

# Spring, Sprang, Sprung: Why Valve Springs Matter So Much

**By Dave Monyhan**

Keep in mind the cam, pushrods, lifters, and rocker arms do all the work in opening the valves, but it is the spring that keeps that valve closed during the operation of the engine. Valve springs can be compressed and expanded throughout their life cycle, sometimes at more than 1,150 times per minute for most high-performance engines. Over its life a valve spring could be compressed millions, billions, or even a trillion or more times.

The valve spring also pushes back against all the other parts like the rocker arm, pushrod and lifter to maintain pressure on the cam lobe. Without valve springs, performance engines (or any engine for that matter) simply won't work. Some may argue this point, since research is going on to completely eliminate the valves and install solenoids, but we can discuss that in the future.

Valve springs come in a variety of sizes and configurations. Some are single with dampeners, others incorporate an inner spring and become a double spring and then there are the extreme or the triple springs. Straight or beehive springs are also another choice.

Spring pressure is the key factor in determining which spring should be used for which application. Camshaft design also plays an important role in determining which spring you will need. Lift is the critical spec when matching valve springs to the camshaft. The more lift you have, the greater the pressure needs to be.

How the engine is going to be used also plays a role. The set-up for a daily driver is going to be vastly different from the dragster which will be different from the oval track which will be different from the street rod which will be different from the ... well, you get my drift.

The quality of the valve spring you choose is also very important. Broken valve springs are a nightmare for engine builders, because when the spring breaks, the valve drops, it hits the piston, and KA-BLUEY; the oil pan is now a device for holding all the little fragments that just disintegrated because that valve spring failed. Race day is over. The Sunday cruise is now a Sunday sit while you wait for the tow truck.

Springs not only come in different lengths and pressures they also come in different diameters. Generally speaking when you increase the spring pressure you will also increase the diameter of the valve spring itself. The cylinder head you're putting these springs into may not be machined for this diameter so you will need to machine the spring seat to accommodate the larger spring. Fixed tooling is available to machine the spring seat, or you can also get an adjustable spring seat cutter to perform this operation right on your seat and guide machine.

Certain procedures are required for all applications of all valve springs, regardless of what you choose for your particular engine. Valve springs need to be measured for specific opened- and closed-heights and the manufacturer's stated pressures must be confirmed. And no matter what, high-performance valve springs should be pre-cycled prior to being installed.

I read a great article written by Paul Titchener of Power Technology while I was researching this article. I had heard of “spring cycling,” a process in which you cycle the valve springs to full coil bind several times to break them in prior to final pressure testing, then measuring before installing them into the cylinder head. Paul’s article explained that they were able to measure almost 10 pounds of lost spring seat pressure by following this spring cycling procedure. This results in more accurate installed heights and less pressure loss when the engine is operated at its racing rpm range. You can read more in Paul’s article at [www.power-t.com](http://www.power-t.com) (click on “Tech Support”).

This cycling process is only for brand new high-performance springs and is not needed for the plain old stock or daily driver applications. I also spoke to Joe Mondello of Mondello Technical School and he says that he cycles all of his race springs and then takes it one step further, by submitting them to a cycle of stress relieving, followed by a cycle of cryogenic freezing. Joe claims to get great results in spring life and performance by this method. You can learn more about Joe’s procedure by going to [www.mondello.com](http://www.mondello.com).

### **Measure, Measure, Measure!**

Before installing a set of springs, there are several critical measurements that you must take. If you choose to skip this step or do a half-hearted job of it, you’re asking for trouble.

Free length is the first measurement you need to take. Free length is measured by placing the springs in a row, separating intake from exhaust if they are different (if they have rotator caps then they will be of different lengths) and measuring the overall length with no pressure applied. If a spring varies by more than .025”, don’t use it. Next inspect your springs closely to ensure the top and bottom are parallel and that they are square. You can use a square to check the spring by placing the spring and the square side-by-side on a flat surface. Make sure the spring is square top to bottom and straight to within .062”.

Reputable spring manufacturers will supply specs with every set of springs. These specs include maximum lift, seat pressures – both open and closed – and coil bind height. Let’s take a look at each one and why it’s important.

Maximum lift is determined by the camshaft you’re using. You must have a spring that will provide at least the amount of lift your camshaft is requiring without entering into the coil bind height.

Closed seat pressure is critical because the spring must close and seal against vacuum and pressure. Weak spring pressures may allow the valve to bounce off the valve seat resulting in power loss and excessive wear. All of the springs in a set should have closed seat pressure within 5 to 10 pounds of each other or you’re asking for spring failure. Another way to look at it is there should be no more than 10 percent difference between the weakest and strongest measurements.

Open Seat Pressure must be enough to keep the lifter in contact with the camshaft during high rpms. The valve must also maintain contact with the rocker arm and the rocker arm to the

pushrod and the pushrod to the lifter and the lifter to the camshaft; if any of these clearances increase you will have engine failure.

You can make minor adjustments to spring pressures with shims, VSIs, or spring washers. They are all the same thing with different names. These shims are used on mostly stock applications to increase the pressures, and are available in .015", .030", and .060" thicknesses. They come in regular steel and hardened steel for high-performance applications. These shims allow you to fine tune the closed and open valve spring pressures. If you find the need to shim past .060", replace that stock valve spring.

As with any component, you need to write everything down on the work order: open height, installed height, pressures at both settings and overall length. This way you have a paper trail to reference when it comes time to freshen up a race motor or in the event of failure. Probably the most important factors in selecting valve springs are correct seat pressure, open pressure and spring rate for the camshaft you are using.

### **Analog vs. Digital Testers**

Now, we all have a spring tester or rater in our shop right? Of course you do. But which type of tester do you have? Some models come only as a analog style of measuring pressure and height, and others in recent times have evolved to digital readouts for pressure down to the tenth of a pound. Height can now be measured in thousandths-of-an-inch.

How do you determine which type is best for you and your customers? I will start with the unit we all grew up with: the analog style of spring tester.

These units have been the backbone of the engine building trade for many years. They are fast, accurate, and easy to use. But their readings are subject to the eye of the beholder. You have to ensure you are looking directly at the dial face to be sure you're reading pressure correctly, and you have to look correctly at the measuring scale to ensure your height is right. A little bit off in either of these measurements is unacceptable.

You can always upgrade the measuring height to either a dial indicator or a digital readout, which takes some of the guesswork out of the equation. I highly recommend the digital readout to measure specific height. There aren't any options for upgrading the pressure dial, so calibration is very critical to ensure your pressure is correct.

Checking a spring with an analog type of spring tester:

- Place the valve spring on the spring tester.
- Compress the spring to the installed height specification and record this pressure reading. Note: pay close attention to the height measurement.
- Compress the spring to the open specification and record this pressure reading. Note: pay close attention to the height measurement.

Many of these machines also include an adjustable stop that allows you to do the set up one time and cycle each spring through at a faster rate. However for the extreme high performance engine you may choose to measure each one individually to ensure it is spot on.

Now let's take a look at how measuring springs is done on a Digital unit.

- Place the valve spring on the spring tester.
- Compress the spring to the installed height specification and record this pressure reading. Note: pay close attention to the height measurement.
- Compress the spring to the open specification and record this pressure reading. Note: pay close attention to the height measurement.

Did you catch it? All of the procedures are the same. Nothing is different for what you do, regardless of whose machine you have.

What I really like about the digital unit is that it allows you to set up your stops for open and closed pressure. Once set, you can quickly go from an open measurement to a closed measurement. Plus the digital readouts eliminate any guessing about spring pressure or height. This unit is fast, accurate and very simple to use.

Now, whichever machine you have is the one you are going to use, so I am not here to tell you which to buy or say one is better than the other. But if you are shopping or in the mood to upgrade, then I'd say check them all out. Contact your favorite shop supply company and compare the features and benefits. Find out what is, what isn't and who is going to be there for re-calibration or technical support before you buy, then select the machine that is best suited for you and your customers' needs.

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