Creating Winning Long-Range Ammunition with the Dillon 550 Press
&
Prometheus Powder Scale

June 29, 2019

Scott Harris
scott_harris64@yahoo.com

Purpose

Ammunition of the highest quality is needed to perform well in F-class, especially for long-range events. Reloading problems that do not impact group size at less than 600 yards, are the source of lost points at 800 to 1,000 yards. In short, it is essential to carefully control all aspects of the manufacturing process to ensure the finished cartridges are virtually identical in every measurable dimension. The purpose of this article is to share some the techniques we use to produce ammunition suitable for long-range F-Class

Our family uses a LOT of ammunition each year in competition. So, minimizing reloading time and effort is almost as important to us as the need to create "perfect" ammo. Laborious, time-consuming methods that might be acceptable for lower-volume competitors simply do not work when shooting 300-1000 rounds per week.

This paper will describe two of the important tools we use to make quality rifle ammunition in the shortest time possible:

- Dillon 550 Progressive Reloading Press
- Prometheus Automated Powder Measure (Gen 2)

Specifically, we will cover the competition-proven "tips & tricks" we have developed over several years of F-class competition.

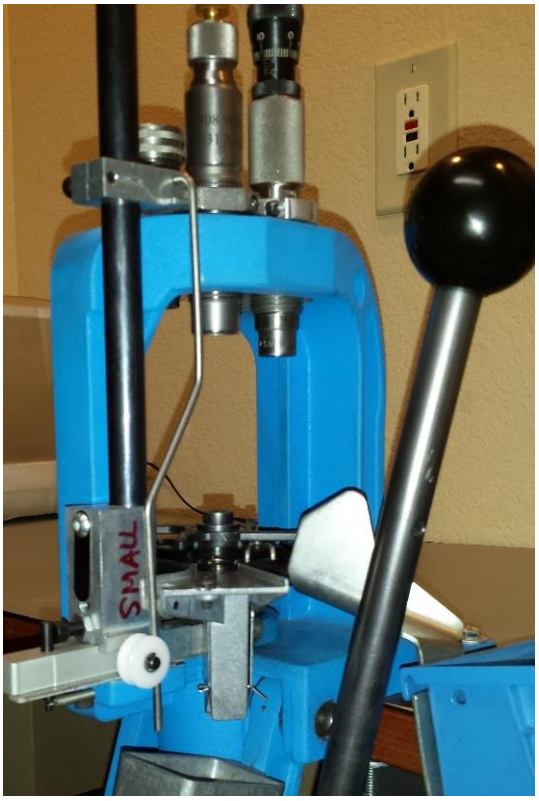
Ammunition Criteria: how we measure our production results

Key traits of match-winning long-range rifle cartridges:

- **Primer Seating**: all primers seated firmly to the bottom of the primer cup with 100% consistency. Usually, this means they are seated a .002-.006 below flush.
- **Sized Brass Concentricity**: sized brass should have zero runout with a maximum allowed runout of .001 measured anywhere along the case length.
- **Neck Tension**: neck tension must be identical from case to case. The amount of neck tension is not as important as the consistency of the neck tension. This is accomplished by trimming, chamfering, annealing, and sizing the neck no more than needed. In addition, carbide turning mandrels are used to improve inside neck uniformity. Lubricity of the neck must be carefully controlled. Bottom line: consistent neck tension is one of the most important ingredients needed to produce superb accuracy.
- **Powder Charge Weight**: top long-range competitors control the powder weight to within +-.02 grains. Every single cartridge produced has the same powder weight with a maximum spread of +-.02 grains.
- **Bullet Seating**: should be perfectly consistent, as measured by bullet runout and seating depth consistency. Cartridge runout, measured on the bullet, should be .002 or less. Seating depth, measured with a bullet comparator, should be within +- .001.
- **Brass & Bullet Quality**: beyond the scope of this article, but essential. It is best to start with components of the highest quality. Lapua brass and Berger bullets work for us!

Next, we will describe how the Dillon Progressive Press and Prometheus Automated Powder Measure are used to produce ammunition meeting these high production standards.

Dillon 550 Press Modifications



Many reloaders think of the Dillon 550 as a tool for high-speed pistol production, but not one that can create match-winning long-range rifle cartridges. In fact, a number of top high power and F-class competitors are indeed using Dillon 550 and 650 presses: with a few small modifications. Once these improvements are made, I can assure you that a Dillon 550/650 will produce ammo competitive with anything on the firing line at a national-level f-class match. So, let's get started.

Shell Plate Modification

Even when tightened as much as possible, the Dillon shell plates allow a considerable amount of case wobble. This play is mostly a good thing, but it does cause problems with primer seating. Case wobble can cause the primers to be seated slightly crooked: not good for accuracy. To fix this problem, grind some material (.005-.015") off the bottom of the shell plate as shown in the picture below.

This is easily accomplished with a sanding block and elbow grease. Continue to remove material until the shell plate can be tightened such that cases are completely immobilized. In this way, you will know enough material has been removed. Then, you adjust the tension so the cases can move freely, but with a minimum amount of slop and wobble in station 1 (priming).

The pictures below highlight the improvement in case tilt achieved after grinding the shell plate and tightening it properly. Primer seating consistency is greatly improved with this change.

BEFORE:

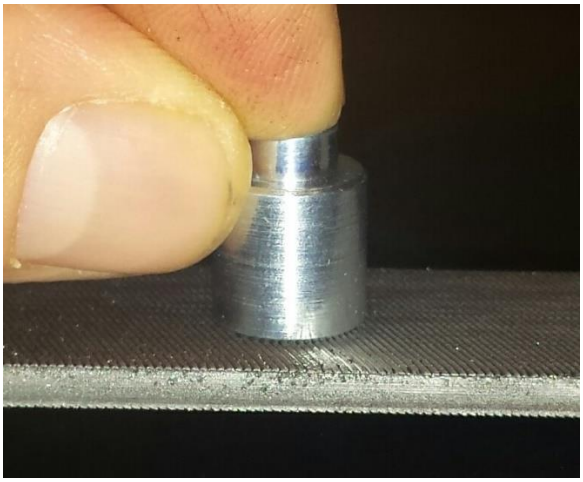
AFTER:

Adjusting Primer Seating Depth

It is essential to seat primers firmly to the bottom of the cartridge case primer cup. Failure to do so will result in inconsistent ignition and poor accuracy. In general, primers should be seated .002 to .007 below flush in the case and this can be roughly measured with a decent set of calipers as shown below:

The Dillon 550 priming assembly often does not seat primers deeply enough to accomplish this task correctly. Fortunately, there is a way to increase the seating depth if needed.

Primer seating depth is controlled by the Dillon 550 primer seating cup as shown below. Specifically, the distance between the bottom of the cup and the shoulder controls the seating depth. To increase seating depth, carefully file/grind one or two thousandths off the bottom of the primer cup as shown in the picture below



The result is the primer seating depth is increased by the amount of material removed from the bottom of the cup. The before and after pictures below show primer seating depth being increased by .004.

BEFORE:

AFTER:

Be careful to remove only a small amount of material at a time and then test primer seating. It is very easy to remove too much material from the bottom of the cup. I had to purchase a few spare cups before getting it right. ☺

In summary, by correcting case wobble and seating depth, the Dillon 550 can be made to seat primers perfectly with almost complete reliability. Most of our match ammunition is primed on the 550 press (the wife does prefer to prime separately, noodle arms.)

Dillon Press, Station 1: Full-length Sizing & Priming

Virtually 100% of our sized brass has zero runout

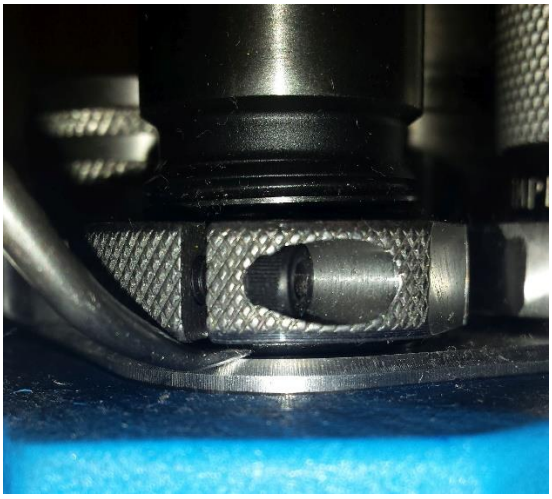
A few simple steps will enable you to do the same.

- **Use a zero-runout, full-length, non-bushing sizing die.** It's impossible to produce sized cases with zero runout if the die itself is less than perfect. Many factory dies have runout. Bushing dies commonly induce more runout than non-bushing dies. In my experience, the most fool-proof sizing method is to use a custom full-length non-bushing die. To determine if your current die is good enough, simply measure case runout before and after sizing. If your case has more runout after sizing than before, there is a good chance the die is the culprit.
- **Float the sizing die.** Allowing the die to float and self-align with the case produces the best concentricity. This is accomplished on the Dillon 550 by using the Uniquetek floating die toolhead. This is actually a Whidden floating die toolhead with clamping screws added by Uniquetek.

Uniquetek/Whidden Floating Die Toolhead

The best way to use these toolheads is to have one per cartridge as shown below. This way, you set up your dies once and that's it. Switching cartridges is as easy as sliding one toolhead out of the press and sliding the new one in.

Notice, below, that the locking ring floats slightly above the toolhead enabling the die to slide/tilt a bit, thereby self-aligning with the case being sized. This produces better runout



The next picture shows the roll pins inserted through the die locking rings. This prevents the loosened lock rings from moving too much.

- **Remove the expander button from the sizing die**. This is the final step to produce zero-runout sized brass. The expander button is often a source of runout in sized cases. We prefer to use carbide turning mandrels (station 2) in place of the expander button because they perform the same task with little to no runout.

“Floated,” custom, full-length, non-bushing sizing die = 0 runout

Dillon Press, Station 2: Mandrel

The second press station contains a Sinclair Gen 2 Mandrel die. Depending on the desired amount of neck tension, a turning, or expanding, or even a custom-sized mandrel can be used. We typically size the inside of the brass necks to .003 less than bullet diameter and then use a carbide turning mandrel which is .002 less than bullet diameter. This means we only size the necks the minimum necessary and that the mandrel lightly expands the case neck. The goal is to use the mandrel as the final step to produce the most consistent neck tension. We prefer carbide mandrels as they require no lubrication. Regular steel mandrels often gall the case necks…..very bad for accuracy. The Sinclair Gen 2 die allows the mandrel to float and no runout is induced during this operation.

It is important not to size the case necks too small because this forces the mandrel to do a lot more work than necessary. This, in turn, can cause even the carbide mandrel to gall and also creates runout. I recommend sizing your necks .002 to .003 under the loaded round diameter and we generally size .003 under.

Sinclair Mandrel Die (floating)

Carbide Mandrel (.002 < bullet diameter)

Dillon Press, Station 3: Powder Drop

Powder is dropped into the case at station 3. Our long-range ammunition MUST have a standard deviation of 7 fps or less when measured over a 20-shot string. A powder measure, regardless of the quality, simply will not get the job done. So, we use a Dillon powder die which allows powder to be manually thrown after the charge has been weighed separately on a high-quality scale: i.e. something similar or better than the Sartorius GD-503 or Entris 64.

“Old Trusty,” Sartorius GD-503:

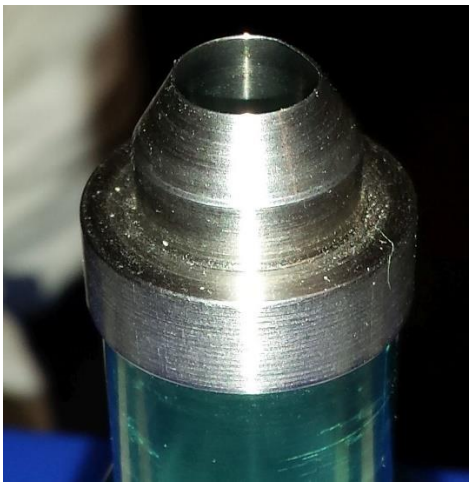
Previously, we used the GD-503 to weigh powder, but that requires a second person to participate in the reloading process. We have eliminated the need for a second person by using a Prometheus automated powder scale which will be discussed in the next section.

Powder Drop Problem #1: hanging kernels

One problem that occurred at this station was random “powder loss.” This is a very subtle problem and it took a long time to identify (aka years). We learned that a few stray kernels of powder would sometimes hang in the powder die leaving that case charged a little light. Those extra kernels would then fall into another case at a later time, making that charge slightly heavy. So much for weighing to the nearest kernel with an expensive lab-grade scale!

The source of the problem can be seen in picture below. A small gap between the powder die body and the cartridge-specific insert creates a ledge for powder to get hung up in:

If powder can get stuck somewhere, it will get stuck somewhere! We resolved this problem by creating a steel insert that completely covers the gap, thereby preventing any powder from hanging up. The picture below shows the insert:



You could bed this gap with JB Weld to achieve a similar result if you did not want to make an insert.

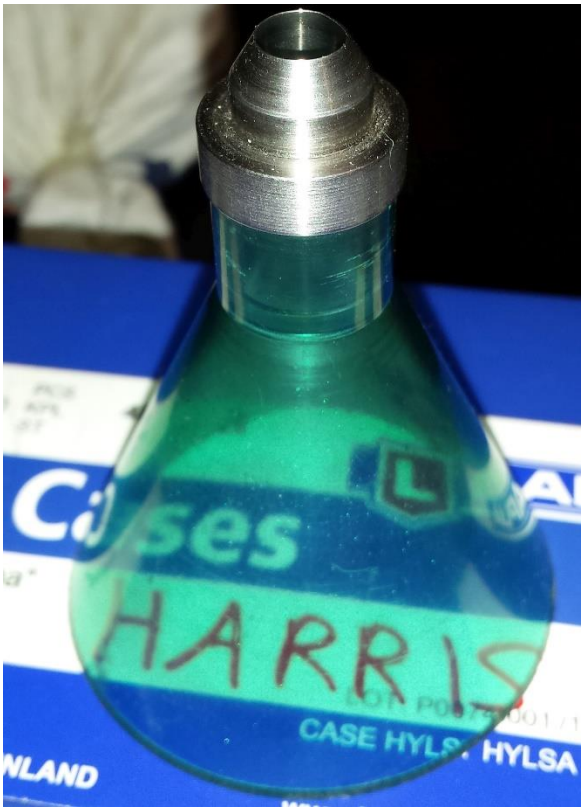
Powder Drop Problem #2: bridging

The second problem at this station is random bridging of powder in the die. In other words, powder sometimes fails to drop into the cartridge case, instead getting stuck in the powder die. This occurs most commonly with the smaller diameter 22 cal and 6mm cartridges. A quick tap on the powder die usually fixes this issue. But, detecting bridging is the real challenge. The Dillon funnel is solid black and it usually takes two powder charges to be dumped before you can see it bridging in the funnel. So, we needed to come up with a way to immediately detect when bridging occurs. This was done as follows:

Modify Powder Die Insert

The powder die insert was modified to allow the die to be screwed down as low as possible into the press. We drilled out the bottom of the die insert to allow the case to go higher up into it…which actually let us screw the powder die lower. The net effect is the distance between bottom of the funnel and top of the cartridge case is minimized. Now, when bridging occurs, the bridged powder column extends up into the (clear) funnel area where it can be easily seen.

Created See-Through Powder Funnel



The standard Dillon powder funnel is a small black plastic piece that you cannot see through. We customized a clear RCBS funnel to work with the Dillon press as shown here. We made a steel insert that was glued to the modified funnel and allowed it to fit perfectly in the Dillon powder die:

Dillon Press, Station 4: Bullet Seating

Toolhead Modification

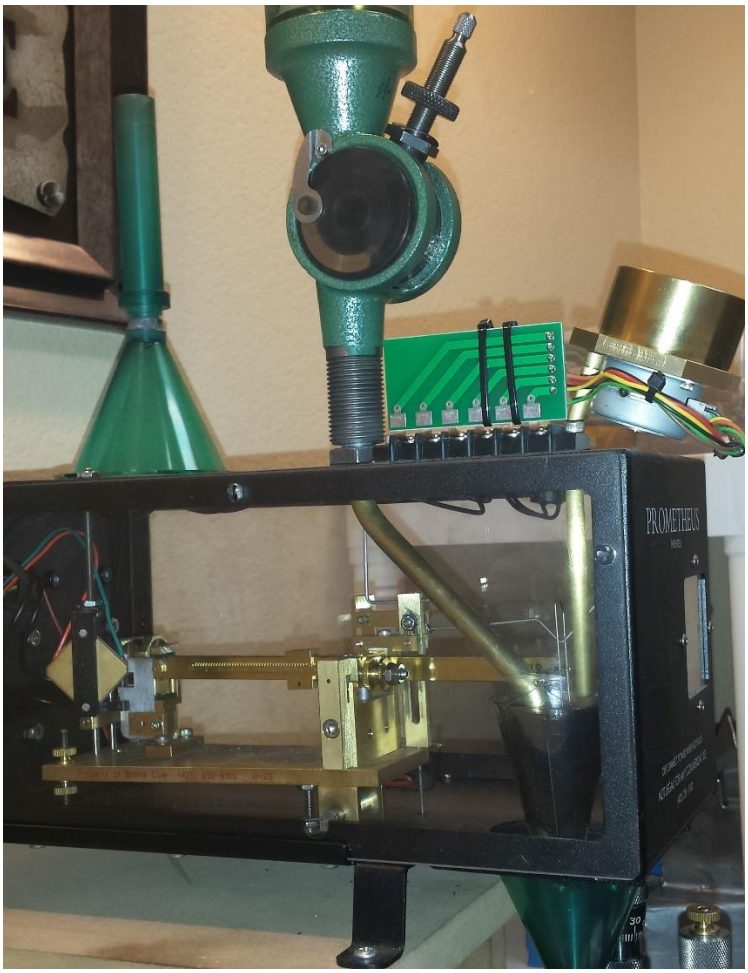
The seating die must be floated at this station for best concentricity. Unfortunately, the Whidden tool head only floats stations 1 & 3 out of the box. So, we used a drill and roll pin to float station 4 just like 1 & 3. In fact, I decided to make it simple and modified the toolhead so all four stations float. It is a simple process, you just need to be careful. A drill press makes this task much easier. You will also need to create two more modified die lock rings. The end result is all four stations float the dies.

Seating Die Modification

The Dillon 550 toolhead positions the 4 dies fairly close together. In fact, the powder drop funnel was bumping into the seating die. So, I modified my Redding seater head/top as shown in the picture below to create necessary clearance.

That's it! The Dillon 550 is now capable of loading near perfect ammo. Next, I'll describe how we use the Prometheus Powder Measure to speed up the reloading process while still measuring charges to the nearest kernel.

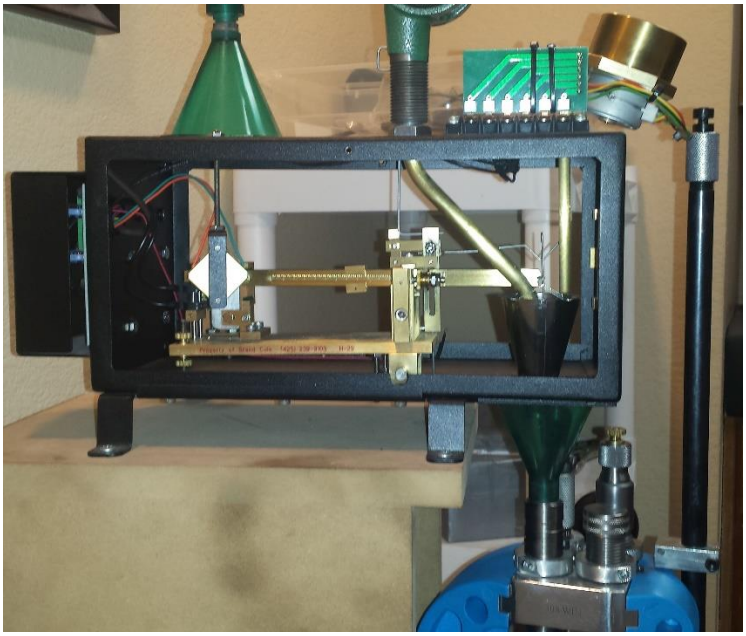
Prometheus Automated Powder Measure



Dropping powder is one of the most time-consuming reloading tasks. Fortunately, the 2nd generation Prometheus, made by Brand Cole, is an amazing machine that automates this process while maintaining to-the-kernel accuracy round after round. We have carefully tested this machine over several months, throwing more than 1,000 charges and then checking the weight with a Sartorius lab-grade scale. Our conclusion: the Prometheus is 100% reliable….or as close to it as any machine can come.

Initially, we planned to double-check every charge thrown by the Prometheus on the Sartorius scale for the important matches. We cannot risk even a single charge being off. However, after checking the thrown charges month after month, we've come to the conclusion that the Prometheus is just as reliable and precise as the Sartorius GD-503: i.e. near perfect. So, now, Prometheus-weighed charges go straight into the case without being checked: for big matches and small.

NOTE: we do weigh finished cartridges for the big matches to ensure they all have powder. It's embarrassing when firing a squib load in competition! ☺ This task goes very quickly when using the Sartorius scale.



To maximize the potential of the Prometheus, we have mounted it directly over station 3 of the Dillon press. A weighted box was created to securely mount the scale at the correct height over the press. Then, we modified the green funnel so it comes up just underneath the bottom of the Prometheus to prevent any kernels from spilling. The result is a simple system to reliably drop powder directly into the cartridge case: The clear funnel enables us to immediately detect and resolve any bridging problems and the metal funnel insert ensures all kernels drop where they belong without hanging in crevices.

This setup enables us to load 2 to 3 rounds per minute depending on the powder type. Previously, we could load at the same rate using the Sartorius scale, but it required two people.

Before, two people:

After, one person:

Eliminating the second person has saved countless hours at the reloading bench. Actually, we can count the number of hours. ☺

15,000 rds/year x 20 seconds/rd = 300,000sec x 1hour/3600sec = 83.3 hours per year. In other words, this little baby is freeing up two work-weeks of our life per year. Expensive? Maybe. Worth every penny? Absolutely!

Appendix A: Our Reloading Process, Step by Step

I am a big believer in NOT using freshly annealed brass. Hence, we use brass that has been once-fired after annealing. The absolute best brass for a big match, in my opinion, is new brass fired a single time and not annealed: fireformed once.

1. New brass processing. Run a carbide turning mandrel through it. Use a carbide primer pocket tool to ensure pockets are all the same depth. Inspect flash holes and deburr when needed...almost never with Lapua brass. We do not trim, chamfer, or deburr new brass. Once prepped, new brass is run through the Dillon press as described in 2. below. New Lapua brass shoots exceedingly well out of the box.
2. "Match-Ready," once-fired brass (new brass fired once or used brass fired once after annealing).
    a. Tumble in a mixture of 70% rice & 30% corn-cob media for 4 hours
    b. De-prime with Sinclair decapping die (using cheap Lee press in garage). Doing so after tumbling ensures the flash hole is cleared of corn cob media.
    c. Lube cases with Hornady One Shot on Sinclair lube racks
    d. Dillon Press
        i. Station 1, full-length size (.003 under bullet diameter), seat primer
        ii. Station 2, expand with carbide turning mandrel (.002 under bullet diameter)
        iii. Station 3, drop powder
        iv. Station 4, seat bullet
        v. Wipe lube off with small towel- ready to fire!
3. Twice-fired brass (or fired twice after annealing)
    a. Tumble in a mixture of 70% rice & 30% corn-cob media for 4 hours.
    b. Anneal with BenchSource machine
    c. Lube, full-length size, and use mandrel
    d. Trim brass with Giraud machine
    e. Tumble again in a mixture of 70% rice & 30% corn-cob media for 4 hours.
    f. Re-lube with One-Shot
    g. Dillon Press: exactly the same as in 2.d. above.

Appendix B: Other Accessories

The following additional accessories are used on our Dillon 550. I do not consider either of these essential, but they serve a purpose and I like them:

1. 550 Primer Track Bearing: http://www.uniquetek.com/site/696296/product/T1571
2. 550 Turbo-Bearing: http://www.uniquetek.com/site/696296/product/T1281

Appendix C: Neck Tension

Special care should be taken to create extremely consistent neck tension:

- Cleaning of brass has a huge effect on neck lubricity. I do NOT recommend wet cleaning methods like tumbling in soapy water and stainless media. Wet tumbling caused me endless grief in a variety of ways and my results improved the moment I stopped wet tumbling. I recommend dry tumbling because it gets the cases as clean as they need to be while leaving a wee bit of powder residue on the inside case necks: a good thing. Try tumbling in a mixture of 70% rice and 30% corn cob. This cleans cases quickly and efficiently both inside and out. As a side note, wet tumbling is a lot of extra work: totally unnecessary.
- Annealing brass helps to create consistent neck tension but can cause its own set of problems. It is important to "re-polish" the inside of the necks after annealing. The annealing process roughens the inside of the necks. This

can be demonstrated by mandrels that become galled and bullets that are scratched badly when using freshly annealed brass. The fix for this problem is to re-tumble the brass for a few hours after annealing & trimming. The rice/corn cob mixture does a great job of polishing the necks, thereby eliminating this issue.

- Most serious high power competitors are using a Giraud Trimmer because it is a speedy and accurate way to trim large quantities of brass. However, sharp edges are left on the case mouth after trimming. This is another reason to re-tumble your brass after annealing / trimming. A few hours of tumbling re-polishes the inside of the case neck and also deburrs the sharp trimmed edges of the case mouth.
- How much should you size your necks? At first, it may appear that there are an endless number of choices. The reality is you will settle on sizing case necks from .001 to .003 under the loaded round diameter. I do NOT recommend sizing .001 under because this creates a risk of the bullet being dislodged or moving after you have seated it. .002 to .003 under is the correct range. In my experience, most cartridges shoot extremely well when the necks are sized .003 under the loaded round diameter followed by a .002 under carbide turning mandrel that lightly expands the neck. This .003 / .002 formula produces zero runout with consistent seating depth and the ability handle jarring without moving the bullet. It travels well and shoots well.
- Some folks advocate dipping case necks or bullets into dry lubricating media as a way to improve neck tension consistency or as a way to prevent mandrel galling. My opinion, this is not needed if you are doing everything else properly. For example, you might need to use dry lubricants after wet tumbling your brass. This simply points to the folly of wet tumbling. Why clean the necks so well if you then have to re-lubricate the necks afterwards? Powder residue is the perfect lubricant for bullet seating. Carbide mandrels are very resistant to galling, which is why I suggest them over less expensive steel mandrels. You do not need lubricant with carbide mandrels. Eliminating the tedious task of lubricating mandrels both reduces your workload and makes the end result more repeatable and consistent.
- Summary: there are many ways to get the job done, but consistent neck tension is a must. My suggestions are focused on getting the job done correctly AND minimizing the amount of work required.