FIREARMS/TOOLMARKS ANALYTICAL METHODS

Table of Contents

Revision History

Revision #	Description of Changes
1	Original Issue of combined method; included in this were grammatical corrections, clarification to documenting observations in iLIMS and generalizing trigger pull testing

AM #1: Firearms Physical Exam and Classification

1.0 Background/References

1.1 This method is designed to act as a guideline to assist in the proper examination of firearms evidence. The examiner may be further assisted by appropriate technical references as well as private and commercial references. The many variables involved in the examination of firearm related evidence precludes a "recipe" type manual.

1.2 References:

- Association of Firearm and Toolmark Examiners Glossary, 4th ed. 2001.
- Firearms and Toolmarks Technical Procedures Manual, Washington State Patrol
- "Physical Examination and Classification of Firearms" Firearms and Toolmarks Procedures Manual , Virginia Division of Forensic Science Amendment C.
- NRA Firearms Factbook. National Rifle Association of America.
- Mathews, J. Howard Firearms Identification Vol. I, 1973.

2.0 Scope

2.1 This analytical method deals with the general, visual and physical examination of firearms.

3.0 Equipment/Reagents

- Comparison microscope
- Stereo microscope
- Ruler
- Barrel rod
- Tape measure
- Scale/Balance
- Micrometer/Caliper
- Methanol
- Acetone
- 10% bleach solution (mix bleach with water at about 1:10 prepare fresh)
- Dish soap and water

4.0 Procedure

4.1 General, Visual and Physical Examination:

4.1.1 Firearm/Ammunition submitted without request for Comparison:

4.1.1.1 Visual and physical examinations are conducted to determine the following firearm features, to be recorded in iLIMS:

- Caliber/Gauge
- Make/Model
- Serial number and location
- Type of action
- Safeties,
- Operating condition
- Rifling characteristics
- Trigger pull (refer to Analytical Method 3 for analytical method)

4.2 Trace Material

Evidence is often submitted with debris that may cover its characteristics. In order to determine class characteristics or compare individual characteristics of the firearm evidence the debris may need to be removed. The debris may consist of blood, tissue, paint, fibers, glass, etc. The value of the debris as trace evidence should be considered during examination. The examiner may choose to forward the item to another section for testing or to collect the trace evidence and create a new evidence item. The examiner will note the finding in his or her case notes.

4.2.1 After an assessment and appropriate actions have been taken to collect or forward trace evidence, the evidence may need to be cleaned to allow for proper examination of the evidence. The examiner will choose an appropriate cleaning solvent or solution. Typically methanol, acetone, a 10% solution of bleach and water or dish soap and water will be used.

4.3 Malfunctioning Firearm Examination

A firearm examiner may be called upon to examine a firearm to determine if the firearm will malfunction. Many of these tests 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, followed by a thorough examination and testing of the firearm. Examinations may include external and internal observations, striking or dropping the firearm in attempts to duplicate the incident as reported. The examiner should attempt to conduct the 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 should be specifically documented in the examiner's notes. A systematic approach should be used for the malfunctioning firearm examination, with recording of all findings and observations. No one procedure can sufficiently outline the steps necessary to examine all firearms for any malfunction. The following examinations should serve as a guideline.

4.3.1 Visual condition of the firearm as received:

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

4.3.2 Visual abnormalities

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

4.3.3 Action- External

- Relationships of the action parts
- Correct assembly
- The proper locking of the action on closing
- Cylinder rotation (securely locks)
- Hand relationship to the ratchet
- Trigger (not returning, sticks, broken spring, etc.)
- Trigger Pull (single action, double action) and striking of hammer

4.3.4 Safeties

- ¼, ½, full cock, seating check (any false positions)
- Function (grip, magazine, disconnector)
- Rebound hammer or inertia firing pin
- Firing pin (relationship to primer, condition)
- Drop hammer several times to check safeties
- Position of the slide or bolt in order to fire
- Condition of safeties

4.3.5 Action Check

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

4.3.6 Test Fire Firearm

- Note any operational problems
- Check the barrel for obstructions before firing
- Misfires
- Ammunition involved (proper cartridge, type reloads, etc.)
- Check consistency of the impression on test-fired components and evidence

4.3.7 Action – Internal

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

4.3.8 Bore/Chamber Casting

Occasionally, firearms are received for which the caliber may not be known or may be different than is designated on the firearm and in the industry literature. In order to facilitate firing of test shots that are the correct caliber for a particular firearm, it may be necessary to make a bore and/or chamber cast. Casts can be made using various casting materials such as low melting point metals and silicone rubber compounds.

4.3.8.1 Insure that the firearm is not loaded

4.3.8.2 Open the action and remove the bolt or bolt assembly

4.3.8.3 Check the bore for obstruction

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

4.3.8.5 Lubricate the chamber

4.3.8.6 Prepare the casting material according to manufactures instructions

4.3.8.7 Pour casting material into the chamber until full

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

4.3.8.9 Remove cast from breech end

4.3.8.10 Use the same steps for casting the bore, but only the last three inches of the bore need to be cast.

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

4.4 Sound Suppressor Examination

4.4.1 A silencer or sound suppressor is a device designed to reduce the noise of discharge that is attached to the barrel of a firearm. Silencers can be commercially made or homemade.

4.4.1.1 Examine the device to determine if it is, or is not characteristic of, a silencer or sound suppression device.

4.4.1.2 Check the bore for obstruction

4.4.1.3 A noticeable reduction in sound between firing of the firearm with the device attached vs. the firing of the firearm without the device is sufficient to determine if the device is a sound suppressor.

4.4.1.4 Multiple tests should be conducted with and without the device.

4.4.1.5 Observations shall be recorded in iLIMS.

4.5 Classification of Fired Cartridge Cases

4.5.1 Caliber Determination

4.5.1.1 Caliber can usually be determined by examination of the headstamp of the cartridge case, and is written as a numerical term that may be depicted with or without a decimal point. If it is not legible on the headstamp, the case can be compared with laboratory standards, manufacturer literature.

4.5.2 Determination of Marks

4.5.2.1 Visual and microscopic examination of cartridge cases may reveal a variety of markings. Types of marks that might be found may be as follows:

- Breech face class marks
- Extractor marks
- Ejector marks
- Resizing marks
- Chamber marks
- Anvil marks (rimfire only)
- Magazine marks
- Ejection port marks
- Other marks

4.5.2.2 As appropriate, compare marks on cartridge cases tests from a firearm or with other cartridge cases (see AM# 5: Microscopic Comparison)

Only the above marks necessary to effect an identification or elimination are required to be documented in the case notes.

4.5.2.3 Interpretation of Results

- May determine caliber and brand/manufacturer/marketer of cartridge case
- May determine if there are suitable markings for identification with a firearm or other fired or chambered components.
- May determine possible firearms that could have fired the cartridge case.
- May be able to identify the firearm in which it was fired or worked through the action of the firearm.

4.6 Classification and Examination of Fired Bullet Evidence

4.6.1 General, visual, and physical examination:

- Caliber/gauge
- Bullet weight
- Number of land and groove impressions
- Direction of twist
- Measured width of land impressions
- Measured width of groove impressions
- Measured diameter
- Bullet composition
- Bullet style
- Possible manufacturer/marketer of the bullet/projectile
- Description of the base of the bullet
- Type and position of cannelures
- Any extraneous markings to include flared base, skid marks, shave marks, and other marks
- Presence of gunpowder and/or powder imprints adhering to the base
- Condition of the fired evidence as received
- Suitability of the fired evidence for comparison purposes

As appropriate, compare marks on bullets with tests from a firearm or with other bullets (see AM# 5: Microscopic Comparison)

4.6.2 Caliber Determination

Caliber or the base diameter is one of the class characteristics of a fired bullet, and is written as a numerical term that may be depicted with or without a decimal point. The determination of caliber may 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. The following may be utilized to determine the caliber of a fired bullet. The condition of the bullet will determine which steps can be utilized:

4.6.2.1 Compare the base diameter of the evidence bullet directly with known test fired standards

4.6.2.2 Measure the base diameter of the evidence bullet using a measuring device and compare this measurement with known measurements published in reference literature

4.6.2.3 Determine the number of land and groove impressions and compare to Section 13, Table 8 of the AFTE Glossary 6th edition.

4.6.2.4 Physical characteristics of the evidence bullet, such as weight, bullet shape, composition, nose configuration, and number and/or placement of cannelures, may aid in caliber determination.

4.6.3 Methods of Measuring Lands and Grooves

The measuring of land and groove impressions on a fired bullet can be accomplished by utilizing either the air-gap method or one of the stereo microscope methods. It may be necessary to measure several suitable land and groove impressions to obtain a reliable measurement. Measurements taken are recorded into iLIMS.

4.6.3.1 Air Gap Method

In the air gap method the fired bullet in question is mounted on one stage of the comparison microscope. The measuring device is mounted on the other stage. Both stages must be using the same magnification level and be in focus.

The land or groove impression is aligned with one of the anchor points of the measuring device and the measurement recorded.

4.6.3.2 Stereo Microscope Grid Method

The fired bullet in question is either held or mounted on a steady surface beneath the stereo microscope.

The land or groove impression of the fired bullet is positioned with both of the anchor points corresponding to points on the alignment grid. Record the measurement.

4.6.3.3 Stereo Microscope Ruler Method

The fired bullet in question is either held or mounted on a steady surface beneath the stereo microscope.

The land or grove impression at the base of the fired bullet is placed perpendicular to the scale of the ruler. The distance between both of the land or groove impression are measured and recorded.

4.6.3.4 LCD Measuring Scale Method

Place the bullet on the left stage and install crosshair eyepiece. Focus and align crosshair with edge of land or groove. Zero the LCD measuring scale. Move stage so crosshair is aligned with other side of land or groove. Record the measurement.

4.6.3.5 FBI General Rifling Characteristics File (GRC)

The FBI's General Rifling Characteristics File (GRC) can be utilized when attempting to determine a list of possible firearms that could have fired an evidence bullet when no firearm is submitted. The GRC specifications can be accessed using various software utilities or the printed reference material. The GRC file is an investigative aid and should not be considered as an all-inclusive list of firearms available with those particular class characteristics.

4.6.3.6 Interpretation of Results

Caliber is written as a numerical term and may be depicted with or without the decimal point. If the base is mutilated the examiner may only be able to determine that the evidence is consistent with a range of calibers or the caliber cannot be determined.

- May determine caliber/gauge, brand, type, style, general rifling characteristics of the fired bullet
- May determine if there are suitable markings for identification with a firearm or with other fired components
- May determine list of possible firearms that could have fired a bullet
- May be able to identify the firearm in which it was fired
- May be able to exclude a firearm from having fired a bullet based on class characteristics.

4.7 Physical examination and Classification of Shotshell Evidence

4.7.1 Shotshell Cases

4.7.1.1 Examination of shot shell cases may include general, visual, physical, gauge determination, and marks determination:

- Shape of shotshell
- Gauge
- Possible manufacturer/marketer of the shotshell case
- Ignition system
- Description of metal used in hull and primer
- Description of headstamp
- Description of firing pin impression

4.7.1.2 Shotshell Gauge Determination

Gauge can easily be determined by examination of the headstamp of a shotshell case. If the headstamp is not legible, the shotshell can be compared with laboratory standards or available manufacturer literature.

4.7.1.3 Determination of Marks

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

- Breech face class marks
- Extractor marks
- Ejector marks
- Resizing marks
- Chamber marks
- Magazine marks
- Ejection port marks
- Markings on the exterior surface of hull
- Other marks

As appropriate, the analyst will compare marks on shotshell case with test form a firearm or with other shotshell cases (see AM# 5: Microscopic Comparison)

4.7.1.4 Interpretation of Results

- May determine gauge and brand/manufacturer/marketer of shotshell case
- May determine if there are suitable markings for identification with a firearm or with other fired components.
- May determine possible firearms that could have fired the shotshell case.
- May be able to determine the firearm in which the shot shell was fired or worked through the action.

4.7.2 Wads

4.7.2.1 Wad Gauge Determination

- Gauge can usually be determined by measuring the diameter of the wad and comparing with laboratory standards or available manufactured literature.
- Direct comparison of the evidence wad to a known reference of similar manufacturers in the composition, design, and diameter.
- Gauge size can also be determined by measuring the base diameter of the wad and comparing the measurement to a known wad-reference measurements
- Manufacturer data may be determined by locating information stamped into the wad or by comparing the evidence wad to a known references. Care must be taken since manufacturers may trade components.

4.7.2.2 Determination of marks on wads

Visual and microscopic examination of the wad may reveal a variety of markings. Microscopic examination of the evidence wad could reveal markings that may be suitable for identification with the shotgun that fired it. If evidence shotshells are submitted with the evidence wad, it may be necessary to disassemble one of the shotshells for a comparison of the unfired wad with the evidence wad.

4.7.2.3 Limitations of method

If the wad is mutilated or soaked with blood the examiner may not be able to specifically determine the gauge size. Some manufactures may also duplicate the design of other manufactures.

4.7.3 Pellets

Visual and microscopic examinations may be done to determine the following:

- Determine the total number of pellets received
- Determine the composition of the pellets
- Determine the number of pellets suitable for comparison purposes
- Note if pellet sizes all appear to be similar - if different determine each size
- Compare evidence pellets to known shot sizes.

4.7.3.1 Comparison of pellets by weight

4.7.3.1.1 Determine the number of pellets suitable for weighing

4.7.3.1.2 Weigh the pellets in grains

4.7.3.1.3 Consult known pellet weights in the NRA Factbook, Table 1 of Appendix G of the AFTE Glossary 4th ed., or manufacture's data.

4.7.3.1.4 The weight of the evidence pellets can also be directly compared to known pellets using the same number of pellets until a similar known weight is obtained.

4.7.3.2 Measuring pellet size

4.7.3.2.1 Choose the best specimen and measure diameter using a micrometer/caliper.

4.7.3.2.2 Consult known pellet sizes in the NRA Factbook, Table 1 of Appendix G of the AFTE Glossary 4th ed., or manufacture's data or compare to a known sample.

4.7.3.3 Interpretation of Results

It may be possible to determine the shot size and composition of pellets.

4.8 Safety Considerations

This procedure involves hazardous materials, operations and equipment. 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 must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate MSDS/SDS for each chemical prior to use.

4.9 Photographs

Photographs shall be stored centrally in the laboratory.

AM #2: Barrel Length and Overall Length Measurement of a Firearm

1.0 Background/References

1.1 Background:

This procedure is used for determining the barrel length and overall length 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.

1.2 General References:

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

2.0 Scope

2.1 Measurements will be classified as "Descriptive" or "Reported."

Descriptive measurements are defined as routine firearm dimension measurements for general documentation. Descriptive measurements are recorded in case notes only.

Reported measurements are defined as measurements which are relevant to the determinations of possession of a "Short Barrel Rifle" or "Short Barrel Shotgun." Reported measurements require the use of a NIST-traceable measuring device. Reported measurements are recorded in the case notes and on the case report.

For barrel length of a shotgun or rifle, if the descriptive measurement is less than 16 inches for a rifle or less than 18 inches for a shotgun, a reported measurement shall be taken.

For overall length of a shotgun or rifle, if the descriptive measurement is less than 26 inches, a reported measurement shall be taken.

If a reported measurement is requested by the customer, but cannot be made with a NIST traceable device because the barrel or overall length is too long, the laboratory will inform the customer that the analysis cannot be performed.

3.0 Equipment/Reagents

3.1 Measurements at or under 24 inches for barrel length or 36 inches for an overall length:

3.1.1 A NIST-traceable or certified measuring device (e.g., ruler or barrel rod) capable of measurements to:

- 1/16th of an inch for a barrel rod.
- 1/32nd of an inch for a ruler.

3.2 Measurements over 24 inches for barrel length or 36 inches for overall length:

- A standard tape measure may be used directly or against a non-marring dowel.

4.0 Procedure

Care must be taken if any object is placed down the barrel for measurement purposes.

4.1 Barrel Length

4.1.1 Revolvers

4.1.1.1 Measure the distance from the breech end of the barrel to the muzzle, excluding the cylinder. This measurement shall be done directly by using a barrel rod. The barrel rod shall be inspected for damage before use. When using a measuring device down the barrel, the rod shall be held parallel with the barrel and read with the barrel end at eye level. Be sure not to damage the barrel or breach when measuring barrel length.

This measurement will be recorded in the case notes rounded up to the nearest 16th of an inch.

4.1.2 Firearms other than Revolvers

4.1.2.1 Measure the distance from the breech face in a closed and locked position to the longest point of the muzzle. This measurement shall be done directly by using a barrel rod. The barrel rod shall be inspected for damage before use. When using a measuring device down the barrel, the rod shall be held parallel with the barrel and read with the barrel end at eye level. Be sure that the firing pin does not protrude past the breach. Be sure not to damage the barrel or breach when measuring barrel length.

4.1.2.2 This measurement will be recorded in the case notes rounded up to the nearest 1/16th of an inch.

4.1.2.3 For barrel length of a shotgun or rifle, if the descriptive measurement is less than 16 inches for a rifle or less than 18 inches for a shotgun, a reported measurement shall be taken and recorded in the case notes. The reported measurement shall be adjusted for any bias associated with the reference standard (e.g. butting) if the measurement is between 15 ¾ inches and 16 inches for rifles or 17 ¾ inches and 18 inches for shotguns.

4.1.2.4 If the barrel length of the shotgun or rifle exceeds the length of the 24 inch NIST-traceable barrel rod, a non-marring dowel rod may be used for a descriptive measurement. The non-marring dowel rod measurement will be compared to a standard tape measure for a descriptive measurement. The measurement will be rounded up to the nearest 1/16 inch on the standard tape measure. Descriptive measurements shall be recorded in the case notes.

4.2 Overall Length

4.2.1 Measure the distance from the butt to the muzzle. Measurement shall be made parallel to the bore using a ruler. The ruler shall be inspected for damage before use. This measurement will be recorded in the case notes rounded up to the nearest 1/32nd of an inch.

4.2.1.1 For overall length of a shotgun or rifle, if the descriptive measurement is less than 26 inches, a reported measurement shall be taken and recorded in the case notes.

4.2.1.2 If the overall length of the shotgun or rifle exceeds the length of the 36 inch NIST-traceable ruler, a standard tape measure may be used for a descriptive measurement. A descriptive measurement using a standard tape measure will be rounded up to the nearest 1/16 inch. Descriptive measurements shall be recorded in the case notes.

4.3 Reporting and Interpretation of Results

4.3.1 For reported measurements, the examiner shall document the serial number of the NIST-traceable or certified measuring device used (i.e. ruler or barrel rod).

4.3.2 “Reported measurements” shall be included in the case report.

4.3.3 “Descriptive measurements” shall not be reported in the case report.

4.3.4 At a minimum, the laboratory will report the measurement result and the estimated expanded uncertainty when it impacts evaluation of a statute, legal requirement, or upon customer request. When measurements are reported, the measurement uncertainty and a statement regarding the coverage probability of 99.73% shall be on the report. The measurement result shall include the measured quantity value (y) along with the associated expanded uncertainty (U), and this measurement shall be reported as y+/-U where U is consistent with the units of Y (i.e. 18 1/2 inches +/- 3/32 inches). The current expanded uncertainty is published as a protected document on the ISPFS shared network drive and is available to all analysts.

4.3.5 Measurement of Uncertainty Estimation

4.3.5.1 An expanded uncertainty of measurement was calculated for barrel length and overall length. Many factors (e.g. environmental and facility conditions, reference standards, analytical method factors) were evaluated for potential contribution to the expanded uncertainty of measurement. A reproducibility study was also performed as a part of the expanded uncertainty. An uncertainty budget is available for barrel length and overall length measurements. The final expanded uncertainty result is converted to a fraction consistent with the smallest division on the measuring devise (1/32th for overall length and 1/16th for barrel length) rounded using the Microsoft Excel arithmetic rules of rounding where by the half way number (5) is rounded up. The expanded uncertainty in the firearms discipline is reported at k=3. Fraction may be simplified as needed (i.e. 4/32nd = 1/8th).

4.3.5.2 At a minimum the uncertainty budget shall be reviewed annually, or upon recalibration of a reference standard, replacement of a reference standard, significant changes to the analytical method, or personnel change within the discipline.

4.4 Safety Considerations

4.4.1 This procedure involves hazardous materials, operations and equipment. 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 must be exercised and the use of personal protective equipment must be considered.

4.4.2 Appropriate hearing and eye protection must be worn when applicable.

AM #3: Trigger Pull

1.0 Background/References

1.1 Trigger pull measures the amount of force that must be applied to the trigger of a firearm to cause the sear to release and discharge the firearm.

During the course of examining a firearm, prior to test firing, measuring trigger pull is useful for safety reasons and as an aid in determining the likelihood of accidental discharge.

1.2 References;

- AFTE Glossary

2.0 Scope

2.1 This procedure utilizes the force of gravity on known weights applied to a firearm's trigger while the muzzle is pointed away from and parallel to the applied force. The usual configuration involves holding the firearm with the muzzle vertical to the floor. Both single and double action trigger pulls should be measured.

3.0 Equipment/Reagents

3.1 The equipment used is a standard device with which weights in varying amounts can be applied to a rod constructed so that it can be hooked over a trigger without touching any other part of the firearm.

3.2 Standards consist of weights that can be combined for a cumulative effect.

4.0 Procedure

4.1 Performing Trigger Pull determinations. *Note: Make sure no live ammunition is in the weapon*

4.1.1 In single action mode, with firearm in a ready to fire state, apply weights to the trigger using the described trigger pull equipment so that the force is applied parallel to the barrel until the firearm will fire (WF).

4.1.2 Remove weights (applied parallel to the barrel) until the firearm will not fire (WNF).

4.1.3 Repeat these measurements until at least two measurements for each condition (will fire, and will not fire) agree within one quarter to one half pound of force.

4.1.4 Record results

4.1.5 Repeat steps 4.1.1 through 4.1.5 for double action mode.

4.2 Reporting Results

4.2.1 Resultant trigger pulls should be recorded in iLIMS. These results may be included in a final report, if requested.

4.3 Safety Precautions

All firearms must be checked to ensure they are not loaded before performing examination.

AM #4: Toolmarks Physical Exam and Classification

1.0 Background/References

1.1 The basic objective in evaluating a questioned toolmark is to determine the suitability and classification of the toolmark. In order to compare a questioned toolmark with a suspect tool or another toolmark it is necessary to conduct a physical examination and classification of the toolmark and tool, which will determine what course the rest of the examination should follow.

1.2 References

- Firearms and Toolmarks Technical Procedures Manual, Washington State Patrol
- "Physical Examination and Classification of Firearms" Firearms and Toolmarks Procedures Manual, Virginia Division of Forensic Science Amendment C.
- "Mikrosil Casting Material Information". AFTE Journal. Vol. 15 No. 2, pg. 80.
- Janneli, R., and Geyer G. "Smoking a Bullet". AFTE Journal. Vol. 9, No. 2, pg. 128.

2.0 Scope

2.1 In order to compare a question toolmark with a questioned 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 reproduce the evidence or questioned toolmark.

3.0 Equipment/Reagents

- Comparison microscope
- Stereo microscope
- Ruler or tape measure
- Micrometer/Caliper
- Dusting tool
- Test media (lead, copper, brass or other soft material)
- Methanol
- Acetone
- 10% bleach solution (mix bleach with water at about 1:10 prepare fresh)
- Dish soap and water
- Magnesium ribbon
- Casting material

4.0 Procedure

4.1 General, visual and physical examination:

The initial examination of a tool or a toolmark includes documentation of the physical description of the tool or toolmark. The tool and/or toolmark will be visually and/or microscopically examined for the presence of any trace material.

4.1.1 Trace Material

4.1.1.1 Evidence is often submitted with debris that may cover its characteristics. In order to determine class characteristics or compare individual characteristics of the tool or toolmark evidence the debris may need to be removed. The debris may consist of blood, tissue, paint, fibers, glass, etc. The value of the debris as trace evidence should be considered during examination. The examiner may choose to forward the item to another section for testing or to collect the trace evidence and create a new evidence submission. The examiner will note the finding in his or her case notes. After an assessment and appropriate actions have been taken to collect or forward trace evidence the evidence may need to be cleaned to allow for proper examination of the evidence. The examiner will choose an appropriate cleaning solvent or solution. Typically methanol, acetone, a 10% solution of bleach and water or dish soap and water will be used.

4.1.2 Tool Examination

The tool examination is generally used to establish the following

- Brand and type of tool
- Size and condition
- Class characteristics of the tool
- Areas of use on the tool
- The medium used for testing
- The type of tests to be conducted (if any)
- Indexing of test standards/marks

4.1.3 Toolmark Examination

4.1.3.1 The toolmark examination is generally used to establish:

- The suitability of the toolmark for comparison purposes
- Class of tool that made the toolmark
- Type of toolmark (striated, impressed, combination)
- Direction of the toolmark
- If the toolmark is not suitable for comparison or does not have the same class characteristics as the suspect tool, then the toolmark is reported as unsuitable for comparison or the tool can be eliminated as having produced the toolmark
- If the toolmark is suitable for comparison, or the toolmark has the same class characteristics as the suspect tool, the examination should continue.

4.1.3.2 Methods used to Enhance Toolmarks for further examination:

- Dusting the tool with fingerprint powder
- Magnesium smoking to reduce the glare on shiny surfaces
- Warning! UV protective safety glasses must be worn

4.1.3.2.1 Short pieces of magnesium ribbon are lit by a flame

4.1.3.2.2 The object to be smoked is passed over the smoke

4.1.3.2.3 If the object collects too much smoke wipe it off and repeat the process.

4.2 Casting

Casting is a procedure used in toolmark examination to make a reverse image of a tool or toolmark, which can then be used for comparative microscopic examination purposes. It may be necessary to make a cast of a tool or toolmark. If an item received for a toolmark examination is too large to be conveniently placed on the microscopes stage, a cast may be made of the tool or 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. Silicon rubber or similar products are used and manufactures instruction shall be followed.

4.2.1 Procedure

4.2.1.1Mix the casting material according to manufactures directions.

4.2.1.2 Apply the casting material over the tool or toolmark to be cast

4.2.1.3 When the casting material is set or cool, gently tap to loosen the cast from the tool or toolmark and then lift to remove the cast

4.2.1.4 Consideration must be given to placing identifying marks as well as orientation marks on the back of the cast, or scribe identifying marks and/or orientation marks onto the tool or toolmark.

4.3 Toolmark Tests Produced

In order to perform a microscopic comparison of a submitted tool with a toolmark, test toolmarks must be produced with the suspect tool. The initial test media must be soft enough to prevent alterations of the tool's working surface, and lead or copper are often used. Additional test marks might require the use of the material used in the original toolmark. Toolmark tests used in for comparison in identifications will be retained and logged into the evidence tracking system.

4.4 Microscopic Comparison (Refer to AM# 5: Microscopic Comparison)

4.5 Interpretation of Results

- The toolmark(s) were identified as having been produced by the same tool or with the submitted tool
- The toolmark(s) were not produced by the submitted tool
- It was not possible to determine whether or not the toolmarks were made by the submitted tool or the same tool.
- Class characteristics of the tool may be identified from the toolmark.

4.6 Safety Considerations

This procedure involves hazardous materials, operations and equipment. 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 must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate MSDS for each chemical prior to use.

4.7 Photographs

Photographs shall be stored centrally in the laboratory.

AM #5 Microscopic Comparison

1.0 Background/References

1.1 Background:

A comparison microscope allows an examiner to identify components back to a firearm that produced markings or identify a toolmark back to the tool that produced the mark. The evidence component is placed on one stage of the microscope, and the known is placed on the other stage.

1.2 References:

- "5 Microscopic Comparisons of Firearms" Firearms and Toolmarks Procedure Manual. Virginia Division of Forensic Science. Amendment B.

2.0 Scope

2.3 This procedure may also be used to compare two unknowns to determine if the same source produced the marks.

3.0 Equipment/Reagents

- Comparison Microscope
- Stereo Microscope
- Camera

4.0 Procedure

4.1 Comparison Microscope Set-up Procedure

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

4.1.2 Select the same set of oculars

4.1.3 Adjust illumination as needed.

4.2 Analysis of Comparisons

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

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

4.3 If an identification is not evident

Consideration should be given to the following:

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

4.4 Interpretation and limitations or results

4.4.1 Identification

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

4.4.1.2 Documentation: A photo will be taken to document identification along with notes describing how the identification was made.

4.4.1.3 It is recognized that photos are not used to make identifications or comparisons but are a means for recording purposes and generally document selected portions of and identification.

Photos are not used to make comparisons and make conclusions because:

- A photograph is a two-dimensional image of an object that is three-dimensional.
- Photographs often contain insignificant detail which will confuse people not trained in microscopic comparison.
- A photograph is a still. An actual comparison is very dynamic, and continuous movement of the samples is an integral part of the examination.

4.4.2 Inconclusive

4.4.2.1 Criteria:

- Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification or elimination.
- Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency or lack of reproducibility.
- Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

4.4.2.2 Documentation: When an item is reported as inconclusive, detailed descriptions will be used to document class characteristics and describe why the sample is inconclusive.

4.4.3 Elimination

4.4.3.1 Criteria:

- Significant disagreement of discernible class characteristics and/or individual characteristics.

4.4.3.2 Documentation: Detailed notes describing class characteristics and individual characteristics.

4.5 Technical Verification

Technical verification is a process of independently performing a comparison or analyzing evidence to determine if the reviewer comes to the same conclusion regarding the analysis as the analyst.

Technical verification will be performed on all conclusions in which individual characteristics contribute to the conclusion (for example an elimination based on class characteristics does not require technical verification, but an inconclusive result based on matching class characteristics but insufficient individual characteristics does).

4.6 Safety Considerations

This procedure involves hazardous materials, operations and equipment. 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 must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions.

4.7 Photographs

Photographs shall be stored centrally in the laboratory.

AM #6: Gunshot Residues and Range Determination

1.0 Background/References

1.1 The residue and range determination procedures are used to determine muzzle to target distance. When a firearm is fired gunshot residues, including primer residues, burned gun powder particles, partially burned gun powder particles, unburned gun powder particles, vaporous lead and particulate metals, are discharged from the firearm.

1.2 References:

- ANON. "Gunshot Residues and Shot Pattern Test"; F.B.I. Law Enforcement Bulletin: 1970; Vol. 39, No 9, pp.7.
- Dillon, John. "The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrate Compounds in Gunshot Residues"; AFTE Journal, 22,3,248.
- Fiegel, F; Anger, V. Spot tests in Inorganic Analysis; 6th ed.; Elsevier Publishing: New York, NY, 1972.
- Dillon, John. "The Sodium Rhodizonate Test: A Chemically Specific Test for Lead in Gunshot Residues"; AFTE Journal, 22,3.
- Dillon, John. "A Protocol for Gunshot Residue Examinations in Muzzle-To-Target Distance Determinations"; AFTE Journal, 22,3.
- Dillon, John. "A Protocol for Shot Pattern Examinations in Muzzle-To-Target Distance Determinations"; AFTE Journal, 23,1.

2.0 Scope

The residues along with the morphology of the bullet hole may be effectively used in determining the possible muzzle to target distance.

3.0 Equipment/Reagents

3.1 Equiptment:

- Microscope
- Balance
- Laboratory glassware
- Rulers or Tape measure
- Camera
- Alternate Light Source
- Iron

3.2 Reagents:

- Sensitized Paper
- 15% Acetic Acid Solution
- 5% Hydrochloric Acid Solution
- Buffer Solution (for Sodium Rhodizonate)
- Diphenylamine Solution
- Dithiooxamide Solution
- Ammonium Hydroxide : Water 2:5
- (Water used in solutions may be tap water)

4.0 Procedure

4.1 Visual examination

4.1.1 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 unburned, burned and partially burned gunpowder
- A hole in the item
- The presence of a visible ring around the perimeter of holes
- The location of all holes, tears, etc.
- The presence of burning, singeing or melting.
- The presence of any possible masking effects.

Data regarding these physical effects and visible residues shall be included in the examination notes. Visual examination may be aided with the use of filtered or IR photography, or an alternate light source.

4.1.2 Interpretation of Results for Visual Examinations:

4.1.2.1 Indicative of/ Consistent with the discharge of a firearm:

- Vaporous lead (smoke)
- Particulate metals
- Unburned, burned and partially burned gunpowder
- Melted adhering gunpowder
- 4.1.1.3 Indicative of/ Consistent with a contact shot:
- Ripping or tearing
- Burning or singeing
- Melted artificial fibers
- Heavy vaporous lead residues

4.1.2.2 Limitations: Possible masking effects

- Dark background color
- Blood Staining

4.2Microscopic examination

4.2.1 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 unburned, burned and partially burned gunpowder
- The presence of melted adhering gunpowder
- The presence of burning, singeing, or melting
- The presence of any possible masking effects

4.2.2 Interpretation of Results for Microscopic Examinations

4.2.2.1 Indicative of/ Consistent with the discharge of a firearm

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

4.2.2.2 Limitations: Possible Masking Effects

- Dark background color
- Blood Staining

4.3 Chemical examinations methods

If multiple chemical examinations are going to be performed on an item they must follow a specific order. Modified Griess first, Dithiooxamide second, Sodium Rhodizonate.

4.3.1 Modified Griess Test

The Modified Griess test may be used independently and or in conjunction with other tests in range determinations. The Modified Griess test utilizes a color chemistry reaction to help distinguish gunshot residue patterns not visible with the naked eye or the microscope. The 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-napthol and produces an orange-red color.

4.3.1.1 Preparation of Reagents

(The following may be made in different amounts using appropriate ratios)

4.3.1.1.1 Sensitized Paper:

Add 0.75 g Sulphanilic acid to 150 ml water

Add 0.42 g of Alpha Napthol to 150 ml methanol

Mix solutions together in a clean tray

Saturate filter paper, desensitized photo paper or computer photo paper in solution

Dry the paper and store in an airtight plastic container

4.3.1.1.2 Acetic acid Solution

Prepare a 15% glacial acetic acid solution.

4.3.1.1.3 Nitrite test swabs

i. Dissolve 0.06 g of sodium nitrate in 100 ml water.
ii. Saturate filter paper or cotton swabs in the mixture. Dry and store in an airtight plastic container.

4.3.1.2 Application Procedure

4.3.1.2.1 Direct application

4.3.1.2.1.1 Place sensitized paper directly under area to be tested.

4.3.1.2.1 2 Soak a piece of nitrate-free cheesecloth or filter paper with the acetic acid solution, and place this over the reverse side of the evidence.

4.3.1.2.1 3 Apply heat and pressure with an iron until the acetic acid solution treated paper is dry.

4.3.1.2.2 Reversed application

4.3.1.2.2.1 Moisten the side of the sensitized paper that will be in contact with the questioned area with the acetic acid solution.

4.3.1.2.2.2 Place the sensitized paper over the area to be tested.

4.3.1.2.2.3 Place a piece of filter paper or nitrite-free cheesecloth over the sensitized paper.

4.3.1.2.2.4 Apply heat and pressure with an iron until the acetic acid solution treated paper is dry.

4.3.1.3 Controls

The control for the Modified Griess procedure consists of placing a test mark, utilizing a nitrite test swab, on the edge of each sensitized paper being used. An immediate orange color should appear. The color shift indicates that the sensitized paper is sensitive to the presence of nitrites.

4.3.1.4 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. Positive results shall be documented with photographs, negative results and results of controls need only be noted.

4.3.2 Dithiooxamide (DTO)

The 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. This test may be effective in determining physical characteristics of bullet holes including entrance vs. exit holes. A fired bullet passing through clothing or other items often leave traces of copper around the bullet hole. The copper transfer comes from copper-containing bullets, and/or the barrel of the firearm. The transfer may be in the form of minute particles, a fine coating of particles, or a fine cloud of vaporized copper. The copper transfer may be an obvious ring or wipe but is often not visible

4.3.2.1 Preparation

4.3.2.1.1 Dithiooxamide Solution: 0.2% solution Dithiooxamide in ethanol (w/v).

4.3.2.1.2 Ammonium Hydroxide solution: 2 parts conc. ammonium hydroxide to 5 parts water.

4.3.2.2 Application Procedure

4.3.2.2.1 Place about three drops of Ammonium Hydroxide solution on filter paper.

4.3.2.2.2 Place the treated paper over the area to be tested.

4.3.2.2.3 Place a second piece of filter paper over the first and apply moderate pressure.

4.3.2.2.4 Remove both pieces of paper and place about 3 drops of Dithiooxamide solution to the tested area of the filter paper.

4.3.2.3 Controls

A positive control will be run each day the reagents are used and the results of the control will be noted in the examination notes.

4.3.2.3.1 A positive control can be obtained by creating a test mark on an appropriate piece of material with known copper, or by wetting 2 swabs with the Ammonium Hydroxide solution and rubbing one on a known piece of copper and then adding the DTO solution to both swabs.

4.3.2.4 Interpretation of Results

A dark greenish-gray color reaction, corresponding to the area tested, indicates a positive reaction for copper. Results will be noted in examination documentation.

4.3.3 Sodium Rhodizonate Test

The Sodium Rhodizonate test is used independently and/or in conjunction with other tests in range determinations. The Sodium Rhodizonate test 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. The 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 not visible.

4.3.3.1 Preparation of Reagents

(These reagents may be prepared in different quantities with the appropriate ratios.)

4.3.3.1.1 Sodium Rhodizonate Saturated Solution: Saturate water with sodium rhodizonate.

4.3.3.1.2 Hydrochloric Acid Solution: Prepare a 5% HCl solution (5 mls conc. HCl in 95 mls of water).

4.3.3.1.3 Buffer Solution: Dissolve 1.9g sodium bitartrate and 1.5g tartaric acid in 100ml of DI water. This may require heat and agitation.

4.3.3.1.4 Acetic Acid Solution: Prepare a 15% acetic acid solution (15 mls glacial acetic acid in 85 mls of water).

4.3.3.2 Application Procedures

4.3.3.2.1 Bashinsky Transfer Technique

4.3.3.2.1.1 Uniformly dampen a piece of filter paper with Acetic Acid solution.

4.3.3.2.1.2 Place the treated filter paper over the hole/area to be tested.

4.3.3.2.1.3 Place a second piece of paper over the first and apply moderate pressure or apply a hot iron for approximately 5 seconds.

4.3.3.2.1.4 Remove both pieces of filter paper and spray the Sodium Rhodizonate solution on to the tested area of the filter paper.

4.3.3.2.1.5 Spray the tested area of the filter paper with the Buffer solution

4.3.3.2.1.6 Spray the tested area of the filter paper with the Hydrochloric acid solution.

4.3.3.2.1.7 Repeat this process on all hole/area to be tested. Both sides of the hole should be tested if there is question of direction.

4.3.3.2.2 Direct Application

4.3.3.2.2.1 Apply Sodium Rhodizonate solution on to the questioned area.

4.3.3.2.2.2 Apply the Buffer solution to the questioned area

4.3.3.2.2.3 Apply the Hydrochloric acid solution to the questioned area.

4.3.3.2.2.4 Repeat this process on all hole/areas to be tested. Both sides of a hole should be tested if there is question of direction.

4.3.3.2.3 Swab Technique

4.3.3.2.3.1 Dampen a swab with Acetic Acid.

4.3.3.2.3.2 Swab the area of interest.

4.3.3.2.3.3 Apply Sodium Rhodizonate solution to swab.

4.3.3.2.3.4 Apply Buffer solution to swab.

4.3.3.2.3.5 Apply Hydrochloric Acid solution to swab.

4.3.3.3 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. Results will be noted in examination documentation.

4.3.3.4 Controls

A positive control will be run each day before the reagents are used to ensure they are working properly. A positive control may be prepared by placing a test mark with a piece of lead on an appropriate material or by wetting a swab with a 5% solution of HCl and swabbing a piece of lead with it.

4.3.4 Diphenylamine Test

The diphenylamine test utilizes a color chemistry reaction to indicate the presence of nitrates and/or nitrites. Diphenylamine reacts with the nitrates or nitrites to give a dark blue color reaction. Some gunpowder particles may be deposited on surrounding objects or clothing. This test can effectively identify an area in which a firearm was discharged through the examination of vacuum sweepings or clothing.

4.3.4.1 Preparation (may be mixed at different quantities with using appropriate ratios.)

4.3.4.1.1 Diphenylamine Solution: add 0.3g diphenylamine to 20ml conc. sulfuric acid. Add this mixture to 10ml glacial acetic acid.

4.3.4.2 Application Procedure

4.3.4.2.1 Examine evidence macroscopically and microscopically.

4.3.4.2.2 Separate potential gunpowder particles based on size, color and shape.

4.3.4.2.3 Place Diphenylamine reagent in an empty spot test well and then add the unknown particles.

4.3.4.3 Interpretation of Results

A dark blue color reaction with an unknown particle indicates the presence of nitrates or nitrites. Results will be noted in examination documentation.

4.3.4.4 Controls

A positive control of known gunpowder will be tested each day the reagent is used and the results will be noted in the examination documentation.

4.4 Test Pattern Methods

In muzzle to target determinations if observations support the findings of a "contact shot" no comparison is necessary. If the observations do not support a "contact shot" finding, a hypothesis will be formed based on observations and use the comparison procedures described in 6.1.6.1 or 6.1.6.2.

4.4.1 Non-Shot Pellet Test Pattern Production

It is an essential prerequisite that the suspected firearm and ammunition consistent with the suspect ammunition be utilized.

4.4.1.1 Preparation

4.4.1.1.1 Attach appropriate sized piece of an appropriate test material to nitrite-free cardboard backing board.

4.4.1.1.2 Tests should be shot in increasing or decreasing range increments until a distance is established both shorter and longer than, that which reproduces the gunshot residue patterns on the suspect item.

4.4.1.1.3 If the test patterns are obtained outside, they must be obtained during appropriate weather conditions. It must not be raining or have strong winds present.

4.4.1.2 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 distance that a particular firearm's muzzle was from the suspect item when it was shot. The witness sheets will be stored centrally in the lab. The location of the sheets will be documented in the case notes.

4.4.2 Shot Pellet Test Pattern Production

It is an essential prerequisite that the suspect firearm and ammunition consistent with the suspect ammunition be utilized.

4.4.2.1 Preparations

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

4.4.2.1.2 Tests should be shot in increasing or decreasing range increments until a distance is established, both shorter and longer than that which reproduces the shot patterns on the suspect item.

4.4.2.1.3 If the test patterns are obtained outside, they must be obtained during appropriate weather conditions. It must not be raining or have strong winds present.

4.4.2.2 Interpretation of Results

By utilizing the suspect firearm and appropriate ammunition it is possible to obtain a reproduction of a shot pattern present on a suspect item. Therefore one can ascertain the approximate distance that a particular firearm's muzzle was from the suspect item when it was shot. The witness sheets will be stored centrally in the lab. The location of the sheets will be documented in the case notes.

4.5 Safety

These procedures involve hazardous materials. It is the responsibility of the user of these procedures to establish appropriate health and safety practices. Proper caution to include adherence to test firing rules and the use of personal protective equipment must be considered to avoid exposure to potential hazards. Consult the appropriate MSDS/SDS for each chemical prior to use.

4.6 Possible Results for Range Determinations

There are many possible results relating to muzzle to target distance and the reporting of residues and shot patterns. This section is included as a guide for the most frequently reported results. It should not be construed as all-inclusive or limiting to the examiner in reporting examination results.

- Item XXX was examined and found to exhibit holes consistent with the passage of projectiles in the XXX (area of target).
- Item XXX was examined and found to exhibit no damage that was consistent with having been produced by the passage of a projectile.
- Visual and chemical examination of the holes and areas surrounding the holes revealed a gunshot residue pattern.
- Visual and chemical examination of the holes and areas surrounding the holes failed to reveal a gunshot residue pattern.
- Portions of XXX were used in distance determination testing.
- The damage found in item XXX is consistent with a contact gunshot.
- Based on tests using the firearm submitted in item XXX and the ammunition submitted in or similar to item XXX, it was determined that the gunshot residue pattern found on item XXX is consistent with a muzzle to target distance greater than XXX but less than XXX.
- The absence of a gunshot residue pattern on Item XXX precludes the determination of a muzzle to target distance.
- The absence of gunshot residue on Item XXX indicates a muzzle to target distance greater than XXX.

4.7 Photographs

Photographs shall be stored centrally in the laboratory.

AM #7: Serial Number Restoration

1.0 Background/References

1.1 Background:

Many valuable items manufactured today have serial numbers for identification. These numbers are usually die-stamped. This process produces a compression of the metal/plastic in the area immediately surrounding and a short distance below the penetration of the die. Serial numbers are produced in a variety of ways.

1.2 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.

2.0 Scope

2.1 The serial number may be restored if the obliteration is not taken past the previously mentioned compression zone. It is desirable to remove 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.

3.0 Equipment/Reagents

3.1Equiptment

- Balance
- Laboratory glassware
- Polishing tools (i.e. dremel tool)
- Sand paper, steel wool
- Magnets
- Camera

3.2 Reagents

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

NOTE: ALWAYS ADD ACID TO WATER. NEVER ADD WATER TO ACID.

3.2.1 Fry's Reagent:

Combine nine (9) grams of Crystalline Cupric Chloride with twelve (12) mL of Concentrated Hydrochloric Acid and ten (10) mL of distilled water. Utilizing these proportions, mix the quantity desired.

3.2.2 Nitric Acid Solution:

Prepare a 25% Nitric Acid solution (25 mL of Concentrated Nitric Acid and 75 mL of distilled water), mix the quantity desired.

3.2.3 Cupric Ammonium Chloride Solution:

Add one (1) gram of Cupric Ammonium Chloride and ten (10) mL of Concentrated Hydrochloric Acid to ten (10) mL of distilled water. Utilizing these proportions, mix the quantity desired.

3.2.4 Ammonium Persulfate Solution:

Prepare a 10% Ammonium Persulfate solution (10 grams of Ammonium Persulfate and 100 mL of distilled water), mix the quantity desired.

3.2.5 45% Sodium Hydroxide Solution:

Prepare a 45% Sodium hydroxide solution (45 grams of Sodium Hydroxide and 100 mL of distilled water), mix the quantity desired.

3.2.6 10% Sodium Hydroxide Solution:

Prepare a 10% Sodium hydroxide solution (10 grams of Sodium Hydroxide and 100 mL of distilled water), mix the quantity desired.

3.2.7 Turner's Reagent:

Add 2.5 grams of Cupric Chloride to 40 mL of Concentrated Hydrochloric Acid, 25 mL of 100% Ethanol and 30 mL of distilled water, mix the quantity desired.

3.2.8 Davis Reagent:

Add 5 grams of Cupric Chloride to 50 mL of Concentrated Hydrochloric Acid and 50 mL of distilled water, mix the quantity desired.

3.2.9 Ferric Chloride:

Add 25 grams of Ferric Chloride to 100 mL of distilled water, mix the quantity desired.

3.2.10 Acidic Ferric Chloride:

Add 25 grams of Ferric Chloride to 25 mL of Concentrated Hydrochloric Acid and 100 mL of distilled water, mix the quantity desired.

3.2.11 Phosphoric/Nitric Acid:

Add 98 mL of 85% Phosphoric Acid (85 mL of Phosphoric Acid and 15 mL of distilled water) to 2 mL of Concentrated Nitric Acid, mix the quantity desired. Or, add 50 mL of Concentrated Phosphoric Acid to 3 mL of Concentrated Nitric Acid, mix the quantity desired.

Or

Add 50 mL of Concentrated Phosphoric Acid to 3 mL of Concentrated Nitric Acid, mix the quantity desired.

3.2.12 Magnaflux:

Use Magnaflux 9CM Prepared Bath or Magnaflux 7HF Prepared Bath, available, premixed from: Magnaflux Corporation, 3624 West Lake Avenue, Glenview, IL, 60026. Phone (847)657-5300

4.0 Procedure

4.1 Surface Preparation and Restoration

Prior to chemical restorations attempts surfaces should be cleaned with methanol or acetone to remove and particles or debris remaining from polishing and or magnetic particle testing.

4.1.1 Polishing Technique

4.1.1.1 Note and record any visible characters prior to polishing.

4.1.1.2 Plastic – if possible, examine the reverse side of the item to see if any characters are visible.

4.1.1.3 Polish the obliterated area by hand, or using a grinding tool.

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

4.1.1.5 Note and record any characters which become visible.

4.1.1.6 If all of the characters do not become visible, proceed to the appropriate chemical/heat restoration procedure

4.1.1.7 Clean the surface with acetone or methanol prior to chemical restoration.

4.1.2 Chemical Restoration

Reagent/Procedure	Suitable for
Fry's, Turner's, Davis Reagent	Steel
Nitric Acid	Aluminum or Brass
Phosphoric/Nitric Acid	Steel / Pot Metal / Aluminum
Cupric Ammonium Chloride	Stainless Steel or Cast Iron
Ammonium Persulfate	Steel
Cupric Chloride	Steel
Sodium Hydroxide	Aluminum
Ferric Chloride	Steel / Pot Metal

Technique

4.1.2.1 Moisten cotton tip applicators (swabs) with the suitable chemical solution and apply to the obliterated area.

4.1.2.2 After a few seconds, wipe off the solution and inspect for visible numbers. Repeat as necessary. This process may take several hours. The examiner may wish to build a clay "dam" around the obliterated area, and fill it with a larger volume of solution.

4.1.2.3 Fry's Reagent - The examiner may wish to alternate between swabs saturated with the Fry's Reagent and the 25% Nitric Acid solution.

4.1.2.4 To speed up the process, the examiner may wish to use an electrochemical process. The positive (+) terminal of a standard lantern battery or other source is connected to the obliterated item and the negative terminal (-) is connected to the cotton swab.

4.1.2.5 If any characters become visible note and photograph these characters.

4.1.3 Magnetic Restoration

The Magnetic Particle Inspection procedure is a non-corrosive, non-destructive technique that utilizes a magnetic field. This method is only applicable with stamped serial numbers in ferrous substrates. Since this technique is non-destructive, it can be attempted at any stage of the restoration: before, during, or after any other methods.

Technique

4.1.3.1 Attach a horseshoe-type magnet to the obliterated test area so that the poles of the magnet are on opposite sides of the area to be restored. This will generate a magnetic field around the test area.

4.1.3.2 Shake the Magnaflux can vigorously and spray into a beaker or other receptacle.

4.1.3.3 With an eyedropper, apply Magnaflux to obliterated area.

4.1.3.4 The ferrous shavings in the Magnaflux solution should align themselves with the stress from the die stamping.

4.1.3.5 If any characters become visible, note and photograph these characters.

4.1.4 Heat Restoration

The Heat procedure is suitable for restoration of serial numbers in plastic.

Technique

4.1.4.1 Apply heat to the area of obliteration utilizing a high intensity lamp.

4.1.4.2 Continue the application of heat until the plastic in the obliterated area starts to liquefy.

4.1.4.3 If any characters become visible note and photograph these characters.

4.2 Controls

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

4.3 Interpretation of Results

If any characters become visible note these characters including partials.

- Photographs are recommended for documentation.
- If unable to photograph, second examiner observation and sign off recommended.
- If known from a reference, report unrestored characters as letter or number.

4.4 Safety Considerations

This procedure involves hazardous materials, operations and equipment. 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 must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate MSDS for each chemical prior to use.

4.5Photographs

Photographs shall be stored centrally in the laboratory.

AM #8: Maintenance and Calibration

1.0 Background/References

1.1 Background

To insure accurate data, all equipment that has a direct effect upon the comparison and measurement processes is kept in proper working order. Measurement devices and reference standards receive periodic calibration. Other equipment is examined and maintained periodically to verify safe/effective operation. Calibration / maintenance intervals may be adjusted based upon past performance, where the item has demonstrated that it will remain within specifications throughout the calibration interval.

Any equipment that appears to be damaged, out of calibration, or functioning improperly is removed from service, until the nature of the problem can be determined and corrected.

1.2 References

Section 1:

- Association of Firearm and Toolmark Examiners Glossary, 4th ed. 2001.
- Firearms And Toolmarks Technical Procedures Manual, Washington State Patrol
- "Physical Examination and Classification of Firearms" Firearms and Toolmarks Procedures Manual , Virginia Division of Forensic Science Amendment C.
- NRA Firearms Factbook. National Rifle Association of America.
- Mathews, J. Howard Firearms Identification Vol. I, 1973.

Section 2:

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

Section 3:

- AFTE Glossary

Section 4:

- Firearms and Toolmarks Technical Procedures Manual, Washington State Patrol
- "Physical Examination and Classification of Firearms" Firearms and Toolmarks Procedures Manual, Virginia Division of Forensic Science Amendment C.
- "Mikrosil Casting Material Information". AFTE Journal. Vol. 15 No. 2, pg. 80.
- Janneli, R., and Geyer G. "Smoking a Bullet". AFTE Journal. Vol. 9, No. 2, pg. 128.

Section 5:

- "5 Microscopic Comparisons of Firearms" Firearms and Toolmarks Procedure Manual. Virginia Division of Forensic Science. Amendment B.

Section 6:

- ANON. "Gunshot Residues and Shot Pattern Test"; F.B.I. Law Enforcement Bulletin: 1970; Vol. 39, No 9, pp.7.
- Dillon, John. "The Modified Griess Test: A Chemically Specific Chromophoric Test for Nitrate Compounds in Gunshot Residues"; AFTE Journal, 22,3,248.
- Fiegel, F.; Anger, V. Spot tests in Inorganic Analysis; 6th ed.; Elsevier Publishing: New York, NY, 1972.
- Dillon, John. "The Sodium Rhodizonate Test: A Chemically Specific Test for Lead in Gunshot Residues"; AFTE Journal, 22,3.
- Dillon, John. "A Protocol for Gunshot Residue Examinations in Muzzle-To-Target Distance Determinations"; AFTE Journal, 22,3.
- Dillon, John. "A Protocol for Shot Pattern Examinations in Muzzle-To-Target Distance Determinations"; AFTE Journal, 23,1.

Section 7:

- 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.

2.0 Scope

2.1 Defining the necessary maintenance and or calibration of equipment used in the Firearms Discipline

3.0 Equipment/Reagents

3.1 Equipment

- Balances
- Comparison microscopes
- Micrometers and Calipers
- NIST traceable devices
- Rulers and tape measures
- Gage blocks
- Trigger Pull Weights
- Leeds LCD Scale

4.0 Procedure

4.1 Maintenance and Calibrations

4.1.1 Balances

4.1.1.1 Maintenance and repairs performed on the balance will be recorded in a maintenance log.

- Balances will be calibrated once per calendar year by a certified outside vendor. If the balance is taken out of service for repair or an event occurs (such as moving the balance) an intermediate check will be performed and documented. In order to pass the intermediate check the accuracy of the balance will be +/- 2%.
- The weights used in intermediate checks will be cleaned and calibrated annually by an outside vendor. The weights will be handled with gloves or tweezers to keep them clean. They will be transported and stored in their case. The documentation for the calibration of the weights will be kept in the front office.

4.1.2 Comparison Microscopes

4.1.2.1 Each microscope will have a maintenance log and any maintenance or repair will be recorded. The uniform magnification of the comparison microscope is checked by comparing two identical stage micrometers at multiple magnifications.

4.1.2.1.1 The comparison microscope shall be checked once per calendar year, after repairs likely to affect magnification and after moving. If the checks indicate the microscope is out of calibration calibrations shall be performed by an approved outside vendor.

4.1.3 Micrometers and Calipers

Each micrometer or caliper will be checked once per calendar year against a certified gauge block or micrometer disk. These checks will be documented and the micrometer or caliper must demonstrate accuracy within .001inches of the intended measurement.

4.1.4 Rulers and other measuring devices.

4.1.4.1 NIST traceable devices

The measuring specifications and accuracy for NIST traceable measuring devices (e.g. barrel rods, traceable ruler) are determined during certification of these devices and can be found in each laboratory's equipment/instrumentation maintenance file. The NIST traceable measuring device will be calibrated and recertified every five years. NIST traceable measuring devices will be stored so as to prevent damage such as bending or melting. The devices shall be handled with care to prevent bending, melting or damage to measuring marks.

4.1.4.2 Rulers and tape measures

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

4.1.4.3 Damage or malformation

4.1.4.3.1 If damage or a malformation (i.e. breakage or melting) occurs that may affect the measuring device it will be taken out of service and marked as out of service until it is repaired or replaced.

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

4.1.5 Gage blocks

Gage blocks will be calibrated by an outside vendor every five years. Gage blocks will be handled with care to prevent bending, breaking or melting and will be transported and stored in their case.

4.1.6 Trigger Pull Weights

Trigger pull weights will be checked once per calendar year. The weights will be checked using certified balance. Tolerance for each weight is +/- 1% of the expected value. If a weight does not fall within the expected value it will be taken out of service and corrective action will be taken. Corrective action may include cleaning the weight or replacing the weight. The weight must be checked and have satisfactory results before being put back in service.

4.1.7 Leeds LCD Scale

The Leeds LCD Scale will be checked against a stage micrometer. These checks will be documented and the Leeds LCD Scale must demonstrate accuracy within .001inches of the intended measurement. Checks will be performed once per calendar year and after changing the battery.

4.2 Handling and Verification of Externally Calibrated Items

4.2.1 Handling of Measuring Equipment

All measuring equipment will be handled and stored in the laboratory by appropriate analysts in a manner which prevents contamination, deterioration or damage and ensures proper functioning of the measurement equipment. All calibrated measurement equipment will be labeled, if possible, with the date of last calibration and date when calibration is next due.

4.3 Shipping

When a piece of equipment is sent to an approved vendor for repair, servicing or calibration it shall be packaged for shipping in such a way as to prevent damage.

4.4 Verification Upon Receipt of Externally Calibrated Item

Equipment received back shall be checked for damage and the certification documentation (containing measuring results, including the measurement uncertainty and/or a statement of compliance with an identified metrological specification.) will be reviewed and initialed before it is put back into service.

4.5 Review of External Calibration Documentation

Calibration Certificates for any externally calibrated item will be checked for compliance with ISO/IEC 17025:2005, Section 5.10 and initialed. All calibration certificates will be centrally stored.

4.6 Safety Considerations

This procedure involves hazardous materials, operations and equipment. 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 must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions.