

Metallic Cartridge Handloading & Bullet Casting Guide



Compiled by Peter.J.Starley
Warwickshire RFD 156

Oak House, Birmingham Road, Warwick. CV35 7DX

Tel:0845 22 66 005 Fax:0845 22 66 006 e-mail:gun.powder@virgin.net

www.black-powder.co.uk



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Handloading Safety

Contrary to what one hears in the news media and the claims made by certain politicians and radical groups, shooting is one of the safest sports -- when practiced by persons of sound judgment in accordance with basic rules of safety. Handloading is a safe and natural extension of that sport.

If any information in this document conflicts with information given in your handloading manual or the instructions your received with your handloading equipment, always follow those instructions -- not mine.

General safety:

- Read the instruction manual for each piece of equipment you use. Keep it handy for later reference.
- Understand what you are doing and why it must be done in a specific way.
- Stay alert when handloading. Don't handload when distracted, disturbed or tired.
- Never handload when under the influence of alcohol or drugs (legal or illegal).
- Never smoke while handloading or near combustibles and explosives.
- Always wear safety glasses while handloading.
- Set up a well-organized, clean, well-lit work area.
- Set up a loading procedure and follow it. Don't vary your sequence of operations.
- Set up your handloading bench where powder and primers will not be exposed to heat, sparks or flame.
- Keep everything locked up and out of the reach of small children.
- Keep your handloading bench clean and uncluttered. Label components and handloads for easy identification.
- Do not eat while handling lead.
- Never try to dislodge a loaded cartridge that has become stuck in the chamber by impacting it with a cleaning rod. Have a competent gunsmith remove the round.
- Follow loading recommendations exactly.
- Don't substitute components for those listed in your manual.
- Start loading with the minimum powder charge given for your cartridge.
- Never exceed manufacturers' handloading data. Excess pressures caused by excessive loads could severely damage a firearm and cause serious injury or death.
- When using an inertial bullet puller, use short, light taps instead of a single heavy blow.
- Never attempt to disassemble a cartridge unless you are absolutely sure the bullet non-explosive or non-incendiary.

Gunpowder Safety:

- Modern ammunition uses smokeless powder to propel the bullet down the barrel. It burns with much greater energy and pressure than blackpowder. Therefore, never use smokeless powder in a firearm designed for blackpowder.
- Specific powders are designed for specific uses. Don't use them for other purposes.

- Never mix smokeless powder and blackpowder.
- Never mix blackpowder and blackpowder substitute such as Pyrodex®.
- Never mix different brands or types of powder.
- Never use an unknown gunpowder.
- Pour out only enough powder for the immediate work.
- Start new loads at 10% under maximum and increase slowly.
- If you throw or measure powder charges by volume, check-weigh the charges every time you begin loading, occasionally during loading and when you finish. Weigh the powder charge in at least 10% of your loads to make sure you are dropping the proper amount of powder.
- Have only one kind of powder on the loading bench at a time.
- Empty the powder measure back into the original powder container when through with a handloading session.
- Wash your hands thoroughly after handling powder.
- Store powders only in original package. Don't repackage.
- Keep powder containers tightly closed when not in use.
- Clean up spilled powder with brush and dust pan; do not use a vacuum cleaner because fire or explosion may result.
- Store powder in cool, dry place.
- Store and keep primers and powder separately.
- Smokeless powder is extremely flammable. Dispose of deteriorated powders according to recommendations in The Properties and Storage of Smokeless Powder SAAMI Reprint #376-2500, which is published in some handloading guides or available from [NRMA](#).

Primer safety:

- Priming materials differ in brisance (initial explosive force) and in the amount of hot gas produced. Don't mix primers of different makes.
- Don't decap live primers. Fire them in the appropriate gun then decap.
- Don't ream out or enlarge the flash hole in primer pockets. This can increase chamber pressure.
- Over-ignition creates higher gun pressures. The best results are obtained by using the mildest primer consistent with good ignition.
- Don't use primers you can't identify. Ask your local police or fire department to dispose of unidentifiable or unserviceable primers.
- Keep primers in the original packaging until used. Don't store in your primer feed tube or primer tray. Return unused primers to the factory package. Don't dump together and store in bulk. There is a risk of mass detonation if one is ignited.
- Open only one package of primers at a time.
- Never attempt to seat, or reseal, a primer in a loaded round.
- Do not force primers. If you feel resistance to seating or feeding of primers, stop and investigate.
- Store primers in a cool, dry place. High temperature, such as in a summer attic, causes them to deteriorate.
- Store and keep primers and powder separately.
- Don't handle primers with oily or greasy hands. Oil contamination can affect ignitability.
- Clean the machines after each use. There have been instances of "primer dusting" in the tubes of loading tools because of vibration.

Lead safety:

- Lead is known to cause birth defects, reproductive harm and other serious physical injury, must be handled with extreme care.
- Never eat, drink, or smoke when handling lead.
- Handle lead bullets or lead shot only in a well ventilated area.
- Always wash hands after handling lead and before eating.
- Molten lead is hot -- 650-750 degrees Fahrenheit. This is no activity for children -- not even to watch!
- The melting pot must have a steady base -- a lap full of hot lead would surely take all the fun out of casting and handloading.
- Never discharge firearms in poorly ventilated areas.

Handloading rifle & pistol cartridges

- Never start with a maximum load. Start with the minimum powder charge and work up in small increments to no more than the maximum listed in your reloading manual watching for indications of excessive pressure.
- If you are using a single stage press, do each step to the lot you are reloading before moving on to the next step.
- Examine cases before loading. Discard any that are not in good condition.
- Label boxes of loaded cartridges. Identify caliber, primer, powder and charge, bullet and weight, and date of handloading.
- Seating depth of the bullet is extremely important in handgun loads. Handgun powders must burn very quickly because of the short barrel. They are sensitive to small changes in crimp, bullet hardness, bullet diameter, primer brisance and especially to bullet seating depth.
- Check the overall length of the cartridge to be sure the bullet is seated properly.
- Accumulation of lead or grease in the bullet seating tool may force the bullet in too far.
- If the bullet isn't seated deeply enough, it may engage the lands of the barrel when loaded. This will increase the chamber pressure.
- If you cast your own bullets, remember their hardness, diameter and lubrication affect the ballistics.
- Plastic cases designed for practice loads (where the bullet is propelled by primer gas only) can't be used for full powder loads.

Prevent missing & double charges

- It is easy to double charge if you are momentarily distracted. Use a depth gauge to check powder height in a shell. A piece of doweling rod can be used as a depth gauge.
- Observe the powder level of cases placed in the loading block. This is a way to discover any cases with missing or double powder charges.
- Take care to operate progressive loaders as the manufacturer recommends. Don't back up the turret or jiggle the handle. Don't use a shell to catch the residue when cleaning out the powder train.

Glossary

Like most other hobbies, handloading has its own "language". Here are some terms you need to be familiar with. See your handloading manual for more handloading information.

- Anneal - The process of altering the structure of metal so as to relieve its working stresses, prevent brittleness, and increase its ductility. Only the case neck is annealed.
- Antimony - A metal which increases the hardness of lead when combined as an alloy.
- Anvil - A metallic part of the primer. The blow from the firing pin crushes the priming mixture against the anvil causing ignition.
- Ball - In military nomenclature this term refers to the bullet.
- Ball Powder - This is a trade name for a double-base smokeless powder developed by Olin Industries. The grains have a spherical, or flattened spherical shape.
- Ballistics - The science of projectiles in motion.
- Ballistic coefficient - Ratio of the sectional density of a bullet to its coefficient of form. Represents the projectile's ability to overcome air resistance in flight.
- Battery cup - A type of primer used in shotshells which makes use of an outside cup to support it in the case.
- Bearing surface - That portion of the bullet surface which bears on, or touches, the bore.
- Bell - To open the mouth of a case slightly in order to seat a bullet more easily. Also called flare.
- Belted case - A case with a band formed into the head of some cases (magnum type) to strengthen the case and to control the headspace of the cartridge.
- Berdan primer - A common European priming system with no integral anvil. Instead, it makes use of an anvil formed in the case itself. It is fitted in the primer pocket in the head of centerfire cartridge cases.
- Black powder - A mixture of charcoal, potassium nitrate, and sulfur used as a propellant in muzzleloaders and early cartridge firearms.
- Boat tail - A bullet design having a tapered base.
- Bore - The inside diameter of a barrel before the rifling is cut.
- Boxer primer - A type of primer used in American rifle and pistol ammunition and featuring a self-contained anvil. It is fitted in the primer pocket in the head of centerfire cartridge cases.
- Brass - An alloy usually of 70% copper and 30% zinc of which most metallic cases are formed. The term also applies to the empty cartridge case.
- Brisance - The detonation rate and intensity of an explosive such as a cartridge primer.
- Bullet - That portion of the cartridge which becomes a projectile when in flight. Sometimes also called ball.
- Bullet & powder scale - A device to weigh charges of powder. A beam scale is a scale where markers, called "poise", are moved along a weight graduated beam, as the pan is filled with powder, until the balance point is reached. An electronic device used to measure the weight of powder in grains or grams.
- Burning rate - A term used to describe the rapidity with which a given powder will burn. The term itself is a relative one based on a comparison with other powders.

- Caliber - The approximate diameter of a bullet or bore, expressed in hundredths of an inch or in millimeters. A bullet with a diameter of .308 inches is called 30 caliber (not .30 caliber).
- Cannelure - A groove (or grooves) cut around the circumference of a bullet or case. These grooves, usually one to a bullet, provide the best means of securely crimping the case mouth into the bullet. In a case, the cannelure is used as a stop for an inserted bullet.
- Canister powder - Powder which is manufactured to consistently meet a standardized specification and packaged so handloaders can get predictable results.
- Cap - Primer.
- Cartridge - A completely loaded, ready-to-fire round of ammunition.
- Case - A cylindrical container which holds the primer, powder and bullet. Also called hull, shell, or brass.
- Case forming - To alter the shape of a case to a different shape or caliber.
- Case neck brush - A metal or nylon brush and handle used to clean the inside of case necks.
- Case trimmer - A device used to remove excess material from a case mouth. Metallic cases stretch after extensive reloading and firing because the brass flows forward. These cases must be trimmed back.
- Case trimmer pilot - The pilot guides the cutting portion of the case trimmer by fitting inside the neck of the case to be trimmed.
- Cast bullet - Bullets for rifle or pistol which are cast from lead or lead alloy. Muzzleloading projectiles and shotgun slugs are cast in pure lead.
- Centerfire - Refers to a cartridge having a primer located in the center of its base. Most centerfire cases are reloadable.
- Chamber - The part of the bore at the breech which is formed to accept and support the loaded cartridge.
- Chambering - A designation given to cartridges with a specific caliber, case size and shape, case head configuration, design, and which should not be used in firearms designed for a different chambering. A chambering is given a name (ie 7mm Mauser, .357 Magnum) to distinguish it from other chambering. This name is usually indicated by a headstamp.
- Chamfer - To bevel the inside of a case mouth. The bevel allows bullets to start into the case mouth without crushing the case.
- Charge - The amount of powder used in the case at each loading. Also refers to the amount of shot used in a shotshell.
- Choke - A constriction at the muzzle of a shotgun barrel designed to control the spreading of shot.
- Chronograph - An instrument used to measure the velocity of a projectile.
- Components - The parts that make up a cartridge. The case, primer, powder and bullet or other projectile.
- Compressed charge - A charge of powder which so nearly fills the case that it is compressed when the bullet is seated.
- Corrosion - The eating away of the bore or case by rust or chemical action.
- Crimp - The bending inward of the case mouth to grip the bullet. Used only with bullets having a cannelure or crimping groove. With shotshells the term applies to the closure at the case mouth.
- Crimped primer - A forcing inward of the brass around the top of the primer pocket. This is frequently found on military cartridges and is done to prevent set-back of primers. The crimp must be removed before repriming the case.
- Deburr - To remove the small metal burrs or roughness from a case mouth or

primer flash hole.

- **Deburring tool** - The deburring tool removes burrs from the inside and outside of any newly trimmed case mouths.
- **Decap** - Removal of the spent primer from a fired case, most often accomplished by the decapping pin in a die during the resizing operation of handloading. Also called deprime.
- **Decapping pin** - A needle-like rod in the sizer die which pushes out the spent primer.
- **Die** - A tool that reforms cartridge cases and seats bullets. In bullet manufacture, a tool that swages bullets or cores, extrudes lead wire or draws jackets.
- **Dram equivalent** - Term used to indicate that a charge of smokeless powder produces the same velocity of a given number of drams of black powder.
- **Drift** - Deviation of a projectile from the line of departure due to its rotational spin or the force of wind.
- **Drop** - The distance a projectile falls, calculated from the line of departure.
- **Double base powder** - Smokeless powder made with nitroglycerine and nitrocellulose base.
- **Duplex load** - The use of two different powders in loading the same cartridge. Not recommended for handloaders.
- **Energy** - A projectile's capacity for doing work at a given range, expressed in foot-pounds.
- **Erosion** - The wearing away of the bore due to friction and/or gas cutting.
- **Expander** - The part of a die that expands the case mouth to receive the bullet.
- **Fireform** - Reforming or changing the shape of a cartridge case by firing it in a chamber of a desired shape.
- **Flash hole** - A hole leading from the primer pocket to the inside of a case through which the primer ignites the powder charge in a case.
- **Foot-pound** - A unit of kinetic energy equal to the effort required to raise one pound of weight to a height of one foot, against the normal pull of gravity.
- **Freebore** - The distance in the barrel, if any, which the bullet travels before it contacts the rifling. Some barrels are purposely relieved to allow the bullet considerable free movement before it strikes the rifling.
- **Gas checks** - A copper or brass cup which is used to protect the base of a cast lead alloy bullet from the effects of burning powder gases.
- **Gliding metal** - A copper-zinc alloy used for bullet jackets and gas checks.
- **Grain** - A unit of weight measure. 437.5 grains equal one ounce; 7000 grains equal one pound.
- **Handloading** - Another term for reloading.
- **Hangfire** - Slang term for any detectable delay in cartridge ignition.
- **Head** - The base of a cartridge case that contains the primer, rim, extracting groove, and headstamp.
- **Headspace** - The distance from the breech face to the part of the chamber which acts as a stop and prevents the cartridge from moving forward.
- **Headstamp** - Markings stamped into the head of a case indicating (in most cases) the manufacturer, caliber and name of the cartridge. On military cases codes are used to indicate manufacturer and date of manufacture.
- **Heel** - The outer edge of the bullet base.
- **Hollow point** - A bullet design which features an axial hole at the point. The purpose of the hole is to aid expansion on impact.
- **Ignition** - The action of setting the powder charge on fire.
- **IMR** - Abbreviation for "Improved Military Rifle."

- **Jacket** - The covering or "skin" of a bullet.
- **Keyhole** - The imprint of a bullet which struck sideways on a target rather than point first.
- **Lands** - The raised portion of the rifling.
- **Loading density** - Ratio of the volume of the powder charge to the volume of the case. The higher the better in terms of accuracy.
- **Lube dent** - A dent in the cartridge case caused by using too much lubricant when resizing.
- **Lube pad** - A pad, impregnated with lubricant, on which cases are rolled before resizing.
- **Lubricant** - Case sizing lubricant is used to reduce friction between the case and die during the resizing operation in reloading. Bullet lubricant is used to help minimize bore fouling when firing lead or lead alloy bullets.
- **Mercuric primer** - An obsolete primer in which the priming material contains mercury.
- **Mid-range trajectory** - Refers to the distance the bullet rises above the line of sight. Mid-range trajectory is calculated halfway between the muzzle and the target.
- **Minute-of-angle** - A unit of angular deviation equal to 1/60th of a degree. For practical purposes, it is usually approximated as equal to one inch at 100 yards.
- **Misfire** - The failure of a cartridge to fire after the firing pin strikes the primer.
- **Muzzle** - The front end of the barrel.
- **Muzzle energy** - See "Energy."
- **Neck** - The upper portion of a cartridge case that grips the bullet. In a bottlenecked case, that portion of the case in front of the shoulder.
- **Neck-size** - To resize only the neck portion of a case.
- **Neck sizer die** - A die used to resize only the neck portion of the fired case back to approximately its original dimensions.
- **Non-corrosive** - Usually refers to primers having a priming mixture which is free of corrosive compounds. Modern primers are non-corrosive.
- **Ogive** - Refers to the nose shape of the bullet. The radius of the curve of a bullet nose.
- **Powder** - The propellant used in most firearms. It produces a large volume of gas when ignited. There are two basic types; smokeless and black powder.
- **Powder charge** - The amount of powder loaded into a case.
- **Powder funnel** - A helpful accessory that facilitates transfer of powder from a scale pan or measure to a cartridge case.
- **Powder measure** - An adjustable volumetric measure that meters out uniform charges of powder.
- **Powder & bullet scale** - A device to weigh charges of powder. A beam scale is a scale where markers, called "poise", are moved along a weight graduated beam, as the pan is filled with powder, until the balance point is reached. An electronic device used to measure the weight of powder in grains or grams.
- **Press** - The tool which performs the major tasks of handloading.
- **Pressure** - The force exerted by a burning charge of a powder in the chamber of a firearm. Expressed normally in pounds per square inch.
- **Primer** - A small metal cap containing a detonating mixture used to ignite the powder charge in the case.
- **Primer pocket** - The cavity in the base of a cartridge into which the primer is seated.
- **Primer pocket swaging** - The "smoothing out" of the crimped primer pocket

found in military cases.

- **Priming** - Installing a new primer into a case.
- **Ram** - The steel shaft running through the center of the press that holds the shell holder and drives the case into the die.
- **Reloading press** - The tool which performs the major tasks of handloading.
- **Resize** - To restore a fired case to approximately its original size.
- **Resizing die** - The reloading die that restores fired cases to designed dimensions and removes spent primers by means of a decapping pin.
- **Rim** - A flange on the head of a case which is engaged by the extractor to pull the case from the chamber.
- **Rimfire** - A cartridge containing the priming mixture within the case rim. Rimless cases are not considered reloadable.
- **Round** - A military term meaning one single cartridge.
- **Round Nose (RN)** - A bullet design which features a rounded nose.
- **Sabot** - a light-weight disposable plastic cup in which a sub-caliber projectile is centered to permit firing in a larger caliber barrel.
- **Seating depth** - The depth to which the base of a bullet is seated below the case mouth.
- **Seating die** - The reloading die that presses the bullet into the neck of the cartridge case, crimping the case if so desired.
- **Sectional density** - A bullet's weight, in pounds, divided by the square of its diameter in inches.
- **Shell holder** - A device attached to the top of the ram which holds the head of the cartridge case as it is moved up and down, into and out of the die.
- **Shoulder** - The angled portion of a bottlenecked cartridge case between the case neck and body.
- **Sizing die** - See resizing die.
- **Spent primer** - A primer that has been fired.
- **Swage** - The forming of an object such as a bullet using pressure in a die instead of casting molten lead in a mould.
- **Throat** - That area of the bore immediately ahead of the chamber tapering to the point where rifling starts.
- **Trajectory** - The path of a projectile in flight relative to the line of sight.
- **Trim-to-length** - The length a cartridge case should be trimmed to after it has stretched past its maximum case length.
- **Turret press** - A reloading press with a rotatable multi-station turret top for positioning dies and powder measure in their appropriate sequence.
- **Twist** - The angle of the rifling in relation to the axis of the bore measured by the length of barrel required to rotate the bullet one complete turn.
- **Velocity** - The speed at which a projectile travels. Usually measured in feet per second at a given range.
- **Vernier caliper** - A slide-type graduated instrument used to measure overall cartridge and case lengths precisely.
- **Wadcutter (WC)** - A bullet design which features a sharp shoulder. Designed to cut a clean round hole in a paper target.
- **Web** - That portion of a cartridge case between the bottom of the primer pocket and the interior of the case.
- **Wildcat** - A cartridge formed by altering an existing commercial case to make a style that is not available from commercial ammunition manufacturers.
- **Work-harden** - The increase in metal hardness due to repeated flexing or stress. See "Anneal."
- **Yaw** - The action of a projectile spinning erratically around its own axis.

- Zero - The ranges at which a firearm will hit the point of aim.

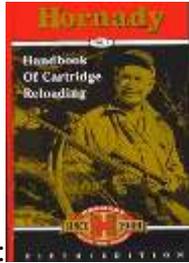
Reasons for Handloading

Most reloaders handload because it is interesting, less expensive than shooting factory loads and because they can often develop more accurate loads for specific guns.

- By handloading you can save 50-65% as compared to the cost of factory ammunition. In my area, I can buy factory 30-06 ammo for about 60-90 cents per round, depending on manufacturer and load. About half of that price is for the reusable brass case and the cost of manufacturing. That's where the savings come in. Of course you'll spend around \$200 for equipment, so you'll need to send a few round downrange before you actually realize any savings.
- Handloaders generally make better shooters, because they can afford to practice more.
- Through handloading you will develop a much keener knowledge of shooting technology and be able to tailor your ammo to a particular firearm. Also, you can shoot more for less, and practice makes perfect.
- By careful experimentation within prescribed limits, you can improve your accuracy for hunting or target shooting by developing the load that works best in a specific firearm. And you can match your ammunition to the type of game you are hunting or your particular kind of target shooting.
- Reloading requires you to save empty cases, thus preventing litter in the field or on the range. Besides, the case or is often the most expensive part of a loaded round, so saving your empties saves you money.
- Reloading allows you to stay in close touch with shooting, even during the off season. It is an enjoyable pursuit that enhances shooting knowledge and ability.
- The handloader can assemble ammunition that just isn't available commercially such as a batch of low-recoil 30-06 rounds with 100 grain cast lead bullets for some plinking that rivals the .22 LR in low cost.
- Handloading may the only way to get ammunition for obsolete and wildcat guns.

Equipment

The following list describes required and optional equipment in the order each item is most likely to be used. Most manufacturers sell their most popular reloading tools in a kit with a bit of a price break. With care, ammunition can be safely handloaded without using the optional tools, but these additional tools can help improve the accuracy of your product.



Reloading manual:

- This is the most important accessory you must have. Without this information, you do not know what is a safe or unsafe load. Always keep current editions, because powder formulas change.
- Most manufacturers of handloading equipment, powders, and bullets sell excellent handloading manuals. These books include step-by-step handloading instructions. They also give proven loads for all popular cartridges with various bullet weights and velocities. In most cases, these loads are safe for firearms in good condition.
- A good example, which I use, is the Speer Reloading Manual. This manual is a complete, step-by-step, top rated reference for everything you want to know about handloading. It contains over 600 pages of information, data and illustrations.
- There are many other excellent books in handloading which can provide supplemental information on the process. I've included several in the [bibliography](#) at the end of this page.



Bench:

- A solid workbench is essential. It needs enough mass (weight) to stay put while you're applying pressure to the handloading press.
- Many handloaders find that the benchtop should be about as high as the handloader's beltline. Another recommendation is to stand 18 inches away from a wall, then pivot your straight arm toward the wall with your fingers outstretched. The point where your fingertips touch the wall is the ideal benchtop height for you.
- You'll want enough bench space to lay out your tools and components.
- A cabinet or some shelves to store and organize components is a nice addition. Shelves should be at least 12 inches above the benchtop.
- You'll want a good overhead lamp to give you a nice, bright work area.

- Any good workbench will do. I'm using a so-called workstation by Sears which is similar to a steel tool cabinet but has a 40-inch height and a 20x32-inch top suitable for mounting my press and other handloading tools. It has 5 drawers for storing components, dies, moulds, and other handloading paraphernalia. It's on wheels, so I can easily move it out of the way when not in use.

Safety glasses



Case cleaning tumblers (optional):

- When fired, ejected empty brass nearly always land in the dirt. The result is dirt or dust inside and outside the case. Dirty ammunition is murder on firearm chambers and bores. Dirty ammunition is murder on your handloading dies, either. Therefore, a wise handloader ensures all his cases are clean before proceeding with the handloading process.
- Simply washing with soap and water, rinsing, drying, and wiping cases is usually sufficient.
- Electric tumblers are very effective cleaning cases and giving them a nice like-new shine. Fill the tumbler with cases and either granulated walnut shells or granulated corn cobs available from the same vendors who sell the tumblers.
- Vibrating tumblers cost from \$50 and up.



Calipers or case length gauge:

- During each firing, the case is stretched by the expanding gasses. The diameter of the case is restored to factory specs by pressing it into a resizing die. The case also stretches in length and can become so long that it can fail to feed properly into the firearm.
- Case length of used cases should be checked against the specs given in your handloading manual.
- Calipers (\$20 and up) can be used to exactly measure the case length.
- A case length gauge (about \$10) will quickly check case length. A typical

gauge covers over 30 different cartridge lengths.



Case trimmer (optional):

- Every time you fire and handload a case it tends to stretch. When a case has stretched beyond the factory-specified maximum length, it must be trimmed to size.
- Sometimes the case mouth is not square and should be squared for best accuracy.
- A device similar in appearance to a small lathe easily and accurately trims cases to size. You will need trimmer pilot for each caliber you handload.
- A good trimmer will cost about \$45 and up.



Deburring tools (optional).

- A case mouth deburring tool removes any burrs around the case mouth left after trimming. It also gives a slight bevel to the inside edge of the case mouth.



Primer pocket tools:

- A primer pocket tool reams the primer crimp found on military brass. Some primer pocket tools also square up the bottom of the primer pocket at a uniform depth. Be careful you don't take out so much metal the pocket won't hold a primer!
- A primer pocket swaging die uses pressure to reform a military primer pocket to accept a new primer. Unlike a pocket reamer, a swaging die ensures the primer pocket is round and of correct dimension as well as free of crimping. Many handloaders prefer the swaging process over reaming the primer pocket.
- Primer pocket brushes are used to clean out primer ash left by the spent primer with a twisting motion.
- Burrs on the inside of the flash hole can cause erratic ignition. Some handloaders use a flash hole deburring tool to remove this burr.

Case neck brush:

- A case neck brush or a bore cleaning brush is used to ensure the inside of the neck is smooth and clean.



Case lube kit:

- Unless you are using carbide dies, you'll need to apply a thin film of lubricant to each case before resizing the case (and decapping the old primer).
- Failure to lubricate will eventually result in a stuck case with the case base pulled off -- not a lot of fun to remedy. Too much lubricant can result in pressure dents in your cases.
- A typical case lube kit contains a bottle of case lube, a case lube pad and a couple of case neck brushes with an accessory handle.
- A good lubricator kit, when properly used, will apply just the right amount of lubricant. Just a light amount of lube on the pad goes a long way. Simply roll several clean, empty cases on the pad together to lube several at once. You only need a light film on the cases. Do not lubricate the case shoulder.
- Many handloaders use a spray lubricant rather than a pad.
- Make sure you remove the lube before dropping the powder in -- oil will ruin your powder.



Primer tray:

- This tray is a clever little device that quickly orients primers anvil up for faster handloading. To use, scatter primers onto the grooved tray, then shake the tray horizontally until all primers are anvil side up. Primers can now be picked up manually into the priming arm.
- If using an automatic primer feed tube, replace the primer tray cover and invert. The primers are now anvil side down and can easily be picked up with the top end of your automatic primer feed tube.



Priming device:

- Most handloading presses have a lever built in to prime empty cases.
- Many handloaders use an automatic primer feeder. This is a tube which feeds primers to the priming lever on the press for quick priming of a large batch of cases. With this tool, primers will drop one at a time into the primer plug and sleeve on the handloading press. Depending on the cartridge you are loading, you will need different tubes for large and small primers.
- A hand priming tool designed specifically for the priming process is available for around \$28.



Reloading trays (aka Loading blocks):

- You will want two trays for each family of calibers you handload. One tray will hold cases which are ready for a specific step in the handloading process. The tray has holes to hold your cases upright so they don't tip and spill powder and for ease of grasping the next case to be processed. As each case is processed, it is placed into the second tray. When the first tray is empty, that handloading step is complete for all cases. You then switch trays and proceed with the next step, etc.



Reloading press:

- The press is used to resize the brass cases, replace the fired primers and seat the bullet.
- Most handloading presses have a bench-mounted cast iron structure which holds a die on its top and a piston-like ram in the base which inserts the case into the die to perform various functions.
- Most presses have a primer foot which presses a new primer into each case as it's processed.
- Press sizes vary quite a bit. Make sure the one you buy will handle the largest cartridge you'll handload.
- Some RCBS press models will also reload shotgun shells -- something to consider.
- A good single-stage press will cost about \$60 and up. With a single stage press, you will change handloading dies between each step, but this only takes a minute.
- Some presses have a turret on top to hold a full set of dies as well as the powder measure. With such a press, all steps are completed on each cartridge without the need to set up for the next step.
- A hand-held press is also available for about \$30.



Shellholder:

- Cartridge cases come in a wide variety of shapes, lengths, and diameters. Most calibers share a head size and configuration with a family of other calibers. You'll need a shellholder for each cartridge family you'll load.
- The shellholder is attached to the ram and grips the base of the cartridge as it is pressed into the dies.



Dies:

- You'll need a set of dies for each caliber you plan to handload. Dies are generally sold in sets of 2 or 3 dies for each cartridge caliber.
- These dies perform various operations on the cartridge including decapping (removing the spent primer from the last loading), sizing (restoring the case to factory designed dimensions), seating the new bullet, and in some cases, crimping the case mouth to grip the bullet.
- The decapping process is done at the same time as the sizing. This is done by a pin which presses the old primer out of its pocket. Most handloaders will eventually break this decapping pin, so it's a good idea to have a couple of spares on hand to avoid interruption of the handloading process.
- You will use a set of two dies for loading bottleneck type cases (most commonly used in rifles). The first die is the resizing die and the de-capping die. At this point you put the new primer into the case. Some sizing dies have the option to open the case mouth up slightly at the extreme end of case travel. Most bullets have a slight indent at the base of the bullet and will begin the seat in the case with no widening of the case mouth at all, and will make a very snug fit that won't have to be crimped. But, if you plan to make some low powered, lead plinkers you would need the option to expand the case mouth a bit. The second die in the 2 die set is for bullet seating and crimping (if required).
- You will use a set of three dies for loading straight-wall type cases (most commonly used in handguns). The additional die in a 3-die set is used to expand the mouth of straight-wall cases. These often use cast lead bullets and even when bullets are sized and lubricated, some lead can be shaved off if the case mouth does not have a slight "flare" or enlargement just where the bullet enters the case. This flare is closed when the bullet is seated or even reversed if you seat the bullet deep enough to crimp the case mouth. The first die of 3 usually just resizes the case back to original dimensions (in some dies it also

decaps). The second die will decap (remove the primer) the case and "bell" or open the case mouth slightly. You control how much opening occurs by how deep you insert the case into the die. This is adjusted by how deep the die is screwed into the press and the lock ring on the die is set to the depth you prefer. At this point you put the new primer into the case. The last of the three dies is for bullet seating and closing the mouth of the case even or even crimping the case mouth on the bullet. Lead bullets usually either have a crimp groove or can be inserted just deep enough to get past the largest part of the bullet to put a slight crimp on the case.

- Most dies are made of steel. One of the most important factors in selecting dies is the hardness of the steel and the polish of the inside (particularly the resizing die). The best dies are made of tungsten carbide and are not supposed to need lubricant. I use it anyway. Nickel-plated cases sometimes scratch steel dies and are best sized in carbide dies.
- The sizing die gets a lot of hard work. If a case has a speck of sand or dirt on it, it can scratch the die. Then, every case sized after that will be scratched. Buy high quality dies. The extra cost up front will be well worth it. Of course, you still should take special care to have cases clean and free of corrosion, dirt, sand, and grit.
- Each die has a lock ring to lock it in the desired adjustment. The lock ring is prevented from moving out of adjustment by a set screw. I recommend you place a lead shot ahead of the setscrew. The lead is softer than the setscrew and will flow into the die thread to stop the lock ring from turning. Much less pressure is then required on the head of the setscrew and damage to the threads is avoided.
- A typical two-die set costs around \$25 and up while a three-die set costs around \$35 and up.

Die locknuts:

- These nuts that have a setscrew to lock the nut to the die. This saves you the time of adjusting the dies every time. This is especially important if you have a single stage press, since you are constantly switching dies out. I recommend you place a lead shot ahead of the setscrew. The lead is softer than the setscrew and will flow into the die thread to stop the lock ring from turning. Much less pressure is then required on the head of the setscrew and damage to the threads is avoided.



Powder measure:

- At least one manufacturer sells sets of dippers to measure the amount of powder to be poured into the freshly primed case.
- Most handloaders use a mechanical powder dispenser made up of a hopper to hold a supply of gunpowder, a volumetric metering mechanism to measure

powder quantity, and a drop tube to pour the measured powder into the waiting case. Such a measure will cost about \$35 and up.

- Fill the powder measure hopper with your favorite powder and adjust the micrometer adjustments on the side to dump exactly the right amount of powder into the case below the spout. A little "kicker" weight is used to shake the measure to ensure all the measured powder charge drops into the case (sometimes some sticks to the sides or hopper). You should always weigh several measures after you get it adjusted to ensure it is consistent with the load you want.
- A good powder measure "throws" a well-controlled amount of powder directly into the empty case. A good measure will be accurate to about 1/10 grain. This is usually considered good enough for most shooting.
- Some powders, due to their granule size and shape, are more difficult to measure consistently. When measuring these powders, it is especially important to be very uniform in your movements when throwing charges.



Scale:

- You will need a scale that weighs in grains. A very accurate scale designed to measure very small weights is essential. Accuracy to tenths of a grain is important. A postal scale just won't do!
- It is necessary to always weigh your powder charge to know how much you are putting in the cases. Even the little "volume" measuring scoops people use need to be checked.
- The accuracy of the charge thrown by the powder measure should be checked prior to each use, periodically during a handloading session, and when changing the amount or type of powder to be dispensed with each "throw."
- Once the accuracy of the powder measure is established (and periodically verified), use of the scale is optional.
- Shooters who are after the optimum accuracy and consistency usually weigh every charge.
- The best scales use a magnet to dampen the beam oscillations for quick, accurate readings. Most handloaders use a balance scale costing around \$60. Electronic scales are also available for about twice that price.

Check weights:

- Use these calibrated weights to verify the accuracy of your scale. These are precision weights in various denominations, from .5 grain to 20 grains for a basic set.



Powder trickler (optional):

- Those handloaders who like to weigh every charge typically "throw" a slightly underweight charge from their powder measure. They then gradually add powder until the desired weight is attained.
- A powder trickler lets you "trickle" little bits of powder into your scales to exactly measure the charge you want. For precision shooting, you might want exactly 48.5 grains of a powder. Set your powder measure to 48 grains, and bulk dump that into the dish on the scales. Then, with the trickler, you turn the knob and trickle in just the amount you need to exactly balance the scales at 48.5 grains. Now you have an exact load and can duplicate it for every round.

Funnel:

- A funnel is essential for pouring weighed charges into cases without spillage.



Bullet moulds (optional):

- Moulds are made of either steel, brass, copper, bronze, or aluminum and have a pair of handles.
- Moulds open like a pair of tongs or pliers to drop the freshly cast bullet.
- Aluminum, copper, bronze, and brass moulds are softer than steel moulds and are easily nicked or scratched, so they need a bit more care.
- Steel moulds are likely to rust if not properly cared for.
- I like the aluminum moulds ([Lee](#) brand moulds are a bargain and of excellent quality). They warm to casting temperature more quickly than the other metals, and need no break-in.
- Prices run from less than \$20 to \$100 and more depending on brand, construction, and number of cavities.
- Custom moulds can be ordered if you need a special size or shape of bullet. Be prepared to pay a premium price.



Lead melting pot or furnace (optional):

- Most bullet casters use a cast iron pot placed over a stove to melt lead for casting bullets.
- Some bullet casters use a pot or furnace with built in thermostatically-controlled electric heating coils to melt lead. The typical lead furnace will hold up to 20-25 pounds of lead. Some have a spigot for pouring lead from the bottom for increased convenience.



Bullet sizer and lubricator (optional):

- This is an important tool if you make your own bullets. It will size the lead bullet to exact caliber and put a lubricant in the lube groove(s) of the bullet to prevent leading of the barrel.

Labels:

- Label every batch of ammunition you handload. You'll want to know how much of what components you used when you find that perfect load for your favorite rifle!
- I also recommend you keep a logbook of each batch you load. A spiral bound notebook with entries containing the information from your labels will suffice.

Logbook:

- This is where you keep all of your loading information, as well as any chronograph reports. For every batch you make, record the date and batch number, along with primer type, powder type and weight, and the bullet type and weight. Once the batch is loaded, take the log book out to the range and record the performance of the load. If you have a chronograph, record the velocity of up to 50 rounds in the batch. Based upon these recordings, you can determine the consistency of the load.

Chronograph (optional):

- This is one of the most expensive parts you will get, but it provides you the

your bullets are, and depending on the model, you can get average, high, and low velocities and standard deviation.



Impact bullet puller (optional):

- Sometimes we load a batch of ammo that just doesn't shoot well. It's nice to be able to disassemble such ammo and recover the components for reuse.
- You insert the bullet, then rap it like a hammer on a hard surface. It uses inertia to harmlessly pop out the bullet so you can recover the components and try again on the round.
- A good bullet puller costs around \$15.
- Kinetic Bullet Puller This device is for those "oops!" that come up occasionally.

Components



Case:

- The metallic cartridge case is the most expensive component of a loaded cartridge. This is the reusable part of the cartridge. You can usually handload a case 10-20 times, depending on case design, the care you give the cases, and the pressures to which they're loaded.
- Most cases are made of brass, an alloy made of 70% copper and 30% zinc, although you might see some made of steel or aluminum. Brass cases are reloadable, other cases are (for most handloaders) not reloadable. Sometimes you will encounter nickel plated brass cases, and they too are reloadable. You may also encounter nickel-plated steel cases which are not reloadable.
- There are three priming systems in use today: rimfire, Berdan (centerfire), and Boxer (centerfire). Only Boxer primed cases are handloadable with the equipment and materials we have readily available in the US.
- The case is manufactured for a single specific chambering, for example 30-'06.
- On the head of the cartridge, there is a head stamp which usually gives the manufacturer's identifier (W-W for Winchester-Western, R-P for Remington-Peters, etc.) as well as the chambering designation (such as 30-'06).
- For best accuracy, it is generally considered best to use cases with the same head stamp when producing a handload batch. This is because different cases have different capacities and strengths.
- There are two basic case types: straight wall and bottleneck. Examples of straight wall cases are 38 Special, 44 Magnum, and 45-70 Government. Examples of bottleneck cartridges are 30-'06, 308 Winchester, and 223 Remington. Straight wall cases are essentially the same outside diameter at the head of the case (except possibly excluding the rim) as they are at the mouth of the case. Bottlenecked cases are not. Bottlenecked cases have a shoulder area, where the case diameter is reduced before the case's neck.
- Bullets are placed into the mouth of either straight walled or bottlenecked cases.
- The areas of a bottlenecked cartridge (from the bullet end working towards the primer end) are: mouth, neck, shoulder, body, head (sometimes called base), extraction groove, and rim.
- There is a primer pocket in the center of the head of both straight walled and bottlenecked cartridges, into which a primer is placed.
- There are five basic case rim configurations: rimmed, semi-rimmed, rimless, belted, and rebated.
- Within certain limits, it is possible to modify the shape of a metallic cartridge case so that it becomes a different chambering. For instance, if the neck diameter of a 308 Winchester case is decreased (called necking down) it is possible to create 7mm-08 Remington cases. It is also possible to neck up a 30-'06 case to a 35 Whelen case. There may be other operations required such as thinning or trimming the neck.



Bullet:

- There are two general classes of commercially available bullets: jacketed lead and lead or lead alloy.
- Jacketed bullets can be loaded to much higher pressures for higher velocities.
- Most jacketed bullets are lead cores surrounded by metal jackets. The most common jacket metal is copper. Sometimes the cores are omitted, and the bullets are called solids.
- Many handloaders also cast their own lead or lead alloy bullets. This adds a new dimension the fun and satisfaction of handloading.
- Some handloaders also create their own bullets swaging -- to pressure-form by forcing the metal through or into a die.
- Lead bullets can be reused if you can recover them, and are willing to remelt and cast them.
- Bullets come in a wide variety of diameters, shapes, and weights. Always use the diameter (caliber) specified for your cartridge. Different shapes and weights are selected based on the intended use of the bullet.
- In the lower powered pistol bullets, the best choice is often a lead bullet. They are cheap and work well. At velocities greater than about 900 fps some leading of the bore will occur. The exception is a lead bullet with a copper "gas check" on its base.
- Hollow point bullets are when you want added expansion for hunting game.
- Wadcutter bullets have a flat nose to cut a perfect round hold in the target. Many hunters also swear by the knock-down power of the wadcutter. If you use a pointed bullet and it exits the game, not all the stopping power of the bullet was used. If it stops in the game and does added tissue damage, the game will more likely be stopped cold. The lowly wadcutter fits this bill.
- Certain bullet shapes are required for proper feeding (ie round nose in many automatic pistols) or safety (ie flat nose in tubular magazines).
- In the high-power rifle pointed bullets for long range and high speeds are usually best.
- Bullets have some or all of the following areas: base, body, grease groove(s), cannelure, ogive, and nose.
- The bullet base is called flat-based if it is the same diameter as the bullet body. If the base is smaller than the body, it is called boat-tailed. If the base is concave, it is called hollow-based.
- A metal disc called a gas-check may sometimes be placed on the base of lead bullets to help reduce leading, protect the base from powder gasses, and allow higher velocities.
- The bullet body is the part that contacts the barrel. The body diameter is approximately the caliber size (such as .308 inches) but may be slightly different for accuracy considerations.
- Cast bullets are frequently sized as a separate operation after they are cast.

- Bullet grease grooves are normally only present on cast bullets, and contain lubricant (usually applied at the same time the cast bullet is sized). Lubricant helps reduce fouling in the barrel.
- The bullet cannelure is an indented ring around the circumference of the bullet body of a jacketed bullet into which the metallic cartridge case may be crimped. The crimp is sometimes present to produce a more consistent grip on the bullet by the case neck, leading to more consistent velocities and hence better accuracy.
- The bullet ogive is the curve of the bullet's body to the nose. This curve (in part) defines the sectional density, which contributes to the ballistic coefficient of the bullet and thus partially determines how the bullet travels through the air.
- The bullet nose can be of several styles: flat nose, wadcutter, semi-wadcutter, round nose, truncated cone, spitzer, hollowpoint.
- The design of a bullet can be made to emphasize various traits like expansion, penetration, ballistic coefficient, artistic beauty, whatever the designer values most. Most commercial bullets are compromises among these various attributes.
- Bullet weights are measured in grains, just as powder. If you will examine loading data for a particular chambering such as 308 Winchester, you will notice that different amounts of the same powder are used to produce similar velocities when different bullet weights are used. You should never switch an existing load to a different bullet weight or style without going back to the loading manual for new data, particularly when working with near maximum loads.
- All other characteristics remaining the same, a heavier bullet will be longer.
- Different bullet lengths prefer different rates of rifling twist (measured by the barrel length used to make one complete rotation of the bullet). Longer bullets generally require a faster twist to stabilize them. Only experimentation will best determine the most accurate load for your firearm. To determine the rate of twist of your firearm, place some tape on your cleaning rod to form a flag near the handle, then place a tight cleaning patch on your cleaning rod tip, then start the rod down the barrel, then place a mark on the cleaning rod, then run the rod into the barrel until the flag makes one complete rotation, then put another mark on the rod. The distance between the two marks is the rate of twist. Once you know the twist rate of your firearm, you can approximate the best bullet length by the formula $l = 150 \times \text{cal} \times \text{cal} / t$ where t is the rate of twist (in inches), cal is bullet diameter (in decimals of an inch), and l is bullet length (in decimals of an inch). Conversely, the ideal twist rate can be approximated by the formula $t = 150 \times \text{cal} \times \text{cal} / l$.



Powder:

- There are two general classes of gunpowder: blackpowder (and substitutes with similar burning characteristics) and smokeless powder.
- Smokeless gunpowder does not explode in your gun -- it burns very quickly. This combustion generally continues for the entire time the bullet is in the gun. The hot, expanding gasses of this combustion build up a very high pressure to accelerate the projectile down the barrel.
- Smokeless powder develops much higher pressures when it burns. Therefore, never use smokeless powder in a firearm designed for blackpowder.
- Blackpowder (a mechanical mixture of 75% charcoal, 15% potassium nitrate [salt peter], and 10% sulfur) is actually an explosive. It is sold in various granule sizes. This granule size affects the rate at which it burns. Always use the granule size specified for your firearm.
- Smokeless powder also is sold in a variety of burn characteristics. Some are designed for pistols, some for shotguns, some for rifles, some for large cartridges, some for small. Always use a powder specified for your cartridge.
- Powder is ignited by the primer's flame.
- Burning rate is roughly how fast a particular powder burns. This is complicated by the fact that the burning rate varies with the pressure inside the cartridge and the barrel. In addition, the pressure changes (rapidly) over time.
- Chemically, there are two varieties of smokeless powder: single-based and double-based. Single-based powders contain nitrocellulose. Double-based powders contain nitrocellulose and nitroglycerine. The addition of nitroglycerine makes double-based powders burn faster and hotter than single-based powders.
- Smokeless powder comes as granules, and the granule shapes describe what category of powder it is. The shapes are: flake, ball (also called spherical), and extruded (also called stick). A particular type of powder will be all one kind of granule shape. The granule shapes as well as the chemical composition of the powder have direct bearing on the burning rate.
- It is not possible to discern what kind of powder you have just by looking at it.
- You want all of the powder to have burned by the time the bullet leaves the barrel. Muzzle flash is an indication that powder is being burned outside the barrel, meaning you are wasting powder.
- There is a basic relationship between how much powder is placed in the case and how much pressure is produced when the cartridge is fired. The more powder in the case, the higher the pressure and the faster the bullet. However, too much pressure results in a decline in accuracy.



Primer:

- The primer is located in a pocket in the cartridge head. When struck by the gun's firing pin, it detonates, sending a hot flash through a hole in the head of the case into the powder, thus igniting it.
- There are two styles of centerfire primers available today: Boxer and Berdan. Although the Berdan primer is an American invention, it is more popular in Europe while the Boxer primer, a European invention is more popular in the



US. This photo shows two examples of 40S&W cases. The two cases on the left are Boxer-primed. Note the single concentric flash hole and the absence of an anvil. The Boxer anvil is an integral part of the primer -- not a part of the case. The two cases on the right are Berdan-primed. Note the concentric anvil located between two flash holes in the upper right. The Berdan primer has no integral anvil -- the Berdan anvil is an integral part of the case.

- Because of special tools needed for Berdan priming and lack of availability of Berdan primers in the US, I will only deal with Boxer primers in this document.
- Boxer primers consist of three separate subcomponents: primer cup, priming compound, and primer anvil. The primer cup is cylindrical, with one end open and the other enclosed. The primer anvil is placed in the open end, with the priming compound between the two. The primer anvil's shape is basically a disc with the center raised so it is adjacent to the priming compound. The priming compound is designed to be shock/crush sensitive, and is an explosive mixture.
- When the gun's firing pin strikes the primer cup's closed end, it indents the primer cup. When the primer cup is deformed, it crushes the priming compound between the priming cup and the primer's anvil. This ignites the priming compound, sending a flame through the flash hole in the metallic cartridge case. Once a primer is fired, it is not reused.
- The primer is inserted into the metallic cartridge case so the anvil end (the open end) faces the flash hole in the case and the closed end of the primer cup is slightly recessed into bottom of the metallic cartridge case. This is so that the primer only ignites when the gun's firing pin strikes it, rather than simply by bluntly striking the head of the cartridge. An example of such blunt impact might be dropping the cartridge on a concrete floor, or when the cartridge is slammed into the gun's chamber by a self-loading gun.
- Fired primers are a good source of information regarding the pressure of the assembled cartridge. Primers which appear flattened are a good indication of excessive pressure, and mean you should not increase pressure any further

(and possibly even reduce pressure).

- Primers are sold in four different sizes and come with different burn characteristics. These are: small pistol, large pistol, small rifle, and large rifle. Primers also come in standard and magnum strength. Always use the correct type of primer as recommended by your reloading data source. Never switch to another strength (or even change manufacturer) of primer when working with anything besides starting loads. Magnum primers are not necessarily required for "magnum" cartridges. Magnum refers (in this case) to the strength of the flame produced by the primer.
- Military ammunition usually will have primers that are crimped in place. This crimp makes removal of the spent primer a bit more difficult, but special tools are available for removing crimped primers and removing the crimp from the empty primer pocket.

Reloading Process

The handloading process involves several simple steps which must be performed correctly and in sequence. There are no shortcuts! Although the process is easy enough, it requires full concentration. Let everybody in the house know that you must have no interruptions or distractions except in an emergency.

Case inspection:

- Examine cases before loading and discard any that are not in good condition.
- Look for damage or flaws that may affect the performance or safety of handloaded ammunition. These flaws can include cracks and scratches in the case, large dents, or corrosion.
- Watch for flattened, pierced, or cratered primers which indicate excessive pressure.
- Watch for gas leaks around the primer indicating excessive pressure or an enlarged primer pocket.
- Watch for spent primers that have backed out of the primer pocket indicating excessive headspace.
- Watch for a bright colored ring around the case just above the web that is often an indicator of likely head separation.
- Ensure each case is of the proper chambering.
- Some steel cases are lacquered such that they can appear to be brass, so check unknown cases with a magnet. Steel cases should be crushed and discarded so you won't accidentally reload them.
- Unless you are set up to reload Berdan-primed cases, deform and discard any cases with Berdan primer pockets (usually pockets containing 2 flash holes and a center post or anvil).
- Discard cases of an unknown origin.

Case cleaning:

- Cases should be decapped prior to cleaning.
- Clean and corrosion-free cases have more than an esthetic value. They are less likely to get stuck in, or damage, your dies. Clean cases require less force during the sizing process. Dirty primer pockets can cause difficulty in properly seating new primers.
- Clean the primer pocket of any primer ash using a primer pocket brush or a flat-bladed screwdriver.
- Clean inside the case neck with a case neck brush or bore cleaning brush of appropriate caliber.
- For best results, use a brass tumbler for cleaning. Tumble until your brass is clean. How long depends upon the amount of brass, condition of brass, and amount and type of tumbling media. Tumbling media comes in two materials: granulated corncob or granulated walnut. Generally, the walnut lasts longer than corncob because it is harder. The corncob seems to give brighter polish. No matter what you use, you can extend the life of your media by using media reactivator, which you pour into used media to restore its cleaning power.
- An alternative to a tumbler is to wash dirty cases in a case-cleaning solution or hot soapy water, rinse thoroughly, then dry in a warm oven (less than 200 degrees Fahrenheit -- too much heat can ruin the heat-treatment of the cases).
- Ensure each case is empty. Sometimes you'll find a pebble or even a smaller

case or bullet jammed inside a case.

- Watch for cases with an unfired primer.
- Lubricate the clean, empty shell before re-sizing the case (and decapping the old primer). While Tungsten Carbide pistol dies don't require lubricating, it's still a good idea. Just a light amount of lube on the pad goes a long way. You can place several cases on the pad and roll them together to lube several at once. You only need a light film on the cases.

Sizing and decapping:

- This is done with your sizing die, the one with the little pin sticking out below the die.
- Depending on how you set your sizing die, this step restores the case neck, or entire case to standard dimensions.
- If the reloaded cartridge is to be used only in the same firearm in which it was previously fired, you need only resize the neck. Otherwise, a full resizing is in order. Full resizing is also required for self-loading firearms.
- This step also decaps (removes the spent primer) the case.
- Military ammo generally has the primer crimped in place. Expect to use more force (and occasional broken decapping pins) to press out crimped primers.
- Straight walled cases use an extra die to put a slight open bell on the case mouth to allow easy bullet seating later. Some dies allow you to, you can dump your powder down through the die and into the case at the same time you're bell it.

Priming:

- Many reloading presses have a priming arm that inserts a new primer as the freshly sized case is withdrawn from the sizing die. Most presses have provisions for a tube that automatically feeds a new primer into the priming lever.
- Be careful and seat the primer slowly to avoid detonating the primer. It is especially important to wear safety glasses during this step.
- Don't look down into the case while pressing the primer home. Primers contain lead styphanate, which is an explosive. You would be surprised how much fire comes out of one primer and how far it spits out.
- The surface of the primer should be slightly below the level of the case base. This protects the primer from firing prematurely when being slammed into the chamber by the bolt.
- A primer that is too high is often a result of a dirty primer pocket.
- Military ammo generally has primers crimped in place. Before handloading used military brass, you will need to carefully ream or swage the crimp to allow seating of a new primer.
- A hand primer is a nice-to-have item. With a hand press, you can prime your brass in your easy chair inside where it's warm. It is important to have eye and ear protection at this point.

Case trimming:

- In the firing and sizing processes, the case tends to stretch a bit. This can affect chambering, pressures during firing, and accuracy. Measure the case

length and trim if necessary.

Powder charging:

- Primed cases are filled with a carefully measured powder charge. You must follow prescribed data in a handloading manual.
- Powder may be measured by a calibrated dipper, a volumetric powder measure or by weighing each individual charge.
- Using the powder measure is faster by having your cases in a shell holder, you just go right down the line dropping powder in. A tap on the powder measure will insure all the powder drops into the case.
- The accuracy of volumetric measures must be calibrated and checked by weighing samples at the beginning of a reloading session and by weighing the charges thrown into samples (one of every 5-10 cases).
- When finished with a block of cases, inspect each one to make sure no cases are empty or have a double charge. Either situation could result in a terrible accident or fatality. I also stick a dowel into each case to check for uniformity of powder depth.

Bullet seating:

- A bullet seating die seats a bullet into the neck of the case to the proper depth, completing the cartridge.
- With some handgun and rifle dies, the seater also crimps the case into the bullet, preventing bullet movement under recoil. Crimps are only applied to lead bullets and to jacketed bullets with a cannelure.
- Most dies also have a crimp feature so while the bullet is being seated, a crimp is applied at the same time. The crimp is important for several reasons. It keeps the bullet from falling out of the case and it holds the bullet long enough for proper pressure to build up. If you over crimp, this will cause an overpressure situation by holding the bullet for too long.
- The more crimp you put on a case, the sooner it will begin to split at the mouth and will have to be discarded.
- With a roll crimp the seater die actually rolls a very small portion of the case mouth into the bullet cannelure. A taper crimp die actually squeezes the case around the bullet with no visible indentation or crimp. The taper crimp die merely removes the bell from the case mouth that was used to ease seating of the bullet and pushes the case mouth parallel to the bullet.
- Using a case gauge or calipers, check the overall length (OAL) of your completed first rounds until they meet the standards specified in your reloading manual.
- Don't be afraid to throw out your first few rounds until you get the die set correctly.

Final Inspection

- If loading cast bullets, wipe any lubricant from the completed round.
- Examine each case for signs of stress such as cracks.
- Ensure primers are properly seated flush or slightly below the head surface.
- Ensure cases are properly crimped if appropriate.
- Ensure overall cartridge length is correct.
- Store in a properly marked box or case designed for storing this particular

chambering.

- Store in a cool, dry place.
- Store in a lockbox or safe separately from your firearms.
- Label the box with details about the load.
- Log the details about the load in your logbook.

Accuracy Tips

- Uniformity is key for accurate loads. For a particular batch, sort you cases by brand or manufacturer. Military cases also have headstamps indicating information such as manufacturer. Different brands and even different lots within a brand can vary in case wall thickness and web thickness in the head. This affects powder capacity and pressure. You might also consider sorting cases by weight for the same reason.
- Trim every case to exactly the same length as specified in your loading manual, ensuring each case mouth is perfectly square
- Lightly ream the the bottom of all primer pockets to ensure they are square and of uniform depth.
- Lightly deburr the inside and outside of the flash holes to ensure they are the same diameter and free of burrs.
- If using in the same firearm in which it was last fired, consider neck sizing only. Exceptions are circumstances where feed reliability is essential such as personal defense, ammo you'll take on a hunt, and semi-automatic, slide-action, and lever-action firearms.
- Use a case neck turning tool to ensure uniform thickness all around the neck.
- Don't mix primer brands or types within a batch.
- Don't use magnum primers unless specifically called for.
- Weigh every powder charge to ensure each case gets exactly the same charge.
- Generally, faster powders give better accuracy.
- Cartridges are designed to shoot within a certain velocity range. Most cartridges shoot best at near their potential with bullets near the middle of the weight range. For best accuracy generally stay away from high pressure loads.
- A powder charge that neatly fills the case seems to burn more consistently from one round to the next.
- For target shooting, select a match grade bullet. Their construction and weight are more consistent and are optimized for accuracy. However, do not use match bullets for hunting -- even if a match bullet is a hollow point, it is not designed to expand and is more likely to ricochet than a bullet designed for hunting.
- Don't just consider boat tail bullets when searching for accuracy. You may often find that a flat- base bullet shoots the best.
- Seat bullets to a uniform depth.
- Consider the twist rate of your firearm when selecting bullet lengths.
- Keep careful records of what you load, so that when you hit the magic recipe, you can duplicate it.
- When experimenting, start at the minimum charge given in your loading manual and load batches of 7-10 rounds, increasing the powder charge in 1/2 to 1 grain increments up to the maximum given in your manual. Mark each 7-10 round batch. At the range, shoot each batch beginning with the lightest charge and record the results. Stop when you reach a charge that shows signs of excessive pressure. Repeat these steps while varying bullet seating depths, bullet weights, powder, and primer brands. With good records, you can easily recognize the best load(s) for your gun.

Casting Lead Bullets

Lead sources:

- Either buy bullet lead or mix your own. Some plumbing supply houses still stock pure lead.
- Pure lead is best for blackpowder shooting where velocities are low.
- Due to bore leading at higher velocities and the higher temperatures of smokeless powder, I do not suggest using pure or scrap lead for velocities above 1,000 fps.
- Scrap lead, although of unknown composition, is a very good source for low-cost lead. The most common source of scrap lead is used wheel weights, obtainable for free or very low cost from service stations and tire shops. You can just melt them down, flux, skim off the metal clips and debris, and you are ready to pour. It usually contains about 3% to 4% antimony to harden the lead.
- I have found that wheel weights, being a bit on the soft side, have just about the right mix for pistol bullets at velocities up to 1,200 fps.
- An alloy of 1 part tin and 16 parts lead can be created by adding solder to lead in the appropriate ration. This will give the hardness needed for velocities up to 1,500 fps.
- Perhaps the best lead for reloading for modern pistols and rifles is linotype lead. This alloy is usually just the right hardness for velocities up to 2,000 fps with around 12% antimony and 4 percent tin.
- Many commercial hard-cast bullets have between 6% and 7% antimony and about 2% tin. Many shooting supply shops sell pure and alloyed lead.
- Higher velocities can be achieved by using gas checks (a small copper cup crimped onto the bullet's base) paper patching, harder lead alloy, sabots (a plastic cup that falls away from the bullet after leaving the muzzle), and by jacketed bullets.
- Some .22 rimfire bullets are made of zinc. Don't use them in lead bullets -- the zinc will ruin the casting quality of your lead.
- The lead alloy used in car batteries has concentrations of acid that make it unsafe to melt them. In addition, battery lead alloy in modern batteries contains other metals that can ruin the lead for bullet casting.

Heat source:

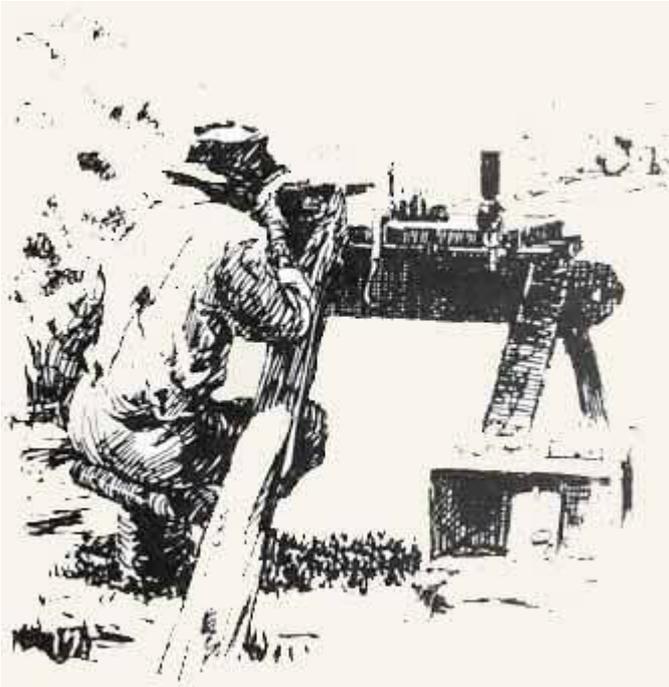
- You can buy an electric furnace if you are really serious or will cast a lot of bullets. They generally have a thermostat control for steady heat. They typically have a spout on the bottom for pouring molten lead into your mould.
- For most bullet casters, an iron pot is enough. I have an old one-quart cast iron saucepan that has served me well. Once a pot has been used to melt lead, it must never be used for cooking food. A gas stove is best for melting lead, but you can also use an electric stove. I use a propane camp stove.
- For consistent results, you'll want a thermometer.

Casting process:

- The best temperature for casting is 650-750 degrees Fahrenheit.
- If you're melting lead in an iron pot, you'll need a ladle to dip lead from the pot and pour it into your mould.
- You'll need flux (I use a chunk of beeswax about the size of a marble) to

encourage the lead, antimony and tin to properly alloy. It also helps separate the molten metal from the dross (dirt, rocks, wheel weight clips, etc.) which you need to skim off.

- Preheat your ladle and mould by immersing them in the molten lead for a couple of minutes.
- Pour the molten lead into the mould until you have a puddle over the sprue hole about half an inch in diameter. As the lead cools, you'll see it change in color. Then pause a few seconds, then tap the sprue cutoff lever with a wooden mallet (I use an old hammer handle) to cut off the sprue. Never use a metal object for this purpose. Then drop the new bullet onto a soft cotton cloth or towel (most synthetic fabrics will melt). If you drop the hot bullet into cold water rather than onto a cloth, its hardness will increase -- a good thing if you want to reduce bore leading at higher velocities.
- Hot bullets are very soft and easily damaged. Be gentle.
- Examine each bullet for voids, bubbles, creases, etc. If it isn't perfect, just drop it back into the pot and pour another. You may likely find that you'll pour a few bullets before the mould temperature is just right for perfect bullets.
- It's possible to use the lead bullets just as they come from the mould, but you'll get best results if you size and lubricate them. You'll need a press and appropriate die for this step. The cast bullet is pressed into the die and lubricating wax is forced into the bullet's lube groove(s). This ensures a perfect fit into the case neck and reduces bore leading.



The Reloading Bench

*by Bob
Glodt*

**Developing Accurate
Black Powder Cartridge
Loads:
Seating Depth**

It is not unusual for a beginning silhouette competitor to struggle for the first couple of years before learning some of the basic principals of developing accurate black powder cartridge loads. Even if a new shooter were to know exactly which primers, cases, lube, powder, or bullets a top competitor was using, that information alone would not be enough to duplicate an accurate load for the rifle he or she is shooting. If there were ever any absolutes in this game, it is “what works well in one rifle may not work well in another.” If you are going to be a competitive shooter you need to learn how to work up your own loads.

When I began competing in this sport over ten years ago, I received a lot of advice on what powder, primer, wad, or bullet to use, but learned very little concerning the basic principals of loading accurate black powder cartridge ammunition. With considerable experience in loading smokeless ammunition I incorrectly assumed the same principles that applied to loading smokeless ammunition, also applied to loading black powder ammunition. When my first black powder cartridge handloads yielded me scores of 5/40 and 10/40 at the National Championships in 1991, I learned quickly that I didn't know near as much as I thought I did. My ammunition was so poor that I had a bullet impact in the road in front of the pig line in a shoot off. Miraculously this stray round actually ricocheted off the road and hit the pig I was instructed to shoot at. If I live to be 102, I will never forget the look on that competitor's face when he saw my pig go down after the bullet had ricocheted off the gravel road. I guess my “bank shot” rattled him a little because he missed his pig, and I won the shoot off. As Billy Dixon would say, “It was a scratch shot.”

For the next several issues of the Black Powder Cartridge News, my goal is to

Seating Depth

One of the first and most important principles of black powder cartridge loading is to understand the concept of seating depth. Seating depth is the distance the bullet is seated into the case and, more importantly, it is “the relationship of the bullet to the rifling in the barrel.”

Determining the proper seating depth is one of the very first things a shooter must determine when working up test loads. You must know what seating depth your particular rifle “likes” before you can begin to fine tune the other components used in the loading process. Improper seating depth alone can totally negate the use of the best powder, the best primer, or the best bullet.

Selecting the proper seating depth will be determined by the type of bullet you are shooting. The bullets used by black powder cartridge competitors will fall into four basic categories: the tapered bullet, the non-tapered bullet, the bore rider bullet, and the paper patched bullet. A tapered bullet has a nose diameter that is generally a couple of thousandths less than bore diameter and will have one or more driving bands that are one or two thousandths larger than the bore diameter. For example, the tapered bullet I shoot in my .40-65 is .398” on the nose, .401” on the top driving band and .408” on the four remaining driving bands. My Badger barrel has a .400” bore and .408” groove diameter.



write a series of columns that hopefully will help the beginning shooter learn and better understand some of the basic principles of loading accurate black powder cartridge ammunition. Some of the topics to be discussed include: seating depth (this issue), bullet casting techniques, forming and expanding cases, lubing bullets, powder performance, bullet selection, and loading on a Dillon press. In addition to covering specific “principles” or guidelines for reloading, some shortcuts and reloading tips will also be covered in these articles.

Please remember that the opinions and guidelines I offer in this column work in my rifles, but may not work in yours. In addition, there is more than one way to produce accurate black powder cartridge handloads, so, if your approach differs from mine and you are achieving good results – do not change what you are doing. Always remember it is the individual gun that will be the final judge of what works and what does not. If you are a new shooter and a veteran shooter has “taken you under his wing,” I recommend that you follow his advice if it is working. If it hadn’t been for outstanding veteran shooters like Ron Long, Mike Lewis, Steve Garbe, Mike Venturino, Ed Duncan, Larry Peterson, Gary Jennings, Larry Long, and Charlie Semmer, I probably would still be banking my shots off the road on the pig line.

Checking the overall length of a loaded round.

By design, the tapered bullet should be seated far enough out in the case that one or more of the tapered driving bands will engage the rifling – this centers the bullet with the bore of the barrel. Another advantage to a tapered bullet is that “seating out” allows more room for powder in the case. When loading with the tapered bullet, it is recommended that you begin by seating the bullet “out” far enough for the rifling to fully engage the tapered band, but “in” far enough that the first non-tapered band is approximately .020” to .030” off the rifling. With the bullet described in the example above, the top tapered band (.401”) will be fully into the rifling, but the second non-tapered band (.408”) is .020” to .030” off the rifling.



Through trial and error you can arrive at the proper seating depth. By inserting a bullet into an empty cartridge case you can chamber the round and then look and see where the rifling is engraving the driving bands. With the aid of a black magic marker to color the driving bands and a good magnifying glass, you will be able to better determine how far off the rifling you are seating your bullet. If the bullet is seated too far in or too far out,

Checking the overall length of a cartridge case.

repeat the process until you arrive at the exact seating depth you are striving for.

Overall Length

Once a seating depth has been determined, measure the overall loaded length of the loaded cartridge, the overall length of the cartridge case, and the overall length of the bullet. By subtracting the length of the cartridge case from the overall length of the loaded round, you will know how far the bullet is protruding out of the case. If you subtract the length of the bullet from the amount the bullet is

A good testing procedure for beginning shooters would be to try one or two bullets with one or two different seating depths per bullet. Each of these combinations should be tested with two different powders and two different primers. If you selected only one bullet to work with in this scenario, you would have eight test loads to evaluate, and could refer to the diagram shown above.

sticking out of the case, you know how far the bullet is seated into the case. All three of these measurements should be recorded in your load development book. Now that you know how far the bullet is protruding into the case, you can now determine how much powder to put in. Unlike smokeless powder, you always fill the case to the base of the wad with powder. A basic principle of loading black powder cartridge ammunition (with the exception of those that compress powder) is that the seating depth determines the powder charge; or stated another way, the seating depth determines the powder charge and the bullet type determines the seating depth.

A non-tapered bullet is one with all driving bands at approximately groove diameter (give or take a thousandths). So, if we use the 40 calibers as an example, all four driving bands would be .408" and the nose on a non-tapered bullet will generally be two or more thousandths smaller than bore diameter. I have found that the seating depth that produces the most accurate load for a non-tapered bullet may vary considerably. Good results may be obtained by seating the top driving just off the rifling (.020" to .030") as was done with the tapered bullet all the way to the other extreme of seating the entire bullet into the case, leaving only the top driving band exposed. Some of the most accurate loads I have developed with non-tapered bullets are ones with a seating depth that allows the bullet to "jump" a considerable distance before engaging the rifling. The point is, "the .020" to .030" off the rifling rule" may not apply here. As with the tapered bullet, no guessing on seating depth is permitted – measurements should be taken and recorded.

The nose of the bore rider bullet is generally only .0005" to .001" smaller than the bore of the barrel. The objective of the bore rider is to have the nose of the bullet close enough to bore diameter that it will "center" the bullet in the barrel. With bore riders, tolerances between the

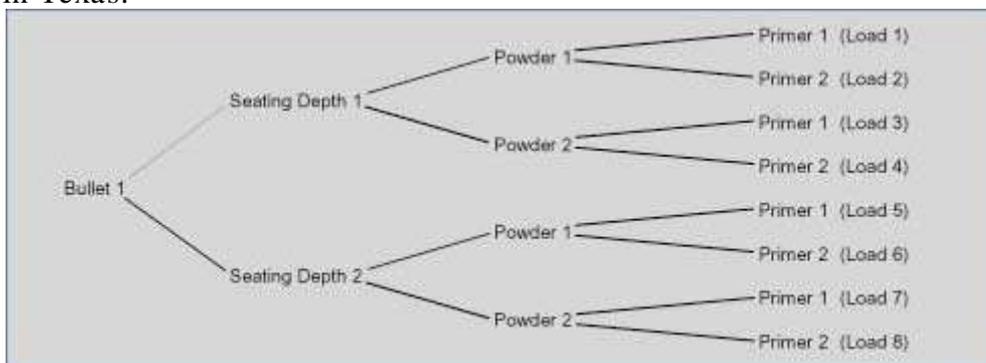


Checking the overall length of a bullet.

Your test loads should be fired from a sand bagged bench rest at 200 meter paper targets. Although not a requirement, if your rifle is equipped with scope blocks, go ahead and use a scope for developing test loads. I suggest that you load 12 rounds for each load being tested. The first two rounds will be shot from a clean cool barrel so they will probably print high on the target. Note where these first two rounds impact the target and then shoot the next ten rounds for group. Blow between each shot just as if you were on the silhouette line. Measure the group but do not include the first two fouler shots in the group. Clean the rifle, allow time for the barrel to cool, and proceed to the next load. If you find a couple of test loads that show potential, test them again at least two more times before passing judgment on the load. Also, it is good to pick a windy day for one of the testing periods. An exceptionally good load will be surprisingly stable even under windy conditions, but sometimes a marginal load that performed fairly well under calm conditions will "fall apart" with a little wind. When testing loads, pay particular attention to how each of the rounds chamber. If some rounds chamber easy and some chamber hard, you may need to adjust seating depth, check the nose diameter of the bullet you are shooting, or blow more between shots. Vertical stringing of shots can be caused by improper seating depth.

bore of the barrel and the nose of the bullet can be so close that hard chambering from fouling can sometime be a problem. If you shoot bore rider bullets, seating depths should be adjusted so that consistent chambering can be achieved. I have found that often bore riders will need to be seated .040" off the first groove sized driving band to achieve consistent chambering. People that shoot bore rider bullets usually develop a very strict and methodical method when blowing moisture into the barrel. Although I have shot some extremely tight groups with bore rider bullets, I have found them to be more sensitive to fouling than the tapered bullet or the non-tapered bullet, especially in the hot and dry weather conditions we experience in Texas.

Working up accurate black powder cartridge ammunition is a process of eliminating the things that don't work and at the same time identifying those things that do work. Someone once aptly described the process as "a long trip down a winding rabbit hole." When starting with a new rifle it is not



With paper patching, there is one basic principle you need to understand: no matter what you do, you can't get them to shoot good groups (just kidding). Paper patching is an art and science unto itself, so my recommendation to a new shooter would be to forget paper patching for right now. Spend your time developing loads using bullets with grease grooves. We may, however, take up paper patching in a separate article in a future issue of the News. If you ever run across Larry Peterson while you are at Raton, ask him about paper patching. Larry can make paper patched bullets shoot and make them shoot well.

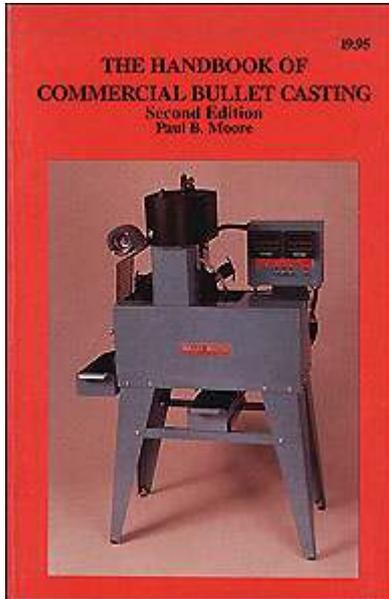
uncommon for an experienced black powder handloader to spend six or more months in load development and load tuning before acceptable groups are achieved. If you are methodical and deliberate in your approach to working up loads, sooner or later you will come up with a load combination that is capable of producing one minute of angle or smaller groups. Once you learn some of the principles of loading black powder cartridge ammunition and how they apply to the guns you shoot, the load development time decreases dramatically. ®

The Handbook of Commercial Bullet Casting

Second Edition

Paul B. Moore

The following is an excerpt from Chapter Two



To gain any appreciation at all of the effect one alloy or another may have on the quality of a bullet or the cost of the final product, a basic understanding of the kinds of materials one is likely to encounter in the bullet casting business is in order.

It is not the purpose of this chapter to champion one alloy over another concerning its application as a bullet alloy, but to clear up misconceptions about the analytical composition of the materials available to the bullet caster. All compositions listed hereafter are extrapolated nominal chemistries determined by the atomic absorption and classical wet analytical techniques. The performance of any given alloy in a single firearm is subject to a host of variables and only one of these is the analytical composition of the bullet itself. The only true test is to try it and see if it works for your application.

Any discussion involving the analytical composition of scrap alloys most certainly has to start with the most common source of salvaged lead alloy, the wheel weight. There is probably not a bullet caster in the country who has not at one time or another melted a pot of dirty wheel weights, skimmed off the clips, dirt and dross and then cast bullets with the remaining alloy. Some bullet casters have more success with wheel weights than others do.

Wheel weights have probably been used by bullet casters since very shortly after the first wheel was balanced with them. Today, wheel weights are manufactured in two distinct compositions, which if mixed at random, have a significant effect on the weight and hardness of the bullets cast with them, undoubtedly contributing at times to the woes of the bullet caster. Analytically, the most common wheel weight is made of three percent antimonial lead with the following nominal composition: antimony 3.00 percent; tin 0.29 percent; arsenic 0.14 percent; copper 0.05 percent; bismuth 0.025 percent maximum; nickel .002 percent maximum; zinc .001 percent maximum; sulfur .001 percent maximum and the remainder lead. The residual elements of bismuth, silver, iron, nickel, zinc and sulfur are essentially the same for almost all the compositions discussed. Consequently, they will be ignored unless they are present in significant amounts.

To make matters more difficult for bullet casters, there is a second reasonably common composition of wheel weights, consisting of antimony 0.68 percent; tin 0.017 percent; arsenic 0.08 percent, copper 0.05 percent and the remainder is lead. Unfortunately, there is no efficient way to separate these two different alloys. And obviously, mixing these two quite different alloys in varieties of unknown proportions can have significant effects on the composition and thus the weight of the bullets cast from the resulting mixtures. With the three percent antimony wheel weight containing more than four times as much hardener as the 0.68 percent-antimony wheel weight, the physical properties of the mixture change as the composition changes. The only effective way to handle the problem is to melt as large a batch as possible and cast it into ingots for later remelting into to cast bullets. This would minimize small lot

variations in composition and at least produce bullets of consistent weight and hardness while the original batch lasts.

The words "Type Metal" in bullet casting circles, almost universally refers to linotype or eutectic alloy. Unfortunately, "Type Metal" is in reality a broad name applied to five categories of material used in manufacture of type, each with three to five sub-classifications. Since there are seventeen of these different type metals, Chart I details the nominal analytical composition of each. Fortunately for the bullet caster, linotype or eutectic alloy is the most commonly available. That is if any can be found at all.

Note that the foundry type contains a relatively large concentration of copper. As far as is known, no one has completed an extensive test of this material as a bullet metal, so its use to the caster of bullets is unknown. In all probability the copper would tend to come out of the solution in the form of high melting inter-metallic compound with tin and antimony, thus impairing castability.

Lead shot, though a single classification of material is in reality many different alloys constructed to impart different physical qualities to the pellet. Buckshot is normally soft or pure lead. Chilled or drop shot is normally a 0.50 percent antimonial lead. Chart II lists specific analyses. Note in the analyses two elements that make these alloys unique. First, none contain tin. Second, both chilled and hard shot contain significant quantities of metallic arsenic. Arsenic metal is introduced into the alloy to reduce surface tension and thereby produce rounded pellets. Tin is withheld because it would negate the effects of arsenic.

For the bullet caster concentrations of arsenic greater than about 0.30 percent can create problems - not from the possible toxic effects as might be expected but because relatively large amounts of arsenic cause metal to shrink unevenly, greatly increasing the probability of cracked bullets, especially in the grease grooves. There is a remote possibility that upon firing or loading a cracked bullet, a portion of the bullet would remain in the barrel - creating a potential bore obstruction for the next shot - or a piece could break off and fall back into the case, creating a potential high pressure situation. The probability of these things occurring is unknown. However, the potential results are severe enough that any lead shot that is to be used as bullet casting material should be diluted enough to reduce the arsenic content to below 0.30 percent.

Lead pipe is commonly thought of as being made of pure lead. Although this idea is not entirely correct, it is not far from the truth. Most lead pipe is made from an alloy called chemical lead, which has a nominal composition of 0.05 percent copper and the balance lead. There is also a significant amount of antimonial lead pipe containing from three to ten percent antimony as indicated by Chart III. The single peculiarity of lead pipe, other than its analytical variability, results from the fact it is extruded, not cast. This peculiarity can deceive the bullet caster. When a lead alloy is extruded, it work softens, sometimes substantially, giving the impression that the material is somewhat softer than it really is. This peculiarity should be of special interest to commercial casters and muzzle loader shooters, since work softened material that is remelted and cast into round ball is considerably harder than in its original extruded form. Always check the hardness of the bullet or ball itself, never the raw material in its original form.

Bearing or Babbitt alloys are used primarily by the automotive and related industries for rod, cam and crankshaft bearings. There are now hundreds of different compositions of such bearings, but most of these are slight variations of twelve major categories. Chart IV details these twelve major categories. Some of them would make fine bullet alloys, like number nine and others would be terrible, number three for example. Unfortunately, there is no practical method of determining exactly which of

these alloys a scrap supply consists of - only by direct chemical analysis. But if you have found a Babbitt alloy that makes good bullets, and they shoot well, there is no reason not to use it for bullets.

Sheet lead is normally used as a sound insulator by construction companies for buildings. Bullet casters may find this material in and around buildings being demolished, or naturally at scrap yards. There are four basic compositions of sheet lead and these are listed in Chart V. The vast majority of this material is manufactured from chemical lead but significant amounts are produced from four percent and six percent antimonial lead. Sheet lead is not cast but rather rolled on rolling mills. Therefore, like lead pipe the antimonial leads work soften and when melted and cast into bullets become harder than the material in its original form.

Strontium lead sheet should be avoided if found and identified because the alloy contains aluminum which increases surface tension of the alloy, inhibiting casting.

Ingot lead can normally be purchased through plumbing supply houses, and contrary to popular belief, it is usually not pure lead. Most lead distributed by plumbing suppliers has an antimony content of approximately 0.30 percent with the balance lead. This material would make good base metal for alloying with other materials, but muzzle loaders cannot count on it being pure. If it causes no problem, then keep using it; but if there is a problem, the antimony content will be the culprit.

Many houses today have lead alloy roof flashings for vents. This material is composed of about 0.30 to 0.50 percent antimony, the rest being lead. This material would also make a good base material for blending with other materials to yield harder bullet metal. Demolished houses are possible sources.

Telephone companies use cable lead to insulate their underground wires from the elements. This material appears to be completely soft. However as an extruded product, it has the same properties of those materials already discussed. It contains 0.50 percent antimony and is about forty percent harder than pure lead after it is cast into bullets. Scrap yards are the most likely source for cable lead, which makes a fine case for further alloying. Note one thing about cable lead: the telephone companies coat the inside of the lead cable sheathing with grease and paper to make it weather hardy. Scrap cable lead therefore smokes like the dickens and will smoke up your house if you don't remove the grease and the paper before melting the lead.

There are hundreds of types of cast solders and Chart VI lists the nominal chemistries of the thirteen most common. Most of these can be purchased in one ingot size or another through local solder distributors or plumbing supply houses. Every bullet caster is familiar with 50/50 solder bar, yet not everyone knows that that the first figure always refers to the tin content and the second figure to the lead content. Of course, to every rule it seems there must be an exception and solders are not exempt - alloy 95/5 contains ninety-five percent tin and five percent antimony, with no significant lead content at all.

Hundreds of alloys are used in the manufacture of batteries. Unlike solder, battery lead is very poor for bullet metal. Of course, it is possible to salvage the terminals, but the plates are an entirely different matter. Manufacturers recover the metal in plates through a smelting process where temperatures reach from eighteen hundred to twenty four hundred degrees Fahrenheit. To make matters even more interesting, battery manufacturers have begun in recent years to use calcium and strontium lead alloys in manufacturing battery plates. It is possible in attempting to melt calcium and strontium lead battery plates, to liberate arsine or stibnite gas - which could be fatal. Avoid batteries as a source for bullet metal.

Deep alloying and refining is a subject that will be discussed in another chapter. However a cursory treatment here is warranted. Alloying is a word used to refer to mixing two or more elements or materials to produce a third material that is somehow more desirable for some purpose than either of the original materials. For instance, if one were to mix equal portions of cable lead and linotype, the resulting lead would contain approximately 6.25 percent antimony and 2.00 percent tin. This is a useful alloy in that it does not waste the high tin and antimony content of the linotype, yet still has the hardness and castability needed for most applications. Another benefit is that scrap lead cable is probably much less expensive than linotype and alloying the two together will double the number of quality cast bullets that could be produced using linotype alone and at a significantly lower cost.

Another possibility would be equal portions of wheel weights and linotype, producing an alloy with approximately 7.5 percent antimony and 2.14 percent tin. This alloy should be slightly harder than the cable and linotype alloy and somewhat less expensive yet.

Another combination that is frequently written about is 50/50 solder bar alloyed with wheel weights. Any addition of more than two percent tin to the wheel weights (or any other alloy used for bullet casting) would be wasteful as well as expensive. Plus, the additional castability and hardness provided by higher concentrations of tin would be negligible. It is even possible to get by with less than two percent tin depending on the bullet mold and style. Try it and see.

Whenever lead alloys are melted, fluxed and skimmed, the material has been refined. Additionally, anytime anything is present that is undesirable, regardless of concentration, then that material needs to be refined. Deep refining will be discussed in another chapter, however, for the present let's say that the easiest and most efficient way to remove undesirable elements is to dilute them down to a low enough level to make their concentration insignificant.

Question: What are the best bullet alloys?

Answer: Alloys will vary depending on the application. More information can be found in the excerpt from the HANDBOOK OF COMMERCIAL BULLET CASTING located in the book section. Magma test casts their molds using an alloy of 6% Antimony, 2% Tin and 92% Lead.

Question: Why do my bullets sometimes look wrinkled?

Answer: The mold isn't hot enough or there is oil residue in the mold cavity. Just drop the wrinkled bullets back in the pot and recast.

Question: What is antimony and why do I need it to cast a bullet?

Answer: Antimony is a metallic chemical element (Sb). It is used to harden other metals. When two or more metals are mixed together they are referred to as an alloy. The typical bullet alloy is made of lead, with antimony added for hardness and tin added for ease in casting.

Question: What is the correct casting temperature for bullet alloy?

Answer: The best casting temperature for any given alloy is the coolest temperature that gives you the best bullets. Every alloy has its own "best" temperature based on the percentages of component metals. Temperature is also affected by air temperature and humidity, and the accuracy of your temperature controls. Temperature is further influenced by the heat absorption/retention of the mold itself. Rule of thumb: Use the coolest temperature that makes good bullets, in that mold, from that particular alloy, on that day. This trial and error method applies to either hand casting or machine casting.

Question: What determines the accuracy of a cast bullet?

Answer: There is a casters' legend that claims the base of the bullet must be smooth and properly formed. Field work has disproved this theory. Instead, tests have proven the single most important factor in determining a bullet's accuracy is the relationship of bullet diameter to the bore. The bullet should be .0005" to .001" larger than the bore. Other than that you must also consider the following:

- Selecting the correct alloy for the type of bullet to be cast.
- Loading the cases to the proper maximum overall length of the finished cartridge and the cartridge fits the firearm properly.
- Being aware of the work-soften factor as you size bullets. Alloyed lead becomes softer as it is swaged. Size as soon as possible after casting.

- Making certain the alloy remains clean.
- Use the correct antimony and tin ratio for the expected velocity of the bullet. As a rule of thumb: 3% antimony for low velocity; 6% antimony and 2% tin for medium to high velocity; 12% antimony and 4% tin for highest velocity bullets. Pure lead should be used for muzzle loader balls. If 3% antimony doesn't cast well in your particular set of molds, try adding 2% tin to it in the form of plumber's fifty-fifty solder bar. The added tin does not increase hardness significantly but does improve the castability of the alloy.
- Lead base bullets harden or soften with age. Lead-tin-antimony alloys slowly harden over the course of about three weeks, and then their final hardness stabilizes. The age hardening quality can affect the ultimate quality and accuracy of the bullet. Tin-lead alloys either do not harden at all or age-soften depending on what specific alloy was used.
- An ineffective lubricant can also cause accuracy problems. Not all lubricants work with all bullets, in all firearms under all conditions. For a general dependable lubricant, try Magma lube.

Question: What causes "fins" on a bullet?

Answer: Fins are caused by mold blocks that are not closing properly. If you suspect a mold block problem, remove the mold and inspect it for foreign matter and machine burs. Clean the mold carefully but thoroughly. Pay attention to the small grooves cut into the mold face leading to the bullet cavities. These are vent grooves and their purpose is to allow air to escape from the mold cavity when the molten lead is poured in. These grooves are typically .0015" to .002" deep. If these grooves become plugged with any foreign matter, the bullets cast in the mold's cavity will not fill out properly.

Question: I want to experiment with different alloys but I'm not sure where to start.

Answer: Complete information on calculations is available in The Handbook of Commercial Bullet Casting. In the chapter discussing alloying and refining, a compositional breakdown of various metal types is listed as well as the simple equation you will need for calculating the ratio of material to another. If you don't want to bother with the math, use the Alloy Program. This is the computer program that automatically computes the cost and materials used in the book. The program is available on 5.25 or 3.5 disk for IBM compatibles. It can be run with Windows like any other DOS based program.

Question: Which bullet is best for paper targets; a wad cutter or a semi-wad cutter?

Answer: That depends on the result you are looking for. A wad cutter will punch a perfectly round hole in a paper target. This is important in many scoring situations. However, because the nose is completely flat it can take a little longer to load. A semi-wad cutter, which still has a flat nose but it has been tapered in from the base diameter, is faster to load. Because of the tapering, the hole produced in the target is more frayed, not as perfectly round. It has a similar effect to jabbing a pencil through a piece of paper. Both are equal in accuracy. Make this personal decision based on the need for high score vs. speed in loading.

Question: What do grains mean to a bullet's accuracy, speed or distance?

Answer: A grain is a unit of measure used in determining the weight of a bullet. One pound equals 7,000 grains, exactly. A heavier bullet is more accurate for long range (over 100 yards) because it retains its velocity. A lighter bullet can use more powder than a heavier bullet in the same size case. The lighter bullet will be faster. Example: a 9mm-115 can travel faster than a 9mm-147

Question: I'm new to the shooting sport. All the different bullet shapes and sizes are confusing. Can you give a basic explanation?

Answer: Explaining bullets would require a small book in itself. For brevity we will confine this to cast lead bullets. A bullet is the metal projectile that, along with primer/gunpowder (explosive), goes inside a metal, usually brass, case. The assembled bullet and case together is called a cartridge. The size of the bullet or cartridge needed is determined by the interior diameter of the gun barrel. This measurement is called a bore. A .38 caliber gun uses a .38 caliber cartridge as a standard rule. There are exceptions.

The type of bullet selected for loading into a case is dependent on the intended use or personal preference. If you were going to be paper target shooting, you would want a wad cutter or semi-wad cutter because they leave distinct, easily scored, holes in the target. For use with a metal target, a flat point, round nose, or combination is a good choice. In a tubular magazine where the nose of one bullet touches the end of the preceding bullet, NEVER use a round nosed bullet. A round nosed bullet can be extremely dangerous if the pressure from the succeeding cartridge on the previous cartridge's primer causes a premature explosion inside the magazine.

The bullet's base is beveled (tapered inward) to ease insertion into the case during reloading. Our designation for this is BB.

Question: What is the purpose of a grease groove?

Answer: All bullets need to be sized and lubricated after they are cast and before they are inserted into their case. A grease groove, also known as a lube or lubricating groove, allows a place for the lubricant. If you are using a manual machine like the Magma Star-sizer or an automatic sizing machine like the Lube Master, the lube will be placed precisely in the groove at the same time that the bullet is sized.

A single lube groove provides one place for the lube. A double lube groove provides two places for the lubrication and so forth through the other lube groove numbers.

Question: Judging from the casting results, the trace elements in my alloy may be too high. What do I do now?

Answer: If you live in or near a major city, you can contact a commercial analytical laboratory and have them analyze the bullet alloy. If a laboratory is not available locally, you can get contact information from the yellow pages of your nearest major city. The library should carry the yellow pages. If you have access to the Internet, this is also a good source for finding a lab and using the yellow pages right from home. Check with the Laboratory for information regarding their procedures and pricing. They may charge for each element they test for or have a simple fee for a complete analysis. If the laboratory tests for each element, request an assay for antimony, calcium, arsenic, copper, aluminum and zinc. The lab will always report the balance as lead. The above elements account for the vast majority of casting problems, particularly aluminum and zinc. Many lead foundries can also perform this testing. If you purchased the lead from them, they may not charge or they may already have the analysis available. Foundries can also be found in the yellow pages as directed above. Once the problem element(s) has been identified, re-melt and adjust the alloy by adding the appropriate materials to compensate for the problem and bring your alloy back into the proper ratio. Another solution is to dilute the inferior material with quality material until the results meet your requirements.