Standard Deviation and Load Development

What is standard deviation and what does it mean? Because standard deviation and average go hand-in-hand, let's first talk about averages. If you talk about average velocity, everyone knows what you mean. You measure the velocity of several shots and you average your readings. If someone asks you the velocity of that ammo, you say that it's about 2950 feet per second. You naturally quote the average velocity, and the listener understands. You know that some shots will be faster than average and some will be slower. You don't even worry about the exact definition of average; it's about the middle.

Confusion doesn't come until someone asks if the velocity is uniform. You are comfortable with quoting the average velocity, but you know that it doesn't tell the whole story. The average does not tell you how much th e velocity readings scatter above and below the average. How do you describe uniformity or assign it a number grade? **The standard deviation is a number that describes uniformity. The smaller the number, the more uniform velocity.** A standard deviation of zero means every velocity was the same. A standard deviation of 29 fps means you expect two-thirds of the individual velocities to be within 28 fps of the average.

Mathematicians and statisticians have talked about uniformity for years. They may call the lack of uniformity dispersion or variance. They may talk about the difference between highest and lowest and call it range, extreme variation or extreme spread. They may talk in terms of the coefficient of variation. They prefer to talk and think in terms of standard deviation. Standard deviation is the best measure of uniformity, and it fits recognized procedures, equations and textbooks.

Modern shooters consider standard deviation as the best measure of velocity uniformity. In the past, shooters used extreme spread or mean absolute deviation as the indicator of uniformity. This was a matter of pre-calculator convenience. Statisticians knew that standard deviation was a better measure of uniformity, but nobody wants to calculate it manually. If you've never computed standard deviations manually, be assured that the pleasure ranks right up there with spit-shining combat boots. You avoid it if at all possible. With machines to do the tedious calculations, we can now all use standard deviation as the measure of uniformity.

Consider what happens when you test a hand load. You hear it go bang, you feel the recoil, you see where it hits the target, and you can measure velocity. We normally don't measure the intensity of the bang or the force of the recoil; we measure only the target and the velocity. Most important is where the bullets hits the target. If all the bullets go into the same hole, and the average velocity is sufficient, you don't worry about velocity uniformity. If the group is larger than you want, you grasp at anything that will give you a clue of what went wrong.

The secret for making smaller groups is uniformity. Other things being equal, the more uniform you can make the ammo, the more likely it will shoot to the same hole Uniform velocities are simply another indicator of uniform ammo. Uniform velocities do not guarantee small groups, nor do large variations guarantee large groups. There are no guarantees, but you can at least put the odds on your side. When you have uniform velocities you can assume that you have a proper primer for the powder,

that you have a reasonable powder for the case and bullet, you did a good job measuring the power, and that your cases were of uniform capacity. Uniform velocities tell you very little about bullet quality, the bedding of the action and barrel, or if the gun vibrations induced by the firing just happen to fall in a sweet spot. When you have erratic velocities and small groups, your bedding is probably good and you have a good average velocity for that powder.bullet combination, but be suspicious of your primer choice and firing pin. If you get both erratic velocities and large groups, go ahead and make significant changes in bullet, powder type, or gun; you probably aren't close to any perfect combination.

The common limitation on the formal use of standard deviation and other statistical procedures in shooting is the number of shots required. Statisticians call it sample size. Invariably statisticians as for more shots than shooters want to fire. Shooters want to shoot five-shot groups, and statisticians want to see at twenty-shot samples. Nobody questions that firing more shots into a group will give you a better statistical measure of both the accuracy and the standard deviation.

Trying to measure the velocity uniformity of your ammo by chronographing only five shots is like measuring the accuracy with one five-shot group. One group is an indication, but you can't trust it to repeat. Likewise, one standard deviation number should be considered only as an indication of uniformity. Although standard deviation is the best available measure of velocity uniformity, it is not good enough to be considered only measure of ammo quality. Use standard deviation numbers as indicators of uniformity, but use them along with other indicators of load performance.

Do you always need to use a large sample size while you are developing your loads? When I shoot a large group, backed up by large standard deviation, I don't waste time trying to measure just how bad the load is. The load could eventually prove to be a good one, but the odds are against it. I'm looking for good loads, and abandon bad loads as quickly as possible. With the large standard deviation confirming the large group, I abandon the load quickly and don't feel guilty for shooting fewer than twenty shots. It's fun to shoot a new load that I hope is good; it's drudgery to shoot a load which I expect to be bad.

Sample size takes care of itself with good loads. If a load looks good, even though you've fired only one five shot group, you don't abandon it and you don't immediately accept it. You try at least two or three more groups of this load to see if it is golden. Th original sample of five shots is now fifteen or twenty. If the load continues to look good, you load and shoot it still more. Even a statistician would be happy with the total number of shots fired with your "keeper" loads.

What are reasonable values for standard deviation? What's a good group size or a good average velocity? It all depends on what you're trying to do. You should use the numbers only for comparison, and you don't compare apples and oranges. If you're working up an elk load for a .375, comparisons to the performance of your .45 ACP or varmint rifle are irrelevant. You don't compare the average velocity of your .375 to the average velocity of your .45 ACP. You don't compare groups from your .375 to the groups from your varmint rifle. Likewise, you don't compare standard deviations between

your .375 and the other guns. The only comparisons that matter are those you make between the .375 loads you keep and the .375 loads that you abandon.

What do you do with the group sizes, average velocities, and standard deviations reported by another shooter? His results can influence which loads you select for trial. Choosing a load that's listed in a manual and also worked for him beats choosing a random load. After you've tested the other shooter's load, his results should not sway your decision. What counts is how the load performs in your gun, when compared to other loads in your gun.

Some shooters question the use of standard deviation in load development. We agree that velocity uniformity or standard deviation should not be the only criteria used in selecting a load. Standard deviation must be considered along with everything else you know about the load. Note that the measured standard deviation includes variations in both the ammo and the chronograph. Chronograph systems with inadequate spacing between skyscreens often give passable readings of average velocity, but questionable readings of standard deviation. Whenever you use standard deviation, remember there is an important corollary of Murphy's law. Its regular use can replace many mathematical theorems and complicated statistical procedures.

Large groups usually repeat;
Large groups with large standard deviations always repeat;
Small groups caused by luck never repeat.