COURSE OVERVIEW

The ***Engine Mechanical Diagnosis*** Course provides Kia service technicians with the opportunity to increase their skill level and efficiency in diagnosing customer's concerns related to Engine Mechanical systems.

In this ***performance-based*** course, Kia service technicians will demonstrate their diagnostic skills through hands-on, Instructor-supervised, guided practices including:

- Diagnostic Tools
- Oil Consumption & Analysis
- Cooling System Checks
- Timing Belt Analysis
- Continuously Variable Valve Timing Tests
- Spark Plug Analysis

COURSE GOAL

Upon completion of this course, the Kia Service Technician will have the ability to diagnose Engine Mechanical concerns the first time, every time.

TARGET AUDIENCE

Kia Dealership Technicians who diagnose and troubleshoot moderately-complex engine systems.

PREREQUISITES

You must complete the following:

- Introduction to Engine Mechanical Diagnostic Web Course.

PRETEST

A pre-test will be given to check your knowledge of engine mechanical diagnostic tools

ABOUT TRAINING MODULES

Today's complex automotive technology demands that you, the professional Kia service technician, stay up-to-date with the latest service information, special tools and complex repair procedures. We have adopted a modular training delivery system that breaks-down the critical information into logical groupings. First you will be presented with system theory and operation, then given a chance to practice what you have learned. Finally, we will test what you have learned through a Performance Assessment.

THEORY

A ***Theory Module*** explains the subject from basic to complex. This allows you to obtain a working knowledge of a component or system, which is a prerequisite for successful diagnosis and repair.

GUIDED PRACTICE

The ***Guided Practice Module*** affords you the opportunity to familiarize yourself with a component or system through hands-on experience. The guided practices are to be Instructor supervised and verified. These exercises may include: the use of KGIS, accessing kdealer.net, lab disassembly and reassembly, live vehicle activities and much more.

PERFORMANCE ASSESSMENT

The ***Performance Assessment Module*** provides the opportunity for you to prove that you can perform the subject matter related tasks and procedures. Each technician must successfully complete this module, which is designed to test your cognitive (knowledge) and motor (hands-on) abilities. The module must be completed individually, not as a team.

GETTING THE MOST OUT OF THIS COURSE

These modules are designed to be part of a structured training plan consisting of lecture, interactive classroom discussion, and hands-on shop activities under the direction of a trained Kia Instructor. After completing the course modules your understanding of the material will be verified through our Performance Assessment Module, you must pass a written and hands-on evaluation.

COURSE MANAGEMENT

The course and its materials are here for you to learn. Use them and your time in a way that will benefit you when you return to your dealership.

TAKE NOTES

Make drawings, jot down notes, and highlight these material to help you remember important details. Each module is designed with ample margins for your important notes.

ASK QUESTIONS

If you do not understand something in this course, ***ask your Instructor*** for clarification. Asking questions is strongly encouraged to help you get the most out of this course.

TEAMWORK

During the hands-on activities, you will often be working as a team. By actively engaging in each activity, you will maximize your learning experience. While in the lab, feel free to ask the Instructor questions at any time.

LEARN AT EVERY OPPORTUNITY

This course is an opportunity for you to learn in a controlled environment under the guidance of a trained Kia Instructor. Through active participation you can build confidence in your abilities to diagnose customer concerns right the first time, every time!

COURSE MATERIAL

Module Number	Module Title	Theory	Guided Practice	Performance Assessment	Guide
EMD 01	Course Guide				X
EMD 02	Diagnostic Tools	X			
EMD 03	Diagnostic Tools		X		
EMD 04	External Inspections	X			
EMD 05	External Inspections		X		
EMD 06	Performance Assessment			X	

AGENDA

Day One

Introduction (CG)	8:00 - 8:20
Diagnostics (Th - Module 2)	8:20 - 9:00
Diagnostics (GP - Module 3)	9:00 - 10:00
Break	10:00 - 10:15
Diagnostics (Th - Module 2)	10:15 - 10:45
Diagnostics (GP - Module 3)	10:45 - 12:00
Lunch	12:00 - 1:00
Diagnostics (Th - Module 2)	1:00 - 1:45
Diagnostics (GP - Module 3)	1:45 - 2:45
Break	2:45 - 3:00
Simulations (Class Demo)	3:00 - 3:15
Simulations (GP)	3:15 - 4:30
Class Wrap-Up	4:30 - 5:00

Day Two

Simulations (GP - Continued)	8:00 - 9:00
Simulations (Discussion)	9:00 - 9:30
Break	9:30 - 9:45
External Inspections (Th)	9:45 - 10:45
External Inspections (GP)	10:45 - 12:00
Lunch	12:00 - 1:00
External Inspections (GP)	1:00 - 2:30
Break	2:30 - 2:45
Performance Assessment	2:45 - 5:00

ICONS

Throughout this course you will come across several icons designed to keep you on track.

The ***Reference Icon*** indicates you must refer to additional publications in order to complete the questions or activity.

The ***Video Icon*** indicates there is a video segment corresponding to the module information.

The ***Activities Icon*** indicates an activity that supports a critical learning objective. These activities are offered to help you master the material.

The ***Feedback Icon*** indicates a progress check meant to provide you with feedback on your understanding of the course material. Based on this information, we recommend you review any areas where you have not mastered the material.

PERFORMANCE ASSESSMENT SCORECARD

The ***Performance Assessment Scorecard*** is used to track your classroom participation, performance on guided practices, performance on diagnosis & troubleshooting, and any written knowledge assessments.

COURSE ACHIEVEMENT

A final score of 80% or higher is needed for completion credit of this course. Scores are calculated based on:

- Simulation Exercises 43 pts
- Guided Practice Exercises 19 pts
- Performance Assessment 38 pts

* Lack of punctuality and disruptive behavior will result in a loss of points from class.

SCORECARD ROUTING

One copy of the scorecard is yours, and one copy is used to update your Kia technical training records. Should you not complete the course, the third copy is forwarded to your Kia District Parts and Service Manager (DPSM).

NOTES:

NOTES:

NOTES:

TARGET AUDIENCE

Kia Dealership Technicians whom are able to diagnose, troubleshoot, and repair engine mechanical related customer concerns.

MODULE GOAL

Upon completion of this module, the Kia service technician will be able to demonstrate the knowledge required to accurately diagnose engine mechanical related customer concerns using specific diagnostic tools.

MODULE OBJECTIVES

Upon completion of this module, you will be able to:

A) Accurately interpret and understand the results of the following diagnostic tools:

- Vacuum Gauge
- Compression Gauge
- Stethoscope and Chassis Ears
- Leak Down Gauge
- Borescope
- Block Check Dye
- Cooling System Pressure Tester
- Global Diagnostic System
- Oil Pressure Gauge
- DVOM (Coolant Electrolysis Test)

B) Understand other variables that can affect engine performance, such as:

- Oil Viscosity
- Oil Consumption
- Oil Analysis
- Cooling System
- Electrolysis

MODULE INSTRUCTIONS

Carefully read through the material, take notes based on the classroom discussion and study each illustration. Throughout the module there will be Progress Check questions for you to answer. You may use the modules to answer the questions.

TIME TO COMPLETE

Approximately 45 minutes

ACRONYMS

DVOM - Digital Volt Ohm Meter
A DVOM is designed to provide in-depth information about the electrical characteristics of a circuit.

HLA - Hydraulic Lash Adjuster
An HLA is a device for maintaining zero valve clearance in an internal combustion engine.

inHG - Inches of Mercury
A unit of measure that is widely used with automotive Vacuum Gauge readings.

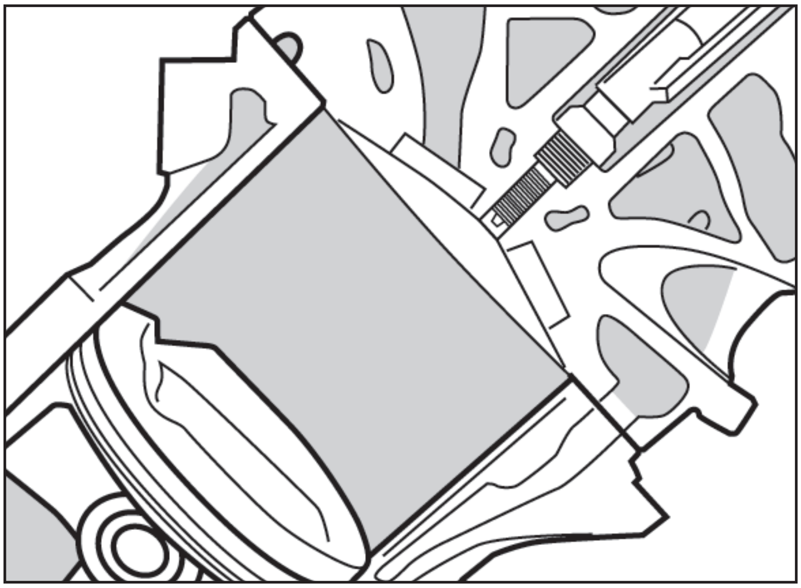
MLA - Mechanical Lash Adjuster
An MLA is typically a tappet or a disc that has a valve clearance specification between the valve and the camshaft. Unlike HLAs, MLAs are not set to zero lash.

PSI - Pounds per Square Inch
A unit of measure for pressure.

RVP - Reid Vapor Pressure
A method of measuring vapor pressure in petroleum products.

TDC - Top Dead Center
The exact top of a piston's stroke.

INTRODUCTION



While computer controlled systems may indicate a concern on a vehicle, there is no substitute for good mechanical diagnostics to isolate the concern. The engine is essentially an air pump and we can use tools to determine how effective the engine processes air and fuel mixtures.

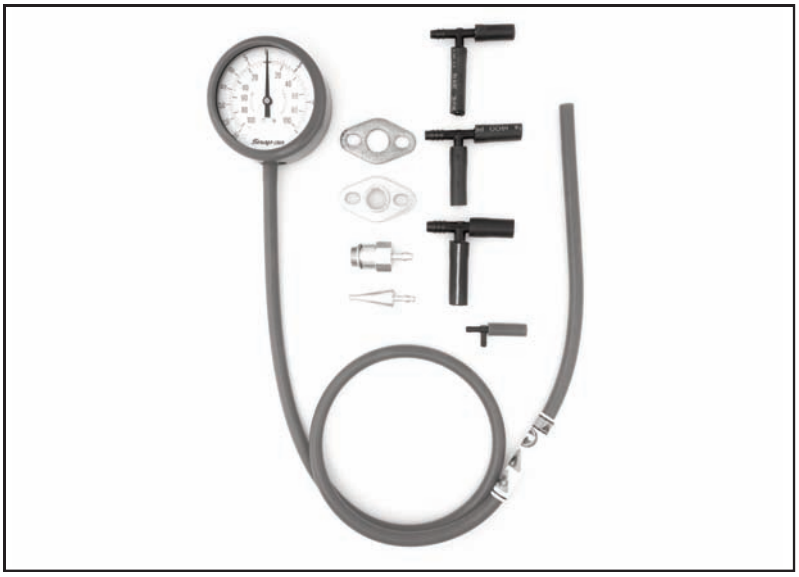
This module will focus on the use of various diagnostic tools that are effective in diagnosing customers engine mechanical related concerns. The tools covered in this module are:

- Vacuum Gauge
- Compression Gauge
- Stethoscope and Chassis Ears
- Leak Down Gauge
- Borescope
- Block Check Dye
- Global Diagnostic System
- Oil Pressure Gauge
- Cooling System Pressure Tester
- DVOM

FEEDBACK: Remember these 2 elements while working with these tools:

1. *Understand the results*
2. *What do the results lead to next?*

VACUUM GAUGE



The Vacuum Gauge is an often overlooked diagnostic tool. Since the pistons, rings, and valves create vacuum in the engine it makes sense to check them for engine mechanical concerns.

Vacuum Gauges read in Inches of Mercury (or inHG). A typical Kia engine will average 18 inHG at idle.

To set up a Vacuum Gauge:

- Make sure the engine is up to normal operating temperature.
- Find a vacuum source behind the throttle body or on the intake manifold. Some instances may require the use of a Vacuum "Tee".

VACUUM GAUGE DIAGNOSTICS

With the Vacuum Gauge connected properly, you can interpret the readings to determine the following conditions:

- *Normal* - steady 18 inHG
- *Worn Rings or Diluted Oil* -This can be tricky since the idle is steady at 18 inHG. A quick throttle application will drop to 0 which also looks normal. The trick is how it recovers after the acceleration. A good engine will bounce up to 26 inHG then normalize to 18 inHG. An engine with worn rings or diluted oil cannot seal as well and will only bounce up to 22 inHG. However, Electronic Throttle Body equipped vehicles have programming that opens the throttle slightly if the vacuum exceeds 22 inHG on deceleration.
- *Sticking Valves* -will hold steady at 18 inHG like a good engine, but when the suspect valve is actuated, the needle will quickly bounce lower 3 to 4 inHG.
- *Burnt Valves or Constantly Leaking Valves* - affect vacuum in the intake manifold and can be detected when the vacuum needle sweeps 6 to 8 inHG in a rhythmic pattern.
- *Poorly Seated Valves* - A steady sweep of the needle that drops 2-4 inHG, then rises to a normal level, will indicate poorly seated valves.
- *Worn Valve Guides* - A needle that sweeps 4-6 inHG may indicate worn valve guides.
- *Weak Valve Springs* - Raise the engine to 2000 RPM. If the needle flicks dramatically between 10-14 inHG, you likely have weak valve springs.
- *Late Valve Timing or Intake Leak* - If the Vacuum Gauge is reading steady around 10 inHG, then there could either be a possible intake leak or late valve timing.
- *Major Intake Leak* - A low reading of 3-6 inHG that is steady may indicate a severe intake leak.
- *Clogged Exhaust* - A severely clogged catalytic converter will slowly reduce vacuum which can be detected under load. Also, a damaged turbocharger will also create a severe exhaust obstruction and will inhibit performance. A vacuum gauge can determine the severity of the exhaust backpressure.

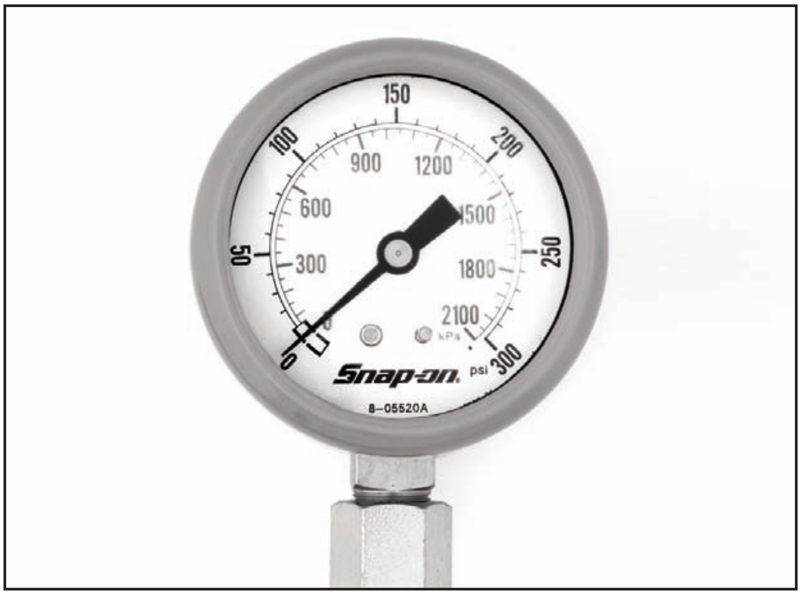
COMPRESSION GAUGE

Compression tests can be used to analyze and diagnose customers' concerns related to engine performance. Possible symptoms may suggests that the cause of a problem may be poor compression (or misfire) due to:

- Burnt Valves
- Blown Head Gasket
- Worn or Broken Rings
- Slipped Timing Belt (or Chain)
- Worn Valves
- Cracked Head
- Restricted Intake Flow
- Restricted Exhaust Flow

CAUTION: Please remember that the adapter hoses for the Leak Down Gauge and the Compression Gauge are not interchangeable. There is a schrader valve on the Compression Gauge adaptor, that is not present on the Leak Down Gauge adaptor.

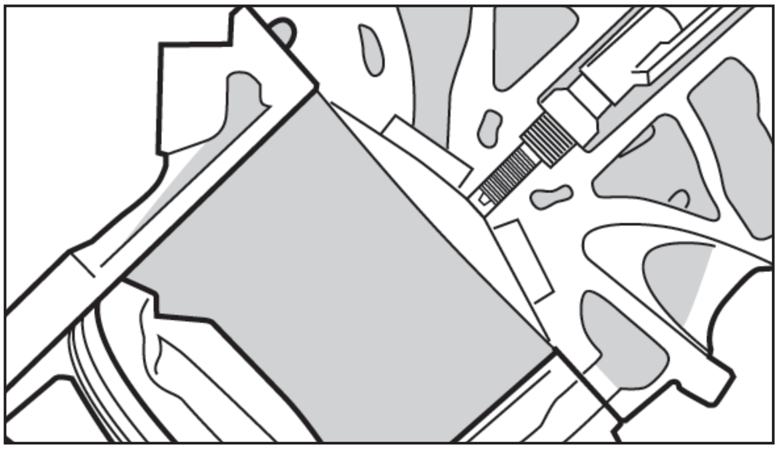
Compression Gauge Diagnostics



Various types of tests can be performed using a compression gauge. There are three tests available with this tool:

- Dry Compression Test
- Wet Compression Test
- Running (or Dynamic) Compression Test

Dry Compression Test



The “dry” compression test (also known as the cranking compression test) is the most common test using the compression gauge when testing the cylinder’s ability to seal properly.

To perform a dry test:

- Block the throttle wide open for unrestricted airflow
- Disconnect the fuel fuse (or pull the Main Relay) to prevent the engine from running and excessive fuel wash into the oil
- Disconnect the ignition fuse (or pull the Main Relay) to prevent possible secondary ignition module damage
- Remove all spark plugs. Inspect them and keep them in order
- Crank the engine 7-8 revolutions on a fully charged battery

* 7-8 revolutions is based on the Technician Times Article and Sedona VQ data.

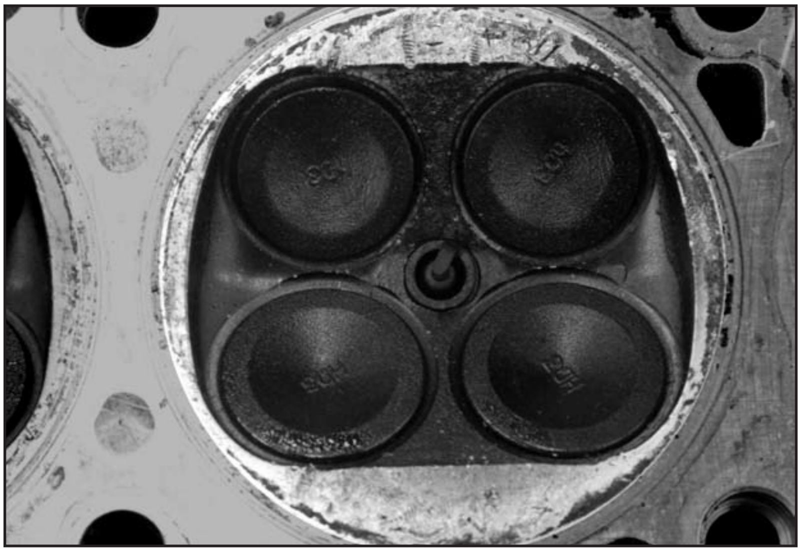
Once the test has been performed on each cylinder the results for each cylinder should be within 20%. If one cylinder has greater than 20% difference, then that cylinder is the likely concern.

FEEDBACK: What caused the cylinders to vary more than 20%?

NOTE: When performing a dry compression test, the data from the first puff should be about half of the total data. In other words, the first crank should register as 90 psi if the overall result is 180 psi.

WARNING: You must disable both Fuel and Spark or personal injury may occur.

Wet Compression Test



The wet compression test is similar to the dry compression test but a small amount of oil is squirted into the cylinder. Why? The oil will apply a film on the cylinder walls which will seal the rings.

If the compression increases dramatically on the wet compression test, then the likely cause for the cylinder concern would be *worn rings*.

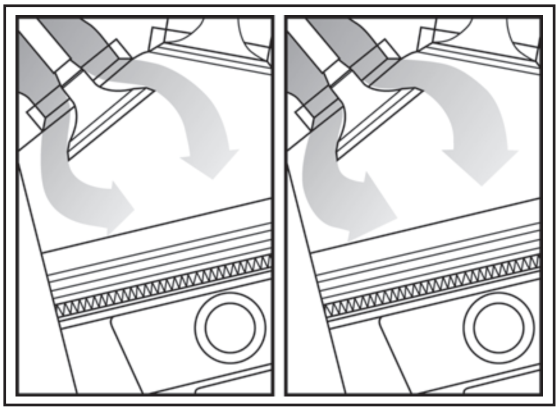
If the compression remains the same on the wet compression test, then the likely causes could be:

- Poor Valve Sealing
- Head Gasket
- Cracked Head
- Cracked Block
- Heavy Cylinder Damage
- Severe Piston Damage

FEEDBACK: Which of these root causes are repairable?

NOTE: Excessively high compression readings (either Dry or Wet) may indicate a clogged exhaust system.

Running Compression Test



A running (or dynamic) compression test is one of the best tests to determine one cylinder's ability to flow air through the intake and exhaust. While the dry and wet compression tests confirm the cylinder's ability to seal, it doesn't isolate the condition of a cylinder's ability to breathe or flow. A vacuum test will check flow in a manifold for all cylinders but not an individual cylinder.

As the title suggests, the engine will be running to test the compression of each cylinder. There are a few differences between this test and the dry and wet compression test. To perform this test you'll need to:

- Reconnect the fuel and ignition systems since they need to be operational
- Install all (but one) spark plugs, the open plug will be used for the compression tester.
- Ground the ignition plug wire by disconnecting the coil-over-plug assembly from the plug being tested to minimize potential damage to the secondary ignition system and reduce the risk of personal injury.
- Disconnect the fuel injector for the cylinder being tested or fuel will wash the lubrication from the cylinder.
- Verify if the customer's concern occurs when the engine is cold or hot. Replicate the concern by running a cold or hot running compression test.

CAUTION: Running the engine may damage the Schrader Valve over time.

NOTE: Schrader Valves in compression gauges are not interchangeable with tire Schrader Valves which will result in lower readings.

Performing the Test

To perform the test, start the engine and record the reading (running compression). The result at idle readings is typically **half** of the cranking compression.

Next, snap the throttle wide open to get a “gulp” of air as if the engine was about to bog and record the reading (snap throttle reading). The result should be 80% of the dry cranking compression.

After performing the running compression test you will have 3 readings:

- Cranking Compression readings (from dry and wet compression tests performed earlier)
- Running Compression readings
- Snap Throttle readings

CAUTION: The Running Compression Test will ruin valve cores on the tester.

VIDEO: Running Compression Test

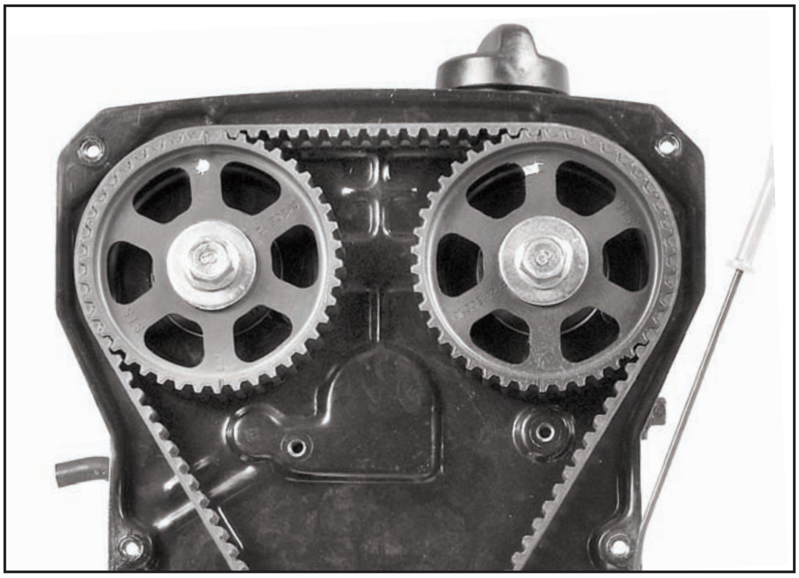
UNDERSTANDING THE RESULTS

If the recorded results look like:

• Cranking Compression	180
• Running Compression	90
• Snap Throttle Compression	95

Notice that the snap throttle compression is much **lower than 80%** of cranking compression. This indicates restricted air intake flow for this cylinder, such as:

- Severly Carboned Intake Valve
- Worn Intake Lobe on the Camshaft
- Rocker Problem
- Variable Intake System concern
- Intake Camshaft Timing off



If the recorded results look:

• Cranking Compression	175
• Running Compression	85
• Snap Throttle Compression	170

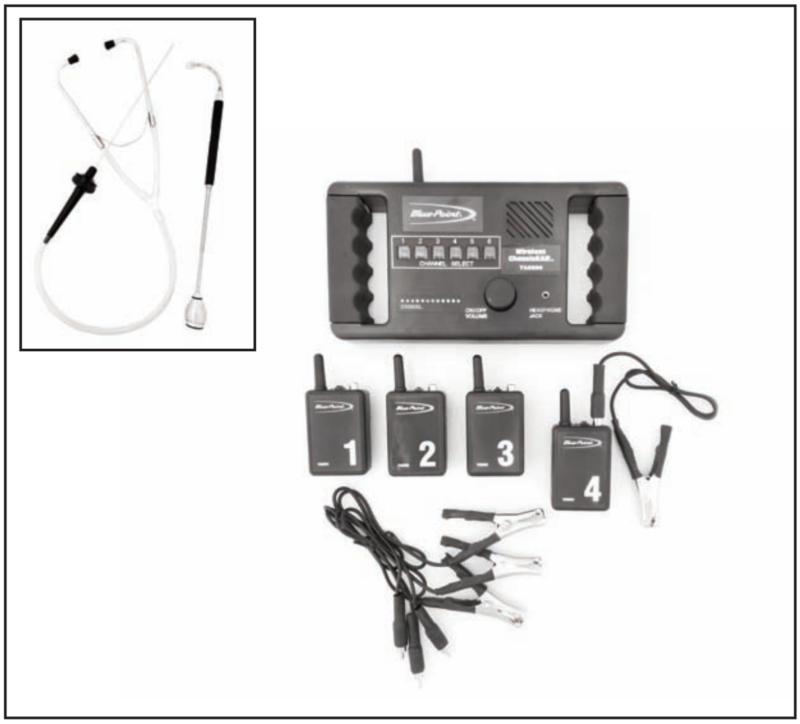
Notice that the snap throttle compression is much **greater than 80%** of the cranking compression. This indicates restricted exhaust flow for this cylinder, such as:

- Worn Exhaust Camshaft Lobe
- Collapsed Hydraulic Lash Adjuster
- Exhaust Camshaft Timing off
- Clogged exhaust

FEEDBACK: Can a worn cam lobe cause a misfire?

NOTE: Accurate diagnosis by choosing the appropriate tool, setting it up correctly, and accurately interpreting the results will help you fix the vehicle right the first time, every time.

STETHOSCOPE AND CHASSIS EARS



Stethoscopes and chassis ears can be very helpful in diagnosing sounds from the engine area. The sensitivity of this equipment can quickly diagnose a top-end sound from a bottom-end sound.

It can also be used to separate Transaxle sounds from the engine sounds. For example, a damaged flexplate or a screw that backs out of a torque converter could make sounds that increase with RPMs which may be disguised as engine sounds.

To operate the chassis ears:

- Attach the clip as close to the suspected noise
- Secure wires away from heat or moving parts
- Start the engine and duplicate the condition
- If driving, have an assistant or use an external speaker if equipped

VIDEO: Electronic Chassis Ears.

LEAK DOWN GAUGE

A Leak Down Gauge (or cylinder leakage tester) is useful to determine the amount of leakage in a combustion chamber. This tool will provide data that can be used to determine if the cylinder is in good condition. A cylinder in poor condition could lead to a misdiagnosis which leads to unnecessary ignition or fuel system work.

Leak Down Gauge - Set Up

To set up the Leak Down Gauge, you'll need to:

- Warm the engine to normal operating temperature
- Remove all spark plugs
- Remove Main Relay
- Remove air cleaner, oil filler cap, and radiator cap.

CAUTION: Use extreme caution when removing the radiator cap from a hot engine. It may be easier to remove the radiator cap prior to warming up the engine.

- Rotate the tested cylinder to TDC on Compression Stroke
- Thread the adaptor into the spark plug hole
- Turn the regulator knob off (full counter clockwise)
- Connect tester to 120 psi air supply
- Dial regulator knob until the supplied pressure is at 100 psi. * Some manufacturers may vary the supplied pressure. Follow the manufacturers instructions carefully
- Record leakage for each cylinder
- Relieve the pressure in the lines by turning the regulator knob counter-clockwise after each test

CAUTION: Warm engines have soft spark plug threads. Be sure to insert the spark plug and tighten by hand. Then use a torque wrench to tighten the spark plug to specification.

VIDEO: Leak Down Gauge.

LEAK DOWN GAUGE READING THE RESULTS

Record the percentage of cylinder leakage for each cylinder. Engines with larger diameter bores will tend to show more leakage than smaller diameter bores.

Leakage less than 15% is acceptable. Leakage over 15% could indicate a concern.

Air escaping excessively is a concern that can be identified by listening from the:

- Intake - intake valve not sealing. * Be sure to have the throttle body open when listening for sounds at the throttle body. If the throttle blades are closed, then the air may bounce back into the intake plenum and enter another cylinder which may sound like a head gasket if the cylinders are adjacent.
- Exhaust - exhaust valve not sealing
- Crankcase - weak or damaged piston rings
- Radiator - bubbles indicate a faulty head gasket or a hairline crack in the engine block or cylinder head
- Adjacent Spark Plug - indicates that the cylinder being tested is leaking into the next cylinder through a faulty head gasket

NOTE: A stethoscope can be useful for detecting small amounts of leaking air while eliminating shop noise. Accurately detecting the location of excessive air loss will help you diagnose the concern and fix it right the first time.

BORESCOPE

The borescope can save a lot of time by viewing inside the cylinder for damage before disassembling the engine. Several good uses for a borescope are:

- Piston Head - view for damage or interference
- Variable Intake Control System - search for any missing clip or missing screws
- Combustion Chamber - foreign material
- Valves - Carbonization or damage

Borescope range in price from the fairly inexpensive to the very expensive. A good borescope will typically have a built in light to view in dark places.

⚠ **CAUTION:** Be sure to disconnect the battery to prevent the starter motor from engaging. If the engine cranks over while inspecting the cylinder, expensive damage will occur.

⚠ **CAUTION:** Be sure to remove the batteries from the borescope after use so they do not leak and cause damage to the bore scope.

BLOCK CHECK DYE

A block check dye can be very useful for confirming a combustion leak into the cooling system via head gasket, cracked cylinder head, or cracked engine block.

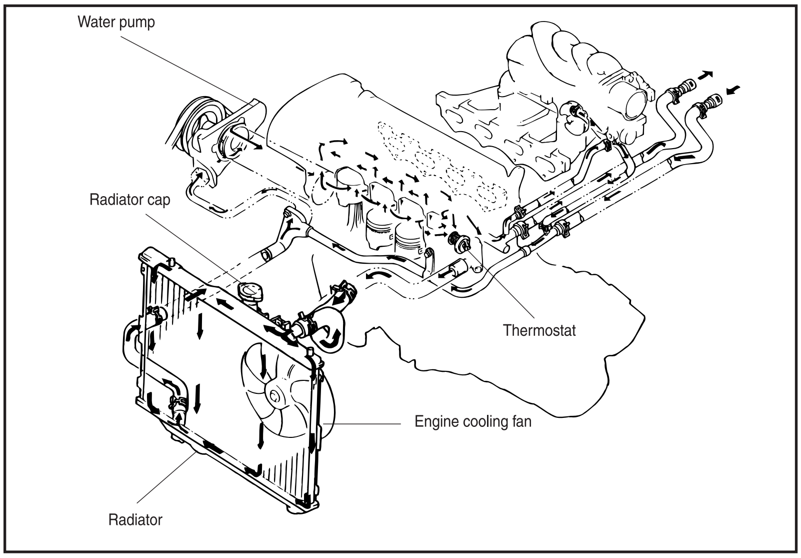
To set up a block check using the dye, follow these steps:

- Drain or siphon the coolant about 2” to 3” below the radiator cap filler neck. * This test does not sample coolant, only exhaust gases present in the cooling system. If coolant is drawn into the test unit then the metallic filter may get contaminated or corroded which will affect the operation of the test.
- Be sure the glass testing tube is clean with no residue from prior tests, then add the test fluid to the glass testing tube up to the “fill-to-here” line
- Snug the glass testing tube onto the radiator filler neck by using the rubber base. Do not twist on the glass tube.
- Start the engine and place the suction bulb onto the top of the glass testing tube. Squeeze the bulb for 1 minute.
- If the dye changes from blue, to green, to yellow then you have a combustion leak
- Always discard the test fluid if it changes color or not. Thoroughly clean and put the tester away.

NOTE: Block check dye can be found in most aftermarket stores. This tester is from Napa Autoparts (P/N BK 7001006).

VIDEO: Block Check.

COOLING SYSTEM

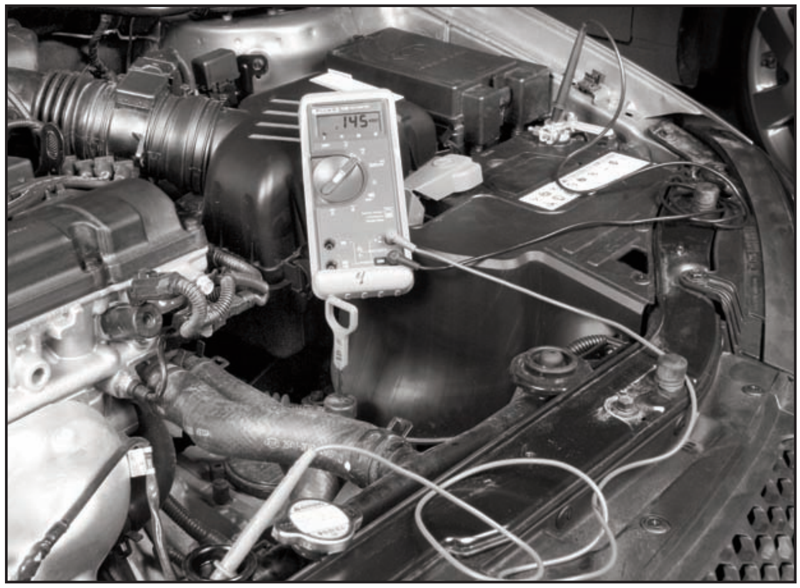


The cooling system is vital for proper engine operation. Without a cooling system the engine would obviously overheat and seize. The typical gasoline engine is about 20% efficient in converting gasoline to mechanical energy, the other 80% is carried away in heat (another form of energy). However, diesel engines are 30% efficient while losing only 70% to heat.

Not only do cooling systems have to remove heat, they also have to warm up the engine fast. A thermostat that is stuck closed would overheat the engine or if it is stuck open then it will take a while to warm up. A thermostat that malfunctions will set a P0128 DTC.

In addition to removing heat and warming up the vehicle quickly, the cooling system must also maintain the proper heat range.

Electrolysis Testing



Care and maintenance of the cooling system is critical for long term reliability. Electrolysis occurs when dissimilar metals decay typically in the radiator and heater core. Unfortunately, electrolysis can also rot away head gaskets and cause a leak.

To check for electrolysis in the cooling system follow these steps:

- Use a DVOM set to DC volts. Place the positive probe of the meter in coolant flow and negative lead on negative battery cable (see photo). Turn on all loads (A/C, headlamps/radio/defroster) and run engine at 2,000 rpm. Record maximum voltage.
- If the voltage is more than 400mV, perform a voltage drop from the engine to the negative battery post and from the frame/body to the negative battery post. Voltage drops should not exceed 100 mV (.1V). Repair and clean grounds if needed. Repeat step #1 to confirm voltage is below limit.
- If voltage is still over 400 mV (.4V), flush coolant and refill with specified concentration.
- If voltage drop is still excessive then add a wire from the radiator/heater core to a good chassis or engine ground. Confirm continuity from core to negative battery cable to confirm proper grounding.

*Technician Times, Volume 7, Issue 3

Cooling System Pressure Tester

A Cooling System Pressure Tester is a great tool for diagnosing cooling concerns and finding coolant leaks. The tester has a gauge that corresponds with the pressure on the radiator cap.

CAUTION: Do not OVER pressurize the system or damage may occur to the cooling system components.

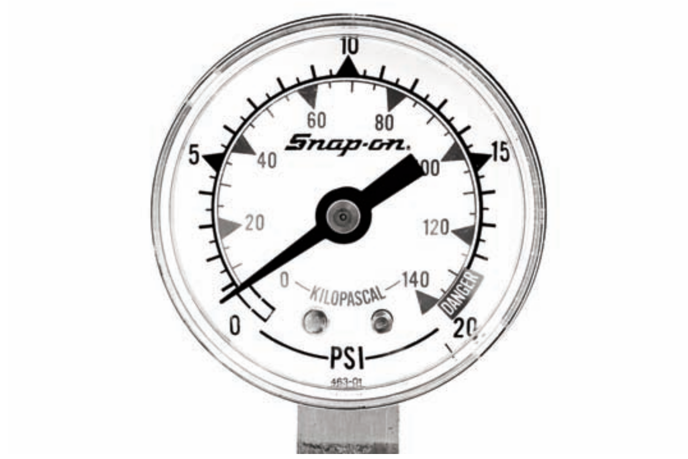
Pressure is critical in a cooling system since it raises the boiling point. If the coolant boils then the bubbles created in the boiling process will stick to the walls of the cylinders in the water jacket and in pockets in the cylinder head. Bubbles displace water and create hot spots which can damage components.

There are two tests that can be performed with the Cooling System Pressure Tester:

- Cooling System Pressure Test
- Radiator Cap Pressure Test

CAUTION: Remember to use pre-mixed 50/50 coolant or mix only with *distilled* water. The process of distillation removes impurities from the water leaving only pure water (without minerals). Mineral deposits can build up in a cooling system and restrict heat transfer.

Testing the Cooling System



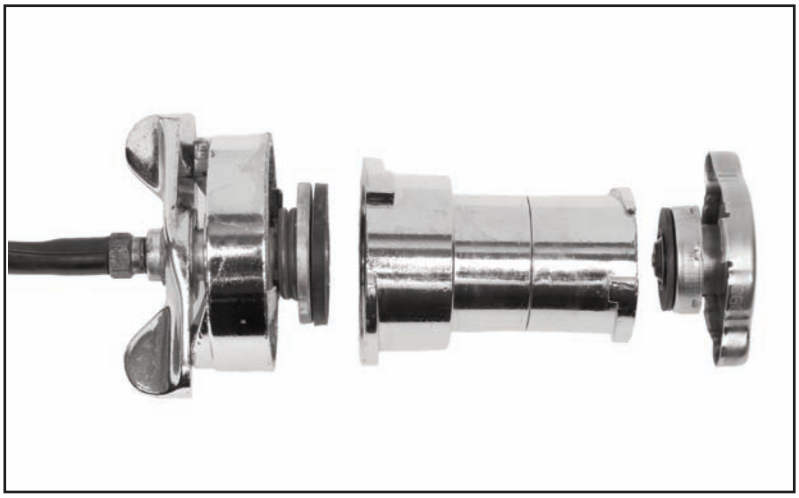
To set up the Cooling System Pressure Tester to test the cooling system, follow these general steps:

- Let the engine cool
- Remove the Radiator Cap and note the PSI rating on the cap
- Connect the Cooling System Pressure Tester to the radiator filler neck and pressurize the system to match the PSI value listed on the cap
- Inspect for leaks. Listen for air bubbles escaping. Watch the gauge for pressure drops.

NOTE: Sometimes the leak will be easy to find. More difficult concerns could take some time. For those tougher concerns, leave the pressure tester on for an hour or even overnight.

NOTE: Kia radiator caps typically have a “1.1” stamped onto the steel tab of the radiator cap. This stands for 1.1 Bar (or Barometric Pressure). Since Barometric Pressure is 14.7 then 1.1 Bar is equal to 16 PSI (rounded up). Be sure to check the Bar Pressure reading on the radiator cap.

Testing the Radiator Cap



To set up the Cooling System Pressure Tester to test the Radiator Cap, follow these general steps:

- Let the engine cool
- Remove the Radiator Cap and connect it to the cap adaptor in the tester kit
- Connect the Cooling System Pressure Tester to the other end of the adaptor
- Pressurize the Radiator Cap, if the cap is working properly, it will relieve at the pressure specified on the cap. If the cap is faulty it will not build to the specified pressure

NOTE: Be sure to inspect the radiator filler neck for dings which may release pressure. Also inspect the rubber on the radiator cap to determine if the cap will seal appropriately.

GLOBAL DIAGNOSTIC SYSTEM

The Global Diagnostic System is a powerful tool that can aid with diagnostics. You can find the latest information by searching Technician Times Articles, Technical Service Bulletins, Pitstop Articles, and Campaigns.

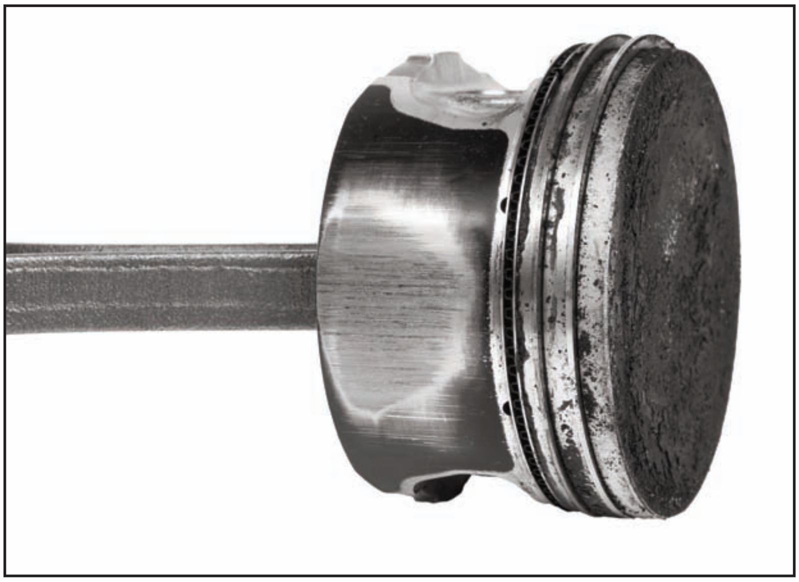
Several clues may indicate something is mechanically wrong with the engine, such as:

- Lean Fuel Trims - caused by low compression
- Injector Pulse Widths - may compensate for mechanical engine concerns
- Diagnostic Trouble Codes - mechanical engine concerns can create misfires
- Power Balance Test - use the GDS to perform an Actuation Test on the fuel injectors

Use the GDS to see if the vehicle has been reprogrammed.

NOTE: Get the latest Service Information for oil pressure specifications and cylinder head bolt torque specifications using the GDS or KGIS.

LUBRICATION



Oil Viscosity

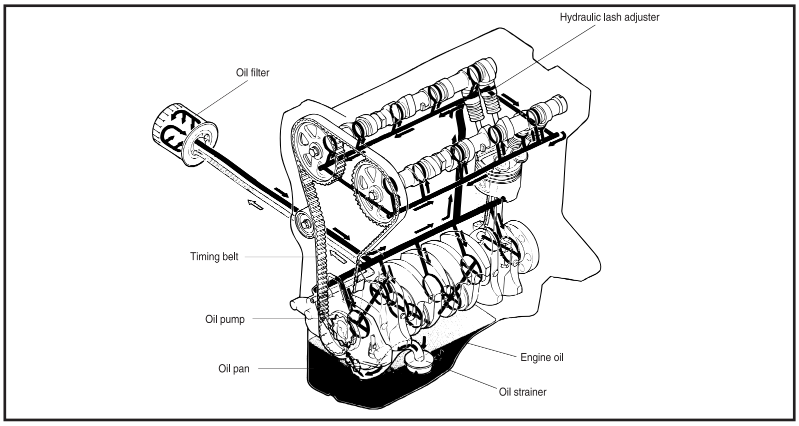
Oil viscosity is the thickness of the oil. A lower viscosity rating means the oil will flow faster while higher viscosity ratings mean the oil will flow slowly.

A Technician Times Bulletin “Engine Oil / Gear Lube Changes” states beginning with production date 7/1/04 that all Kia vehicles will be using 5w-20 oil. If 5w-20 isn’t available, then 5w-30 can be substituted.

The 5w-20 used in Kia vehicles flows well for a wide variety of temperatures. The “5” indicates the flow at cold temperature while the “20” indicates the flow at operating temperature.

It has been said that oil is the “life blood” of an engine which means it is important to keep clean and viable. Oil that has been contaminated with fuel dilution, contaminated with water, or not maintained where the oil has extended beyond the manufacturer recommended service interval will have adverse affects on the mechanical components that require lubrication.

OIL CONSUMPTION



We often receive calls asking what is normal oil consumption. Kia does not publish any official oil consumption numbers, however, we can offer some general guidelines.

- Normal oil consumption should be in the range of 1 quart every 2000 to 4000 miles dependent on vehicle operating conditions. Examples of operating conditions that can increase oil consumption are:
  - High speed driving with frequent wide open throttle operation.
  - Mountain and city driving.
  - New vehicles with less than 3000 miles (during engine break-in, oil consumption could be up to 1 quart/1000 miles).
  - Heavily-loaded vehicle (full passenger/cargo load).
- Always check the oil level hot, with the engine at normal operating temperature. Remember fluid expands when hot.

Technician Times, Volume 2, Issue 3

NOTE: On the subject of city driving oil consumption, keep in mind that the engine is often idling for long periods of time in stop-and-go situations, and traffic jams. This results in many hours of engine running time without covering many miles, which will give high oil consumption numbers that are not realistic.

OIL CONSUMPTION

External Inspections

Careful diagnosis for an oil consumption concern is critical. One example could be a stuck thermostat. If the thermostat is stuck open then it may inhibit the engine from warming up which will cause excessive deposits. Those deposits could cause stuck oil control rings which leads to excess oil on the cylinder walls and cause an oil consumption concern.

FEEDBACK: If the oil consumption concern is valid, then begin with some *external inspections*:

- Are there any publications on this concern?
- Is the engine overfull?
- Are there any external leaks?
- Is there Blue Smoke from the exhaust?
- Any deposits on the spark plugs?
- Is the vehicle short-tripped?
- Does the vehicle idle prolonged periods?
- Does the service history, or lack of one, add evidence for oil consumption?
- Excessive oil in the intake? This could be caused by a malfunction in the PCV system causing excessive reverse flow or excessive reverse flow caused by blow-by in the system.

<u>Inspect the PCV system for</u>:

- Wrong PCV valve (aftermarket?).
- PCV valve installed improperly.
- PCV stuck open (deposits, high idle).
- PCV fresh air hose blocked.
- PCV vacuum hose blocked.
- PCV baffling damaged on valve cover.

OIL CONSUMPTION

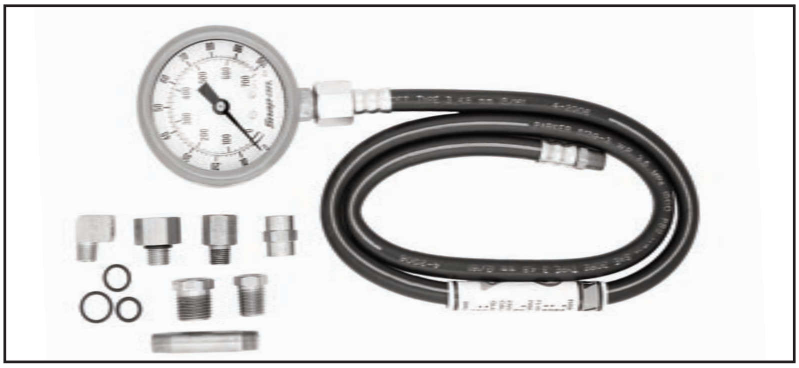
Internal Inspections

Oil consumption can also result from internal engine mechanical concerns. A compression gauge and leak-down gauge can determine if they cylinder is having ring sealing problems. This can be an internal concern for excessive oil consumption.

FEEDBACK: Other *internal causes* for oil consumption are:

- Cylinder wall damage
- Wrong head gasket after a repair could have blocked head drain holes which would flood the head with too much oil and force oil past the valve guides.
- Aligned rings.
- Seized rings.
- Piston deposits in the ring grooves.
- Valve deposits could indicated oil consumption down the valve guides. A borescope would be handy for this inspection.
- Valve guide seals.
- Valve guide wear.
- Cylindricity means that the cylinder must be a perfect hole, rings will not seal if cylinders are tapered or oval.
- Cylinder scoring.
- Cylinder bluing from lack of lubrication.
- Cylinder glazing means for new rings to seal that the cylinders must first be deglazed.
- Excessive ring-end gap.
- Excessive bearing clearance will have increased oil flow and could sling excessive oil on the cylinder wall increasing oil consumption.

Oil Pressure



Oil is vital to your engine's mechanical components and pressure is how it gets there. Oil pressure will vary for nearly every Kia engine so be sure to check the Service Information for the latest specifications.

Oil Pressure Gauge

Oil pressure can be checked with an Oil Pressure Gauge. The Oil Pressure Gauge is very useful to determine excessive HLA sounds or bottom-end concerns. When setting up the gauge be sure to:

- Check that the oil is at the proper level
- Warm the engine up to operating temperature
- Check the gauge to see it is operating properly
- Remove the oil sending unit
- Connect the gauge to the oil sending unit port
- Start the engine and check for leaks around the gauge
- Keep the gauge away from the hot exhaust or any moving parts
- Record the data

Reading the Results

The reading will be low, normal, or high relative to specification.

- Low - clogged pick up screen, faulty oil pump, worn connecting rod or main bearings, aftermarket oil filter, contamination, damaged oil pan, or stuck relief valve
- Normal - inspect for maintenance and change oil as needed
- High - possible restriction in the oil galleries or stuck relief valve

NOTE: Some engine noise concerns have been results of aftermarket oil filters.

Oil Analysis

Spectrochemical Analysis (ppm)

Iron	Chromium	Lead	Copper	Tin	Aluminum	Nickel	Silver	Silicon	Boron	Sodium	Magnesium	Calcium	Barium	Phosphorus	Zinc	Molybdenium	Titanium	Vandium	Potasium
18	1	28	5	5	9	0	0	19	2	0	15	2323	0	954	1023	72	0	0	0

Physical Properties

Fuel (%Vol)	Vis @ 40 C cSt	Vis @ 100 C cSt	Water (%Vol)	Soot/Solids (%Wt)	Coolant
<1	N/A	9.07	0	N/A	NO

An oil analysis is not a common test method for most concerns. However, it can be useful for persistant concerns or for customers who are meticulous about their Kia.

A Wear Metal Reference Guide will relate the trace metals found in the analysis and relate them to the suspect component.

NOTE: The oil analysis can be very useful for customers who also experience an oil consumption or coking concern.

Iron - Cylinders, Gears, Rings, Crankshafts, Liners, Bearings, Housings, Rust
Chromium - Rings, Roller Bearings, Rods, Platings Lead, Bearing Overlays
Copper - Bearings, Bushings, Thust Washers, Oil Cooler, additives in the oil
Tin - Bearings, Bushings, Piston Platings
Aluminum - Pistons, Bearings, Pumps, Rotors, Thrust Washers
Nickel - Valves
Silver - Bearings, Bushings, Platings
Manganese - Liners, Rings, additive in fuel

Silicone - Airborne contaminants (poor air filtration) and abrasives in the oil used as an anti-foaming agent
Boron, Sodium, and Potassium - Found in anti-freeze

Magnesium, Calcium, and Barium - Detergent additive and dispersant
Phosphorous, Zinc, and Molybdenum - Anti-Wear additive

Fuel Pressure Gauge

Three elements are required for combustion which are air, spark, and fuel. If there is a fuel delivery concern, the customer's vehicle may experience a no-start, poor idle, or poor acceleration concern.

There are several fuel tests available:

- Static - Performed with engine off and fuel pump energized.
- Running - Engine at idle.
- Residual - Fuel system is pressurized then turned off. The system should hold pressure for a specified time then diminish.
- Fuel Pressure Regulator - Engine at idle and record reading. Then disconnect vacuum to regulator and record reading. Specified reading should change or there may be a faulty regulator.
- Fuel Pressure Drop - An injector pulser is used to energize the injector momentarily. A typical setting is 100 pulses per 5 milliseconds which should drop pressure equally among all injectors. A variance more than 3 psi indicates a dirty injector. Very little drop means the injector may be clogged.

Kia specifies the Running Fuel Test in the Service Information which varies per vehicle. Please check the Service Information for the latest procedures and specifications.

Seasonal Fuel Changes

Some drivability concerns can be related to a seasonal fuel change. If you live in a climate zone that is affected by seasonal fuel changes be sure to note possible fuel transitions at local service stations.

Customers may commonly experience a hard-start when cold, poor idle, or poor acceleration concerns.

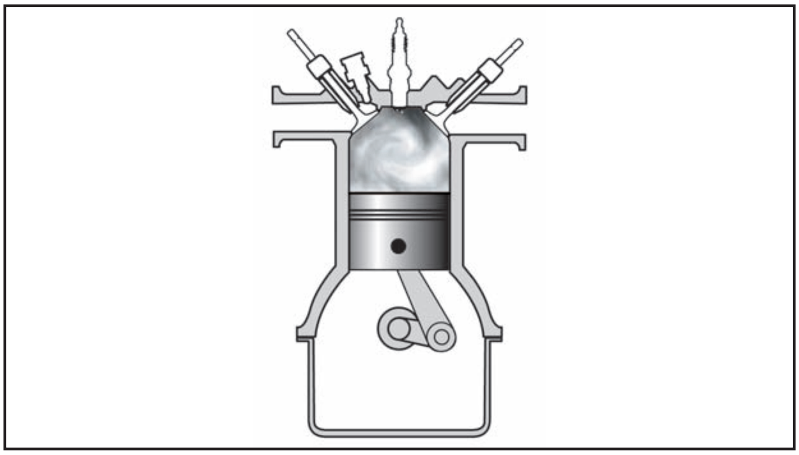
When a service station exchanges seasonal fuels, they are compensating for fuel volatility. One common measurement for fuel volatility is the Reid Vapor Pressure (RVP). Fuel in colder weather will have a higher RVP to allow fuel to vaporize and burn easier in colder climates. Warmer weather conditions require a lower RVP to reduce emissions and to resist vapor lock.

If a RVP concern is suspected, ask:

- Is the reported concern taking place during fuel changeover season?
- Did the customer purchase fuel outside of the city or state?
- Are many customers experiencing the same concern?
- Does the concern take place during cold or hot starts?
- Are running and residual fuel pressure checks within specifications?

* Technician times 10/1/2005

SUMMARY



Diagnostic tools are very useful for accurately diagnosing engine mechanical concerns. The engine is an air pump that must draw in air. It must also be able to remove the burnt gases from the combustion chamber. Using these diagnostic tools will help you determine how well the engine is sealing, compressing, and flowing.

In this module, you have learned how to:

A. Accurately interpret and understand the results of the following diagnostic tools:

- Vacuum Gauge
- Compression Gauge
- Stethoscope and Chassis Ears
- Leak Down Gauge
- Borescope
- Block Check Dye
- Global Diagnostic System
- Oil Pressure Gauge
- Cooling System Pressure Tester
- DVOM

B. Understand other variables that can affect engine performance, such as:

- Oil Viscosity
- Oil Consumption
- Oil Analysis
- Cooling System
- Electrolysis

PROGRESS CHECK QUESTIONS

1. A technician is performing a proper leak down test on a Kia 2.0L engine.

   Technician A says if you hear air coming from the exhaust pipe during this test, this would indicate a faulty exhaust valve.

   Technician B states that if you hear air coming from the intake manifold during this test, this would indicate a faulty intake valve. Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician B

2. Two technicians are discussing leak down testing.

   Technician A says the engine should be at operating temperature before performing this test.

   Technician B says you should fill the cylinder with unregulated shop air. Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician B

3. A technician is using a borescope in a Kia engine.

   Technician A says that you can view carbon deposits on the intake valves with this tool.

   Technician B says you can view the piston for signs of damage. Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician B

QUESTIONS

4. Two technicians are discussing how to use the GDS as a resource to find information related to a mechanical engine concern.

   Technician A says you can search the latest Technician Times Articles, Technical Service Bulletins, Pitstop Articles, and Service Campaigns.

   Technician B says you need a special tool that is not supplied with the GDS to read Fuel Trim data. Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician B

5. Two technicians are discussing Oil Viscosity with oil filled up from the factory.

   Technician A says Kia only uses 5w-20 in current production vehicles.

   Technician B says fuel contamination will lower the viscosity of the oil. Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician B

6. Two Technicians are discussing electrolysis.

   Technician A says electrolysis can rot away head gaskets.

   Technician B says the voltage should not exceed 200mV at idle. Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician B

TARGET AUDIENCE

The target audience for this module consists of Kia service technicians who diagnose vehicles with engine mechanical concerns.

MODULE GOAL

Completing this module prepares you to diagnose and troubleshoot engine mechanical concerns using the appropriate diagnostic tool.

MODULE OBJECTIVES

Upon completion of this module, you will be able to accurately set-up, calibrate, and interpret the readings of the following diagnostic tools:

- Vacuum Gauge
- Compression Gauge
- Chassis Ears
- Leak Down Gauge
- Block Check Dye
- Borescope
- Oil Pressure Gauge
- Cooling System Pressure Tester
- Electrolysis Test

MODULE INSTRUCTIONS

Carefully read through the material and take notes based on the classroom discussion. Throughout the module there will be activities for you to participate in.

REQUIRED MATERIALS

In order to complete this module, you will need the following items:

- Pen or Pencil
- Safety Glasses

TIME TO COMPLETE

Approximately 2 hours

GUIDED PRACTICE 1

Vacuum Gauge

Follow all shop safety rules.

Assigned Vehicle: ______________________________

1. Find the appropriate adaptor for the Vacuum Gauge (if applicable).

2. Connect the Vacuum Gauge to the vehicle.

3. Pull the Main Relay. With the Vacuum Gauge secured, crank the engine. What was the cranking vacuum? ______________________________

4. Reconnect the Main Relay. With the Vacuum Gauge secured, start the engine. What is the reading on the Vacuum Gauge with the Air Conditioning Off?

____

5. Turn the A/C on, what is the reading on the Vacuum Gauge? ______________________________

6. Is this a normal or abnormal condition? ________
If abnormal, what may be the cause(s)? ________

____

____

* If abnormal, contact your Instructor.

7. Snap the throttle (not rev the engine). What does the Vacuum Gauge do?______________________
Why? ______________________________

____

____

8. With the engine idling, disconnect a fuel injector connector. What is the reading on the vacuum gauge?

____

9. Turn off the engine and put the Vacuum Guage back in it's case.

Instructor's Initials ______

GUIDED PRACTICE 2

Compression Gauge (Dry & Wet)

Follow all shop safety rules.

Assigned Vehicle: ______________________________

1. Open the Compression Tester Kit and make sure all of the appropriate accessories are available.

2. With a DVOM, check battery voltage. What is the reading? _______ If the engine turns slowly then the Compression Gauge readings will be lower.

3. Bring the engine to operating temperature to ensure tight tolerances.

4. Pull the Main Relay and open the throttle plates. Set the parking brake

5. Remove all of the spark plugs.

6. Perform a DRY COMPRESSION TEST: Insert the adaptor into the spark plug hole of cylinder number one.

7. Crank the engine over 6 - 7 times (the same number of times per test), perform the test on each cylinder, and record the results below.

⚠ **CAUTION:** Be sure to release the pressure in the gauge by pressing the release button before moving the gauge to the next cylinder.

8. Perform a WET COMPRESSION TEST: Add a few squirts of oil to each cylinder. Insert the adaptor into the spark plug hole of cylinder number one.

9. Crank the engine over 6 - 7 times, perform the test on each cylinder, and record the results below.

⚠ **CAUTION:** Be sure to release the pressure in the gauge by pressing the release button before moving the gauge to the next cylinder.

#1 Dry/Wet	#2 Dry/Wet	#3 Dry/Wet	#4 Dry/Wet
#5 Dry/Wet	#6 Dry/Wet	#7 Dry/Wet	#8 Dry/Wet

10. Did the values change? _____

GUIDED PRACTICE 3

Follow all shop safety rules.

Compression Gauge (Running)

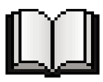
1. Perform a RUNNING COMPRESSION TEST: Put all of the spark plugs back into the cylinder except for the cylinder to be tested. <u>Be sure to torque the spark plugs to specification.</u>

2. Ground the plug wire or disconnect the coil-over-plug unit for the cylinder to be tested to minimize damage to the control module.

3. Disconnect the fuel injector for the cylinder to be tested.

4. Carefully thread the adaptor into the spark plug hole. Connect the tester.

5. Start the engine and record the (engine running) readings. Can you get a good reading? <u>If not</u>, try inserting the schrader valve and test again.



NOTE: Use the technique that will give you the best reading to complete the exercise.

6. Quickly snap the throttle to get a gulp of air into the cylinder. <u>Do not REV the engine...</u> the gulp of air is what we are measuring, not RPM. Record your results for each cylinder.

#1 ____ #2 ____ #3 ____ #4 ____
#5 ____ #6 ____ #7 ____ #8 ____

7. Are the results within specification? ____________
If no, list the possible concerns __________________
____
____

8. Put the components back into their case and reset the engine.

Instructor's Initials ____

GUIDED PRACTICE 4

Follow all shop rules.

Chassis Ears

1. Remove the Chassis Ears from the container.

2. Connect the clips to in locations to detect the specified sounds:
    a. Valve Train
    b. Accessory
    c. Bottom End
    d. Automatic Transaxle

3. Secure the transmitters and cables away from heat and moving objects. Turn the transmitters ON.

4. Start the engine and double-check the transmitters, clips, and cables to ensure they are free from heat and moving objects.

5. Turn on the receiver and adjust the volume as needed.

6. Toggle the receiver buttons 1 -4. Notice the intensity meter. Do you hear any abnormal sounds?
____
____

7. Gently snap the throttle. Did you hear any abnormal sounds? ____________________________
____

8. Hold the throttle steady between 2000 - 2500 RPM. Do you hear any abnormal sounds? __________
____

9. Turn off the engine. Put the transmitters and receiver back into the case.

Instructor's Initials ____

GUIDED PRACTICE 5

Follow all shop rules.

Leak Down Gauge

1. Bring the engine up to operating temperature.

2. Remove all of the spark plugs.

3. Remove the intake hose, oil filler cap, and radiator cap.

4. Position the cylinder to be tested in the Top Dead Center position of the Compression Stroke.

CAUTION: Remember to only rotate the engine in the direction of normal rotation or you may jump timing.

5. Insert the adaptor into the spark plug hole hand tight.

6. Turn the regulator on the leak down gauge fully counter-clockwise before connecting the gauge to the air supply hose.

7. Connect the air supply to the gauge. Connect the gauge to the adaptor in the engine. Adjust the regulator knob to 100 psi on the gauge.

#1 ____ #2 ____ #3 ____ #4 ____

#5 ____ #6 ____ #7 ____ #8 ____

8. Record the cylinder leakage below.

9. Did you hear any excessive sounds from the throttle body, oil filler cap, or exhaust? ____________
Were there in any bubbles from the radiator? ______

10. Reduce the regulator pressure to 0 psi before disconnecting the adaptor.

11. Repeat steps 4 - 10 for each cylinder to be tested.

12. After all cylinders have been tested, return the equipment back to the storage container and reset the vehicle.

Instructor's Initials ____

GUIDED PRACTICE 6

Follow all shop rules.

Block Check Dye

1. Set the emergency brake or raise the vehicle so the wheels are off the ground.

2. Remove the radiator cap. Drain the coolant so the fluid level is about 1” - 2” from the base of the filler neck.

3. Remove block check test kit from container. Pour blue fluid into the glass test unit to the marked “fill level”. Put the lid back on the primary fluid container.

4. Place the glass test unit onto the radiator filler neck by securing and gently twisting the rubber base.

CAUTION: Do NOT twist the glass tube since the force can crack the glass tube.

5. Start the engine and let it warm to operating temperature. Place the rubber squeeze bulb onto the glass test unit. Squeeze the rubber bulb for 1 minute with the engine running.

CAUTION: You will be sampling air in the top of the radiator for combustion gases. Do not sample coolant! If coolant is entering the glass test unit, you will need to drain more coolant from the system.

6. What color is the fluid after 1 minute of squeezing the bulb on a warm engine? ______________________

7. If the fluid is blue and didn’t change, then it is safe to pour back into the primary container and reuse. If the color of the fluid changed, then it must be disposed and the glass test unit must be rinsed clean.

NOTE: Fluid reuse is only for Training Center purposes to conserve fluid.

8. Return the components back to the storage container and reset the vehicle.

Instructor’s Initials ____

GUIDED PRACTICE 7

Borescope

Follow all shop rules.

1. Locate an engine on the engine stand.

2. Locate a Borescope tool. Be sure to read the operation manual to the Borescope prior to operating the Borescope.

3. If the engine has spark plugs installed, you will need to then take a spark plug socket and socket wrench to remove the socket from the cylinder head.

4. Rotate the cylinder to be examined so that the piston is at BDC.

5. At this point you will need to turn on the Power to the Borescope.

6. Insert the Borescope end into the cylinder and begin to perform the inspection. Do you notice anything abnormal on the cylinder walls such as scoring or scratches? Also, check the bottom of the valves (if possible)

____

____

WARNING: Be careful not to drop any debris, including attachments for the Borescope, into the cylinder or damage will occur. Check to ensure that all attachments for the Borescope have been returned to their storage container.

7. Inspect the top of the piston head; this will give you some insight to the usage of the engine. You will look for signs of excessive carbon build up (misfire or short-tripping), or if it is running lean you will be able to see signs of piston burning hot (scorching or pitting). Do you see anything unusual?

____

____

8. Return your equipment to their proper storage container and reset your work station.

Instructor's Initials ____

GUIDED PRACTICE 8

Follow all shop rules.

Oil Pressure Test

1. Raise the vehicle and locate the Oil Pressure Switch. With a drain pan handy, remove the Oil Pressure Switch. Be sure to protect your eyes, clothes, and anything else that can be damaged by oil.

2. Connect the Oil Pressure Gauge to the engine through the Oil Pressure Switch hole.

3. Find the oil test specifications on the Global Diagnostic System or KGIS.

WARNING: Be careful of hot surfaces and moving parts.

4. Start the engine.

What is the cranking oil pressure? ________________
What is the running oil pressure? ________________
Was the test performed Hot or Cold? ____________
What RPM was the test performed as specified on the Global Diagnostic System? ______________________
Is this within specification? ______________________

Test the Oil Pressure Switch

5. With a DVOM set to Ohms, is there continuity between the terminal and the body? ______________
If there is no continuity, the switch is bad.

6. Check the continuity between the terminal and the body when the fine wire is pushed. Is there continuity?
____
If there is continuity even when the fine wire is pushed, then the switch is bad.

7. Use a Mighy Vac, and apply 7 psi to the oil hole of the switch. Is there continuity? _________
If there is no continuity when 7 psi is applied through the oil hole, then the switch is operating properly.

8. With 7 psi of vacuum applied, also check for air leakage. If air leaks, the diaphragm is broken and the switch will need to be replaced.

9. Return the equipment to their proper storage containers and reset the vehicle.

Instructor's Initials ____

GUIDED PRACTICE 9

Cooling System Pressure Tester

Follow all shop rules.

This test is best if performed on a cool engine. Heat causes parts to expand and may seal a leak.

1. Carefully remove the radiator cap and protect yourself from any coolant.

2. Check the coolant level in both the reservoir and radiator. Are they within specification? ____________

3. Connect the cooling system pressure tester to the radiator filler neck. Pressurize the system to the PSI indicated on the radiator cap. Is the system holding the pressure? ________________________________
Are there any leaks? ___________________________
If so, where is the source of the leak? ____________
____

4. Remove the cooling system pressure tester and connect the adaptor to test the radiator cap. What is the pressure rating of the radiator cap? ___________
What is the pressure reading on the tester? ________
Is this within specification? _____________________

5. Return the equipment to its storage case and reset the vehicle.

Instructor's Initials ____

GUIDED PRACTICE 10

Coolant Electrolysis Test

Follow all shop rules.

WARNING: Be careful when removing the radiator cap on a hot engine or personal injury may result.

1. Use a DVOM set to DC volts. Place the positive probe of the meter in coolant flow and negative lead on negative battery cable (see photo). Turn on all loads (A/C, headlamps/radio/defroster) and run engine at 2,000 rpm. Record maximum voltage.

2. If the voltage is more than 400mV, perform a voltage drop from the engine to the negative battery post and from the frame/body to the negative battery post. Voltage drops should not exceed 100 mV (.1V). Repair and clean grounds if needed. Repeat step #1 to confirm voltage is below limit.

Record your results ____

3. If voltage is still over 400 mV (.4V), notify your Instructor.

4. Return the equipment to their storage container and reset the vehicle.

Instructor's Initials ____

NOTES:

TARGET AUDIENCE

Kia Dealership Technicians whom are able to diagnose, troubleshoot, and repair engine mechanical related customer concerns.

MODULE GOAL

Upon completion of this module, the Kia service technician will be able to demonstrate the knowledge required to accurately inspect external engine mechanical related customer concerns using specific diagnostic tools.

MODULE OBJECTIVES

Upon completion of this module, you will be able to accurately interpret and understand the following external engine mechanical inspections:

- Timing Belt / Chain
- Continuously Variable Valve Timing (Dual)
- Oil Control Valve
- Oil Control Valve Filter
- Oil Pan Inspection
- Turbocharger
- Spark Plug Analysis

MODULE INSTRUCTIONS

Carefully read through the material, take notes based on the classroom discussion and study each illustration. At the end of the module there will be Progress Check questions for you to answer. You may use the modules to answer the questions.

TIME TO COMPLETE

Approximately 45 minutes

ACRONYMS

CVVT - Continuously Variable Valve Timing
A system that varies valve timing and overlap for optimum performance and emissions.

DTC - Diagnostic Trouble Code
An electronic signal stored in an automotive computer, indicating the presence of a fault detected by that computer.

D-CVVT - Dual Continuously Variable Valve Timing
A system where both the intake and exhaust camshafts have continuously variable valve timing capabilities.

MIL - Malfunction Illumination Lamp
A lamp on the dash that illuminates with the presence of a DTC.

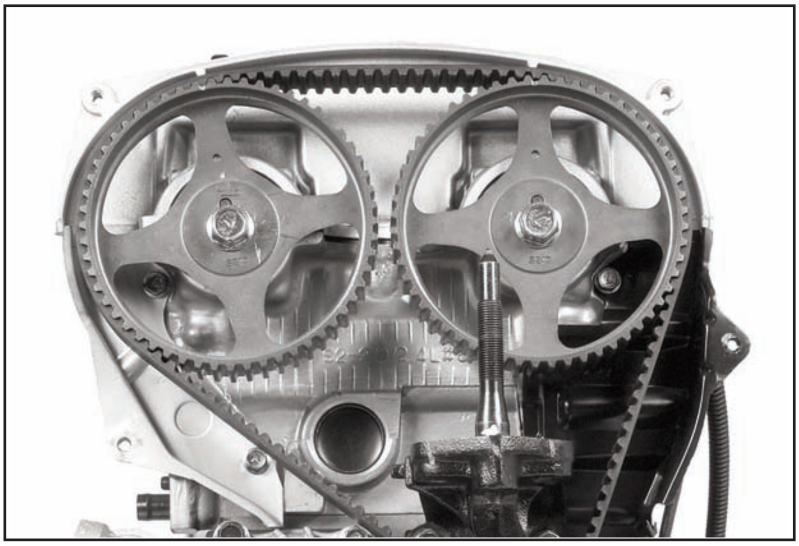
NVH - Noise, Vibration, & Harshness
NVH is the name given to the field of measuring, and modifying, the noise and vibration and harshness characteristics of vehicles.

OCV - Oil Control Valve
A component in the CVVT system that controls the oil flow to the CVVT unit.

RPM - Revolutions Per Minute
A measure of crankshaft revolutions in an engine.

VCM - Variable Charge Motion
VCM uses an input from the ECM to control a series of flaps at the intake manifold. VCM is used to promote tumbling of the air in the intake manifold on Warm-Up.

INTRODUCTION



Not all engine mechanical concerns can be diagnosed using a scantool and simply checking for DTCs. There are instances when checking the mechanical components is needed to accurately diagnose a concern.

This module will focus on the use of various external engine inspections that are effective in diagnosing customers engine mechanical related concerns. The tools covered in this module are:

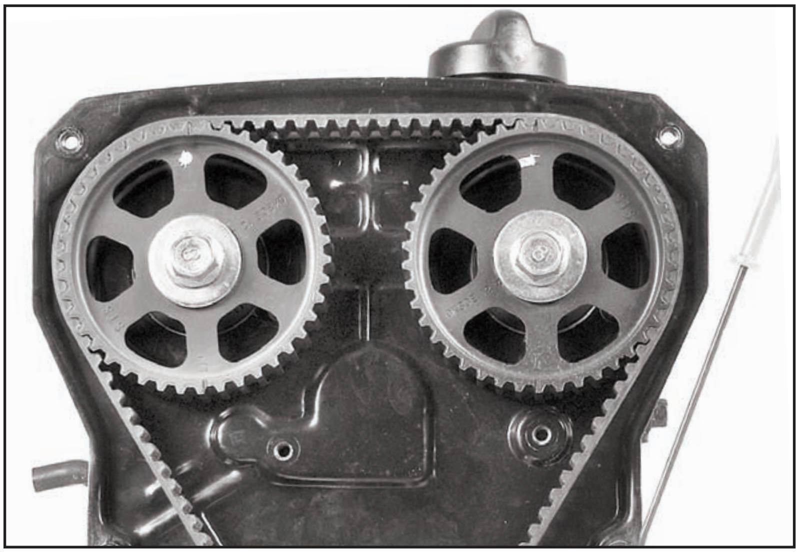
- Timing Belt / Chain
- Continuously Variable Valve Timing
- Oil Control Valve
- Oil Control Valve Filter
- Oil Pan Inspection
- Spark Plug Analysis

FEEDBACK: Remember the Kia 5-Step Process:

- Verify the Concern
- Analyze the Concern
- Diagnose the Concern
- Repair the Concern
- Verify the Repair

This module focuses on accurately diagnosing the concern prior to repairing and replacing parts on a customer’s vehicle.

TIMING BELT & TIMING CHAIN



The timing belt is a critical component that keeps the camshafts mechanically timed to the crankshaft. The marks on the camshaft sprockets and crankshaft must line up perfectly with their corresponding alignment marks. If the marks do not line up, whether it is due to age or the timing belt slipped, then there will be a drivability concern and possible damage on an interference engine.

Over time, the belts and chains tend to wear and need service. Symptoms of belt stretch could include performance or a MIL illumination. Some timing chains may also produce excessive noise due to chain stretch

NOTE: Only 2 Kia engines are non-interference:

- 2.0L used on earlier Sportage models up to 2002
- 1.8L used on Sephia (up to 2001) and Spectra (up to 2004) models

FEEDBACK: What is the timing belt interval service?

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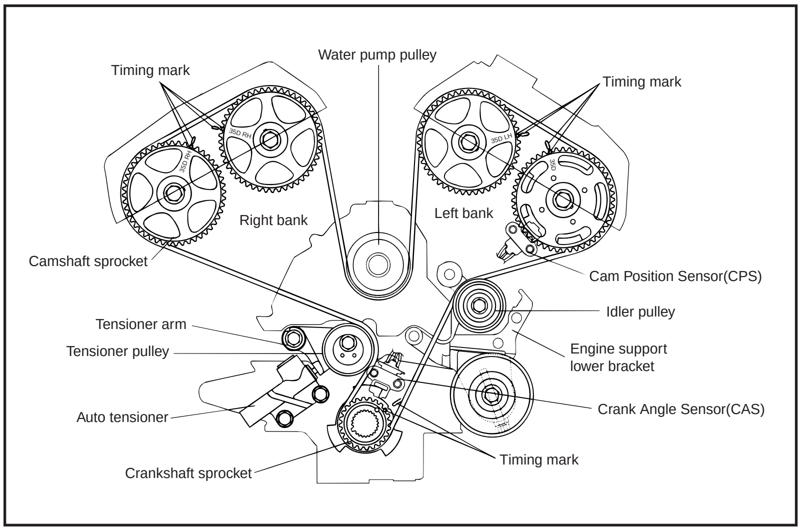


When the timing belt is working properly, the valve timing is in perfect synchronization with the crankshaft, connecting rods and pistons.

Kia uses two types of timing components:

- Timing Belt
- Timing Chain

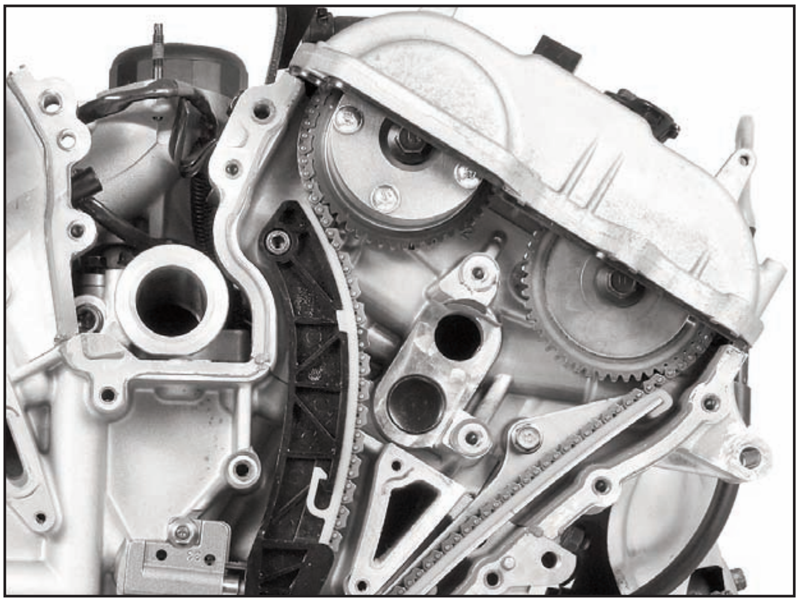
Timing belts tend to be quieter than chains which reduces NVH related customer concerns. Also, timing belts are less costly to manufacture, less mass than a chain and do not require lubrication.

However, there are times when the timing belts or chains do not work properly due to a:

- Skipped tooth or damaged sprocket
- Worn from normal use
- Weak tensioner

CAUTION: It is recommended to inspect and replace the timing belt tensioner if necessary when servicing the timing belt. The tensioner can fatigue over time causing timing related concerns shortly after service of a new timing belt. *This does not apply to ratcheting-oil pressure type tensioners.*

CAUTION: Always turn the crankshaft and belt in the direction of engine rotation. Turning the crankshaft in the opposite direction of rotation may cause the belt to jump timing.



When a customer experiences a timing chain concern, typical concerns include:

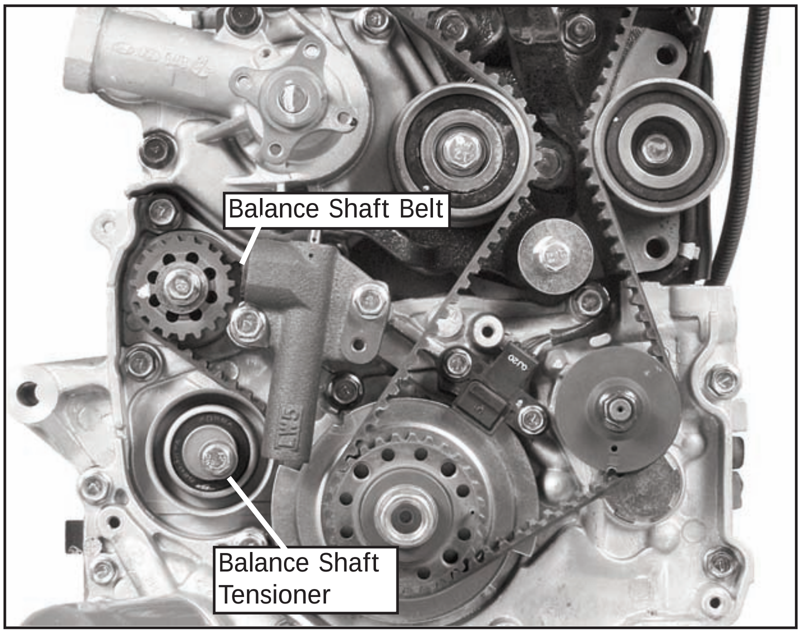
- Engine misfire (possible MIL illumination)
- Abnormal Valve Train Noise regardless of engine speed
- If the timing belt (or chain) breaks, mechanical damage will occur on an interference engine. Also, the engine may not crank since the crankshaft may not rotate due to debris or damage.

Follow the Service Information for vehicle specific data for timing belt replacement.

CAUTION: If a non-ratcheting-oil pressure type tensioner must be reused, be sure to compress the tensioner in a vertical position, not horizontal. If the tensioner is compressed horizontally, then air could get past the seal into the high pressure chamber which could result in weaker tensioner pressure, excessive valve timing noise, and timing mark concerns. Also, the tensioner must be set undisturbed on the block for a minimum of 5 minutes before cranking the engine over.

While the timing belt is off, be sure to check all pulleys and accessory drives for smooth operation. If a customer is concerned with a noise under the hood, it may be a result of an accessory, pulley, or bearing wearing out.

BALANCE SHAFTS



When servicing the timing belt (or chain), it is also a good idea to service the balance shafts timing belt or chains.

Technician Times:
KMA recommends that the counter balance shaft belt/timing belt be replaced when replacing the engine timing belt on 2.4L Optima MS vehicles, even though this replacement is not specifically required per the maintenance section of the Optima Service Manual.

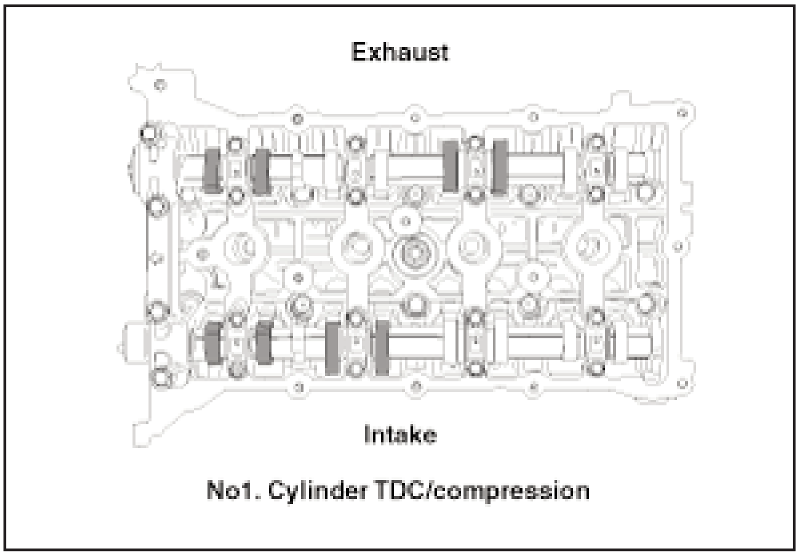
The counter balance shaft belt tensioner is a manual adjustment type. The belt should be inspected for looseness every time the engine timing belt is inspected.

Recommended service intervals are as follows:

- *Under normal conditions, the engine timing belt and counter balance shaft belt should be inspected every 30,000 miles and replaced every 60,000 miles.*
- *Under severe conditions the engine timing belt and counter balance shaft belt should be inspected every 20,000 miles and replaced every 40,000 miles.*

* Courtesy of Technician Times

VALVE ADJUSTMENTS



Valve adjustments are sometimes required due to engine wear or camshaft replacements. Engine wear that affects valve adjustments include camshaft lobe wear and tappet wear.

All engines in Kia vehicles have an inspection and replacement schedule depending on the engine type and customer's usage style (Normal or Severe Maintenance Schedule in the Owner's Manual).

How Does Valve Lash Affect Engine Operation?

Having the proper valve lash adjustment promotes the following conditions:

- Helps maintain the proper engine operating temperature
- Helps maintain optimum fuel economy
- Reduces unusual oil consumption and wear
- Helps maintain rated horsepower output
- Helps extend the life of the engine
- Helps keep a lower cost of ownership.

Setting the Valve Lash Adjustment Too Tight

Having a valve lash adjustment too tight, the following conditions can occur:

- Poor idle quality (un-even)
- Low end performance would suffer
- Cause the engine to run hotter than normal
- Potential exhaust valve damage (burned valves)

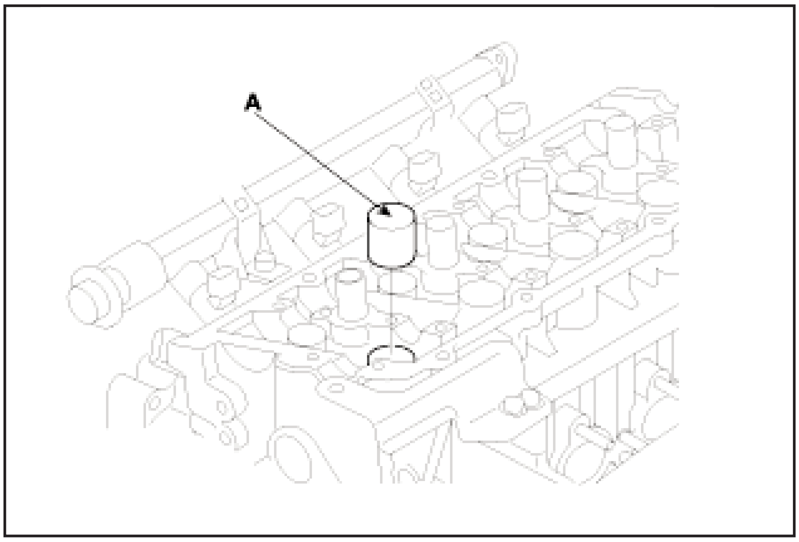
Setting the Valve Lash Adjustment Too Loose

Having a valve lash adjustment too loose, the following conditions can occur:

- A “noisier” than normal valve train.
- Cause an accelerated wear on valve train components.
- Potential chance of damaging/breaking of valve train components.
- High end performance loss.
- Could cause a slight improvement of low end performance.

A combination of these two conditions could cause an un-even idle and possible engine damage.

Types of Valve Lash Adjustors



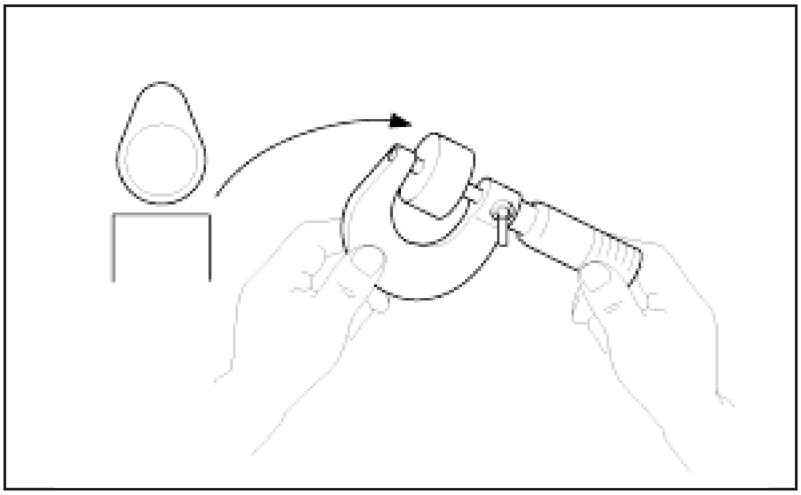
There are two types of Valve Lash Adjustors used in the Kia Motors family of engines, these are:

- HLA – Hydraulic Lash Adjustor (aka Hydraulic Tappet)
- MLA – Mechanical Lash Adjustor (aka Solid Tappet)

An HLA consists of a hollow expanding piston (oil filled) situated between the cam lobe and the valve. HLAs are designed to ensure that the valve train always operates with "zero" clearance, lending to quieter operation and less frequent valve lash clearance adjustments. Clean oil is critical to the operation of HLAs. Oil is fed into the HLA which lifts a piston inside the adjustor, this provides the proper lash adjustment as the camshaft applies "lift" to the tappet. When the valves are closed, the lifters should bleed down and be at a ready-state to fill again for the next lift from the camlobe. Oil is provided by the oil galleries to the HLAs which should always be free from sludge or debris.

An MLA is a "solid" bucket-shaped or flat tappet design situated between the cam lobe and the valve. Because of the solid nature of its design, these require more frequent routine/scheduled servicing to check for correct valve lash clearance. MLAs do not have the "squishing" sound like an HLA when operating, but MLAs may create a slight tapping sound on start up.

Types of Mechanical Lash Adjustors



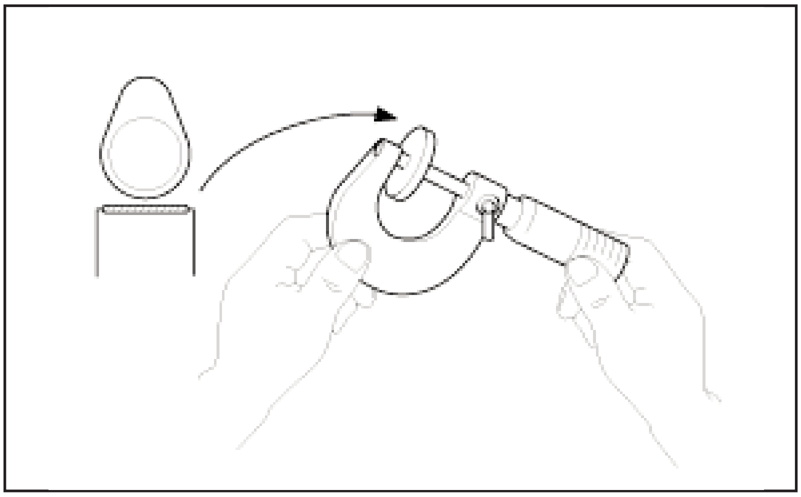
In the Kia Motors family of engines two types of MLAs are used:

- Bucket style
- Puck (shim) style

The “Bucket” style is shaped like a bucket with its open end facing the top of the valve stem and its bottom-side touching the cam lobe. The valve stem rides inside of the bucket shaped opening.

The “Puck” or shim style consists of a solid disc that rides on the bottom-side of the bucket touching the cam lobe.

Both of these MLA types require being removed from the engine and replaced (as required) to ensure the proper operating valve lash clearance.



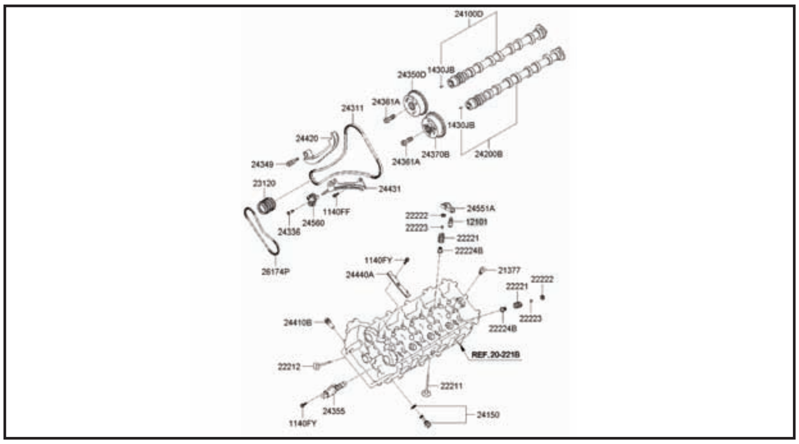
Service Maintenance

The period of scheduled maintenance of the MLA adjustors require scheduled service intervals between 48 – 60 months or 60,000 miles.

The servicing differences between these two types of valve lash adjustors are:

- A faulty HLA (noisy adjustor) is simply replaced. There isn't any measurement that can be made.
- A faulty/noisy HLA means that the internal piston mechanism is not providing the correct "hydraulic" action required to activate the valve properly and maintain the recommended "zero" clearance.

This "hydraulic" action can be tested and possibly found to be just dirty. This testing method is available in the vehicle's service information to help determine if the adjustor needs to be replaced (faulty) or simply cleaned. A faulty MLA means the required thickness of the adjustor component (adjustor itself or the shim) does not provide the recommended valve lash clearance to operate the opening and closing (timing) of the valve properly.

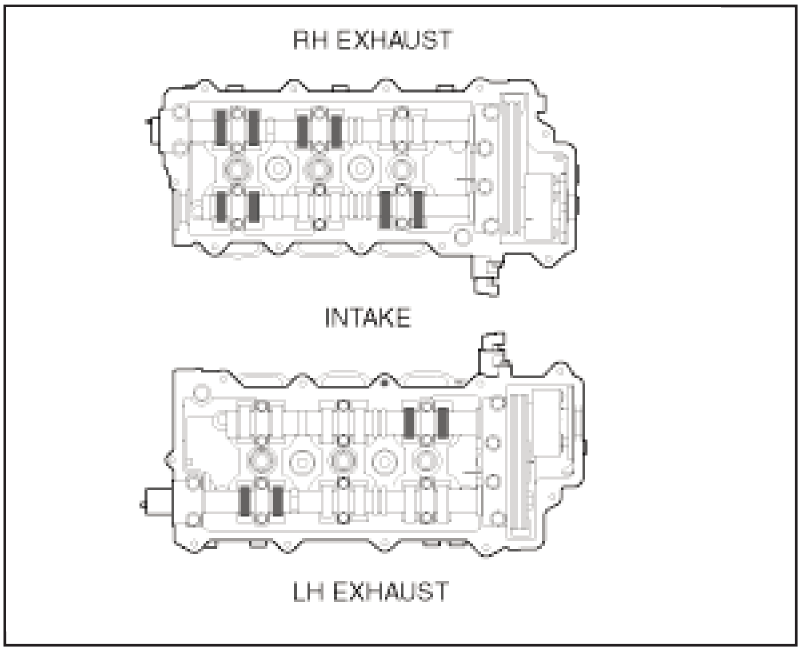


Other reasons to replace an adjustor(s) could fall under the following conditions:

- Excessive clearance/wear found in all/most of the adjustors.
- Due to a service condition the cylinder head and/or the engine block needs to be replaced.

Checking MLA Clearance

Adjustors, or tappets, are measured for proper range of clearance by their thickness using a micrometer. This proper thickness is what ensures that an engine will run smoothly and to its peak horsepower rating.

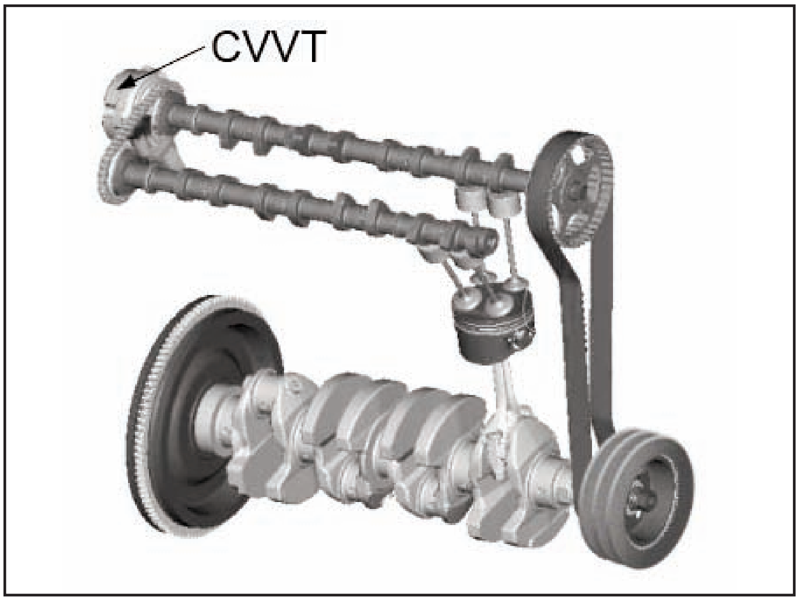


The recommended adjustor clearance is measured between the base circle of the camlobe (when the valve is fully closed) and the valve adjustor (a.k.a tappet or sim). A feeler gauge is used to represent the proper clearance between the cam and the adjustor.

If the feeler gauge tolerances are lower than specification in the space between the cam lobe and the adjustor then the valve adjustor is too thick (clearance too small). A thinner adjustor should be used to replace the existing one.

If the feeler gauge is too loose (clearance too large), then a thicker adjustor should be used.

CONTINUOUSLY VARIABLE VALVE TIMING SYSTEM



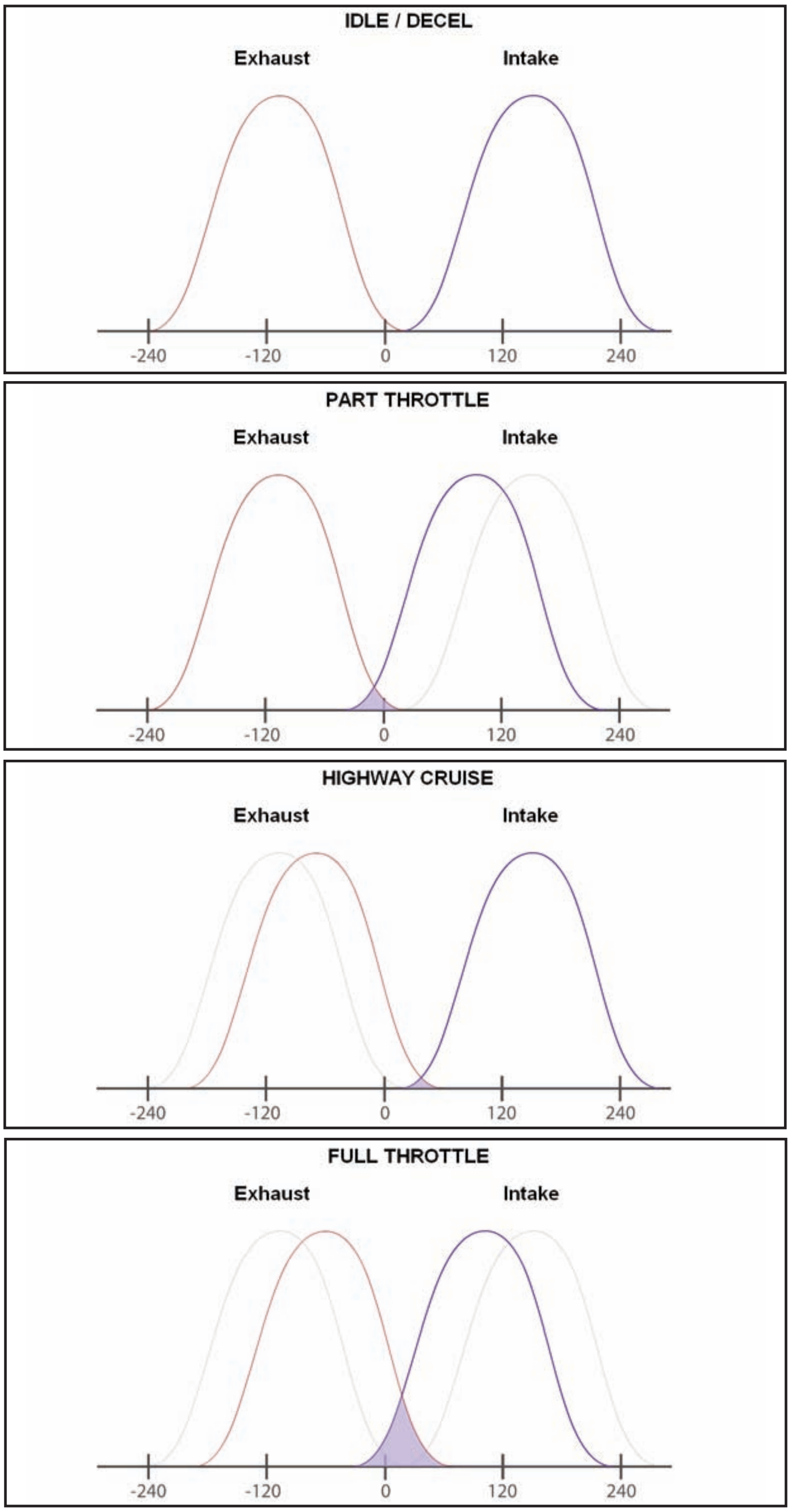
Kia Motors now uses a Continuously Variable Valve Timing (CVVT) System in its vehicles. The crankshaft is in direct rotation with the exhaust (and/or intake) camshaft sprocket. Oil provides the hydraulic pressure into the CVVT unit which adjusts the timing of the intake camshaft. This means the intake camshaft can have a range of degrees of advance incrementally between 0° and 40°.

Many of our engines adjust both the intake and exhaust camshafts at the same time. This dual configuration is often referred to as the Dual Continuously Variable Valve Timing (D-CVVT) System. The D-CVVT will use a separate CVVT unit to operate each camshaft.

Why go through all of this trouble?

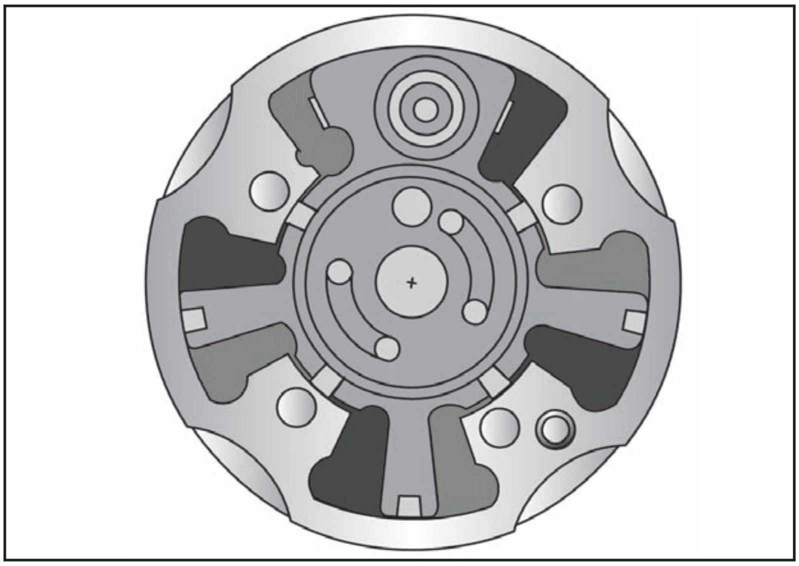
Kia uses the CVVT to enhance performance that will increase engine efficiency as well as reduce emissions.

CONTINUOUSLY VARIABLE VALVE TIMING SYSTEM



NOTE: Kia engines equipped with CVVT do not have EGR valves. Since Kia can control the amount of camshaft overlap we can vary the timing of the camshafts under the right conditions to create a natural EGR effect that reduces NOx emissions.

CVVT COMPONENTS



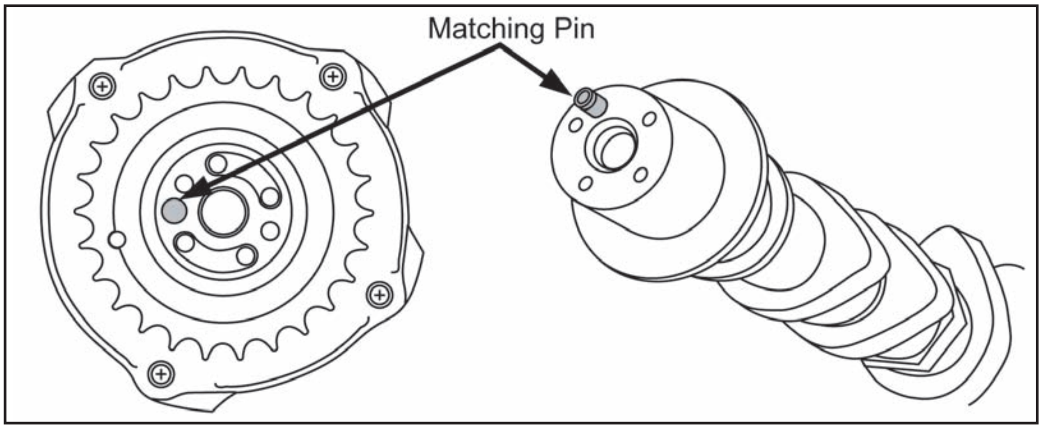
The heart of the CVVT unit consists of a:

- Sprocket
- Rotor (aka Vane)
- Locking Pin
- Vane Seals
- Housing

The CVVT uses hydraulic pressure from the engine oil supply to pressurize either the advance or retard side of the vane. The vane moves clockwise or counter-clockwise within the housing depending on which side of the vane is pressurized.

NOTE: A locking pin is used to hold the CVVT unit in the full retard position which is the same as the at-rest position when the engine is off when located on the exhaust camshaft. If the CVVT unit is located on the intake camshaft, then the at-rest position is fully advanced.

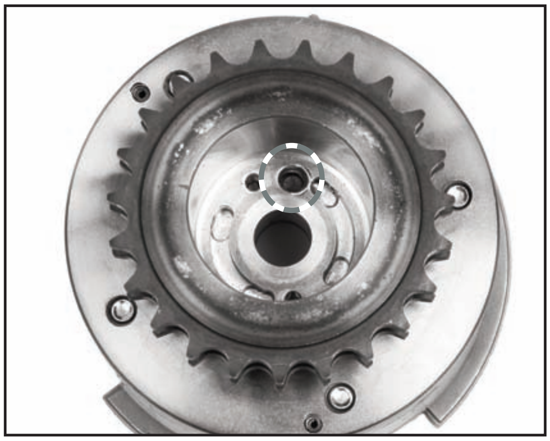
When the oil supply is fed to the CVVT unit then the locking pin will release and the vane can advance incrementally between 0° and 40°.



The CVVT mounts directly onto the intake camshaft and/or on back side of exhaust cam. The locator matching pin is used to align the CVVT unit to the proper location.

Pitstop: *On a small number of 2.7L engines built before 9-21-2006, an "under-torque" condition to the camshaft bolts that secure the CVVT (which includes the intake sprocket) and the exhaust sprocket was recently identified. As a result of this condition the CVVT camshaft locator dowel pins and/or camshaft locator bore may become distorted & elongated.*

This distortion allows relative movement between the CVVT Unit (which includes the intake sprocket) or exhaust sprocket and the camshaft, throwing the cam timing off slightly. This condition generally will not produce any drivability concerns, and can at times set a very intermittent P0300 (Multiple Cylinder Misfire).

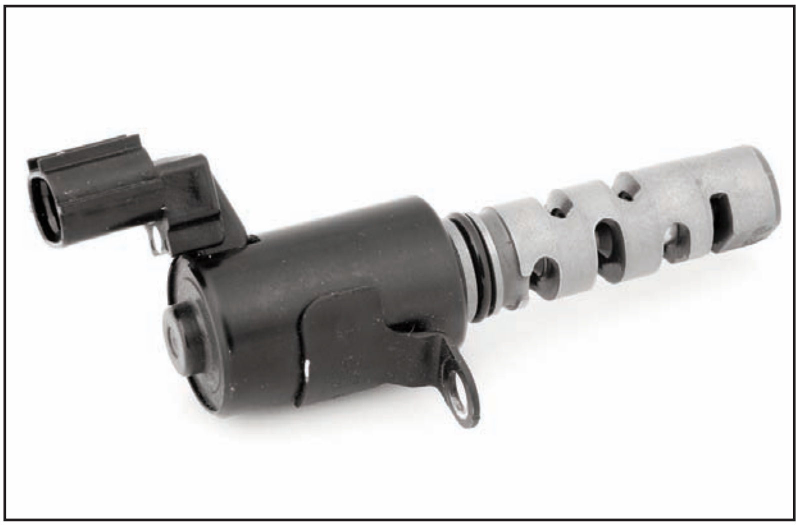


If you suspect that the valve train components might be distorted, a check of the camshaft position with the GDS and visual inspection of the valve train is required. Using GDS in Current Data mode, monitor the desired & actual camshaft position parameters on both engine banks. The desired value should be at 0° when the engine is idling. If the actual position exceeds +/– 3.00 (fluctuating) the position of the CVVT / exhaust dowel pin and camshaft bores should be inspected.

If excessive wear has been identified on the CVVT (including the intake sprocket)/ exhaust sprocket / camshafts replace all these components together due to component wear. Tighten both the CVVT unit (which includes the intake sprocket) & exhaust camshaft sprocket bolt to 49.2~57.9 lb-ft while maintaining the stationary position of the camshaft by holding the hexagon portion of the camshaft. Failure to properly inspect valve train components and/or torque the intake and exhaust camshaft bolts can cause wear and repeat dowel pin & bore distortion.

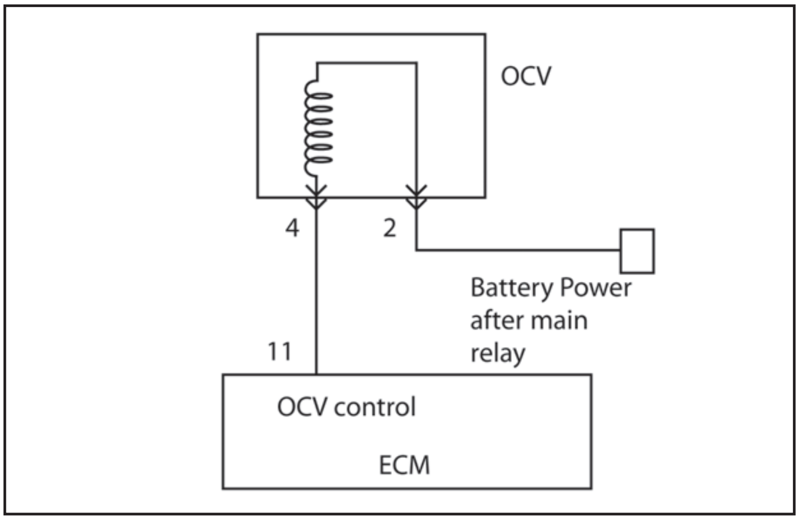
* Courtesy of Pit Stop

CVVT - Oil Control Valve



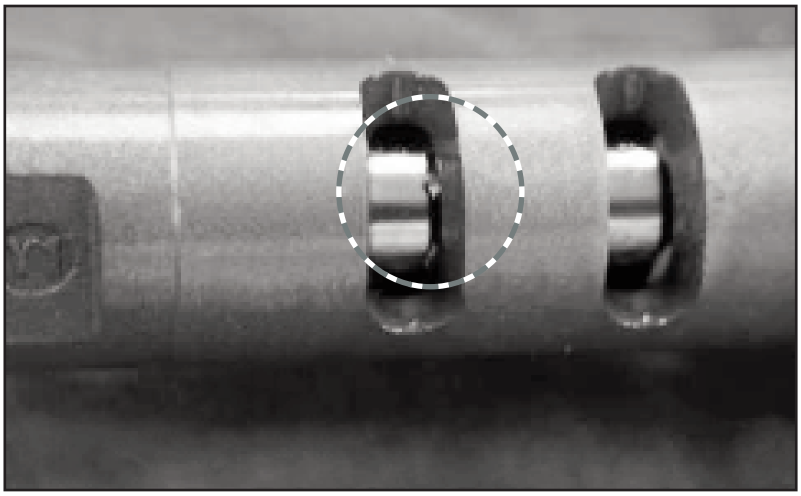
The oil control valve (OCV) controls the flow of oil to either the advance or retard chambers of the CVVT unit. When pressure is sent into either of the advance or retard chambers, the opposite chamber releases pressure back through the valve.

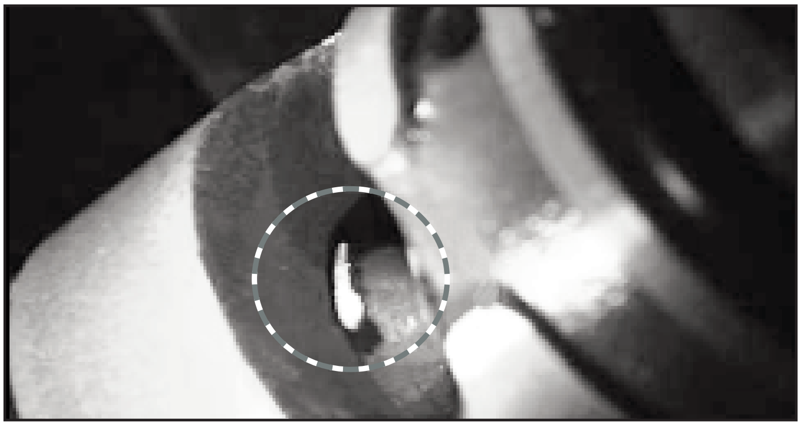
The OCV receives full battery voltage and duty cycles to assure the proper advance or retard of the intake camshaft.



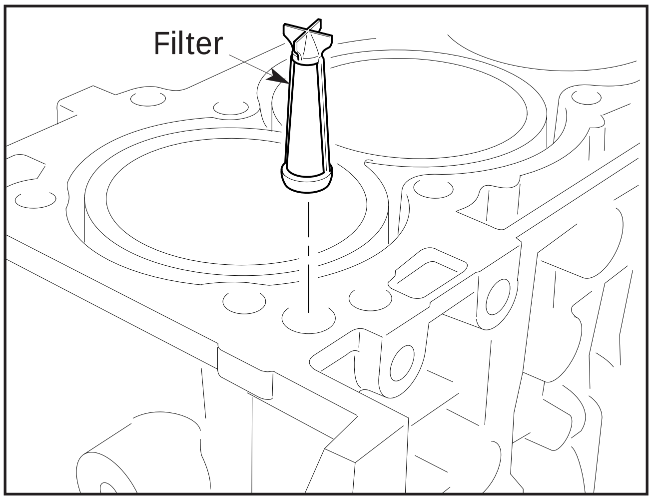
The Oil Control Valve (OCV) can be tested using the Global Diagnostic Scantool Actuation Tests.

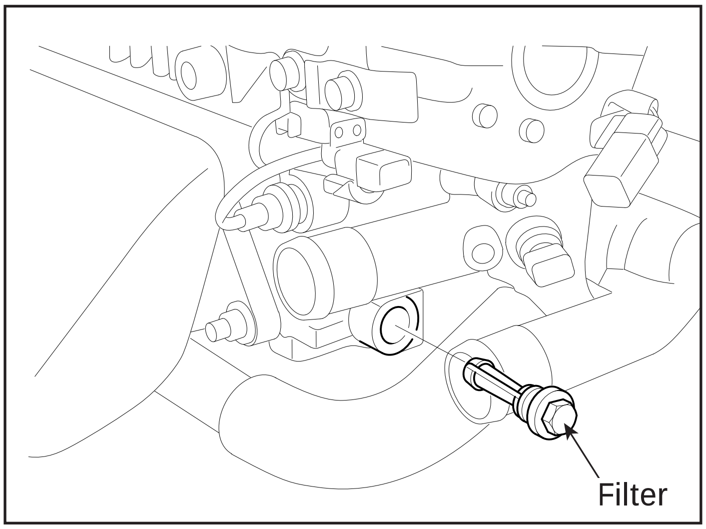
This should put the CVVT to full advance and the idle should stumble. If it doesn't change, then debris may be clogging the OCV or the supply oil passages may be clogged.

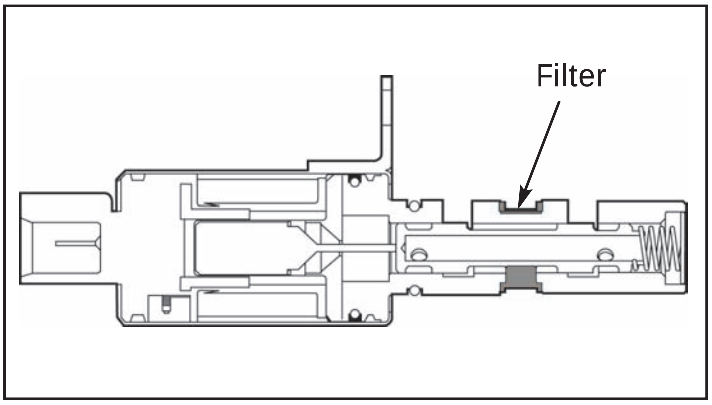




CVVT Oil Filter







The CVVT Oil Filter is a secondary filter that is separate from the engine's primary filter. It is designed to provide extra filtering to protect the CVVT Oil Control Valve from debris that can potentially damage the valve and create an engine performance concern.

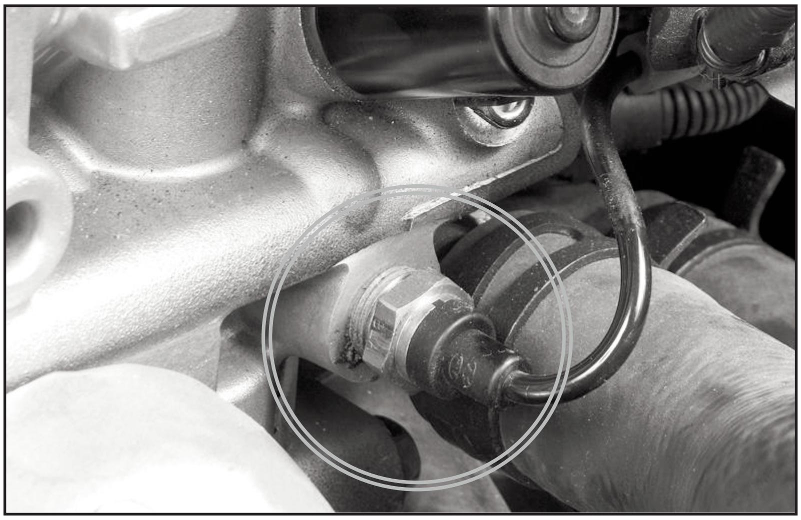
The location of the CVVT Oil Filter can be:

- on the side of the block
- internal between the engine block and the cylinder head
- integrated to the OCV and is not serviceable

The filter is designed to be removed and cleaned if it becomes clogged. This task is obviously more difficult if the filter is located within the engine. Refer to the vehicle's Service Information for location and service data.

NOTE: The CVVT Oil Filter can become clogged due to sludge, lack of maintenance, or debris. Emphasize customer maintenance to reduce potential CVVT Oil Filter concerns.

CVVT Oil Temperature Sensor



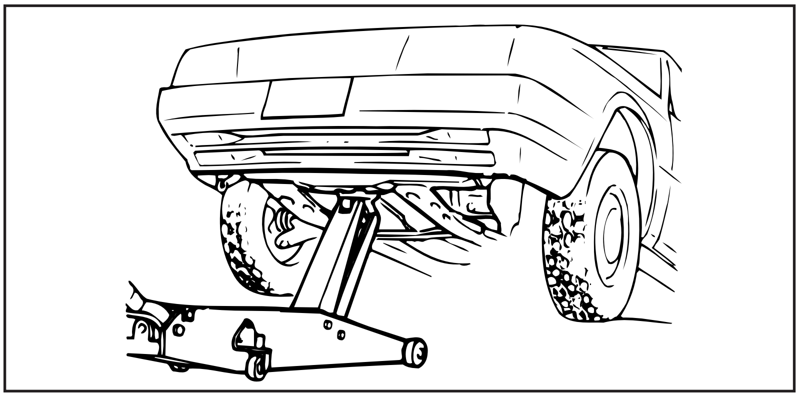
Oil flows differently when it is cold than when the engine is warm. When the oil is cold it is typically thick. The thicker viscosity affects the CVVT operation and the ECM must compensate for the different flow values.

NOTE: Kia recommends 5w-20 on all engines built after July 1, 2004 (5w-30 is a suitable alternative). Oil that is not recommended can also have an affect on CVVT operation as well as non-manufacturer additives.

If the Oil Temperature Sensor terminals become corroded, which increases resistance in the circuit, then the ECM will set a DTC P0196, P0197, or P0198. Follow the Service Information for the latest component tests.

The Oil Temperature Sensor requires 2 trips to illuminate the MIL.

OIL PAN



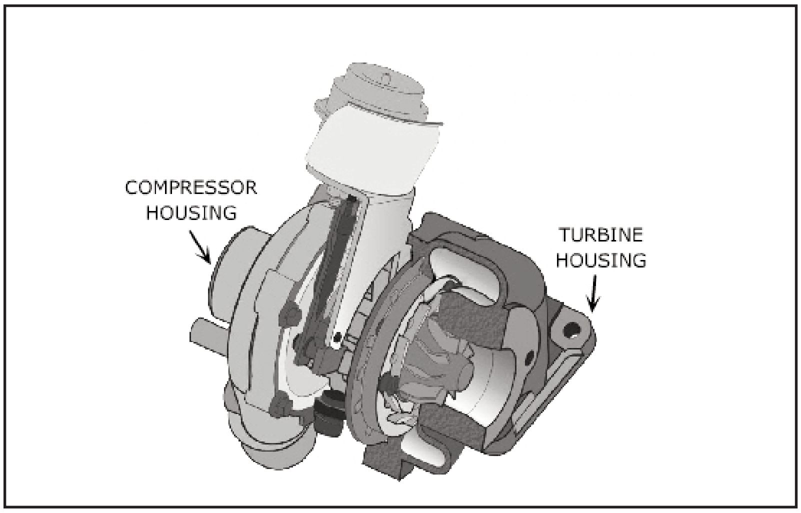
It may seem obvious not to raise a vehicle by the oil pan as pan damage does occur. Oil must circulate throughout the entire engine and any restriction to oil flow that isn't designed by the manufacturer is not recommended.

Some customers with oil pan damage may experience lower end noise regardless of engine RPM. This is due to oil starvation to the connection rod bearings and main bearings.

FEEDBACK: Is oil pan damage covered under warranty?

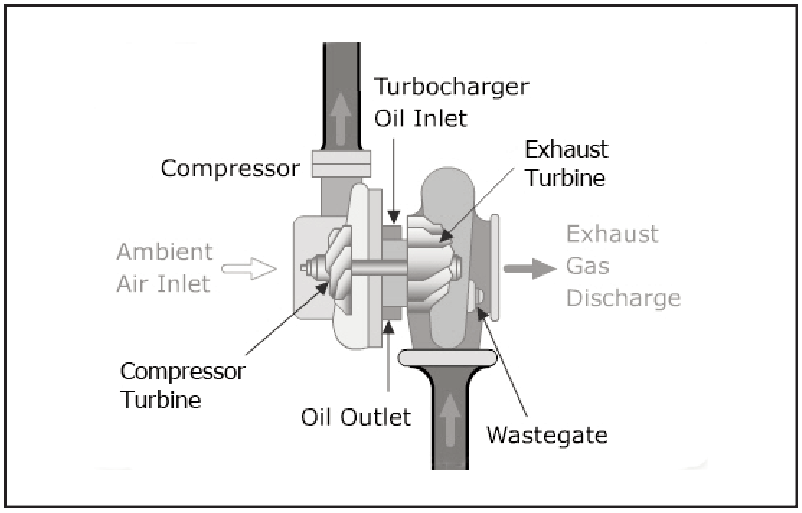
What is the policy for bearing replacement?
What engine conditions can be determined by examining the dipstick?

TURBOCHARGERS



A turbocharger is a set of turbines used to increase horsepower without increasing engine size or without adding a lot of additional weight to the vehicle. The power increase comes from “boosted” manifold pressure when under load, but increases fuel economy when the vehicle stabilizes to normal vacuum pressure when at cruising speeds. Another benefit is that it is not driven off of engine mechanics but off of exhaust air.

How the Turbocharger Works

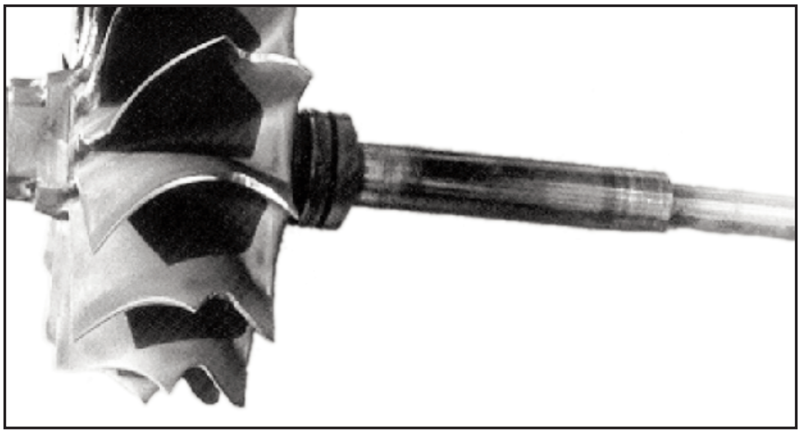


Turbochargers have two separate turbines that are joined by one common shaft. The first turbine is called the exhaust turbine and it is what is used to drive the second turbine which is called the compressor.

The common shaft rides on a set of bearings which are lubricated by filtered engine oil. This oil is typically supplied by a hose that is drawn from the housing at or near the oil filter. The oil is kept in the center housing by a set of seals at each end of the common shaft.

The exhaust turbo housing is mounted to the exhaust manifold and is driven from exhaust gasses. As the exhaust gases flow through the exhaust turbine it spins the turbo, this turbo in turn then spins the compressor turbine which draws in outside air and compresses the air as it flows through the compressor housing. This air that flows out of the compressor is pressurized in the intake manifold and then forced into the cylinders.

Turbocharger Maintenance (Oil)



Special maintenance should be taken when changing the oil. Follow the recommended maintenance schedule for the specific vehicle. The reason for this is that the turbo is utilizing hot exhaust gases and is spinning at a high rate of speed. This causes the oil to get very hot in the center housing and can cause thermal viscosity breakdown as a result of these high temperatures. If there is some doubt regarding a vehicle's oil maintenance, then an Oil Analysis test may be helpful to educate the customer about oil maintenance and the type of oil recommended by the manufacturer.

NOTE: Kia only recommends factory oil and filters. An improper oil filter may not filter debris from the oil that can get between the bearing and the shaft which results in permanent pitting or grooving.

Since the shaft spins on bearings, oil must be clean and operation pressure must be maintained at the bearings. Low oil pressure or clogged oil ports before the bearings can quickly damage the shaft bearings. A clogged return line after the bearing may cause the shaft seals to leak due to too much pressure.

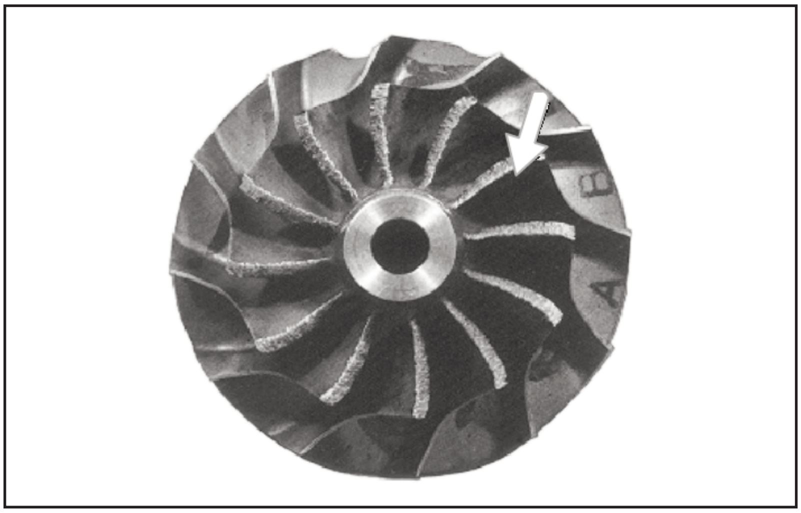
Turbocharger Maintenance (Oil)

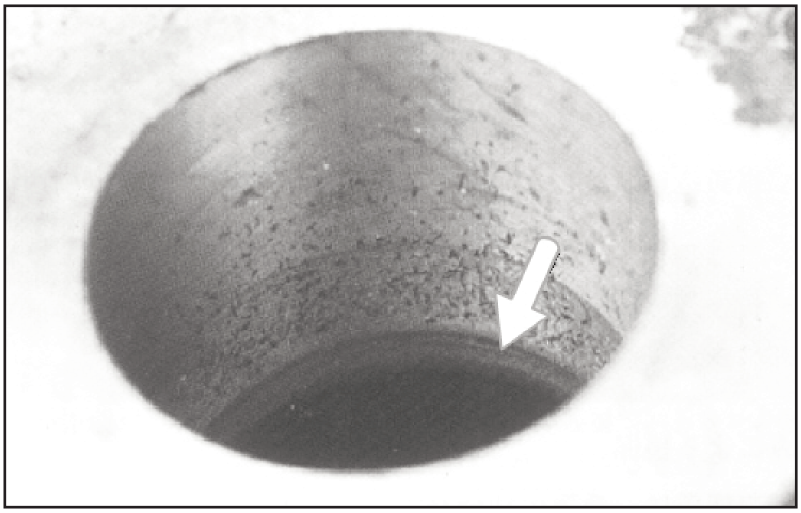
A clogged return line may be caused by oil “coking” issues. Coking is a solid residue that develops when engine oil is subjected to extreme oxidative and thermal breakdown and when the lubrication system is operating at extreme temperatures. The oil filter will pick up most of the coke deposits until the filter reaches its maximum saturation point which will then force the filter to go to by-pass mode. Coking builds up in the oil galleys over time and an oil filter in by-pass mode may increase the deposit rate in the oil galleys.

Turbochargers work off the exhaust gases which transfers heat into the housing. Also, the turbocharger shaft is spinning over 100,000 RPM which also can stress oil and add heat. This is an example of some of the extreme conditions where the solid residue from coking will create deposits in the oil galleys.

NOTE: The coking thresholds for oil vary per the individual company’s formula. Follow the Kia’s maintenance recommendations oil changes always and be extra vigilant if the vehicle is equipped with a turbocharger.

Turbocharger Maintenance (Air Filter)

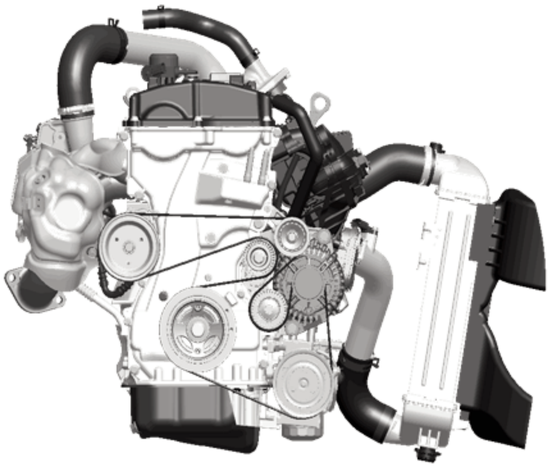




Kia Motors only recommends genuine Kia Parts for air filters. If an aftermarket filter is used or if the air filter has been removed, then small bits of debris may enter the compressor side of the turbo housing. The turbine wheel blades are balanced from the manufacturer and are at risk of being nicked or cracked. A turbocharger can spin at very high speeds. If the blades are damaged on the turbine and it becomes out of balance, then the turbo may possibly have a rattle which varies relative to the amount of damage to the bearing.

NOTE: Make sure that the air filter is clean and not full of debris. This can result in low flow to the compressor or could lead to debris in the compressor itself.

Related General Turbo Concerns



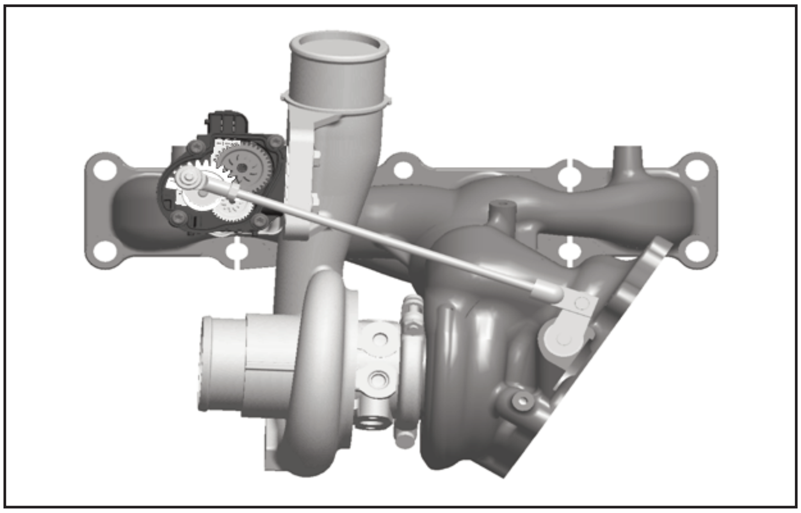
One of the concerns that customers have may be a loss of power. There are a few different reasons for this concern:

- Clogged air filter - If the intake is starving the turbo of fresh air, then this will limit the amount of boost that the compressor can produce resulting in a loss of power.
- One of the compressed air intake pipes could be leaking or disconnected - If an intake pipe is leaking or disconnected, then the compressed air that is being produced for the engine by the turbo is being released into the atmosphere which means there will be a reduction of boost pressure.

Another concern that a customer may have is that every time they have their oil changed they notice after a few weeks that their oil may be low. This typically means that the car is burning oil or using oil. When a car is turbocharged you have to take a look at the signs for the oil consumption. An area you should look it at the turbo. This sometimes happens when the turbo is abused. Check the turbo housing for oil seepage at the shaft seals. While you are inspecting the seals, check the shaft for excessive endplay. This may mean that the oil is escaping from around the shaft seals and is leaking into the housing of the turbo.

NOTE: If the oil is not flowing freely as a result of a partially clogged port after the shaft bearings, the oil may be building up in the housing and burned. An Oil Pressure Gauge may be helpful to determine if the right PSI is being delivered through the turbo.

The Waste-Gate



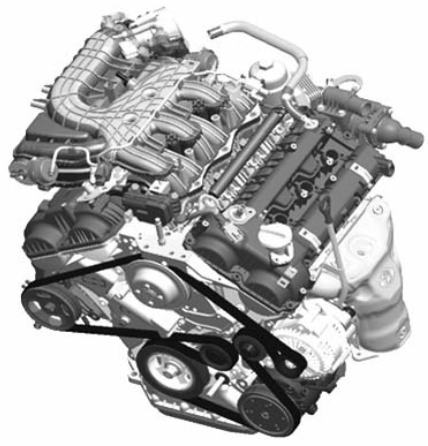
The waste-gate is also considered a blow off valve. The purpose for this waste-gate is to protect the turbo and motor from being harmed from too much boost. The waste-gate is a valve that basically is a short cut for excessive air pressure to be diverted away from the turbine when there is too much boost being produced. With an excessive amount of air flowing over the compressor turbine, the turbo can over rev and permanently damage the turbo or cause damage to the engine.

The waste gate is actuated by a valve that drives a shaft which will open and close the waste-gate. This valve can either be actuated electronically or by vacuum. This valve will be set by the manufacturer to a predetermined amount and when it reaches that limit the valve will then open the waste-gate and release the pressure in the turbo away from the compressor turbine. This will cause the turbo to slow down or stop producing boost as part of the vehicle's normal operation.

A waste-gate that is stuck open, or partially open will cause the vehicle to have a noticeable loss of power. This loss of power will be a result of the turbo never reaching its full boost pressure that is determined by the manufacturer.

With a waste-gate that is stuck closed, the customer will notice a significant amount of boost at higher speeds. The concern with too much boost is that under load the waste-gate can no longer protect the turbo and result in permanent turbo and/or engine damage.

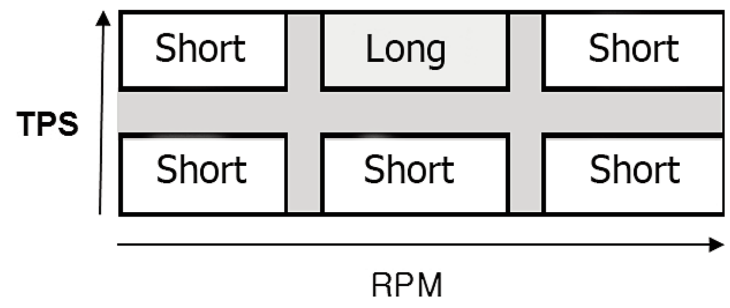
VARIABLE INTAKE MANIFOLD



The Variable Intake System (VIS) Manifold is designed to increase engine efficiency and to maximize horsepower. Typically intake manifolds are limited to maximize horsepower at a specific range by tuning the intake manifold for a specific power band. Kia Motors overcame this limitation by designing an intake manifold that could provide increased horsepower at both low and high RPMs, reduced emissions, and increased fuel economy. A shorter intake manifold is used to maximize the engine's efficiency by giving it a more free flowing air when at low & high RPMs while under load. A longer intake manifold port is used to maximize torque at the mid-range RPMs.

Kia Motors has designed an intake manifold that could produce an output for both types of power ranges, by developing a manifold that is designed with both a long and short set of runners that can be operated by either a vacuum-actuated valve or an electric solenoid/motor.

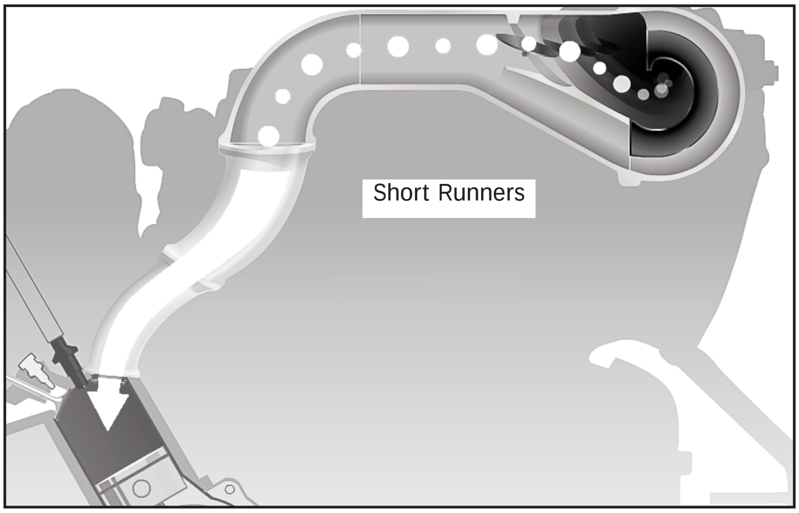
VARIABLE INTAKE MANIFOLD

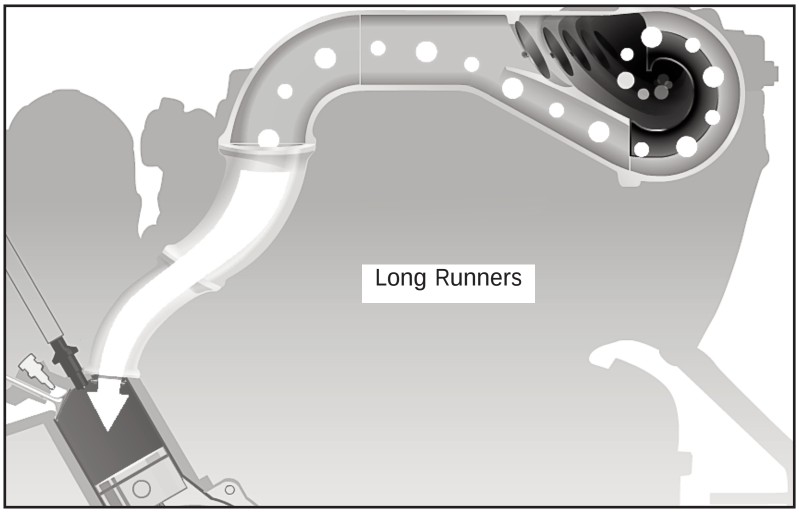


There are several RPM bands where the Variable Intake Manifold operates for peak engine efficiency. The precise RPMs may vary per engine size, but the methodology is the same. Generally, the operations are executed at low, middle, and high RPMs which may vary depending on the engine load.

At low and high RPMs, the air flow is routed through the shorter runners of the intake manifold by way of the control valve. This produces more free flowing air when the engine needs more air. The amount of air that is taken through the intake manifold while traveling through the short runners creates a condition that enhances the cylinder's filling capacity with air and fuel.

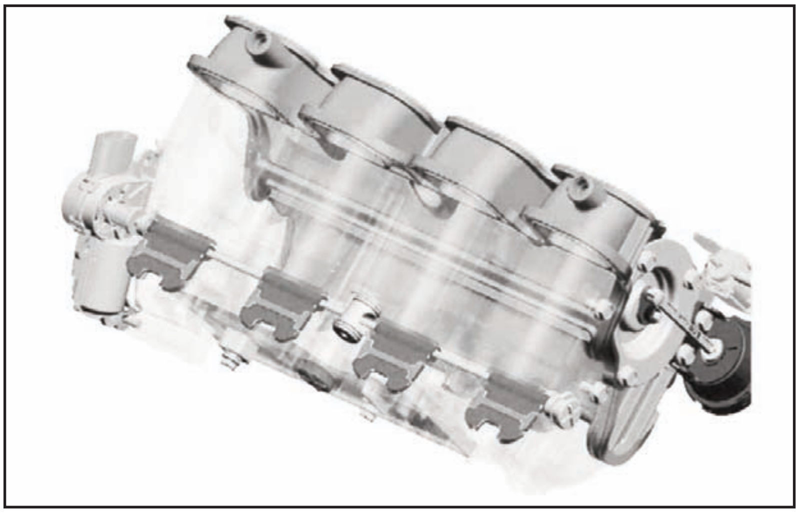
At mid-range RPMs the air flow is routed through the long intake runners in the manifold. This process creates a specific port velocity so that when the air and fuel mixture enters the cylinder (combustion chamber) and is ignited, the mixture burns cleaner and more efficiently. The air flow through the longer intake manifold essentially maximizes the volume of air in the cylinder which provides higher engine efficiency for lower end torque at specific RPMs.





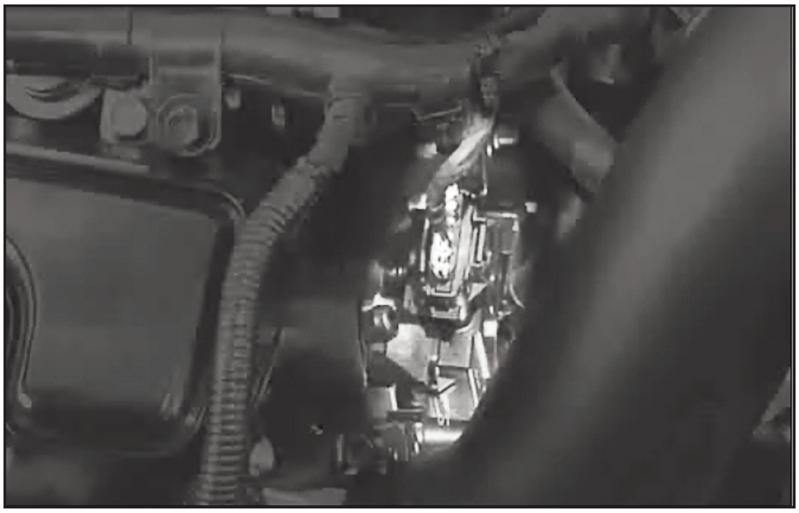
The airflow in the ports resonates at a certain frequency which depends on airflow speed. If the intake air can match that frequency under that specific load, that the air in the manifold is resonating at, then as a result the air flow is less disturbed and will increase the amount of air that can pass through to the ports. The vacuum actuated valve or the electronically controlled solenoid valve is then designed to operate the internal valves at these predetermined loads. To produce more torque, the longer ports resonate differently than the shorter ports. This means that when you are at low rpm and under load, and need more torque, the air flow goes through the longer ports. Depending on the needs of the engine, air can then be diverted through a combination of both long and short runners to get air that is resonating at different frequencies.

VCM



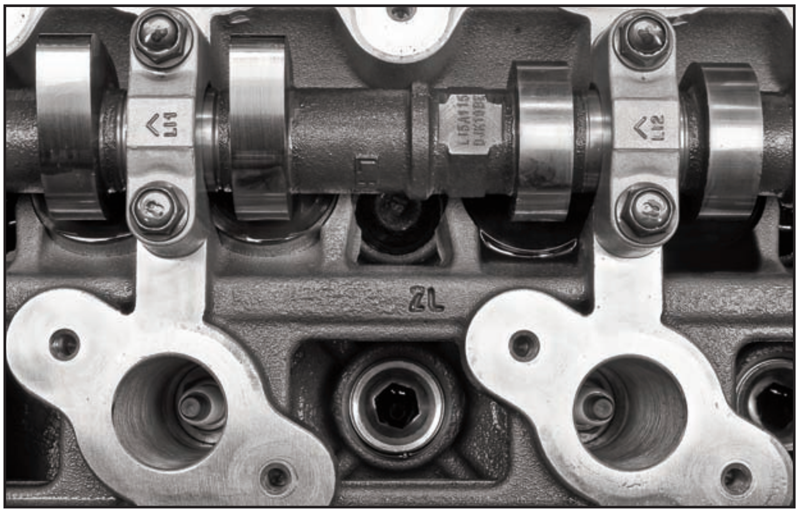
Variable Charge Motion (VCM) is being used in conjunction with the variable intake manifold. VCM uses an input from the ECM to control a series of flaps at the intake manifold. VCM is used to promote tumbling of the air in the intake manifold on Warm-Up. Tumbling of the air promotes mixing of the fuel and air, which improves drivability, lowers emissions, and reduces misfires at lower RPMs.

Diagnosis of the VCM



To verify the operation of the VCM, connect a scan tool and actuate the VCM. Watch VCM for movement while actuating VCM. If you can not verify movement of the actuator, disconnect the actuator and check for free movement of the VCM shaft. VCM only actuates during warm-up and at low RPM's. If a customer's vehicle has a low-power concern, this could be caused by ECT sensor faults which will cause the VCM to operate at higher RPM's or after the engine has warmed up.

Torque-To-Yield Bolts

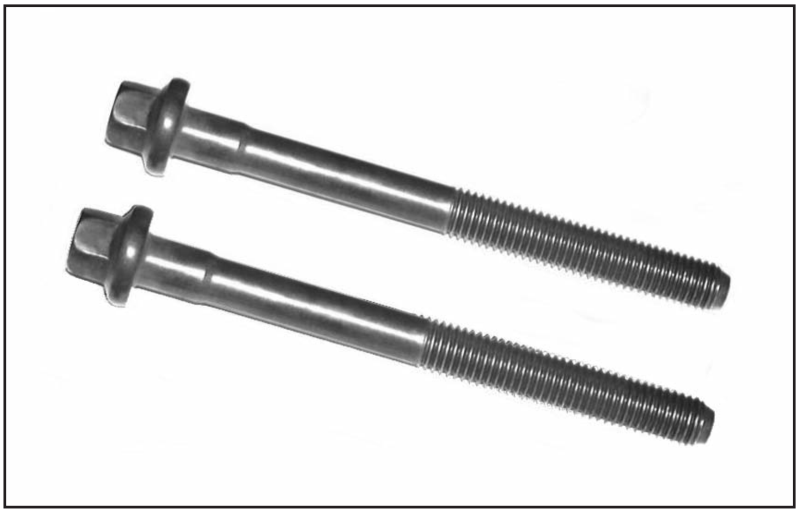


Torque-To-Yield bolts are designed with a specific length and have a specific tensile strength. They are used because they provide a more accurate means of fastening and they are also less susceptible to engine vibrations. Through the process of tightening bolts, there is an effect that is referred to as “clamping”. Because Torque-To-Yield (TTY) bolts have a relative low tensile strength; the bolts go through a process of elasticity which can create a relatively high clamping strength for their size.

The process to tighten a TTY head bolt is somewhat unique in that the bolt is first tightened to a specific torque; this torque is then followed by torque to turn. When they reach this phase of the process, Torque-To-Yield head bolts reach the elastic stage, and depending on the tensile strength, if the bolts are turned beyond their recommended specification then they are vulnerable to breaking. Since TTY bolts are tightened to torque and then torque to turn within their specification where they reach their strongest point, the TTY bolts create much higher clamping rate than standard bolts.

NOTE: Common locations for Torque-To-Yield bolts are the cylinder head bolts and crankshaft bolt. Always refer to the Service Information for torque values and specifications.

Torque-To-Yield Bolts



Once a bolt is tightened beyond its yield point they can no longer reach the same clamping strength, because they have then been permanently stretched. The risk of reusing a TTY head bolt is that they are prone to breaking since they have already been stretched.

CAUTION: Never reuse a Torque-To-Yield bolt.

Torque-To-Yield bolts have the ability to expand and contract while retaining a constant pressure such as on a cylinder head gasket.

Crankshaft Bolts

PREVIOUS		NEW	
Crankshaft pulley bolt	Special washer	Crankshaft pulley bolt	Special washer
			
N/A		23127 39801QQK	
Gold	Black	Gray	Gray

The crankshaft pulley bolt is a critical fastener that requires accurate torque execution. The difficulty with applying torque to the crankshaft pulley bolt is that the crankshaft tends to rotate when torque is applied. It is recommended to secure the crankshaft (Kia offers several Special Service Tools for various applications) so that the crankshaft can be held stationary while the crankshaft bolt is being torqued.

CAUTION: Under NO circumstances should the bolt be installed using an impact gun! A bolt may come loose shortly after the vehicle has been serviced. The usual indicator of such loosening is a customer's concern of a rattling noise coming from the engine compartment. Ultimately, this may be traced to the crankshaft pulley assembly. Proper bolt torque is essential for long term durability and increased customer satisfaction.

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SPARK PLUG ANALYSIS

One of the simplest checks that can be performed on an engine is to closely analyze the spark plugs. Racers have known for years that proper combustion and engine operating conditions can be determined with a spark plug inspection.

Kia only uses aluminum cylinder heads and it is not recommended to remove or install the spark plugs on hot cylinder heads or the spark plug threads may get stripped out.

CAUTION: Dielectric grease does NOT conduct electricity. It does have excellent thermal properties and can be used on the porcelain section on spark plugs as well as on the rubber portion of the spark plug boots.

Do not put dielectric grease on any metal component such as the spark plug threads or the spark plug connector. An alternative is to use Copper Anti-Seize which conducts electricity and will reduce the potential for the spark plug threads seizing in the cylinder heads. The aluminum cylinder heads and the steel spark plug threads are dissimilar metals and will have a tendency to seize over long service intervals.

CAUTION: Be sure to torque plugs to the manufacturer's specification. Never install with an air tool.

NORMAL - This plug has been running at the correct temperature in a "healthy" engine. Operating in such a desirable environment results in deposits that will be light tan or gray in color with most grades of commercial gasoline.

OIL FOULED - A spark plug shorted by excessive oil entering the combustion chamber. This is often caused by piston rings or cylinder walls that are badly worn. Oil may also be pulled into the chamber because of excessive clearance in the valve stem guides, or badly worn valve stem seals. If the PCV valve is plugged or inoperative, or if the hose is clogged, it can cause a buildup of crankcase pressure. This condition can force oil and oil vapors past the rings and valve guides into the combustion chamber.

CARBON FOULED - Basically, soft, sooty carbon deposits, as shown below, have a dry, black appearance. If only one or two plugs in a set are fouled, it is a good practice to check for sticking valves, or bad secondary ignition wires. Fouling of the entire set might result from an incorrect heat range spark plug or an over-rich air/fuel mixture caused by a clogged air cleaner filter element. Fuel injectors that malfunction can also lead to this condition. Other causes include weak ignition system voltage or poor cylinder compression.

WORN - This spark plug shown has served its useful life and should be replaced. Voltage required to fire the plug has approximately doubled and will continue to increase the longer the engine operates.
Even higher voltage requirements (as much as 100%) above normal may occur when the engine is accelerated quickly. Poor engine performance and a loss of fuel economy are traits of worn spark plugs.

INSULATOR GLAZING - This condition may cause misfiring at high engine RPM. Shiny deposits usually suggest that temperatures have suddenly increased during hard acceleration. As a result, normal metallic deposits do not have a chance to slough off the plug and they melt and form a conductive coating which causes the misfire.

MECHANICAL DAMAGE - Mechanical damage to the firing end is caused by some foreign object in the combustion chamber. When working on an engine, it is advisable to keep the spark plug holes covered to prevent debris from entering the combustion chamber during service.

OVERHEATED - Note the dead white or gray insulator nose which appears "blistered." Electrode gap wear rate will be considerably in excess of that normally expected. This is often caused by overadvanced ignition timing, poor engine cooling system efficiency (scale, stoppages, low level), a very lean A/F mixture, a leaking intake manifold, or the use of a spark plug too hot for the application.

SPLASH FOULED -Can be caused by bad valve seals. Note how the center electrode is fouled on one side.

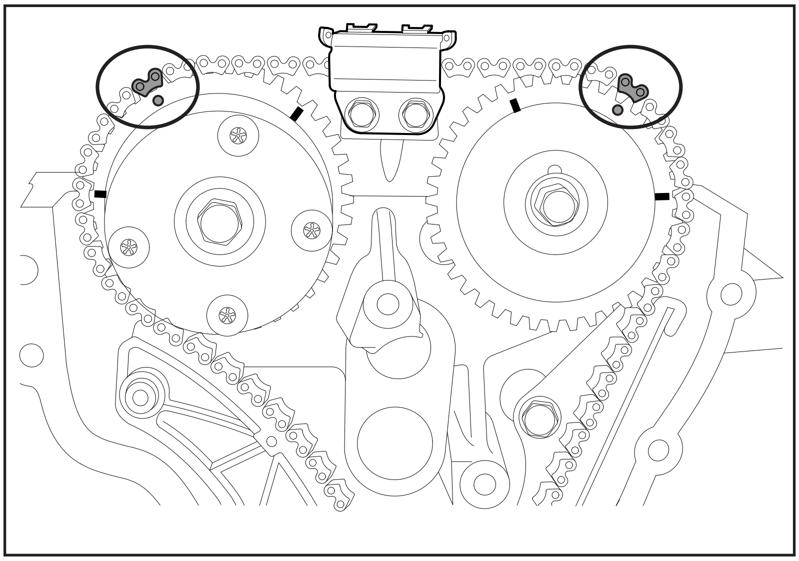
ASH FOULED -A buildup of combustion deposits comes from burning oil and/or fuel additives during combustion. These are normally nonconductive. However, when heavier deposits are allowed to accumulate over long mileage periods resulting in a plug misfire condition.

GAP BRIDGING - This rare condition is caused by combustion deposits thrown loose and are lodged between the electrodes, causing a dead short and misfire. Fluffy materials that accumulate on the side electrode may melt to bridge the gap when the engine is suddenly put under a heavy load.

PREIGNITION - This causes the center electrode and the ground electrode to melt. Preignition is caused by glowing combustion chamber deposits, hot spots in the combustion chamber due to poor control of engine heat, or ignition cross-firing between spark plug wires.

DETONATION - Can fracture the insulator nose of the spark plug. Explosions that occur when the operating condition exists apply extreme pressure on internal engine components. Major causes include a faulty EGR valve, lean air/fuel mixtures, ignition timing advanced too far, and insufficient octane rating of the gasoline.

SUMMARY



External systems can create engine mechanical concerns. As a Kia service technician, you should be able to demonstrate the knowledge required to accurately inspect external engine mechanical related customer concerns.

In this module, you have learned about the following external engine mechanical inspections:

- Timing Belt / Chain
- Continuously Variable Valve Timing
- Oil Control Valve
- Oil Control Valve Filter
- Oil Pan Inspection
- Spark Plug Analysis

PROGRESS CHECK QUESTIONS

1. Two technicians are discussing Kia engines.

   Technician A says that all Kia engines are non-interference engines.

   Technician B says that only the 1.8L on the Sephia/Spectra and 2.0L used on the early Sportage are non-interference engines.

   Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician

2. A technician is replacing a timing belt and has a discussion with another technician.

   Technician A says that you should rotate the crankshaft opposite normal engine rotation.

   Technician B says that a new tensioner may be needed, but if an old tensioner must be used that it must be compressed vertically.

   Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician

3. A vehicle pulls into a Kia Service Center with a Continuously Variable Valve Timing Concern.

   Technician A says that oil viscosity can affect CVVT operation.

   Technician B says that a clogged OCV filter could affect CVVT operation.

   Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician

PROGRESS CHECK QUESTIONS

4. Two technicians are discussing the removal and replacement of a CVVT unit on a Kia vehicle.

   Technician A says that the CVVT camshaft bolt must be torqued to specification or the camshaft locator dowel pin could damage the locator bore and set a P0300 DTC.

   Technician B says the camshaft must be fixed or secured while torquing the CVVT camshaft bolt.

   Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician

5. A vehicle is being serviced with new spark plugs.

   Technician A says that dielectric grease should be applied to the spark plug boots and the threads on the spark plug shell.

   Technician B says that it is best to install the spark plug with an air tool.

   Who is correct?

   A. Technician A only

   B. Technician B only

   C. Both Technician A and Technician B

   D. Neither Technician A nor Technician

NOTES:

NOTES:

TARGET AUDIENCE

The target audience for this module consists of Kia service technicians who diagnose vehicles with engine mechanical concerns.

MODULE GOAL

Completing this module prepares you to diagnose and troubleshoot engine mechanical concerns using the appropriate diagnostic tool.

MODULE OBJECTIVES

Upon completion of this module, you will be able to perform the task in each guided practice:

- Continuously Variable Valve Timing Inspection
- Valve Clearance Inspection
- Timing Belt / Timing Chain
- Oil Control Valve
- Oil Control Valve Filter
- Balance Shaft Alignment

MODULE INSTRUCTIONS

Carefully read through the material and take notes based on the classroom discussion. Throughout the module there will be activities for you to participate in.

REQUIRED MATERIALS

In order to complete this module, you will need the following items:

- Pen or Pencil
- Safety Glasses

TIME TO COMPLETE

Approximately 2 hours

GUIDED PRACTICE 1

Follow all shop safety rules.

Continuously Variable Valve Timing Inspection

1. Go to the CVVT station and locate the following components:
   - Air Hose
   - Air Nozzle with rubber tip
   - CVVT Unit mounted on camshaft
2. Find a GDS that is available and locate the CVVT Testing procedures for a 2008 Spectra (LD). Go to Engine Mechanical System > Cylinder Head Assembly > Repair Procedures. Carefully read and understand steps 1 - 6.
3. Connect the Air Hose to the air supply, and then connect the Air Nozzle to the Air Hose. Use the Air Nozzle to test the CVVT unit. If a camshaft is not available, then find the appropriate hole on the CVVT unit.

WARNING: Hearing protection may be recommended.

4. Does the CVVT unit rotate freely after the locking pin has been released? ______________________
5. If the CVVT unit does not rotate after the locking pin has been released, what could be the concern?

   ____

   ____

   ____
6. Return the components to the table and disconnect the Air Hose and Air Nozzle.

Instructor's Initials ____

GUIDED PRACTICE 2

Follow all shop safety rules.

Valve Clearance Inspection

1. Go to the cylinder head station which features the Spectra 2.0L (Beta Engine) cylinder head. Locate the following components:
   - Special Service Tool for turning the camshaft and clearancing the tappet
   - Feeler Gauge
   - Pick with magnet
   - Cylinder head from a 2.0L Spectra
   - Micrometer
2. Find a GDS that is available and locate the section that covers adjusting the intake and exhaust valves. Go to 2008 Spectra 2.0L > Engine Mechanical System > General Information > Repair Procedures. Carefully read and understand steps "A" through "I".
3. Measure and record the existing clearance. ______
4. Using the tools available, remove a shim for both the intake and exhaust.
5. Measure the shims. What is the thickness for both the intake and exhaust shims?
   - Intake ________________________________
   - Exhaust _______________________________
6. Use the Adjusting Shim Selection Charts on pages 4 and 5 for reference.
7. Are these shims within specification? __________
8. If they are out of specification, which shim is required to bring the clearance back into specification?

   ____
9. Reassemble the cylinder head and place the tools carefully on the workbench.

Instructor's Initials ____

Adjusting Shim Selection Chart (Intake)

Measured clearance mm (in.) \ Install shim thickness mm (in.)		2.00 (0.0787)	2.02 (0.0795)	2.04 (0.0803)	2.06 (0.0811)	2.08 (0.0819)	2.10 (0.0827)	2.11 (0.0831)	2.12 (0.0835)	2.13 (0.0839)	2.14 (0.0843)	2.15 (0.0846)	2.16 (0.0850)	2.17 (0.0854)	2.18 (0.0858)	2.19 (0.0862)	2.20 (0.0866)	2.21 (0.0870)	2.22 (0.0874)	2.23 (0.0878)	2.24 (0.0882)	2.25 (0.0886)	2.26 (0.0890)	2.27 (0.0894)	2.28 (0.0898)	2.29 (0.0902)	2.30 (0.0906)
0.000 - 0.020	(0.0000 - 0.0008)													1	1	1	1	1	2	2	2	2	3	3	3	3	4
0.021 - 0.040	(0.0008 - 0.0016)											1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4
0.041 - 0.060	(0.0016 - 0.0024)									1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5
0.061 - 0.080	(0.0024 - 0.0031)							1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5
0.081 - 0.100	(0.0032 - 0.0039)						1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6
0.101 - 0.119	(0.0040 - 0.0047)					1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6
0.120 - 0.280	(0.0047 - 0.0110)																										
0.281 - 0.300	(0.0111 - 0.0118)	3	4	4	5	5	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11
0.301 - 0.320	(0.0119 - 0.0126)	4	4	5	5	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11
0.321 - 0.340	(0.0126 - 0.0134)	4	5	5	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12
0.341 - 0.360	(0.0134 - 0.0142)	5	5	6	6	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12
0.361 - 0.380	(0.0142 - 0.0150)	5	6	6	7	7	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13
0.381 - 0.400	(0.0150 - 0.0157)	6	6	7	7	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13
0.401 - 0.420	(0.0158 - 0.0165)	6	7	7	8	8	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14
0.421 - 0.440	(0.0166 - 0.0173)	7	7	8	8	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14
0.441 - 0.460	(0.0174 - 0.0181)	7	8	8	9	9	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15
0.461 - 0.480	(0.0181 - 0.0189)	8	8	9	9	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15
0.481 - 0.500	(0.0189 - 0.0197)	8	9	9	10	10	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16
0.501 - 0.520	(0.0197 - 0.0205)	9	9	10	10	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16
0.521 - 0.540	(0.0205 - 0.0213)	9	10	10	11	11	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17
0.541 - 0.560	(0.0213 - 0.0220)	10	10	11	11	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17
0.561 - 0.580	(0.0221 - 0.0228)	10	11	11	12	12	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18
0.581 - 0.600	(0.0229 - 0.0236)	11	11	12	12	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18
0.601 - 0.620	(0.0237 - 0.0244)	11	12	12	13	13	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19
0.621 - 0.640	(0.0244 - 0.0252)	12	12	13	13	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19
0.641 - 0.660	(0.0252 - 0.0260)	12	13	13	14	14	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20
0.661 - 0.680	(0.0260 - 0.0268)	13	13	14	14	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20
0.681 - 0.700	(0.0268 - 0.0276)	13	14	14	15	15	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20		
0.701 - 0.720	(0.0276 - 0.0283)	14	14	15	15	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20				
0.721 - 0.740	(0.0284 - 0.0291)	14	15	15	16	16	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20						
0.741 - 0.760	(0.0292 - 0.0299)	15	15	16	16	17	17	18	18	18	18	19	19	19	19	20	20	20	20								
0.761 - 0.780	(0.0300 - 0.0307)	15	16	16	17	17	18	18	18	19	19	19	19	20	20	20	20										
0.781 - 0.800	(0.0307 - 0.0315)	16	16	17	17	18	18	19	19	19	19	20	20	20	20												
0.801 - 0.820	(0.0315 - 0.0323)	16	17	17	18	18	19	19	19	20	20	20	20														
0.821 - 0.840	(0.0323 - 0.0331)	17	17	18	18	19	19	20	20	20	20																
0.841 - 0.860	(0.0331 - 0.0339)	17	18	18	19	19	20	20	20																		
0.861 - 0.880	(0.0339 - 0.0346)	18	18	19	19	20	20																				
0.881 - 0.900	(0.0347 - 0.0354)	18	19	19	20	20																					
0.901 - 0.920	(0.0355 - 0.0362)	19	19	20	20																						
0.921 - 0.940	(0.0363 - 0.0370)	19	20	20																							
0.941 - 0.960	(0.0370 - 0.0378)	20	20																								
0.961 - 0.980	(0.0378 - 0.0386)	20																									

Measured clearance mm (in.) \ Install shim thickness mm (in.)		2.31 (0.0909)	2.32 (0.0913)	2.33 (0.0917)	2.34 (0.0921)	2.35 (0.0925)	2.36 (0.0929)	2.37 (0.0933)	2.38 (0.0937)	2.39 (0.0941)	2.40 (0.0945)	2.41 (0.0949)	2.42 (0.0953)	2.43 (0.0957)	2.44 (0.0961)	2.45 (0.0965)	2.46 (0.0969)	2.47 (0.0972)	2.48 (0.0976)	2.49 (0.0980)	2.50 (0.0984)	2.51 (0.0988)	2.52 (0.0992)	2.53 (0.0996)	2.54 (0.1000)	2.56 (0.1008)	2.58 (0.1016)	2.6 (0.1024)	2.62 (0.1031)	2.64 (0.1039)	2.66 (0.1047)	2.68 (0.1055)	2.70 (0.1063)	2.72 (0.1071)	2.74 (0.1079)	2.76 (0.1087)
0.000 - 0.020	(0.0000 - 0.0008)	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	11	11	12	12	13	13	14	14	15	15
0.021 - 0.040	(0.0008 - 0.0016)	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	12	12	13	13	14	14	15	15	16
0.041 - 0.060	(0.0016 - 0.0024)	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	12	12	13	13	14	14	15	15	16	16
0.061 - 0.080	(0.0024 - 0.0031)	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	13	13	14	14	15	15	16	16	17
0.081 - 0.100	(0.0032 - 0.0039)	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	14	14	15	15	16	16	17	17
0.101 - 0.119	(0.0040 - 0.0047)	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	14	14	15	15	16	16	17	17	18
0.120 - 0.280	(0.0047 - 0.0110)																																			
0.281 - 0.300	(0.0111 - 0.0118)	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	18	18	19	19	20	20				
0.301 - 0.320	(0.0119 - 0.0126)	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	19	19	20	20					
0.321 - 0.340	(0.0126 - 0.0134)	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	19	19	20	20						
0.341 - 0.360	(0.0134 - 0.0142)	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	20	20							
0.361 - 0.380	(0.0142 - 0.0150)	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	20	20								
0.381 - 0.400	(0.0150 - 0.0157)	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20									
0.401 - 0.420	(0.0158 - 0.0165)	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20										
0.421 - 0.440	(0.0166 - 0.0173)	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20											
0.441 - 0.460	(0.0174 - 0.0181)	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20													
0.461 - 0.480	(0.0181 - 0.0189)	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20															
0.481 - 0.500	(0.0189 - 0.0197)	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																	
0.501 - 0.520	(0.0197 - 0.0205)	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																			
0.521 - 0.540	(0.0205 - 0.0213)	17	17	18	18	18	18	19	19	19	19	20	20	20	20																					
0.541 - 0.560	(0.0213 - 0.0220)	18	18	18	18	19	19	19	19	20	20	20	20																							
0.561 - 0.580	(0.0221 - 0.0228)	18	18	19	19	19	19	20	20	20	20																									
0.581 - 0.600	(0.0229 - 0.0236)	19	19	19	19	20	20	20	20																											
0.601 - 0.620	(0.0237 - 0.0244)	19	19	20	20	20	20																													
0.621 - 0.640	(0.0244 - 0.0252)	20	20	20	20																															
0.641 - 0.660	(0.0252 - 0.0260)	20	20																																	

Intake valve clearance (Cold) :
0.20 mm (Spec.) 0.12 ~ 0.28mm (Limit)
Example : The 2.24 mm shim is installed, and the measured clearance is 0.450 mm. Replace the 2.24mm shim with a new No. 13 shim.

New shim thickness mm(in.)

Shim No.	Thickness		Shim No.	Thickness	
1	2.00	(0.0787)	11	2.40	(0.0945)
2	2.04	(0.0803)	12	2.44	(0.0961)
3	2.08	(0.0819)	13	2.48	(0.0976)
4	2.12	(0.0835)	14	2.52	(0.0992)
5	2.16	(0.0850)	15	2.56	(0.1008)
6	2.20	(0.0866)	16	2.60	(0.1024)
7	2.24	(0.0882)	17	2.64	(0.1039)
8	2.28	(0.0898)	18	2.68	(0.1055)
9	2.32	(0.0913)	19	2.72	(0.1071)
10	2.36	(0.0929)	20	2.76	(0.1087)

HINT : New shims have the thickness in miliimeters imprinted on the face

Adjusting Shim Selection Chart (Exhaust)

Measured clearance mm (in.) \ Install shim thickness mm (in.)		2.00(0.0787)	2.02(0.0795)	2.04(0.0803)	2.06(0.0811)	2.08(0.0819)	2.10(0.0827)	2.11(0.0831)	2.12(0.0835)	2.13(0.0839)	2.14(0.0843)	2.15(0.0846)	2.16(0.0850)	2.17(0.0854)	2.18(0.0858)	2.19(0.0862)	2.20(0.0866)	2.21(0.0870)	2.22(0.0874)	2.23(0.0878)	2.24(0.0882)	2.25(0.0886)	2.26(0.0890)	2.27(0.0894)	2.28(0.0898)	2.29(0.0902)	2.30(0.0906)	2.31(0.0909)	2.32(0.0913)	2.33(0.0917)	2.34(0.0921)	2.35(0.0925)	2.36(0.0929)	2.37(0.0933)	2.38(0.0937)	2.39(0.0941)	2.40(0.0945)	2.41(0.0949)	2.42(0.0953)	2.43(0.0957)	2.44(0.0961)	2.45(0.0965)	2.46(0.0969)	2.47(0.0972)	2.48(0.0976)	2.49(0.0980)	2.50(0.0984)	2.51(0.0988)	2.52(0.0992)	2.53(0.0996)	2.54(0.1000)	2.56(0.1008)	2.58(0.1016)	2.60(0.1024)	2.62(0.1031)	2.64(0.1039)	2.66(0.1047)	2.68(0.1055)	2.70(0.1063)	2.72(0.1071)	2.74(0.1079)	2.76(0.1087)
0.000-0.020	(0.0000-0.0008)																					1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	9	9	10	10	11	11	12	12	13	13
0.021-0.040	(0.0008-0.0016)																				1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	10	10	11	11	12	12	13	13	14
0.041-0.060	(0.0016-0.0024)																	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	10	10	11	11	12	12	13	13	14	14
0.061-0.080	(0.0024-0.0031)															1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	11	11	12	12	13	13	14	14	15
0.081-0.100	(0.0032-0.0039)													1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	11	11	12	12	13	13	14	14	15	15
0.101-0.120	(0.0040-0.0047)											1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	12	12	13	13	14	14	15	15	16
0.121-0.140	(0.0048-0.0055)									1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	12	12	13	13	14	14	15	15	16	16
0.141-0.160	(0.0056-0.0063)							1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	13	13	14	14	15	15	16	16	17
0.161-0.180	(0.0063-0.0071)						1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	14	14	15	15	16	16	17	17
0.181-0.199	(0.0071-0.0078)					1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	13	13	14	14	15	15	16	16	17	17	18
0.200-0.360	(0.0079-0.0142)																																																													
0.361-0.380	(0.0142-0.0150)	3	4	4	5	5	6	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	18	18	19	19	20	20				
0.381-0.400	(0.0150-0.0157)	4	4	5	5	6	6	7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	19	19	20	20					
0.401-0.420	(0.0158-0.0165)	4	5	5	6	6	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	19	19	20	20						
0.421-0.440	(0.0166-0.0173)	5	5	6	6	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	20	20							
0.441-0.460	(0.0174-0.0181)	5	6	6	7	7	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	20	20								
0.461-0.480	(0.0181-0.0189)	6	6	7	7	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20									
0.481-0.500	(0.0189-0.0197)	6	7	7	8	8	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20										
0.501-0.520	(0.0197-0.0205)	7	7	8	8	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20											
0.521-0.540	(0.0205-0.0213)	7	8	8	9	9	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20													
0.541-0.560	(0.0213-0.0220)	8	8	9	9	10	10	11	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20															
0.561-0.580	(0.0221-0.0228)	8	9	9	10	10	11	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																	
0.581-0.600	(0.0229-0.0236)	9	9	10	10	11	11	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																			
0.601-0.620	(0.0237-0.0244)	9	10	10	11	11	12	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																					
0.621-0.640	(0.0244-0.0252)	10	10	11	11	12	12	13	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																							
0.641-0.660	(0.0252-0.0260)	10	11	11	12	12	13	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																									
0.661-0.680	(0.0260-0.0268)	11	11	12	12	13	13	14	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																											
0.681-0.700	(0.0268-0.0276)	11	12	12	13	13	14	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																													
0.701-0.720	(0.0276-0.0283)	12	12	13	13	14	14	15	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																															
0.721-0.740	(0.0284-0.0291)	12	13	13	14	14	15	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																																	
0.741-0.760	(0.0292-0.0299)	13	13	14	14	15	15	16	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																																			
0.761-0.780	(0.0300-0.0307)	13	14	14	15	15	16	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																																					
0.781-0.800	(0.0307-0.0315)	14	14	15	15	16	16	17	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																																							
0.801-0.820	(0.0315-0.0323)	14	15	15	16	16	17	17	17	18	18	18	18	19	19	19	19	20	20	20	20																																									
0.821-0.840	(0.0323-0.0331)	15	15	16	16	17	17	18	18	18	18	19	19	19	19	20	20	20	20																																													
0.841-0.860	(0.0331-0.0339)	15	16	16	17	17	18	18	18	19	19	19	19	20	20	20	20																																																
0.861-0.880	(0.0339-0.0346)	16	16	17	17	18	18	19	19	19	19	20	20	20	20																																																			
0.881-0.900	(0.0347-0.0354)	16	17	17	18	18	19	19	19	20	20	20	20																																																						
0.901-0.920	(0.0355-0.0362)	17	17	18	18	19	19	20	20	20	20																																																										
0.921-0.940	(0.0363-0.0370)	17	18	18	19	19	20	20	20																																																														
0.941-0.960	(0.0370-0.0378)	18	18	19	19	20	20																																																																		
0.961-0.980	(0.0378-0.0386)	18	19	19	20	20																																																																						
0.981-1.000	(0.0386-0.0394)	19	19	20	20																																																																								
1.001-1.020	(0.0394-0.0402)	19	20	20																																																																									
1.021-1.040	(0.0402-0.0409)	20	20																																																																											
1.041-1.060	(0.0410-0.0417)	20																																																																													

Intake valve clearance (Cold) :
0.28 mm (Spec.), 0.20 ~ 0.38 mm (Limit)
Example : The 2.24 mm shim is installed, and the measured clearance is 0.450 mm. Replace the 2.24 mm shim with a new No. 11 shim.

New shim thickness mm(in.)

Shim No.	Thickness		Shim No.	Thickness	
1	2.00	(0.0787)	11	2.40	(0.0945)
2	2.04	(0.0803)	12	2.44	(0.0961)
3	2.08	(0.0819)	13	2.48	(0.0976)
4	2.12	(0.0835)	14	2.52	(0.0992)
5	2.16	(0.0850)	15	2.56	(0.1008)
6	2.20	(0.0866)	16	2.60	(0.1024)
7	2.24	(0.0882)	17	2.64	(0.1039)
8	2.28	(0.0898)	18	2.68	(0.1055)
9	2.32	(0.0913)	19	2.72	(0.1071)
10	2.36	(0.0929)	20	2.76	(0.1087)

HINT : New shims have the thickness in milimeters imprinted on the face

GUIDED PRACTICE 3

Follow all shop safety rules.

Timing Belt Service

1. Find the engine on a stand that is designated by your Instructor.
2. Find a GDS and get the Service Information for that engine. Typically, the information for servicing timing belts can be found under Engine Mechanical System > Timing System > Timing Belt > Repair Procedures.
3. Following the procedures listed in the Service Information, remove the timing belt.

CAUTION: Only turn the crankshaft in the normal operating rotation otherwise the timing may slip. Once removed, show the timing belt to the Instructor.

4. Reinstall the belt and compress the tensioner following the procedure in the Service Information.
5. When completed, ask the Instructor to review the timing belt installation.
6. Return the tools and the engine.

Instructor's Initials ____

GUIDED PRACTICE 4

Timing Chain Service

Follow all shop safety rules.

1. Find the engine on a stand that is designated by your Instructor.
2. Find a GDS and get the Service Information for that engine. Typically, the information for servicing timing chains can be found under Engine Mechanical System > Timing System > Timing Chain > Repair Procedures.
3. Following the procedures listed in the Service Information, remove the timing chain.

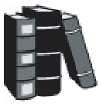
CAUTION: Only turn the crankshaft in the normal operating rotation otherwise the timing may slip. Once removed, show the timing chains to the Instructor.

4. Reinstall the chain and compress the tensioner following the procedure in the Service Information.
5. When completed, ask the Instructor to review the timing chain installation.
6. Return the tools and the engine.

Instructor's Initials ____

GUIDED PRACTICE 5

Oil Control Valve



Follow all shop safety rules.

1. Locate the vehicle recommended by your Instructor. Make sure you have a DVOM available.

2. Find a GDS and obtain information on the Oil Control Valve. Typically, it can be found under Fuel System > Engine Control System > CVVT Oil Control Valve > Repair Procedures.

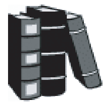
3. Test the resistance of the oil control valve with a DVOM. What was your reading? __________

4. Was your reading within specification? __________

Instructor's Initials ____

GUIDED PRACTICE 6

Oil Control Valve Filter



Follow all shop safety rules.

1. Using the GDS or computer lab, find the information to answer the blanks below.

   External - for external filters

   Internal - for internal filters

   Solenoid - for filters in the solenoid

2. 1.6L Rio JB ______________________________
3. 1.6L Soul AM ______________________________
4. 2.0L Spectra LD ___________________________
5. 2.0L Forte TD _____________________________
6. 2.4L Optima MG ___________________________
7. 2.7L Optima MG ___________________________
8. 3.3L & 3.8L Sorento BL _____________________
9. 3.5L Sorento XM ___________________________
10. 4.6L Tau Borrego HM _______________________
11. List the items that must be removed to service the internal filter?

    ____

    ____

    ____

    ____

12. List the items that must be removed to service the solenoid filter?

    ____

    ____

    ____

    ____

GUIDED PRACTICE 7

Balance Shaft Alignment (Belt)

Follow all shop safety rules.

1. Loosen the “B” belt tensioner for the balance shafts.

2. Remove the “B” belt from the engine. Once removed, show the “B” belt to the Instructor.

3. Find a GDS and get the Service Information for that engine. Typically, the information for servicing the balance shaft belt can be found under Engine Mechanical System > Timing System > Timing Belt > Repair Procedures.

NOTE: The access port on the side of the engine to align the balance shafts. Use a screwdriver or similar tool to keep the shafts aligned while installing the belt.

4. Reinstall the belt following the procedure in the Service Information.
5. When completed, ask the Instructor to review the balance shaft belt installation.
6. Return the tools and the engine.

Instructor’s Initials ____

GUIDED PRACTICE 8

Balance Shaft Alignment (Chain)

Follow all shop safety rules.

1. Find a GDS and get the Service Information for that engine. Typically, the information for servicing the balance shaft chain can be found under Engine Mechanical System > Timing System > Repair Procedures.

2. Remove the balance shaft chain and balance shaft module from the engine. Once removed, show both the chain and the balance shaft module to the Instructor.

3. Reinstall the chain and the module following the procedure in the Service Information.

5. When completed, ask the Instructor to review the balance shaft chain and module installation.

6. Return the tools and the engine.

Instructor's Initials ____

GUIDED PRACTICE 9

Follow all shop safety rules.

CVVT Activity

1. Hook up the GDS to the vehicle.

CAUTION: Always have the ignition off whenever you plug or unplug the oil control valve connectors or damage may occur to the computer.

2. Check the resistance of the oil control valve on the bench with a DVOM. Remove the Oil Control Valve (OCV) from the engine and check the resistance of the OCV on the work bench with a DVOM.
3. Find the resistance specification in the GDS and compare.
4. Connect the OCV to the connector in the harness (but do NOT install it in the vehicle). With the Key ON, Engine OFF - Use the GDS and perform an Actuation Test on the OCV unit. Is the unit jammed or does it operate as designed?

   ____

   ____

5. Reinstall the OCV and leave the connector UNPLUGGED. Using the GDS, find the Current Data values for "Camshaft Position - Target" and "Cam Actual Position" and graph them. Start the vehicle and gently cycle the engine between 1500 - 2500 several times.

   Record your values below:

   ____

   ____

6. Turn off the vehicle and reconnect the OCV connector. Make sure that the engine bay is clear and restart the engine. Monitor the same Current Data values as in Step 5 and gently cycle the engine between 1500 - 2500 several times.

   Record your values below:

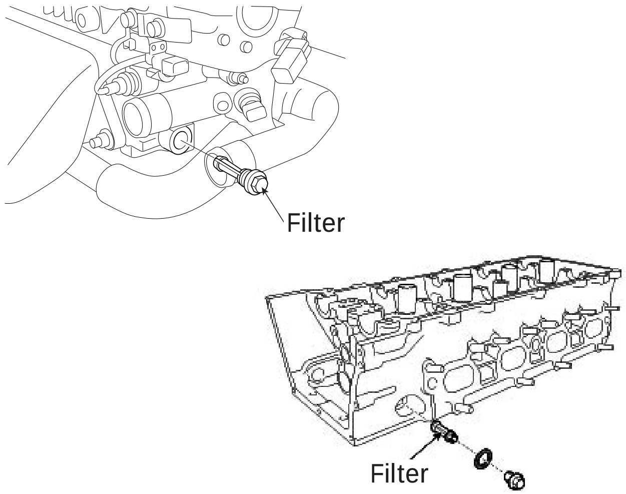
   ____

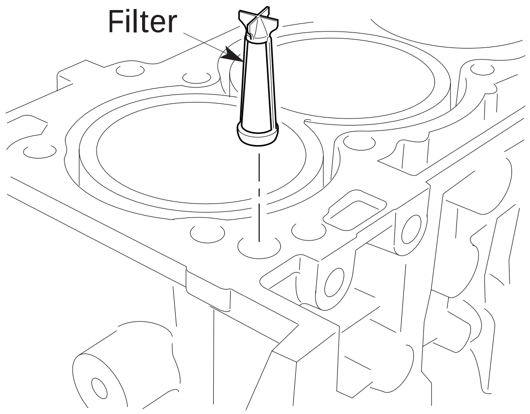
   ____

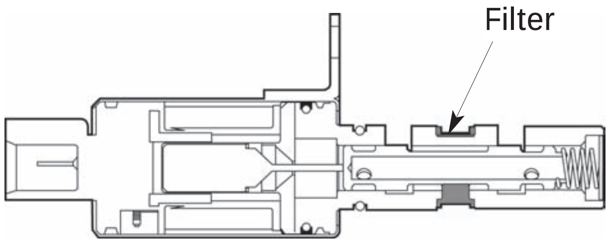
7. Clear all codes and reset your workstation.

Instructor's Initials ____

CVVT Filter Location







Exterior Cylinder Head

Rio JB	1.6L Alpha (II)
Soul AM	1.6L Gamma
Soul AM	2.0L Beta
Sportage KM	2.0L Beta
Spectra LD	2.0L Beta
Borrego HM	4.6L Tau

Between Cylinder Head & Engine Block

Forte TD	2.0L Theta II
Optima TF	2.0L Theta II
Optima MG	2.4L Theta
Rondo UN	2.4L Theta
Forte TD	2.4L Theta II
Sorento XM	2.4L Theta II
Optima MG	2.4L Theta II
Rondo UN	2.4L Theta II
Sportage SL	2.4L Theta II
Optima TF	2.4L Theta II

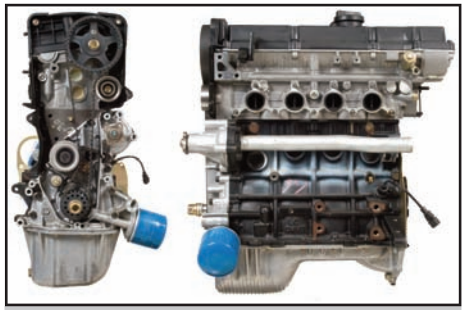
Built into the OCV Soleniod

Optima MG	2.7L Mu
Rondo UN	2.7L Mu
Sorento BL	3.3L Lambda
Sorento XM	3.5L Lambda II
Sedona VQ	3.8L Lambda
Amanti GH	3.8L Lambda
Sorento BL	3.8L Lambda
Borrego HM	3.8L Lambda

Kia Engine Family

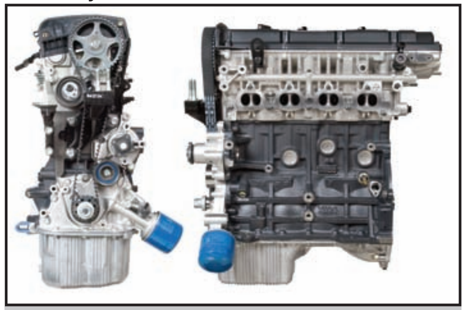
* Some earlier engine models may not be shown

KIA MOTORS

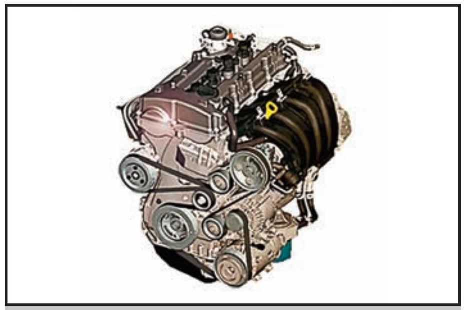


1.6L ALPHA & ALPHA II
2005 - 2009 Rio (JB) ALPHA
2010 - Present Rio (JB) ALPHA II

1.6L GAMMA
2010 - Present Soul (AM)

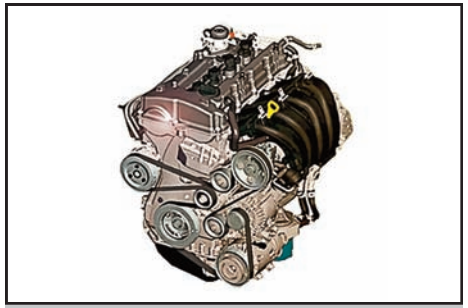


2.0L BETA
2004.5 - Present Spectra (LD)
2005 - Present Sportage (KM)

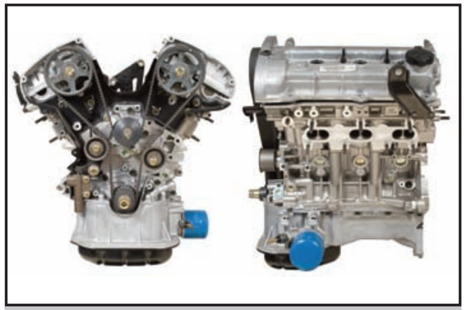


2.0L THETA II
2010 - Present Forte (TD)

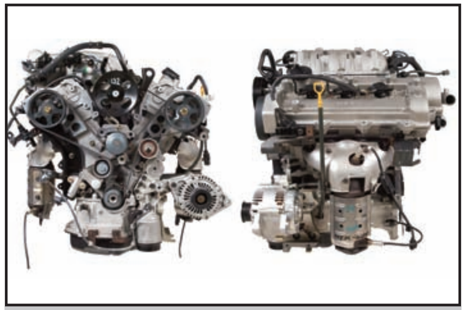
2.4L THETA
2006 - 2009 Optima (MG)
2007 - 2009 Rondo (UN)



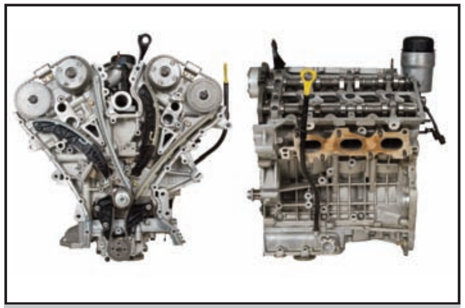
2.4L THETA II
2010 - Present Forte (TD)
2011 - Present Sorento (XM)
2010 - Present Optima (MG)
2010 - Present Rondo (UN)
2011 - Sportage (SL)



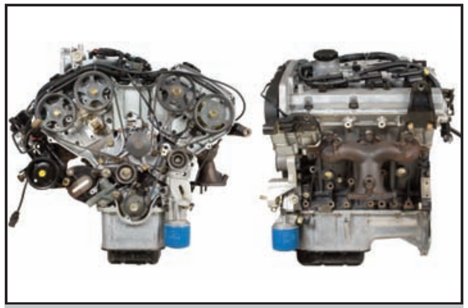
2.7L DELTA
2001 - 2006 Optima (MS)
2005 - 2010 Sportage (KM)



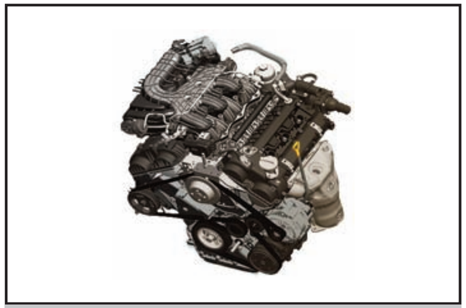
2.7L MU
2006 - Present Optima (MG)
2007 - Present Rondo (UN)



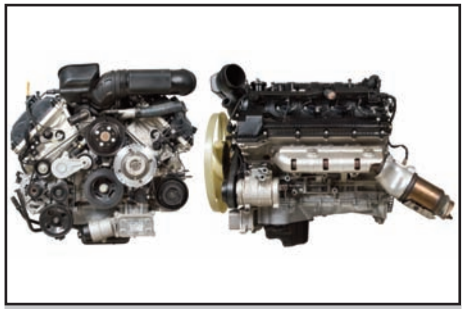
3.3L & 3.8L LAMBDA
2006 - Present Sedona (VQ) 3.8L
2007 - Present Amanti (GH) 3.8L
2007 - Present Sorento (BL) 3.8L
2009 - Present Borrego (HM) 3.8L
2007 - Present Sorento (BL) 3.3L



3.5L SIGMA
2002 - 2005 Sedona (GQ)
2003 - 2006 Sorento (BL)
2004 - 2006 Amanti (GH)



3.5L LAMBDA II
2011 - Present Sorento (XM)



4.6L TAU
2009 - Present Borrego (HM)

KIA MOTORS

Oil Pressure Test Port Locations

* All Tests are to be performed with engine oil at normal operating temperatures

1.6L ALPHA & ALPHA II
2005 - 2009 Rio (JB) ALPHA
2010 - Present Rio (JB) ALPHA II
12.8 PSI @ Idle

1.6L GAMMA
2010 - Present Soul (AM)
14.5 PSI @ 800 RPM

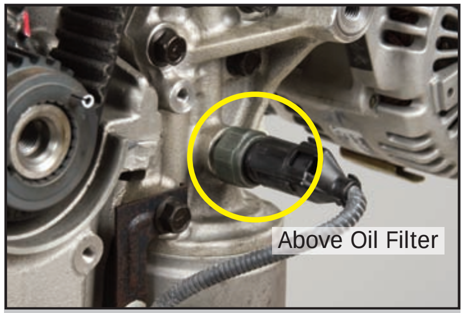
2.0L BETA
2004.5 - Present Spectra (LD)
2005 - Present Sportage (KM)
35.5 PSI @ 1500 RPM

2.0L THETA II
2010 - Present Forte (TD)
15.6 PSI @ 1000 RPM

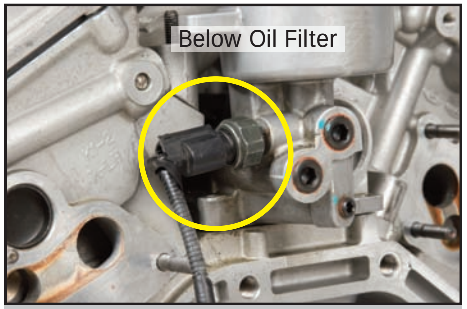
2.4L THETA
2006 - 2009 Optima (MG)
2007 - 2009 Rondo (UN)
24 PSI @ 1000 RPM

2.4L THETA II
2010 - Present Forte (TD)
2011 - Present Sorento (XM)
2010 - Present Optima (MG)
2010 - Present Rondo (UN)
2011 - Sportage (SL)
11.4 PSI @ Idle

2.7L DELTA
2001 - 2006 Optima (MS)
2005 - 2010 Sportage (KM)
11.4 PSI @ Idle

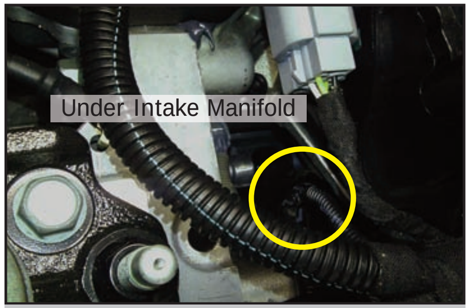


2.7L MU
2006 - Present Optima (MG)
2007 - Present Rondo (UN)
18 PSI @ 1000 RPM

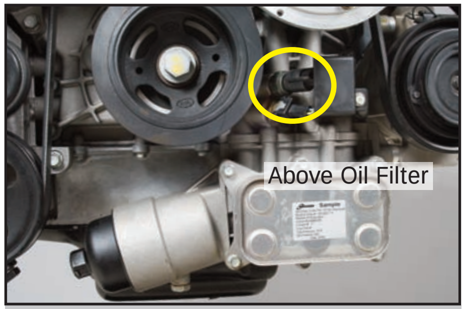


3.3L & 3.8L LAMBDA
2007 - Present Sorento (BL) 3.3L
2006 - Present Sedona (VQ) 3.8L
2007 - Present Amanti (GH) 3.8L
2007 - Present Sorento (BL) 3.8L
2009 - Present Borrego (HM) 3.8L
18.77 PSI @ 1000 RPM

3.5L SIGMA
2002 - 2005 Sedona (GQ)
2003 - 2006 Sorento (BL)
2004 - 2006 Amanti (GH)
11.6 PSI @ Idle



3.5L LAMBDA II
2011 - Present Sorento (XM)
18.77 PSI @ 1000 RPM



4.6L TAU
2009 - Present Borrego (HM)
50.76 PSI @ 6000 RPM

GROUP	MODEL
Engine	**See Below**
NUMBER	DATE
050	**August 2009**

TECHNICAL SERVICE BULLETIN

SUBJECT:

TORQUE SPECIFICATIONS ON "TORQUE TO YIELD" ENGINE COMPONENT BOLTS

This bulletin provides information on torque specifications for cylinder head, crankshaft, main & rod bearing cap bolts by means of torque-angle method, using a torque wrench and torque angle gauge. Information is provided for the following models:

Engine		Affected Models
Alpha	1.6L	Rio (JB)
Gamma	1.6L	Soul (AM)
Beta	2.0L	Spectra (LD), Soul (AM), Sportage (KM)
Theta	2.0L	Forte (TD), Optima (MG), Rondo (UN)
	2.4L	
Mu	2.7L	Optima (MG), Rondo (UN)
Delta	2.7L	Sportage(KM)
Lambda	3.3L	Sorento (BL)
	3.8L	Amanti (GH), Sorento (BL), Sedona (VQ), Borrego (HM)
Tau	4.6L	Borrego (HM)

CAUTION

Unless torque specifications are followed, further engine damage may occur, resulting in possible warranty charge back.

File Under: Engine

Circulate To: [X] **General Manager** [X] **Service Manager** [X] **Parts Manager** [X] **Service Advisor(s)** [X] **Technician(s)** [X] **Body Shop Manager** [X] **Fleet Repair**

SUBJECT: TORQUE SPECIFICATIONS ON "TORQUE TO YIELD" ENGINE COMPONENT BOLTS

Cylinder Head Bolts

Engine		Tightening Torque	Remarks
Alpha	1.6L	(21.7ft.lb) or (3.0kgf.m) + 90˚→ Loosen → (21.7ft.lb) or (3.0kgf.m) + 90˚	Under no circumstances should previously used cylinder head bolts be used again. Always install new.
Gamma	1.6L	(14.5ft.lb) or (2.0kgf.m) + 90± 5˚+ 100± 5˚	
Beta	2.0L	M10 bolt: (18.1ft.lb) or (2.5kgf.m) + 60~65˚+ 60~65˚ M12 bolt: (21.7ft.lb) or (3.0kgf.m) + 60~65˚+ 60~65˚	
Theta	2.0L	(25.3ft.lb) or (3.5kgf.m) + 90˚~95˚ + 90˚~95˚	
	2.4L		
Mu	2.7L	(18.1ft.lb) or (2.5kgf.m) + 60˚±2˚+ 45˚±2˚	
Delta	2.7L	(18.1ft.lb) or (2.5kgf.m) +60˚±2˚ + 45˚±2˚	
Lambda	3.3L	(28.9ft.lb) or (4.0kgf.m) + 120˚±2˚+ 90˚±2˚	
	3.8L		
Tau	4.6L	No.1~10 bolt: (25.3ft.lb) or (3.5kgf.m) + 90˚±2˚+ 120˚±2˚ **No.11~12 bolt: (24.6~26.8ft.lb) or (3.4~3.7kgf.m)**	Please note: There is no need to additionally tighten the bolt numbers **11** and **12** by torque angle. These are not torque to yield bolts. Refer to next page for bolts location and their sequence illustration.

Main Bearing Cap Bolt

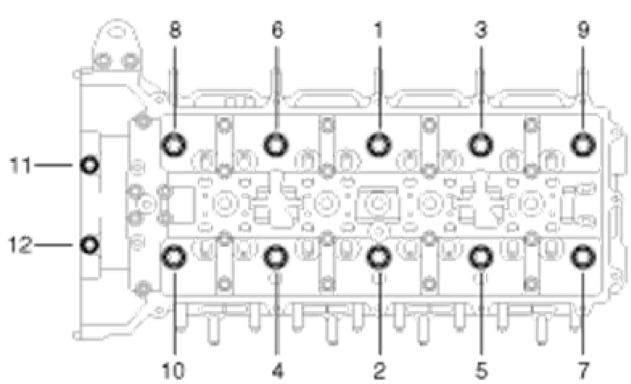
Engine		Tightening Torque	Remarks
Alpha	1.6L	(39.8~43.4ft.lb) or (5.5~6.0kgf.m)	Ok to re-use old bolt (This is not a torque to yield bolt).
Gamma	1.6L	(14.5±1.45ft.lb) or (2.0±0.2kgf.m) + 90˚±2˚	Under no circumstances, should previously used main bearing cap bolts be used again except 1.6L Alpha engine for which previous ones can be re-used.
Beta	2.0L	(21.7±1.45ft.lb) or (3.0±0.2kgf.m) + 60~64˚	
Theta	2.0L	(21.7±1.45ft.lb) or (3.0±0.2kgf.m) + 120~125˚	
	2.4L		
Mu	2.7L	M8 bolt: (11.6±2.17ft.lb) or (1.6±0.3kgf.m) + 90~95˚ M10 bolt: (21.7±2.17ft.lb) or (3.0±0.3kgf.m) + 90~95˚	
Delta	2.7L	M8 bolt: (11.6±2.17ft.lb) or (1.6±0.3kgf.m) + 90~95˚ M10 bolt: (21.7±2.17ft.lb) or (3.0±0.3kgf.m) + 90~95˚	
Lambda	3.3L	No.1~8 bolt: (36.2ft.lb) or (5.0kgf.m)+ 90˚, No.9~16 bolt: (14.5ft.lb) or (2.0kgf.m) + 120˚, **No.17~22 bolt: (21.7~23.2ft.lb) or (3.0~3.2kgf.m)**	Please note: There is no need to additionally tighten the bolt numbers **17-22** on Lambda engine and **21-35** on Tau engine. Refer to next page for bolts location and their sequence illustration.
	3.8L		
Tau	4.6L	No.1~20 bolt: (28.9 ±1.45ft.lb) or (4.0 ±0.2kgf.m) + 120˚ **No.21~35 bolt: (15.9~18.8ft.lb) or (2.2~2.6kgf.m)**	

SUBJECT: TORQUE SPECIFICATIONS ON "TORQUE TO YIELD" ENGINE COMPONENT BOLTS

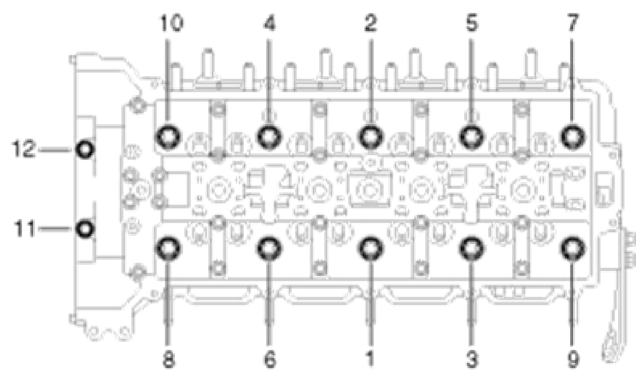
Connecting Rod Cap Bolts

Engine		Tightening Torque	Remarks
Alpha	1.6L	(23.1~25.3ft.lb) or (3.2~3.5kgf.m)	Ok to re-use old bolt (This is not a torque to yield bolt).
Gamma	1.6L	(14.5±1.45ft.lb) or (2.0±0.2kgf.m) + 90±2˚	Under no circumstances should previously used connecting rod cap bolts be used again except on 1.6L Alpha engine, as indicated above.
Beta	2.0L	(14.5±1.45ft.lb) or (2.0±0.2kgf.m) + 90±2˚	
Theta	2.0L 2.4L	(14.5±1.45ft.lb) or (2.0±0.2kgf.m) + 90±2˚	
Mu	2.7L	(14.5ft.lb) or (2.0kgf.m) + 90~94˚	
Delta	2.7L	(11.6~14.5ft.lb) or (1.6~2.0kgf.m)+ 90~94˚	
Lambda	3.3L 3.8L	(14.5±1.45ft.lb) or (2.0±0.2kgf.m) + 90±2˚	
Tau	4.6L	(18.1±1.45ft.lb) or (2.5±0.2kgf.m) + 100±2˚	

Cylinder head bolt configuration on 4.6L Tau engine

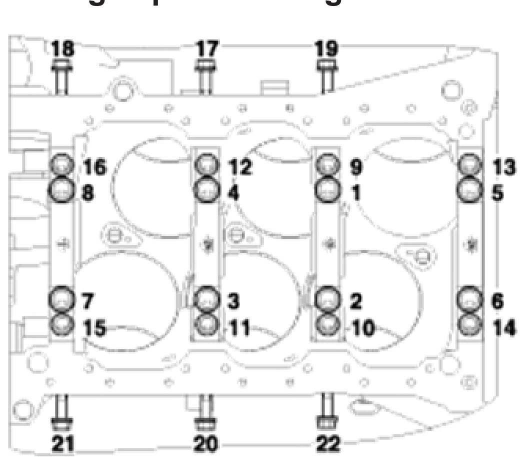


Left hand bank, bank 1

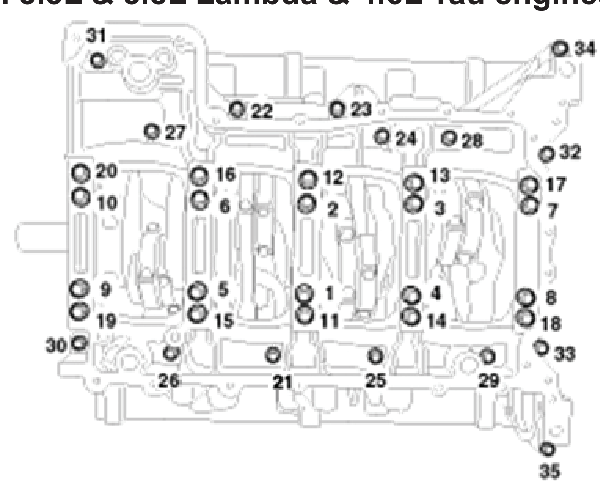


Right hand bank, bank 2

Main bearing cap bolt configuration on both 3.3L & 3.8L Lambda & 4.6L Tau engines



3.3L/3.8L Lambda Engine



4.6L Tau engine

KIA MOTORS The Power to Surprise®	GROUP **Engine Mechanical System**	MODEL **Sorento 2003-2006**
	NUMBER **PS035**	DATE **April 25, 2006**

PITSTOP TECHNICAL OPERATIONS

SUBJECT:

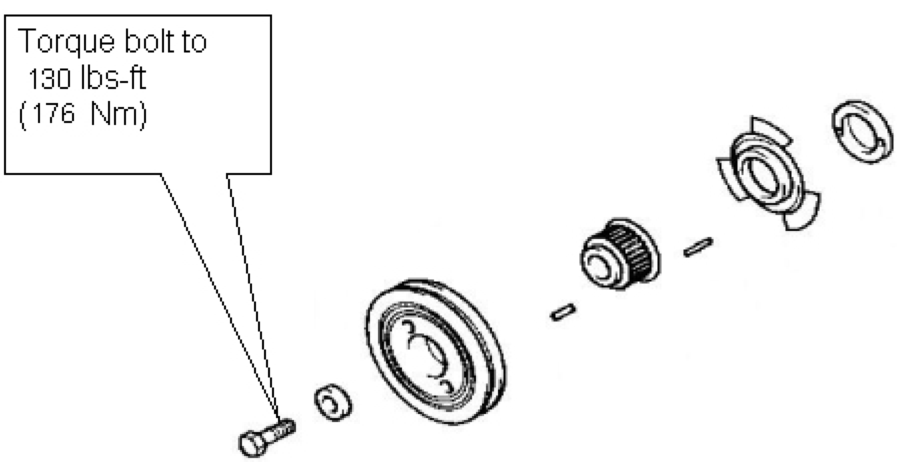
PITSTOP: 2003~2006 SORENTO CRANKSHAFT BOLT (3.5L) TORQUE GUIDELINES (UPDATED 2007-08-13)

REVISED PROCEDURE, (Supersedes all published articles)

KMA has received some questions regarding the proper torque of the Crankshaft Pulley Bolt. The bolt and washer should be replaced every time the bolt and washer are removed and **SHOULD NOT BE RE-USED.** This bolt and washer must torque to 130 lbs. ft. (176 Nm) by hand using a properly calibrated torque wrench. The flywheel must be held stationary while the bolt is being tightened. Under NO circumstances should the bolt be installed using an air impact gun!

Proper torque is essential for long term durability and increased customer satisfaction.

Part Name	Part Number	Hardware Color
Bolt-Crankshaft	23127 39801	Gold-->Silver
Washer	23126 32021	Black-->Silver



Spark Plug Analysis

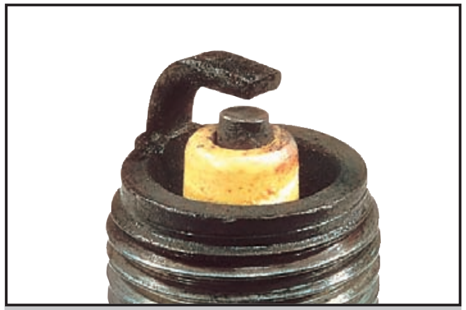
KIA MOTORS

NORMAL
Plugs operating in the correct temperature range results in deposits that will be light tan or gray in color.

CARBON FOULED
Check for sticking valves, bad ignition wires/coils, sticking fuel injectors, clogged air cleaner, or poor compression.

DETONATION
A faulty EGR valve, lean fuel trims, and insufficient octane rating of the gasoline can result in Detonation.

GAP BRIDGING
Combustion deposits thrown loose may lodge between the electrodes, causing a dead short and misfire.



INSULATOR GLAZING
Shiny deposits occurs when temperatures have suddenly increased during hard acceleration and form a conductive coating which causes a misfire.

ASH FOULED DEPOSITS
A buildup of combustion deposits from burning oil and/or fuel additives during combustion may cause a misfire.

PREIGNITION
Glowing combustion chamber deposits, hot spots from a faulty cooling system, or ignition cross-firing between spark plug wires are causes of Preignition.

OIL FOULED
Caused by excessive oil entering the combustion chamber by worn piston rings, scored cylinder, worn valve guides,worn valve stem seals, or a faulty PCV system.

OVERHEATING
The “blistered” appearance on the insulator can be caused by poor engine cooling system efficiency (scale, stoppages, low level), or an intake leak.

WORN
Poor engine performance and a loss of fuel economy are traits of worn spark plugs due to the increased voltage required to fire the plug.

SPLASH FOULED
Can be caused by bad valve seals. Note how the center electrode is fouled on one side.

MECHANICAL DAMAGE
Mechanical damage to the firing end is caused by a foreign object in the combustion chamber.

* Images courtesy of NGK and Champion Spark Plugs

Engine Troubleshooting

Engine Will Not Crank Over

KIA MOTORS

Condition	Cause	Correction
Won't crank	Battery connections	Check unswitched electrical components to see if they work Check to see if the headlights dim or go out when the ignition is cranked Check battery voltage of 12.4v or higher Jump the starter motor
	Weak battery	Check for 12.4v or higher, recharge if necessary Use Midtronics Battery Tester to determine battery condition
	Starter interruptions	Check for add on alarms or aftermarket accessories
	Starter solenoid or wiring	Check for power at starter solenoid, if none, then trace power supply If power is getting to the solenoid, then benchtest starter
Solenoid clicks but won't crank	Weak battery	Check for 12.4v or higher, recharge if necessary Use Midtronics Battery Tester to determine battery condition
	Battery cables corroded	Perform voltage drop at battery, check cables, replace cables as needed
	Starter worn or defective	Perform starter draw test under load, replace as needed - 1.6L Alpha > 118 ~ 130 Amps (Not Kia Service Information Data) - 2.0L Beta > 126 ~ 147 Amps (Tested on A/T vehicles, cold) - 2.4L Theta > 131 ~ 150 Amps - 2.7L Mu > 135 ~ 148 Amps - 3.3L & 3.8L Lambda II > 128 ~ 153 Amps
	Starter spins / engine won't turn	Check starter alignment, look for missing flywheel teeth Check to see the starter is secured to the proper torque specification
	Starter engages but stops	Remove spark plugs and check for coolant in the cylinders Check for a seized engine, manually turn over the engine to verify Inspect the engine for a cracked block or cylinder head Inspect timing chain assembly and rotate

Engine Troubleshooting

Engine Cranks Over But Will Not Start

KIA MOTORS

Condition	Cause	Correction
Engine seems to crank slow	Weak battery	Check for 12.4v or higher, recharge if necessary Use Midtronics Battery Tester to determine battery condition
	Battery cables corroded	Perform voltage drop at battery, check cables, replace cables as needed
	Starter worn or defective	Perform starter draw test, replace as needed
	Starter spins / engine won't turn	Check starter alignment, look for missing flywheel teeth Check to see the starter is secured to the proper torque specification
	Engine mechanical drag	Check for a tight engine
Engine seems to crank faster than normal	Engine mechanical concern	Check compression with a compression tester Check for internal damage with a borescope Use a leak down tester to check for poor cylinder sealing Check cam timing
Engine cranks normal but won't start	Cranking voltage	Perform an open-post voltage test for at least 10.5v while cranking
	Injectors not opening / no fuel	Check using artificial enrichment
	No ignition / spark	Check secondary ignition system Check CKP & CMP signals, reluctor wheel
	Camshaft and Ignition timing	Check for camshaft rotation Inspect timing belts for missing teeth
	Exhaust restriction	Check cranking vacuum at 3 - 6 inHG Disconnect catalytic converter and check flow Check for severe intake restriction

Engine Troubleshooting

Artificial Enrichment

Condition	Cause	Correction
Starts and dies with artificial enrichment	Fuel supply	Check for fuel in the tank (level, type, and condition)
	Faulty fuel pump	Use the GDS and perform an Actuation Test on the fuel pump Check the inertia switch or fuel cut switch, reset as necessary Check fuel pump relay and fuse
	Fuel pressure	Check fuel pressure Inspect fuel filter for blockage (fuel tank contamination)
	No injector pulse	Check wiring, grounds, and fuses
	Fuel injector clogged	Perform a fuel pressure drop test Perform top end engine clean
	Air restriction	Check for a severe intake restriction
	Exhaust restriction	Check cranking vacuum at 3 - 6 inHG Disconnect catalytic converter and check flow
Won't start with artificial enrichment	Ignition / Spark	Check secondary ignition system
	Camshaft and Ignition timing	Check for camshaft rotation Inspect timing belts for missing teeth
	Air restriction	Check for a severe intake restriction
	Exhaust restriction	Check cranking vacuum at 3 - 6 inHG Disconnect catalytic converter and check flow

Engine Troubleshooting

Engine Starts and Dies

Condition	Cause	Correction
Engine starts and dies cold	Cold start enrichment	Check coolant temperature sensor (Mode 6) Check injector flow
	Injector concerns	Perform wiggle test on wires Perform a fuel pressure drop test Perform top end engine clean
	Air restrictions	Check for a severe intake restriction
	Exhaust restriction	Check cranking vacuum at 3 - 6 inHG Disconnect catalytic converter and check flow
Engine starts and dies after a short period	Fuel pressure	Check fuel pressure Inspect fuel filter for blockage (fuel tank contamination)
	Exhaust restriction	Check cranking vacuum at 3 - 6 inHG Disconnect catalytic converter and check flow
Engine starts and runs poorly	Engine drivability concerns	Perform engine drivability diagnostics

Engine Troubleshooting

Misfire & Noises

Condition	Cause	Correction
Engine misfire with abnormal internal lower engine noises	Worn crankshaft bearings	Use chassis ears to confirm the lower engine noise. Perform oil pressure test to estimate excessive bearing wear
	Worn thrust bearings	Use a dial indicator to determine excessive crankshaft end play
	Worn piston rings	Perform a dry and wet compression test to determine leakage - Oil consumption may be the cause for the misfire
Engine misfire with valve train noise	Stuck valves	Inspect valves with a borescope for excessive carbon build up
	Worn or jumped timing	Check timing marks for alignment
Engine misfire with coolant consumption	Faulty head gasket Damaged cylinder head or engine block	Perform a leak down test and/or block check dye test - If the engine was overheated, then the cylinder head and block may need to be inspected for warpage.
Engine misfire with excessive oil consumption	Worn valves or valve seals	Use a borescope for excessive oil present in the intake runner
	Worn piston rings	Perform a dry and wet compression test to determine leakage
Engine noise on start up, but only lasting a few seconds	Incorrect oil viscosity	Check for maintenance and oil additives Replace oil with correct viscosity Perform an oil analysis to check for contaminates and oil viscosity
	Worn thrust bearing	Use a dial indicator to determine excessive crankshaft end play
Engine noise under load	Low oil pressure	Perform an oil pressure test Check for blockages and sludging
	Excessive bearing clearance	Perform oil pressure test to estimate excessive bearing wear

KIA MOTORS

Engine Troubleshooting

Misfire & Noises

Condition	Cause	Correction
Upper engine noise regardless of engine speed	Low oil pressure Damaged valve spring Worn or damaged lifters	Check oil pressure Isolate the noise with chassis ears or stethoscope Check valve lash
	Lifter or Fuel Injector	Perform Cylinder Balance Test - The noise will deaden when suspect cylinder is disabled
	Worn or faulty timing belt Damaged cam sprocket Worn timing tensioner	Inspect timing assembly Check timing belt tensioner
	Worn camshaft lobes	Perform a running compression test on the suspect cylinder
	Worn valve guides Stuck valves	Run a vacuum test using a vacuum gauge
	Worn drive belt, idler, tensioner, or bearing	Remove the drive belt to see if the noise goes away Inspect each components operation, bearing spins smoothly
Lower engine noise regardless of engine speed	Low oil pressure Worn rod / main bearings	Check oil pressure - Estimate excessive bearing wear Perform Cylinder Balance Test - The noise will deaden when suspect cylinder is disabled
	Loose / damaged flywheel	Remove access panel or starter motor and inspect, snug torque converter bolts to manufacturer specification
	Damaged oil pan Damaged oil pick up	Inspect the oil pan for damage Check oil pressure
	Worn pistons and rings	Perform a dry and wet compression test