A Better Ballistic Coefficient

For centuries now, science has been helping us gain a more accurate understanding of our world. The branch of science we care about as shooters is known as ballistics. The science of ballistics is well developed and understood by those who study it, but the tools and information being used by average shooters is not necessarily optimal for the shooter's applications. In other words, there is a better, more accurate way for shooters to use ballistics to help them predict trajectories and hit targets. ***The purpose of this article is to present a better way for shooters to calculate ballistics.***

What is a Ballistic Coefficient?

Most shooters, especially long range rifle shooters, are familiar with the Ballistic Coefficient (BC). Without getting into the math, I'll define the ballistic coefficient in words as: ***The ability of the bullet to maintain velocity, in comparison to a '<u>standard projectile</u>'.*** A high BC bullet can maintain velocity better than a low BC bullet under the same conditions. All measures of ballistic performance including drop and wind deflection are related to the bullet's ability to maintain velocity. In short; *the higher the BC, the better the all-around ballistic performance of the bullet will be.*

How a Ballistic Coefficient is used

Details of ballistic trajectories can be predicted with computer programs using all the relevant variables, including BC. As with all prediction programs; the accuracy of the outputs depends on the accuracy of the inputs. Here is where we have to examine the real meaning and implications of using a Ballistic Coefficient to characterize the bullet's ability to maintain velocity.

It's a relatively well known fact that the BC of a bullet is different at different velocities. Not many shooters know why it changes, or what the consequences are. To understand why a BC changes at different speeds, we have to go back to the definition of BC, which is: ***The ability of the bullet to maintain velocity, in comparison to a '<u>standard projectile</u>'.*** It's the 'standard projectile' part of the definition that we need to key in on. What is the 'standard projectile'? What does it look like?

To date, the 'standard projectile' used to define BCs for the entire sporting arms industry is the G1 standard projectile. The G1 standard projectile which is shown in Figure 1 has a short nose, flat base, and bears more resemblance to a pistol bullet or an old unjacketed lead black powder cartridge rifle bullet than to a modern long range rifle bullet.

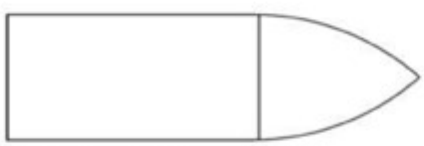

Figure 1. The G1 standard projectile.

The reason why the BC of a modern long range bullet changes so much at different velocities is because modern bullets are so different in shape compared to the G1 standard that its BC is based on. In other words, the drag of a modern long range bullet changes differently than the G1 standard projectile, so the coefficient relating the two (the ballistic coefficient) has to change with velocity.

There are several ways to *manage* the problems caused by the dependence of BC on velocity. One way is to use a G1 BC that's averaged for the speed range you're interested in. This will get you close, but what if the BC of the bullet is advertised for a speed range that's different than what you're interested in? It's not easy to adjust the BC for different average velocities. Another way to deal with the problem of a velocity dependent BC is to give the BC in several velocity 'bands' (Sierra bullets uses this approach to advertise the BCs of their bullets). This can be an accurate approach, but it leaves a lot of room for misinterpretation. For example, many shooters don't understand why there are different BCs and choose the wrong one. Furthermore, not all ballistics programs allow you to input multiple BCs. In short; ***the use of the***

nonrepresentative G1 standard (Figure 1) to define BC is responsible for the velocity dependence and associated problems with BCs.

A better standard for long range bullets

If you look at the G1 standard projectile again in Figure 1, you might think; "it's too bad there isn't a standard that's more representative for modern long range bullets". In fact, there are several standard projectiles, all with different shapes, that are much more representative of modern long range bullets than the G1 standard. The standard that bears the closest resemblance to most modern long range bullets is the G7 standard, shown in Figure 2.

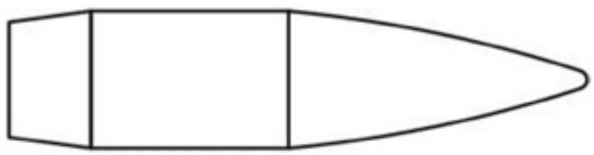

Figure 2. The G7 standard projectile.

As you can see, the G7 standard projectile, with its long boat tail and pointed ogive bears a much stronger resemblance to a modern long range bullet than the G1 standard projectile. As a result, ***the BC of a modern long range bullet that's referenced to the G7 standard is constant for all velocities!*** In other words, a trajectory that's calculated with a 'G7 BC' doesn't suffer from the same velocity dependence problems and inaccuracies as calculations that are made with a G1 BC.

Another benefit of using G7 BC's is that it allows a more fair comparison between bullets. For example, consider two .30 caliber 168 grain match bullets from different manufacturers. Even if both projectiles are identical in shape and weight, it's possible for them to have different advertised BCs if the BCs are calculated for different velocities. For instance, if one of the bullet's BC is calculated for a 3000 fps (muzzle velocity) and the other is calculated for an average velocity between 3000 fps and 1500 fps, then the BC that's based only on muzzle velocity will be higher, but less relevant for long range shooting than the *average* BC. In other words, the two bullets actually have the same BC, but the 'smoke and mirrors' that results from the velocity dependence of G1 BC creates the illusion that one bullet is better than the other. If you considered the G7 BC of the two bullets, it would be the same for all speeds.

You may observe that not *all* bullets look more like the G7 standard, and that's true. For the short, flat based, blunt nosed bullets, the G1 standard is actually more representative. For that reason, BCs for flat based bullets should continue to be referenced to the G1 standard. In other words, ***the G7 BC is better for boat tailed bullets, while G1 BCs are better for flat based bullets.***

Why were we stuck with G1 for so long?

One obvious difference between G1 BCs and G7 BCs is that the numeric value of the G7 BC is lower than the numeric value of the G1 BC. For example, if a bullet has a G1 BC of .550, the G7 BC will be close to .282 (same bullet). Even though the G7 BC of .282 is a much more accurate representation of the bullet at all speeds, ***the numeric value of the G7 BC is lower***. If you know anything about marketing, then it's obvious why we've been stuck with G1 BCs for so long. ***Since the G1 standard projectile is the highest drag standard, BCs referenced to that standard will be higher than BCs referenced to any other standard.*** As we know, when it comes to marketing, the facts and quality of information is often compromised in order to present a more favorable advertisement. For many years, bullet makers have known(*****) that the G1 standard is a poor standard for long range bullets but continue to use it. Why? One reason is because it's believed that the first company to advertise G7 BCs will 'confuse' people, and the lower numeric value of the G7 BC will push people away from their product.

It's easy to understand the fear of being *the first* to do something new. It will take time to explain and it may hurt sales at first. That's OK. *At Berger Bullets we are committed to the success of shooters.* Mostly that means making the best bullets possible. That commitment also includes providing shooters with the most suitable and accurate information so they can use those bullets most effectively. Berger's commitment to the shooter is why we are making the leap to G7 referenced BCs. The change will take time to get used to, but in the end, shooters will be empowered to make better informed decisions about their equipment. In the end, shooters will be able to calculate more accurate trajectories. In the end, the other bullet companies will follow and provide G7 BCs for their long range bullets because it's the right thing to do. ***In the end, this change will mean greater success for shooters.***

(*****-Sierra bullets wrote an article which acknowledges that G7 referenced BCs are more appropriate for modern long range bullets: http://www.exteriorballistics.com/ebexplained/articles/the_ballistic_coefficient.pdf)

Using the G7 BC: Calculating trajectories

Most modern ballistics programs are being created with the ability to use BCs that are referenced to different standards (G1, G5, G7, etc). Calculating a trajectory with a G7 BC is as simple as selecting "G7 BC" in the program, and giving the program a G7 BC instead of a G1 BC. All the other inputs are handled the same. There are many free ballistics programs that can calculate trajectories using G7 BCs including the Applied Ballistics free Online Calculator: http://www.appliedballisticsllc.com/ballistics

Using the G7 BC: Comparing bullets

One way that BC is used by shooters is to compare the relative performance of bullets. Comparing bullets by BC is only possible if the BCs are referenced to the same standard. For example, if you know the G1 BC of one bullet is .500, and the G7 BC for another bullet is .230, it's impossible to tell which is better just from the BCs. Since other bullet companies don't yet advertise G7 BCs for their bullets, how is it possible to compare other brands bullets to Berger's G7 BC? Ideally, one tester would test the bullets from all the companies using the same method, and report the G7 BCs. I have recently completed such a study and the test results including G7 BC's for over 175 bullets of all major brands are published in one book. The book is called: *Applied Ballistics for Long Range Shooting* and is available from *Applied Ballistics, LLC* (http://www.appliedballisticsllc.com/index_files/Book.htm). I began the testing and writing of this book 2 years before I became the Chief Ballistician for Berger Bullets. I used the same test procedure (repeatable within +/- 1%) to measure the G1 and G7 BCs for all brands of bullets so meaningful comparisons can be made between brands.

Conclusion

Science has a good track record as a method for reaching accurate conclusions. Ballistics is the science of shooting, and the use of the G1 standard has been a glaring error in the way that we shooters apply our science. For too long now, the unfortunate influences of marketing and advertising have kept us from being able to use our science to its fullest potential. As part of our commitment to the success of shooters, Berger Bullets is bringing the application of small arms ballistics out of the marketing hype and G1 dark ages and offering accurate and *properly referenced* G7 BCs for our long range bullets.

All of the pieces are now in place for shooters to take full advantage of this more accurate kind of BC. Berger now provides G7 BCs for our bullets. The book: *Applied Ballistics for Long Range Shooting* provides G7 BCs for all other brands of bullets. Ballistics programs are available that can calculate trajectories using the G7 BCs. In conclusion; everything is now available for shooters to take immediate advantage of this new type of BC and do everything that was possible with the old G1 BCs, only better.

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