CHAPTER 13

SPEER HANDGUN BULLETS

DEEPCURL®

Handgun Hunting Bullets

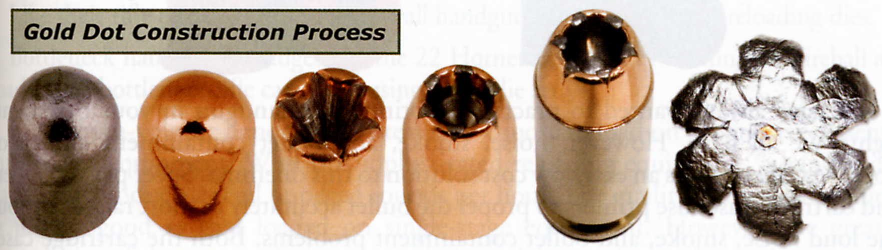
Hunting or field backup with a handgun requires a tough bullet with a core bonded to the jacket. This prevents core-jacket separation to assure deep penetration and maximum weight retention. Speer DeepCurl handgun bullets have been designed to meet this challenging set of requirements using heavy, electroplated jackets with pre-formed petals for controlled expansion.

GOLD DOT®

Jacketed Hollow Point Bullets for Personal Defense

There is a reason why Speer Gold Dot handgun bullets are the preferred choice of all types of shooters for their personal defense: true bonded core construction combined with carefully engineered cavity and jacket design to provide consistent, reliable bullet expansion and penetration. Repeated tests by law enforcement agencies, instructors, trainers, and individual shooters have confirmed Gold Dot bullets are the best, most reliable handgun bullets you can buy for personal defense.

Gold Dot Construction Process



GOLD DOT® SHORT BARREL®

Jacketed Hollow Point Bullets for Personal Defense

Many CCW holders prefer a compact handgun for concealed carry purposes. However, the short barrel of such guns substantially reduces the muzzle velocity which in turn reduces the bullet's terminal ballistic effectiveness. The Speer Gold Dot Short Barrel bullet line has been specifically designed to improve terminal ballistic performance from such compact handguns while retaining all the benefits that make Gold Dot effective.

TMJ®

Totally Encapsulated Lead Core

Unlike other so-called full metal jacket bullets that leave the lead core exposed at the base, Speer's Total Metal Jacket (TMJ) pistol bullets completely enclose the lead core in a copper jacket. TMJs are an excellent choice for handguns with ported compensators, suppressors and muzzle brakes because the closed base design prevents lead from fouling the ports. TMJ bullets are especially designed to feed exceptionally well in semi-automatic handguns, and they are available in most pistol calibers.

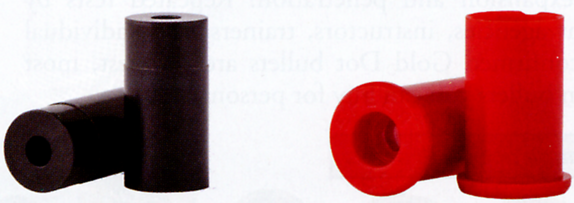
LEAD

Traditional Wadcutter, Semi-Wadcutter and Round Nose Handgun Bullets

For decades, Speer swaged lead handgun bullets have provided low cost training, practice, and informal target shooting (aka "plinking") to generations of shooters. Speer lead bullets are swaged to the correct size from lead alloy, then coated with a multi-layer lubrication system to minimize leading in your barrel.

PLASTIC TRAINING AMMUNITION

For Indoor Practice



You have always wanted to practice shooting your handgun in your basement, right? We all have. However, noise, smoke, and bullet containment are major obstacles. Speer offers an easy, low cost solution to this dilemma. Speer plastic bullets and cartridge cases use primers to propel the bullet accurately at short range without the loud noise, smoke, and bullet containment problems. Both the cartridge cases and the bullets are reusable! Available in 38/357, 44Spl/44, and 45 Auto.

PLASTIC SHOT CAPSULES

For Dispatching Pests and Rodents at Close Range

No doubt that you have seen Speer handgun caliber shot cartridges on dealer shelves. They seemed an ideal solution to dispatch pests and rodents around the house or workplace. As a handloader, you have undoubtedly considered shot capsules with shot sizes not offered by the factory. Consider no more. Speer shot capsules are offered as components in three popular handgun calibers (38, 44, 45).

CHAPTER 9

WHEN ALL ELSE FAILS: TROUBLESHOOTING TECHNIQUES

This section should help you diagnose and fix problems that may occur during the loading process or at the range.

Sizing Problems—Stuck Cases

The most common sizing problem is sticking a case in the sizer die. When you lower the ram, the shell holder pulls the rim off the case, leaving it stuck in the die. The usual cause for this problem—little or no lube on the case. Frictional forces during sizing are very high, and without adequate lubrication, the case may seize in the die. Removing a stuck case from the die must be done with care and special equipment to avoid ruining the die. The stuck case seldom harms the die; improper removal techniques do the damage.

RCBS® makes two tools to handle this problem: the Stuck Case Remover™ and the Stuck Case Remover-2™ kits. The former is used with standard dies and the latter with dies having a removable guide bushing or elevated expander balls. Both units are designed to gently ease a case from the die. The case is lost, but not your precision die. If you do not have one of these tools, you can send your die to the RCBS Customer Service department to have a stuck case removed.

Ensuring the case has adequate lube will usually eliminate this problem. The first case sized in a new die usually requires slightly more lube than subsequent cases. After the first few cases are sized, less lubricant can be used. If you feel a case hesitate as it enters or exits the die, make sure the next case has enough lubricant before sizing. When using a new die for the first time, flush it with an aerosol solvent such as Gun-Flush® from Gunslick to remove the shipping preservatives. For bottleneck cartridges, clear any material from the small vent hole in the side of the die with a small wire or punch. They do their best to hide the hole; look in the threads as it is often found there.

A die that has been damaged by sizing too many gritty cases will become rough enough to increase resizing forces. Stop using the die until it can be repaired or replaced. To avoid this problem, thoroughly clean cases before sizing.

Dents in the Case Shoulder

You can have too much of a good thing. Only the case body—not the shoulder and neck—needs lubrication. Although lubrication is necessary, excessive lube will collect in the shoulder area of the die. When a case is sized, the trapped lubricant can create hydraulic dents in the shoulder. The vent hole normally allows excess lubricant to escape. However, if force is applied rapidly, the excess lube may not vent fast enough. If you find hydraulic dents, first check to see that the vent hole is clear and clean the die. Excess lube on the pad can be removed with a clean shop rag or paper towel.

An oil-dented case will usually fire without failing, but it may be weakened. Discard the case rather than risk a case failure.

Difficult Sizing

If you notice that you need to exert more force than usual when sizing (even though the case is clean and properly lubed and the die is clean), stop and do the following:

- Make sure that you have the correct die installed.
- See if the case is the correct one. A 358 Winchester case is similar in appearance to the 35 Remington but is larger in diameter.
- See if the case was excessively bulged from previous firings. Some surplus military cases that have been fired in machine guns will have more bulge than cases fired in a sporting rifle.
- Check the case for major dents or other damage.

Special Sizing Dies for Semi-Automatic Rifles

Difficult chambering or extraction can occur in some makes of semi-automatic rifles. Reloading with RCBS Small Base™ sizing dies usually corrects the problem because the SB die reduces the case diameter slightly more than a standard sizing die.

Headspace Problems—Bottleneck Cases

Headspace for a bottleneck cartridge is controlled by the position of the shoulder. If the case shoulder is pushed back too far during sizing, excessive headspace will result and cause poor accuracy or misfires. In the worst case, a case may rupture and ruin a rifle and/or injure the shooter or bystanders.

Shoulder position can be accurately measured to ±.001 inches with the RCBS Precision Mic™. See Chapter 7 for more information on this tool. Due to the quality of most current reloading dies, oversizing is rare. However, three factors can cause this:

- The die or shell holder has been modified by removing metal where they meet. Either alteration puts the shoulder of the die too close to the shell holder resulting in excess headspace. Never modify a sizer die or shell holder.
- The sizer die and shell holder are different makes. Although most manufacturers of dies and shell holders use the same reference dimensions, a mismatch can occur. Usually it is small and does not create a safety hazard. Avoid homemade shell holders or mixing different brands of dies and holders—you have no guarantee that they are dimensionally compatible.
- A rifle has a "long" chamber due to excessive headspace. Even though the dies are properly adjusted, the case will fire-form to the chamber's longer base-to-shoulder length. Normal sizing pushes the stretched shoulder back, reducing accuracy potential and case life. The Precision Mic will tell you if your rifle has this condition and how much to adjust the die to avoid recreating an excessive headspace condition.

Neck Expansion Problems

If neck expanding seems unusually difficult, remove the spindle assembly and inspect the expander ball. Grit accumulating on top of the ball increases the force needed to expand the neck. Clean it while it's out and verify that the rod is not bent.

Normally, expander balls will process tens of thousands of cartridge cases without showing wear. However, really dirty cases can scratch the working surfaces of the ball. If so, polish the ball lightly or replace it.

It's normal for fired cases to have powder residue on the interior. If the residue is unusually heavy, it can cause hard neck expansion even with a properly adjusted and maintained expander. Case necks should be cleaned thoroughly with an RCBS Case Neck Brush after lightly rolling the brush across your case lube pad. Don't dip the brush in lube—too much lube will contaminate the powder.

Priming Difficulties—"Hard" Primer Seating

Difficult primer seating is a fairly common problem. If you encounter this, STOP LOADING UNTIL THE PROBLEM IS CORRECTED. Never force a primer or use sharp blows during any priming operation. Slow, even pressure is mandatory for safety. Here are some things to check:

- **Is the primer the correct size?**
- **Is the primer punch the correct size and shape?**
- **Is the primer punch bent?**
- **On swing-arm primer punches, is the arm free to move fully into position?** A buildup of primer residue on and around the arm and its spring can prevent it from centering under the case. The effect is similar to that of a bent punch—the primer is misaligned and cannot smoothly slip into the case. Clean excess residue from the press regularly.
- **Is the primer pocket clean and undamaged?**
- **Does the case have a crimped pocket?** Completely remove the crimp with an RCBS Primer Pocket Swager.

RCBS Primer Pocket Brush

Primer pocket shape can vary with the brand of case, and even within one brand. If the radius between the sidewall and the bottom of the pocket is too large, it will stop the primer anvil prematurely causing a high primer and misfires. RCBS makes three sizes of its Primer Pocket Uniformer to remove this excess metal leaving a square pocket bottom that greatly improves seating and ignition. The Uniformer fits in the electric Trim Mate™ or Universal Case Prep Center but may also be used manually.

You will eventually encounter some combination of primer and cartridge case that causes excessive priming force. A different combination is the only solution to this problem.

Primer Feeding in Progressive Reloading Equipment

Progressive reloading presses feed primers through automated devices. A buildup of dirt and residue causes most malfunctions in these priming systems. Progressive equipment must be cleaned regularly to ensure safe and smooth operation. Remove the shellplate in rotary-type loaders to clean under it. Keep the primer shuttle and the surrounding area clean. DO NOT USE OIL except as directed by the tool manufacturer.

Check primer feed tubes for residue and damage. Replace any bent or damaged tubes; never attempt to repair them. If the tubes are dirty inside, clean them with hot, soapy water and thoroughly dry before use.

If the priming mechanism is clean and still doesn't work properly, go back to your instruction manual to learn the procedure for proper adjustment. If in doubt, contact the equipment manufacturer.

Powder Charging

This critical area of handloading is, fortunately, one where few problems occur. However, two potential problems can occur that can lead to significant safety problems.

Missing Powder Charge

A missing powder charge will cause a misfire. In small-capacity cases, it is also possible for the primer's output to drive the bullet out of the case and stick it in the bore—a dangerous condition if another cartridge is fired! Careful process control and simply paying attention when handloading will assure you avoid this situation.

If after you have seated the bullet, you suspect that you failed to charge a case, a simple test will help you find out. Place a primed, uncharged case (same brand) and a bullet of the same weight you loaded in the scale pan and record the weight. Then weigh the suspect cartridge. If the suspect cartridge weighs within a few grains of the weight of the bullet and primed case alone, then the charge is missing.

Proper charging practices and inspection will eliminate missing powder charges. Review Chapter 5 for the recommended procedures.

Progressive loading equipment reduces the opportunity for inspection compared to single-stage equipment. Review Chapter 8 for more information on these tools.

Variable Powder Charges

A charge variation of a few tenths of a grain in a large rifle case may have little effect on accuracy or performance. However, variations of several grains can cause problems. Accuracy can suffer and charges falling on the high side may cause excessive pressures. These large variations are usually caused by improper powder measure techniques.

Operate the handle in a consistent manner. When throwing large charges of rifle powder, allow enough time for the entire charge to flow through the measure. Check the powder measure routinely to see that all lock screws and fittings are tight. Routinely check a charged case on your scale to ensure the charge weight hasn't changed.

If you are not using a powder measure and get large variations in hand-weighed charges, make certain that your scale is clean. Dust in the pivots (mechanical scales) can cause erroneous readings. Is the scale level? If you move the scale to another location in the shop, always rezero it with the leveling screw. Check the scale with calibrated weights available from RCBS and other manufacturers.

Is the scale affected by drafts? A cardboard deflector placed over a vent or around the scale will eliminate the problem. Mechanical scales must be located at least three feet from fluorescent light fixtures to avoid interference from electromagnetic fields.

Bullet Seating Problems—Hard Bullet Seating

Hard bullet seating can ruin cases for further reloading. Here's a checklist:

- **Are you using the proper diameter bullet?** A 7mm bullet is .007 inches larger than a 270 Winchester bullet and will also cause dangerous pressures if the cartridge is chambered and fired.
- **Has the case neck been properly sized and expanded?** If you fail to adjust the expander ball properly, the bullet can collapse the case. Expander rods held by collets in some makes of dies can loosen, slide up, and not expand the case neck at all.

- **On straight-wall cases, is there enough flare on the case mouth?** Variable flare is often due to non-uniform case lengths.
- **Is the case mouth too sharp?** If loading new cases, you must chamfer the inside of the case mouth to remove burrs, but only after you have made sure the case mouth is round; otherwise, it will be uneven or incomplete.
- **Is the seater die adjusted properly?** If the die is too low it will deform the area below the shoulder on bottleneck cases. A very small bulge can result (often nearly invisible) but feeling the case may let you know if there's a problem. If the case will not chamber, this could be the reason.

Bullets Fall into the Case

This is an easy problem to spot and fix. Check the following items:

- Are you using a bullet of the correct diameter?
- Did you fail to properly size the case?

Lead Bullets that Seat Deeper as Loading Progresses

This is caused by bullet lubricant gradually building up on the seater plug or the crimp shoulder. The buildup pushes each bullet slightly deeper into the case until the seating depth is excessive. In some cartridges this can cause excessive pressure. Remove the seater die and disassemble and clean it thoroughly. A very light coat of oil or release compound will slow future buildup. Remember that too much oil is worse than none at all!

All Speer® lead handgun bullets now feature an improved lubricant that virtually eliminates lube accumulating in the seater die.

Crimping Problems

Never attempt to roll-crimp jacketed bullets that do not have a crimping groove. Doing so will only damage the bullet and degrade accuracy.

If you have trouble crimping bullets that have a crimping groove, look for the following:

- **Is the proper die installed in the press?**
- **Is the seater plug adjusted so that the crimp groove meets the crimp shoulder in the die?** If not, adjust the seating depth accordingly. Attempting to crimp above or below the groove will probably damage both case and bullet.
- **Are the cases trimmed to uniform length?** Variable lengths will cause some cases to be crimped too much and others very little. If cases are trimmed too short, you may not be able to crimp them at all.
- **Are you collapsing the case mouths or shoulders during crimping?** If so, you are applying too much crimp. Adjust the die to apply less crimp. When crimping bullets in cases with thin mouths (32-20, 44-40, 375 H&H, etc.), you will find that seating and crimping in separate operations will minimize this.

"Erasers" for Reloaders

If you discover that you have made a mistake, you will need to take the defective cartridge apart to salvage the components. Just as pencils have erasers to correct mistakes, the reloader has access to a couple of different ways to "erase" their errors. Bullet pullers come in both collet and inertial types.

Collet Bullet Pullers

RCBS sells a collet-type bullet puller that mounts in the die station of a single-stage press. The puller unit usually consists of three parts: the body, a threaded shaft with a handle and a collet. Collets are caliber-specific—you will need a collet for each diameter bullet you need to pull. A 30-caliber collet will work with most standard .308 inch diameter rifle bullets.

The puller body is screwed into the die station and the collet attached to the handle assembly. Insert the cartridge into the proper shell holder and raise the ram so that the bullet (but not the case mouth) fully enters the collet. Turn the puller handle clockwise until the bullet is firmly gripped. Give the press handle a sharp upward blow to lower the ram and extract the bullet. Turning the handle counterclockwise releases the pulled bullet from the collet.

The pulled bullet will likely have shallow marks from the collet jaws. Most bullets' performance will not be affected by these marks and can be reused. However, thin-jacketed varmint bullets may be crushed in the process and should be discarded.

Inertial Bullet Pullers

The collet-type puller cannot be used to pull lead bullets or most jacketed handgun bullets and can damage thin-jacketed varmint bullets. In these situations, an inertial puller is the answer.

Inertial pullers look like hammers with hollow heads. The cartridge is placed in a chuck assembly that grips the rim or extractor groove with the cartridge inside the puller body. The assembled unit is struck against a hard surface. The puller and the cartridge case stop but the inertia of the bullet causes it to move forward out of the case.

Inertial Bullet Puller

Bullets removed with the inertial puller are seldom damaged unless excess force is used. The bullet and powder charge are caught in the puller body for reclaiming.

Do not try to pull the bullet with one hard blow. Several light taps will pull the bullet safely and effectively. Heavy blows can break the puller or deform the bullet and may cause the cartridge to discharge.

Here are some safety precautions to follow when using an inertial puller, regardless of make:

- NEVER put a rimfire case in an inertial puller.
- NEVER attempt to disassemble a black powder cartridge with an inertial puller.
- NEVER use an inertial puller to pull bullets from cartridges with high primers. Under certain conditions, the primer can snap hard against the bottom of the pocket and ignite. Use a collet-type puller if possible.
- NEVER attempt to disassemble any cartridge whose projectile type cannot be positively identified. Accidents have occurred when someone attempted to pull an explosive military projectile.
- ALWAYS use short, light taps instead of one heavy blow to remove the bullet.

- ALWAYS wear safety/shooting glasses when pulling bullets, just as in any other stage of reloading.

Tech Tip: Some factory ammunition, particularly military ammo, has a mouth sealant that effectively "glues" the bullet in place. When disassembling ammunition that may have this seal, run the cartridge into a bullet seating die of the proper size and seat the bullet about .005 to .015 inches deeper. This normally breaks the seal and makes extraction much easier.

At the Range

Sometimes problems with handloaded ammunition does not show up until you get to the range. They may be functional problems but can also be accuracy problems.

Misfires

Misfires have been discussed in Chapter 4, but this problem is common enough to warrant additional discussion. By far, the majority of misfire problems are due to a handloading error or a gun problem—not a primer defect.

Handloading Problems

- **Is the cartridge the correct one for the firearm?**
- **Is there propellant in the case?** Weighing the cartridge and comparing it to a primed case and loose bullet of the same type will usually tell you if the charge is missing.
- **Did you fail to remove the old primer from the case?**
- **Is the primer seated below flush with the case head?** Incorrect primer seating depth is the most common cause of misfires in handloaded ammunition. The anvil legs must make contact with the bottom of the cup. CCI and Federal primers should be seated between .003 and .005 inches below flush for optimum sensitivity.
- **Has the primer or ammunition become contaminated with oil or water?**
- **In a bottleneck case, has the shoulder been pushed back too far?** This creates excessive headspace, and the firing pin has to reach too far to make solid contact with the primer. Shoulder position can be checked with the RCBS Precision Mic.
- **In a straight-wall rimless case, is the case short?** This also increases headspace. Measure the case length with calipers and check against the minimum case length in the reloading data.

Gun Problems

Gun problems also cause misfires. Firearms-related items to check are:

- **Is the firing pin broken or damaged?** Check to see if the firing pin marked the primer.
- **Is the firing pin spring adequate?** Some after-market spring kits may not have the same energy as the original spring. Original springs may be altered or weaken with age. See that the firing mechanism is properly assembled. Some revolvers have a screw that controls the position and tension of the mainspring. Make sure this screw is fully seated.
- **Is the firing mechanism coated with grease or dirt that can slow the firing pin fall?** This problem will most likely show up in cold weather. A spray solvent like Gun-Flush® from Gunslick is useful for cleaning grease buildup.

- **Is there a buildup of powder residue or grease in the area of the chamber and breech face?** Residue here can cushion the firing pin blow, especially with rimmed cartridges. Thorough cleaning will usually correct the problem.
- **In rifles and semi-auto pistols, is there excessive headspace?** In revolvers, is there excessive front-to-rear play in the cylinder? This condition, *endshake*, is due to normal wear. Excessive headspace or endshake puts the cartridge too far from the firing pin, weakening its blow. Consult a qualified gunsmith to determine if excessive headspace or endshake is present and have it corrected.

The Bolt is Hard to Open

With any ammunition, a "sticky" bolt lift is a BIG DANGER SIGN. The cartridge may have produced excessive pressure causing the brass case to deform and wedge in the chamber. When you get the action open, examine the case for signs of high-pressure. DO NOT fire any more loads from that batch.

Primers that clearly show excessive chamber pressure. Note that the radius between the primer cup and case head pocket has been flattened. Another sign is that 'witness' mark is on the right example caused by the ejector on the bolt face.

For safety's sake, always assume the hard bolt opening is signaling excessive pressure. However, having difficulty opening the bolt could also be due to a mechanical problem with the rifle such as a rough or dirty chamber.

Clean and dry the bore and chamber to completely remove grease or oil before each range trip. Cartridge cases are designed to grip the chamber walls at peak pressure and then release when the pressure drops. Oil in the chamber or on the cartridge will cause the case to slip in the chamber at peak pressure and increase the thrust on the bolt. This may cause hard opening at normal pressures. In addition, excessive lubricant can attract and accumulate dirt.

Again, hard opening can be due to several factors; but your first reaction must be to think "DANGER!" and cease firing until the cause is understood and corrected.

Unusual Sounds and/or Recoil

Firearms producing supersonic velocities (over about 1100 fps) make a sharp crack when fired. You probably have a good idea of how your firearm sounds and feels when firing factory ammunition. A soft report or unusually light recoil could indicate a squib load and the danger of a bullet being lodged in the barrel. Before firing any more ammunition, check for a bore obstruction.

If you hear a faint hissing sound following a shot or hear a sound like the opening of a beverage can when you open the bolt, you almost certainly have a bullet stuck in the bore! The bullet has plugged the bore, and the residual gases are slowly escaping.

Luckily this revolver was strong enough to hold together for 14 bullet-in-bore shots! This shooter failed to recognize not only the lack of recoil, or the odd report, but also that their gun was nearly half a pound heavier by the time the cylinder locked up!

Wait until the hissing noise stops then check the bore and clear any obstructions before taking another shot.

Variable reports are a sign of inconsistent propellant charge weights or ignition. These variations usually occur when using a hard-to-ignite propellant with a standard primer or when trying to develop reduced velocity loads in a large case. Either switch to a magnum primer or choose a different propellant from the load data.

Double sounds such as a "ker-WHUMP" or a detectable delay after pulling the trigger are also signs of poor ignition. They are relatively common when working up reduced loads in large cases. Normally, switching to a quicker burning propellant will eliminate this problem. We have provided lab-tested reduced loads for many of the rifle cartridges in this manual.

Semi-Automatic Rifles

For best performance in most gas-operated semi-autos, use propellants having a medium burning rate. Slow-burning propellants may create too much gas for the gas system to handle. On the other hand, quick-burning powders may not generate enough gas to operate the action. Reloads should be kept close to factory velocity specifications for reliable functioning.

Light loads or a dirty chamber can cause poor extraction. If you discover that fired cases are covered with tiny dents, powder residue has built up in the chamber. Clean the chamber with a brush. Light loads can also cause poor feeding and extraction because they do not generate enough gas to fully cycle the action. The first round fired may have enough power to eject the fired case but not enough to move the bolt far enough to pick up the next cartridge in the magazine.

Some rifles function best with crimped bullets; others require no crimping. Several Speer bullets feature cannelures so that secure crimping can be performed. If a handloader wants to shoot 150-grain bullets in a 30-caliber semi-auto, they can choose the 150-grain Grand Slam which has a crimping cannelure. The crimp has two advantages in this class of rifle. It smoothes the sharp edge at the case mouth and also prevents the bullet from being shoved into the case when it strikes the feed ramp.

Many semi-auto sporters have very light barrels. To effectively evaluate accuracy, allow sufficient time between shots for the barrel to cool. This recommendation also applies to any rifle with a slim barrel profile.

Poor Accuracy

There are many factors that can affect accuracy. We will assume you are shooting from a solid rest and using a firearm that has already demonstrated its ability to produce good groups. Before troubleshooting the ammo, it is a good idea to troubleshoot the gun as follows:

- **Is the rifle chambered for the ammunition you're shooting?** Some cartridges will chamber and fire in firearms intended for a different cartridge. If you shoot a 257 Roberts cartridge in a 7mm Mauser rifle, the bullets would not properly contact the rifling and you will see "keyholes" in the target—if they even hit the target! Keyholes are elongated bullet holes caused by a tumbling bullet.
- **Are you positioning the firearm on the rest consistently?** Try to make each setup the same.
- **Is the barrel touching the rest?** Bench testing requires that the rest contact the rifle's forearm, not the barrel.
- **Are the sights firmly attached to the firearm?** Screws can work loose from recoil, allowing the sights to move with each shot.
- **Are the screws holding the action in the stock secure?** A loose action screw in a bolt-action rifle can open groups significantly. Front screw should be tight, rear screw snug.
- **Is the bore fouled with lead or jacket material?** This problem will usually show up later in the shooting session as more residue builds up in the bore.
- **Has a wood stock warped due to moisture absorption?** If your rifle and ammo shot well last season but refuse to perform now, a warped stock should be a prime suspect. If this happens, consult a gunsmith to have the situation corrected.

If these factors do not seem to be the problem, then review the things that can directly affect the ammunition:

- **Under-ignition**—This is usually caused by using a standard primer when a magnum primer is recommended. The lower energy output of a standard primer may result in widely varying velocities. On the target, this usually takes the form of vertical stringing of the shots. This condition is more prevalent in cold weather.
- **Excessive headspace**—A bottleneck case with the shoulder pushed back too far or a rimless straight case trimmed too short can degrade accuracy.
- **Unnecessary crimp**—Have you attempted to crimp a rifle bullet that doesn't have a crimping groove? Group sizes can increase as much as 40 percent because this damages the jacket.
- **Mixed cartridge cases**—Your cases should have the same headstamp and preferably be from the same lot. Some folks weigh their cases and sort into groups. Near-equal weights can mean near-equal capacity. You will have to do your own research as to whether or not this has an effect on group size.
- **Excessive lubricant**—Have you removed all traces of sizing lubricant from the cases? If not, they will be inconsistent in the way they grip the chamber at peak pressure.
- **Wind conditions**—A strong, gusting crosswind will cause horizontal dispersion of the groups. Light, high-velocity bullets are more subject to wind conditions than heavier, slower bullets. There's not much you can do about this problem. You may have to pack up and try again on a calmer day.

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Ammunition loaded with care and attention will give fine results. Handloading is a more rewarding hobby if you relax and take the time to enjoy it.

QUICK REFERENCE
VELOCITY/MACH NUMBER COMPARISON CHART †

(† Footnote: "At Standard Temperature and Pressure; Mach number is affected by atmospheric conditions")

FT/S	M/S	MPH	MACH
100	30	68	0.09
200	61	136	0.18
300	91	205	0.27
400	122	273	0.36
500	152	341	0.45
600	183	409	0.54
700	213	477	0.63
800	244	545	0.72
900	274	614	0.81
1000	304	682	0.90
1100	341	762	1.00
1200	366	818	1.08
1300	396	886	1.16
1400	427	955	1.25
1500	457	1023	1.34
1600	488	1091	1.43
1700	518	1159	1.52
1800	549	1227	1.61
1900	579	1295	1.70
2000	610	1364	1.79
2100	640	1432	1.88
2200	671	1500	1.97
2300	710	1568	2.06

FT/S	M/S	MPH	MACH
2400	732	1636	2.15
2500	762	1705	2.24
2600	792	1773	2.33
2700	823	1841	2.42
2800	853	1909	2.51
2900	884	1977	2.60
3000	914	2045	2.69
3100	945	2114	2.78
3200	975	2182	2.87
3300	1006	2250	2.96
3400	1036	2318	3.02
3500	1067	2386	3.14
3600	1097	2454	3.23
3700	1128	2523	3.31
3800	1158	2591	3.40
3900	1189	2659	3.49
4000	1219	2727	3.58
4100	1250	2795	3.67
4200	1280	2864	3.76
4300	1311	2932	3.89
4400	1341	3000	3.94
4500	1372	3068	4.02

STANDARD CONDITIONS FOR TESTING SPORTING AMMUNITION

Altitude: sea level = 0 feet/meters

Air Temperature: 59° Fahrenheit/15° Centigrade

Air Density: .0751 lbs/ft^3

Relative humidity: 78%

Barometric pressure: 29.53 In./750.0 MM of Hg (Mercury)

Manufacturers of sporting ammunition use these standard conditions as a baseline for testing production lots of ammunition. In addition, most manufacturers also develop additional company standards for their ammunition, such as ballistics at very low and very high temperatures.

When necessary, samples of ammunition from production lots are "conditioned" under specific temperature and humidity conditions before testing.

For the handloader, the lesson here is to store your primers, propellants, and loaded ammunition in a cool, dry place.

APPROXIMATE CORRECTION FACTORS FOR AMBIENT AIR TEMPERATURE (SAAMI)

For every 1° F. below 59° F. at standard conditions, deduct 1.7 fps from muzzle velocity down to -40° F.

For every 1° F. above 59° F. at standard conditions, add 1.7 fps to muzzle velocity up to +160° F.

EXPECTED CHANGE IN MUZZLE VELOCITY IN FPS PER INCH OF RIFLE BARREL LENGTH

Muzzle Velocity +/-	Expected Change in Muzzle Velocity Per inch of Rifle Barrel Length
Less than 2,000 fps	5 fps
2,001 to 2,500 fps	10 fps
2,501 to 3,000 fps	20 fps
3,001 to 3,500 fps	30 fps
3,501 to 4,000 fps	40 fps
4,001 to 4,500 fps	50 fps

Test barrel length is listed for each cartridge. Most rifle test barrels are 24 inches in length.

INTERIOR BALLISTIC FORMULAS

RECOIL

Use these four steps to calculate the recoil energy of your gun and evaluate the results.

Step 1. Calculate the *Recoil Impulse* of Your Gun in Foot-Pounds

Formula:

$$RI = \frac{(W_B \times V_M + 1.75 \times V_M \times W_P)}{225{,}400}$$

Where:

RI = Recoil Impulse of the gun in foot-pounds.
W_B = Bullet weight in grains.
V_M = Velocity of bullet at the muzzle in feet per second.
W_P = Weight of powder charge in grains.

Step 2. Calculate the *Recoil Velocity* of Your Gun in Feet per Second

Formula:

$$RV = \frac{32.2 \times RI}{W_G}$$

RV = Recoil velocity of your gun in feet per second.
RI = Recoil impulse of your gun in foot-pounds (from Step 1).
W_G = Weight of gun in pounds (including all accessories such as scope, mounts, lasers, white lights, sling and a full magazine of ammunition).

Step 3. Calculate the Free Recoil Energy of Your Gun in Foot-Pounds

Formula:

$$FE = W_G \times RV^2/64.4$$

FE = Free recoil energy of gun in foot-pounds.
WG = Weight of gun in pounds (from Step 2).
RV = Recoil velocity of gun in feet per second (from Step 2).

Step. 4 Evaluate the Results

Of course recoil is perceived by each shooter differently. However, here is a general categorization to give you an idea. As a reference point: 224 Valkyrie produces about 5 ft-lbs of recoil, a 30-06 in the neighborhood of 25 ft-lbs, and a 470 Nitro Express comes in at a bruising 70 plus ft-lbs!

Perceived Recoil	Foot-Pounds of Recoil
Light	Less than 10 ft-lbs.
Mild	11 to 20 ft-lbs.
Moderate	21-30 ft-lbs.
Heavy	31-40 ft-lbs.
Very Heavy	41-50 ft-lbs.
Extremely Heavy	51 or more ft-lbs.

EXPANSION RATIO

This formula is used to evaluate the ratio of bore volume to cartridge case volume. Cartridge cases with excessive case capacity in relation to bore volume are said to be "over bore capacity" as they cannot efficiently burn all of the heavy powder charge in the available bore volume.

STEP 1. Calculate the Bore Volume of Your Gun in Cubic Inches

Formula:

$$V_B = L \times D_G \times .773$$

V_B = Bore volume in cubic inches.

L = Distance from the base of the seated bullet to the muzzle in inches.

Don't measure this with an assembled cartridge. The risk of accidental discharge is too great. Instead, on a closed and empty chamber, simply measure the distance from the muzzle to the bolt face with a cleaning rod. Then do a little arithmetic to subtract out the distance from the case head to the approximate location of the bullet heel when properly seated.

D_G = Groove diameter in inches.

STEP 2. Calculate the Expansion Ratio

Formula:

$$ER = \frac{V_B + V_C}{V_C}$$

ER = Expansion ratio.

V_B = Bore volume in cubic inches.

V_C = Chamber volume in cubic inches.

EFFICIENCY

Use this four step formula to calculate the efficiency of your handload in converting the potential chemical energy in your propellant into bullet kinetic energy.

STEP 1. Calculate *Muzzle Energy* in Foot-Pounds

Formula:

$$ME = \frac{W_B \times V_M^2}{450{,}400}$$

ME = Muzzle energy in foot-pounds.

W_B = Bullet weight in grains.

V_M = Muzzle velocity in feet per second.

STEP 2. Calculate *Potential* Energy

Formula:

$$PE = W_P \times AE$$

PE = Potential energy in ft-lbs

W_P = Powder weight in grains

AE ("Average Energy" is an estimate of energy contained in one grain of propellant) = 170 ft-lb/gr for single-base propellants, 200 ft-lb/gr for double-base propellants.

Step 3. Calculate Cartridge Load Efficiency in percent

Formula:

$$CE = \frac{ME}{PE}$$

CE = Efficiency percentage
ME = Muzzle energy in ft-lbs
PE = Potential energy in ft-lbs

STEP 4. Evaluate the Results

Cartridge Load Efficiency	Rating
50%	Excellent
36-49%	Above average
25-35%	Average
Less than 25%	Very common

GREENHILL'S FORMULA FOR THE RIFLING TWIST RATE

Every bullet has an optimum rifling twist rate. Over the years, this formula has proven useful to determine the approximate rifling twist rate for a specific bullet diameter and length. This has become more important today as many calibers are available in several different rifling twist rates depending on which bullet you plan to use. For example the 223 Rem/5.56 barrels are made with rifling twist rates of 1:14 in., 1:12 in., 1:10 in., 1:9 in., 1:8 in. and 1:7 in.

Greenhill's formula is quick and easy to use for "back of the napkin" type estimates. There are certainly more precise, and more cumbersome methods that can be used.

In general, a faster rifling twist rate is required to stabilize longer, heavier bullets in a given caliber. Lighter and shorter bullets in a given caliber are best served by a slower rifling twist rate.

Use the constant's value of "150" for bullets with a muzzle velocity below about 2,800 fps. Use a value of "180" for muzzle velocities greater than 2,800 fps. Also note that this simplified version of Greenhill's Formula assumes a traditional lead core and copper jacket bullet construction. Solid copper bullets, for instance, would predict a needed twist rate about 10% faster due to the lower specific gravity of the material. It should also be noted that Mr. Greenhill's math predicts a generally conservative number; meaning that many bullets can be spin-stabilized at somewhat slower rotational velocities.

Use this formula to estimate the approximate rifling twist rate for your handloads.

Formula:

$$TR = \frac{150 \times D_B^2}{L_B}$$

TR = Twist rate in inches per turn.

D_B = Bullet diameter in inches (squared).

L_B = Bullet length in inches.

EXTERIOR BALLISTIC FORMULAS

BULLET STRIKING ENERGY

This formula will allow you to calculate bullet striking energy at a given distance. In order to determine the best bullet and load combination for their requirements, many handloaders like to compare the striking energy and momentum of various bullets at different selected ranges. If such data is not at hand, you can calculate any bullet's striking energy and momentum using the formulas below.

Formula:

$$SE = \frac{W_B \times V_I^2}{450,400}$$

SE = Striking energy in foot-pounds.

W_B = Bullet weight in grains.

V_I = Impact velocity of bullet in feet per second at desired range.

BULLET STRIKING MOMENTUM

Using this formula, you can calculate the striking momentum of a bullet.

Formula:

$$SM = \frac{W_B \times V_I}{225,200}$$

SM = Striking momentum in *pound-seconds.*

W_B = Bullet weight in grains.

V_I = Striking velocity of bullet in feet per second at desired range.

BULLET MASS

Formula:

$$M_B = \frac{W_B \times 7000}{32.17}$$

M_B = Mass of bullet in pounds mass.

W_B = Weight of bullet in grains.

SECTIONAL DENSITY OF A BULLET

This formula is useful to calculate the sectional density of a bullet. A higher number can indicate increased stability.

Formula:

$$SD = \frac{W_B}{7000 \times D_B{}^2}$$

SD = Sectional density

W_B = Bullet weight in grains.

D_B = Bullet diameter in inches.

BALLISTIC COEFFICIENT OF A BULLET

The ballistic coefficient of a bullet is a numerical expression of its ability to overcome air resistance in flight. A high ballistic coefficient is increasingly desirable as distance to the target increases. The form factor chart below will allow you to calculate an *approximate* ballistic coefficient. We also list a relative G1 ballistic coefficient of our bullets on the web.

While a ballistic coefficient is certainly better than nothing, it is worth noting that the BC of a given bullet varies substantially with velocity. It also varies to a lesser extent with atmospheric conditions and bullet stability.

The ballistic coefficient can be approximated using the following formula.

Formula:

$$BC = \frac{W_B}{7000 \times i \times D_B{}^2}$$

BC = Ballistic coefficient number.

W_B = Weight of bullet in grains.

$D_B{}^2$ = Bullet diameter in inches squared.

i = Form factor (see chart below).

Bullet Ogive Profile	Form Factor (i)
Very sharp	.60
Sharp (secant)	.70
Sharp (tangent)	.85
Semi-round nose	1.00
Round or flat nose	1.20
Boat tail base, subtract	.06
Very small meplat, subtract	.07

BULLET TIME OF FLIGHT IN AIR

Bullet time of flight is an important factor to reduce the effects of wind drift. A bullet with a high ballistic coefficient reduces flight time compared to those with low ballistic coefficients.

Formula:

$$T = \frac{2R}{MV + V_I}$$

T = Time of flight in seconds.
R = Range to target in feet.
MV = Muzzle velocity in feet per second.
V_I = Bullets impact velocity at target in feet per second.

BULLET TIME OF FLIGHT IN A VACUUM

You will need this to calculate wind drift (see below).

Formula:

$$T_V = \frac{R}{MV}$$

T_V = Time of flight in a vacuum in seconds.
R = Range to target *in feet*.
MV = Muzzle velocity in feet per second.

BULLET WIND DRIFT IN A 90° CROSSWIND

Wind drift is a factor shooters must always take into account. Bullets with high ballistic coefficients have less wind drift than bullets with low ballistic coefficients.

Formula:

$$D_W = V_W\,(T - T_V)$$

D_W = Wind deflection in feet.
V_W = Crosswind velocity in feet per second.
T = Bullet time of flight in air in seconds (see above).
T_V = Bullet time of flight in a vacuum in seconds (see above).

BULLET ROTATIONAL SPEED

This number can be used to compare twist rates at various muzzle velocities. Bullet rotational speed drops off very little in flight.

Formula:

$$V_R = \frac{MV \times 60 \times 12}{T}$$

V_R = Rotational velocity of bullet in revolutions per minute.
MV = Muzzle velocity in feet per second.
T = Rifling twist rate in inches per turn.

TERMINAL BALLISTIC FORMULAS

MEAN VERTICAL OR HORIZONTAL DEVIATION

$$D_A = \frac{\sum (DH \text{ or } DV)}{N}$$

D_A = Average distance of all shots from horizontal or vertical center.
DH = Horizontal distance of each shot from center of group.
DV = Vertical distance of each shot from center of group.
$\sum$ = Sum of all horizontal or vertical shots from center of group.
N = Number of shots in group.

MEAN RADIUS OF SHOTS

$$MR = \frac{\sum (DC)}{N}$$

MR = Mean radius of shots (average distance from center of group).
DC = Distance of each shot from center of group.
$\sum$ = Sum of the distances of each shot from center of group.
N = Number of shots in group.

HATCHER'S FORMULA FOR RELATIVE STOPPING POWER OF HANDGUN BULLETS

This formula was developed by General Julian Hatcher in 1935. While it lacks in many technical aspects, it is of historical interest, if not practical use.

Formula:

$$M_B \times S_B \times A = RSP$$

RSP = Relative stopping power number.
M_B = Momentum of bullet.
S_B = Multiplier for shape of bullet (from chart below).
A = Cross sectional area of bullet (see chart below).

S_B Multipliers

Bullet Construction/Shape	Multiplier
Jacketed round nose	.90
Jacketed flat nose	1.00
Lead round nose	1.00
Lead blunt round nose	1.05
Lead flat nose	1.10
Lead wadcutter	1.25

Caliber	Cross Sectional Area in Sq. Inches
22	.039
25	.049
30	.075
32	.077
9mm	.098
357/38	.101
41	.129
44	.144
45	.159
50	.196

POWER FACTOR (NRA)

This number is used to determine the classification of various handgun calibers and loads for NRA combat pistol competition.

Formula:

$$NPF = V_B \times W_B$$

NPF = NRA power factor (must be 120,000 or more).

V_B = Muzzle velocity of bullet in feet per second.

W_B = Bullet weight in grains.

POWER FACTOR (IPSC)

This number is used to determine the classification of various handgun calibers and loads for IPSC combat pistol competition.

Formula

$$IPF = \frac{W_B \times V_B}{1000}$$

IPF = IPSC power factor (must be 160 or more to make major caliber classification).

W_B = Bullet weight in grains.

V_B = Muzzle velocity in feet per second.

COMMON HEADSTAMPS

Here is an abbreviated list of common manufacturer's headstamps found on centerfire rifle and handgun ammunition you can use as a reference when sorting and identifying fired brass.

HEADSTAMP	MANUFACTURER	COUNTRY
ADI	Australian Defense Industries	Australia
AGUILA	Industrias Technos S.A.	Mexico
ARMSCOR, AP	Armscor U.S.A.	U.S.
BHA	Black Hills Ammunition	U.S.
CBC	Comphania Brasilia de Cartuchos	Brazil
CCI	CCI/Speer	U.S.
COR-BON	Cor Bon	U.S.
F C	Federal Premium Ammunition	U.S.
GFL	Fiocchi Munizioni S.p.A.	Italy
HORNADY	Hornady Manufacturing Co.	U.S.
IMI	Israel Military Industries, Ltd.	Israel
JAG	Jagemann Sporting Group	U.S.
LAPUA	NAMMO Lapua Oy	Finland
LAZZERONI	Lazzeroni Arms Co.	U.S.
LC	Lake City Army Ammunition Plant	U.S.
LFB	Luft fur Ballistik	Germany
MEN	Metallwerk Elisenhutte GmbH	Germany
MESKO	MESKO Spolka Akcyjna	Poland
MFS	MFS 2000 Inc. (div. of RUAG)	Hungary
MKE	Makina ve Kimya Endustrisi	Turkey
NORMA	Norma AB (div. of RUAG)	Sweden
NOS	Nosler, Inc.	U.S.
PETERSON	Peterson Cartridge	U.S.
PMC	Poongsan Metals Corp.	South Korea
PMP	Pretoria Metal Pressings (DENEL)	South Africa
PPU	Prvi Partizan Uzice	Serbia
REM, R-P	Remington Arms Co.	U.S.
RUAG	RUAG Ammotec	Germany, Switzerland
SAKO	Sako, Ltd. (div. of Beretta)	Finland
SAX	Sax Munitions GmbH	Germany
SBR	Southern Ballistic Research	U.S.
S&B	Sellier & Bellot	Czech Republic
SHM	Suddeutsche Hulsenmanufactur	Germany
SIG	SIG Sauer, Inc.	U.S.
SPEER	CCI/Speer	U.S.
SWIFT	Swift Bullets	U.S.
TW	Twin Cities Army Ammunition Plant	U.S.
WEATHERBY	Weatherby, Inc. (made by Norma)	U.S.
WIN, W-W	Winchester Ammunition	U.S.
X-treme	Howell Munitions	U.S.
2nd AMEND	2nd Amendment Ammunition	U.S.