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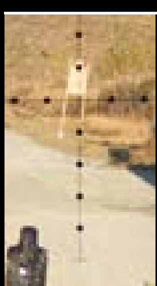
AR, M-16, AND M-4
HOW MUCH RANGE CAN YOU GET?

BY: KEN JAVES / *PHOTOS COURTESY KEN JAVES www.shibumitactical.com*



THE VIEW AT 700m THROUGH A SPOTTING SCOPE.

The long range potential of standard 5.56mm carbines has historically been underrated, with the shorter barreled “mouse-gun” relegated to 100m-and-in engagements and targets beyond that range served up to the “designated marksman” (DM) or sniper.

However, I have witnessed some remarkable shots taken with issued M-16s and M-4s. In 2006 in Ramadi, Iraq, one of my riflemen (not a DM or Sniper) observed an insurgent mortar team bail out of the back of a Hi-Lux pickup and begin setting up their tube to rain 60mm HE on one of our positions in the city. Using the ranging reticle and ballistic drop compensator (BDC) in his issued ACOG he estimated the range, lined up the appropriate crosshair, pressed the trigger on his M-16A4, and dropped one member of the mortar team into the nearby canal. The rest immediately scrambled back to their truck and made continued on next page

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BRAVO COMPANY 16-INCH CARBINE WITH VORTEX VIPER PST OPTIC.

a hasty exit; leaving their mortar, ammo and buddy behind. Out of curiosity I dug out the Vector laser range finder and ranged the shot at a touch over 700 yards. I also have multiple expert qualification scores with M16-A2, A4 and M4-A1 rifles on the Marine Corps course of fire which was shot with iron sights (they have since ruined this standard) out to 500 yards. What makes that qualification interesting is the military specification for the rifle and ammunition combination requires that it be able to hold a 4.5 minute of angle (1 MOA is 1.047 inches at 100yds) group. This means that the group size would be 23.6 inches at 500 yards, but the target is only 19.5 inches wide.

In this article we are going to explore what can be achieved with a standard 5.56mm M4-style carbine and relatively low-cost supporting equipment wielded by a shooter with solid marksmanship fundamentals, but who may not have years of specialized long range shooting or ballistics training. We will also look at what upgrades will provide the most performance improvement without sacrificing the carbine's capability in its intended role as a short to mid-range platform.

EQUIPMENT

For this experiment I selected my Bravo Company rifle which has a 16 inch standard-profile, chrome-lined barrel with a 1:7 right hand twist. The optic was a Vortex Viper PST 1-4x with a second focal plane TMCQ (Mil) reticle and tactical turrets with .2 mil/click adjustments. This scope can be had for under $450 with a little searching on the net. A Bushnell Elite 1500 laser range finder was used to establish the distance to each target. I also used a Kestrel 3000 Weather Meter for gathering wind and environmental data paired with a Smartphone/tablet for GPS info and the Applied Ballistics Mobile application using a custom drag curve for the 77Gr. SMK projectile provided by Applied Ballistics (appliedballisticsllc.com.) The use of a range-finder, weather meter and ballistics program dramatically reduces the learning curve, time and ammunition required to calculate and make hits at extended ranges; especially when travelling between different shooting environments as I did for this test. This technology was in its infancy during my first foray into sniping, but has advanced to the point where anyone can access the most advanced ballistic solvers from the palm of their hand for under $30. However, the quality of the result is only as good as the data input to the program. I decided to use Black Hills 77 Grain OTM ammunition due to its improved accuracy and consistency. The commercial 5.56mm BH 77Gr. OTM is identical to the military Mk-262 Mod 1 that I have been issued overseas (and was used to take out that insurgent mortarman) which was developed to provide increased accuracy and terminal performance over M855 when used in the Mk18 Special Purpose Rifle. Per the factory specifications the Mk-262 utilizes a 77Gr. semi-cannelure Sierra Matchking projectile at 2750 fps out of a 20 inch test barrel. It was also widely issued to deployed Marine Corps units in both theaters until the development of the Mk318 SOST cartridge.

RESULTS

I will now jump ahead to the results of the experiment and then back-track to explain the process that produced the results. The first target was an IDPA silhouette (center circle measures 8 inches) placed at 300m/328yds, the wind was 3-5 mph from 9 o'clock and the sun was setting behind the shooting position. The elevation of the shooting position was 295 feet, temperature was 84 F with an absolute/station pressure of 30.35 in Hg. Five shots were fired resulting in a 7 inch group (2.23 MOA) just low and right of target center. No wind correction was applied to the scope which explains why the group was slightly right of center. The elevation error can be chalked up to a combination of improperly measuring the vertical angle from the shooting position to the target (approximately 30 down) and not accounting for Coriolis effect[1] when I plugged the data into the Applied Ballistics program. I simply did not think of it at the time, but when I zeroed the rifle in North Carolina I was firing due West and for this experiment I was firing due East, which would cause impacts to be low. Another factor could have been inaccuracies in average velocity measurement based on instrument errors or the conditions that I collected the data under. The sample size for velocity collection was small (only 15 rounds) and the conditions were less than ideal, with winds up to 25mph that resulted in my having to sandbag-in the chronograph after picking it up off the ground twice. I also did not have time to perform a turret tracking test on the scope to determine if the elevation and windage adjustments were as advertised. Remember how I mentioned the result is only as good as the data entered?

300M TARGET THROUGH THE SPOTTING SCOPE

The 500m/547yd target was engaged with five rounds under the same conditions with the exception of the wind, which had died to 1-2 mph and the angle to the target changed to approximately 25 down. The five shots resulted in a 10.5 inches group (2.01 MOA) which was again low and right of center. I believe the elevation error is again a result of my failure to account for Coriolis effect and accurately measure the angle from the shooting position to the target or potential errors in measured muzzle velocity.

500M TARGET THROUGH SPOTTING SCOPE

I only had time to engage the 700m/777yd target with three rounds as I was losing light and racing the shadow line toward the target. The conditions were also making it difficult for my spotters to observe the vapor trail/trace of the bullet and impacts on the target. With only 4x magnification to work with, if I had waited any longer, I would not have been able to accurately discern the target from the reticle as the shadow crossed the target. The wind remained the same at 1-2mph, the angle to the target was less than 5 degrees and I finally remembered to account for Coriolis in the ballistic program, so my elevation adjustments and final result were much closer. The three shots resulted in a 9.5 inches group (1.30 MOA) that was just a bit low and right of center.

700M TARGET THROUGH SPOTTING SCOPE

One of the reasons I chose this particular rifle for this experiment was that I had never fired it beyond 100m and had no long range data on it. This allowed me to demonstrate what could

U.S. M855 (left) with the Black Hills 77Gr. OTM / Mk262 (right) at 100m.

A match-grade barrel shrunk the M855 group (left) by ½ MOA and brought the Black Hills 77Gr. OTM (right) down to 1 MOA, with no flyers.

Swapping out ammo is probably the most cost-effective solution that offers the greatest gain in precision.

be done, essentially cold, from 100m out to 700m solely relying on the output of a ballistic solver. Even with the input errors I think this demonstrates that with a standard carbine, quality ammunition, a reasonably competent shooter, favorable shooting conditions and a good program; hits out to 700m and beyond are achievable. When analyzing the group sizes from this test it is easy to draw the false conclusion that the group size is shrinking as the range increases. That would be very improbable from a physics standpoint as the angular dispersion of the bullets can only increase with range. I believe the observed results are more a factor of small sample size and statistical error than evidence that the rifle is more precise at longer ranges. If we use the most realistic group (2.23 MOA at 300m) the resultant group size would be 17.9" at 700m (on an 18 inches wide target). Keep in mind this was also done under very favorable wind conditions against a static target and as more complicating factors are added the percentage of rounds you can realistically expect to impact the target is reduced.

PROCESS

I began by zeroing the rifle at 100m and collecting velocity data for the ammunition I planned on using. I also collected the environmental data for the zeroing conditions as the ballistic solver will use this as a baseline to compare against and calculate from when firing in a different environment (altitude, temperature, barometric pressure; all are factors that affect the flight of a projectile.) Ideally, for the most accurate input and realistic bullet drop, you would want to zero as far out as possible which aids in determining how closely the ballistic model matches reality for your rifle/ammo combination.

Since I was personally limited to 100m (as I expect are most people) I used that for the baseline input. I then packed up the rifle and transported it halfway across the country. Before firing the first shot for the test I ranged each target then sat down and plugged the new environmental data for the new location into the profile I had established for my rifle in the Applied Ballistics Ap. This included a >30 F temperature shift, 280ft elevation change, latitude change and a 180 spin in firing direction from my initial zeroing conditions. This would normally take sitting down with a sheet of equations, ballistic charts, tables and the data book for my rifle (with the conditions and result of every round I've fired) to figure out my rough windage and elevation adjustments prior to my first shot. Now, within seconds of inputting the new data I had firing solutions from 0-1000m. The next step is firing to determine how close the output from the ballistic solver matches reality. Any adjustments to the solver, either to velocity or the ballistic coefficient of the projectile, to accurately reflect the reality of the impacts is known as *Ballistic Calibration.*

At the end of the test, while reviewing the impacts on the targets and comparing my final windage and elevation settings with that provided by the App, I noticed variations between the two which I determined to be linked to the errors I outlined in the results section above. Once the errors are corrected or the ballistic calibration is complete the profile is stored in the Ap and all that is required when shooting at a different location or under different conditions is to input the appropriate data and generate a new firing solution. The ballistic applications are excellent tools if the effort is made to learn the program and the variables, they reduce the learning curve, allow a shooter to jump from location to location without having to shoot new data, lowers the amount of ammunition expended to dial in a rifle in a new environment, and reduces the amount of time and ammo spent to get first round hits. However, the programs cannot read wind (yet,) they rely on batteries and technology that can fail in extreme environments and they are still slower than an experienced shooter who knows his rifle and has trained under all conditions and environments.

UPGRADES

There are hundreds of ways to improve the accuracy or performance of your rifle and most depend on how much money you are willing to invest. I will cover three common upgrades that I feel provide the most value when setting up a carbine for extended range.

The first is quality ammunition. Swapping out ammo is probably the most cost-effective solution that offers the greatest gain in precision. There is no reason to use match grade, high ballistic coefficient cartridges when plinking in the backyard or during your local 3-Gun match, so you can use the cheap stuff for that and keep the expensive rounds for when the accuracy requirements are higher. A comparison of U.S. M855 with the Black Hills 77Gr. OTM / Mk262 sees a dramatic difference in group size (3 MOA vs. 2 MOA with better consistency) even at 100m which can mean a 24 inches group vs. an 18 inches group at 700m.

Next is the use of a match-grade barrel. A high quality barrel can increase the precision of the rifle, offering more consistency, but does come at a higher cost and typically reduced barrel life. The use of a match-grade barrel shrunk the M855 group by ½ MOA and brought the BH 77Gr. OTM down to 1 MOA, with no flyers.

The last item I will cover is the optic, specifically the amount of magnification. There are pros and cons associated with increasing the amount of magnification, particularly with the intended role of a carbine-type rifle. Increasing the maximum magnification of the optic allows for better target identification and more easily defined aiming points which typically result in smaller group size. The downside to higher magnification is a reduced field of view which increases the amount of time required to find targets through the scope and makes it more difficult to track close or moving targets. One other feature is the adjustment increments on the elevation and windage turrets. The .2mil/click increment on the Viper PST scope results in a two centimeter (~3/4 inches) shift in point of impact at 100m. A smaller adjustment will make it easier to accurately center the group when zeroing. Where a group is offset about 3/8 inch to the right, a one-click adjustment would move the group center 3/8 inch too far to the left. The downside to smaller adjustments becomes apparent when trying to make large changes in windage or elevation to engage fleeting targets or when the range is drastically different.

> A match barrel can increase precision of the rifle.

CONCLUSIONS

While it has been demonstrated that making accurate hits at extended range with a carbine is entirely possible, we have not discussed if it is a good idea or not. One of the drawbacks of smaller calibers is the amount of velocity and energy they lose as the distance increases. For the 77Gr. OTM, for the rifle and test conditions above, it had 1912fps and 625-ftlbs of energy at 300m, 1520fps and 395-ftlbs at 500m, and 1200fps and 246-ftlbs at 700m. For comparison, a .22 Magnum has 325-ftlbs of energy at the muzzle, and a 124gr. 9mm pistol round has 384. So, if you couldn't ethically justify shooting something with a 9 or .22 you may want to consider reducing the effective range of your 5.56 platform. .224 (yes .224) caliber bullets that will fit in standard magazines are also not the optimal profile or weight for resisting the effects of wind as the range increases. Under windy conditions the probability of accurately engaging a distant target is reduced more than with higher caliber and higher ballistic coefficient projectiles. One other factor based on velocity is where the bullet slows into transonic and then subsonic speeds. This zone, and how the bullet enters and exits it, has the effect of essentially randomizing the bullet's path and results in inconsistent groups and key-holing. This also poses a problem for ballistics solvers unless the developer has tested that specific projectile into subsonic velocities and tweaked the computer model to match reality. From a user's perspective, this usually requires the purchase of a custom drag curve which is what I did for this experiment. For anyone who is interested in my initial velocity data and group size comparisons I will post them at www.shibumitactical.com/articles.

Hitting torso-size targets (and similarly sized animals) with a good combination of 5.56 AR style rifle, optic and ammo at 1000 (+) meters is doable. Marine and Army Designated Marksmen routinely engage targets with M-4s with ACOGs and issued ammo at 750 meters. The greater the range, however, the lower the performance (for incapacitation) of the 5.56 round on impact.

Thanks to the Marines of 3rd Force Reconnaissance Company for their outstanding spotting support and expertise during the live-fire testing portion of this experiment.

BIO

Ken Javes (www.shibumitactical.com) has over 19 years of military and security contracting experience to include multiple combat and contract deployments to South West Asia. He has served with Marine Infantry and Force Reconnaissance units. He possesses instructor certifications from multiple agencies and organizations, and is a graduate of the USMC Scout/Sniper course.

[1] an effect whereby a mass moving in a rotating system experiences a force (the Coriolis force) acting perpendicular to the direction of motion and to the axis of rotation. On the earth, the effect tends to deflect moving objects to the right in the northern hemisphere and to the left in the southern and is important in the formation of cyclonic weather systems.