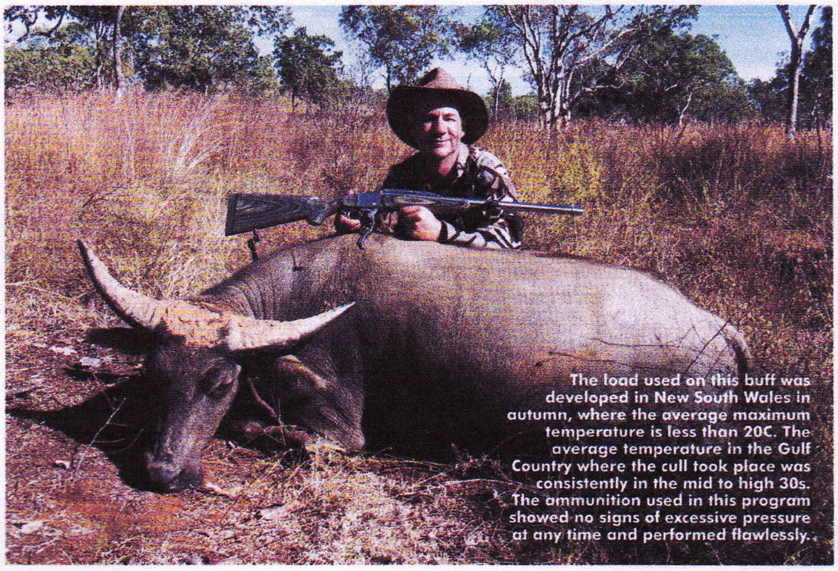
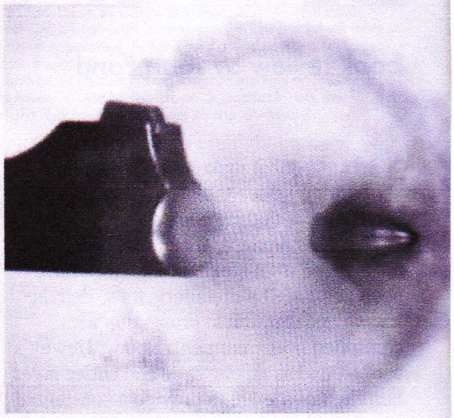
Temperature and ammo pressure

by Steve Hurt



The load used on this buff was developed in New South Wales in autumn, where the average maximum temperature is less than 20C. The average temperature in the Gulf Country where the cull took place was consistently in the mid to high 30s. The ammunition used in this program showed no signs of excessive pressure at any time and performed flawlessly.



High-speed photography of a bullet and propellant gases exiting a rifle muzzle. The Kurzzeit PVM 08 chronograph depicted is among the most highly accurate available and a base line requirement for precision or long-range work. Photo courtesy of Kurzzeit.

The effects of temperature on ammunition are rarely discussed, but they are a particularly important issue when any load development is under consideration. This is most important when hunting in the extremes of temperature and distance. Traditionally, this has been primarily because these influences were once extremely difficult to measure or quantify by the average rifle shooter; this is not so today. In this article, we take a closer look at the influence of temperature on load development and how we can use it to our advantage.

The most exciting developments in modern smokeless powders in recent times are changes in the use of retardants required to adjust the burning rates and therefore pressure build-up rates. Until recently, retardants were generally a graphite-based coating applied to the outside of the powder granule (regardless of its different shape and size and whether it is a single- or double-based chemical composition of a particular product). Once the retardant has been burned away, combustion occurs at a rapid and rising rate as the surface area of the granules decreases.

With new-generation powders, such as Alliant's Reloder 17 and 33, the retardant is now part of the formula. This, it is claimed, allows the burning rate to be controlled better throughout the entire combustion process, generating a longer, more sustained pressure curve. The result, according to the manufacturer, is higher velocities without exceeding safe pressure limits. This sustained pressure curve is also claimed to reduce the perception of recoil. They're big claims, but not without substance.

Among the issues that arise out of the relationship between powder, temperature, volume and pressure that are seldom discussed but of critical importance to reloaders are the events known as detonation and delayed ignition. Detonation is described as an explosion, rather than a fast but progressive burn. A number of possible explanations have been put forward to explain this phenomenon, including the use of too low a load density of slower powders, where primer-flash overignites the whole powder volume all at once in the chamber.

What has recently become known (demonstrated in testing conducted by the producers of Pressure Trace II and Kurzzeit, specialists in high-speed, in-flight bullet photography) is that detonation can occur not just in the chamber, but further up the barrel, at the muzzle and beyond. No-one seems to be able to explain with any level of satisfaction as to how this happens or why, but there is no doubt that the results of chamber-based detonation are capable of damaging firearms and causing injury.

It *appears* that the further from the cartridge chamber detonation occurs, the less destructive it becomes, possibly due to the reduction in fuel left to burn, the new and increasing volume, and reduction in resistance - as the projectile is now moving - to the point where most shooters never know it has even occurred, unable to distinguish it from recoil or muzzle flash.

This issue is at the other end of the scale to the effect of delayed ignition, otherwise known as 'hang fire'. This situation most often occurs when poor ignition, caused by extremely low temperature, incorrect component selection or faulty/poor quality components coincide to produce erratic and unpredictable ignition. This unpredictability can produce delayed ignition and therefore discharge by several seconds. Obviously, neither detonation, nor hang fires are desirable outcomes.

Conventional wisdom is that a load density of 90 per cent or more (especially when powders with a burning rate equal to or slower than AR 2209 are used) of an appropriate powder, properly ignited within temperature tolerance, will substantially reduce the possibility of detonation ever occurring. At the same time, use of appropriate components and keeping forecast pressures (not powder charges) within 20 per cent of maximum is recognised as being within the accepted floor or minimum margin of safety to reduce the likelihood of both detonation and hang fire.

To demonstrate this, let's have another look at the working example for the .300 Winchester Magnum:

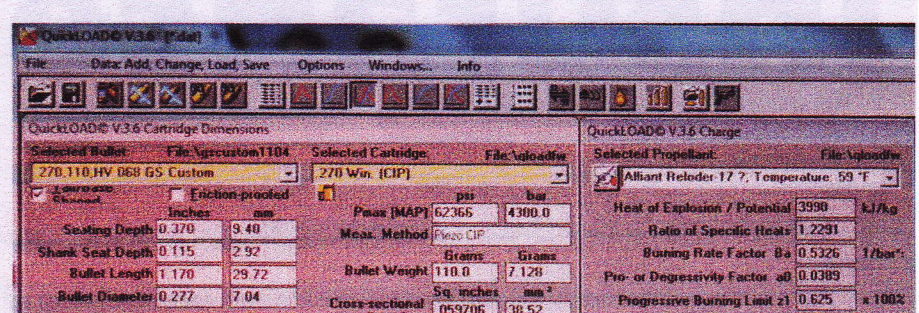
SAAMI maximum pressure standard: 62,366psi
Brass: Winchester
Powder: H4350
Primer: Federal 215M
Projectile: GS Custom 308177HV
70 grains of H4350 at 38C = 62,185psi
(load density = 98.6%)
68 grains of H4350 at 0C = 50,320psi
(load density = 95.8%)
Pressure variance: 11,865psi

We find that with a load reduction of just 2 grains of powder, from 70 grains of H4350 at 38C to 68 grains of powder, the forecast is to produce 50,320psi of pressure at 0C, according to QuickLOAD. This is close enough to 19 per cent below the maximum SAAMI pressure standard. It is about as low as we can go if we use the parameter of 38C to establish the 62,366psi SAAMI maximum. This start load has a density of 95.8 per cent, which exceeds the 90 per cent minimum by a significant margin. It is therefore reasonable to assume that a load of 68 to 70 grains of H4350 (in this specified example) will be safe to use from 0 to 38C - a very practical temperature range for this country.

This is a very narrow load band recommendation and is a direct result of the temperature extremes nominated in this example. If this cartridge was only ever going to be used between 20 and 25C, the load range between minimum and maximum powder charge would be much broader. (It must also be noted here that this load is specific to this projectile, which is a very low shot start resistance, low-pressure projectile. Use of this data with another projectile or case will increase pressures substantially.)

This approach *appears* as a significant departure from the traditional loading manual mantra. However, it is important to keep a few very important things in mind. Most loading manuals are developed in controlled laboratory conditions in the United States. As a rough rule of thumb, the advice provided to reloaders without scientific equipment is to reduce loads

The QuickLOAD program is the biggest advance in reloading science available to the shooting public in many years. It takes some time to learn, but is well worth the effort.



10 per cent (of maximum) in powder ume, resulting in an approximate 20 cent reduction in maximum pressure, hin the accepted safety margin, *provided temperature doesn't change.* Now, these ding manuals are produced by the same npanies that manufacture ammunition or munition components and these manu- turers clearly aren't silly. When was the t time anyone ever heard of fresh factory munition causing catastrophic failure?

These .375 H&H loads are being tested in a cold-climate application, in this case for a sambar deer hunt in the Southern Alps.

The major challenge for any manufacturer is that they don't know the conditions under which their product will be used and therefore have to develop the product for safe use over the widest possible range of conditions. This is why reloaders will sometimes be confused when load recommendations between minimum and maximum are more than occasionally less than 10 per cent apart. Temperature fluctuations affect different powders in different ways in various cartridges.

It is also important to note that not all loading manuals declare the temperature at which data was developed and none state the suitable temperature application range. This doesn't make the information wrong, but it doesn't necessarily advance our understanding when developing a load for ourselves. When a manual doesn't specify the projectile, seating depth or temperature, the value of such advice has to be brought into question, as each in their own right have the capacity to significantly influence chamber pressure.

The most worthwhile reloading manuals are those which specify at least these minimum benchmarks. The challenge is that, even if the assumptions that generated the safe pressure band for a particular load were declared and explained, most shooters still don't have the capacity to work with the information to adjust pressure expectations, without pressure monitoring facilities such as Pressure Trace II or at least a predictive program such as QuickLOAD.

For those who may be thinking that these interactive electronic programs are a direct substitute for a good reloading manual, think again. This is definitely not the case. They are *complementary* to, not substitutes for. Quality reloading manuals are essential reference frameworks, which keep us from flying off on theoretical or whimsical tangents.

Where the available electronic tools agree with competent, benchmarked loading manuals, we can be reasonably assured that we are on the right track. From here, we need only adjust those variables unique to our specific circumstances. Knowing the assumptions or how to factor them into

>

your load development will allow you to get the very best from your equipment, both in terms of safety and accuracy. Significant variance is cause for concern and really should be investigated thoroughly before any attempt at loading is considered.

To give substance to this logic, let's consider the following example. Imagine we established our *maximum* load in autumn in central western New South Wales at say 15C (similar to the conditions in which Hornady develops its ammunition data) and then headed to central North Queensland nine months later with our favourite rifle to hunt pigs in a temperature of 38C, some 23C higher than when the load development was conducted. What would happen? Who knows? Obviously pressures higher than when we established our 'maximum' will be generated and likely to exceed the SAAMI standard. Whether or not this results in equipment failure will be a function of the safety tolerances of the particular firearm being used. Failures may or may not occur in a singular event, or even three or four, but the effects of excessive strain on equipment are cumulative and we really don't want to go there.

The upshot of all this is: when hunting in our hotter climes, we should consider reloading manual recommended maximums with extreme caution. When hunting in the colder extremes, we should consider minimum load recommendations with equal care if we are to remain inside the accepted pressure standards at all times. Since it is important to be conservative in load development, it is always wise to consider the first signs of excessive or insufficient pressure as warnings, not aberrations. The second warning may not be so kind.

So here we are, in a cold place, planning on hunting in a warm one, or vice versa. Perhaps we just want a load for the broadest application. We don't have access to a sophisticated electronic load program or testing facility and we are trying to develop a safe, accurate load for the other. What now? The loading manuals have been studied carefully, with a load combination carefully considered and a starting point arrived at.

For hot-climate load development in a cold environment, take a small foam lunchbox and a basic thermometer available from the local chemist for a couple of dollars. Having loaded up the test rounds, place them in the foam box and place the box under your car heater with the lid off. The purpose is to simulate, say, a 38C day - there is rarely any need to go higher than this and it is definitely not recommended to do so. Obviously, naked flame heat sources should never be used.

When the thermometer indicates the desired simulated temperature conditions have been reached, one at a time, remove a round and fire the round downrange according to normal testing procedures. Do so quickly, as ambient conditions will restore the round to the present environmental conditions in less than a minute or so, especially in a fresh chamber. Place the round in your internal breast pocket if there is any hint of delay. Check for signs of excessive or insufficient pressure. Repeat the process for the next round and so on.

Should you find yourself in the reverse situation of preparing cold-weather rounds in a hot climate, using the same foam box with lid, place the loaded rounds and thermometer in a plastic bag and pack them on ice, again using the thermometer in the plastic bag to indicate when the desired temperature has been achieved. Withdraw the rounds, again one at a time as required.

Using this approach to load development, there is unlikely to be any unpleasant safety surprises in using such ammunition in the new environment. Exploring the influences of temperature and air density on projectile flight paths is another subject altogether and a conversation for another time. ●