Ada County Sheriff's Office

Forensic Lab

Firearms Analytical Method

Version 1.0

1 Scope

1.1 The primary objective of firearms and tool mark examination is to provide relevant information by performing meaningful, timely, and effective forensic analysis and interpretation of firearms and tool mark evidence.

1.2 The discipline of firearms examination encompasses several areas that relate to firearms and include, but are not limited to, the comparison of fired bullets and cartridge cases; the identification of ammunition components; the determination of muzzle-to-target distances; the evaluation of firearm functioning, alterations and modifications; the evaluation of firearms, ammunition, and accessories for compliance or violation of state and federal laws; and the examination of silencers.

1.3 Each case is unique and must be evaluated by the individual examiner. All analyses can't be appropriately covered in a procedures manual nor can all possible variations be included. It is always the examiner's responsibility to choose the best analytical scheme for each individual case.

2 References

2.1 Ada County Sheriff's Office Forensic Lab Quality Assurance Manual

2.2 Ada County Sheriff's Office Forensic Lab Health and Safety Manual

2.3 Ada County Sheriff's Office Forensic Lab Firearms Reference Collections

2.4 Firearms related books

2.5 Association of Firearm and Tool Mark Examiners (AFTE) Glossary, GRC Database and Journals

2.6 Equipment Operation Manuals

2.7 ATF Standards and Recommendations

3 Terms and definitions

Accidental discharge
The inadvertent discharge of a firearm as a result of some failure on the part of the firearm. Accidental discharge is often caused by a safety device that was broken, deficient, compromised, or missing from the firearm that, if present and operative, would have prevented the discharge.

Accuracy
The extent to which a given measurement agrees with the standard value for that measurement.

Ammunition
One or more loaded cartridges consisting of a primed cartridge case, propellant, and with or without one or more projectiles.

> **Ball**
> A term generally used by the military for a cartridge with a full metal jacketed bullet or solid metal projectile.
> **Tracer**
> A projectile that has a burning compound in its base which permits observation of its flight.
> **Incendiary**
> A projectile containing a chemical compound which ignites upon impact with the intended purpose of starting fires.

Assault rifle
A compact, select-fire, detachable box magazine-fed firearm, that utilizes a centerfire rifle cartridge and is designed primarily for military use.

Automatic
Weapon which continues to fire until the trigger is released.

Ballizing (ball burnishing)
The smoothing of the tops of the lands of a rifled barrel by the forced passage of a hardened steel ball of appropriate diameter.

Barrel
Part of a firearm through which a projectile or shot travels under pressure of gasses, compressed air or other like means. A barrel may be rifled or smooth.

> **Barrel obstruction**
> Any foreign object or lodged bullet in the bore of a barrel which prevents unhindered passage of projectile(s) when fired. Also known as bore obstruction.
> **Bulged/ringed barrel**
> A barrel fired while containing an obstruction. This results in excessive pressure causing a bulge in the barrel.

Battery cup
A flanged metallic cup used in shotshell primer assemblies that provides a rigid support for the primer cup and anvil. Also known as a battery pocket.

Bearing surface
Portion of a bullet's outer surface that comes into direct contact with the interior surface of the barrel. Also known as the band.

Black powder
The earliest form of propellant; a mixture of potassium or sodium nitrate, charcoal and sulfur.

Black powder substitute
Mixture with similar burning characteristics as black powder that is safer and produces less fouling.

Bore
The interior of a barrel forward of the chamber.

Bore slugging
The process of driving a piece of lead through the bore of a rifled barrel to determine the minimum bore and groove diameters.

Breech Face
The part of the breechblock or breech bolt which looks against the rear of the chamber, and is against the head of the cartridge case or shotshell during firing.

Broaching
A manufacturing process for machining flat, round and contoured surfaces. A toothed cutting tool known as a broach is pushed or pulled across the work piece, with each tooth removing only a small portion of material.

Bullet
Refers to the projectile alone that is expelled from the gun barrel when fired. It engages the lands and grooves of the weapon causing it to spin.

Boattail
Specific design of projectile having a tapered or truncated conical base.

Jacketed bullet
Projectile having an inner core typically enveloped by a metallic substance.

Bunter
The die which produces the headstamp on rimfire cartridge cases or the headstamp and primer pocket on centerfire cartridge cases.

Button
A tool made from solid carbide used in barrel rifling that is larger than the reamed bore. There are three surfaces to the button tool. The straight cylindrical portion of the tool is the pilot and aligns the tool to the bore. The next portion of the button tool is larger in diameter and it is the portion of the tool that forces the grooves into the barrel. This section is ground to the exact reverse of the finished rifling pattern, i.e., the land on the button produces the groove in the barrel. The last diameter area of the button tool is the bore section of the tool, which passes over the top of the land, smoothing it and maintaining a true round bore. Any toolmarks that are in the barrel before rifling with the button will still be in the barrel after the rifling, although they will be smoothed considerably.

Caliber
A term used to designate the specific cartridge for which a firearm is chambered. The diameter of the circle formed by the tops of the lands in a rifled barrel, or simply the diameter of the bore of the barrel. The "true" caliber is the actual diameter of the bullet.

Cannelure
A circumferential groove generally of a knurled or plain appearance on a bullet or cartridge case.

Cartridge
Pre-assembled firearm ammunition containing a projectile, primer and powder within a case. It is loaded into the chamber of a firearm where it is discharged.

Cartridge case
The metal housing in which the bullet is seated. The cartridge case contains the propellant powder.

Chamber
The rear part of the barrel bore that has been formed to accept a specific cartridge or shotshell. In a revolver, the holes in the cylinder represent multiple chambers.

Choke
An interior constriction at or near the muzzle end of a shotgun barrel bore for the purpose of controlling shot dispersion.

Class characteristics
Measurable features of a specimen which indicate a restricted group source. They result from design factors and are determined prior to manufacture.

Confidence interval
Type of estimate computed from the statistics of the observed data. This proposes a range of plausible values for an unknown parameter.

Crane
The part of the solid frame revolver on which the cylinder is swung out to the side to accomplish loading and ejecting. Also known as **yoke**.

Crimp
The inward shaping of the mouth of a cartridge case or shotshell to secure the projectile(s). Crimps may also be used to retain primers in primer pockets.

Crown
Any of various forms of muzzle treatment meant to protect the rifling.

Cylinder
The rotating component of a firearm that contains the chambers.

> **Cylinder gap**
> In a revolver, the maximum space between the cylinder and the barrel. This space is typically measured with the cylinder in the rearmost position.

Cylinder alignment
The relationship of the axis of the chamber in a revolver cylinder to the axis of the bore.

Deflagration
A rapid combustion reaction caused by heat transfer into the reacting material. This reaction is accompanied by a vigorous evolution of heat and flame. It is usually dependent upon having fuel and oxidizing agents in very close contact.

Derringer
The generic term applied to many variations of small one, two, or even four shot pistols, using both percussion caps and cartridges.

Dram equivalent
The accepted method of correlating relative velocities of shotshells loaded with smokeless propellant to shotshells loaded with black powder.

Extractor
A component of a firearm which is designed to remove the cartridge, cartridge case, or shotshell from the chamber of the firearm.

Ejector
A mechanical device of a firearm which expels a cartridge, cartridge case or shotshell.

Firearm
An assembly of a barrel and action from which a projectile(s) is propelled by products of combustion.

Firing pin
The part of a firearm mechanism which strikes the primer or rim of a cartridge to initiate ignition in order to fire a cartridge or shotshell.

Forcing cone
- The tapered section at the front end of a shotgun chamber by which the diameter of the front end of the chamber is reduced to bore diameter.
- The tapered section towards the muzzle end of a shotgun barrel that gradually reduces in size from bore diameter to choke diameter.
- The tapered entrance to the bore at the breech end of a revolver barrel.

Gas check bullet
A lead alloy projectile with a copper or gilding metal cup pressed over the base. This metal cup is used to protect the base of the bullet from deformation due to the hot gases produced during firing.

Gauge
- Term used in the identification of a shotgun bore. The gauge is equal to the number of round lead balls of bore diameter that equal one pound.
- An instrument or device for measuring or testing a parameter such as a headspace gauge or trigger pull gauge.

Gaussian distribution (normal)
Type of continuous probability distribution for a real-valued random variable.

General rifling characteristics (GRC)
The number, width, and direction of twist of lands and grooves in a barrel of a given caliber firearm.

Grain
A unit of weight. The grain unit is commonly used in American and English ammunition practice to measure the weight of components. There are 7,000 grains in a pound, 437.5 grains in one ounce and 15.432 grains in a gram.

Grip
- In handguns, the handle.
- In long guns, the portion of the stock located behind the action which is normally grasped by the shooter's trigger hand. Also known as the **wrist**.

Hammer
A component of the firing mechanism which strikes the firing pin or primer.

Hammer forging
The formation of spiral grooves in the bore of a rifle barrel by means of inserting a mandrel with a rifling configuration into the barrel blank.

Handgun
Firearm designed to be held and fired in one hand.

Headspace
The distance from the face of the closed breech to the surface in the chamber on which the cartridge case seats.

Headstamp
Series of marks, letters and/or numbers impressed on the base of the cartridge by the manufacturer to indicate the caliber/gauge and by whom it was manufactured.

Individual characteristics
Marks produced by the random imperfections or irregularities of tool surfaces. These characteristics are produced incidental to manufacture and/or caused by use, corrosion or damage. They are unique to that tool to the practical exclusion of all other tools.

Jacket
The envelope enclosing the core of a projectile.

Jar-off
A condition in which a firearm may fire if dropped or jarred when the safety is off and without the trigger being pulled.

Loading gate

- The hinged piece attached to the frame of revolvers that can be opened to permit loading of the chambers.
- A spring-loaded cover for the loading port of a long gun.

Machine gun

Firearm design that feeds rifle cartridges, fires, extracts and ejects cartridge cases as long as the trigger is fully depressed and there are cartridges in the feed system. Also referred to fully-automatic.

Magazine

- A secure storage place for gunpowder, ammunition, or explosives.
- A container for cartridges which has a spring and follower to feed those cartridges into the chamber of a firearm. The magazine may be detachable or an integral part of the firearm.

Mean

The average of a set of numbers.

Measurement

A number that shows the size or amount of something. The assignment of a number to a characteristic of an object or event, which can be compared with other objects or events.

Measurand

A quantity or object intended to be measured.

Meplat

A term describing the flat, measurable portion of a bullet, specifically the tip's diameter.

Misfeed

Any malfunction during the feeding cycle of a repeating firearm resulting in the failure of a cartridge or shotshell to enter the chamber completely. Also known as failure to feed.

Misfire

A failure of the priming mixture to be initiated after the primer has been struck an adequate blow by a firing pin, or the failure of the initiated primer to ignite the powder.

Muzzleloader

Any firearm which is loaded with gunpowder and projectile(s) through the muzzle end of the bore or through the front end of a cylinder in the case of a muzzle loading revolver.

National Integrated Ballisitic Information Network (NIBIN)/ Integrated Ballistics Identification System (IBIS)

NIBIN is a searchable database developed by the ATF and FBI to assist state and local police with violent crime reduction efforts, to foster cooperation in the best interests of law enforcement, and to ensure a unified approach to developing future networking technologies in order to create a national ballistics system. The IBIS™ system allows the user to acquire, digitize and compare the fine markings on fired cartridge cases. NIBIN is the database and IBIS is the software.

Negligent discharge
The discharge of a firearm as a result of operator error.

Obturation
The sealing of a bore and chamber by pressure. During the firing process, pressure swells the cartridge case against the chamber walls which minimizes the rearward flow of gases between the case and the chamber wall. The same pressure, applied to the base of the projectile, causes it to swell or upset, filling and sealing the bore.

Ogive
The curved portion of the bullet forward of the bearing surface.

Out of battery discharge
A discharge that takes place when the firearm's locking mechanism is not fully closed. It is normally the result of the shooter intentionally pulling the trigger. Upon firing, the unsupported case may rupture and vent gasses back into the action. Also known as premature firing.

Percussion firearm
A means of ignition of a propellant charge by mechanical blow against the primer or percussion cap.

Pistol
A handgun in which the chamber is integral with the barrel.

Plastic deformation
Permanent change in the shape or size of a solid body without fracture resulting from the application of a sustained stress beyond the elastic limit.

Precision
The extent to which a given set of measurements of the same sample agree with their mean.

Primer
The ignition component of a cartridge.

Range
The difference between the lowest and highest values.

Revolver
Weapon with a revolving cylinder containing a number of firing chambers which may be successively lined up with and discharged through a single barrel.

Recoil
The rearward movement of a firearm resulting from firing.

Rifle
Firearm with a rifled bore designed to be fired from the shoulder.

Rifling
Grooves cut or impressed into the bore of a firearm barrel to impart a twisting motion on a projectile when fired.

Safety
A device on a firearm intended to help provide protection against accidental discharge under normal usage when properly engaged.

Sear
A part which retains the hammer or striker in the cocked position until the trigger is pulled.

Semi-automatic
Weapon which uses a portion of the energy of discharge to eject the empty cartridge case, reload a fresh round into the chamber and cock the action ready for firing each time the trigger is pulled.

Shot
Spherical pellets used in loading shotshells or cartridges. Shot can be in many forms- lead, steel, bismuth, tin, zinc, etc.

Shot collar
A plastic or paper insert surrounding the shot charge in a shotshell that aids in keeping the shot compact, reducing the shot pattern. It can also cut down flattening or deformation of shot/pellets during barrel travel. Also known as shot sleeve.

Shotgun
A long gun designed to shoot from the shoulder, typically having a smooth bore and designed to fire shotshells.

Shotshell
A unit of ammunition that may contain a single projectile or multiple projectiles/pellets.

Sideplate
A removable plate in the frame or receiver of a firearm that allows access to internal parts or upon which some internal parts are mounted.

Slam fire
The accidental discharge of a firearm upon closing of the action which may be due to one of the following:

- Firing pin that has struck and failed to retract
- Primer that is either inadequately seated or overly sensitive
- Weak or broken firing pin retaining spring which fails to overcome the intertia of motion imparted to firing pin during closure, thereby allowing the firing pin to strike the primer with sufficient force to cause discharge
- Firearm with inadequate headspace

Slide
A member attached to and reciprocating with the breechblock.

Slippage marks
Typically produced by revolvers and have the appearance of widening of the land impressions at their beginning point. Also known as **skid marks** or **jump marks.**

Shaving (bullet shearing)
The cutting of metal from a bullet due to a cylinder misalignment in a revolver.

Smokeless powder
Propellant containing primarily nitrocellulose (single base) or both nitrocellulose and nitroglycerin (double base).

Sprue
The opening through which metal or plastic can be poured into a mold. The waste piece that is cast in the opening.

Stock
The rear end of a long gun which is normally placed against the shooter's shoulder.

Stove-pipe
A failure to eject in which the cartridge case is caught in the ejection port by the forward motion of the bolt or slide.

Striation/striae
Contour variations, generally microscopic, on the surface of an object caused by a combination of force and motion where the motion of the tool is approximately parallel to the plane being marked.

Subclass characteristics
Features that may be produced during manufacture that are consistent among items fabricated by the same tool in the same approximate state of wear. These features are not determined prior to manufacture and are more restrictive than class characteristics.

Sub-machine gun
An automatic or select fire firearm chambered for a pistol cartridge.

Swage
To form metal under pressure. Normally performed in a press, using a punch or die.
Trigger
The part of a firearm mechanism that is moved manually to cause the firearm to discharge.

> **Hair trigger**
> Term used to describe a trigger requiring very low force to actuate. The light pull of a second trigger in a double set trigger mechanism.

Twist
The direction (right or left) and rate at which the rifling of the firearm turns within the bore.

Type A evaluation
May be based on any valid statistical method for treating data. Examples are calculating the standard deviation of the mean of a series of independent observations.

Type B evaluation
Usually based on scientific judgement using all of the relevant information available, which may include:

- Previous measurement data
- Experience with, or general knowledge of, the behavior and property of relevant materials and instruments
- Manufacturer's specifications
- Data provided in calibration and other reports
- Uncertainties assigned to reference data taken from handbooks

Unintentional discharge
Firearm discharging at a time not intended by the user.

Wad
A felt, cardboard, paper or plastic component used in a shotshell for various purposes.

4 General Requirements

See ACSO Forensic Lab Quality Assurance Manual

5 Structural Requirements

See ACSO Forensic Lab Quality Assurance Manual

6 Resource Requirements

6.1 General

6.1.1 Safe Firearm Handling

6.1.1.1 This procedure involves hazardous materials, operations, and equipment. This procedure does not address all the potential safety problems associated with its use. Occasionally, loaded firearms are received as evidence and require special handling; in these instances, extra caution should be exercised until the firearm can be rendered safe. Laboratory personnel shall practice the four following universal firearms safety rules:

1. Firearms are treated as if they are loaded at all times.
2. Always keep the firearm pointed in a safe direction.
3. Keep your finger off the trigger until ready to fire.
4. Be aware of your backdrop.

6.1.1.2 Firearms will only be handled by personnel who have attended a Firearms Safety Course. Personnel should also attend refresher courses periodically.

6.1.1.3 The firearm shall be evaluated for safety prior to test firing. Checks should include proper mechanical function, physical condition, modifications, bore obstructions, and test fire ammunition compatibility.

6.1.1.3.1 Any problems or doubts concerning the test firing of a firearm should be brought to the attention of the Firearms Technical Lead or laboratory management.

6.1.1.3.2 No more than three cartridges/shotshells should be loaded into the firearm during the initial testing of the firearm.

6.1.1.3.3 Remote firing should be used if there is a reasonable concern that holding and firing the firearm might subject the analyst to injury.

6.1.1.3.4 If determined the gun is not able to be test fired, the reason shall be documented.

6.1.1.4 A magazine received in a loaded condition shall first be unloaded prior to conducting any examinations or using it with a firearm.

6.1.1.5 Test firing or any examination of the firearm that utilizes ammunition or an ammunition component shall only be performed in designated test firing areas.

6.1.1.6 A minimum of two people shall be present when test firing is being carried out.

6.1.1.6.1 All individuals present when shooting must keep a vigilant awareness of the target and the surrounding environment.

6.1.1.7 Appropriate hearing and eye protection shall be used. Examiners can also wear body armor or face shields if desired.

6.1.1.7.1 Double coverage hearing protection shall be worn by all individuals present during shooting, unless testing conditions preclude it (e.g. when performing a sound suppressor examination).

6.1.1.8 The commencement of firing will be verbally announced and/or the area cleared when test firing is to begin.

6.1.1.9 For indoor testing, ensure there is adequate ventilation.

6.2 Personnel

See ACSO Forensic Lab Quality Assurance Manual

6.3 Facilities and Environmental Conditions

There are no specific environmental factors, outside those provided in a standard laboratory facility, which would influence the quality of the test results.

6.4 Equipment

6.4.1 Measuring Equipment

6.4.1.1 Micrometers and Calipers

Calipers are precision instruments used to measure physical dimensions, often inside measurements, outside measurements, or depths. Micrometers are similar, but are often configured for more specific measurement types, such as only measuring outside dimensions or only inside dimensions.

6.4.2 Comparison Microscope

A comparison microscope allows an examiner to identify a fired component back to the firearm that produced the markings on the evidence. The evidence component is placed on one stage of the microscope, and the known standard is placed on the other stage. This procedure may also be used to compare unknown fired components to determine if they were fired in/from the same firearm.

6.4.2.1 Method

6.4.2.1.1 Select the same objective (magnification) setting and ensure that the objectives are locked in place.

6.4.2.1.2 Select the same set of oculars.

6.4.2.1.3 Adjust illumination as needed.

6.4.2.2 Analysis of Comparisons

6.4.2.2.1 If the suspect firearm is submitted, test fires from the firearm should first be compared to determine what microscopic characteristics are reproduced.

6.4.2.2.2 Compare the unknown evidence to either another piece of unknown evidence or a known test by placing the unknown on the left-hand stage and the known test on the right-hand stage.

6.4.2.3 If an identification is not evident, consideration should be given to the following:

- Angle of lights
- Type of lights
- Need for additional known test samples
- Position of the evidence, the tests, or both
- Cleaning the firearm and producing additional tests
- The possibility that a different firearm was used

6.4.3 Bullet Recovery Systems

6.4.3.1 Water Recovery Tank

A water recovery tank can be used to during the initial test firing of handguns and rifles, to recover bullets to the best extent possible. It may also be used to retrieve slugs fired from shotguns.

6.4.3.1.1 Ensure that the water level is appropriate.

6.4.3.1.2 Ensure that all lids or doors of the recovery system are closed and properly secured.

6.4.3.1.3 Test firing into a bullet recovery system shall be done with the muzzle of the firearm inserted into the shooting tube so that any discharge from the muzzle will be captured within the recovery system.

- It is acceptable for the muzzle to be lined up with the shooting tube, but not inserted, if the firearm is secured in the remote firing stand.

6.4.3.1.4 Do not exceed the velocity limitation of the bullet tank.

6.4.3.1.4.1 The velocity limitation should be posted on the tank.

6.4.3.2 Bullet-Trap Range

The bullet trap range is usually used to test fire firearms when the recovery of the fired projectile(s) is not necessary.

6.4.3.2.1 Fire the firearm into the front of the bullet-trap.

6.4.3.2.2 Do not exceed the velocity limitation of the bullet-trap.

6.4.3.2.2.1 The velocity limitation should be posted on the trap.

6.4.3.3 Remote Firing

During the course of examining a firearm, it may be determined that it would be unsafe for the examiner to fire the firearm by holding it as designed. If it is necessary to obtain test standards from this firearm, the firearm should be fired remotely.

6.4.3.3.1 Set up the remote-firing device in front of the appropriate recovery system, as per guidelines set forth by the device manufacturer.

6.4.3.3.2 Place firearm in device.

6.4.3.3.3 Dry-fire the firearm in the remote firing device before using ammunition.

6.4.3.3.4 The examiner should load no more than one cartridge/shotshell into the firearm during the initial testing of the firearm.

6.4.3.3.5 Activate the remote device while standing behind a protective shield or at a safe distance away from the firearm.

6.4.4 Reference Collections

Reference collections may be necessary or useful for firearm and toolmark examinations. Reference collections may be kept at the discretion of the Technical Lead to accommodate varying laboratory needs.

6.4.4.1 Firearms

The laboratory shall maintain a firearms reference collection. This will include firearms from recognized manufacturers but may also include improvised and clandestine firearms.

Duplicate firearms may be kept. Duplicates allow the examiner to track variations, changes in manufacture techniques, mechanics and markings that might not be denoted as a model change by the manufacturer.

6.4.4.1.1 The reference collection shall be kept in a secure area with limited access.

6.4.4.1.2 All firearms will be assigned a unique identification number and recorded in the laboratory's Reference Collection spreadsheet. The reference collection spreadsheet shall contain the following information, as available:

- Make
- Model
- Caliber
- Type
- Serial number (if present)
- Date received in the laboratory

6.4.4.1.3 Any changes to the collection such as, firearms being transferred from the collection, destroyed or returned to the original agency shall be documented on the appropriate form.

6.5 Metrological Traceability

6.5.1 Micrometers and Calipers

Accuracy must be established prior to a micrometer or caliper being put into service after purchase, maintenance or repair. Measurements made in the Firearms and Toolmarks discipline using micrometers and calipers are not identified as critical measurements. Therefore, comparison to a NIST traceable standard is not required.

6.5.1.1 Checks Prior to Use

The micrometer or caliper will be checked prior to use to ensure that it closes to an indicated 0.000" and is functioning properly. This check does not need to be documented.

6.5.1.2 A performance check shall be conducted annually on micrometers or calipers using certified gauge blocks or micrometer disk.

6.5.1.2.2 The equipment is considered accurate if it is ± 0.002 inches of the known measurand.

6.5.1.2.2.1 If a micrometer or caliper does not meet the accuracy listed above, it shall be taken out of service and either replaced of repaired by an approved vendor.

6.5.2 Rulers and Tape Measures

6.5.2.1 NIST traceable measuring devices shall be calibrated by an external ISO/IEC 17025 accredited vendor prior to placing into service and once every accreditation cycle.

6.5.2.1.1 NIST traceable measuring devices will be stored so as to prevent damage such as bending or melting. The devices shall be handled with care to prevent bending, melting or damage to measuring marks.

6.5.2.1.1.1 If damage or malformation occurs that may affect the measuring device, it will be taken out of service until it is repaired or replaced.

6.5.2.1.1.2 Damaged NIST certified measuring devices will be calibrated by an approved vendor before being put back into service.

6.5.2.1.2 All maintenance/verification shall be documented in the Firearms Equipment binder or related spreadsheet located on the z-drive.

6.5.2.2 Non-calibrated rulers and tape measures may be used for descriptive measurements only. Descriptive measurements using an un-calibrated measuring device will be included in the case notes but will not be included in the report.

6.5.3 Trigger Pull Measuring Device

6.5.3.1 Known Trigger Weights

The known trigger weights will be verified initially, and checked annually thereafter, using a balance. Tolerance for each weight is +/- 5%. If the difference between the reading and the expected weight exceeds 5% then corrective action will be taken. Corrective action can be cleaning the weights and re-verifying, replacing the weights or sending the weights to a vendor for recertification. This verification will be documented in the Firearms Equipment binder or related spreadsheet located on the z-drive.

6.5.3.2 Spring Measuring Device

The spring gauge trigger pull measuring device will be verified annually using the known trigger weights, checking at ½ lb., 5 lbs., and 10 lbs. Tolerance for the spring gauge is + ¼ lb. If the difference between the reading and the trigger pull weight exceeds the specified tolerance, then the spring scale will be taken out of service. The scale will then be replaced or repaired. This verification will be documented in the Firearms Equipment binder or related spreadsheet located on the z-drive.

6.5.4 Comparison Microscope Magnification and Integral Scale

6.5.4.1 After installation or maintenance, a performance check shall be conducted on each set of objectives to ensure they are in compliance.

6.5.4.2 The comparison microscope shall be checked annually and whenever moved or disassembled, to ensure equal magnification of each set of paired objectives used for comparisons. Any bridge or similar device that alters magnification of both sides of the bridge will be checked with at least one of the paired objectives. This can be done by comparison of stage micrometers on each stage.

6.5.4.2.1 Acceptance Criterion:

- All magnification of oculars shall be accurate (less than or equal to ± 0.0010" of the target value)

6.5.4.2.1.1 If above accuracy is not observed, the microscope shall be taken out of service and repaired by an approved service vendor.

6.5.4.3 The integrated scale will be checked yearly and whenever they are disassembled or have the battery replaced. Verification checks can be performed using glass stage micrometers over a distance 0 to 1 inches; integrated scales displaying errors of over 0.0010 inches will be removed from service until the issue is corrected.

6.5.4.4 The stage micrometers shall be calibrated by an outside vendor once every accreditation cycle.

6.5.4.5 All maintenance/checks shall be documented in the Firearms Equipment binder or related spreadsheet located on the z-drive.

6.5.5 General Rifling Characteristics (GRC) Database Search Software

Software programs used to produce possible weapons lists from general rifling characteristics measurements will be performance checked each time the software is updated or replaced. The following three sets of GRC data will be searched, and the success of the database search will be checked to ensure the correct firearms' makes are listed in the results.

6.5.5.1 To perform the check, enter the following three sets of general rifling characteristics data and execute a search for each:

Search Criteria			Target Response
Specific Caliber	**Number of L & G Direction of Twist**	**Ll Width**	**Make**
22 Long Rifle	16R	0.012"	Marlin
357 Magnum	6L	0.055"	Colt
44 Magnum	5R	0.126"	S&W

6.5.5.2 If the list from each search includes at least one report of the listed make, the application can be considered validated and may be used for casework. GRC search software not producing the target response listed above will NOT be used in casework.

6.5.5.3 Record the success or failure of the tests in the Results Section of the Performance Check Worksheet.

6.5.6 Balances

6.5.6.1 An intermediate check shall be performed monthly on all balances, using certified weights. Intermediate checks shall also be performed if the balance has been moved, placed back into service or purchased.

6.5.6.1.1 If a balance fails an intermediate check, the check is repeated. If the balance still fails, the balance will be taken out of service until it can be recalibrated or repaired.

6.5.6.1.2 Balances shall be calibrated annually by an approved outside vendor that is accredited to ISO/IEC 17025 and whose scope of accreditation covers the calibration performed.

6.5.6.2 Weights used to check the balance accuracy shall NIST traceable. Weights shall be re-certified once every accreditation cycle by an approved vendor.

6.5.7 Gage blocks

Gage blocks will be calibrated once every accreditation cycle by an approved vendor. Gage blocks will be handled with care to prevent bending, breaking or melting and will be transported and stored in their case.

6.6 Externally provided services and products

6.6.1 All reagents, solvents, etc. used should be reagent grade or higher purity grades.

6.6.2 There are no quality requirements for prepared solutions commonly used to clean firearms and there are no quality requirements for commercially manufactured casting materials.

6.6.3 None of the supplies or services are deemed critical EXCEPT the calibrations specifically documented.

7 Process Requirements

7.1 Review of requests, tenders and contracts

See ACSO Forensic Lab Quality Assurance Manual

7.2 Selection, verification and validation of methods

See ACSO Forensic Lab Quality Assurance Manual

7.3 Sampling

Sampling is not used in the firearms discipline.

7.4 Handling of test or calibration items

7.4.1 Examination of Firearms

7.4.1.1 Initial Examination

At a minimum, record the following firearm features:

- Caliber/gauge
- Make/Model
- Serial number
- Condition
- General Rifling Characteristics (GRC-number and direction)
- For revolvers- document the position of the cylinder and the position of any halos, if present, around the front end of the chambers. If the chambers are loaded, remove the cartridges, being sure to document the position of each cartridge in the cylinder.
- For shotguns- presence, type and setting of shotgun choke

Analyst may record the following details specific to the firearm at their discretion:

- Magazine/cylinder capacity
- Accessories
- Bore/overall condition
- Additional observations (e.g. trigger pull and barrel/overall length)

Record the following additional firearm features for comparison:

- Firing mechanics
- Type of action
- Safeties and operability

7.4.1.1.1 Trace Material

Evidence is often submitted with debris that may cover its characteristics. In order to determine class characteristics or compare individual characteristics of the firearm evidence the debris may need to be removed. The debris may consist of blood, tissue, paint, fibers, glass, etc. The value of the debris as trace evidence should be considered during initial examination. Every effort should be made to properly preserve removed debris, even if this examination was not requested by the agency. The examiner shall note any findings in the case file.

7.4.1.1.1.1 Items collected as trace evidence are considered evidence and shall be retained.

7.4.1.2 Barrel and Overall Length

Barrel length is defined as the distance between the muzzle end of the barrel and the face of the closed breechblock or bolt for firearms other than revolvers. On revolvers, it is the overall length of the barrel including the threaded portion within the frame. Overall length of a firearm is defined as the dimension measured parallel to the axis of the bore from muzzle to a line at a right angle to the axis and tangent to the rearmost point of the butt plate or grip.

7.4.1.2.1 Permanently affixed barrel extensions (poly chokes, flash suppressors, etc.) are considered part of the barrel and overall length of the firearm. Removable barrel extensions are not considered part of the barrel length or overall length and shall be removed prior to taking measurements.

7.4.1.2.2 Barrel and overall length measurements shall be conducted using calibrated measuring devices. If the barrel length or overall length exceed the capacity of the calibrated measuring devices, the length may be estimated using other suitable measuring equipment.

7.4.1.2.3 Measurements will be classified as "descriptive" or reported. Measurements shall be expressed in inches and fractions of an inch given to the readability of the measuring device (i.e. to the nearest 16^{th} or 32^{nd} of an inch).

7.4.1.2.3.1 Descriptive measurements are defined as routine firearm dimension measurements for general documentation. These measurements are recorded in case notes only. A standard measuring device (e.g. tape measure, ruler) may be used for these measurements.

74.1.2.3.2 Reported measurements are defined as measurements which are relevant to the determination of possession of a "Short barreled rifle or shotgun" or "Sawed off rifle or shotgun". These measurements are recorded in the case notes and in the report.

7.4.1.2.4 **Barrel Length**

7.4.1.2.4.1 Revolvers

Measure the length of the barrel. Do not include the cylinder's length in this measurement. Record measurement in notes.

7.4.1.2.4.2 All other firearms

Measure the distance from the breech face to the muzzle.

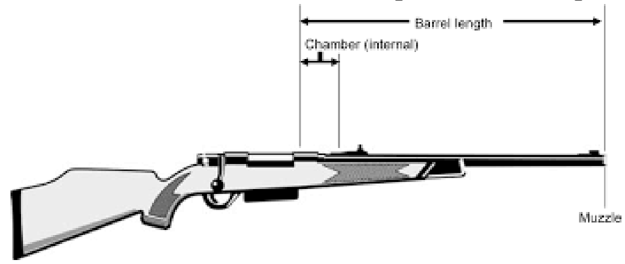
7.4.1.2.4.2.1 Ensure the firearm is unloaded and close the breech, breechblock or bolt.

7.4.1.2.4.2.2 If necessary, cock the firearm so the firing pin is not protruding through the firing pin aperture.

7.4.1.2.4.2.3 Insert measuring device down the muzzle end of the barrel until contact is made with the face of the breech, breechblock or bolt and position the moveable ring until it is flush with the muzzle end of the barrel.

7.4.1.2.4.2.3.1 Remove the rod and align the breech end of the rod to the end of the measuring ruler on the device.

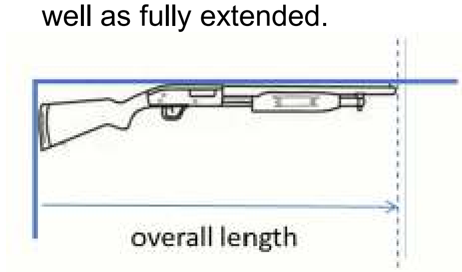
7.4.1.2.4.2.4 Record the measurement at the edge of the collar that was flush with the longest barrel edge.



7.4.1.2.5 **Overall Length**

Measure and document the distance from the furthest rearward end of the firearm to the muzzle, holding the measuring device parallel to the bore.

7.4.1.2.5.1 Complete documentation shall include, overall length measured with the stocks collapsed, folded or closed as well as fully extended.



7.4.1.2.6 **Reporting of Results**

The measurement uncertainty associated with barrel and overall length shall be included on the report when the measurand value is within +/- ½ inch of a legal specification:

Firearm Type	Barrel Length	Overall Length	Specification
Rifle	Less than 16 inches	Less than 26 inches	Short-barreled rifle
Shotgun	Less than 18 inches	Less than 26 inches	Short-barreled shotgun

7.4.1.2.6.1 For reported measurements, the examiner shall document the serial number of the NIST-traceable or certified measuring device.

7.4.1.2.6.1.1 Descriptive measurements do not need to be reported in the case report.

7.4.1.2.6.2 When measurements are reported, the measurement uncertainty and a statement regarding the coverage probability of 95.45% shall be on the report.

7.4.1.3 Trigger Pull

Trigger pull is defined as the amount of force which must be applied to the trigger of a firearm to cause sear release. This examination can provide important information regarding the mechanical operating condition of the firearm.

7.4.1.3.1 The trigger pull of a firearm can be obtained utilizing standard trigger weights or a spring gauge. The trigger weights make contact with the trigger at a point where the trigger finger would normally engage the trigger. The trigger pull of a firearm shall be reported if the examination is performed.

7.4.1.3.1.1 The case notes shall indicate which method was used to measure the trigger pull.

7.4.1.3.2 The firearm shall be pointed in a safe direction at all times during trigger pull testing. Recheck the firearm to ensure it is unloaded prior to measuring trigger pull.

7.4.1.3.3 A fired cartridge case or "dummy" cartridges should be used to measure the trigger pull of a rimfire firearm. The examination should not be performed on an empty chamber.

7.4.1.3.4 For single-action trigger pull, cock the firearm. For double-action trigger pull, do not cock the firearm.

7.4.1.3.5 Trigger pull should be measured parallel to the bore of the firearm whenever practical. Any significant variation shall be documented in notes.

7.4.1.3.6 When using trigger weights, slowly lift the firearm upward with the trigger, ensuring weights are parallel to the bore.

- If the weight comes off the flat surface without the sear releasing, add more weight to the trigger hook.
- If the sear releases before the weights come off the flat surface, remove weight from the trigger hook.

7.4.1.3.7 When using a spring gauge, secure firearm in a vice and attach gauge to trigger and pull until the sear releases.

7.4.1.3.8 Continue until the least weight required to cause the sear to release is determined.

7.4.1.3.9 Measurements shall be repeated a minimum of three times and the results recorded.

7.4.1.3.9.1 A minimum of three measurements shall be taken for each chamber of a revolver. Record weight used for each test.

7.4.1.3.10 **Reporting of Results**

7.4.1.3.10.1 The lightest weight that results in reliable sear release after multiple tests shall be reported.

7.4.1.3.10.1.1 The results acquired are only an approximation.

7.4.1.4 Function Testing

A mechanical malfunction of a firearm is its partial or complete failure to operate as designed. A malfunction may include, but is not limited to, any failure in the cycle of fire such as a failure to feed, fire, extract or eject. It could also include potential sources of accidental discharges, such as slam fire and jar-off.

Any evaluations/observations regarding firearm malfunctions shall be documented in notes. The examiner should attempt to conduct the examination(s) in a manner so as not to alter the firearm. Any change to the firearm shall be documented in the notes. Documentation shall include the type of evaluation performed and their results.

7.4.1.4.1 The following list of examinations should serve as a guideline.

7.4.1.4.1.1 Visual condition of Firearm as Received

- Cocked/uncocked
- Safety position
- Loaded/unloaded
- Cartridge position
- Stuck cartridge/discharged cartridge cases
- Presence and/or location of flares

7.4.1.4.1.2 Visual abnormalities

- Barrel (loose, damaged, etc.)
- Receiver (condition)
- Slide (condition)
- Parts broken or missing (firing pin, ejector, extractor)
- Screws (loose or missing)
- Alterations or adaptations
- Sights

7.4.1.4.1.3 Action- External

- Relationships of the action parts
- Correct assembly
- The proper locking of the action on closing
- Cylinder rotation (securely locks)
- Hand relationship to the ratchet

- Trigger (not returning, sticks, broken spring, etc.)
- Trigger pull (single action, double action) and striking of hammer

7.4.1.4.1.4 Safeties

- ¼,1/2, full cock, seating check (any false seating positions, pull off/push off, etc.)
- Function (grip, magazine, disconnector)
- Rebound hammer or inertia firing pin
- Firing pin (relationship to primer, condition)
- Drop hammer several times to check safeties
- Position of the slide or bolt in order to fire
- Condition of safeties

7.4.1.4.1.5 Action Check

- Check feeding of magazine (lips, follower), carrier or lifter, and feed ramp
- Slam fire
- Extractor and/or ejector markings on evidence cartridges/discharged cartridge cases
- Marks exhibited on the cartridges/discharged cartridge cases
- Check for any inherent "quirks" known about the particular firearm based on literature or case data

7.4.1.4.1.6 Special Situational Tests

The examiner shall consult with the Firearms Technical Lead to devise a systematic approach for situational testing prior to a malfunctioning examination of the firearm. Tests can include, but are not limited to, drop, jar off or rotational testing. The force to be used could alter or damage internal parts and their working relationship(s). Care should be exercised when testing a firearm to minimize examiner-caused damage that could prevent the determination of the cause of the reported malfunction.

7.4.1.4.1.7 Action-Internal

- Hammer notches (worn, burrs, dirt, etc.)
- Sear (worn, broken, burrs, etc.)
- Safeties (relationship and general parts relationship)
- Springs (weak, broken, altered, etc.)
- Signs of any tampering or faulty assembly

7.4.1.4.2 **Test Firing**

Test firing a firearm is performed for a variety of reasons to include: determining operability, generating standards for microscopic comparisons, and generating muzzle to target test patterns for comparison.

7.4.1.4.2.1 Remote firing should be used if there is a reasonable concern that hand firing might subject the examiner or observer to injury.

7.4.1.4.2.1.1 It is recommended the examiner test the firearm with empty, primed cartridge cases if there is concern that the firearm might be damaged or destroyed by testing with normal cartridges.

7.4.1.4.2.1.2 The examiner may choose to temporarily replace damaged parts with those from the firearms reference collection in order to make the evidence gun safe to fire. All substitutions shall be documented.

7.4.1.4.2.1.3 Consider loading and firing single cartridges if the firearm exhibits the potential for full auto fire.

7.4.1.4.2.2 Examiners should evaluate whether to pass a dry patch through the barrel prior to test firing. This patch may be released with the firearm.

7.4.1.4.2.3 If the test fired ammunition components are to be used for microscopic comparison, the ammunition shall be indexed prior to test firing.

7.4.1.3.2.3.1 Ammunition should be marked to record the sequence of firing (e.g. T-1, T-2, T-3).

7.4.1.4.2.4 A minimum of three test cartridges shall be fired as a means of establishing the reproducibility of the marks left on the ammunition by the firearm.

7.4.1.4.2.5 Laboratory ammunition similar to the evidence should be used.

7.4.1.4.2.5.1 Evidence ammunition can be used for test firing. When a limited amount of evidence ammunition is available, determine its most prudent and effective use. Evidence ammunition shall be inspected for signs of reloading because such ammunition may present a safety hazard.

7.4.1.4.2.5.2 Ammunition should be examined for existing chambering, cycling or manufacturing marks prior to test firing.

7.4.1.4.2.5.3 Ammunition shall be suitable for the firearm being tested. The pressure developed by the cartridge shall not exceed the capability of the firearm.

7.4.1.4.2.6 **Marking Evidence Firearms**

Each bullet and cartridge case shall be marked with a minimum of, examiners initials and item designation. If the item of evidence is damaged or too small to mark directly, the packaging shall be marked in such a way as to allow the examiner to later identify the item.

7.4.1.3.2.6.1 Be cognizant in the placement of permanent identification marks on impression evidence so that significant working surfaces and existing identifying marks are not altered. The examiner should mark evidence firearms using permanent ink marker, paint pen or scribe.

7.4.1.4.3 **Reporting of Results**

Examination conclusions for function testing may include:

- "The firearm is functional"
- "The firearm is non-functional"
- "The firearm has been modified"
- "The firearm has been damaged"
- Any abnormal functioning of the firearm observed shall be described in the report.
- Clearly communicate the limitations of testing for malfunctions with the statement "Results of the examination reflect the conditions of the firearm as received and the testing conditions applied to the firearm in the laboratory. If the firearm functions as designed during the examination, it does not assure the firearm was in proper working order at the time of the incident."

7.4.1.5 Bore/Chamber Casting

Occasionally, evidence items may need to be replicated for testing purposes or for other case-dependent circumstances. This can include, but is not limited to: fired ammunition components, unfired ammunition and/or components, firearm surfaces, surfaces with toolmarks, and tool surfaces.

Additionally, firearms may be received for which the caliber may not be known or may be different than is designated on the firearm and in the literature. In order to facilitate firing of test shots that are of the correct caliber for a particular firearm, it may be necessary to make a bore and/or chamber cast. Then, by measuring the cast, the correct cartridge can be selected for firing. The presence of subclass characteristics and the widths of the lands and grooves in a barrel may also be determined by examining a bore cast.

Casts can be made using various casting materials such as low melting point metals and silicone rubber compounds. The case notes should document the brand of casting material used. Casts made of the evidence used to formulate results/conclusions will be returned with the evidence; however, they do not need to be itemized.

7.4.1.5.1 Open the action and remove the bolt or bolt assembly.

7.4.1.5.2 Check the bore for obstruction.

7.4.1.5.3 Push a cleaning patch in the barrel, from muzzle end, until it is ½ inch to ¼ inch from the beginning of the chamber.

7.4.1.5.4 If desired or necessary, lubricate the chamber with gun oil, silicone spray, or some other similar substance such as WD40.

7.4.1.5.5 Do not allow casting material to flow into breech as it will make extraction of the cast difficult.

7.4.1.5.6 When the casting material is set or cooled, gently tap end of cleaning rod to loosen the cast from the chamber and then remove the cast from the breech end.

7.4.1.5.7 Use same steps for casting the bore.

7.4.1.5.8 **Reporting of Results**

The correct caliber of the firearm can be determined by measuring the mouth, base, overall length, rim (if pertinent), shoulder length of the chamber cast or the diameter of the bore cast.

7.4.2 Ammunition Identification

Identification of ammunition or ammunition components can provide information essential to an investigation. This process includes determining nominal caliber, specific caliber, brand or manufacturer, identifying expending components, recognizing reloaded cartridges and anomalies such as modified or misused cartridges.

7.4.2.1 Cartridge and Shotshell Identification

Identifying a cartridge includes determining the nominal caliber and the specific caliber or cartridge designation. The headstamp may reveal the designation as well as the manufacturer. Cartridges may be encountered where the headstamp does not supply this information or it may not accurately depict the true cartridge designation because the cartridge has been fabricated from a different case. To identify an unknown cartridge, assess relevant information and compare to literature, reference collection(s) or other sources.

7.4.2.1.1 Record the following features:

- Caliber
- Possible manufacturer/marketer of the cartridge case
- Description of metal used in cartridge case and primer
  - Straight wall, tapered wall, bottle necked
  - Rimmed, rimless, rebated rim
- Description of headstamp
  - Study the headstamp information and compare to reference headstamp guides or reference ammunition.

7.4.2.1.2 Take measurements of the:

- bullet diameter
- case neck, shoulder, base and rim diameters
- case length
- note any other relevant details

Compare measurements and observations of the cartridge to known cartridge dimensions from tables from Cartridges of the World or other references.

7.4.2.1.3 Determination of Marks

Visual and microscopic examination of the cartridge/cartridge case may reveal a variety of markings. Types of marks that might be found may be as followings:

- breech face marks
- extractor marks (clock position, if possible)
- ejector marks (clock position, if possible)
- resizing marks
- chamber marks
- anvil marks
- magazine marks
- ejection port marks
- firing pin impression (class and individual characteristics)
- firing pin drag

- slide scuff mark (head @ rim)
- slide drag mark (wall)

7.4.2.1.4 Firearms-related class characteristics associated with cartridge cases include:

- Caliber
- Position and shape of the extractor and ejector marks
- Shape of the firing pin impression
- General type of breech or bolt impressions (parallel, cross-hatched, circumferential)

7.4.2.1.4.1 If the class characteristics are in agreement and the evidence is suitable for comparison, the examination can proceed to the comparison of individual characteristics.

7.4.2.1.5 The sources of individualizing characteristics on cartridge cases and shotshells include:

- Firing pin
- Firing pin aperture
- Ejector
- Extractor
- Loaded chamber indicator
- Breech/bolt face
- Chamber walls
- Magazine
- Ejection port
- Anvil (in rimfire)
- Shell stop

7.4.2.1.5.1 As appropriate, compare marks on cartridge/cartridge case with tests from a firearm or with other cartridges/cartridge cases.

Any component markings that can be produced by cycling cartridges through the action of a firearm (chamber, extractor, ejector, other mechanism marks) shall not be reported as "fired in/from" marks unless it is has been determined through testing that marks having the same characteristics (depth, shape, individual detail, etc.) are produced only during the firing process. When the firearm is available, at least two cartridges should be cycled through the action to ensure they are fired in marks as opposed to cycle through the action marks.

7.4.2.1.5.2 Tests of cycled ammunition shall be treated as evidence. The method or procedure followed (steps taken) to produce cycling marks shall be documented in the case notes.

Only the above marks necessary to affect an identification or elimination are required to be photographed and/or described in examination documentation.

7.4.2.1.5.3 For inconclusive conclusions, all pertinent mechanism markings shall be evaluated and documented in the examination documentation.

7.4.2.1.6 Determination of Number of Weapons Involved
All cartridge cases in the same case submission shall be inter-compared in order to determine the number of possible weapons involved.

7.4.2.2 Shotshell Identification
By examining wadding, an examiner may be able to determine the gauge size, manufacturer and if the wad may possess markings suitable for comparison with the firearm that fired it. By examining recovered shot pellets, the examiner may be able to determine the actual shot size. The determined size can be compared to the shot size loaded in submitted shotshells or to the size indicated by markings on the hull of the submitted shotshell case.

7.4.2.2.1 Record, at a minimum, the following features:

- gauge
- possible manufacturer/marketer of the shotshell/shotshell case
- description of metal used in hull and primer
- composition of hull (i.e. plastic/paper, color, ribbed/smooth)
- description of headstamp

7.4.2.2.2 Determination of Marks
Visual and microscopic examination of the shotshell/shotshell case may reveal a variety of markings. Types of marks that might be found are as follows:

- breech face marks
- extractor marks
- ejector marks
- resizing marks
- chamber marks
- magazine marks
- ejection port marks
- markings on the exterior surface of the hull
- firing pin impression
- firing pin drag

7.4.2.2.2.1 As appropriate, compare marks on shotshell/shotshell case with tests from a firearm or with other shotshell/shotshell cases.

Any component markings that can be produced by cycling shotshells through the action of a firearm (chamber, extractor, ejector, other mechanism marks) shall not be reported as "fired in/from" marks unless it is has been determined through testing that marks having the same characteristics (depth, shape, individual detail, etc.) are produced only during the firing process. When the firearm is available, at least two shotshells should be cycled through the action to ensure they are fired in marks as opposed to cycle through the action marks.

7.4.2.2.2.2 Tests of cycled ammunition shall be treated as evidence. The method or procedure followed (steps taken) to produce cycling marks shall be documented in the case notes.

Only the above marks necessary to affect an identification or elimination are required to be photographed and/or described in examination documentation.

7.4.2.2.2.3 For inconclusive conclusions, all pertinent mechanism markings shall be evaluated and documented in the examination documentation.

7.4.2.2.2.4 Document if the item contains suitable markings for comparison to determine identification with a firearm or with other ammunition components.

7.4.2.3 Wads

7.4.2.3.1 Record, at a minimum, the following features:

- color of wad
- description of wad composition
- shape of wad
- diameter and/or approximate length of wad
- gauge
- possible manufacturer/marketer of the wad using reference materials. The reference used shall be documented.

7.4.2.3.2 Wad Gauge Determination

Gauge can usually be determined by measuring the diameter of the wad and comparing with laboratory standards or available manufacturer's literature.

Manufacturer data can be determined by locating information stamped into the wad or by comparing the evidence wad to known laboratory references. Record the reference collection number or the manufacturer and box load number.

7.4.2.3.3 Determination of Marks

Visual and microscopic examination of the wad may reveal a variety of markings. Microscopic examination of the evidence wad could reveal markings that may be suitable for identification with the firearm that fired it. As appropriate, compare marks on the wad with tests from a firearm or with other wads.

7.4.2.4 Pellets

7.4.2.4.1 Record, at a minimum, the following features:

- total number of pellets received
- composition of the pellets
- if pellet sizes visually appear to be similar or different
- The following may be used to determine pellet size from diameters/weights:
  - Choose the best specimens and measure diameter
  - Weigh the pellets in grains or ounces
    - Divide weight of pellets by total number weighed
  - Consult a reference source (e.g. NRA handbook, manufacturer data, etc.) to determine the shot size which corresponds to evidence shot. The reference used shall be documented.
  - Evidence pellets can also be compared to laboratory references of known shot sizes side by side until a known shot size is determined. A stereomicroscope may aid in this determination.
  - The weight of the evidence pellets can also be directly compared to weight of references using the same number of pellets until a similar known weight is obtained.

7.4.2.4.2 Document if the item is suitable for comparison to ammunition components, as appropriate.

7.4.2.5 Reloaded Ammunition

7.4.2.5.1 **Method**

7.4.2.5.1.1 Document the original appearance of the cartridge, including any details that may indicate the round has been reloaded. For metallic cartridges, signs of reloading may include:

- Breaks in the primer lacquer sealer, showing the original primer has been replaced
- presence of multiple extractor or ejector marks
- resizing die striae along the longitudinal axis of the case body
- resizing die marks on the neck of the bottle necked cases, causing an abrupt line where the die stopped
- shoulder dents resulting from excess lubricant during resizing
- non-factory crimp of the case mouth used to secure the bullet

- evidence of cleaning or "tumbling" to remove oxidation prior to reloading
- evidence of cleaning where the colored annealed neck and shoulder area does not show a contrast with the color of the rest of the cartridge (seen with some military ammunition).

7.4.2.5.1.2 Determine whether the headstamp information matches the bullet design.

7.4.2.5.1.3 For shotshells, signs of reloading may include:

- breaks in the primer lacquer sealer, showing the original primer has been replaced
- resizing die striae along the longitudinal axis of the metal head
- irregular or non-factory star crimps or roll crimps
- shot (pellet) size does not conform to the shot size markings on the shotshell case
- wadding brand or type does not conform to the headstamp brand if it is available only as a reloading component

7.4.2.5.1.4 Evaluate whether the cartridges are reloads by separating the cartridge components and inspecting the interior of the case.

7.4.2.2.1.4.1 A previously fired case will show internal soot/carbon residues, especially near the primer flash hole.

7.4.2.6 Safety

7.4.2.6.1 Eye protection shall be worn while disassembling ammunition.

7.4.2.6.2 When using a kinetic bullet puller, make sure the cartridge is held securely in the device. Also be aware that kinetic bullet pullers are not intended to be used for disassembly of cartridges with exploding bullets or rimfire ammunition.

7.4.2.6.3 If the ammunition has been determined to be reloaded, care must be taken if to be test fired. The reliability of reloaded ammunition may be questionable, and precautions should be taken prior to test firing. A remote firing device should be used.

7.4.2.7 Interpretation/Reporting of Results

7.4.2.7.1 The analyst can determine the nominal and specific calibers of ammunition examined based on the physical dimensions of the cartridges. These dimensions shall be compared to known reference standards and/or published literature.

7.4.2.4.1.1 Actual measurements may differ slightly from reference materials.

7.4.2.7.2 The analyst can determine whether the cartridge has been reloaded. The analyst should be aware that cartridge components from different manufacturers may be combined resulting in component combinations that are not commercially available.

7.4.2.7.3 The analyst should be mindful that cartridge cases can be reformed or reconfigured into different specific calibers, resulting in a mis-match between headstamp information and the actual cartridge dimensions.

7.4.2.7.4 Wildcat cartridges are cartridges that have never been manufactured commercially or available publicly. The analyst should be aware that wildcat cartridges may be encountered, and the dimensions may not correspond to any reference data.

7.4.3 Fired Bullet Examination

Fired bullet examination encompasses the examination and evaluation of toolmarks on ammunition or its fired components to:

- Associate bullets and cartridge cases to a specific firearm
- Determine if a group of bullets or cartridge cases were fired or cycled in one or more firearms or are otherwise associated
- Develop investigative information about the make and/or model of the associated firearm

This process is accomplished by comparing toolmarks left by a firearm on the ammunition (cartridge) and its fired components. In this context, the firearm surfaces are the tools that leave toolmarks on the cartridge components.

7.4.3.1 General, Visual, Physical and Trace Examinations

The following features should be recorded as applicable:

- Caliber/gauge
- Bullet/slug weight
    - Record weight of bullets in grains
    - Record weight of slugs in ounces or grains
- Number of land and groove impressions on a fired bullet
- Direction of twist
- Measured width of the land impressions
- Measured width of the groove impressions
- Measured diameter
- Bullet composition
- Bullet style
- Possible manufacturer/marketer of the bullet/projectile, if needed use reference materials
- Description of the base of the bullet
- Type and position of cannelures
- Any extraction markings to include flared base, skid marks, shave marks, and other marks
- Condition of the fired evidence
- Suitability for comparison purposes
- GRC Search for possible firearms from which bullet was fired
- As appropriate, compare marks on bullets with tests from a firearm or with other bullets

7.4.3.2 Caliber Determination

Caliber is one of the class characteristics of a fired bullet and is written as a numerical term that may be depicted with or without a decimal point. Determining caliber will aid the examiner during identification or elimination of a suspect firearm. The following may be utilized to determine the caliber of any fired bullet. The condition of the bullet will determine which steps can be used:

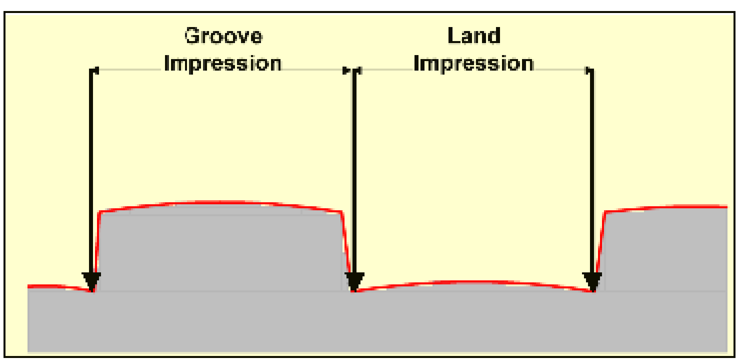
- Compare the diameter of the evidence bullet directly with known fired test standards
- Measure the diameter of the evidence bullet using a measuring device and compare this measurement with known measurements published in reference literature
- Determine the number and widths of the land and groove impressions and compare to the applicable table in the current edition of the AFTE Glossary
- Determine the widths of one land and groove impression, and multiply by the number of land and groove impressions to obtain the circumference. Use the mathematical formula $C=\pi d$ to determine the diameter of the bullet.
- Physical characteristics of the evidence bullet, such as weight, bullet shape, composition, nose configuration and number and placement of cannelures, may aid in caliber determination

7.4.3.3 Methods of Measuring Land and Groove Impressions

One of the class characteristics used for firearms identification is the width of the land and groove impressions. The measuring of land and groove impressions on a fired bullet can be accomplished by utilizing the integrated scale. In measuring a fired bullet to determine the width of the land and groove impression, it is paramount that the points used for beginning and ending measurement utilize the anchor points shown below.

7.4.3.3.1 Each available land and groove impression shall be measured and recorded.

7.4.3.3.1.1 For multiple bullets having similar general rifling characteristics, only one bullet needs to be measured. For bullets that are microscopically identified to tests produced with a firearm, either the tests or questioned bullet(s) may be measured.



7.4.3.3.1.2 In the microscope reticle method, the fired bullet in question is mounted on a steady surface beneath the microscope. The land or groove impression of the fired bullet is positioned with both of the anchor points corresponding to points on the alignment scale. Record the measurements observed on the scale.

7.4.3.4 Cases without Firearms Recovered

7.4.3.4.1 Generation of Possible Weapons List

May use both bullet and cartridge case data (GRC, Fired Reference Collection, etc.)

7.4.3.4.1.1 Determine the class characteristics of the fired component to include: caliber, weight, type, direction of twist, number of land and groove impressions and their widths, chamber, ejector/extractor mark locations and manufacture if possible.

7.4.3.4.1.2 Compare the rifling class characteristics with appropriate data files. Data files include: lab data, FBI General Rifling Characteristics File (GRC), or other similar published data.

7.4.5.3.1.2.1 Be mindful of the possibility of ammunition interchange or use of improper ammunition.

7.4.3.4.1.3 If a list of possible weapons is reported, the rifling class characteristics the list is based upon shall be included in the report. Appropriate qualifying statements should be included in the report to reflect any limitations of the data.

7.4.3.5 Class Characteristics Comparison

Compare the observable class characteristics of the fired evidence ammunition component to the class characteristics of the firearm, or to the firearms-related class characteristics on the other fired evidence ammunition components.

7.4.3.5.1 Firearm-related class characteristics associated with bullets include:

- Caliber
- Number and widths of land and groove impressions
- Direction of twist

7.4.3.5.2 If the class characteristics are in agreement and the evidence is suitable for comparison, the examination can proceed to the comparison of individual characteristics.

7.4.3.6 Individual Characteristics Comparison

Both striated and impressed marks are evaluated for uniqueness. Individualizing features used for comparison and identification of bullets are generally found in the rifling impressions and occasionally in other areas.

7.4.3.7 Determination of Number of Weapons Involved

All bullets in the same case submission shall be inter-compared in order to determine the number of possible weapons involved.

7.4.3.8 Interpretation/Reporting of Results

7.4.3.8.1 AFTE Theory of Identification

Theory of identification as it relates to comparative evidence enables a conclusion of common origin of two toolmarks to be reached when the unique surface contours of the toolmarks are in "sufficient agreement" and the potential for subclass characteristics influence has been considered and eliminated.

"Sufficient agreement" is related to the significant duplication of individualizing characteristics as evidenced by the correspondence of a pattern or combination or patterns. In striated toolmarks, correspondence of a pattern can be demonstrated by the presence of consecutive matching striae (CMS).

The relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrow or other irregularities within one set of toolmarks are evaluated and compared to the corresponding features in the second set of toolmarks.

Agreement is determined to be significant when it exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool.

The statement "sufficient agreement" exists between two toolmarks means the likelihood another tool could have made the mark is so unlikely as to be considered a practical impossibility.

7.4.3.8.2 Subclass Characteristics

Subclass characteristics are defined as discernable surface features of an object that are more restrictive than class characteristics in that they are:

- Produced incidental to manufacture
- Are significant in that they relate to a subset of the class to which they belong
- Can arise from a source that changes over time

7.4.3.8.2.1 Examples include: bunter marks, cut rifling grooves, extrusion marks on pipe, etc. Exercise caution in distinguishing subclass characteristics from individual characteristics.

7.4.3.8.2.2 If identification-quality correspondence exists between the evidence and test fired components, but subclass potential cannot be eliminated, an identification to a particular firearm cannot be made.

7.4.3.8.2.2.1 Qualify such an association with a statement that indicates the evidence mark was made by a limited number of firearms that includes the evidence firearm.

7.4.3.8.3 Consecutive Matching Striae (CMS)

Consecutive Matching Striae (CMS) is a useful tool that can be used to document the level of correspondence between two striated toolmarks and should be recorded with photographs, diagrams or notes.

7.4.3.9 Cleaning Methods

7.4.3.9.1 Blood Cleanup

Blood can cause difficulties in visualization and may compromise microscopic examination. Any number of solutions can be used to clean blood from your sample.

7.4.3.9.1.1 Tergazyme

- Add 7.5 grams of Tergazyme to 1L of water heated to approximately 50C.
- Soak sample in solution for 30-60 minutes or until you obtain desired results. Rinse the sample with warm water and set aside to dry.

7.4.3.9.1.2 Haemo-sol

- Add 3.9 grams of Haemo-sol to 1L of water heated to approximately 50C.
- Soak sample in solution for 30-60 minutes or until you obtain desired results. Rinse the sample with warm water and set aside to dry.

7.4.3.9.1.3 10% Ammonium Hydroxide

- Depending on the concentration of the NH_4OH, usually around 320mL NH_4OH to 680mL of deionized water.
- Soak sample in solution for 30-60 minutes or until you obtain desired results. Rinse the sample with warm water and set aside to dry.

7.4.3.9.2 Rusty Firearms

Rusty firearms or those found in water may be submitted for examination. To prevent further damage to the firearms, immediate attention should be given to firearms that are recovered from water. The examiner should instruct the agency that recovers the firearm to submit the firearm in a container of the fluid it was found/recovered from. If this is not possible:

7.4.3.9.2.1 Soak or spray the firearm with a water displacing product such as WD-40, SiliKroil or Kroil.

7.4.3.9.2.2 If needed, chemicals suitable for removing rust may be used.

7.4.3.9.2.3 Document if the firearm is too rusted to be functional and all methods used to clean the firearm.

7.4.4 Serial Number Restoration

Many valuable items manufactured today have serial numbers for identification. These numbers are usually die stamped. Stamping a serial number in metal deforms the metal below the surface of the visible number. Serial numbers are removed and/or obliterated in a variety of ways. Enhancements in the contrast can result in the visualization of an obliterated serial number during the restoration process.

7.4.4.1 Polishing

It is desirable to remove (polish) the grinding and filing scratches introduced during obliteration. The polishing procedure can be effective independently but is more often used in conjunction with various chemical or magnetic procedures.

7.4.4.1.1 Method

7.4.4.1.1.1 Initial inspection of the serial number area for coatings, trace material or any character remnants as well as possibly determining the method of obliteration.

7.4.4.1.1.2 The following shall be documented, if applicable:

- Method of obliteration
- Location of obliteration
- Initial observations. Document with a sketch, photo or written description.
- Medium obliteration found in/on (magnetic/non-magnetic)

7.4.4.1.1.3 Note and record any visible characters prior to polishing.

7.4.4.1.1.4 Polish the area of the obliteration using either a:

- Dremel type tool with a sanding/polishing disc.
- fine grit sandpaper.

7.4.4.1.1.5 Depending on the extent of the obliteration, continue polishing until the surface is mirror-like removing all scratches. If the obliteration is severe it may not be possible or desirable to remove all of the scratches.

7.4.4.1.2 Interpretation of results

7.4.4.1.2.1 If any characters become visible document these characters, preferably with photographs. If unable to photograph, a second observer can confirm results.

7.4.4.1.2.2 If characters do not become visible, proceed to the appropriate chemical or magnetic restoration procedure.

7.4.4.2 Chemical Restoration

The chemical restoration procedure is suitable for restoration of serial numbers in metal. The die stamping process is a form of "cold-working" metal. A side effect of cold-working is the decrease of that item's ability to resist chemical attack. Therefore, the utilization of chemical etching will affect the compressed area of the obliterated number faster and to a greater degree than the non-cold worked area surrounding it. This procedure, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in metal.

7.4.4.2.1 Reagent Preparation

The following reagents are the most common reagents used for serial number restoration. Other acceptable reagents used for serial number restoration can be found in literature provided by the FBI, AFTE, and the "Handbook of Methods for the Restoration of Obliterated Serial Numbers" by Richard S. Treptow. Varying the reagent concentrations is acceptable.

7.4.4.2.1.1 The reagent lot numbers used for serial number restoration will be recorded in the examiner's case notes on the day they were used.

7.4.4.2.1.1.1 Fry's Reagent

90 grams Cupric Chloride (CuCl2)
Add 100 mL distilled water (H20)
Add 120 mL Hydrochloric Acid (HCl)

7.4.4.2.1.1.2 Turner's Reagent

2.5 grams Cupric Chloride (CuCl2)
Add 40 mL Hydrochloric Acid (HCl)
Add 25 mL Ethyl Alcohol
Add 30 mL distilled water (H20)

7.4.4.2.1.1.3 Davis Reagent

5 grams Cupric Chloride (CuCl2)
Add 50 mL distilled water (H20)
Add 50 mL Hydrochloric Acid (HCl)

7.4.4.2.1.1.4 Griffin's Reagent

30 grams Cupric Chloride (CuCl2)
Add 30 mL distilled water (H2O)
Add 30 mL Hydrochloric Acid (HCl)
Add 120 mL Methanol

7.4.4.2.1.1.5 Acidic Ferric Chloride Solution

25 grams Ferric Chloride (FeCl3)
Add 100 mL distilled water (H20)

Add 25 grams Hydrochloric Acid (HCl)

7.4.4.2.1.1.6 25% Nitric Acid Solution

75 mL distilled water (H20)
Add 25 mL Nitric Acid (HNO3)

7.4.4.2.1.1.7 Ferric Chloride Solution

25 grams Ferric Chloride (FeCl3)
Add 100 mL distilled water (H20)

7.4.4.2.1.1.8 Nitric and Phosphoric

6 mL Nitric Acid (HNO3)
94 mL Phosphoric Acid (H3PO4)

7.4.4.2.1.1.9 10% Sodium Hydroxide Solution

100 mL distilled water (H2O)
Slowly add 10 grams Sodium Hydroxide (NaOH)

7.4.4.2.2 Method

7.4.4.2.2.4 Utilize appropriate chemical reagent and document reagents used.

Magnetic Media

- Fry's reagent
- Turner's Reagent
- Davis reagent
- 25% nitric acid
- Griffin's Reagent

Non-Magnetic Media

- Ferric chloride
- Acidic ferric chloride
- 25% nitric acid
- 10% sodium hydroxide
- Nitric and phosphoric

7.4.4.2.2.5 Apply the chemical solution to the area of obliteration with swabs that have been moistened with the chemical solution.

7.4.4.2.3 Interpretation of Results

7.4.4.2.3.1 List all characters restored. List all possibilities for partial characters restored.

7.4.4.2.3.2 Photographs are the recommended documentation. If unable to photograph, a second observer sign off is recommended.

7.4.4.2.4 Controls

It will be determined that the reagents are functioning if there is a positive reaction with the metal in a serial number restoration.

7.4.4.3 Magnetic Restoration

The Magnaflux® technique is used to detect surface or subsurface flaws in iron or steel. Magnetic particles, applied to a magnetized specimen, outline the obliterated characters in a successful restoration. A side effect of cold-working is the increase of that item's magnetism. Therefore, the utilization of this method will affect the compressed area of the obliterated number rather than the non-cold worked area surrounding it. This procedure, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in magnetic metal. The Magnaflux® technique is nondestructive and can be applied without hindering other restoration methods.

7.4.4.3.1 Method

7.4.4.3.1.1 Determine whether the specimen is suitable for testing with Magnaflux® by placing a magnet on the area of obliteration. The specimen is suitable if it can be magnetized.

7.4.4.3.1.2 Clean the area of obliteration. Allow this to dry before proceeding.

7.4.4.3.1.3 Apply the prepared Magnaflux bath to the area of obliteration with a disposable pipet. Record the lot number of the Magnaflux bath in the case notes on the day used.

7.4.4.3.1.4 Place the magnet behind the area of obliteration, with the poles on either side of the area. This placement may be adjusted to reveal more or different areas of the obliteration.

7.4.4.3.2 Interpretation of Results

List all characters restored or all possibilities for partial characters restored. If any characters do not become visible, proceed to the appropriate chemical restoration procedure.

7.4.5 Distance Determination

When fired, a firearm produces smoke produced from vaporous lead and partially burnt powder. These products can be deposited onto the target in a pattern that changes with distance. Determining the distance between a firearm and its target can be useful for investigative and reconstruction purposes. This pattern can be reproduced allowing the examiner to determine an approximate muzzle to target distance for the original shot. Shotgun pellet patterns can also be reproduced.

When performing distance determinations, the examiner should attempt to replicate the conditions under which the evidence pattern was produced. The suspect firearm and ammunition, if available, shall be used to make the test patterns. If a suspect firearm is not available, a firearm of similar make, model and barrel length should be used, with appropriate documentation. If suspect ammunition is not available, ammunition of similar brand and type should be used if this can be determined.

7.4.5.1 Visual Examination

7.4.5.1.1 Overall photographs, with a scale, of the garment/object as received shall be taken.

7.4.5.1.1.1 Close-up photographs of the damaged area(s) and area(s) containing gunpowder particles shall be taken prior to chemical processing. A scale should be included.

7.4.5.1.2 The visual examination of an item for gunshot residue should include the examination and/or consideration of the following:

- The presence of vaporous lead (smoke)
- The presence of particulate metals (shavings of lead, copper, brass)
- The presence of unburned, burned and partially burned gunpowder
- A hole in the item and/or the location of all holes, tears, etc.
- The presence of a visible ring around the perimeter of holes
- The presence of burning, singeing or melting.
- The presence of any possible masking effects.

7.4.5.1.3 All observations shall be included in the examination notes. Visual examination may be aided with the use of filtered or IR photography, or an alternate light source.

7.4.5.1.4 The following characteristics are indicative of/consistent with a contact shot:

- Ripping or tearing
  - Ripping is characterized as “stellate” or star-shaped tearing as well as three-pointed defects such as “L” or “T” shape
- Burning or singeing
- Melted artificial fibers
- Heavy vaporous lead residues

7.4.5.1.5 The following are limitations that may be observed:

- possible masking effects
- dark background color
- blood staining
- clothing type or material

- adverse handling and improper packaging may affect adherence of particles

7.4.5.2 Microscopic Examination

7.4.5.2.1 The microscopic examination of an item for gunshot residue should include the examination and/or consideration of the following:

- The presence of vaporous lead (smoke)
- The presence of particulate metals (shavings of lead, copper, brass)
- The presence of unburned, burned or partially burned gunpowder
- The presence of melted gunpowder
- The presence of burning, singeing or melting

7.4.5.2.2 **Interpretation of Results**

7.4.5.2.2.1 The following observations are indicative of/consistent with the discharge of a firearm:

- Vaporous lead (smoke)
- Particulate metals
- Unburned, burned and partially burned gunpowder
- Melted gunpowder

7.4.5.3 Chemical Examination

Evidence items should be chemically processed prior to creation of test shots. Cartridge cases and bullets fired during range determination do not need to be collected. If multiple chemical examinations are going to be performed on a single item, they must follow a specific order: Modified Griess, Dithiooxamide, sodium rhodizonate.

7.4.5.3.1 Nitrite Test: Modified Griess

In the modified Griess test a series of chemical reactions results in the conversion of nitrite compounds (the products of incomplete burning of gunpowder) to an orange dye. The pattern is preserved on the test paper for comparison with test patterns.

7.4.5.3.1.1 Preparation of Nitrite Test Paper

<u>Sulfanilic Acid Solution</u>
Dissolve 1.0g of sulfanilic acid in 200mL of water.

<u>1-naphthol solution</u>
Dissolve .056g of 1-naphthol in 200mL of methanol.

Combine equal volumes of the above solutions and pour into a non-reactive photo processing tray.

Dip pre-cut sheets of Inkjet photographic paper into the tray. Drain and set the sheets aside to dry. Store in plastic bags in refrigerator.

7.4.5.3.1.2 Preparation of Nitrite Test Swabs

Dissolve 0.6g of sodium nitrite in 100mL of deionized water.

Soak cotton-tipped ends of swabs in the solution. Set aside and allow to dry. Store in a closed container.

7.4.5.3.1.3 Method

- Place the glossy side of the nitrite test paper facing up. Lay the area of interest against the glossy side of the test paper. Index the paper using features on the item such as seams, cuts, or suspected bullet holes.
- Saturate a piece of filter paper with a 15% acetic acid solution.
- Place the filter paper on the back of the item. See note below.
- Press a hot iron on to the filter paper.
- Separate the nitrite test paper and the item. Examine the test paper for any color change.

NOTE: the order of the layers, starting from the bottom to the top, should be:

- nitrite test paper (glossy side up)
- item (area of interest contacting glossy side of test paper)
- saturated filter paper

After treatment, the filter paper can be tested for the presence of lead.

7.4.5.3.1.4 Reverse Method

- Tape a piece of filter paper to the back of a piece of nitrite test paper.
- Index the test paper by placing the area to be tested down on the glossy side of the nitrite test paper and marking.
- Remove the nitrite test paper from the area to be tested.
- Wipe the finish side of the nitrite test paper with 15% acetic acid
- Replace the nitrite test paper glossy side down onto the area to be tested, realigning the index marks Apply a hot iron to the filter paper on the back of the test paper.

- Separate the nitrite test paper and the item. Examine the test paper for any color change.

7.4.5.3.1.5 Interpretation

The development of an orange color indicates the presence of nitrite.

7.4.5.3.1.6 Controls

The nitrite test paper is quality tested by wetting a nitrite test swab with 15% acetic acid and touching it onto a portion of the nitrite test paper. The development of an orange color confirms the sensitivity of the paper. A blank moistened swab is used as a negative control; no color reaction should occur. The results are recorded in the examination documentation.

7.4.5.3.2 Dithiooxamide (DTO) for copper:

Dithiooxamide (DTO) can detect the presence of copper. When a copper jacketed projectile impacts a surface, trace residual copper may be left behind. DTO will produce a green-grey color in the presence of copper.

7.4.5.3.2.1 Reagent Preparation

Dithiooxamide Solution

0.2% solution dithiooxamide in ethanol (w/v):

- Mix 0.2 g DTO in enough ethanol to make 100 mL

Ammonium Hydroxide solution

- Mix 20 mL concentrated ammonium hydroxide in sufficient deionized water to make 50 mL.

7.4.5.3.2.2 Method

- Place ammonium hydroxide solution on a piece of filter paper until thoroughly dampened.
- Place the filter paper over the area to be tested and apply pressure for approximately 30 seconds. Do not allow movement of the filter paper against the surface of the item.
- Remove the filter paper and spray thoroughly with DTO solution.

7.4.5.3.2.3 Interpretation

Positive: A positive reaction will show a dark greenish-gray color.

Other metals can also be detected with this solution; cobalt will show an amber color and nickel will show a violet color.

Negative: No color change should be observed.

7.4.5.3.2.4 Controls

Positive: Wet filter paper with the ammonium hydroxide solution and rub it on a known piece of copper, then add the DTO solution.

Negative: Wet filter paper with the ammonium hydroxide solution, and then add the DTO solution.

Working solutions will be checked at the time of use.

7.4.5.3.3 Sodium Rhodizonate (NaRho) for lead

Sodium Rhodizonate (NaRho) allows lead-containing residues in bullet wipe and/or projectile impact sites to be made visible by a color reaction. Lead will produce a pink color after the addition of Sodium Rhodizonate, followed by a violet color after the addition of hydrochloric acid.

7.4.5.3.3.1 Reagent Preparation

<u>Saturated solution</u>
Saturate water with sodium rhodizonate (.27g in 200ml water or until the color of iced tea)

<u>Hydrochloric Acid Solution</u>
Hydrocholoric acid 5 mL
Deionized water 95 mL

<u>pH 2.8 Buffer Solution</u>
Sodium bitartrate 1.9 grams
Tartaric acid 1.5 grams
Deionized water 100 mL
*This may require heat and agitation.

<u>Acetic Acid Solution</u>
Glacial acetic acid 15 mL
Deionized water 85 mL

7.4.5.3.3.2 Method

- Dampen filter paper and apply to item or moisten the questioned area of the item with acetic acid solution.
- Apply sodium rhodizonate solution to the filter paper or sample.
- The buffer solution may be applied to remove the yellow background color.
- Apply hydrochloric acid solution to the sample.

7.4.5.3.3.3 Interpretation

Positive: A positive reaction will show a pink color after the addition of sodium rhodizonate and a violet or purple color after the addition of the hydrochloric acid. Results can fade quickly.

Negative: No color change should be observed

7.4.5.3.3.4 Controls

Positive: Wet filter paper with acetic acid and apply to a sample with known lead, and then apply solutions as listed above.

Negative: Wet filter paper with acetic acid and apply other solutions listed above.

Working solutions will be checked at the time of use.

7.4.5.3.4 Bashinsky Transfer Method

The following transfer method of the Rhodizonate test can be used. It is best used on items that are dark in color, when direct application of the reagents to the evidence is not desirable, or when also testing using the Modified Griess test.

7.4.5.3.4.1 Method

- Place filter paper on the area of the item to be tested. Index the paper using features on the item such as seams, cuts, or suspected bullet holes.
- Remove the filter paper and dampen it with 15% acetic acid.
- Apply the dampened filter paper on the area to be tested using the index marks and cover with several layers of dry filter paper and iron until dry.
- Remove the filter paper that was in direct contact with the item and spray it with saturated rhodizonate solution. The filter paper can be sprayed with the pH 2.8 buffer solution to remove the yellow background color. Document the results promptly as color changes may fade.

7.4.5.3.4.2 Interpretation

Positive: A positive reaction will be a rapid formation of a pink color.

The presence of lead can be confirmed by applying the 5% HCl solution to the questioned item. A color-change from pink to violet-blue confirms the presence of lead.

Negative: No color change should be observed.

7.4.5.3.4.3 Controls

Positive: Wet filter paper with acetic acid and apply to a sample with known lead, and then apply solutions as listed above.

Negative: Wet filter paper with acetic acid and apply other solutions listed above.

Working solutions will be checked at the time of use.

7.4.5.3.5 Limitations

7.4.6.3.5.1 Possible masking effects include:

- Dark background color
- Blood staining

7.4.6.3.5.2 Clothing type, material, adverse handling or improper packaging may affect adherence of particles and limit the ability to perform range determinations.

7.4.5.4 Test Pattern Production

Using a questioned firearm and appropriate ammunition, it may be possible to replicate a gunshot residue and/or shot pellet pattern(s) present on an evidence item. In conjunction with a working hypothesis formed from the observations of the visual, microscopic and chemical testing of the evidence item(s), test patterns are produced at known distances. The test patterns are then compared to the questioned pattern(s) to determine an approximate bracketed distance the firearm was from the questioned item at the time of firing.

A systematic approach should be used with range determination, weighing the necessary examinations based on the scenario while also considering that shooting evidence is dynamic, can be complicated and has varying conditions of quality.

7.4.5.4.1 Attach an appropriately sized piece of test material to nitrite-free backing board (file folders work well).

7.4.5.4.2 Patterns shall be generated at known distances until an appropriate range of distances or maximum distance can be established. When establishing a range of distances, test patterns shall include distances that generate residues greater and less than those observed on the evidence item.

7.4.5.4.2.1 Digital images of all patterns, with a scale visible, shall be retained in case notes.

7.4.5.4.3 The known test patterns shall be processed using the same methods that were applied to the evidence item.

7.4.5.4.4 **Interpretation of Results**

7.4.5.4.4.1 By utilizing the suspect firearm and appropriate ammunition, it is possible to obtain a reproduction of a gunshot pattern present on an item of evidence. Therefore, one can ascertain the approximate distance that a firearm's muzzle was from the item of evidence at the time it was shot by bracketing the suspect pattern with test patterns at known distances.

7.4.5.4.4.2 A conclusion can be reached by comparing the diameter of the known patterns with the unknown pattern(s). Patterns should be measured with a ruler.

7.4.5.4.4.3 To employ a bracketing technique it is necessary to determine at what distance a smaller known pattern is consistently produced and at what distance a larger known pattern is consistently produced.

7.4.5.4.4.4 A disclaimer shall be noted on the report that the ranges are determined under controlled conditions. Conditions that may have been present during the time of the incident may have an adverse effect on the possible range.

7.4.5.4.4.4.1 Possible scene factors that could affect the pattern range include: weather conditions, dynamic movement of the target material at the time of the shot and non-flat target surfaces. All of these factors may have an influence on the amount of particles detected during analysis versus the amount of particles that may have been present at the time of the incident.

7.4.5.4.5 Reporting Results

Interpreting results from gunshot residue pattern analysis should be approached with caution. Conclusions may be limited by the examiner's ability to reproduce conditions of the shooting or by condition of the evidence. Appropriate conclusions include contact/near contact, reporting a range, further than a given distance and limited information/inconclusive.

7.4.5.4.5.1 Contact/Near-contact

Contact or near contact may be reported based on such factors as bullet hole morphology, presence of muzzle imprint or patterns in GSR from muzzle devices or barrel/cylinder gap.

7.4.5.4.5.2 Reporting a Range

The analytical results are expressed by providing the minimum and maximum distances between which the test patterns resemble the evidence pattern. Beyond the expressed range, the test patterns clearly diverge from the evidence.

7.4.5.4.5.3 Further than a Given Distance

The analytical results are expressed by providing the minimum distance in which the test patterns resemble the evidence pattern in cases in which no gunshot residue was detected. The report should indicate other possible reasons why no gunshot residue may be present, such as the presence of an intervening target.

7.4.5.4.5.4 Limited Information/Inconclusive

The conclusions may be limited by the examiner's ability to reproduce conditions of the shooting or by condition of the evidence. These limitations may not allow a range for muzzle-to-target distance to be defined. The condition of the evidence may also preclude an interpretation.

7.4.6 Sound Suppressor Examination

A sound suppressor is any device designed to reduce the noise of a firearm's discharge. Sound suppressors can either be commercially produced or homemade. While a suppressor is typically a tubular metal device, they can vary in shape, form and construction. They may also be fashioned from other objects such as plastic drink containers or engine mufflers.

7.4.6.1 Initial Examination

7.4.6.1.1 Determine whether preservation of or chemical testing for gunshot residues is probative. If so, collect swabs prior to further examination.

7.4.6.1.2 Inspect the device and document the basic construction without disassembling. A borescope or x-ray machine may be used in order to determine internal construction.

7.4.6.1.2.1 If unable to acquire test fires utilizing the device, then report whether or not the device exhibits characteristics of a suppressor.

7.4.6.1.3 If an appropriate firearm can be coupled with the device, then test fire at least one time with the device in place and one time with the device removed.

7.4.6.1.3.1 Document the conditions and the environment.

7.4.6.1.3.2 Hold as many variables as possible constant (e.g. ammunition, firing location, firing position, etc.)

7.4.6.1.3.3 Document any observations with respect to a reduction in sound.

7.4.6.1.3.4 If the device is permanently attached to the firearm, then a firearm of the same make, model, caliber and barrel length may be test fired in order to compare the level of report.

7.4.6.1.4 After test-firing, the examiner may choose to disassemble the device in order to determine any internal construction components.

7.4.6.2 Reporting of Results

The report should assess whether the submitted device provided a reduction in sound or is capable of providing a reduction in sound based on its design features.

7.4.7 IBIS/NIBIN

7.4.7.1 Types of Entries

7.4.7.1.1 Test fire cartridges created exclusively for IBIS entry will be designated as exemplars. These cartridges may be entered into IBIS by any authorized NIBIN/IBIS operator.

7.4.7.1.1.1 IBIS exemplars will be discarded after entry.

7.4.7.1.2 Following IBIS guidelines and ATF IBIS Data Entry Protocol, requested test fires will be entered in the NIBIN database. The selected cartridge cases may be cleaned with acetone when appropriate and placed in the cartridge case holder of the IBIS unit. When the acquisition in complete, the images are sent to the NIBIN server for correlations.

7.4.7.1.2.1 A manual correlation may be requested as needed. Correlations will be performed and reported.

7.4.7.2 Test Fired Cartridge Cases (Exemplars)

The test fired cartridge cases will be examined microscopically and one will be selected to be entered into NIBIN unless the test fired cartridge cases differ considerably in appearance (i.e. different headstamp or compositions, primer shear on one and not the other, etc). If they differ, two cases may be entered at the discretion of the IBIS user.

7.4.7.2.1 When an ejector is present, the IBIS user should acquire the ejector mark based on the ULTRA ELECTRONICS protocol.

7.4.7.3 Evidence Cartridge Cases

Cartridge cases and firearms recovered in association with a crime for IBIS entry must be submitted and documented as evidence. Any cartridge cases or firearms that meet the ATF criteria for entry will generally be entered.

7.4.7.3.1 For all entries, if two or more evidence cartridge cases are submitted of the same caliber family, the IBIS user will examine the cartridge cases microscopically evaluating the caliber, the class characteristics of the breech face marks and the firing pin impression to determine which item(s) should be entered into IBIS.

7.4.7.3.1.1 When an ejector is present, the IBIS user should acquire the ejector mark. If class characteristics vary or ammunition type varies, a test fire from each group should be entered into IBIS.

7.4.7.4 Reporting of Results

7.4.7.4.1 For entry of only exemplars, no report will be generated.

7.4.7.4.2 For evidence cartridge cases and/or laboratory created test fires, a notation shall be put on the report denoting which items will be/were entered into IBIS/NIBIN.

7.5 Technical Records

7.5.1 Digital Images

7.5.1.1 At least one representative photograph shall be taken illustrating an identification or group of identifications.

7.5.1.1.1 Photographs of a sufficient number will be taken to document an identification when there is correspondence observed in multiple areas.

7.5.1.1.2 Photographs shall delineate the specific item/test #'s for each specimen depicted, the magnification or objective setting and the index orientation.

7.5.1.2 Images generated during the examination are for documentary purposes. They are not considered as evidence, but rather as a supplement to the documentation notes, thus it is not necessary to track images nor is it required to retain all captured images. Notations may be added to an image to specify individual characteristics, measurements, etc. Original images to be included with the case record shall be uploaded to LIMS.

7.5.2 Examination Documentation

Examination records shall include each examination activity performed, to include the sequence and results of each. This will allow for another examiner to evaluate the data, interpret the results and be able to repeat the various steps used by the examiner in the analysis under conditions as close as possible to the original examination.

7.5.2.1 When recording a measurement, the value displayed on the device shall be recorded in its entirety.

7.5.2.2 Test fired bullets and cartridge cases

Tests may be produced from submitted evidence ammunition or laboratory stock ammunition/components. The examination documentation shall contain the types of materials and data that are generated during analysis.

7.5.2.2.1 Test fired components used for comparison purposes are considered evidence and shall be retained.

7.5.2.2.2 Additional ammunition may be test fired and the components retained as non-evidential reference items or retained for training purposes.

7.5.2.2.3 Fired components resulting from function testing do not need to be retained.

7.5.2.2.4 NIBIN test fires

Test fire cartridge cases created exclusively for IBIS entry will be designated as exemplars and do not need to be retained as evidence.

7.5.2.2.5 Bore/chamber casts

Casts produced during the analysis process shall be considered evidence. Any cast produced will be created with a description to include "cast of".

7.6 Evaluation of Measurement Uncertainty

The results of the uncertainty estimations are expressed as a "coverage factor" or "level of confidence".

For a coverage factor (k) of 1, the level of confidence is 68.27% that the true value lies between the measured value and plus or minus the estimated uncertainty.

For a coverage factor (k) of 2, the level of confidence is 95.45% that the true value lies between the measured value and plus or minus 2 times the estimated uncertainty.

For a coverage factor (k) of 3, the level of confidence is 99.73% that the true value lies between the measured value and plus or minus 3 times the estimated uncertainty.

Unless otherwise stated, the estimated uncertainties will be reported with a k factor of 2 (approximately 95% confidence).

7.6.1 Uncertainty of Measurement for Barrel Length and Overall Length

7.6.1.1 An expanded uncertainty is calculated for barrel length and overall length. Many factors (e.g. environmental and facility conditions, reference standards, analytical method factors) are evaluated for potential contribution to the expanded uncertainty of measurement. A reproducibility study is performed as part of the expanded uncertainty. The final expanded uncertainty results are converted to a fraction consistent with the smallest division on the measuring device.

7.6.1.1.1 Using the Precision measuring device, each analyst will measure the reference firearms. The measurement will be recorded to the nearest $1/16^{th}$ or $1/32^{nd}$.

7.6.1.1.2 Records should contain the following:

- The measurand: the barrel length of a firearm and/or the overall length of a firearm
- How traceability is established for the measurand: ruler affixed to Precision measuring device.
- Equipment used: Precision measuring device with a ruler
- Uncertainty components considered: environmental and facility conditions, reference standards, etc.
- Data used in estimate of repeatability, precision, and/or reproducibility: Variation of each measurement from the mean of the measurements made by all examiners on single measurand.
- Calculations performed: The combined standard uncertainty shall be calculated using the Root Sum Squares formula
- combined standard uncertainty, coverage factor, coverage probability, and expanded uncertainty

7.6.1.2 At a minimum, the uncertainty shall be reviewed annually, or upon recalibration of the reference standard, replacement of a reference standard or significant changes to the analytical method.

7.7 Ensuring the Validity of Results

7.7.1 Documentation

7.7.1.1 The case file shall contain the following information:

- description of, the conditions of, and identification of the item analyzed
- where applicable, a statement of the estimated uncertainty of the measurement

7.7.1.2 The appropriate manufacturer's nomenclature should be used for describing a firearms part, ammunition components and tools. The Association of Firearm and Toolmarks Examiners' (AFTE) Glossary should be used for definitions.

7.7.1.3 The correspondence of class characteristics between two items of evidence shall be recorded with notes, photographs and/or worksheets. The following shall be included in the documentation:

- Identify the areas of correspondence relied upon to make all bullet identifications. Where only small areas of correspondence are found, record the relative positions of test and evidence bullets using assigned land and groove numbers and by indicating areas within the land or grooves with annotations on sketches or photographs.
- Identify the areas of correspondence relied upon to make all cartridge case identifications. This should include identification of the gun's working surface that created the mark(s).
- Results which are transitory or do not store well, such as chemically treated gunshot residue transfers, should be recorded using sketches, photocopies or photography.

7.7.2 Verifications

7.7.2.1 When identification or inconclusive conclusions are made, the conclusions shall be reviewed and confirmed by a second qualified analyst.

7.7.2.1.1 Verifications may be done by direct examination (evidence bullet vs. test fired bullet through the comparison microscope) or by reviewing photographs taken to support the conclusion.

7.7.2.1.2 The verification shall be documented in the case file.

7.7.3 Reagents

The preparation of any reagent shall be documented in the Reagent Preparation Log.

7.7.3.1 After preparation, the reagents shall be tested for reliability prior to use in casework. The result, date and initials shall be recorded in the Reagent Prep Log. For reagents that are prepared fresh for each examination, the test result shall be recorded in the examination documentation.

7.7.3.1.1 The following reagents shall be checked every three months to ensure reliability, if not made fresh for each examination. It will be determined that the reagents are functioning if there is a positive reaction with metal.

- Fry's Reagent
- Turner's Reagent
- Davis's Reagent
- Acidic ferric chloride

- Ferric chloride solution
- Hydrofluoric acid solution
- Cupric chloride in nitric acid
- Griffin's Reagent

The routine checks shall be documented in the Reagent Prep Log.

7.8 Reporting the Results

7.8.1 The report shall contain the following information:

- A description of all items received in the case
- Description of items collected or created during analysis, to include item number.

7.8.2 The following AFTE Range of Conclusion statements shall be reported when applied to bullet, cartridge case and/or any other "toolmark" comparison(s):

Identification
Agreement of a combination of individual characteristics and all discernable class characteristics where the extent of agreement exceeds that which can occur in the comparison of toolmarks made by different tools and is consistent with the agreement demonstrated by toolmarks known to have been produced by the same tool.

Inconclusive
Some agreement of individual characteristics and all discernable class characteristics, but insufficient for an identification.

Agreement of all discernable class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency or lack of reproducibility.

Agreement of all discernable class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

Elimination
Significant disagreement of discernable class characteristics and/or individual characteristics.

Unsuitable
Unsuitable for microscopic comparison.

7.8.3 Date of receipt of items is not critical to the validity and application of test results and does not need to be reported.

7.9 Complaints

See ACSO Forensic Lab Quality Assurance Manual

7.10 Nonconforming work

See ACSO Forensic Lab Quality Assurance Manual

7.11 Control of data and information management

See ACSO Forensic Lab Quality Assurance Manual

8.0 Management System Requirements

See ACSO Forensic Lab Quality Assurance Manual

Firearms Analytical Method History

Issuing Authority: Forensic Lab Manager

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