A New Concept in Deep Penetration of Solid Rifle Bullets in Large Animals

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Introduction; I'd like to remind the reader that this article is about the penetration of solid non-deforming bullets, not the killing of elephants or buffalo. As you read, you will see statements of fact that are not to be applied in the field because of their limited value in real hunting situations. However, I used them to make my point or for comparison purposes only. Hopefully there will be some information here that can be applied in the field to make your hunting safer and more productive.

Like poachers, one could shoot elephants behind the forelegs with an AK47 in 7,62x39 or the .303 British. However, that is not ethical hunting. Or one could do like Bell and shoot the 7x57 Mauser, 175 grain solid at 2350 fps while perched high atop a ladder so as to find the right spot with the correct angle in front of the ear hole (which is the weakest point of an elephant's skull). Like Bell, you should have a gun bearer with your big double for backup.

For sport elephant hunting today, we want a cartridge that guarantees that a headshot is a kill shot under most circumstances, especially on an angry, charging animal. That means the bullet has to completely penetrate and exit the head from all possible angles. With frontal shots, sometimes a massive part of the trunk must also be penetrated. If an elephant is wounded, it could run and disappear into the bush. In such cases, you will need deep penetration to reach the vitals as you shoot the south end of a northbound animal.

Looking at modern solid bullets with sectional densities of .310 to .350, launched with a muzzle velocity of 2350 to 2500 fps or faster, and used at a distance of 20-35 yards for a head shot, a hit to the brain with any solid .375 or .416 caliber bullet will do. The .458 or .510 diameter bullets can give an extra margin of safety for a near miss of the brain and will still bring down or kill the animal.

The .338 Winchester Magnum, .375 H&H, .416 Rigby, 416 Remington Magnum, 450 Dakota .458 Lott, 460 Weatherby and 500 A-Square (with hot loads) – all have what it takes to deliver reliable and deep penetration. There are other cartridges, which fire the same bullet diameters as the above-mentioned cartridges do, and which are up to the task, and then there are cartridges, cloaked in myth, the use of which could mean a fatal situation for the hunter (because of the lack of deep penetration). However reports on such events are normally not for the public. A different example: A 535 grain .510 bullet at 2350 fps traveling diagonally through an elephant's head from ear to opposite eye and not exiting. The elephant might get up quickly if the brain is missed (assuming no secondary missiles). If you have to use a rifle from the largest-calibers group, go with the hottest cartridge/load you can handle.

If penetration is the first parameter, then the frontal area of a bullet is the second parameter to look at. If you want a big gun, .510 or bigger, we are coming to the end of recoil tolerance soon, because the older cartridges in the .600 and .700 range do not have sufficient penetration and the modern cartridges in this group - .577 Tyrannosaur or .585 Nyati - give problems with recoil for most hunters. The matter is different for smaller game,

but as previously mentioned, here we are discussing the hunting of large dangerous game with the highest possible performance and penetration.

No discussion on shot placement is available here; one can read about it everywhere. Penetration is often neglected and can vary a lot depending on the bullet's path inside the animal. We are not looking at the caliber, not the bullet mass, not even the kinetic energy - we are looking for the cartridge and bullet with the most penetration a hunter can carry in the field.

Years ago, as big game hunting reports on bullet failure with copper jacketed, lead core, FMJ bullets started coming in, it became evident that bending, breaking up and flattening of the bullet shank (acting as a rudder), were real problems. Example: A hunter using a .375 H&H with a 300 grain FMJ copper jacketed, lead core bullet shot a buffalo in the shoulder, the bullet entered the animal, struck the shoulder blade and bent 90 degrees along with flattening the shank. The bullet with this rudder-shaped shank made a 180-degree turn, exiting the buffalo on the same side it entered. The bullet flew back and struck the hunter in the shin breaking his leg, leaving the PH to finish the job for the hunter.

To answer these problems, bullet manufacturers came out with monolithic solids that offered better performance. There were only minor complaints - less penetration in the game, loss of powder volume in the cartridge case because of seating depth and sometimes a ruined rifle due to a mismatch in bore/bullet diameter, a problem for older rifles. Today's projectiles, with the new generation of steel jacketed bullets with lead alloys or even tungsten cores, give better performance than the monolithic bullets (they are very rigid). A monolithic is more susceptible to bending than the new FMJ bullets. The new FMJ bullets are the shortest solids, giving that extra bit of powder capacity and showing maximum penetration for the bullet diameter.

In a .458 Winchester Magnum, which of these bullets would penetrate best? And which is most suitable for a thick skinned animal? (All these bullets are .458 caliber non-deforming bullets)

1. **500 grains at 2000 fps?**
2. **400 grains at 2500 fps?**
3. **350 grains at 2860 fps?**

Answer: With all parameters being equal, there would be little difference in penetration. However, with the .458 Winchester Magnum it is impossible to compensate mass with velocity and stay within safe pressure limits. Only the 500 grains at 2000 fps is a realistic choice. To achieve these velocities with the 350 and 400 grain bullets, which have lower sectional densities, we would have to raise pressure above the maximum safe level.

There is another very important reason to use bullets with a Sectional Density (SD) greater than .300. Calculation of drag within biological material is extremely complicated, but one fact we do know is that higher SD bullets decelerate at a slower rate than lower SD bullets. This means the heavier bullets keep their momentum longer than lighter bullets (of the same diameter), which lose their momentum more rapidly as they travel through the target. A bullet keeping momentum longer results in deeper penetration. Neither kinetic energy nor momentum is primarily responsible for the penetration ability of a bullet in an animal.

In general, such characteristics of a moving body say nothing about its penetration through a medium. What is primarily responsible?

The most important feature for penetration is "momentum density" - a basic value describing the penetration in solid materials of non-deforming projectiles. Momentum areal density indicates the penetration potential of a projectile. Momentum areal density is defined as the momentum of the projectile divided by the projectile's cross-sectional area.

The next most important feature for penetration is the projectile's frontal area and shape. Because we need energy, we have to add weight behind this frontal area and the result is sectional density. Nose geometry is merely a fine tuning, in that it tweaks forces exerted upon the projectiles during flight to keep the projectile stable i.e. no tumbling, yawing off a straight path, etc. <u>Therefore, point geometry does have a significant effect on straight line penetration.</u> We will get to this in the next section.

If we have a given frontal area and sectional density, the traveling bullet has to compensate for the decelerating forces acting on its surface. This working force has to be delivered by the kinetic energy of the bullet. That is another important feature for penetration. For a rough comparison we can use the penetration index. It is calculated from the kinetic energy, sectional density and frontal area as follows.
Penetration Index = SQRT [Kinetic Energy X Sectional Density / Frontal Area]
This equation can be shown through dimensional analysis to be identical to that of the original premise, momentum density:
Penetration Index = Momentum / Frontal Area

Momentum is calculated from mass and velocity in any suitable units. Here we use grains-mass and feet per second. Likewise frontal area can be in any suitable units and here we use square inches. These units give Penetration Index (PI) figures which are quite large and unwieldy, so a scaling constant is needed. For historical reasons, the value of the scaling constant is 43,000 which yields the following equation:
Penetration Index = bullet weight, grains X muzzle velocity, fps / bullet diameter squared / 43,000

cartridge designation	bullet diameter	bullet weight	muzzle velocity	momentum	sectional density	muzzle energy	frontal area	penetration index
	inch	grain	fps	lbm-fps	w/d^2	ft-lb	in^2	
22 Hornet	0.224	45	2450	16	0.128	600	0.0394	51
7x57 Mauser	0.284	175	2400	60	0.310	2238	0.0633	121
30-06	0.308	200	2640	75	0.301	3095	0.0745	129
338 Win Mag	0.338	250	2660	95	0.313	3927	0.0897	135
375 H&H	0.375	300	2590	111	0.305	4468	0.1104	128
375 H&H	0.375	325	2470	115	0.330	4402	0.1104	133
9,3x64	0.366	293	2575	108	0.312	4313	0.1052	131
9,3x64	0.366	286	2400	98	0.305	3657	0.1052	119
416 Rigby or Rem	0.416	410	2400	141	0.338	5243	0.1359	132
404 Jeffery	0.423	400	2313	132	0.319	4751	0.1405	120
458 Win Mag	0.458	480	2200	151	0.327	5158	0.1647	117
458 Win Mag	0.458	500	2150	154	0.341	5131	0.1647	119
458 Win Mag	0.458	500	1900	136	0.341	4007	0.1647	105
458 Lott	0.458	480	2400	165	0.327	6138	0.1647	128
458 Lott	0.458	500	2400	171	0.341	6394	0.1647	133
450 Dakota	0.458	500	2450	175	0.341	6663	0.1647	136
460 Weatherby	0.458	500	2550	182	0.341	7218	0.1647	141
470 N. E.	0.475	500	2150	154	0.317	5131	0.1772	111
470 N. E.	0.475	500	2050	146	0.317	4665	0.1772	106
470 Capstick	0.475	500	2400	171	0.317	6394	0.1772	124
505 Gibbs	0.505	525	2400	180	0.294	6713	0.2003	115
500 N. E.	0.510	570	2150	175	0.313	5849	0.2043	110
500 N. E.	0.510	570	1900	155	0.313	4568	0.2043	97
500 Jeffery	0.510	535	2400	183	0.294	6841	0.2043	115
500 Jeffery	0.510	570	2350	191	0.313	6988	0.2043	120
495 A-Square	0.510	570	2400	195	0.313	7289	0.2043	122
500 A-Square	0.510	600	2500	214	0.330	8325	0.2043	134
50 BMG	0.510	750	2600	279	0.412	11255	0.2043	174
577 N. E.	0.585	750	2050	220	0.313	6997	0.2688	104
577 Tyrannosaur	0.585	750	2470	265	0.313	10158	0.2688	126
585 Nyati	0.585	750	2400	257	0.313	9590	0.2688	122
600 N. E.	0.620	900	1950	251	0.334	7597	0.3019	106
700 N.E.	0.700	1000	2000	286	0.292	8880	0.3848	95
4 bore	1.000	1881	1300	349	0.269	7057	0.7854	57

The comparison of a good-sized rock with a bullet illustrates the relation of a small to a big caliber; here also momentum alone is misleading. In comparing a .284 cal 175 grain bullet at 2400 fps compared with a .620 cal 900 grain bullet at 1900 fps, we find the .284 has less than one third energy, a quarter of the momentum, but 25% more penetration. Another stringent example: A .620 cal 900 grain bullet at 1900 fps compared with a .510 cal 570

grain bullet at 2400 fps, same energy, but the .510 has 20% less momentum and 40% higher penetration!

Some experts claim that momentum is the property to look to for the penetration ability and performance of bullets. That is not possible. The momentum is physically related to the kinetic energy (divided by the velocity) and does not primarily control the penetration. You can prove it: Take a running start and heave a 10-pound rock at a large game animal hard as you can. That rock possesses the same momentum as a high-velocity .458 inch, 500 grain bullet. When the rock hits the animal, it will become evident that there is no penetration. So we can conclude that neither kinetic energy nor momentum is solely responsible for the penetration of a bullet.

A projectile will penetrate as long as the shear stress exerted by the projectile on the target is greater than the shear strength of the target. Shear stress is herein defined as the force on the projectile divided by the projectile's cross-sectional area. The penetration depth is determined by interaction with the medium. If there were no interaction, the penetration would be infinite. The mechanism of the deceleration is very complex and hard to calculate from basic figures because we do not know the drag functions in the different media a bullet encounters traversing the animal.

Penetration also depends on bullet construction. Deforming bullets (soft nose) sometimes show less penetration at higher velocity because they encounter more resistance from the medium due to the altering of their shape as they expand. Non-deforming bullets (solids) cannot exhibit lower penetration when traveling at higher velocity (all other parameters being equal). But one can still find myths describing less penetration at higher velocities as well as arguments presenting erroneous physical statements.

1. **Simple logic: When the higher velocity bullet decelerates to a lower velocity, it will penetrate to a smaller degree.**
2. **Physics: The force, which is needed to penetrate, is $F = m\, dV / dt = d(m*V) / dt$. In other words, force equals the change in momentum with time, and more depth is gotten with higher velocity.**

The following section largely based on research by Norbert Hansen (see http://www.grosswildjagd.de/penetrat.htm - SuperPenetrator)

Do solid bullets tumble in tissue?

Why do solids (non-deforming bullets) penetrate animal tissue and most artificial targets straight to a sufficient extent? In literature we find, following the results of Fackler's thesis that all solids must tumble immediately in an aqueous media (tissue), and would not penetrate sufficient, because the gyroscopic stabilization in air, caused by the rifling twist which should have no effect in the thousand fold denser tissue. But only solid spitzers in general are unstable in soft media, esp. aqueous tissue, and after traveling a few inches they start to tumble. They are not able to generate the stabilizing supercavitation effect therefore are lacking deep penetration. Nevertheless they can show devastating wounding effects and killing power. The actual behavior depends on many factors (material of the target, length of the ogive, shape of the nose etc.). In hard materials (plywood) they can go straight because the tumbling is prevented by forces acting on the shank of the bullet. But flat point solids, round nose solids and the like are going straight through the target! Why is it solids

bullets do not immediately tumble in tissue, when the rules of physics and experts in ballistics say they must tumble in aqueous media?

To come up with a sound explanation lets look at a phenomenon that we are just now beginning to understand 'supercavitation'.

To hydro engineers, cavitation is a known phenomenon. Cavitation happens when water is forced to move at extremely high speed, e.g. inside of a pump or around an obstacle, such as a rapidly spinning propeller. The pressure of the fluid drops due to its high speed and when the pressure drops below the vapor pressure of the water, it vaporizes — typically forming small bubbles of water vapor, thus changing water into its gas phase. In ordinary hydrodynamics, cavitation is a mostly unintended and undesirable phenomenon: The bubbles are typically not sustained but implode as they and the water around them suddenly slows down again, with a resulting sudden rise in ambient pressure. These small implosions can even lead to physical damage, e.g., to badly designed fast-rotating propellers.

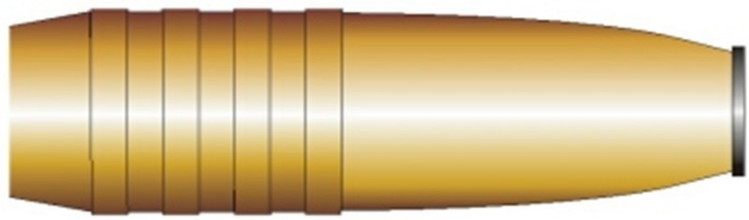
Supercavitation is the use of cavitation effects to create a large bubble of gas inside a liquid, allowing an object to travel at great speed through the liquid by being wholly enveloped by the bubble. The cavity (i.e., the bubble) reduces the drag on the object and precisely this makes supercavitation an attractive technology.

In supercavitation, the small gas bubbles produced by cavitation expand and combine to form one large, stable, and predictable bubble around the supercavitating object. The bubble is longer than the object, so only the leading edge of the object actually contacts the aqueous medium. The rest of the object is surrounded by low-pressure water vapor. A supercavitating body has extremely low drag, because its skin friction almost disappears. Instead of being encased in water, it is surrounded by the water vapor in the supercavity, which has much lower viscosity and density.

A supercavity can also be formed around a specially designed projectile. The key is creating a zone of low pressure around the entire object by carefully shaping the nose and firing the projectile at a sufficiently high velocity. At high velocity, water flows off the edge of the nose with a speed and angle that prevent it from wrapping around the surface of the projectile, producing a low-pressure bubble around the object. With an appropriate nose shape, the entire projectile may reside in a vapor cavity.

Supercavitation technology can be used to produce high-speed undersea weaponry. Scientists at the Naval Undersea Warfare Center in Newport, Rhode Island demonstrated in 1997, a fully submerged launch of a supercavitating projectile with a muzzle velocity of 5,082 feet per second, making it the first underwater weapon to break the sound barrier. More recently the US unveiled supercavitating bullets. That program was inspired by the menace posed by harbor mines during the Gulf War. The slow and dangerous job of disarming mines often falls to divers because bullets lose momentum and direction after traveling a couple of feet through water, which is one thousands of times denser than air. But supercavitating bullets fired from planes or helicopters could pierce and detonate mines from a safe distance. Very important is the gyroscopic stabilization of the bullet traveling in a supercavitation bubble. Projectiles shot from barrels without a twist are quite unstable within their vapor cavities. Firing supercavitating bullets from barrels with slightly faster rate of twist than normal for a given diameter and length increased stabilization inside their vapor cavities.

Which bullets nose shape is the best for generating the supercavitation bubble and maximum penetration in aqueous media (tissue)?



Tests done by Norbert Hanson with prototype bullets he called SP bullets: At the nose is a hard, relatively small disk with a sharp, protruding edge (cavitator disk) where the hydrodynamic flow is converted to a quasi aerodynamic flow. The diameter of the cavitator disk for a .458 bullet at 2400 fps should be 5 mm to 8.5 mm. The greater the diameter, the more stable was the flight through water or tissue. But the penetration in solid media (bone) decreases with the diameter of the disk. A good compromise is 6 mm to 7.5 mm. diameter cavitator disk. The disk was made as an insert from hardened steel in a bullet of copper or machined as an integral part of a monolithic bullet from brass.

Three test setups were used:

- **#1- A row of 12 thin-walled 2 ½ gallon water containers measuring 12X7.5" and backed by a 1" hard particle board for recovering the bullets.**
- **#2- Same as #1 but separated by a 1" resin bonded hard particle boards.**
- **#3- A row of fifty 1" resin bonded hard particle boards placed one against the other.**

By checking the holes made by the bullets in the walls of the consecutive containers, it is easy to observe when the bullet starts tumbling and is generating keyholes. Bullets of 500 grain were shot from a .458 Lott at 2400 fps. Twist 1:14. Distance 100 yards. The test bullet was used with the layout as described, the reference bullet was the 500 grain Woodleigh FMJ.

The observations:

1. **Shots through the water containers (setup #1) with the SP show a stable flight and a penetration up to more than twofold compared to the Woodleigh FMJ. The FMJ reference bullet starts tumbling in the 5th container and then mostly leaves the setup. The SP starts tumbling in the 10th container and sometimes did not tumble after a 12th container, depending on the diameter of the cavitator disk. The tumbling was a 90 degree turn, further penetrating broadside, no deformation of the bullet was observed. Often a change in the direction of flight was observed. The broadside flight is stable, if the gyroscopic stabilization is no longer active.**

2. **On shots through the resin bonded hard board (setup #3), SP bullets with smaller diameter cavitator disk show a penetration 50% more than the reference bullet, with increasing disk diameter, as the penetration in water is increased, and the penetration in the hard board decreased. Both the Sp bullet and the reference bullet cut a path of more than 38" deep. In such materials and probably also in bone the forces acting in front of the center of gravity of the bullet are likely to be compensated by forces working behind the center of gravity, the result is straight line travel through the target.**

3. **Water and aqueous tissue is the most critical issue with respect to stabilization. In the water and resin bonded board (setup #2), the Sp bullets exhibited no tumbling or other kind of destabilization and would be caught by the 9th board, the FMJ bullet would start tumbling and leave the setup by the 6th water container. The bullet should be launched from a barrel with a twist as fast as possible.**

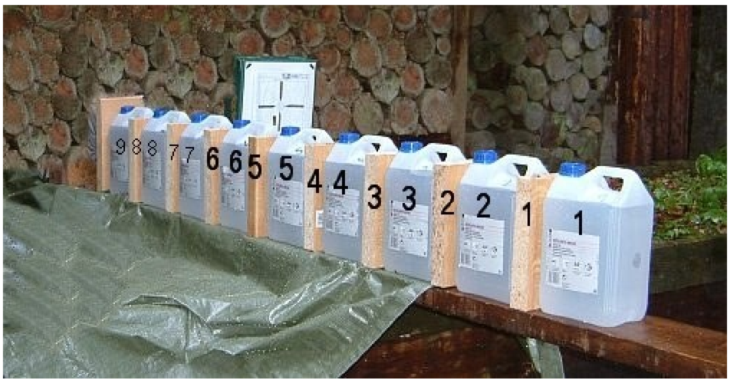
Penetration is a very complicated matter and tests are very dependent on the setup and the materials used.

A very important fact for maximum penetration in aqueous media (tissue) is also the twist of the barrel. In the water vapor bubble the stabilization is not as easy as in air. So instead of the 1:14 twist normally used in .458 calibers it should be replaced by a 1:12 or even 1:10. In the meantime this observation has confirmed by other authors.

Important for close up shots: Bullets must be "asleep". If the angle of yaw (precession) is relatively high near the muzzle, the bullet tends to tumble at impact and is not able to build up a perfect supercavitation bubble. Full stabilisation for a twist of 1:16 or 1:14 is established at about 20 yards. That holds especially for smaller calibers, e.g. some .223 military rounds are stabilized only at about 80 yards. At closer distances they tumble.

The only value of artificial target media such as plywood, wet paper, gelatin and others is to compare one bullet to another in that particular medium. Generally we can distinguish two different mechanisms of penetration in animals:

1. **The penetration in aqueous tissue; limited by the stability of the bullet's travel in a supercavitation bubble.**
2. **The penetration in bone, hide and sinews; limited by the forces acting on the bullet, (jam pressure, friction, shear resistance, viscosity).**



Because the penetration in aqueous tissue is the most important, the best correlation an amateur can achieve, is with targets of high water content (above 80% like tissue) are thin-walled water containers. Penetration is not a question of friction, density or other forces decelerating the bullet, but how long the gyroscopic stabilization is preserved in a supercavitation bubble, which is generated by the bullet its self. If this stabilization is lost, the bullet starts tumbling and changes its direction and penetration comes to an end. For more penetration and stabilization, the concept of the SP bullet was created.

Hansen tested the new SP bullet on several elephants with frontal head shots. Penetration and stability was extreme good. But a further comparison to the conventional shape was not possible, because also my 500 gr Woodleigh at 2350 f/s was penetrating as well and all bullets from frontal brain shots were disappearing in the guts. In the stress of a hunt, which

had also other objectives, it was not possible to recover the bullets. So, if you have the right cartridge with a penetration index around 120 to 130, you can use any modern solid. The advantage of the SP design is more pronounced, the more aqueous the medium is. With the SP bullet we can find the optimum diameter for the cavitator in relation to the bullets diameter and angle off axis of the head for a given caliber and velocity.

The balance between penetration and shock transfer or energy dissipation on the travel through the animal can also be optimized for the new SP bullet. The edge of the disk generates the supercavitation bubble, its diameter determines the energy transfer and amount of penetration.

It depends on the relative diameter of the meplat (FN area) and the resulting drag function, which bullet is the winner with respect to penetration. But we don´t need penetration much more than 2 meters. A good balance between stable penetration (supercavitation) and pressure wave generation (tissue damage) results in the best bullet for elephant skulls.

End of Hansen-based section

Elephant broad side shots are already effective with good soft nose bullets. In practice the actual layout of the SP bullet should be useful with cartridges with a low penetration index. Conventional solid bullets with a PI around 130 have plenty penetration ability.

Observations hunting thin skinned game with the SP bullets indicate that they are also very suitable for non-dangerous big game hunting. Sp bullets are wounding like soft nose bullets because they have an enormous pressure generation effect of supercavitation. Also the initial impact mechanism seems to favor the SP bullet. The entrance holes of the bullets (only a few inches apart on the same elephant head at the same time) are much smaller for the SP bullet than for the conventional FMJ. This indicates that there is a lesser initial splash than with the conventional bullet design.

Some observations, which show how different the penetration depth on a head shot on an elephant bull, can be:

- **Shot with a .458, 500gr Woodleigh FMJ at 2400 fps. PI = 132. Recovered bullets showed no sign of any deformation.**
- **Side brain shots .458 500gr SP at 2400 fps, with an angel up to 45°: the bullet excited on the opposite side. Penetration: more than 40".**
- **Frontal brain shot .458 500gr SP at 2400 fps. Entered between the eyes, the bullet went through the brain, passes the Atlas joint, broke two ribs and travels another 40" through the flesh. Total Penetration around 80".**
- **Side head shot with a .458, 500gr Woodleigh FMJ at 2400 fps, aimed at the ear but the angle was slightly backwards, so it missed the brain and the shots were hitting the Atlas joint (the first vertebra connecting the head). It must have an extraordinary tough structure. There was no bullet exit they stuck under the hide on the opposite side. Penetration: about 30".**
- **.500 NE: Trusting on the myths around this caliber and that lower velocity penetrates deeper, a hunting party used reduced loads (less than 1900 f/s) to save stress their valuable double rifles. PI = 70. They could not drop any elephant with frontal head shots.**
- **7x57: Bell used a load with PI = 110 with success.**

- **.458 500gr, 2400 f/s. PI = 132. Diagonal through an elephant bulls head, bullet exits.**
- **.510 535gr, 2400 f/s. PI = 98. The same path as above from ear to opposite eye: the bullet sticks under the hide.**
- **.600 NE and .700 NE: It depends on the load, PI 70 to 90. No problems with side brain shots, but there are a lot of reports on failures with frontal brain shots. Sometimes the trunk can be a very hard to penetrate obstacle. But the old ivory hunters developed the technique to knock down the animal and gave it a final lung shot.**
- **.416 Rigby, PI = 130, very good reputation since its introduction as one of the best performers with respect to penetration.**
- **4bore and 22Hornet: Almost same penetration, with shot behind the shoulder enough penetration, but the Hornet would have too little energy for a killing lung shot.**

There is another simple rule for a dangerous game cartridge with a safety margin:
Use a .400 upwards diameter bullet with a sectional density of minimum .310 at a muzzle velocity of 2400 fps.

To date, the main emphasis of research into supercavitation has been into the development of torpedoes, due to the fact that supercavitating torpedoes can give an overwhelming advantage to a navy possessing them in quantity (assuming that the opposing navy doesn't possess them).

Bibliography:

A.B. Alphin, *Any Shot You Want. (one of the first to try and devise a PI, his formula is a little different than mine but has nearly the same results. This is also the source used as a basis for much of Norbert Hansen's has done.)*

Norbert Hansen, *Crosswildjagd*
http://www.grosswildjagd.de/penetrat.htm - SuperPenetrator

Wikipedia

Items influenced from these following sources:
http://www.stratmag.com/issueMay-15/page02.htm
http://www.gsgroup.co.za/articlepvdw.html

And many others that I can't remember. If you find your work within this document and wish to be included in this Bibliography, please contact me through AmmoGuide.com – Thank you.