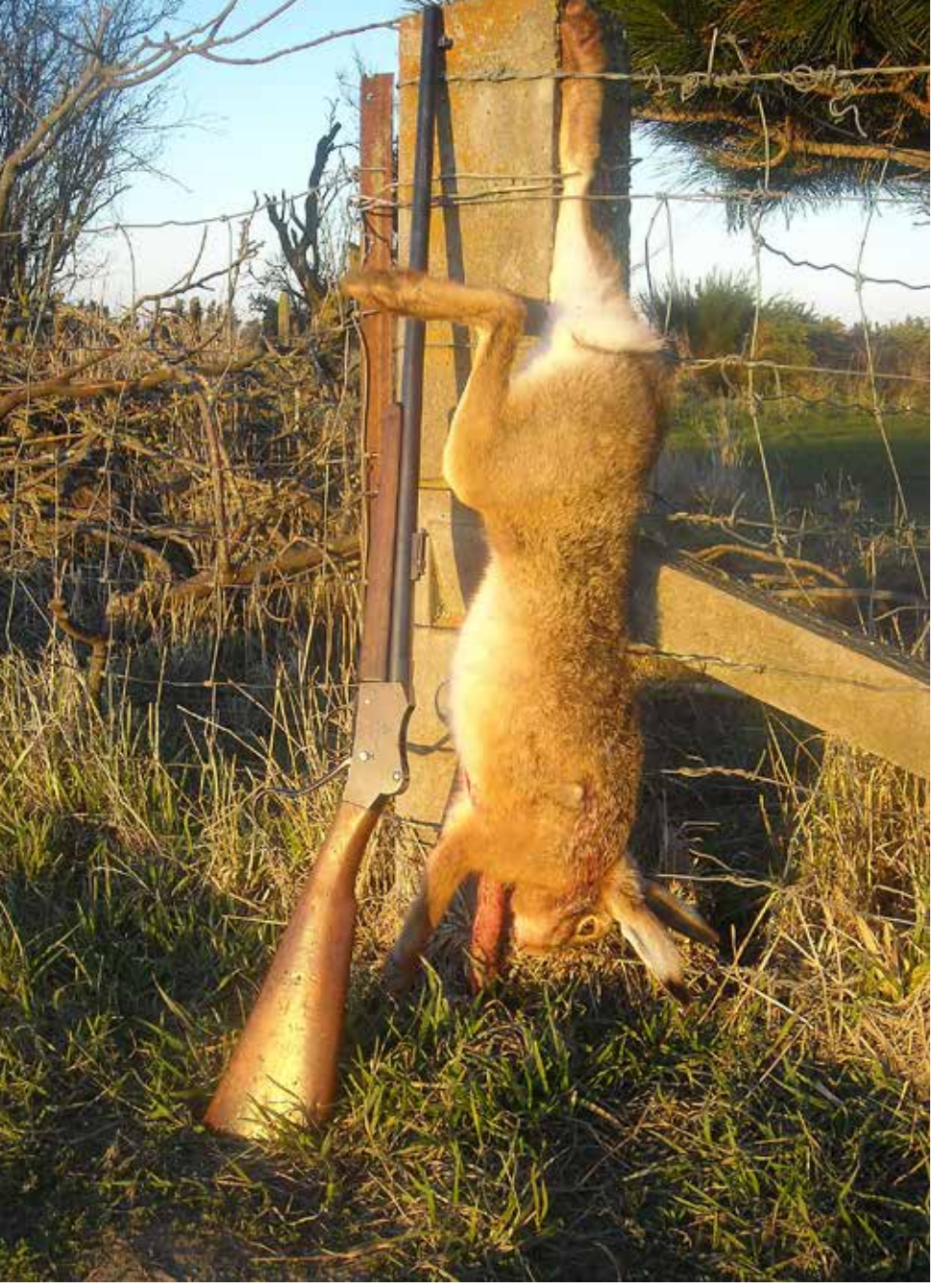
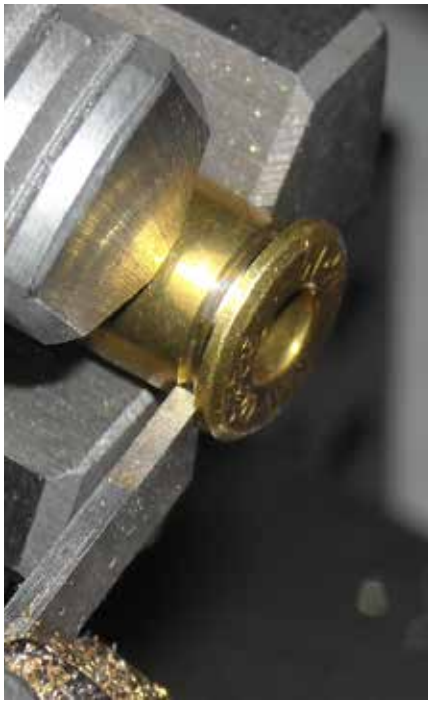


Jeff bowled this hare over at a genuine 100 yards using one of his hand-loaded hollow-point rounds.



The thickness of a .32-20 case rim is best reduced by removing brass from the front of rim, not the rear (see text).

CADET FORCES –

Experimenting with a .310 Cadet...

JEFF BROWN

The school holidays saw the Brown family in Wanaka on what is best described as earthquake respite. The latest quake had left us all a little frail and although our house and family were intact, a week in Central Otago where the ground did not move was more than welcome. While down that way I took the opportunity to catch up with a pair of like-minded lead slingers, one of whom I had not actually met in person before.

The three of us spent a good couple of hours in the host's shed chewing the fat related to all things shooting. I came away with no small amount of "reloading/casting shed" envy, but that was not all. Also in my possession was a Westley-Richards .310 Martini Cadet rifle sporting a brand new BSA barrel, along with a CBE bullet mould and a set of CH4D loading dies.

Grinning like the proverbial Cheshire cat I collected the family from whence they had been billeted for the afternoon and "fessed" up about the new addition to the family.

WHAT'S A .310 CADET?

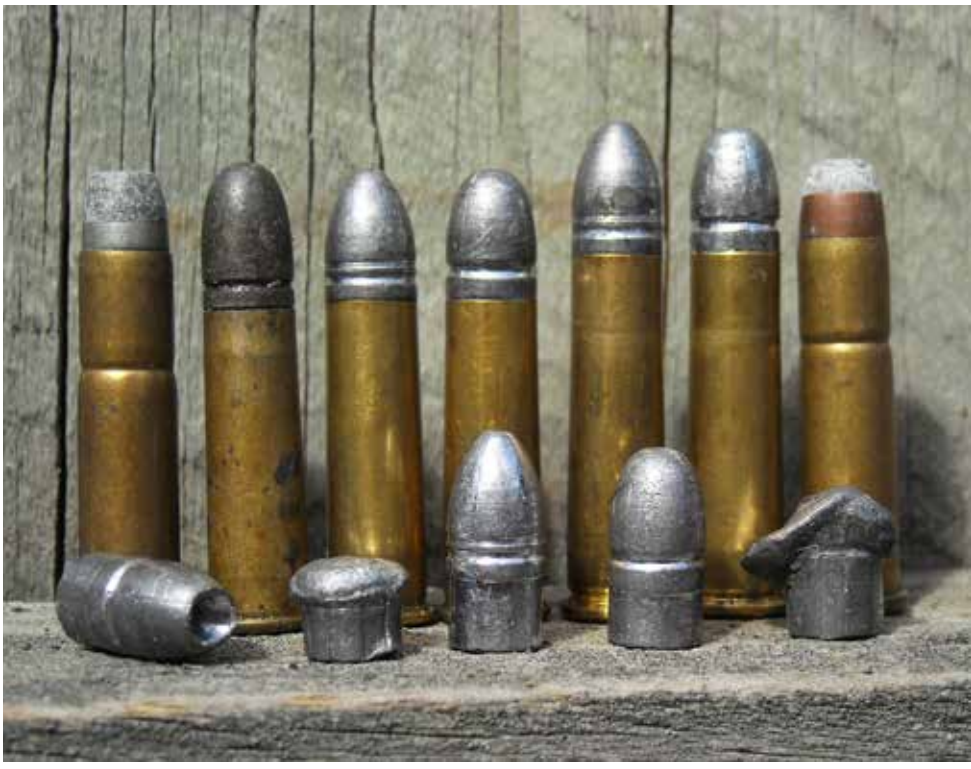
During 1900-1901 Greener released a new cartridge onto the British shooting scene. The .310 Greener, later to be known as the .310 Cadet, was developed as an economical, light recoiling, short range target round and was quickly adopted by the military for musketry training, especially among youth cadet forces. The factory round, by modern standards, is sedentary at best, pushing a 0.318-.325" calibre swaged, soft lead bullet of 120 grains at a leisurely 1200fps. The .310 designation comes from the British propensity to name cartridges based on the bore diameter which in this case is a nominal 0.310 inch between rifling lands. Nominal groove measurements range from 0.316" to 0.320".

Barrels were marked ".310-12-120" representing .310 calibre, 12 grains of smokeless powder and a 120 grain projectile, though later loads utilised six grains of a different propellant. The cartridge is of the older outside lubricated variety, the same as our current .22lr rimfire. The projectile girth measures the same as the outside of the case mouth and has a reduced diameter "heel" that is loaded into the cartridge case and subsequently slugs up to groove diameter upon firing, just as the .22lr does.

The .310 Cadet quickly developed a reputation for fine accuracy and was embraced with gusto by the Australian armed forces who bought tens of thousands of rifles and produced their own ammunition domestically. During WW II the Australian Cadet rifles were issued to home guardsmen and FMJ ammunition was manufactured in keeping with the rules of warfare.

COMPONENTS – BRASS

Bertram Brass of Australia produces virgin brass, but for those who want to make their own, the .310 case is very similar to the American .32-20. As luck would have it I load for a .32-20 rifle I built some years ago, coincidently on a Martini action. The primary differences are that the .310 case rim is thinner at 0.045 inch compared to the .32-20 rim at 0.065 inch, and the Cadet case is quite a bit shorter. This is where the fun begins.



Cartridge line up – Back row from the left; factory .32-20 round, original factory Cadet, hand-loaded CBE 325 125 in short case, CBE 320 120 in short case, same in long cases, factory .32-20.

Front row; CBE 320 120 hollow pointed, recovered HP from wet phone books, CBE 325 125, CBE 320 120, recovered 320 120.

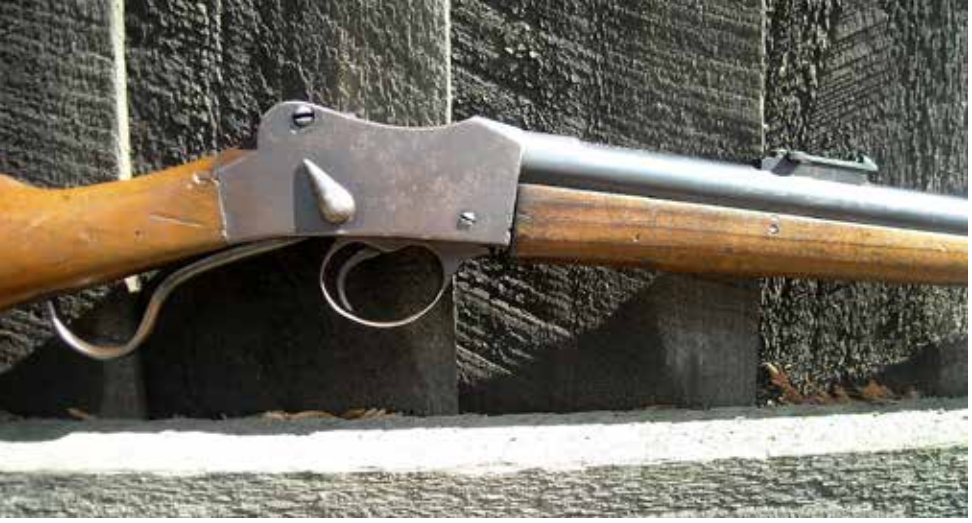
SOURCE	RECOMMENDED CASE LENGTH
Cartridges of the World, Barnes	*1.020 inch and 1 1/8 inch (1.125")*
Handloader's Digest, W.E Hill Jnr, 1970	*1.100 inch*
CBA Fouling Shot Journal, G Betteridge	*1.065 from front of rim (1.100" OAL)*
Factory rounds disassembled by Jeff	*1.090 inch*

To make .310 brass from .32-20 it is necessary to remove 0.020 inch from the front of the rim behind the case web. To remove material from the rear of the case rim would decrease the depth of the primer pocket and primers would protrude, thereby either not chambering, or igniting upon chambering due to being crushed.

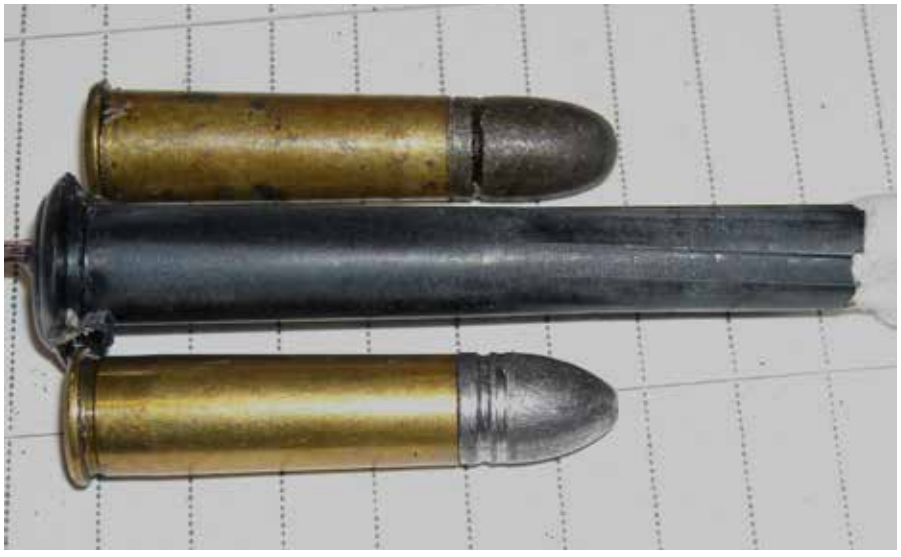
Curiously an article published in the 5th Anniversary "Handloader's Digest" of 1970 suggested exactly that; removing material from the rear. This is one of the many errors our North American cousins made with the Cadet rifle due to a lack of proper understanding.

With that sorted, regular .32-20 brass can then be full-length sized in .310 dies and trimmed to length. Once again, this is where things get tricky. What is the correct length for a Cadet case? Good question. Below I have compiled a list from various sources with case length recommendations: See table above.

As the astute reader will see there's quite a bit of variation and this is assuming the chamber has not been altered as often happened in the US. Many Cadet rifles had a .32-20 reamer run into them to increase the depth of the rim recess to allow the chambering of factory .32-20 ammunition. This practice, while entirely safe, produced terrible accuracy as .32-20 projectiles measure .311-.312 inch and literally rattled down the Cadet barrels. Likewise many rifles were rechambered to .32-40 calibre which at least uses a fatter 0.321" projectile, although reports were that in this more powerful chambering the light little Martinis leapt around a bit!



Jeff's Cadet has suffered a few knocks over the years and came with a mismatched fore-end.



Top; original factory Cadet round, middle; a chamber cast made of sulphur and graphite powder, bottom; a short case with one of Jeff's cast CBE 325 125 bullets.

BULLETS

There are only three mainstream suppliers of .310" bullet moulds I know of; RCBS, NEI and CBE. The RCBS bullet has a good reputation and the boys in the machine shop appear to have done their homework. NEI I cannot comment on. Without exception however, the major worldwide authority and supplier of moulds for the little colonial round is Jim Allison of Cast Bullet Engineering (CBE) in NSW, Australia. (www.castbulletengineering.com).

Jim presently offers no less than seven moulds for the Cadet, and in fact this is where he started in the mould making business back in 1985 after becoming frustrated at a lack of readily available or proper moulds for the .310 round. He set to making his own mould and it all lead (pardon the pun) from there. It's no secret that I am a huge CBE fan and not just because of the quality of Jim's moulds but more importantly, because of his complete understanding of the rounds that have pride of place in our history; the .310 Cadet and .303 British being the best examples of his work.

CBE moulds produce the right size and weight bullets that shoot! To that end I was pleased to begin with the CBE 320-120 RN which was soon followed up with Jim's latest release, the 323-125 in a single cavity mould he sent me for evaluation. Cast in 40–1 lead/tin alloy, the 320-120 weighs 122 grains and measures .309-310"/.319-320", while the .323-125 weighs 129 grains and measures 0.309-310"/.323-324".

LOADING AND SHOOTING

It would be nice to say that success came easily but that would be less than true. A lot of primers were popped at the range before any semblance of accuracy was achieved.

After arriving home from holiday my first task was to make a chamber cast to allow measures to be taken. Chamber casts are very straight forward and I like to use plain old sulphur with a bit of graphite powder thrown in for good measure. Sulphur is cheap and available from the garden section of all hardware stores. Start by lightly oiling the chamber and barrel, then plug the barrel with a cleaning patch just ahead of the throat. Out of doors, carefully melt the sulphur, being sure to avoid getting a lung full of SO2 gas; a most unpleasant business that is.

Once melted, pour the liquid into the chamber where it will set in about 30 seconds, then gently remove the casting by pushing it out with a cleaning rod – measure it immediately as the sulphur will shrink. My chamber cast revealed a groove diameter of 0.318 inch and a "throat" of 0.322 inch. In reality the Cadet chamber does not have a throat per se but rather a progressive taper from rim to rifling. My throat measurement is taken from the area immediately behind the start of the rifling. Given the throat measurement of 0.322" and the diameter of the cast CBE 320-120 bullet being .319-.320" I was immediately concerned that the projectile would be undersized.

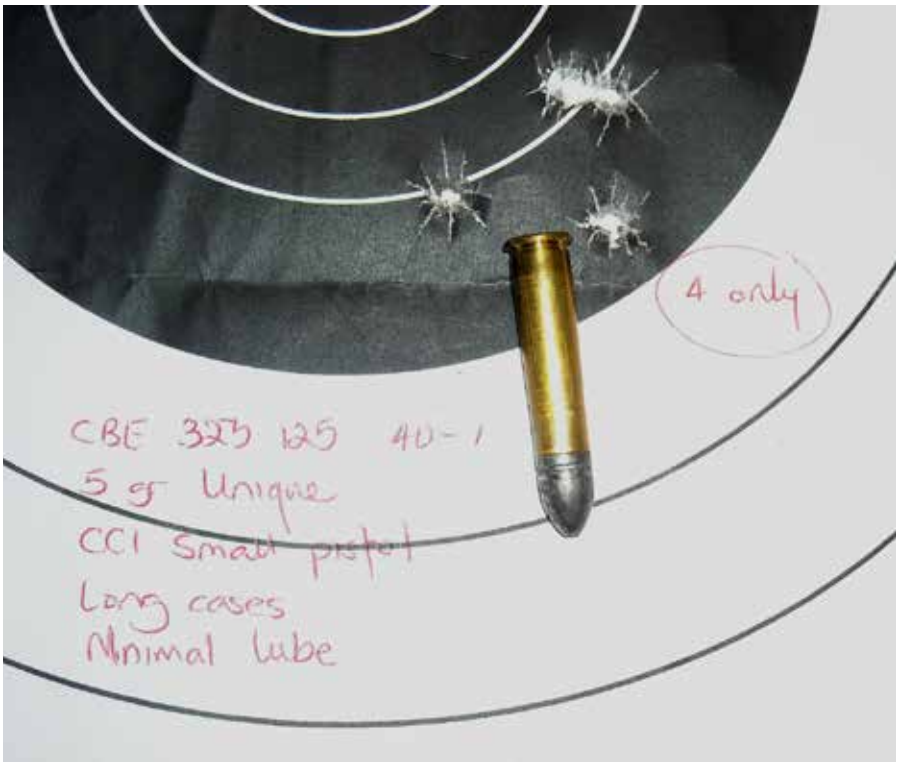
Figuring that starting a bit longer was better than too short, I trimmed 20 cases to 1.125 inch OAL and range testing commenced. Small pistol primers supplied the source of ignition and I have come to favour them for all small cases as they are milder than their rifle counterpart and produce better results. The list of powders sampled consisted of Alliant Unique and Green Dot, Vectan A1, AR2205 and WST. My bullets were cast in 40–1 lead/tin alloy. The results were disastrous – leading of the bore and nil accuracy; some bullets arrived at the target sideways. My initial fears of an undersized bullet appeared to have been well founded given the leading; a tell tale sign.

The cat amongst the pigeons was that when the 323 125 arrived with a diameter matching the throat the results were exactly the same. Maybe a harder or softer alloy might help? The original factory bullets registered at 6.8 BHN (Brinell Hardness Number)) so were very soft. My 40–1 alloy was 7.8 BHN. More projectiles were cast in pure lead and wheel weight alloy and the results were the same. Both low-density polyethylene (LDPE) and beeswax wads to protect the base of the bullets were sent down range and still little improvement. My tenacity was beginning to flag.

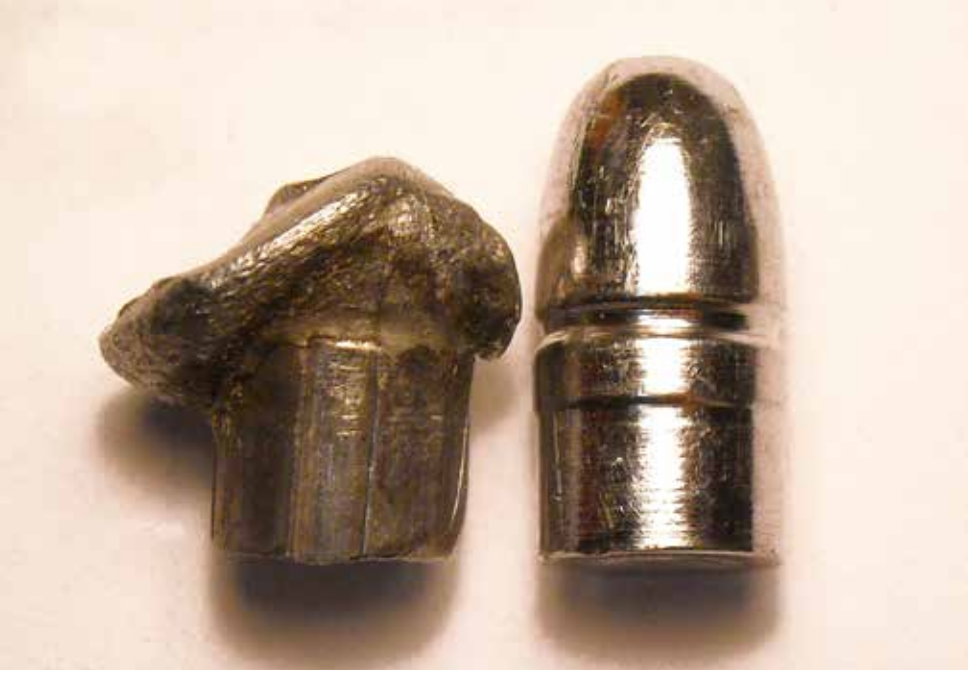
About that time a blinding flash of inspiration descended upon the loading bench. Black powder! Due to the different burning characteristics of black powder, which is more of a push than a kick-start, I thought is was worth trying some loads to see if the rifle would group rather than pattern. Around 17 grains of Swiss 3Fg powder was

all the little cases would hold so I made a compression plug to pack the powder down into the case enough to seat the heel of the bullet fully. To keep fouling under control the two sample loads I assembled consisted of first, a duplex load of 14 grains of 3Fg on top of a "kicker" of 3 grains of AR2205 with a LDPE wad under the bullet, and second, a full 17 grain charge of 3Fg with a "grease cookie" and LDPE wad under the bullet.

The charge of smokeless powder under the black powder acts to provide a hotter burn, resulting in less fouling. The "grease cookie" (lube wad) is intended to provide an increased amount of lubricant to the bore to prevent powder fouling building up. Results at the range were like night and day. The duplex turned in a group hovering around 1 inch at 50 metres with the black powder/grease cookie load only slightly larger. No barrel cleaning between shots took place for either load. The duplex load with the AR2205 kicker worked so well the bore of the rifle was shiny after firing; something I have never seen shooting black powder. Success, but at risk of looking a gift horse in the mouth, why?



Unique powder also proved suitable for the .310 Cadet, and produced very acceptable 50 metre groups in the old Martini-action rifle.



Left; a CBE 320 120 bullet cast in 40-1 alloy recovered from wet phone books at 50 metres. Upon firing the heel has slugged up to groove diameter and there's still some lube left in the groove.

POWDER	CHARGE (GRAINS)	VELOCITY (FPS)
Winchester Super Trap (WST)	4.5	1200
	5.0	1300
	5.3	1350
	5.6	1400
Alliant 2400	9.5	1370
Swiss 3Fg black powder	17.5 with 2mm grease wad	1220
AR2205/Swiss 3Fg black powder	3.8/14.0 with LPDE wad	1420 **
Vectan A1	5.5	1340
	6.0	1430

THE WHYS AND WHEREFORES

I need to take the reader back a few steps here to help work this out. Prior to shooting the Cadet I corresponded with a few Australian and British shooters who are very well informed on the subject of wringing match accuracy out of the .310 round. Almost all of them suggested not sizing fired cases, but instead to decap, reprime, charge with powder and thumb seat a bullet so that it'll engage the rifling when it's chambered. Not sizing my cases did not allow for the bullet heel to be held tightly and it certainly did not engage the rifling. Something was afoot with my chamber and after conducting another sulphur cast it became obvious that to get projectiles to engage the rifling the cases would need to be significantly longer than all the literature suggested.

To establish a more suitable cartridge case length I took a .32-20 case with the rim thinned as described above, full-length sized it, seated a 320-120 bullet and tried to chamber the dummy round. The case was repeatedly trimmed in small increments until the bullet engraved in the rifling down to the main driving band and the dummy round chambered completely. The final case overall length was 1.275 inches. That is 0.255" or 6.5mm more than Barnes states in "Cartridges of the World" and only 0.040 inch shy of a .32-20 case.

Now twenty cases of 1.275" OAL were prepared and testing commenced again with smokeless powders and the 320-120 bullet, again cast in 40–1 alloy. Alliant 2400 turned in usable groups but left a lot of unburnt powder in the bore suggesting that pressures were insufficient for clean combustion. Vectan A1 struggled and was problematic. Unique came up trumps producing groups at 50 metres hovering around "minute of rabbit head" and better, but the best powder by far was the Winchester Super Trap (WST) of which 5.1 grains produces bang on 1300fps, burns super clean and groups around the magical inch mark at 50 metres. Of further interest were that bullets hollow pointed in my mini lathe (using a small centre drill) shot better than in their original solid, round nose state. I reckon that moving the centre of gravity back towards the heel helped them fly more consistently.

So in my Cadet, longer cases are required for smokeless but shorter cases worked fine with the black powder and duplex black powder loads. Again – why? The shorter cases leave the bullet heels momentarily unsupported and exposed to the hot burn of the smokeless powder gases. The gases

have a very small window of opportunity to scoot around the edges of the bullet (prior to it slugging up to full diameter in the rifling) and cause leading and zero accuracy. I deduce that the compressed column of black powder acts to protect the bullet as it enters the chamber mouth and is sufficient to block the path of the gases long enough for the bullet to obturate out to full diameter. The kicker charge of AR2205 will get the bullet and black powder column moving and plug the chamber/bore prior to the main black powder charge igniting. In essence the black powder column is a combustible gasket albeit one with a very brief life expectancy.

REG'S BARREL

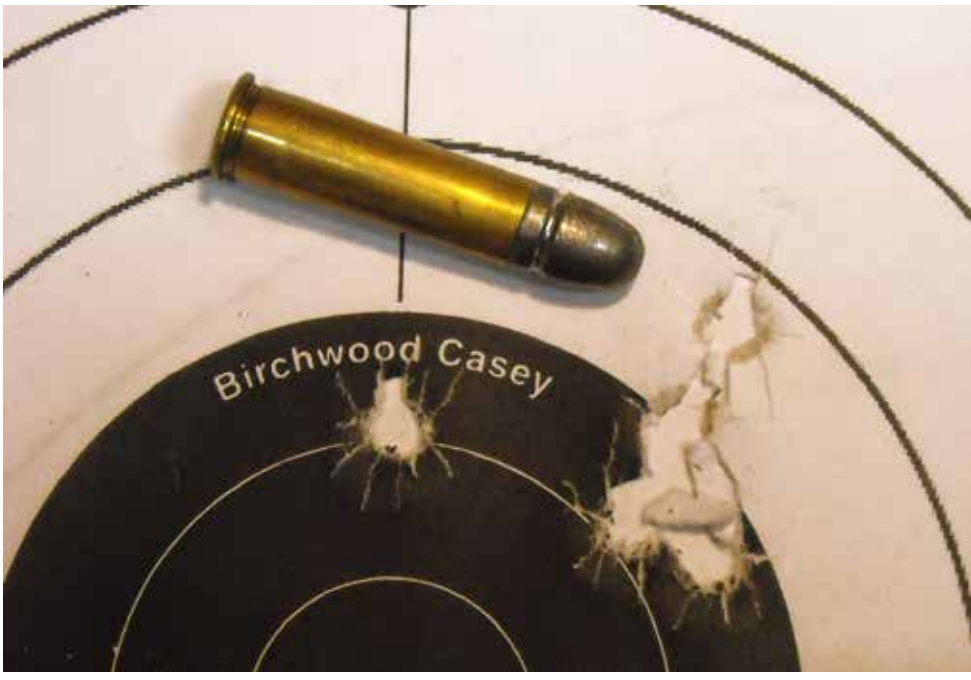
Another club member took some interest in me beating my head against the concrete bench top at the range and commented that he had a brand new Cadet barrel at home that he thought one day might find a home on an action should one become available. I immediately asked if he would mind my taking a chamber cast of his barrel so I could compare it to my own. The new barrel was forthcoming and was a thing of beauty, still wrapped in the factory grease-proof paper and stamped "MADE BY BIRMINGHAM SMALL ARMS CO. LTD, ENGLAND 1909, CARTRIDGE 310" and "310 12 120".

The sulphur/graphite chamber cast was rather revealing. Reg's chamber, visually at least, looked very much the same as mine. The rifling started in basically the same position, however the throat area immediately in front of the rifling measured 0.318 inch on his barrel; mine is 0.322 inch. Both barrels measured the same at 0.325 inch at the part of the chamber where a factory case mouth would locate when chambered. Without a doubt Reg's barrel would be far more tolerant of the short cases purely and simply because his rifle's throat is 0.004 inch tighter than mine. Without shooting it there is no way to be sure but four thousandths of an inch is an awful lot when you're shooting cast bullets. What Reg's barrel demonstrated was that my chamber had not been altered. It wasn't that I had a longer chamber; I had a fat chamber and the longer cases were taking up the slack.

LOAD DATA.

All loads were assembled using CCI small pistol primers and 40–1 lead/tin alloy. All bullet lubricant used was Beaver Grease™ Original. ** Denotes short cases as per text.

The author and publisher accept no liability for the use of this data.



A 50 metre group shot with the cast CBE 325 125 bullets and a duplex load comprising a layer of AR2205 behind Swiss blackpowder.

JEFF'S POINTERS ON LOADING THE .310 CADET

So what have I learned that might prevent others from reinventing the wheel?

Begin by making a chamber cast to ascertain the internal dimensions of your barrel.

Order a bullet mould that matches as closely as possible the throat of your chamber. Allowing for the front of the bullet to engage in the rifling, the rear driving band should be as close to a perfect fit as possible.

Make your own cases if you are able to. It would be worth paying someone to alter the rims of .32-20 brass to allow you to trim cases to fit your chamber perfectly. Start with a full length .32-20 case, full length sized in a .310 die, seat a bullet in the case and try to chamber. Gradually reduce the case's overall length until the dummy round chambers, engraving the bullet slightly. Remember that due to the heel bullet design and the way the shoulder at the top of the heel butts onto the case mouth, the case length dictates the overall cartridge length.

Cast bullets in soft alloy. The factory rounds I have measured are 6.8 BHN similar to .22lr bullets, and 40-1 lead/tin alloy worked very well for me. Stick-on wheel weights would be a good starting point also with 1-2% tin added to help them flow.

If you have access to multiple powders try them all. Recommendations made to me ranged from Trail Boss to AR2207. For the most part powders in the burning range of Alliant Unique appear perfect. When extraction gets sticky it is time to back off. The pressures will not be dangerous but the Martini Cadet has poor extraction and this governs the top-end loads. Accuracy with 40–1 alloy will drop off rapidly long before pressures become an issue. An accurate cast load is a safe cast load.

Minimise the use of bullet lube. With a well matched bullet only a tiny amount of lube is required in the small grease groove(s).

Small pistol primers provide a mild ignition sequence in such a small case, so they're worth considering when you're chasing the best accuracy.

So there you have it – my post-earthquake project to take my mind off things. Ironically the process nearly drove me mad, but I have yet to find a rifle I could not get to shoot with cast bullets and the Cadet was not going to be the first!

Jeff (aka; the Cast Bullet Kid)