Measured Trajectory Angles at the Target for .22 LR, .45 ACP, and 45-70

by Paul Rittmann and John Hauer

At the 1000 yd range the metal parts of the target carriers are hidden from the shooters to protect the pit crew from bullet splatter. However, if a bullet is fired at a large enough initial trajectory angle, the bullet may enter the target pit at such a steep angle that it could hit the metal frame of the target carrier. Of interest in this regard are .22 LR for mini-Palma matches, the .45 ACP from a semi-auto Thompson at the Vintage Military Rifle matches, and of course the various black powder long range loads from Sharps and similar rifles.

Following the procedure used by others, John Hauer and Paul Rittmann constructed a double target arrangement to measure trajectory angles at the target. The measurements were conducted at the 1000 yd range at the Rattlesnake Mountain Shooting Facility located about 8.5 miles north of Benton City in southeastern Washington on July 6, 2006.

As you can see from John Hauer's photos (last page), the two targets were held together with 8-foot 1" x 2" lumber. The targets were 7 feet apart. The 1" x 2" are attached to the target frames at the same distance from the bottom and top of the targets, 10.5". We rested the front target on the railroad ties and adjusted the height of the rear target so the 1" x 2" are level.

I fired ordinary 36-grain .22 LR ammo through a Ruger 10/22 at 200 yd and 300 yd. At 200 yd the bullet holes in the rear target were closer to the top than the ones in the front target. In other words, the bullets were still rising. This is because the soil protecting the target frames and pit crew is about 6 feet higher than the gravel located at the 200 yd line. The measured difference in bullet hole position for two bullets was -0.63" and -0.44". At 300 yd the rear hole was lower on the target than the front hole. The measured difference for the only bullet we measured was 0.69". It took several rounds to get on paper. The crosshairs were near the top of the number board. The rifle was zeroed for 100 yd.

I also fired my semi-auto Thompson at 200 yd and 300 yd. At 200 yd the bullets were also rising. The bullet hole difference for two bullets was -0.38" and -0.25". At 300 yd the difference for two bullets was 1" and 1.63". John also measured the muzzle speed of the 230 grain jacketed round nose bullets. The 8-shot average was 935 fps with a standard deviation of 13 fps. The slowest bullet was 921 fps. The fastest was 956 fps.

At this point we learned that it takes two people to measure bullet holes on the second target when the holes are in the upper half of the target. One person stands on the ladder and holds the tape measure near the holes while the other person reads the tape measure from a position on the berm. Also, holes in the upper half of the target cannot be patched until the apparatus is disassembled. We only had a 6-foot ladder with us. A taller ladder would be a good idea.

John fired his 45-70 from 600, 800, 900, and 1000 yd. The 45-70 was a Shilo 1874 Sharps with a 6X MVA scope. Two loads were used, with black powder and a muzzle velocity of 1190 fps in both cases. Load #1 used the 535 grain Lyman Postell bullet, which is fairly pointed. Load #2 used the Lyman 520 grain "Government" bullet, which has a very round nose. Load #1 was fired from 600, 800, 900, and 1000 yd, and load #2 was fired only at 1000 yd. We put up a second target to get a zero and then went to the double target to measure bullet drop.

Load #1 produced a 2” height difference when fired from 600 yd, 4” from 800 yd, 4.31” from 900 yd, and 5.38” from 1000 yd. . Load #2 required an extra 4 minutes of elevation at 1000 yd, but produced the same trajectory angle at the target as load #1 at that distance.

John was firing in a typical Rattlesnake wind coming from behind the shooter at 15 to 20 mph. The 45-70 bullets get blown around as much as any other caliber, and this may have affected the observed bullet drop.

The soil between the pit crew and the shooting line peaks about 8 feet in front of the target. The metal bar at the top of the carrier is 10 inches below the top of the soil, so a good rule of thumb is any bullet falling less than 1 in 10 (at the targets) is safe. This corresponds to an angle of 5.7 degrees. Since our double target had a 7-foot spacing, any drop less than 8 inches is safe. Thus all of the loads were safe at the distances tested.

Lessons learned:

(1) Get a bigger ladder, or find a way to lower the double target.
(2) Use a 2^{nd} target to get on paper, and then use the double target.
(3) The test apparatus held up well in a wind that gusted to about 20 mph directly into the targets. Setup/takedown is much easier if the wind is hardly blowing.

The table below shows some of the details measured.

Load	Range	Distance from the Top Edge to the Hole, inches		Height Difference (inches)	Trajectory Angle (degrees)
		1st Target	2nd Target		
.22 LR	200 yd	40	39.375	-0.625	-0.43
36 grain		44.9375	44.5	-0.4375	-0.30
Ruger 10/22	300 yd	39.4375	40.125	0.6875	0.47
.45 ACP	200 yd	10.125	9.75	-0.375	-0.26
230 grain		22	21.75	-0.25	-0.17
Thompson	300 yd	21	22	1	0.68
		34.375	36	1.625	1.11
45-70	600 yd	51	53	2	1.36
Shilo Sharps	800 yd	29	33	4	2.73
535 gr	900 yd	4.6875	9	4.3125	2.94
	1000 yd	28.25	33.625	5.375	3.66
520 gr		36.375	41.75	5.375	3.66

Notes:

- 1st & 2nd targets are 7 feet apart.
- Measuring distance on the 2nd target was not exact because the target could not be lowered. (Distances less than 30 inches could not be patched either.)
- The trajectory angles are computed from the measured height difference using the formula, Angle = Arctan (Difference / 84 inches).

Trajectory Drop Tests

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