STARTUNED®

Information for the Independent Mercedes-Benz Service Professional

February 2009 U.S. $6.00 € 12.50 Volume 9 Number 1

Pneumatic Door Locks

Secondary Air Systems

Timing Chains

Sub Frame R&R

Mercedes-Benz

TO OUR READERS

Welcome to *StarTuned*, the magazine for independent service technicians working on Mercedes-Benz vehicles. Your Mercedes-Benz dealer sponsors *StarTuned* and provides the information coming your way in each issue.

Mercedes-Benz wants to present the information you need to know to diagnose and repair Mercedes-Benz cars accurately, quickly and the first time; text, graphics, on-line and other technical sources combine to make this possible.

Feature articles, derived from approved company sources, focus on being useful and interesting.

Our digest of technical information can help you solve unanticipated problems quickly and expertly.

Our list of Mercedes-Benz dealers can help you find Genuine Mercedes-Benz Parts.

We want *StarTuned* to be both helpful and informative, so please let us know just what kinds of features and other diagnostic services you'd like to see in it. We'll continue to bring you selected service bulletins from Mercedes-Benz and articles covering the different systems on these vehicles.

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IN THIS ISSUE

StarTuned

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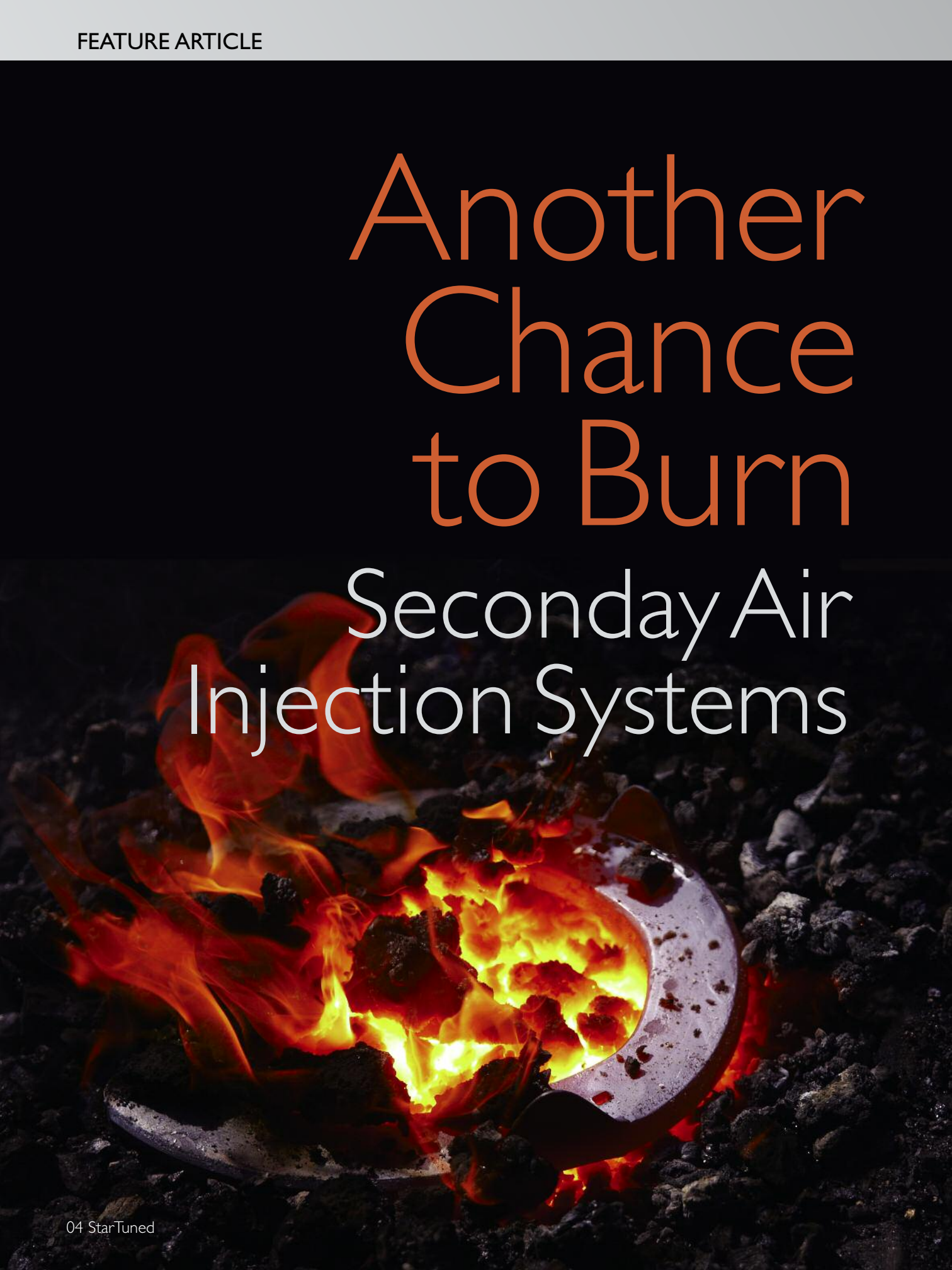
Another Chance to Burn

Seconday Air Injection Systems



Just like a blacksmith's bellows, the Mercedes-Benz AIS "fans the flames," promoting rapid oxidation of pollutants in the exhaust stream

Whether you believe technological developments are motivated by tightening government regulations, or by the desire to add value for new-car buyers, there's no doubt that they are coming along at an ever-increasing rate. Secondary air injection systems, however, have a long history – they've been fighting air pollution since the 1970s. Of course, they're way different today from what they were then.

Originally, a belt-driven pump forced air into the exhaust manifold to help oxidize escaping HC and CO. This was taken one step further when that air was used to feed the fire in the old two-way catalytic converter. In the early '80s when the three-way cat became popular, the air was piped into the cat downstream of the reduction section after the engine warmed up so that it wouldn't interfere with the reaction that broke down NOx, yet was available for the oxidation section.

Beltless

A modern Mercedes-Benz secondary AIS (Air Injection System) does away with that energy-wasting and space-hogging belt in

On V8 engines, the secondary air system is easy to test. Everything is right in front of you. Here we have the air pump, shut-off valves and switch-over solenoid, all nicely accessible.

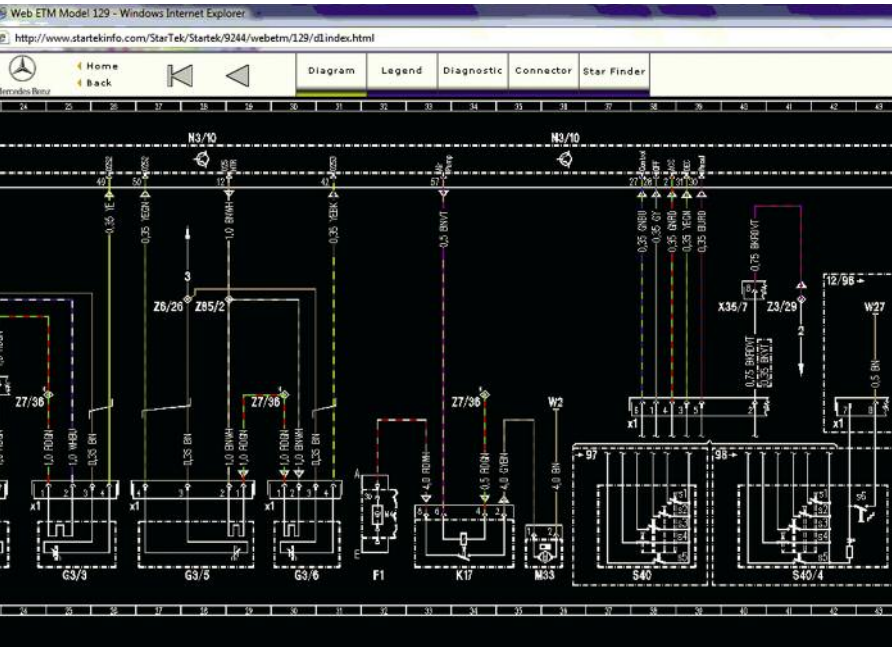
On supercharged models, the compressor generates the air that is supplied to the exhaust ports through this shut-off valve. Notice the solenoid mounted nearby that supplies vacuum to open the shut-off valve.

favor of an electrically-driven pump. This also allows much more precise control of airflow, which is necessary as emissions regulations continue to become stricter on both federal and state levels, and as the quest for improved fuel efficiency continues.

The secondary air pump motor is only activated when the engine is relatively cold – below 60 deg. F. It is only commanded on for up to two and a half minutes. This is sufficient to warm up the catalytic converters. The pump receives its power supply from the secondary air pump relay, which is operated by the ME control unit. The system is also activated during closed-loop operation, but only to test the system's ability to pump air into the exhaust – the ME control unit looks at the reaction of the O2 sensors.

There is one exception to this rule. Early 111 Evo engines (four-cylinder supercharged) do not use an electric pump. The ME control unit uses the supercharger to generate the necessary pressure/flow of fresh air to the exhaust. On models with an electronically-controlled "compressor" clutch, the clutch is activated at engine temperatures below 60 deg. F., and can be kept engaged for about two and one half minutes. On later 111 engines, there is no supercharger clutch, so the compressor is always spinning. The recirculation flap is held closed to allow the compressor to make the relatively small amount of air pressure/flow that the exhaust air injection requires.

When the secondary air pump motor is activated cold, or you cause it to activate, you can measure the amp draw of the pump. As you can see here, around 26 amps should be your reading with a normal motor. If it is lower, the pump portion is probably worn. If the amp reading is too high (fused 40 amps) the motor may be seizing up.



Your paid subscription to www.startekinfo.com allows you to pull up the wiring diagram for the engine management system. Look at components K17 (relay) and M33 (air pump motor), and you should be able to come up with a diagnostic plan to activate the relay and test the air pump.

Shut-off valve

From the pump, the air is directed to a shut-off valve. This valve is vacuum-controlled, and is normally closed to block exhaust gases from reaching the pump when the system is not energized. On four- and six-cylinder engines, there is only one shut-off valve, but there are two on eight- and twelve-cylinder models. When the system is active, a switch-over solenoid supplies vacuum to the shut-off valve(s). This solenoid is ground-controlled by the ME. Remember, with engine temperature below 60 deg. F. the switch-over solenoid is grounded, which supplies vacuum to the shut-off valves, opening them. Air is then supplied to the secondary air passages cast into the cylinder head and exits into the exhaust ports. This oxygen rich air mixes at the earliest point with the hottest exhaust gases and promotes continued combustion. The heat generated from this process in the exhaust manifold heats up the catalytic converter fast and therefore reduces overall emissions quickly.

Being an emissions control system, AIS must have self-diagnostic capabilities. So, has its own monitor. Both the secondary air pump and the switch-over solenoid are activated during a normal drive cycle. Once the pump supplies fresh air through the shut-off valve into the exhaust stream, the O2 sensors register the high oxygen content in the fresh air and this signal causes the ME control unit to assume that the engine is running lean. The ME's adaptation programming tries to compensate for the lean condition by adding fuel. The ME looks for a Lambda value change of 25%. If the change is less than 25%, the control unit determines that there is low flow of the secondary air injection system and flags a code of P0410, or one of its variants. This could be caused by no voltage to the secondary air pump, or a weak pump. An inoperable switch-over solenoid or a stuck shut-off valve can also cause codes. If all these components are functioning properly, you may still have the problem of blocked passages in the cylinder heads. How are you going to determine what's at fault?

Codes and testing

Since problems in the secondary air system usually do not cause drivability symptoms, you will probably be diagnosing a code in the P0410 range. The customer will more than likely bring in the vehicle with a CEL (Check Engine Light) or MIL (Malfunction Indicator Lamp) on. You are going to have to test components, and you are going to have to start somewhere. Having a Compact III or Basic is a tremendous help when

it comes to diagnosing any problem with a Mercedes-Benz system, but we believe you need to back up any scan tool diagnostics with direct component testing for verification.

Testing the pump is fairly simple. Remove the engine covers and provide power to the motor connector. You should hear a loud whirring noise. Whenever you compress air, even though filtered, you are going to condense water, especially in high-humidity climates. This moisture can get into the electrical portion of the motor and cause failures. This is why the motor is usually mounted on the engine. The heat should cause any built-up moisture to evaporate. The current draw of a good pump will be 25 to 26 amps. Any lower and you're probably not pumping much air, and anything higher and the motor is starting to seize.

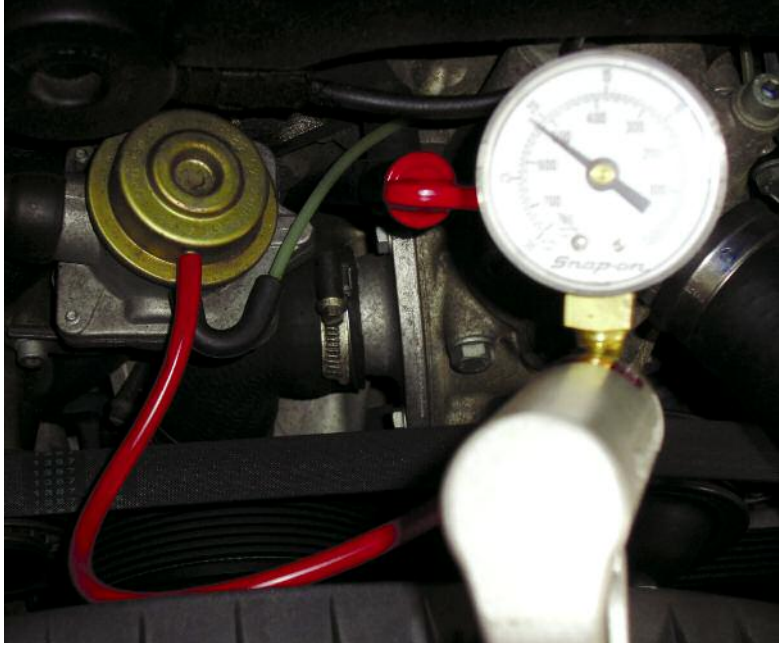
If you are lucky enough to have the vehicle overnight, you can verify the air pump relay operation. The pump power supply wire should see battery voltage within a few seconds of a cold start. This voltage can remain on for up to 150 seconds. If voltage is low or not there at all, you will need to locate the secondary air pump relay. You can manually ground the relay and see that voltage is supplied to the pump. With a paid subscription to www.startekinfo.com, you can retrieve a wiring diagram for the vehicle and component location using Star Finder. As mentioned earlier, the relay is controlled by the ME. With your Compact III or Basic, you can command the relay on even if the engine is already warmed up. Or, you can apply a test light to the ground control of the relay. You should hear the relay click and the pump run. The current draw of the relay is around 100mA. If this is not the case, verify that you have voltage to both the control coil and switched circuit of the relay.

If everything so far is in working order, you will want to test the switch-over solenoid and shut-off valves. The solenoid valve is controlled by the ME, so the Compact III or Basic scan tool will be able to activate the solenoid, or you can once again manually ground the solenoid with a grounded test light while the engine is running. You should measure manifold vacuum at the shut-off valves.

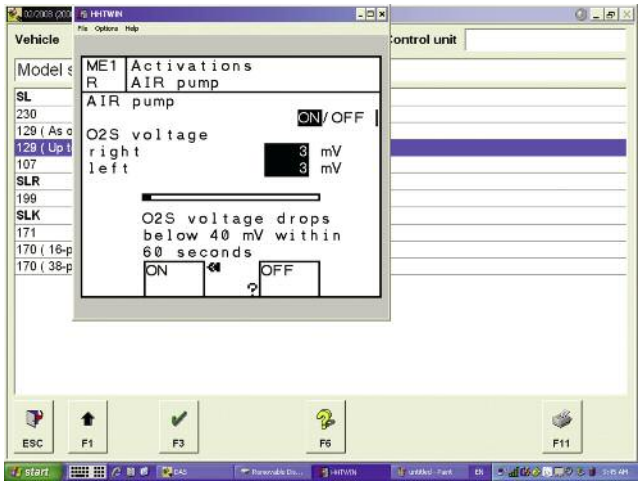
The switch-over solenoid receives manifold vacuum, and, when energized, directs this vacuum to the shut-off valve. You can energize this solenoid through the SDS software in your Compact III, or simply ground it with a test light and check for vacuum at the shut-off valve.

What does the O2 sensor say?

To test the shut-off valve, you can apply vacuum to it with a hand-held vacuum pump – it should hold. How will you verify that it is actually open? You could remove and physically watch for movement, but there are better methods. You can apply vacuum to the valve and watch the front (upstream) O2 sensor signal. It should drop to 0 mV with the secondary air pump commanded on and vacuum applied to the shut-off valve. If the O2 sensor reads a lean condition, but does not drop to zero, you can assume that the shut-off valve is working, but there may be an additional problem. The ME control unit looks for the Lambda (fuel trim) reading to compensate for the false lean condition by adding 25% more fuel. If the secondary air passages are clogged or restricted in the cylinder head, the O2 sensor will not see the false lean condition and as a result



You can apply vacuum to the shut-off valve and see if it holds. This should also open the valve. If you remove the hose from the air pump motor you should feel exhaust coming out of the valve while the engine is running.



Using your Compact III or Basic scan tool, you can perform a secondary air flow test while the engine is running. Even on older vehicles such as this 129 chassis, you can use the HHT software to command the secondary air system on and see the reaction of the O2 sensors.

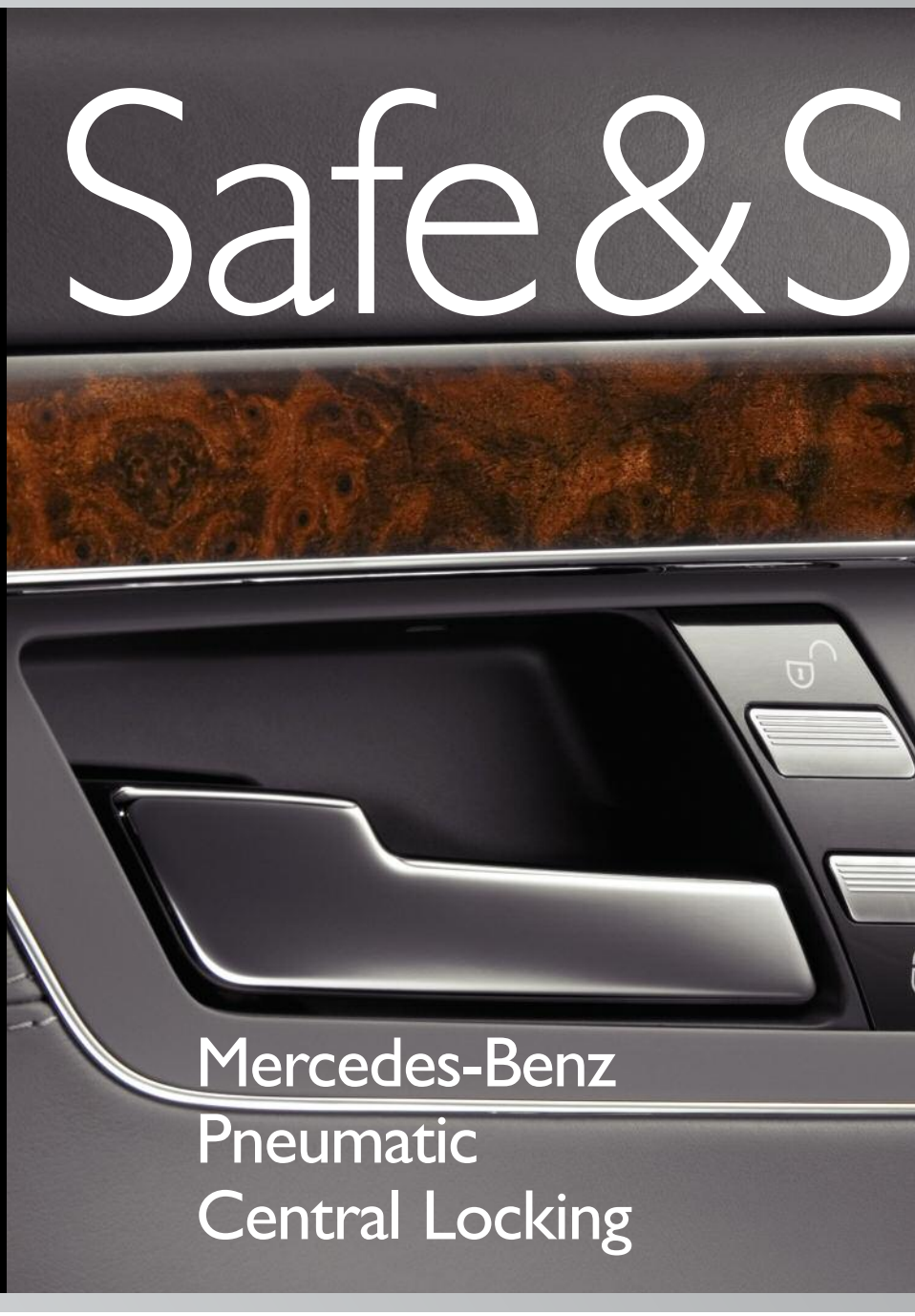
the ME will set a code for low secondary air flow. This is one of the more difficult problems to repair. Short of removing the cylinder head for a thorough cleaning, you will have to find a way to clear the carbon built-up in the intake passages.

With a little luck and some good chemicals you may be able to clear the passages in the cylinder head without removal. Remove the shut-off valves and pour a reasonable amount of cleaning solution down the ports. You can remove the exhaust manifolds and plug off the secondary air ports, but this is not necessary. You will have to let the cleaning solution sit over night. It also make take a few applications before the passages are clear, but after softening up the carbon in the ports, apply shop air pressure to the shut-off valve exhaust ports and you should be able to open up the passages. If not, the cylinder head will need to be removed for better access to the ports.

You can do it

Although pollution control devices add complexity to an engine's air/fuel/ignition management system, the above should serve to illustrate that as long as you understand how any part of that system works, you can follow a logical process to come up with an accurate diagnosis. That capability will make you popular among your customers. One more thing: Think about adding the passages of the AIS to any carbon-cleaning service you offer.

Safe&S



Mercedes-Benz Pneumatic Central Locking

Mercedes-Benz vehicles have always had some unique features. Along with reliability, longevity, safety and performance, they've helped make these engineering masterpieces some of the most sought-after vehicles in the world.

One unique feature introduced in the 1960s is the pneumatic central locking system, which, as the name implies, does not use the electro-mechanical actuators other manufacturers employ. Instead, it uses a combination of vacuum and pressure to move the door lock actuators quietly and dependably. It has withstood the test of time and continues to this very day. As with any unique system, however, there is a certain level of familiarity that is necessary in order to diagnose and repair the system.

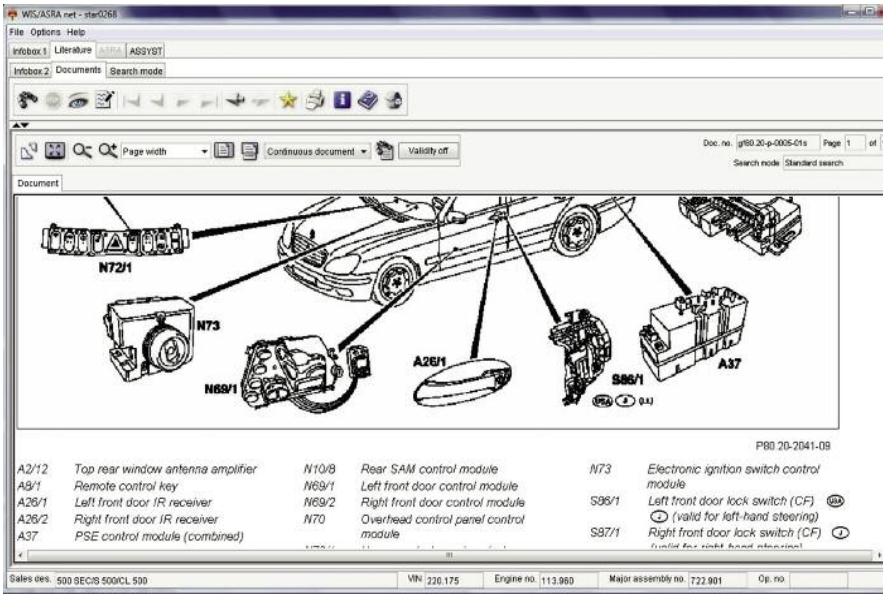
ecure

One of the convenience features used most by your customers is the central locking system. Years ago, M-B took a completely different approach to this by making it pneumatic instead of electrical

Historical Perspective

The earliest reference we can find to pneumatic central locking in Mercedes-Benz archives is from over 40 years ago. Back then, engine intake manifold vacuum stored in tanks did the locking, but the system soon evolved to use combination vacuum/pressure pumps to supply the force needed. From 1983 onward, the change from vacuum to pressure is accomplished by electrically reversing the rotation of the motor – negative control voltage for vacuum, positive for pressure. Previously, this had been done by means of a switching valve. A typical pump, by the way, should produce .5 Bar (7 psi) within two or three seconds.

With a paid subscription to www.startekinfo.com, you have access to WIS (Workshop Information System), which will allow you to pull up an operational schematic of the central locking system. This shows all the components involved in commanding the PSE module to lock/unlock the doors.



Pressure in the system is relieved in 15 to 20 seconds after the pump stops. If there's a heavy leak, the electronics that control it switch it off in 25 to 60 seconds.

Since about 1986, most M-B cars have had what's called the "multi-point" (also called "3-Point") system. If you're not sure what you're dealing with, go to the passenger's door and unlock. If all the other doors do the same, you've got multi-point. If not, either you're working on a car with the older single-point system (which unlocks only from the driver's door), or there's a problem. But since you've been presented with a complaint about this feature, you may be unable to get any action out of it whatsoever. That means you've got to dig deeper.

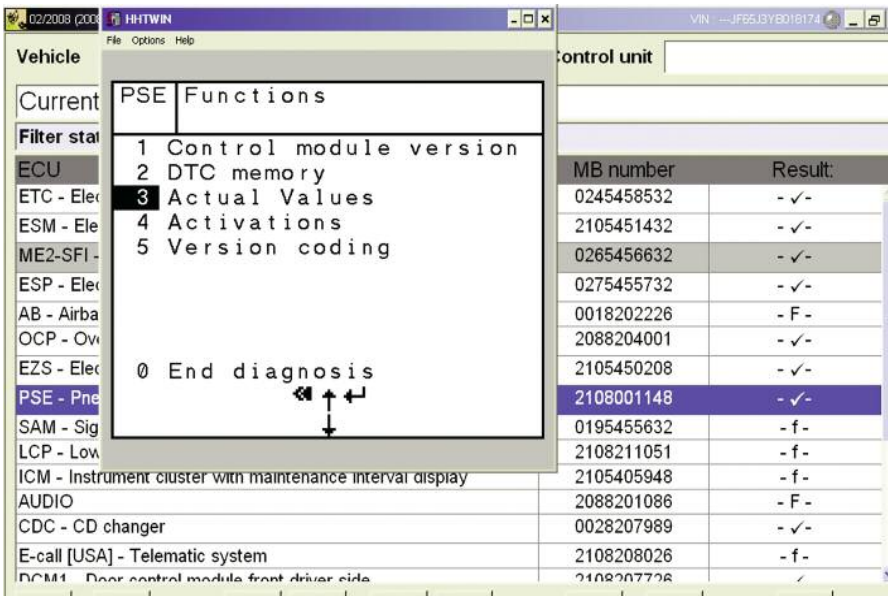
Around 1990, IRCL appeared, which meant the locking function could be operated by either the door lock switches, or an infra-red remote. The PSE (Pneumatic System Equipment) module received all of the inputs and outputs to command the door locks. By '96, the door switch contacts were eliminated, and the RCL (Radio Central Locking) module took control.

The integration of central locking with anti-theft and remote control systems evolved as the years went by, and is quite complex with dozens of variations. Since a magazine article cannot possibly provide all the details, you will definitely need www.startekinfo.com, and WIS for specific information on the model at hand. Here, we will cover the basic principles and significant additions to give you a roadmap. We'll offer one quick tip, however: If the vehicle has an EDW alarm system, you can disconnect the intermediate plug of the EDW cable harness from the connector (M14/1x2, or M14/2x2) and connect the central locking cable harness directly to the supply pump. If central locking works okay now, it's time to delve into the EDW.

PSE Modern System Operation

At the heart of the central locking system is the pneumatic control unit, which is in total control of the pneumatic portion of the system, and the vacuum/pressure pump is mounted inside it. It also plays a role in operating the Closing Assist (CA). The PSE module is usually mounted under the rear seat on sedans and in the trunk on smaller coupes. As the PSE module evolved, so have its inputs — more than just direct switch inputs command it.

Nylon hose is used to connect all of these components and route vacuum and pressure throughout the central locking and closing assist systems. These hoses direct vacuum/pressure from the PSE module to the individual door lock actuators. They have a single port on one side of a diaphragm. Supplying vacuum to it moves the actuator to either the lock or unlock position. Supplying pressure to the same port does the opposite. As you can imagine, this needs to be a “closed” system.



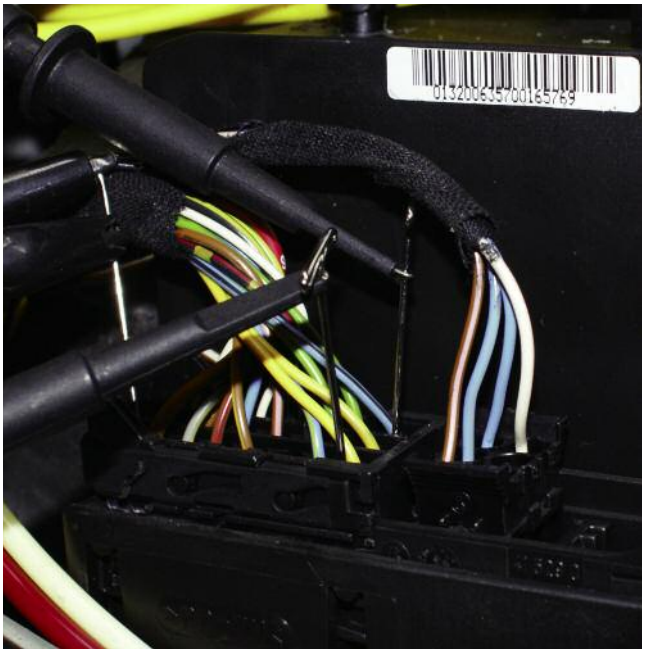
Your Compact III or basic scan tool can access data that includes version identification, diagnostic trouble codes, actual values, actuations and coding. This is an excellent way to check multiple switch inputs, even those from other control units, without having to test each individual circuit.

Any leaks can cause malfunction.

As mentioned, from the early '90s the PSE module received all of the inputs and outputs to command the door locks. Starting with the early versions, one of the basic commands to be seen by the PSE module are those from the left and right door switches, which are within the pneumatic actuators. Rotating the key in the door lock or actuating the lock button atop the door signals the PSE. There is one switch contact for the lock command and another for unlock, and they are wired together with the trunk lock switch. Any of these inputs can switch the signal voltage of the PSE module to ground. When the module sees this, it will either lock or unlock the doors. There are other switched inputs, but most of them are for determining door and trunk latch positions.

Later PSE modules have self-diagnostic capabilities. It can store codes and data even with systems as far back as HHT, which is incorporated into the Compact III SDS system. You can see multiple switched inputs at a glance. You can monitor the lock and unlock command switches in each individual latch, trunk tumbler, trunk lid position, individual door position and interior CL switches. Since there can be variations depending on vehicle options, the PSE module needs to be version coded if replaced. Some vehicles have CA (Closing Assist), others have RCL (Remote Central Locking) or CF (Comfort Lock system) options.

If the vehicle is equipped with Infra-Red (IR) remote



By monitoring the SN1 and SN2 signals, you can evaluate the command to the PSE module to both lock and unlock the doors. You do not need to use an oscilloscope to monitor these signals. A DMM will work fine. You are looking for a 12V signal on each of these wires.

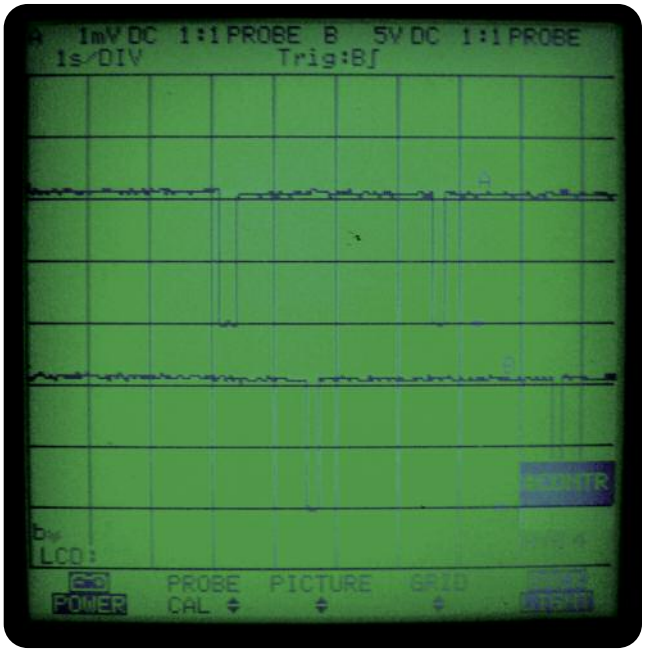
controls, there are some differences in the way the system works. The basic door lock/unlock switch signals are supplemented with door switch commands referred to as SN1 and SN2 signals, which originate in the Remote Central Locking (RCL) module. Either can command the doors to lock/unlock. By '96, the door switch contacts were eliminated. The RCL has taken over for these manual controls. This means the RCL is in control of the door locks and the signals to the PSE module have to be tested in order to determine if the PSE is working. These SN1 and SN2 signals are also passed on to the ATA (Anti-Theft Alarm) system to confirm that an acceptable remote opened the doors before the engine is allowed to start (as of '98 with SmarKey, engine starting is a seperate function from CL and ATA). Knowing this can be helpful in diagnosing the PSE function if it is not working. Open the driver's side window, close the hood, trunk and all the doors. Allow the vehicle's alarm to arm itself. Then, use the remote to open the doors. If the doors do not unlock, reach in through the window and try to start the engine. If it starts, you know the RCL signal made it to the ATA module and therefore must have made it to the PSE module. The module should have unlocked the doors. If the engine does not start, you may have a problem with the RCL system. Monitor the voltages on SN1 and SN2 and see if the 12V signals get pulled to ground for either the lock or unlock command.

A later evolution of the system is the Convenience Feature (CF). This integrated the operation of many body controls into one control unit, including power windows, power door locks and power sliding pop-up roof. The CF control unit directly controls the windows. Door locks are still controlled by the PSE unit, but it receives commands from either the door switches or the CF control unit. After '96 when the door switches were eliminated, the Drive Authorization System (DAS) radio frequency/Infrared (IR) control module took over commanding the PSE unit to operate the power door locks.

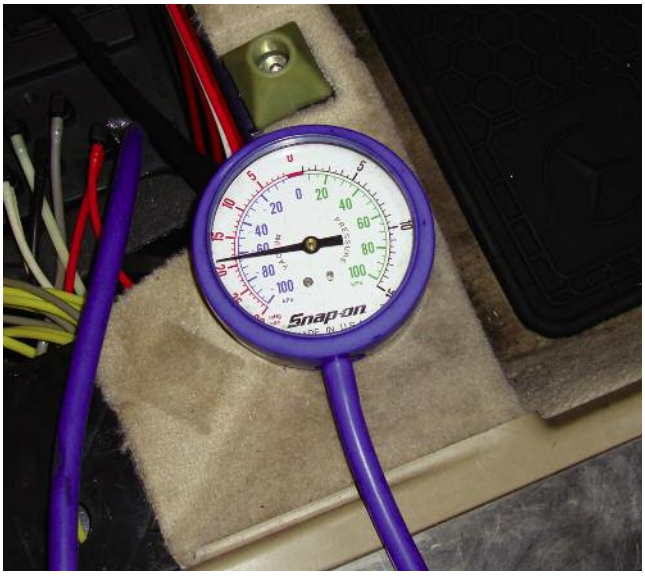
Another feature closely related to the PSE system is Closing Assist (CA), which uses its own separate control unit that is referred to as the CA supply pump. It is only used for locking, not for unlocking. The goal is to continue to close the door all the way after latch contacts the door jamb. A door microswitch indicates when the door is almost closed and this signals the CA system to supply vacuum/pressure to the CA actuators in the door latch assemblies.

Testing the System

If the pneumatic central locking system is not functioning properly, one of the first steps is to find out if there is a problem with the pneumatic system – the vacuum/pressure pump, nylon lines, or any of the three to five actuators – such as a leak, binding, or seizing. This can be done fairly easily at the PSE control module. You will notice a single large line



Looking at these signals on a dual trace scope allows you to see the lock command (upper trace) and unlock command (lower trace). As you can see, the 12V signal gets pulled to ground when the door locks are actuated, in this case by the RCL unit as the remote button is pushed to open and close the doors. The signals are there, but the pneumatic pump did not turn on. At this point, check for powers and grounds to the PSE unit. If they are good, replace the PSE module.



The PSE module contains its own vacuum/pressure pump. Vacuum is used to lock the door. You can monitor the vacuum supply with a gauge while commanding the system to lock. A good pump and pull almost 20 in. Hg.

The same line that supplies vacuum to the individual door lock actuators also supplies pressure. A good pump can produce almost 1.0 bar (14 psi). Of course, an air leak will decrease both vacuum and pressure.

coming out of the module and feeding one of two separate vacuum distribution hubs. The yellow one supplies both vacuum and pressure to the smaller yellow lines, which are the individual vacuum/pressure supply lines for the actuators. By removing this line and connecting a vacuum/pressure gauge, you can see if the pump is capable of generating the necessary vacuum or pressure. If the pump is okay, move on to the lines and actuators. If there is a vacuum leak here, none of the door lock actuators will move. If only one actuator will not move it could simply be bad, seized or leaking actuator, or its hose may be leaking or crimped. There are check valves throughout the system to isolate the problem line. Because of the way the lines are spread throughout the vehicle, looking for leaks can be one of your more difficult tasks.

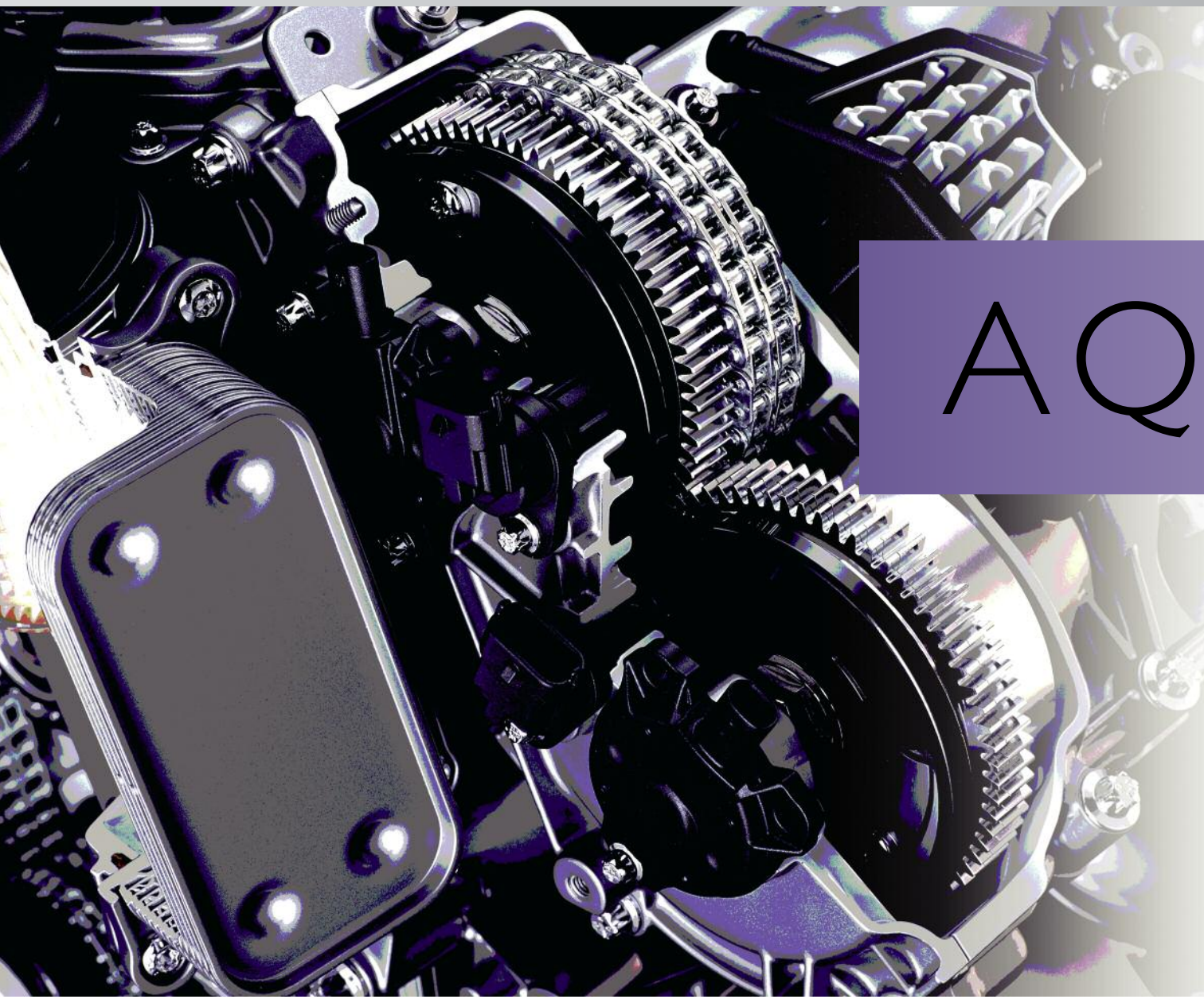
You could use a hand-held pump to see if you can build and maintain vacuum. Depending on the number of lines and actuators, this could take quite a few strokes. Another way of testing for leaks is one that you have used for testing intake manifolds and EVAP systems: the smoke machine. It is invaluable tool for pressurizing the pneumatic system with smoke and watching for where it leaks out.

Remember that there are check valves in the system and the pressure from your smoke machine may cause these valves to shut. Try keeping the pressure low.

Rounding Up

Although the PSE module is now integrated with multiple control units, the basic function of supplying vacuum and pressure can still be isolated and tested. Remember that there are exceptions to the rules. For instance, the 230 chassis has electro-mechanical door unlock solenoids that react faster than pneumatically controlled actuators. This is a requirement for the "Keyless Go" system since just touching a door handle will command the door to unlock.

All that is required to diagnose the pneumatic system properly is vacuum/pressure testing the lines for leaks, monitoring scan data through SDS for door, trunk and lock position, and backing up these steps with actual testing of the wiring at the PSE module. Isolating the PSE system makes the diagnosis and testing easier and allows you to provide your customers with the safety and security they deserve.



AQ

Mercedes-Benz timing chains and tensioners last and last. But, given the tremendous number of miles people put on these vehicles, they will need attention sooner or later

uestion of Timing

In order for a four-cycle engine to work, there must be precise coordination among the intake, compression, power and exhaust strokes. Advances in engine technology have helped increase performance throughout the rpm range. Variable intake manifold runners optimize air intake velocity, variable valve timing has broadened the power band, and variable lift further fine-tunes air intake and exhaust flow for even greater performance, efficiency and economy. Regardless of how high-tech intake and exhaust events have become, maintaining basic cam/crank timing remains essential.

Keeping Time

Mercedes-Benz vehicles have always excelled in sound engineering and reliability. From Formula 1 to Indy cars, Mercedes-Benz engines have always been in the top tier. The same engineering principles that are used to create a reliable race engine are also used for production vehicles. One steadfast belief held by the company's engineers is in the reliability of the timing chain. The valve trains found in large six cylinder, V8 and twelve cylinder engines naturally have more mass to move than those of little fours. This puts undue stress on the camshaft drive mechanism, making a timing belt marginal, and making replacement at regular intervals necessary. On the other hand, in a properly-maintained vehicle timing chains and related hardware can last well over 200,000 miles. Eventually, however, wear will reach the point where diagnosis and replacement will be needed, so you have to know how to perform the job properly. This is usually not too difficult a task providing you had the correct tools, and any shop specializing in Mercedes-Benz vehicles should have such items as a chain pin remover/installer.

First Scenario

Typically, you will need to deal with the timing chain because of noise from a stretched chain or weak tensioner, or because the cylinder head must be removed for whatever reason. Either way, the timing chain has to be removed and put back into proper synchronization upon reassembly. In the case of noise, the job is not as daunting as you may think. Mercedes-Benz has service procedures that make this a relatively simple task. Many Mercedes-Benz engines have the timing cover cast as one unit with the block, so the cover cannot be removed to access the timing chain.

Continued on page 20

Genuine Mercedes-Benz Remanufactured A/C Compressors

Why Buy Genuine?

Replace — We replace more parts than aftermarket brands.

Engineered — Designed to meet original OEM drawings.

Manufactured — Made with same OE components as factory parts.

Assembled — Completely assembled from components and not just repaired.

New — Tested to new unit standards.

Quality, Reliability and Value

The quality, reliability and value of the Genuine Mercedes-Benz Remanufactured A/C Compressor wasn't meant to be taken lightly. It is not only an exact replacement for the original unit, it's also remanufactured and tested to meet the same strict specifications as the original, so it performs just as well. And like all remanufactured parts, it's covered by the Mercedes-Benz limited parts warranty.* In fact, the only detectable difference you'll find between a Genuine Mercedes-Benz Remanufactured A/C Compressor and a new one is the price. Which we're sure you'll find quite refreshing.

It's All In the Process

Remanufacturing Process (Genuine Mercedes-Benz)

1. Dismantle core and clean all components.
2. Replace key components 100% with new OE part.
3. Test all other critical components.
4. Replace components that do not meet specs.
5. Assemble, test and box.

Rebuilt Process (Typical Aftermarket)

1. Identify damaged part or parts.
2. Replace damaged part with non-OE part and clean.
3. Re-assemble, test and box.

*See your Mercedes-Benz dealer for details and a copy of the Mercedes-Benz Spare Parts Limited Warranty.

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DENSO

Available only through your local Mercedes-Benz Dealer

Mercedes-Benz

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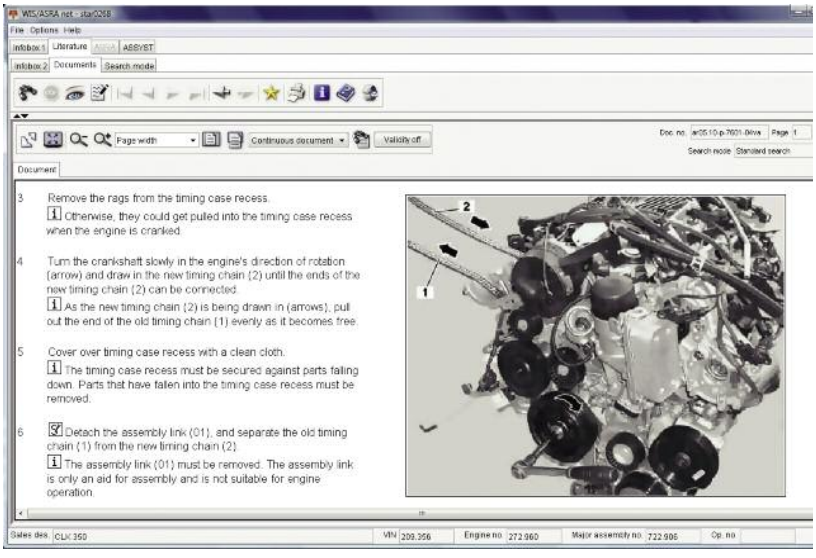

Your paid subscription to www.startekinfo.com will allow you to access WIS documents. Here the correct step-by-step procedures are laid out for you. You are also linked to pages that let you know what special tools you will need. The procedure for drawing in the new chain is pictured here.

There is a straightforward procedure, however, that makes replacement possible anyway. The first step is to remove the valve covers. Also remove the spark plugs to make it easier to turn the crankshaft by hand. You may want to start with the engine at TDC, it's not really necessary. In most Mercedes-Benz "Checking Engine Timing" procedures, you are asked to rotate the crankshaft to a specific point on the pulley. This is usually not TDC, but a specific degree mark past TDC. If you are so inclined, you can apply paint marks on the cam gears and adjacent marks on the timing case cover to check your work once you have changed the timing chain.

The next step is to use the chain separating tool to force out the two pins of one outer link. This will break the chain and leave two sides of inner links exposed. Install a service master link on the chain leading into the upper portion of the engine. Use one pin to attach this link to the upper side of the chain currently installed in the engine. Connect the other half of the service master link to the new replacement chain. You should now have one long continuous chain half installed in the engine. Grab the lower half of the old timing chain coming up from crankshaft toward the passenger side camshaft and pull. While doing this, rotate the crankshaft pulley clockwise. This will draw in the chain. It is critical not to rotate the engine counter-clockwise at any point in the repair. If you do, the chain tensioner

On this 111 engine, if the camshafts are in their home position you will be able to install a cam positioning tool in the backs of the cam sprockets. The screwdriver indicates the location of one of the holes (intake cam). Notice how the intake and exhaust cam lobes are facing one another. This gives you a ballpark idea that you have the timing close.

Should the going get a little rough

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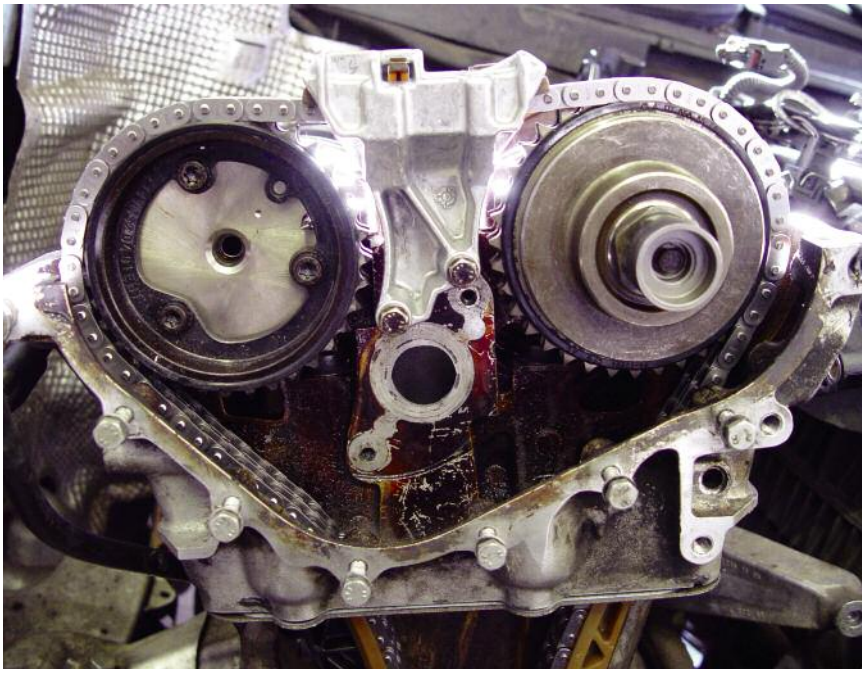


Look at the intake cam on the right and you can see the camshaft timing adjuster. Since the engine rotates clockwise, you need to turn the adjuster counter-clockwise all the way until it stops, then engage the timing chain.

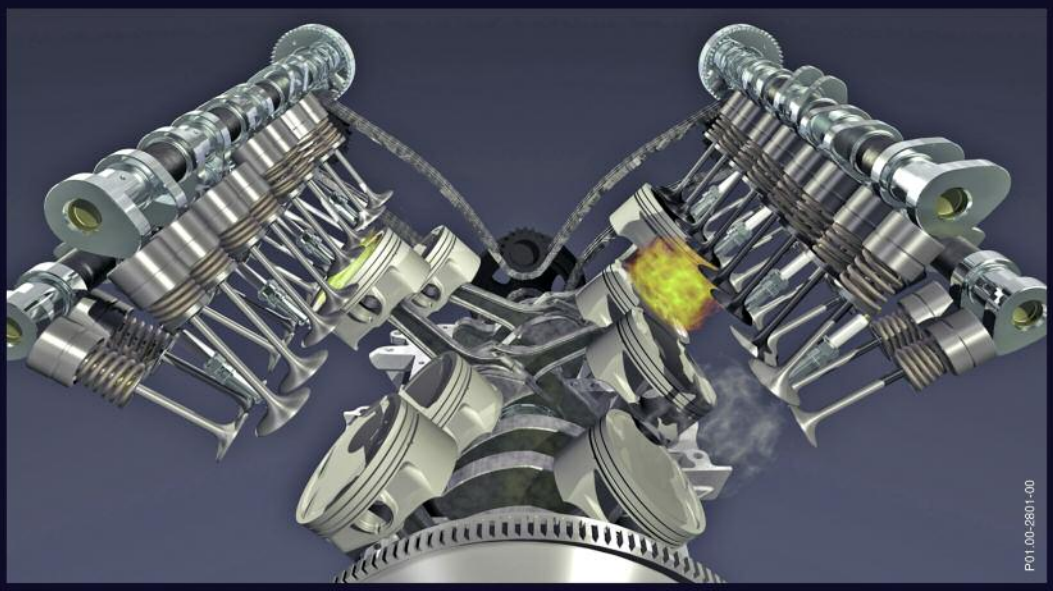
will collapse and probably allow the chain to jump teeth on one of the sprockets, thus throwing off valve timing. If you continue to rotate the engine clockwise you will eventually draw in the entire section of new double-roller chain and once again see the service master link.

At this point, you must remove the service master link as it is only intended to be used during service. Install the permanent link with a chain link pin installer. The tensioner may be pushing on the chain hard enough as it comes up from the crankshaft that the two ends won't meet. So, you can loosen the tensioner to help with the installation of the permanent link. Don't take the tensioner out all the way as this may allow enough slack for the chain to jump time. The permanent link outer plates need to be installed and a chain rivet installer must be used to stake down the roller pins just like those of the other links. Rotate the engine several times by hand and watch for your paint marks to be sure valve timing is correct.

At this point it should be safe to remove the tensioner and either install a new one or reset the old one. Resetting the tensioner is critical. As you ran the new chain in and the old one out, the tensioner's spring pushed outward to take up the slack in the chain. If you were to leave it in this position, the chain would be far too tight. In severe cases, this can snap off a cam sprocket! To reset the tensioner, remove the center cap with a hex key socket, and the pre-load spring will fall out (watch out for the aluminum sealing washer). These are hydraulically-assisted tensioners that require engine oil pressure to add tension as engine rpm rises. The pre-load spring pushes on a piston that in turn pushes on the chain tensioner guide. The piston ratchets outward to apply tension. Once it ratchets out, it will not return even with the spring removed. So, remove the whole body of the tensioner, pull the piston out and away from the pre-load spring cap.

Now you can mount the body of the tensioner into the timing case cover, making sure the aluminum sealing washer is properly installed. Put the piston into the opening of the tensioner body followed by the pre-load spring, then install the cap over the spring and thread the cap into the tensioner body. Some force will be required to compress the spring, which is necessary to keep the chain tight enough for start-up. Once the engine is running, oil pressure does the job. That's why it's important to replace both aluminum sealing washers even if you're reusing the old tensioner. By the way, when ordering a new tensioner you should be aware that it does not come with the threaded cap, so you will need to use the cap from the old one.

FIRE...



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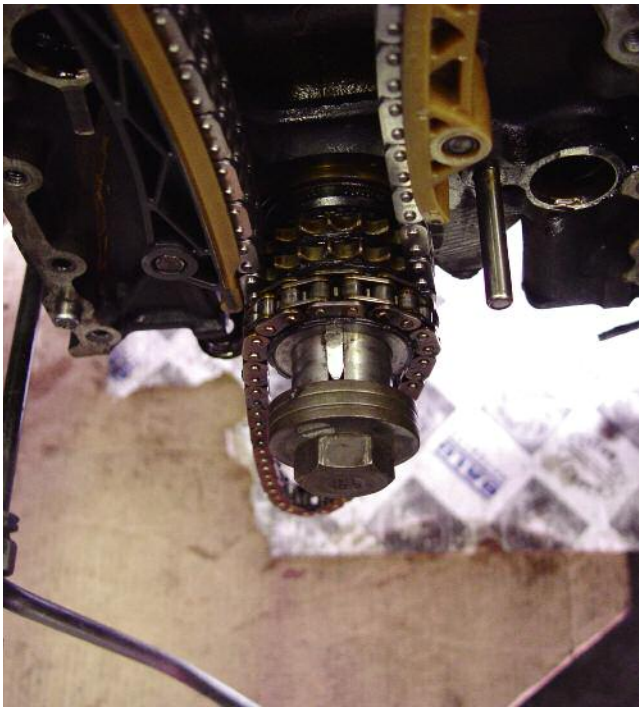

Mercedes-Benz usually times its engines at a position other than TDC. In the case of this 111 engine, the timing pulley should be set to 20 deg. after TDC. This puts the keyway in the crankshaft at just about the 12 o'clock position. Now, you should be able to line up the cams.

Second Scenario

If more extensive service work such as a cylinder head R&R is performed, it may be easier to simply remove the timing chain as one unit. Start by removing the tensioner. You can then remove either the camshaft timing sprockets, or the camshafts themselves, depending on the particular engine. For instance, on the M272 motor the timing chain only drives the intake cam, which then drives the exhaust cam by means of gears. In this case, the cams will have to be removed to access the timing chain. Drop the oil pan to access the crankshaft sprocket and you will also have access to the chain guides. After removing the tensioner, valve cover(s), chain guides, cam sprockets and oil pan, you will be able to remove and replace the unbroken chain. This procedure also requires some special tooling since you have to properly align the camshafts and crankshaft.

Over the years, Mercedes-Benz has used several different ways to assure that the camshafts and crankshaft are properly synchronized – too many to be thoroughly explained in a magazine article. So, we will provide a simple overview. There are usually a few types of special tools to lock down the camshafts. Some enter through the rear of the sprockets. An alignment pin passes through a hole in the cam cap and a hole in the sprocket. With variable valve timing comes the important step of setting the intake cam sprocket to the home position (retarded). Hold the camshaft itself in the locked position with a wrench and twist the camshaft adjuster in the opposite direction of timing chain rotation, which results in the retarded position. If there is any question of a camshaft adjuster not moving freely, now would be the time to change it. The use of non-approved oils in these engines can cause sludge build-up and jamming in the adjuster mechanism. This can lead to misfires, poor idle and the MIL/CEL coming on. On newer engines, special tools bolt down to the valve cover flange on the head, and tabs lock into the cam sprocket, but these will be covered in future articles. Generally, the crankshaft is located a few degrees past TDC and is not locked down.

Closing Up

With the timing chain and camshaft adjuster in the proper position you can start re-installing the chain guides, oil pan, valve covers and tensioner as outlined earlier. It is always a good idea to rotate the engine by hand several times to verify all components are properly timed and that the chain meshes smoothly. The final step should be to install the spark plugs and fire up the engine, allowing time for oil pressure to reach the tensioner before accelerating.

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The Straight & Narrow

When evaluating chassis integrity after collision damage you need to take the extra steps to verify straightness. The inherent value of a Mercedes-Benz vehicle definitely makes these extra steps worthwhile.

Look at the collision industry statistics compiled in the last few years and you will notice an increase in vehicles defined as a total loss by insurance companies. The reason for this is multi-faceted. Increases in the cost of parts, the shortage of certified body techs, and collision repair facility tooling/environmental compliance costs have all contributed to the overall price of a repair. Also, the vehicles themselves often contribute to the added cost. Exotic metals, construction welding technology and fastening techniques have all required retooling and training, which adds to the overhead of any collision repair shop. Mercedes-Benz vehicles, however, retain sufficient value to justify the cost of repairing most collision damage.

Reputable shops know the importance of returning the vehicle's structural integrity to its pre-collision state. When dealing with frame damage, it's essential to restore the basic framework for proper chassis dynamics (such as suspension alignment) and future crash-worthiness. You may ask yourself, "When should I check chassis alignment?" and, "How can I do a better job of pulling that chassis into alignment?"

Assessment

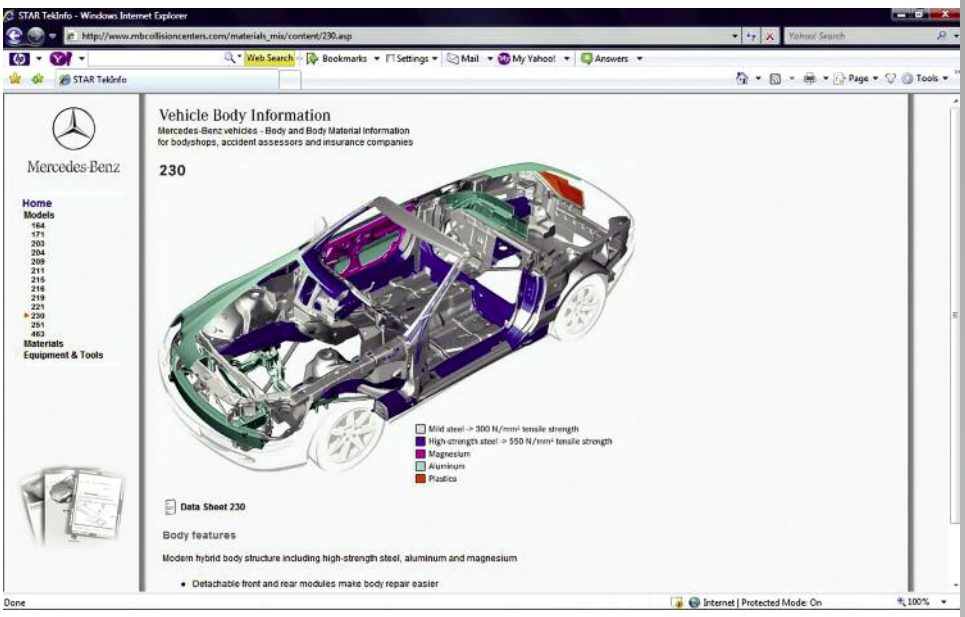
One of the first steps that is often overlooked and/or taken for granted is the damage assessment. This is more than just a visual overview of the parts that will need to be replaced. A deeper analysis should be incorporated into the assessment. Look at the point of impact and determine its direction. You should think like a detective at this point and try to recreate the accident in your head. It sounds like common sense, but this usually gives a good indication of what points you should start pulling from. Also, this may be a good way to gauge from what direction you should start pulling once the chassis has been initially straightened.

Next, look for damage at the farthest point from the impact. This gives you the total surface area of all of the damaged panels. Even if the damage in this area is minimal, it needs to be straightened. During the pulling process, it can be used as a gauge of the straightness of the overall section. If the farthest point of damage after pulling has now returned to its original shape, you may want to start pulling from another point.

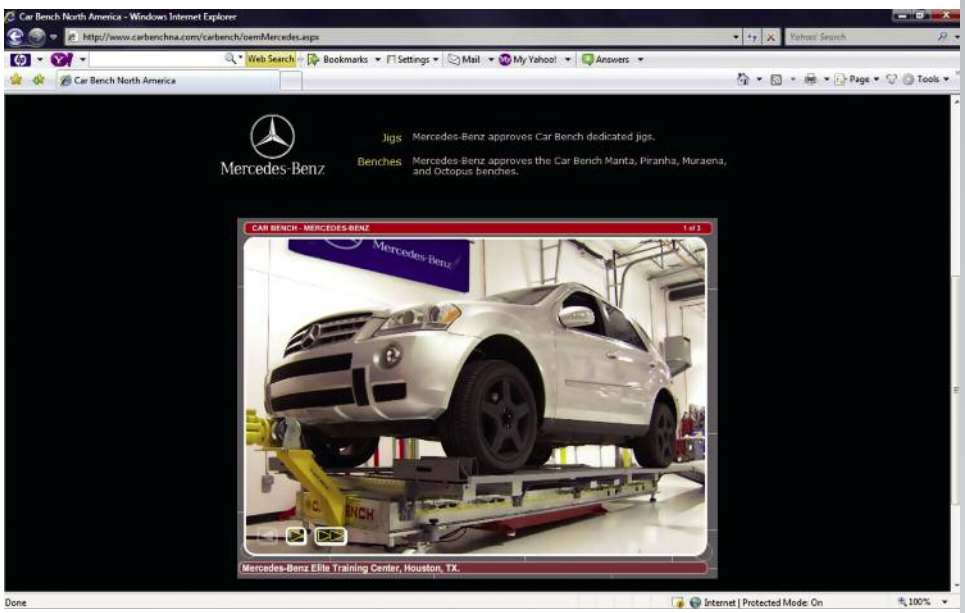
Back to assessing the damage, the next step is to look for indirect or secondary damage that was caused by this collision. Although we realize this is not always the case, it is often a good idea to start pulling the frame in a linear direction extending the body front to rear. Pulling front to rear will "stretch" the chassis into a straighter position. Obviously, with corners and angled frame panels this will not always be the best way to go, but it is a start. Sometimes it is better to pull the framework at 90 degree angles to the panel's original location. This may take several steps as you change the location and/or the direction of the pull point to stay perpendicular to the panel you are pulling. These are just some general guidelines regarding frame alignment meant to get you thinking about the next step, which is developing a repair plan.

Measuring Up

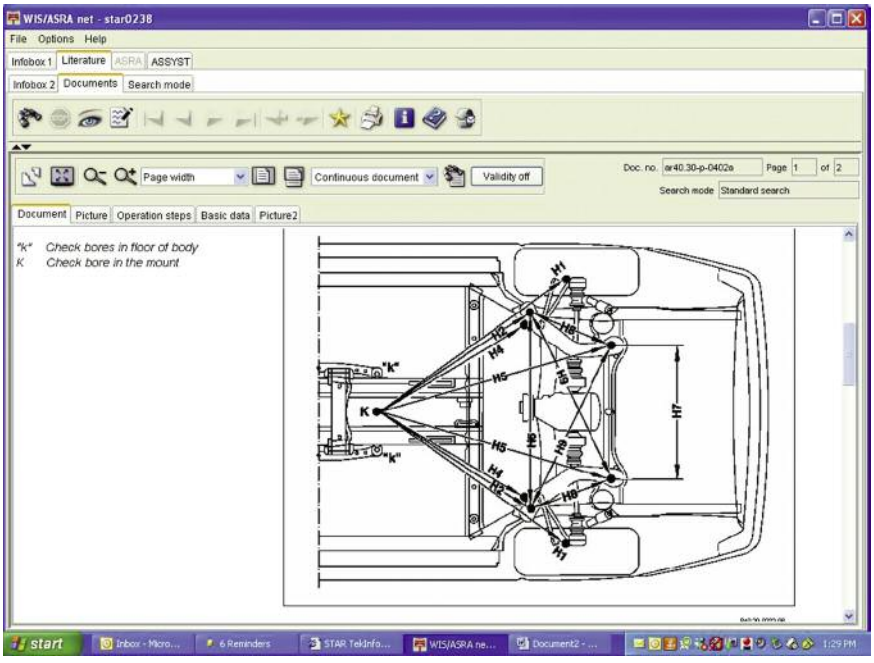
An old adage says, "Before you can go anywhere you have to know where you are." The same can be said for frame straightening. This next step in the repair process involves measuring chassis alignment on a bench or "jig" against Mercedes-Benz or



Before you start the pulling process you need to know what metals you are working with. Mercedes-Benz uses different metals with different strength levels to achieve structural strength and occupant safety. A visit to www.mbcollisioncenters.com and your membership gets you this important data.



Car Bench is a Mercedes-Benz approved alignment jig for frame straightening. There are various models available, and by visiting www.carbenchna.com you can arrange bench rental and download measurement specifications.



With a paid subscription to www.startekinfo.com, you can use WIS-Net to pull up the K-point measurement data. This information is only used for diagnostic purposes, particularly on older models built before the turn of the millennium. You can use these measurement points to see how bad the damage is.

the bench manufacturer's specifications. Here is where a hard decision has to be made: Is the frame damaged beyond repair? No one wants to put in all the labor to get to this point and not repair the vehicle. Totals should have been weeded out during the damage estimate.

On earlier Mercedes-Benz models (previous to the 210 chassis), chassis damage was measured off of a K-point. That is, a point within the driveshaft tunnel that was hopefully the least likely to be hit in an accident. The K-point is a diagnostic tool for body men to use to straighten frames. From this K-point you measure the distance to all suspension pick-up points and see if the chassis has twisted. From here, you pull on the frame until you match the measurements. These measurements are supplied by Mercedes-Benz through WIS-Net, which you can access with a paid subscription to www.startekinfo.com. Aside from having the step-by-step procedure to replace interior body panels, it also contains measurements for K-point frame diagnostic procedures. If you have a hard time locating the K-point measurement specifications, try entering a chassis number or the entire VIN and look under group 40.30.

Here is a Celette bench with a 230 chassis set up for measurements and pulling. The framework setup and procedures are all available on the website. Remember, you can use higher strength steels to pull lower strength steel, but you cannot reverse the rule.

Newer vehicles utilize a different procedure: measuring off of an alignment bench. Mercedes-Benz has approved two bench manufacturers for chassis alignment, the Car Bench, and the Celette chassis alignment bench. If you have invested in the Celette or Car Bench jig, you can access those measurements from their websites. The Celette website is www.celette-us.com. On the home page, select the "Fixture bench Setup Sheets" field, then select your model chassis. There may be VIN number differences, so be sure to select the correct identification number. The Car Bench website is www.carbenchna.com. From the home page, select "Support," then "Resources." From there, select the "+" symbol next to the heading "Datasheets," followed by the type of bench you are working with, the manufacturer (Mercedes-Benz), model and chassis variant if applicable. Rental units are available from either manufacturer. These are the two chassis alignment jigs officially approved by Mercedes-Benz.

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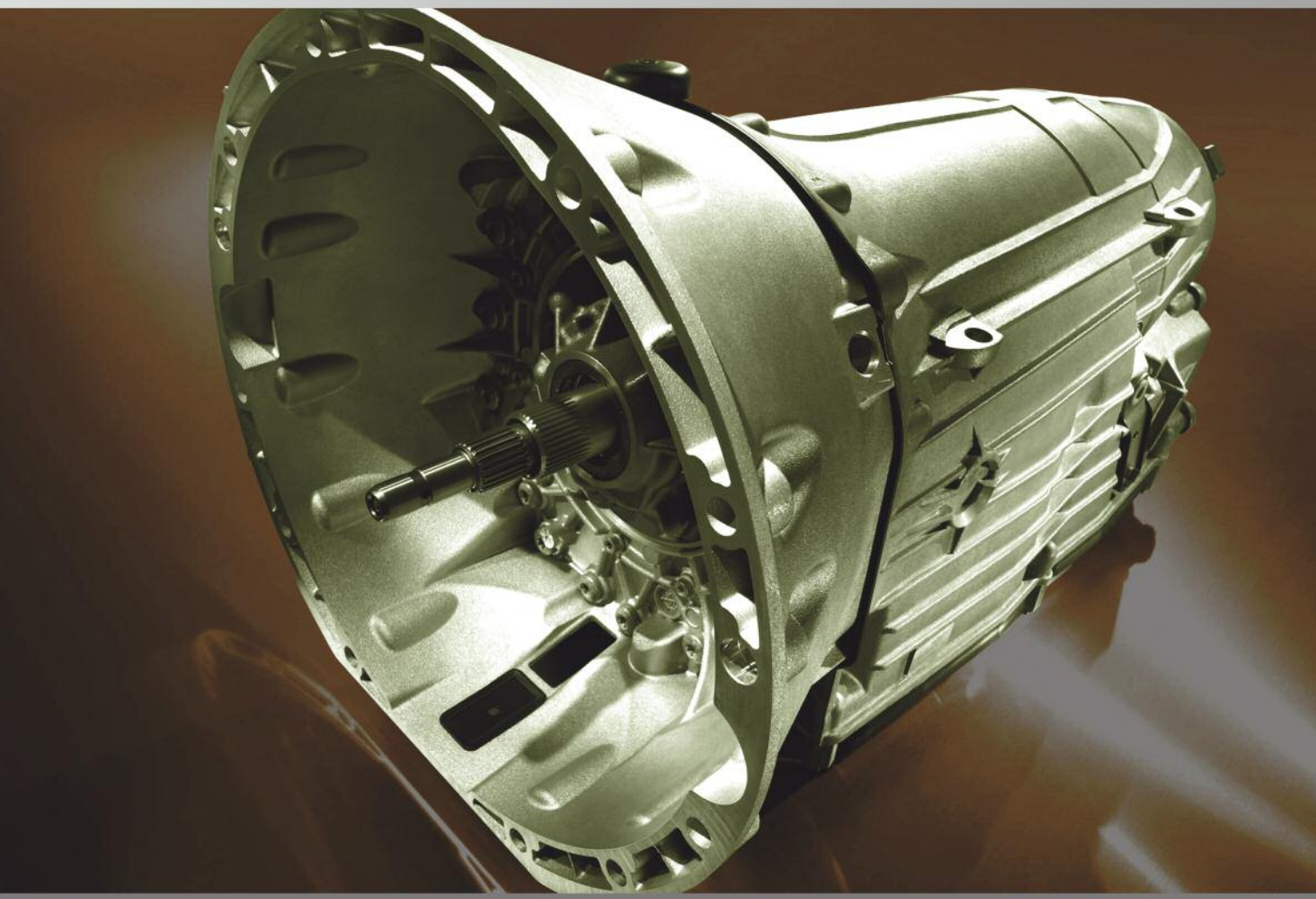

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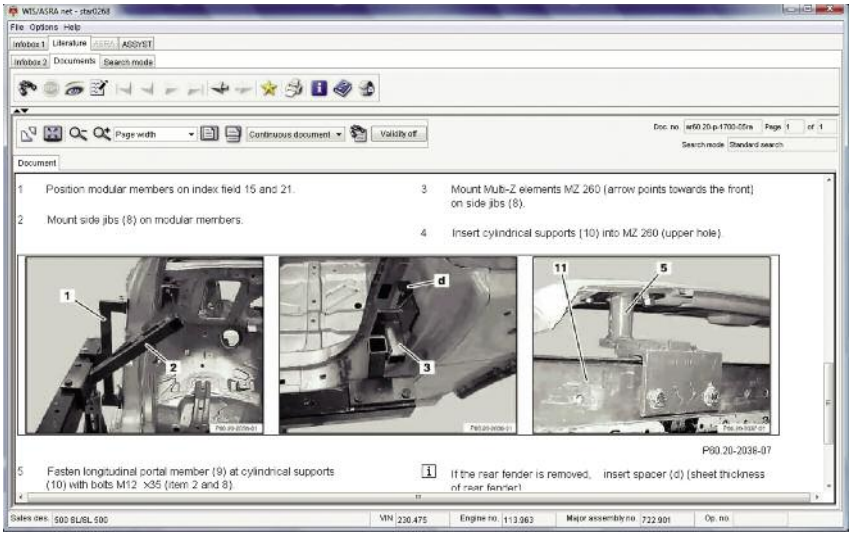
Bending To Your Will

Once the chassis is on the bench and the measurements have been taken, you can start pulling. Frame straightening is an art developed through experience, but there are some relatively new concerns with Mercedes-Benz designs and metal composition. In some cases, of course, the damage to a panel will be so great that straightening may not be the best option compared to replacement. In the case of high-strength steel, this becomes a requirement. High-boron steel is very difficult to reform after crash damage because it is so strong. Mercedes-Benz uses four grades of steel: mild steel, high-strength steel, modern high-strength steel and finally ultra high-strength steel. Mild steel is much easier to pull. The higher strength steels can be pulled, but often return to the pre-pulled shape. Ultra high-strength steel is heat formed, so without extensive equipment it is virtually impossible to reform and will need to be replaced. When damage is localized, it is much easier to cut out the damaged section and replace it.

Here is a frame attached to the bench. Points on the chassis can be measured from here, and you can start the pulling process. On this 230 chassis, you need to be aware of the different metals and their relative strengths.



With your paid subscription to www.startekinfo.com, you can access step-by-step instructions for alignment bench assembly and measurement procedures. You also are provided with replacement procedures for interior structural panels as well as exterior body panels.

Ultra-high strength steel is more widely used in new Mercedes-Benz chassis such as the 204, 216 and 251, and to a lesser degree on the 164, 171, 211, 215 and 220 chassis. The 216 chassis has incorporated even more higher-strength steels than other Mercedes-Benz models. When pulling ultra high-strength steel, it will obviously react differently from modern high-strength, high-strength and mild steel. The key point to remember is that you can use higher-strength steels to pull and align lower-strength steels, but you cannot do the opposite for obvious reasons. You will simply deform the lower-strength steels in the process. Use ultra high-strength to pull the chassis, then cut out the sections of ultra high-strength steel and weld or bond and rivet in the new sections. In the case of the 215 chassis, you have to be even more careful pulling panels since high-strength steel and mild steel is mated with aluminum structural panels. On a positive note, when pulling aluminum Mercedes-Benz always recommends replacement over repair work.

In Conclusion

Your extensive experience as a body man will serve you well while assessing the damage, measuring the alignment points and during the actual pulling procedure. Simply keep in mind the Mercedes-Benz recommended procedures outlined in WIS-Net and the knowledge of the various metal compositions of the chassis you are working on should yield a structurally-sound and trouble free-repair.

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Motor Werks of Barrington
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Napleton's Autowerks
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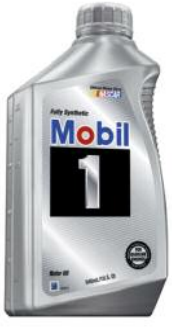

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