

Ammunition Reloading – Basic guidelines for TR shooters.

Compiled by Schalk Cullinan (c2008)

Index

1. Introduction
2. Safety
3. Equipment
4. Ammunition nomenclature
5. Reloading process
6. Accuracy and velocity goals
7. Conclusion

1. Introduction

Due to the current growth of new and junior shooters in TR shooting, a need has arisen for basic guidelines concerning the reloading of ammunition, specifically for .308 Win TR rifles. These guidelines are also applicable to other calibres and forms of target shooting. SABU rules allow for the use of hand loaded ammunition in matches and competitions, unless specified to the contrary.

A wealth of reloading literature exists and provides excellent information about the reloading process. It is recommended that the new hand loader obtains some copies of these and thoroughly familiarise themselves with all the steps of the reloading process. In this guide, attention is given to the basic reloading process necessary to deliver ammunition which is safe, delivers repeatable and acceptable results, suitable for the demands of TR competitions. It is aimed particularly at juniors and those who have little or no experience of ammunition reloading. This article is an update of a previous article prepared by the author (c1996), for use by SABU members and other countries' TR shooters.

Ammunition reloading follows a structured process and short cuts should not be considered. Similarly, this document should be read completely.

2. Safety

Safety is of the utmost importance and not negotiable. During the process described in this document, all the steps have safety in mind as the prime objective.

It is highly recommended that shooters who are not familiar with ammunition reloading first seek advice from and observe experienced hand loaders with a proven track record of technical expertise and the ability to produce safe, reliable and suitably accurate ammunition, before this guide and processes mentioned is applied.

The immense magnitude of the resulting forces that are generated during the firing process of a cartridge (internal ballistics) demand that the utmost attention to detail and safety is given at all times during the reloading process.

During the firing process of a cartridge, a chain of events occur in a minute fraction of a second, resulting in what some refer to as a “quick world” as compared to the “slow world” we live in. Consider the following as an illustration of this.

The major parameters involved in the internal ballistics during the firing of a cartridge are:

- a. Chamber pressure. The chamber pressure generated is in the order of 400 Mpa (60 000 psi), this can be equated to a column of water 40km high!
- b. Time. Ignition of the primer, propellant powder charge and the development of peak chamber pressure occur typically in .1 millisecond (.0001 second). The complete process from the firing pin igniting the priming compound until the bullet exiting the barrel occurs typically in 1.5 milliseconds (.0015 second). This translates to a barrel having “worked” for only 1.5 seconds for every 1000 rounds fired!
- c. Acceleration and velocity. The bullet of 10 grams (155gr) accelerates from 0 to 900 m/s (2950 fps or 3240km/h or 2025mph) in 1.5 milliseconds. This equates to a force of 15 000N or 1.5 times the mass of a small car. The acceleration is in the region of 150 000 G, the human body can only tolerate about 10 G.

Due to the enormity of the forces involved during this stage, it is potentially very dangerous. The process can be likened to a snowball effect, any change to the pressure/time relationship influences the other and both can increase exponentially. Any errors induced by the reloading process that have an influence on these parameters, can have catastrophic results.

The reloading process has two safety aspects, namely:

- a. Loading ammunition that is safe to use. The guidelines mentioned in this document have this in mind as the primary objective.

- b. Safe reloading practices. This consists of the steps of the reloading process and methods that must be done, or not done when powder and primers are handled.

It is recommended that new or inexperienced hand loaders embrace and employ these safe practices religiously from the start, while loading ammunition:

- Wear safety glasses when handling primers
- Keep away from small children
- Store powder and primers in clearly identified, original packaging
- Never mix smokeless and black powders
- Have only one type of powder or primers on the loading bench at a time
- Follow powder manufacturer's recommendations with regards to maximum load data
- **Be alert and pay attention to detail whilst loading**
- Handle primers with respect, never force primers into the primer pockets
- Never use an electrical vacuum cleaner to clean spilt powder, the spark from the brushes of the motor is known to have ignited powder dust present in the air
- Follow the correct steps of the reloading process
- Check the powder level visually in charged cases before seating bullets
- Keep accurate records
- **Alcohol and gunpowder don't mix!**
- No smoking or open flames!

3. Equipment

The following list of equipment is essential to enable the loading of safe, reliable and accurate ammunition:

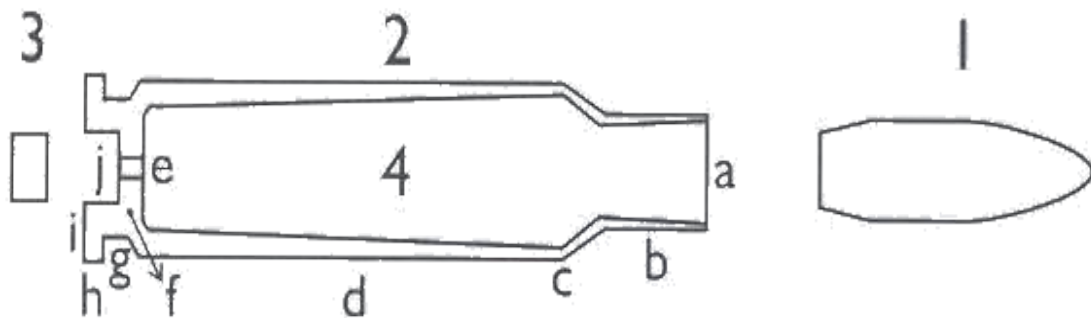
- Reloading press
- Dies
- Shell holder
- Case cleaner
- Case lube equipment
- Primer seating tool
- Primer pocket uniformer and brush
- Flash hole deburring tool
- Case length trimmer
- Chamfering tool
- Powder scale

- Powder dispensing equipment
- Bullet puller
- Measuring tools
- Loading tray
- Ammunition holders

Quality reloading equipment that is used correctly and properly maintained will deliver a quality product and last for many years.

4. Ammunition nomenclature

A cartridge consists of the following components:



1. Bullet
2. Case
3. Primer
4. Powder

The case is usually made of brass (typically 70% Copper and 30% Zinc).
Parts of the case are:

- a. Mouth
- b. Neck
- c. Shoulder
- d. Body
- e. Flash-hole
- f. Web
- g. Extractor groove
- h. Rim
- i. Head
- j. Primer pocket

The greatest financial saving realized is due to the fact that the cartridge case, the single most expensive component, can be re-used numerous times. A case life of 10 reloading cycles is not uncommon, when handling and treating cases with caution, even longer lifecycles are reported in various reloading literature.

5. Reloading process

The steps of the reloading process of fired cases are described in this section. Some of the steps will not be applicable to new unfired cases; this will become clear from the text.

A. CASE CLEANING, INSPECTION AND LUBRICATION

The necks of fired cases are usually covered with a dark sooty deposit, the product of the combustion of the powder and primer compounds. This deposit is abrasive and may lead to damage of the die's interior surface finish and change critical dimensions of the die. Cases may also be tarnished due to sweat from handling and from exposure to humidity in the atmosphere.

Clean cases enhance the ability to inspect them for defects and potential failures, such as cracks, dents, insipient head separations, etc. The sizing lubricant can also be applied more uniformly, this in turns leads to easier resizing and more uniform resultant dimensions of the sized cases, especially the amount the shoulder on the case is pushed back from fired dimensions.

There are many different methods available to clean cases. It is recommended to use a case tumbler with suitable media to clean cases. Methods that employ mechanical (e.g. steel wool) or chemical processes are not recommended, as they may lead to a change in the dimensions of the cases or affect their composition. Ammonia, an ingredient of many chemical case cleaners, must be avoided at all costs. It causes stress corrosion which leads to the formation of cracks and resulting shorter case life.

New, unfired cases need only be cleaned if their finish warrants attention.

Loaded ammunition must never be cleaned in a case tumbler! The cleaning action of the case cleaner can alter the geometry of the propellant kernels; this changes the burn rate of the powder and may lead to catastrophic results.

The cleaned cases may now be inspected for defects, potential failures, mixed manufacturers, Berdan-primed cases, etc. Berdan-primed cases (usually from military/Nato ammunition) have 2 off-centre flash-holes; the decapping pin of the sizer die cannot remove Berdan primers and they will damage or break the decapping pin.

During the inspection of cleaned cases, check for the following defects:

- Split case mouths
- Dents on the mouth, shoulder and body
- Cracks
- Head separations
- Enlarged primer pockets
- Damaged rim and head
- Any other obvious defects

Cases found with any of these defects must be destroyed to prevent inadvertent further use, which may result in a dangerous failure.

The next step is to apply lubricant to the clean, inspected cases. **Cases without lubricant will become stuck in the sizing die!** Once again, there are many different methods to apply case sizing lubricant to cases, e.g. aerosol sprays, roll-on lubes using lube pads, etc. The important goal is to apply an evenly spread thin layer of lubricant to the case body and neck. Lubricant must also be applied to the inside of the case mouth to ease the passage of the expander button and to prevent uneven lengthening of the cases.

Avoid applying too much lubricant, it results in dents on the shoulders and varies the amount the shoulders of the cases are pushed back during the sizing operation.

B. SIZING AND DEPRIMING

The installation of the sizing die in the press is critical to achieve the correct amount of case shoulder setback (headspace), case life longevity, safety, reliability and accuracy. A fired case approximately resembles the dimensions of the chamber that it is fired in; during the case sizing operation those dimensions are reduced to enable smooth and reliable chambering, easy bolt closure and ensuring sufficient case neck tension to grip the new bullet securely and in sufficiently straight alignment with the chamber. Too much case shoulder setback must be avoided; this creates excessive headspace in the chamber, leading to case separations, reduced case life, and inconsistent primer ignition and contributes to inaccuracy. This is one of the reasons that some people prefer neck sizing dies to full length case sizing dies, it then however becomes important to keep cases separated that have been fired in different chambers.

It is however possible to resize fired cases with a full length sizing die to accurately fit the chamber they were fired in and maintaining a consistent headspace (shoulder setback) dimension, for case life longevity, reliability, safety and accuracy.

Whilst the fired case is being resized, the fired primer is removed simultaneously by the decapping pin in the sizing die. Obviously the decapping pin must be correctly aligned in the centre of the die to remove the fired primer through the flash-hole, and to prevent damage to the decapping pin.

Once cases have been sized it is important to remove the remaining case sizing lubricant from the surface of the cases. An easy way to achieve this is to return the sized cases to the case cleaner for a suitable time period.

Sizing dies should be maintained (cleaned) periodically to remove any accumulated crud and case sizing lubricant, this will enable the ability to maintain correct sized case dimensions.

C. PRIMER POCKET CLEANING AND UNIFORMING

Fired primers leave a combustion residue on the bottom of the primer pocket, these needs to be removed to enable the correct seating of a new primer. The correct seating requires that the anvil feet of the primer be in firm contact with the bottom surface of the primer pocket, to ensure reliable and consistent primer ignition, an important factor contributing to achieving consistent velocity, reliability and accuracy.

The depths of the primer pockets vary due to the tolerances of the manufacturing process, leading to the surface of seated primers varying in depth below the case head. This will also contribute negatively to achieving consistent velocity and accuracy.

It is thus recommended that the depths of case primer pockets be cut to a consistent depth, by using a cutter (“primer pocket uniformer”) specifically designed for this purpose. This operation needs to be done only once, also on new unfired cases, thereafter the cutter is used to clean primer pockets.

D. FLASH-HOLE DEBURRING

During the manufacturing process, many manufactures punch the primer flash-hole in the case, rather than drilling. This leads to the occurrence of random formation of burrs on the inside of the flash-hole. These burrs affect the primer flame and deter the consistent ignition of the propellant

charge, once again to the detriment of achieving consistent velocity and accuracy.

These flash-hole burrs may be removed by using a suitable “flash-hole deburring” tool that also cuts a consistent sized flash-hole and chamfer the inside edge of the flash-hole.

This operation is best done when fired primers have been removed, or when new cases are employed.

E. CASE LENGTH TRIMMING

Fired cases expand to resemble the dimensions of the chamber, due to pressure exerted on them by the gasses of the ignited powder charge. When a fired case is resized, these dimensions are reduced. The expansion experienced at the web of a fired case is sized to a smaller dimension by the sizing die; this material must go somewhere, resulting in the increase of the case length. Chambers have a finite length; once this length is exceeded a dangerous situation arises. If case lengths are allowed to exceed this limit, the end of the chamber crimps the case mouth into the bullet surface, and cannot expand to release the bullet upon firing. This delays the internal ballistic process, resulting in higher chamber pressures (remember the snowball effect), creating the potential of a catastrophic failure (explosion) and putting competitor’s safety at risk.

All cases do not increase in length at the same rate, differing case lengths result in inconsistent neck tension on the bullets, leading to inconsistent ignition, velocity and resulting inaccuracy. It is thus recommended that case lengths be trimmed after every sizing cycle, to remove one variable in the equation necessary for repeatable and consistent velocity and accuracy.

The maximum case length specified by the industry standards for the .308 Winchester case is 2.015” (51,2mm); the recommended trim length is 2.005” (50,9mm).

During the case trimming operation, burrs are formed on both the inside and outside of the case mouth. These burrs must be removed; they damage the surface and heel of the bullet (the junction of the boat tail and the parallel bearing surface of the bullet). Various chamfering (“case deburring”) tools are available to perform this critical operation to ensure acceptable concentricity (“run out”) of the seated bullet in a loaded cartridge.

New unfired cases should also be length trimmed to remove manufacturing length tolerances and burrs.

F. PRIMING OPERATION

New primers may now be seated in suitably prepared cases. It is recommended that primers are seated using a suitable priming tool that is sensitive to the touch, to “feel” when the primer anvil feet are in contact with the bottom of the primer pocket to ensure correct and consistent seating of primers.

Once primers are seated, the seating depths should be checked to ensure that no primers are proud of (elevated above) the case head. This can be potentially dangerous, leading to accidental discharges, hang-fires or misfires. The seating depth can be easily checked by running the point of the index finger over the case head and primer surface to detect any primers that are standing proud of the case head.

Primers must under no circumstances be exposed to or come in contact with perspiration, oil or solvents. These attack and degrade the priming mixture and can result in hang-fires or misfires. Primers must always be stored in the original factory packaging and never in glass bottles. Primers are very sensitive to shocks/impacts; the resultant shock of a dropped bottle of primers is enough to set off a chain reaction of exploding primers.

In the interest of safety, it is strongly recommended that safety glasses be worn when handling primers and during the primer seating operation.

G. POWDER DISPENSING

A safe charge weight of a suitable propellant powder can now be weighed off and dispensed into primed cases. There are many different methods of weighing/measuring powder and dispensing the powder to primed cases. The traditional method is to use a powder measure in combination with a powder scale (balance type or electronic), powder “trickler” and funnel to charge cases. Lately automated electronic equipment has become available on the market, their main advantage being the time savings that are achieved by their use.

Once the primed cases have been charged with a safe weight of suitable powder, it is important to visually check the powder column height in the cases. Any suspicious powder column heights must be checked, to prevent under or overcharges, also to ensure that all cases are charged with powder.

Powder should never be left for long periods of time or overnight in powder dispensers. The powder absorbs moisture and this changes the ballistic properties of the powder. Powder must always be stored in the

original containers and properly sealed when not in use, preferably in a cool, dark, and dry location.

H. BULLET SEATING

The appropriate weight bullets may now be seated in charged cases. The seating die is employed to achieve this. Set-up of the seating die is also critical to achieve the desired results. Most seating dies have a built-in bullet/case crimping capability. Dies should be set up not to crimp the case mouth into the bullet, crimping is not recommended for ammunition that is required for high levels of accuracy and precision.

The seating stem of the seating die must be adjusted to give the desired cartridge overall length. The length of the cartridges should not exceed the maximum determined length for a specific bullet/chamber combination; this may lead to a bullet being lodged in the rifling in the case of an unexpected need to unload an unfired cartridge. (Some bullet manufacturers recommend that VLD –type bullets be seated into the rifling, but this is not recommended for the inexperienced.)

During the bullet seating operation attention must be given to seat bullets carefully to achieve acceptable alignment and concentricity (run-out).

I. RECORD KEEPING

Once all the charged cases have been loaded, the ammunition must be packaged or stored in suitable holders until required for use. The containers/holders must be clearly marked, identifying the pertinent details such as the bullet weight and type, powder type and charge, primer, case, cartridge overall length, etc.

An accurate record must also be kept of the ammunition that is loaded, documenting all relevant details of the components and test results, if available. This system of record keeping will eventually result in a valuable and accurate data base of information and reference as to which combination of components deliver acceptable or desired results in a specific rifle.

6. Accuracy and Velocity goals

The following serves as a guideline for the inexperienced, and as thus is not cast in stone.

TR (Bisley) is fired at ranges starting at 300m and extending all the way to include 900m. The rules determine that bullets used may not exceed 156

grain mass. The target dimensions used (SABU rules, c2007) imply that the 300m target has the most stringent accuracy requirement, in terms of angular measurement. Ammunition that is suitable for TR purposes must then comply with predetermined levels of accuracy and suitable velocity, to deliver repeatable, consistent and safe results across various ranges.

VELOCITY GOALS

Independent ballistic experiments have shown that when the transonic velocity zone (approx. 1000 - 1250fps) is approached by the typical match bullet, the bullet's flight is subjected to a phase of instability. When remaining velocities are in this transonic zone, the resultant accuracy of the bullet is affected negatively.

It thus follows that to deliver predictable and consistent accuracy at the longest ranges fired; the velocity of the bullet must remain above this transonic velocity zone. Using suitable match bullets, experiments and experience has shown that a minimum average muzzle velocity of 2920 fps is required to keep the remaining velocity above this transonic zone at 900m, especially when fired at sea level and at low temperatures.

Another, almost more important, velocity goal that is not apparent at first, is to load ammunition that delivers the smallest possible velocity spreads. The importance of this only becomes apparent when the dimensions of the 900m target are considered in relation to the bullet drop due to gravity, caused by velocity variations.

The SABU 900m target dimensions are as follows:

Aiming mark (4 points):	1118mm/44"
Bull (5 points):	508mm/20"
V-bull:	254mm/10"

The bullet drop due to gravity, calculated with the aid of external ballistic PC programmes, using a suitable bullet under worst case conditions, at an average muzzle velocity of 2920 fps, the vertical contribution of velocity variations to bullet drop at 900m is as follows:

75 fps variation:	560mm/22" vertical elevation difference
50 fps variation:	380mm/15" vertical elevation difference
25 fps variation:	190mm/7.5" vertical elevation difference

Only now does the importance of loading ammunition that delivers consistent velocities become clear, especially at the longer ranges. At shorter ranges the influence is much less. As an example the same conditions were used for a range of 300m, with the following results:

75 fps variation:	35mm/1.4" vertical elevation difference
50 fps variation:	24mm/.94" vertical elevation difference
25 fps variation:	12mm/.47" vertical elevation difference

The SABU 300m target dimensions are as follows:

Aiming mark:	600mm/23.6"
Bull (5 points):	140mm/5.5"
V-bull:	70mm/2.8"

From the above it is recommended that a velocity extreme spread of less than 35 fps for 10 shots be the acceptable goal.

ACCURACY GOALS

As mentioned previously, the 300m target poses the most stringent accuracy requirement, measured in minutes of angle. Relatively large velocity variations have negligible influence at this range, compared to the longer ranges.

It is however desirable that a 10 shot group, fired at 300m from a dead rest, must have less vertical elevation spread than the v-bull height. An accuracy goal of 10 shots with less than 45mm vertical elevation spread at 300m is not unreasonable.

ADDITIONAL FACTORS TO CONSIDER

The following factors contribute to the 2 abovementioned goals; the hand loader is able to control them to achieve the desired goals.

a. Case volume (weight)

The internal volume of a case contributes to the pressure and resultant velocity generated by a powder charge. The prepared cases all have similar exterior dimensions; any differences in weight can be contributed to variations in case wall dimensions, affecting the internal case volume. By weighing cases, the internal volume can be controlled to a large degree.

A case weight spread of 1 grain is approximately equal to .12 grain charge weight. In the typical .308 load the velocity/load ratio is approximately 70 fps per grain charge weight. Thus, a case weight spread of 1 grain equates to about 8 fps velocity variation.

b. Load weight variations

The hand loader is able to weigh all charges 100% accurately. As previously mentioned, 1 grain of powder equals 70 fps velocity, thus .1 grain powder weight spread represents about 7 fps velocity.

c. Bullet weight

Minimal variations in bullet weight of up to 1 grain have very little influence on the velocity and trajectory of the typical TR load. It is recommended however, to do a spot check on every new lot of bullets to confirm the nominal weight and that no abnormal weight variations occur.

d. Cartridge overall length

The amount of bullet jump has a major impact on the accuracy performance of the ammunition/barrel combination. Each barrel has unique characteristics and only by experimentation can the most suitable length be determined.

e. Primers

The contribution of different primers to the accuracy and velocity spreads can also only be determined by actual firing tests. Select primers on the basis of the brand that delivers the most consistent velocities with a specific combination of components.

7. Conclusion

By conscientiously following and applying the steps discussed in this guide, ammunition that is safe, reliable and meeting the accuracy requirements of modern TR shooting, can be produced with ease. It is a hobby in its own and can deliver much satisfaction and joy when the desired results are delivered on the firing ranges.