SUBARU®

Technician Reference Booklet

Belt Driven ValveTrain Boxer Engines

Module 104

AUTOMOTIVE Youth Educational Systems® YES PROUD PARTNER

MSA5P1104C

February 2011

THIS TECHNICAL REFERENCE BOOKLET (TRB) IS DESIGNED TO BE USED IN A CLASSROOM ENVIRONMENT OR AS A GUIDE FOR SELF-STUDY.

THE TRB IS NOT INTENDED TO BE USED AS A SUPPLEMENT OR SUBSTITUTE FOR THE SERVICE MANUAL. ALWAYS CONSULT THE APPROPRIATE SERVICE MANUAL WHEN PERFORMING ANY DIAGNOSTICS, MAINTENANCE OR REPAIR TO ANY SUBARU VEHICLE.

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Foreword

All Subaru of America, Inc. engines are of the four stroke, four cycle internal combustion design. The four strokes are the following: Intake, Compression, Power and Exhaust.

Subaru of America, Inc. vehicles are powered by boxer style opposed cylinder engines.

The engine horsepower has increased over the last several years at the same time as customer and governmental expectations for major component longevity and fuel mileage. This has meant better materials and engine design practices have been utilized. Higher quality piston and piston ring design as well as material construction have been used to obtain closer cylinder wall to piston clearance over more operating temperatures and longer mileage intervals. This has resulted in decreased "leak-down" for production engines. This "leak-down" percentage has decreased significantly over the last several years to where everyday street engines have cylinder sealing that once was the standard for racing applications.

Higher compression ratios have also been obtained. The compression ratio for all currently used Subaru engines that are naturally aspirated (non-turbocharged) are all over 10.1. This compression ratio was only previously seen in high performance and racing applications. Compression ratio is calculated by dividing the area in the cylinder head valve area for each cylinder by the distance in the combustion chamber at the bottom of the cylinder stroke. In the aforementioned 10.1 example, the cylinder head combustion area is 1/10 the size of the cylinder when the piston is in its lowest position in the cylinder.

New advances in computer design, fuel injection, ignition timing regulation, and air fuel swirl technology usage in the combustion chamber have greatly contributed to increased power output.

It is the desire of Subaru of America, Inc. that you derive the maximum possible knowledge from this engine course in order to do a complete diagnosis and repair of Subaru engines in order to achieve the utmost in customer satisfaction.

Introduction

This Technicians Reference Booklet is intended to introduce the 2.5 liter naturally aspirated (N/A), (Phase 1) and (Phase 2) engines, the 2.5 liter (DOHC) (Phase 1) and (Phase 2) engines, the 2.0 liter turbo engine.

This reference book reviews the mechanical features of these engines and the differences between existing engines. It also covers the procedures used in diagnosing and overhauling these engines. The text and slides also cover the new technologies and differences associated with variable valve lift and variable valve timing as well as active valve lift. The reference book text and illustrations are derived from and follow the classroom lectures and slide presentations. They are intended to supplement and reinforce classroom instruction and serve as an additional technical reference source. A list of applicable Service Bulletins, TechTips, Special Service Tools, pages for notes and cautions are included in this booklet.

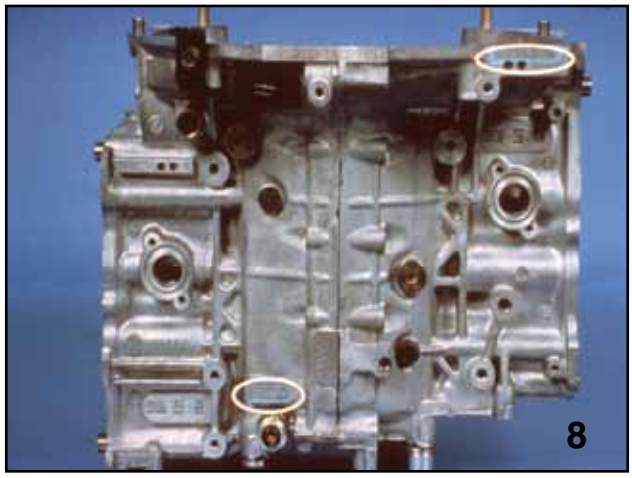
Technician worksheets are to be completed during the hands on lab work segments of the engine series module.

Always refer to the appropriate model year Subaru Service Manual and the applicable Subaru Service Bulletins on the STIS web site, for all specifications and detailed service procedures.

STi 2004 Engine

General Overview

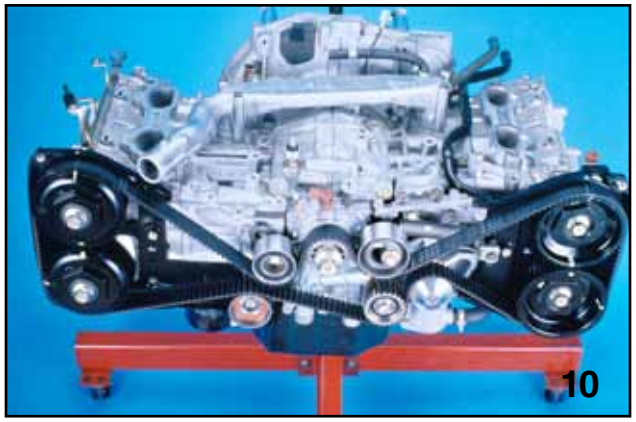
2.5 Engine Identification



Engine Serial and Designation Number

The engine serial number is located on the machined boss on the left side of the clutch housing. The 2.5 liter engine designation is EJ25.

2.5 Liter Engine Features Phase 1



2.5 Liter Engine

The 2.5 liter engine uses double overhead camshafts that are belt driven. Belt tension is maintained through the use of the hydraulic tensioner.

Camshaft Sprocket (Left Bank) (Rear)

Camshaft Sprocket Timing Marks (Left Bank)

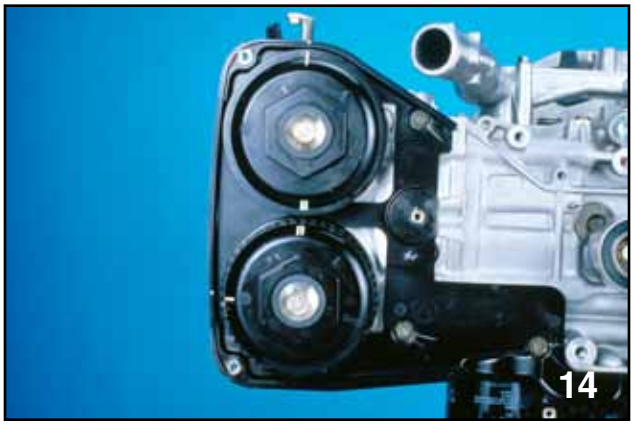
Camshaft sprockets are constructed from a resin type material with a metal key pressed into the sprocket for maintaining proper sprocket to shaft orientation.

The timing marks on the left bank intake camshaft sprocket are positioned at 12:00 o'clock and 6:00 o'clock. The 12:00 o'clock mark, which aligns with a timing mark on the timing belt housing, is used for camshaft to engine timing. The 6:00 o'clock mark is used for timing the intake camshaft to the exhaust camshaft, which has a timing mark at the 12:00 o'clock positions. The remaining timing mark on the exhaust camshaft sprocket, positioned at the 3:00 o'clock, ensures the exhaust camshaft sprocket is timed correctly to the engine. With all timing marks aligned, the intake and exhaust camshaft are in a loaded state. If the timing belt were removed, the camshafts would suddenly revolve from the force of the valve springs. To prevent this from occurring maintain the intake camshaft position and carefully unload the camshaft by allowing it to slowly rotate counterclockwise, (exhaust clockwise) while removing the belt.

NOTE: USE SPECIAL TOOL J-42908 FOR HOLDING CAMSHAFT SPROCKETS DURING BELT INSTALLATION. IT MAY ALSO BE USED FOR LOADING AS WELL AS UNLOADING THE CAMSHAFTS.

CAUTION: VALVE DAMAGE WILL OCCUR IF BOTH CAMSHAFTS ARE TURNED INCORRECTLY AFTER THE TIMING BELT HAS BEEN REMOVED.

Valve Interference



Camshaft Sprocket Timing Marks (Right Bank)

The right bank intake sprockets timing marks are similar in location and purpose as the left bank, however, the exhaust camshaft sprocket on the right bank uses a timing mark at the 9:00 o'clock position to ensure proper camshaft to engine timing.

Camshafts

To access the cylinder head bolts, the camshafts must be removed. Follow the procedure outlined in the on the STIS web site for performing this task. The camshafts are held to the cylinder head with bearing caps that are marked (right side) I1TD, I3TD, E1TD, E3TD.

Valve Spring Assembly

Valve servicing is accomplished by utilizing special tool 499718000 and a universal valve spring compressor. The single valve spring is color coded red and rests on a metal spring seat which is used to prevent cylinder head wear. A special tool (498267700) will be required to adjust valve guide height, if replacement is necessary. A valve guide reamer (499767400) and a valve guide remover (499767200) will also have to be used. The hydraulic lash adjuster is of the same type as the 3.3 and requires no servicing.

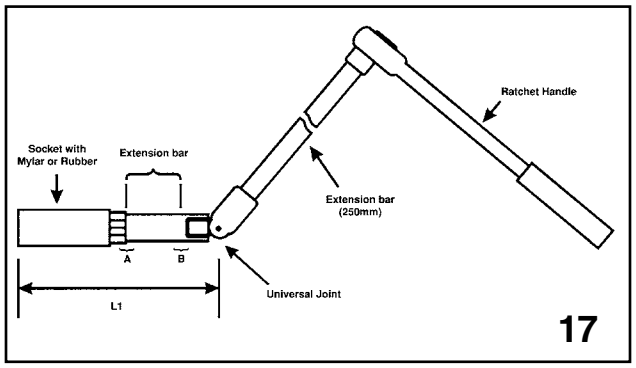
Spark plugs for the 2.5 liter engine will be platinum tipped, NGK PFR5B-11.

Spark Plug Replacement Procedure for 2.5 Liter Engine

1. Remove battery, washer tank and air cleaner.
2. Remove high tension cords.
3. Cover ATF pipes and ABS pipes with cloth to prevent them from damage during replacement of spark plugs.
4. Remove spark plugs by using a general service tool with the special instruction described below.

Installation

1. Set the spark plug into the socket.
2. Tighten the spark plug in the cylinder head with the socket. It is necessary to support the end of the socket by a finger.
3. When the spark plug can be felt to be tightened with 2 or 3 rotations, remove the socket from the spark plug.



Spark Plug Removal

4. Confirm if the spark plug is screwed into the hole properly by touching it with a finger. If it is difficult to touch it by finger, confirm its condition by using mirror and so on.
5. Reset the socket on the plug then tighten it with the proper torque.
6. Install high tension cords.
7. Install battery, washer tank, and air cleaner.

NOTE:

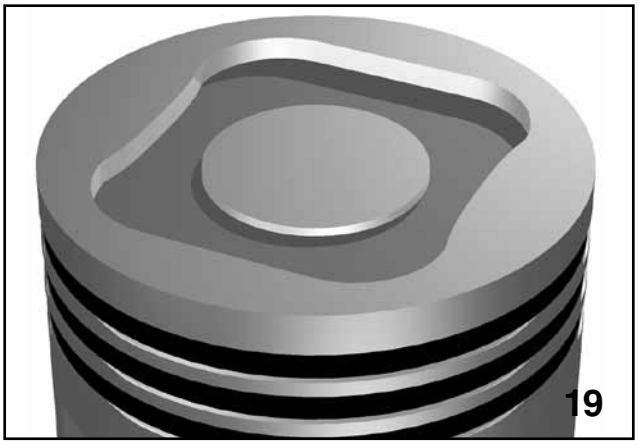
1. Length L1 (100mm, 3.94") is most important for ease of removal and installation.
2. Wrap points A & B with tape to prevent them from separating during work.
3. An approximate 250mm long extension bar is recommended to be used between the ratchet and the universal joint.

1997 2.5 Engine DOHC (Phase 1) Changes

The double overhead camshaft engines have had internal and external changes that yield an approximately 10 % increase in power and 3% increase in fuel economy. Accomplishing this involves many factors, one of which is engine friction reduction.

The piston, a major source of engine friction has been coated with a friction reducing agent called Molybendium. This thin coating not only allows a smoother travel through the cylinder but also reduces cylinder wall scuffing.

The skirt of the piston has been reshaped and the overall weight has reduced by approximately 100 grams. Compression ratio has been increased to 9.7 to 1 by reshaping the crown of the piston. This eliminates the clearance that was available between the piston at TDC and a fully opened valve. Piston pin offset has been changed to 0.5 mm. Piston to cylinder wall clearance has been reduced by increasing the piston diameter.

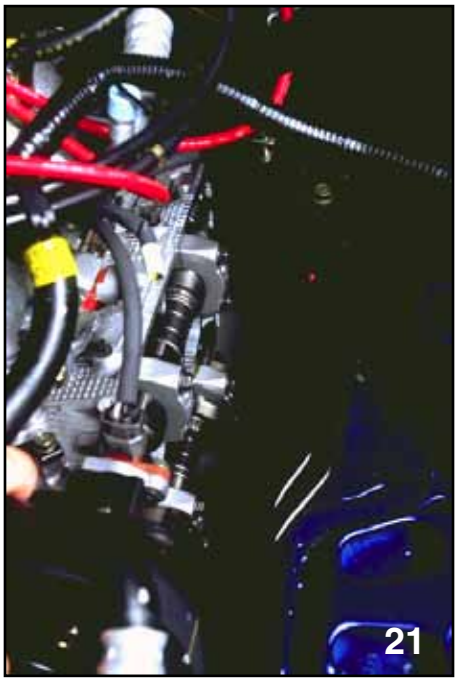


Redesigned 2.5 Liter Piston

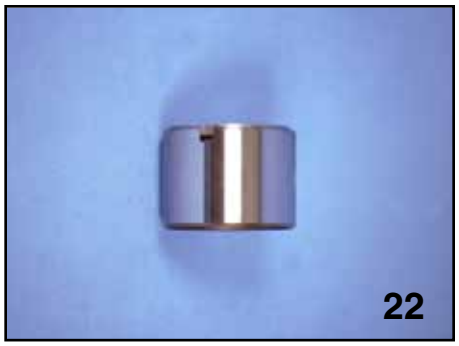
Another source of high engine friction is the valve train. Hydraulic lash adjusters are always in contact with the camshaft or valve rockers. The hydraulic pressure of the lash adjuster must be overcome during operation and the most critical time of engine start. To overcome this situation and to contribute to the total reduction of friction loss the DOHC engines will have solid valve adjusters.

The scheduled service of these valve trains is set at 100,000 miles and is not required during the PDI. The DOHC engine uses an adjustment shim. There are 94 shim sizes.

2.5 Liter Valve Assembly



2.5 Liter Head on the car



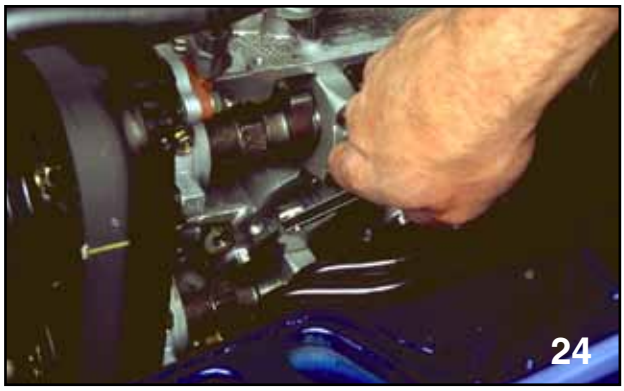
Bucket and Shim Assembly

NOTE: USE A THIN NONMAGNETIC TOOL PLACED IN THE NOTCH OF THE LASH ADJUSTER TO REMOVE SHIM. (SPECIAL TOOL J-43979)

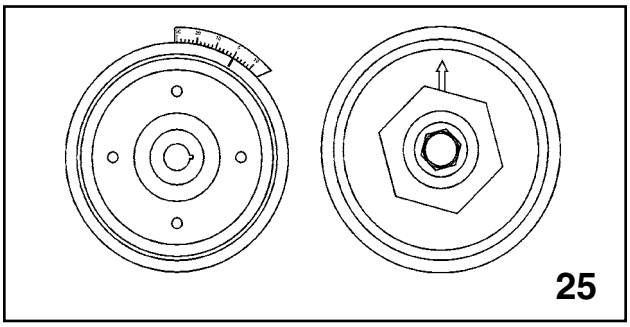
Identifying Shim Size

NOTE: THE PRINTED SIZE OF THE SHIM SHOULD BE INSTALLED AWAY FROM THE CAMSHAFT LOBE.

As you can see the space between the valve train and the frame rail of a DOHC is some what limited, however valve adjustment is possible by performing the following: Refer to the 1997 Legacy Subaru Service Manual on the STIS web site. Supplement.



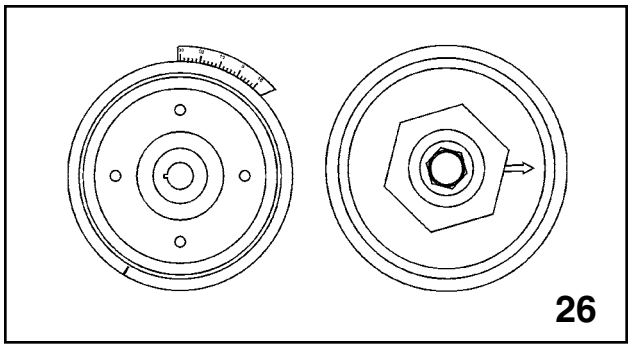
Checking Valve Clearance on the Car



Exhaust Valve Clearance on Cylinders 1 and 3

Step 1

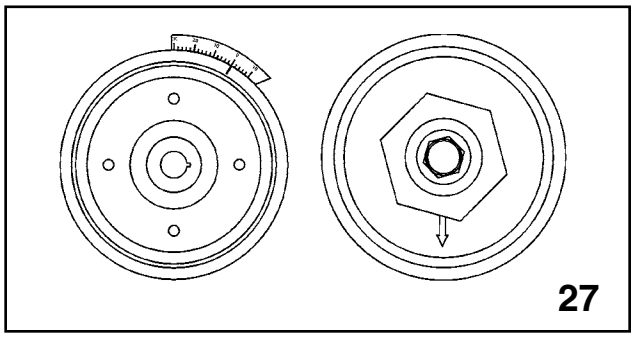
- Set the crankshaft sprocket at 0 degrees. (use crankshaft wrench)
- Set the left intake camshaft sprocket arrow at 12 o'clock (Please remember that the camshaft sprocket has an arrow and a mark used for belt timing. Make certain to use the arrow and not the mark for valve clearance check.)
- The engine is now set for allowing the clearance check of the exhaust valves on cylinders 1 and 3 only. (Please remember that the profile of a camshaft with solid lifters has a ramp that is used to gradually take up the clearance between the lift of the lobe and the lash adjuster.)
- Measure the clearance ensuring the thickness gauge is placed as shown on previous page.
- Record the measurement



Intake Valve Clearance on Cylinders 1 and 3

Step 2

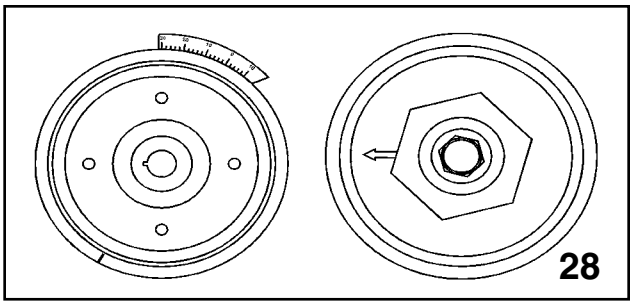
- Rotate the crankshaft 180 degrees.
- The left intake camshaft arrow should now be at 3 o'clock (Figure 7).
- Check the clearance of the intake valves on cylinders 1 and 3 only.
- Record the measurement



Exhaust Valve Clearance on Cylinders 2 and 4

Step 3

- Rotate the crankshaft 180 degrees.
- The left intake camshaft arrow should now be at 6 o'clock.
- Check the clearance of the exhaust valves on cylinders 2 and 4 only.
- Record the measurement



Intake Valve Clearance on Cylinders 2 and 4

Step 4

- Rotate the crankshaft 180 degrees.
- The left intake camshaft sprocket arrow should now be at 9 o'clock.
- Check the clearance of the intake valves on cylinders 2 and 4 only.
- Record the measurement.

Step 5

- Use the formula below to choose the new shim:

NOTE: REFER TO SUBARU SERVICE MANUALS ON STIS WEB SITE.

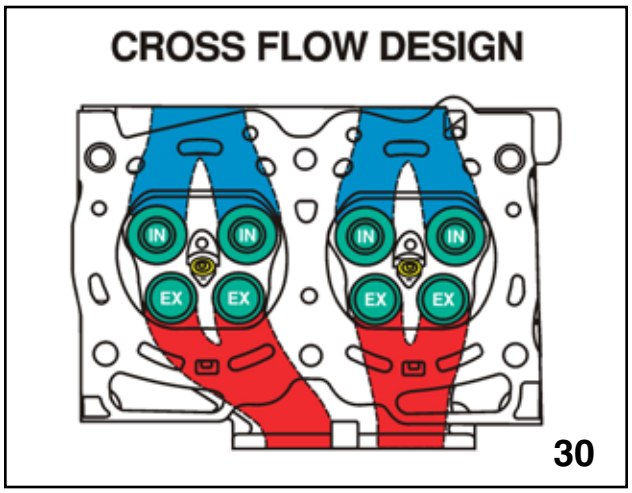
Intake valve S = V + T-.20
Exhaust valve S = V + T-.25
S = Shim thickness to be used
V = Measured valve clearance
T = Shim thickness in use

Standard Valve Clearance

(Intake valves 0.20 +/- 0.02 mm)
(Exhaust valves 0.25 +/- 0.02 mm)

1997 2.5 Engine DOHC (Phase 1) Features

The 2.5 liter DOHC four valves per cylinder engine is an addition to the existing Subaru "Boxer" design. The horizontally opposed, 4 stroke, 4 cylinder, liquid cooled, gasoline engine has aluminum alloy block and heads. It uses a normally aspirated MPI system. The cylinder liners are of a cast iron dry type design.



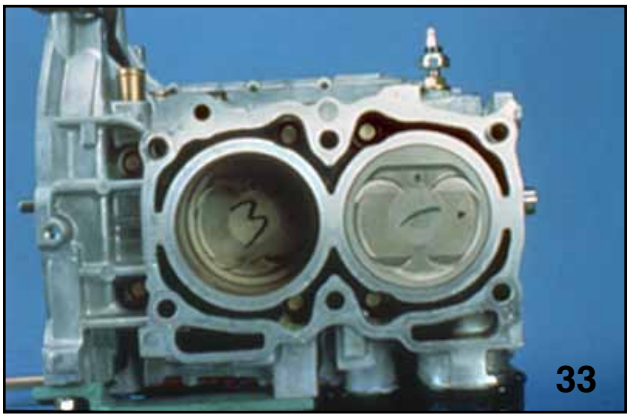
Cylinder Head Design

Crankshaft Assembly

The balanced forged crankshaft has fillet rolled micro-polished journals for increased strength and reduced friction. Due to the "Boxer" design, a counterbalance shaft is not required.

Connecting Rods

Due to increased material used to strengthen the large end of the rod, the rod bolts are pressed into the rod. An oiling notch is located on the large end of the rod below the FUJI symbol. This provides oil flow to the piston pin and the cylinder walls. The rods are not drilled.

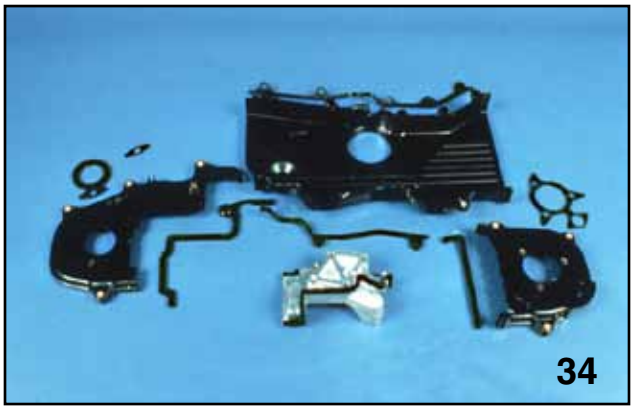


N/A Pistons

The 2.5 liter pistons are cast aluminum alloy and feature a 2 mm offset piston pin. The pistons are directional for the left and the right side of the engine and are stamped with an "L" or "R". In addition, each piston is stamped with an arrow which must point to front of the engine. The valve reliefs for the intake and exhaust valves are different sizes to prevent valve contact with the piston should the cam belt break. The pistons use three rings, two compression and one oil.

Belt Driven Valve Train Boxer Engines (104)

A single belt is used to drive the camshafts and the water pump. This provides more precise valve timing. The cam belt width is 30 mm (1.18 inches) to increase cam belt life. The belt is constructed of wear resistant double canvas and heat resistant rubber materials with a wire core. A round tooth profile is used for quieter operation. The belt has an automatic cam belt tensioner which allows for thermal expansion and contraction. The cam belt path is from the crankshaft sprocket to the tensioner, to the left camshaft sprocket, to the water pump pulley, to the lower left idler to the lower right idler, to the right camshaft sprocket, to the upper right idler and back to the crankshaft sprocket. This has increased the belt life to 105,000 miles.



Cam Belt Covers

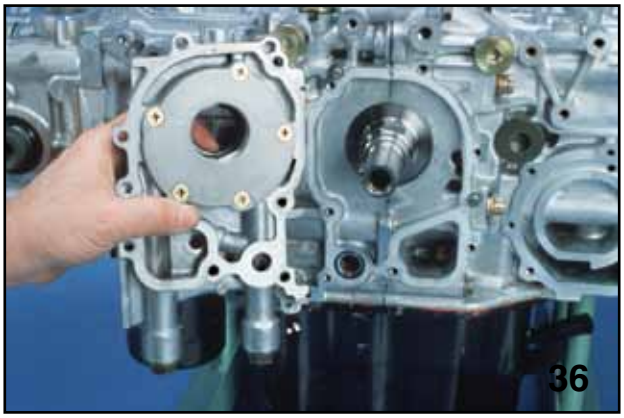
The cam belt covers and dust seals are resin molded and protect the timing belt from dust and water. There are additional dust seals on the left and right inner covers. These seals increase protection of the cam belt from dust and water and also improve cam belt noise isolation.

Water Pump Assembly-Cooling System

The water pump pulley is driven by the back side of the timing belt. The pump is mounted to the lower front of the engine. The thermostat is located in the lower part of the pump housing. This location provides even engine warm-up by improved metering of the coolant temperature. The thermostat senses the temperature of the crankcase and radiator coolant as it is mixed.

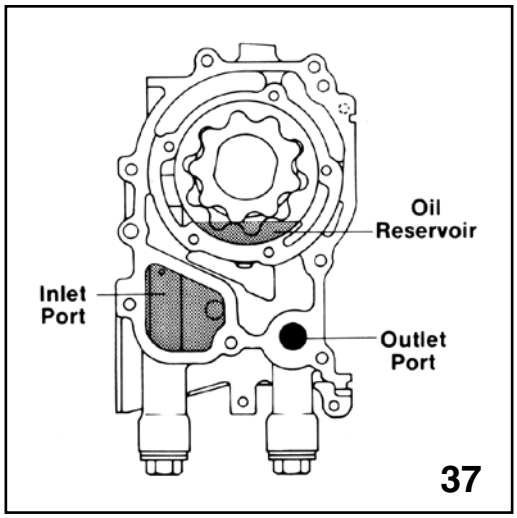
Because the thermostat housing is located on the lower front of the engine, all of the coolant must be drained to change the thermostat.

The heater core also serves as the bypass system.



Oil Pump

The trichoid gear type oil pump is driven directly by the crankshaft. The pump is bolted to the front of the engine for serviceability. The relief valve located in the pump regulates oil pressure to 71 psi (5 kg-cm2). The filter bypass valve is located in the oil filter.



Oil Pump Cross Section

The oil pump has a reservoir which maintains oil for rotor lubrication. This is especially helpful when the engine has not been operated for extended periods of time. The reservoir also provides emergency oiling for the pump if there is temporary loss of oil supply.

Camshaft Sprockets

Notice the locating pin on back of the sprockets for reinstallation. Also locate the reluctors on the back of the left camshaft sprocket. These are the cam angle sensor reference triggers. Inspect the locating pin and reluctors for damage.

NOTE: THE LEFT CAMSHAFT SPROCKET MUST NOT BE INSTALLED ON THE RIGHT CAM SHAFT, AS DAMAGE TO THE INNER RIGHT CAM BELT COVER MAY OCCUR. A NO START CONDITION ALSO WILL RESULT.

Tensioner Bracket Removal

Remove the mounting bolts and carefully remove the tensioner bracket to avoid damage to the friction-fit dust seals.

Inner Cam Belt Cover Removal

Remove the left and right inner cam belt covers. Note the location of the friction-fit dust seals.

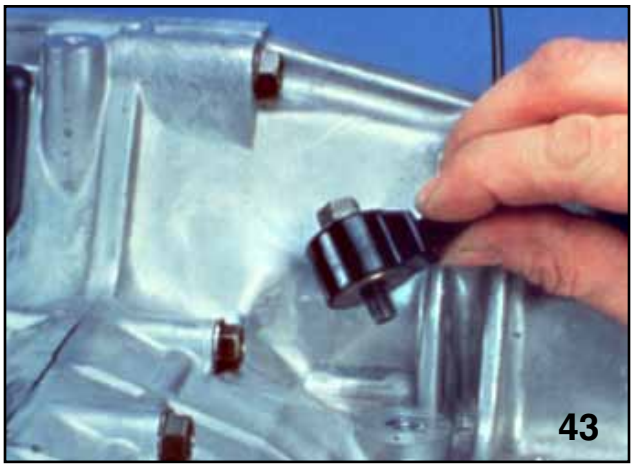
Engine Accessory Removal

Remove the hoses, electrical connections, sensors, switches, intake manifold, and intake manifold gaskets.

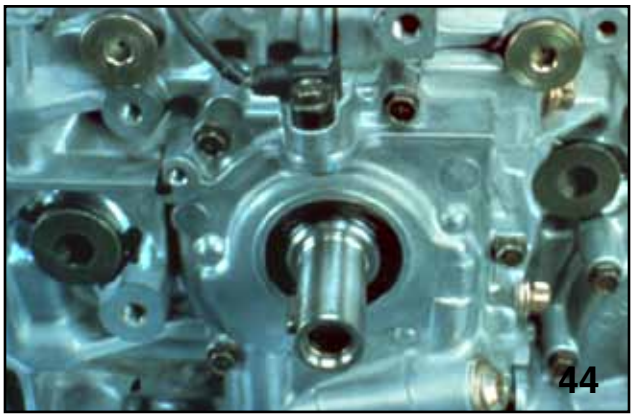
NOTE: THE RUBBER COATED METAL GASKETS ARE ONE TIME USE ONLY.

Remove the Water Transfer Pipe

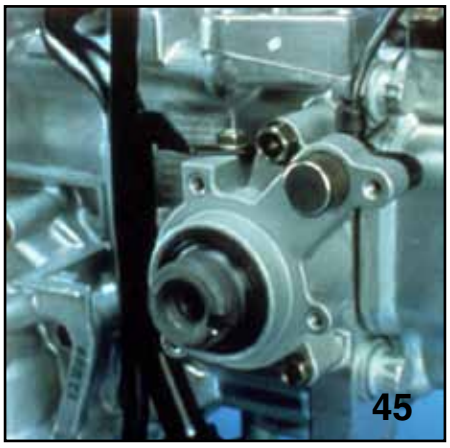
Remove the water transfer pipe and O-rings. New O-rings must be used at reinstallation.



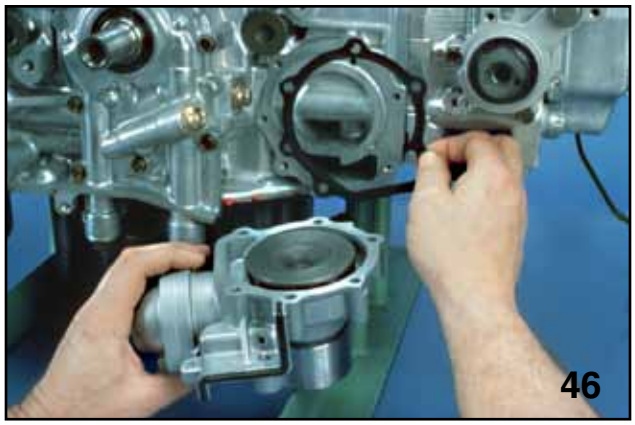
Remove Knock Sensor



Remove Crank Angle Sensor



Remove Cam Angle Sensor



Remove Water Pump

Remove dip stick tube and then remove the water pump and rubber coated metal gasket. The gasket is onetime use only. Retain the dust seals for later reassembly.

Remove Oil Pump

Remove the oil pump. Observe the condition and location of the O-ring seal and the dust seals. Retain the dust seals for later reassembly.

Loosen all head bolts in the reverse order of the tightening sequence, and then remove all of the cylinder head bolts except #1. Lightly tap the cylinder head with a rubber mallet to loosen the head from the gasket. Then remove #1 bolt and the cylinder head with the head gasket. Repeat the above steps for the other cylinder head.

NOTE: THE HEAD GASKETS ARE CARBON COMPOSITION WITH INTEGRATED O-RINGS. ALWAYS USE NEW GASKETS. CHECK FOR PROPER ORIENTATION.

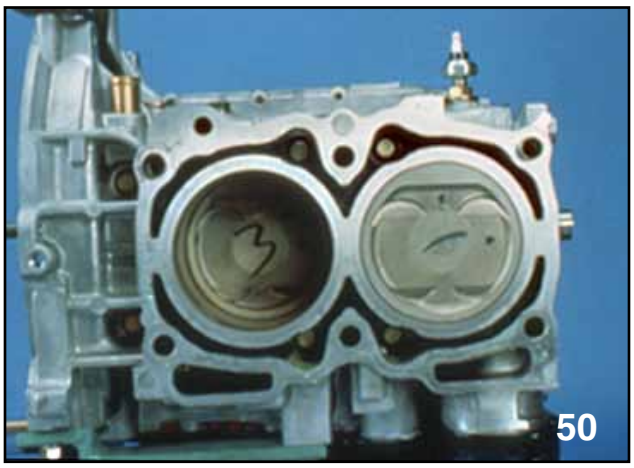
Remove Oil Pan

Remove the oil pan bolts. Use a thin gasket scraper/putty knife and a rubber mallet to loosen the oil pan. Remove the oil pan. Notice the location of the oil seal for the drain tube. Remove the oil pickup tube and also note the O-ring. Remove the oil pan baffle plate (windage tray).

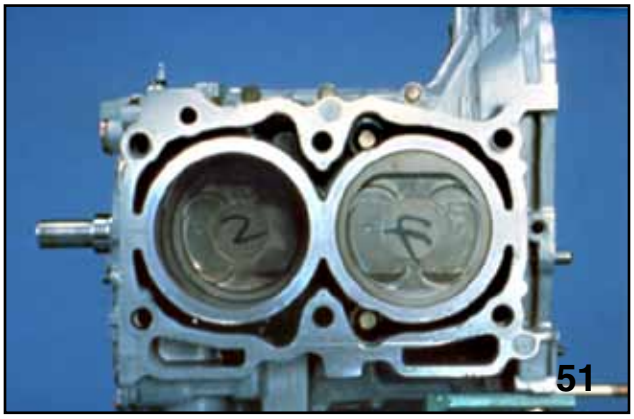
Piston Pin Removal

Use piston pin remover **499097300** or **499097500** to remove the piston pin. Insert the tool 3/4 of the way into the pin and pull the tool with the pin through the access hole. Repeat for the remaining pistons. Finally, rotate the crankshaft to position the pistons at the top of the cylinders. Repeat the procedure for the other cylinders.

NOTE: USE CAUTION WHILE ROTATING THE CRANKSHAFT TO PREVENT THE CONNECTING ROD LARGE ENDS FROM DAMAGING THE LOWER CYLINDER BORES.



Crankcase Hidden Bolts (Right Bank)



Crankcase Hidden Bolts (Left Bank)

To split the crankcase remove ALL 16 of the crankcase bolts. Six (6) of the bolts are hidden in the water passages, four in the RH case (1-3 side) and two in the LH case (2-4 side).

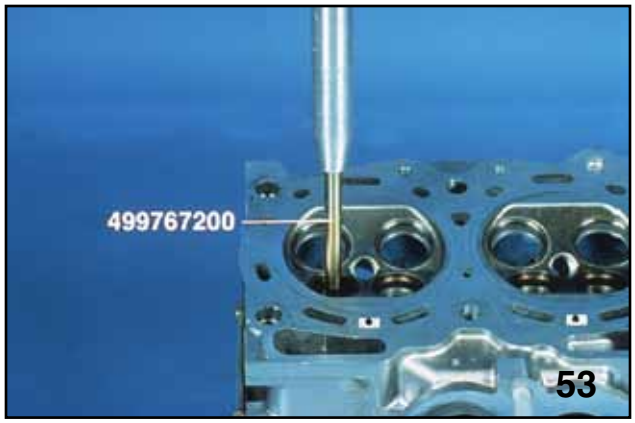
NOTE: ALL SIX (6) OF THE HIDDEN SHOULDERED CRANKCASE BOLTS HAVE SEALING WASHERS. THESE BOLTS ARE NOT INTERCHANGEABLE WITH THE OTHER CRANKCASE BOLTS. THE SEALING WASHERS ARE ONE TIME USE ONLY.

Crankcase Half with O-Rings

Carefully separate the crankcase halves.

NOTE: IDENTIFY THE LOCATION OF THE FOUR O-RINGS (THREE SMALL, ONE LARGE), IN THE MATING SURFACE OF THE RIGHT (1-3 SIDE) CRANKCASE. THE BLACK O-RINGS ARE FOR OIL PASSAGES, THE ORANGE O-RING IS FOR A COOLANT PASSAGE.

Finally, inspect the rocker arm cam contact surface. Replace the rocker arm(s) when they are scored or gouged.



Valve Guide Removal

Use a press, cylinder head table, **498267200**, and valve guide removal tool **499767200** to remove the valve guides.

Precautions

Follow the precautions listed below when inspecting and servicing engine components.

a. Clean all parts thoroughly.

b. Remove all gaskets and sealing material.

Caution: Do not damage aluminum mating surfaces

c. Use compressed air to insure clear oil and coolant passages.

d. Do not damage components when removing carbon.

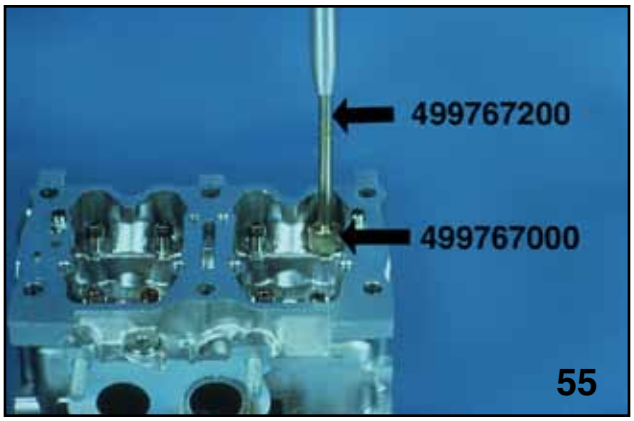
e. Keep parts in order to ease reassembly.

f. Service all valves as a set.

Refer to the Subaru Service Manual on the STIS web site for the detailed step-by-step inspection and servicing steps. The following information addresses only the special steps which are distinctive to the 2.2L engine.

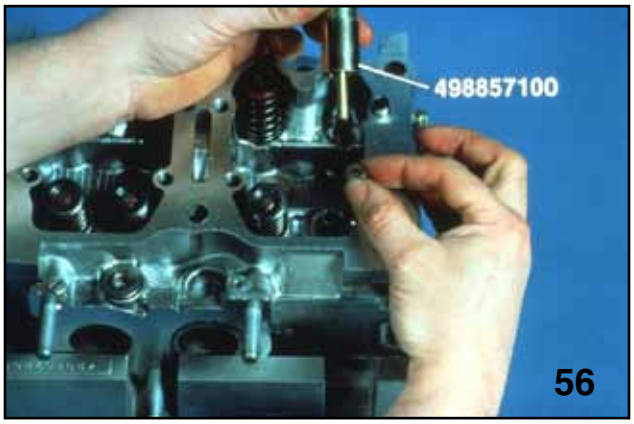
Valve Components

Use valve spring remover **499718000** to remove the valve springs. Then remove the valves and seals. The intake seals are black and the exhaust seals are brown.



Installing Valve Guides

Install the valve guides using a press, cylinder head table **498267200**, valve guide remover **499767200**, and valve guide adjuster **499767000**.



Installing Valve Guide Oil Seal

Use valve seal installer **498857100**, to install the valve guide seals (black for intake, brown for exhaust). Then use cylinder head table **498267200** and valve spring remover **499718000** to install the valve spring and retainer. Install the camshaft into the cylinder head bearing journals. Be careful to not damage or score the camshaft journals.

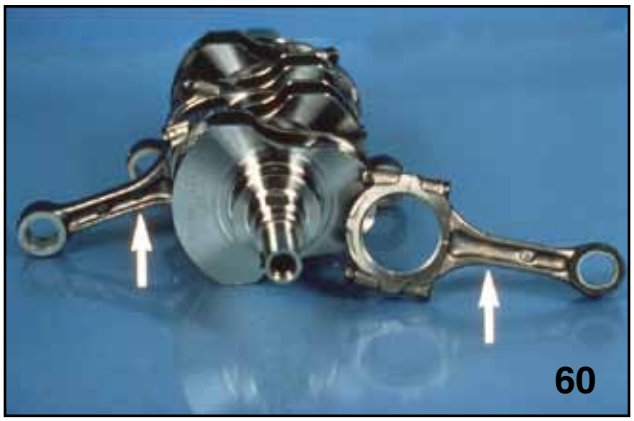
Installing the Oil Seal

Install the left rear camshaft plug (oil seal). Then install the oil seal using oil seal installer **499587100**.

Storing Cylinder Heads

Temporarily store the cylinder head by standing it on the exhaust manifold studs. Repeat these steps for the other cylinder head.

Engine Reassembly



Assemble Crankshaft

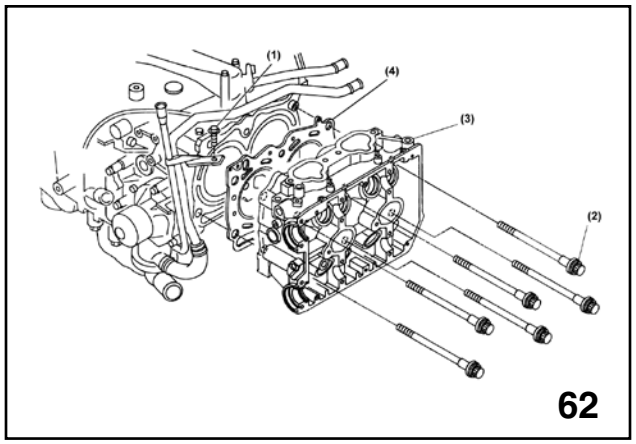
Always refer to the applicable Subaru Service Manual on the STIS web site for the bearing size, oil clearance, and torque specifications. The "FUJI" symbol on the connecting rods must face the front of the engine.

Crankcase Sealer and O-Rings

Apply sealant to the crankcase mating surface on the o-ring side of the crankcase. Do not allow the sealant to enter the O-ring grooves, oil passages, or bearing grooves. Install the crankshaft assembly. Align the connecting rods, and assemble the crankcase halves.

CAUTION: REMOVE ALL FLUIDS FROM THE THREADED PORTIONS OF THE CASE HALVES. THIS PREVENTS HYDROSTATIC LOCK AND POTENTIAL CRACKING OF THE CRANKCASE.

Follow correct sequence from the Subaru Service Manual on the STIS web site.



Cylinder Head

(1) Bolt
(2) Cylinder head bolt
(3) Cylinder head
(4) Cylinder head gasket

1) Install cylinder head and gaskets on cylinder block.

CAUTION: USE NEW CYLINDER HEAD GASKETS.

2) Tighten cylinder head bolts per Subaru Service Manual specifications on STIS web site.

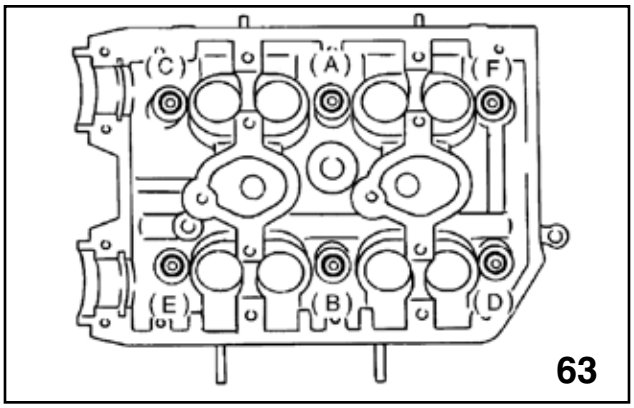
(1) Apply a coat of engine oil to washers and bolt threads.

(2) Tighten all bolts to 29 N•m (3.0 kg-m, 22 ft.-lb.) in alphabetical sequence.

Then tighten all bolts to 69 N•m (7.0 kg-m, 51 ft.-lb.) in alphabetical sequence.

(3) Back off all bolts by 180 first; back them off by 180 again.

(4) Tighten bolts (A) and (B) to 34 N•m (3.5 kg-m, 25 ft-lb).



Bolts

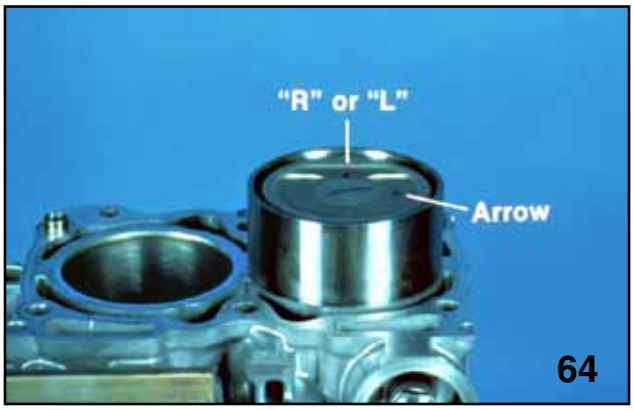
(5) Tighten bolts (C), (D), (E) and (F) to 15 N•m (1.5 kg-m, 11 ft-lb).
(6) Tighten all bolts by 80 to 90 in alphabetical sequence.

CAUTION: DO NOT TIGHTEN BOLTS MORE THAN 90.

(7) Further tighten all bolts by 80 to 90 in alphabetical sequence.

CAUTION: ENSURE THAT THE TOTAL "RE-TIGHTENING ANGLE" [IN THE TWO PREVIOUS STEPS] DO NOT EXCEED 180.

3) Install oil level gauge guide attaching bolt (LH side only).



Piston Installation

The pistons are directional and must be returned to the original cylinder locations. Use correct size piston guide to install the pistons. The pistons are marked with an "L" for the left side and an "R" for the right side. The arrow on the head of each piston must point to the front of the engine.

Circlip Removal

Rotate the crankshaft to position the connecting rod with the piston. Use piston pin guide 499017100 to align the piston and connecting rod. Then install the piston pin. Install the circlip. Note the proper direction of the circlip on early production models. The tangs must be tilted out. Repeat for the remaining pistons. Slowly rotate the crankshaft two (2) revolutions. This confirms the proper installation of the pins. Install the front piston pin access plugs. Use new aluminum sealing rings and sealer.

NOTE: DO NOT OVER TIGHTEN. CONSULT SUBARU SERVICE MANUAL ON THE STIS WEB SITE FOR SPECIFICATIONS.

Install the left side access cover and new o-ring, PCV baffle plate, and piston pin plug using a new sealing ring and sealer.

Installing Oil Pick-Up Tube

Install the oil pan baffle plate and oil pickup tube. Be sure to install a new O-ring to the oil pickup tube.

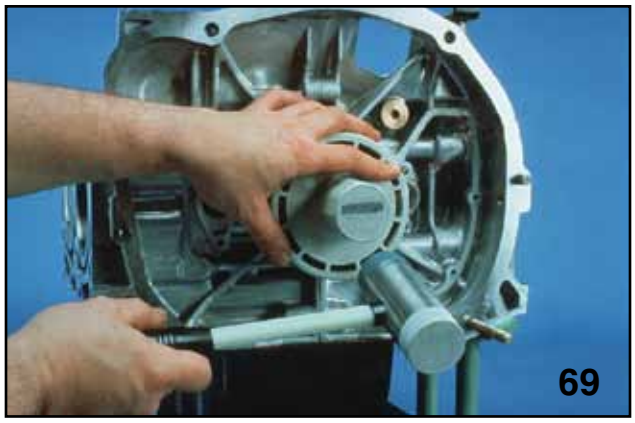
NOTE: DO NOT OVER TIGHTEN OR BOLT DAMAGE WILL OCCUR.

Oil Pan Drain Tube Seal

Install a new oil seal on the oil return tube. Apply liquid gasket sealer FUJI Bond 1207C or equivalent to the oil pan mating surface. Install the oil pan and oil pan retaining bolts. Diagonally torque the oil pan bolts on one pass to 0.5 Kg-m (3.6 ft lbs).

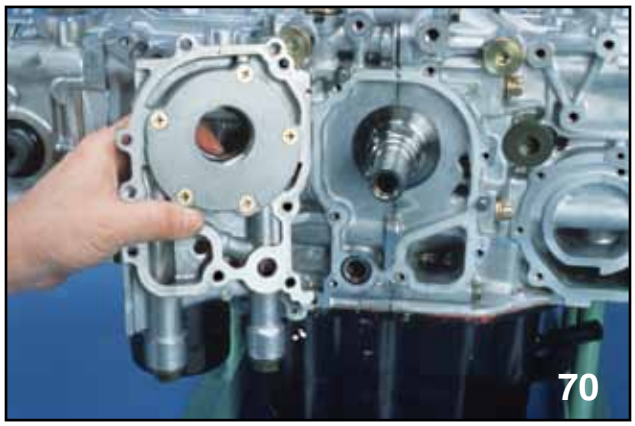
Dipstick Tube and Seals

Install the dipstick tube. Be sure to use two (2) new o-ring seals.



Installing Rear Crankshaft Oil Seal

Install the rear main oil seal using seal installer (499587200), oil seal guide (499597100) and a plastic hammer. Lubricate the seal with engine oil prior to installation.



Installing Oil Pump

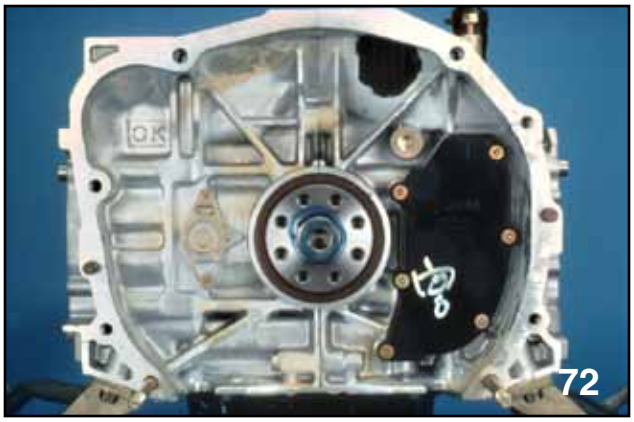
Install the oil pump. Refer to the 1995 Subaru Service Manual on the STIS web site section 2-4 [W1E0] for proper location of the sealer and O-ring. Apply FUJI Bond 1215 sealer or equivalent to the mating surface of the oil pump. Align the flats (2) on the oil pump with the flats (2) on the crankshaft and the mounting holes in the oil pump flange with the two (2) dowel pins. Install the mounting bolts and torque to specifications.

2.5 Engine 1999 Enhancements DOHC (Phase 1) and SOHC (Phase 2)

The 1999 2.5 Liter engine will be designated Phase 1 aor pahse 2. 2.5 liter engines equipped on the Legacy will be phase 1 design while the Impreza and Forester will utilize phase 2 design 2.5 liter engines.

The 2.5 liter phase 2 engines are SOHC engine with a newly designed cylinder head. The (phase 1) 2.5 liter engine uses the same cylinder head configuration that it has used on prior year models with the crankcase and bell housing sharing the same characteristics of the new phase 2 engines.

Common Changes in the 2.5 liter (phase 1 and 2 engines.)



Engine to Transmission Mounting

The engine and the transmission are fastened with 6 bolts and 2 studs.

Thrust Bearing Location

The thrust bearing has been moved to the number 5 position.

Main Bearing Oil Grooves

Oil groove in the number 1 and 3 have been changed to supply additional lubrication to the crank journal.

New Features of the 2.5 Liter (Phase 2) SOHC Engine

2 Rocker Shaft Assembly

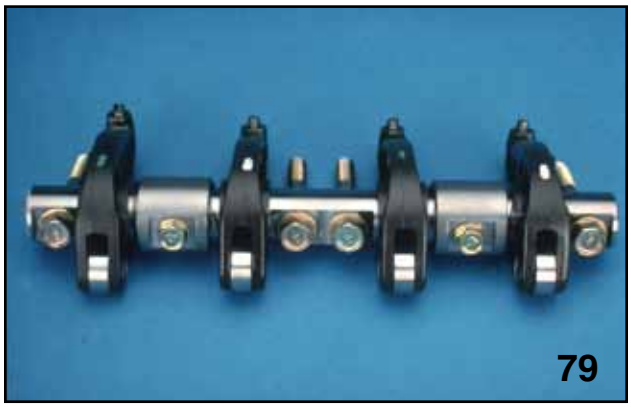
The cylinder head will be a 2-rocker shaft valve system.

The valves are positioned at a larger angle than previous model years. The intake valves are positioned 23 degrees off center with the exhaust valves positioned 20 degrees off center. Prior model year engines utilized a 15-degree positioning angle.

New Head Gasket Design

Head gasket thickness is 0.7 mm.

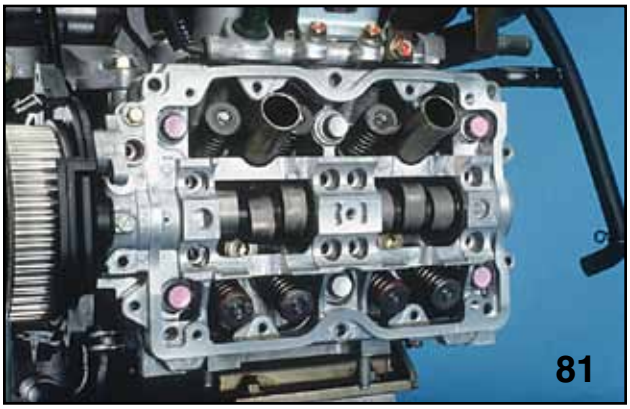
Rocker Arm Identification



Roller Rockers and Wave Washers

Adjustment Screw and Nut

The intake rocker arms are marked so they are correctly placed on the rocker shaft when servicing. An IN1 or IN2 will be embossed on each rocker arm. As viewed from the front of the engine the Number 1 intake valve of each cylinder and the number 2 intake valve have an IN1 marked and IN2 marked rocker arm that mates with it. New IN1 rocker arms can also be identified by a Green painted mark on the top of the rocker arm. The IN2 rocker arms have a white mark. Proper positioning is maintained through the use of a wave washer located between the rocker shaft arm and rocker arm shaft support.



Camshaft Secured by Camcase

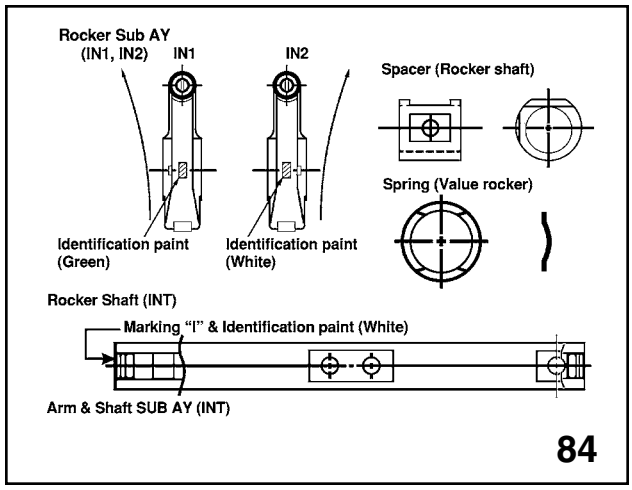
Camcase Sealing Points

Sealing Groove

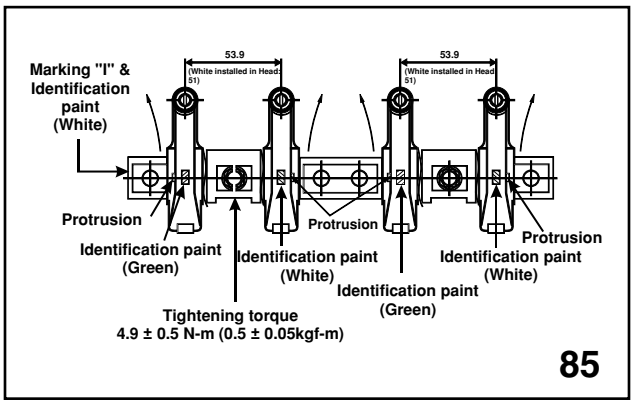
The camshaft is secured to the cylinder head with the camcase. An oil passage in the cylinder head provides the passageway in the camcase with oil that leads to the intake rocker shaft. Oil from the camshaft is collected on the opposite side of the passageway leading to the intake rocker shaft to provide oil to the exhaust rocker shaft.

Sealing of the camcase is accomplished by using a thin layer of three bond applied in the channel around the camcase edge. After the three bond (1280B) is applied, the camcase must be installed to the cylinder head and onto the engine before the three bond has time to cure. Failure to do this will result in oil leaks.

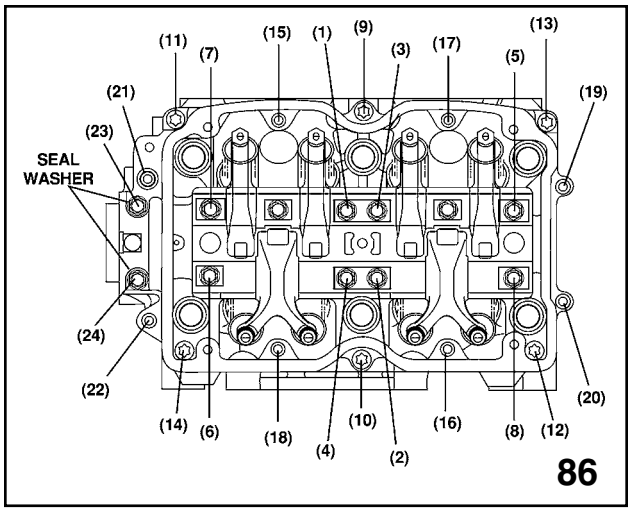
NOTE: CYLINDER HEAD AND CAMCASE MUST BE REPLACED TOGETHER. (LINE BORED)



Rocker Identification



Rocker Arm Measurements



Cam Case Tightening Sequenc

The spark plug pipe is pressed into the cylinder head and is not serviceable. If it becomes damaged the cylinder head must be replaced. The seals installed onto the ends of the spark plug pipes seal against the valve covers and should be replaced when the valve cover is removed.

Timing Belt Marks

Timing belt marks on the left bank will be made onto the inner timing belt cover and the edge of the camshaft sprocket. The crank shaft timing mark remains on the reluctor with engine block mark just below the crank angle sensor. The right bank camshaft sprocket has a mark at the edge that is matched with the seam line formed by the meeting of the camcase and cylinder head. (12:00 o'clock position)

Right Bank Timing Mark Window

The right bank timing mark can be checked with outer cover in place using the provided window.

Open Deck Design

Piston With Valve Reliefs

Piston design on the 2.5 liter engine. The compression ratio is 10 to 1.

Remanufactured Short Block Quality Acceptance

The following information describes conditions that may be found on new remanufactured short block assemblies.

Surface Scratch Cylinder Wall Chamfer

Cylinder wall area, 1mm < or less is acceptable and will not cause a sealing problem.

Dent on Head Gasket Mating Surface (Flat)

Flat area on cylinder wall or engine block mating head gasket mating surface.

2mm< or less is okay and will not cause a head gasket sealing problem.

Scratch on Head Gasket Mating Surface (Flat)

2.5 liter SOHC engine; spec. is 1.6ra or less (smoother) scratch or gouge (dent).

NOTE: 1.6RA AS WRITTEN ON PICTURE IS REPRESENTING A VALUE OF ROUGHNESS OR ROUGHNESS AVERAGE. THIS VALUE INDICATES HOW SMOOTH A SURFACE IS, INCREASING ITS ABILITY TO SEAL, SUCH AS A CYLINDER HEAD TO ENGINE BLOCK SURFACE.

THE NUMBER IS DERIVED FROM A SCALE USUALLY UNDERSTOOD BY MACHINE SHOP PERSONNEL. IN COMPARISON YOU ARE LOOKING FOR A SURFACE THAT WOULD APPEAR TO HAVE BEEN CLEANED BY CROCUS CLOTH OR SIMILAR ABRASIVE MATERIAL.

2.0 Liter Engine Features - WRX From 2002~2005

2.0 Liter Engine

Cam Belt and Idler Pulleys

The EJ-2.0 engine is a double over head camshaft, turbo charged engine. The timing belt procedure and routing is very similar to other Subaru DOHC, engines, however, the increased power output of the engine requires the use of an additional timing belt idler pulley. Manual transmission vehicles are equipped with additional belt guides that function during deceleration or fuel cut from high rpm running conditions.

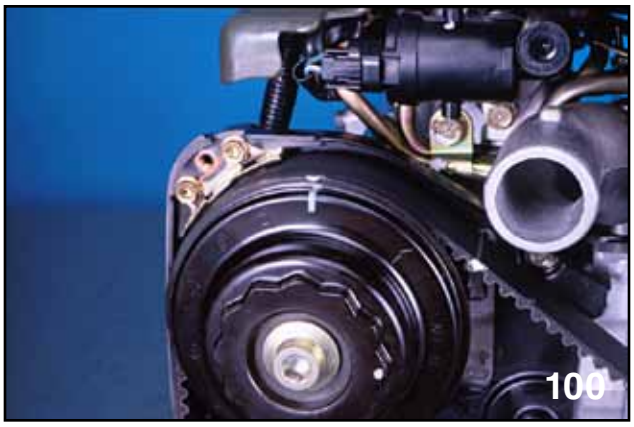
NOTE: WHEN SERVICING THE TIMING BELT RETURN ALL IDLER PULLEYS AND BELT GUIDES TO THEIR ORIGINAL POSITIONS.

Intake Camshaft Sprocket Timing Marks (Left Bank)

Exhaust Camshaft Sprocket Timing Marks (Left Bank)

The left bank intake camshaft sprocket is metallic and the camshaft reluctor is made onto the backside. The timing marks for belt installation are at 12:00 (I) and 6:00 (II).

The left exhaust sprocket is made of a resin material with its timing marks during belt installation at 12:00 (II) and 3:00 (I). The exhaust 12:00 (II) mark lines up with 6:00 (II) of the intake sprocket. (A timing belt guide is located at the lower left side of the sprocket of manual transmission models.)



Intake Camshaft Sprocket Timing Marks (Right Bank)

The right intake sprocket is also made of a resin material with its timing marks during belt installation at 12:00 (I) and 6:00 (II). (A timing belt guide is located at the upper left side of the sprocket of manual transmission models.)

Exhaust Camshaft Sprocket Timing Marks (Right Bank)

Finally, the right exhaust sprocket is made of a resin material with its timing marks during belt installation at 9:00 (I) and 12:00 (II). The exhaust 12:00 (II) mark lines up with 6:00 (II) of the intake sprocket. (A timing belt guide is located at the lower left of the sprocket of manual transmission models.)

Note: it is critical that all timing marks be confirmed to the correct position. Incorrect positions will result in valve and piston damage.

Engine Designation Number

The engine class number (Engine designation number) is located near the front of the engine behind the oil-sending unit and in front of the engine coolant temperature sensor.

Factory Coolant Pipe Plug

A coolant pipe located on the left hand bank is sealed with a rubber plug at the factory. Do not remove the plug to service any part of the cooling system. When performing coolant pressure tests check plug for leaks.

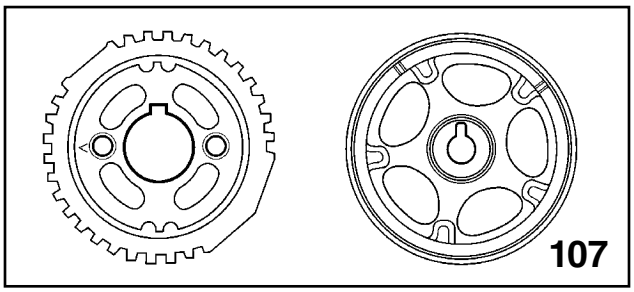
2.0 Liter Valve Train Assembly

2.0 Liter Head Bolt Access

The valve train for the EJ 2.0 is the same design used on other DOHC engines. A new shim tool (2002 only) has been developed to allow valve adjustment without removing the camshafts. The camshaft inner cover, camshaft sprockets and camshafts must be removed to access the cylinder head bolts. 2003 and newer use select fit lifters to obtain correct valve clearance.

Turbo Oil and Coolant Passages (Right Bank)

The rear of the right bank cylinder head serves as the mounting for the oil and coolant passages for the Turbo Charger.



Crankshaft and Camshaft Sprockets for the 2.0 Turbo Engine

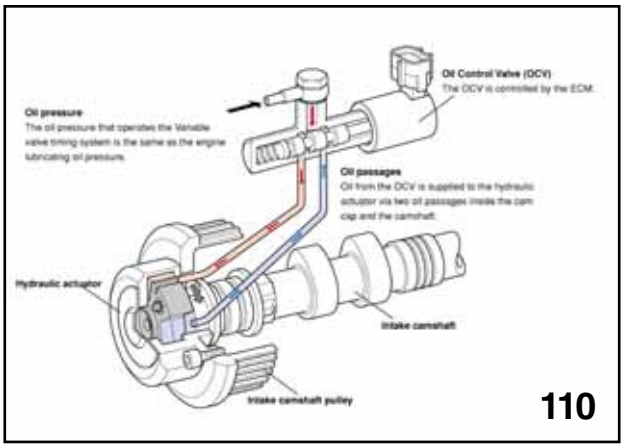
Piston pin design is strengthened with a near solid, non hollow design. Pin removal from pistons during disassembly requires a small diameter long thin punch or pliers to remove the pin.

Additional material is installed in the center of the piston pins in the 2.0 engine for strengthening.

2004 Variable Valve Timing System (2.5 Liter Engine)

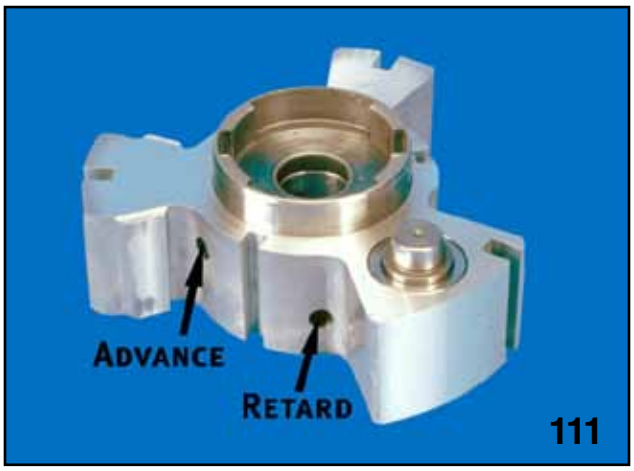
Engine

Variable valve timing functions to increase engine power output, improve fuel consumption and decrease exhaust emissions. These benefits are achieved by controlling the opening and closing time of the intake valves. The ECM monitors the engine operating condition and camshaft positions and controls the output duty ratio to oil control valves located on each cylinder head. The oil control valves in turn control the oil pressure to and from each intake camshaft sprocket. This allows the movement of the camshaft within the sprocket, controlling the opening and closing time of the intake valves.

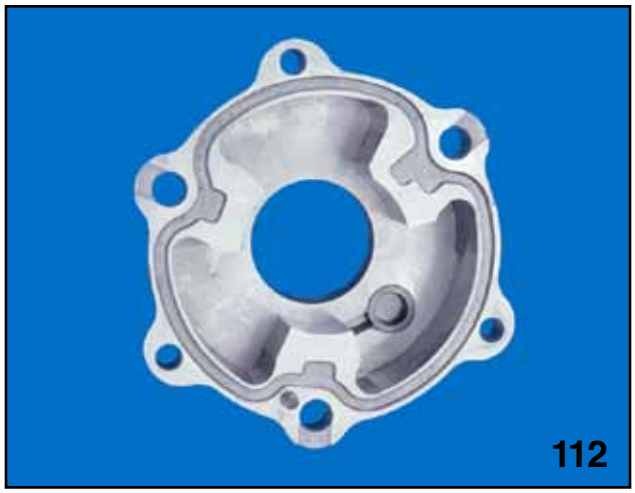


Camshaft (artwork)

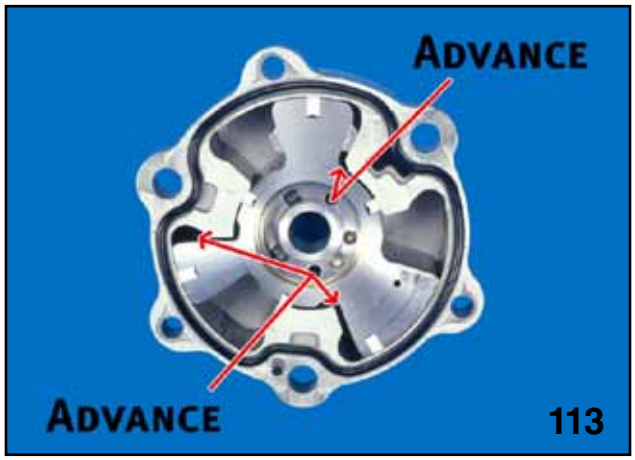
The intake camshaft sprocket is a non serviceable hydraulic actuator consisting of a set of sealing vanes, rotor and a fail-safe lock valve. The camshaft is secured to the rotor with a bolt. The position of the rotor within the camshaft sprocket forms advance and retard chambers. Changing the balance of oil pressure to these chambers moves the rotor to advance or retard the intake camshaft.



Camshaft Sprocket Rotor

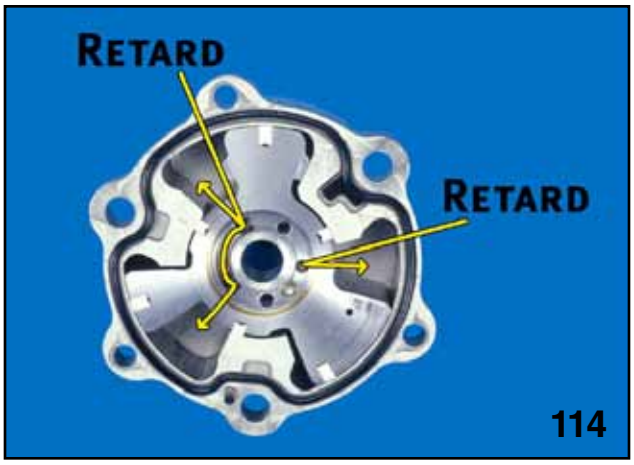


Sprocket Housing



Advance Chambers

The fail-safe lock valve must operate to mechanically release the rotor from the sprocket before normal variable valve timing operation can begin. The fail-safe lock valve is unlocked by the oil pressure of the engine from the oil control valve when ever the camshaft is advanced and locked in place by the removal of pressure from the advance chamber and spring tension. The purpose of the valve is to allow the camshaft to operate in a preset fixed position in the event of a failure in the oil control valve or related hydraulic circuits. The camshaft position with the fail-safe lock valve seated is at full retard.



Retard Chambers

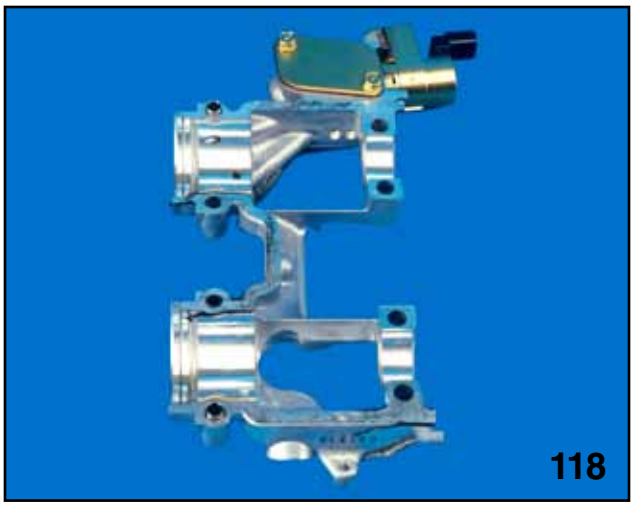
Cylinder Head

Saddle Cap

An oil control valve is located on each cylinder head, receiving a common duty ratio signal.

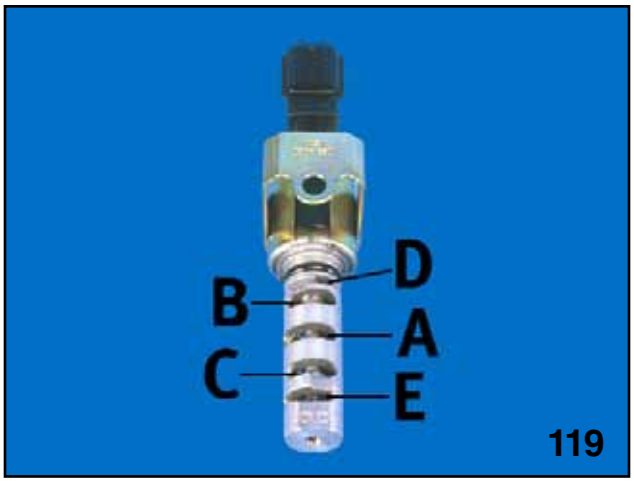
The oil control valve housing and the front camshaft saddle caps are incorporated into one unit.

Camshaft

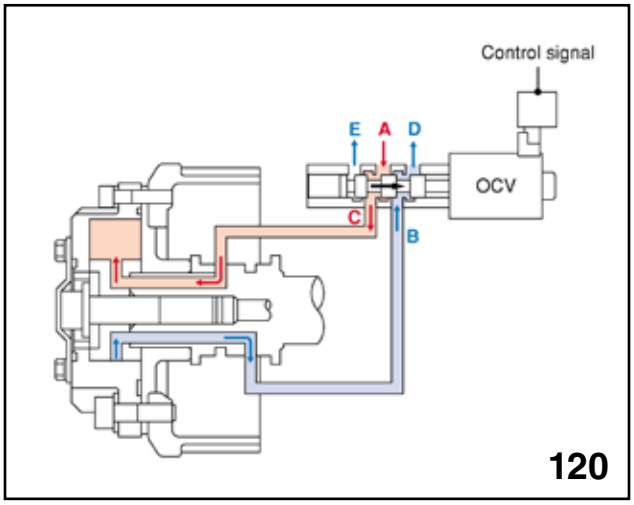


Oil Control Valve

Passageways in the oil control housing carry oil under pressure to and from the camshaft. The camshaft passageways then carry the oil to and from the camshaft sprocket. The forward passage way is for the advance chambers and the rear passage way is for the retard chambers.



OCV



ABCD

The oil control valve chamber A is oil pressure into the valve. Chamber B provides a passage from the camshaft sprocket to drain D during advance.
Chamber B also provides a passage way to the camshaft sprocket during retard.
Chamber C provides a passage way from the camshaft sprocket to drain E during retard.
Chamber C also provides a passage way to the camshaft sprocket during advance.

Intake Camshaft Sprocket

Special Tool Installed

Access to the intake camshaft bolt is obtained after removing the end cap. The bolt is hollow to allow oil to enter the front of the camshaft sprocket to lubricate the area where the rotor and the camshaft sprocket rotate against each other. Be certain to properly position the o-ring when reinstalling the end cap.

Make sure the special tool is positioned properly to avoid slippage as sprocket bolts are very tight.

Special tool 499977500 wrench is used to hold the camshaft sprocket while the bolt is being removed or installed.

499977500 Wrench

Camshaft Sprocket Bolt

The shape of the wrench is made to match the shape made into the sprocket.

The intake camshaft bolt on each intake camshaft is hollow. Exhaust camshaft bolts are solid. Do not mix them up as the intake sprocket will be damaged from lack of lubrication.

Hall Effect Sensor Over Camshaft

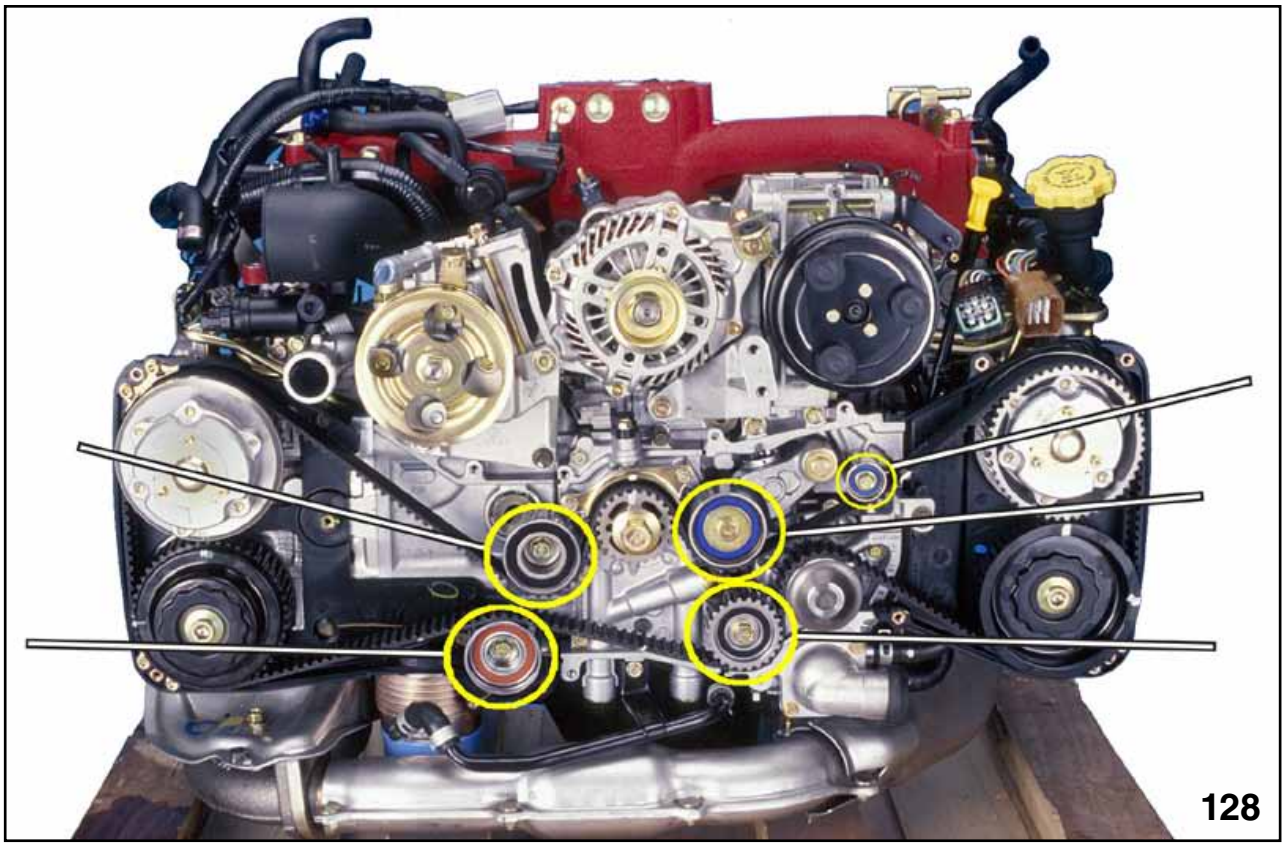
Sensor With Connector

A Hall effect camshaft sensor is used on the rear of each camshaft. These sensors are used to control the variable valve timing and to also provide camshaft information for ignition and fuel control.

NOTE: SENSOR FOR PCV PRESSURE FOR OBD II.

Oil Pipes

The oil supply for the passenger side oil control valve is shared with the turbo charger. The driver side oil control valve receives oil from a pipe from the front of the cylinder head.

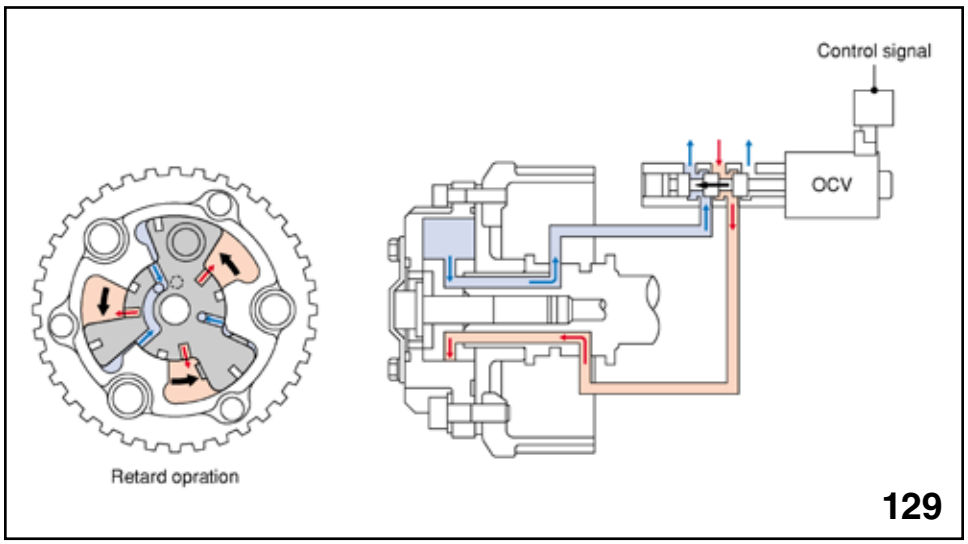


Engine Timing Belt Configuration And Bearing Identification

Proper timing belt configuration and pulley color identification.

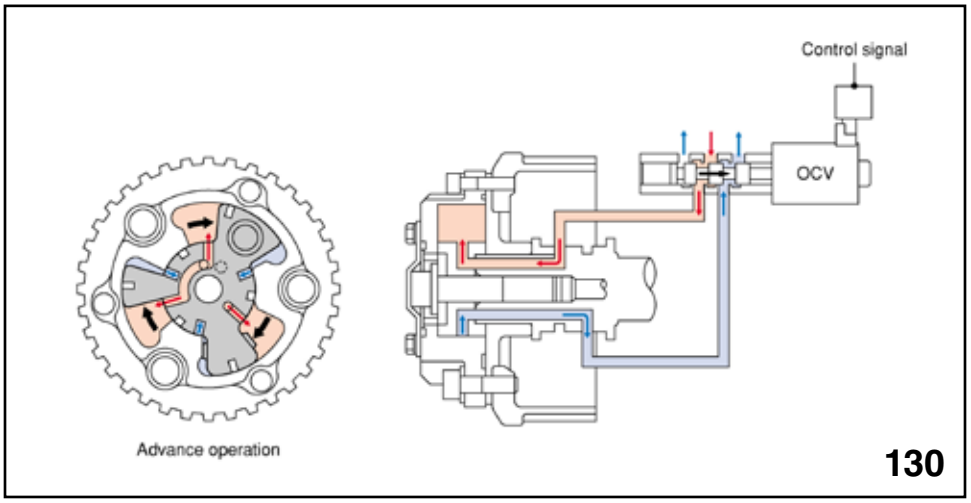
Operation

Variable Valve Timing



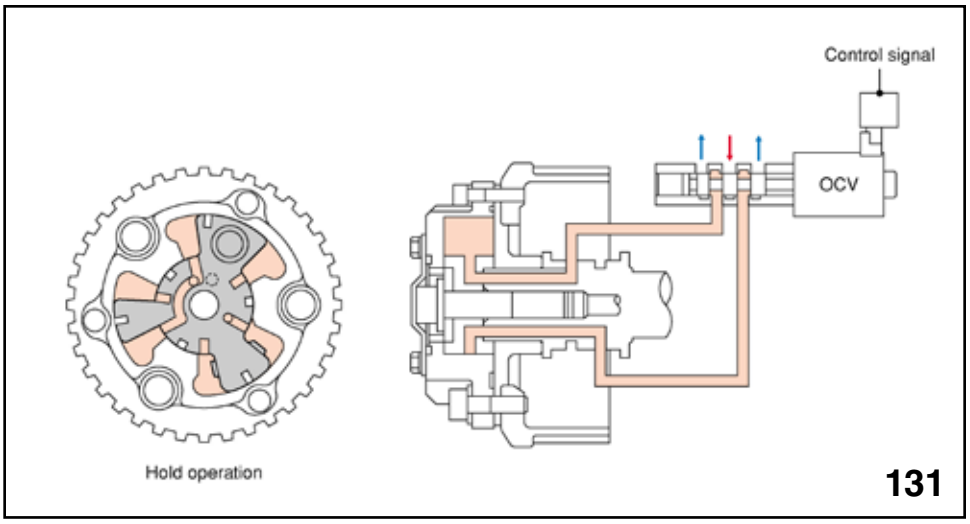
Retard Operation

The oil control valve duty ratio during the time the camshaft is being retarded is low. This will affect the balance of pressure against the rotor to move the rotor in the opposite direction of engine rotation. This will retard the opening and closing of the intake valves as compared to the exhaust valves and crankshaft position.



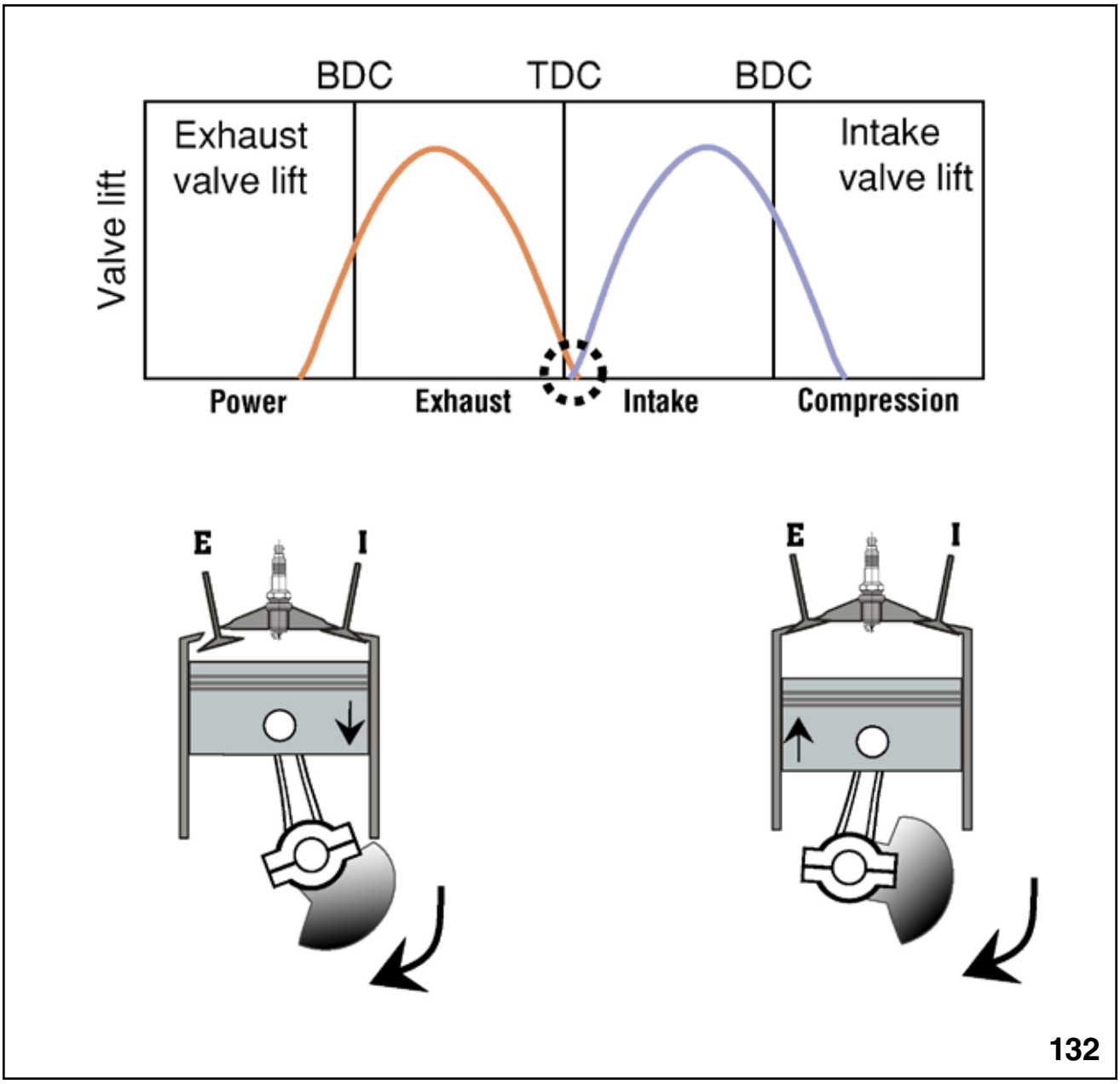
Advance Operation

The oil control valve duty ratio during the time the camshaft is being advanced is high. This will affect the balance of pressure against the rotor to rotate the rotor in the same direction of engine rotation. This will advance the opening and closing of the intake valves as compared to the exhaust valves and crankshaft position.



Hold Operation

The oil control valve duty ratio during the time the camshaft is being held is a certain valve. The two ports connected to the hydraulic actuator are closed by the valve, sealing the oil in the retard and advance chambers. This will maintain the balance of pressure against the rotor so that the camshaft is neither advanced or retarded as compared to the exhaust valves and crankshaft position.



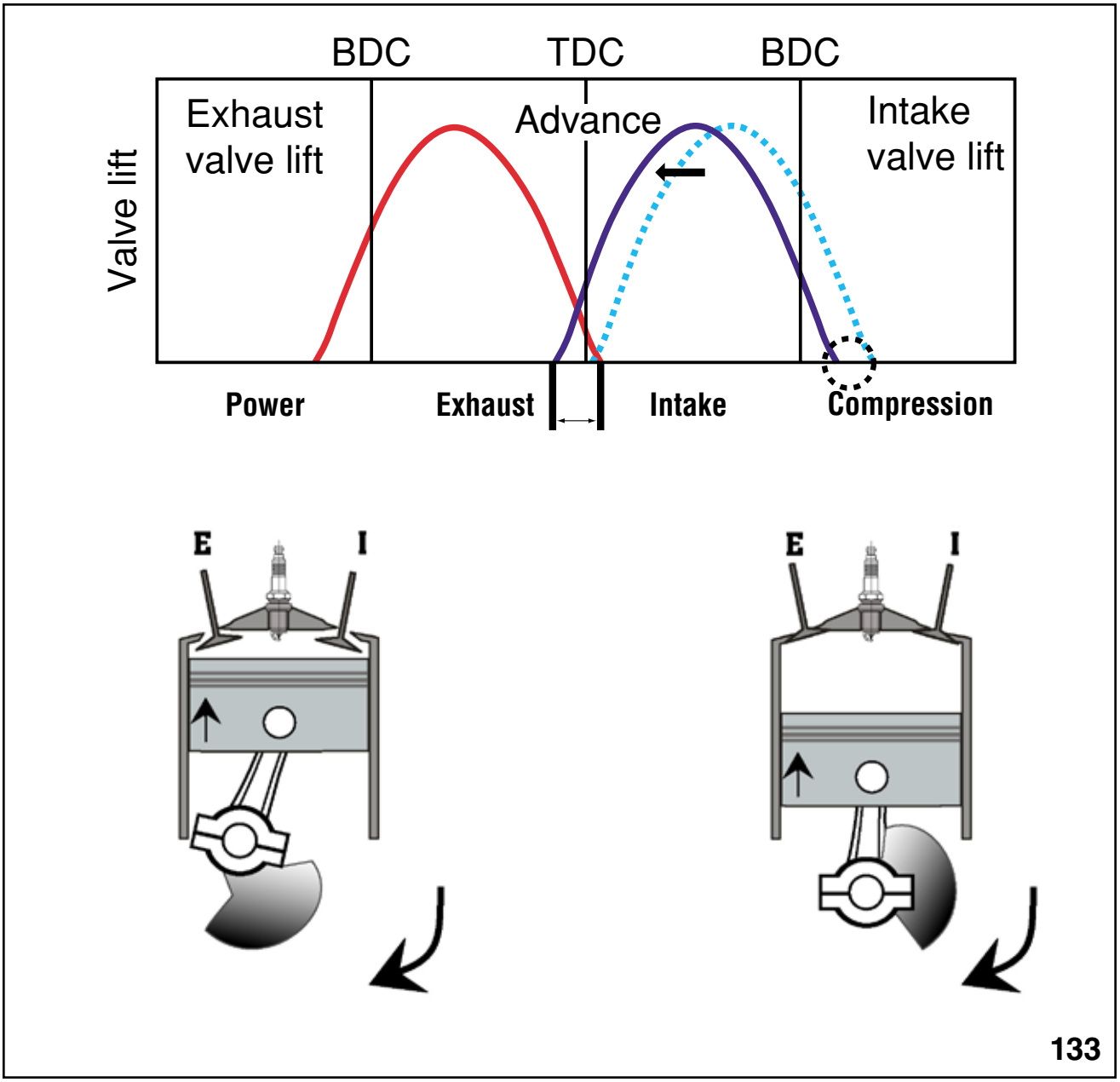
End of Exhaust Stroke
Beginning of Intake Stroke

Moving up on compression stroke

Light Engine Load

At idle the intake valves are timed to open a few degrees after TDC of the exhaust stroke. This takes advantage of the large volume of negative pressure created by the exhaust stroke and the positive pressure consisting of air/ fuel mixture now more efficiently fills the cylinder. The exhaust valves will remain open a few degrees down on the intake stroke.

Air/Fuel mixture will continue to fill the cylinder until a few degrees up on the compression stroke, Minimizing the air that goes back into the intake manifold.



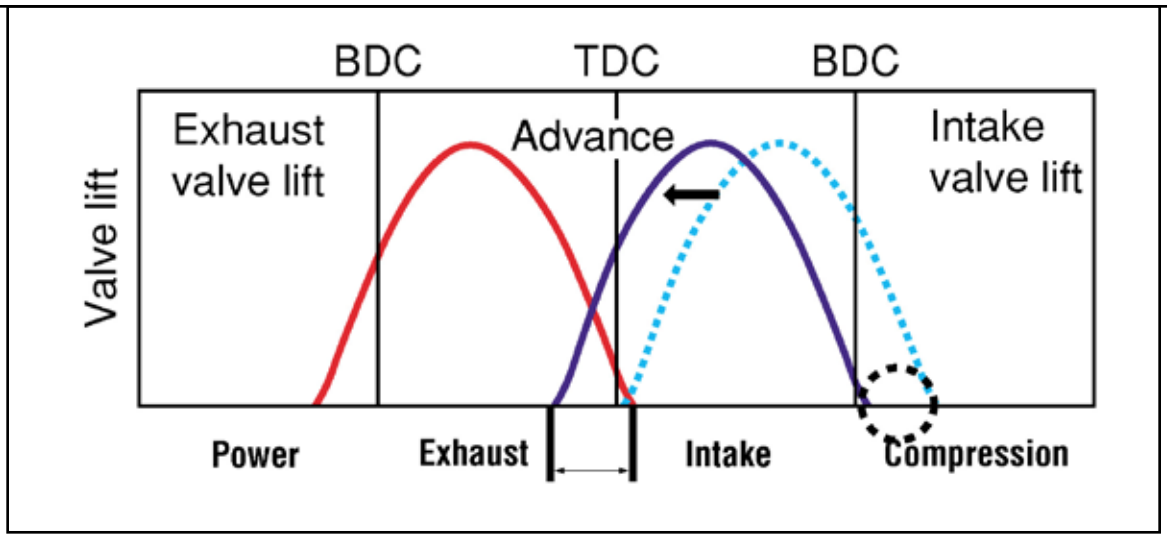
Near the end of exhaust *Moving up on compression stroke*

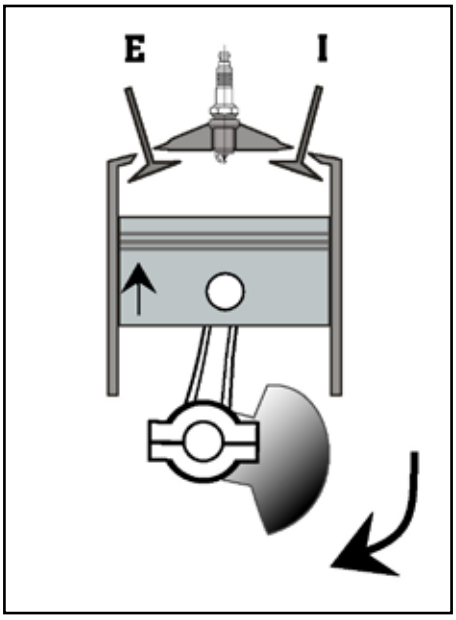
Medium Engine Load

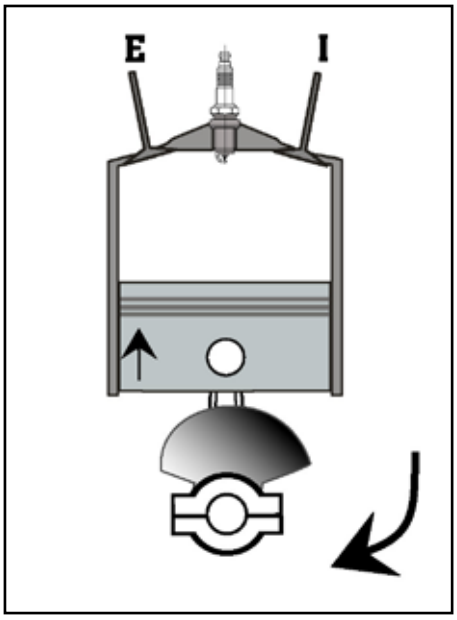
During small to medium engine load operating conditions the intake valves are opened sooner. This advanced setting allows some of the pressure created during the exhaust stroke to flow back into the intake manifold, creating and EGR effect.

This helps reduce the creation of Nox. As the engine load increases the pressure inside the manifold becomes higher than that of the cylinder on exhaust stroke, eliminating the EGR affect.

The intake valves are closed sooner on the compression stroke improving volumetric efficiency.







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Moving Up On Exhaust Stroke *Near the beginning of compression stroke*

Heavy Engine Load

During heavy engine load operating conditions the intake valves are opened sooner. This produces a scavenging effect to clear the cylinder of exhaust gas.

Closing the intake valves sooner on the compression stroke further increases the volumetric efficiency and assists with generating high engine power output.

2004 2.5 Turbo Engine

Engine Block

Combustion Chamber

The 2.5 liter DOHC turbo engine for the WRX STi is designed with a semi-closed type cylinder block.

The 2004 2.5 engine was also used in the forester with less horsepower and torque due to changes in ht eturbocharger, intercooler, cylinder heads and camshafts.

This provides stronger holding of the cylinder liners and improves the gas sealing characteristics between the cylinder block and cylinder head. The cylinder block itself has a cast in reinforcement above the number 5 main shaft journal that improves strength and noise control.

The exhaust valves are sodium filled to improve heat transfer. Do not resurface exhaust valves. Dispose of discarded valves in accordance with regulations in your area.

The intake valve is hollow to reduce reciprocating weight.

Valve clearance is adjusted by replacing the selective shim less valve lifter.

Spark plugs are made with an Iridium center electrode to improve performance.

Additional changes include reshaping of the oil pan, to prevent aeration on turns, and the shape of the piston top to control compression ratio.

Lower Radiator Cap

Upper Coolant System Cap

The lower radiator cap contains only a pressure relief. The upper coolant system cap contains both a vacuum relief and a pressure relief. The lower radiator will open to pressure at 137+_14.7 kPa. The upper coolant system cap opens to pressure at 108+-15 kPa and under vacuum at -1.0 to - 4.9 kPa.

Pressure Plate

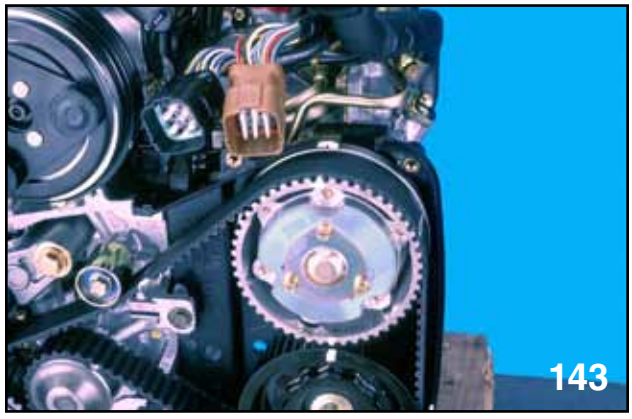
Flywheel

The flywheel is larger and lighter. The clutch is a hydraulic pull type with a clutch disc of 240 mm is longer than WRX.

Position the two heavy marks of the flywheel and pressure plate at least 120 degrees apart upon reassembly.

Timing Belt Timing Marks

Intake Camshaft Passenger Side



Driver Side Intake Camshaft

Crank Shaft

Passenger Side Exhaust Camshaft

Driver Side Exhaust Camshaft

NOTE: TIMING BELT RETAINERS MUST BE INSTALLED TO AVOID LOSING THE BELT ESPECIALLY ON HARD DECELERATION WHEN ENGINE IS TWISTING.

NOTES:

Engine

"LEGACY 2.5 i, OUTBACK 2.5 i and OUTBACK 2.5 i LIMITED:"
2.5L PHASE II

SOHC 16V HORIZONTALLY OPPOSED 4 CYLINDER
DISPLACEMENT: 2.5 LITERS (2457 CC / 150 CU INCHES)
BORE/STROKE: 99.5 x 79mm (3.92 x 3.11 INCHES.)
HORSEPOWER: 168 HP @ 5600: RPM
TORQUE: 166 LB-FT @ 4000 RPM
COMPRESSION RATIO: 10.0:1
ENGINE TYPE: EJ25

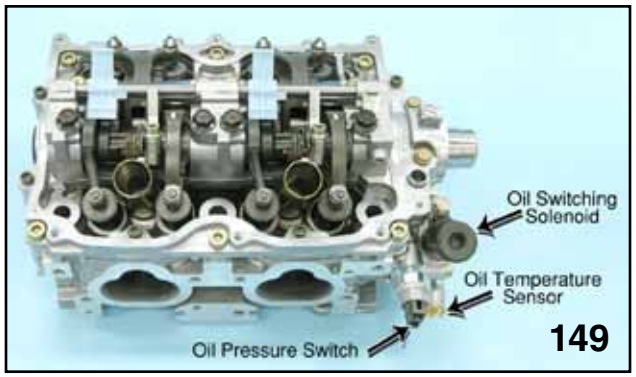
"LEGACY 2.5 GT, 2.5 GT LIMITED, OUTBACK 2.5 XT and OUTBACK 2.5 XT LIMITED:"
2.5L INTERCOOLED TURBO

DOHC 16V HORIZONTALLY OPPOSED HIGH OUTPUT 4 CYLINDER
TURBOCHARGED
MAXIMUM BOOST PRESSURE: 700 mmHg (13.5 PSI)
INTERCOOLED
DISPLACEMENT: 2.5 LITERS (2457 CC / 150 CUBIC INCHES)
BORE/STROKE: 99.5 x 79mm (3.92 x 3.11 INCHES)
HORSEPOWER: 250 HP @ 6000 RPM
TORQUE: 250 LB-FT @ 3600 RPM
COMPRESSION RATIO: 8.2:1
ENGINE TYPE: EJ25
ACTIVE VALVE CONTROL SYSTEM (AVCS) VARIABLE VALVE TIMING **147**

Engine Types

2006 2.5 Naturally Aspirated Engine

The 2.5 naturally aspirated engine has increased in horsepower and torque over the previous model year. Horsepower is rated at 175 at 6,000 RPM and 169 ft. lbs. of Torque at 4,400 RPM.



Cylinder Head

NOTE: OIL TEMPERATURE SENSOR IS USED ONLY TO DETERMINE OIL TEMPERATURE FOR DIAGNOSIS. (MINIMUM TEMPERATURE 15°C OR 59° F)

Naturally aspirated models are equipped with i-Active Valve Lift System. The system operates similar to the variable valve lift system of 3.0 liter engine of the Legacy and Subaru B9 Tribeca vehicles.

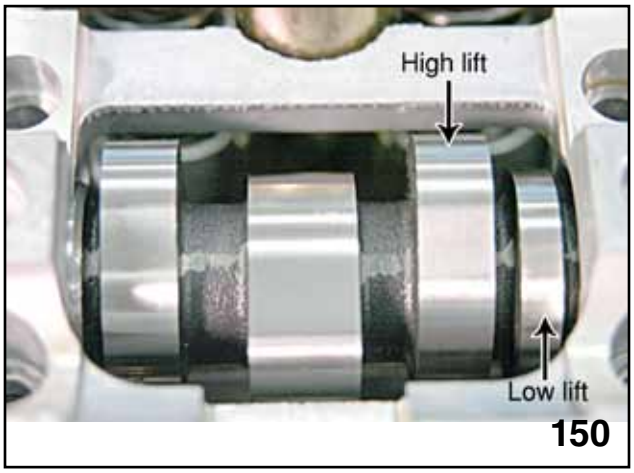
Operating one of two intake valves per cylinder, the i-Active Valve Lift System increases combustion chamber swirl at low engine speeds and increases air flow during high engine speeds.

NOTE: THE REASON FOR CHANGE INTERVALS ON PLATINUM SPARK PLUGS AND WHY SOME NEED TO BE CHANGED AT 30,000 MILES AND OTHERS AT 60,000 MILES.

THE REASON FOR THIS IS THE SPARK PLUGS ON 2.5L NA ENGINES, THE ELECTRODE SIDE OF THIS PLUG IS PLATINUM BUT THE PLUG CORE SIDE IS NOT PLATINUM. THEREFORE, IT IS A MAINTENANCE INTERVAL EVERY 30,000 MILES.

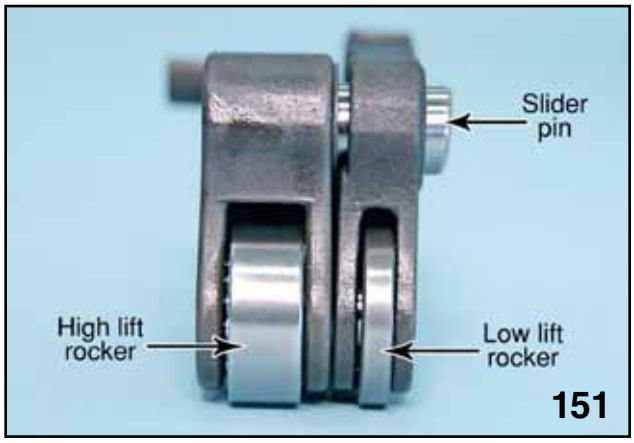
ON THE 2.5L TURBO AND 3.0L ENGINES, BOTH THE ELECTRODE SIDE AND THE PLUG CORE SIDE ARE PLATINUM.

THEREFORE, IT IS A MAINTENANCE INTERVAL EVERY 60,000 MILES.

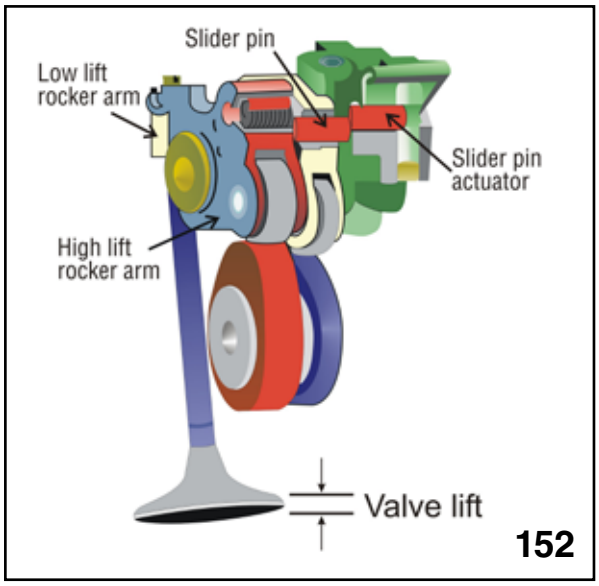


Camshaft

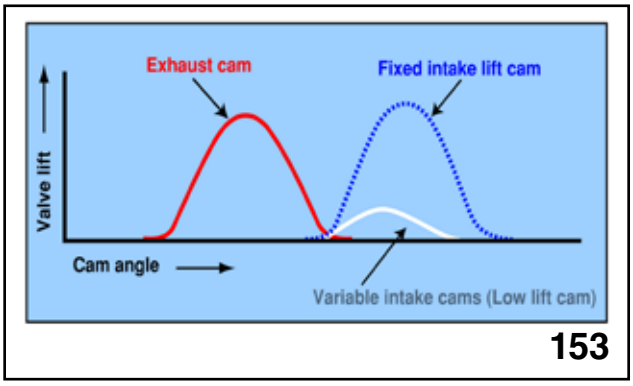
The inboard intake camshaft lobe of each cylinder is actually two lobes. The shorter lobe provides the lift for the low speed or mode 1 operation and the higher lobe provides the lift for high speed operation or mode 3.



Rocker Arm

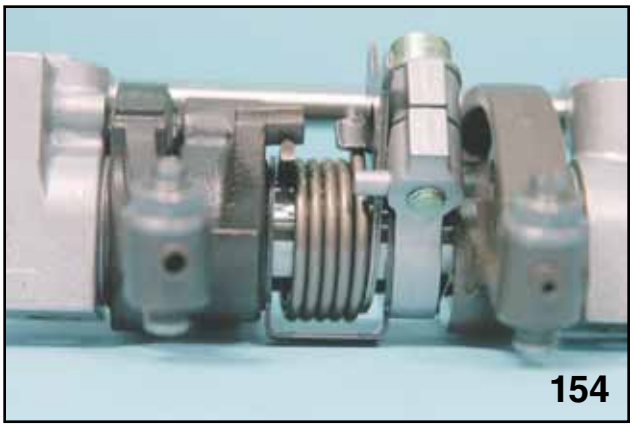


Valve and Rocker Arm (Low Lift)



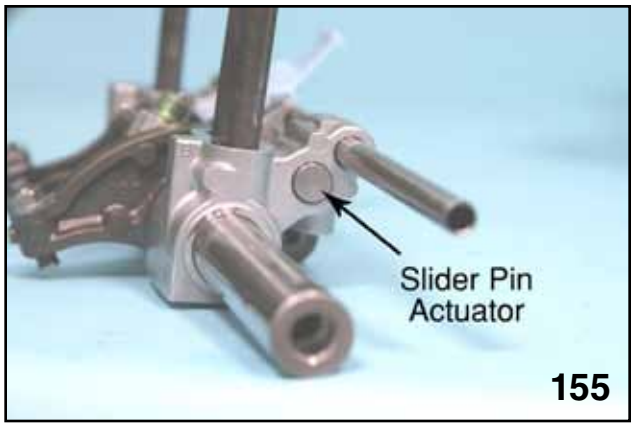
Lift Graph
(Both rocker arms operate independently)

During low speed operation (mode 1) the low lift camshaft lobe transfers the lift and duration of the low speed camshaft lobe to the top of the intake valve.



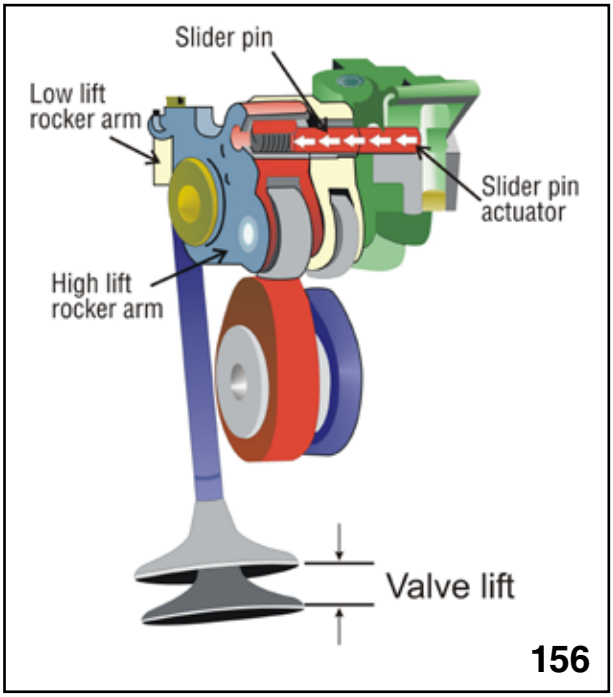
Tension Spring

The high lift rocker arm moves freely and has no affect on the intake valve. The high speed rocker arm utilizes a tension spring to maintain the correct positioning and to prevent noise as it has no load applied to it.

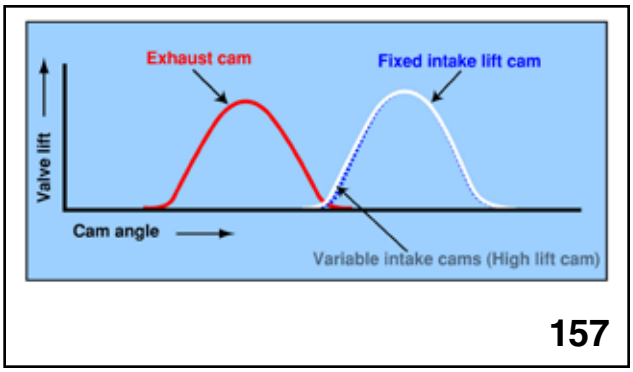


Slide Pin Actuator

A duty ratio signal sent to an Oil Switching Valve on the left and right side engine cylinder heads affects the build up of oil pressure behind a slider pin actuator of each cylinder. An increase in duty ratio closes the oil pressure release and the slider pin moves outward.



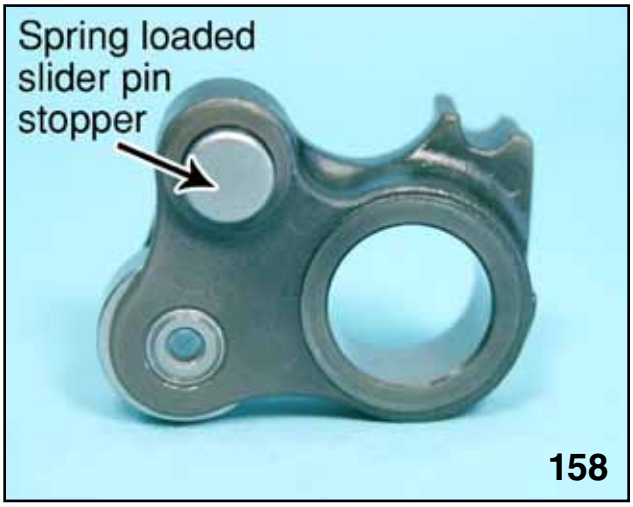
Valve and Rocker Arm (High Lift)



Lift Graph

(Both rocker arms locked together)

During high speed operation (mode 3) the slider pin actuator moves outward from the center rocker shaft support due to the increase in oil pressure behind the actuator. The actuator pushes the slider pin positioned in the low lift rocker arm into the slider pin stopper located in the high speed rocker arm. This action mechanically locks the two rocker arms together. The lift and duration of the high lift camshaft lobe is transferred from through the high lift rocker arm to the low lift rocker arm and then to the top of the intake valve.



Slider Pin Stopper

When the engine returns to mode 1, the oil pressure behind the slider pin actuator is drained away and the spring tension behind the slider pin stopper pushes the slider pin away from the high lift rocker arm and the low lift rocker arm functions from the low lift camshaft lobe only.

Oil Level Sensor

Upper Oil Pan

The oil pan upper case has been added to all 2.5 engines. This new design adds the rigidity needed for the front engine mount.

A new oil level sensor system has been added to all engines. This system will check the oil level at idle only. The light will illuminate when the oil level falls to the following levels:

4 cylinder engines 2.8 to 2.9 quarts

A float type sensor is utilized that is equipped with a small magnet. The magnet keeps a reed switch closed when the oil level is not low.

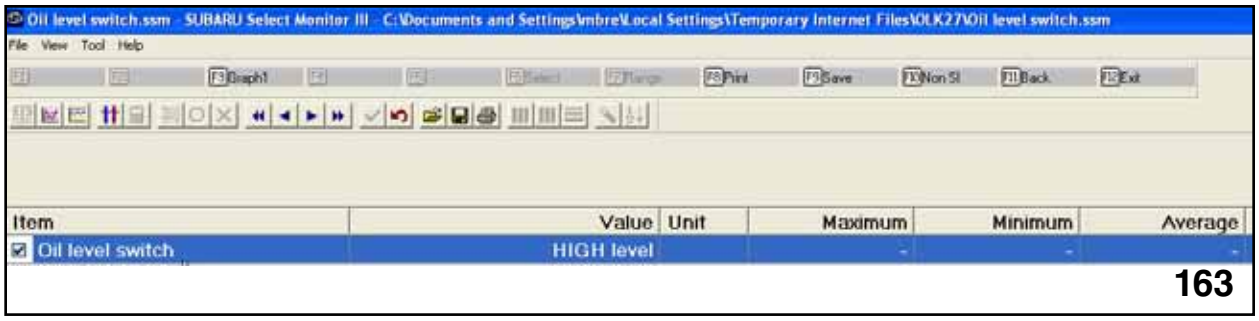
Once the light is ON the ECM memory must be cleared to extinguish the light, or allow the engine to operate until warm. There is no DTC when the light is illuminated. A PID on the SMIII engine menu will indicate “High” if the oil level is above the light on threshold and “Low” when it is at or below the threshold.

Removal

Float

When replacing the sensor the oil must be drained from the engine. During removal the sensor must be lifted slightly and then turned approx. 90 degrees towards the rear so that the float chamber will clear. The sensor has one wire leading to the ECM. The ground for the sensor is attached at the rear mounting bolt.

NOTE: DO NOT APPLY A HIGH PRESSURE WASH DIRECTLY ONTO THE SENSOR AS DAMAGE MAY RESULT.



PID Oil Level Switch

General hand tools and supplies

Dial indicator	Rubber or Plastic Hammer
Dye penetrant	Fuji Bond 1105 or equivalent
Feeler gauge	Fuji Bond 1280B or equivalent
Micrometers	Fuji Bond 1107C or equivalent
Plastigauge	Fuji Bond 1215 or equivalent
Press	Torque wrench (ft-lb) and (in. lb.)

Reference Materials

Subaru Technical Information System (STIS)
Technician Reference Booklets

Special Tools

Special Tools		2.0L	(97 to 99) (Solid) DOHC (Phase 1) 2.5L	(1999 & Later) SOHC (Phase 2) 2.2 & 2.5L	3.0	(2004 & Later) DOHC	3.6L
498457000	Engine stand adapter RH	X	X		X		
498457100	Engine stand adapter LH	X	X		X		
498747100	Piston guide		X				
498857100	Valve oil seal guide	X	X	X	X		
499017100	Piston pin guide	X	X	X		X	
499037100	Connecting rod bushing remover & installer	X	X	X			
499097500	Piston pin remover		X		X		
499207100	Camshaft sprocket wrench		X	X		X	
499587100	Camshaft oil seal installer	X	X	X	X	X	
499587200	Crankshaft oil seal installer	X	X	X	X	X	X
499587300	Camshaft oil seal installer						
499587400	Oil pump seal installer						
499597000	Camshaft oil seal guide		X	X	X		
499718000	Valve spring remover	X	X	X	X	X	X
499767000	Valve guide adjuster	X					
499767200	Valve guide remove	X	X	X			
499767400	Valve guide reamer	X	X	X			
499817000	Engine stands (2)	X	X				
499977000	Crank pulley wrench	X	X				
898968600	Circlip pliers (or SNAP-ON long nose pliers 911CP)				X		
499597100	Crankshaft oil seal guide	X		X	X		
498747300	Piston guide		X	X	X	X	

Special Tools		2.0L	(97 to 99) (Solid) DOHC (Phase 1) 2.5L	(1999 & Later) SOHC (Phase 2) 2.2 & 2.5L	3.0	(2004 & Later) DOHC	3.6L
499585500	Valve oil seal guide						X
499977500	Cam sprocket wrench						X
18252AA000	Crankshaft socket				X		X
18251AA050	Valve guide adjuster (Intake)						X
18251AA060	Valve guide adjuster (Exhaust)						X
18332AA020	Oil filter wrench						X
18355AA000	Pulley wrench						X
18334AA000	Pulley wrench pin set						X
499585700	Oil seal guide						X
499207300	Camshaft sprocket wrench						X
498267600	Cylinder head table	X					
498267700	Valve guide adjuster	X	X				
499987500	Crankshaft socket			X			
J-43979	Shim remover tool		X				
J-42908	Camshaft sprocket holding tool		X				
498497100	Crankshaft stopper	X	X	X	X	X	X
18254AA00	Piston guide				X		
18350AA000	Connecting rod bushing remover & installer	X		X	X		X
499587700	Camshaft oil seal installer	X		X	X		
18251AA000	Valve guide adjuster				X		
499765700	Valve Guide remover				X		X
499765900	Valve Guide reamer				X		X
499977100	Crank pulley wrench			X	X	X	
18252AA00	Crankshaft socket				X		
499587500	Oil seal installer			X	X	X	
18329AA000	Shim replacer assemble				X		
18233AA000	Piston pin circlip pliers				X		
398744300	Piston guide	X					X
499097700	Piston pin remover assembly	X		X			X
499207400	Camshaft sprocket wrench	X		X			
499977300	Crank pulley wrench	X		X			
499987500	Crankshaft socket	X		X			
499587600	Oil seal guide	X				X	
499597200	Oil seal guide	X				X	
498187200	Shim replacer	X			X		
499767700	Valve guide adjuster (intake)			X			
499767800	Valve guide adjuster (Exhaust)			X			

Special Tools		2.0L	(97 to 99) (Solid) DOHC (Phase 1) 2.5L	(1999 & Later) SOHC (Phase 2) 2.2 & 2.5L	3.0	(2004 & Later) DOHC	3.6L
499817100	Engine stand (2)	X		X			
49949700	Torx plus			X			
499097600	Piston pin remover assembly		X				
498187100	Shim replacer kit		X				
42099AE00	Fuel line connection remover				X	X	X
18232AA000	Engine stand				X		X
498277200	Flywheel stopper	X	X	X	X	X	X
18354AA000	Valve rocker holder 2006 phase two non-turbo						
18258AA000	Spring installer 2006 phase two non-turbo						

Service Bulletins

No.	Date	Title	Subject
02-90-94R	12/02/94	95MY Legacy with engine numbers between and including 003167 through 042715	Engine oil pump leaks
01-143-96	12/23/96	Recommended sealants and adhesives	
02-92-03	11/28/03	All Legacy H-6 Models	Crankshaft pulley and cover Modification
02-93-04	11/05/04	Legacy, Impreza and Forester Vehicles	Modification of timing belt tensioner bracket
02-94-05	02/02/05	1999~04MY Forester 2.5L SOHC N/A, 1999~04MY Impreza 2.5L SOHC N/A, 2000~04MY Legacy 2.5L SOHC N/A (Except 2004MY Legacy U5 specifictation vehicles)	Revised cylinder block spectifications
02-95-05	03/25/05	1997~99 Legacy; 98MY Forester; 98MY Impreza with 2.5L DOHC engines	Hybrid Engine Short Block Release
02-96-05	09/19/05	Remanufactured SOHC short block release	Various SOHC shrot block availability
02-95-05R	09/22/05	1997~99MY Legacy; 98MY Forester 98MY Impreza with 2.5L DOHC engine	2.5L Remanufactured DOHC short block release
02-97-05	10/06/05	04MY Forester 2.5L turbo; 04MY Baja 2.5L turbo; 04MY Impreza STi 2.5L turbo	Active valve control system (AVCS) union screw filter
09-42-05	04/15/05	All Models	Cautions concerning engine coolant
09-39-04	05/07/05	2005MY Legacy & Outback vehicles	Engine coolant system refilling
02-100-06R	10/31/06	All Models	Cylinder Head Gasket (Residual carbon deposits and rubber coating removal)
09-45-06	11/28/06	All Models	Radiator cap information
02-101-07	02/28/07	All Turbo Equipped Models (4 cyl)	Turbo vehicle operation & care
09-47-07	08/31/07	All Models	Coolant flushing machines and additives
02-103-07R	10/29/07	All Turbo Equipped Vehicles (4 cyl)	Turbocharger oil supply mesh screen
11-85-07	10/15/07	2008 Legacy Outback & Forester NA PZEV	PZEV Engine Noise

Continued on next page

No.	Date	Title	Subject
02-104-08	02/19/08	2006-2007MY Impreza & Forester 2.5 NA	Intake Manifold Modification
02-105-08	02/28/08	2008MY Tribeca 3.6L (6 cyl)	Cylinder block & piston design change
02-106-08R	06/02/09	All Vehicles Equipped with Turbo	Turbocharger Mesh Filter Screen
02-107-09	03/24/09	2004~06MY Baja 2.5L Turbo 2004~06MY impreza 2.5L Turbo 2004~06MY Forester 2.5L Turbo 2004~06MY Legacy/Outback 2.5L Turbo	Intake Camshaft Replacement

Warranty Bulletin

No.	Date	Applicability	Subject
WXV-79	09/2000	2000MY Subaru Legacy and Outback and Outback Vehicles with Manual Transmission	Engine Control Module (ECM
WWF-89	04-2002	2000~01MY Subaru Legacy and Outback 4EAT 2000~02MY Impreza MT5 or 4EAT 2001~02MY Forester MT5 or 4EAT	Engine Control Module (ECM) Reprogramming
WWJ-93	09-2002	Certain 2003MY Legacy, Outback and Baja Models	Engine Water Pump
WWP-99	02-2004	2000~2002MY Subaru Legacy and Outback; 1999~2002MY Impreza; 1999~2002MY Forester	Engine Cooling System Conditioner
WWU-05	10-2004	2004MY Turbo Subaru Forester, STi and Baja	Engine Oil Control Valve Cover Bolts
WWX-08	06-2006	2004MY California PZEV Spec. Subaru Legacy and Outback 2.5i NA	Engine Control Module (ECM Reprogramming
WWY-09	06-2006	2006MY Baja, Legacy, Outback and B9 Tribeca	Engine Cooling System Flush and Refill

TECH TIPS

Date	Subject
02/95	Idle quality complaints on '95 Legacy
02/95	Synthetic engine oil
04/95	Engine testing-back to basics
07/95	Synthetic lubricant usage - updated information
10/95	Oil viscosity change for 1996 Subaru vehicles
01/96	2.5 Liter motor engine knocking or tapping noise
09/96	1997MY engine noise
09/96	Legacy 2.2L and Impreza 1.8L, 2.2L engine oil filling
10/96	Welcome to shim city
04/97	New cam belt tensioner
08/97	Assembling 1997 and Newer engines
10/97	Molybdenum coating on pistons
11/97	Engine noise
11/97	2.5L engine cylinder head bolt tightening sequence
05/98	Legacy engine belt guides
09/98	1996 2.5L exhaust valves
10/98	2.2L front crankshaft oil seals
11/98	1999 Legacy short blocks
01/99	Leaking front crankshaft oil seals
03/99	SIA installed engine oil
04/00	2000MY spark plug application chart (revised 01-31-00)
08/00	Engine noise when cold
01/01	Oil pumps - replacement vs resealing
02/01	3.0L 6 cylinder engine valve train servicing
02/01	Engine noise when cold
05/01	Three Bond 1280B
06/01	2002MY WRX Turbo cool down procedure
03-04/02	Oil filters: H-4 versus H-6 engines
08/02	2.0L Camshaft cap torque correction
09-10/02	DOHC Turbo valve specification
01-02/03	Radiator hose leakage

Continued on next page

Tech TIPS

Date	Subject
01-02/03	SOA Replacement ignition wire set
05/03	Coolant seepage from water pump
05/03	2004 Baja and Forester turbo engine oil filters
07/03	Cam belt tensioner replacement
07/03	Vehicle Re-engineering/modifying
11/03	Head gasket repairs
11/03	Oil filter application clarification
12/03	ISC valve cleaning
01/04	Engine noise
04/04	Cruise control cable retainer clip (WWQ-01 campaign)
04/04	H-6 Engine cover torque
08/04	Pressure washing of vehicle engine compartment- All models
09/04	ODS code 29
03/05	Intercooler spray tank
07/05	Oil classification change for 2006MY vehicles
08/05	Short blocks replaced under warranty
09/05	LH cylinder head assembly /CHANGED PN 11063AB120
10/05	Safe handling of sodium filled valves
04/06	Platinum spark plug change intervals
06/06	H6 Oil Level explained (6 cyl.)
02/07	Turbocharger Oil Supply filter (4 cyl.)
03/07	Oil supply line filters (4 cyl.)
05/07	Engine oil specification information (All)
06/07	Engine cooling system service and care recommendations (All)
07/07	3.6 H6 Oil filter wrench information (6 cyl.)
10/07	Genuine Subaru cooling system conditioner information (All)
11/07	2008 Tribeca 3.6 engine oil dipstick information (6 cyl.)
11/07	Subaru super coolant information (All)
01/08	Revised turbocharger oil supply routing (4 cyl.)
02/08	Subaru engine valve adjustment information (All)

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Tech TIPS

Date	Subject
03/08	More Subaru super coolant information (All)
04/08	more valve adjustment information (All)
05/08	Engine oil pan drain plug gaskets: **Not all the same** (All)
06/08	Don't Forget to Check Those Banjo Bolt Filters
11/08	WWM-96 Rear Suspension Sub Frame Corrosion Campaign
01/09	Bank-Specific Misfires and Active Valve Control System (VVT)
02/09	Oil Filter Replacement Precautions
03/09	Important Short / Long Block Replacement Reminder
04/09	P0171, Rough Running Condition After Cold Start
08/09	Turbocharged Engines: Oil Supply Reminder

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