

A PHYSICS PROFESSOR'S VIEW OF BALLISTICS

PART V (Terminal Ballistics including handguns)

By Bert Blanton

Previously we talked about the first requirement for hunters to bring down an animal was to hit their target and THEN to obtain adequate PENETRATION with the bullet. In other words the round will not do anything but knock the game down and make a bruise unless it penetrates its skin and then penetrates far enough into tissues to disrupt its anatomy. If it happens to penetrate adequately, there are many styles of bullets designed to do the most damage. Most of these are pretty similar. We are not going to deal with bullet styles here. Maybe another time!

There are 3 main factors which affect the penetration of a projectile into anything. 1) Velocity of the projectile, 2) mass (weight) of the projectile, and 3) shape factor of the projectile. A 4th factor is "hardness" but here we are going to assume that the bullet is always much harder than the tissues it is trying to penetrate.

Velocity: It is pretty easy to visualize that the faster moving any given projectile is, the more likely it is to penetrate skin and tissue. We have heard the story of the soda straw penetrating wood during a tornado due to its extreme velocity. The faster a given bullet is moving, the greater its penetration into anything it hits. The exception might be if the bullet is fragile and it hits something very hard there will be very little penetration. Trying to penetrate layers of clothing, vests, or car doors complicates this subject and we will not address it here.

Mass: A heavy projectile has more momentum (inertia) (energy) than a low mass projectile so it is harder to stop. Try stopping a 150 ton freight train doing 3 mph with your 1 ton Chevy Bellaire. A heavy projectile moving at the same speed as a light weight one will penetrate farther. Would you rather get hit by a 0.5g nerf projectile doing 800 fps or a 230g lead one?

Shape Factor: This may be a little harder to wrap your head around. Have you ever seen a nurse hold a hypodermic syringe about 2-3 inches from a patient's arm and throw it at it? The needle will penetrate about 1/4"-1/2". Imagine a syringe with a 1/4" diameter flat nosed needle of the same weight thrown from the same distance. Hah! It will bounce off of the patient's skin. Same weight, same velocity but no penetration! So slender pointy things penetrate better than big flat pointed things.

Okay now let's look at a new tool to analyze these things. It is Hornady's "HITS" calculator. It takes these 3 factors into account. Hornady has the following to say about it:

"HITS calculator

The 'Hornady Index of Terminal Standards' (HITS) calculator is a resource designed to help hunters choose effective bullet/cartridge combinations for any hunting situation in the world. Traditional muzzle energy figures do not take into account for the manner in which energy is transferred from the bullet to game animals. HITS factors in Bullet Weight, Sectional Density, Ballistics Coefficient, and Impact Velocity and delivers a rating that will fall into one of the four classifications below. Bullet construction is also a very important factor to consider. If you have questions as to which Hornady bullet is right for you, there is a quick performance reference listed at the bottom of the page.

The H.I.T.S. rating on Hornady ammunition is based on: 100 yard impact velocities for rifles, muzzleloaders, and shotguns and 50 yard impact velocities for handguns."

"HITS Classifications

The Hornady Index of Terminal Standards (H.I.T.S.) is intended as a guideline to help hunters compare cartridge and bullet combinations. Beginners and seasoned hunters alike will find these standards useful when sorting through online chat room discussions and gun shop "hype" to make sense of an onslaught of varying information.

The index considers variables such as impact velocity, ballistic coefficient, sectional density and bullet weight. Bullet construction is another important factor in determining the best combination. H.I.T.S. is intended for use with hunting bullets, as match bullets may perform unpredictably on game animals.

Remember, H.I.T.S. is merely a guideline to help you choose the proper bullet/cartridge combination. Be sure to consider impact velocity and bullet construction and select a bullet that is appropriate for your situation. "



Small Game

less than 500 H.I.T.S.

The basic rule of thumb is that a H.I.T.S. rating of 500 or below describes a bullet/cartridge combination best suited for small game animals weighing less than 50 pounds.



Medium Game

500-900 H.I.T.S.

A rating of 501 to 900 applies to bullet/cartridge combinations that are applicable for medium-sized game such as deer, antelope, black bear, and caribou, or game weighing 50 to 300 pounds.



Large Game

901-1,500 H.I.T.S.

A rating of 901 to 1,500 specifies cartridge/bullet combinations well-suited for large and heavy, but not generally considered dangerous game. This includes elk, moose, African plains game, red stag, American bison, and other animals weighing between 300 to 2,000 pounds.



Dangerous Game

over 1500 H.I.T.S.

A rating of 1,501 or greater indicates cartridge/bullet combinations that are suitable for dangerous game - game that is content hunting you back. There is no weight rating on this category since animals like African lions may weight only 400 pounds.

On the following pages I have run 3 investigative scenarios on the HITS calculator for rifles and then some for handguns. Bigger HITS numbers mean bigger game. I have interpreted that to also mean better penetration and possible stopping power. We will concentrate on penetration.

The first graph is using a .243 caliber with 100 g bullets at different impact velocities. The second is a .243 at the same 2000 fps impact velocity with different bullet weights. The third is a 100g bullet with an impact velocity of 2000 fps but of different shape factors (calibers).

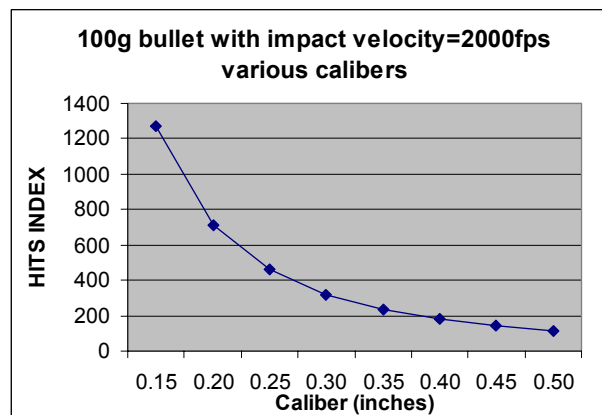
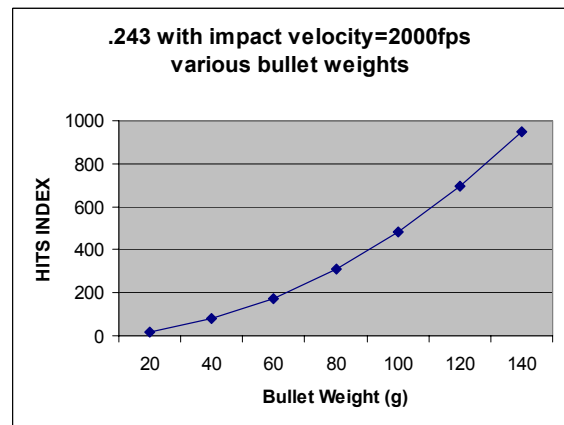
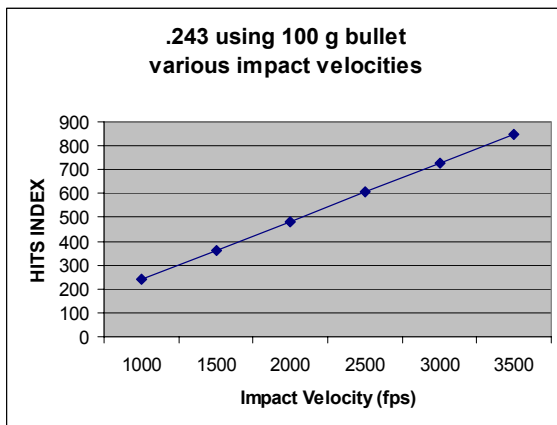
The first graph says that there is a positive linear relationship between impact velocity and HITS numbers. **More velocity=bigger game.** If you use a .243 you should use a faster bullet for bigger game. Use a bullet with better Ballistic Coefficient, use more/better powder, or shoot closer in where velocity is still up.

The second says there is a positive rapidly increasing relationship between HITS index and bullet weight. **Heavier bullets of the same caliber=bigger game. A small cahnge in bullet weight gives an increasingly larger increase in HITS index.** If you use a .243, use a heavier bullet for bigger game. Best choice for bigger game would be a heavy bullet moving as fast as you can get it. You can't get heavy bullets moving as fast as you can get lighter bullets moving without blowing something up so use the heaviest bullet you can safely use. Check the examples below.

The third graph shows an almost linear inverse relationship between caliber and HITS index. **Larger caliber=smaller game.** Wait! What did I say? When I first saw this graph I wasn't sure that I believed it. It says that if I have a long skinny bullet moving at 2000 fps it will penetrate better than a short fat bullet of the same WEIGHT moving at 2000 fps (a 100g .50 caliber bullet will be pretty short. A 100 g .15 caliber bullet will be pretty long). This is the hypodermic needle we talked about. More about this later.

So now what do these graphs mean to the hunter? You are going to have to run several HITS scenarios to choose a caliber and a bullet that gives you the best HITS index number (I have done a few for you below). Choose a caliber that suits your recoil tolerance or your pocketbook or the availability of ammo and go from there. Same problem you have always had but now you have the calculator and some knowledge to help make your decision. You will see that the bullet weight has the most effect, the velocity next, and the shape factor least.

We all know you don't hunt Cape buffalo with a .243. When you run some numbers, you find that you don't have enough powder or a big enough case or a big enough bullet to get there. You have to go to larger cases to get a heavy enough bullet moving fast enough to do the job.



EXAMPLES:

Let's say we think we need a HITS number of 1000 to go Elk hunting in Oklahoma (*Hornady says 901-1500 for elk*). Let's choose a caliber and bullet using the HITS calculator.

CALIBER (in)	BULLET WT. (g)	100 yards		200 yards		300 yards	
		Impact Vel (fps)	HITS	Impact Vel (fps)	HITS	Impact Vel (fps)	HITS
.243 Win	100	2612	632	2386	577	2171	525
.257 Roberts	120	2569	802	2349	733	2140	668
.260 Rem	140	2487	999	2284	918	2090	841
7mm-08 Rem	150	2438	973	2235	892	2043	815
.270 Win	110	3125	705	2868	647	2624	592
	130	2829	890	2633	828	2434	766
	140	2760	1009	2579	942	2404	878
	150	2654	1112	2446	1024	2266	948
.308 Win	150	2611	885	2410	817	2219	752
	165	2481	1015	2272	930	2073	848
	175	2427	1121	2262	1050	2102	971
	180	2388	1165	2213	1080	2045	998
30-06 Spring	110	3088	564	2797	510	2524	461
	125	2779	653	2446	575	2136	502
	150	2666	704	2435	825	2216	751
	165	2607	1067	2395	980	2193	897
	180	2524	1231	2355	1149	2193	1070
	220	2120	1544	1859	1354	1623	1182
.300 Win Mag	130	3204	816	2927	746	2667	680
	150	2898	982	2661	904	2435	825
	165	2816	1152	2594	1062	2382	975
	180	2774	1353	2595	1266	2424	1182
	190	2726	1481	2558	1390	2396	1302
	200	2476	1491	2263	1362	2060	1240
7mm Mag	140	2924	1015	2709	941	2504	869
	150	2832	1130	2647	1056	2469	985
	160	2752	1246	2563	1161	2381	1078
	175	2530	1373	2320	1259	2121	1151
.223 Rem	69	2642	361	2353	321	2084	285
30-30 WCF	160 FTX	2151	829	1917	739	1700	656
.22 Win Mag	50	1197	89	-	-	-	-
.22 LR	40	1011	48	-	-	-	-

What this says is 1) if you are going to hunt with a .270 and might shoot the elk at 300 yds, use a 150g bullet. 2) If you are going to use a 30-06, choose a 165g or 180g bullet. 3) If you must use your beloved 30-30, plan on only shooting at 50-75 yds. You must pass on the long shots even though you can probably hit the elk. 4) In every case the heavier bullet is better even though they are slower! As always, shot placement, bullet design, and handloading are also big factors not included here.

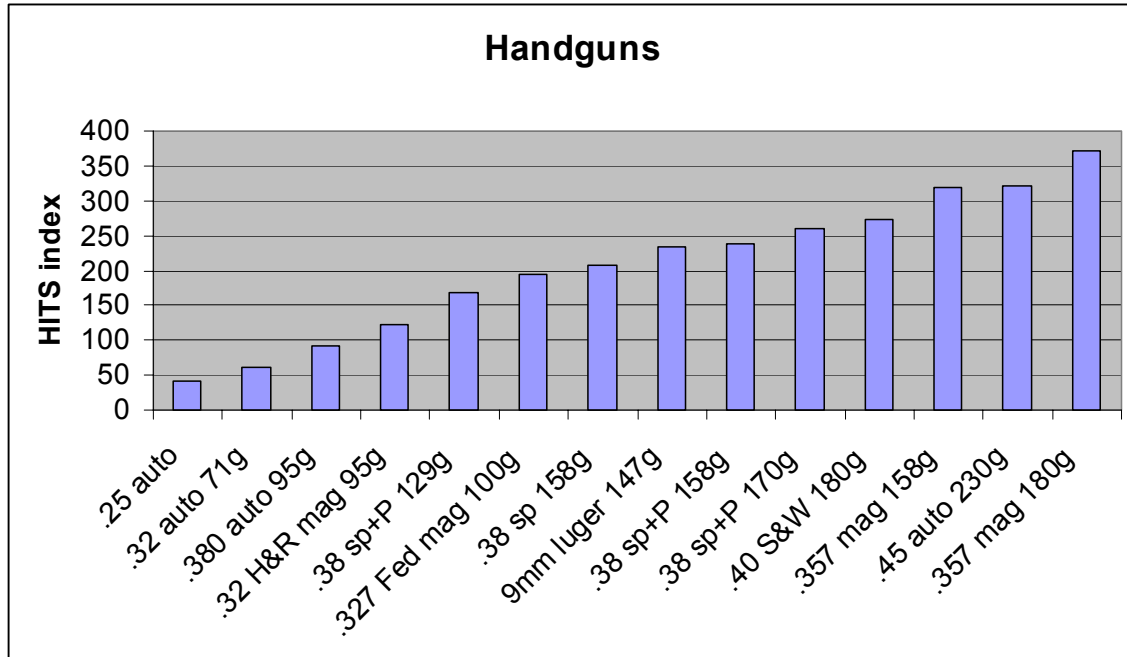
HANDGUNS

Now for handgun shooters and those concerned about self-defense (most of us). I ran the HITS calculator for several handgun scenarios (handguns are 50 yds). The results are charted below.

The greatest penetration/game size of the ones I ran goes to a .357 Mag with 180 g bullet. Next is .45 auto with a 230g, then .40 S&W with 180g then .38 sp+P then 9mm luger. Below .38sp+p it falls off pretty quickly. I did not do +P on any calibers except .38 special. You can run it on your caliber if you like. A 9mm+P would probably jump up several places. BTW Hornady says less than HITS=500 should be "small game". These are also all at 50 yards. We are concerned more about 10 yards. This graph tracks very closely with various stopping power tables and charts I have seen including some testing done on goats.

Notice that the 9mm with 147g bullet is almost the same as a 38 sp+P with 158g bullet and less than a .38 sp+P with a 170g bullet. It is almost in a class with 40 S&W.

I am also sorry to say that it looks like a .380 auto is a "mouse gun" (I have been wanting one due to their small size). If you take out the revolvers, there is a big jump from .380 auto to 9mm in autoloaders. The big boys say "9mm or larger" for self-defense and Hornady's calculator agrees 100%. If you want a revolver, then ".38 special or larger" with the possible exception of .327 Fed Mag. The .38 sp+P with a heavy bullet is quite adequate if 5 rounds is enough for you.



Again you are looking for bullet mass, then velocity. It turns out these handgun results obviously get better with larger calibers in contrast to the caliber chart we saw earlier. This is because the bullet mass/weight increases rapidly with caliber increases and overshadows the shape factor effect.

Your ammo numbers may be somewhat different from mine. For the most part, I used Federal factory ammo ballistics. This HITS calculator can be found on the Hornady web site at <http://www.hornady.com/hits/calculator>.