINE**.

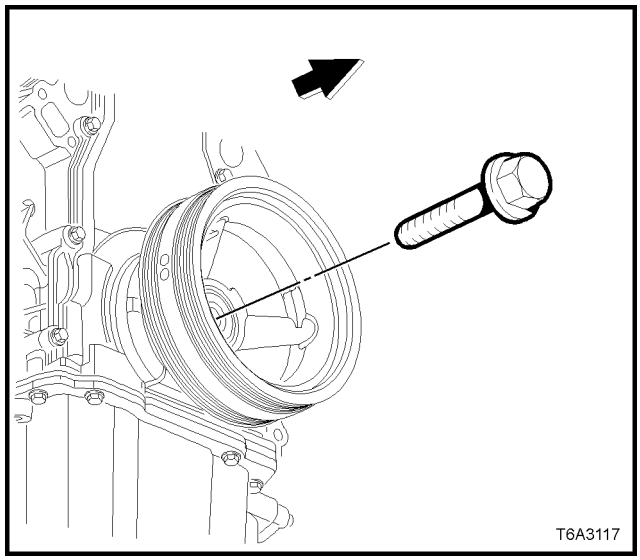


Figure 6A3-167

2.25 COOLANT PUMP

LT Section No. – 00-325

REMOVE

NOTE: Apart from the rear cover, O-ring and thermostat assembly, the coolant pump is not serviceable and if found to be faulty must be replaced as an assembly.

1. Allow engine to cool to ambient temperature (less than 50°C), then slowly remove screw-on pressure cap from the coolant reservoir.

CAUTION: DO NOT REMOVE SCREW-ON PRESSURE CAP WHILE THE ENGINE COOLANT TEMPERATURE IS ABOVE 50°C, AS PERSONAL INJURY MAY RESULT.

2. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. Battery Disconnection Procedures** before disconnecting the battery.

3. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
4. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
5. Loosen coolant pump drive pulley bolts.

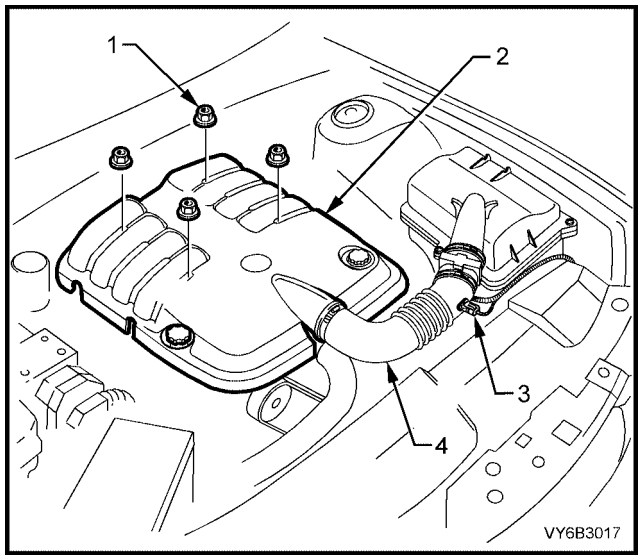


Figure 6A3-168

6. Remove engine accessory drive belt (2), using a 15 mm ring spanner, refer to **2.6 ENGINE DRIVE BELTS - REPLACE**, in this Section.

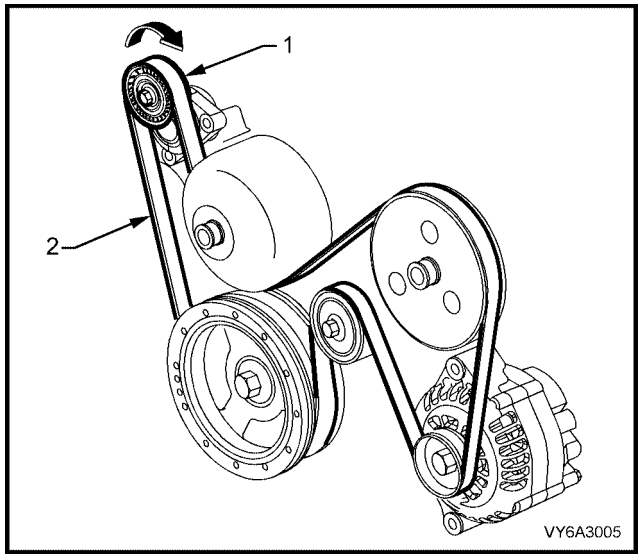


Figure 6A3-169

7. Drain engine coolant. Refer to **2.3 DRAINING AND FILLING COOLING SYSTEM**, in Section 6B3 ENGINE COOLING.

IMPORTANT: The information in **2.1 SERVICE NOTES (Environmental Issues),** Section 6B3 ENGINE COOLING is to be read and acted upon.

8. Disconnect both heater hoses, the outlet and inlet hoses from the coolant pump.

CAUTION: Always wear protective safety glasses when working with spring type hose clamps. Failure to do so could result in eye injury.

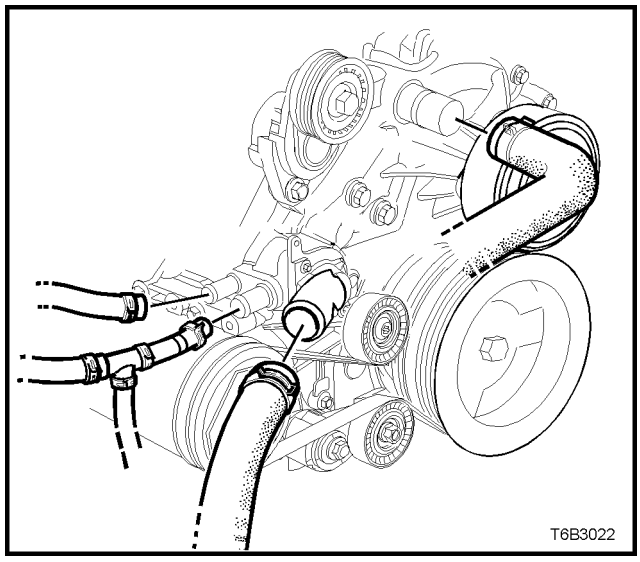


Figure 6A3-170

9. Remove the two bolts (1) securing the drive belt tensioner (2) to the coolant pump housing and set the tensioner to one side.

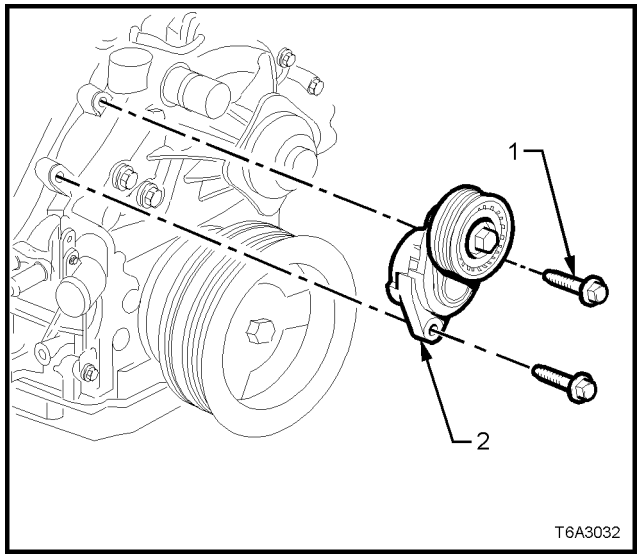


Figure 6A-171

10. Loosen, then remove the six bolts (1) securing the coolant pump (2) to the cylinder block.
11. If necessary, use a soft faced hammer to lightly tap coolant pump housing (2) to dislodge it from the cylinder block.
12. Remove coolant pump, carrier type gaskets (3) and discard.

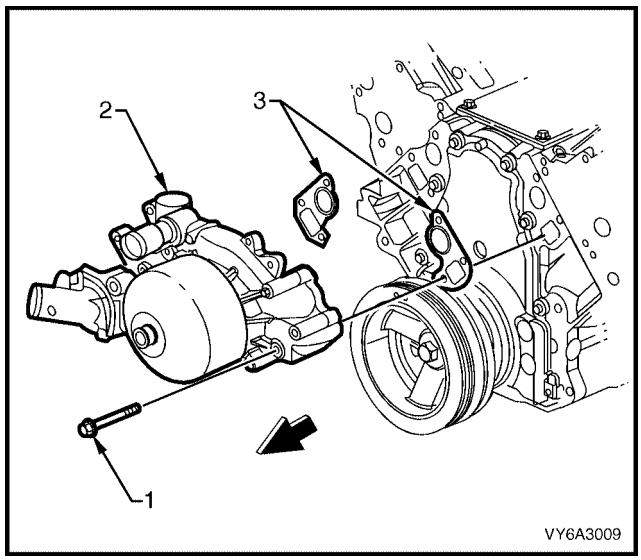


Figure 6A-172

DISMANTLE

NOTE: Apart from the service operations described here, there are no other serviceable parts in the coolant pump assembly and if required, then the assembly must be replaced as a complete unit.

1. If required, remove the five bolts (4) securing the rear cover (3) to the coolant pump (2). Tap with a soft faced hammer to dislodge the cover from the pump body.
2. Remove the sealing O-ring (1) from the coolant pump body (2).
3. For thermostat remove, test and reinstall procedures, refer to **2.9 THERMOSTAT**, in Section 6B3 ENGINE COOLING.

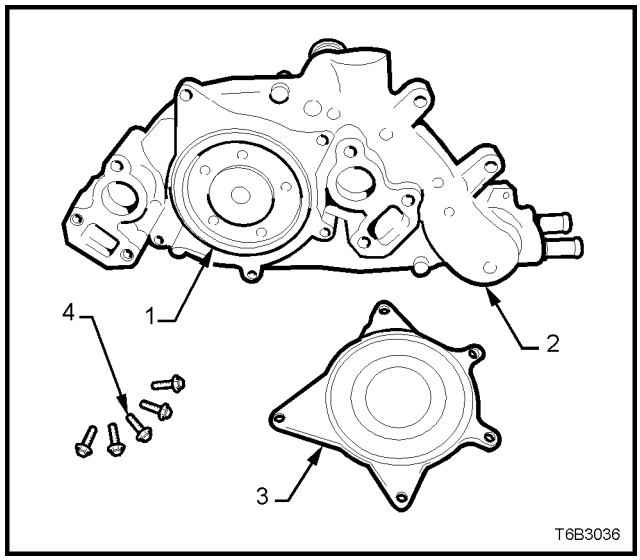


Figure 6A-173

CLEAN AND INSPECT

1. Remove the old gasket or gasket material from the coolant pump sealing surfaces and cylinder block, taking care not to scratch the machined surfaces.
2. Clean all dirt and debris from the coolant pump housing.
3. Inspect the coolant pump for the following:
   - Gasket surfaces for excessive scratches or gouging.
   - Hose sealing surfaces for scratches, gouging or corrosion.
   - Restrictions, corrosion or evidence of cavitation within the internal coolant passages or on the pump impeller.
   - Excessive side-to-side play in the pulley shaft.
   - A loose belt pulley or a pulley with excessive wear or scoring on the belt tracking area.
   - Evidence of coolant leakage at the coolant outlet housing or rear cover gasket (if these parts have not been removed).
   - Leakage at the coolant pump vent hole. A stain around the vent hole is acceptable. If leakage occurs (dripping) with the engine running and the cooling system pressurised, replace the coolant pump.

REASSEMBLE

1. Install a new O-ring seal to the cleaned groove in the pump housing, then install the cover and retaining bolts.
2. Gradually tighten every second bolt until the correct torque specification is reached.

COOLANT PUMP REAR COVER	
TORQUE SPECIFICATION	14 Nm

REINSTALL

Installation is the reverse to removal except for the following items:

1. Ensure that the coolant pump and cylinder block surfaces are clean and dry.
2. Using two bolts inserted into the coolant pump on each side as guides, install NEW gaskets over them and install the coolant pump to the cylinder block.
3. Install remaining bolts and tighten to the correct torque specification, in two stages.

COOLANT PUMP BOLT		
TORQUE SPECIFICATION	Stage 1:	15 Nm
	Stage 2:	30 Nm

4. Install the engine accessory drive belt tensioner and attaching bolts, tightening to the correct torque specification.

ENGINE ACCESSORY DRIVE BELT TENSIONER BOLT	
TORQUE SPECIFICATION	40 - 60 Nm

5. Install all removed radiator hoses and clamps.

CAUTION: ALWAYS WEAR PROTECTIVE SAFETY GLASSES WHEN WORKING WITH SPRING TYPE HOSE CLAMPS. FAILURE TO DO SO COULD RESULT IN EYE INJURY.

6. Install the engine accessory drive belt. Refer **2.6 ENGINE DRIVE BELTS - REPLACE** in this Section.
7. Refill cooling system, refer to **2.3 DRAINING AND FILLING COOLING SYSTEM** in Section 6B3 ENGINE COOLING.
8. Check for cooling system leaks, refer to **2.8 PRESSURE TESTING** in Section 6B3 ENGINE COOLING.

2.26 CRANKSHAFT FRONT OIL SEAL

LT Section No. – 00-325

REPLACE

1. Remove the crankshaft balancer. Refer **2.24 CRANKSHAFT BALANCER** in this Section.
2. Using Tool No. Eb

308 (or commercial equivalent) remove seal from the front cover.

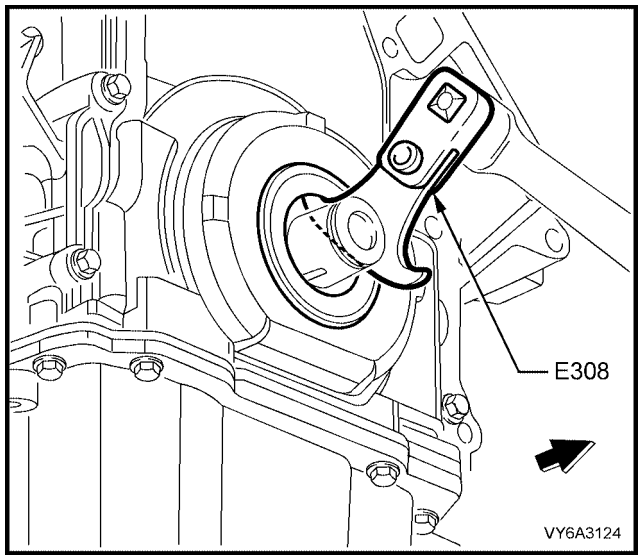


Figure 6A3-174

3. Lubricate the outer edge of a NEW oil seal (1) and the front cover oil seal bore with clean engine oil.

IMPORTANT: Do not lubricate the oil seal sealing surface. Refer **CRANKSHAFT OIL SEALS**, in 1.4 ENGINE LUBRICATION SYSTEM, in this Section.

4. Install the crankshaft front oil seal (1) onto the guide of Tool No. J 41478.
5. Install the threaded rod (with nut, washer, guide, and oil seal) of Tool No. J 41478 into the end of the crankshaft.
6. Using a set spanner, hold the head of the installer bolt, then rotate the installer nut clockwise, using a second set spanner, until the seal bottoms in the cover bore.
7. Remove the tool from the crankshaft.
8. Inspect the oil seal for correct installation. The oil seal should be installed evenly and completely into the front cover bore.
9. Install the crankshaft balancer, refer **2.24 CRANKSHAFT BALANCER**, in this Section.

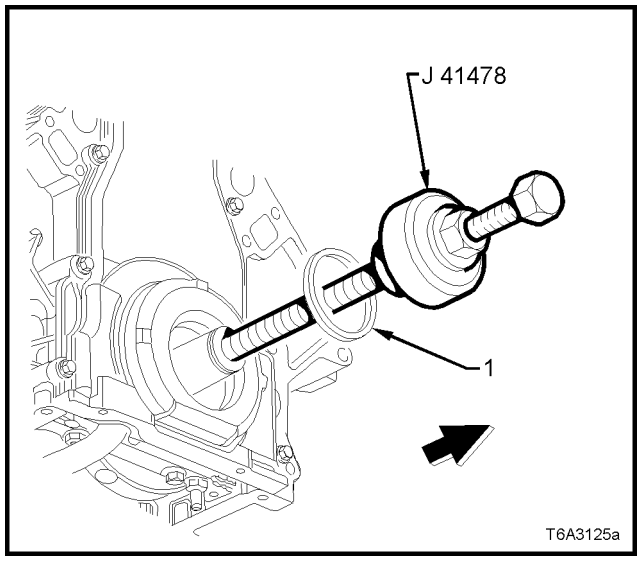


Figure 6A3-175

2.27 ENGINE MOUNTS

LT Section No. – 00-475

CHECK

1. Check in the area of the mounts for signs of fluid leakage. If oil leakage from a mount is visible, the mount is defective and must be replaced.
2. Using a suitable engine lifting crane, raise the engine to remove the weight from the mounts and to place rubber in *slight* tension. Then, check that the mounting rubber has not deteriorated, split or separated from its metal plates.
3. Replace mount if found to be defective.

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. BATTERY DISCONNECTION PROCEDURES** before disconnecting the battery.

2. Drain the cooling system. Refer to **Section 6B3 ENGINE COOLING - GEN III V8 ENGINE**.

IMPORTANT: The information in **2.1 SERVICE NOTES (Environmental Issues),** Section 6B3 ENGINE COOLING is to be read and acted upon.

3. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
4. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
5. Raise front of vehicle and place on safety stands. For location of jacking and support points, refer to **Section 0A GENERAL INFORMATION**.
6. Remove the exhaust pipe to manifold flange nuts on the engine mount side to be removed.
7. From under the vehicle, remove the lower mounting to crossmember nut for both mounts.

NOTE: A commercially available, 18 mm deep socket will be required for this operation.

8. Lower the vehicle to the ground, then remove the exhaust manifold on the engine mounting side to be removed. Refer to **2.21 EXHAUST MANIFOLD - REMOVE**, in this Section.
9. Use suitable engine lifting equipment to raise the engine, removing the weight from the engine mounts.

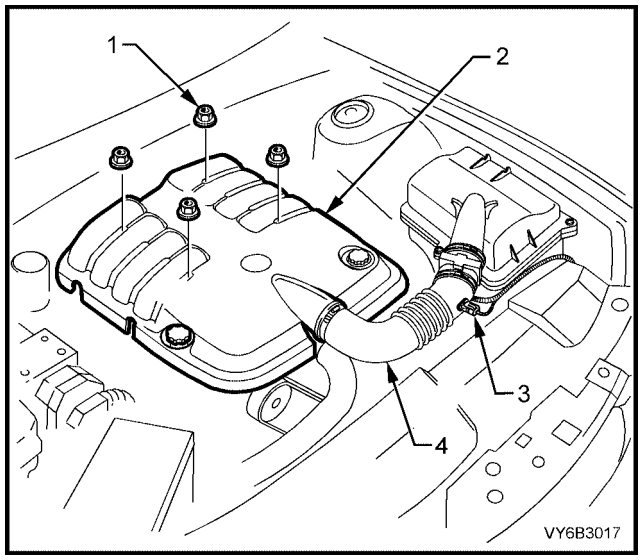


Figure 6A3-176

10. Remove the mount bracket to engine block bolts.
11. Lift the mount and bracket assembly from the crossmember and remove from the vehicle.
12. Remove the engine mount to bracket nut and separate the heat shield and mount from the bracket.

NOTE: While the left hand mount is shown, the operation is similar for either engine mount except that, for the right hand engine mount, remove the battery harness bracket bolt, before removing the mounting bracket to engine block bolts.

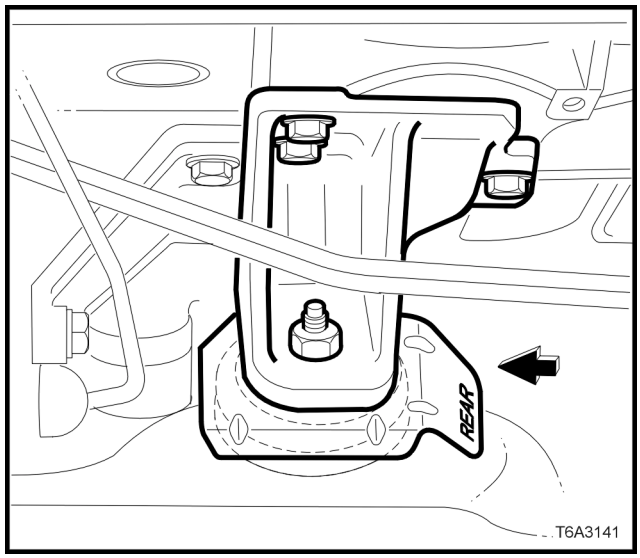


Figure 6A3-177

REINSTALL

Reinstallation of either or both engine mounts is the reverse to removal, except for the following points.

1. If removed from the bracket, reinstall the engine mount and heat shield, then tighten the nut to the correct torque specification.

ENGINE MOUNT TO BRACKET NUT TORQUE SPECIFICATION	80 Nm

2. Install the engine mount stud into the crossmember, then install the bracket to cylinder block bolts and tighten to the correct torque specification.

ENGINE MOUNTING BRACKET BOLT TORQUE SPECIFICATION	50 Nm

3. Lower the engine allowing the weight to settle on the crossmember, install both engine mount nuts and tighten to the correct torque specification.

ENGINE MOUNT TO CROSSMEMBER TORQUE SPECIFICATION	80 Nm

4. Install exhaust manifold. Refer to **2.21 EXHAUST MANIFOLD - REINSTALL** in this Section.

3. MAJOR SERVICE OPERATIONS

3.1 ENGINE ASSEMBLY

LT Section No. – 00-500

REMOVE

1. Disconnect the ground cable from the battery.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. Battery Disconnection Procedures** before disconnecting the battery.

2. Loosen the screw-on pressure cap on the coolant surge tank to relieve any system pressure, then remove cap.

CAUTION: To avoid serious personal injury, never remove the screw-on pressure cap when the engine is hot. Sudden release of cooling system pressure is very dangerous and could cause personal injury.

3. Remove the four engine dress cover decorative nuts (1), then remove the dress cover (2) from the engine.
4. Remove the air intake sensor wiring harness connector (3), then loosen both hose clamps securing the intake duct (4) to the MAF sensor and the throttle body. Remove the duct (4) from the engine.
5. De-pressurise fuel rail. Refer to **2.13 FUEL SYSTEM PRESSURE RELIEF**, in this Section.

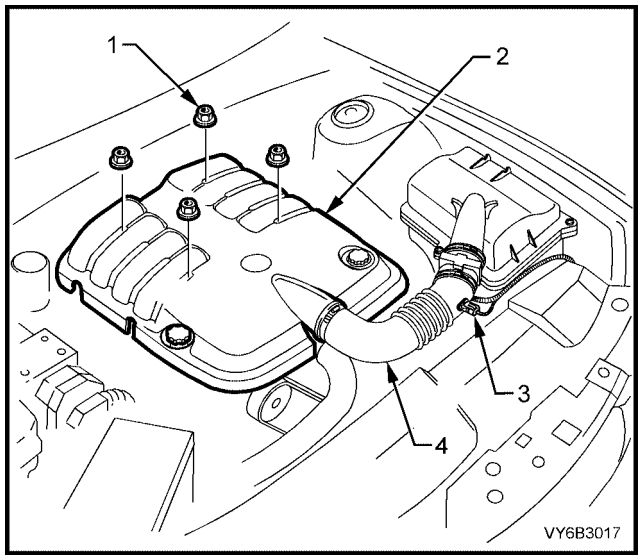


Figure 6A3-178

IMPORTANT: Before draining coolant, the information in **2.1 SERVICE NOTES (Environmental Issues),** Section 6B3 ENGINE COOLING is to be read and acted upon.

6. Place a suitable drain tray beneath the engine, then loosen the worm drive hose clamp (1) on the lower hose at the left hand radiator tank, remove the hose and drain the coolant.
7. Loosen the second worm drive hose clamp securing the lower left hand hose to the transfer tube and remove the lower left hand hose from the vehicle.

CAUTION: Wear safety glasses to avoid eye injury.

NOTE: If access to the transfer tube hose clamp is poor, then disconnect the lower hose from the radiator, left hand tank. After the radiator is removed (Step 10), the transfer tube and all lower hoses can then be removed as an assembly.

8. Loosen top radiator worm drive hose clamp at the engine and a spring type clamp at the radiator (2), then remove the top hose from the engine.
9. Remove the engine cooling fans and radiator. Refer to **Section 6B3 ENGINE COOLING – GEN III V8 ENGINE**.

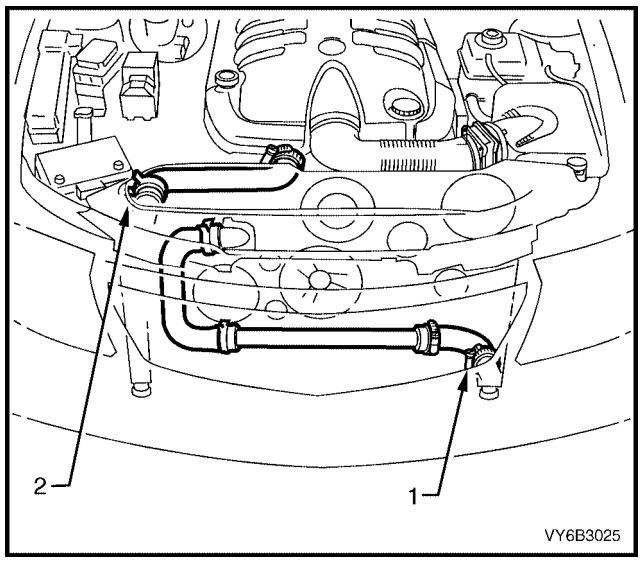


Figure 6A3-179

10. Recover refrigerant charge, refer to **Section 2C AIR CONDITIONING – SERVICING AND DIAGNOSIS**.

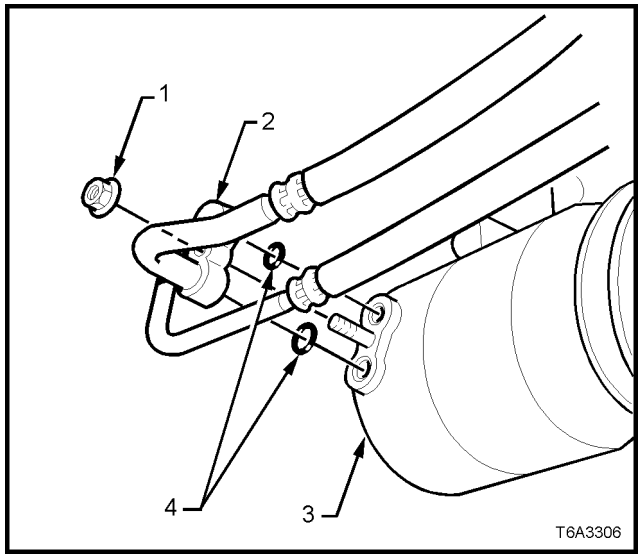


Figure 6A3-180

12. After removing the four oil pan under-tray bolts, remove the tray from the vehicle.
13. Remove oil pan drain plug and drain engine oil into a suitable container. Reinstall drain plug once oil has drained sufficiently.
14. Disconnect windshield washer hose (1) at the in-line connector located at the rear, left hand side of the engine hood.

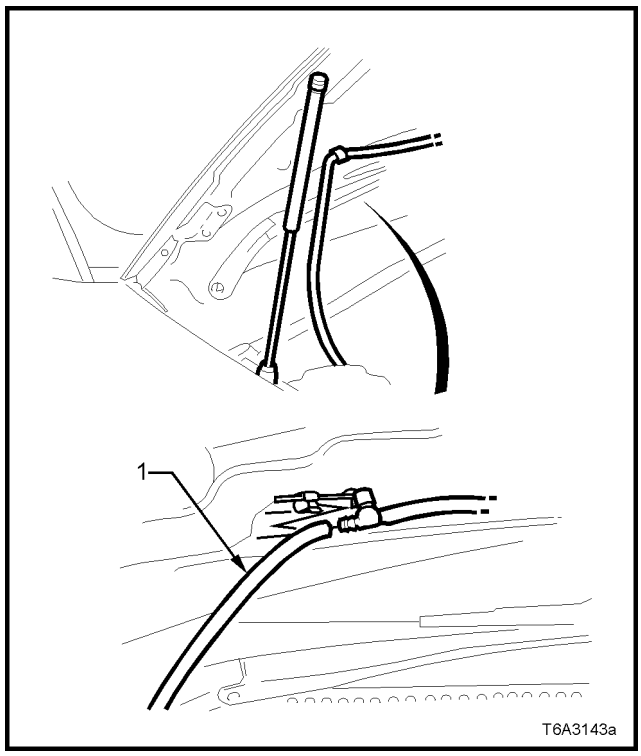


Figure 6A3-181

15. With engine hood adequately supported, remove clips (2) securing upper ends of struts (1) to hood pivots (3).

    Disengage struts (1) from hood pivots (3) and lay struts onto inner fender panel.

16. Using an assistant to hold the hood assembly, remove the engine hood bracket to hinge attaching bolts (4), as shown, then carefully lift the hood assembly clear of the vehicle.

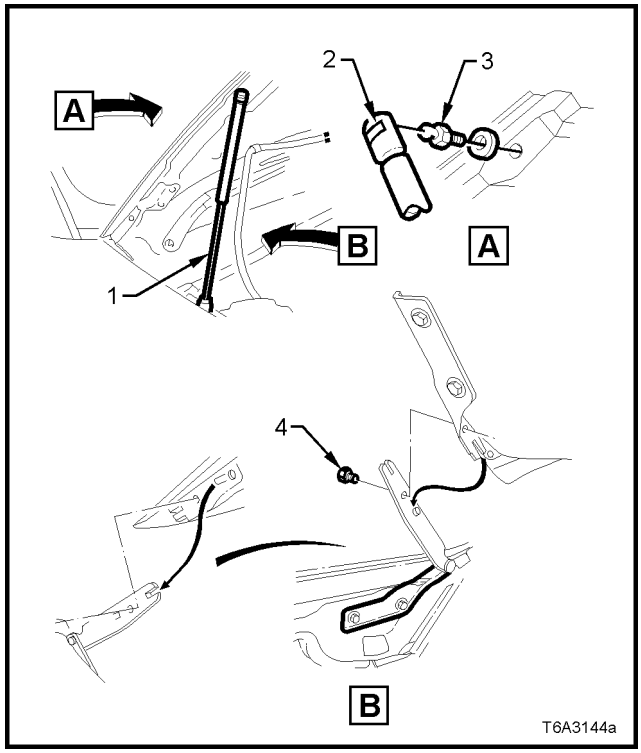


Figure 6A3-182

17. Remove both heater hose clamps at the engine water pump, taking note of the hose layout. Plug open ends to prevent dirt entry.

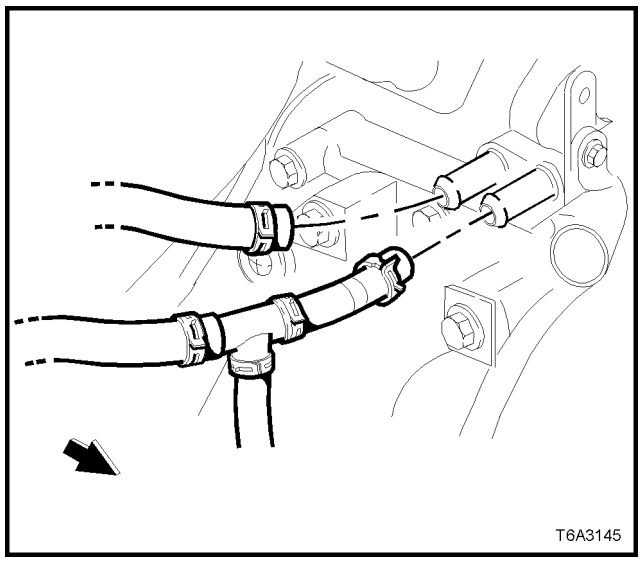


Figure 6A3-183

18. Remove the screw (1) securing the ground lead to the engine cylinder block and from the left hand engine mount (2).
19. Remove the nut (3) securing the battery harness ground terminals to the ABS/TCS control module bracket stud (4).
20. Remove the ground terminal (5) at the battery, followed by the positive lead (6). Lay the harness on the engine.

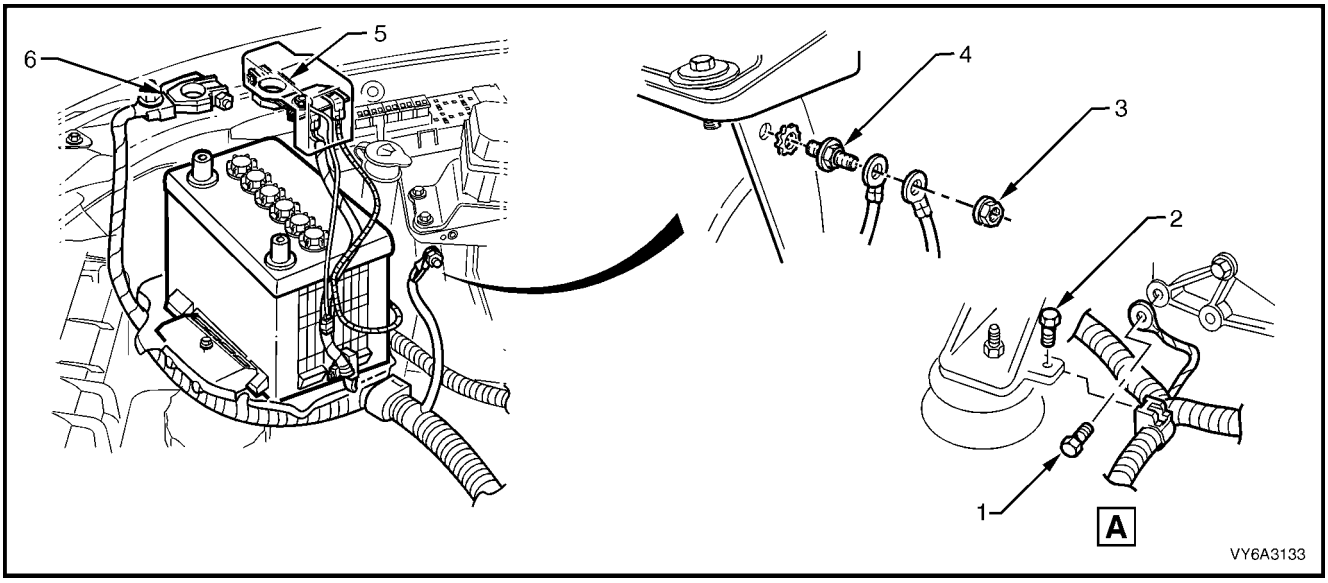


Figure 6A3-184

21. Disconnect the wiring harness connectors from:
    1. Mass Air Flow Sensor.
    2. Intake Air Temperature Sensor.
    3. Air Conditioning Pressure Sensor.
    4. Main to Powertrain Wiring Harness.

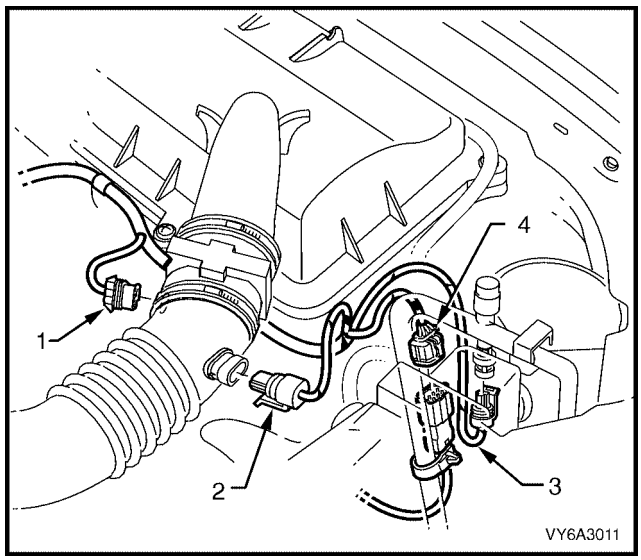


Figure 6A3-185

22. Disconnect powertrain wiring harness clips (6) from the engine compartment dash panel retaining bracket ('5', view D), refer Figure 6A3-186.
23. Referring to Figure 6A3-186, disconnect powertrain wiring harness connectors from the surge tank, low coolant switch ('1', view A) and the theft deterrent horn ('4', view C).

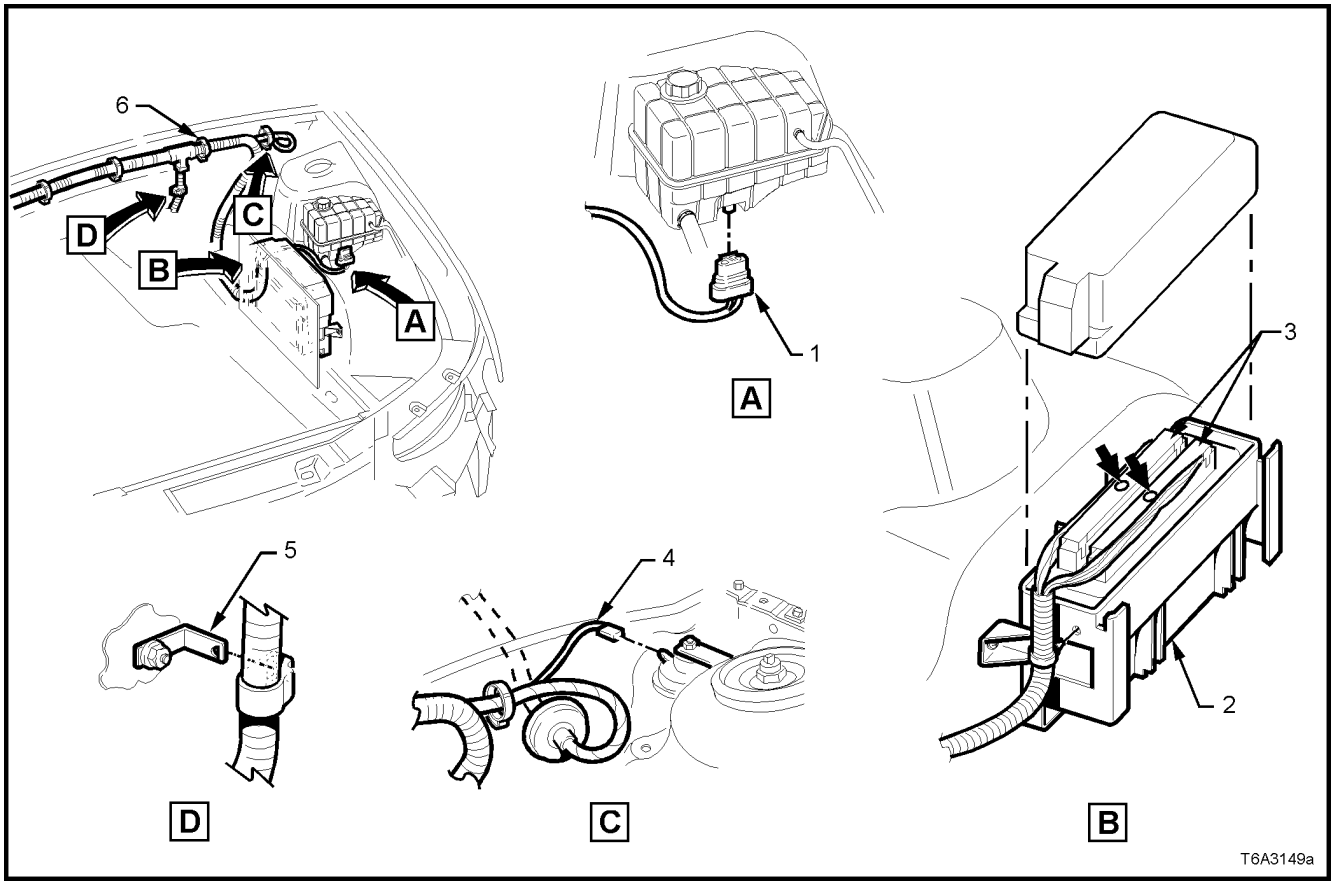


Figure 6A3-186

24. Loosen hose clamps and remove hoses from the coolant surge tank. Then grasp the surge tank and firmly pull to remove it from the retaining pegs.
25. Remove the cover from the Powertrain Control Module (PCM).
26. Remove both PCM connectors (see '3', view B in Figure 6A3-186) in the engine bay, after removing the retaining screw (bold arrows) from each connector.
27. Remove the PCM wiring harness retaining clip from the PCM container, to free the harness.
28. Remove the engine wiring harness retaining clip from the power steering pipe bracket at the engine front.

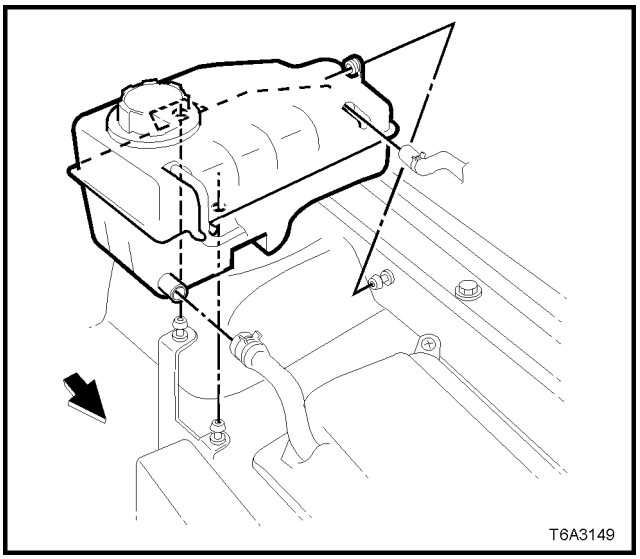


Figure 6A3-187

29. From inside the passenger compartment of the vehicle, remove the left hand shroud panel trim, and glove box assembly. For details, refer **Section 1A3 INSTRUMENT PANEL AND CONSOLE**.
30. Remove the PIM (1), either by using fingers (or a flat bladed screwdriver) to push on and dislodge the retaining hook, then remove the PIM and Throttle Relaxer Module (TRM) (if fitted), as an assembly.
31. Remove the (TRM) connector (2) (if fitted), as follows:

– Lift the locking lever on the TRM connector (2), pivot down and remove the connector from the lower hook.

32. Remove the wiring harness connector (3) from the Powertrain Interface Module (PIM).
33. Cut the wiring harness straps (4) and discard.
34. Disconnect the Powertrain to Main wiring harness connector, X206 (5).
35. Release the harness to dash panel grommet (6) and feed the harness and connectors out into the engine bay.
36. Lay the powertrain wiring harness on top of the engine.

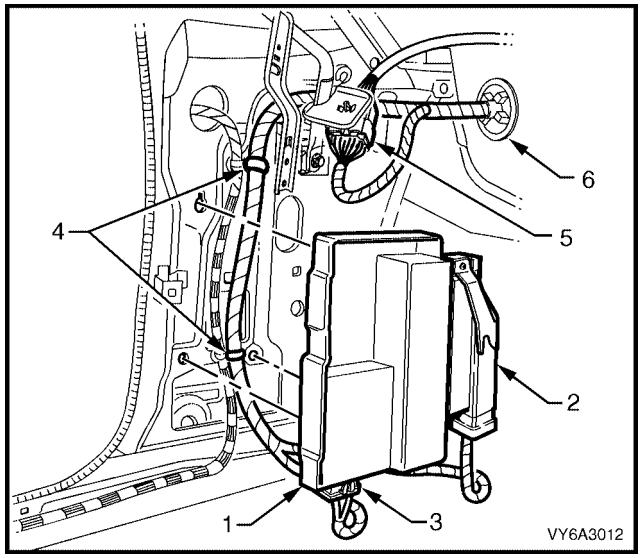


Figure 6A3-188

37. Disconnect the cruise control cable (1) (if fitted) (refer Figure 6A3-189) from the stud (2) on the throttle body valve lever (3), then remove the outer cable (8) from the retainer bracket (4).
38. Lift the throttle cable (5) from the clip (6) at the fuel rail crossover pipe, then lift the cable (5) from the retainer bracket (4).
39. Remove the inner throttle cable (7) from the throttle body valve lever (3).
40. Set the cable/s to one side.

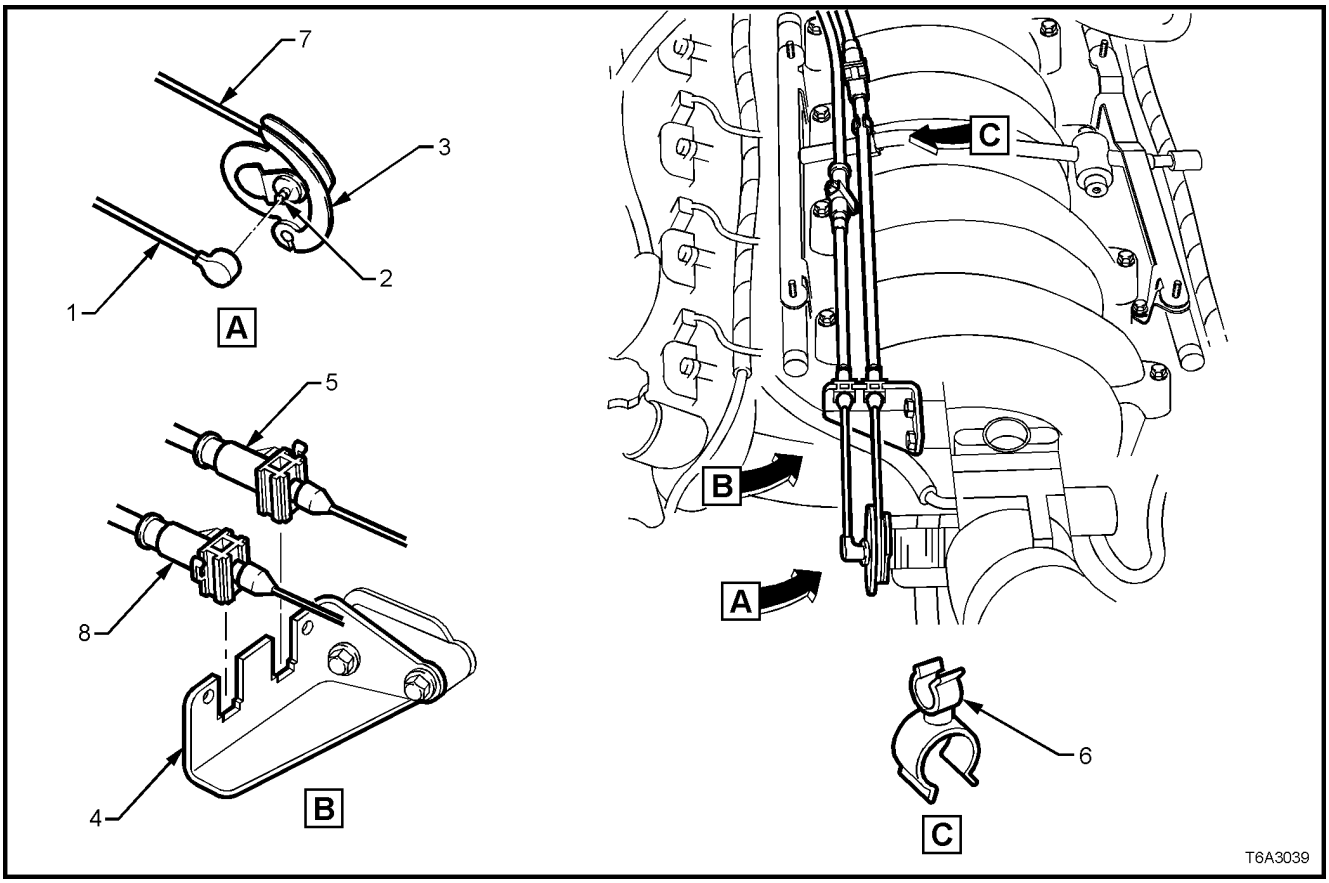


Figure 6A3-189

41. Using quick connect release Tool No. 7371, open tool and install over fuel rail line.
42. Close 7371 and pull into fuel rail line quick connect (1) to release it from the fuel rail, pull back on the quick connect (1), to remove. Remove the quick connect release tool from the fuel rail line.
43. Disconnect the vapour line (2) connection to the EVAP purge control valve (3) and set to one side.

IMPORTANT: Plug all openings to prevent fuel leaking and dirt/contaminants from entering the fuel system.

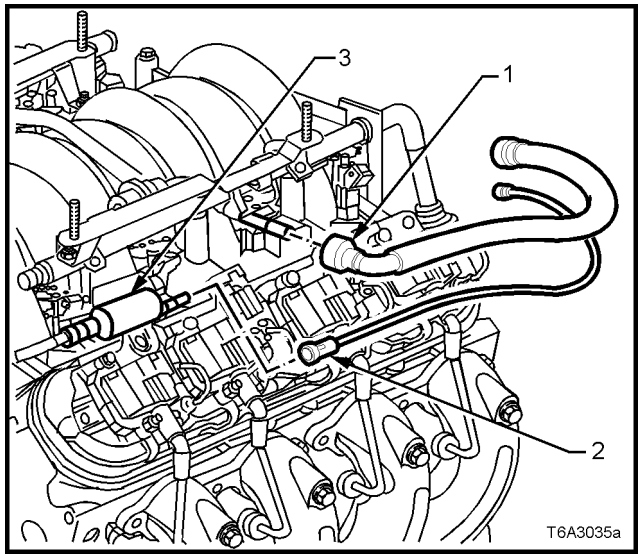


Figure 6A3-190

44. Loosen the hose clamp on the return hose at the power steering reservoir end.
45. After placing a suitable container under the reservoir, remove the hose and drain the reservoir fluid.

IMPORTANT: Plug both openings to prevent dirt entry.

46. Using tie wire or similar, secure the hose to one side.

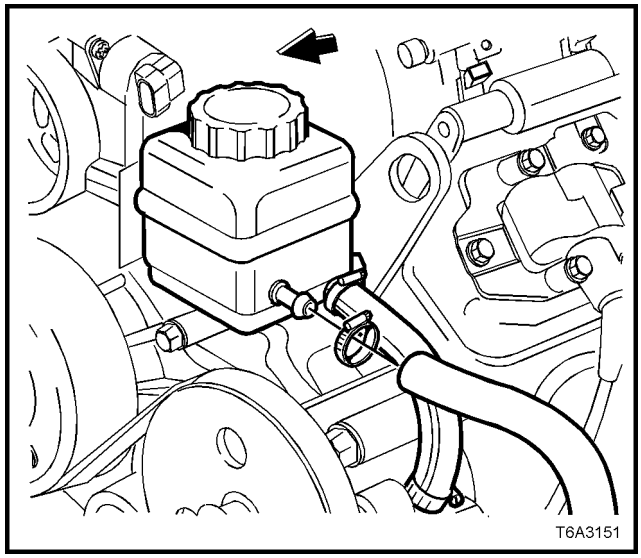


Figure 6A3-191

47. Loosen and remove the high pressure line flare nut (1) and O-ring (2) from the pump outlet fitting at the rear of the power steering pump. Use a back-up spanner on the outlet fitting when loosening the flare nut.

IMPORTANT: Plug both openings to prevent fluid loss and/or dirt entry.

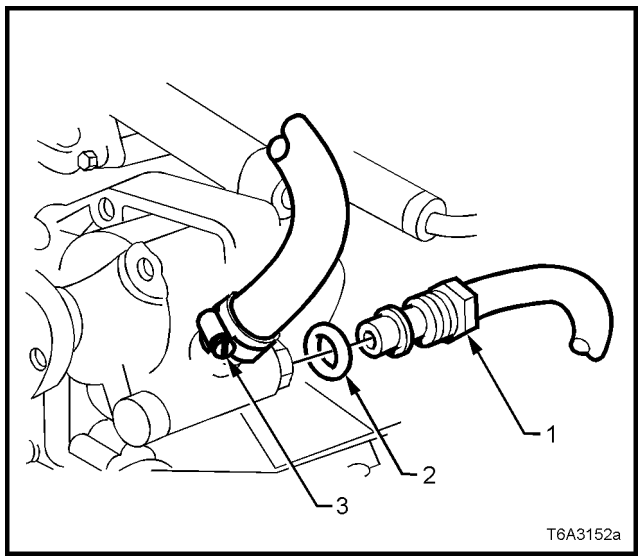


Figure 6A3-192

48. Disconnect the brake booster and heater control, vacuum hoses from the rear of the intake manifold.

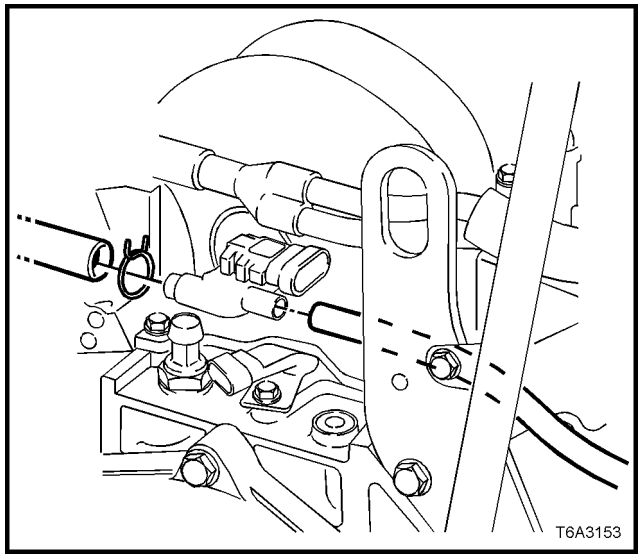


Figure 6A3-193

49. Remove number 3 spark plug lead and plug from the left bank, then remove the upper left engine mount to engine bracket nut, using a socket, universal joint, long extension and ratchet.
50. For the right hand engine mount, repeat the above process by removing the second spark plug lead and plug (or cylinder No. 4 spark plug), to gain access to the upper, right hand engine mount nut. To improve the removal process, also remove the lower mount retaining nut.

NOTE: To improve access to these two nuts, an alternative method is to remove both exhaust manifolds. Refer to **2.21 EXHAUST MANIFOLD**, in this Section, for the necessary procedure, if required.

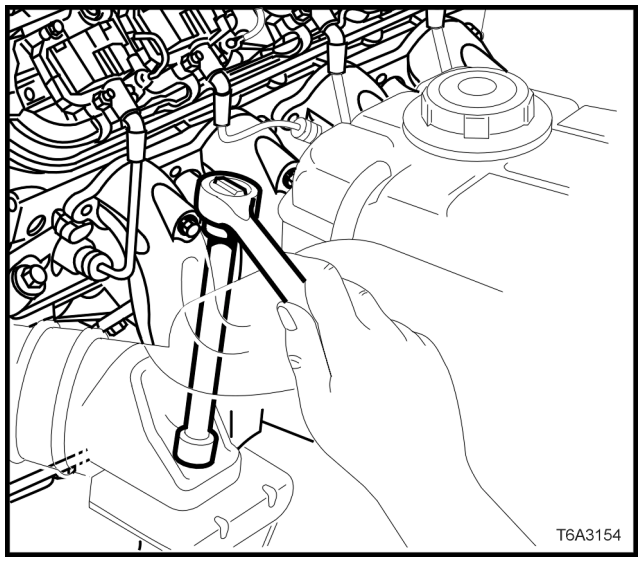


Figure 6A3-194

51. Remove the ignition coil and module for cylinder number 8 for right hand drive vehicles or number 7 for left hand drive vehicles. Refer to **Section 6C3-3 SERVICE OPERATIONS**.

NOTE: This step is necessary to gain additional clearance around the brake vacuum booster, when the engine is lifted during the removal process.

52. With manual transmission equipped vehicles, remove the bolt securing the clutch master cylinder reservoir bracket to the end of the master cylinder. Refer to **Section 7A2 CLUTCH** for further information.

NOTE: This step is necessary to reduce the possibility of damage to the reservoir, during the engine removal procedure.

53. Raise vehicle front and rear and support on safety stands. For location of jacking and support points, refer to **Section 0A GENERAL INFORMATION**.
54. Remove the three bolts and nuts securing the propeller shaft, front coupling. Refer to **Section 4C PROPELLER SHAFT AND UNIVERSAL JOINTS**. To disconnect the propeller shaft from the front spigot. It may be necessary to remove the two centre bearing to underbody bolts and lower the propeller shaft. Use tie wire to secure the sliding yoke to the rear of the transmission.
55. Disconnect the gear shift control from the transmission. Refer to **Section 7B2 MANUAL TRANSMISSION - GEN III V8 ENGINE**, or **Section 7C4 AUTOMATIC TRANSMISSION - ON-VEHICLE SERVICING**.

56. From under the front of the vehicle, remove the four bolts securing the oil pan under-tray.
57. Remove the two bolts (2) holding the power steering, high pressure line (1) brackets to the oil pan.

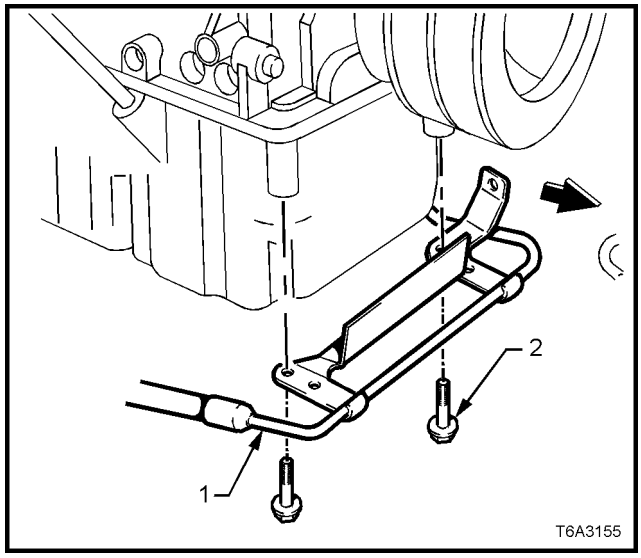


Figure 6A3-195

58. While not essential, it is recommended that the oxygen sensors (1) are removed from the exhaust pipes, to avoid accidental damage.

a. Disconnect the wiring harness connectors from each oxygen sensor.

b. Remove both oxygen sensors from the exhaust pipes.

c. Plug openings in exhaust pipes.

59. Remove both exhaust pipe to manifold flange nuts.

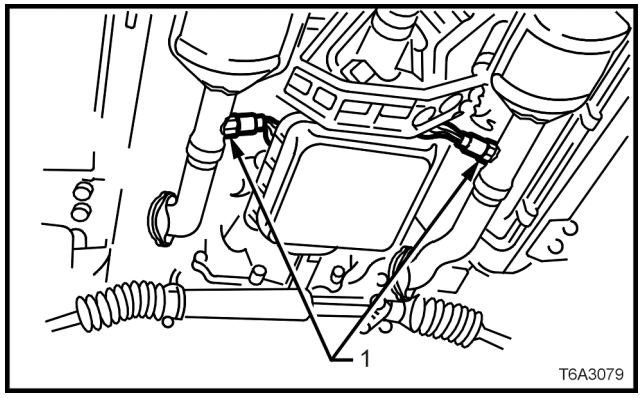


Figure 6A3-196

60. Remove the two bolts (2) securing the catalytic converter bracket (1).

IMPORTANT: Take note of any spacers that may be included between the bracket and the catalytic converter, as these must be reinstalled when the engine is fitted back into the vehicle.

NOTE: While Figure 6A3-197 shows an automatic transmission equipped vehicle, this operation is the same for manual transmission vehicles.

61. Lower the vehicle to the ground.

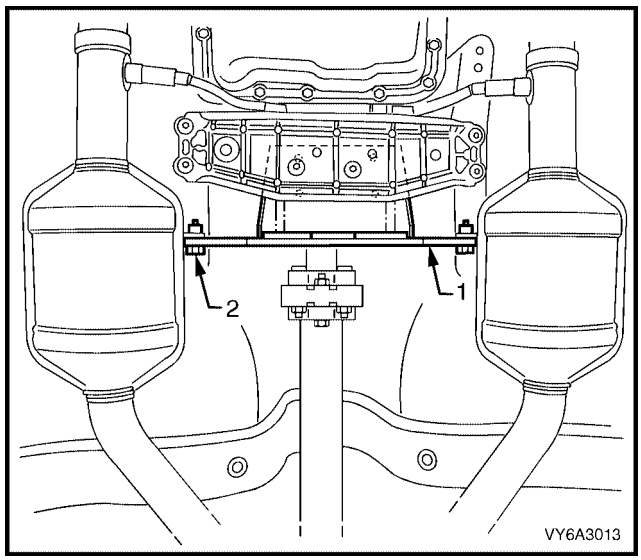


Figure 6A3-197

62. Attach a suitable lifting chain and hooks to the engine lifting brackets located at the left hand front (1) and right hand rear (2) of the engine.
63. Using a suitable lifting crane, raise the engine slightly to take the weight off the engine mounts.

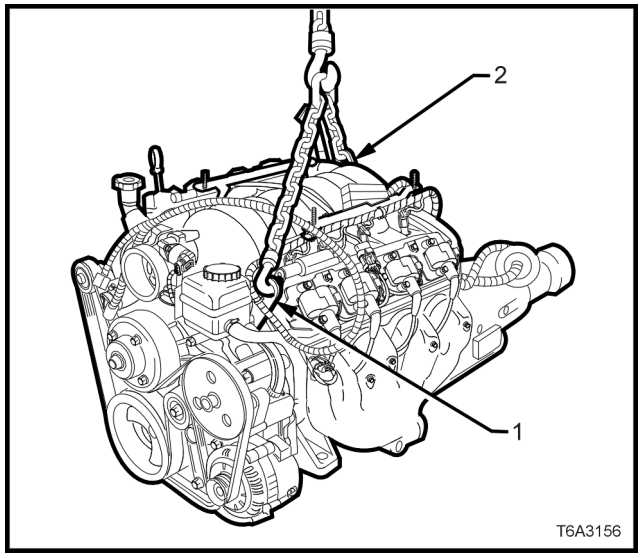


Figure 6A3-198

Vehicles with Manual Transmission

64. Mark the relationship of the engine rear crossmember (2) to the frame, to assist with alignment on reassembly.
65. Remove the four bolts (3) holding the rear crossmember (2) to the frame, remove the rear mounting to crossmember nuts (4), then remove the crossmember from the vehicle.
66. Remove the catalytic converter bracket to transmission extension bolts (7) and nuts, then remove the bracket (6) from the vehicle and set to one side.

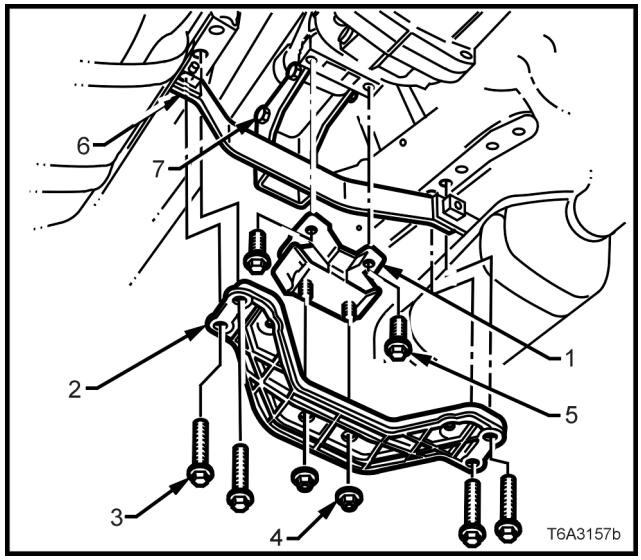


Figure 6A3-199

Vehicles with Automatic Transmission

67. Using a scriber or similar, mark the relationship of the engine rear crossmember (2) to the frame, to assist with alignment on reassembly.
68. Remove the four bolts (3) holding the rear crossmember (2) to the frame, remove the rear support to crossmember nuts (4), then remove the crossmember from the vehicle.
69. Remove the rear mount to transmission extension housing bolts (5) and nuts, then remove the mount (1) and the catalytic converter bracket (6).

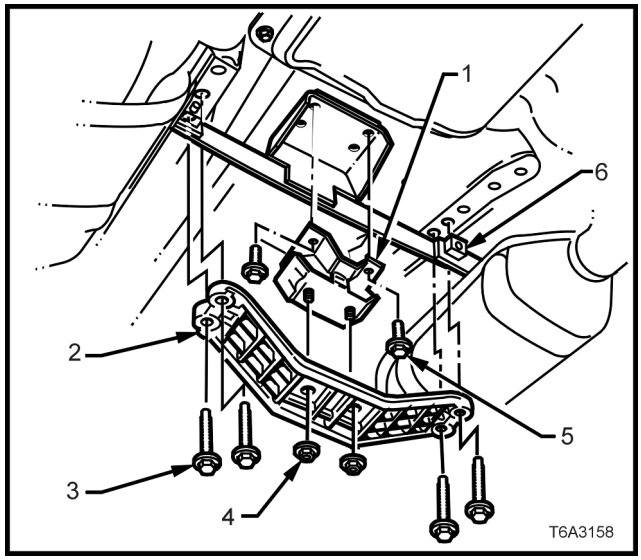


Figure 6A3-200

70. Raise engine and transmission assembly with front tilted upward and a floor jack supporting the rear of the transmission assembly.

IMPORTANT: Take care when removing engine and transmission assembly, that no part of the assembly is allowed to rest on the power steering rack.

NOTE: Do not allow the engine to swing forward and damage the air conditioning condenser (if fitted).

71. Continue to lift and manoeuvre the engine and transmission assembly clear of the engine bay.

DISASSEMBLE

1. Remove the wiring harness connectors and earth connections from the engine and transmission assembly and carefully set the wiring harness to one side.
2. Remove the transmission and mount the engine assembly in a suitable engine stand. The most practical position overall, is to mount the engine on the side, using the engine mount bolt holes.

IMPORTANT: If the engine is to be dismantled and in particular, the camshaft is to be removed, then the camshaft lobe lift check should be carried out, prior to the removal of the cylinder heads. Refer to **3.2 CAMSHAFT LOBE LIFT MEASURE** for details.

3. Drain engine oil into a suitable, clean container.
4. Remove the following components, as described in either this Section or other, designated Sections:
   a. Oil filter, refer to **2.3 ENGINE OIL FILTER & ADAPTOR REPLACE** in this section.
   b. Engine drive belts, refer to **2.6 ENGINE DRIVE BELTS – REPLACE ENGINE ACCESSORY BELT AIR CONDITIONG COMPRESSOR BELT** in this section.
   c. Air conditioning compressor, refer **Section 2B, AIR CONDITIONING - REMOVAL AND INSTALLATION**
   d. Engine accessory drive belt idler and tension pulley assemblies, refer to **2.7 ACCESSORY BELT IDLER PULLEY REPLACE** and **2.9 ACCESSORY BELT TENSIONER REPLACE** in this section.
   e. Air conditioning drive belt idler and tension pulley assemblies, refer to **2.8 A/C BELT IDLER PULLEY REPLACE** and **2.10 A/C BELT TENSIONER** in this section.
   f. Generator and mounting brackets, refer **Section 6D3-1 CHARGING SYSTEM - GEN III V8 ENGINE**.
   g. Intake manifold, refer to **2.14 INTAKE MANIFOLD** in this section.
   h. Vapour vent pipe, refer to **2.15 VAPOUR VENT PIPE** in this section.
   i. Engine valley cover, refer to **2.16 ENGINE VALLEY COVER** in this section.
   j. Valve rocker arm covers, refer to **2.17 VALVE ROCKER ARMS & PUSH RODS** in this section.
   k. Valve rocker arms and push rods, refer to **2.18 VALVE STEM OIL SEAL AND.OR VALVE SPRING** in this section.
   l. Oil level indicator and exhaust manifolds (if not already removed), refer to **2.20 OIL LEVEL INDICATOR AND TUBE** and **2.21 EXHAUST MANIFOLD** in this section. Plug the oil level indicator hole in the oil pan to avoid dirt entry.
   m. Cylinder heads and valve lifters, refer to **2.22 CYLINDER HEAD** and ***2.23* VALVE LIFTERS** in this section.
   n. Starter motor, refer **Section 6D3-2 STARTING SYSTEM - GEN III V8 ENGINE**.
   o. Crankshaft balancer, refer to **2.24 CRANKSHAFT BALANCER** in this section.
   p. Coolant pump assembly, refer to **2.25 COOLANT PUMP** in this section.

REASSEMBLE

Reassembly of the components listed in step 4. of the DISASSEMBLE description above, is the reverse of the disassembly procedures, except for specific points stated in each description for that component.

For other engine components that are detailed in this Section, the reassembly process is also detailed.

REINSTALL, SETUP AND TESTING

Installation of the engine assembly is the reverse of removal procedures, noting the following points:

1. Ensure that all fasteners are tightened to the correct torque specifications, as detailed in **6. TORQUE SPECIFICATIONS**, at the end of this Section.
2. Use only the specified engine lubricant type and quantity. It is recommended that a fluorescent oil dye, such as that contained in J 28481-B, be added to assist in any future oil leak diagnosis.
3. Fill the cooling system with the proper quantity and grade of coolant. Refer **Section 6B3 ENGINE COOLING - GEN III V8 ENGINE**.
4. Check transmission fluid level, topping up as required, using the specified lubricant for the transmission fitted. Refer **Section 7C4 AUTOMATIC TRANSMISSION - ON-VEHICLE SERVICING**.
5. Disable the ignition system. Refer to **2.5 COMPRESSION CHECK** in this Section, for details.
6. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
7. Enable the ignition system, start the engine and listen for unusual noises.
8. Check the vehicle oil pressure gauge or warning lamp and confirm that the engine has acceptable oil pressure. If necessary, install an oil pressure gauge and measure the engine oil pressure. Refer to **2.4 ENGINE OIL PRESSURE - CHECK**, in this Section.
9. Run the engine speed at about 1,000 rpm until the engine has reached normal operating temperature.
10. Listen for sticking lifters and other unusual noises.
11. Check for oil, fuel, coolant and exhaust leaks while the engine is running, correcting as required.
12. Perform a final inspection for the proper engine oil and coolant levels.
13. Check engine hood alignment.

3.2 CAMSHAFT LOBE LIFT

MEASURE

IMPORTANT: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft, push rods and valve lifters installed in the engine.

1. To measure the camshaft lobe lift, proceed as follows:
   a. Remove the valve rocker arms and bolts. Refer **2.18 VALVE STEM OIL SEAL AND.OR VALVE SPRING**, in this Section.
   b. Install an M8 x 1.25 dial indicator mounting stud into the valve rocker arm bolt hole.
   c. Assemble the components of a commercially available dial indicator (or Tool J 8520) and position onto the installed stud, as shown.
   d. Position the shaft of the dial indicator onto the end of the pushrod.
   e. Zero the dial indicator dial.
   f. Slowly rotate the crankshaft clockwise until the dial indicator obtains its highest and lowest readings.
   g. Repeat for all valves and compare the readings obtained against specifications.

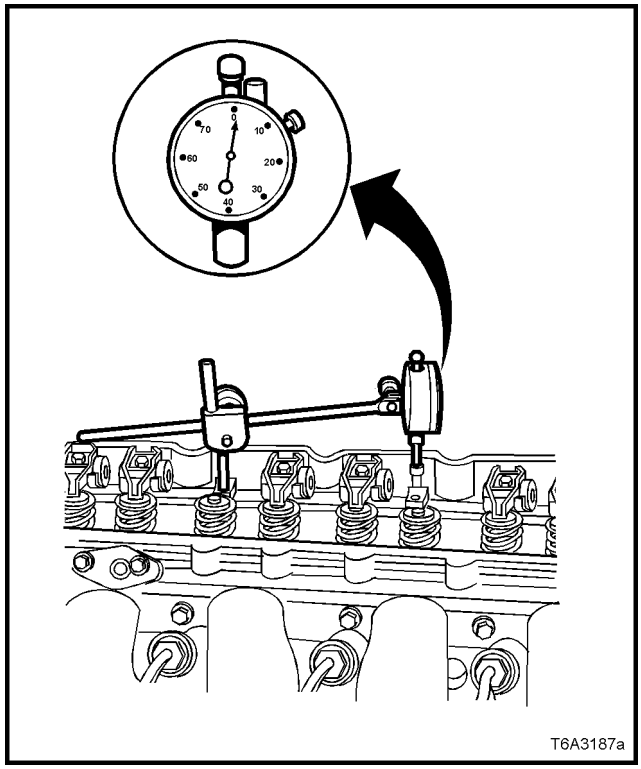


Figure 6A3-201

Camshaft Lobe Lift Specification:

Intake Lobe	7.43 mm
Exhaust Lobe	7.43 mm

NOTE: If the readings are not within specification, then the camshaft lobes are worn and require further investigation when the camshaft is removed.

3.3 OIL PAN

LT Section No. – 00-275

REMOVE

IMPORTANT: Because of critical alignment procedures required for oil pan installation, it is strongly recommended that the engine assembly is removed from the vehicle, before oil pan removal.

1. Remove the starter motor. Refer **Section 6D3-1 STARTING MOTOR – GEN III V8 ENGINE**.
2. Remove the right close-out cover screw and cover (View 'A').
3. Remove the left close-out cover screw and cover (View 'B').

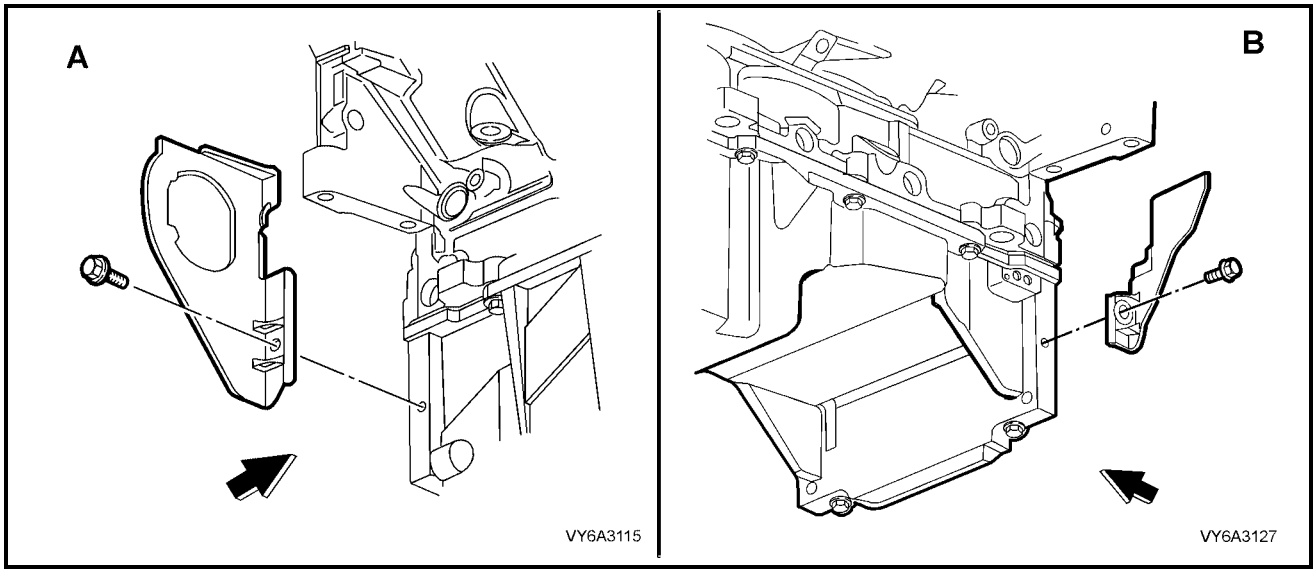


Figure 6A3-202

4. Invert the engine assembly.
5. Remove the oil pan bolts, loosening gradually from the ends and working inwards toward the centre.
6. Bump the oil pan sideways with the heel of a hand or a rubber hammer, to dislodge the seal.

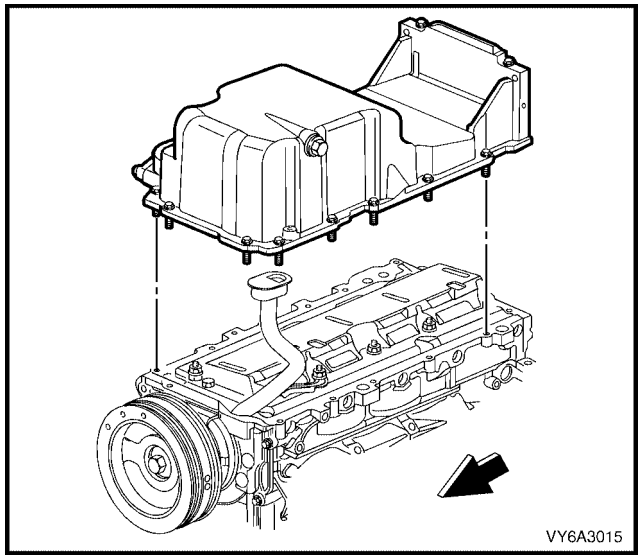


Figure 6A3-203

DISASSEMBLE

NOTE: The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket as a service replacement, it is not necessary to install new oil pan gasket rivets.

IMPORTANT: Do not allow metal shavings or other foreign material to enter the oil passages in the oil pan during gasket removal. Plug all openings before commencing drilling operations.

1. Use a sharp twist drill (3) to drill out each of the retaining rivets (2), as required.
2. Remove the oil pan gasket (1) from the oil pan.
3. Discard the gasket and rivets.

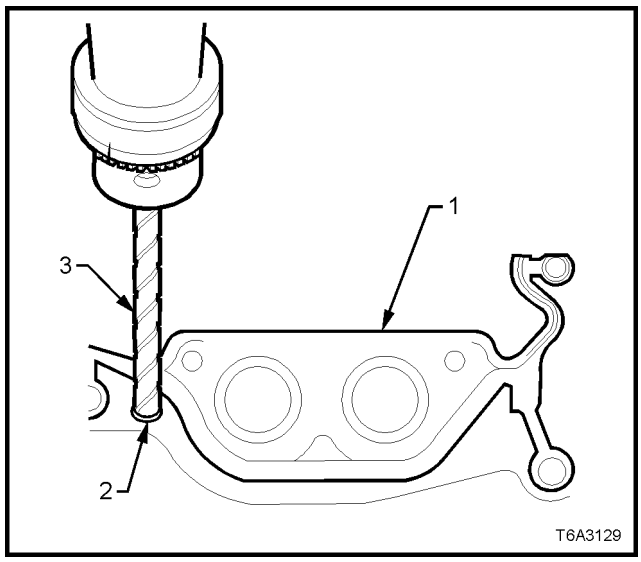


Figure 6A3-204

4. Remove the oil transfer cover nuts (3), cover (2), and gasket (1). Discard the gasket (1).
5. Remove the two O-rings (4) and discard.

NOTE: If removal of the oil transfer cover nuts (3) is required while the oil pan is still installed (e.g. during fitment of an external oil cooler), the studs MUST NOT be removed. Otherwise the transfer pipes and gasket inside the oil pan, may become dislodged.

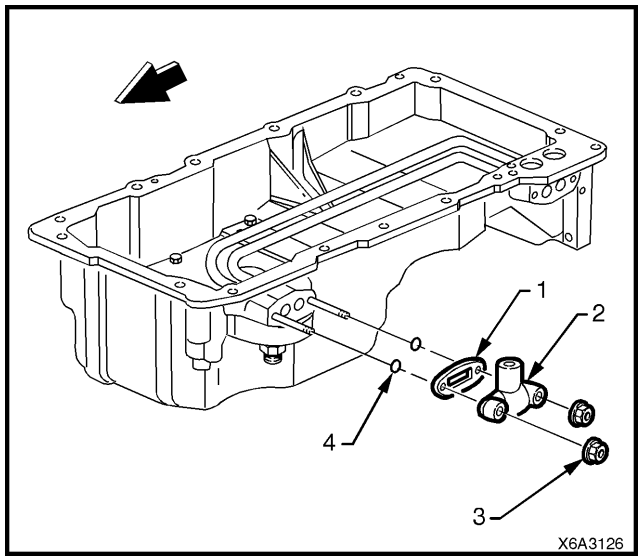


Figure 6A3-205

6. Remove the two oil filter transfer tube bolts (3).
7. Remove the oil filter transfer tubes (1) and discard the gaskets (2).
8. If required, use an Allen key socket to remove the oil gallery plugs (4).

NOTE: Because of thread sealant applied to the threads, it is recommended that the front studs are left attached to the transfer tube assembly and the whole assembly withdrawn from inside the oil pan.

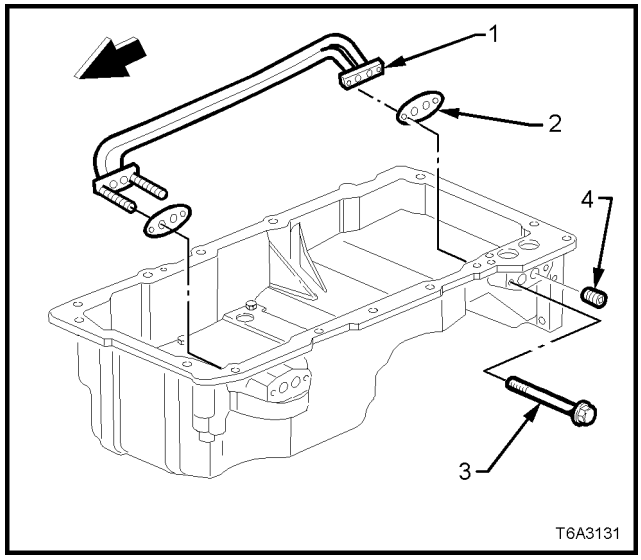


Figure 6A3-206

9. Remove the oil pan baffle bolts (six places) and baffle.

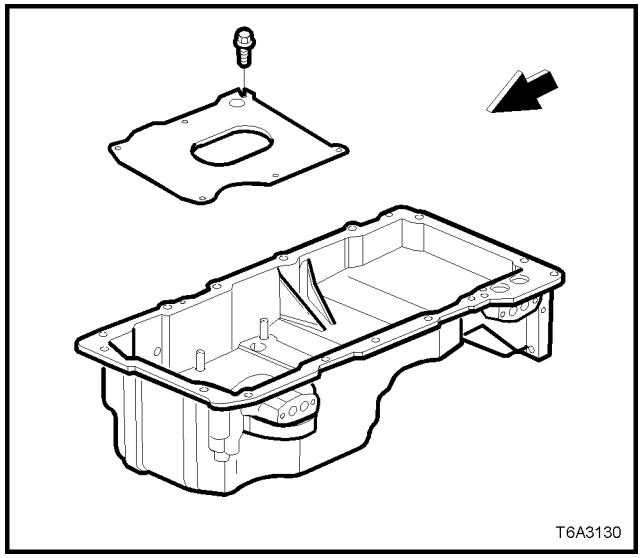


Figure 6A3-207

CLEAN AND INSPECT

1. Clean the oil pan in a suitable solvent. Ensure that all oil passages and recesses are thoroughly cleaned.
2. Clean the oil pan gasket surfaces, using a plastic scraper to avoid scratching or damaging the machined surfaces.
3. Dry the oil pan with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

4. Inspect the oil pan for the following:
   a. Gasket sealing surfaces for excessive scratches or gouging.
   b. Oil pan drain plug and threaded drain hole for damaged threads. The drain plug O-ring seal may be reused if not cut or damaged.
   c. Oil filter sealing surface (A) for scratches or gouging.
   d. Oil filter adaptor (1) for a loose fit or damaged threads.
   e. Oil passages for restrictions.
   f. Oil filter bypass valve (2) in the oil filter flange for proper operation Lightly push the bypass valve into the bore. The valve spring should reseat the valve to the proper position.
5. Inspect the oil transfer tube for damage or restrictions.

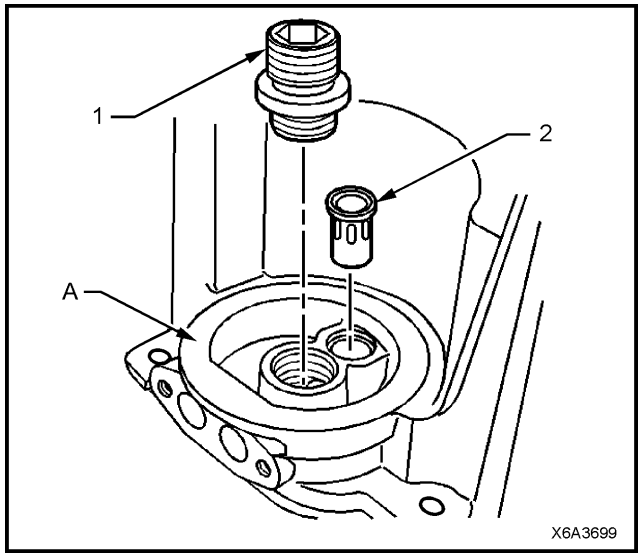


Figure 6A3-208

REASSEMBLE

1. Install the oil pan baffle and retaining bolts and tighten to the correct torque specification.

OIL PAN BAFFLE BOLT TORQUE SPECIFICATION	12 Nm

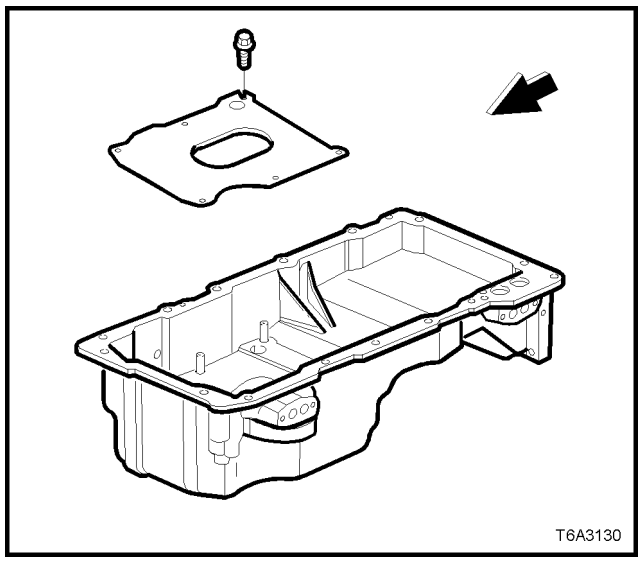


Figure 6A3-209

2. If removed, apply thread lock compound such as Loctite 242 (or equivalent) to the cleaned threads of the oil gallery plugs (4).
3. Use an Allen key socket and tighten the oil gallery plugs to the correct torque specification.

OIL GALLERY PLUG TORQUE SPECIFICATION	25 Nm

4. Apply thread lock compound such as Loctite 242 (or equivalent) to the cleaned threads of the oil transfer tube bolts (3)
5. Using NEW gaskets (2), install the oil filter transfer tubes (1).
6. Install the two bolts (3) and tighten to the correct torque specification.

OIL FILTER TRANSFER TUBE TORQUE SPECIFICATION	12 Nm

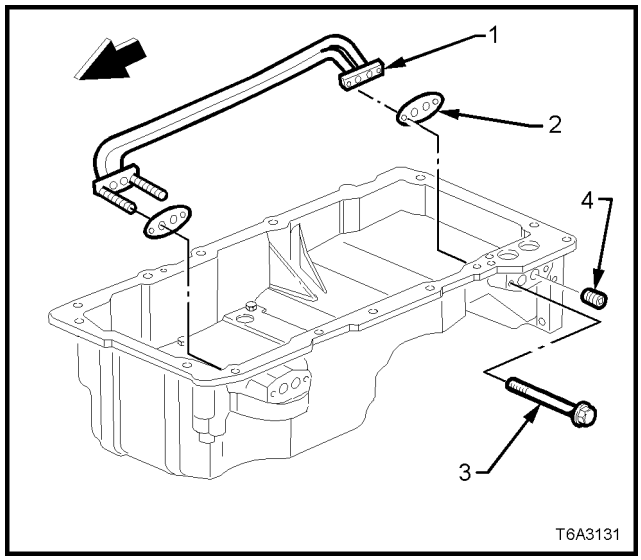


Figure 6A3-210

7. Install NEW oil pan transfer cover O-rings (4), gasket (1), cover (2) and nuts (3).
8. Tighten the nuts to the correct torque specification.

OIL PAN TRANSFER COVER NUT TORQUE SPECIFICATION	12 Nm

9. If removed, install the oil filter adaptor and tighten to the correct torque specification.

OIL FILTER ADAPTOR TORQUE SPECIFICATION	55 Nm

10. If required, install a NEW oil filter bypass valve, using a suitable size socket and hammer to fully seat in the oil filter flange.

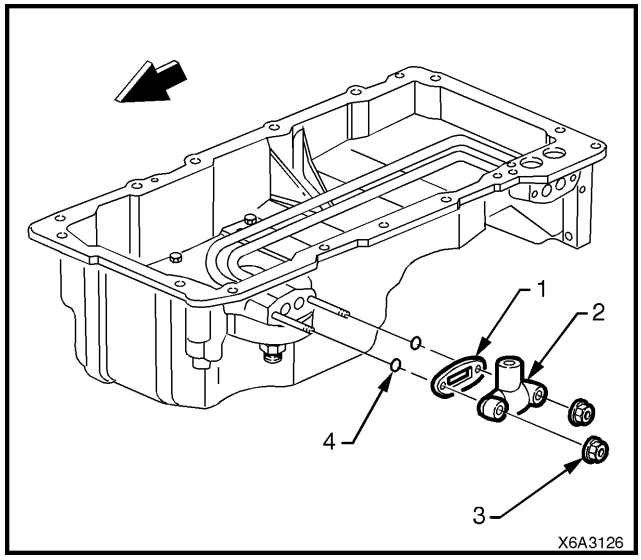


Figure 6A3-211

REINSTALL

IMPORTANT: The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission bell housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the engine block and the rear of the oil pan are flush. The rear of the oil pan must NEVER protrude beyond the engine block and transmission bell housing plane.

NOTE 1: Do NOT reuse the oil pan gasket.

NOTE 2: It is not necessary to rivet the NEW gasket to the oil pan.

1. Apply a 5 mm wide bead of sealant such as Loctite 565 or equivalent, 20 mm long to the engine block, as shown. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface.

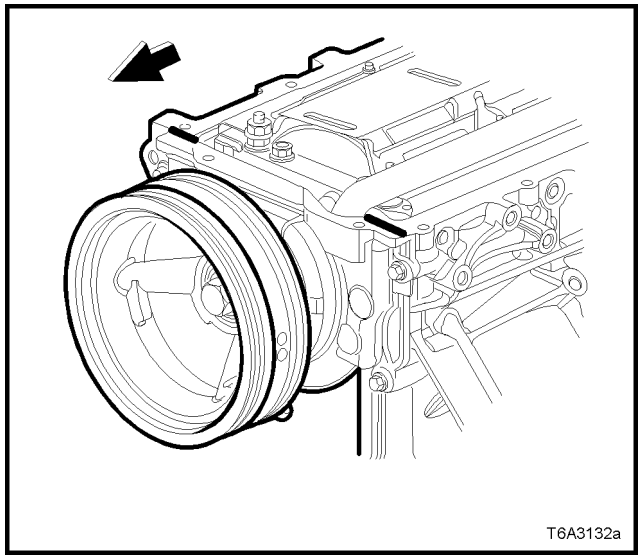


Figure 6A3-212

2. Apply a 5 mm wide bead of sealant such as Loctite 565 or equivalent, 20 mm long, to the engine block, as shown. Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface.

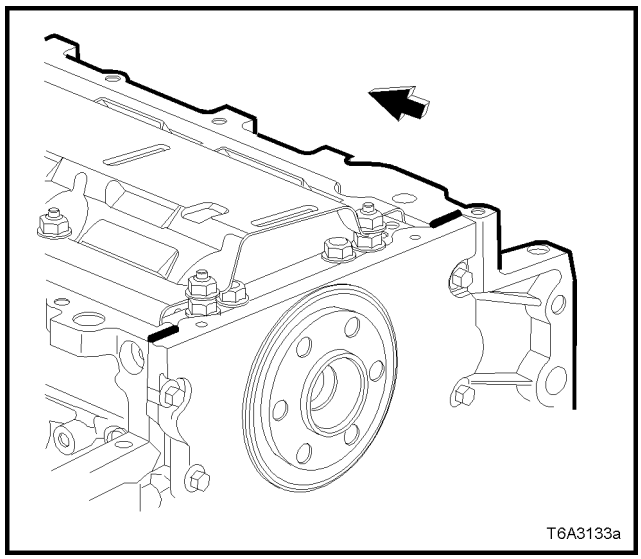


Figure 6A3-213

3. Pre-assemble the oil pan gasket to the oil pan.

IMPORTANT: Be sure to align the oil gallery passages in the oil pan and engine block properly with the oil pan gasket.

4. Install the oil pan bolts to the pan and through the gasket. Install the oil pan, gasket and bolts to the engine block. Tighten bolts finger tight. Do not over-tighten.
5. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission bell housing mounting surfaces.

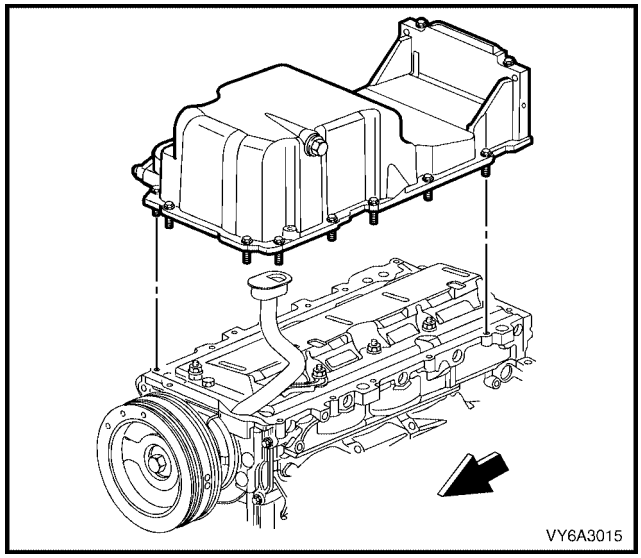


Figure 6A3-214

6. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.
7. Install the oil pan to front cover bolts and the oil pan to rear cover bolts, tightening to the correct torque specifications.

OIL PAN TO FRONT COVER TORQUE SPECIFICATION	25 Nm
OIL PAN TO REAR COVER BOLT TORQUE SPECIFICATION	12 Nm

NOTE: This preliminary step is required to avoid oil pan 'creep' and create a misalignment condition.

8. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission bell housing mounting surfaces.
9. Insert a feeler gauge between the straight edge and the oil pan transmission bell housing mounting surface and check to make sure that the oil pan is flush to no more than a 0.25 mm gap between the pan and straight edge (dimension 'A').

IMPORTANT: The rear of the oil pan must NEVER protrude beyond the engine block and transmission bell housing mounting surfaces.

10. Install remaining oil pan to cylinder block bolts and tighten to the correct torque specification.

OIL PAN TO CYLINDER BLOCK TORQUE SPECIFICATION	25 Nm

If the oil pan alignment is not within specification, remove the oil pan and repeat the above procedure.

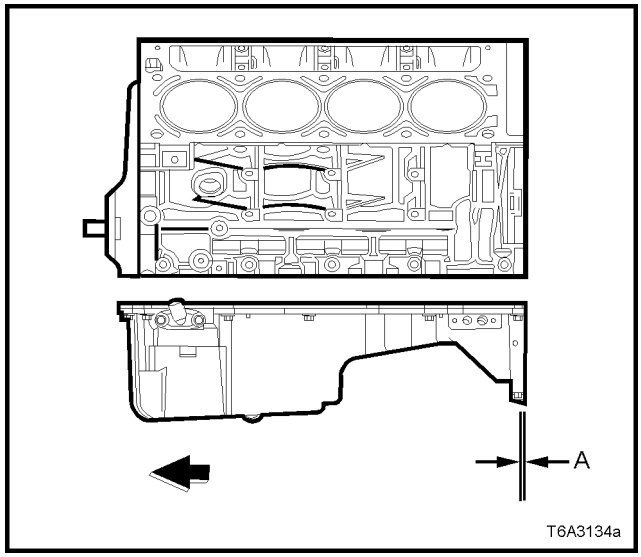


Figure 6A3-215

3.4 ENGINE FRONT COVER

LT Section No. – 00-375

REMOVE

IMPORTANT: Because of critical alignment procedures required for the reinstallation of the front cover and oil pan, it is strongly recommended that the engine assembly is removed from the vehicle, before oil pan removal.

1. Remove the crankshaft balancer. Refer **2.24 CRANKSHAFT BALANCER - REMOVE**, in this Section.
2. Remove the front cover bolts.
3. Remove the front cover and gasket. If the gasket is undamaged, it maybe re-used.

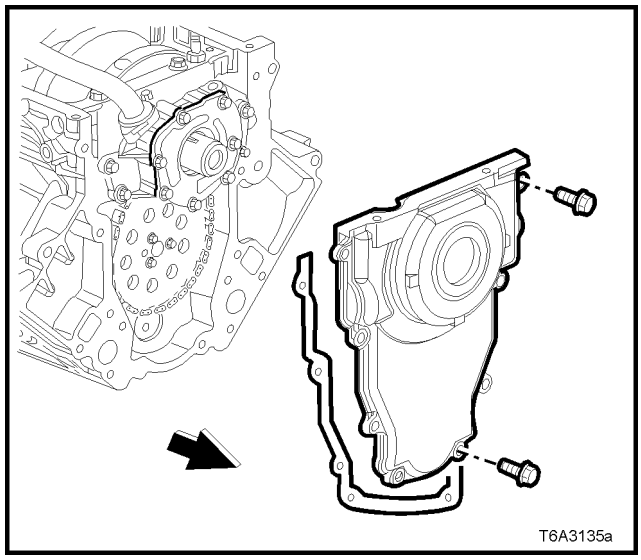


Figure 6A3-216

CLEAN AND INSPECT

1. Prise the old oil seal from the front cover and discard.
2. Clean the front cover in a suitable solvent and blow dry.

CAUTION: Wear safety glasses to avoid eye injury.

3. Inspect the front cover sealing surfaces for excessive scratches and/or gouges.
4. Inspect the front cover gasket for damage to the membrane or distortion to the aluminium carrier.
5. Inspect the front cover to oil pan threaded holes for damaged threads or debris. Refer to **3.16 THREAD REPAIR**, in this Section, if rectification is required.
6. Inspect the cover crankshaft oil seal bore for damage.

REINSTALL

NOTE 1: Do not reuse the crankshaft oil seal if inspection shows it to be damaged in any way.

NOTE 2: Do not apply any type of sealant to the front cover gasket.

NOTE 3: The special tools in this procedure must be used to properly align the engine front cover at the oil pan surface and to centre the crankshaft front oil seal.

NOTE 4: All gasket surfaces should be free of oil or other foreign material during assembly.

NOTE 5: The crankshaft front oil seal MUST be centred in relation to the crankshaft. The oil pan sealing surface at the front cover and engine block MUST also be aligned within specifications.

NOTE 6: An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.

1. Install the front cover gasket, cover, and bolts onto the engine.
2. Tighten the cover bolts finger tight only. **Do not tighten.**

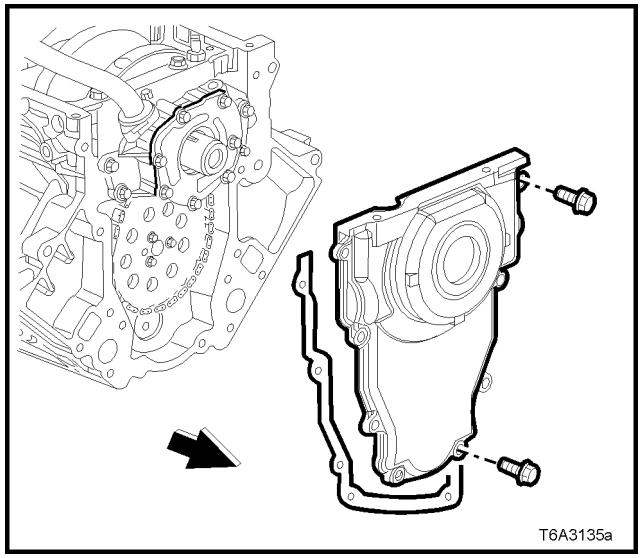


Figure 6A3-217

3. Assemble alignment tool J 41480 to front cover and install bolts (1) (part of Tool J 41480), in the locations shown but do not tighten.
4. Install the alignment tool bolts (2) (part of Tool J 41480) to the engine block and tighten to the specified torque.

FRONT COVER ALIGNMENT TOOL BOLT TO ENGINE BLOCK TORQUE SPECIFICATION	25 Nm

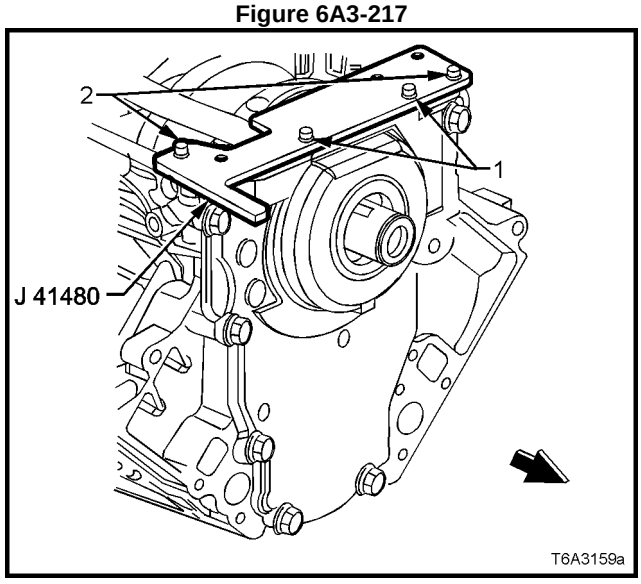


Figure 6A3-218

5. Install centralising Tool J 41476 as shown and hold in position by hand.

IMPORTANT: DO NOT install the crankshaft balancer bolt to retain the alignment tool. If the bolt is installed and over-tightened the alignment tool will be destroyed!

NOTE: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Tighten the two bolts (1) securing Tool J 41480 to the front cover, to the specified torque.

ALIGNMENT TOOL TO FRONT COVER BOLT TORQUE SPECIFICATION	25 Nm

7. Tighten the engine front cover bolts to the correct torque specification.

ENGINE FRONT COVER BOLT TORQUE SPECIFICATION	25 Nm

8. Remove the alignment tools.

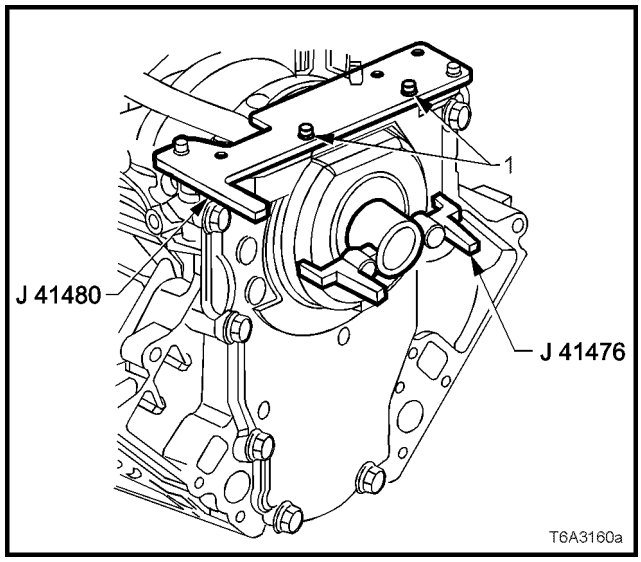


Figure 6A3-219

9. Measure the oil pan surface to front cover for flatness, as follows:

a. Place a straight edge across the engine block and front cover oil pan sealing surfaces. Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

b. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no more than 0.25 mm below flush (dimension 'A').

c. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.

10. If the correct front cover to engine block alignment cannot be obtained, replace the front cover.

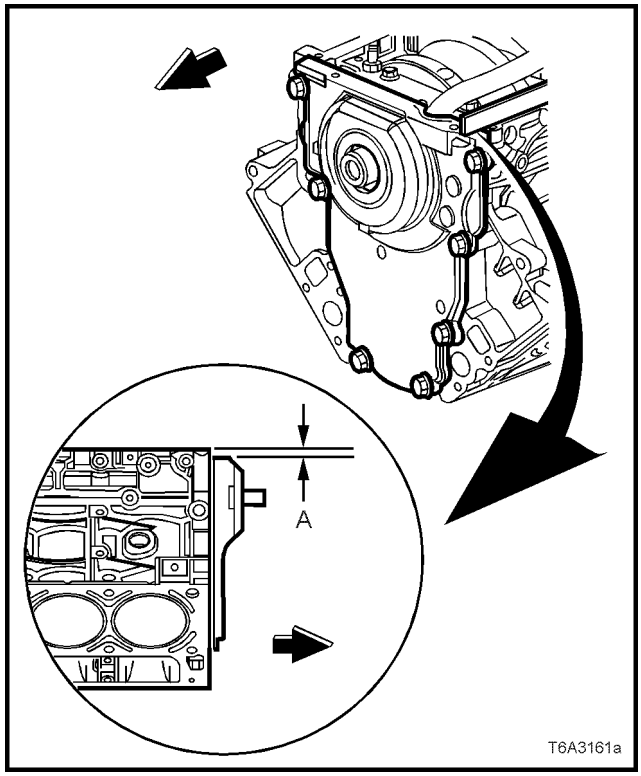


Figure 6A3-220

CRANKSHAFT FRONT OIL SEAL – INSTALL

IMPORTANT: Do not lubricate the oil seal sealing surface.

1. Lubricate the outer edge of the oil seal (1) and the front cover oil seal bore with clean engine oil.
2. Install the crankshaft front oil seal (1) onto the guide of Tool No. J 41478.
3. Install the threaded rod (with nut, washer, guide, and oil seal) of Tool No. J 41478 into the end of the crankshaft.
4. Using a set spanner, hold the head of the installer bolt, then rotate the installer nut clockwise, using a second set spanner, until the seal bottoms in the cover bore.
5. Remove the tool from the crankshaft.
6. Inspect the oil seal for correct installation. The oil seal should be installed evenly and completely into the front cover bore.
7. Install the crankshaft balancer, refer **2.24 CRANKSHAFT BALANCER**, in this Section.
8. Reinstall oil pan. Refer **3.3 OIL PAN - REINSTALL**, in this Section.

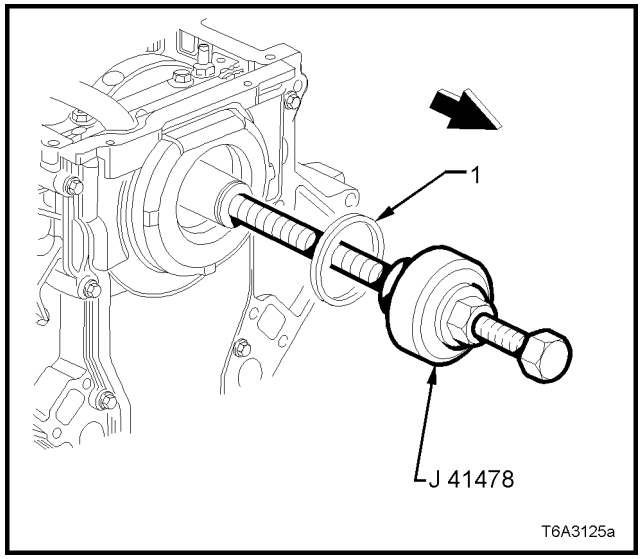


Figure 6A3-221

3.5 ENGINE FLYWHEEL/FLEXPLATE

LT Section No. – 00-400

NOTE: The following fasteners MUST be replaced (■) when performing this operation:

■ Flywheel/Flexplate retaining bolts.

REMOVE

IMPORTANT: Note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The engine flywheel must be reinstalled to the original position and direction. The engine flywheel will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.

If replacing a flywheel, note the location of any existing balance weight pins (relative to the position of the flywheel locating hole). If replacing the flywheel and balance weight pins *are* installed in the original flywheel, then use a suitable pin punch and remove the pins from the old flywheel and then reinstall them in the same relative location in the replacement part.

NOTE 1: Balance weight pins will only be fitted to some engines that may have been dynamically balanced at manufacture, where balance weight pins are required to balance the crankshaft/flywheel assembly. Hence the need to reinstall them to a new flywheel, in the same position.

NOTE 2: A correctly installed balance weight pin will be either flush or below flush with the machined surface of the flywheel.

1. If this operation is to be carried out with the engine installed in the vehicle, remove the transmission and clutch assembly (if required). Refer :

   Section 7B2 MANUAL TRANSMISSION - GEN III V8 ENGINE,

   Section 7A2 CLUTCH - GEN III V8 ENGINE

   Section 7C4 AUTOMATIC TRANSMISSION.
2. Mark the end of the crankshaft and the flywheel/ flexplate, using a felt tipped pen or similar. Remove the engine flywheel/ flexplate bolts.
3. Remove the engine flywheel/flexplate.

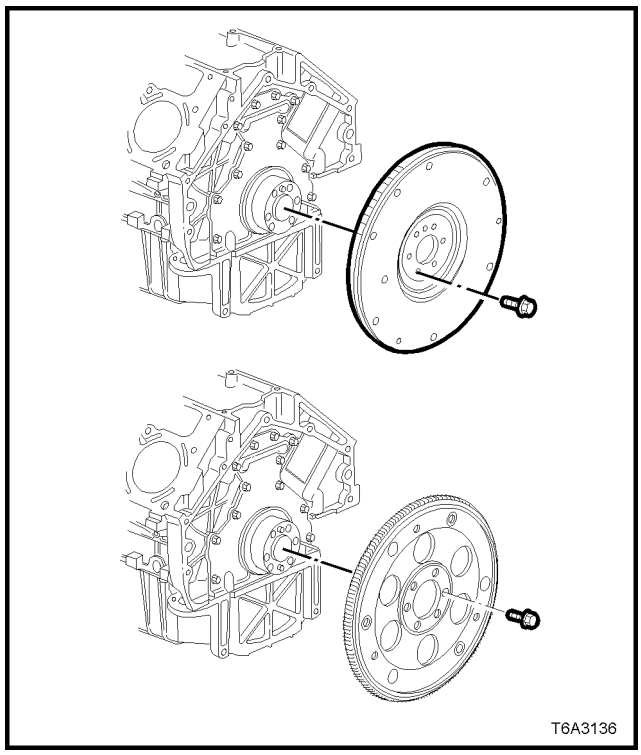


Figure 6A3-222

CLEAN AND INSPECT

Flywheel

1. Clean the flywheel in a suitable solvent and blow dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect the flywheel for loose or improperly installed balance weights (if applicable). A correctly installed balance weight should be either flush or below the machined surface of the flywheel.
3. Inspect the flywheel for the following:
   a. Damaged ring gear teeth (1).
   b. Grooves or scoring (2).
   c. Rusted surface (3).
   d. Pitted surfaces (4).
   e. Loose or incorrectly positioned ring gear. The ring gear is an interference fit onto the flywheel and should be positioned completely against the flange of the flywheel.
   f. Missing, bent or damaged pressure plate locating pins. The two locating pins are pressed into the flywheel and are spaced 170° apart.

IMPORTANT: In order to maintain the correct component balance, contact surface taper and heat transfer, should any flywheel damage be observed, then the flywheel is NOT to be machined and must be replaced.

Flexplate

4. Inspect the flexplate for the following:
   a. Damaged ring gear teeth.
   b. Stress cracks around the crankshaft bolt hole locations.
   c. Welded areas that retain the ring gear to the flexplate.

IMPORTANT: Do not attempt to repair any welded areas that retain the ring gear to the flexplate. Replace the flexplate assembly if welds are cracked.

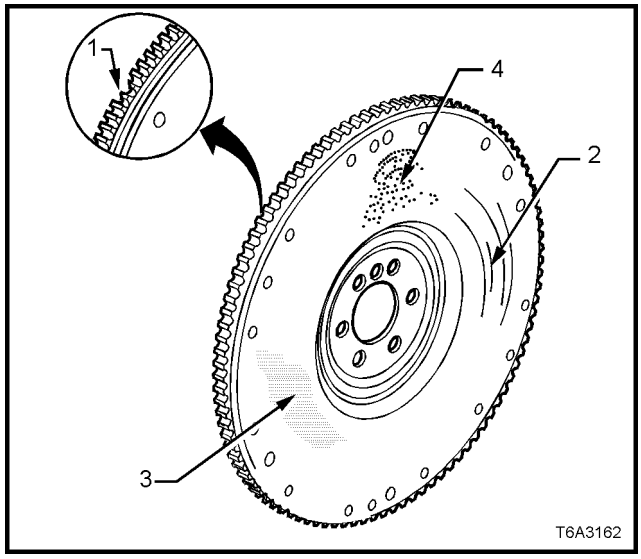


Figure 6A3-223

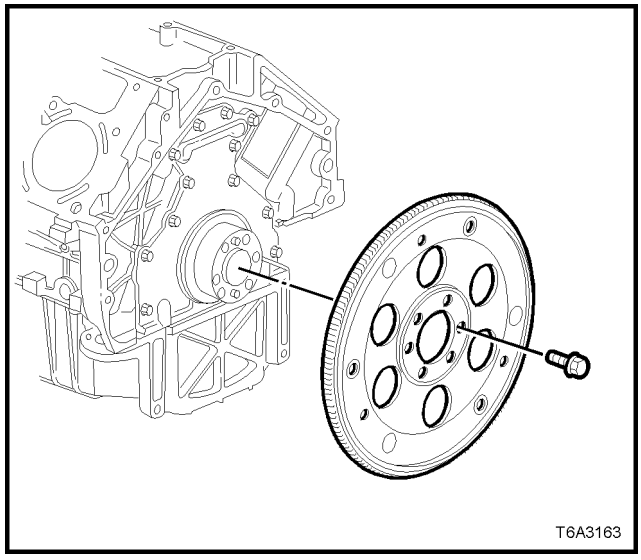


Figure 6A3-224

REINSTALL

1. If replacing a flywheel;
   a. Install any balance weights, as required, in the same locations as noted on the old flywheel. Location is important, as the presence of balance weight pins in the old flywheel are an indication that the crankshaft and flywheel were balanced as a complete unit in original manufacture.
   b. Use the flywheel locating hole as reference and scribe an alignment mark corresponding to the one on the original flywheel.
2. Install the flywheel/flexplate, aligning the scribed marks on the crankshaft and flywheel/flexplate.

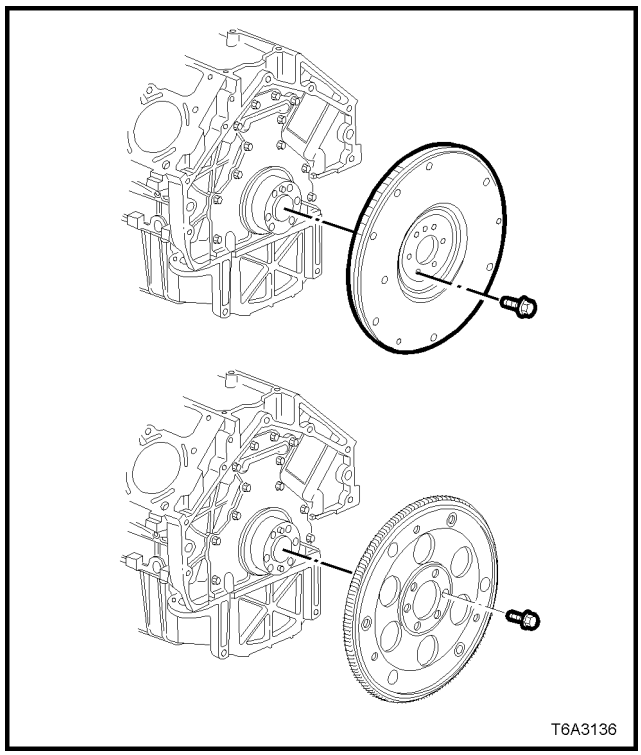


Figure 6A3-225

3. Loosely install NEW flywheel/flexplate bolts, tightening in the sequence shown in Figure 6A3-227, to an initial torque specification of 20 Nm.
4. Install the ring gear holding Tool No. J 42386-A, using the two starter motor bolts. Tighten both bolts to 50 Nm.

NOTE: Ensure that the teeth of the holding tool engage correctly with the ring gear teeth , before tightening the fasteners.

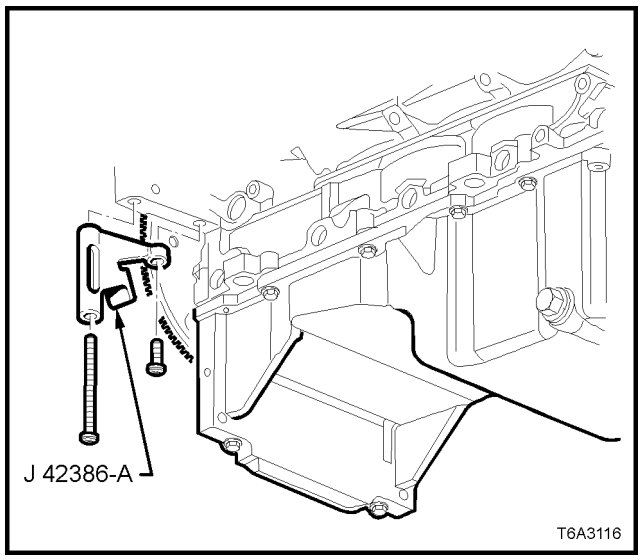


Figure 6A3-226

5. Continue to tighten the flywheel/flexplate bolts in the sequence shown, in two additional stages and to the correct torque specification.

FLYWHEEL/FLEXPLATE BOLTS TORQUE SPECIFICATION	Stage 2: 50 Nm Stage 3: 100 Nm

6. Reinstall clutch and transmission, as required. Refer **Section 7A2 CLUTCH - GEN III V8 ENGINE**, **Section 7B2 MANUAL TRANSMISSION - GEN III V8 ENGINE** or **Section 7C4 AUTOMATIC TRANSMISSION**.

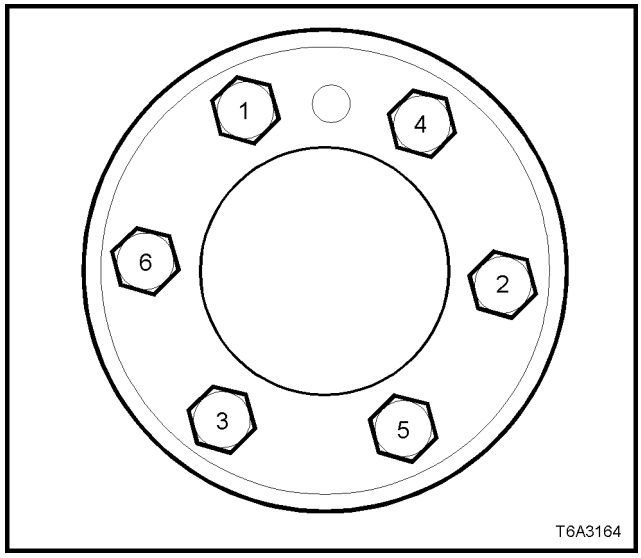


Figure 6A3-227

3.6 ENGINE FLYWHEEL RING GEAR

REPLACE

Automatic Transmission:

The ring gear is welded to the flexplate and is serviced only as an assembly. Refer to **3.5 ENGINE FLYWHEEL/FLEXPLATE**, in this Section.

Manual Transmission:

While previously, the ring gear was welded to the flywheel, the flywheel/ring gear combination is now a one-piece, pressed assembly and, as such, is no longer serviceable. Should any damage be evident to the ring gear, then the flywheel must be replaced. Refer to **3.5 ENGINE FLYWHEEL/FLEXPLATE**, in this Section.

3.7 CRANKSHAFT SPIGOT BEARING

REPLACE

1. Disconnect battery ground lead.

IMPORTANT: Disconnection of the battery affects certain vehicle electronic systems. Refer to **Section 00 CAUTIONS, 5. Battery Disconnection Procedures** before disconnecting the battery.

2. Remove manual transmission and the clutch assembly, refer to **Section 7B2, MANUAL TRANSMISSION - GEN III V8 ENGINE** and **Section 7A2 CLUTCH - GEN III V8 ENGINE**.
3. Using Tool J 23907, (also released as Tool 6A22-2 and slide hammer 7A28) or commercial equivalent, remove the spigot bearing from the rear of the crankshaft. Discard the removed bearing.

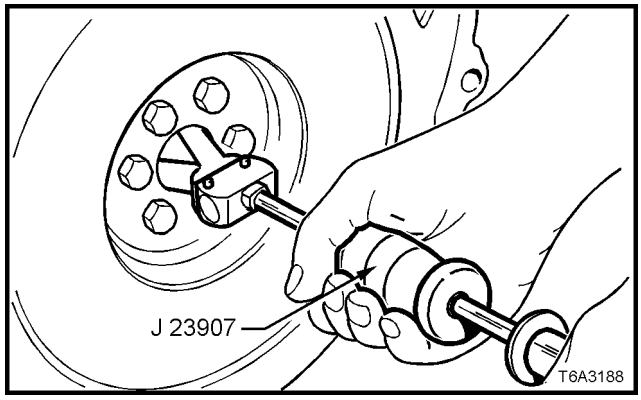


Figure 6A3-228

4. Check that the crankshaft rear oil gallery plug is not a loose fit, damaged or leaking.
5. If replacement is required, apply sealant such as Loctite 242 or equivalent, to the sides of a new plug (1) and install to the correct depth.

Crankshaft Rear Oil gallery Plug Depth Specification

DISTANCE 'A'	31.2 – 31.6 mm

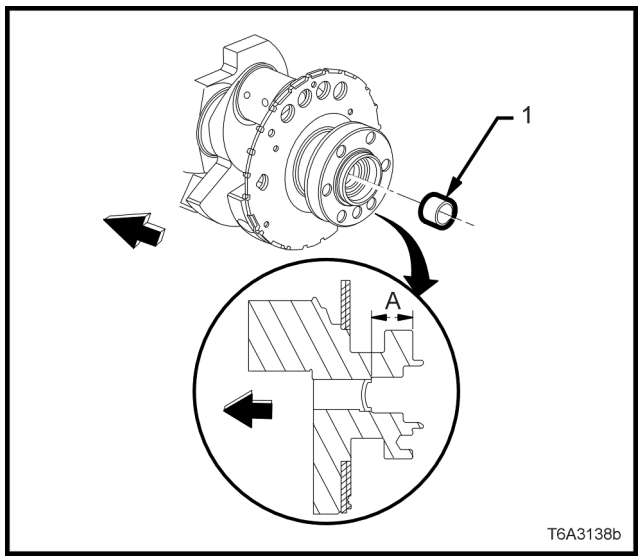


Figure 6A3-229

6. Using a suitable, stepped (or piloted) driver such as Tool J 38836 and flat washer (2), install a replacement bush (1) to the rear of the crankshaft, until flush with the crankshaft counter-bore, as shown.
7. Lubricate the bearing with a small amount of SAE 90 gear oil.
8. Reinstall clutch assembly and manual transmission, refer to **Section 7A2 CLUTCH - GEN III V8 ENGINE** and **Section 7B2 MANUAL TRANSMISSION - GEN III V8 ENGINE**.
9. Reinstall the starter motor. Refer **Section 6D3-2 STARTING SYSTEM - GEN III V8 ENGINE**.
10. Reconnect battery ground lead.
11. Check starter motor operation and road test vehicle to check transmission and clutch operation.

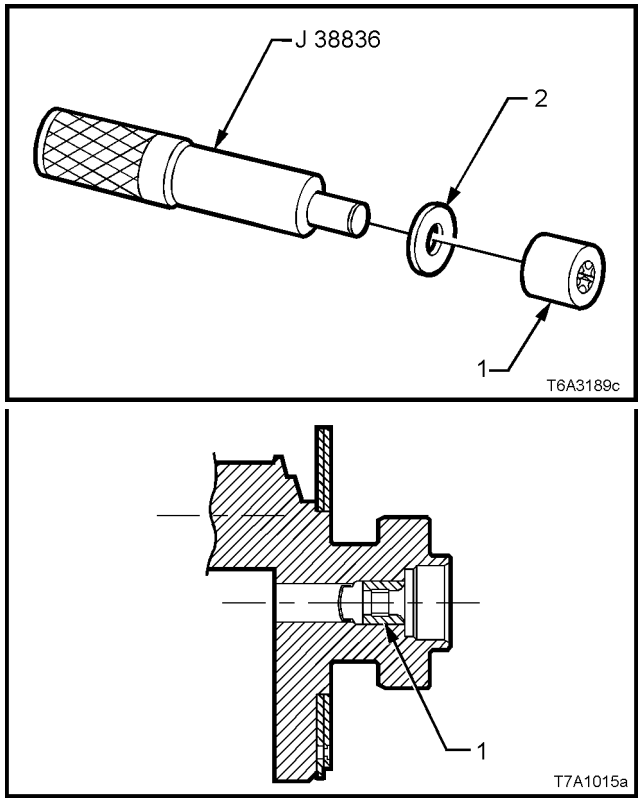


Figure 6A3-230

Techline

3.8 ENGINE REAR COVER

LT Section No. – 00-200

REMOVE

IMPORTANT: Because of critical alignment procedures required for the reinstallation of the rear cover and oil pan, it is strongly recommended that the engine assembly is removed from the vehicle, before oil pan removal.

1. With the flywheel/flexplate removed, refer **3.5 ENGINE FLYWHEEL/FLEXPLATE**, in this Section, remove the rear cover bolts.
2. Remove the rear cover and gasket. If the gasket is undamaged, it may be re-used.
3. Prise the rear main oil seal from the housing, taking care not to distort the rear cover nor scratch the oil seal bore in the rear housing.

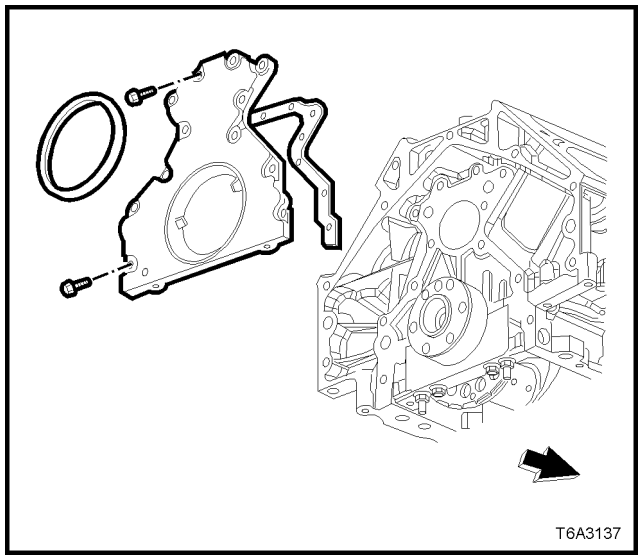


Figure 6A3-231

CLEAN AND INSPECT

1. Clean the cover in a suitable solvent and blow dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect the gasket sealing surface for excessive scratching or gouging.
3. Inspect the gasket for damage to the seal membrane or distortion to the aluminium carrier.
4. Inspect the cover to oil pan threaded holes for debris or damage. Refer to **3.16 THREAD REPAIR**, in this Section, if rectification is required.
5. Inspect the rear main oil seal bore for damage.

REINSTALL

NOTE 1: Do not reuse the crankshaft rear oil seal.

NOTE 2: Do not apply any type of sealant to the rear cover gasket.

NOTE 3: The special tools in this procedure are used to properly align the engine rear cover at the oil pan surface and to centre the crankshaft rear main oil seal.

NOTE 4: All gasket surfaces should be free of oil or other foreign material during assembly.

NOTE 5: The crankshaft rear main oil seal MUST be centred in relation to the crankshaft and is to be installed after the rear cover installation. The oil pan sealing surface at the rear cover and engine block MUST also be aligned within specifications.

NOTE 6: An improperly aligned rear cover may cause premature oil seal wear and/or engine assembly oil leaks.

1. If removed, inspect the rear main oil gallery plug and ensure that it is of the later design (‘A’). If of the earlier design (‘B’) then it must be replaced.

NOTE: Visually, the later plug has a thicker end boss (‘X’) that the earlier design (‘Y’).

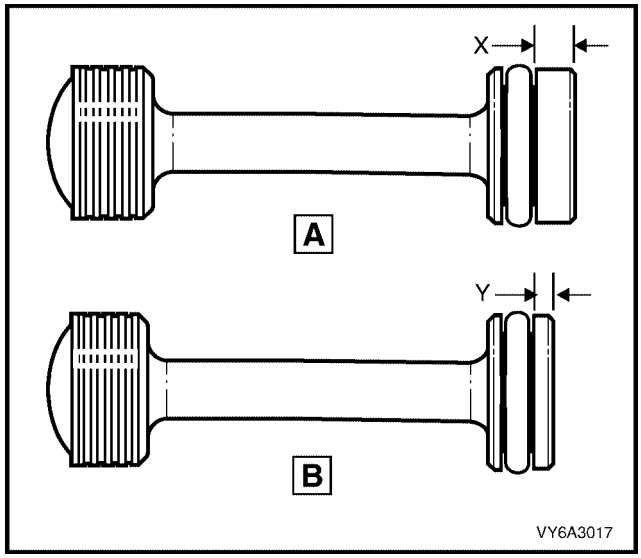


Figure 6A3-232

2. Lubricate the O-ring with clean engine oil and install the plug into the rear of the cylinder block. Carefully install until the plug comes to a stop against the stepped bore of the oil gallery. At this point, the plug should be protruding by approximately 1.2 mm (distance ‘A’).

NOTE: When the rear cover and gasket are installed, the plug protrusion will rest against the rear cover machined internal surface.

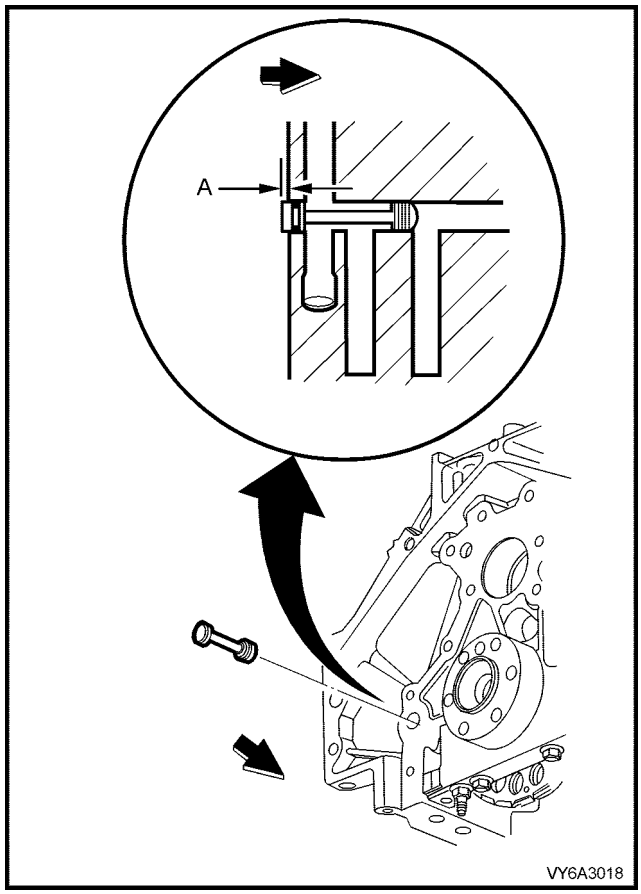


Figure 6A3-233

3. Install the rear cover gasket, the rear cover and bolts.

NOTE: If undamaged, the original cover gasket can be re-used.

4. Only tighten the rear cover bolts finger tight. **Do not overtighten**.

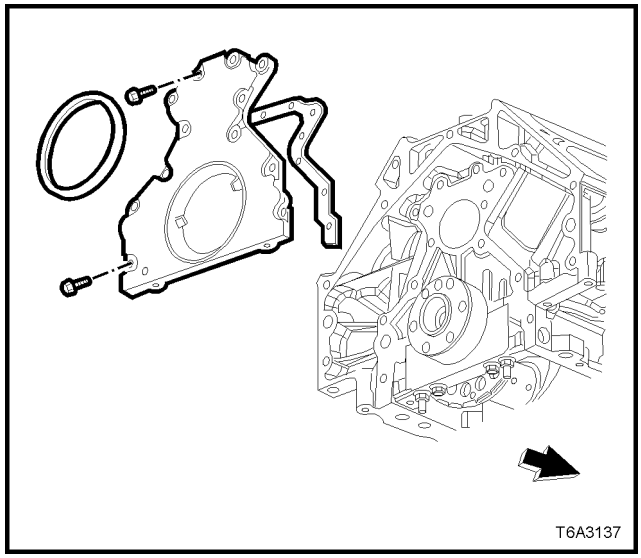


Figure 6A3-234

5. Assemble the alignment tool J 41480 to rear cover and install bolts (1) (part of Tool J 41480) in the locations shown but do not tighten.
6. Install bolts (2) (part of Tool J 41480) to the engine block and tighten to the specified torque.

REAR COVER ALIGNMENT TOOL BOLT TO ENGINE BLOCK TORQUE SPECIFICATION	25 Nm

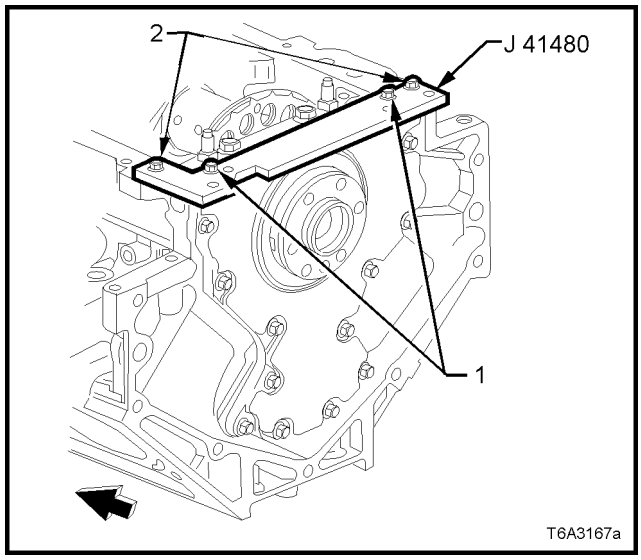


Figure 6A3-235

7. Rotate the crankshaft until two opposing flywheel/ flexplate mounting bolt holes are parallel to the oil pan surface of the engine block (arrows).
8. Install alignment Tool J 41476 to the rear of the crankshaft.

NOTE: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

9. Install the two screws supplied with Tool J 41476 and tighten with a screwdriver until snug. **Do not over-tighten.**

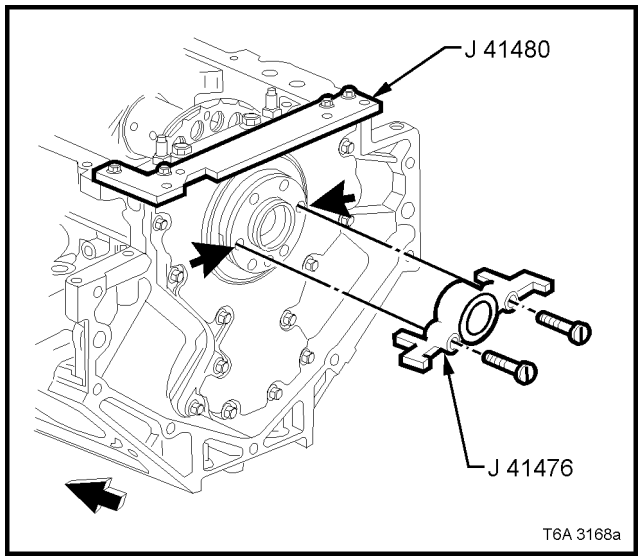


Figure 6A3-236

10. Tighten the alignment Tool J 41480 bolts (1) to the rear cover to the specified torque.

REAR COVER ALIGNMENT TOOL BOLT TO REAR COVER TORQUE SPECIFICATION	12 Nm

11. Tighten the engine rear cover bolts to the correct torque specification.

ENGINE REAR COVER BOLT TORQUE SPECIFICATION	25 Nm

12. Remove the alignment tools.

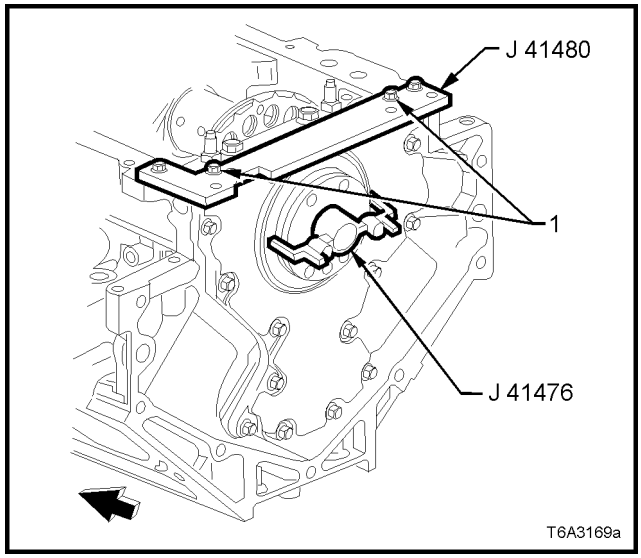


Figure 6A3-237

13. Measure the oil pan surface to rear cover for flatness, as follows:
    a. Place a straight edge across the engine block and rear cover oil pan sealing surfaces. Avoid contact with the portion of the gasket that protrudes into the oil pan surface.
    b. Insert a feeler gauge between the rear cover and the straight edge tool. The cover must be flush with the oil pan surface or no more than 0.25 mm below flush (dimension 'A').
    c. If the rear cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
14. If the correct rear cover to engine block alignment cannot be obtained, replace the rear cover.

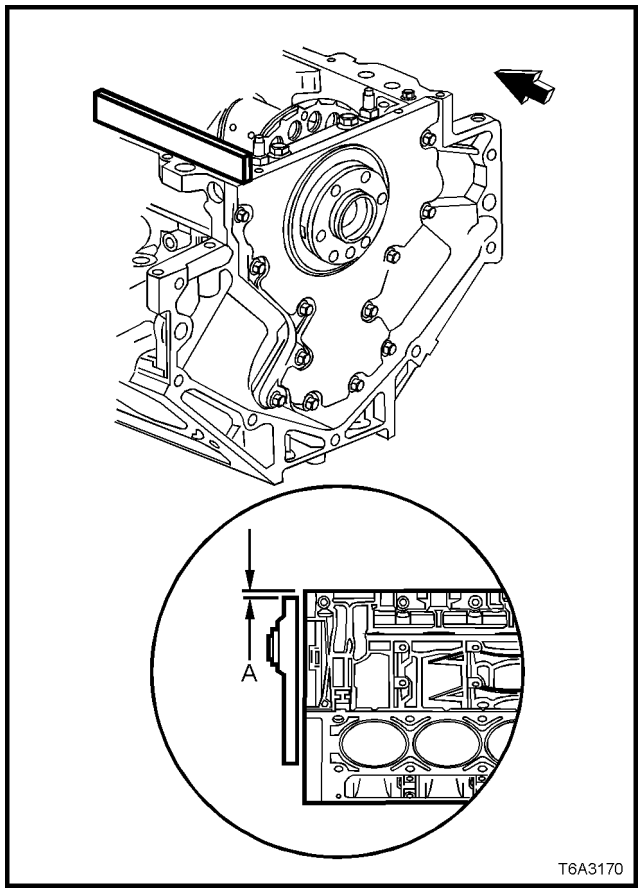


Figure 6A3-238

CRANKSHAFT REAR OIL SEAL - INSTALL

IMPORTANT: Do not lubricate the oil seal inside diameter (ID) nor the crankshaft seal surface

1. Lubricate the outer edge of the oil seal (OD) with clean engine oil.
   DO NOT allow oil or other lubricants to come into contact with the seal surface.
2. Lubricate the rear cover oil seal bore (2) with clean engine oil.
   DO NOT allow oil or other lubricants to come into contact with the crankshaft seal surface.
3. Install the cone (2) of installation Tool No. J 41479 with bolts, to the rear of the crankshaft. Tighten the bolts until snug. Do not over-tighten.
4. Install a NEW oil seal (3) onto the taper of the installation tool (2) and push the seal to the rear cover bore.
5. Install the threaded rod of the installation Tool No. 41479 (1), into the tapered part (2), until the tool contacts the oil seal.
6. Align the oil seal (3) with the tool, then rotate the handle of the tool (1) clockwise until the seal enters then bottoms into the rear cover bore.

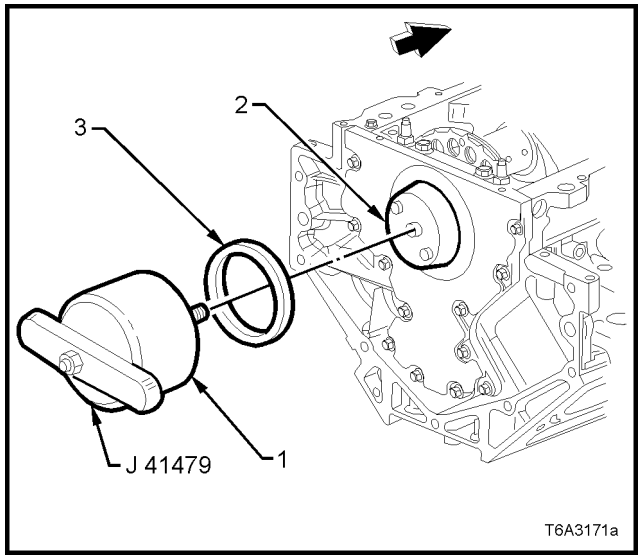


Figure 6A3-239

7. Remove both parts of the installation tool.
8. Reinstall flywheel. Refer to **3.5 ENGINE FLYWHEEL/FLEXPLATE**, in this Section.
9. Reinstall clutch and transmission, as required. Refer **Section 7A2 CLUTCH - GEN III V8 ENGINE, Section 7B2 MANUAL TRANSMISSION - GEN III V8 ENGINE** or **Section 7C4 AUTOMATIC TRANSMISSION**.

3.9 OIL PUMP, PUMP SCREEN, AND DEFLECTOR

LT Section No. – 00-251

REMOVE

IMPORTANT: Because of critical alignment procedures required for the reinstallation of the front cover and oil pan, it is strongly recommended that the engine assembly is removed from the vehicle, before this service operation is carried out.

1. Remove oil pan, refer **3.3 OIL PAN – REMOVE**, in this Section.
2. If the harmonic balancer and front cover have not already been removed, refer to **2.24 HARMONIC BALANCER - REMOVE** and **3.4 ENGINE FRONT COVER - REMOVE**, in this Section.
3. Remove the oil pump pick-up screen bracket nut from the crankshaft oil deflector and the tube retaining screw from the oil pump body.
4. Remove the oil pump screen and tube assembly, and the O-ring seal from the oil pump bore.

   Discard the O-ring.
5. Remove the remaining crankshaft oil deflector nuts.
6. Remove the crankshaft oil deflector, noting that the cover orientation is stamped 'REAR' to assist in correct installation.

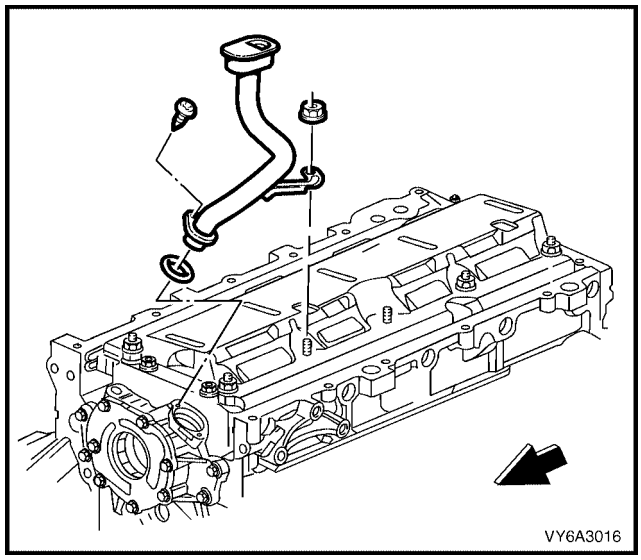


Figure 6A3-240

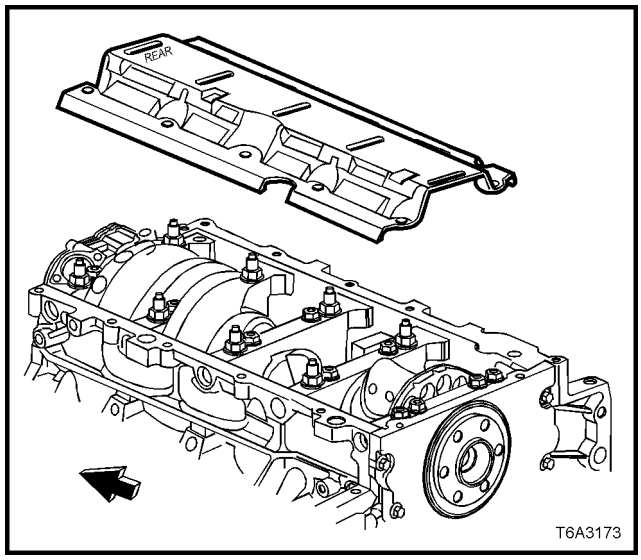


Figure 6A3-241

7. Remove the four bolts securing the oil pump to the front of the engine, then remove the oil pump from the crankshaft.
8. If the oil pump is not being opened, plug all openings to avoid the entry of dirt or debris or wrap in a plastic bag.

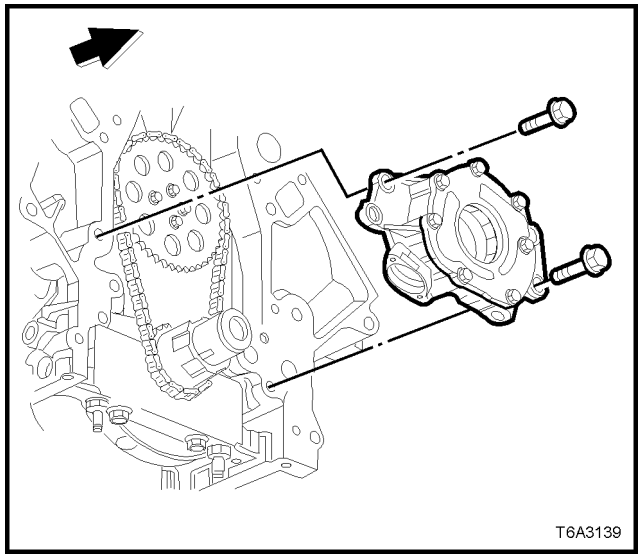


Figure 6A3-242

OIL PUMP DISASSEMBLE

1. Remove oil pump cover bolts, then remove the cover.

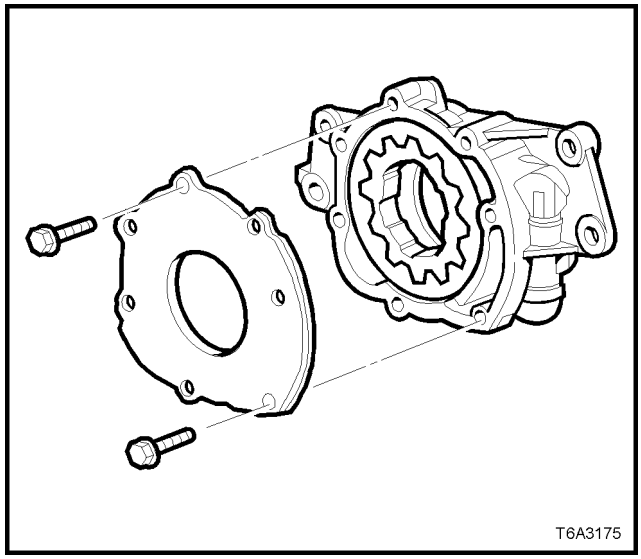


Figure 6A3-243

IMPORTANT: Mark or identify the relationship of the gears for reassembly.

2. Remove the inner drive gear and outer driven ring, from the oil pump body.

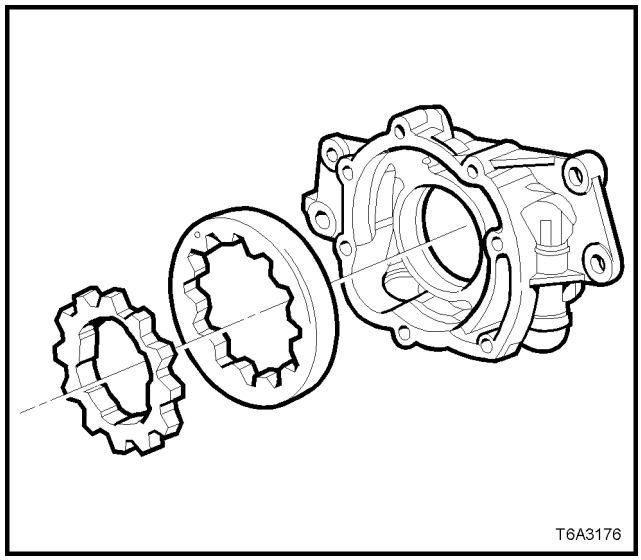


Figure 6A3-244

3. Unscrew the oil pressure relief valve plug and remove spring and valve from the oil pump body.

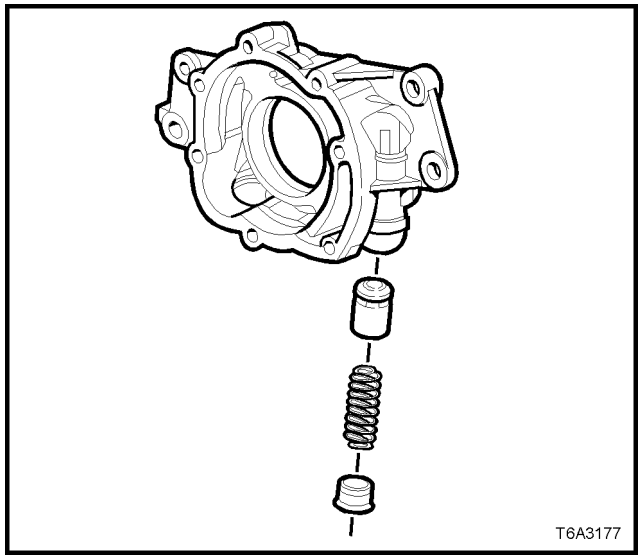


Figure 6A3-245

CLEAN AND INSPECT

NOTE: Apart from the oil pressure relief valve spring, there are no other parts of the oil pump nor the oil pump pick-up screen and pipe that are serviced separately. If either component is found to be worn or damaged, then that assembly must be replaced. Do not attempt any repairs to either component.

Apart from thread reclamation and the correction of minor conditions, replace the oil pump assembly if any of the following conditions are observed.

1. Clean all parts in a suitable solvent and blow dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect the oil pump housing for cracks, excessive wear, scoring or casting imperfections.
3. Inspect the oil pump housing to engine block oil gallery surface for scratches or gouging.
4. Inspect the oil pump housing for damaged bolt hole threads. See Section **3.16 THREAD REPAIR**, if required.
5. Inspect the oil pump relief valve plug and bore for scratched or damaged surfaces and the screw thread for damage. The pressure relief valve must move freely in its bore with no restrictions.
6. Inspect the oil pump internal oil passages for restrictions.
7. Inspect the drive and driven gears for chipping galling or wear. Minor burrs or imperfections on the gears can be removed with a fine oil stone.
8. Inspect the inner gear drive splines for excessive wear.

Replace the oil pump pick-up screen and pipe assembly if either of the following conditions are observed.

1. Inspect the oil pump pick-up screen for clogging with debris or restriction.
2. Inspect the screen mesh for broken or loose strands.

OIL PUMP REASSEMBLE

Reassembly is the reverse of the disassembly process, except for the following items:

1. Liberally coat all oil pump components with clean engine oil before assembly.
2. Take note of the relationship of the inner to the outer oil pump gears when assembling.
3. Tighten the oil pump cover screws to the correct torque specification.

OIL PUMP COVER TO BODY SCREW TORQUE SPECIFICATION	12 Nm

4. Install a NEW pressure relief valve spring.
5. Tighten the pressure relief valve plug to the correct torque specification.

OIL PUMP PRESSURE RELIEF PLUG TORQUE SPECIFICATION	12 Nm

6. Rotate the assembled pump, checking for smoothness of operation by rotating the inner drive gear.

REINSTALL

1. Check the oil pump and engine block oil gallery passages to ensure that any debris is removed.
2. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump onto the sprocket, until the pump housing contacts the face of the engine block.
3. Install the oil pump bolts and tighten to the correct torque specification.

OIL PUMP BOLT TORQUE SPECIFICATION	25 Nm

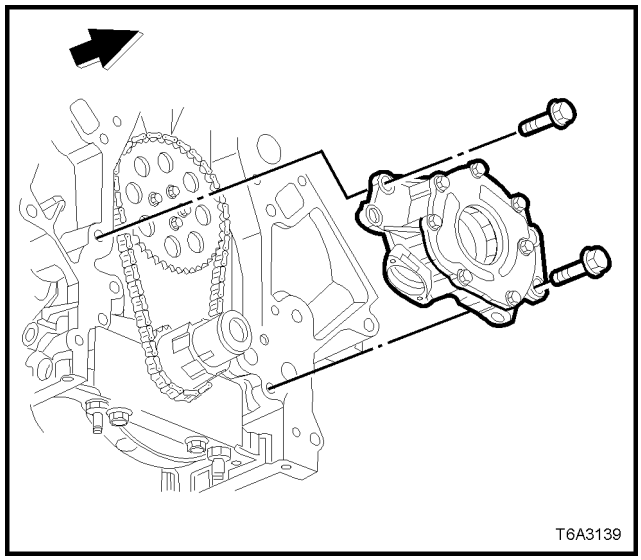


Figure 6A3-246

4. Install the crankshaft oil deflector, noting that the ‘REAR’ stamping on the deflector is located at the rear of the engine.
5. Install all the crankshaft oil deflector nuts to the main bearing cap studs and tighten to the correct torque specification.

CRANKCASE OIL DEFLECTOR NUT TORQUE SPECIFICATION	25 Nm

NOTE: Do not install a nut to the stud used to secure the oil pick-up bracket, at this time. Refer to Figure 6A3-248 for the location.

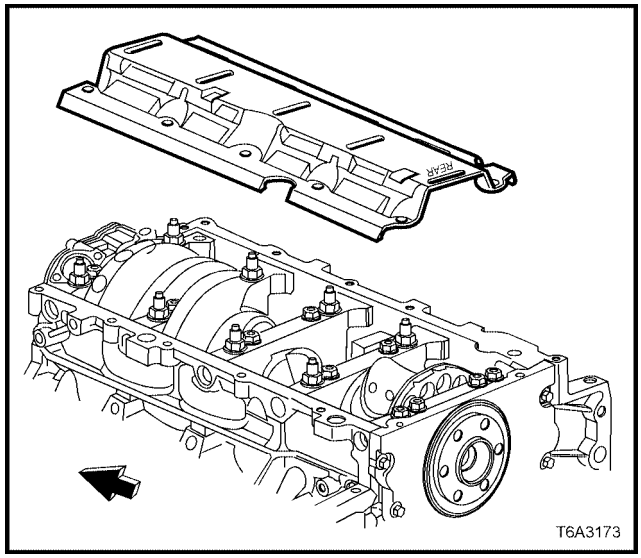


Figure 6A3-247

6. Lubricate a NEW oil pump pick-up tube O-ring (1) with clean engine oil and install onto the oil pump pick-up tube (2).
7. Fully install the pick-up tube (2) into the oil pump housing, aligning the support bracket (3) with the main bearing cap stud.
8. Reinstall the remaining nut (4) to the main bearing cap stud and tighten to the correct torque specification.

CRANKCASE OIL DEFLECTOR NUT TORQUE SPECIFICATION	25 Nm

9. Install the pick-up tube screw (5) and tighten to the correct torque specification.

OIL PUMP PICK-UP TUBE SCREW TORQUE SPECIFICATION	12 Nm

NOTE: Ensure that the pick-up tube is fully installed before tightening the retaining screw.

10. Reinstall the oil pan, refer to **3.3 OIL PAN - REINSTALL**, in this Section.
11. Reinstall the front cover, refer to **3.4 ENGINE FRONT COVER – REINSTALL** and **2.24 HARMONIC BALANCER - REINSTALL**, in this Section.

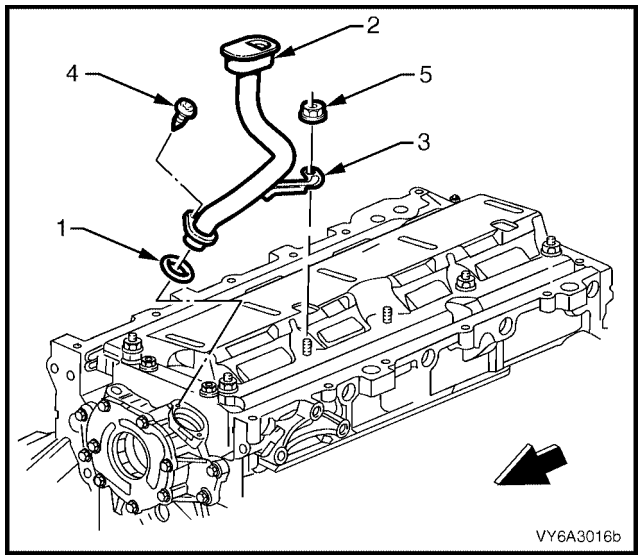


Figure 6A3-248

3.10 TIMING CHAIN AND SPROCKETS

LT Section No. – 00-225

REMOVE

IMPORTANT: Because of critical alignment procedures required for the reinstallation of the front cover and oil pan, it is strongly recommended that the engine assembly is removed from the vehicle, before this service operation is carried out.

1. Remove oil pan, refer **3.3 OIL PAN - REMOVE**, in this Section.
2. If the harmonic balancer and front cover have not already been removed, refer to **2.24 HARMONIC BALANCER – REMOVE** and **3.4 ENGINE FRONT COVER – REMOVE**, in this Section.
3. Remove the oil pump, refer **3.9 OIL PUMP, PUMP SCREEN AND DEFLECTOR**, in this Section.

NOTE: If the cylinder heads and valve train are still installed, temporarily install the harmonic balancer bolt and turn engine until the timing marks on the crankshaft and camshaft sprockets are aligned, refer Figure **6A3-257**. Remove the harmonic balancer bolt.

4. Remove the camshaft sprocket bolts (1), then remove the sprocket (2) and chain (3) from the camshaft and crankshaft sprocket.

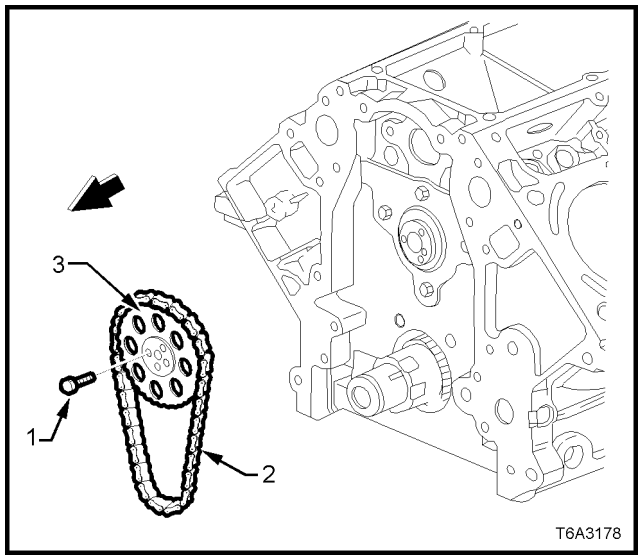


Figure 6A3-249

5. Use Tool No's J 41558, J 41816-2, the bolts from J 21427-01 and puller J 8433-1, assemble as shown and remove the crankshaft sprocket from the nose of the crankshaft
6. Remove the crankshaft sprocket drive key from the crankshaft nose, if required.

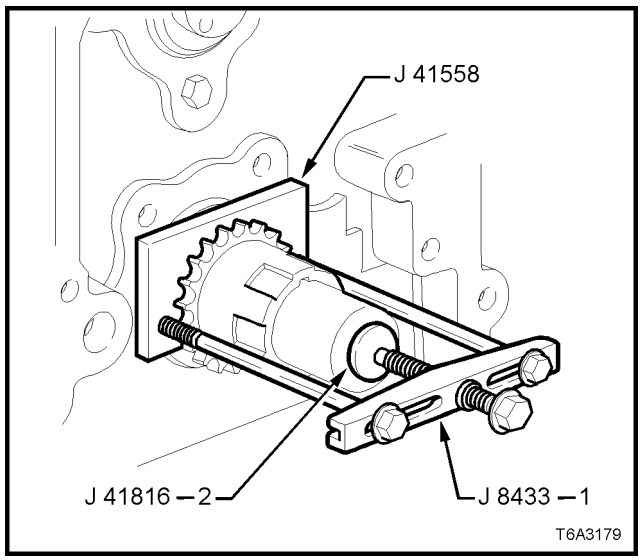


Figure 6A3-250

CLEAN AND INSPECT

1. Clean the sprockets and timing chain in suitable solvent and blow dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect the timing chain for binding or wear.

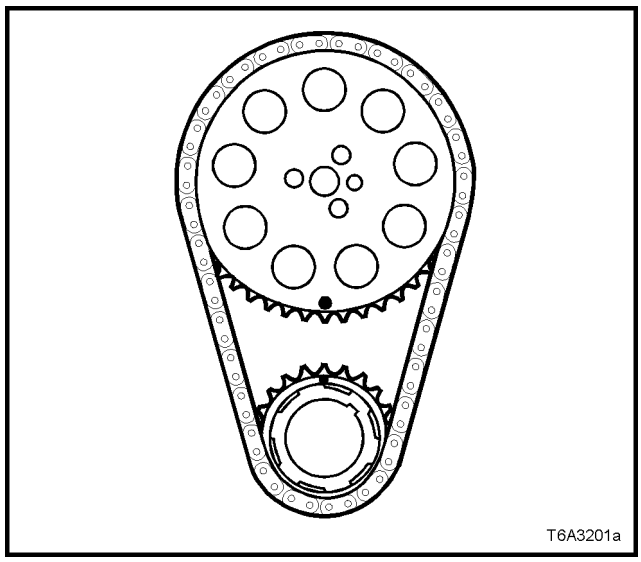


Figure 6A3-251

3. Inspect the camshaft and crankshaft sprockets for:
   a. Worn teeth (1).
   b. Damaged teeth (2).
   c. Chipped teeth (3).
   d. Worn valleys between the sprocket teeth.

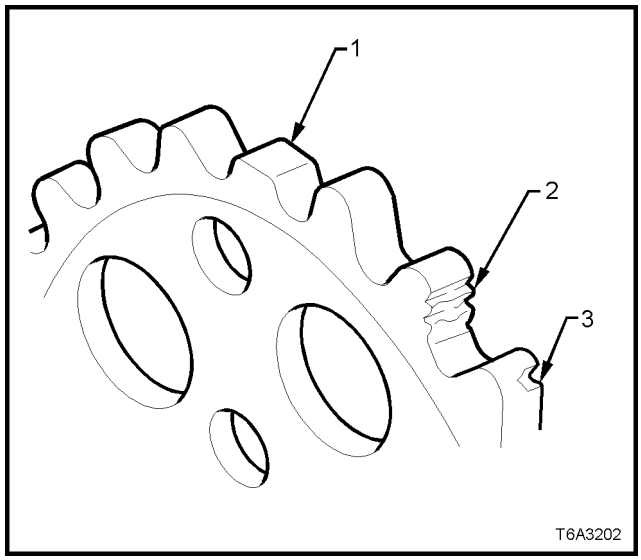


Figure 6A3-252

4. Inspect the crankshaft sprocket keyway (1) for wear.
5. Inspect the crankshaft sprocket oil pump drive splines (2) for wear.

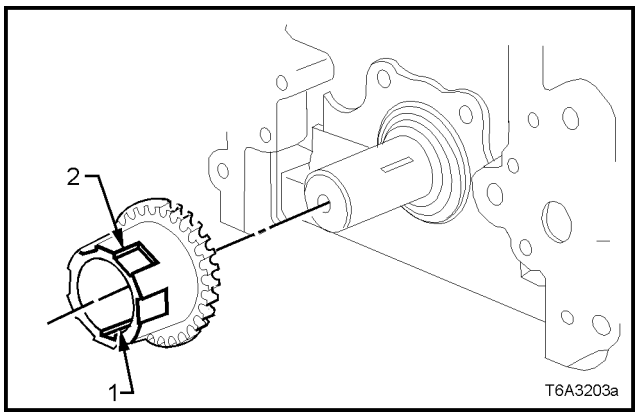


Figure 6A3-253

REINSTALL

1. If removed, install the crankshaft sprocket drive key into the crankshaft.

   The key should be tapped into place until each end bottoms on the crankshaft.

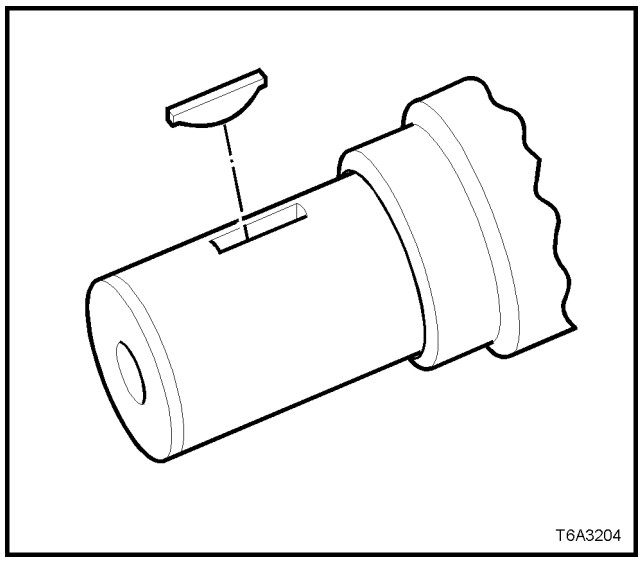


Figure 6A3-254

2. Install the crankshaft sprocket onto the crankshaft nose, aligning the keyway with the key.
3. Use installer J 41665 to install the crankshaft sprocket, as follows:

a. Install the threaded bolt, nut and flat washer from Tool J 41478) through the end plate and stepped sleeve of Tool J 41665.

b. Screw threaded bolt into the crankshaft, using set spanner (1).

c. While holding the threaded bolt with set spanner (1), turn the nut on the threaded bolt with a second set spanner (2), moving installer J 41665 to fully install the crankshaft sprocket onto the crankshaft nose.

d. When crankshaft sprocket has been fully installed, remove installation tools.

4. If required, temporarily install the harmonic balancer bolt and rotate the crankshaft until the timing alignment mark is at the 12 o'clock position. Refer Figure **6A3-263**.

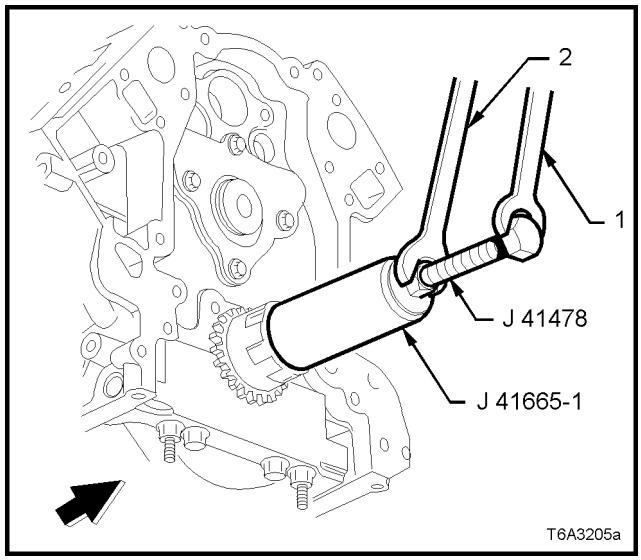


Figure 6A3-255

5. Install the camshaft sprocket (3), aligning the peg on the camshaft with the sprocket hole. Check that the timing mark is at the 6 o'clock position. Refer Figure **6A3-263**.
6. If required, temporarily install the camshaft sprocket bolts and use a suitable lever to rotate the camshaft sprocket until the timing mark is correctly aligned. Remove the bolts (1) and sprocket (3).
7. Install the timing chain (2) to the camshaft sprocket (3), align the camshaft peg with the camshaft sprocket hole by eye, then install the timing chain to the crankshaft sprocket.
8. Install the camshaft sprocket over the camshaft peg.

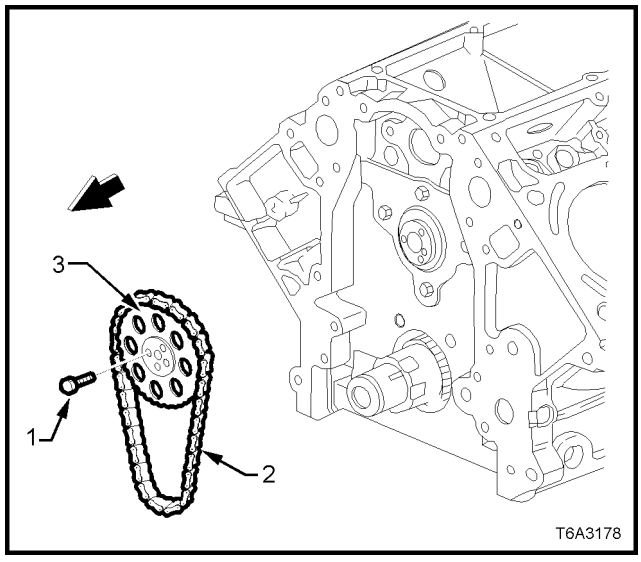


Figure 6A3-256

9. Before installing the camshaft sprocket bolts ('1' in Figure 6A3-262), check that the timing marks are aligned as shown. If not, repeat Steps 4 to 8 above.
10. Install the camshaft sprocket bolts and tighten to the correct torque specification.

CAMSHAFT SPROCKET BOLT TORQUE SPECIFICATION	35 Nm

11. Reinstall the oil pump, refer **3.9 OIL PUMP, PUMP SCREEN AND DEFLECTOR**, in this Section.
12. Reinstall oil pan, refer **3.3 OIL PAN – REMOVE**, in this Section.
13. Reinstall the front cover and harmonic balancer. Refer **3.4 ENGINE FRONT COVER – REINSTALL** and **2.24 HARMONIC BALANCER – REINSTALL**, in this Section.

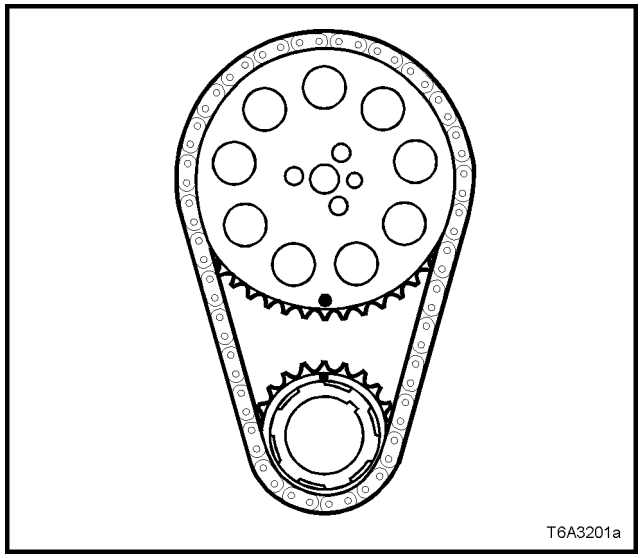


Figure 6A3-257

3.11 CAMSHAFT

LT Section No. – 00-175

REMOVE

IMPORTANT: Because of critical alignment procedures required for the reinstallation of the front cover and oil pan, it is strongly recommended that the engine assembly is removed from the vehicle, before this service operation is carried out.

1. Remove the intake manifold assembly, if this operation has not already been carried out. Refer **2.14 INTAKE MANIFOLD – REMOVE**, in this Section.
2. Remove the camshaft sensor bolt and sensor from the engine block.

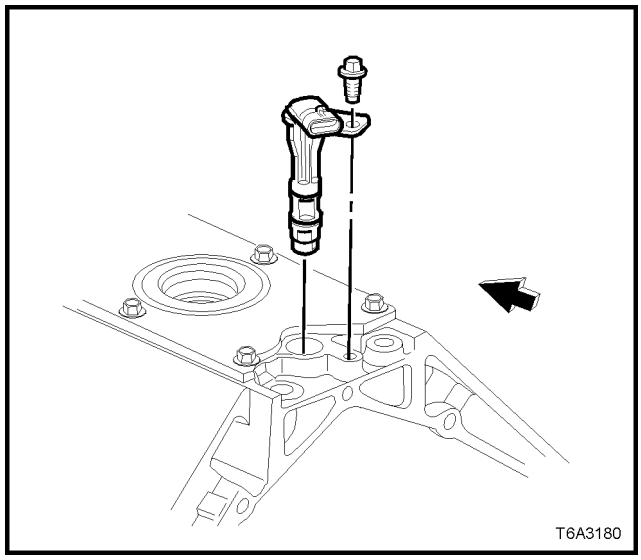


Figure 6A3-258

3. Remove oil pan, refer **3.3 OIL PAN - REMOVE**, in this Section.
4. If the harmonic balancer and front cover have not already been removed, refer to **2.24 HARMONIC BALANCER - REMOVE** and **3.4 ENGINE FRONT COVER - REMOVE**, in this Section.
5. Remove the oil pump, refer **3.9 OIL PUMP, PUMP SCREEN AND DEFLECTOR**, in this Section.
6. Remove the camshaft chain and sprocket. Refer **3.10 TIMING CHAIN AND SPROCKETS - REMOVE** in this Section.
7. Remove the camshaft retainer bolts then remove the retainer and gasket.

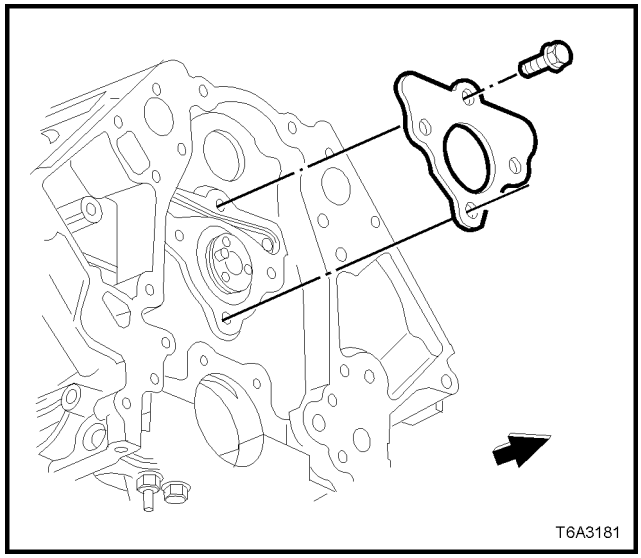


Figure 6A3-259

8. Install three, M8 x 1.25 x 100 mm bolts (e.g. removed coolant pump bolts) in the front of the camshaft and use as a handle to rotate and remove the camshaft from the engine block.

NOTE: As all camshaft bearing journals are the same size, care must be taken when removing the camshaft, to avoid damaging the bearings.

9. Remove the three bolts from the camshaft.

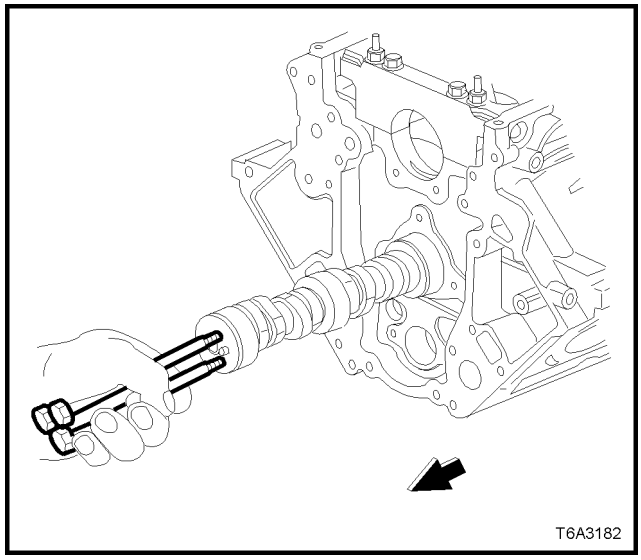


Figure 6A3-260

CLEAN AND INSPECT

1. Clean all components with a suitable solvent and blow dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

2. Inspect the camshaft for:
   a. Scoring or excessive wear to the bearing journals (1).
   b. Scoring or excessive wear to the camshaft lobes (2).
   c. Damaged threads (3) or debris in threaded holes.
   d. Damage to the camshaft sprocket pin (4).
   e. Nicks or damage to the camshaft position reluctor ring.

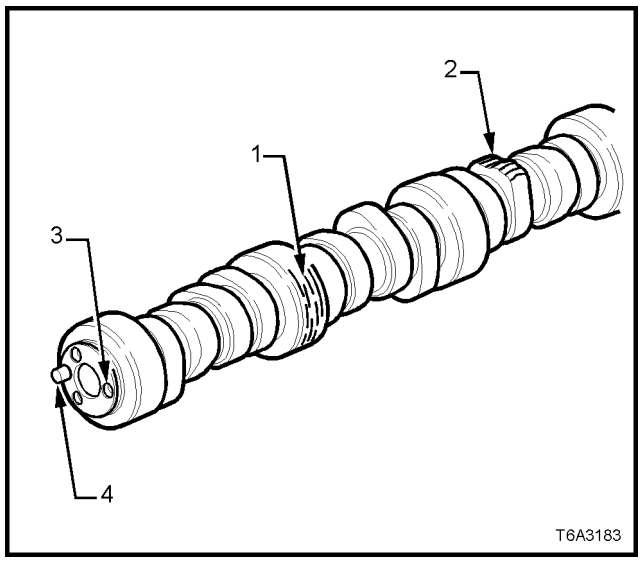


Figure 6A3-261

3. Measure the camshaft journals for wear and out-of-round, using a micrometer.

   Replace the camshaft if either of these measurements is outside specification.

Camshaft Journal Specifications	
Camshaft Journal Out-of-Round	0.025 mm Max.
Camshaft Bearing Journal Diameter	54.99 mm Min.

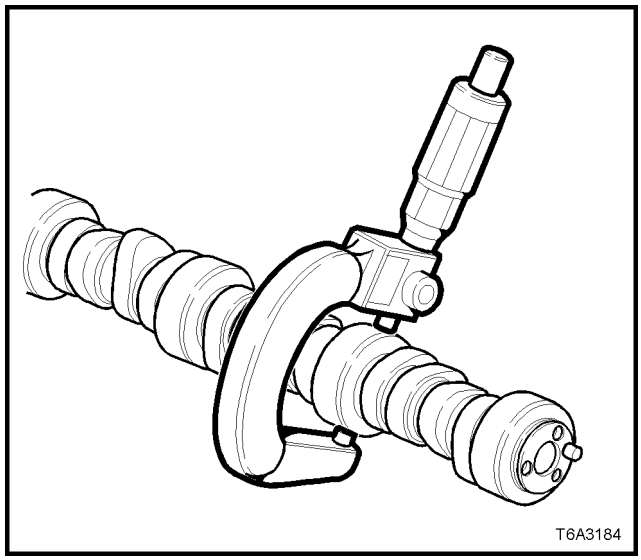


Figure 6A3-262

4. Measure camshaft lobes for wear, using a micrometer

   Replace the camshaft when the cam lobe dimension is to the minimum specification or less, for either the intake or exhaust lobes.

Camshaft Journal Specifications	
Intake Lobe Height	46.67 mm Min.
Exhaust Lobe Height	46.67 mm Min.

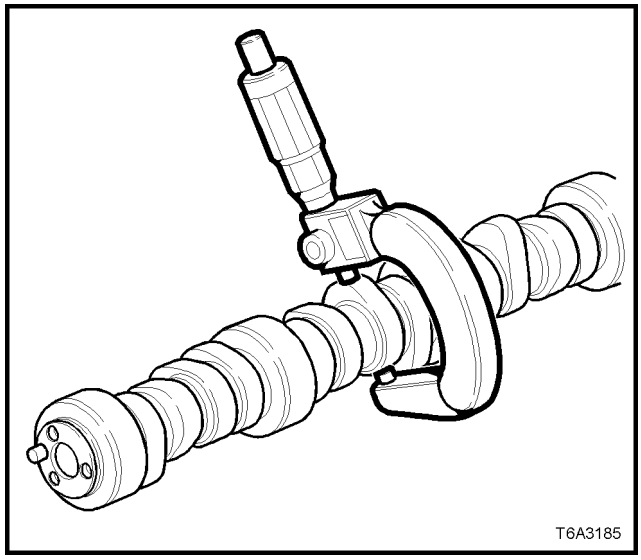


Figure 6A3-263

5. Mount the camshaft either in Vee blocks or between centres.
6. Using a suitable dial indicator mounted as shown, rotate the camshaft and check the runout on the centre bearing journal.

   Replace the camshaft if the runout exceeds the specification.

Idler Gear End Play Spec.

Camshaft Runout Specification	
Camshaft Runout	0.05 mm Maximum

7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

   If the gasket is not cut or damaged, it may be re-used.

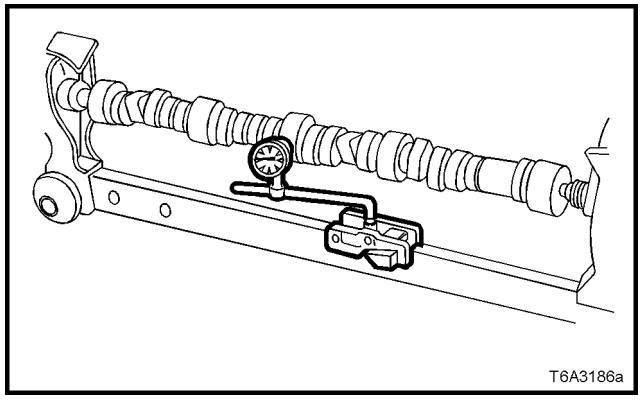


Figure 6A3-264

REINSTALL

NOTE: If camshaft replacement is required, the valve lifters must also be renewed.

1. Lubricate camshaft journals and the bearings with clean engine oil.
2. Install three M8 x 1.25 x 100 mm bolts into the camshaft front journal.
3. Using the bolts as a handle, carefully install the camshaft into the engine block.

NOTE: As all the camshaft bearing journals are the same size, care must be taken to avoid bearing damage during camshaft installation.

4. Remove the three bolts after camshaft installation.

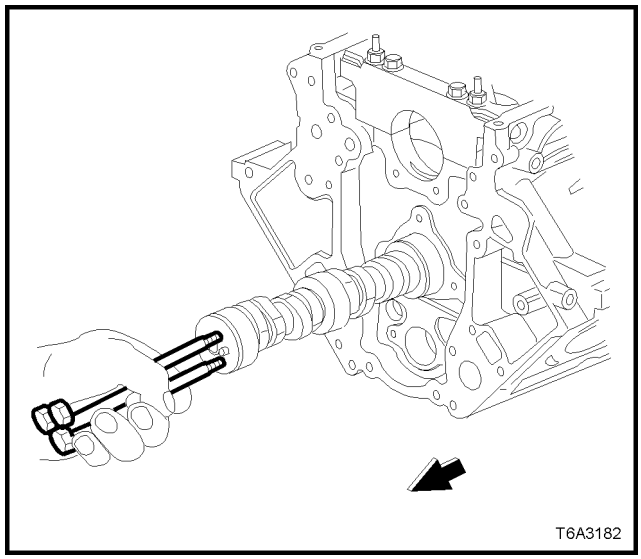


Figure 6A3-265

5. Ensure that the engine block surface is clean and free of debris, then install the camshaft retainer plate with the sealing gasket facing the engine block.
6. Install the camshaft retainer bolts and tighten to the correct torque specification.

CAMSHAFT RETAINER BOLT TORQUE SPECIFICATION	25 Nm

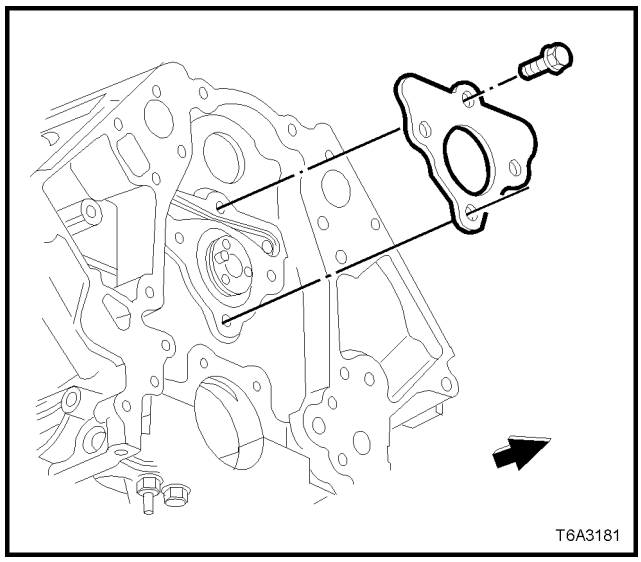


Figure 6A3-266

7. Inspect the camshaft position sensor O-ring, renewing if it is cut or damaged.
8. Lubricate the O-ring with clean engine oil, install to the sensor.
9. Install the camshaft position sensor and the retaining bolt and tighten to the correct torque specification.

CAMSHAFT POSITION SENSOR BOLT TORQUE SPECIFICATION	25 Nm

10. Reinstall the camshaft chain and sprocket. Refer **3.10 TIMING CHAIN AND SPROCKETS**, in this Section.
11. Reinstall the oil pump, refer **3.9 OIL PUMP, PUMP SCREEN AND DEFLECTOR**, in this Section.
12. Reinstall the front cover and harmonic balancer. Refer **2.24 HARMONIC BALANCER** and **3.4 ENGINE FRONT COVER**, in this Section.
13. Remove oil pan, refer **3.3 OIL PAN – REMOVE**, in this Section.
14. If required, reinstall the intake manifold assembly. Refer **2.14 INTAKE MANIFOLD**, in this Section.

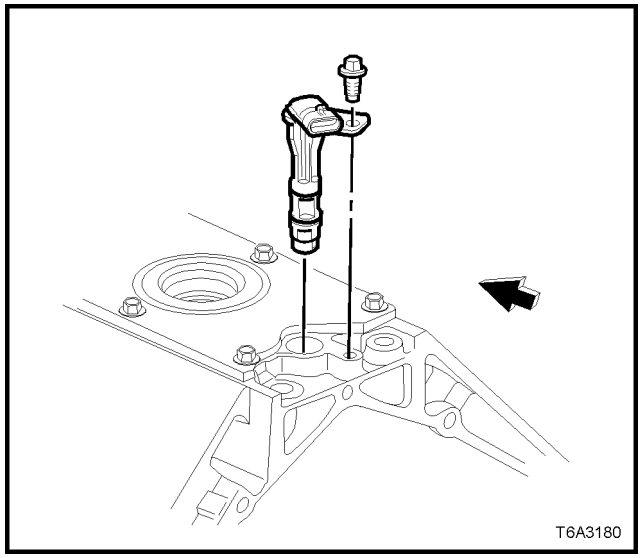


Figure 6A3-267

3.12 PISTON, CONNECTING ROD AND BEARING

LT Section No. – 00-550

NOTE: The following fasteners MUST be replaced (■) when performing this operation:

■ Connecting rod bolts and nuts.

REMOVE

IMPORTANT: Because of critical alignment procedures required for the reinstallation of the oil pan, it is strongly recommended that the engine assembly is removed from the vehicle, before this service operation is carried out.

1. Remove both cylinder heads. Refer **2.22 CYLINDER HEAD – REMOVE**, in this Section.
2. Remove oil pan, pump screen and deflector, refer **3.3 OIL PAN – REMOVE** and **3.9 OIL PUMP, PUMP SCREEN AND COVER – REMOVE**, in this Section.
3. If required, use a commercially available cylinder ridge remover, to remove any cylinder ridge present, adopting the following procedure:

a. Rotate the crankshaft until the piston is at the bottom of its stroke (BDC).

b. Place a cloth on top of the piston.

c. Use the cylinder ridge remover to remove the cylinder ridge.

d. Again rotate the crankshaft until the piston is at the top of its stroke (TDC).

e. Remove the cloth and any metal shavings from the piston crown.

4. Using a paint stick or etching tool, matchmark each connecting rod and its cap. The connecting rod caps MUST be assembled to the original position and direction.

   DO NOT apply a stamping mark on the side of the connecting rod and/or cap as this may affect alignment and the geometry of the assembly.

5. Mark the top of each piston to identify its specific bore.
6. Remove the connecting rods bolts, loosening progressively from side to side.

IMPORTANT: Ensure that the connecting rod bearings are organised so they will be installed in the original position and location.

7. Remove each connecting rod cap.

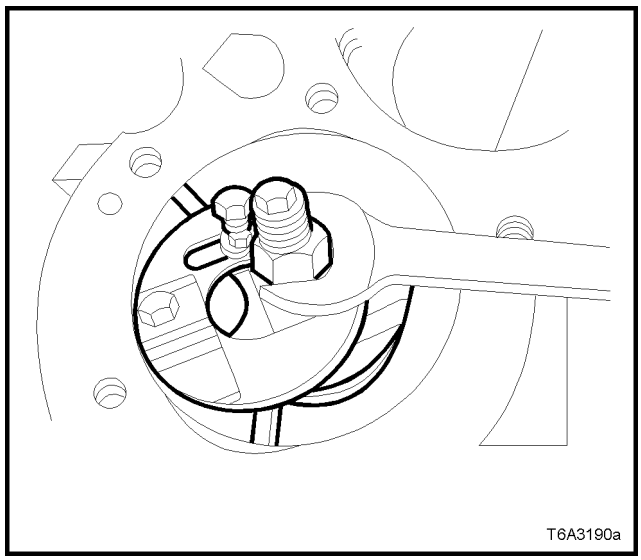


Figure 6A3-268

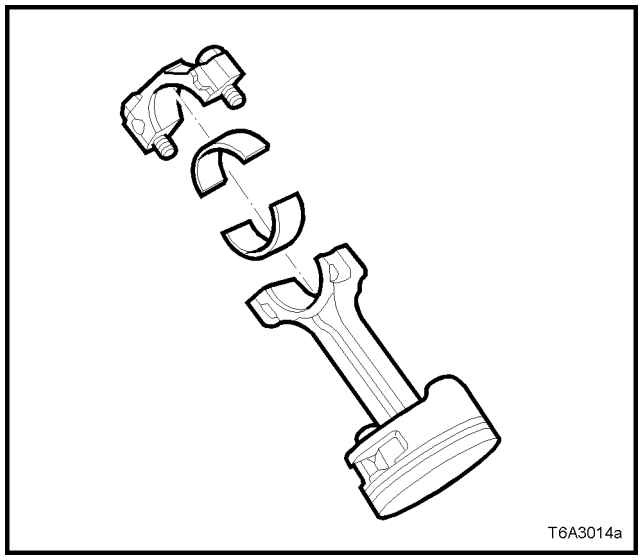


Figure 6A3-269

8. Install guide pins Tool J 41556 to the connecting rod to be removed.

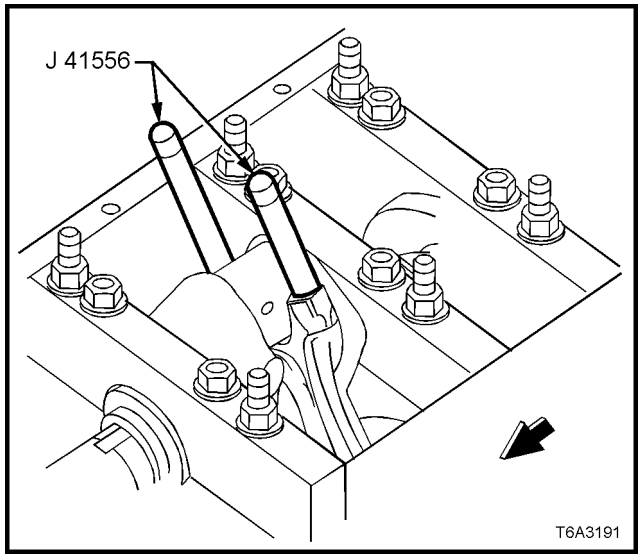


Figure 6A3-270

9. Use a hammer handle to tap lightly on the end of the guide pin Tool J 41556 and remove the piston and connecting rod from the cylinder bore.
10. Once removed, assemble the connecting rod cap, bearing shells and bolts to the matching connecting rod.

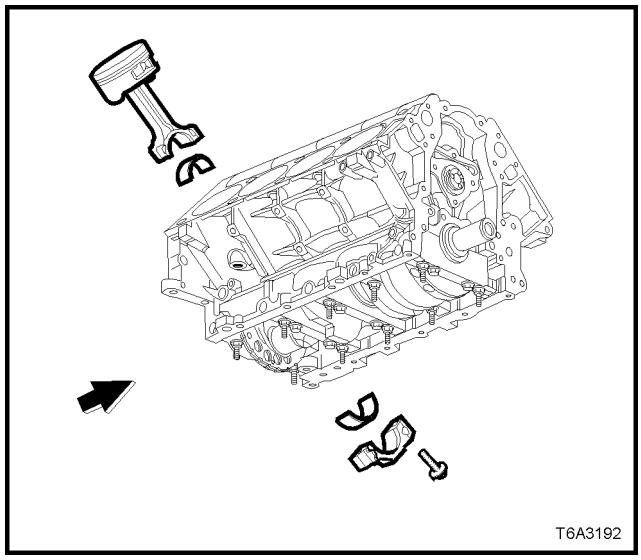


Figure 6A3-271

DISASSEMBLE

1. Remove the piston rings from the piston.

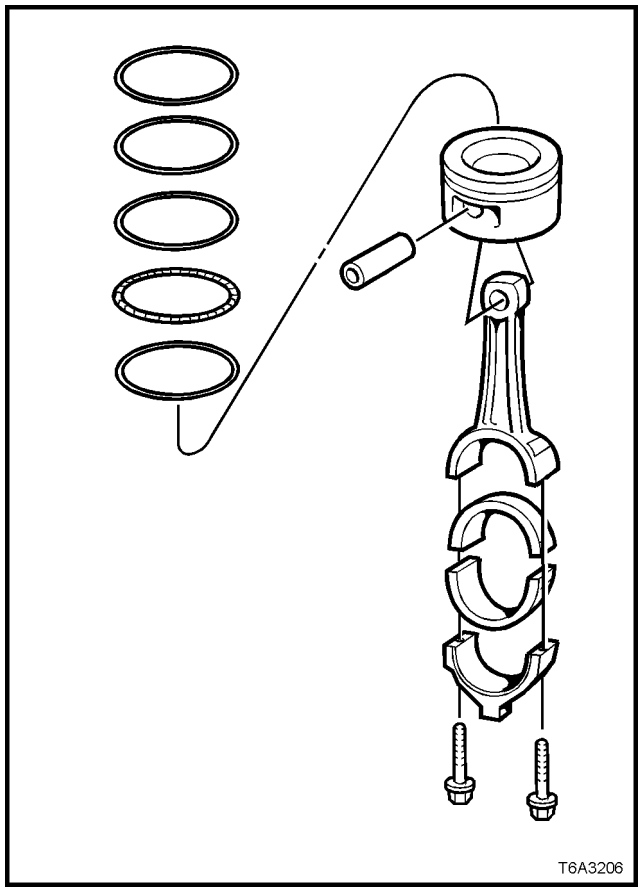


Figure 6A3-272

2. Insert fork insert J 24086-905 onto the bridge of Tool J 24086-C. Mount the piston assembly so that the fork insert is between the connecting rod and the piston. Install pin remover J 24086-8A.
3. Place the assembly under an hydraulic press and remove the piston pin from the piston and connecting rod assembly.

NOTE: The piston and pin are a matched set and are not serviced separately. Mark the pin to piston to ensure correct reassembly if original parts are to be re-used.

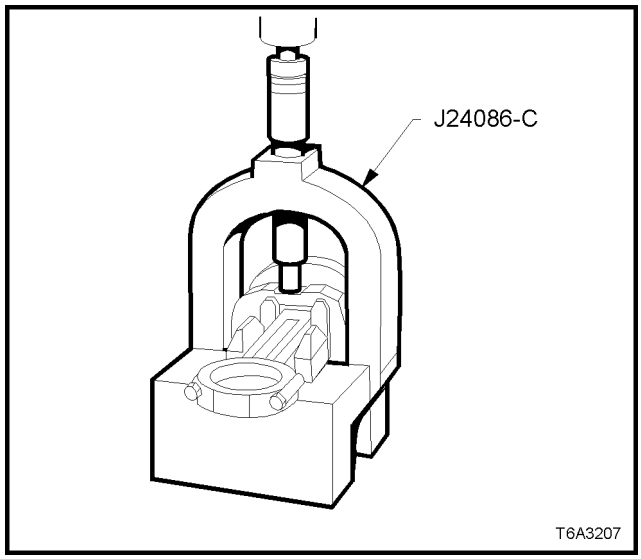


Figure 6A3-273

CLEAN AND INSPECT

Piston and Pin

1. Clean any varnish from the piston and pin, with a suitable cleaning solvent. DO NOT use a wire brush for this process.
2. Dry the cleaned parts with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

3. Clean the piston ring grooves with a commercially available tool.
4. Clean the oil lubrication holes and slots in the ring grooves.

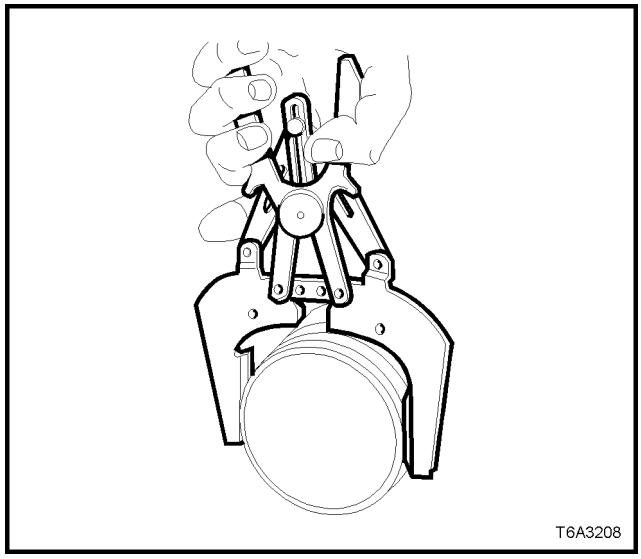


Figure 6A3-274

5. Inspect each piston and pin for the following:
   a. Cracks in the piston lands, skirt or the pin bosses.
   b. Piston ring grooves for nicks, burrs or warpage which may cause the piston ring to bind. MINOR imperfections may be removed by using a fine file.
   c. Eroded areas on top of the piston (1).
   d. Scuffed or damaged skirts (2).
   e. Scoring to the piston pin bore (3) or the piston pin.

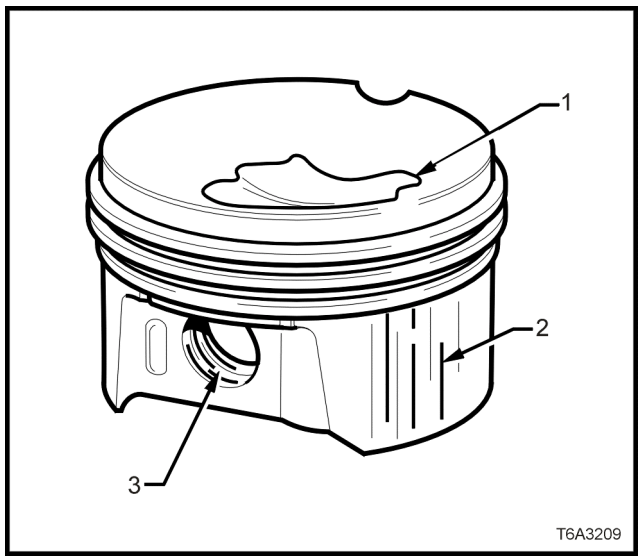


Figure 6A3-275

6. Measure the piston ring to piston groove side clearance, as follows:
   a. Insert the edge of a NEW piston ring into the correct piston ring groove.
   b. Roll the piston ring around the groove.

NOTE 1: If binding is caused by a distorted piston ring groove, MINOR ring groove imperfections may be removed with a fine file.

NOTE 2: If binding is caused by a distorted piston ring, replace the ring.

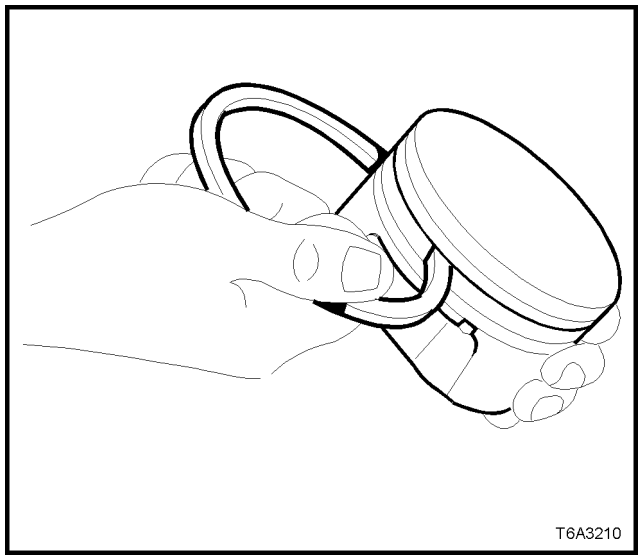


Figure 6A3-276

NOTE: For each of the following measurements, ensure that the micrometer zeroing has been

carried out and the measurements are all taken with components at room temperature.

7. Again using a new piston ring in the correct location, check the side clearance using a feeler gauge. If side clearance exceeds specification, try another piston ring set before condemning the piston.

Piston Ring Side Clearance Specification	
Top compression ring	0.040 - 0.085 mm
Second compression ring	0.040 - 0.080 mm
Oil control ring	0.010 - 0.220 mm

8. If the piston ring side clearance exceeds specification, the piston and pin assembly must be replaced.

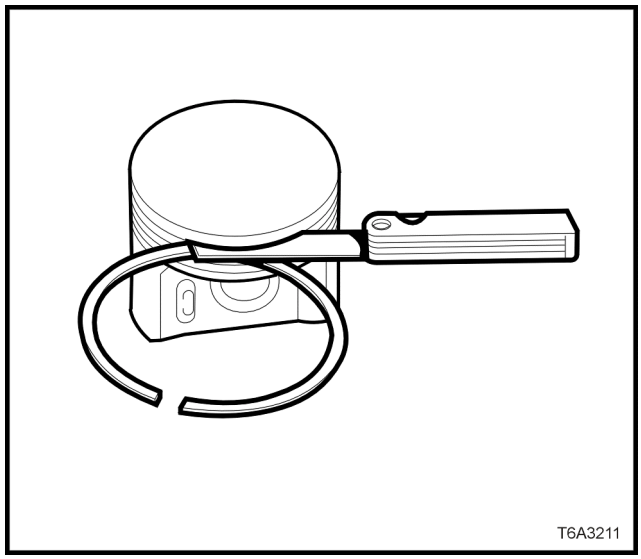


Figure 6A3-277

9. To measure the pin-to-bore clearance, first measure the pin with a micrometer.

Piston Pin Specification	
Piston Pin Diameter	23.997 - 24.000 mm

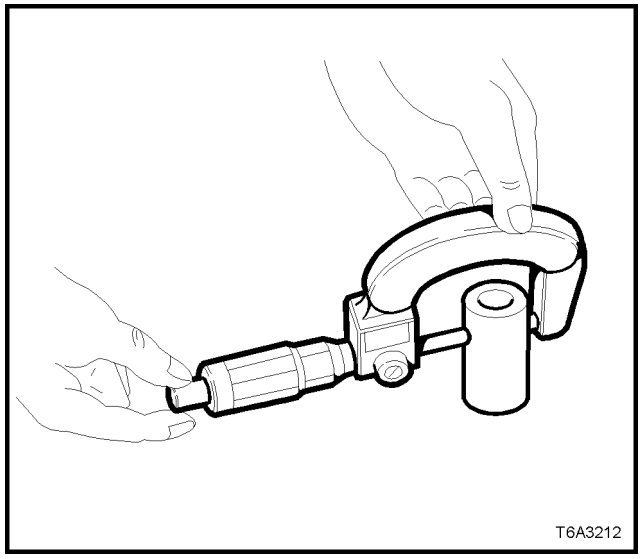


Figure 6A3-278

10. Using a suitable inside micrometer, measure the matching piston pin bore on each side.
11. Subtract the piston pin dimension from the piston pin bore size to obtain the clearance.
12. If the clearance exceeds specification, the piston and pin assembly must be replaced.

Piston Pin to Bore Clearance Specification	
Piston pin clearance (Maximum)	0.010 - 0.020 mm

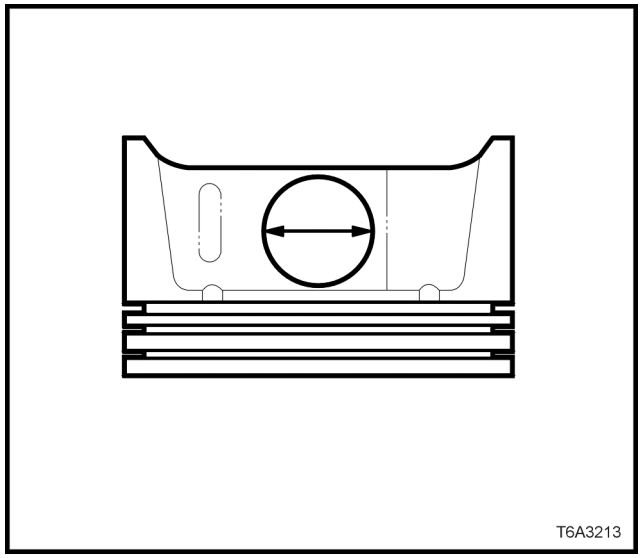


Figure 6A3-279

13. Measure the piston for out-of-round, as follows:
    a. With a suitable sized micrometer at right angles to the piston pin bore, measure the piston skirt dimension, 11 mm above the bottom of the skirt.
    b. Measure the piston at two different points and compare the readings
    c. If the difference exceeds specification, then replace the piston and pin assembly.

Piston Skirt Out-of Round Specification	
Piston skirt dimension variation	0.018 mm Maximum

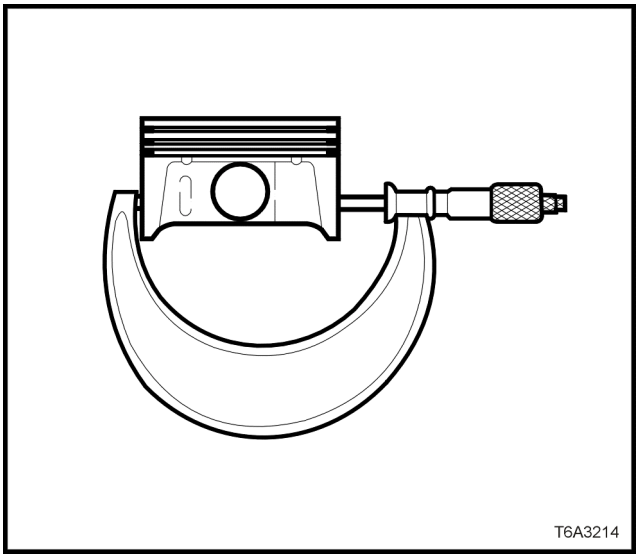


Figure 6A3-280

Connecting Rods and Bearings

NOTE: The powdered metal connecting rod and cap are machined for the correct clearances. The connecting rod and the cap must be used as an assembly, with no repairs or modifications carried out to either mating surface.

1. Clean each connecting rod and matching cap in a suitable solvent.
2. Clean the connecting rod bolt threads and inspect for damage. Do not attempt to repair damaged threads in this location. Replace the connecting rod, cap and bolts as an assembly if thread damage is found.
3. Blow parts dry using compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

4. Inspect the connecting rod for the following defects:

a. Twisting, using commercially available alignment equipment.
b. Bending. Check length with suitable measuring equipment.
c. Nicks or gouging in the bearing bore.
d. Damage to the bearing locating slots in the bearing bore.
e. Correct fit of the connecting rod and cap mating surfaces.

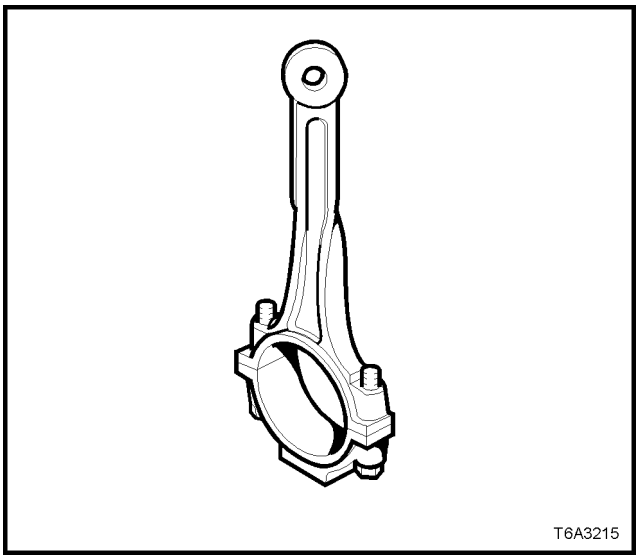


Figure 6A3-281

Connecting Rod Specification	
Centre to Centre Length	154.90 ± 0.02 mm
Width	24.00 ± 0.05 mm
Twist	0.010 mm Maximum
Bend	0.02 mm Maximum

5. Reinstall the connecting rod big end cap and bolts. Tighten bolts to the correct torque specification.

CONNECTING ROD CAP BOLT TORQUE SPECIFICATION	Stage 1:	20 Nm
	Stage 2:	60° turn angle

6. Measure the connecting rod big end bore, using a suitable inside micrometer, checking for ovality. Replace any connecting rod assembly that exceeds specification.

Connecting Rod Big End Ovality Specification	
Connecting rod big end ovality	0.008 mm Maximum

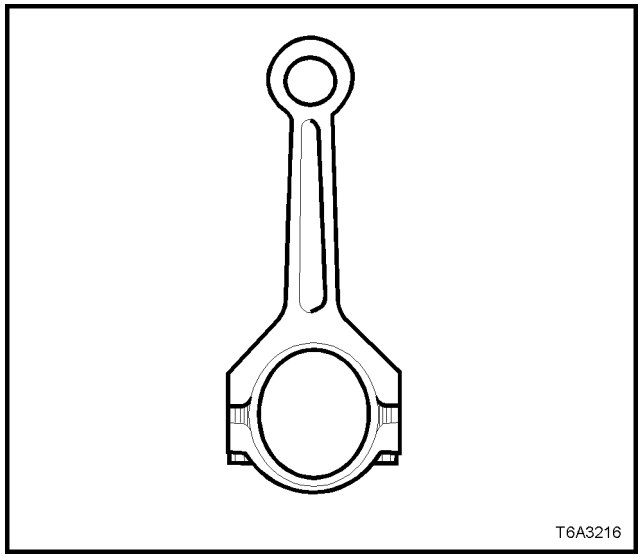


Figure 6A3-282

7. Inspect connecting rod bearing halves for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

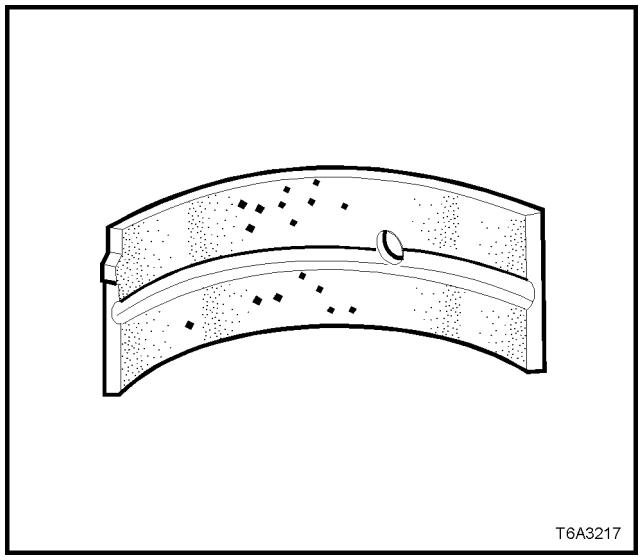


Figure 6A3-283

8. Inspect connecting rod bearing halves for excessive scoring or discolouration.
9. Inspect the connecting rod bearings for dirt or debris embedded into the bearing material or backing metal.

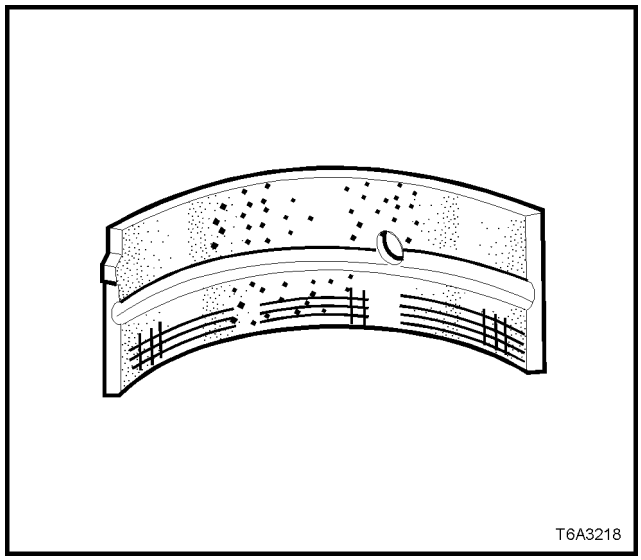


Figure 6A3-284

10. Inspect connecting rod bearing halves for improper seating, indicated by bright, polished section/s on the bearing material.

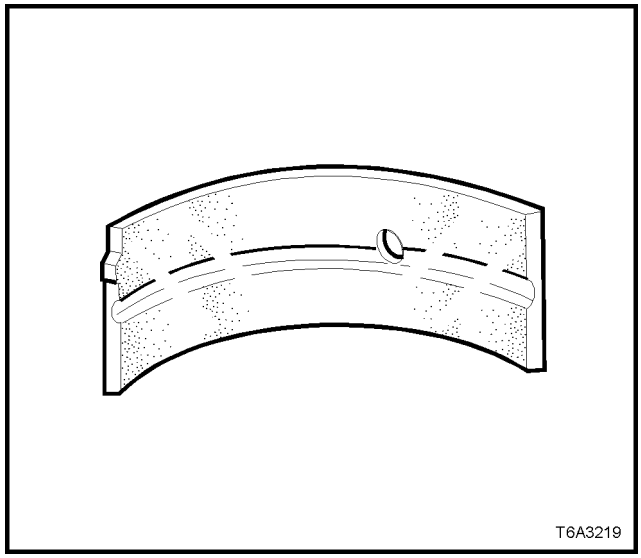


Figure 6A3-285

Measuring Piston Ring End Gap

1. Insert a new piston ring into the bore that it is to be fitted and push it down the bore, using the piston, inverted in the bore, until the ring is approximately 6.5 mm below the piston ring travel area.
2. Insert a feeler gauge and measure the piston ring end gap. End gap specifications are as follows:

Piston Ring End Gap Specifications	
Top compression ring	0.230 - 0.380 mm
Second compression ring	0.440 - 0.640 mm
Oil control ring	0.180 - 0.690 mm

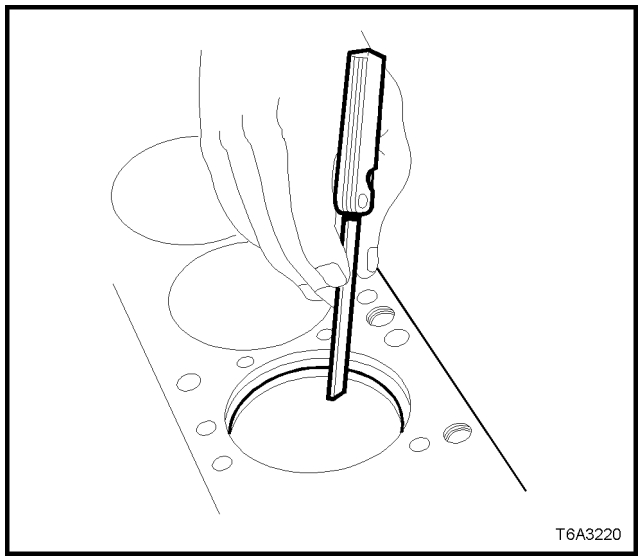


Figure 6A3-286

REASSEMBLE

Piston Selection

NOTE 1: All measurements should be taken at normal room temperature.

NOTE 2: A used piston and pin set may be reinstalled if, after cleaning and inspection, they are both within specification.

1. With a micrometer at right angles to the piston pin bore, measure the piston skirt at 11 mm from the lower edge.
2. Record the piston diameter.

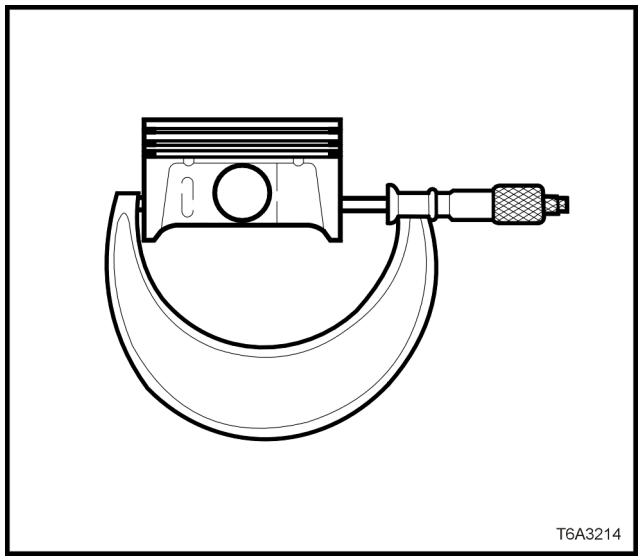


Figure 6A3-287

3. Check that the micrometer is at the recorded piston diameter.
4. With Tool J 8087 (or commercial equivalent), held between the micrometer anvils as shown, zero the dial indicator.

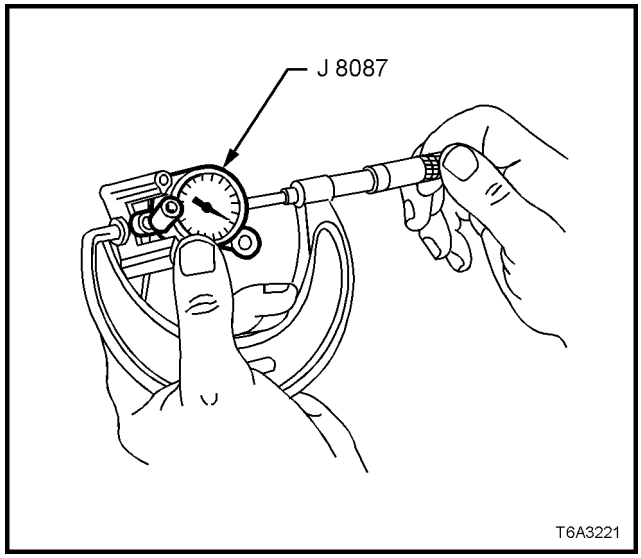


Figure 6A3-288

5. Use bore gauge J 8087 (or commercial equivalent), measure the cylinder bore diameter, at a point 57 mm from the top of the bore.
6. Record the cylinder bore diameter.
7. Subtract the piston diameter from the cylinder bore measurement, in order to determine the piston to bore clearance.

Piston to Bore Clearance Specification	
Clearance range	0.018 - 0.054 mm

8. If the clearance is outside this specification, select another piston and measure it and re-calculate the clearance. If the correct clearance cannot be obtained using this method, then the cylinder bore may require honing for an oversize piston fitment, or the cylinder block will need to be replaced.
9. When the correct piston to bore clearance is obtained, mark the piston crown for correct installation.

NOTE: The cylinder bore must be checked for ovality and taper before this operation is attempted. Refer **3.15 CYLINDER BLOCK - CYLINDER BLOCK CLEAN, INSPECT AND MEASURE**, in this Section.

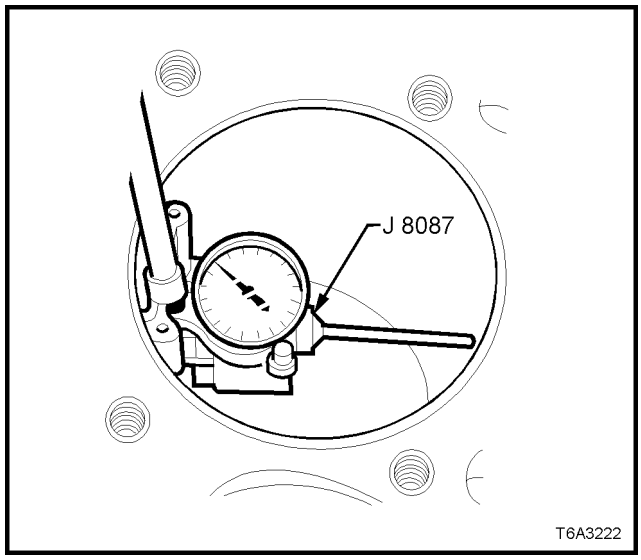


Figure 6A3-289

Piston to Connecting Rod

NOTE: Take particular care when assembling the piston to the connecting rod, that component matching and orientation is correct.

1. The connecting rod alignment should be with the flat portion of the bolt flange (1) facing forward. Also note that the piston alignment mark has the correct orientation.
2. Lubricate the piston pin bore and piston pin with clean engine oil.

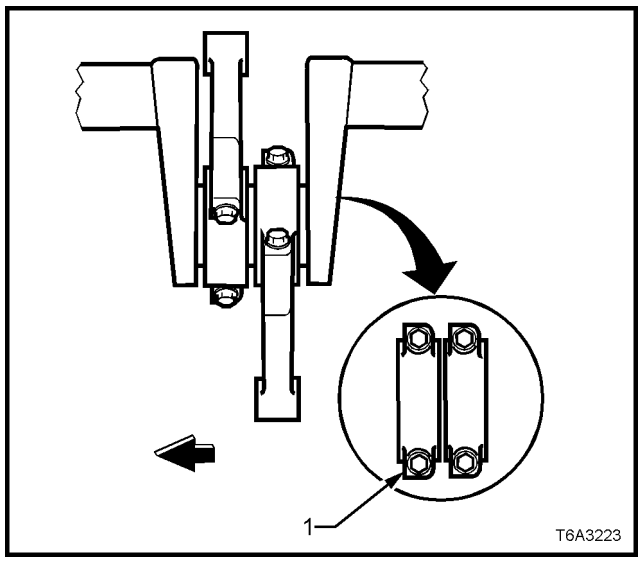


Figure 6A3-290

3. With the connecting rod inserted with the correct orientation into the piston, insert the Black piston pin guide, J 24086-1A from Tool J 24086-C, into the lower piston pin boss to pre-align the piston and connecting rod pin holes.
4. Insert fork insert J 24086-905 between the piston and connecting rod, around the piston pin guide J 24086-1A, then mount the assembly into the fork bridge of Tool J 24086-C.

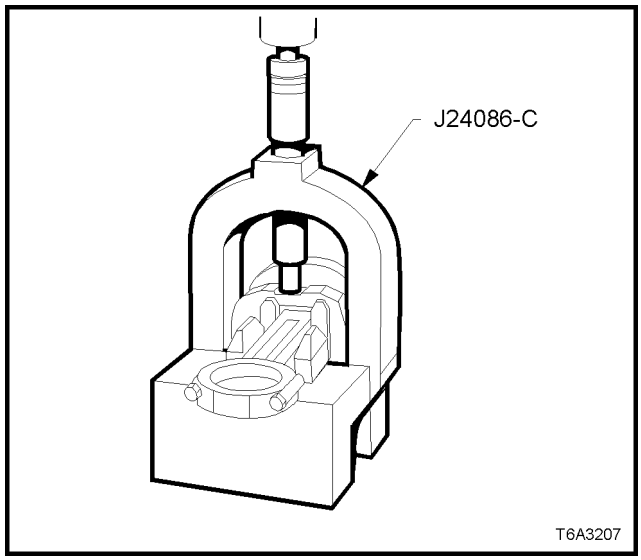


Figure 6A3-291

5. Adjust installer, J 24086-9, to a setting of “I-9”, as shown. Lock this position with the knurled ring.

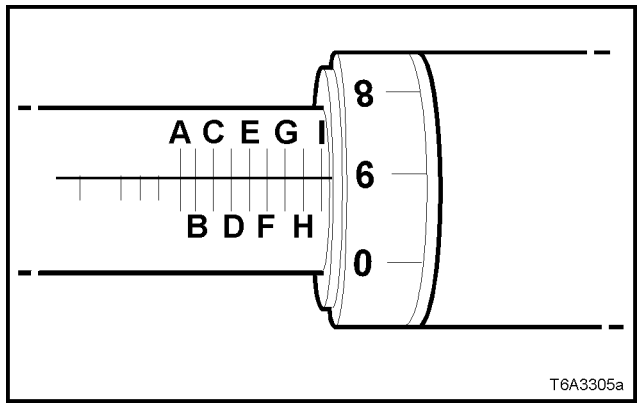


Figure 6A3-292

6. Insert the adjusted installer to Tool J 24086-C and press the piston pin into the connecting rod, until the installer bottoms out.
7. Check that the piston pin has been installed correctly.

   The piston pin will be installed correctly, if the piston pin is centred in the piston and the connecting rod is also centred between the piston pin bosses, i.e. the connecting rod should have equal spacing on each side of the piston pin boss.

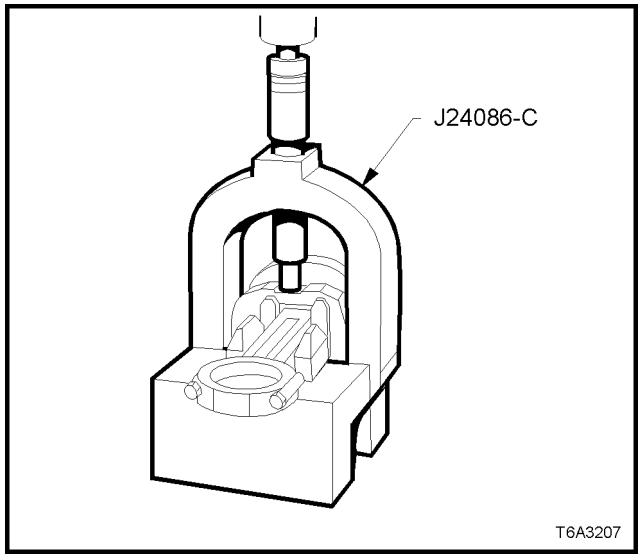


Figure 6A3-293

PISTON RINGS

NOTE: Use commercially available piston rings pliers and only expand the piston ring sufficiently to slide over the piston. Excessive expansion will permanently distort the piston ring.

1. Install the piston rings to each piston, in the following manner:
   a. Install the oil control spacer to the lower ring groove. Ensure that the ends do not overlap.
   b. Install the lower oil control ring segment. There are no identifying marks, indicating orientation, as this ring may be installed in either direction.
   c. Install the upper oil control ring segment in a similar manner.
   d. Stagger the ends of the three oil control ring components by at least 90°.
   e. Using commercially available piston ring pliers, install the second compression ring, noting that the dimple or orientation mark must face upwards to the piston crown.
   f. Using commercially available piston ring pliers, install the top compression ring. This ring has no orientation marks and may be installed in either direction.
   g. Stagger the compression ring gaps a minimum of 25 mm.

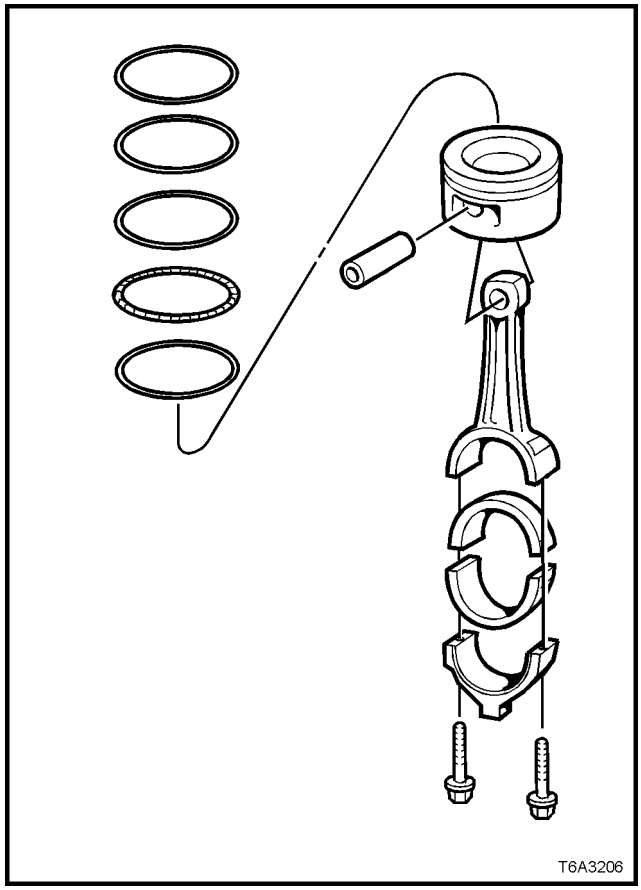


Figure 6A3-294

REINSTALL

NOTE 1: Before installation, check that the piston ring end gaps are staggered correctly and that the piston has been assembled to the connecting rod in the correct manner.

NOTE 2: Before honing the cylinders, refer to **3.15 CYLINDER BLOCK, BORING AND HONING**, in this Section for important information, relating to this task.

1. Lightly lubricate the piston, cylinder bore, piston rings and bearing surfaces with clean engine oil.
2. Remove the connecting rod cap and bearing shell from the connecting rod being installed and install the connecting rod guide pins, Tool J 41556.
3. Install a commercially available piston ring compressor over the piston rings and compress.
4. Install the piston and connecting rod assembly into the correct cylinder bore, checking that the piston alignment mark is facing the front of the engine.
5. While holding the piston ring compressor squarely and firmly against the engine block, gently tap the piston into the bore, using a wooden hammer handle, until all piston rings have entered the bore.
6. Complete installation by using the pins, Tool J 41556 to guide the connecting rod onto the crankshaft journal.

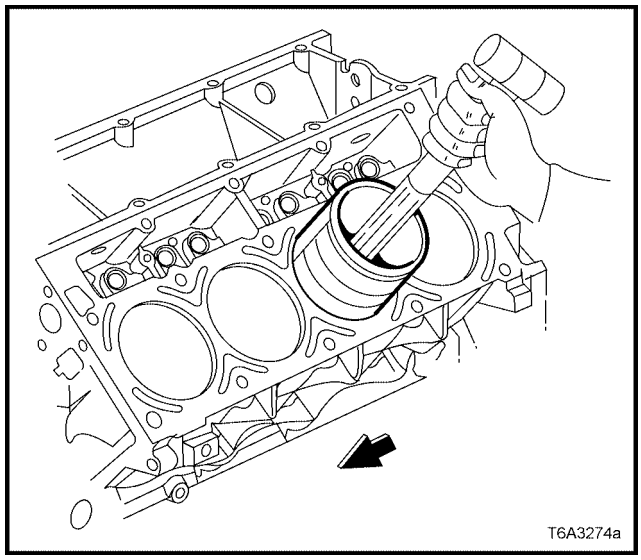


Figure 6A3-295

7. Remove connecting rod guides, Tool J 41556 and check that the upper bearing shell is correctly installed in the connecting rod. Apply clean engine oil to the upper bearing shell.
8. Install lower connecting rod bearing into the cap, lubricate with clean engine oil and install, ensuring that the cap orientation is correct. Refer Figure 6A3-296.

IMPORTANT: The bearing oil clearance must be checked before final installation of the connecting rod caps. Refer to **3.13 CRANKSHAFT AND BEARINGS**, Main Bearing Oil Clearance - Check, in this Section.

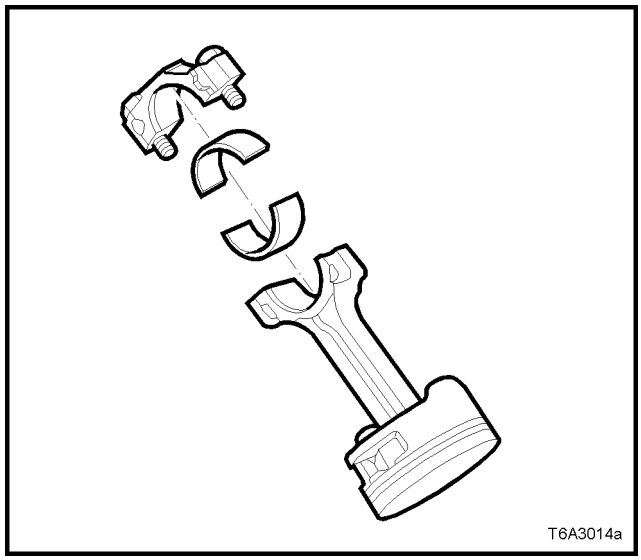


Figure 6A3-296

9. Install NEW connecting rod cap bolts and tighten in two stages, to the correct torque specification.

NOTE: Since inception, there have a been a number of changes to the connecting rod bolts. Regardless of when the engine was built, the critical aspect relating to connecting rod bolts is that a ‘matched pair’ must be used on each connecting rod.

The most visible identification of a ‘matched pair’ can be determined by the presence of 'dimples' on the bolt head, witnessed by one, two or three, as shown.

IMPORTANT: As bolt design 'A' has a different torque specification than bolts 'B' and 'C', replacement connecting rod bolts, MUST be of the same design for each connecting rod. Using different design bolts on the one connecting rod will apply uneven clamp loads and/or connecting rod bore distortion.

DESIGN ‘A’ CONNECTING ROD CAP BOLT TORQUE SPECIFICATION	Stage 1: Stage 2:	20 Nm 60° turn angle
DESIGNS ‘B’ and ‘C’ CONNECTING ROD CAP BOLT TORQUE SPECIFICATION	Stage 1: Stage 2:	20 Nm 75° turn angle

NOTE: Use torque angle meter Tool E7115 to achieve the second reading.

10. With a pair of connecting rods installed onto the same crankshaft journal, use a plastic faced hammer to lightly tap each connecting rod sideways to settle and ensure that side clearance exists.
11. Using feeler gauges check that the connecting rod side clearance is to specification.

Connecting Rod Side Clearance Specification	
Side Clearance	0.11 - 0.51 mm

NOTE: If side clearance is insufficient, re-check bearing oil clearance and/or connecting rod alignment.

12. Reinstall oil deflector, oil pump screen and oil pan, refer **3.9 OIL PUMP, PUMP SCREEN AND COVER - REINSTALL** and **3.3 OIL PAN - REINSTALL**, in this Section.
13. Reinstall both cylinder heads. Refer **2.22 CYLINDER HEAD - REINSTALL**, in this Section.

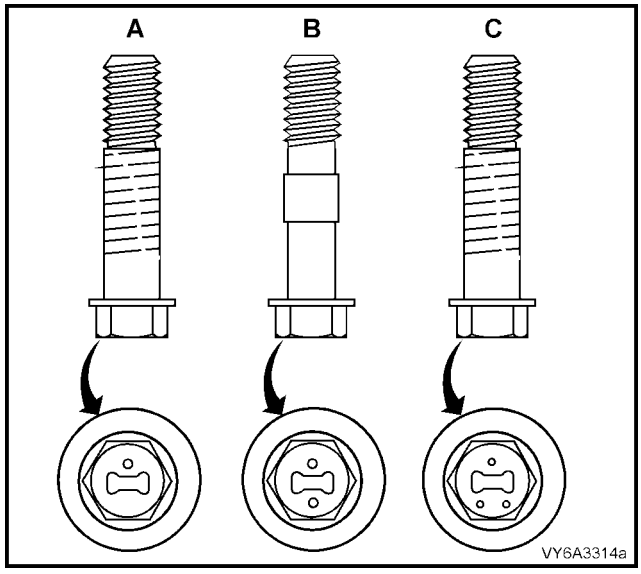


Figure 6A3-297

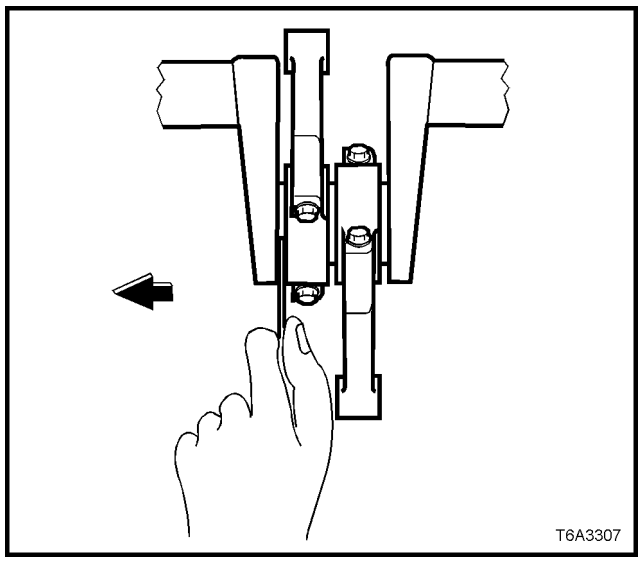


Figure 6A3-298

3.13 CRANKSHAFT AND BEARINGS

LT Section No. – 00-200

REMOVE

1. Remove engine from vehicle, refer **3.1 ENGINE ASSEMBLY - REMOVE**, in this Section.
2. Remove the following items from the engine assembly;
   a. Starter motor, refer **Section 6D3-2 STARTING SYSTEM - GEN III V8 ENGINE**.
   b. Oil pan, refer **3.3 OIL PAN**, in this Section.
   c. Crankshaft balancer, refer **2.24 CRANKSHAFT BALANCER**, in this Section.
   d. Front cover, refer **3.4 FRONT COVER**, in this Section.
   e. Oil pump, screen and deflector, refer **3.9 OIL PUMP, PUMP SCREEN AND DEFLECTOR**, in this Section.
   f. Timing chain, refer **3.10 TIMING CHAIN AND SPROCKETS**, in this Section.
   g. Flywheel/Flex plate, refer **3.5 FLYWHEEL/ FLEXPLATE**, in this Section.
   h. Rear cover, refer **3.8 ENGINE REAR COVER**, in this Section.
3. Remove the crankshaft position sensor retaining bolt, then remove the sensor from the cylinder block.

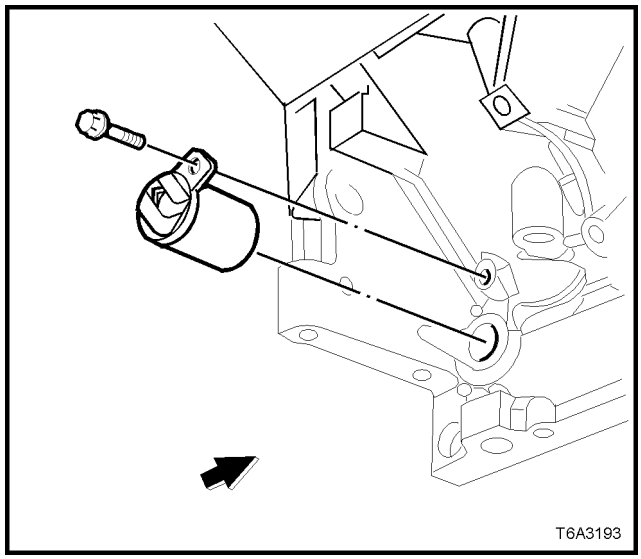


Figure 6A3-299

4. Remove the crankshaft main bearing cap M8 side bolts (1). While these bolts must be renewed on final assembly, place the removed bolts to one side, as they will be required when checking the main bearing oil clearance.
5. Remove the main bearing cap M10 bolts and studs, loosening each pair gradually. Take note of the stud positions for reassembly.

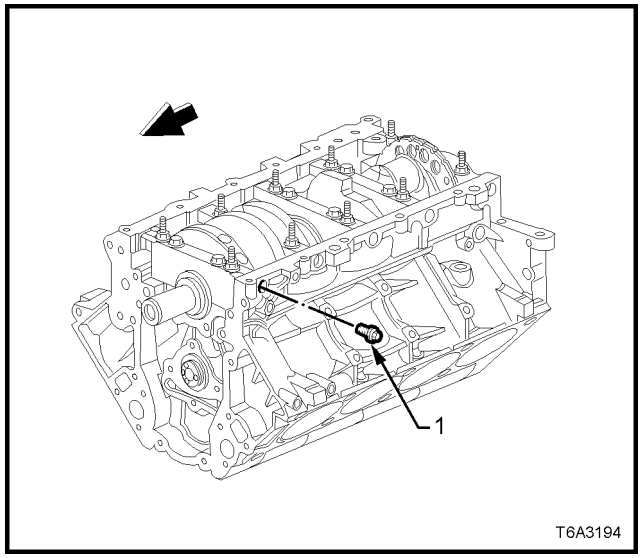


Figure 6A3-300

6. Loosen the bolts of main bearing removal Tool J 41818 to separate the chamfered collets. Then install the chamfered sections into each main bearing cap bolt hole, aligning the flats of the collets with those in the holes.
7. Tighten the bolts of Tool J 41818 to 11 Nm.
8. Install slide hammer, Tool J 6125-1B to J 41818 and remove main bearing cap.

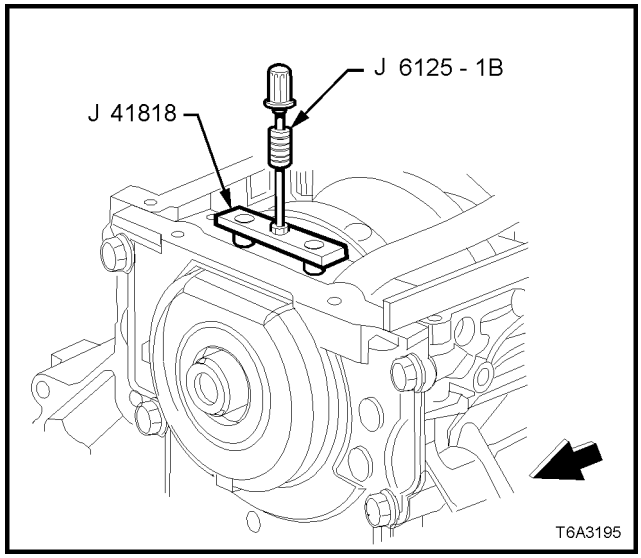


Figure 6A3-301

9. Remove the remaining main bearing caps in the same way. Check that the lower main bearing shells are also removed with each cap.

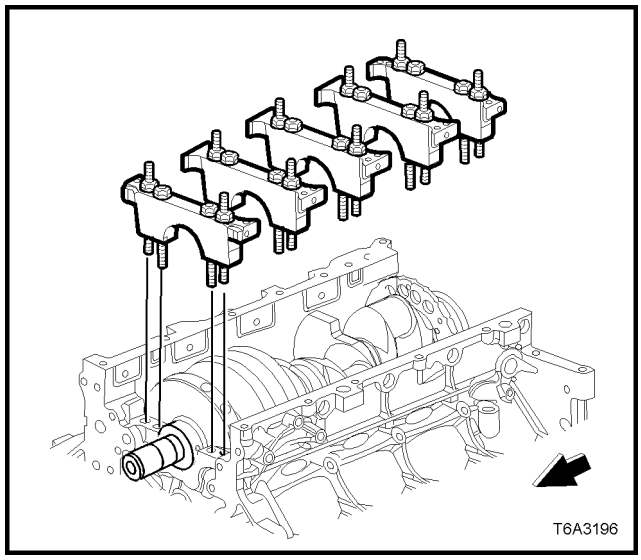


Figure 6A3-302

10. Remove the crankshaft from the cylinder block, lifting evenly to avoid jamming against the main thrust bearing.

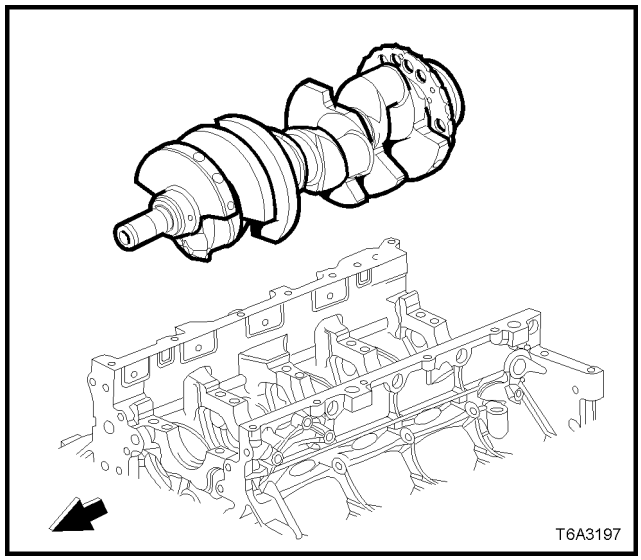


Figure 6A3-303

IMPORTANT: When the crankshaft (1) has been removed, take particular care that the reluctor ring (2) is not damaged, as this part is an integral part of the crankshaft and is not serviced separately. Therefore, it is suggested that the removed crankshaft be supported on two wooden 'V' blocks or other suitable soft surface.

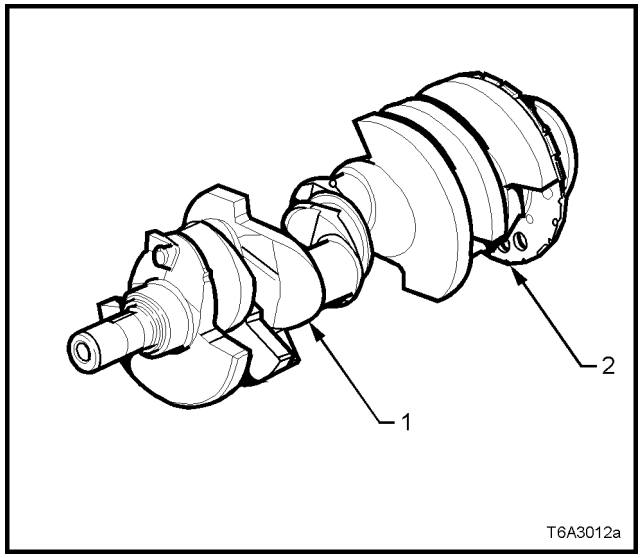


Figure 6A3-304

11. Remove the crankshaft main bearings from the cylinder block and the main bearing caps.

NOTE: Take particular care to organise all parts so they can be reinstalled in their original positions.

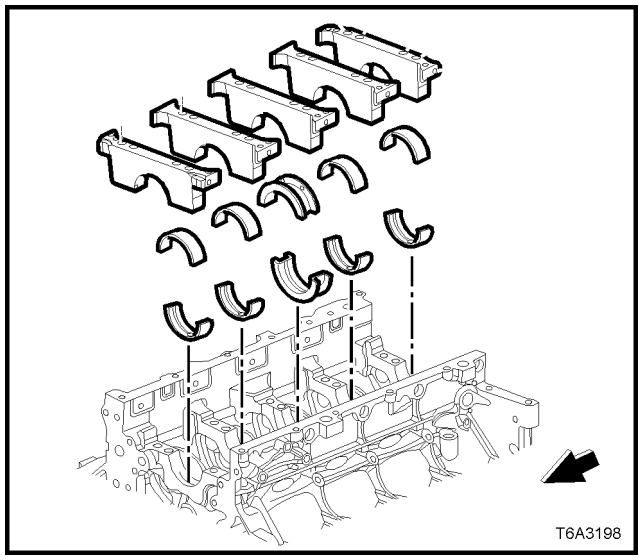


Figure 6A3-305

CLEAN AND INSPECT

IMPORTANT: Take care not to damage the reluctor ring on the crankshaft, as this part is non-serviceable.

1. Clean the crankshaft with a suitable solvent.
2. Thoroughly clean all oil passages and inspect for restrictions or burrs.
3. Blow dry with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

4. Carry out a visual inspection of the crankshaft for damage.
5. Inspect the crankshaft reluctor ring lobes for damage. The reluctor ring teeth should not have imperfections on either the rising or falling edges.

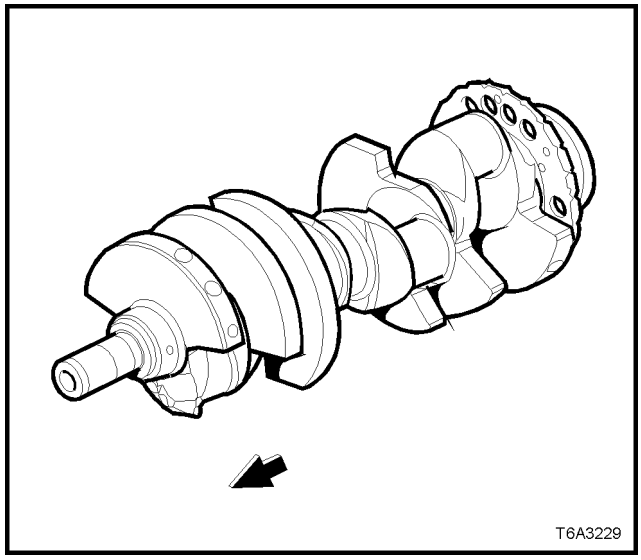


Figure 6A3-306

6. Inspect the crankshaft journals for wear (1). Journals should be smooth with no signs of scoring, wear or damage.
7. Inspect the crankshaft journals for grooves or scoring (2).
8. Inspect the crankshaft journals for scratches or wear (3).
9. Inspect the crankshaft journals for pitting or embedded bearing material (4).

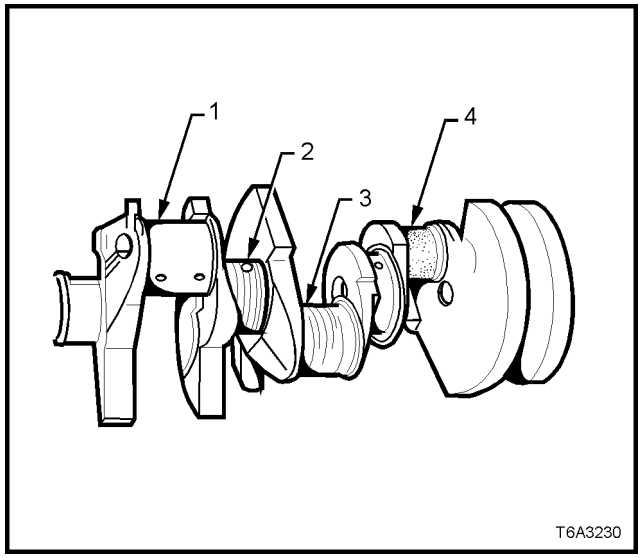


Figure 6A3-307

10. Inspect the crankshaft key (1), keyway (2) and threaded hole (3) for damage.

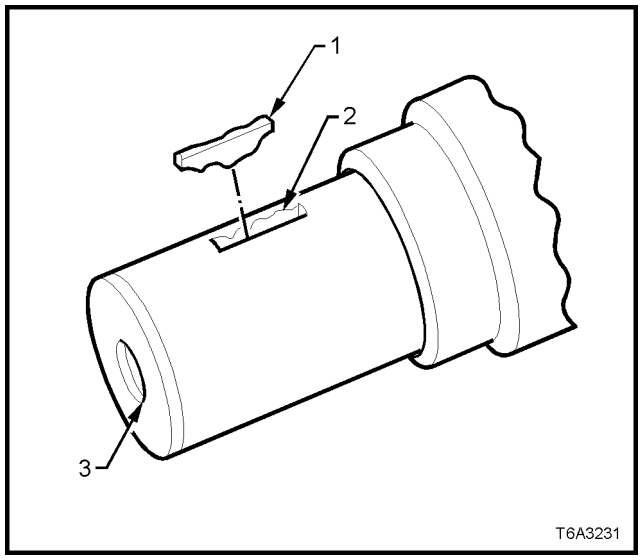


Figure 6A3-308

11. Measure all crankshaft journals for wear and out-of-round.

Crankshaft Journal Specifications	
Connecting Rod Journal Diameter	53.308 mm Min.
Connecting Rod Journal Out-of-Round	0.010 mm Max.
Connecting Rod Journal Taper	0.010 mm Max.
Main Bearing Journal Diameter	64.993 mm Min.
Main Bearing Journal Out-of-Round	0.008 mm Max.
Main Bearing Journal Taper	0.020 mm Max.

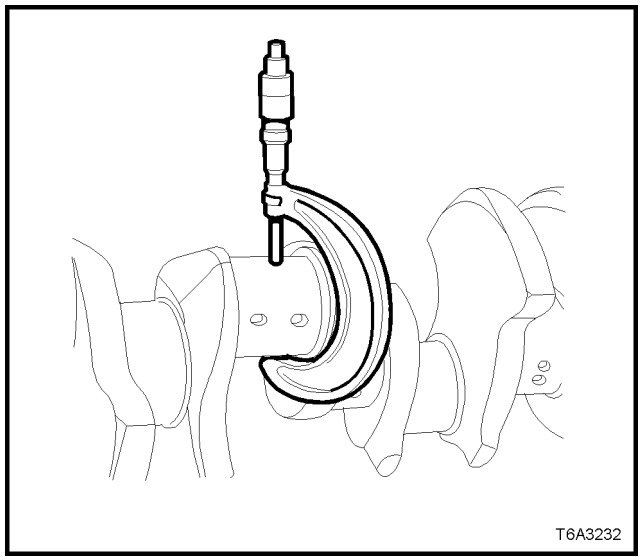


Figure 6A3-309

12. Support the crankshaft, either on ‘V blocks on a flat surface or in a commercial jig as shown.
13. Using a commercially available dial indicator, mounted to a magnetic stand, measure the following crankshaft main bearing journal runout dimensions:

    Crankshaft runout at the front and rear, intermediate main bearing journals.

    Crankshaft rear flange.

    Reluctor ring (measured 1.00 mm below the minimum tooth diameter), at the rear surface.

    Crankshaft thrust wall at the centre main bearing.

Main Bearing Journal Runout Specifications	
Reluctor Ring Lateral Runout	0.250 mm Maximum
Crankshaft Thrust Wall Runout	0.025 mm Maximum
Crankshaft Rear Flange Runout	0.050 mm Maximum

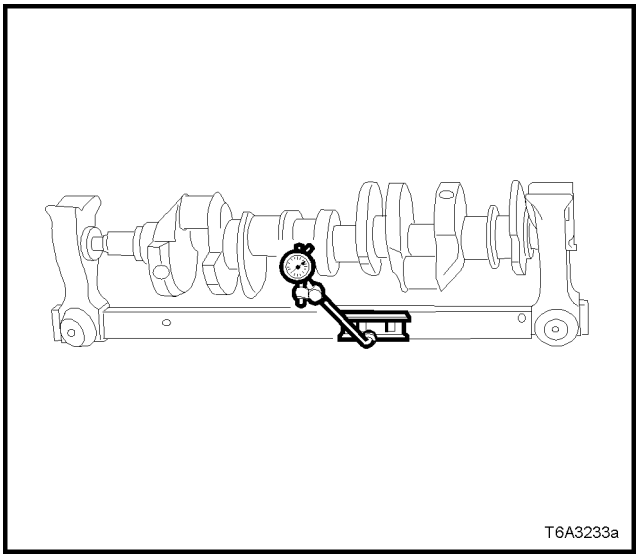


Figure 6A3-310

14. Check the rear crankshaft oil gallery plug for a loose fit or leaking.
15. If replacement is required, apply sealant such as Loctite 242 or equivalent, to the sides of a new plug (1) and install to the correct depth.

Crankshaft Rear Oil gallery Plug Depth Specification

DISTANCE ‘A’	31.2 – 31.6 mm

NOTE: If a manual transmission is fitted to the vehicle, it will be necessary to first remove the spigot bush. Refer to **3.7 CRANKSHAFT SPIGOT BEARING – REPLACE**, in this Section.

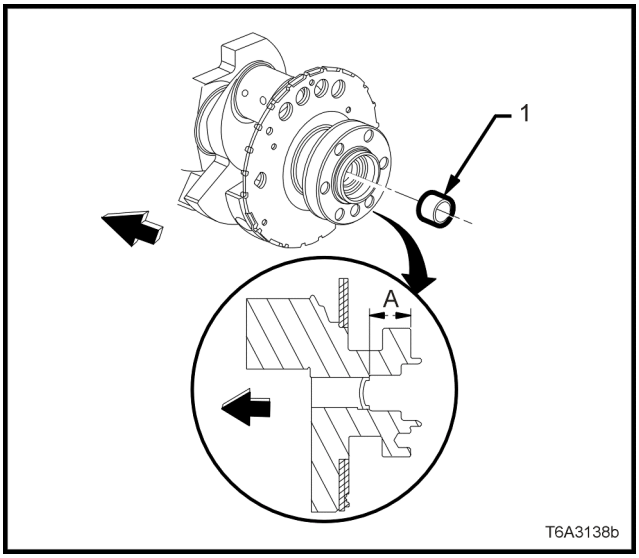


Figure 6A3-311

Main Bearings - Inspect

1. Inspect connecting rod bearing halves for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

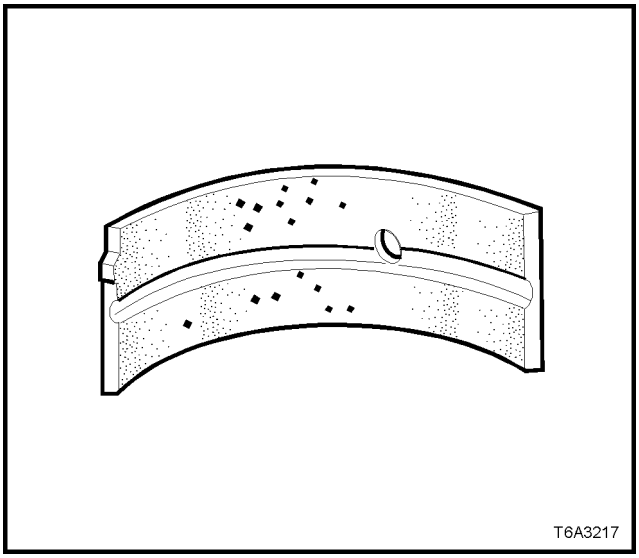


Figure 6A3-312

2. Inspect connecting rod bearing halves for excessive scoring or discolouration.
3. Inspect the connecting rod bearings for dirt or debris embedded into the bearing material or backing metal.

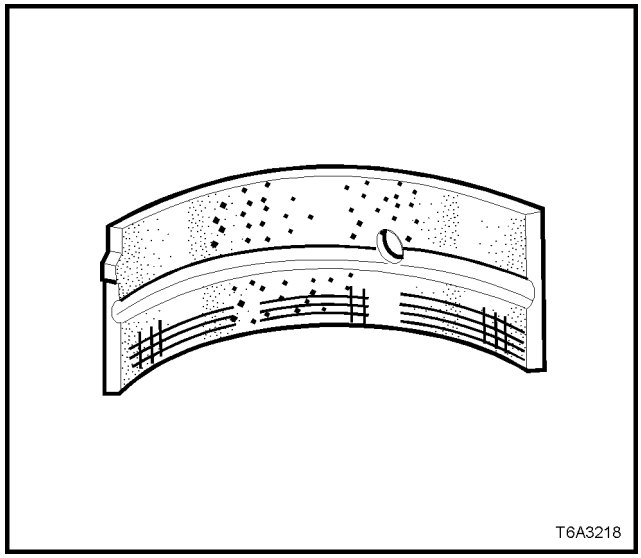


Figure 6A3-313

4. Inspect connecting rod bearing halves for improper seating, indicated by bright, polished section/s on the bearing material.

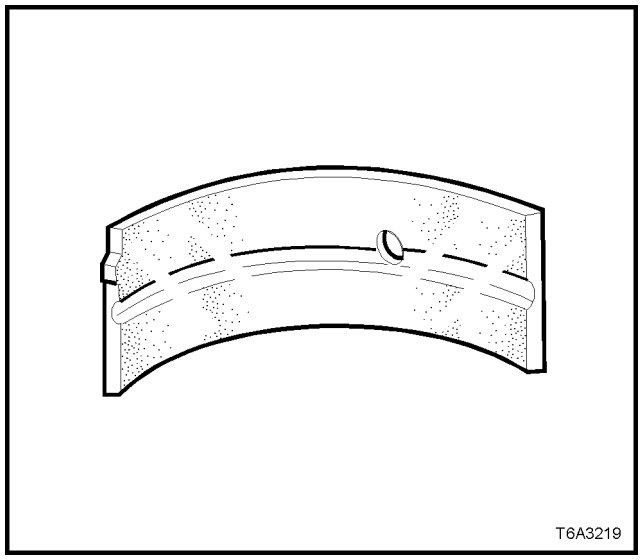


Figure 6A3-314

Main Bearing Oil Clearance - Check

1. After thoroughly cleaning all relevant parts, install bearing halves into the cylinder block and main bearing caps.

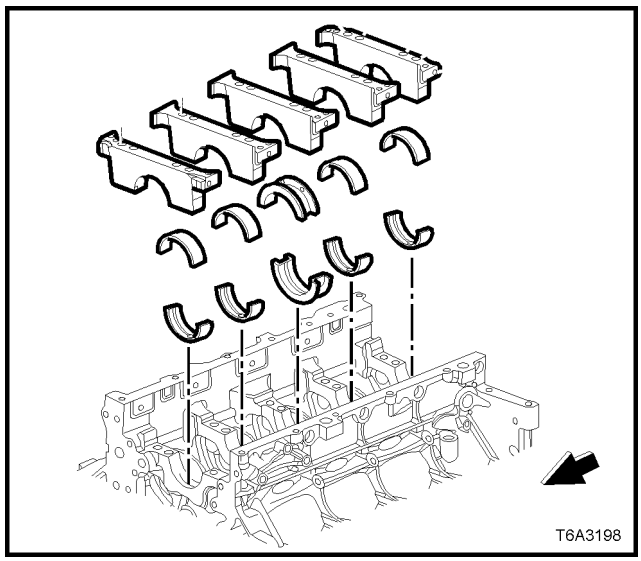


Figure 6A3-315

2. Install crankshaft to cylinder block, ensuring that the crankshaft is held square to avoid jamming/ damaging the centre main thrust bearing.
3. Install a small strip of plastic gauging material across the full width of the main bearing journal.

NOTE 1: Do not place the gauging material across an oil feed hole.

NOTE 2: Ensure that the crankshaft does not rotate during this process.

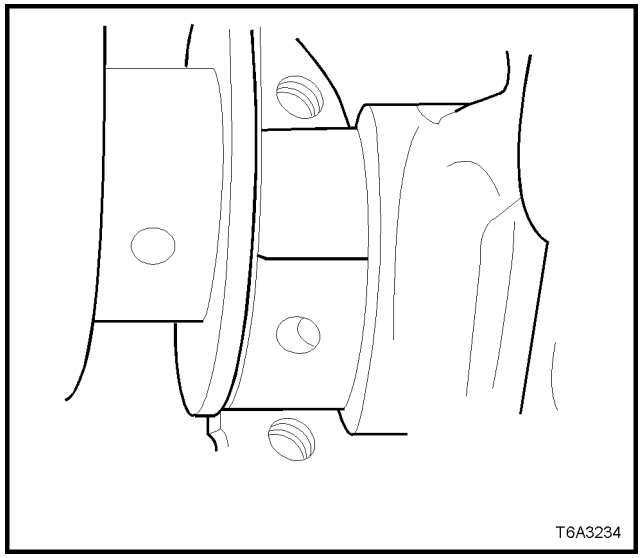


Figure 6A3-316

4. Install main bearings, caps, bolts and studs in the same order as removal.

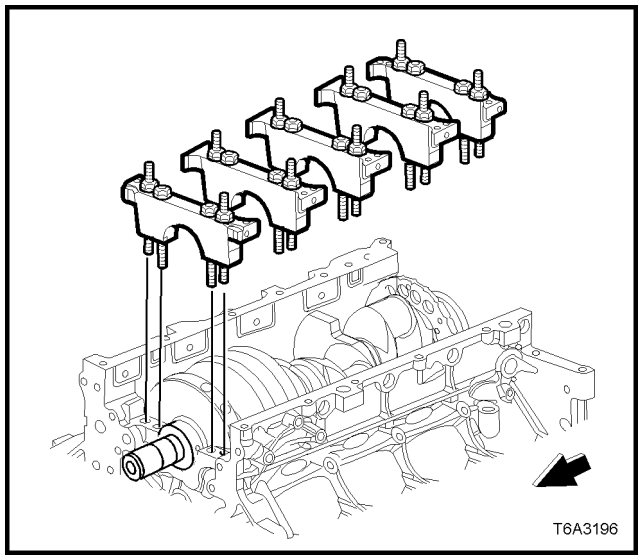


Figure 6A3-317

5. Tighten main bearing cap bolts and studs to the correct torque specification and in the correct sequence.

MAIN BEARING INNER BOLTS (1 - 10)	
TORQUE SPECIFICATION	Stage 1: 20 Nm Stage 2: 80° turn angle
MAIN BEARING OUTER STUDS (11 - 20)	
TORQUE SPECIFICATION	Stage 1: 20 Nm Stage 2: 53° turn angle

NOTE: Use torque angle meter E7115 to achieve an accurate second reading.

6. Tighten the side cap bolts to the correct torque specification, first on one side, then on the other.

MAIN BEARING CAP SIDE BOLTS	
TORQUE SPECIFICATION	25 Nm

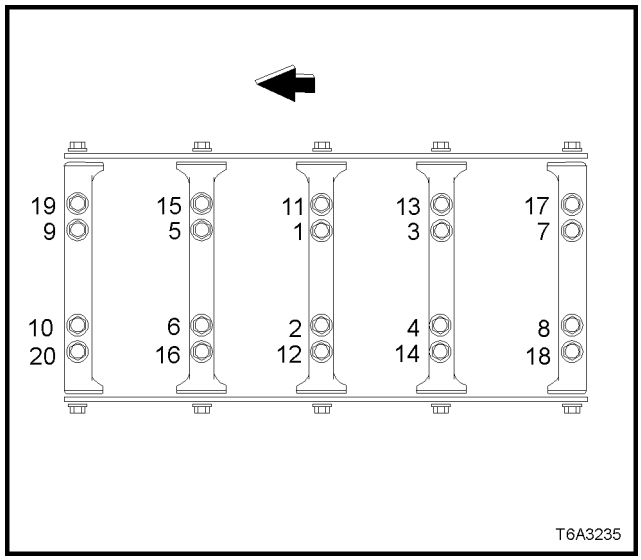


Figure 6A3-318

7. Remove the main bearing cap M8 side bolts (1) and discard, as new bolts must be used on final assembly.

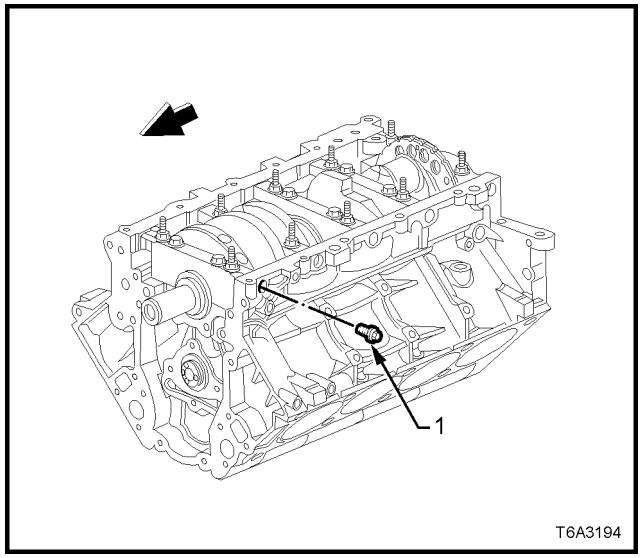


Figure 6A3-319

8. Loosen the bolts of main bearing removal Tool J 41818 to separate the chamfered collets, then install the chamfered sections into each main bearing cap bolt hole, aligning the flats of the collets with those in the holes.
9. Tighten the bolts of Tool J 41818 to 11 Nm.
10. Install slide hammer, Tool J 6125-1B to J 41818 and remove main bearing caps.

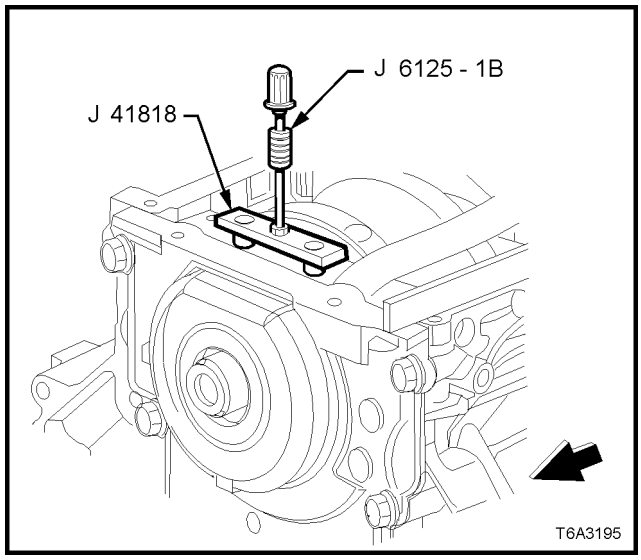


Figure 6A3-320

11. Remove the remaining main bearing caps in the same way.

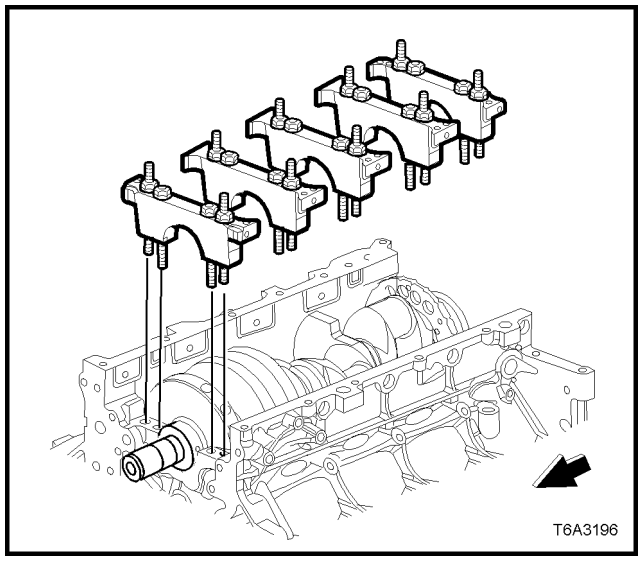


Figure 6A3-321

12. Using the scale supplied with the gauging plastic, measure the deformed plastic at its widest part.
    - If the deformed strip shows a width variation exceeding 0.020 mm, remove the crankshaft and measure the journal with a micrometer.
    - If the bearing clearance is greater than 0.076 mm (connecting rod) or 0.065 mm (main), select and install an undersized bearing set, then re-check the oil clearance.
    - If clearance specification cannot be obtained, the crankshaft must be reground for use with the next under-sized bearings.

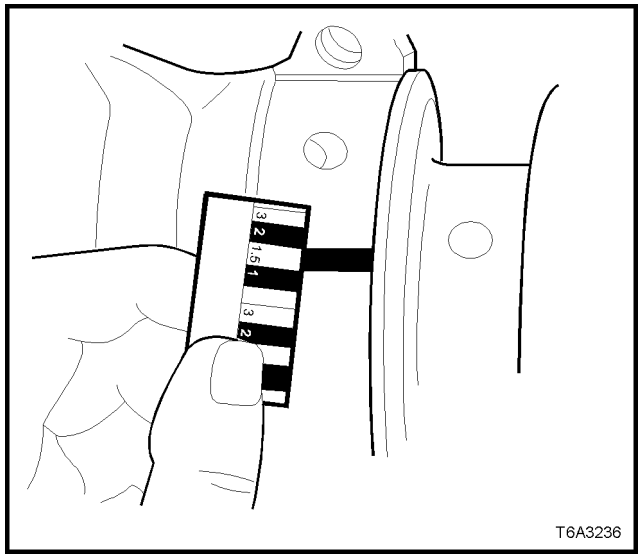


Figure 6A3-322

REINSTALL

1. Apply clean engine oil to the bearing halves and crankshaft journals.

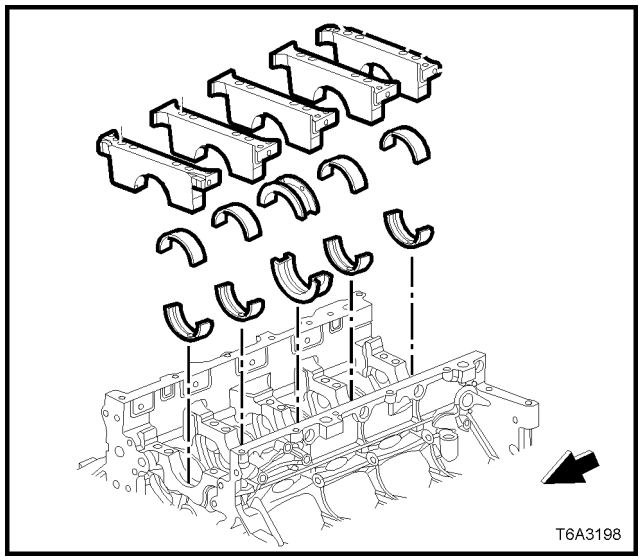


Figure 6A3-323

2. Install crankshaft to cylinder block, ensuring that the crankshaft is held square to avoid jamming/ damaging the centre main thrust bearing.

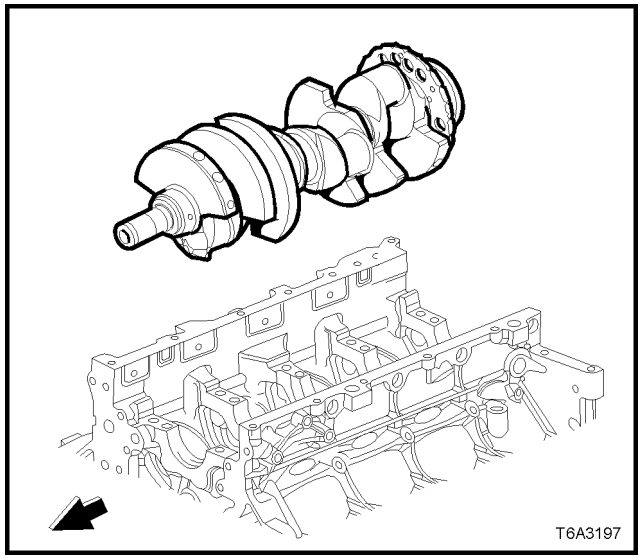


Figure 6A3-324

3. Install main bearings, caps, bolts and studs in the correct order.

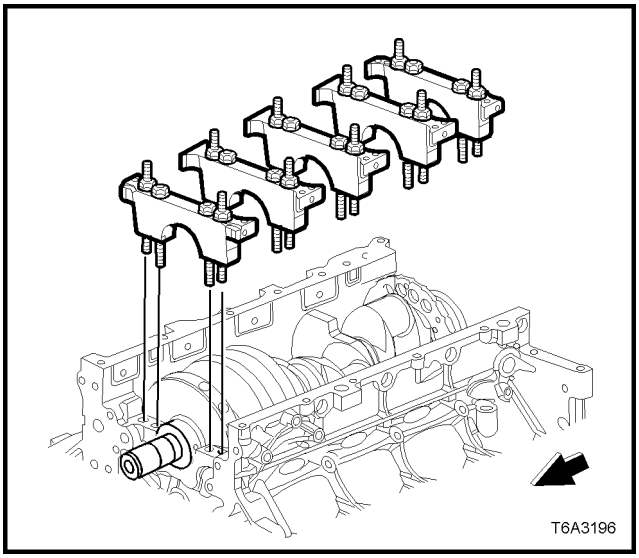


Figure 6A3-325

4. Tighten main bearing cap bolts and studs to the correct torque specification, in the correct sequence.

MAIN BEARING INNER BOLTS (1 - 10)	
TORQUE SPECIFICATION	Stage 1: 20 Nm Stage 2: 80° turn angle
MAIN BEARING OUTER STUDS (11 - 20)	
TORQUE SPECIFICATION	Stage 1: 20 Nm Stage 2: 53° turn angle

NOTE: Use torque angle meter E7115 to achieve an accurate second reading.

5. Install NEW M8 main bearing cap side bolts and tighten to the correct torque specification, first on one side, then on the other.

MAIN BEARING CAP SIDE BOLTS	
TORQUE SPECIFICATION	25 Nm

NOTE: New main bearing cap side bolts have a sealant patch applied to the bolt flange.

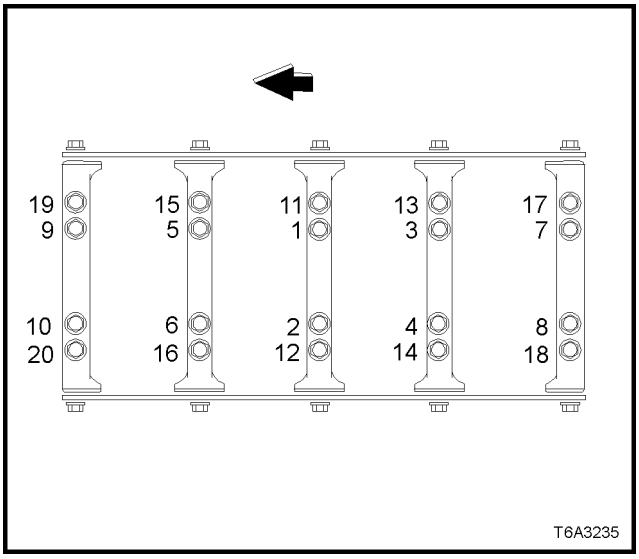


Figure 6A3-326

6. Thrust the crankshaft rearward then forward, using a suitable lever.
7. Insert a feeler gauge between the centre main bearing and the crankshaft thrust bearing surface.

Crankshaft End Play Specification	
Crankshaft End Play	0.040 - 0.20 mm

NOTE 1: If the bearing clearance is not within specification, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections can be removed with a fine stone.

NOTE 2: After measuring crankshaft end float, leave the crankshaft in the forward position. Particularly when a manual transmission if fitted to the engine, this will lessen bearing shock when the engine is started and the clutch is first released.

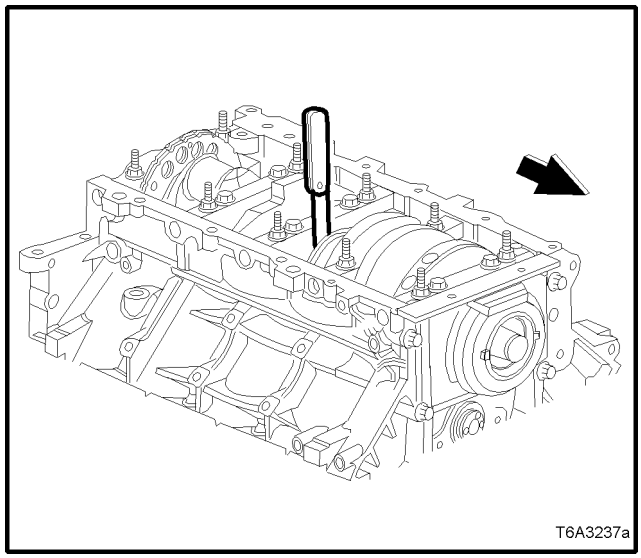


Figure 6A3-327

8. Inspect the crankshaft position sensor O-ring for nicks, cuts or other damage. If undamaged, the O-ring may be re-used.
9. Coat the O-ring with clean engine oil.
10. Install the sensor, aligning the retaining bracket notch with the threaded holed in the cylinder block.
11. Install the retaining bolt, tightening to the correct torque specification.

CRANKSHAFT POSITION SENSOR TORQUE SPECIFICATION	25 Nm

12. Reinstall the following items to the engine assembly;

a. Rear cover and flywheel/Flex plate, refer **3.8 ENGINE REAR COVER** and **3.5 FLYWHEEL/ FLEXPLATE**, in this Section.

b. Timing chain, refer **3.10 TIMING CHAIN AND SPROCKETS**, in this Section.

c. Oil pump, screen and deflector, refer **3.9 OIL PUMP, PUMP SCREEN AND DEFLECTOR**, in this Section.

d. Front cover and crankshaft balancer, refer **3.4 FRONT COVER** and **2.24 CRANKSHAFT BALANCER** in this Section.

e. Oil pan, refer **3.3 OIL PAN**, in this Section.

f. Starter motor, refer **Section 6D3-2 STARTING SYSTEM - GEN III V8 ENGINE**.

13. Reinstall engine into vehicle, refer **3.1 ENGINE ASSEMBLY – REINSTALL** in this Section.

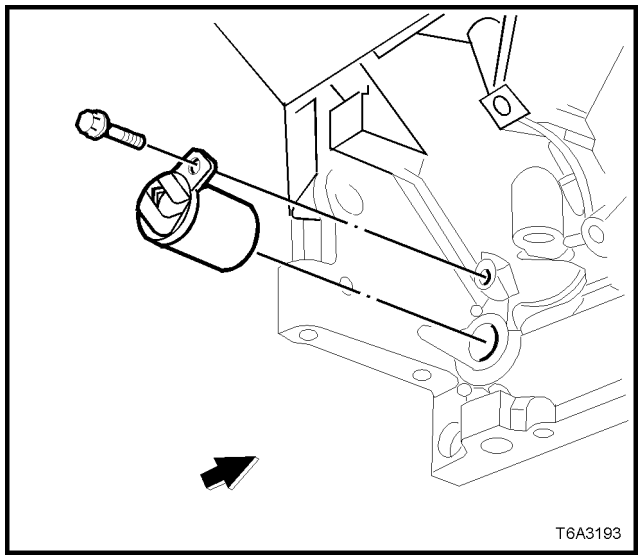


Figure 6A3-328

3.14 ENGINE BLOCK PLUGS

LT Section No. – 00-248

REMOVE

1. Using an 8 mm Allen key socket and bar, remove the coolant drain plug from the right hand rear of the cylinder block.

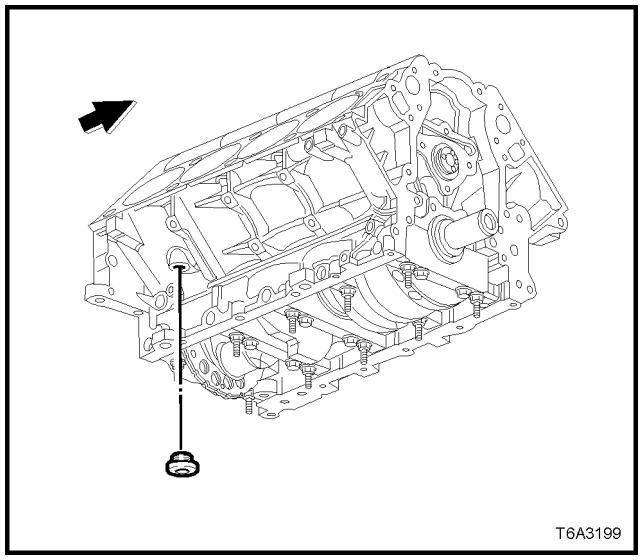


Figure 6A3-329

2. Remove the three plugs from the left hand side of the cylinder block, using an 8 mm Allen key socket and bar for plugs ‘1‘ and ‘3’ and a 17 mm Allen key socket for plug ‘2’.

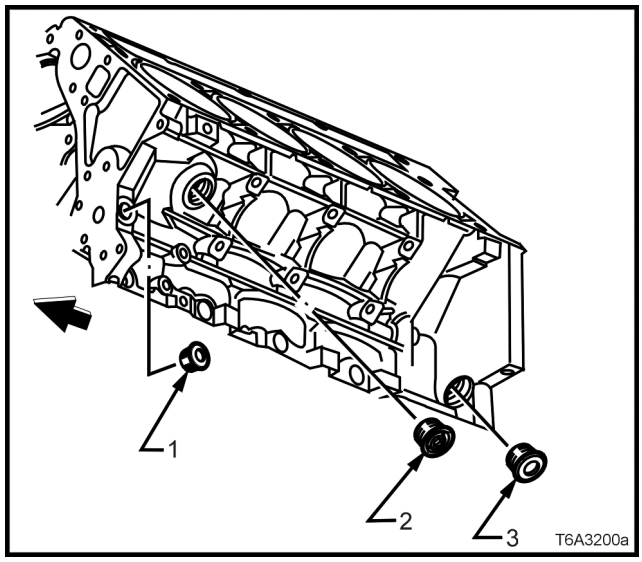


Figure 6A3-330

3. If not removed in previous operations, remove the oil pressure sensor (1) from the top of the cylinder block, at the left hand rear, using Tool J 41712 and suitable 3/8” drive socket bar.

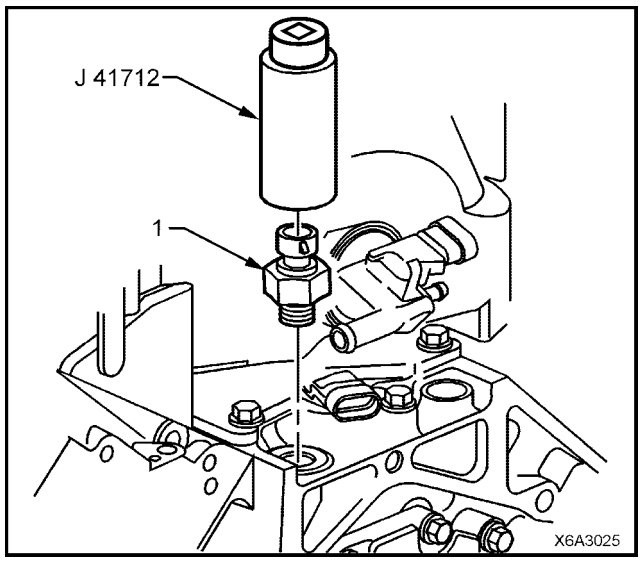


Figure 6A3-331

NOTE: Only remove the plug from the front of the engine block, if replacement is required.

4. Remove the engine block, front oil gallery plug. A suggested method is to:
   a. Drill a small pilot hole through the plug.
   b. Install a self tapping screw into the plug.
   c. Using a slide hammer with a suitable fitting, remove the plug.
   d. Discard the removed plug.

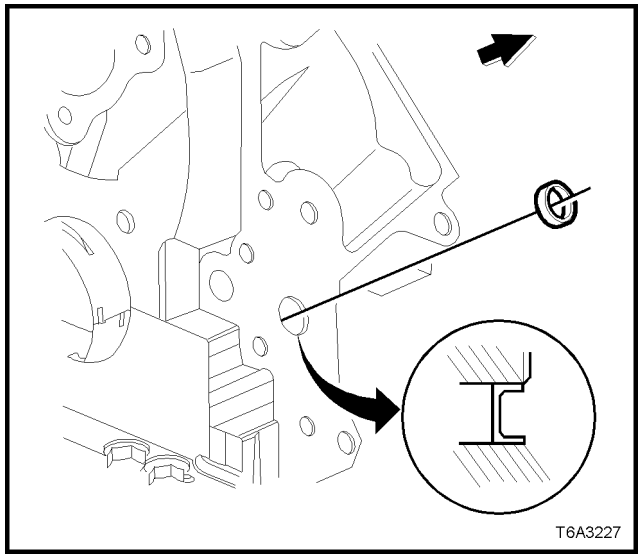


Figure 6A3-332

5. To remove the rear oil gallery plug, either one of two methods can be used:
   a. With the front plug removed, use a suitable length of MS rod (e.g. 5 mm) inserted from the front of the engine block and a hammer to tap the rear oil gallery plug free.
   b. With the cylinder block plug removed (#3 in Figure 6A3-330 and position '1'), use a small screwdriver inserted in the plug aperture to prise the oil galley plug free.

CAUTION: Take care not to slip during this latter operation, as the machined edges of aluminium components are extremely sharp.

6. Inspect the O-ring seal on the removed gallery plug and if undamaged, it may be re-used during assembly.

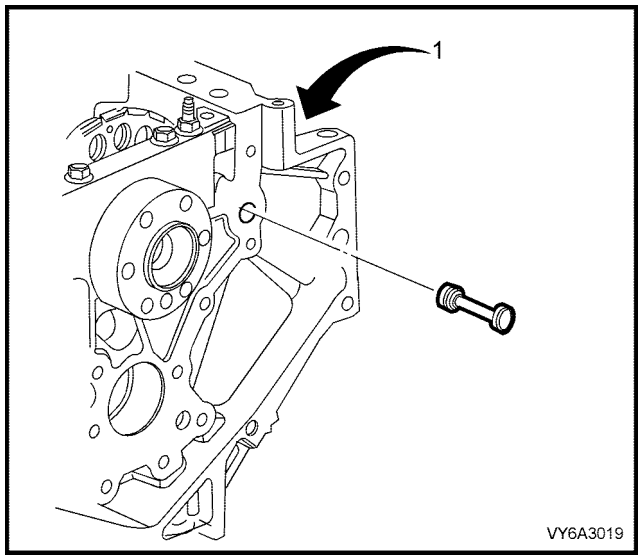


Figure 6A3-333

7. If removed, inspect the rear main oil gallery plug and ensure that it is of the later design ('A'). If of the earlier design ('B') then it must be replaced.

NOTE: Visually, the later plug has a thicker end boss ('X') that the earlier design ('Y').

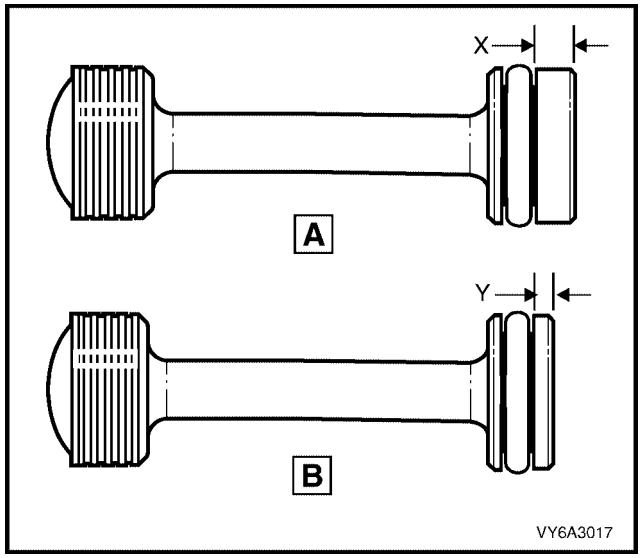


Figure 6A3-334

REINSTALL

1. Apply a 3 mm bead of sealant such as Loctite 565 or equivalent, to the right hand rear, engine block coolant drain plug sealing washer.
2. Install the plug and tighten to the correct torque specification, using an 8 mm Allen key socket.

COOLANT DRAIN PLUG TORQUE SPECIFICATION	60 Nm

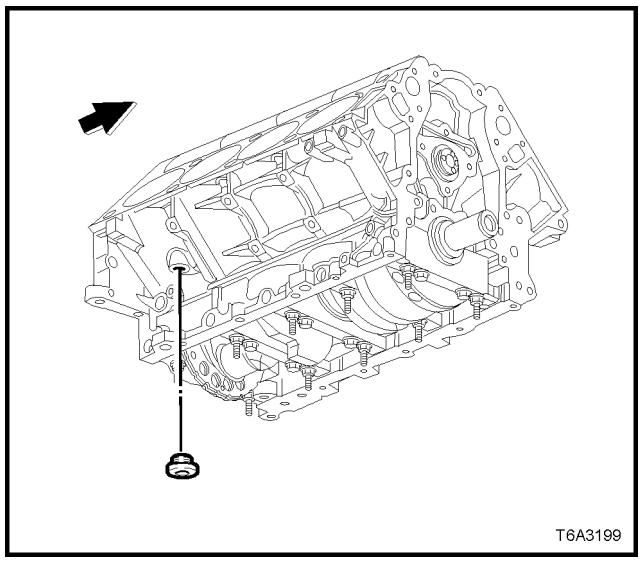


Figure 6A3-335

3. Apply a 3 mm bead of sealant such as Loctite 565 or equivalent, to the sealing washer on each of the left hand side engine block plugs.
4. Install each plug and tighten to the correct torque specification, using an 8 mm Allen key socket for plugs ‘1’ and ‘3’ and a 17 mm Allen key socket for plug ‘2’.

COOLANT DRAIN PLUG – ALL TORQUE SPECIFICATION	60 Nm

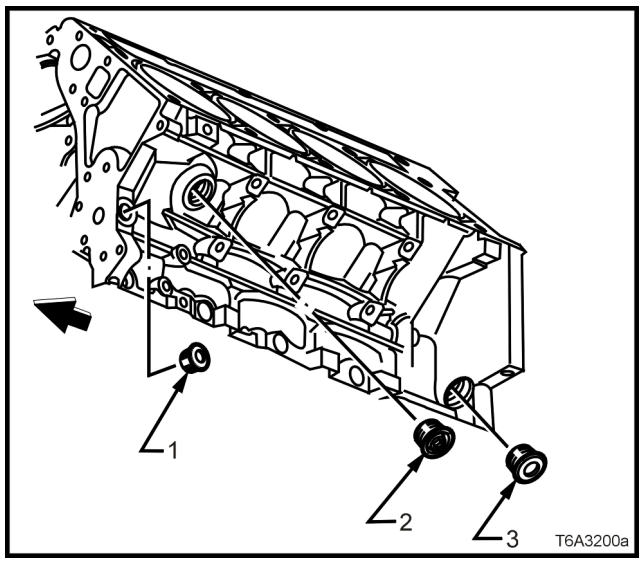


Figure 6A3-336

5. Lubricate the O-ring with clean engine oil and install the plug into the rear of the cylinder block. Carefully install until the plug comes to a stop against the stepped bore of the oil gallery. At this point, the plug should be protruding by approximately 1.2 mm (distance ‘A’).

NOTE: When the rear cover and gasket are installed, the plug protrusion will rest against the rear cover machined internal surface.

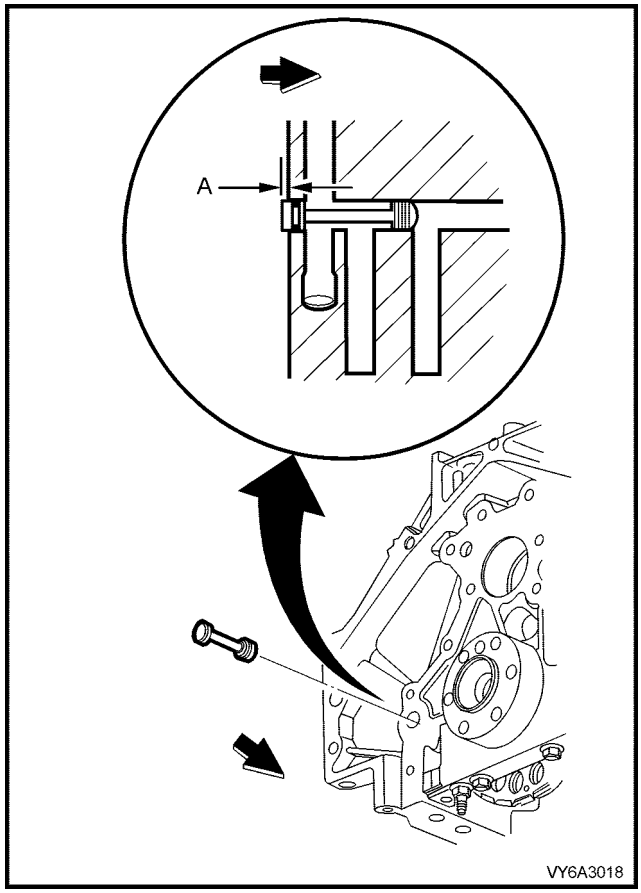


Figure 6A3-337

6. Apply a sealant such as Loctite 242 or equivalent to the side of a NEW front oil gallery plug.
7. Install the NEW, front oil gallery plug to the engine block to the specified depth, to clear the engine block chamfer.

Front Oil Gallery Plug Installation Specification

Below Flush	2.2 - 2.8 mm

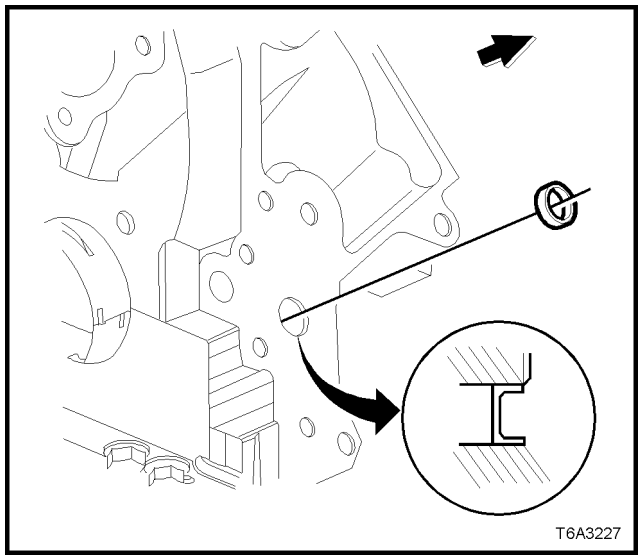


Figure 6A3-338

8. Apply sealant such as Loctite 565 or equivalent to the cleaned threads of the oil pressure sensor (1) and reinstall, using Tool No. J 41712 and suitable 3/8” drive socket equipment. Tighten to the correct torque specification.

OIL PRESSURE SENSOR TORQUE SPECIFICATION	20 Nm

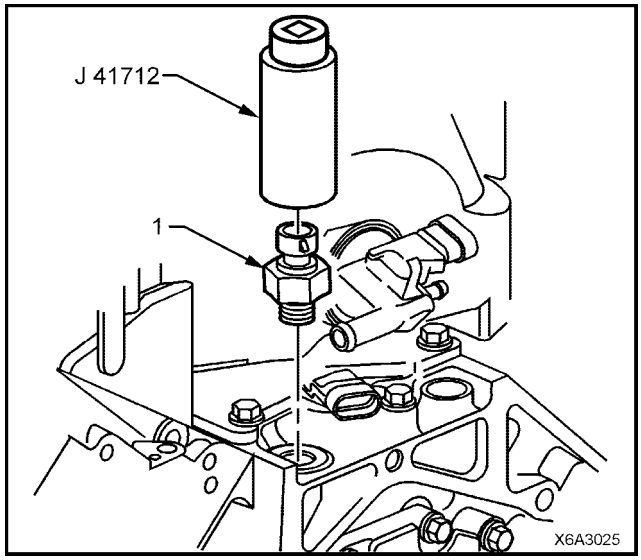


Figure 6A3-339

3.15 CYLINDER BLOCK

LT Section No. – 00-248

CAMSHAFT BEARINGS - REPLACE

NOTE 1: Care must be taken during bearing removal and installation, not to damage bearings that are not being replaced.

NOTE 2: The following operations involve the use of universal camshaft bearing remover/installer, Tool J 33049 and finished size camshaft bearings. If installing unfinished size bearings, installation must be carried out by a specialist machine shop and then line bored to the correct finished size.

NOTE 3: While it is preferred that the camshaft bearings are removed and installed in a bare cylinder block, the operation can be carried out by removing the crankshaft and the camshaft, even though it is difficult to negotiate the tool past the connecting rod big end journals.

The camshaft can be removed without having to first remove the cylinder heads and hydraulic lifters. By removing the push rods and inverting the engine, the hydraulic lifters will drop sufficient to clear the camshaft journals.

1. Prior to bearing removal, inspect all camshaft bearings for a loose fit in the engine block bearing bores.

NOTE: If a bearing is found to be loose, it may have been caused by an enlarged, out of round or damaged engine block bearing bore.

2. The universal camshaft bearing remover/installer, Tool J 33049, consists of the following components;

   Nylon Guide Cone (1).
   Small Driving Washer (2).
   Large Driving Washer (3).
   Expanding Drivers and Rubber Sleeves (4 - 8).
   Driver Extension Bar (9).
   Driver Bar (10).
   Expander Assembly (15). Consists of parts 11 - 14.

3. To replace the camshaft bearings on the GEN III V8 engine, select the following components from Tool J 33049:

   Nylon Guide Cone (1).
   Large Driving Washer (3).
   Expanding Drivers and Rubber Sleeve (7).
   Driver Bar (10).
   Expander Assembly (15).

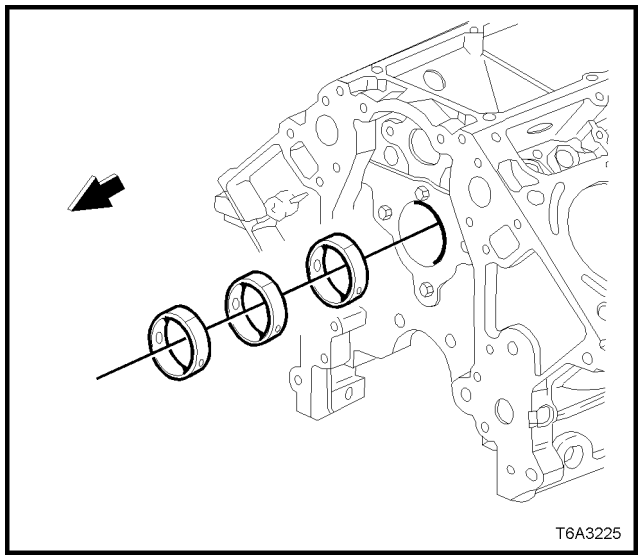


Figure 6A3-340

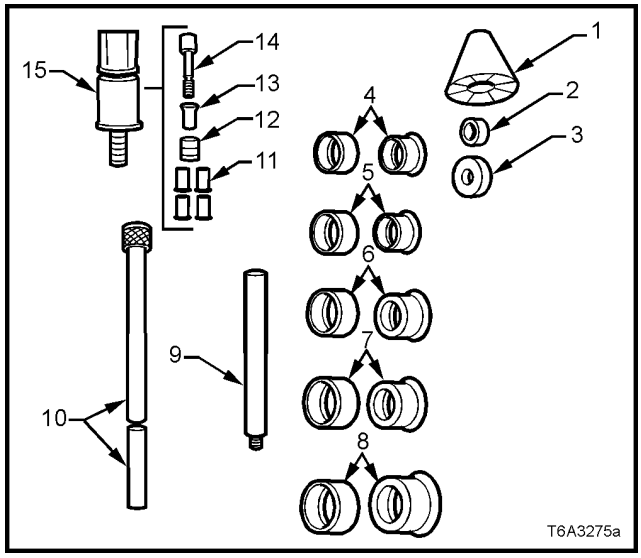


Figure 6A3-341

4. Install expanding driver with its rubber sleeve (1), over the expander assembly (2), with the numbered flanges of the expanding driver facing the threaded end of the expander assembly (2), as shown.

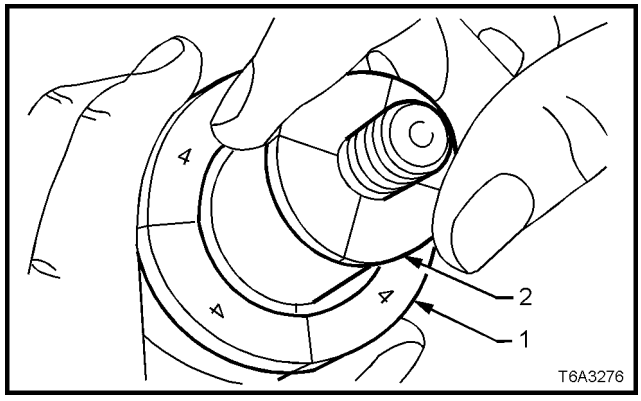


Figure 6A3-342

5. Once installed, ensure that the separations in the expander assembly segments, are aligned with those of the expanding driver as shown ('A').

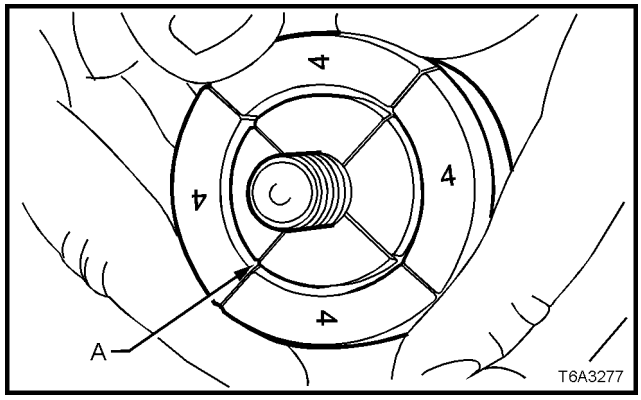


Figure 6A3-343

6. Manoeuvre the assembly into the cylinder block, in front of the bearing to be removed, then install the large driving washer (3) over the threaded end of the expander assembly (5).
7. Slide the nylon cone (1) over the driver bar (2) with the smaller diameter toward the cylinder block.

NOTE: The components shown in Figure 6A3-349 are shown removed from the cylinder block for clarity.

8. Carefully insert the driving bar through the camshaft bearings, from the front of the cylinder block and screw the bar to the expander assembly.
9. With the expander assembly inserted into the camshaft bearing, hold the hexagonal end of expander assembly (5) with a spanner and hand tighten the driver bar until the expanding driver (4) is tight in the bearing shell.

IMPORTANT: Do not overlook fitting the driving washer over the threaded end of the expander assembly before installing the driver bar.

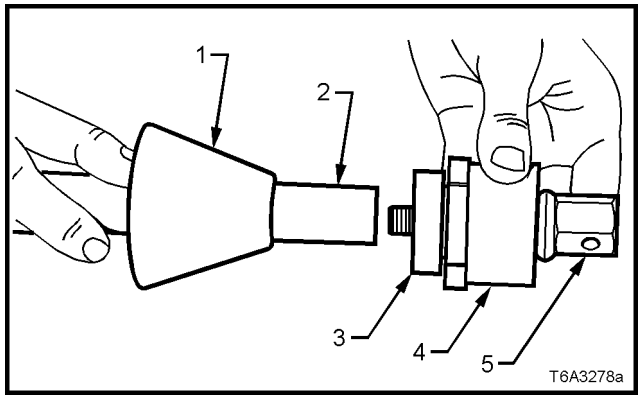


Figure 6A3-344

10. Push the guide cone into the front camshaft bearing to align the driver bar.
11. While holding the guide cone in place with one hand, drive the bearing from the cylinder block.
12. Repeat this process with the remaining bearings being removed.

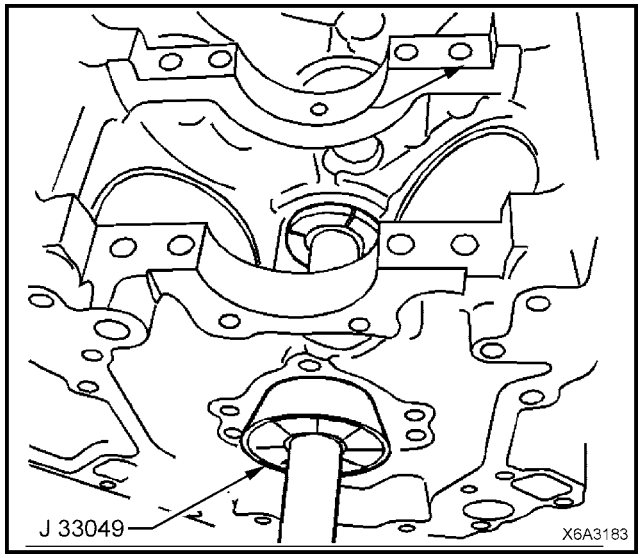


Figure 6A3-345

NOTE: To remove the front bearing, install the driver bar from the rear of the cylinder block, using the guide cone in the rear camshaft bearing bore, as shown in **Figure 6A3-350**.

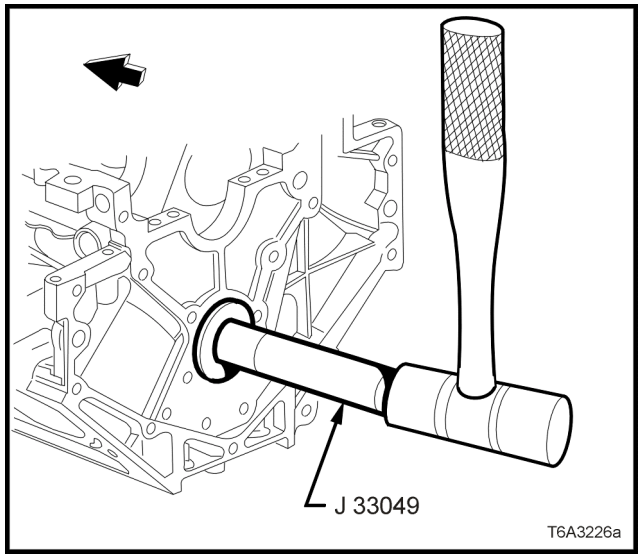


Figure 6A3-346

13. To install a new bearing, proceed in a similar way to bearing removal, except for the following items:
    a. The join in the new camshaft bearing ('A') must be aligned with the top of the engine block. To assist with alignment, use a felt tip pen to mark the back of the bearing, 180° from the join, as this will be visible when installing the bearing.
    b. While the oil feed is generous in length and allows some degree of hole misalignment, as much care as possible must be made during installation.
    c. Install each bearing until it is centrally located in the cylinder block bore, then use a thin piece of wire to ensure that the oil feed passage is not obstructed in any way.
    d. To install the front camshaft bearing, install the driver bar into the rear bearing and use the guide cone at that location.

    IMPORTANT: Take care when installing the driver bar through the newly installed bearings to avoid damage.

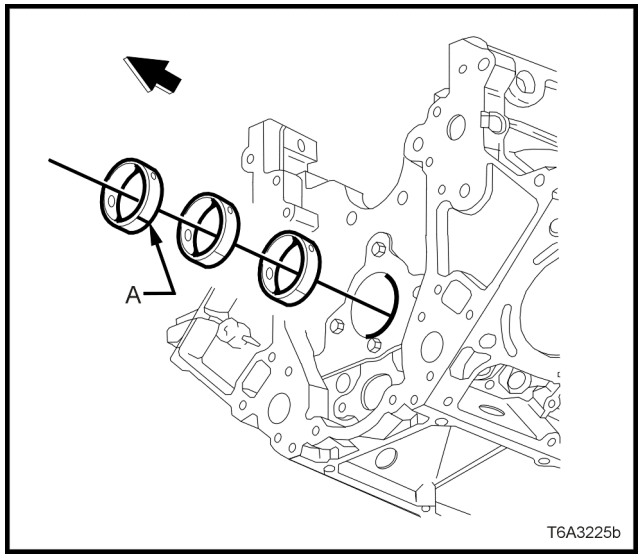


Figure 6A3-347

CYLINDER BLOCK, CLEAN, INSPECT AND MEASURE

Clean

NOTE 1: Do not use a caustic solution to clean the aluminium engine block.

NOTE 2: When cleaning an engine block in a thermal type oven, do not exceed 232° C.

1. Clean the engine block in a suitable solvent, to remove all sludge, dirt, or debris.
2. Dry the block with compressed air.

CAUTION: Wear safety glasses to avoid eye injury.

3. Clean all gasket surfaces, taking care to only use a plastic scraper to avoid damaging machined surfaces.
4. After removing all engine block plugs (Refer **3.14 ENGINE BLOCK PLUGS**, in this Section), clean all coolant passages and oil galleries.
5. Clean the main bearing caps, taking care not to mix them from their original order.
6. Clean any residue of cylinder head bolt thread sealant from the cylinder block threads, using installer, Tool No. J-42385-107 (this tool is part of the thread repair kit, J-42385).

IMPORTANT: Do not use anything but this thread tool to clean the cylinder head threads in the cylinder block.

7. Use compressed air to clean all residue from bolt holes.

CAUTION: Wear eye protection to prevent injury.

Inspect

Inspect the following areas:

1. The cylinder walls for excessive scratches, gouging, or ring ridge.
2. The coolant jacket for cracks.
3. The valve lifter bores for excessive scoring or wear.
4. The crankshaft bearing webs for cracks.
5. The gasket sealing surfaces for excessive scratches or gouging.
6. The oil galleries for restrictions.
7. All threaded bolt holes for damage.

Measure Cylinder Bore

1. Adjust the micrometer to 96.0 mm.
2. Insert the bore gauge into the micrometer and zero the bore gauge dial, Tool J 8087 (or commercial equivalent).

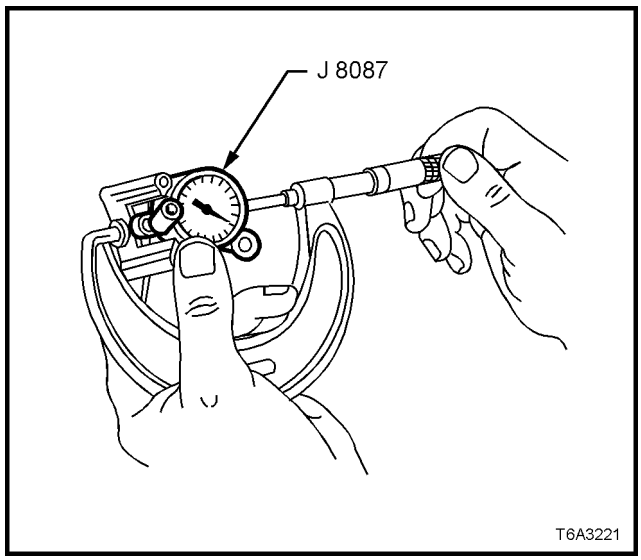


Figure 6A3-348

3. Use a bore gauge and measure the cylinder bore for taper.
   - Slide the bore gauge up and down throughout the length of the cylinder bore. Check the bore both parallel and perpendicular to the centreline of the crankshaft.
   - Recondition cylinders with less than 0.018 mm taper with a hone. Refer **CYLINDER BORING AND HONING**, in this Section.
   - Cylinders with more than 0.018 mm taper must be fitted with an oversize piston.

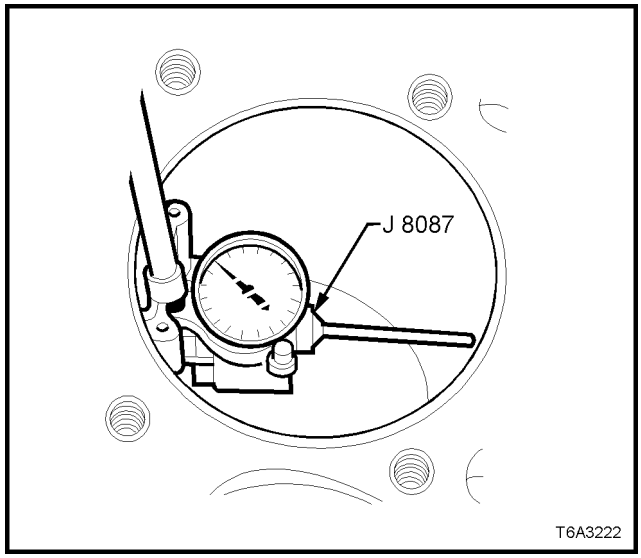


Figure 6A3-349

4. Use a bore gauge and measure the cylinder bore for out-of-round:
   - Measure the bore, both in line with the centreline and perpendicular to the engine centreline. Check for bore out-of-round at a depth of 9 mm (‘A’), 57 mm (‘B’) and 127 mm (‘C’) from the cylinder head surfaces.
   - Calculate the difference between the two measurements at each location. The results will indicate any out-of-round bore condition.
   - Cylinders with more than 0.18 mm out-of-round must be honed and fitted with an oversize piston.

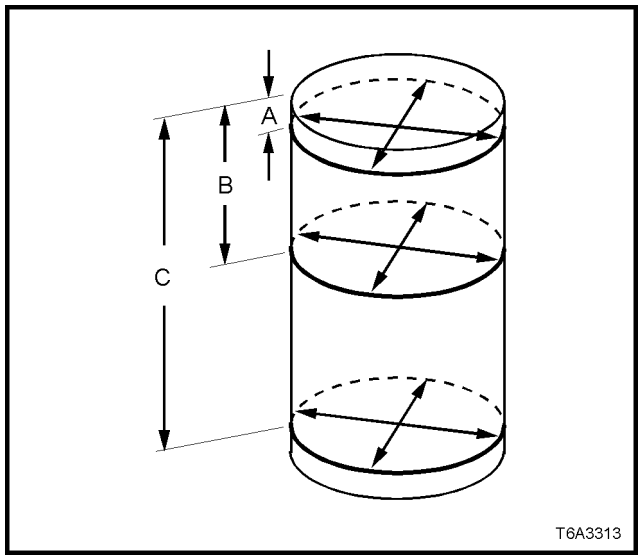


Figure 6B3-350

Measure Engine Block Cylinder Head Deck

1. Using a straight edge and feeler gauges, check the flatness of the engine block, cylinder head deck surfaces. If found to be outside specification, the engine block must be replaced, as machining is not recommended.

Engine Block Cylinder Head Flatness Specification	
Measured within a 150 mm area	0.11 mm Maximum
Measured over block length	0.22 mm Maximum

CYLINDER BORING AND HONING

Boring Procedure

1. Oversize service piston and piston ring sets are available in 0.25 mm.

IMPORTANT: GEN III V8 cylinder boring is not permitted.

2. It is recommended to hone the cylinder to achieve proper fit for the oversize piston. Refer to the CYLINDER HONING PROCEDURE for the proper honing information.

Honing Procedure

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston. All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.
3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100 grit stone.

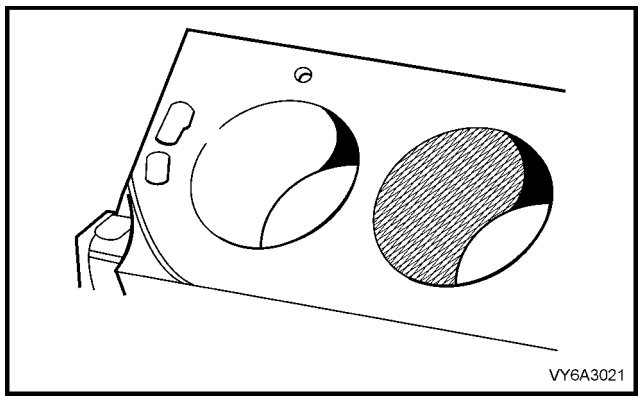


Figure 6A3-351

4. Perform final cylinder honing with a 240 grit stone and obtain a 45 degree cross hatch pattern.
5. A 240 grit stone is preferred for final honing. If a 240 grit stone is not available, a 220 grit stone may be used as a substitute.
6. When honing to eliminate taper in the cylinder, make full strokes for the complete bore length. Repeatedly check the measurement at the top, the middle, and the bottom of the bore.
7. The finish marks should be clean but not sharp. The finish marks should also be free from embedded particles and torn or folded metal.
8. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, the final cylinder honing dimension required, can be determined.
9. When finished, the reconditioned cylinder bores should have less than or meet the specified out-of-round and taper requirements.
10. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
11. Perform final measurements of the piston and the cylinder bore.
12. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
13. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure

Using a ball type or self centring honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240 grit stone of silicone carbide or equivalent material when performing the deglazing procedure.

A 240 grit stone is preferred for final honing. If a 240 grit stone is not available, a 220 grit stone may be used as a substitute.

3.16 THREAD REPAIR

GENERAL INFORMATION

With the extensive use of aluminium alloy in the construction of the GEN III V8 engine, thread repair skills are required to repair damaged threads caused by careless handling or over-torquing of fasteners.

This Section describes the recommended method of repairing threads in three specific areas of the engine;

- General Thread Repair.
- Cylinder Head Bolt Hole Thread Repair.
- Main Cap Bolt Hole Thread Repair.

Detailed descriptions of all thread specifications used in this engine are listed in **3.17 THREAD REPAIR SPECIFICATIONS** in this Section, contains .

The available Thread Repair Kit, Tool J 42385/100/200/ 300, uses the Time Sert® thread repair process that involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1).

During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place.

Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

CAUTION: Wear safety glasses to avoid eye injury.

IMPORTANT: The use of a cutting type fluid GM P/N 1052864, (or WD 40®, or equivalent) is recommended when performing the drilling, counter-boring, and tapping procedures.

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

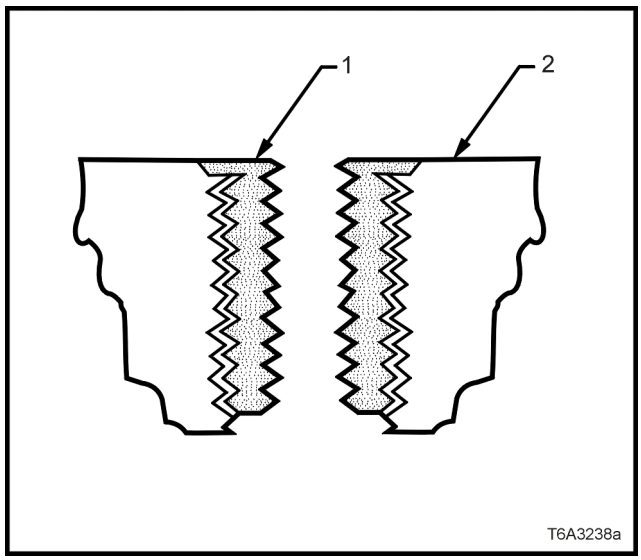


Figure 6A3-352

GENERAL THREAD REPAIR

1. Drill out the threads of the damaged hole (1) to the correct depth for the thread being repaired:
   - M6 inserts require a minimum drill depth of 15 mm.
   - M8 inserts require a minimum drill depth of 20 mm.
   - M10 inserts require a minimum drill depth of 23.5 mm.
2. Using compressed air, clean out any chips.

CAUTION: Wear safety glasses to avoid eye injury.

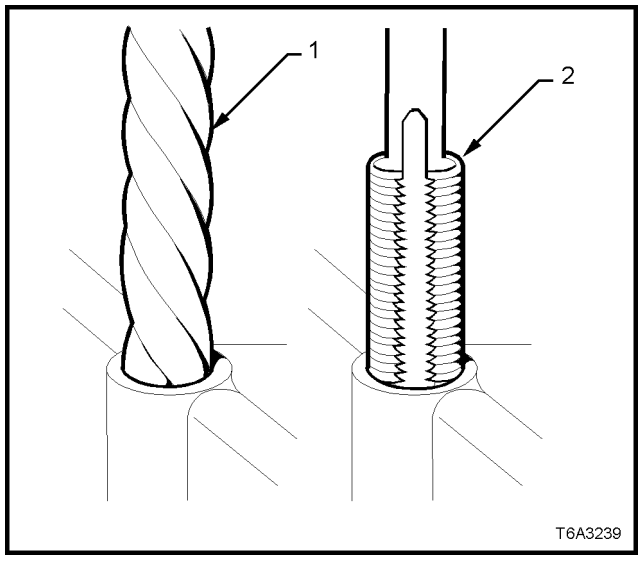


Figure 6A3-353

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

CAUTION: Wear safety glasses to avoid eye injury.

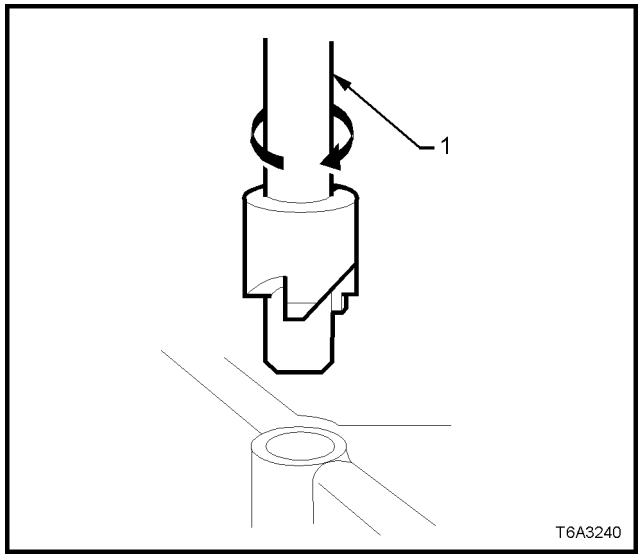


Figure 6A3-354

5. Using a tap wrench (2), tap the threads of the drilled hole to the correct depth for the thread being repaired.
   - M6 inserts require a minimum tap depth of 15 mm.
   - M8 inserts require a minimum tap depth of 20 mm.
   - M10 inserts require a minimum tap depth of 23.5 mm.
6. Using compressed air, clean out any chips.
7. Spray a suitable cleaner such as GM P/N 12346139, P/N 12377981 or equivalent, into the hole.

IMPORTANT: Do not use any cleaning agents that contain Trichloralethane, as this is harmful to aluminium.

8. Using compressed air, clean any cutting oil and chips out of the hole.

CAUTION: Wear safety glasses to avoid eye injury.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

IMPORTANT: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

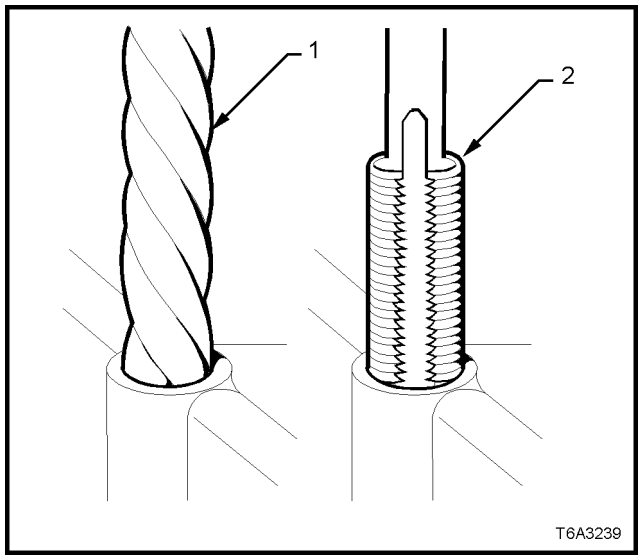


Figure 6A3-355

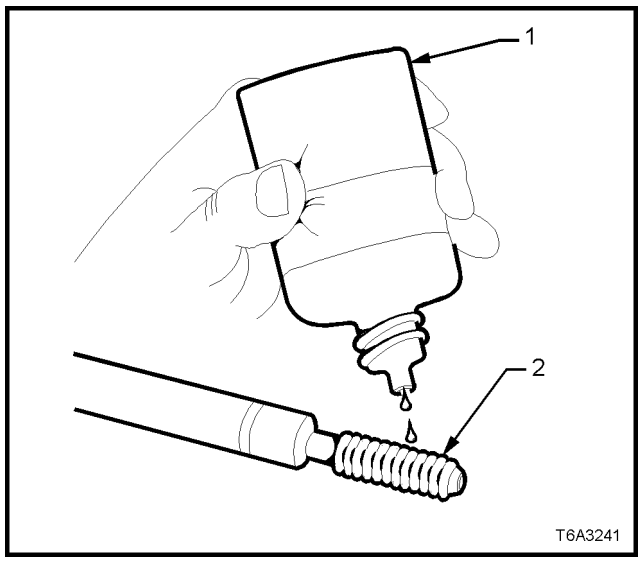


Figure 6A3-356

10. Install the insert (2) onto the driver tool (1).

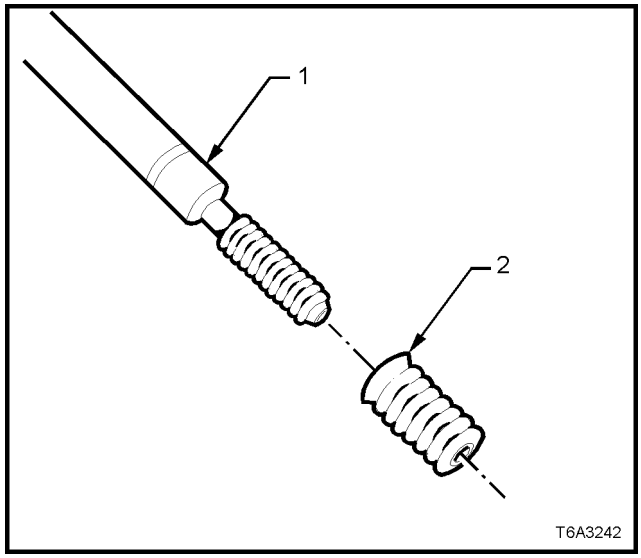


Figure 6A3-357

11. Apply threadlock Loctite 272 (1) or equivalent (GM P/N 12345493) to the insert OD threads (2).

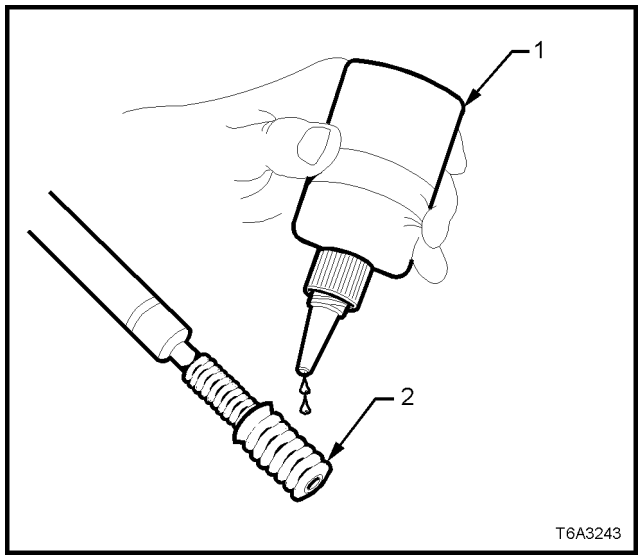


Figure 6A3-358

12. Using the installer tool (1), install the insert (2) into the hole.
13. Continue to install the insert until the flange of the insert contacts the counter-bored surface.
14. Continue to rotate the installer tool (1) through the insert. The installer tool (1) will tighten up before screwing completely through the insert. This is normal since the bottom threads of the insert are being formed and mechanically locked into the hole.
15. Remove the driver. The repair is complete.

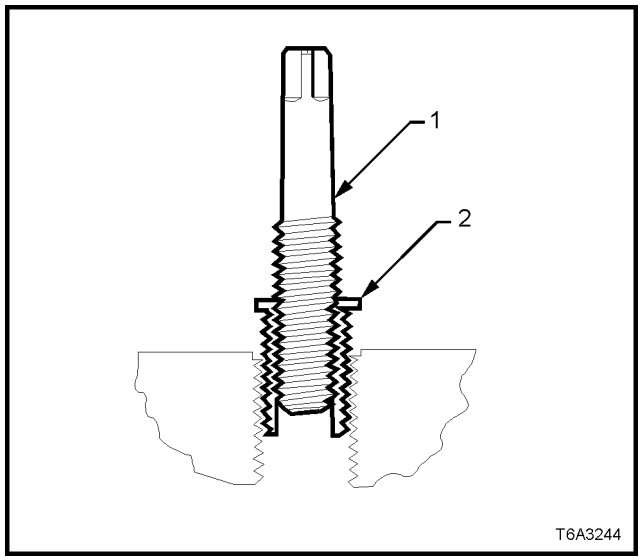


Figure 6A3-359

16. Inspect the insert for proper installation into the hole.
17. A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

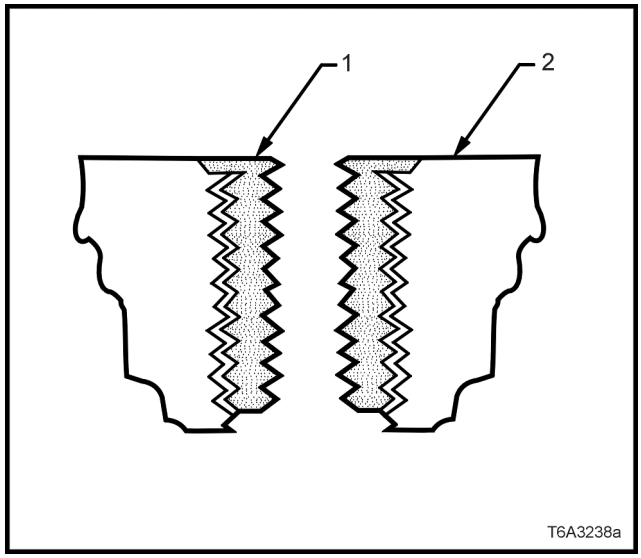


Figure 6A3-360

CYLINDER HEAD BOLT HOLE THREAD REPAIR

The cylinder head bolt hole thread repair kit consists of the following items:

1. Drill
2. Tap
3. Installer
4. Sleeve
5. Alignment Pin
6. Bushing
7. Bolts
8. Fixture Plate

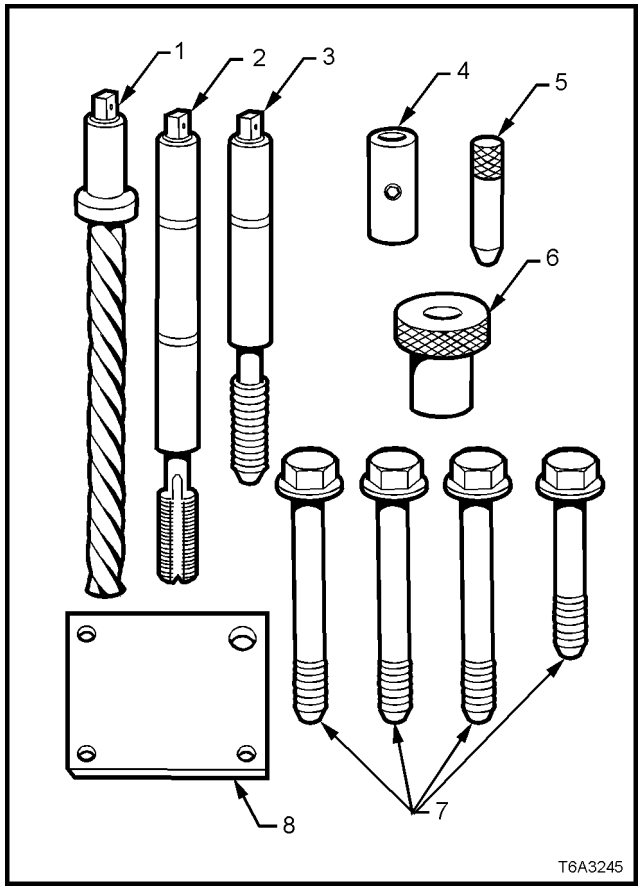


Figure 6A3-361

CAUTION: Wear safety glasses to avoid eye injury.

IMPORTANT: The use of a cutting type fluid GM P/N 1052864, (or WD 40®, or equivalent) is recommended when performing the drilling, counter-boring, and tapping procedures.

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.
2. Position the fixture plate and bushing over the hole that is to be repaired (4).

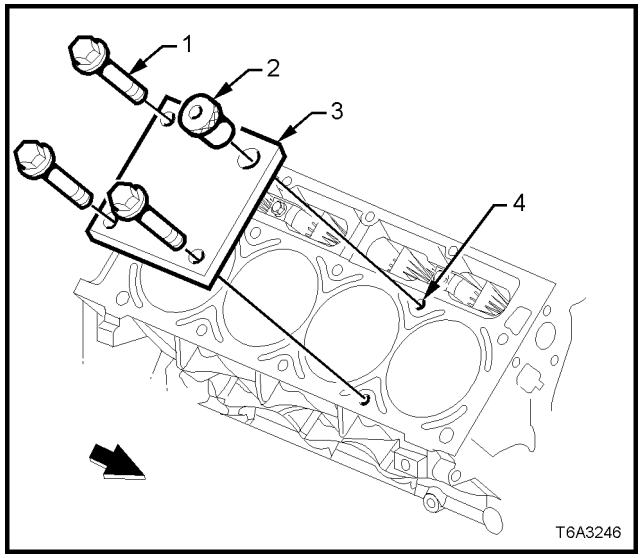


Figure 6A3-362

3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

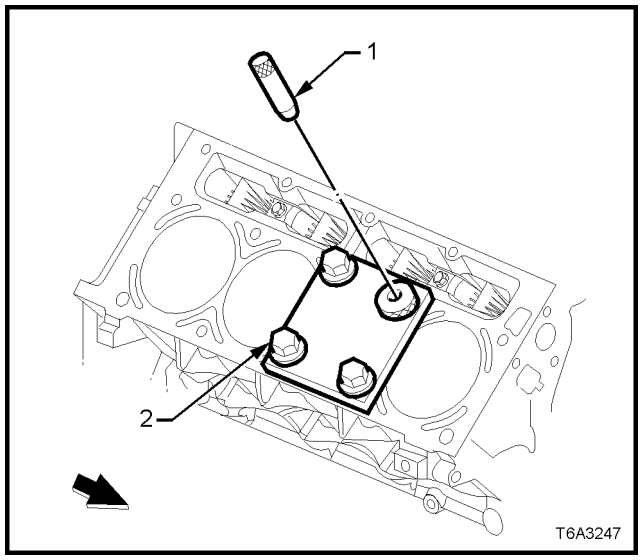


Figure 6A3-363

6. Cylinder head bolt holes 1-8 are the deep holes and will be drilled without the drill sleeve.
7. Cylinder head bolt holes 9 and 10 are the more shallow holes, so drilling MUST be done with the drill sleeve in place

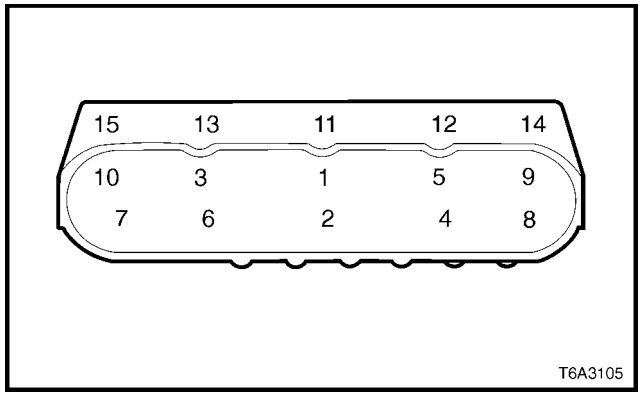


Figure 6A3-364

8. Install the sleeve (2) onto the drill (1) (if required).

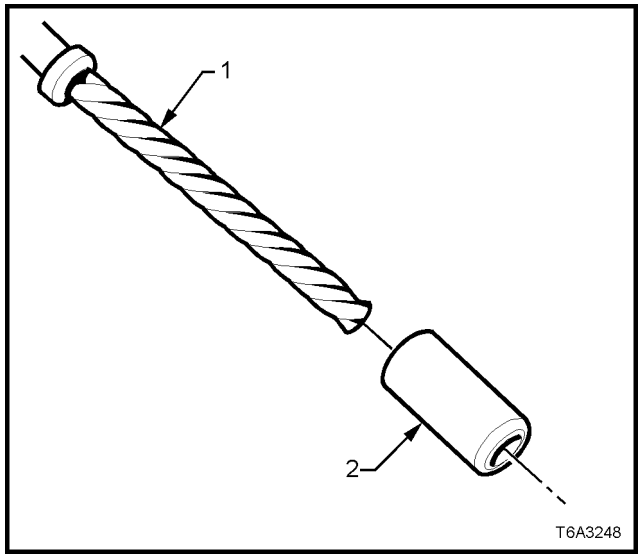


Figure 6A3-365

9. Drill out the threads of the damaged hole.
10. Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.
11. Using compressed air, clean out any chips.

CAUTION: Wear safety glasses to avoid eye injury.

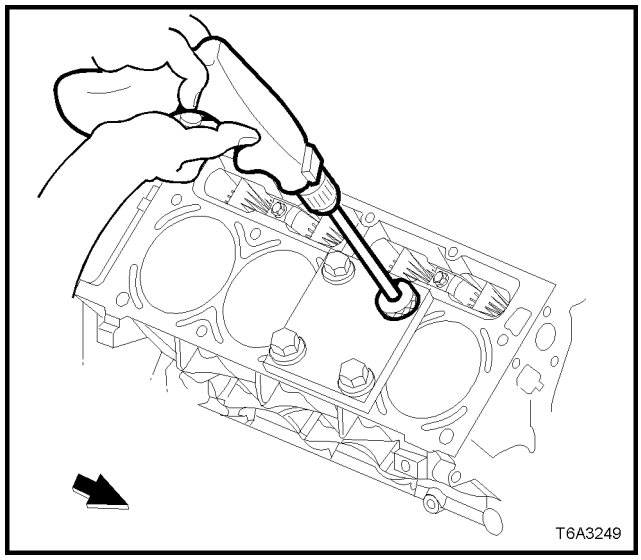


Figure 6A3-366

12. Using a tap wrench, tap the threads of the drilled hole.

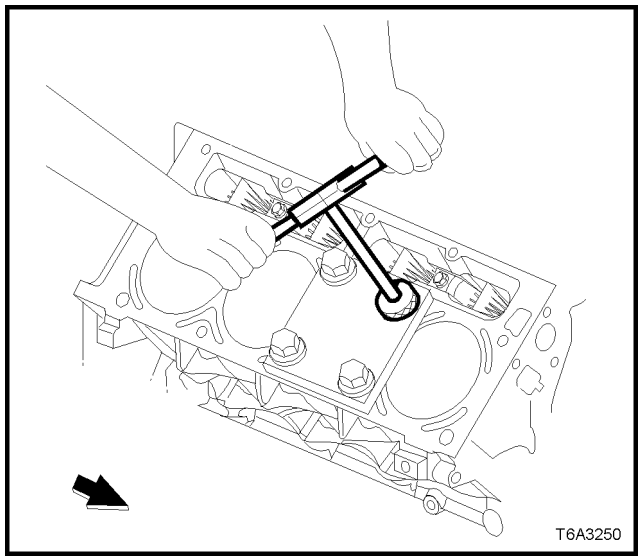


Figure 6A3-367

13. In order to tap the new threads to the proper depth, rotate the tap into the hole until the marks (1 or 4) on the tap align with the top of the drill bushing (3), as follows:
    - For the deeper cylinder head bolt holes (1-8), rotate the tap until the upper mark on the tap (4) aligns with the top of the drill bushing.
    - For the shallower cylinder head bolt holes (9 and 10), rotate the tap until the lower mark on the tap (1) aligns with the top of the drill bushing.
14. Remove the fixture plate (2), bushing (3), and bolts.
15. Using compressed air, clean out any chips.
16. Spray a suitable cleaner such as GM P/N 12346139, P/N 12377981 or equivalent, into the hole.

IMPORTANT: Do not use any cleaning agents that contain Trichloralethane, as this is harmful to aluminium.

17. Using compressed air, clean any cutting oil and chips out of the hole.

CAUTION: Wear safety glasses to avoid eye injury.

18. Lubricate the threads of the installer tool (2) with the driver oil (1).

IMPORTANT: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

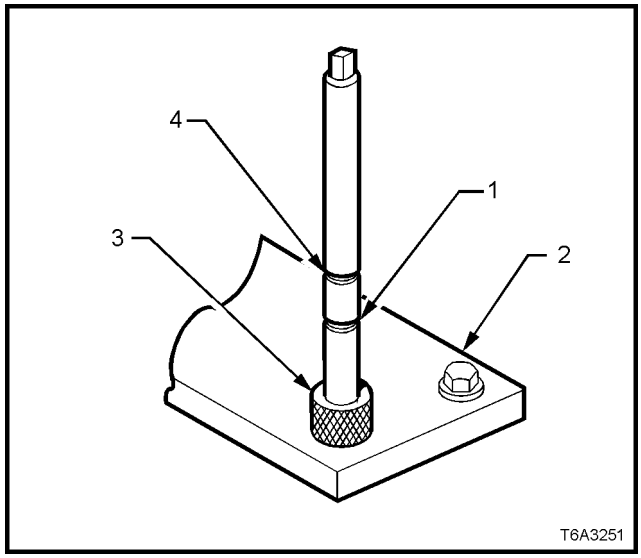


Figure 6A3-368

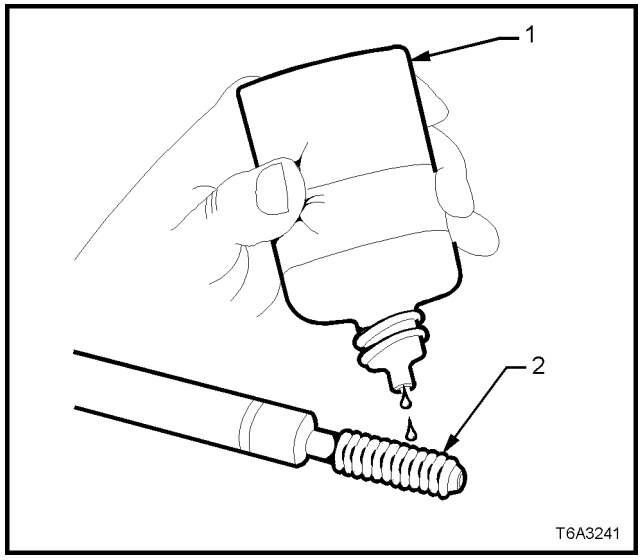


Figure 6A3-369

19. Install the insert (2) onto the driver tool (1).

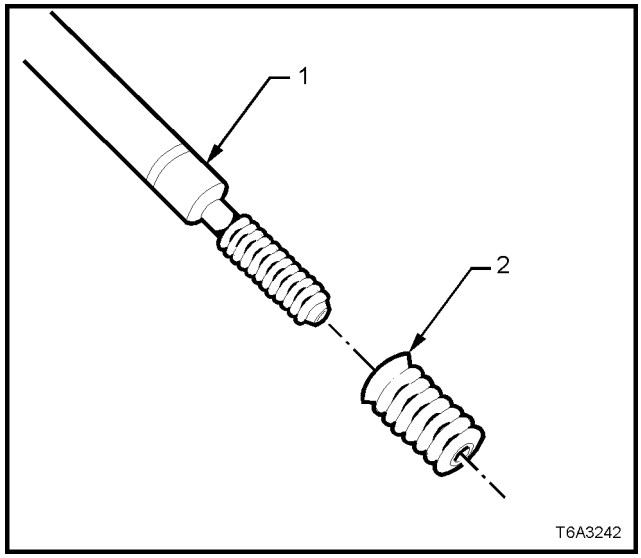


Figure 6A3-370

20. Apply threadlock Loctite 272 (1) or equivalent (GM P/N 12345493) to the insert OD threads (2).

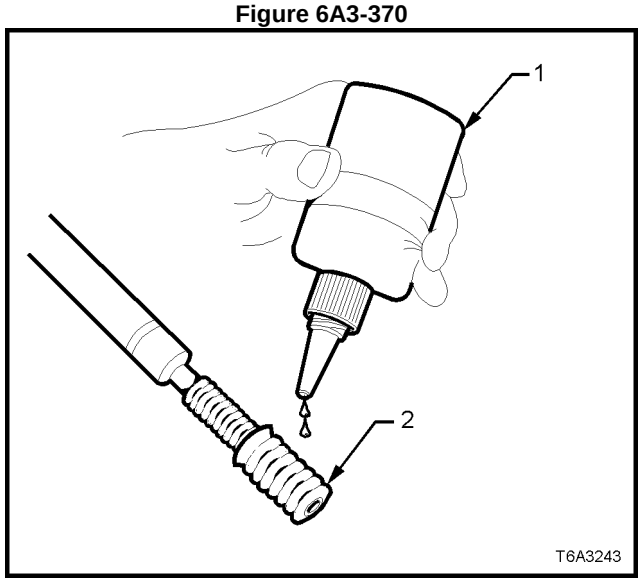


Figure 6A3-371

21. Install the insert and driver (1) into the hole.
22. Continue to install the insert until the flange of the insert contacts the counter-bored surface.
23. Continue to rotate the installer tool (1) through the insert. The installer tool (1) will tighten up before screwing completely through the insert. This is normal since the bottom threads of the insert are being formed and mechanically locked into the hole.
24. Remove the driver. The repair is complete.

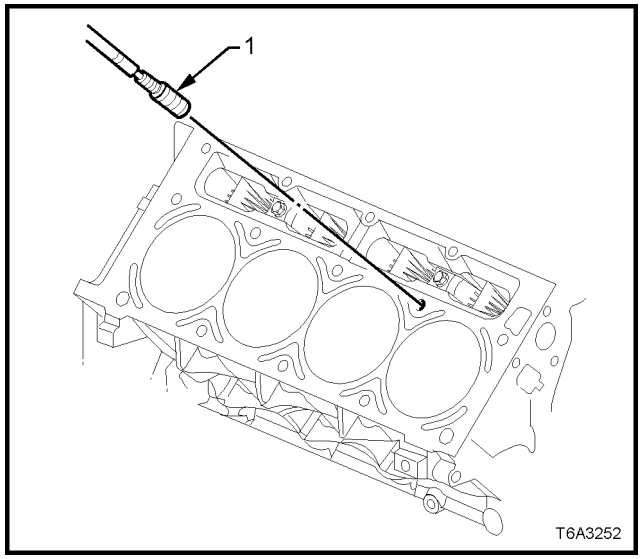


Figure 6A3-372

MAIN CAP BOLT HOLE THREAD REPAIR

The main cap bolt hole thread repair kit consists of the following items:

1. Drill
2. Tap
3. Installer
4. Fixture Plate
5. Long Bolts
6. Short Bolts
7. Alignment Pin
8. Bushing

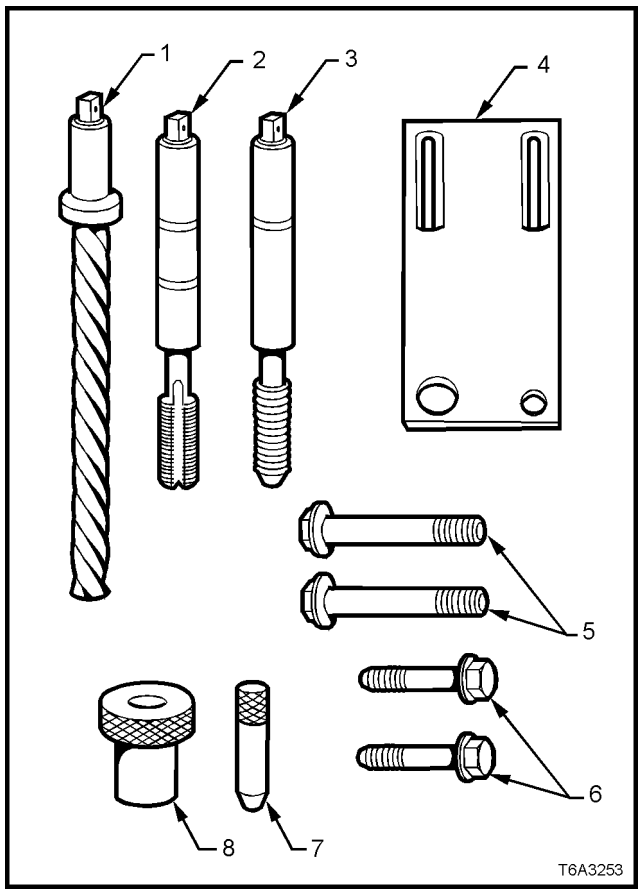


Figure 6A3-373

CAUTION: Wear safety glasses to avoid eye injury.

IMPORTANT: The use of a cutting type fluid GM P/N 1052864, (or WD 40®, or equivalent) is recommended when performing the drilling, counter-boring, and tapping procedures.

Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Position the fixture plate and bushing over the hole that is to be repaired. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

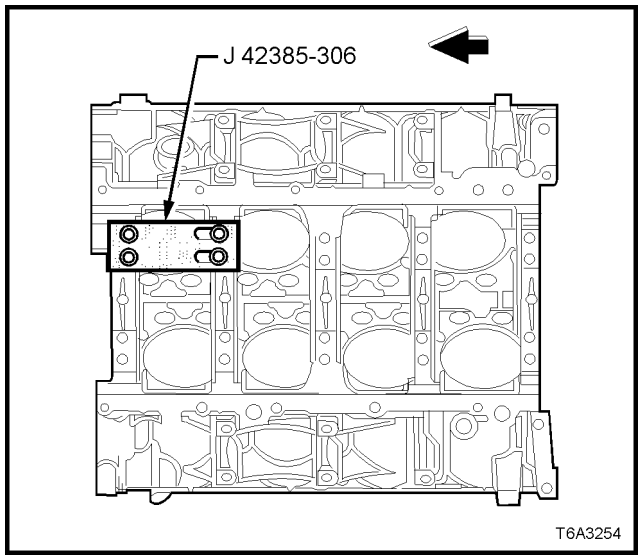


Figure 6A3-374

2. Drill out the damaged hole.

NOTE: The outer bolt hole locations (11-20) have the shallower counter-bores. Use bushing (8), J 42385-316 with the drill.

3. Drill until the stop collar of the drill bit or the sleeve contacts the bushing.
4. Using compressed air, clean out any chips.

CAUTION: Wear safety glasses to avoid eye injury.

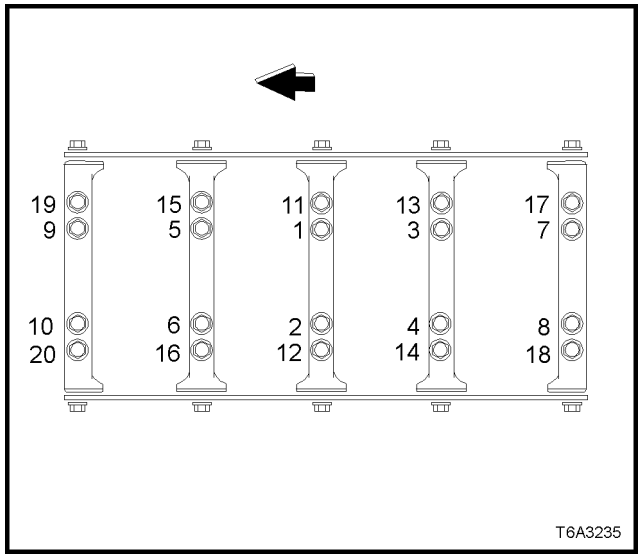


Figure 6A3-375

5. In order to tap the new threads to the proper depth, rotate the tap into the hole until the marks (1 or 4) on the tap align with the top of the drill bushing (3), as follows:
   - For the deeper main cap holes (1-10), rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).
   - For the shallower main cap holes (11-20), rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).
6. Remove the fixture plate (2), bushing (3), and bolts.
7. Using compressed air, clean out any chips.
8. Spray a suitable cleaner such as GM P/N 12346139, P/N 12377981 or equivalent, into the hole.

IMPORTANT: Do not use any cleaning agents that contain Trichloralethane, as this is harmful to aluminium.

9. Using compressed air, clean any cutting oil and chips out of the hole.

CAUTION: Wear safety glasses to avoid eye injury.

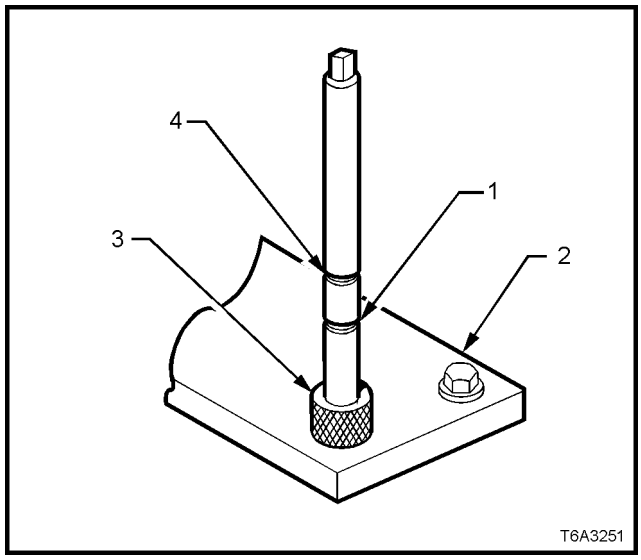


Figure 6A3-376

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

IMPORTANT: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

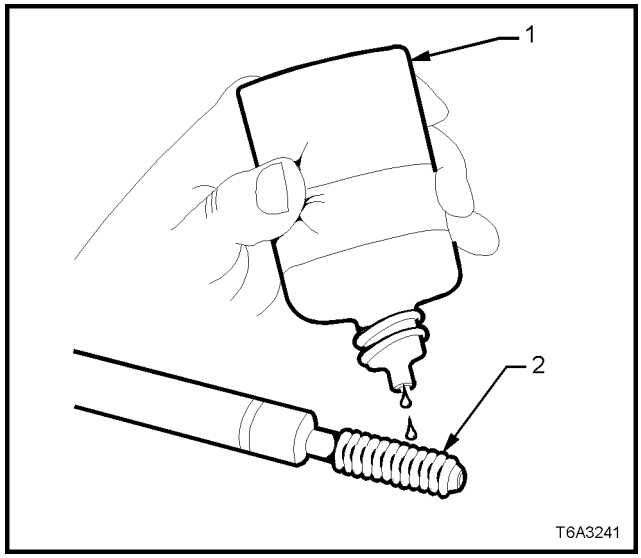


Figure 6A3-377

11. Install the insert (2) onto the driver tool (1).

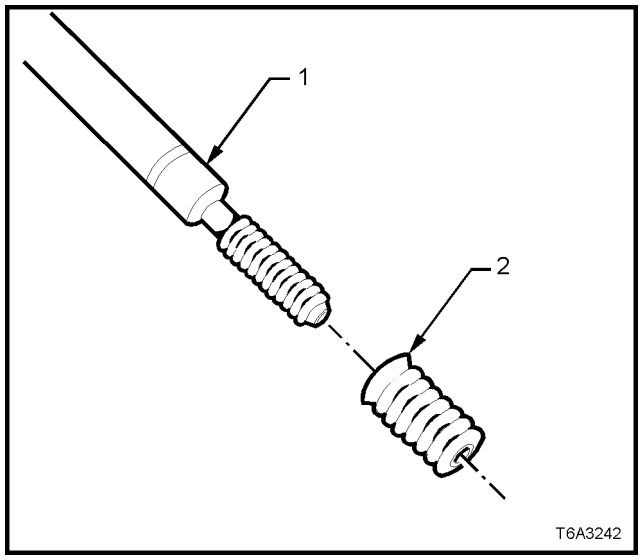


Figure 6A3-378

12. Apply threadlock Loctite 272 (1) or equivalent (GM P/N 12345493) to the insert OD threads (2).

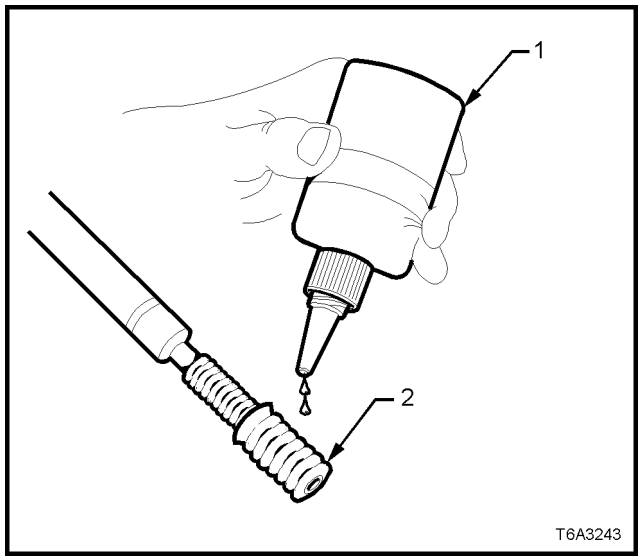


Figure 6A3-379

IMPORTANT: The fixture plate (1) and bushing (2) remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (3) through the fixture plate and bushing and into the hole.
14. Rotate the driver tool until the mark on the tool (4) aligns with the top of the bushing (2).

NOTE: The installer tool will tighten up before screwing completely through the insert. This is normal since the bottom threads of the insert are being formed and mechanically locked into the hole.

15. Remove the driver. The repair is complete.

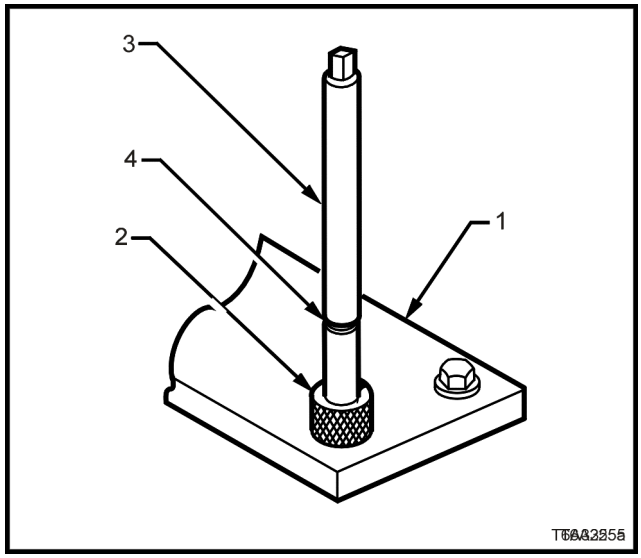


Figure 6A3-380

3.17 THREAD REPAIR SPECIFICATIONS

ENGINE BLOCK - FRONT VIEW

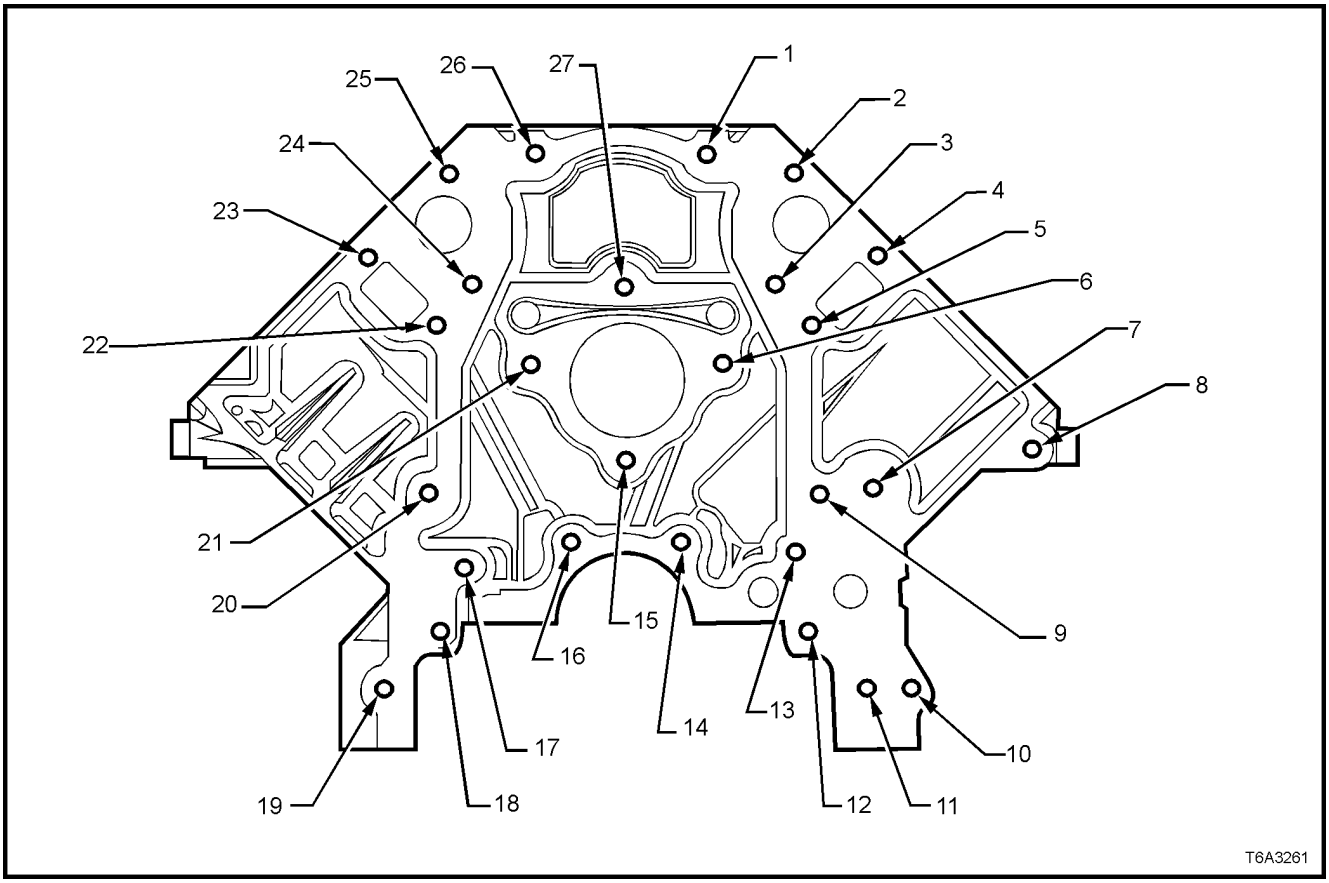


Figure 6A3-381

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1-6	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
7	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	25.0	19.5
8	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	32.5	25.0
9	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
10	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	Through	Through
11-13	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
14	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	Through	18.0
15	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
16	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	Through	18.0
17-27	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5

ENGINE BLOCK - REAR VIEW

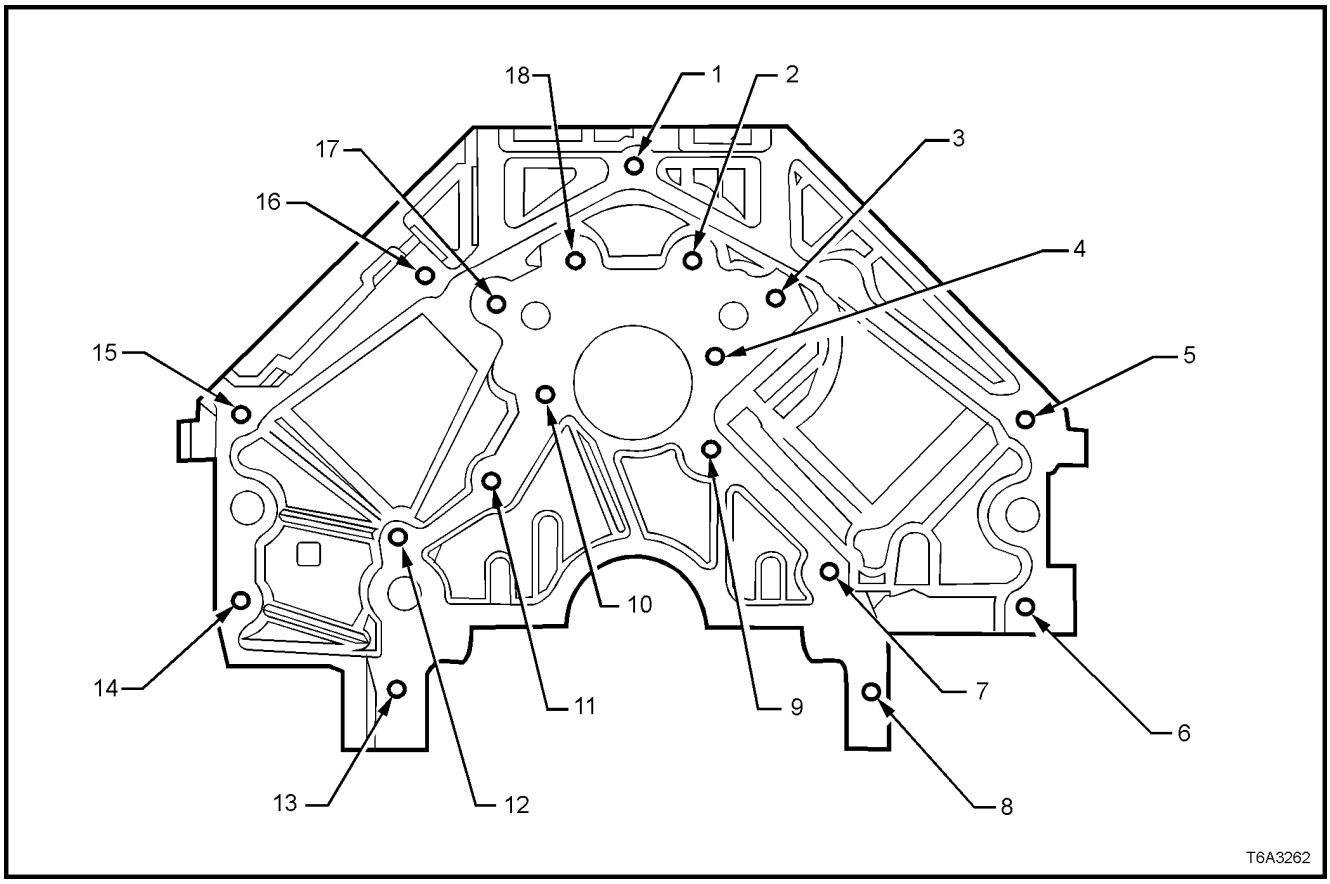


Figure 6A3-382

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0	21.5
2-4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
5-6	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0	21.5
7-13	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
14-16	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0	21.5
17-18	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5

ENGINE BLOCK - LEFT SIDE VIEW

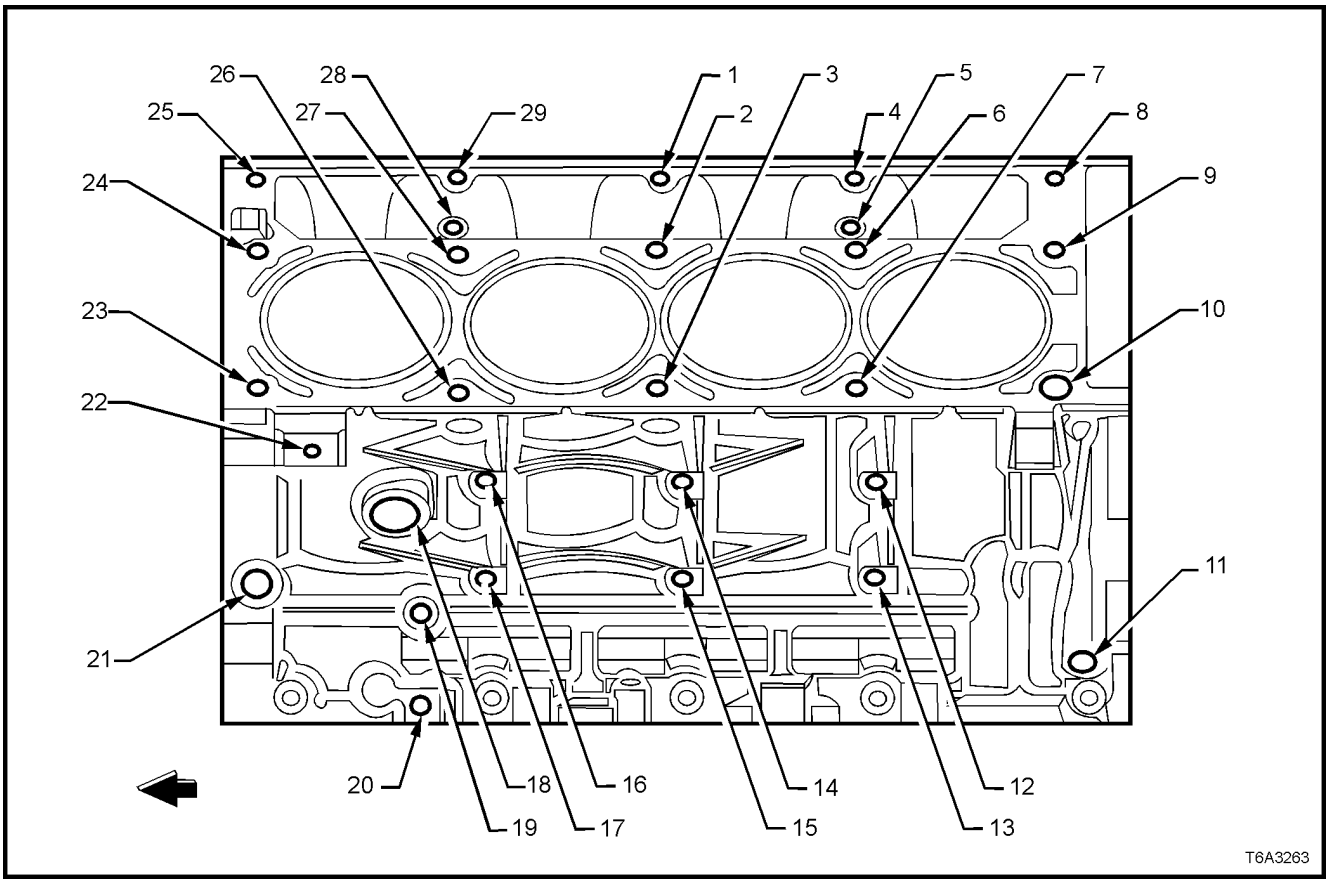


Figure 6A3-383

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
2-3	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
5	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5	16.0
6-7	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
9	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0	60.0
10	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
11	—	—	—	—	—	—	—	—
12-17	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	29.0	23.0
18	M28 x 1.25	—	—	—	—	—	—	—
19-20	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0	16.0
21	M16 x 1.5	—	—	—	—	—	—	—
22	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0	21.5
23	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
24	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0	60.0
25	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
26-27	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
28	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5	16.0
29	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0

- Bolt holes 2, 3, 6, 7, 10, 23, 26, and 27 have a 85 mm counterbore included in the 124.0 mm drill depth.
- Bolt holes 9 and 24 have a 30 mm counterbore included in the 69.0 mm drill depth. Use sleeve J 42385-315 with the drill and tap.

ENGINE BLOCK - RIGHT SIDE VIEW

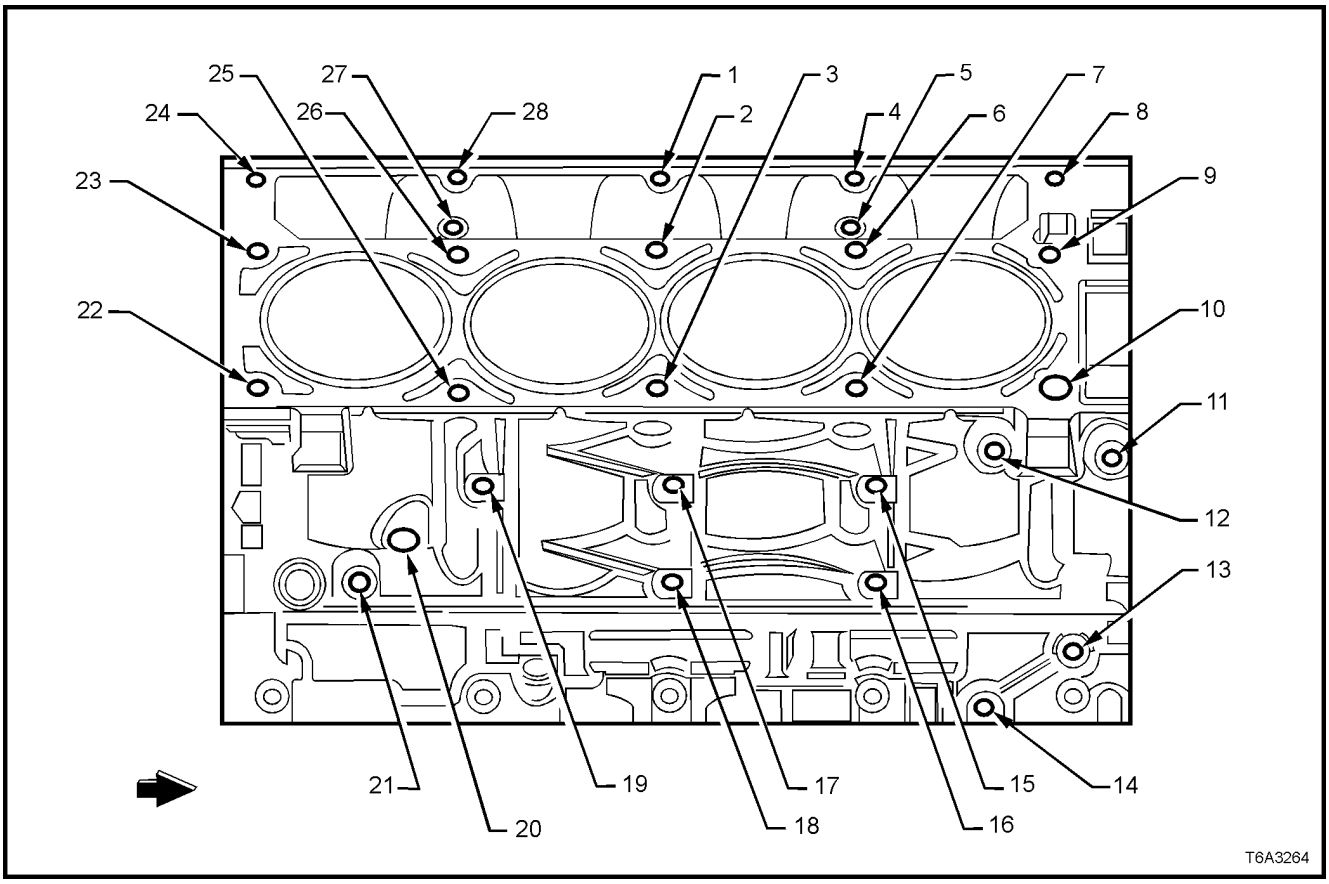


Figure 6A3-384

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
2-3	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
5	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5	15.0
6-7	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
9	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0	60.0
10	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
11-14	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0	21.5
15-19	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	29.0	23.0
20	M16 x 1.5	—	—	—	—	—	—	—
21	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
22	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
23	M11 x 2	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0	60.0
24	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
25-26	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0	115.0
27	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5	15.0
28	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0

- Bolt holes 2, 3, 6, 7, 10, 22, 25, and 26 have a 85 mm counterbore included in the 124.0 mm drill depth.
- Bolt holes 9 and 23 have a 30 mm counterbore included in the 69.0 mm drill depth. Use sleeve J 42385-315 with the drill and tap.

ENGINE BLOCK - BOTTOM VIEW

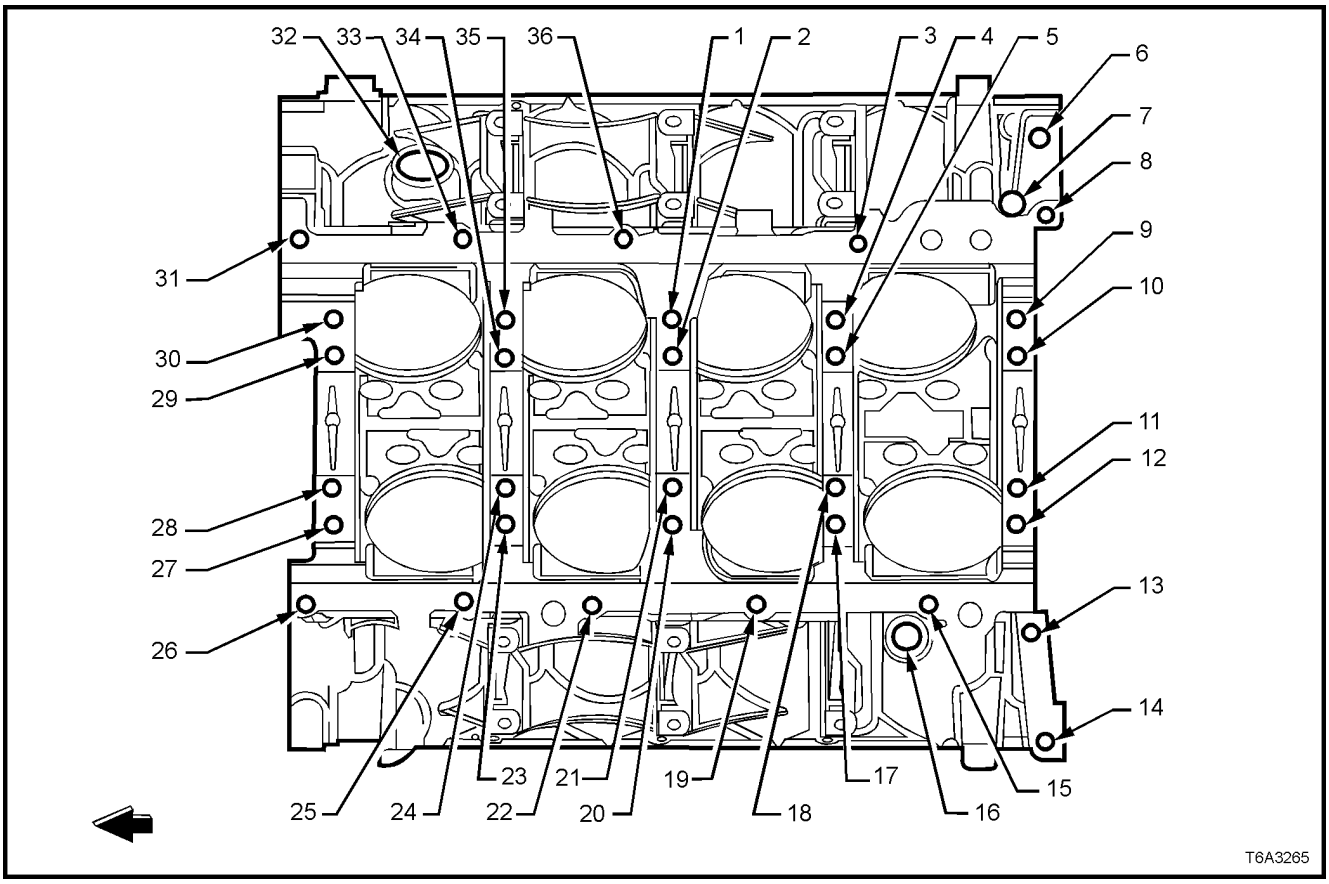


Figure 6A3-385

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
2	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0
3	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
4	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
5	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0
6	M16 x 1.5	—	—	—	—	—	—	—
7	N/A	—	—	—	—	—	—	—
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
9	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
10-11	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0
12	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
13-14	M10 x 1.5	J 42385-215	J 42385-101	—	J 42385-213	J 42385-214	42.5	37.0
15	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
16	M16 x 1.5	—	—	—	—	—	—	—
17	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	
18	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
19	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
20	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0
21	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
22	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
23	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
24	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
25-26	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
27	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
28-29	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0
30	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
31	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
32	M28 x 1.25	—	—	—	—	—	—	—
33	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5
34	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5	44.0
35	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0	25.5
36	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5	17.5

- Bolt holes 2, 5, 10, 11, 18, 21, 24, 28, 29, and 34 have a 20.5 mm counterbore included in the 53.5 mm drill depth.
- Bolt holes 1, 4, 9, 12, 17, 20, 23, 27, 30, and 35 have a 1.5 mm counterbore included in the 31.0 mm drill depth. Use sleeve J 42385-316 with the drill and tap..
- Bolt holes 13 and 14 have a 11.5 mm counterbore included in the 42.5 mm drill depth. Use sleeve J 42385-311 with the drill and tap.

ENGINE BLOCK - TOP VIEW

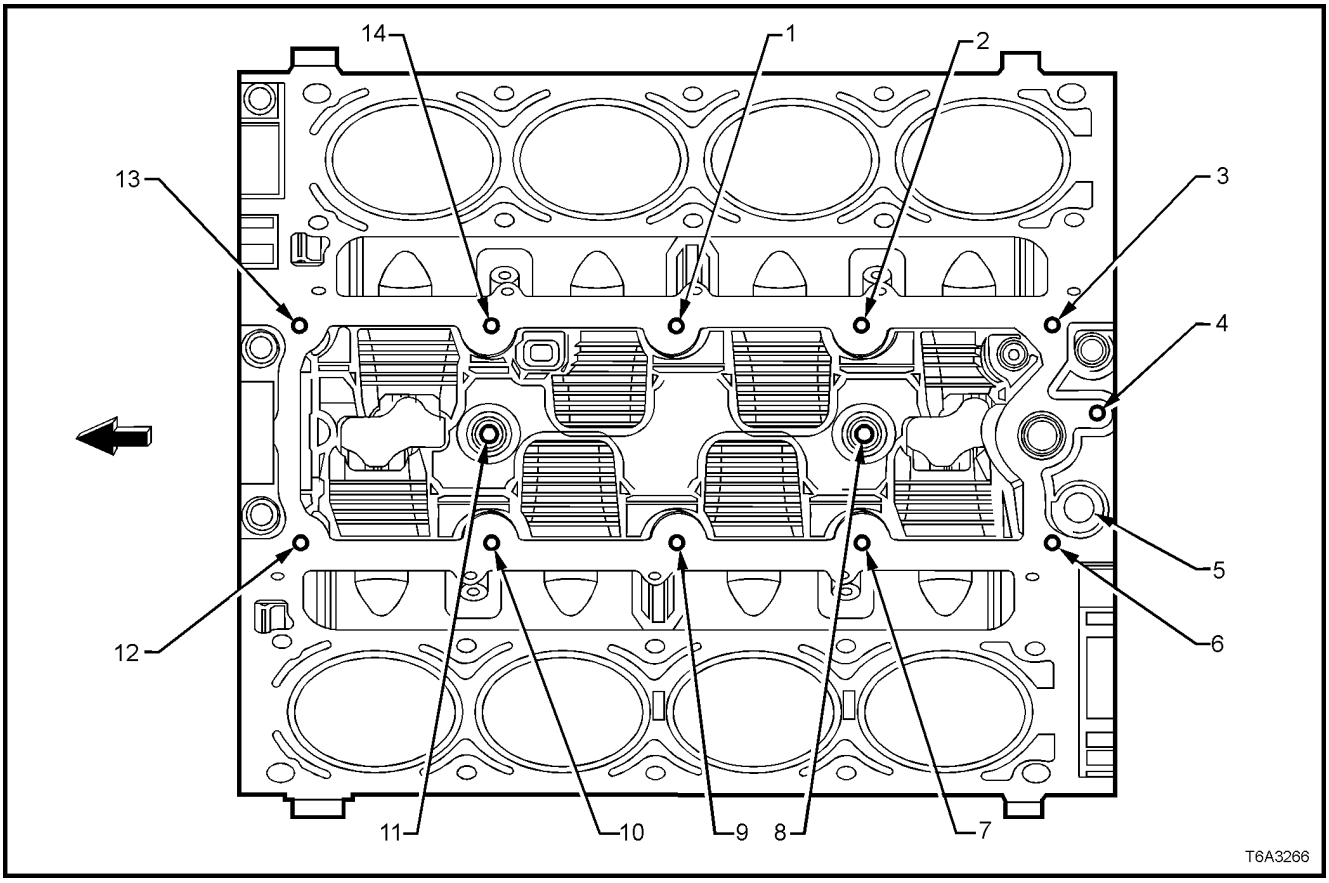


Figure 6A3-386

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1-4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
5	M16 x 1.5	—	—	—	—	—	—	—
6-7	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
8	M10 x 1.5	J 42385-216	J 42385-211	J 42385-212	J 42385-213	J 42385-214	22.5	17.0
9-10	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
11	M10 x 1.5	J 42385-216	J 42385-211	J 42385-212	J 42385-213	J 42385-214	22.5	17.0
12-14	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0

CYLINDER HEAD - TOP VIEW

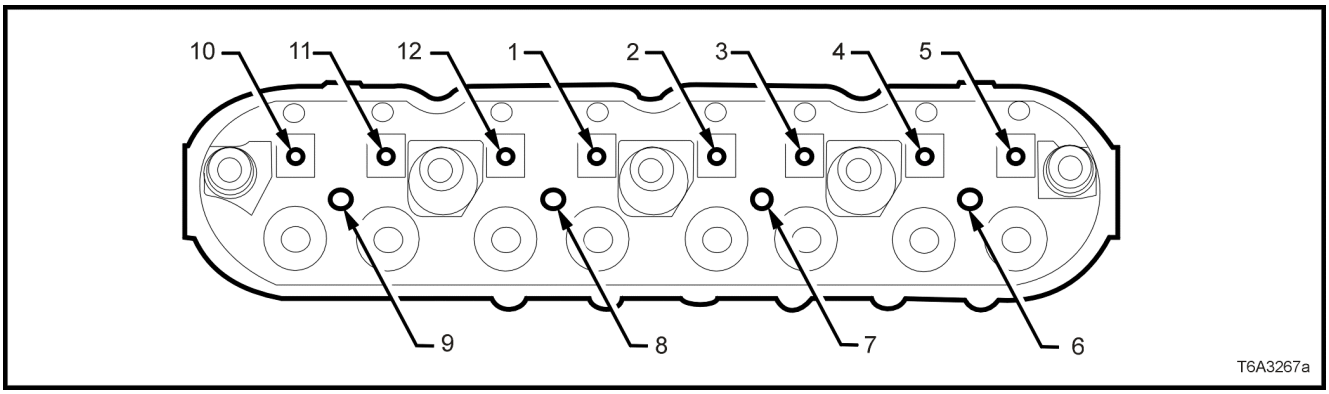


Figure 6A3-387

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1-5	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0
6-9	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	20.05	16.05
10-12	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5	19.0

CYLINDER HEAD - END VIEW

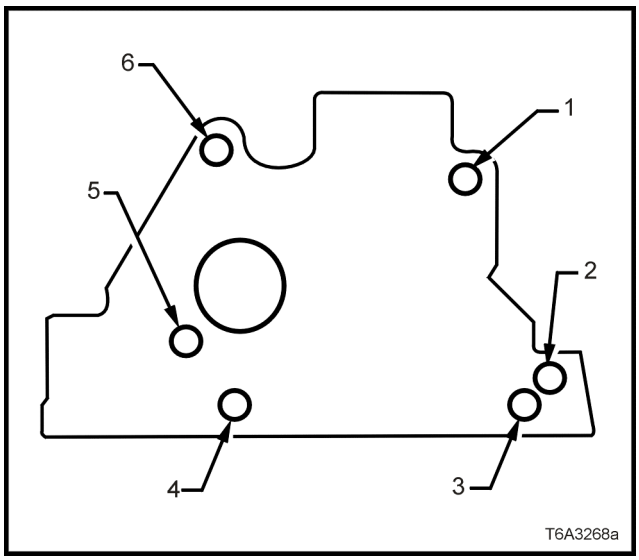


Figure 6A3-388

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0	20.0
2	N/A	—	—	—	—	—	—	—
3	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0	20.0
4	N/A	—	—	—	—	—	—	—
5-6	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0	20.0

CYLINDER HEAD - EXHAUST MANIFOLD SIDE VIEW

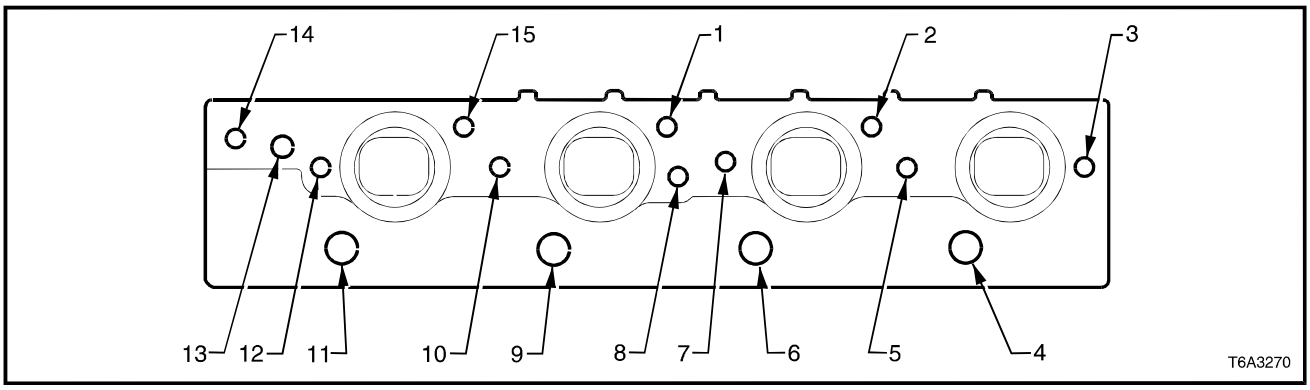


Figure 6A3-389

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1-2	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0	20.0
3	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0	16.0
4	M14 x 1.25	—	—	—	—	—	—	—
5	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0	16.0
6	M14 x 1.25	—	—	—	—	—	—	—
7-8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0	16.0
9	M14 x 1.25	—	—	—	—	—	—	—
10	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0	16.0
11	M14 x 1.25	—	—	—	—	—	—	—
12	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0	16.0
13	M12 x 1.5	—	—	—	—	—	—	—
14-15	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0	20.0

CYLINDER HEAD - INTAKE MANIFOLD SIDE VIEW

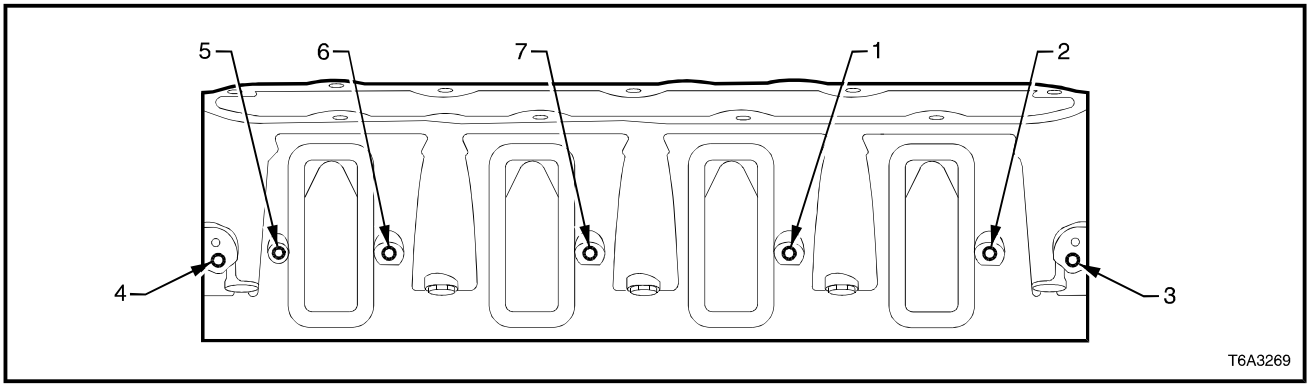


Figure 6A3-390

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Maximum Drill Depth mm	Maximum Tap Depth mm
1-2	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	Through	Through
3-4	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5	15.0
5-7	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	Through	Through

4. DIAGNOSIS

4.1 BASIC ENGINE MISFIRE DIAGNOSIS

GENERAL INFORMATION

1. Engine performance diagnosis procedures are covered in **Section 6C3 POWERTRAIN MANAGEMENT GEN III V8 ENGINE** and should be referred to for diagnosis of any Driveability, Emissions, or Check Powertrain Lamp concerns.
2. The following diagnosis covers common concerns and possible causes.
3. When the proper diagnosis is made, the concern should be corrected by adjustment, repair or replacement as required.
4. Refer to the appropriate section of the service manual for each specific procedure.
5. This diagnostic table will assist in engine misfire diagnosis due to a mechanical concern such as a faulty camshaft, worn or damaged bearings or bent pushrod.
6. This table will not isolate a crossed injector wire, faulty injector or any other driveability component failure that may cause a misfire.
7. The Powertrain On-Board Diagnostic System checks must be performed first. Refer to **Section 6C3-2A POWERTRAIN MANAGEMENT GEN III V8 ENGINE, DIAGNOSTIC CHARTS**.
8. When using this table to make a Base Engine Misfire diagnosis, begin with the preliminary information below and then proceed to the specific category.

DIAGNOSTIC PROCEDURE

Checks	Action
Preliminary	1. Perform a visual inspection of the following: • A loose or improperly installed engine flywheel or crankshaft balancer. • Worn, damaged, or misaligned accessory drive system components. 2. Listen to the engine for any abnormal internal engine noises. 3. Inspect the engine for acceptable oil pressure. Refer to 2.4 ENGINE OIL PRESSURE – CHECK in this Section. 4. Verify if the engine has excessive oil consumption. Refer to 4.4 OIL CONSUMPTION DIAGNOSIS, in this Section. 5. Verify if the engine has coolant consumption. 6. Perform a compression test on the engine.
Intake Manifold Leaks	1. An intake manifold that has a vacuum leak may cause a misfire. 2. Inspect for the following: • Improperly installed or damaged vacuum hoses. • Faulty or improperly installed intake manifold and/or gaskets. • Cracked or damaged intake manifold. • Inspect the areas between the intake runners. • Improperly installed or damaged Manifold Absolute Pressure (MAP) sensor housing (located at the rear of the intake manifold). • Improperly installed or damaged MAP sensor housing O-ring seal. • Improperly installed MAP sensor. • The sealing grommet of the MAP sensor should not be torn or damaged. • Improperly installed throttle body or damaged gasket. • Warped intake manifold. • Warped or damaged cylinder head sealing surface.
Coolant Consumption	1. Coolant consumption may or may not cause the engine to overheat. Inspect for the following: • External coolant leaks. • Faulty cylinder head gasket. • Warped cylinder head. • Cracked cylinder head. • Damaged engine block.

Checks	Action
Oil Consumption	1. Oil consumption may or may not cause the engine to misfire. Remove the spark plugs and inspect for an oil fouled spark plug. 2. Perform a cylinder compression test. Refer to 2.5 COMPRESSION CHECK in this Section. 3. If the compression test indicates worn valves or valve guides, inspect for the following: • Worn valve guides. • Worn valve stems. • Worn or burnt valves or valve seats. • Worn, brittle, or improperly installed valve stem oil seals. 4. If the compression test indicates worn or damaged piston rings, inspect the following: • Broken or improperly seated piston rings. • Excessive piston ring end gap. • Excessive cylinder bore wear or taper. • Cylinder damage. • Piston damage.
Abnormal Internal Engine Noises	1. With the engine running, try and determine if the noise is timed to camshaft speed or crankshaft speed. **NOTE:** Using a timing light, two knocks per flash is crankshaft speed and one knock per flash is camshaft speed. 2. If the noise is timed to camshaft speed, inspect the following: • Missing or loose valve train components. • Worn or loose valve rocker arms. • Worn or bent pushrods. • Faulty valve springs. • Bent or burnt valves. • Worn camshaft lobes. • Worn or damaged timing chain and/or sprockets. **IMPORTANT:** A slight COLD knock or piston slapping noise could be considered normal if not present after the engine has reached normal operating temperatures. 3. If the knock is timed to crankshaft speed, inspect the following: • Worn crankshaft main or connecting rod bearings. • Piston or cylinder damage. • Worn piston or piston pin. • Damaged or faulty connecting rod. • Excessive carbon build-up on the top of the piston.
No Abnormal Internal Engine Noise	1. Inspect for a worn or improperly installed timing chain and/or sprockets. 2. Remove the valve rocker arm cover on the side of the engine with the cylinder that is misfiring. 3. Inspect for the following: • Loose valve rocker arm bolts. • Bent push rods. • Faulty valve springs. • Faulty valve lifters (bleeding down). • Worn or improperly seated valves. • Worn camshaft lobes.

4.2 ENGINE NOISE DIAGNOSIS

There are four steps to diagnosing engine noise. You must determine the following:

The type of noise. For example, is the noise a light rattle/tapping or a low rumble/knocking?

The exact operating condition under which the noise exists. Note factors such as the ambient temperature, the amount of engine warm-up time, the engine temperature, engine speed other specifics.

At what rate the noise occurs, and at what location in the engine. Remember, engine noises are generally synchronised to either engine speed (crankshaft, flywheel, connecting rods, balancer, or pistons and related components) or one-half engine speed (valve train noise such as rocker arms, valve lifters, and timing chain). Try to determine the rate at which the noise is occurring.

Compare the engine sounds to other engines. This is required to make sure you are not trying to correct a normal condition.

Checks	Action
Noise on Start-Up but Only Lasts a Few Seconds	1. This noise condition may be caused by: • Improper oil viscosity. Install the recommended oil viscosity for the expected temperatures. • Incorrect oil filter without the anti-drainback feature. • Worn or dirty hydraulic valve lifters. • Excessive piston to bore clearance. • Excessive piston pin to piston clearance. • Excessive crankshaft bearing clearance.
Knocks Cold and Continues for 1 to 2 Minutes	1. Common causes for a cold start knock, are: • Loose or broken crankshaft balancer or accessory drive components. • Excessive piston to bore clearance. • A cold piston knock which disappears in 1.5 minutes should be considered acceptable. • A cold engine knock usually disappears when the specific cylinders secondary ignition circuit is earthed.
Intermittent Noise on Idle, Disappearing When Engine Speed is Increased	1. Intermittent noises at idle can be caused by: • Improper oil viscosity. Install the recommended oil viscosity for the expected temperatures. • Lower than specified oil pressure. Install an oil pressure gauge and measure the engine oil pressure. • Dirty or worn hydraulic valve lifter.

Checks	Action
Valve Train Noise (Rattle/Tapping)	1. The following conditions may cause valve train noise: • Lower than specified oil pressure. • Worn or faulty oil pump. • Loose oil pump-to-engine block bolts. • Loose or damaged oil transfer tube and/or gaskets. • Loose valve rocker arm attachments. • Worn valve rocker arm bearings. • Worn valve rocker arm and/or pushrod. • Broken valve spring. • Sticking valves. • Worn, dirty, or faulty hydraulic valve lifters. • Worn camshaft lifter lobes. • Worn valve guides or valve stems. • Bent, broken, or damaged timing chain sprocket teeth.
Knocks at Idle Hot (Rumble/Knocking)	1. The following conditions may cause a knocking noise: • Malfunctioning accessory drive system components. • Loose or broken crankshaft balancer. • Detonation or spark knock. • Check for proper operation of the cooling, knock, and ignition control components. • Refer to diagnostic information in 6C3 POWERTRAIN MANAGEMENT - GEN III V8 ENGINE. • Excessive connecting rod bearing clearance. • Excessive piston pin to bore clearance. • Bent connecting rod. • Excessive crankshaft main or thrust bearing clearance. • Loose torque converter bolts. • Cracked or damaged flywheel. • Exhaust leak at the manifold.
Exhaust System Noise and/or Leakage	1. Exhaust system noise and/or leakage may be caused by the following conditions: • Improperly installed or misaligned exhaust system components. • A cracked or broken exhaust manifold. • Damaged or worn gaskets and/or seals. • Burned or rusted out exhaust system components. • A broken or loose exhaust clamp and/or bracket.

4.3 VALVE TRAIN DIAGNOSIS

GENERAL INFORMATION

- A light tapping noise at one-half engine speed, or any varying frequency, may indicate a valve train problem. These tapping noises will typically increase with engine speed.
- Before attempting to diagnose valve train noise, check for the proper oil level and thoroughly warm up the engine. By doing this you will bring all engine components to a normal state of expansion.
- While sitting in the drivers seat, run the engine at various speeds and listen for any abnormal engine noise.
- Whenever Valve Lifter Diagnosis is necessary, always use a listening device such as a stethoscope. Tools such as this will help to isolate any lifter noise and identify noises that could be mis-diagnosed as lifter noise.

DIAGNOSTIC PROCEDURE

Checks	Action
A light tapping noise similar to valve train noise.	1. This light type of noise may be caused by the following: • Fuel injectors. • Evaporative emission (EVAP) purge solenoid. • Detonation. • Loose heat shields.
Causes of Valve Train Noise	1. Any or a combination of the following can cause valve train noise: • Poor oil quality caused by water contamination, aeration, or fuel dilution. • Low engine oil pressure. • Worn or faulty oil pump. • A loose or plugged oil pump screen. • Loose or damaged oil transfer tube. • Loose valve rocker arm attachments (causing excessive valve lash). • Worn or damaged valve rocker arm bearings. • Worn valve rocker arm and/or pushrod. • Broken valve spring. • Sticking valves. • Valve lifters worn, dirty, or faulty. • Broken valve lifter guide. • Camshaft valve lifter lobes worn. • Worn valve guides or valve stems. • Worn, damaged, or missing valve keys. • Bent pushrods. • Excessive play in the camshaft timing chain. • Bent, broken, or damaged timing chain sprocket teeth.

DIAGNOSTIC TABLE

Definition: A light tapping noise at one half engine speed, or any varying frequency.

Step	Action	Value(s)	Yes	No
1	Is there valve train noise?	–	Go to Step 2	System OK
2	Check for a high engine oil level. A engine with the oil level above the FULL mark allows the crankshaft counterweights to churn the oil into foam. When foamy oil is pumped into the lifters, the lifters become noisy. A solid column of oil ensures proper lifter operation. Is the oil level too high?	–	Go to Step 3	Go to Step 4
3	Drain engine oil until level is correct. Is there valve train noise?	–	Go to Step 4	System OK
4	Check for a low engine oil level. A engine with the oil level below the ADD mark may allow the oil pump to pump air at high engine speeds. Is the oil level too low?	–	Go to Step 5	Go to Step 6
5	Add oil as required. Is there valve train noise?	–	Go to Step 6	System OK
6	Check for proper engine oil pressure. Refer to 2.4 ENGINE OIL PRESSURE – CHECK, in this Section. Is the engine oil pressure within specifications?	–	Go to Step 7	Go to Step 7
7	1. Check the oil pump screen for damage or a loose fit to the oil pump. 2. Inspect for a missing or damaged oil pump screen O-ring seal. Is the oil pump screen loose or is the screen or O-ring seal damaged?	–	Go to Step 8	Go to Step 9
8	Repair as required. Is there valve train noise?	–	Go to Step 9	System OK
9	Check for a damaged oil pump or loose mounting bolts. Refer to Oil Pump Clean and Inspect, in this Section. Is the oil pump damaged or are the fasteners loose?	–	Go to Step 10	Go to Step 11
10	Repair as required. Is there valve train noise?	–	Go to Step 11	System OK
11	Remove and inspect the valve lifters, guides, rocker arms, and pushrods. Refer to Valve Rocker Arm and Push Rods Clean and Inspect and Valve Lifters and Guides Clean and Inspect, in this Section. Are components worn or damaged?	–	Go to Step 12	Go to Step 13
12	Repair as required. Is there valve train noise?	–	Go to Step 13	System OK
13	Perform a camshaft lobe lift test. Refer to 3.2 CAMSHAFT LOBE LIFT – Measure in this Section. Is the test within specification?		Go to Step 17	Go to Step 14
14	Remove the engine front cover and inspect the timing chain and sprockets for excessive wear or damage. Refer to 3.8 TIMING CHAIN AND SPROCKETS, in this Section. **IMPORTANT:** Pushrod engines are designed so that a timing chain more than one tooth improperly positioned will cause valve interference with the piston. Are the components worn or damaged, or improperly positioned?	–	Go to Step 15	Go to Step 16
15	Replace components as required. Is there valve train noise?	–	Go to Step 16	System OK
16	Replace camshaft and/or bearings and all hydraulic valve lifters. Refer to 3.9 CAMSHAFT, in this Section. Is there valve train noise?	–	Go to Step 17	System OK
17	Perform a complete disassembly of the engine and inspect all components. Are components worn or damaged?	–	Go to Step 18	System OK
18	Replace the worn/damaged components as required.	–	System OK	–

4.4 OIL CONSUMPTION DIAGNOSIS

Definition: Excessive oil consumption (not due to leaks) is the use of 0.95 litres or more of engine oil within 2,500 kilometres.

Checks	Action
Preliminary	1. The causes of excessive oil consumption may include the following conditions: • External oil leaks. Refer to 4.6 OIL LEAK DIAGNOSIS in this Section. • Incorrect oil level or improper reading of the oil level indicator. With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2-3 minutes) and check for the correct engine oil level. • Improper oil viscosity. Refer to the vehicle Owners Manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage. • Crankcase ventilation system restrictions or malfunctioning components. • Worn valve guides and/or valve stems. • Worn or improperly installed valve stem oil seals. • Piston rings broken, worn, not seated properly. Allow adequate time for the rings to seat. Replace worn piston rings as necessary. • Piston and rings improperly installed or incorrectly fitted to the cylinder bore. • Excessive piston to bore clearance.

4.5 OIL PRESSURE DIAGNOSIS

Conduct an oil pressure check, as detailed in **2.4 ENGINE OIL PRESSURE - CHECK**, in this Section

Checks	Action
Oil Pressure Below Specification	1. Inspect the engine for one or more of the following: • Oil pump worn or dirty. • Oil pump to engine block bolts loose. • Oil pump screen loose, plugged or damaged. • Oil pump screen O-ring seal missing or damaged. • Malfunctioning oil pump oil pressure relief valve. • Excessive bearing clearances. • Cracked, porous or restricted oil galleries. • Oil gallery plugs leaking, missing or incorrectly installed. • Broken/malfunctioning hydraulic valve lifters.
Oil Pressure Above Specification	1. Inspect for one or more of the following: • Plugged or incorrect oil filter fitted. • Malfunctioning oil by-pass valve. • Malfunctioning oil pressure gauge or sensor.

4.6 OIL LEAK DIAGNOSIS

NOTE: Most fluid leaks can be repaired by visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. When a leak has been located, determine the *cause* of the leak. Otherwise the leak will most probably re-occur.

Step	Action	Value(s)	Yes	No
1.	1. Operate the vehicle until it reaches normal operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait for at least 15 minutes. 4. Check for oil drips. Are oil drips present?	–	Go to Step 2	Go to Step 3
2.	1. Identify the type of fluid and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	–	Go to Step 10	Go to Step 3
3.	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces. • Fittings • Cracked or damaged components. Can you identify the source of the leak?	–	Go to Step 10	Go to Step 4
4.	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait for at least 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	–	Go to Step 10	Go to Step 5
5.	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the source of the leak?	–	Go to Step 10	Go to Step 6
6.	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the powder surface discolouration. Can you identify the type of fluid and the approximate location of the leak?	–	Go to Step 10	Go to Step 7
7.	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the source of the leak?	–	Go to Step 10	Go to Step 8

Step	Action	Value(s)	Yes	No
8.	1. Using the Dye and Black Light Kit, Tool J 42220, identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	–	Go to Step 10	Go to Step 9
9.	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces. • Fittings. • Cracked or damaged components. Can you identify the source of the leak?	–	Go to Step 10	System OK
10.	1. Check for the following conditions: • Higher than recommended fluid levels. • Higher than recommended fluid pressures. • Plugged or malfunctioning fluid filters or pressure bypass valve. • Plugged or malfunctioning engine ventilation system. • Improperly tightened or damaged fasteners. • Cracked or porous components. • Improper sealants or gaskets where required. • Improper sealant or gasket installation. • Damaged or worn gaskets or seals. • Damaged or worn sealing surfaces. Is there mechanical damage to the engine?	–	Go to Step 11	–
11.	Repair or replace all damaged components.	–	Go to Step 1	–

5. SPECIFICATIONS

GENERAL	
Engine Type	V8 OHV
Displacement	5.7 litre (5,670 cm^3 - 346 in^3)
Bore	99.0 – 99.018 mm
Stroke	92.0 mm
Compression Ratio	10.1:1
Firing Order	1-8-7-2-6-5-4-3
Spark Plug Type	AC 41-952 or Denso PTJ16R15
Spark Plug Gap	1.52 ± 0.05 mm
LUBRICATION SYSTEM	
Oil Capacity (without Oil Filter Change)	5.2 litres
Oil Capacity (with Oil Filter Change)	5.7 litres
Oil Pressure (Minimum-Hot)	90 kPa @ 1,000 rpm
	125 kPa @ 2,000 rpm
	165 kPa @ 4,000 rpm
Oil Type	10W - 30 SJ GF2 (Service Refill)
CAMSHAFT	
End Play	0.025 - 0.305 mm
Journal Diameter	54.99 - 55.04 mm
Journal Diameter Out-of-Round	0.025 mm (Maximum)
Lobe Lift (Intake and Exhaust)	7.43 mm
Lobe Height (Intake and Exhaust)	46.67 mm (Minimum)
Runout (Measured at the Intermediate Journals)	0.050 mm
CONNECTING ROD	
Centre to Centre Length	154.90 ± 0.02 mm
Width	24.00 ± 0.05 mm
Bearing Bore Diameter	56.505 - 56.525 mm
Bearing Bore Out-of-Round (Production)	0.004 mm
Bearing Bore Out-of-Round (Service Limit)	0.008 mm
Bearing Clearance (Production)	0.023 - 0.065 mm
Bearing Clearance (Service Limit)	0.023 - 0.076 mm
Side Clearance	0.110 - 0.510 mm
Twist	0.010 mm Maximum
Bend	0.02 mm Maximum

CRANKSHAFT

End Play	0.040 - 0.200 mm
Connecting Rod Journal	
Bearing Clearance (Production)	0.023 - 0.065 mm
Bearing Clearance (Service Limit)	0.023 - 0.076 mm
Diameter (Production)	53.318 - 53.338 mm
Diameter (Service Limit)	53.308 mm (Minimum)
Taper (Production)	0.005 mm (Maximum for 1/2 of the Journal Length)
Taper (Service Limit)	0.020 mm (Maximum)
Out-of-Round (Production)	0.005 mm
Out-of-Round (Service Limit)	0.010 mm
Main Journal	
Bearing Clearance (Production)	0.020 - 0.052 mm
Bearing Clearance (Service Limit)	0.020 - 0.065 mm
Diameter (Production)	64.993 - 65.007 mm
Diameter (Service Limit)	64.993 mm (Minimum)
Out-of-Round (Production)	0.003 mm
Out-of-Round (Service Limit)	0.008 mm
Taper (Production)	0.010 mm
Taper (Service Limit)	0.020 mm (Maximum)
Reluctor Ring Runout (Measured 1.0 mm below Tooth Diameter)	0.700 mm (Maximum)
Runout (at Rear Flange)	0.050 mm (Maximum)
Thrust Wall Runout	0.025 mm
Thrust Wall Width (Production)	26.14 - 26.22 mm
Thrust Wall Width (Service)	26.2 mm (Maximum)

CYLINDER BORE

Cylinder Bore Diameter	99.0 - 99.018 mm
Cylinder Bore Taper and Out-of-Round	0.018 mm (Maximum)

CYLINDER HEAD

Engine Block Deck Flatness (Measured within a 150 mm area)	0.080 mm
Engine Block Deck Flatness (Measured over Full Length of Cylinder Head)	0.100 mm
Exhaust Manifold Deck Flatness	0.220 mm
Intake Manifold Deck Flatness	0.220 mm
Height (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm (Minimum)

ENGINE BLOCK

Camshaft Bearing Bore Diameter	55.063 - 55.088 mm
Cylinder Head Deck Surface Flatness (Measured within a 150 mm area)	0.080 mm
(Measured over Full Length of Block Deck)	0.220 mm
Cylinder Head Deck Height (Measured from Crankshaft centreline to Deck Face)	234.57 - 234.82 mm
Main Bearing Bore Diameter (Production)	69.871 - 69.889 mm
Main Bearing Bore Out-of-Round	0.005 mm
Valve Lifter Bore Diameter (Production)	21.417 - 21.443 mm

INTAKE MANIFOLD

Intake Manifold Cylinder Head Deck Flatness (Measured at Gasket Sealing Surfaces)	0.50 mm

OIL PAN AND FRONT/REAR COVER ALIGNMENT

Oil Pan to Rear of Engine Block Alignment (at Transmission Housing Mounting Surface)	0.000 - 0.250 mm (Maximum)
Front Cover Alignment (at Oil Pan Surface)	0.00 - 0.50 mm
Rear Cover Alignment (at Oil Pan Surface)	0.00 - 0.50 mm

PISTON

Piston Outside Diameter (at Size Point)	98.964 - 98.982 mm
Piston Skirt, Dimensional Variation	0.018 mm (Maximum)
Piston to Bore Clearance (Production)	0.018 - 0.054 mm
Piston to Bore Clearance (Service Limit)	0.018 - 0.054 mm (Maximum)
Piston Pin	
Pin Clearance to Piston Bore (Production)	0.010 - 0.020 mm
Pin Clearance to Piston Bore (Service Limit)	0.010 - 0.020 mm (Maximum)
Pin Diameter	23.997 - 24.0 mm
Pin Fit in Connecting Rod	0.020 - 0.043 mm (Interference)
Piston Rings	
Top Compression Ring End Gap (Production) (Measured in Cylinder Bore)	0.230 - 0.380 mm
2nd Compression Ring End Gap (Production) (Measured in Cylinder Bore)	0.440 - 0.640 mm
Oil Control Ring End Gap (Production) (Measured in Cylinder Bore)	0.180 - 0.690 mm
Top Compression Ring End Gap (Service) (Measured in Cylinder Bore)	0.230 - 0.380 mm (Maximum)
2nd Compression Ring End Gap (Service) (Measured in Cylinder Bore)	0.440 - 0.640 mm (Maximum)
Oil Control Ring End Gap (Service) (Measured in Cylinder Bore)	0.180 - 0.690 mm (Maximum)
Top Compression Ring Groove Clearance (Production)	0.040 - 0.085 mm
2nd Compression Ring Groove Clearance (Production)	0.040 - 0.080 mm
Oil Control Ring Groove Clearance (Production)	0.010 - 0.220 mm
Top Compression Ring Groove Clearance (Service)	0.040 - 0.085 mm (Maximum)
2nd Compression Ring Groove Clearance (Service)	0.040 - 0.080 mm (Maximum)
Oil Control Ring Groove Clearance (Service Limit)	0.010 - 0.220 mm (Maximum)

VALVE SYSTEM

Valve Lifter	Hydraulic Roller
Valve Rocker Arm Ratio	1.70:1
Valve Lash	Net Lash-No Adjustment
Valve Margin	1.25 Minimum
Valve Face Angle	45 degrees
Valve Seat Angle	46 degrees
Valve Seat Runout	0.050 mm (Maximum)
Width (Intake)	1.020 mm (Maximum)
Width (Exhaust)	1.780 mm (Maximum)
Valve Stem Clearance (Production-Intake)	0.025 - 0.066 mm
Clearance (Production-Exhaust)	0.025 - 0.066 mm
Clearance (Service-Intake)	0.093 mm (Maximum)
Clearance (Service-Exhaust)	0.093 mm (Maximum)
Diameter (Production)	7.955 - 7.976 mm
Diameter (Service)	7.95 mm (Minimum)
Valve Spring Free Length	52.9 mm
Pressure (Closed Valve)	340 N at 45.75 mm (Minimum)
Pressure (Open Valve)	980 N at 33.55 mm (Minimum)
Installed Height (Intake)	45.75 mm
Installed Height (Exhaust)	45.75 mm
Valve Lift Intake	11.99 mm
Exhaust	12.15 mm
Valve Guide Installed Height (From Cylinder Head Spring Seat Surface to Top of the Valve Guide)	17.32 mm

SEALANTS AND ADHESIVES

Coolant Sensor Threads	Loctite 565 or equivalent (GM P/N 12346004)
Crankshaft Rear Oil Gallery Plug	Loctite 242 or equivalent (GM P/N 12345382)
Cylinder Head Core Hole Plugs	Loctite 242 or equivalent (GM P/N 12345382)
Cylinder Head Expansion Plugs	Loctite 242 or equivalent (GM P/N 12345382)
Cylinder Head M8 Bolt Threads	Loctite 242 or equivalent (GM P/N 12345382)
Engine Block Front Oil Gallery Plug	Loctite 242 or equivalent (GM P/N 12345382)
Engine Block Coolant Drain Plug Sealing Washers	Loctite 565 or equivalent (GM P/N 12346004)
Engine Flywheel Bolt Threads	Loctite 242 or equivalent (GM P/N 12345382)
Exhaust Manifold Bolt Threads	Loctite 272 or equivalent (GM P/N 12345493)
Fuel Rail Bolt Threads	Loctite 242 or equivalent (GM P/N 12345382)
Ignition Coil and Bracket Assembly Bolt Threads	Loctite 242 or equivalent (GM P/N 12345382)
Intake Manifold Bolt Threads	Loctite 242 or equivalent (GM P/N 12345382)
Oil Pan Surface at Front and Rear Covers	Loctite 565 or equivalent (GM P/N 12378190)
Oil Pressure Sensor Threads	Loctite 565 or equivalent (GM P/N 12346004)
Oil Transfer Tube Bolts and Stud Threads	Loctite 242 or equivalent (GM P/N 12345382)

6. TORQUE WRENCH SPECIFICATIONS

NOTE

■ **Fasteners must be replaced after loosening.**

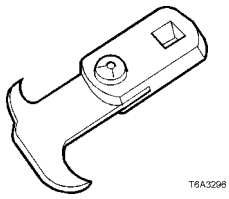
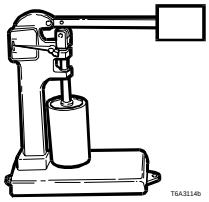
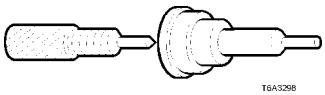
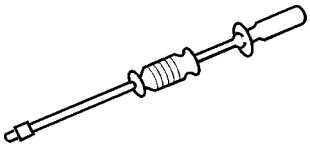
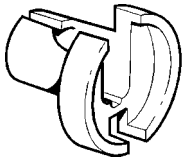
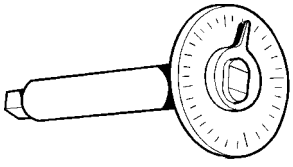
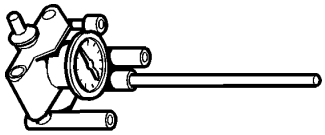
● **Vehicle must be at curb height before final tightening.**

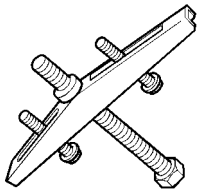
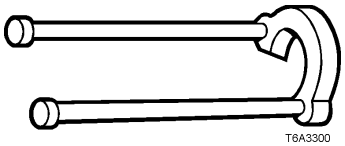
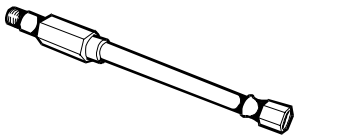
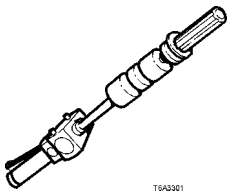
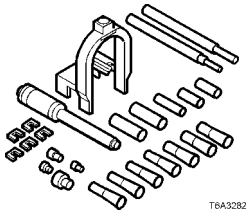
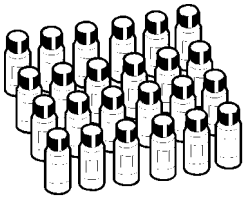
♦ **Fasteners either have micro encapsulated sealant applied or incorporate a mechanical thread lock and should only be re-used once. If in doubt, replacement is recommended.**

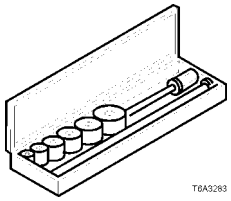
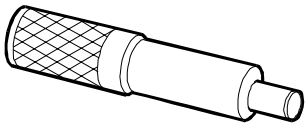
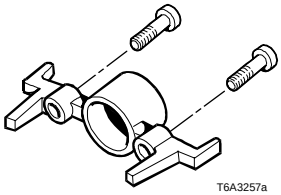
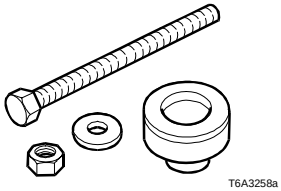
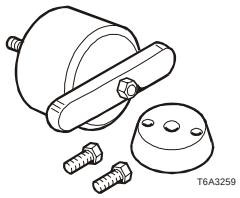
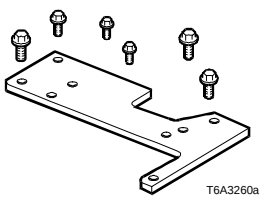
			Nm
	Air Conditioning Compressor Drive Belt Idler Pulley Bolt		50
	Air Conditioning Compressor Mounting Bracket to Cylinder Block Bolts		50
	Air Conditioning Compressor to Mounting Bracket Bolts		50
	Accelerator Control Cable Bracket Bolts		10
	Accessory Drive Belt Idler Pulley Bolt		50
	Accessory Drive Belt Tensioner Bolt		50
	Alternator Bracket to Cylinder Block Bolts		50
	Alternator Support Bracket to Cylinder Block Bolts		30
	Catalytic Converter Bracket Bolts to Catalytic Converters		25
	Catalytic Converter Bracket Bolts/Nuts to Manual Transmission Extension		50
	Camshaft Retainer Bolts		25
	Camshaft Position Sensor Bolt		25
	Camshaft Sprocket Bolts		35
	Close-out Cover Retaining Bolt (Each Side)		12
	Clutch Housing to Engine Block Bolt (Manual Transmission)		50
■	Connecting Rod Bolts	Stage 1 (‘A’, ‘B’ and ‘C’ designs)	20
		Stage 2 (‘A’ design only)	60° turn angle
		Stage 2 (‘B’ and ‘C’ designs)	75° turn angle
♦	Coolant Temperature Sensor		20
	Coolant Inlet Housing Bolts		15
	Coolant Pump Bolts	First Pass	15
		Final Pass	30
■	Crankshaft Balancer Bolt:	Stage 1 with new Bolt	50
		Stage 2 with new Bolt	140° turn angle
	Crankshaft Main Bearing Cap Bolts	(Inner – Stage 1 in Sequence)	20
		(Inner – Stage 2 in Sequence)	80° turn angle
	Crankshaft Main Bearing Cap Studs	(Outer – Stage 1 in Sequence)	20
		(Outer – Stage 2 in Sequence)	53° turn angle
■ ♦	Crankshaft Main Bearing Cap Side Bolts		25
	Crankshaft Oil Deflector Nuts		25
	Crankshaft Position Sensor Bolt		25
♦	Cylinder Head Bolts (in Sequence)	Stage 1 – all M11 and M8 Bolts	30
■		Stage 2 – all M11 Bolts	90° turn angle
		Stage 3 – only Longer M11 Bolts	90° turn angle
		Stage 3 – only Medium Length Bolts	50° turn angle
	Cylinder Head Coolant Plug		20
	Cylinder Head Core Hole Plug		20
♦	Engine Block Coolant Drain Plugs		60
♦	Engine Block Oil Gallery Plugs		60
	Engine Dress Cover Bracket Nut		6
	Engine Dress Cover Retaining Nut		10
	Engine Front Cover Bolts		25
	Engine Mount to Bracket or Crossmember Nut		80
	Engine Mount Bracket to Cylinder Block Bolt		50

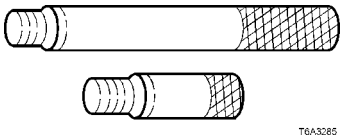
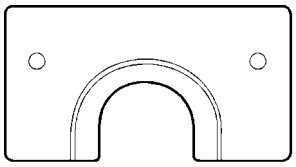
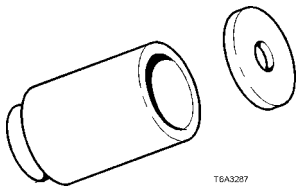
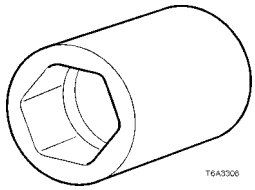
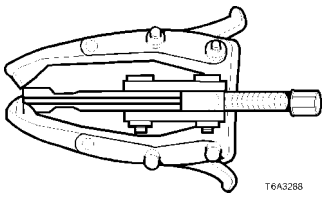
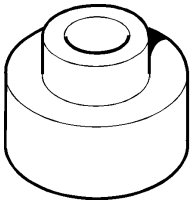
	Engine Rear Cover Bolts		25
	Engine Rocker Cover Bolts		12
	Engine Service Lift Bracket M10 Bolts		50
	Engine Service Lift Bracket M8 Bolt		25
	Engine Valley Cover Bolts		25
♦	Exhaust Manifold Bolts	Stage 1	15
		Stage 2	25
	Exhaust Manifold Heat Shield Bolt		9
■	Flywheel/Flexplate Bolts (in Sequence)	Stage 1	20
		Stage 2	50
		Stage 3	100
♦	Fuel Rail Bolts		10
♦	Ignition Coil-to-Bracket Bolts		12
♦	Ignition Coil Bracket-to-Valve Rocker Arm Cover Bolts		12
♦	Intake Manifold Bolts (in Sequence)	Stage 1	5
		Stage 2	10
	Knock Sensors		20
	Oil Filter		30
	Oil Filter Adaptor		55
	Oil Level Indicator Tube Bolt		25
	Oil Pan Blanking Screw Plug		25
	Oil Pan Baffle Bolts		12
	Oil Pan Closeout Cover Bolt (Either Side)		10
	Oil Pan Drain Plug		25
♦	Oil Pan Gallery Screw Plug		25
	Oil Pan M8 Bolts (Oil Pan to Engine Block and to Front Cover)		25
	Oil Pan M6 Bolts (Oil Pan-to-Rear Cover)		12
	Oil Pan Transfer Cover Nut		12
	Oil Pan Under-Tray Bolt		30
♦	Oil Pressure Sensor		20
	Oil Pump-to-Engine Block Bolts		25
	Oil Pump Cover Bolts		12
	Oil Pump Relief Valve Plug		12
	Oil Pump Pick-Up Tube to Oil Pump Screw		12
	Oil Transfer Cover Nuts		12
♦	Oil Transfer Tube Bolts		12
♦	Oil Transfer Tube Nuts		12
♦	Oxygen Sensor		41
	Positive Crankcase Ventilation (PCV) System Strap Nut		12
	Spark Plugs (New Cylinder Head - ‘Coining’))		20
	Spark Plugs		15
	Starter Motor Bolt		48
	Throttle Body Bolts		12
	Torque Converter Housing to Engine Block Bolts (Automatic Transmission)		50
♦	Torque Converter to Flexplate Attaching Bolts (Automatic Transmission)		65
	Transmission Crossmember to Side Frame Bolts		25
	Transmission Support to Crossmember Nuts		60
	Transmission Support to Transmission Extension Housing Bolts		25
	Valve Lifter Guide Bolts		12
■	Valve Rocker Arm Bolts		30
	Vapour Vent Pipe Bolts and Studs		12

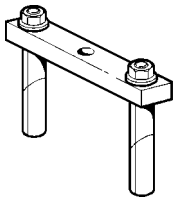
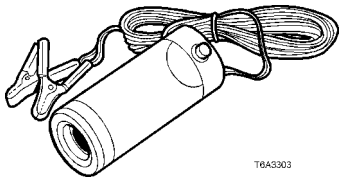
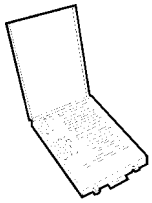
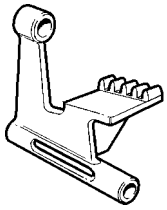
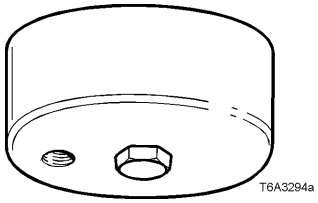
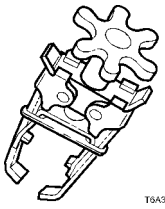
7. SPECIAL TOOLS

TOOL NUMBER	ILLUSTRATION	DESCRIPTION	CLASSIFICATION
E308	 T6A3296	SEAL REMOVER Previously released. Also numbered, 56750	Desirable
49 U012 006	 T6A3114b	HYDRAULIC VALVE LIFTER TESTER Previously released. Used in conjunction with testing fluid SPx No. E1151 Also numbered 6A23.	Unique
E1152	 T6A3298	VALVE LIFTER ASSEMBLY TOOLS Used to assist in assembly of the hydraulic valve lifters. Previously released, as 6A24.	Unique
J6125-1B	 T6A3280	SLIDE HAMMER Used in conjunction with J 41818 to remove main bearing caps. Previously released.	Unique
7371	 T6A3295	QUICK CONNECT RELEASE TOOL Previously released for releasing fuel line quick connects on V6 S/C engine after fuel system has been de-pressurised. Used on GEN III V8 engine for the same purpose	Mandatory
E 7115	 T6A3304	TORQUE ANGLE WRENCH Used to accurately tighten fasteners when an angle torque is required. Previously released.	Unique
J 8087	 T6A3299	CYLINDER BORE CHECKING GAUGE Also as a commercial equivalent. Previously released.	Unique

TOOL NUMBER	ILLUSTRATION	DESCRIPTION	CLASSIFICATION
J 8433-1	 T6A3281	PULLEY PULLER Used to remove GEN III V8 engine crankshaft timing gear sprocket, in conjunction with J 41558 and J 41816 –2. Previously released.	Unique
J 21427-01	 T6A3300	PULLER ADAPTOR Used in conjunction with J 8433-1, J 41558 and J 41816-2 to remove crankshaft timing gear sprocket. Previously released to remove automatic transmission speed sensor ring.	Unique
J 22794	 T6A3256a	ADAPTOR Used to facilitate the application of air pressure to a cylinder when replacing a valve spring or valve stem oil seal with the cylinder head installed. Previously released.	Desirable
J 23907	 T6A3301	SLIDE HAMMER Also released as remover, 6A22-2 and slide hammer 7A28. Previously released.	Unique
J 24086-C	 T6A3282	PISTON PIN REMOVER/INSTALLER Universal tool containing selective components to suit multiple engine applications. Previously released.	Unique
J 28431-B	 T6A3302	FLUID DYE Used in conjunction with black light, leak detection lamp J 42220 to locate various types of vehicle fluid leaks. Supplied in packs of 24, 1 ounce bottles. Previously released.	Desirable

TOOL NUMBER	ILLUSTRATION	DESCRIPTION	CLASSIFICATION
J 33049	 T6A3283	CAMSHAFT BEARING REMOVER/ INSTALLER Universal tool containing selective components to suit multiple engine applications. Previously released.	Unique
J 37378-1		VALVE GUIDE REAMER Used to ream worn valve guides to suit oversize valve stem. Previously released.	Unique
J 38836	 T6A3 189b	PILOTED DRIVER Used to install the spigot bush in the crankshaft. Previously released.	Unique
J 41476	 T6A3257a	FRONT AND REAR COVER ALIGNMENT TOOL Used to align both the front and rear engine covers during installation. Previously released.	Desirable
J 41478	 T6A3258a	CRANKSHAFT FRONT OIL SEAL INSTALLER Threaded bolt, nut and washer are also used in conjunction with J 41665 to install the crankshaft balancer. Previously released.	Desirable
J 41479	 T6A3259	CRANKSHAFT REAR OIL SEAL INSTALLER Previously released.	Desirable
J 41480	 T6A3260a	FRONT AND REAR COVER ALIGNMENT TOOL Used in conjunction with alignment tool J 41476, to correctly align the front and rear engine covers. Previously released.	Desirable

TOOL NUMBER	ILLUSTRATION	DESCRIPTION	CLASSIFICATION
J 41556	 T6A3285	CONNECTING ROD GUIDES Used to assist in piston and connecting rod installation. Previously released.	Desirable
J 41558	 T6A3286	CRANKSHAFT SPROCKET REMOVER Used in conjunction with the bolts from J 21427-01 and pulley puller J 8433, to remove the crankshaft sprocket. Previously released.	Desirable
J 41665	 T6A3287	CRANKSHAFT BALANCER INSTALLER Comprises stepped sleeve, J 41665-1 and end plate J 41665-2. Used in conjunction with Tool J 41478, to install the crankshaft balancer and crankshaft sprocket. Previously released.	Desirable
J 41712	 T6A3308	OIL PRESSURE SENSOR SOCKET Used in conjunction with 3/8” drive socket equipment to remove/reinstall oil pressure sensor. Previously released.	Desirable
J 41816	 T6A3288	THREE LEGGED PULLER Used in conjunction with J 41816-2 to remove crankshaft balancer. Also commercially available. Previously released.	Desirable
J 41816-2	 T6A3289	ADAPTOR Used in conjunction with puller J 41816 to remove crankshaft balancer. Previously released.	Desirable

TOOL NUMBER	ILLUSTRATION	DESCRIPTION	CLASSIFICATION
J 41818	 T6A3290	CRANKSHAFT BEARING CAP REMOVER Used in conjunction with slide hammer J 6125-1B to remove main bearing caps. Previously released.	Desirable
16296	 T6A3303	BLACK LIGHT, LEAK DETECTION LAMP Used with dye, Tool J 28431-B to locate the source of various vehicle fluid leaks. Previously released.	Desirable
J 42385	 T6A3293	THREAD REPAIR KIT Comprises; Cylinder Head/Rear Main Bearing Cap Kit J 42385-100 General Kit J 42385-200 Fixtures/Hardware Kit J 42385-300 Previously released.	Unique
J 42386	 T6A3292	FLYWHEEL HOLDING TOOL Previously released.	Desirable
J 42907	 T6A3294a	OIL PRESSURE ADAPTOR Fitted to the oil filter adaptor and used in conjunction with a commercially available oil pressure gauge and hose. Previously released.	Desirable
J38606	 T6A3284	VALVE SPRING COMPRESSOR Used in conjunction with spark plug adaptor J 22794 to remove valve springs with cylinder head/s installed. Previously released as KD2078, for the V6 engine.	Desirable