Buzzing Bees or Mushrooms?

"Hard Cast or Soft Cast bullets:
a preliminary test to see what is safest?"

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This series of tests was precipitated by an initial article by Sundown Jones, SASS # 5403, in the February, 2003 SASS *Cowboy Chronicle* regarding the buzzing bees (Bouncing Bullets) that seem to fly and buzz around any given cowboy shoot on any given day and stage. Shortly after reading the article, I shared a practice shooting session with Wild Gene Hiccup , SASS # 35870 (AKA, Gene Curcio) during which we experienced the very same phenomenon; splatter, shrapnel and zinging lead. As a result of some informal testing with different loads and bullet alloys we wrote a follow on article which was printed in the December *Cowboy Chronicle.* That article was titled the same as above.

To recap that article and give you an insight into why we wanted to be a bit more scientific with this one, I will paraphrase its major content:

"…… *a few of us were shooting at a fellow SASS members home shooting range and noticed that we could hear shrapnel from his loads bouncing on the metal roof of his hay barn. This wasn't too unusual or exciting until we realized the barn was a good twenty yards* ***behind*** *us! We also soon discovered that it was only his loads that were fragmenting and causing the rattle on the roof. The others shooting that day were field-testing some bullets from a new bullet company that produces a very soft lead alloy. The alloy the others were shooting was in the range of about 8 Brinnel Hardness (BHN8). The loads from Wild Gene Hickup's ammo were from another company and were advertised as being an alloy in the range between 22 and 24 BHN. We all decided to stop and do a fairly structured test to see if there really was a difference.*

We selected one target that seemed to predominate in sending the bullet pieces back over our heads and on to the roof. We then marked the spot from which the shots were fired and loaded a pistol with the harder alloy bullets. Sure enough, of the five rounds fired three resulted in the rattle of buzzing bees on the roof. We then loaded the same pistol with the same velocity load only using the softer alloy from the new company. Miraculously there were no reports of raining splatter on the roof. This procedure was repeated several times and the same results were experienced. Next the group decided to see how much of the bullets were recoverable from the catch pit under the target.

After raking a clean area beneath each of the five metal loosely hanging targets the pistols were loaded with the harder alloy ammunition. Again the raining of bees was evident. After a series of 25 shots we all went forward to inspect the ground under the targets. It was surprising to discover that we could only find eleven significant pieces of the individual bullets. The most common discovery was the bore sized base equal to about half of the original length of the bullet. This half a bullet piece was almost completely bore diameter, except for the very nose end, which had about a .040" to .080" bell effect (where did the rest of the bullet go?). The area was again raked clear and the same pistol was loaded with the same velocity load using the softer alloy bullet. Again 25 shots were fired at the series of targets. As before with these bullets, there was no rattle of raining buzzers on the barn roof. After the series of shooting we went *forward to inspect the catch pit area. To our surprise we discovered that most of the bullets were of about "quarter sized" tulip blossomed mushrooms. These were bullets fired from a 357 magnum Ruger Vaquero using a standard cowboy action load. Those flattened bullets not found immediately below the target plates were found along a parallel axis to the target stands and ranged as far as ten feet to the side. Not all the recovered bullets (21) produced the classic tulip petal mushroom but all did demonstrate a complete flattening and weighed between 70% and 90% of original weight. The harder alloy bullet remains weighed at best 30% to 40% of original weight……"*

The current article is a step above the informality of that first test, but does follow the principles of scientific discovery and replication. Given the above as an introduction and a serious rationale for the purpose to test different components for range safety. I hope the following information and strategies will be a foundation for further testing by several others. This is not a situation to be overlooked or taken lightly.

As outlined in the original article, the testers merely listened for a reactive impact on a metal roof and raked the area to look for remaining evidence of the projectile. This brief study was designed to determine a test layout and procedure for collecting actual trajectories of bullets and fragments. To begin I would like to offer some standard definitions and others that evolved from this set of tests,

Definitions:

Bees: The "Petal" fragments from a fragmented bullet after impact.
Bullet: The complete projectile fired from a firearm
Bullet Alloy: The formula of and metals in the cast bullet. The basic metals are Lead, Tin and Antimony
- **Hard :** an advertised hardness between BHN20 and BHN24
- **Medium:** an advertised hardness between BHN12 and BHN16
- **Soft:** an advertised hardness between BHN8 and BHN10

Button: A bullet base near bore diameter which weighs less than 60% of the bullets original weight, yet has no Petals
CAS/SASS load: Any loading that produces a bullet velocity of over 650fps
Fragment: Any part of the bullet which separates from the core integrity upon impact larger than a #6 birdshot(see also "Petal")
Mushrooms: Those bullets which retain more than 90% of their original weight and 80% of their Petals.
Petal: That part of the impacted bullet which is retained in the deformed structure, but has flattened out like a petal of a flower (if separated it becomes a Fragment or Bee)**.**
Angle of Incidence : The angle at which the bullet strikes the target
Refractive Angle (Angle of Refraction): The angle the bullet, or bullet parts (Fragments, Petals, Buttons or Mushrooms) departs from the target after impact
- **Vertical refractive angle**: the angle the fragments depart from the target which varies from the hypothetical vertical plane; or perpendicular to the ground

Horizontal refractive angle: the angle the fragments depart from the target which varies from the hypothetical horizontal plane, or parallel with the ground

Safest Bullet: The bullet containing the alloy which refracts the least amount of fragmentation towards the firing line

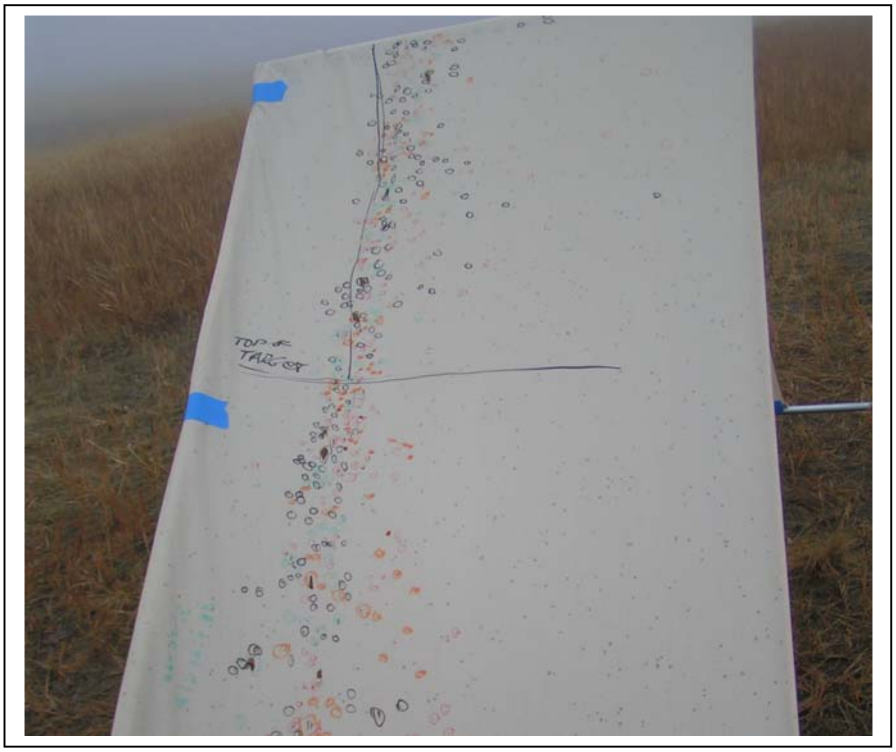
Target: Standard steel plate used in shooting stages

Zingers: The smallest of fragmented particles that sting but don't penetrate the skin but can cause eye injury, about the size of a grain of sand (about the size of #7shot or smaller)

The whole point of this treatise is to determine if one alloy is safer (meaning fewer fragments impacting at or behind the firing line) and if so, what range of hardness provides the safest range conditions. Since most SASS targets seem to be of similar size and shape, it was determined for this study that any target approximately 16" by 16" would represent the average mass and subsequent reaction to the test loads.
This test was set up with only one steel target and was selected because it had the smoothest 'face' in the stable. As it turned out, this particular target had a slight bit of radius and thus was not absolutely flat, it was actually bowed a bit in the middle with the fading radius forming away from the shooting position, or convexed. In reality, this was a safer target than absolutely flat or concaved facing the shooter.

The standard CAS/SASS loads compared were in .45 Colt, .38 Special and .32-20. All loads were fired from pistols with 5-1/2" barrels and shot by the same shooter, from the same distance and angle to the same point of impact at the center of the steel surface. All loads in each caliber/gun combination incorporated the same powder, powder charge, primer, and case. The only variable being tested was the bullet alloy/hardness from different manufacturers. The alloy hardness numbers which determined whether they were classified as "Soft", "Medium" or "Hard" were taken from the respective manufacturer's web information. For the purpose of this study the definitions as listed under "Bullet Alloy" above will define the relative hardness's.

The purpose of this study was to determine not only that bullets might fragment in different configurations but also to determine if there was a consistent direction and range in which the fragments might predominate. The earlier study had already demonstrated that there was a difference. This study was to determine to what degree there was fragmentation and what direction they went. We needed a medium that would actually capture the impact of the flight of the fragments so we could measure their flight direction and relative size. To determine a measurement of fragments from target impact a "house" of paper was erected around the target. This "house' was a steel tent frame that normally supports a canvas wall tent that measures sixteen feet by twenty feet. Preliminary test assessment strongly suggested that a house that completely encapsulated the target was both difficult to erect and maintain, but was also unnecessary. The first shots from setup firings very clearly displayed a distinct pattern for the refractive fragments. Consequently, the complete "house' configuration was scrapped and a single wide sheet of waxed butcher paper was stretched across the frame. We first fired ten (10) rounds of a single bullet alloy and measured the relative angles and number of punctures in the paper. After review of this target it was concluded that rather than a single sheet for each caliber and alloy, it would be more demonstrative, and easier, to fire fewer bullets' but shoot all the alloys from a single caliber/pistol at the same target and then compare the angle, size, and concentrations of fragments (see photo below).



Methodology:

The method of testing was relatively simple. We erected a tent frame, hung a target, stretched and anchored a paper over the frame then returned to the shooting position loaded the test loads and fired them at the center of the target. After firing one set of the loads (five rounds of the alloy) we returned to the target paper and, using a handy colored felt pen, marked all the holes from that test sequence. We then repeated the marking with a different color of felt marker for each load until all the loads are fired. At the conclusion of firing all the alloy test loads, we recovered the paper and hung a new one for the next caliber. Once all the test loads had been fired we took take the recovered test patterns to a nice, large flat wall and from the base lines for "center of target" and "top of target" counted all the holes, measured the average angle of refraction and somewhat subjectively estimated the size differences in each zone. Zone is a newly introduced term and is defined below.

Zone S-1, (Safe-One) was defined as that area the area with an angle less than 15 degrees from the vertical plane of the target AND 90 degrees below the plane of the top of the target. These fragments had all the appearance of being refracted in such a trajectory that they would reach neither the berm, the shooting line nor the next bay.

Zone S-2 (Safe-Two) was defined as that area contained with a 15 degree arc on each side of the vertical centerline of the target, or a total of 30 degrees of vertical dispersion. These fragments also had the appearance of dispersing in an area not considered significantly hazardous for the range. Observations suggested these fragments would lose all energy before they contacted a shooter anywhere on the range.

That left Zone X, the area remaining between the two “S” zones, but including only the fragment count that was also outside a 15 degree horizontal plane. It was somewhat arbitrarily determined that this area provided the zone that contained the trajectory which would most likely result in any fragment with sufficient energy reaching the shooting line for any given shot.

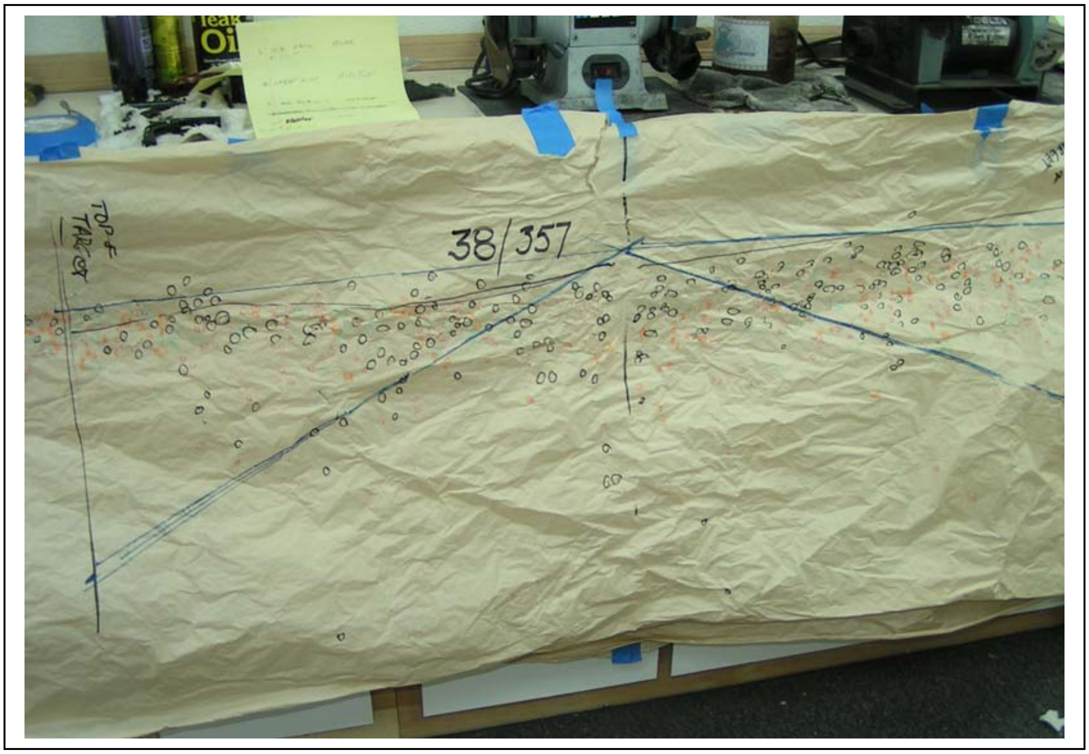
Since only five shots for each caliber and alloy resulted so may holes to count and analyze within zone X, the data will only reflect fragment and definable zinger counts from that area.

The table below summarizes the count for fragments, zingers and “large” chunks that penetrated the capture paper. Remember a fragment is larger than a #6 birdshot and a zinger is at or smaller than a #7 birdshot. The term “Large” was added for the table to include those fragments that tore a sizeable hole or rip in the paper and measured in the over ½” class all the way up to over 1” in length.

Zone “X” Fragment Count

	Caliber	32-20	38/357	45 Colt
Hard Cast				
	Fragment	4	17	15
	Zinger	9	43	22
	Large	2	0	3
Medium Cast				
	Fragment	12	10	15
	Zinger	33	21	7
	Large	3	0	2
Soft Cast				
	Fragment	1	2	0
	Zinger	0	9	0
	Large	0	0	0

Sample Test Sheet (38/357)



Some conclusions:

Rather than compare the obvious, it should be somewhat apparent that a soft alloy bullet results in the least amount of fragmentation returning toward the firing line. From this collection of data it also seems, and the “Warthogs” will appreciate this, that a 45 caliber using a soft alloy bullet is the safest ammunition on the range!   The surprising comparison was to notice that a 32-20 with hard cast alloy bullets is “safer” than with medium alloy bullets, but definitely safer with a softer alloy. Thus, the “safest” bullet. All other comparisons certainly do support the premise that softer alloy bullets provide a safer range environment.

While only the fragment count for what is defined as zone “X” were counted for analysis, it should be noted (see picture above) that there was a mass of fragment evidence between the 10 degree angle and the 15 degree angle. Further study of the trajectories of these fragments and their impact at the shooting line needs to be assessed.

The major conclusion to be appreciated from this study is that more study with some more restrictive parameters and more precise test sheet placement needs to be conducted.

Some considerations, recommendations and variables:

While only the fragment count for what is defined as zone “X” were counted for analysis, it should be noted (see picture above) that there was a mass of fragment evidence between the 10 degree angle and the 15 degree angle. Further study of the trajectories of these fragments and their impact at the shooting line needs to be assessed. Also, this study concerned itself with a single target with a shooter firing perpendicular to its surface. Additional study needs to address the impact of a series of targets as are normally placed in a shooting stage and the impact of dissimilar angles of incidence. And, finally, but not lastly by any means, we need to determine the effects of target integrity, namely pitted faces, concaved and convexed shaped target faces

The results for additional testing may, in the long run, help us design better target placement designs, set a standard for target integrity and provide a guideline for berm placement and shooter spectator areas. In addition, it may influence more shooters to become more selective with their loading components regarding safety of their fellow shooters..

I encourage anyone seeking similar knowledge, or those questioning the data above, to undertake additional testing with whatever controls they choose. This study was/is not intended to be the last word on the subject, but hopes it will inspire others to continue testing.