ARKANSAS STATE CRIME LABORATORY

FIREARMS & TOOLMARK QUALITY MANUAL

Executive Director:

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Section 1.0 Introduction

The purpose of this Quality Manual is to establish general guidelines for the handling of firearms, tool mark evidence, serial number evidence; the examination of firearms evidence, tool mark and serial number evidence; the reporting of firearms, tool mark and serial number results; and the response to court commitments.

Goal

It is the goal of firearm examiners to insure the quality, integrity, and accuracy of the examination and analysis of firearm and tool mark evidence through the implementation of a Quality Assurance Program and to:

1. Provide such services to law enforcement agencies, attorneys, and courts in criminal matters in accordance with the policies of the laboratory.
2. Provide expert witnesses for criminal judicial proceedings in accordance with the policies of the laboratory.

Objective

It is the objective of the Quality Assurance Program to:

1. Monitor, on a routine basis, the examinations and analyses of the firearms examiners by means of quality control standards and proficiency tests.
2. Verify that all section protocols and procedures are within established performance criteria, that the quality and validity of the analytical data are maintained and that the raw data gathered provides a sound foundation for reliable conclusions.
3. Ensure that problems are noted and that corrective action is taken and documented.

1.1 Organizational and management structure

Refer to FA-DOC-03 for Firearms Section Organization & Management Structure

Section 2.0 Personnel Qualifications and Training

2.1 Job Description- See Employee History Binder

2.2 Educational Requirements

2.2.1 Chief Firearms Examiner

The position requires a minimum of a four year degree from an accredited college or university with a major in forensic science, criminalistics, or in a physical or natural science and five years of professional experience as a Firearms Examiner in a forensic laboratory.

2.2.2 Firearms Examiner

A four year degree from an accredited college or university with a major in forensic science, Criminalistics, or in a physical or natural science and one year of professional experience as a Firearms Examiner in a forensic laboratory or identification division. In addition, completion of the Association of Firearms and Toolmark (AFTE) Training Program, The Arkansas State Crime Laboratory Firearms Examiner Training Program or a comparable program from another forensic laboratory or institution is required.

2.2.3 Firearms Examiner Trainee

Individuals with a four year degree from an accredited college or university with a major in forensic science, Criminalistics or in a physical or natural science and a broad knowledge and background in firearms is recommended.

2.3 Special Training Requirements

Professional experience as a Firearms examiner in a recognized forensic laboratory, institution, or an identification division may be substituted on a one year work time for one year of the required educational background. The individual must have testified as an expert in the field of Firearms identification in a court of law.

An individual selected as a Firearms analyst trainee must be able to successfully complete the AFTE Training Program, the Arkansas State Crime Laboratory Firearms Training Program or a comparable program from another forensic laboratory or institution is required.

Section 3.0 Facilities

The Firearms section consists of six office areas, two microscope examinations room, GSR/Serial number restoration room, tool room, bullet recovery room, indoor firing room, firearms reference library and a NIBIN firearm processing room.

3.1 Security

Access to all of the office areas, microscope examination room, tool room, bullet recovery room, indoor firing range and a NIBIN firearm processing rooms require a key for access twenty four hours a day.

The firearm reference library is accessed by entry through evidence receiving where a log is maintained regarding entry and exit.

Section 4.0 Evidence Handling

4.1 Scope:

Evidence must be preserved to prevent significant change or alteration during the examination through the completion of analysis. Evidence must be kept secure and the chain of custody must be maintained once an examiner from the Firearms Section has assumed custody of that evidence.

4.2 Classification:

Items submitted or received through the use of a laboratory submission form will be treated as evidence. Ammunition components which have been test fired through firearms for the purpose of examination or entry into the NIBIN computer database will be identified and treated as reference material requiring the identification of the appropriate laboratory case number on the outside package or inside information card.

4.3 Basis:

In order to maintain the security, chain of custody and to prevent change, all evidence must be stored under proper seal, in the proper packaging and in a secure area.

4.4 Procedures For Evidence Handling:

Evidence will be checked out from Evidence Receiving in accordance with evidence policies.

4.4.1 Evidence handling upon initial examination:

- Be aware of all the sections and testing that involves the evidence. Take the necessary precautions to preserve the integrity of the evidence.
- Descriptions of evidence containers, sealing, initials (this includes both outer and inner packaging) and evidence that is to be examined will be recorded in the case notes. Any discrepancies should be noted.
- When evidence containers are opened for examination, opening through the seals of other individuals who handled the evidence should be avoided, if at all possible.
- When evidence containers are opened for examination, the contents should be inventoried. This inventory should be matched to the Crime Laboratory Submission Sheet.
- Discrepancies shall be noted in the examiner's notes. If deemed necessary, the submitting officer or agency will be notified. All case-related communication will be documented on an ASCL-FORM-06 Agency Contact Form.
- Evidence in progress may be stored in lockable cabinets, the tool room, the GSR/Serial number restoration room, and the ammunition storage room. Evidence must be kept in one of these locations for overnight storage.
- Each piece of evidence or its most appropriate proximal container must bear the following identifiers:

1. Laboratory number (e.g. YYYY-000000)
2. Laboratory (section) Item number
3. Examiner's initials

- If reusing the original container is impractical, a new evidence container may be used. It shall also be marked and sealed according to laboratory procedures and the original evidence packaging shall be maintained, either inside the second evidence container or complete documentation along with a picture of original packaging. Documentation of the change in packaging along with description must be entered into the case file for future reference.
- The evidence will be returned to Evidence Receiving in a timely manner after completion.
- All pertinent information about the evidence will be recorded in the examiner's notes. Case documentation must be sufficient to allow a technical peer review to be conducted.

Section 5.0 Validation

- Refer to ASCL Lab Wide Quality Manual

Section 6.0 Analytical Procedures

Introduction

This section provides standard procedures for tests and examinations performed by the forensic firearms and tool marks examiner. These procedures may involve hazardous materials, operations and equipment. These procedures do not purport to address all of the safety problems associated with its use. It is the responsibility of the user of these procedures to establish appropriate safety and health practices and determine the applicability and normal limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered (see ASCL Health and Safety Manual for safety requirements). Personal protective equipment includes, but is not limited to: lab coats, latex or nitrile gloves, safety glasses, and hearing protection devices. The examiner must consider the practicality and/or desirability to wear some form of bullet resistant clothing. Proper caution should include strict adherence to the ASCL Health and Safety Manual.

6.1 Firearms Identification Protocols

6.1.1 Physical Examination and Classification of Firearms

- **Other Related Procedures**
  - Safe Firearm Handling
  - Pre-Firing Safety Checks
  - Trigger Pull Examination
  - Barrel and Overall Length Measurements

6.1.1.1 PROCEDURE or ANALYSIS

- The initial examination of any firearm will include the completion of a firearm worksheet. This worksheet will include the manufacture data, if available, of the firearm and will serve as a source to document the condition of the firearm as received and any tests performed to or with the firearm.
- The firearm worksheet may also include determining the following when appropriate:
  - Location and type of trace evidence
  - Caliber/Gauge
  - Make/Model
  - Serial Number
  - Firing Mechanics
  - Type of Action
  - Safeties
  - Operating Condition
  - Trigger Pull

- Rifling Characteristics
- Barrel Length
- Overall Length
- Any other data as per Appendix 4.

6.1.2 Safe Firearm Handling

Firearms evidence in the laboratory environment must be handled correctly and treated with respect. Occasionally, loaded firearms are received in evidence for a particular examination. These, of course, need very special handling. **All firearms must be treated as though they are loaded**. This rule cannot be over stressed and must be followed at all times, whether it's in the evidence receiving area, firearms section, test firing area or in court. Safe firearm handling within the laboratory environment corresponds with safe firearm handling in general. The only way to prevent accidents is to practice safety at all times.

- **OTHER RELATED PROCEDURES**
  - Physical Examination and Classification of Firearms
  - Pre-Firing Safety Checks
  - Trigger Pull Examination
  - Barrel and Overall Length Measurements

6.1.2.1 PROCEDURE or ANALYSIS

- The muzzle of the firearm must always be pointed in a safe direction.
- Prior to any examination, regardless of which section is receiving the firearm, a competent individual must ascertain the loaded or unloaded condition of the firearm. This process must be accomplished before the firearm is received by the laboratory.
- Test firing or any examination of the firearm that utilizes live ammunition, or a live ammunition component, will only be performed in designated test firing areas.
- A firearm will not be placed in the evidence vault or returned to any agency in either a loaded condition or prior to its loaded or unloaded condition being checked.

6.1.2.2 REFERENCES

- "A Guide to Firearms Safety", A Safety and Educational Publication of the National Rifle Association, May 1994.
- "Technical Protocols for the Handling of Firearms and Ammunition", FBI, June 1992.

6.1.3 Pre-Firing Safety Examination

It is the responsibility of the firearm examiner to ensure that all appropriate safety function checks are performed on a firearm or item of ammunition prior to test firing. The following is a list of safety checks, which shall be considered. The examiner must be mindful that individual case situations may require a more extensive function test process than that which is listed here.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling

6.1.3.1 PROCEDURE or ANALYSIS

- Deciding whether or not a firearm can be safely test fired from the normal hand held position
  - Is the chamber/bore clear?
  - Are there any signs of cracks or weaknesses in major parts of the firearm; such as the frame, slide or barrel?
  - Does the firearm function, lock-up or dry fire as you would expect it to?
  - Is the correct ammunition being utilized?
- Is it appropriate to utilize the evidence ammunition?
  - Are there signs of reloading? If so, reconsider the need to test fire the evidence ammunition.
  - Are there splits in the cartridge case neck and/or other significant damage to the cartridge case?
  - Is the ammunition of the correct caliber? This assessment of caliber cannot be based on the head stamp!
  - Are there existing toolmarks on pertinent surfaces of the ammunition?
  - Is the ammunition needed for other tests; i.e., range determinations?
- Muzzle Loaders.
  - Does the chamber/barrel appear sound?
  - Do the percussion nipples have oversize flash holes?
  - If a black powder firearm is received in the loaded condition, it must have the bullet and charge removed. It may then be properly loaded prior to test firing.
  - Is this an "original" muzzleloader or a modern reproduction? "Originals" must always be remote fired.

6.1.3.2 INTERPRETATION OF RESULTS:

If any of the above considerations cannot be answered with a clear "yes" or otherwise rectified and test firing is necessary, that firearm must be remote fired.

6.1.4 Trigger Pull Examination

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 vital information regarding the mechanical operating condition of the firearm. The trigger pull of a firearm can be obtained utilizing standard trigger weights, which make contact with the trigger at a point where the trigger finger would normally rest.

- **OTHER RELATED PROCEDURES**

- Physical Examination & Classification of Firearms
- Safe Firearm Handling

- **INSTRUMENTATION**
  - Standard Trigger Weights
  - Spring Gauge

6.1.4.1 PROCEDURE or ANALYSIS

The trigger pull examination normally is conducted after the firearm has been successfully test fired. There is a remote possibility that the firearm may be damaged during this examination.

- **SINGLE ACTION TRIGGER PULL WITH STANDARD TRIGGER WEIGHTS**
  - Insure that the firearm is unloaded.
  - Cock the firearm.
  - Hold the firearm with the muzzle vertical.
  - Rest the trigger hook of the standard trigger weight hanger on the trigger where the average finger would normally rest, making sure it is not touching any other part of the firearm, with the weights hanging parallel to the bore of the firearm.
  - Add the weights until the sear releases.
  - Check two or three times, resetting the sear connection after each attempt. Record the heaviest weight at which the sear will hold and not release. Record the lightest weight necessary to cause consistent sear release. This will be the trigger pull range. Note any revolver cylinder chamber that alters the trigger pull
  - It should be noted that measuring the trigger pull of a rimfire firearm should not be performed on an empty chamber. A “dummy” cartridge should be used. The examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a “dummy” cartridge in this instance as well.

- **DOUBLE ACTION TRIGGER PULL WITH STANDARD TRIGGER WEIGHTS**
  - Insure that the firearm is unloaded.
  - Hold the firearm with the muzzle vertical.
  - Rest the trigger hook of the standard trigger weight hanger on the trigger where the average finger would normally rest, making sure it is not touching any other part of the firearm, with the weights hanging parallel to the bore of the firearm.
  - Add weights until the weights pull the trigger through the double action sequence and the sear releases.
  - Check two or three times, resetting the sear connection after each attempt. Record the heaviest weight at which the sear will hold and not release. Record the lightest weight necessary to cause consistent sear release. This will be the trigger pull range. Note any revolver cylinder chamber that alters the trigger pull.
  - It should be noted that measuring the trigger pull of a rimfire firearm should not be performed on an empty chamber. A “dummy” cartridge should be used. The

examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a "dummy" cartridge in this instance as well.

- **SINGLE ACTION TRIGGER PULL WITH SPRING GAUGE**
  - Insure that the firearm is unloaded.
  - Cock the firearm.
  - Hold the firearm with the muzzle parallel to the spring gauge.
  - Insure the Spring Gauge indicator is "zeroed".
  - Rest the trigger hook of the Spring Gauge on the trigger where the average finger would normally rest. Make sure it is not touching any other part of the firearm and the Spring Gauge is parallel to the bore of the firearm.
  - Apply pressure to the Spring Gauge, until the sear releases.
  - Check two or three times, resetting the sear connection after each attempt.
  - Record the lightest weight(s) necessary for sear release.
  - Note any revolver cylinder chamber that alters the trigger pull.
  - It should be noted that measuring the trigger pull of a rimfire firearm should not be performed on an empty chamber. A "dummy" cartridge should be used. The examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a "dummy" cartridge in this instance as well.
- **DOUBLE ACTION TRIGGER PULL WITH SRING GAUGE**
  - Insure that the firearm is unloaded.
  - Hold the firearm with the muzzle parallel to the spring gauge.
  - Insure the Spring Gauge indicator is "zeroed".
  - Rest the trigger hook of the Spring Gauge on the trigger where the average finger would normally rest. Make sure it is not touching any other part of the firearm and the Spring Gauge is parallel to the bore of the firearm.
  - Apply pressure to the Spring Gauge, until the sear releases.
  - Check two or three times, resetting the sear connection after each attempt.
  - Record the lightest weight(s) necessary for sear release.
  - Note any revolver cylinder chamber that alters the trigger pull.
  - It should be noted that measuring the trigger pull of a rimfire firearm should not be performed on an empty chamber. A "dummy" cartridge should be used. The examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a "dummy" cartridge in this instance as well.

6.1.4.2 INTERPRETATION OF RESULTS:

The results acquired are only an approximation and a different technique may lead to a different trigger pull weight. The trigger pull is normally recorded to the nearest ¼ pound weight increment.

6.1.4.3 REFERENCES

- Gamboe, Tom, "MAFS Firearms Workshop: Trigger Pull Methods," AFTE Journal, Vol. 18, No. 3, p. 77.
- Rios, Ferdinand and Thorton, John, "Static vs. Dynamic Determination of Trigger Pull," AFTE Journal, Vol. 16, No. 3, p. 84.

6.1.5 Barrel and Overall Length Measurement of a Firearm

Barrel length is defined as the distance between the 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. Barrel length normally should include compensators, flash hiders, etc., if permanently affixed. Overall length of a firearm is defined as the dimension measured parallel to the axis of the bore from muzzle to a line at right angles to the axis and tangent at the rearmost point of the butt plate or grip. Removable barrel extensions, poly chokes, flash hiders, etc., are not part of the measured barrel length or overall length. Care must be taken if any object is placed down the barrel to help expedite the measurement. Only a non-marring item may be placed down the barrel, and only after all other tests are performed.

- **OTHER RELATED PROCEDURES**
  - Physical Examination & Classification of Firearms
- **INSTRUMENTATION**
  - Ruler (and/or)
  - Tape Measurer (and/or)
  - Non-marring Dowel

6.1.5.1 PROCEDURE or ANALYSIS

6.1.5.1.1 BARREL LENGTH

6.1.5.1.1.1 REVOLVERS:

- Measure the distance from the breech end of the barrel to the muzzle, excluding the cylinder. This measurement can be done directly or by placing a non-marring item down the barrel, marking the distance from the breech end of the barrel to the muzzle and measuring this item.
- This measurement will be recorded in inches.

6.1.5.1.1.2 FIREARMS OTHER THAN REVOLVERS:

- Measure the distance from the breech face in a closed and locked position to the muzzle. This measurement can be done directly or by placing a non-marring item down the barrel, marking the distance from the breech end of the barrel to the muzzle and measuring this item.
- This measurement will be recorded in inches.

6.1.5.1.2 OVERALL LENGTH:

Measure the distance from the butt to the muzzle. Measurement shall be made parallel to the bore and recorded in inches.

- **INTERPRETATION OF RESULTS:**
  - Measurements obtained should be considered only approximations based on the device used to obtain the measurements.

6.1.5.2 REFERENCES

- "The Proper Method for Measuring Weapons", AFTE Journal, Vol.14, No. 3, p. 10.

6.1.6 Rusty Firearm Examination

Rusty firearms or those found in water, etc. may be submitted for examination. Immediate attention must be given to these firearms to prevent further damage to the firearm. The examiner should instruct an agency recovering the firearm in a fluid such as water, to submit the firearm in a container of the fluid. If this is not practical, the agency can be instructed to immediately and thoroughly spray the firearm with a water-displacing product such as WD-40® or other similar product to prevent further deterioration. It should be noted that the firearm might be too rusted to be functional. Any firearm that cannot be unloaded must be examined in an area designated for firing firearms (preferably a range).

- **OTHER RELATED PROCEDURES**
  - Physical Examination & Classification of Firearms

6.1.6.1 PROCEDURE or ANALYSIS

- An examiner must take all necessary steps to insure that the firearm is unloaded. If it cannot be readily verified to be unloaded it must be examined in an area designated for the firing of firearms. Determining whether or not a firearm is unloaded may necessitate a complete disassembly or in some cases, destruction (e.g. cutting)
- The examiner must determine to what extent restoring the firearm is necessary (i.e., for test firing, for recovering manufacturer information, serial number, etc.).
- Soak the firearm in penetrating oil, de-rusting solvents or similar material.
- Periodically check the firearm until the firearm functions, or the desired information is recovered. Clean the firearm with gun cleaning solvent, cleaning patches and cloth. Care must be taken if any object is placed down the barrel. Only a non-marring item should be placed down the barrel.

6.1.6.2 REFERENCES

- Denio, Dominic, "Making a Rusted Gun Functional," AFTE Journal, Vol. 13, No. 3, p. 29

6.1.7 Sound Suppressor Examination

A silencer or sound suppressor is any device attached to the barrel of a firearm designed to reduce the noise of discharge. Silencers can be commercially produced or homemade. They are typically tubular metal devices, but may vary in shape or form.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling
  - Physical Examination & Classification of Firearms

6.1.7.1 PROCEDURE or ANALYSIS

- Examine device to determine if it is, or is characteristic of, a silencer or sound suppression device.
- Examiner will document and record his/her findings.
- After an initial examination, a report can be issued that the device is, or is characteristic of, a silencer or sound suppression device.
- Testing of a firearm and firearm/silencer combination must be conducted in an appropriate setting, usually a range.
- In many instances the noticeable reduction in sound between the firing of the firearm with the device attached vs. the firing of the firearm without the device is sufficient to determine that the device is a sound suppressor.

6.1.7.2 REFERENCES

- Silencers - A Review And A Look At The State Of The Art," AFTE Journal, Vol. 23, No. 2, p. 668.
- Crum, Richard A. and Owen, Edward M., "Silencer Testing," AFTE Journal, Vol. 21, No. 2, p. 433.

6.1.8 Malfunctioning Firearm Examination

A firearms examiner may be called upon to examine a firearm to determine if the firearm will malfunction. Many of these cases will deal with the question: "Will the firearm fire without pulling the trigger?" In these instances it should be the goal of the examiner to acquire a detailed account of the incident by thoroughly examining and testing the firearm. Examinations may include external and internal observations, or striking or dropping the firearm in attempts to duplicate the incident as reported. The examiner should attempt to conduct his/her examinations in a manner so as not to alter the firearm. However, there may be occasions when damage may occur. Any change to the firearm must be specifically documented in the examiner's notes.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling
  - Primed Cases

6.1.8.1 PROCEDURE or ANALYSIS

No one procedure can sufficiently outline the steps necessary to examine all firearms for any malfunction. However, the following list of examinations should serve as a ***guideline*** for the examiner.

- Physical Check (Condition of Firearm as Received):

- Cocked/Uncocked
- Safety position
- Loaded/Unloaded
- Cartridge Position
- Stuck Cartridges/Discharged Cartridge Cases
- Presence and/or location of flares

- Visual Abnormalities:
  - Barrel (loose, etc.)
  - Receiver (condition)
  - Slide (condition)
  - Parts broken or missing especially:
    - The firing pin
    - The ejector or
    - The extractor
  - Screws (loose or missing)
  - Alterations or adaptations
  - Sights
  - 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 (worn)
    - Trigger pull (single action, double action) and striking of hammer.
  - Safeties: (Drop hammer several times to check below safeties.)
    - ¼ , ½ , Full Cock, Seating check (any false seating positions, pull off/push off, etc.)
    - Grip, magazine, disconnector: function
    - Thumb/Finger – note positions when firearm will fire
    - Rebound hammer or inertia firing pin
    - Position of the slide or bolt in order to fire
    - Condition of safeties
  - Action Check

- Check feeding
  - Magazine
  - Carrier or lifter
  - Feed Ramp
  - Magazine lips, etc.
- Slamfire
  - Extractor and/or Ejector markings on evidence cartridges/discharged cartridge cases
  - Unusual marks exhibited on the cartridges/discharged cartridge cases.
  - Check for any inherent "quirks" known about the particular firearm based on literature or case data.
- Test Fire Firearm (note operation, misfires, etc.):
  - Note any operational problems
  - Ammunition involved (proper cartridge, type, reloads, etc.).
  - Check consistency of the impression on test and evidence.

- Special Situational Tests:
- Care should be exercised when the force to be used in testing could alter or damage internal parts and their working relationship(s). Damage caused by the examiner may prevent the examiner from determining the cause of the reported malfunction.
- Action (Internal)
  - Hammer Notch(s)
    - Worn
    - Burrs
    - Dirt, etc.
  - Sear
    - Worn
    - Broken
    - Burrs, etc
  - Safeties (relationships and general parts relationship)
    - Broken
    - Altered,etc
    - Signs of any tampering or faulty assembly.

6.1.8.2 REFERENCES

- Thompson, Roger C., "Firearms Malfunction Worksheets," AFTE Journal, Vol. 15, No. 1, p. 100.
- American National Standards Institute, Inc., “American National Standard Voluntary Industry Performance Standards Criteria for Evaluation of New Firearms Designs Under Conditions of Abusive Mishandling for the Commercial Manufacturers”. (ANSI/SAAMI Z299.5-1985), November, 1985.

6.1.9 Firearms Reference Library

A Firearms Reference Library, File or Collection is maintained by the laboratory for various scientific reasons, to include:

- To identify the make, model and source of evidence firearms.
- To provide exemplar firearms for various scientific testing purposes which might otherwise compromise an evidence firearm.
- To provide an exemplar resource for training new forensic scientists/evidence technicians or in developing new technology for the scientific examination of firearms.
- To provide a source of firearms parts for the temporary repair of evidence firearms for test-firing purposes.
- To provide a resource for the identification of firearms parts recovered at a crime scene.
- To provide a resource for the location and style of firearm serial numbers.
- **OTHER RELATED PROCEDURES**
    - Safe Firearm Handling
    - Ammunition Reference Collection

6.1.9.1 PROCEDURE or ANALYSIS

A Firearms Reference Library must be maintained under strict regulations and controls. Firearms, which are deemed unsuitable for scientific purposes, should be verifiably destroyed. The laboratory assumes all responsibility for security, control and destruction of these firearms.

A written record should be made immediately upon receipt of a firearm, intended for the reference collection, in a “FIREARM LOG”. This entry should initially include;

- the log number assigned.
- the date received.
- the submitting agency or source of the firearm.
- the receivers initials.

The “FIREARM LOG ” may be produced electronically by spreadsheet. The following data columns may be used in the firearm log books. It is suggested that these columns be kept in the same order as listed below with the log number being the first entry on the left side of the spreadsheet.

- LOG NUMBER:
  - Assigned by the receiving laboratory at the time of receipt of the firearm.
- DATE RECEIVED:
  - Date received at the laboratory.
- AGENCY or SOURCE:
  - The agency or person transferring control of the firearm to the laboratory.
- CALIBER:
  - Caliber or gauge of the firearm.
- MANUFACTURER:
  - Make, brand and manufacturer, if known.
- MODEL:
  - Model number(s) and/or name.
- TYPE:
  - Type of action.
- FINISH:
  - Finish on firearm.
- BARREL LENGTH:
  - The barrel length of the firearm.
- SERIAL NUMBER:
  - The serial number as stamped on the firearm. "NONE" if the serial number does not exist or cannot be found. OBLIT if the serial number has been obliterated.
- COMMENTS:
  - Notes regarding transfers, destruction, location case numbers, etc.

It is recommended that a receipt be issued for every firearm received for the reference library or destruction utilizing a standardized form. The respective log number assigned to each firearm should be recorded on this form. These forms should be maintained in some reasonable order.

Firearms reference library should be displayed and maintained in such a manner as to prevent the firearms deterioration and to facilitate their inventory, safety and control.

All firearms received for reference or disposal should have their assigned log number inscribed on the frame and/or receiver. Furthermore, all firearms placed in the reference library should be tagged in such a manner so as to display that firearm's location within the collection.

It is recommended that a system, whether it be a card file, or a computer data base also be maintained. This will facilitate cross-referencing the collection between various fields.

Great care must be given if the section decides to maintain only a computer database. The historical archive that a Log provides and the difficulty to alter records within a Log must be considered.

6.1.9.2 REFERENCES

- AFTE Glossary, 3rd Edition

6.1.10 Test Firing and Recovery of Test Fires

In order to perform a microscopic comparison of a submitted firearm, a minimum of two (2) test shots should be fired and recovered. Recovery methods include the water tank, and the cotton waste recovery box. The type of firearm and ammunition tested will usually dictate the type of recovery method used. The water recovery tank is usually used to recover bullets from handguns, rifles and slugs fired from shotguns. The cotton waste recovery box is usually used to recover bullets from handguns, rifles and slugs fired from shotguns. The indoor firing range is usually used to test fire firearms when the recovery of the fired projectile(s) is not necessary. One should be aware of the maximum velocity of the projectile that can be fired into a particular water tank, as well as the proper water depth needed for firing. One should be aware of the maximum velocity of the projectile that can be fired into a particular cotton waste recovery box.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling
  - Downloading
  - Primed Cases

MINIMUM ANALYTICAL STANDARDS and CONTROLS

Test fired bullet and cartridge case samples are to be treated as reference material only. If a test fired bullet/cartridge case is used for comparison purposes at a later date, it will be documented on the examiner's report as being a reference bullet/cartridge case previously test fired in the firearm and retained at the Arkansas State Crime Laboratory.

  - Test fire reference collections will be maintained in a secure area accessible by Firearms Section personnel. Archived material will be stored in a secure area in the ASCL Annex.

6.1.10.1 PROCEDURE or ANALYSIS

- A test fire information card will be filled out to include the ASCL case #, item # and identifying information (if available) for the test firearm. The test fire information card will be stored with the test fired bullets and cartridge cases.
- The examiner should consider marking the bullet and cartridge case of each test shot with the;
  - Full or abbreviated laboratory case number and
  - Full or abbreviated item number and/or
  - examiner's initials.

- If the examiner does not, or is unable to, mark the test fired bullet/cartridge case with the above information, then the package containing the test fires and information card will be sealed and initialed.
- The examiner should consider indexing and sequencing each shot and perform these functions if necessary.
- Proper hearing and eye protection must be worn.
- Ensure that the Exhaust fans or system is turned on.
- Ensure all warning systems are activated.
- The examiner should consider the number of cartridges being loading into the firearm during the initial testing of the firearm.
- Ejected discharged cartridge cases **must** be retrieved.
- For Water Tank Recovery
    - Ensure that the water level is appropriate.
    - Ensure that all lids or doors of the water recovery tank are closed and properly secured.
    - Fire the firearm through the shooting port. If the firearm is capable of firing both single and double action modes, a minimum of one (1) shot per mode should be obtained.
    - Recover the bullets using the vacuum tube.
- For Cotton Waste Recovery Box
    - The examiner should consider wetting the first section of cotton in the box.
    - The examiner should consider the placement of paper partitions at various points in box to ensure tracking of the test shot, as well as insuring that the cotton is packed down so as not to retain previous bullet paths.
    - Ensure that all lids or doors of the box are closed and properly secured.
    - Fire the firearm through the shooting port. If the firearm is capable of firing both single and double action modes, a minimum of one (1) shot per mode should be obtained.
    - Bullets should be recovered by searching through cotton, using partitions as guides.
- For Indoor Firing Range
    - If the firearm is capable of firing both single and double action modes, a minimum of one (1) shot per mode should be obtained.
    - The examiner should check the range to make sure no materials are left behind.
- For Remote Firing
    - Set up the chosen remote firing device, as per guidelines set forth by the manufacturer, in front of the appropriate recovery system.

- Place firearm in device. It is recommended that the examiner first dry-fire the firearm in the remote firing device before using live ammunition.
- Activate the remote device while standing behind a protective shield or while standing at a safe distance away from the firearm.
- Obtain fired tests.

6.1.10.2 REFERENCES

- Newquist, Andrew M., "New Bullet Recovery System", AFTE Journal, February 1973, p.9.
- Molnar, S., "A Novel Bullet Recovery Method", AFTE Newsletter, 16, p.17.
- Operators Manual, Water Recovery Tank, CyberNational Inc.
- "Bullet and Cartridge Case Recovery", AFTE Journal, Vol. 16, No. 2, p.75.
- McBrayer, William S., "What? Another Water Tank and Bullet Stop!", AFTE Journal, Vol. 10, No. 2, p.90.
- Biasotti, A. A., "Vise/Rest for Remote Firing," AFTE Journal, Vol. 11, No. 4, p.16.

6.1.11 Downloading

Due to the limitations of a firearms identification section's bullet recovery devices, it may be necessary to reduce or change the powder load of the cartridge in order to obtain a velocity suitable for safely collecting test standards for comparison purposes. Even with a reduced load, it may be necessary to fire the firearm remotely.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling
  - Test Firing and Recovery of Test Fires
  - Primed Cases
- **INSTRUMENTATION**
  - Balance / Scale

6.1.11.1 PROCEDURE or ANALYSIS

Pull the bullet of the cartridge using an inertia bullet puller or a reloading press.

Remove existing powder.

Weigh the pulled bullet.

Consult a reloading manual, such as Lyman, and obtain the powder charge for the weight of the pulled bullet and the new velocity needed.

Weigh out the appropriate powder charge and place in existing cartridge case.

Loosely pack a small piece of tissue or other similar material into the case to fill the gap between the bullet and powder.

Seat the bullet back into the cartridge case using a rubber mallet or a reloading press.

If appropriate powder is not available, a reduced load using 50% of the original powder can be used. It should be noted that great care must be taken when performing this type of downloading. 50% downloading CANNOT be used with slow burning powders. 50% downloading CANNOT be used with many non-canister powders.

When utilizing downloaded ammunition it is imperative that the examiner checks the barrel for obstructions between each firing. The bullet, cartridge case, or shotshell of each test shot should be marked appropriately.

6.1.11.2 REFERENCES

- Lyman Reloading Handbook for Rifle, Pistol and Muzzle Loading, Lyman Gun Sight Products, Middlefield, Conn., 1971.
- "Reduced Powder Loads," AFTE Newsletter, No. 3, p.14.

6.1.12 Primed Cartridge Case/Shotshell

During the course of examining a firearm, it may be determined that it would be unsafe for the examiner to fire the firearm as designed. If it is not necessary to obtain test standards for comparison purposes, the firing condition of the firearm can be tested using a primed empty cartridge case or shotshell.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling
  - Bullet Trap

6.1.12.1 PROCEDURE or ANALYSIS

Obtain a primed empty cartridge case in the desired caliber or pull the bullet of a live cartridge using an inertia bullet puller or reloading press, retaining only the primed cartridge case. For shotguns, obtain a primed empty shotshell in the desired gauge or cut open a live shotshell removing all components, retaining only the primed shotshell.

- Commercial firing pin testing devices are available for shotguns and may be used.

Proper hearing and eye protection must be worn.

Ensure that the Exhaust fans or system is turned on.

Ensure all warning systems are activated.

Load the primed empty cartridge case, primed empty shotshell or commercial firing pin testing device into the chamber of the firearm and test fire in front of the bullet trap.

When utilizing a primed empty it is imperative that the examiner check the barrel for obstructions between each firing.

Repeat if the firearm has more than one action.

Obtain all tests.

6.1.13 Caliber Determination

Caliber, or the base diameter, is one of the class characteristics of a fired bullet. The determination of caliber will aid the examiner during the identification or elimination of a suspect firearm. If no firearm is submitted, the bullet's caliber may be used in determining the General Rifling Characteristics of the firearm involved.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - GRC Utilization
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope
  - Calipers/Micrometer
  - Measuring Projector

6.1.13.1 PROCEDURE or ANALYSIS

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 base diameter of the evidence bullet directly with known fired test standards.
- Measure the base 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 lands and grooves and compare to Appendix G, Table 6, of the AFTE Glossary (current edition is available on the AFTE website).
- 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.

6.1.13.2 INTERPRETATION OF RESULTS:

Caliber is written as a numerical term and will be depicted with the decimal point when applicable. If the base is mutilated, the examiner may only be able to determine that the evidence is consistent with a range of calibers or that the caliber cannot be determined.

6.1.13.3 REFERENCES

- Mathews, J. Howard, Firearms Identification Vol. I, 1973.
- Barnes, Frank C., Cartridges of the World, 7th Edition, 1993.
- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.
- Lutz, Monty C. and Ward, John G., "Determination of Bullet Caliber From an X-ray," AFTE Journal, Vol. 21, No. 2, p. 168.

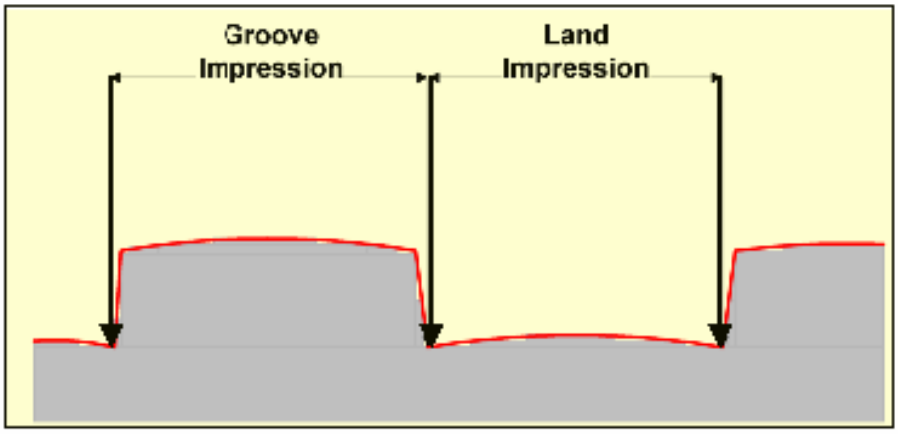
6.1.14 Measuring Land Impression and Groove Impression Widths

One of the class characteristics used in the discipline of firearms identification is the width of the land impressions and groove impressions. These measurements aid the examiner during the identification or elimination of a suspect firearm. If no firearm is submitted, these measurements will be used in determining the General Rifling Characteristics of the firearm involved. The measuring projector procedure utilizes an MP-6 Measuring Projector or equivalent. The comparison microscopes have specific software for measurements. The air gap procedure utilizes a comparison microscope and a micrometer.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - GRC Utilization
- **INSTRUMENTATION**
  - Measuring Projection Scope
  - Comparison microscope
  - Software for the Comparison Microscope
  - Stereo Microscope
  - Ruler/Micrometer

6.1.14.1 PROCEDURE or ANALYSIS

In measuring a fired bullet to determine the width of the land impression or the groove impression, it is paramount that the points used for beginning and ending a measurement comply with the discipline-wide practice. This practice utilizes the anchor points shown below.



- For the Measuring Projection Scope:
  - The fired bullet in question is mounted in the measuring projector's bullet holder.
  - The land impression of the fired bullet is placed in a horizontal position with one of the anchor points corresponding with the measuring projector's alignment grid.
  - Zero the direct reading scale of the measuring projector.

  - Rotate the micrometer, thereby moving the fired bullet laterally, until the next anchor point is reached and record the measurement in thousandths of an inch or to the appropriate measurement standard for the local laboratory.
  - Repeat this procedure for the groove impression.
  - For specific operating instructions on the instrument utilized, consult the operator's manual.
- For the Comparison Microscope using Software
  - The fired bullet in question is mounted in the microscope bullet holder.
  - (For the FSC microscope) The land impression of the fired bullet is placed in a horizontal position with one of the anchor points corresponding with the measuring alignment mark.
  - For the FSC using the Palm emulator and a live image, select the left or right stage position on the PALM emulator, select START and move the fired bullet stage laterally, until the next anchor point is reached and record the measurement in thousandths (mils) of an inch from the PALM emulator.
  - (For the SPOT software) Take a photograph of the desired image with the land impression or groove impression visible.
  - (SPOT software) Draw a measurement line over the portion of interest.. Record the measurement in thousands of an inch.
  - Repeat this procedure for the groove impression.
  - For specific operating instructions on the instrument utilized, consult the operator's manual.
- For Air Gap
  - The fired bullet in question is mounted on one stage of the comparison microscope. The micrometer is mounted on the other stage.
    - Both stages must be using the same magnification level (objective setting) and be in focus.
  - Align the image of the measurement gap (opening) of the micrometer with the image of the appropriate land impression being measured and record the measurement to the nearest hundredth or thousandth of an inch or appropriate measurement.
  - Repeat the above utilizing the groove impression.
- For the Stereo Microscope with a ruler/micrometer
  - The fired bullet in question is either held or mounted on a steady surface beneath the stereo microscope.
  - The land impression at the base of the fired bullet is placed perpendicular to the scale of the ruler.

- Measure the distance between both anchor points of a land impression and record the measurement to the nearest hundredth or thousandth of an inch or appropriate measurement.
- Repeat the above utilizing the groove impression.

6.1.14.2 INTERPRETATION OF RESULTS:

It may be necessary to measure several of each land and groove impression in order to record a reliable measurement.

6.1.14.3 REFERENCES

- U.S. Department of Justice, Federal Bureau of Investigation, NCIC, Criminalistics Laboratory Information System (CLIS) Operating Manual, 1978.
- Unitron MP-6 Operating Manual.
- Leica FSC Operating Manual.
- Leica UFM-4 Operating Manual
- SPOT Operating Manual by Diagnostic Instruments
- Leica Application Suite Software
- Walsh, J. F., "Accuracy, Speed and Conversion in Rifling Measurements," AFTE Journal, Vol. 9, No. 1, p. 50.
- AFTE Newsletter, No. 4, December 1969, p. 28.

6.1.15 National Integrated Ballistic Information Network

The National Integrated Ballistics Information Network (NIBIN) is a computerized system for acquiring and storing the images of unidentified bullets and cartridge cases as well as known bullets and cartridge cases. NIBIN images portions of the surface (land engraved areas) of a bullet and the primer/firing pin and ejector areas of fired cartridge cases using state of the art optical and electronic technology. These images are then stored in databases and sophisticated algorithms are used to correlate the images against each other using filters such as caliber, rifling specifications, date of crime and date of entry. These correlations produce lists of possible matches with the highest score at the top of the list. A firearms examiner or NIBIN technician can then call up the images to compare them side by side on a monitor. If a possible association is found during this screening process then the physical items are compared by a firearms examiner utilizing traditional comparative microscopy techniques. A new employee with the Firearms and Tool Marks section (or subsection Operation Shutdown) cannot use the NIBIN technology until they have been properly trained and received clearance through Forensic Technologies, Inc. and the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). Cautions pertaining to electrical equipment and computer storage media should be observed by anyone utilizing the NIBIN technology.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification of Fired Evidence
  - Examination and Physical Classification of Fired Cartridge Cases

  - Examination and Physical Classification of Fired Shotshells
  - Microscopic Comparison
- **PREPARATION**
  - Cartridge Case – The examiner should consider marking the sides of the cartridge case to indicate where the extractor and/or ejector markings are for proper alignment.
  - Bullet - Mount the bullet in the designated holder with a glue gun as outlined in the IBIS Training Course student handbook.
- **INSTRUMENTATION**
  - Remote Data Acquisition System (RDAS).
- **MINIMUM ANALYTICAL STANDARDS and CONTROLS**
  - In accordance with ASCLD 1.4.1.6 (E), the NIBIN bullet and cartridge case samples are to be treated as reference material only. If a test fired bullet/cartridge case is used for comparison purposes at a later date, it will be documented on the examiner's report as being a reference bullet/cartridge case previously test fired in the firearm and retained at the Arkansas State Crime Laboratory.
    - Test fired bullet and cartridge case reference samples will be maintained in a secure area accessible by Firearms Section personnel. Archived material will be stored in a secure area in the ASCL Annex.

6.1.15.1 PROCEDURE or ANALYSIS

- A test fire information card will be filled out to include the ASCL case #, item # and identifying information (if available) for the test firearm. The test fire information card will be stored with the test fired bullets and cartridge cases.
- The examiner should consider marking the bullet and cartridge case of each test shot with the;
  - Full or abbreviated laboratory case number and
  - Full or abbreviated item number and/or
  - examiner's initials.
- If the examiner does not, or is unable to, mark the test fired bullet/cartridge case with the above information, then the package containing the test fires and information card will be sealed and initialed.
- Cartridge Case – Using the RDAS, open the BRASSCATCHER software and enter the specimen information as outlined in the RDAS operators' manual or the IBIS Training Course student handbook.
- Bullet – Using the RDAS, open the BULLETPROOF software and enter the specimen information as outlined in the RDAS operator's manual or the IBIS Training Course student handbook.
- The examiner must therefore insure that;

  - Any evidence bullet selected for entry into NIBIN must have at least one clear and distinct land engraved area and must have sufficient individual characteristics to be able to affect a match.
  - Any evidence cartridge case selected for entry into NIBIN must have sufficient individual characteristics within the firing pin impression and/or within the breech face marks on the primer to affect a match.
  - If there are more than one matching evidence bullets and/or cartridges cases suitable for entry into NIBIN, the examiner should select the best one for entry or, if necessary, more than one if different individual characteristics reproduce better on different tests.
  - Any information about the identification of evidence bullets/cartridge cases to each other and the selection of certain specimens for entry into NIBIN must be documented within the case notes.
- For Firearms requests, a notification of entry into the NIBIN system will be included in the examiner's report.
- For Operation Shutdown requests, a NIBIN Evidence Evaluation Form (FA-FORM-05) will be completed and attached to evidence that has been processed/evaluated for entry into the NIBIN system.

6.1.15.2 REFERENCES

- RDAS OPERATORS MANUAL
- IBIS Training Course Student Handbook

6.1.16 GRC Utilization

The FBI's General Rifling Characteristics File can be utilized when attempting to determine a list of possible firearms that could have fired an evidence bullet when the correct firearm was not submitted.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - Measuring Land Impression and Groove Impression Widths

6.1.16.1 PROCEDURE or ANALYSIS

The General Rifling Characteristics File can be accessed using the PC software version, or the current printout of the file.

Follow the operating instructions listed specifically within each of the above systems utilizing the caliber and rifling characteristics of the evidence bullet.

6.1.16.2 INTERPRETATION OF RESULTS:

The GRC File is an investigative aid and should not be construed as an all-inclusive list of firearms available with those particular rifling characteristics.

6.1.16.3 REFERENCES

- U.S. Department of Justice, Federal Bureau of Investigation, NCIC, Criminalistics Laboratory Information System (CLIS) Operating Manual, 1978.
- Walsh, J. F., "Accuracy, Speed and Conversion in Rifling Measurements," AFTE Journal, Vol. 9, No. 1, p. 50.
- AFTE Newsletter, No. 4, December 1969, p. 28.

6.1.17 Wadding Determination

By examining wadding, the examiner may be able to determine the gauge size, manufacture, and if the wad contains markings suitable for comparison, the firearm that discharged it.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - Measuring Land Impression and Groove Impression Widths
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope
  - Micrometer
  - Caliper
  - Measuring Projector

6.1.17.1 PROCEDURE or ANALYSIS

- Determine gauge size by;
  - Directly comparing the evidence to known laboratory standards of similar manufacture or composition by comparing the base of evidence to the bases of the standards until a similar size is found.
  - Gauge size can also be determined by measuring the base diameter of the wad and comparing these measurements to known measurements.
- Measurements may be obtained by utilizing a;
  - Caliper
  - The air gap
  - The stereo microscope with ruler/micrometer/caliper
  - The measuring projector.
- Manufacturers' data can be determined by locating information stamped into the wad or by comparing the wad to known laboratory standards.
- Microscopic examination may reveal striations suitable for identification of the wad back to the shotgun that fired it.

- If evidence shotshells are submitted, it may be necessary to disassemble one for the determination of gauge size or manufacturer.
- Record all information on the appropriate worksheet.

6.1.17.2 INTERPRETATION OF RESULTS:

If the wad is mutilated or soaked with blood or other body fluids, the examiner may not be able to specifically determine gauge size. The examiner should also recognize that some manufacturers might duplicate the design of another manufacturer.

6.1.18 Shot Determination

By examining recovered shot pellets, the examiner may be able to determine the actual shot size. The determined size can then be compared to the shot size loaded in submitted live shotshells or to the size that the submitted discharged shotshell was marked to have contained.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - Measuring Land Impression and Groove Impression Widths
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope
  - Micrometer
  - Caliper
  - Measuring Projector

6.1.18.1 PROCEDURE or ANALYSIS

The examiner may use one or all of the below techniques to determine shot size.

- Visual/Microscopic Comparison
  - Determine the total number of pellets received.
  - Determine the composition of the pellets.
  - Determine the number of pellets suitable for comparison purposes. Make note if pellet sizes all appear to be similar in size. If several different sizes are present, determine each specific size.
  - Compare laboratory standards of known shot sizes side by side with the evidence pellets until a known shot size is determined. A stereo microscope may aid in this determination. This can be done one size at a time or several sizes at a time; however, if more than one size is used at a time, care should be taken not to mix up the shot.
  - Record findings on worksheet.
- Comparison by Weight

  - Record the total number of pellets received.
  - Determine the composition of the pellets.
  - Determine the number of pellets suitable for weighing. Make note if pellet sizes all appear similar. If several sizes present, determine each specific size.
  - Weigh the pellets in grams or grains.
  - Divide weight of pellets by total number weighed.
  - Consult known pellet weights in Table 1 of Appendix G of the AFTE Glossary (3rd Edition) and determine shot size, which corresponds to evidence shot.
  - The weight of the evidence pellets can also be directly compared to weight of standards using the same number of pellets until a similar known weight is obtained.
- Measuring Pellet Size
  - Determine the total number of pellets received.
  - Determine the composition of the pellets.
  - Determine the number of pellets suitable for comparison purposes. Make note if pellet sizes all appear to be similar in size. If several different sizes are present, determine each specific size.
  - Choose the best specimen and measure diameter using a caliper and record in hundredths or thousandths of an inch or the appropriate measurement.
  - Consult known pellet sizes in Table 1 of Appendix G of the AFTE Glossary (3rd Edition) and determine shot size, which corresponds to evidence shot.

6.1.18.2 REFERENCES

- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.

6.1.19 Physical Examination & Classification of Fired Bullet/Slug Evidence

The initial examination of any fired bullet/slug evidence will include the completion of a worksheet. These worksheets will include the physical description of the fired evidence and will serve as a source to document the condition of the evidence as received and any tests or comparisons performed.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - Measuring Land Impression and Groove Impression Widths
  - Caliber Determination
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope
  - Micrometer

- Caliper
- Measuring Projector
- Scale/Balance

6.1.19.1 PROCEDURE or ANALYSIS

A worksheet will be filled out according to the appropriate Appendices. This may include noting the following:

- If any trace material is present.
- The caliber.
- The bullet/slug weight should be measured in grains.
- The number of lands and grooves on a fired bullet.
- The direction of twist.
- The measured width of the land impressions.
- The measured width of the groove impressions.
- The composition of the bullet/slug.
- The bullet style.
- The possible manufacturer/marketer of the bullet/slug/projectile.
- A description of the base of the bullet.
- The type and position of cannelures.
- Any extraneous markings to include:
    - Skid Marks
    - Shave Marks
    - Flared Base
    - Other Marks
- The presence of gunpowder and/or powder imprints adhering to the base.
- The condition of the fired evidence as received.
- The suitability of the fired evidence for comparison purposes.

6.1.19.2 REFERENCES

- Howe, Walter, J., "Laboratory Work Sheets" AFTE NEWSLETTER NUMBER TWO, August 1969, p.13.
- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.

6.1.20 Physical Examination & Classification of Fired Cartridge Cases

The initial examination of any fired cartridge case evidence will include the completion of a worksheet. These worksheets will include the physical description of the fired cartridge case and will serve as a source to document the condition of the evidence as received and any tests or comparisons performed.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - Measuring Land Impression and Groove Impression Widths
  - Caliber Determination
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope
  - Micrometer
  - Caliper
  - Measuring Projector
  - Scale/Balance

6.1.20.1 PROCEDURE or ANALYSIS

A worksheet will be filled out according to the appropriate Appendices and individual laboratory policy. This may include noting the following:

- If any trace material present.
- Caliber
- The possible manufacturer/marketer of the item.
- Ignition System
  - Centerfire
  - Rimfire
  - Other
- Shape of cartridge case.
- Description of cartridge case and primer.
- Description of head stamp
- Description of Firing Pin Impression
- Description of other markings, to include:
  - Breech Face Markings
  - Extractor

- Ejector
- Resizing Marks
- Chamber Marks
- Anvil Marks
- Magazine Marks
- Ejection Port Markings
- Other Marks

6.1.20.2 REFERENCES

- Howe, Walter, J., "Laboratory Work Sheets" AFTE NEWSLETTER NUMBER TWO, August 1969, p.13.
- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.

6.1.21 Physical Examination & Classification of Fired Shotshells

The initial examination of any fired shotshell evidence will include the completion of a worksheet. These worksheets will include the physical description of the fired shotshell and will serve as a source to document the condition of the evidence as received and any tests or comparisons performed.

- **OTHER RELATED PROCEDURES**
  - Trace Material Examination
  - Measuring Land Impression and Groove Impression Widths
  - Caliber Determination
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope
  - Micrometer
  - Caliper
  - Measuring Projector
  - Scale/Balance

6.1.21.1 PROCEDURE or ANALYSIS

A worksheet will be filled out according to the appropriate Appendices. This may include noting the following:

- If any trace material is present.
- Gauge/Bore/Caliber
- The possible manufacturer/marketer of the item.

- Ignition System
  - Centerfire
  - Rimfire
  - Other
- Shape of the shotshell.
- Description of the shotshell and primer.
- Description of the head stamp.
- Description of the Firing Pin Impression.
- Description of other markings, to include:
  - Breech Face Markings
  - Extractor
  - Ejector
  - Resizing Marks
  - Chamber Marks
  - Anvil Marks
  - Magazine Marks
  - Ejection Port Markings
  - Other Marks

6.1.21.2 REFERENCES

- Howe, Walter, J., "Laboratory Work Sheets" AFTE NEWSLETTER NUMBER TWO, August 1969, p.13.
- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.

6.1.22 Subclass Characteristics

When examining an item of fired evidence it is important for the examiner to evaluate the markings observed for potential subclass characteristics. Caution should be exercised in distinguishing subclass characteristics from INDIVIDUAL CHARACTERISTICS. Subclass characteristics are discernible features of an object which are more restrictive than CLASS CHARACTERISTICS in that they are:

- Produced incidental to the manufacturing process.
- Are significant in that they relate to a smaller group source (a subset of the class to which they belong).
- Can arise from a source which changes over time.
- Examples may include: bunter marks, broach cut marks, concentric circled breech face marks, etc.

6.1.23 Microscopic Comparison

In order for an examiner to identify an item of fired evidence back to the firearm that produced it, a microscopic comparison utilizing a comparison microscope must be performed. The comparison microscope allows the examiner to place the evidence on one side of the microscope and the known standard on the other side. This procedure may also be used to compare two unknown pieces of fired evidence together to determine if they were made by the same firearm.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification of Fired Evidence
  - Examination and Physical Classification of Fired Cartridge Cases
  - Examination and Physical Classification of Fired Shotshells
  - Trace Material Examination
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope

6.1.23.1 PROCEDURE or ANALYSIS

The procedure steps below do not have to be performed in the order listed; however, all steps must be considered and/or addressed:

- Select the correct objective (magnification) setting and ensure that the objectives are locked in place.
- Select the correct set of oculars (eyepieces).
- The illumination (lights) used must be properly adjusted. Oblique lighting is usually preferred.
- If a firearm is included as part of the evidence, compare the test shots produced from this firearm to determine what microscopic characteristics are reproducing.
- Compare unknown fired evidence to either another piece of unknown fired evidence or a known standard by placing the unknown fired evidence on one stage and the other piece of unknown fired evidence or known standard on the other stage.
- The entire unknown should be considered.
- If an identification is not initially made, the examiner should consider the following factors:
  - Angle of lights
  - Type of lights
  - The need for additional known standards
  - The position of the evidence, the tests or both
  - The possibility of using magnesium

6.1.23.2 INTERPRETATION OF RESULTS:

- A sufficient correspondence of individual characteristics will lead the examiner to the conclusion that both items (evidence and tests) originated from the same source.
- An insufficient correspondence of individual characteristics but a correspondence of class characteristics will lead the examiner to the conclusion that no identification or elimination could be made with respect to the items examined.
- A sufficient disagreement of class and/or individual characteristics will lead the examiner to the conclusion that both items (evidence and tests) did not originate from the same source.
- A lack of suitable microscopic characteristics will lead the examiner to the conclusion that the items are not suitable for comparison.
- All identifications and eliminations must be verified by a second examiner.
    - Verifications will be documented on an ASCL Firearms Verification Form.
- Additional types of documentation that may be considered are as follows:
    - Photomicrograph depicting comparison or characteristics
    - Sufficient notes
    - Diagrams
    - Sketches

6.1.23.3 REFERENCES

- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.
- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.1.24 Trace Material Examination

Fired Evidence recovered during an investigation may contain trace material transferred from the crime scene. This trace material may be in the form of blood, tissue, plaster, paint, hairs, fibers, glass, etc. If trace evidence is present, the examiner should consider contacting the appropriate section to determine if further examination of the trace material is necessary. Removal of trace material may also be necessary to allow the proper examination of the fired evidence.

- **OTHER RELATED PROCEDURES**
    - Examination and Physical Classification of Fired Evidence
    - Examination and Physical Classification of Fired Cartridge Cases
    - Examination and Physical Classification of Fired Shotshells
    - Microscopic Comparison
- **SAFETY CONSIDERATIONS**
    - Refer to the lab wide ASCL Health and Safety Manual

- **INSTRUMENTATION**
  - Scale/Balance
  - Stereo Microscope

6.1.24.1 PROCEDURE or ANALYSIS

- Examine the fired evidence visually and microscopically for any trace material and record in notes.
- Contact appropriate section to determine if further examination of trace material is necessary.
- If further examination of trace material is necessary;
  - Have the appropriate section collect the material. If the appropriate section has agreed for the firearms examiner to remove the trace evidence:
    - Remove material being careful not to damage the fired evidence.
    - Place the removed trace material in a suitable container/packaging for submission to the appropriate section for further examination.
- If the trace material is not going to be retained for further examination, proceed with the following steps that are applicable.
  - For evidence containing blood, tissue or other biohazards, soak the evidence for at least one (1) minute in a 10% bleach solution.
  - Remove loose material by rinsing the fired evidence with methanol or water.
  - Remove plaster by rinsing the fired evidence with methanol or water.
  - Remove paint by soaking the fired evidence in methanol or acetone.

6.1.24.2 REFERENCES

- Howe, Walter, J., "Laboratory Work Sheets" AFTE NEWSLETTER NUMBER TWO, August 1969, p.13.
- Association of Firearm and Toolmark Examiners Glossary, 3rd Edition, 1994.
- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.2 *Range Determination Protocol*

When a firearm is fired, gunshot residues are discharged from the firearm. These residues can be in the form of burnt gunpowder particles, partially burnt gunpowder particles, unburnt gunpowder particles, vaporous lead, and particulate metals. These gunshot residues along with the morphology of the bullet hole can effectively be used in determining the possible muzzle to target distance.

Unless specifically requested by the investigating agency, clothing received from the Medical Examiner's office will not be processed by the Firearms Section for gunshot residue/range determination. A statement will be added to the Firearm's report stating to the effect that: The clothing was not examined at this time. If further examination is deemed necessary at a later date, please re-submit to the Arkansas State Crime Laboratory for examination.

6.2.1 Visual Examination

- **OTHER RELATED PROCEDURES**
  - Microscopic Examination

6.2.1.1 PROCEDURE or ANALYSIS

The visual examination of an item for gunshot residue will 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 partially burnt and/or unburnt gunpowder
- The presence of melted adhering gunpowder
- A hole in the item
- The presence of a visible ring around the perimeter of holes
- The location of all holes, tears, missing buttons, etc.
- The presence of burning or singeing or melting
- The presence of any possible masking effects
- The direction of artifacts surrounding the hole

Data regarding these physical effects and visible residues must be included in the examiners notes.

6.2.1.2 INTERPRETATION OF RESULTS:

- Indicative of/or Consistent with the Discharge of a Firearm.
  - Vaporous Lead (smoke)
  - Particulate Metals (shavings of lead, copper, brass)
  - Unburned Gunpowder (morphology)

    - Melted Adhering Gunpowder
- Indicative of/ Consistent with the Passage of a Bullet.
    - A hole in the item
    - Visible ring around the perimeter of holes
    - Location of all holes, tears, missing buttons, etc.
- Indicative of/ Consistent with a Contact Shot
    - Ripping or Tearing
    - Burning or Singeing
    - Melted Artificial Fibers
    - Heavy Vaporous Lead Residues
    - Location of all holes, tears, missing buttons, etc.
- Possible Masking Effects
    - Dark Background Color
    - Blood Staining
    - Intervening Object
- If the above observations support the findings of a "contact shot" no comparison is necessary.
- If the observations do not support a "contact shot" finding, a working hypothesis will be formed based on the above observations. This hypothesis will be utilized in the comparison procedure.

6.2.1.3 REFERENCES

- Anon., (1970). "Gunshot Residues and Shot Pattern Test", F.B.I. Law Enforcement Bulletin, Vol. 39, No. 9, p.7.
- Dillon, John, H., "A Protocol for Gunshot Residue Examinations in Muzzle-To-Target Distance Determinations", AFTE Journal, Vol.22, No.3, p.32.

6.2.2 Microscopic Examination

- **OTHER RELATED PROCEDURES**
    - Visual Examination
- **INSTRUMENTATION**
    - Stereo Microscope

6.2.2.1 PROCEDURE or ANALYSIS

The microscopic examination of an item for gunshot residue will 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 partially burnt and/or unburnt gunpowder
- The presence of melted adhering gunpowder
- A hole in the item
- The presence of a visible ring around the perimeter of holes
- The location of all holes, tears, missing buttons, etc.
- The presence of burning or singeing or melting
- The presence of any possible masking effects
- The direction of artifacts surrounding the hole

Data regarding these physical effects and visible residues must be included in the examiners notes.

6.2.2.2 INTERPRETATION OF RESULTS:

- Indicative of/ Consistent with the Discharge of a Firearm.
    - Vaporous Lead (smoke)
    - Particulate Metals (shavings of lead, copper, brass)
    - Unburned Gunpowder (morphology)
    - Melted Adhering Gunpowder
- Indicative of/ Consistent with the Passage of a Bullet.
    - A hole in the item
    - Visible ring around the perimeter of holes
    - Location of all holes, tears, missing buttons, etc.
- Indicative of/ Consistent with a Contact Shot
    - Ripping or Tearing
    - Burning or Singeing
    - Melted Artificial Fibers
    - Heavy Vaporous Lead Residues
    - Location of all holes, tears, missing buttons, etc.
- Possible Masking Effects
    - Dark Background Color
    - Blood Staining
    - Intervening Object

- If the above observations support the findings of a "contact shot" no comparison is necessary.
- If the observations do not support a "contact shot" finding, a working hypothesis will be formed based on the above observations. This hypothesis will be utilized in the comparison procedure.

6.2.2.3 REFERENCES

- Anon., (1970). "Gunshot Residues and Shot Pattern Test", F.B.I. Law Enforcement Bulletin, Vol. 39, No. 9, p.7.
- Dillon, John, H., "A Protocol for Gunshot Residue Examinations in Muzzle-To-Target Distance Determinations", AFTE Journal, Vol.22, No.3, p.32.

6.2.3 Infrared (IR) Photographic Examination

The Infrared (IR) Photographic examination is used independently and/or in conjunction with other tests in range determinations. The IR examination utilizes filtered color photography to help distinguish obscure or faint gunpowder patterns. This test detects residue patterns, a product of the incomplete burning of gunpowder, by unmasking the dark colored background to produce a visualization of available residues or patterns.

- **OTHER RELATED PROCEDURES**
  - Visual Examination
- **SAFETY CONSIDERATIONS**
  - This procedure may also involve hazardous materials to include evidence that may be contaminated with a biohazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
  - Proper caution to include strict adherence to the Biological Hygiene Plan in the ASCL Health and Safety Manual must be exercised.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
- **INSTRUMENTATION**
  - Sony DSCF828 Digital camera
  - Hoya R-72 Infrared filter
  - Incandescent light source
- **MINIMUM ANALYTICAL STANDARDS and CONTROLS**
  - NONE

6.2.3.1 PROCEDURE or ANALYSIS

Place the object to be photographed on to a suitable stand (copy) or table and illuminate with a good source of bright incandescent light.(200w). Screw the IR filter onto the end of the camera lens, set the camera to "NIGHTSHOT" and photograph with automatic camera settings. It is recommended that you also take standard B&W or color photographs to document your work.

The IR Photographic examination of an item for gunshot residue will 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 partially burnt and/or unburnt gunpowder
- The presence of melted adhering gunpowder
- A hole in the item
- The presence of a visible ring around the perimeter of holes
- The location of all holes, tears, missing buttons, etc.
- The presence of burning or singeing or melting
- The presence of any possible masking effects
- The direction of artifacts surrounding the hole

Data regarding these physical effects and visible residues must be included in the examiners notes.

6.2.3.2 INTERPRETATION OF RESULTS:

- Indicative of/ Consistent with the Discharge of a Firearm.
    - Vaporous Lead (smoke)
    - Particulate Metals (shavings of lead, copper, brass)
    - Unburned Gunpowder (morphology)
    - Melted Adhering Gunpowder
- Indicative of/ Consistent with the Passage of a Bullet.
    - A hole in the item
    - Visible ring around the perimeter of holes
    - Location of all holes, tears, missing buttons, etc.
- Indicative of/ Consistent with a Contact Shot
    - Ripping or Tearing
    - Burning or Singeing
    - Melted Artificial Fibers
    - Heavy Vaporous Lead Residues

  - Location of all holes, tears, missing buttons, etc.
- Possible Masking Effects
  - Dark Background Color
  - Blood Staining
  - Intervening Object
- If the above observations support the findings of a "contact shot" no comparison is necessary.
- If the observations do not support a "contact shot" finding, a working hypothesis will be formed based on the above observations. This hypothesis will be utilized in the comparison procedure.

6.2.4 Haemo-Sol Cleaning of Bloodstains

The Haemo-sol cleaning is used independently and/or in conjunction with other tests in range determinations. The Haemo-sol cleaning technique is a method of removing blood deposits from bloodstained clothing in an effort to make visible the underlying gunshot residue deposits.

- **OTHER RELATED PROCEDURES**
  - Visual Examination
  - Microscopic Examinations
- **SAFETY CONSIDERATIONS**
  - This procedure may also involve hazardous materials to include evidence that may be contaminated with a biohazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
  - Proper caution to include strict adherence to the Biological Hygiene Plan in the ASCL Health and Safety Manual must be exercised.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
  - If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.
- **PREPARATION**
  - Prepare a 2% weight/volume Haemo-Sol solution
- **INSTRUMENTATION**
  - Scale/Balance

6.2.4.1 PROCEDURE or ANALYSIS

- Place the bloodstained clothing in a shallow tray covering the effected area with the Haemo-sol solution.
- Let soak, undisturbed for 8-12 hours. Carefully pour off Haemo-sol solution and air dry. Filter solution if necessary.

6.2.4.2 INTERPRETATION OF RESULTS:

- With careful treatment, the blood should be removed and the underlying residues should be visible.

6.2.4.3 REFERENCES

- AFTE Journal (Vol26, Num. 1, Jan 1994), GUNSHOT RESIDUE TESTING OF BLOOD STAINED GARMENTS; Hueski, E.

6.2.5 Diphenylamine Test

The Diphenylamine test (DPA) is used independently and/or in conjunction with other tests in range determination. The DPA test utilizes a morphological and color chemistry reaction to indicate the presence of cellulose and nitrates. The DPA test reacts with cellulose to produce a morphological change resulting in a significant swelling to the granule and to produce a dark greenish-blue to nearly black color reaction This test can effectively be used in determining the physical presence of discharged gunpowder particles including the determination of entrance versus exit holes and the presence of gunshot residues.

It should be noted that if multiple chemical examinations are going to be performed on an item they must follow a specific order.

- First- Acetone
- Second- Diphenylamine

- **OTHER RELATED PROCEDURES**
  - Modified Griess - Direct Application Technique
  - Modified Griess - Reverse Application Technique
  - Sodium Rhodizonate Procedure- Bashinsky Transfer Technique (BTT)
  - Sodium Rhodizonate Procedure- Direct Application Technique (DAT)
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
  - If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.
- **PREPARATION**

- **Refer to Firearms and Tool Marks Section Chemicals and Reagents Log for instructions on preparing specific chemicals and reagents.**
- Diphenylamine Solution:
- 100% Acetone.

- **INSTRUMENTATION**
  - Scale/Balance
- **MINIMUM ANALYTICAL STANDARDS and CONTROLS**
  - The Standards & Controls for the DPA test consists of placing a granule of known gunpowder in a spot plate, applying one to two drops of acetone. After the swelling, place one to two drops of diphenylamine solution to the swollen gunpowder and watch for the color change to blue. By performing the DPA test procedure on this test granule the examiner can determine if in fact the DPA test is reacting properly.
    - Standards & Controls will be performed at the time evidence is examined using this process. The controls check will be documented in the examiner's notes.

6.2.5.1 PROCEDURE or ANALYSIS

- Place one granule of gunpowder into a clean spot plate.
- Place one to two drops of acetone onto the granule; observe the swelling of the granule from one to two times its original size and becoming semi-translucent.
- Place one to two drops of Diphenylamine solution onto the swollen particle; observe the color reaction.

6.2.5.2 INTERPRETATION OF RESULTS:

- A swelling of the granule is a positive reaction of acetone with cellulose
- A dark greenish-blue color reaction, corresponding to the swollen area tested, constitutes a positive reaction for nitrates.

6.2.5.3 REFERENCES

- Steinberg, M., Leist, Y., and Tassa, M., "A New Field Kit for Bullet Hole Identification", Journal of Forensic Sciences, Vol. 29, No. 1, p. 169.
- Fiegel, F. and Anger, V., (1972). Spot Tests in Inorganic Analysis, 6th Ed., Elsevier Publishing Co., New York, New York.
- Jungreis, Ervin. V75,(1985), Spot Test Analysis; Clinical, Environmental, Forensic and Geochemical Applications; Wiley-Interscience Publishing, New York

6.2.6 Modified Griess Test

The Modified Griess test is used independently and/or in conjunction with other tests in range determinations. It utilizes a color chemistry reaction to help distinguish obscure or faint gunpowder

patterns. This test detects nitrites, a product of the incomplete burning of gunpowder, by reacting with acetic acid to form nitrous acid. This acid combines with alpha-naphthol and produces an orange-red color reaction.

It should be noted that if multiple chemical examinations are going to be performed on an item they must follow a specific order.

- First- Modified Griess
- Second- Dithiooxamide
- Third- Sodium Rhodizonate

- **OTHER RELATED PROCEDURES**
  - Sodium Rhodizonate Test
  - Dithiooxamide Test
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
  - If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.
- **PREPARATION**
  - **Refer to Firearms and Tool Marks Section Chemicals and Reagents Log for instructions on preparing specific chemicals and reagents.**
  - Sensitized Blank
  - Acetic Acid Solution
  - Nitrite Test Strips
- **INSTRUMENTATION**
  - Scale/Balance
- **MINIMUM ANALYTICAL STANDARDS and CONTROLS**
  - The Minimum Analytical Standards & Controls for the Modified Griess procedure consists of placing a test mark, utilizing a Nitrite Test Strip, on one of the sensitized blanks being used. An immediate orange color should appear on the sensitized blank. This color shift indicates that the sensitized blank is sensitive to the presences of nitrites.
    - Standards & Controls will be performed at the time evidence is examined using this process. The controls check will be documented in the examiner's notes.

6.2.6.1 PROCEDURE or ANALYSIS

- Modified Griess – Direct Application Technique (DAT)

  - Place the sensitized blank (photo paper - emulsion side down or sensitized filter paper) over the area to be tested.
  - Soak a piece of nitrite free cheesecloth or filter paper with the acetic acid solution, and place this over the reverse side of the evidence.
  - Apply heat and pressure with an iron until the acetic acid solution treated paper is dry.
- Modified Griess – Reverse Application Technique (RAT)
  - Wipe the side of the sensitized blank that will be in contact with the questioned area with the acetic acid solution.
  - Place the sensitized blank (photo paper - emulsion side down or filter paper) over the area to be tested.
  - Place a piece of filter paper or nitrite free cheese cloth over either the sensitized blank or evidence depending on what is being used for a blank.
  - Apply heat and pressure with an iron until the acetic acid solution treated paper is dry.

6.2.6.2 INTERPRETATION OF RESULTS:

Any orange, orange-red indications on the paper are the results of the chemically specific test for the presence of nitrite residues

6.2.6.3 REFERENCES

- Dillon, John, "The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrate Compounds in Gunshot Residues", AFTE Journal, Vol. 22, No. 3, p.248.
- Anon., (1970). "Gunshot Residues and Shot Pattern Test", F.B.I. Law Enforcement Bulletin, Vol. 39, No. 9, p.7.
- Fiegel, F. and Anger, V., (1972). Spot Tests in Inorganic Analysis, 6th Ed., Elsevier Publishing Co., New York, New York.

6.2.7 Sodium Rhodizonate Test

The Sodium Rhodizonate is used independently and/or in conjunction with other tests in range determinations. The Sodium Rhodizonate utilizes a color chemistry reaction that is specific for lead and can effectively be used in determining the physical characteristics of bullet holes including the determination of entrance vs. exit holes. Fired bullets passing through clothing and/or other objects often leave traces of lead around the bullet hole. This lead transfer comes from the surfaces of the bullet, the barrel and/or the primer residue. This lead transfer can be in the form of minute particles, a fine coating of powder particles or a fine cloud of vaporized lead. At times this lead transfer is an obvious ring or wipe around the hole but is more often invisible.

It should be noted that if multiple chemical examinations are going to be performed on an item they must follow a specific order.

- First- Modified Griess
- Second- Dithiooxamide
- Third- Sodium Rhodizonate

- **OTHER RELATED PROCEDURES**
  - Modified Griess Test
  - Dithiooxamide Test
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
  - If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.
- **PREPARATION**
  - **Refer to Firearms and Tool Marks Section Chemicals and Reagents Log for instructions on preparing specific chemicals and reagents.**
  - Sodium Rhodizonate Solution
  - Hydrochloric Acid Solution
  - Buffer Solution
  - Acetic Acid Solution
- **INSTRUMENTATION**
  - Scale/Balance
- **MINIMUM ANALYTICAL STANDARDS and CONTROLS**
  - The Standards & Controls for the Sodium Rhodizonate test consists of placing a test mark, utilizing a piece of known lead, on the item to be tested. This test mark must be well away from any holes examined. By performing the Sodium Rhodizonate procedure on this test mark the examiner can determine if in fact the Sodium Rhodizonate solution is reacting properly and whether the item being tested will produce any false positives/negatives.
    - Standards & Controls will be performed at the time evidence is examined using this process. The controls check will be documented in the examiner's notes.
  - An alternative set of Standards & Controls for the Sodium Rhodizonate test consists of utilizing cotton swabs dampened with a 5% Hydrochloric acid solution. One of the treated swabs is rubbed against a piece of known lead. This swab is then processed with the Sodium Rhodizonate test to insure that the test is reacting properly. Another treated swab is rubbed on the item to be tested. This must be well away from any holes examined. This swab is then processed with the Sodium Rhodizonate test to insure that the item being tested will not produce a false positive.
    - Standards & Controls will be performed at the time evidence is examined using this process. The controls check will be documented in the examiner's notes.

6.2.7.1 PROCEDURE or ANALYSIS

- Sodium Rhodizonate – Direct Application Technique (DAT)
  - Spray the Sodium Rhodizonate Solution on to the questioned area.
  - Spray the tested area with the Buffer Solution.
  - Spray the tested area with the Hydrochloric Acid Solution.
- Sodium Rhodizonate – Bashinsky Transfer Technique (BTT)
  - Uniformly dampen a piece of filter paper with the Acetic Acid Solution.
  - Place the treated filter paper over the hole/area to be tested.
  - Place a second piece of filter paper over the first and apply moderate pressure or apply a hot iron for approximately 5 seconds.
  - Remove both pieces of filter paper and perform the treatment steps as outlined above in the Direct Application Technique.
- Repeat this process on all holes/areas to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.

6.2.7.2 INTERPRETATION OF RESULTS:

A violet or purple colored ring, corresponding to the margin of the hole, or a violet or purple colored stain, corresponding to the area tested constitutes a positive reaction for lead.

6.2.7.3 REFERENCES

- Dillon, John, "The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrate Compounds in Gunshot Residues", AFTE Journal, Vol. 22, No. 3, p.248.
- Anon., (1970). "Gunshot Residues and Shot Pattern Test", F.B.I. Law Enforcement Bulletin, Vol. 39, No. 9, p.7.
- Fiegel, F. and Anger, V., (1972). Spot Tests in Inorganic Analysis, 6th Ed., Elsevier Publishing Co., New York, New York.

6.2.8 Dithiooxamide (DTO) Test

The Dithiooxamide (DTO) test is used independently and/or in conjunction with other tests in range determination. The DTO test utilizes a color chemistry reaction to indicate the presence of copper. The DTO test reacts with copper to produce a dark greenish-gray to nearly black color reaction. It should be noted that the DTO test will also react with cobalt, leaving an amber color reaction, and nickel, leaving an violet color reaction. This test can effectively be used in determining the physical characteristics of bullet holes including the determination of entrance vs. exit holes. Fired bullets passing through clothing and/or other objects often leave traces of copper around the bullet hole. This copper transfer comes from the surfaces of a copper containing bullet and/or the barrel of the firearm. This copper transfer can be in the form of minute particles, a fine coating of powder particles or a fine cloud of vaporized copper. At times this copper transfer is an obvious ring or wipe around the hole but is more often invisible.

It should be noted that if multiple chemical examinations are going to be performed on an item they must follow a specific order.

- First- Modified Griess
- Second- Dithiooxamide
- Third- Sodium Rhodizonate

- **OTHER RELATED PROCEDURES**
  - Modified Griess
  - Sodium Rhodizonate
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
  - If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.
- **PREPARATION**
  - **Refer to Firearms and Tool Marks Section Chemicals and Reagents Log for instructions on preparing specific chemicals and reagents.**
  - Dithiooxamide Solution
  - Ammonia Solution
- **INSTRUMENTATION**
  - Scale/Balance
- **MINIMUM ANALYTICAL STANDARDS and CONTROLS**
  - The Standards & Controls for the DTO test consists of placing a test mark, utilizing a piece of known copper, on the item to be tested. This test mark must be well away from any holes examined. By performing the DTO procedure on this test mark the examiner can determine if in fact the DTO test is reacting properly and whether the item being tested will produce any false positives/negatives.
    - Standards & Controls will be performed at the time evidence is examined using this process. The controls check will be documented in the examiner's notes.
  - An alternative set of Standards & Controls for the DTO test consists of utilizing cotton swabs dampened with the ammonia solution. One of the treated swabs is rubbed against a piece of known copper. This swab is then processed with the DTO test to insure that the test is reacting properly. Another treated swab is rubbed on the item to be tested. This must be well away from any holes examined. This swab is then processed with the DTO test to insure that the item being tested will not produce a false positive.

- Standards & Controls will be performed at the time evidence is examined using this process. The controls check will be documented in the examiner's notes.

6.2.8.1 PROCEDURE or ANALYSIS

- Place three drops of the ammonia solution on a piece of filter paper.
- Place the ammonia treated filter paper over the hole to be tested.
- Place a second piece of filter paper over the first and apply moderate pressure for approximately 5 seconds.
- Remove both pieces of filter paper and place 3 drops of the Dithiooxamide Solution to the tested area of the filter paper.
- Repeat this process on all holes to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.

6.2.8.2 INTERPRETATION OF RESULTS:

A dark greenish-gray color reaction, corresponding to the area tested, constitutes a positive reaction for copper.

6.2.8.3 REFERENCES

- Lekstrom, J.A. and Koons, R.D., "Copper and Nickel Detection on Gunshot Targets by Dithiooxamide Test", Journal of Forensic Sciences, Vol. 31, No.4, p. 1283.
- Steinberg, M., Leist, Y., and Tassa, M., "A New Field Kit for Bullet Hole Identification", Journal of Forensic Sciences, Vol. 29, No. 1, p. 169.
- Fiegel, F. and Anger, V., (1972). Spot Tests in Inorganic Analysis, 6th Ed., Elsevier Publishing Co., New York, New York.

6.2.9 Distance Determination Test Pattern Production

In order to properly perform a muzzle-to-target range determination examination, it is usually necessary to attempt to reproduce the gunshot residue patterns or the shot patterns present on the suspect item. This reproduction is accomplished by shooting tests at varying distances until the gunshot residue pattern or shot pattern present on the suspect item is reproduced. It is an essential prerequisite that the suspect firearm and ammunition consistent with the suspect ammunition be utilized.

- **OTHER RELATED PROCEDURES**
  - Safe Firearm Handling
- **PREPARATION**
  - Test Target Media
    - Attach appropriate size pieces of cotton twill material or a piece of the evidence material to a nitrite free cardboard backing board for non-shot pellet test patterns.

- The test media for shot pellet test patterns is an appropriate sized piece of poster board, cardboard or heavy paper.

6.2.9.1 PROCEDURE or ANALYSIS

- Obtain and review the required information from related laboratory case files and/or Medical Examiner's Office files.
- Tests should be shot one per piece of target media.
- Tests should be shot in increasing or decreasing range increments until a range of distance is established that reproduces the gunshot residue or shot patterns on the suspect item.

6.2.9.2 INTERPRETATION OF RESULTS:

By utilizing the suspect firearm and appropriate ammunition it is possible to obtain a reproduction of a gunshot residue pattern present on a suspect item. Therefore one can ascertain the **approximate bracketed** distance that particular firearm's muzzle was from the suspect item when it was shot.

6.2.9.3 REFERENCES

- Anon., (1970). "Gunshot Residues and Shot Pattern Test", F.B.I. Law Enforcement Bulletin, Vol. 39, No. 9, p.7.
- Dillon, John, H., "A Protocol for Gunshot Residue Examinations in Muzzle-To-Target Distance Determinations", AFTE Journal, Vol.22, No.3, p.257.
- Dillon, John, H. "A Protocol for Shot Pattern Examinations in Muzzle-to-Target Distance Determinations", AFTE Journal, Vol. 23, No. 1, p.49.

6.2.10 Gunshot Residue (GSR) Pattern Without a Gun

In order to properly perform a muzzle-to-target range determination examination, it is usually necessary to attempt to reproduce the gunshot residue patterns present on the suspect item. This reproduction is accomplished by shooting tests at varying distances until the gunshot residue pattern present on the suspect item is reproduced. Sometimes, however, the firearm and ammunition is not available for examination or testing purposes and still the Gunshot Residue (GSR) patterns are developed visually, microscopically and chemically through the procedures outlined in the previous sections. With this situation, the reporting of the GSR pattern information may still be vital to the investigation.

- **OTHER RELATED PROCEDURES**
  - Distance Determination Test Pattern Production
  - Safe Firearm Handling
- **INSTRUMENTATION**
  - Stereo Microscope

6.2.10.1 PROCEDURE or ANALYSIS

- Obtain and review the required information from the related laboratory case files and/or the Medical Examiner's Office files.
- Process each item of evidence with the procedures previously outlined as applicable.
- Document or record on worksheets the significant GSR pattern information for each item of evidence.

6.2.10.2 INTERPRETATION OF RESULTS:

- Indicative of/ Consistent with the Discharge of a Firearm (**non-contact**). The presence of all or any of the following:
  - Vaporous Lead (smoke)
  - Particulate Metals (shavings of lead, copper, brass)
  - Unburned Gunpowder (morphology)
  - Melted, Adhering Gunpowder
  - Presence of residues confirmed to be GSR
- Indicative of/ Consistent with the Passage of a Bullet.
  - A hole in the item
  - Visible ring around the perimeter of the hole
  - Presence of residues confirmed to be GSR.
- Indicative of/ Consistent with a **Contact Shot**
  - Ripping or Tearing
  - Burning or Singeing
  - Melted Artificial Fibers
  - Heavy Vaporous Lead Residues
  - Presence of residues confirmed to be GSR
- Residues Confirmed as being Gunshot Residue
  - Elements in residues being present and originating from ammunition or bullet components.
- If the above observations support the findings of a "contact shot" no comparison is necessary.
  - These results only need to be reported as a "**Contact Shot**"
- If the observations support a "non-contact shot" finding, a working hypothesis will be formed based on the above observations. This hypothesis will be utilized in the interpretation procedure.

- These results only need to be reported as a "**Non-Contact Firearm Discharge**" elaborating on the nature of residues found. (ie: lead vapor, discharged gunpowder and or bullet wipe)
- Classifications:
  - CLOSE-the presence of lead vapor, discharged gunpowder and bullet wipe.
  - INTERMEDIATE- the presence of discharged gunpowder and bullet wipe.
  - DISTANT-the presence of bullet wipe.

6.2.10.3 REFERENCES

- Anon., (1970). "Gunshot Residues and Shot Pattern Test", F.B.I. Law Enforcement Bulletin, Vol. 39, No. 9, p.7.
- Dillon, John, H., "A Protocol for Gunshot Residue Examinations in Muzzle-To-Target Distance Determinations", AFTE Journal, Vol.22, No.3, p.257.
- "Gunpowder and Gunshot Residues", F.B.I Publication.
- Di Maio, V. "Gunshot Wounds", Elsevier Pub.
- Fisher, Spitz, etal; "Medicalegal Investigations of Death", Thomas Scientific

6.3 *Tool Mark Identification Protocol*

6.3.1 Examination and Physical Classification – Tool

The initial examination of a tool will include the completion of a general laboratory worksheet. This worksheet will include the physical description of the tool. It will also serve as a source to document the condition of the evidence as received and any tests or comparisons performed with the tool.

- **INSTRUMENTATION**
  - Stereo Microscope

6.3.1.1 PROCEDURE or ANALYSIS

- A laboratory worksheet utilized for a tool examination should be filled out which may include noting the following.
  - If any trace material is present.
  - The class characteristics of the tool
  - The type of tool
  - The brand name of tool
  - The size of the tool
  - The condition of the tool
  - Type of tests conducted (if any)
  - The medium used for testing

6.3.1.2 REFERENCES

- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.3.2 Examination and Physical Classification – Tool Mark

In order to compare a questioned tool mark with a suspect tool, it is necessary to evaluate the tool mark. This evaluation will consist of a physical evaluation and classification of the tool mark. This evaluation will help determine what course the rest of the examination should take. The basic objective in evaluating a questioned tool mark is to determine the suitability and classification of the tool mark.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification – Tool
  - Trace Material Examination
  - Test Standards
- **INSTRUMENTATION**
  - Stereo Microscope

6.3.2.1 PROCEDURE or ANALYSIS

A systematic approach should be used for the physical examination and classification of questioned tool marks. Consideration should be given to:

- The suitability of the tool mark for comparison purposes.
- Class of tool that made the tool mark.
- Major and minor classes of tool marks
- Physical characteristics of tool marks
- Direction of tool mark.

6.3.2.2 INTERPRETATION OF RESULTS:

- If the tool mark is suitable for comparison, then the examination may continue.
- If the tool mark has the same class characteristics as the suspect tool, then the examination may continue.

6.3.2.3 REFERENCES

- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.3.3 Subclass Characteristics

When examining a tool mark it is important for the examiner to evaluate the markings observed for potential subclass characteristics. Caution should be exercised in distinguishing subclass

characteristics from INDIVIDUAL CHARACTERISTICS. Subclass characteristics are discernible features of an object which are more restrictive than CLASS CHARACTERISTICS in that they are:

- Produced incidental to the manufacturing process.
- Are significant in that they relate to a smaller group source (a subset of the class to which they belong).
- Can arise from a source which changes over time.
- Examples may include: mold marks, bunter marks, etc.

6.3.4 Trace Material Examination

Tools and tool marks recovered during an investigation may contain trace material transferred from the crime scene. This trace material may be in the form of blood, tissue, plaster, paint, hairs, fibers, glass, etc. If trace evidence is present, the examiner should consider contacting the appropriate section to determine if further examination of the trace material is necessary. Removal of trace material may also be necessary to allow the proper examination and testing of a tool.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification – Tool
  - Examination and Physical Classification – Tool Mark
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual
- **INSTRUMENTATION**
  - Scale/Balance

6.3.4.1 PROCEDURE or ANALYSIS

- Examine the tool or tool mark visually and microscopically for any trace material and record in notes.
- Determine if further examination of trace material is necessary.
- If further examination of trace material is necessary;
  - Have the appropriate section collect the material. If the appropriate section has agreed for the firearms examiner to remove the trace evidence:
    - Remove material being careful not to damage the tool or tool mark.
    - Place the removed trace material in a suitable container/packaging for submission to the appropriate section for further examination.
- If the trace material is not going to be retained for further examination, proceed with the following steps that are applicable.
  - For evidence containing blood, tissue or other biohazards, soak the evidence for at least one (1) minute in a 10% bleach solution.
  - Remove loose material by rinsing the tool or tool mark with methanol or water.
  - Remove plaster by soaking the tool or tool mark in a 15% acetic acid solution.

- Remove paint by soaking the tool or tool mark in methanolor acetone.

6.3.4.2 REFERENCES

- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.3.5 Test Standards

In order to compare a questioned tool mark with a suspect tool, test standards or marks are usually made with the suspect tool. The basic objective in preparing test standards is to attempt to duplicate the manner in which the tool was used to produce the evidence or questioned tool mark.

Test standards created using a suspect tool are to be treated as reference material only. If a test standard is used for comparison purposes at a later date, it will be documented on the examiner's report as being a reference standard previously created using the suspect tool and retained at the Arkansas State Crime Laboratory.

Tool mark test standards will be maintained in a reference collection in a secure area accessible by Firearms Section personnel. Archived material will be stored in a secure area in the ASCL Annex.

A test standard information card will be filled out to include the ASCL case #, item # and identifying information (if available) for the suspect tool. The test fire information card will be stored with the test standards.

The examiner should consider marking the tool mark test standards with the;

- Full or abbreviated laboratory case number and
- Full or abbreviated item number and/or
- examiner's initials.

If the examiner does not, or is unable to, mark the test standards with the above information, then the package containing the test standards and information card will be sealed and initialed.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification – Tool
  - Trace Material Examination
  - Physical Examination & Classification-Tool Mark
  - Evidence Evaluation
- **PREPARATION**
  - Test Media:
    - The initial test media should be soft enough to prevent alterations of the tool's working surface.
    - Lead is usually the material utilized.
    - Subsequent tests might require the use of a harder test media to better reproduce the tool marks.

6.3.5.1 PROCEDURE or ANALYSIS

- A systematic approach should be used for the production of test marks or standards. Consideration should be given to the following:
  - Areas of recent use on the tool in question.
  - Direction of use and angle of the tool in relation to the surface being marked.
  - Indexing of test standards/marks.

6.3.5.2 REFERENCES

- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.3.6 Microscopic Comparison

In order for an examiner to identify a toolmark back to the tool that produced it, a microscopic comparison utilizing a comparison microscope must be performed. The comparison microscope allows the examiner to place the evidence on one side of the microscope and the known standard on the other side. This procedure may also be used to compare to unknown toolmarks together to determine if they were made by a single tool.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification – Tool
  - Examination and Physical Classification – Tool Mark
  - Trace Material Examination
  - Test Standards
- **INSTRUMENTATION**
  - Comparison Microscope
  - Stereo Microscope

6.3.6.1 PROCEDURE or ANALYSIS

The procedure steps below do not have to be performed in the order listed; however, all steps should be considered and/or addressed:

- Select the correct objective (magnification) setting and ensure that the objectives are locked in place. Select the correct set of oculars (eyepieces).
- The illumination (lights) used must be properly adjusted. Oblique lighting is usually preferred.
- Compare unknown toolmark to either another unknown toolmark or a known standard by placing the unknown toolmark on the left hand stage and the other unknown toolmark or known standard on the right hand stage.
- The entire toolmark must be considered.
- If an identification is not initially made, the examiner should consider the following factors:

- Angle of lights
- Type of lights
- The need for additional known standards
- The position of the evidence, the tests or both.
- The possibility of using magnesium smoke.
- The possibility of cleaning the tool.
- The possibility that the tool itself has changed

6.3.6.2 INTERPRETATION OF RESULTS:

- A sufficient correspondence of individual characteristics will lead the examiner to the conclusion that both items (evidence and tests) originated from the same source.
- An insufficient correspondence of individual characteristics but a correspondence of class characteristics will lead the examiner to the conclusion that no identification or elimination was made with respect to the items examined.
- A disagreement of class and/or a sufficient disagreement of individual characteristics will lead the examiner to the conclusion that both items (evidence and tests) did not originate from the same source.
- A lack of suitable microscopic characteristics will lead the examiner to the conclusion that the items are not suitable for comparison.
- All identifications and eliminations must be verified by a second examiner.
  - Verifications will be documented on an ASCL Firearms Verification Form.
- Additional types of documentation that may be considered are as follows:
  - Photomicrograph depicting comparison or characteristics
  - Sufficient notes
  - Diagrams
  - Sketches

6.3.6.3 REFERENCES

- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.3.7 Magnesium Smoking

Magnesium smoking is a technique of reducing the glare of a shiny object by lightly coating the surface with fine magnesium smoke. This smoking is traditionally done manually, however a diode sputtering system used for coating Scanning Electron Microscopy (SEM) specimens might also be used.

- **SAFETY CONSIDERATIONS**

- Refer to the lab wide ASCL Health and Safety Manual.
- The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
- If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.

- **PREPARATION**
  - Cut short strips of magnesium ribbon off the roll.
  - Both the roll and the strips should be stored properly based on the NFPA code.
- **INSTRUMENTATION**
  - Diode Sputtering System (if used)

6.3.7.1 PROCEDURE or ANALYSIS

6.3.7.1.1 MANUAL SMOKING:

- The short pieces of magnesium ribbon are lit.
- The object to be smoked is passed over the smoke generated by the burning magnesium.
- If the object collects too much smoke, wipe the smoke off and repeat the process.
- The coating should be light enough to see the color of the item smoked through the coating of smoke.

6.3.7.1.2 AUTOMATED SMOKING:

- The appropriate instructions for the particular instrument should be followed.
- These techniques simply reduce the glare of an object under examination and are non-destructive, non-invasive techniques.

6.3.7.2 REFERENCES

- Janneli, R., and Geyer, G., “Smoking a Bullet”, AFTE Journal, Vol. 9, No. 2, p. 128.

6.3.8 Casting

If an item received for a toolmark examination is too large to be conveniently placed on the microscope’s stages a silicon rubber cast can be made of the toolmarks in question. There are also occasions when a cast of a toolmark might be received as evidence. In either case, any test standards made will also have to be cast in order to perform a comparison. Mikrosil®, Duplicast® or other types of silicon rubber casting material are similar products and procedurally are equivalent as long as the manufacturers instructions are followed.

- **OTHER RELATED PROCEDURES:**
  - Test Standards

  - Microscopic Comparison
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

6.3.8.1 PROCEDURE or ANALYSIS

- Prepare the casting material as per manufacturer's specifications.
- Cascade the casting material over the toolmark to be cast.
- Allow the cast the appropriate amount of time to cure.
- Gently lift the cast off the toolmark.
- Consideration must be given to placing identifying marks as well as orientation marks on the back of the cast.
- Casts will be retained with the test standards in the test reference collections.

6.3.8.2 REFERENCES

- ANON., "Mikrosil Casting Material Information" AFTE Journal, Vol.15, No. 2, p. 80.
- Barber, D.C. and Cassidy, F.H., "A New Dimension with 'Mikrosil' Casting Material", AFTE Journal, Vol. 19, No. 3, p.328.

6.4 *Serial Number Restoration Protocol*

6.4.1 Serial Number Restoration

Many valuable items manufactured today have serial numbers for identification. These numbers are usually die stamped. This process produces a compression of the metal or plastic in the area immediately surrounding and a short distance below the penetration of the die. Serial numbers are removed and/or obliterated in a variety of ways. The serial number may be restored if the removal/obliteration is not taken past the previously mentioned compression zone.

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 heat restoration procedures.

The chemical restoration procedure or sometimes referred to as the chemical or acid etching 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.

The electrochemical technique using the standard chemical etchants is an enhanced form of chemical restoration, in which the application of a voltage potential assists the oxidation of the specimen. The utilization of this method will again affect the compressed area of the obliterated number faster and

to a greater degree than the non cold-worked area surrounding it. This procedure is used on magnetic metal.

- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
  - If needed, consult the appropriate Material Safety Data Sheet (MSDS) for each chemical.
- **PREPARATION**
  - **Refer to Firearms and Tool Marks Section Chemicals and Reagents Log for instructions on preparing specific chemicals and reagents.**
  - Fry's Reagent
  - Turner's Reagent
  - Davis Reagent
  - 25% Nitric Acid
  - Acidic Ferric Chloride
  - Ferric Chloride
  - 10% Sodium Hydroxide
- **INSTRUMENTATION**
  - Scale/Balance
  - Power source

6.4.1.1 PROCEDURE or ANALYSIS – POLISHING

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

- Note and record any visible characters prior to polishing.
- Polish the area of the obliteration using either a:
  - dremel type tool with a sanding/polishing disc.
  - fine grit sand paper.
- 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 the scratches.

6.4.1.2 INTERPRETATION OF RESULTS:

- If any characters become visible note these characters.

- If characters do not become visible, proceed to the appropriate chemical or heat restoration procedure.
- All findings must be verified by a second examiner.
    - Verifications will be documented on the ASCL Serial Number Restoration Worksheet (FA-FORM-10).
- Additional types of documentation that may be considered are as follows:
    - Photograph depicting comparison or characteristics
    - Sufficient notes

6.4.1.3 PROCEDURE or ANALYSIS – CHEMICAL RESTORATION

- Utilize the "Polishing Procedure" if necessary.
- Determine the serial number medium's physical properties, i.e. magnetic or non-magnetic.
- Utilize appropriate chemical reagent.
    - Magnetic Media (ferrous)
        - Fry's Reagent
        - Turner's Reagent
        - Davis Reagent
        - 25% Nitric Acid
    - Non-Magnetic Media (non-ferrous)
        - Ferric Chloride
        - Acidic Ferric Chloride
        - 25% Nitric Acid
        - 10%Sodium Hydroxide
- Apply the chemical solution to the area of obliteration utilizing cotton tip applicators or swabs that have been moistened with the chemical solution.
- **INTERPRETATION OF RESULTS:**
    - If any characters become visible note these characters.
    - All findings must be verified by a second examiner.
        - Verifications will be documented on the ASCL Serial Number Restoration Worksheet (FA-FORM-10).
    - Additional types of documentation that may be considered are as follows:
        - Photograph depicting comparison or characteristics
        - Sufficient notes

6.4.1.4 PROCEDURE or ANALYSIS – ELECTROCHEMICAL RESTORATION

Attach the specimen to the positive terminal of the power supply via an alligator clip.

Thoroughly soak the cotton tip of an applicator with the appropriate chemical enchant and attach this to the negative terminal of the power supply via an alligator clip, being certain to do so on a moistened area at the base of the cotton tip.

Turn on the power supply and adjust the voltage to 6V.

Wipe the area of obliteration, being careful to not touch the surface of the specimen with the alligator clip.

6.4.1.5 INTERPRETATION OF RESULTS:

Note any characters that become visible prior to proceeding with each step, as well as during the wiping process.

- All findings must be verified by a second examiner
  - Verifications will be documented on the ASCL Serial Number Restoration Worksheet (FA-FORM-10).
- Additional types of documentation that may be considered are as follows:
  - Photograph depicting comparison or characteristics
  - Sufficient notes

6.4.1.6 REFERENCES

- Treptow, Richard, S., Handbook of Methods for the Restoration of Obliterated Serial Numbers, NASA, 1978.
- Polk, Donald, E. and Giessen, Bill, C. "Metallurgical Aspects of Serial Number Recovery", AFTE Journal ,Vol. 21, No. 2, p.174.
- Bureau of Alcohol, Tobacco and Firearms Laboratory, Serial Number Restoration Handbook, 1999.
- Turley, Dennis M. Restoration of Stamp Marks on Steel Components by Etching and Magnetic Techniques. JFS 32(3): 640-649.
- Deats, Marcellus. Serial Number Restoration Information. AFTE Journal 12(3): 82-83.
- Matthews, J. Howard. Firearms Identification. Volume I. pp 77-80. Charles C. Thomas. Springfield, Illinois. 1962.
- Miller, Ken E., Current Assist for Die Stamp Impression Restoration, AFTE Journal 4(3): 38.

6.5 *Fracture Match Protocol*

6.5.1 Fracture Match

In order to compare a questioned fracture with suspect evidence, it is necessary to evaluate the fracture. This evaluation will consist of a physical evaluation and classification of the evidence. This evaluation will help determine what course the rest of the examination should take. The basic objective in evaluating a questioned fracture is to determine the suitability and classification of the evidence. Tool marks recovered during an investigation may contain trace material transferred from the crime scene. This trace material may be in the form of blood, tissue, plaster, paint, hairs, fibers, glass, etc. If trace evidence is present, the examiner should consider contacting the appropriate section to determine if further examination of the trace material is necessary. Removal of trace material may also be necessary to allow the proper examination and testing of a tool mark. In order for an examiner to identify a fracture back to another, a microscopic comparison utilizing a stereo microscope should be performed. The stereo microscope allows the examiner to place the evidence within the same field. This procedure may also be used to compare two unknown tool marks together to determine if they were made by an object.

- **OTHER RELATED PROCEDURES**
  - Examination and Physical Classification – Tool
  - Examination and Physical Classification – Tool Mark
  - Trace Material Examination
- **SAFETY CONSIDERATIONS**
  - Refer to the lab wide ASCL Health and Safety Manual.
  - The use of personal protective equipment must be considered to avoid exposure to any potential hazards.
- **INSTRUMENTATION**
  - Stereo Microscope
  - Scale/Balance

6.5.1.1 PROCEDURE or ANALYSIS - EXAMINATION

- A systematic approach should be used for the physical examination and classification of questioned evidence and fracture. Consideration should be given to:
  - Physical Characteristics
  - Color
  - Texture
  - Mold Characteristics
  - Design Features
  - Numbers and Letters
  - Fracture Lines

- Surface Properties

6.5.1.2 INTERPRETATION OF RESULTS:

If the fracture evidence is suitable for comparison the examination may continue.

6.5.1.3 PROCEDURE or ANALYSIS – TRACE MATERIAL EXAMINATION

- Examine the evidence visually and microscopically for any trace material and record in notes.
- Contact appropriate section to determine if further examination of trace material is necessary.
- If further examination of trace material is necessary;
  - Have the appropriate section collect the material. If the appropriate section has agreed for the firearms examiner to remove the trace evidence:
    - Remove material being careful not to damage the evidence.
    - Place the removed trace material in a suitable container/packaging for submission to the appropriate section for further examination.
- If the trace material is not going to be retained for further examination, proceed with the following steps that are applicable.
  - If the trace material is not going to be retained for further examination, proceed with the following steps that are applicable.
  - Remove loose material by rinsing the evidence with methanol or water.
  - Remove plaster by soaking the evidence in a 15% acetic acid solution.
  - Remove paint by soaking the evidence in methanol or acetone.
- Use CAUTION with plastics.

6.5.1.4 PROCEDURE or ANALYSIS – MICROSCOPIC COMPARISON

The procedure steps below do not have to be performed in the order listed; however, all steps should be considered and/or addressed:

- The illumination (lights) used must be properly adjusted. Oblique lighting is usually preferred.
- Compare the fracture edges of one evidence sample to the other identifying unique edge patterns.
- The entire fracture must be considered.
- If an identification is not initially made, the examiner should consider the following factors:
  - Angle of lights
  - Type of lights
  - The position of the evidence
  - The possibility of cleaning the evidence

6.5.1.5 INTERPRETATION OF RESULTS:

- A sufficient correspondence of individual characteristics will lead the examiner to the conclusion that both fractures originated from the same source.
- An insufficient correspondence of individual characteristics but a correspondence of class characteristics will lead the examiner to the conclusion that no identification or elimination was made with respect to the items examined.
- A disagreement of class and/or a sufficient disagreement of individual characteristics will lead the examiner to the conclusion that both items did not originate from the same source.
- A lack of suitable microscopic characteristics will lead the examiner to the conclusion that the items are not suitable for comparison.
- All identifications and eliminations must be verified by a second examiner
    - Verifications will be documented on an ASCL Firearms Verification Form.
- Additional types of documentation that may be considered are as follows:
    - Photomicrograph depicting comparison or characteristics
    - Sufficient notes
    - Diagrams
    - Sketches

6.5.1.6 REFERENCES

- DeForest, Gaensslen, and Lee, Forensic Science: An Introduction to Criminalistics, McGraw-Hill, New York, 1983

6.6 -Range of Conclusions

6.6.1 Firearms Range of Conclusions

- Identification (Positive)
  - The fired evidence in question was fired with the suspect firearm.
  - The fired evidence in question was fired from the same firearm, firearm not received.
- Elimination (Negative)
  - The fired evidence in question was not fired with the suspect firearm.
  - The fired evidence in question was not fired from the same firearm, firearm not received.
  - The discipline recognizes that an elimination of a firearm by other than class characteristics is possible but that such an elimination is an exceptional situation.
  - If an examiner arrives at an opinion where he/she eliminates a firearm, for any reason, the examiner must substantiate the reasons supporting his/her opinion and incorporate them into his/her work notes.
- Inconclusive
  - The fired evidence in question cannot be identified or eliminated as having been fired with the suspect firearm.
  - The fired evidence in question cannot be identified or eliminated as having been fired with the same firearm, firearm not submitted.
- Unsuitable
  - The fired evidence in question is not suitable for comparison purposes.
- Unidentifiable
  - The evidence in question cannot be identified as being fired evidence.

6.6.2 Toolmarks Range of Conclusions

- Identification (Positive)
  - The toolmark evidence in question was made with the suspect tool.
  - The toolmark evidence in question was made with the same tool, tool not received.
- Elimination (Negative)
  - The toolmark evidence in question was not made with the suspect tool.
  - The toolmark evidence in question was not made with the same tool, tool not received.
  - The discipline recognizes that an elimination of a toolmark by other than class characteristics is possible but that such an elimination is an exceptional situation.

- Inconclusive
    - The toolmark evidence in question cannot be identified or eliminated as having been made with the suspect tool.
    - The toolmark evidence in question cannot be identified or eliminated as having been made with the same tool, tool not submitted.
- Unsuitable
    - The toolmark evidence in question is not suitable for comparison purposes.
- Unidentifiable
    - The evidence in question cannot be identified as being a toolmark.

6.7 Work Sheets

Laboratory work sheets serve several purposes, these include;

- documenting the work done.
- as a useful aid in guiding the examination.
- as well as serving as an archive for future reference.

According to ASCLD/LAB Accreditation standards; "In general, documentation to support conclusions must be such that in the absence of the examiner, another competent examiner or supervisor could evaluate what was done and interpret the data." ASCLD/LAB goes on to state that "Since case notes and records of observation are subject to subpoena or discovery, they must be of a permanent nature. Handwritten notes and observations must be in ink, not pencil. Any corrections to notes must be made by an initialed single strike out. Nothing in the handwritten information should be obliterated or erased".

6.7.1 Firearm Work Sheets:

- A firearm work sheet may take on many forms but should minimally contain the following information:
    - Laboratory Case Number
    - Caliber/Gauge
    - Make
    - Model
    - Serial Number
    - Firing Mechanics
    - Type of Action
    - Safeties
    - Operating Condition
    - Trigger Pull
    - Rifling Characteristics
    - Barrel Length
    - Any other information the examiner might find useful.

6.7.2 Fired Bullet Work Sheet:

- A fired bullet work sheet may take on many forms but the examiner should minimally consider containing the following information:
    - Laboratory Case Number
    - Trace Evidence

- Bullet Caliber
- Bullet Weight
- Bullet Morphology
- Bullet Rifling Characteristics
- Physical Condition of the bullet
- Any other information the examiner might find useful.

6.7.3 Discharged (Expended) Cartridge Case Work Sheet:

- A discharged cartridge case work sheet may take on many forms but the examiner should minimally consider containing the following information:
  - Laboratory Case Number
  - Cartridge Case Caliber/Designation
  - Head Stamp Information
  - Morphology of the Cartridge Case
  - Type of Firing Pin Impression
  - Type of Breech Face Markings
  - Detailing any extraneous markings
  - Any other information the examiner might find useful.

6.7.4 Firearms Worksheets

The Firearms Section will normally use the Data Extension Forms in the Justice Trax, however, should the need arise, manual forms may be utilized and scanned into the Justice Trax database.

- Justice trax Data Extension Forms available for use.
  - Ammunition
  - Bullet
  - Expended Cartridge Case
  - Expended Shotshell
  - Firearm
  - Loaded Shotshell
  - Serial Number Restoration
  - Shotshell Components
  - Tool Marks
- See Firearms Forms listed on the Controlled Documents (Q-drive) for listings and examples of manual forms utilized by the Firearms Section.

Section 7.0 Calibration and Maintenance:

All instrument/equipment quality control is subject to the following parameters:

- All equipment and instrumentation will be maintained in a clean, orderly, and safe condition
- If an instrument is not working properly or potential problems are observed, it is the duty of the analyst to immediately take the appropriate steps to repair/correct the problem or inform the appropriate person of the problem. Any problem and the action to correct the problem must be logged in the Firearms Equipment Maintenance and Calibration Record
- Instruments that are not working properly must be clearly identified for all employees who may use that instrument
- Instruments that are not in service must be clearly marked
- Designated instruments will be subject to a schedule of calibration or quality control checks with traceable or certified standards
- All maintenance (routine or periodic) and repairs on designated instruments will be recorded in the logbook

All logbooks will be kept in an area located close to the instrument or equipment and readily available to each analyst/examiner who utilizes

7.1 Calibration Standards

It is necessary that all instruments/equipment must be properly maintained, calibrated and documented.

7.1.1 Comparison Microscope:

- **Annually (+/- 3 months):**
  - The comparison microscope will be cleaned and serviced by an outside certified technician.
  - Minor repairs **may** be done by the examiner.
  - A performance check of the measurement software for the microscopes will be performed (+/- 0.003”) using a NIST traceable stage micrometer at least annually.
  - These steps will be documented in the instrument’s maintenance/calibration logbook.

7.1.2 Stereo Microscope:

- AS NEEDED:
  - The stereo microscope will be cleaned and checked for serviceability.
  - Minor repairs **may** be done by the examiner.
  - These steps will be documented in the instrument’s maintenance/calibration logbook.

7.1.3 Measuring Projection Microscope:

- **Annually (+/- 3 months):**
  - The measuring projection microscope will be cleaned and checked using NIST traceable gauge blocks measurements of 0.050 and 0.200.
  - Projector should measure within **+/- 0.003"** of the traceable gauge blocks to be acceptable. If not, it will be removed from service until it has been repaired and re-calibrated.
  - Minor repairs **may** be done by the examiner.
  - These steps will be documented in the instrument's maintenance/calibration logbook.

7.1.4 Stage Micrometer

- **Every 5 years (+/- 3 months)**
  - The stage micrometer will be recertified against a NIST Traceable standard.
  - If the micrometer disagrees with the NIST standard by greater than +/- 0.003" than it shall be removed from service.
  - These steps will be documented in the maintenance/calibration logbook.

7.1.5 Balances/Scales

- **Annually (+/- 3 months):**
  - The balance/scale will be verified by using 20g and 30 g certified weights. The weights should weigh within **+/- 1.0 grain**. If they do not, the balance will be removed from service until repaired and recalibrated.
  - If balance is moved to a different location (such as a different room or a countertop) it must be re-verified. This is done by using the 20 gram and the 30 gram weight that have been verified. The weights should weigh within **+/- 1.0 grain**. If they do not, the balance will be removed from service until repaired and recalibrated.
  - These steps will be documented in the instrument's maintenance/calibration logbook.

7.1.6 IBIS / NIBIN

- The NIBIN system will be cleaned and/or serviced as needed by a company representative.
- The NIBIN system stage will be calibrated weekly utilizing the system calibration ring.
- These steps will be documented in the instrument's maintenance/calibration logbook.

7.1.7 Trigger Pull Devices

7.1.7.1 Dead Trigger Weights (Free Weights)

- **Annually (+/- 3 months):**
  - The dead trigger weights will be checked annually on a certified balance **(+/- 2%).**

- If at any time a weight is damaged or appears damaged, it will be individually weighed on a certified balance. Dead weights should weigh within **+/-2%** of stated weight to be acceptable. If not, the weight will be removed from service.
- These steps will be documented in the Firearms Equipment Maintenance and Calibration Record.

7.1.7.2 Spring Measuring Device:

- **Annually (+/- 3 months):**
  - The spring measuring device will be checked annually. **(+/- ½ lb)**
  - If at any time it is damaged or appears damaged, it will be checked by using weights of 2 lbs, 5 lbs and 10 lbs that have been verified. The scale should measure within **+/- ½ lb** of known standards to be acceptable. If not, it will be removed from service until it has been repaired and re-calibrated.
  - These steps will be documented in the Firearms Equipment Maintenance and Calibration Record.

7.1.8 Digital Caliper/ Dial Caliper

- **Annually (+/- 3 months):**
  - The micrometer/calipers will be calibrated utilizing NIST traceable certificate blocks of 0.050 inches, 0.200 inches, 0.400 inches and 1.000 inches. The calipers should measure within **+/-0.003 inches.** If not, it will be removed from service until it has been repaired and re-calibrated.
  - This will be documented in the instrument's maintenance/calibration logbook.

7.1.9 Rectangular Gage Blocks
(0.050 inches, 0.200 inches, 0.400 inches and 1.000 inches)

- **Every 5 years (+/- 3 months)**
  - The rectangular gage blocks will be recertified against a NIST Traceable standard.
  - If a rectangular gage block disagrees with the NIST standard by greater than +/- 0.003" than it shall be removed from service.
  - These steps will be documented in the maintenance/calibration logbook.

7.1.10 Measuring Rulers

- **Certified Master Ruler** – This ruler will be stored separately from the other measuring rulers used in the Firearms Section.
  - **Every 5 years (+/- 3 months)**
    - The Master Ruler will be recertified against a NIST Traceable standard.

        - If the Master Ruler disagrees with the NIST standard by greater than +/- 1/32" than it shall be removed from service.
        - These steps will be documented in the maintenance/calibration logbook.

- **Steel Measuring Rulers**
    - **Annually (+/- 3 months):**
        - The steel measuring rulers will be checked against the Certified Master Ruler.
        - If a steel measuring ruler disagrees with the Certified Master Ruler by greater than +/- 1/16" than it shall be removed from service.
        - These steps will be documented in the maintenance/calibration logbook.

Section 8.0 Proficiency Testing:

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01)

Section 9.0 Case Records

9.1 Examination Documentation

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01)
    - Supporting examination documentation (e.g. pictures, GRC data, etc) must contain the Evidence Number for the item(s).

9.2 Technical and Administrative Review

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01)

Section 10.0 Testimony Review

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01)

Section 11.0 Audits

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01)

Section 12.0 Complaints

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01)

Section 13.0 Miscellaneous

- Refer to lab wide ASCL Quality Manual (ASCL-DOC-01) for items not previously addressed in the Firearms Section Quality Manual (FA-DOC-01).

Section 14.0 APPENDIX

14.1 Glossary

- Definitions for firearms terms are located in the published AFTE Glossary.

14.2 Abbreviations

- Refer to Firearms Section Abbreviations List (FA-DOC-04).