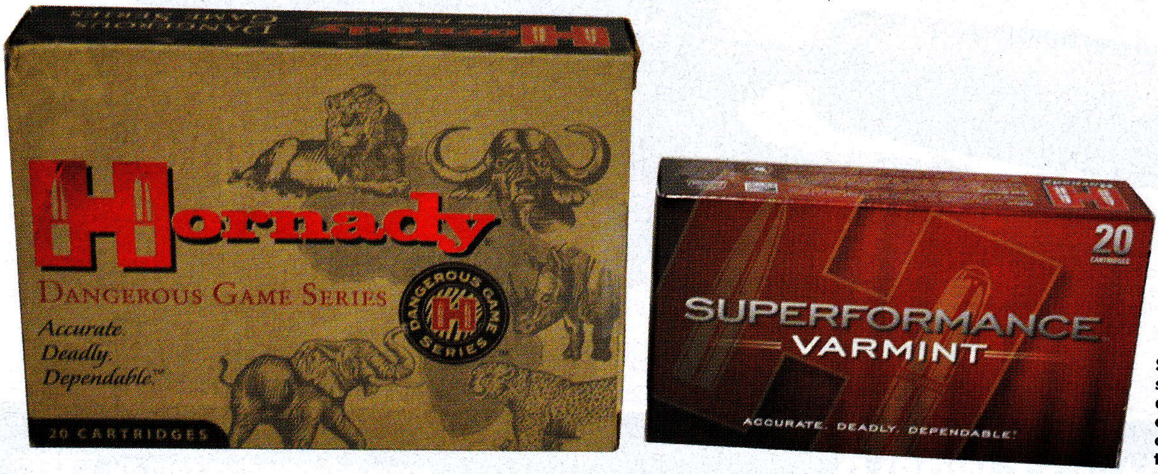
Choosing projectile stability levels

and cartridge pressure management

by Steve Hurt



Some manufacturers such as Hornady declare the purpose of the ammunition or components on their packaging.

In the October *Australian Shooter*, we covered the principle of a projectile going to sleep under the 'spinning top analogy'; now it is time to consider where on the scale we want to be in terms of the job at hand, climatic conditions and the intended range or distance.

From an accuracy point of view, 'perfect' stability is when the projectile has a gryoscopic stability (Sg) factor very close to 1.0. This occurs when the projectile has the least amount of pitch and yaw about its axis, and is simultaneously flying very near to the desired 'point on flight'. Projectiles in this state are extremely accurate.

If a projectile is spun too fast, it can become 'over-stable' and groups may open up as a result, at least at longer ranges. This may not be a problem, and may even be desirable when hunting heavy game at short range in thick bush, but it becomes a liability and definitively so as ranges become extended. As a general rule of thumb, it is appropriate for the precision shooter to ensure that the chosen projectile has a theoretical Sg as close as possible to 1.4 at launch (as calculated in the standard climatic conditions). This ensures that the Sg doesn't fall below 1.0 under adverse or deteriorating conditions.

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This approach will allow the projectile to be nearest to the 'point on flight' position and have the highest average ballistic coefficient over its entire flight path, without having to worry about the conditions on the day. When the Sg falls below 1.0 on launch, the effects are dramatic and shots can go off-target by up to 1m at 100m. The shots that do hit the target leave elongated holes from the projectiles entering sideways. Thank you to Mr Glen Roberts of Precision Shooting for his contribution on this subject.

So what Sg is best when selecting a bullet to load for hunting? Years of testing and observation have produced a few 'rules of thumb':

1. An Sg of 1.6+ (without upper limit) is required for bush hunting large, heavy and dangerous game at less than 200m, and normally less than 50m.

2. General, medium-game hunting in open country out to 500m requires an Sg in the 1.4 to 2.0 range.

3. Long-range hunting (in excess of 500m) requires a minimum Sg of 1.3 in the specific and known climatic conditions of the moment, but it is considered better not to exceed 1.5 in either case. This is obviously a small window, where use of the Don Miller Twist Rule formula (see the October Australian Shooter*) is absolutely essential in assessing a projectile's potential suitability for a specific task.*

So, if stability is such a wonderful thing, then why is the Sg recommendation for long range so much lower? Why do the groups start to open up with higher stability factors? The answer lies in balancing the forces. There is such a thing as 'too much and not enough' in most aspects of life. Physics is no exception.

Sg degrades more slowly than velocity. A highly stable projectile rotating on its axis wants to maintain that axis in flight, just like the spinning top on a moving table. The problem is that forward velocity decelerates at a much quicker rate and starts to reflect the influences of gravity.

A highly stable axis, as it commences its descent from the apex of its trajectory arc, will want to maintain this attitude and present itself to the atmosphere (and potentially the target) in an aircraft-like 'belly-flop' approach. Air pressure under the nose of the projectile then starts to multiply the destabilising factor of wind resistance, placing upward pressure on the nose. A slower rotation of the projectile in flight tends to promote a 'nose-over' approach, minimising resistance to the projectile's flight path and maintaining its stability for longer. It also more closely approaches the target as it was designed to, point first, without cant or yaw.

Sg and temperature

This is a relatively simple one. Temperature is not just a load safety issue; it also influences flight path stability. Higher temperatures mean lower air density and therefore resistance. Higher temperatures increase a projectile's stability factor, while lower temperatures decrease it.

The difficulty arises when the temperature, such as altitude, can influence air density to the point where it can vary a projectile's gyroscopic stability factor by almost 0.3 over the previously nominated 0-38C range. Hence, the nominated Sg of 1.4 as the general standard, as it gives greatest flexibility for margin of error at the time of loading.

Clearly then, temperature range nomination and climatic condition estimation becomes a much more critical issue for long-range hunters, particularly if the selected projectile's midrange Sg/temperature calculation is close to either the minimum or maximum end of the appropriate stability scale.

Shot start initiation pressure

The next principle, often latent under the old 'conventional' projectile paradigm but brought to the fore with the new generation of projectiles, is the tremendous variance in shot start initiation pressures (SSIP) that now confront reloaders. SSIP is almost self-explanatory; it is the resistance or inertia the projectile provides (and must be overcome) when it enters the barrel throat at the commencement of ignition. This is sometimes called 'engraving pressure'.

Until the arrival of the so-called new-generation projectiles, conventional projectiles, regardless of brand, tended to operate in what must now be considered a relatively tight or narrow SSIP band width. As such, it was rarely discussed, other than in terms of increased resistance in relation to weight, bearing surface engagement, and the need to be careful.

The new generation of projectiles has changed this significantly. As stated, the ductility of copper and its alloys are significantly different to lead. In the context of internal ballistics, the biggest implications are for the swaging process, where the bullet is forced to conform to the shape imposed on it under pressure, as it moves into the chamber throat. This is where material ductility, hardness and bearing surface have to be balanced very carefully by the manufacturer and reloader alike.

Consider the SSIP pressures of the following similar weight .308 projectiles (sourced from the QuickLoad program):

- Conventional jacketed lead core - 3626psi

Other manufacturers such as Woodleigh provide information regarding the best choices of calibre, projectile and velocity recommendations for a particular purpose, in catalogues generally available from your local gunshop.