Is Steel An Acceptable Alternative?

Most best quality game guns have the shorter 2½ inch chambers, meaning that the C.I.P. proof regulations state that they cannot under any circumstances be used with steel shot.

Conversely, this pair of Churchills (in the main picture) have 2¾ inch chambers, choked Improved Cylinder and Half, which technically means that they could be used with Steel shot game loads, although this is extremely unlikely due to their value and the potential risk of barrel damage.

But even if they were, what would be the effective range of steel game loads and would they be worthwhile?

Winchester ballistic data

Many game shots might regard Steel shot as eminently unsuitable for their best quality guns, considering that its use requires the acqisition of a modern gun specially proved for steel pellets.

This is true of the higher performance steel loads for modern steel shot proved guns, but a reduced performance steel loading is allowed for use in older guns proved for lead shot.

Although these loadings are unsuitable for use in 2½ inch chambered game guns, and must in no circumstances be used in them, they can be used in other guns with longer 2¾ inch chambers.

How effective is steel shot?

With much confusion over the available performance levels of Steel shot pellets, especially those loaded in Steel Game cartridges, perhaps the time has come for an objective unbiased apparasal of its potential in the field.

There are a host of other contentious steel shot issues, regarding the suitability of guns, the degree of choke to use, the potential for barrel and chamber cone damage, pattern density, increased recoil, the potential for ricochets, damage to woodland areas and many other things.

But more specifically, for the purposes of this appraisal, an accurate listing of the effective ranges of steel shot pellets as loaded in the standard 32gram game loads is needed.

They are offered in three pellet sizes, FE6/UK5 (2.8mm), FE5/UK4 (3.05mm) & FE4/UK3 (3.25mm), but the two smaller sizes are of extremely limited utility.

Performance History

From the outset of its use in the USA for waterfowl hunting, it was thought that the use of steel shot pellets two pellet sizes larger would be sufficient to compare with the performance of lead shot.

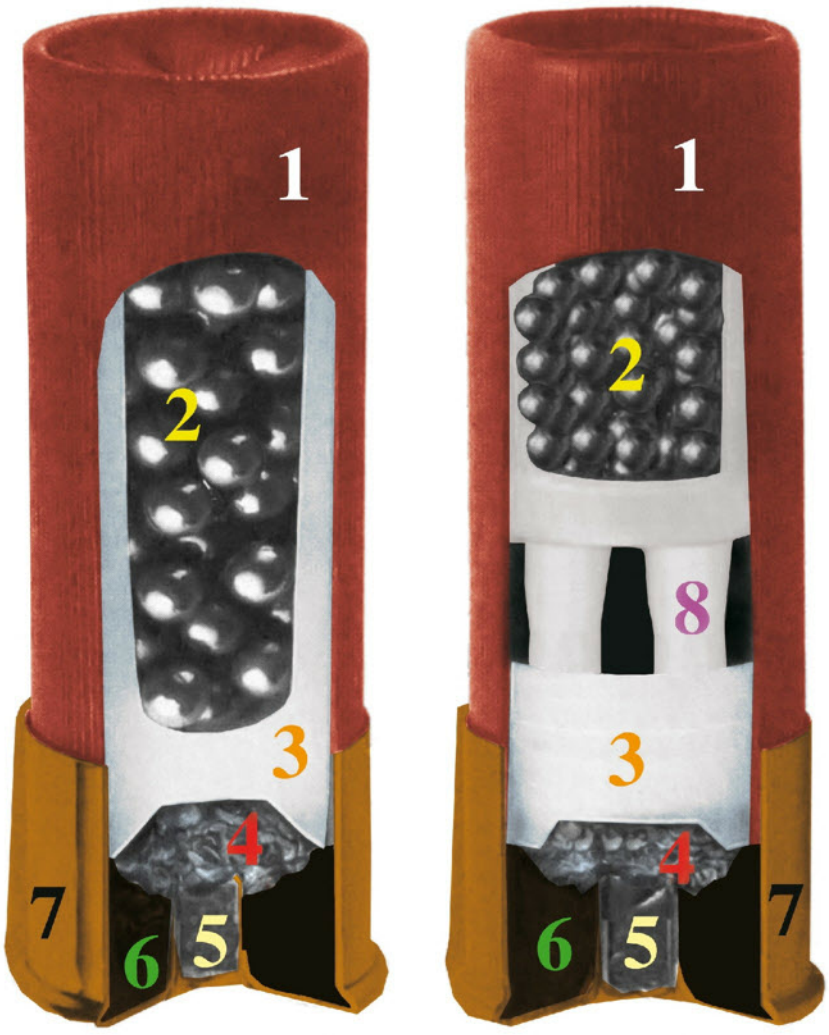
This theory was based on the readily available (in the US) standard pellet striking energy tables. So that after due consulation, the concensus was that as long as the pellets performance could match this criteria, all would be well here they fell into error. Winchester did a lot of work in reappraising the ballistic potential of shotgun pellets and some corrections were made to the established lead shot data tables after extensive testing. This data has been refered to as the new ballistics and all of the charts and data within this report are based on the up to date revised ballistics information.

At first glance, the premise of comparable pellet striking energy appears perfectly reasonable, but unfortunately it does not hold up under closer inspection, for many good reasons.

Pellet Density

Firstly, steel pellets of any given size are far more numerous than their lead counterparts, an inescapable fact brought about by the much lower density of steel when compared with lead.

For example, with US number 6 pellets (the very close equivalent of 2.8mm UK number 5 shot at 2.79mm diameter) there are 223 lead pellets to the ounce (28.35grams), but with steel this has grown to 315 a 41.3% increase.



STEEL SHOT **LEAD SHOT**

1 Case, 2 Shot, 3 Plastic Wad , 4 Powder, 5 Primer, 6 Shock absorbing and Gas sealing base wad (this is considerably lower in this particular steel load), 7 Metal case head, 8 Cushioning section of The lead Shot plastic wad (not present in the steel load).

Higher density levels are very important, enabling shot pellets to resist the ravages of air resistance that are constantly trying to slow them down when in flight. Clearly with the handicap of such a large density reduction, the same sized steel pellets cannot possibly perform in a like manner.

Weight & Diameter Issues

Even when there are similar numbers of pellets in the load, with the individual pellet weights of both types being broadly similar, the steel pellets are still have a considerable disadvantage. They must of necessity be of a larger diameter than the lead pellets for a given individual weight this brings its own problems.

As soon as the larger steel pellet leaves the muzzle it encounters the drag of air resistance, which, because of its considerably larger diameter than the lead pellet of equivalent weight, is more severe. This slows the steel pellet down much more rapidly, shortening its potential range.

Therefore the striking energy potential of steel and lead pellets of the same individual weight will not be evenly matched.

Pellet count

With the two sizes larger concept there will be of necessity, fewer steel pellets in the same load weight than with lead. This means that the individual steel pellets will be heavier than their lead counterparts, which might at first seem encouraging.

Unfortunately the equivalent performing steel pellets are considerably larger. This means that a higher level of energy will be needed than with the equivalent smaller lead pellet. This is so that they can penetrate the vital organs effectively beyond 25yards range they have to force a larger cavity through the target.

Velocity limitations

It has been suggested that launching the steel pellets at a very high velocity could overcome their inherent shortcomings, but along this path lie immovable obstacles.

The maximum legal velocity allowed by the C.I.P. proof authority for steel game loads in lead shot proofed guns is close to 1400fps at the muzzle. Most manufacturers load below this level, to avoid exceeding the legal velocity limit under some climatic conditions.

The velocities used in the charts are taken from the fastest commercially loaded Steel Game cartridges available in the UK, the others were a little slower, but the fastest ones were used to give steel the best chance when compared with lead shot.

**Steel Fe5/UK4 (3.05mm) pellets are not much more effective in the field for game shooting than Lead UK 7.5 (2.3mm) pellets.
When used unwittingly, they can be the cause terrible wounding to ground game and larger birds within normal sporting ranges.**

For game or duck shooting with steel, FE size #4 at 3.25mm (UK number3 equivalent) which is the largest steel pellet size allowed in lead shot proofed guns, will be needed to come close to matching the performance of UK lead number 6.5, and even then, within maximum range limitations. Steel shot smaller than FE 4 (UK number 3) cannot be recommended, as the penetration needed to kill cleanly at reasonable ranges just isn t there.

Extensive moderate range field tests have dramatically shown up these limitations, demonstrating the unsuitability for rabbits, or similarly tough quarry, of a game load of 32grams of steel FE 5 shot of 3.05 mm diameter (UK 4 equivalent).

A dreadful case in point was one unfortunate rabbit at just over 30 yards range, having been shot no less than three times with a 12bore FE5/UK4 32gram game steel load through a half choke; each shot had been a visibly direct hit within the pattern. The poor creature was finally put out of its misery and immediately dispatched, with a fourth shot, using a lead shot UK number 5 cartridge.

This was a disgusting experience and one that shall never again be repeated by the tester.

The propensity of these steel FE5/UK4 (3.05mm) pellets for inflicting appalling levels of wounding to both ground game and larger birds is totally unacceptable, on both a sporting and moral basis.

This is because the FE5/UK4 Steel (3.05mm) pellets only just exceed the penetration of UK number 7½ (2.3mm) lead pellets. UK 7 ½ s are extremely popular for clay targets, but apart from Snipe, are not considered suitable for game birds.

The two sizes larger myth

From graph number 1, it can be seen that merely going two sizes larger with steel game pellets is insufficient. We may have parity of pellet energy, but the penetration is wanting. The frontal area of the FE6/UK5 (2.8mm) pellet is 35% larger than the lead UK number 7 (2.4mm), so it will need a lot more more energy than the lead pellet to penetrate the same distance through the quarry.

Clearly as the actual energy levels are lower, it cannot hope to perform at these ranges; with the FE6/UK5 (2.8mm) pellet running out of steam at 28yards with a penetration of 1.09inches. This is the same penetration at 28yards that the lead UK number 7 (2.4mm) pellet has at 40yards.

Because of its third greater frontal area, the Steel FE6/UK5 (2.8mm) needs about a third more pellet energy to match the penetration of the lead UK 7 (2.4mm).

Going larger, the penetration of the FE5/UK4 (3.05mm) steel pellet is still totally outclased by the UK number 7 (2.4mm) lead pellet at all ranges.

With the still larger increase in frontal area (60% plus) over the lead UK number 7 (2.4mm) pellet, the steel FE5/UK4 (3.05mm) pellet needs an even higher energy level, to match the lead number 7s (2.4mm) penetration at 40yards, but it is unable to do so.

Even with the use of the absolute maximum allowed velocity (about 1400feet per second), this is unachieveable. Unless cartridges are specially loaded by the private individual user (not restricted by proof house velocity regulations) to achieve a still higher velocity with FE5/UK4(3.05mm) Steel shot, which would have to be a minimum of 1470feet per second at the muzzle (with 1.54ft/lbs of energy and 1.09inches of penetration at 40yards), going three sizes larger still doesn t quite cut the mustard. The significant 36% increase in the recoil of this much faster load would be most unwelcome.

Clearly if we are going to have sufficient penetration of the vital organs to match the performance of lead shot, something rather better than 3.75 sizes larger will be needed.
Going four sizes larger, the lead number 7 (2.4mm) pellet is finally surpassed at 40yards by the FE4/UK3 (3.25mm) steel pellet, but the unfortunate potential downside here, is the unnecessarily excessive damage caused to birds shot at 25yards or less by these larger steel pellets.
They will be simply blown to pieces at the closer ranges due to the rather limited window of operation of such large sizes of shot with their relatively high close range energy levels the cannon ball effect.

The problem is that although the penetration is a little greater than the lead number 7 shot (but not UK Lead 6.5), it is making a much larger hole in the bird; consequently the use of FE4 (UK3) steel shot below 25 yards is not recommended for game birds.
The maximum range for crossing birds should be restricted to 38.5yards, which is but a 13.5yard window from which to operate.
Going away birds require higher levels of penetration, (because their outgoing speed detracts from the pellets striking velocity) so the range should be more restricted. In the case of a 45mph (66 feet per second) pheasant this would be to 31.5yards.

Although 2.5 sizes larger than the lead 7.5 (2.3mm), the Steel FE6/UK5 (2.8mm) pellet lags way behind with its powers of penetration, a situation that becomes progressively worse as the range increases.

It is in fact slightly inferior in its penetrative powers to lead 8 (2.2mm)shot, so it cannot be considered for anything other than Snipe and even then, at carefully considered ranges.

The 4 sizes larger Steel FE5/UK4 (3.05mm) pellet is needed before a slight increase in the penetrative capabilites of the lead 7.5 (2.3mm) pellet is realised.

32gram Steel Game Loads

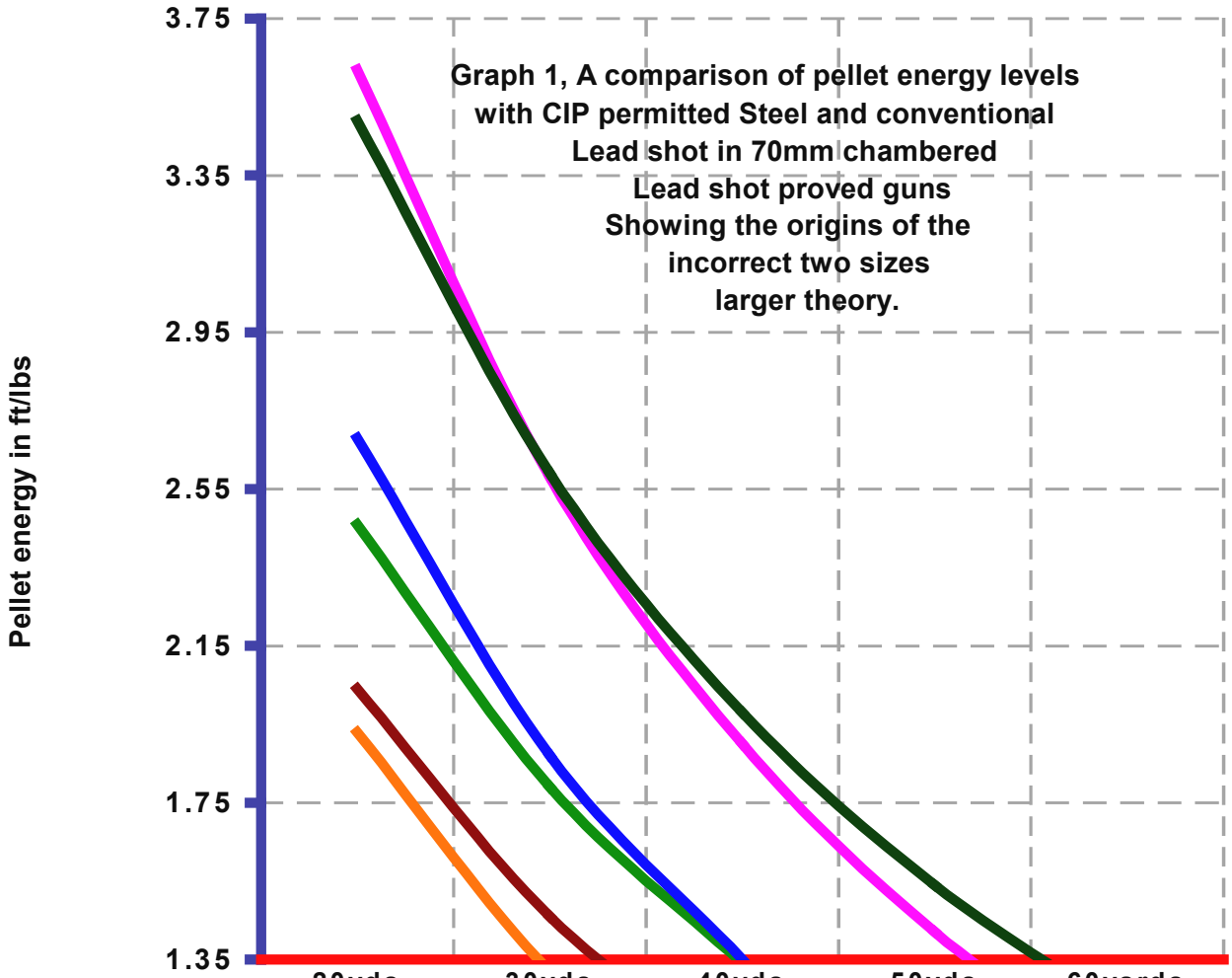
Left: 3.05mm Steel FE5 pellets (UK4), simply do not have the downrange penetrative ranging power for game birds, only just exceeding UK 7.5 lead shot.
They can inflict appalling levels of wounding to rabbits and larger birds that can then go off to die a painful, slow and lingering death; which is totally unnacceptable.

Right: The larger 3.25mm FE4 pellets, although marginally better than Lead 7(2.4mm) shot, cannot match the downrange penetrative power of 6.5 (2.5mm) lead shot.

The striking energy level of the lead UK 7 pellet lies between the steel FE6/UK5 (2.8mm) & FE5/UK4 (3.05mm) pellets, but the penetrative power of the lead 7 (2.4mm) is far superior at all ranges out to 40yards than either of them.

The largest Steel pellets that are available for standard 12bore game guns with 2¾ inch chambers are the FE4/UK 3 s at 3.25mm diameter.

These are the only ones that should be used for shooting game birds or other suitable live quarry (not rabbits), but even so, their penetrative ranging power is limited, being slightly superior to UK Lead 7 s, but inferior to UK Lead 6.5 s.

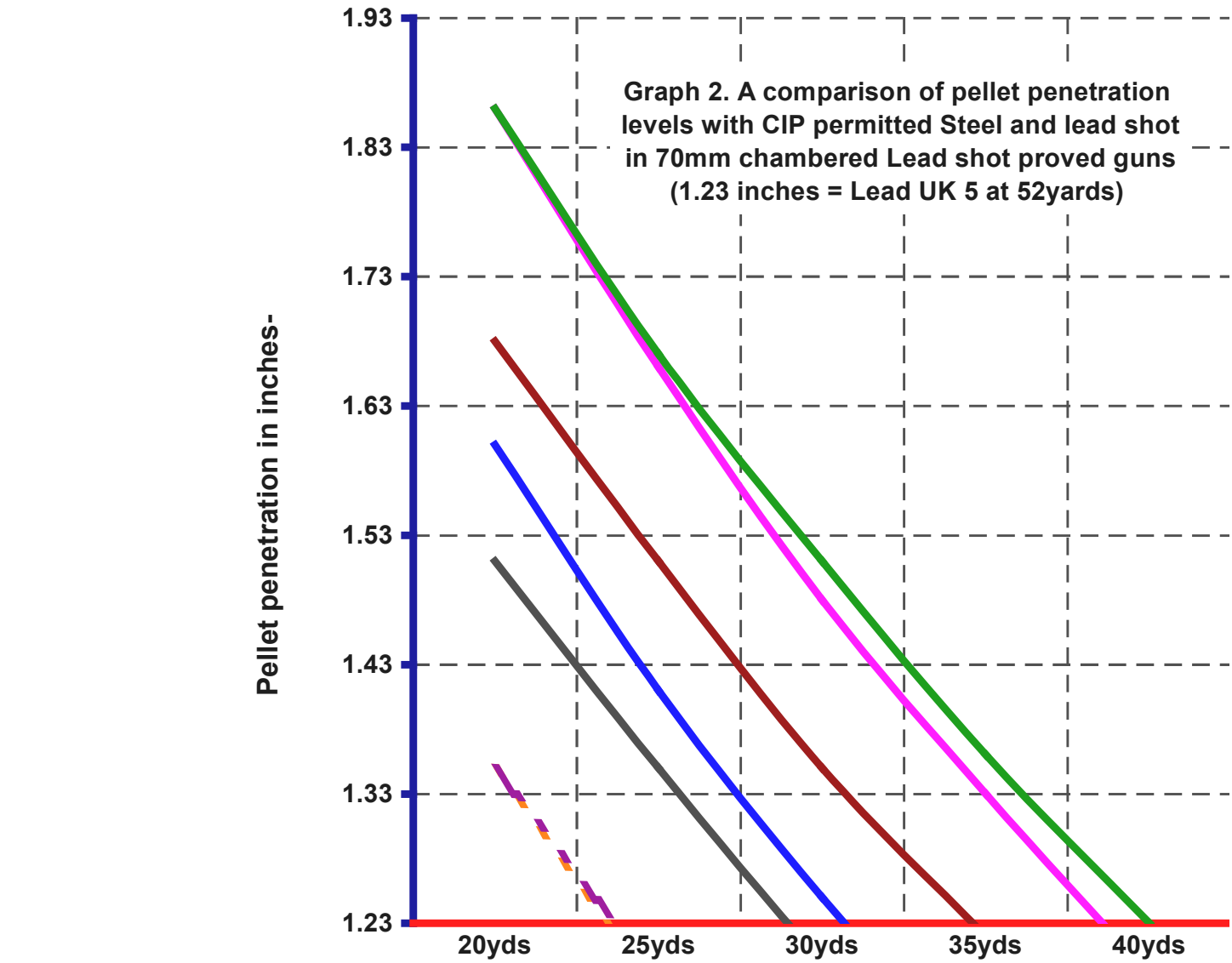


Exploding The Myth Of The Two Pellet Sizes Larger Striking Energy Theory

Graph 1: the horizontal red line shows the traditionally suggested minimum pellet energy level suitable for larger game birds (pheasants) of 1.35ft/lbs. The pellet energy levels look encouraging for the FE5 steel pellets out to 40yards, being virtually identical to UK Lead 6.5 shot; potentially idicating its usefulness for both Partridges and Grouse. The Steel FE4 (UK3) looks as if it might be a replacement for Lead UK 5 s, to tackle Pheasants.

Unfortunately these impressions are false, as it is the adequate penetration through to the vital organs that is the key to real world success in the field with shot pellets, as can be seen in graph 2.

With equivalent or close equivalent striking energy levels, the steel pellets are much larger in diameter than the lead ones, this increase in size, limits their ability to reach the vital organs of the quarry.



The Real World Of Pellet Penetration

Graph 2: the red horizontal line crosses the graph at a reasonable minimum level of penetration, (1.23inches equals typical Lead UK5 shot at 52yards and typical Lead UK6.5 shot at 40yards) for a clean kill of crossing larger game birds and ducks; thus indicating the maximum effective range.

The progressive penetration limitations at 40yards of even the largest FE4 (3.25mm) size of steel shot (1.23inches at 38.5yards) can be clearly seen when compared to lead number 6.5 (2.5mm) shot.

Going away birds travelling at 45mph will reduce this range by around 7 yards.

Conclusion

The currently permitted steel game pellets clearly cannot replace lead on a like for like basis.

Their range is limited to an absolute 38yards maximum for crossing or driven game birds with the largest FE4/UK3 (3.25mm) size available in the so-called steel game loadings. ***(Follow the pink line down to its indicated maximum penetration range of FE4/UK3 steel pellets penetration in Graph 2)***

Shots taken at going away game birds with this largest steel shot size are limited still further to about 31yards being caused by the speed of the bird s flight away from the shooter detracting from the pellet s penetrative power. ***(The speed of an outgoing 45mph bird is 66 feet per second, this has to be deducted from the retained speed of the steel pellet to obtain a true figure for adequate penetration).***

Steel shot has a very limited acceptable window of performance in the field.

Shots taken at closer ranges than this, will simply render game birds fit for nothing but the ferrets.

This is the so-called cannon ball effect of very large pellets blasting the edible flesh and raking the birds with shot.

Shots taken beyond the range window , will simply produce large numbers of pricked and wounded birds that will be lost to the bag and fly on to suffer a slow and painful death.

Inceasing the velocity of steel game loads is severely hampered by the CIP regulations, so this is not a viable option for commercial cartridge loading companies. It is not an effective answer, as with pellets of the same weight and number in the load, more than an extra 500 feet per second is needed, with enormous increases in recoil; considerably more than twice that of a standard lead shot game cartridge with the same weight of shot. ***(For full details of this insurmountable velocity problem, see part 4 of the steel shot for clay target series on the www.fourten.org.uk web site)***

The only thing steel shot has going for it is its cheaper price than the other non-toxic alternatives, but its use in English game guns is extremely limited to those with 70mm chambers.
In practice, the chance of a damaged barrel or chamber cone with an errant steel pellet when fired through a valuable best quality game gun (or indeed any other), is clearly not a gamble worth taking.

Fibre wad only shoots will not be able to use steel shot with cartridges loaded with the traditional fibre wad column as used in lead shot game cartridges. Some type of all encasing photodegradable plastic wad will be the only cost effective and practical alternative in the vast majority of cases.

Ricochets with steel shot pellets can be a serious problem, both from hard ground surfaces and in wooded areas, so steel shot should not be used there.

Shots over water using steel shot can also be dangerous, as ricochets off of the surface are more common than might be appreciated, especially when the angle of impact is within certain ranges.

To show that this is not conjecture, Nelson famously made good use of this with his cannon balls, bouncing them off of the water in front of enemy ships, exacting decisive damage in the process.

It was Nelson s example of employing ricocheting cannonballs that Barne s Wallis quoted as being the inspiration for the bouncing bomb as used by the Dambusters , in their famously daring raid on the dams of the Ruhr in Germany during WWII.