Firing Solution Check List

By Doc Beech

The first thing that a lot of shooters consider when the predicted firing solution is not the same as the real world firing solution is “should I adjust the BC or the MV”. This depends on where the firing solution is off at. First things first, always make sure you are using the correct form factor (G1 vs G7). Shooters can and do get good results using the wrong form factor, but just because you do something wrong once and get away with it, doesn't mean it won't come back to bite you. So even if someone tells you that using the wrong form factor is ok, do yourself a favor to avoid any future issues and use the correct form factor. Second, where possible use Custom Drag Models. These are not G1/G7 BCs but are the actual drag data for the bullet. If you are going to use a BC then always look for a BC from our tested lab results. Lots of BCs on ammo boxes favor the marketing side of numbers. In the images here, you will see what kind of error can occur from calibrating the wrong variable. This is an important factor to consider.

To start with here is some general principles:

I) If the firing solution is off in the supersonic range, then you need to be calibrating the muzzle velocity.
II) If the firing solution is off in the transonic/subsonic range, then you need to be calibrating the DSF (Drop Scale Factor) or adjusting your BC.
III) MV & Ballistics calibration can be done outside the recommended ranges. Just understand that you are imposing a certain amount of unavoidable error in your firing solutions. The Software/Apps/Devices will allow for it, but in some cases you will be doing more harm than good.
IV) Group Size is Important (Calibrations need 1/2 MOA 5 Shot Group Resolution minimum).
V) Incorrectly adjusting the wrong variable (BC instead of MV) will result in unintended, uncorrectable errors.

Just because your firing solution is off, doesn't always mean it’s the MV, BC, or the Solver that is incorrect. Here are several things that can be going on that cause the solution to not match your observed impacts. As you go through this checklist you will find space under each topic to for notes or confirmation remarks to that variable and a check box for when you are done with that section:

1. Are you using a Custom Drag Model? If not, are you using the correct for factor G1 vs G7. Custom Drag Models will always be more accurate, and will also negate any form factor short comings at ELR Distances:
    a. Custom Drag Models: http://www.appliedballisticsllc.com/cdm
    b. G1 vs G7: http://www.appliedballisticsllc.com/Articles/ABDOC2.3%20-%20Form%20Factors%20A%20Usefull%20Tool.pdf

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2. Where did you get the G1/G7 BC from? It is recommended you only use BCs from our lab which have been independently tested, as it is not uncommon for marketing to be used in the BC on a box of bullets: http://appliedballisticsllc.com/ballistics-educational-resources/bullet-data/
    a. Averaged BCs vs Peak BCs. An Averaged G7 BC is just like it sounds. The BC is averaged over a certain amount of the bullets flight path. Preferably through the transonic zone, which is how AB does it. A Peak BC has the potential to look better on paper, and is commonly used in marketing, but does not necessarily represent the bullets BC during flight and can lead to firing solution errors if used. Make sure if you use a BC you are using the Averaged G7 or a Segmented BC.

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3. How did you measure your velocity? Not all chronographs are the same, and the use of a poor or unreliable chronograph can cause issues: http://www.appliedballisticsllc.com/Articles/ChronographChapter.pdf. We recommend the Lab Radar as the most reliable and accurate currently on the market.

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4. How did you calculate your MV? Chronographs only measure velocity at their location, they do not measure Muzzle Velocity. http://www.appliedballisticsllc.com/Articles/ABDOC121_VelocityDecay.pdf

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5. Have you calculated and accounted for your powder's Temp-Sensitivity? Generally, our testing has shown that rounds have a muzzle velocity variation between 0.2 and 3 fps of shift per degree of temp change Fahrenheit: http://appliedballisticsllc.com/Articles/Testing%20for%20Temperature%20Sensitivity%20-%20PT1.pdf

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6. What's the standard deviation (SD) of your ammunition's muzzle velocity? Is your SD around 10 FPS? 10 FPS is the minimum you should be trying to obtain for Long Range Shooting. This will equal about a 1 MOA Vertical Spread at 1000 yards on average.

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7. Have you tested your scopes turret tracking? Scopes are not always perfect, and will have a variation in what they are marked as, and how they track as you click them. This is a common point of error, and every shooter should know how their turrets function. We recommend you perform the following test: http://appliedballisticsllc.com/Articles/TallTarget.pdf
    a. In apps this is generally called Sight Scale Factor (SSF) or Turret Correction Factor. The AB Engine Supports the use of this correction.

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8. Did you zero check your scope at different magnifications? There are many moving parts inside a scope, and multiple lenses which must be aligned and remain aligned through use. It is important to check your scopes zero at multiple different magnifications and look for any shift, which would be caused by the reticle moving or the lenses falling out of alignment during erector travel.

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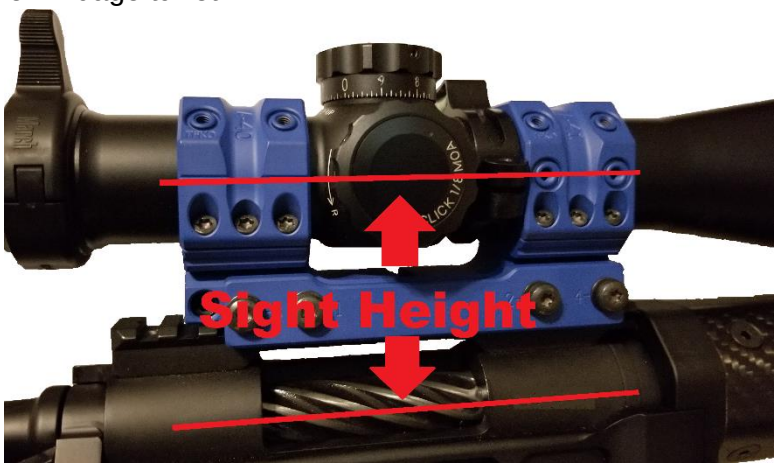
9. How did you measure Sight Height? Where from? It is the distance from the center of the bore to the center of the scope's axis. The sight height should be measured at the center of the windage turret.



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10. Are you correctly using, and do you know how to correctly adjust your parallax? When adjusting parallax the crosshairs and image should not move when your move your head around behind the scope. This may not always mean 100% focus of the object, as things like mirage can distort the image.

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11. Was there any mirage distorting the target image during the time of firing? Mirage can cause the targets image to displace from its actual location, knowing how properly adjust for and manage mirage is important when determining the accuracy of a firing solution.

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12. TMOA vs SMOA. Not all scopes, ballistic apps & more are made the same. It is always good to double check is your scope working in TMOA or SMOA. It's also good to make sure the software you are using is working in the same units you are. 1" @ 100 yards is known as Shooter's MOA (SMOA), and is not the same as True MOA (1.047" @ 100 yards). All AB Software functions in TMOA unless otherwise specified.

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13. Verifying Range (and LRF Error). You would be surprised how inaccurate LRF devices can be, especially some of the cheaper ones. Modern Advancements in Long Range Shooting Vol 2 shows some LRF testing; the actual results vs advertised performance were disappointing in a lot of cases. While many LRF devices are good to +/- 3% of the range to target, some are off by 5% and more. The further you go out, the more of an issue this is. Even with 1% accuracy at 1000 yards that's +/- 10 yards. 3% error at even 800 yards +/-24 yards. It's always good that a user verifies their LRF is providing accurate results. (This is a good tip for all of your equipment.)

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14. Direction of Fire + Latitude (Vertical Coriolis). This one is interesting, because it's so easy to account for. If your shots seem high, check to see your DOF. If you are shooting east, and your firing solution is high by 4 inches at 1000 yards. It might be Vertical Coriolis (vCor), and not actual error. For example, using a standard 308 175 gr setup, if you were to shoot 1000 yards to the west, then shoot 1000 yards to the east and changing nothing else, the shift would be around 8 inches at a latitude of 40 degrees.
    a. Make sure you have updated your Direction Of Fire.
    b. Make sure you have input the correct Latitude.

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15. Aerodynamic Jump (accuracy of wind measurement). The AB Engine has this one figured out for you guys. However, users have sometimes noticed "I am off by a tenth of a mil, or a fifteenth of a mil" and they didn't account for AJ or more specifically didn't remove it from the zero bias. This has been the cause of errors for shooters before.
    a. Aerodynamic Jump Zero Bias. This is when you had a crosswind that influenced Aerodynamic Jump in to your zero. For example. If you zeroed your rifle in a 10mph crosswind you would have AJ built in to your zero. So, when you add AJ to the firing solution you now have twice as much AJ on the scope. This is easy to correct for, simply remove the AJ from your zero before you lock your turrets in after you have zeroed.

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16. Barometric Pressure vs Station Pressure. This is a commonly misunderstood variable. I will break this down in to two sections to make it easier to understand:
    a. Barometric Pressure - This is the pressure at a measured location calibrated to that locations elevation. It prevents airplanes from hitting the ground when flying on instrumentation. When you input the Barometric Pressure in to the Altimeter on a plane it will read 0ft when on the ground. Bullets don't generally care about calibrating for the locations elevation, however this can input error in to a firing solution. To use this correctly you essentially need to know your elevation and back calculate to Station Pressure (Many ballistic calculators do this for you) but the difference in elevation between you and the weather station do cause errors.
    b. Station Pressure (Ambient Pressure) - This is the true atmospheric pressure at the location you are at. Many devices like the Garmin® Fortrex® 701, Kestrel® Elite, Sig® Kilo® 2400, RAPTAR-S…. read this directly. For accuracy purposes, this is what you should be using.

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17. Density Altitude – Density Altitude is a "reference" altitude for shooting. It allows you to generate charts using a mixture of readings which are calculated in to a single number. DA is very easy to skew, and not an accurate method for developing firing solutions. We recommend you avoid this.

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18. ICAO vs ASM: Most modern Ballistic Calculators use ICAO Standard Atmosphere (59 Deg F & 29.92 inHg) however others do still use ASM (59 Deg F, 29.53 inHg, 78% rh). All AB Calculators use ICAO and all AB Bullet Libraries are built on ICAO Atmospheric Standards. By using our systems, you can avoid any errors this would cause all together.

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19. Incorrectly doing a ballistic calibration. This one is common, so here is the guide on doing it properly: http://www.appliedballisticsllc.com/Articles/BallisticCalibration.pdf

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20. Positional Shooting Zero Shift. Are you shooting in the same position you zeroed at? Have you verified that you are able to hold zero when moving from Prone to Kneeling? It is not uncommon for a shooter's hold on the rifle to be different when shooting from different positions. This causes a shift in the zero of the rifle, and you should be training on always maintaining a zero in different positions. This comes with practice.

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21. Shooting Surfaces/Platform. The type of ground you are going to shoot off of is going to play a factor in your performance. If the ground is soft sand, you might find your bipod sinking in. If the surface is concrete you may find you have more bipod jump. Understanding your performance on different shooting surfaces, and what you need to do to manage the rifles recoil on those surfaces, is going to help you succeeded in competition shooting. Are you shooting off the hood of a car (rebounding metal surface) or are you shooting off soft grass (energy absorbent). Knowing and understanding this aspect will help you maintain good form and performance.

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22. Return to Zero. Some shooters don't think about this, but the zero is not the only important thing you should be doing at 100 yards. The other factor is your rifles ability to return to zero. You should be checking your equipment's ability to run elevation and bipod adjustments needed for shooting 1 mile and beyond, then return all systems to a 100 yard state and ensure its back to zero on target. With some fairly new, non-competition endured, equipment being developed at a rapid pace, it is good to test that it reliably performs and that includes returning to zero. This becomes even more important, as more external assistive devices like the TACOMHQ and Adjustable Scope Base devices become more readily available.

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As you can see its easy for a firing solution to appear to have an error in it, but it's just bad data being fed in to the solution. When a firing solution is only "slightly" off, always double check your variables for why, it could be something as simple as turrets that are not tracking perfectly.

Ballistic Calibration is covered in great detail, in Accuracy and Precision for Long Range Shooting. https://store.appliedballisticsllc.com/ProductDetails.asp?ProductCode=0002 Included is how to properly do live fire verification with your ballistic calibration.