Determining when to replace solenoids seems like a topic most transmission technicians are concerned with. Many techs would prefer not to replace them during rebuilds. This is most likely a cost-driven decision. And it’s understandable, because depending on the unit, replacing the solenoids can increase the cost of a rebuild considerably. But there’s no clearly defined line as to when you need to replace solenoids and when you don’t.

One thing you need to consider is whether you’re dealing with an on/off solenoid or a PWM solenoid. Here’s why: An on/off probably isn’t going to see more than about a million cycles in 70-80 thousand miles, while the PWM may easily see 500 times that. Imagine beating a hammer against your bench, and the difference between what it would look like after a million impacts versus 500 million impacts.

Ignoring other factors such as contamination, and recognizing the additional wear they receive, how comfortable would you be with reusing a PWM solenoid that’s been in service for 50,000 miles? That’s not to say you only need to replace PWM solenoids, but rather to point out that solenoids are wear items, and they have a finite life.

Consider, too, the length of the warranty you’re offering, and the cost of having to rebuild a transmission for free. How does that affect your decision-making process? Or how much time will you spend diagnosing and replacing a solenoid once the transmission is rebuilt and back in the car? What’s the cost associated with that?

Developing a definitive list of which solenoids must be replaced and which ones should be replaced could be difficult. In general though, you should probably plan to replace the solenoids whenever:

- the transmission has a hard parts failure.
- the transmission has overheated
- there’s obvious damage to the solenoid, or even if you strongly suspect it’s damaged.
- the solenoid fails a resistance or operational test.
- the transmission has high mileage; over 70,000 miles or so.

Other considerations, such as duty cycle versus on/off solenoids, can be misleading if you don’t understand the solenoid’s relationship with the entire system.
Try The Complete Solution

Superior Transmission Parts’ Total Packages give you everything you need to eliminate the majority of shifting complaints and boost valve wear problems all in one economical package. In addition to the latest Shift Correction Package updates you get a precision crafted Superior Steel Series boost valve - along with time saving installation.

Quality and Value In One Package

The Total Package is intended to give you a better value than buying a valve body kit and boost valve individually. The Total Package takes Shift Correction Packages one step further and gives builders still another reason to Make The Shift To Superior!

The Choice Is Yours

<table>
<thead>
<tr>
<th>Trans.</th>
<th>Original S.C.P.</th>
<th>The Total Pkg.</th>
</tr>
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<tbody>
<tr>
<td>E4OD</td>
<td>KE4OD</td>
<td>KE400-V</td>
</tr>
<tr>
<td>AXOD</td>
<td>KAXOD</td>
<td>KAX00-V</td>
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<td>AXOD-E</td>
<td>KAXOD-E</td>
<td>KAX00-E-V</td>
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<tr>
<td>4L80-E</td>
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<td>K4L80-E-V</td>
</tr>
<tr>
<td>C6</td>
<td>KC6</td>
<td>KC6-V</td>
</tr>
<tr>
<td>700-R4</td>
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<td>K700-R4-V</td>
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<tr>
<td>200-4R</td>
<td>K200-4R</td>
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</tr>
<tr>
<td>AXOD-E</td>
<td>KAXOD-E</td>
<td>**</td>
</tr>
</tbody>
</table>

* Boost Valve Included In Original SCP. ** Complete PR Valve Train included in Original S.C.P. All boost valves are sold separately except 4L80-E.

The New Mercedes 722.6 Chico Bushing Kit

Another simple solution from Superior -- the new Mercedes 722.6 Chico Bushing Kit features the new smaller hub bushing that fits the only new output shaft available from Mercedes. This high quality naval brass bushing allows the use of the new output shaft with the earlier drum -- a big savings. The kit also includes the earlier sized bushing to replace the stock bushing if no damage has occurred to the original output shaft. (K050)

Looking for a Superior product? Call 800-451-3115 or Visit Us On Our Website @ www.superior-transmission.com
Solenoids: Test or Replace

The key is educating yourself on how solenoids work and on how they fit into the whole system. Then you factor in the costs associated with warranties and the value of your time. Somewhere in that mix you’ll find the decision that best suits your needs, your customer’s needs, and the needs of your business.

Solenoid Testing and Flushing

Any discussion about reusing solenoids invariably leads to the topic of solenoid testers and flushers. Testing a solenoid before you install it only makes sense, because it’s much easier and less time consuming to test the solenoids while the unit’s on the bench. At a minimum, you should check the resistance, even on brand new solenoids. But what about dynamic testing and cleaning?

No matter what you’ve heard about solenoid flushing, there’s no way to get a solenoid clean simply by flushing a cleaning fluid through it, or even cycling it on and off while flushing. All contaminants collect where there’s little or no fluid flow through the solenoid. If fluid did flow through that location of the solenoid, chances are contaminants wouldn’t collect there.

What’s more, any metallic particles will slowly become magnetized and will start to stick to the sides of the solenoid. All the flushing in the world won’t get rid of those particles. And let’s not forget, flushing still has no effect on the wear in the solenoid.

So, in general, while flushing may be better than nothing, it’s not a whole lot better.

Does Solenoid Testing Work?

Solenoid testers are a great idea, but finding one that can accurately test the performance or function of the solenoid is next to impossible. It’s not sim-
ply a matter of whether the solenoid works or not, because the solenoid is part of a hydraulic circuit in the transmission. It’s more a matter of how that solenoid’s performance affects the other components on the same hydraulic circuit. And the duplication of that circuit is critical if you want to get reliable results.

Many repair shops use a bench top tester that just clicks the solenoid on and off; it doesn’t really test much. And there are some applications where the solenoid doesn’t click, simply because of how it’s designed. That doesn’t mean the solenoid doesn’t work; it just doesn’t click.

In general, hydraulic testers simulate the normal operating conditions of the solenoid more accurately, so the results they provide seem to be more accurate than pneumatic (air) testers. On the down side, hydraulic testers tend to be more expensive than pneumatic testers.

Regardless of which type of tester you’re using, it’s important to be careful when testing solenoids. Many technicians have damaged perfectly good solenoids simply by testing them improperly. The most common mistake seems to be trying to make a PWM solenoid click like an on/off solenoid. If you leave a PWM solenoid energized too long, you’ll melt the coil winding insulation. And it doesn’t take long: maybe 20-30 seconds is enough to raise the solenoid’s internal temperature to well over 400° F or 500° F.

That’s not to suggest that solenoid testers aren’t a good idea; it simply means that you need to take test results with a grain of salt. Just because a solenoid checks out okay doesn’t guarantee it’ll work in the transmission. Solenoid testing is a great idea, as long as you understand the tester’s limitations.

The real question is: How will solenoid life affect your bottom line? Many repair shops are offering warranties for 3 year/36,000 miles. With that long of a warranty, it’s important to make sure the transmission is going to work right…and keep on working. With the improved quality of components available from the aftermarket, a rebuilt transmission really should be better than the original, so a 3/36 warranty isn’t unreasonable. A properly rebuilt transmission should last well beyond the warranty period. This is one of those variables you need to consider when deciding whether to replace the solenoid or not.

Air vs. Oil

There’s virtually no correlation between testing with air and testing with oil. While both media are considered fluids, big problems come into view when trying to draw any comparisons between the two. Air is a compressible fluid, so the physical properties of density (mass of air per unit volume) are vastly different regarding pressure, temperature and volume. Oil, on the other hand, is a non-compressible fluid, so its density remains pretty much constant, and it isn’t affected by changes in pressure, temperature and volume.

Fluid Properties of Air

The fluidic properties of air are
interrelated, and may be predicted using a mathematical equation known as the ideal gas law. While this is beyond the scope of this topic, the basic idea is that a change in pressure, temperature or volume will cause a change in the other two properties, due to the change in air density. This becomes even more unpredictable when the air is moving, because then we have to consider air velocity, volumetric flow rates, air expansion through an orifice, heating and cooling effects, and so on.

For example, if you heat a fixed volume of air in a closed container, the pressure in the container will increase. This is because the air molecules absorb the heat and try to expand, pushing against the walls of the container. If you did the same with oil, you would end up with hot oil, but the pressure would essentially remain unchanged.

Now take that same air in the container, and let it escape through a small orifice. More air will escape under high pressure than under low pressure, because the density has changed, and more molecules are compressed into the same amount of space. Since oil isn’t compressible, the number of oil molecules that can pass through an orifice depends solely on the size of the orifice. The volumetric flow rate will be the same; what will change is the velocity at which the oil exits. So the same amount of oil gets out, it’s just moving much faster.

**Air Testing Solenoids**

There are only certain things we can learn from air testing a solenoid. Air testing can show that a solenoid has the ability to let air flow, or it can stop the flow of air. But, since air molecules are so much smaller than those of oil, air testing may indicate a leak that may not occur with oil. The drop in air pressure and air flow rates will vary, based on air pressure values, air temperature, air quality (moisture in the lines), test fixture volume, fixture temperatures, and any restrictions created by the piping and fittings.

The more precisely you want to test a solenoid, the more these variations can affect your tests. This becomes even more evident when checking PWM or proportional solenoids. Because their designs are intended to balance and control the flow and pressure of oil, their response to air is basically meaningless.

That doesn’t mean air testing is completely useless: It can be valuable when checking new solenoids that haven’t seen any wear, contamination or abuse. But with used solenoids, air testing can only show whether the solenoid can open and close. There’s no way to predict how a used solenoid will stand up under high temperatures, or how long it will continue to operate until the internal component wear will cause a problem. Even then, air testing is only useful for testing on/off solenoids. PWM and proportional solenoids need a non-compressible fluid to balance the armature position and meter solenoid output properly.

**Oil Testing Solenoids**

Oil testing can provide more reliable test results, if the test is conducted in the appropriate manner. The transmission solenoid is only a component part in a complete hydraulic circuit. The reactions of other components within the circuit affect how the solenoid functions.

All of the hydraulic circuit components are related by pressure. Without a difference in pressure, there can be no
COMPLAINT:
• Insufficient line rise
• Soft shifts under load
• Clutch failure

CAUSE:
Worn boost valve assembly

CORRECTION:
Replace boost valve assembly to prevent oil leakage.
Part No. 95200-03K

COMPLAINT:
• E4OD, overdrive is lost
• 4R100, catastrophic failure

CAUSE:
The retaining ring does not have enough tension, causing it to come out of the groove

CORRECTION:
This retaining ring will not expand, and will stay in place.
Part No. 36744-01
Solenoids: Test or Replace

Oil flow. Spool valve areas, spring loads, regulator valves, orifice restrictions, filters, and so on, all affect the pressure in the circuit. Differences in volume determine the rate pressure builds or drops. For example, it would take much longer to pressurize a sealed 55-gallon drum than it would to pressurize the average accumulator.

Temperature also plays a major role, as the viscosity of oil decreases with temperature. So, as the oil heats up, it becomes “thinner” and has less resistance to flow. But at the same time, that “thinner” oil is more likely to leak. To test a solenoid properly with oil, all physical conditions of the hydraulic circuit must be present. And testing should be conducted at the proper temperature to ensure real life viscosity values.

PWM and Pressure Control Signals

All PWM and proportional solenoids should be tested in oil. Reliability of the results depends on the test fixture and how it relates to the original hydraulic circuits. Flow rates are not as critical as pressure build and decay rates within the circuit.

Accurate electrical signals are critical. With computer driver circuits providing signals such as peak-and-hold signals, two-stage variable PWM signals, and current averaging, it’s important that the tester duplicate the control signal accurately to provide useable test results. The difference of just a few milliseconds of control signal can make a huge difference in how the solenoid regulates pressure.

Even if the tester replicates the electrical signal and hydraulic circuit configuration accurately, no tester can predict how much life is left in a solenoid. Some PWM solenoid will see up to 600,000,000 cycles in 80,000 miles. So, even if the solenoid checks good, age should be a factor in determining whether to reuse or replace a solenoid.

Summary

While there are many different styles of solenoid tester on the market, of varying levels of complexity, no equipment exists that can guarantee the useful life that remains in a used solenoid. Some solenoid defects can be identified with such equipment, but only if those defects are evident during the test procedure.

Should you test or replace? Consider such issues such as the length of your warranty and how long the solenoid’s been in service. And don’t forget to factor in how much it actually costs to test a used solenoid, rather than install a new one that comes with a guarantee.

Which test equipment is right for you? Here’s a quick breakdown of the Pros and Cons of each type of system:

**Air Testing**

**Pros**
- ✓ Less expensive
- ✓ Cleaner
- ✓ Will identify plugged or non-functional solenoid
- ✓ Can identify a leaking solenoid

**Cons**
- ✓ Doesn’t replicate vehicle conditions
- ✓ Won’t identify solenoid failure at high temperatures
- ✓ Limited use on PWM and proportional solenoids
- ✓ Can’t predict useful remaining solenoid life

**Oil Testing**

**Pros**
- ✓ Will identify plugged or non-functional solenoid
- ✓ Will identify a leaking solenoid
- ✓ Control signals are better approximations of actual vehicle signals

**Cons**
- ✓ More expensive
- ✓ Not as clean (although shops are used to oil anyway!)
- ✓ Hydraulic circuits aren’t adequately represented in test fixtures
- ✓ Won’t identify solenoid failure at high temperatures
- ✓ Data output may not have fine enough resolution to predict response of fast acting solenoids
- ✓ Can’t predict useful remaining solenoid life