



Idaho State Police Forensic Services

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# FIREARMS/TOOLMARKS ANALYTICAL METHODS

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Firearms/Toolmarks Analytical Methods

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## 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
2	Grammatical corrections. AM# 1; 4.4: added chemical testing to section. 4.6.3.5: added AFTE GRC and general guidelines for searching; 4.3.9 added section for general guidelines of test fires. AM# 4; 4.3: changed to return test marks to agency. AM# 6; 4.4.1.2 and 4.4.2.2: added bracketing wording. AM# 7; 3.2.12: added "or equivalent". 4.1.3: added "Magnaflux". AM# 8; removed duplicated references. Added section 4.8 to AM# 6, clarified control requirements.
3	
4	AM# 1; 4.3.9.1: Added check of test fire ammunition for manufacturing and cycling marks. AM# 6; 4.3.1.3: Remove test marks from paper before use.
5	Updated references. AM #2; 2.1.2: Added "Sawed Off Rifle or Shotgun". AM# 6; 4.1.1 and 4.2.1: Changed "will" to "can". 4.4.1 and 4.4.2: Allowed the use of an identical firearm.
6	Updated references. AM#1: Clarification on casting, add disposition of casts (4.3.7.11). Added details for test firing equipment and use (4.3.9.2 and 4.3.9.3). Added section on situational/function testing (4.3.10), Added section on the examination of rusty firearms (4.3.11), Clarification to land and groove measurements and GRC search criteria. AM#4 Added cast item designation and disposition; AM#5 Added Documentation requirements for verifications. AM#7 Added section on Barcode decryption
7	AM #3 clarifying trigger pull variabilities; AM #6 additional clarification points added to interpretation. Addition of AM #9 IBIS/NIBIN entry
8	AM #1: Clarified documentation of comparison items. Added 4.6.4 Chemical testing for fragments. AM #6: Changed to Proximity Determination. AM#9: Defined case identification number.
9	AM #6 Additional information on evidence types accepted for Proximity Determination, AM #9 added comparison notation
10	AM #1, 6, 7 and 9. Updated photography storage statements to be consistent with electronic storage, clarification on reagent preparation documentation. AM#6 added clarification for limitations of testing and interpretation of results. AM #1 removal of Sound Suppressor examination, this is not covered in the ISPF5 training. AM #9- added information for addition of NIBIN terminal in Meridian and clarification on entries and lead notifications.
11	AM #1 – update and clarification added to safety check procedure, addition of examination and use for test firing of unfired cartridges, removed unused procedures for measuring land and groove impressions.

	<p>AM #2- clarified when UM is to be reported, giving guideline of range to report if near statutory level.</p> <p>AM # 9- NIBIN procedures updated to include information required in the ATF MROS's for NIBIN sites not previously required.</p>
12	<p>AM #1- NIBIN technician processing cartridge case evidence without firearms/comparisons service request</p> <p>AM# 8 Addition of Firearm reference collection and storage of ammunition guidelines</p>
13	<p>AM #10 Scan Acquisition of 3D representation samples.</p> <p>AM #5 addition of conflict resolution, addition of limitations during comparisons, minor wording changes and clarification within multiple methods.</p>
14	<p>AM#5 Incorporation of Virtual Comparisons using Cadre Instrument, and clarification of verifications using the same instrumentation as the original comparison; AM#8 addition of maintenance requirements for VCM related references and instruments; AM#10 minor clarifications</p>
15	<p>AM #9 update information relating to NIBIN site 367, addition of NIBIN Site 567</p>

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# AM #1: Firearms and Ammunition 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, to include firearms, unfired and fired ammunition and associated components. 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, 6th ed. 2001.
- Firearms and Toolmarks Technical Procedures Manual, Washington State Patrol
- Forensic Firearms Identification Unit, Test Methods: Indiana State Police Version 18
- Firearms/Toolmark Procedures Manual, Virginia Department of Forensic Science. Revision 7
- "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. 1, 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, at minimum, the following firearm features, to be recorded in iLIMS:

- Caliber/Gauge
- Make/Model
- Serial number and location
- Type of action
- Safeties and their functionality
- Operating condition
- Rifling characteristics
- Trigger pull (refer to Analytical Method 3 for analytical method)
- NOTE: If outside references are used to determine make or possible model, a description of the reference may be noted in the case file.

### 4.2 Trace Material

Evidence is often submitted with debris that may cover its characteristics. This includes all types of evidence received by the firearms section (firearms, magazines, unfired cartridges, fired ammunition components, etc). 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 completed steps taken for preservation, collection and cleaning in the case notes.

4.2.1 After an assessment and appropriate actions have been taken to collect or forward for preservation, biological or trace evidence, the evidence may 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. Documentation shall be noted in the firearms worksheet regarding the cleaning procedure.

### 4.3 Firearm Functionality 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 Prior to completion of any examination perform an additional safety check

- 4.3.1.1 Remove the magazine (pistol/rifle) or unlatch the cylinder/open the loading gate.
- 4.3.1.2 Visually examine the chamber and bore for any obstructions
- 4.3.1.3 Rack the slide (pistol)/charge the bolt (rifle) at least one time with force or manually eject the cartridge case(s) if present.
- 4.3.1.4 Lock or hold open the slide/bolt/cylinder.
- 4.3.1.5 Feel to make sure no cartridges are in the chamber, if not visually able to inspect.

#### 4.3.2 Visual condition of the firearm as received, note any issues that may be of a safety concern or damage present to the firearm prior to continuing examination:

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

#### 4.3.3 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



#### 4.3.4 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

#### 4.3.5 Safeties

- ¼, ½, full cock, seating check (any false positions)
- Function (grip, magazine, disconnecter)
- 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

#### 4.3.6 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.

#### 4.3.7 Action – Internal, (*may require disassembly of the firearm*)

- 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 Magazine Check

- Capacity of magazine should be checked and documented, when magazine is submitted
  - Use of dummy ammunition is recommended for magazine capacity checks.
  - For magazines integral to the firearm: If dummy ammunition is unavailable and live ammunition is used to check capacity, capacity check will be performed in the area used for test firing with appropriate safety equipment (headphones and shooting glasses).
- If magazine is submitted with ammunition loaded within, it will be removed and documented prior to further examination

#### 4.3.9 Bore/Chamber Casting

Bore and Chamber casting may be completed at the analyst discretion for a number of reasons. Those include:

- possible evaluation for potential subclass characteristics
- 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.

4.39.1 Ensure that the firearm is not loaded

4.3.9.2 Open the action and remove the bolt or bolt assembly

4.3.9.3 Check the bore for obstruction

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

4.3.9.5 Lubricate the chamber (this may be done using a cleaning patch)

4.3.9.6 Prepare the casting material according to manufactures instructions

4.3.9.7 Pour/inject the casting material from the muzzle end starting at the chamber end working toward the muzzle.

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

4.3.9.9 Remove cast from muzzle end.

4.3.9.10 **For Chamber casting:** Use the same steps for casting the bore, but only the last three inches of the bore on the chamber end need to be cast.

4.3.9.11 Casts produced during the analysis process shall be considered a sub-item of the item that was used in the casting process. Any cast produced will be documented in the firearms notes and included with the test fires or entered into the LIMS system as a sub-item with a description to include "cast of xxx". A barcode will be affixed to the cast packaging and upon completion of examination the casts will be returned to the submitting agency along with the firearm/tool. Alternatively, casts could be included in the same ILIMS item as the test fires if the description includes notation of the casts being included.

4.3.10 If an examiner is unable to determine the caliber of the firearm: the examiner can determine the correct caliber by measuring the mouth, base, overall length, rim (if pertinent), shoulder length of the cast, or the diameter of the bore cast. Measurements should be checked with an external reference prior to the firearm being test fired. Record the interpretation in iLIMS.

4.3.11 Test Firing Methods:

4.3.11.1 Origin of ammunition for Test Firing

- Ammunition utilized for test firing shall be documented in the case notes.
- When possible, use ammunition of a similar composition to that of any evidence submitted for comparison.
- If it is determined the best ammunition available is the ammunition submitted as evidence with the firearm, a portion of the evidence ammunition may be used for test firing.
  - Record the specific evidence item number (of the ammunition) used.
  - The Laboratory Report shall indicate that portions of the evidence ammunition were utilized during testing, the amount of ammunition used and the disposition of the evidence items used for test firing (ie repackaged in lab item XX.XX).
  - Caution shall be exercised to ensure any marks present from previous loading/cycling do not interfere with testing.
- All ammunition used for test firing and comparison purposes are considered lab generated evidence. and will be packaged in a new evidence envelope, and properly labeled.
- Test fires will be a sub-item of the firearm they are generated from. The test fires will be added into the ILIMS system as a new sub-item, and a barcode affixed to the evidence envelope.
- All test fires will be returned to the submitting agency at the conclusion of firearms examinations.

4.3.11.2 The purpose of test firing is to collect ammunition components for microscopic comparison, determination of marking reproducibility and uniqueness used for comparison, as well as determination of the firearm's functionality. Test fires from all eligible firearms will be entered into IBIS/NIBIN. A minimum of two (2) tests fires should be fired and recovered. If a firearm functions in single action and double action a minimum of one test fire should be obtained using each method of firing.

4.3.11.2.1 Prior to the use of ammunition (laboratory or evidence) for producing test fires, the ammunition should be checked for damage, corrosion, manufacturing and cycling marks that could affect firing or comparisons.

4.3.11.2.2 Recovery methods include water recovery tank, cotton recovery system and the bullet trap. The recovery method used will be based on the examiners experience in conjunction with the type of firearm, ammunition used and types of comparisons requested.

4.3.11.2.3 Test firing shall be completed with at least one additional person and shall never be done alone.

4.3.11.2.4 Examination of the firearm and test firing correlates to function testing and proper operability.

- Note any operational problems or general functionality of the firearm
- 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

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

#### 4.3.11.3 Water Tank and Cotton Box Recovery

The water recovery tank is generally used to recover bullets from handguns and small caliber rifles. Refer to section 4.3.10.3.1 for instructions for use of the remote firing device. Recovery of fired projectiles using the cotton box is generally for larger caliber rifles.

- Ensure that down range area is free from personnel
- Proper hearing and eye protection must be worn by all individuals near the test firing area (within the firearms lab, or in close proximity to the cotton box or snail trap)
- Ensure that the bullet collection device is properly prepared
  - (Water tank) Ensure that the tank is set to blower and the main power is on
- Notify the appropriate individuals that test firing will be occurring (this may include Forensic employees, as well as, Patrol and Dispatch)
- Ensure that all lids or doors of the recovery tank are closed and properly secured. No more than three (3) cartridges/shotshells should be loaded into the firearm during the initial testing of the firearm
- Load a semiautomatic firearm with the muzzle inserted into the shooting tube or pointed toward the entry end of the cotton box Test firing into the bullet recovery system should be done with the muzzle of the firearm inserted into the shooting tube (water tank) or within an appropriate distance from the entry end of the cotton box
- Note any operational problems or malfunctions with firearm
- Recover the test fired bullets using an appropriate device
- Retrieve all fired cartridge cases/shotshells

##### 4.3.11.3.1 Remote Firing Device

Due to the potential hazard of the firearm malfunctioning or undergoing a catastrophic failure, the scientist must be stationed behind a protective shield or at a safe distance from the firearm when discharging the firearm.

4.3.11.3.1.1 Assemble/position the remote firing device, as per guidelines set forth by the manufacturer, in front of the appropriate recovery system.

4.3.11.3.1.2 Place firearm in device. It is recommended that the scientist first dry-fire the firearm in the remote firing device before using live ammunition.

4.3.11.3.1.3 It is recommended that no more than three (3) cartridges are loaded into the firearm at a time during the test firing of the firearm. *Exception:* when testing full-auto conversions, no more than 5-6 cartridges may be loaded in the firearm.

4.3.11.3.1.4 Activate the remote device while standing at a safe distance with necessary protective devices (ie closing door to water tank room).

4.3.11.3.1.5 Obtain fired test standards.

#### 4.3.11.4 Bullet/Snail Trap Recovery

- The snail trap is generally used to test fire firearms when the recovery of projectiles is not necessary.
- Ensure that down range area is free from personnel
- Proper hearing and eye protection must be worn by all individuals near test firing
- Ensure that the bullet collection device is properly prepared
- Notify the appropriate individuals that test firing will be occurring (this may include dispatch, patrol, transportation department and residents that have requested notification)
- No more than three (3) cartridges/shotshells should be loaded into the firearm during the initial testing of the firearm. Maintain a safe distance from the trap opening to avoid ricochet, Fire the firearm into the front of the snail trap
- Retrieve cartridge cases/shotshells

#### 4.3.11.5 Preparing primed Cartridges/Shotshells for test firing or Drop testing procedures

It may be necessary to test firearm functionality without test firing the firearm using whole ammunition. To prepare a primed only case: use the inertial bullet puller to remove the bullet from the appropriate cartridge (do not use the inertial puller with rimfire cartridges).

4.3.11.6 After test firing the examiner shall mark each bullet and cartridge case with a minimum of, item designation (i.e. 1.1A, 1.1B, 1.1C). When the items are very limited in space, full case and item designators and examiner markings may be placed on packaging.

4.3.11.7 Test fires will be scanned into the Cadre 3D Imaging casework database. Digital representations will be considered a work product and maintained within the 3D database. Digital representation scans may be used for comparison purposes if additional comparisons are requested.

#### 4.3.12 Special Situation Testing:

4.3.12.1 This includes situation testing of malfunctioning or alteration of the internal parts of a firearm based on information provided by the submitting agency. Tests can include but are not limited to drop testing or striking the firearm with a rubber or plastic mallet. Drop testing should be performed using a padded landing zone for the firearm to assist in preventing examiner caused damage. The force used in situational testing could potentially alter or damage internal parts and working relationship(s) within the firearm. Care should be used to minimize potential examiner-caused damage. Primed only cartridges should be used in situational testing, to allow for examination of potential firing.

4.3.12.2 Upon request the firearms examiner may perform testing to determine if a firearm is capable of firing in full auto mode due to manipulation or design. The procedure to complete this special testing may use external references available to the examiner. Documentation of the testing performed should be noted in the case notes.

4.3.12.3 if a firearm requires disassembly to determine what may be the cause of the malfunction, actions taken to examine the firearm more extensively shall be documented in the case notes.

#### 4.3.12.4 Interpretation:

- If the primed case detonates, examination of the internal parts of the firearm should be completed to determine if there is potential damage, missing or broken parts.
- If the primed case does not detonate, this is indication that the firearm may not discharge when dropped, slammed, thrown down or falls due to improper storage or neglect.

#### 4.3.13 Rusty Firearm Examination

Rusty firearms or those found in water, etc. may be submitted for examination. To prevent further damage to the firearm, immediate attention should be given to firearms that are recovered from water. The examiner should instruct the agency that recovers the firearm to submit the firearm in a container of the fluid it was found/recovered from. If this is not possible, the submitting agency should immediately and thoroughly coat the firearm with a water displacing product (i.e. WD-40). It should be noted that the firearm may be non-functional based on the extent of the rust, but it may still be loaded.

It is the responsibility of the examiner to determine:

- If the firearm is safe
- What extent restoring the firearm is possible (i.e. for test firing, for determining manufacturers information, serial number etc)

### *Suggested Technique*

- The firearm should be soaked in penetrating oil, de-rusting solvents or similar material to dissolve rust
- Periodically check the firearm until desired information is attainable.
- Clean the firearm with gun cleaning solvent, cleaning patches and cloth (only non-marring items should be placed in the barrel of the firearm.
- Any and all methods used to clean the firearm shall be documented in the case notes

#### 4.3.14 Documentation of examinations

4.3.14.1 Dependent on case circumstances: documentation of examinations should include detail regarding the examinations performed and results of any such function testing. If a firearm is disassembled to perform safety checks, the disassembling should be completed after test firing.

- At minimum the following may be noted: Condition of the evidence as received, any additional parts, or accessories included in the evidence, general condition of the item, and damage seen.

#### 4.3.15 Function testing reporting guidelines:

4.3.15.1 When function testing is performed it will be noted on the case report the results of the function testing.

4.3.15.2 Malfunction reporting: the description of the malfunction and description of if or how it was resolved will be noted on the case report

4.3.15.3 Non-functional firearms: the report will indicate the reason for non-functioning of the firearm as received. If repair was not successful, it will be documented on the case report

### 4.4 Physical Examination and Classification of Fired Cartridge Cases

#### 4.4.1 Caliber Determination

4.4.1.1 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 or manufacturer literature.

#### 4.4.2 Determination of Marks

4.4.2.1 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

#### 4.4.2.1.1 Preliminary inspection of evidence

Examination and documentation of the fired cartridge case should include inspection for visual damage and suitability for comparison (if additional items are received for comparison purposes).

If an item is determined to be unsuitable for examination- details regarding limited factors will be documented in the case file (this may include the use of photographs, or results entered into the ILIMS system).

4.4.2.2 As appropriate, compare marks on cartridge cases to test fires from a firearm or with other evidence cartridge cases (see AM# 5: Microscopic Comparison). Cross-case comparisons will be completed at the request of the submitting agency, or due to a NIBIN lead.

4.4.2.2.1 Only the above marks necessary to affect an identification or elimination, and those used for comparisons are required to be documented in the case notes.

4.4.2.2.2 Documentation of all items compared should be recorded in ILIMS.

#### 4.4.2.3 Examination of Item for NIBIN Entry Only- ***No Firearms Comparisons requested (May be completed by a trained NIBIN technician)***

4.4.2.3.1 Evidence may be visually examined and pertinent information documented, at minimum the headstamp, caliber, firing pin shape and packaging will be recorded in ILIMS.

4.4.2.3.2 Case Management Acquisition reports will be attached to the assignment and included in the notes.

4.4.2.3.3 A general notification report will be issued for documentation that the entry was completed for the item, no technical review will be required. Individuals approved to complete administrative reviews for firearms related cases, will complete an administrative review on the NIBIN Only entry case notifications performed by a NIBIN technician.

4.4.2.3.4 All NIBIN entries will be performed following AM #9 IBIS/NIBIN procedures and the Acquisition procedures from Ultra Technologies/ATF

#### 4.4.2.4 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.

### 4.5 Physical Examination and Classification of Fired Bullet Evidence

#### 4.5.1 General, visual, and physical examination:

- Caliber/gauge
- Bullet/fragment 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

#### 4.5.1.1 Preliminary inspection of evidence

Examination and documentation of the fired bullet should include inspection for visual damage and suitability for comparison (if additional items are received for comparison purposes).

If an item is determined to be unsuitable for examination- details regarding limited factors will be documented in the case file (this may include the use of photographs, or results entered into the ILIMS system).

- 4.5.1.1 As appropriate, compare marks on expended bullets with test fires from submitted evidence firearm(s) or with other expended bullets (see AM# 5: Microscopic Comparison).
- 4.5.1.2 Only the above marks necessary to affect an identification or elimination, and those used for comparisons are required to be documented in the case notes.
- 4.5.1.3 Documentation of all items compared should be recorded in ILIMS.

#### 4.5.2 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:

- 4.5.2.1 Compare the base diameter of the evidence bullet directly with known test fired standards
- 4.5.2.2 Measure the base diameter of the evidence bullet using a measuring device and compare this measurement with known measurements published in reference literature.
- 4.5.2.3 Determine the number of land and groove impressions and compare to Section 13, Table 8 of the AFTE Glossary 6th edition.
- 4.5.2.4 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.

#### 4.5.3 Methods of Measuring Lands and Grooves

One of the class characteristics used in firearms identification is the width of land and groove impressions. These measurements may aid the examiner during the identification or elimination of a suspect firearm. If no firearm is submitted, the measurements will be used for determining the General Rifling Characteristics (GRC) of the possible firearm involved. When measuring a fired bullet to determine the width of the land and groove impressions, the points used for the beginning and end of the measurements comply with discipline-wide practices. Below are the points that should be utilized during measurement.



The measuring of land and groove impressions on a fired bullet can be accomplished by utilizing either the air-gap method, the LCD 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.

#### 4.5.3.1 Air Gap Method

4.5.3.1.1 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.

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

#### 4.5.3.2 LCD Measuring Scale Method

4.5.3.2.1 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.

#### 4.5.3.3 General Rifling Characteristics File (GRC)

The FBI's or AFTE'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.

4.5.3.3.1 To Complete a GRC Search the following should be used as a guideline:

- Fill in the applicable fields at the bottom of the GRC Search page with pertinent case information, Analyst name, and information obtained from bullet examination, and then run the database search.

- Search parameters for land and groove impression widths, where the edges are rounded with no clear edge and/or there is some variation in measurements, should include a tolerance of +/- 0.005 inch.
- Search parameters for land and groove impression widths, where the edges are crisp, defined rifling edges and/or there is minimal variance in measurements, should include a tolerance of +/- 0.002 inch to +/- 0.005 inch.
- If multiple evidence bullets have been identified to each other, one list of possible firearms may be generated.
- If multiple evidence bullets with differing class characteristics are contained in the case, a GRC will be list of possible firearms should be compiled for each group of bullets with differing class characteristics.
- At the discretion of the examiner a GRC search may be conducted and included when an inconclusive comparison to a test fire determination is made.
- If the list contains more than 10 firearms, at minimum, the four most common may be reported or it may be reported that the list is too numerous to be of use for investigative purposes.

#### 4.5.3.4 Interpretation of Results

Caliber is written as a numerical term and may be depicted with or without the decimal point, may also be reported as nominal caliber class. 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.

#### 4.5.3.5 Limitations:

Determination of a specific manufacturer of the evidence will not be determined based on this procedure. This is due to replication of designs seen within the ammunition manufacturing community, or bullets manufactured and loaded into multiple brands of ammunition within the same caliber.

#### 4.5.4 Chemical Testing

Chemical testing used for copper and lead may be conducted on possible fragments that are submitted to the laboratory for analysis.

##### 4.5.4.1 Dithiooxamide (DTO)

The DTO test utilizes a color chemistry reaction to indicate the presence of copper.

###### 4.5.4.1.1 Swab Technique

4.6.4.1.1.1 Dampen a swab with Ammonium Hydroxide.

4.6.4.1.1.2 Swab the area of interest.

4.6.4.1.1.3 Apply Dithiooxamide solution to swab.

###### 4.5.4.1.2 Controls

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

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

###### 4.5.4.1.3 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; photographs are not required.

##### 4.5.4.2 Sodium Rhodizonate Test

The Sodium Rhodizonate test utilizes a color chemistry reaction that is specific for lead.

###### 4.5.4.2.1 Swab Technique

4.5.4.2.1.1 Dampen a swab with Acetic Acid.

4.5.4.2.1.2 Swab the area of interest.

4.5.4.2.1.3 Apply Sodium Rhodizonate solution to swab.

4.5.4.2.1.4 Apply Buffer solution to swab. (optional)

4.5.4.2.1.5 Apply Hydrochloric Acid solution to swab.

#### 4.5.4.2.2 Interpretation of Results

A violet or purple colored stain, corresponding to the area tested constitutes a positive reaction for lead. Results will be noted in examination documentation; photographs are not required.

#### 4.5.4.2.3 Controls

A positive and negative control will be run each day before the reagents are used to ensure they are working properly. A positive and negative control may be prepared by placing a test mark with a piece of lead on an appropriate material or by wetting two swabs with a solution of Acetic Acid and swabbing a piece of lead with one.

### 4.6 Physical Examination and Classification of Shotshell Evidence

#### 4.6.1 Shotshell Cases

4.6.1.1 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

##### 4.6.1.1.1 Preliminary inspection of evidence

Examination and documentation of the fired shotshell evidence should include inspection for visual damage and suitability for comparison (if additional items are received for comparison purposes).

If an item is determined to be unsuitable for examination- details regarding limited factors will be documented in the case file (this may include the use of photographs, or results entered into the ILIMS system).

##### 4.6.1.2 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.

#### 4.6.1.3 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 marks
- Firing pin impression
- 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 examiner may compare marks on shotshell cases with test fires from a firearm or with other shotshell cases (see AM# 5: Microscopic Comparison)

#### 4.6.1.4 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.

### 4.6.2 Wads

#### 4.6.2.1 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 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 reference. Care must be taken since manufacturers may trade components.



#### 4.6.2.2 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.

#### 4.6.2.3 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. Determination of a specific manufacturer of the evidence will not be determined based on this procedure.

#### 4.6.3 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.

##### 4.6.3.1 Comparison of pellets by weight

4.6.3.1.1 Determine the number of pellets suitable for weighing

4.6.3.1.2 Weigh the pellets in grains

4.6.3.1.3 Consult known pellet weights in the NRA Factbook, Table 1 of Appendix G of the AFTE Glossary 6th ed. or most current edition, or manufacture's data.

4.6.3.1.4 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.

##### 4.6.3.2 Measuring pellet size

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

4.6.3.2.2 Consult known pellet sizes in the NRA Factbook, Table 1 of Appendix G of the AFTE Glossary 6th ed., or manufacture's data or compare to a known sample.

##### 4.6.3.3 Interpretation of Results

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

4.6.3.4 Examination of Item for NIBIN Entry Only- No Firearms Comparisons requested  
(May be completed by a trained NIBIN technician)

4.6.3.4.1- Evidence may be visually examined and pertinent information documented, at minimum the headstamp, gauge and packaging information will be recorded in ILIMS.

4.6.3.4.2 Case Management Acquisition reports will be attached to the assignment and included in the notes.

4.6.3.4.3 – A general report will be issued for documentation that the entry was completed for the item, no technical review will be required. Individuals approved to complete administrative reviews, will complete an administrative review on the NIBIN Only entry case notifications performed by a NIBIN technician.

4.6.3.4.4 All NIBIN entries will be performed following AM #9 IBIS/NIBIN procedures and the Acquisition procedures from Ultra Technologies/ATF

4.7 Physical Examination and Classification of Unfired ammunition/cartridges

4.7.1 Unfired ammunition should be documented for report purposes. Unfired ammunition may be used, at the discretion of the examiner, for test firing of evidential firearm submitted under the same agency case number, if the laboratory ammunition collection does not contain cartridges similar to any evidence possibly submitted under the same laboratory case.

4.7.1.1 Preliminary inspection of evidence

Examination and documentation of the unfired ammunition should include inspection for visual damage and suitability for use in test firing (if additional items are received for comparison purposes).

If an item is determined to be unsuitable for examination- details regarding limited factors should be documented in the case file (this may include the use of photographs, or results entered into the ILIMS system.

4.7.3 The following should be considered:

- Presence of trace or biological material
- Caliber
- The possible manufacturer/marketer of the item
- Description of headstamp
- Description of the loaded bullet (FMJ/TMJ, JHP, Lead, etc)
- Description of any other markings present, which may include loading marks, cycling marks, and firing pin impressions.
- Description of ammunition box (if submitted) should include at minimum (brand, manufacturer, description as printed on package, product code, lot number and packaging capacity, to include any cartridges missing from box)

## 4.8 Conclusion of testing Packaging Recommendations

Upon completion of examination, all evidence should be packaged accordingly, in order to prevent loss or damage:

### 4.8.1 Firearms:

- Firearm will be secured to packaging, in a manner that visual inspection can render a firearm unloaded without removing from packaging (example: zip-tie through the magazine well with the slide in the rearward locked position, zip tie through cylinder of revolver with hammer zip-tied in a “locked” position), any ammunition that may have been submitted within the firearm package will be separate from the firearm and magazine within the original packaging)

### 4.8.2 Unfired Ammunition or Fired ammunition components

- Internal packaging may be added to the original packaging by the firearms examiner if it is deemed appropriate to prevent loss of evidence within the original packaging. Example: a jacketing fragment is placed loosely in an evidence envelope; upon return of the evidence the examiner may place the fragment in a coin envelope or small plastic bag and return the repackaged item to the evidence envelope.
- If internal packaging is added by the laboratory, it should be noted in the case notes for that item.

## 4.9 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.

## 4.10 Photographs

Photographs shall be digitally retained by the laboratory.

## 4.11 Three-Dimensional (3D) Representative acquisitions of Fired cartridge cases

Fired cartridge cases acquired in 3D representation scans will be retained by the laboratory and notated in the case file and relayed to the submitting agency on the analytical case report.

# 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 and can be used to determine compliance with firearm related statutes and laws. 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."

- 2.1.1 Descriptive measurements are defined as routine firearm dimension measurements for general documentation. Descriptive measurements are recorded in case notes only.
- 2.1.2 Reported measurements are defined as measurements which are relevant to the determinations of possession of a "Short Barrel Rifle", "Short Barrel Shotgun" "Sawed Off Rifle or 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.
- 2.1.3 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.
- 2.1.4 For overall length of a shotgun or rifle, if the descriptive measurement is less than 26 inches, a reported measurement shall be taken.
- 2.1.5 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 (see [AM #8 section 1.1](#)). 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 breech when measuring barrel length.

4.1.1.2 For revolvers barrel length measurements should **exclude** the cylinder. If necessary, remove the cylinder from the firearm and place a flat object (block, small metal piece) on the forcing cone end of the barrel.

4.1.1.3 This measurement will be recorded in the case notes rounded up to the nearest 1/16<sup>th</sup> 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 (see [AM #8 section 1.1](#)). 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 breech. Be sure not to damage the barrel or breech when measuring barrel length.

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

4.1.2.3 For barrel length of a shotgun or rifle, if there is visible alteration to the barrel and the descriptive measurement is less than or equal to 16 inches for a rifle or less than or equal to 18 inches for a shotgun, a reported measurement shall be taken and recorded in the case notes and placed on the report.

4.1.2.3.1 The reported measurement will include the uncertainty of measurement if the measurement is between 15  $\frac{3}{4}$  inches and 16 inches for rifles or 17  $\frac{3}{4}$  inches and 18 inches for shotguns.

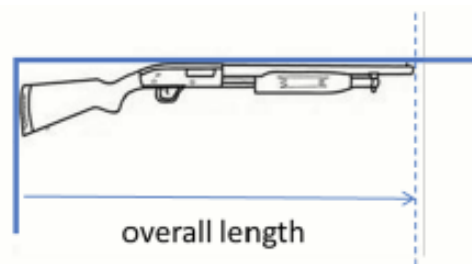
4.1.2.4 If the barrel length of the shotgun or rifle exceeds the length of the 24-inch NIST-traceable barrel rod, a non-marring dowel rod may be used for a descriptive measurement. The non-marring dowel rod measurement will be compared to a standard tape measure for a descriptive measurement. The measurement 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. An alignment square or 90-degree angle should be used to align the butt of the firearm, also ensuring the barrel is parallel to the measuring device. Measurement shall be made parallel to the bore using a ruler/yard stick. 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 or equal to 26 inches, a reported measurement shall be taken, 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. A reported measurement is taken if the descriptive measurement is +/- 1/8 inch for overall length, and 1/4 inch for barrel length, of any defined statutory regulation.
- 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.

#### 4.3.5 Uncertainty of Measurement Reporting

- 4.3.5.1 When measurements are reported, the measurement uncertainty and a statement regarding the coverage probability of 99.73% shall be included 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  $y \pm U$  where U is consistent with the units of Y (i.e. 18 1/2 inches +/- 3/32 inches). The current expanded uncertainty is published electronically as a protected document and is available to all analysts.

#### 4.3.6 Measurement of Uncertainty Estimation

- 4.3.6.1 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 device (1/32nd 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 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.

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# AM #3: Trigger Pull

## 1.0 Background/References

Trigger pull measures the amount of force that must be applied to the trigger of a firearm in a manner parallel to the barrel to cause the sear to release and discharge the firearm. Based on experience, trigger pulls can vary based on model, age, sear construction, condition, as well as, how close to parallel the barrel is positioned during examination of trigger pull. All of these factors and potentially others may have an effect on the trigger pull weight measured.

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 firearm. For rimfire firearms, a dummy cartridge should be used when performing trigger pull testing to avoid damaging the firearm.*

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).

4.1.1.1 Firearm should be raised with force applied in a slow and consistent manner, with every attempt to avoid rapid movements of the firearm.

- 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. The resulting range of will not fire to will fire may be included in a final report.

#### 4.3 Safety Precautions

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

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# AM #4: Toolmarks Physical Exam and Classification

## 1.0 Background/References

### 1.1 Background

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
- Isopropyl Alcohol
- 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 should 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 the 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 microscope 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 when a comparison is performed.
- Silicon rubber or similar products are used and manufacturer's instructions shall be followed.

### 4.2.1 Procedure

4.2.1.1 Mix the casting material according to manufacturer's 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 and 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

4.3.1 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; lead or copper are often used. Additional test marks might require the use of the material used in the original toolmark. Multiple test marks should be produced to allow for determination of reproducibility.

4.3.2 The examiner shall mark each testmark used for comparison with a minimum of, examiner's markings and item designation (ie. 1.1A, 1.1B, 1.1C).

4.3.3 Testmarks used for comparison shall be considered a sub-item of the tool they resulted from. Testmarks will be entered into the LIMS system and a barcode affixed to the testmarks packaging. Upon completion of examination the testmarks will be returned to the submitting agency along with the tool.

4.3.3.1- Casts produced during the analysis process shall be considered a sub-item of either the toolmark or the tool testmark. Any cast produced will be entered into the LIMS system as a test mark item with a description to include "cast of". A barcode will be affixed to the cast packaging and upon completion of examination the casts will be returned to the submitting agency along with the tool.

#### 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/SDS for each chemical prior to use.

#### 4.7 Photographs

Photographs shall be digitally retained by the laboratory.

# AM #5 Microscopic Comparison

## 1.0 Background/References

### 1.1 Background:

1.1.1 A light comparison microscope (LCM) allows for side-by-side examination of evidence and test marks produced by the laboratory. The ability to complete side-by-side comparison 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.

1.1.2 Virtual comparison microscopy (VCM) allows for side-by-side examination and comparison of digital representations of fired ammunition components.

### 1.2 References:

- "Microscopic Comparisons of Firearms" Firearms and Toolmarks Procedure Manual. Virginia Division of Forensic Science. Amendment B.
- Cadre TopMatch User Manual and online training videos
- "F-311 TopMatch System Procedure" Montana Forensic Science Division
- "F-204 Verification of Casework" Montana Forensic Science Division

### 1.3 Definitions

- **Light Comparison Microscopy (LCM)** – use of a comparison microscope to examine evidence items for side-by-side microscopic comparisons for purposes of determining source conclusions.
- **Virtual Comparison Microscopy (VCM)**- use of digital representations of evidence items for side-by-side microscopic comparisons for purposes of determining source conclusions.

## 2.0 Scope

2.1 This procedure is used when there are multiple items to compare to each other, comparisons are completed in pairs. This may be comparison of a known reference item (lab created test fire/test mark) to an evidence item(s), or it may also be used to compare two evidence items to determine if the same source/tool produced the marks.

2.2 It is at the discretion of the examiner as to which type of comparison is completed during the examination of evidence. A combination of LCM and VCM, or use of a single procedure may be used for the examination/comparisons.

### 3.0 Equipment/Reagents

- Light Comparison Microscope (LCM)
- Cadre TopMatch System and Virtual Comparison Microscopy (VCM) Software
- Stereo Microscope
- Camera

### 4.0 Procedure

#### 4.1 Light 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, rotation and viewing angles, as needed.

#### 4.2 Light Comparison Microscope (LCM) Comparison process

- 4.2.1 If the suspect tool or firearm is submitted, test fires from the firearm or test marks produced from the tool should first be compared to determine what microscopic characteristics are reproduced, and are sufficient for comparison purposes.
- 4.2.2 Compare the unknown evidence to either another piece of unknown evidence and/or a known test by placing the unknown on the left-hand stage and the known test on the right-hand stage.
- 4.2.3 Document comparison notes in the appropriate section of ILIMS.
- 4.2.4 If areas of sufficient characteristics for comparison are 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
  - 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
- 4.2.5 Document comparison notes in the appropriate section of ILIMS.
  - 4.2.5.1 The comparison documentation must be clear enough that another qualified firearm and toolmark examiner, without the benefit of the evidence itself, can review the case record, understand what was examined/compared, and evaluate why the examiner arrived at the reported conclusion(s).



#### 4.3 Virtual Comparison Microscope (VCM) Comparison process- Cartridge Cases Only

- 4.3.1 Prior to performing comparisons using the VCM, cartridge cases will be scanned into the TopMatch system following manufacturer acquisition procedures and procedures found in [Analytical Method 10](#) of this manual.
- 4.3.2 Each analyst will use their individual credentials to access the database and applicable samples for comparisons.
- 4.3.3 Comparisons are performed using the TopMatch Incident Analysis software on the acquisition instrument computer or the analysts' workstation computer.
- 4.3.4 Load applicable incident, and digital representation of items needing comparison.
- 4.3.5 Complete comparison annotations, and case notes (to include areas used for the basis of the conclusions reached) for each comparison set performed. Comparison sets may be items from the same laboratory case (incident) or items from different cases.
- 4.3.5.1 Screenshots may be taken to document areas of comparison. The captured screenshots will be exported into the case notes generated by Incident Analysis software upon the completion of all comparisons performed using the VCM software. A single image may be used for multiple evidence items where the same conclusion is reached using the same area of interest.
- 4.3.5.2 If visualization enhancements are used for comparisons, document such enhancements in the case notes of Incident Analysis. *For example, use of the flatten firing pin feature, for comparison of firing pin drag marks*, should be noted either in the comparison notes section or by using the screenshot function.
- 4.3.6 Set comparison conclusion for each comparison performed in the comparison screen.
- 4.3.7 Generate case notes with examination documentation and attach to applicable ILIMS assignment. The case notes from Incident Analysis will be included in the assignment's analytical notes.
- 4.3.8 Documentation of comparison results must also be notated in ILIMS.
- 4.3.9 Additional instructions and procedures for the use of comparison and documentation tools for Incident Analysis software are located in the most up to date TopMatch manual, centrally stored and available on the TopMatch computer.

#### 4.4 Interpretation, Results and limitations of LCM and VCM comparisons

##### 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 the general area of the identification, documentation in ILIMS will be completed to include which items (ie 1.1A was used for comparisons) were compared and the individual characteristics that were used as the basis for the identification.

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 an identification. Photographs may be referenced to determine if comparisons or examinations of additional evidence may be necessary (Photographs can be used to determine class exclusions- and conclude that additional examinations will not be completed).

4.4.1.3.1 Photos are generally 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:

- *Inconclusive A* - Agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification.
- *Inconclusive B* - Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficient or lack of reproducibility. Or some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification or elimination.
- *Inconclusive C* - 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, including the test item used for comparison will be used to document class characteristics and describe why the comparison resulted in an inconclusive result.

#### 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, including the test item used for comparison, will be used to describe class characteristics and describe why the comparison resulted in an elimination.

## 4.5 Limitations

### 4.5.1 General limitation relating to comparisons by light comparison microscopy.

4.5.1.1 In some instances, it may not be possible to determine the class characteristics due to the properties or conditions of the substrate or incomplete toolmark reproduction.

4.5.1.2 Due to variations in substrate, changes in tool working surfaces from wear, corrosion, damage, or the employment of unusual tool/work piece orientations, toolmark reproduction may be incomplete or insufficient, as a result it may not be possible for an examiner to reach a source conclusion.

4.5.2 Virtual Comparison Microscopy (VCM) is limited to fired cartridge cases and the surface that a three-dimensional toolmark topographical instrument is capable of measuring to produce a digital representation. Additionally, individual characteristics may be present on the evidentiary item but may not be reproduced during a scan. This may be due to interference from lacquer/sealant, environmental damage, debris, areas of acquisition or measuring limits for an instrument.

## 4.6 Technical Verification

4.6.1 Technical verification is a process of a qualified firearms examiner independently performing an unbiased comparison, examining or analyzing evidence to determine if the verifying examiner comes to the same conclusion regarding the comparison or analysis as the original examiner.

4.6.2 All technical verifications are to be performed prior to the release of a signed report, or any release of results outside the firearm and toolmark section.

4.6.3 Technical verification will be performed on all conclusions in which individual characteristics contribute to the conclusion

4.6.3.1 All identification, inconclusive and non-class characteristic eliminations require technical verification.

4.6.3.2 Eliminations based on class characteristics do not require technical verification

4.6.4 Technical verification will be completed using the same comparison instrumentation as what was used to obtain the conclusion by the original examiner.

4.6.4.1 LCM comparisons require verification by LCM.

4.6.4.2 VCM comparisons require verification using VCM.

4.6.4.2.1 When verifications are completed using VCM, the verifier will access the images using their own login credentials. This will prevent the verifier from seeing any documentation of the comparisons that may have been made by the initial examiner.

### 4.6.5 Verification Documentation Requirements

4.6.5.1 If technical verification is completed by an ISPFs examiner, the verification will be documented in the appropriate ILIMS assignment.

4.6.5.2 If technical verification is completed by an experienced firearms examiner not employed with ISPFS, a hardcopy Verification Checklist and Technical Review Checklist will be attached to the corresponding assignment and included in the notes packet in ILIMS.

#### 4.7 Conflict Resolution (applicable to all examinations where conflict may arise)

##### 4.7.1 Step 1 – Analyst level

4.7.1.1 The conflicting analysts should discuss the matter, refer to any applicable references and attempt to resolve the matter to the agreement of all parties. If the initial conclusion is changed, documentation in the technical record is required.

4.7.1.2 If the resolution cannot be achieved by the affected analysts, the discussion will be elevated to the next level.

##### 4.7.2 Step 2 – Third Analyst

4.7.2.1 As there are three qualified examiners within the Forensic Science Division the third qualified analyst will be used.

4.7.2.2 The third analyst will conduct an independent examination. If the initial conclusion by the primary examiner is changed, documentation in the technical record is required.

##### 4.7.3 Step 3 – No resolution

4.7.3.1 If a resolution cannot be achieved, the most conservative option will be the officially reported option. Documentation is required in the technical record.

#### 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.

#### 4.9 Photographs/Digital Images

##### 4.9.1 Photographs using digital camera

4.9.1.1 Photographs are notes of examination and shall be digitally retained by the laboratory.

4.9.1.2 It will be communicated to the customer in the case report when photographs are captured and stored by the laboratory.

4.9.1.3 A single image may be used to depict multiple areas, a combination of multiple images may be used or a single image may be used for multiple evidence items where the same conclusion is reached using the same area of interest.

#### 4.9.2 Digital/3D images obtained from the TopMatch Instrument

- 4.9.1.1 The original item (i.e. fired cartridge case) submitted to the laboratory is considered evidence, is documented by a chain of custody and is returned to the submitting agency at the completion of analysis.
- 4.9.2.1 Digital images are considered to be a work product of the examiner and are stored in the TopMatch system as part of the case record.
  - 4.9.2.1.1 The images in the system are labeled, at a minimum, with the laboratory case number and item number which corresponds to the associated case and evidence information in the LIMS.
- 4.9.2.2 Annotations and deletions can be made to digital images but the image itself is unable to be altered when stored in the TopMatch System.
- 4.9.2.3 If an image is deleted from the TopMatch System the reason for the deletion will be documented in the case record.
- 4.9.2.4 It will be communicated to the customer in the case report when digital image(s) are captured and stored in the TopMatch system.

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# AM #6: Proximity Determination

## 1.0 Background/References

1.1 The proximity determination procedures are used to determine approximate muzzle to garment 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. These particles can potentially be deposited on objects forward of the barrel at the time of discharge.

### 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 garment distance.

## 3.0 Equipment/Reagents

### 3.1 Equipment:

- Microscope
- Balance
- Laboratory glassware
- Rulers or Tape measure
- Transparent Overlays
- Camera
- Alternate Light Source/VSC
- 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

Note: Reagents in this method are generally prepared for single use. When applicable, storage conditions and/or requirements for stored reagents or materials are notated in the preparation instructions for that item.

## 4.0 Procedure

### 4.1 Visual examination

4.1.1 The visual examination of an item for gunshot residue can include the examination and/or consideration of the following. Visual examination can include items of clothing submitted to the lab for examination or photographs submitted as evidence.

- 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 the physical effects and visible residues examined shall be included in the examination notes. Visual examination may be aided with the use of filtered or IR photography, an alternate light source or VSC. Copies of any photographs submitted as evidence will be retained and electronically store with the examination documentation photographs.

### 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

#### 4.1.2.2 Indicative of/Consistent with a contact shot:

- Ripping or tearing
- Burning or singeing
- Melted artificial fibers
- Heavy vaporous lead residues

#### 4.1.2.3 Limitations:

##### Possible masking effects

- Dark background color
- Blood Staining
- Clothing type, material, adverse handling or improper packaging may affect adherence of particles and limit the ability to perform range determinations.

## 4.2 Microscopic Examination

### 4.2.1 The microscopic examination of an item for gunshot residue can 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

Incident circumstances, including but not limited to, intermediary/intervening objects, weather, clothing type and/or material, adverse handling or improper packaging may affect adherence of particles and limit the ability to perform range determinations.



### 4.3 Chemical examinations methods

Evidence items should be chemically processed prior to creation of test shots. Cartridge cases and bullets fired during range determination need not be collected. If items are collected, they will be logged into the ILIMS system and designated as an additional sub-item of the firearm in which they were fired from. Sub-items will be documented on the examination report and returned to the submitting agency.

*If multiple chemical examinations are going to be performed on an item, they must follow a specific order. **Modified Griess first, Dithiooxamide second, then 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 to the naked eye or when using a 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-naphthol and produces an orange-red color.

##### 4.3.1.1 Preparation of Reagents

(The following may be made in different amounts using appropriate ratios for single-use.) Documentation of reagent preparation shall be performed in the appropriate reagent log file.

###### 4.3.1.1.1 Sensitized Paper:

- Add 0.75 g Sulphanilic acid to 150 ml water
- Add 0.42 g of Alpha Naphthol 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 in a dark area for up to 2 months.

###### 4.3.1.1.2 Acetic acid Solution

- Prepare a 15% glacial acetic acid solution.

###### 4.3.1.1.3 Nitrite test swabs

- Dissolve 0.06 g of sodium nitrate in 100 ml water.
- Saturate filter paper or cotton swabs in the mixture. Dry and store in an airtight plastic container for up to 6 months.

#### 4.3.1.2 Application Procedure

4.3.1.2.1 Direct application (may be used when item is thin fabric or porous material)

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 (may be used with items of thicker fabric or non-porous material)

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

Prior to the use of sensitized paper on case items a positive and negative control will verify the sensitized paper was prepared correctly. The controls for the Modified Griess procedure consist 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. Cut the test marks off the paper before applying to the evidence to avoid possible contamination.

The negative control may consist of making a similar test mark using a non-nitrite test swab with the Acetic Acid solution or the treatment of the paper with Acetic acid prior to testing the item. No color reaction should take place.

#### 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 including a ruler, negative results and results of controls need only be noted.

#### 4.3.1.5 Limitations:

Incident circumstances, including but not limited to, intermediary/intervening object, weather, clothing type and/or material, adverse handling or improper packaging may affect adherence of particles and limit the ability to perform range determinations.

#### 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

(The following may be made in different amounts using appropriate ratios for single use.) Documentation of reagent preparation shall be performed in the appropriate reagent log file.

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 Swab Technique

4.3.2.3.1 Dampen a swab with Ammonium Hydroxide.

4.3.2.3.2 Swab the area of interest.

4.3.2.3.3 Apply Dithiooximide solution to swab.

##### 4.3.2.3 Controls

A positive and negative 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 and negative control can be obtained by creating a test mark on an appropriate piece of material with known copper, or by wetting two 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; photographs are not required.

#### 4.3.2.5 Limitations:

Clothing type and/or material, intermediary/intervening objects may affect adherence of particles and limit the ability to perform range determinations.

#### 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.) Documentation of reagent preparation shall be performed in the appropriate reagent log file.

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 mL conc. HCl in 95 mL 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 mL glacial acetic acid in 85 mL 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 (optional)
- 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 (optional)
- 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. (optional)
- 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; photographs are not required.

#### 4.3.3.4 Controls

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

#### 4.3.3.5 Limitations:

Incident circumstances, including but not limited to, intermediary/intervening object, weather, clothing type and/or material, adverse handling or improper packaging may affect adherence of particles and limit the ability to perform range determinations.

## 4.4 Test Pattern Methods

In muzzle to garment 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. Test patterns will be produced at the appropriate ranges designated by the results of the evidence testing. Test Patterns will be creating using methods defined in section 4.4.1 or 4.4.2 of this method.

### 4.4.1 Non-Shot Pellet Test Pattern Production

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

#### 4.4.1.1 Preparation

4.4.1.1.1 Attach appropriately sized piece of an 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 Tests may be shot in duplicate, if ammunition supplies allow.

4.4.1.1.4 If the test patterns are obtained outside, they must be obtained during appropriate weather conditions. It must not be raining/snowing 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 submitted item when it was shot by bracketing the suspect pattern with test patterns at known distances. A conclusion can be reached by comparing the diameter of the known patterns with the unknown pattern. Patterns can be measured with a ruler or transparent overlay to determine the approximate diameter of major concentration. To employ a bracketing technique, it is necessary to determine at what distance a smaller known pattern is consistently produced and at what distance a larger know pattern is consistently produced.

The witness sheets will be stored centrally in the lab.

A disclaimer should be noted on the report that the ranges are determined under controlled conditions. Conditions that may have been present during the time of the incident may have an adverse effect on the possible ranges. Possible scene-based factors that could affect the pattern range may include weather conditions, dynamic movement of the target material at the time of the shot, non-flat target

surfaces, intervening objects/clothing, as well as, treatment of the target material post incident.

All of these factors which are difficult to accurately account for may have an influence on the number of particles detected during analysis versus the amount of particles that may have been present at the time of the incident.

#### 4.4.2 Shot Pellet Test Pattern Production

It is an essential prerequisite that the suspect firearm or other identical 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 appropriately 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 Test may be shot in duplicate if ammunition supplies allow.

4.4.2.1.4 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, under controlled conditions, that a particular firearm's muzzle was from the suspect item when it was shot by bracketing the suspect pattern with test patterns at known distances. The witness sheets will be stored centrally in the lab.

#### 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 garment distance and the reporting of residues and shot patterns. Generally, results may include indicative of a contact/near contact distance, an intermediate range reported, or the analysis yields the absence of particles or components used in determining a proximity (ie past the drop off range for the firearm/ammunition combination).

#### 4.7 Photographs

Photographs shall be digitally retained by the laboratory.

#### 4.8 Reviews

Results may be reviewed using just notes and photographs or by using the witness panels at the reviewer's discretion.

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# 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

### 3.1 Equipment

- 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. Documentation of reagent preparation shall be maintained on the appropriate reagent log.

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.

### 3.2.12 Magnaflux:

Use Magnaflux 9CM Prepared Bath or Magnaflux 7HF Prepared Bath (or equivalent) 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, isopropanol or acetone to remove any 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 scratches that may hinder restoration.

4.1.1.5 Note and record any characters which become visible.

4.1.1.6 If no characters 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 (The following are considered recommendations)

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 (Magnaflux)

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.

#### 4.1.5 Barcode Decryption

4.1.5.1 Inspect barcode to ensure that at least portions of the full barcode are available.

4.1.5.2 Determine if all bars are present.

4.1.5.3 Delineate the bars into character units.

4.1.5.3.1 Use of an enlarged photograph or photocopy is recommended.

4.1.5.3.2 Start at the far-left bar and count five bars over then label this as the first character set.

4.1.5.3.3 Repeat this procedure for the remaining bars to identify all character sets. There will be nine (9) character sets visible.

4.1.5.4 Interpret and document the barcode element size patterns.

4.1.5.4.1 Each bar and space from left to right is to be labeled "W" for wide or "N" for narrow.

4.1.5.4.2 Complete this for each character set.

4.1.5.4.3 Using the Bar Code 39 table below, begin correlating each developed pattern sequence from the individual character sets to determine the character represented by the pattern.

4.1.5.5 Record results in ILIMS.

**Bar Code 39 Table**

Character	Pattern	Character	Pattern	Character	Pattern
0	NNNWWNWN	F	NNWNWWNN	U	WWNNNNNN
1	WNNWNNNN	G	NNNNWNNW	V	NWWNNNNN
2	NNWNNNNW	H	WNNNNWNN	W	WWWNNNNN
3	WNWNNNNN	I	NNWNNWNN	X	NWNNWNNN
4	NNNWWNNN	J	NNNNWNNN	Y	WWNNWNNN
5	WNNWWNNN	K	WNNNNNWW	Z	NWWNNNNN
6	NNWWWNNN	L	NNWNNNWW	Space	NWWNNWNN
7	NNNWNWNN	M	WNWNNNNN	*	NWNNWNNN
8	WNNWNNWN	N	NNNNWNNW	\$	NWNWNNNN
9	NNWNNWNN	O	WNNWNNWN	/	NWNWNNWN
A	WNNNNWNN	P	NNWNNWNN	+	NWNNWNNN
B	NNWNNWNN	Q	NNNNNNWW	%	NNNWNWNN
C	WNWNNWNN	R	WNNNNWNN	-	NWNNNNWN
D	NNNNWNNW	S	NNWNNWNN	.	WWNNNNWN
E	WNNNWWNN	T	NNNNWNNN	This cell blank	

## 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. Documentation of the positive reaction will be noted in the case notes.

## 4.3 Interpretation of Results

If any characters become visible during the restoration process, note these characters including partials on the appropriate worksheet.

- 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/SDS for each chemical prior to use.

## 4.5 Photographs

Photographs shall be digitally retained by the laboratory.

# AM #8: Maintenance, Calibration, Reference Collections and Ammunition Inventory

## 1.0 Background/References

### 1.1 Background

To ensure 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.

## 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
- TopMatch-3D Instrument and Comparison software
- Sinusoidal microscale reference specimen, (quality control standard)
- Ball Grid Array (BGA)

## 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 every 5 years 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 Light Comparison Microscope

4.1.2.1.1 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.

4.1.2.1.1.1 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.

4.1.2.1.1.2 It is recommended that the microscope be cleaned and services by an approved outside vendor at least once every 5 years, or when needed.

##### 4.1.2.2 Virtual Comparison Microscope

4.1.2.2 Each 3D Instrument/Virtual Comparison microscope will have a maintenance log and any maintenance or repair will be recorded.

4.1.2.2.1 Prior to casework acquisition the appropriate quality checks will be completed. Refer to AM 10: Quality control section

#### 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 .001 inches 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, sinusoid) 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 (5) 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 Onstage LCD Scale

The on-stage 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.

#### 4.1.8 Sinusoidal microscale reference

The Sinusoidal microscale reference will be run prior to and scan acquisition of casework samples. The sinusoid will be calibrated every two (2) years. Checks will be performed upon return from calibration. The sinusoid measurements shall fall within the guardrails set during calibration of the Cadre instrument.

#### 4.1.9 Ball Grid Array (BGA)

The BGA will be run when a new gel pad is being used for the first time, completion of the acquisition with the ball grid array will register the gel pad as being approved for use.

### 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 examiners 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 Reference Collection and Laboratory ammunition

### 4.6.1 Firearms Reference Collection

4.6.1.1 A firearms collection is maintained for reference, temporary use of parts to render non-functional evidence firearms functional, and for training purposes. The Firearms reference collection is housed in the Coeur d'Alene laboratory and inventoried annually. Reference firearms shall be kept in secure areas. Access to the firearms reference collection is limited to Firearms Section personnel, laboratory management, and designated auditors.

### 4.6.2 Laboratory Ammunition Inventory

4.6.2.1 The Firearms/Toolmark section maintains an inventory of ammunition, designated as lab supplies, this ammunition can be used for training, test firing evidence firearms, creating NIBIN exemplars, research purposes and general examination.

4.6.2.1.1 Ammunition should be stored in a cool, and dry location away from heat sources, open flames, solvents, other chemicals and the firearms reference collection.

4.6.2.2 Ammunition is stored separately from the firearms reference collection.

4.6.2.3 Evidence or ammunition used for inventory or research purposes, which may be examined or stored in other sections of the laboratory (ie. Latent Print or Biology discipline) should be stored in accordance with 4.6.2.1.1 of this method.

4.6.2.4 A list of ammunition and characteristics shall be maintained for ammunition located in the Firearms section and will be centrally stored electronically and available to lab personnel.

## 4.7 Transportation of Reference Collection Items

Reference collection firearms and required ammunition will be stored in a manner that is defined above.

Reference Collection firearms and required ammunition for test firing may be transported by a firearms examiner for training purposes. The examiner transporting, should ensure that the firearm is not loaded, and ammunition is separated. When transporting reference firearms, it is not acceptable to leave the firearm in plain sight or unattended in a vehicle for a prolonged period.

#### 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.

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## AM #9: IBIS/NIBIN

### 1.0 Background/References

#### 1.1 Background

In 1999, the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) established the National Integrated Ballistic Information Network (NIBIN) to provide federal, state, and local partner agencies with an automated ballistic imaging system. Integrated Ballistic Identification Systems (IBIS) technology takes digital images of cartridge cases from crime scenes or a crime gun exemplar/test fire. Within hours, IBIS compares those images against previous NIBIN entries. If a high-confidence candidate emerges, firearms examiners can compare the original physical evidence microscopically to confirm the match. This is a NIBIN “lead,” or the linking of two (or more) different investigations.

The goals of the NIBIN program are to reduce firearms violence through promoting a comprehensive evidence collection, timely entry and correlation of evidence, providing investigative support, and ongoing facilitation of feedback regarding NIBIN program. As an ATF-NIBIN partner, the Idaho State Police Forensic Services is committed to assisting the ATF in the NIBIN program.

Currently ISPFSS has two NIBIN terminals that can be accessed. The Coeur d’Alene Laboratory houses a NIBIN unit (Site 567US). The Meridian Laboratory has access to the NIBIN unit (Site 451US) located at ISP Headquarters. Prior to December 2024, ISPFSS had access to Site 367 located at the Washington State Patrol Crime Laboratory located in Cheney, Washington. These units are deployed by the ATF and are the property of the ATF and U.S. Government. Specialized security clearance is required for all IBIS/NIBIN users and is issued by the ATF.

Each IBIS /NIBIN user is required to complete the ATF IBIS/NIBIN Acquisition training and pass a competency test administered by the ATF, or an approved NIBIN Acquisition Trainer (NAT) prior to participating in the NIBIN program. ISPFSS may require additional training to perform entries for casework related samples.

##### 1.1.1 Goals & Objectives

Efficiently participate in collection and data entry of eligible fired cartridge cases into the IBIS database. This will be achieved by entry of exemplar test fires, evidence test fires, or crime scene evidence by an approved NIBIN user in a timely manner as defined by the ATF MROS.

## 1.2 References

1. *Moving Toward a More Effective NIBIN*, version 1.0, Ron Nichols, NIBIN National Technology Coordinator
2. *Coordinating NIBIN and Forensic Science Laboratory Efforts*, Ron Nichols, NIBIN National Technology Coordinator
3. Washington State Patrol Firearms and Toolmark Technical Manual Revision 13. March 21, 2022
4. 2022 NIBIN MROS, Bureau of Alcohol, Tobacco, Firearms and Explosives

## 1.3 Definitions

**Acquisition:** digital imaging process of various markings on fired cartridge cases that is completed by a NIBIN user using the BrassTrax Acquisition equipment

**Correlation** – The automated comparison of an acquired digital image to other images in the databases using an algorithm that provides a list of ranked possible matches.

**Correlation Review** – The on-screen comparison of digital images by a trained technician/specialist to determine the potential for two cartridge cases to have been fired from the same weapon.

**NIBIN Lead:** an **unconfirmed**, potential association between two or more items of firearms related fired ammunition components based on a correlation review of the digital images in the NIBIN database by a user trained in correlations. A NIBIN lead is intended to provide a lead for investigative purposes.

**NIBIN Hit:** The result of two or more items acquired that have been examined and confirmed by a firearms examiner, as to having been fired from the same firearm. NIBIN Hits are based on **correlation reviews** of digital images using the MatchPoint+ **system and microscopic confirmation from a firearms examiner.**

**NIBIN National Correlation and Training Center (NNCTC)** – The ATF facility located in Huntsville, Alabama that performs timely correlation reviews for multiple NIBIN Sites and also provides training for Qualified NIBIN Users.

**Qualified NIBIN User:** technician or Firearms examiner trained by the ATF, ULTRA/FTI, or a NIBIN Authorized Trainer (NAT) to perform acquisitions and or correlation reviews of ballistic images on the national network.

**Reception Date:** date evidence for NIBIN entry is **first accessible** by the laboratory/NIBIN site for **any** forensic analysis (ex: LP, BIO or FA). This will be entered as the submission date for the applicable laboratory submission.

## 2.0 Scope

- 2.1 Defining the requirements and standard procedures for firearms related evidence entry and maintenance in relation to the NIBIN database program managed by the ATF. NIBIN Acquisition entries may be completed by any personnel who have successfully completed the required NIBIN Acquisition training. NIBIN entry does not require any additional training outside of quality control and general laboratory policies.

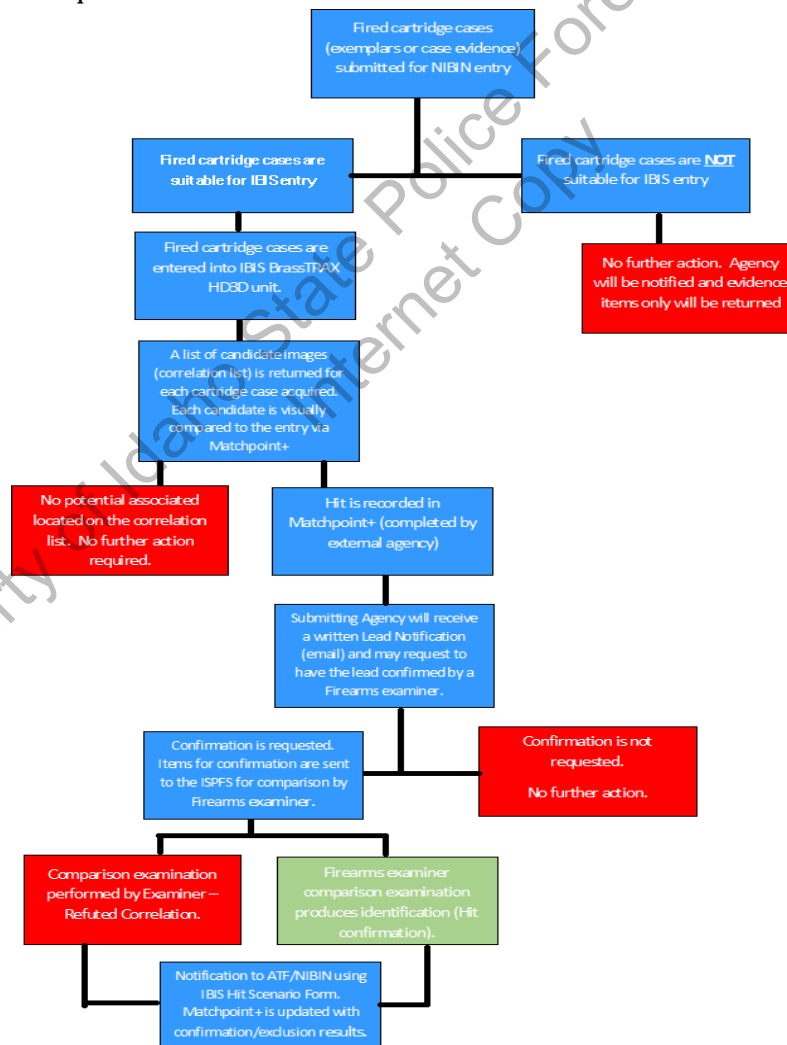
## 3.0 Equipment/Reagents

### 3.1 Equipment

- Stereo Microscope
- IBIS BrassTRAX HD3D acquisition unit

## 4.0 Procedure

### 4.1 IBIS Acquisition Flow Chart



## 4.2 Type of IBIS Entries

### 4.2.1 Methods of Submission

IBIS/NIBIN only test fires (exemplars) will be submitted to the lab with the required information.

All cartridge cases or firearms submitted to ISPFs for IBIS/NIBIN entry may be handled as follows:

- Cartridge cases or firearms submitted as evidence will be documented and handled per the ISPFs Quality Manual.
- Test fire cartridge cases created by the submitting agency exclusively for NIBIN entry, will be designated as exemplars, and may be submitted to a drop box located in the ISP Headquarters building or shipped to the ISPFs Laboratory in Coeur d'Alene or Meridian. These cartridge cases may be entered into IBIS by any authorized NIBIN/IBIS operator. Exemplars will be discarded after entry.

Following IBIS guidelines and ATF IBIS Data Entry Protocol, requested test fires will be entered into the NIBIN database. The selected cartridge cases may be cleaned with acetone when appropriate and placed in the cartridge case holder of the IBIS unit. When the acquisition is complete, the images are sent to the NIBIN server for correlations. A manual correlation may be requested as needed. Correlations will be performed and reported by an external agency.

### 4.2.2 Test Fired Cartridge Cases (Exemplars)

Test fires are acquired by test firing two cartridges using the standard or appropriate ammunition.

Exemplars generated by a law enforcement agency may be submitted by any of the methods described above. At this time, it is preferable for agencies to generate their own exemplars, as it streamlines the process for IBIS entry.

For agencies that need assistance creating exemplars for IBIS, the agency may bring the firearm into the Coeur d'Alene lab, where a firearms examiner can assist with the test firing process. An agency representative must be present and complete the required collection and documentation for the exemplar submission.

The test fired cartridge cases will be visually examined and one will be selected to be entered into NIBIN unless the test fired cartridge cases differ considerably in appearance (i.e. different headstamp or compositions, primer shear on one and not the other, etc.). If they differ, two cartridge cases may be entered at the discretion of the IBIS user. When an ejector is present, the IBIS user should acquire the ejector mark based on ULTRA ELECTRONICS protocol.

All firearm and exemplar related information will be entered into the IBIS instrument following ULTRA ELECTRONICS guidelines and ATF/IBIS Data Entry Protocol.



#### 4.2.3 Evidence Cartridge Cases/Firearms

4.2.3.1 Cartridge cases and firearms recovered in association with a crime for IBIS entry must be submitted and documented as evidence. Any evidence/scene cartridge cases or test fires from evidence firearms that meet the ATF criteria for entry will be entered into IBIS/NIBIN. **Evidence cartridge cases will not be accepted for IBIS entry using the drop box.**

4.2.3.2 Prior to handling casework evidence, the operator will review all pertinent case information to ensure all other case considerations such as, but not limited to, DNA or latent prints analyses have been addressed. For all entries, if two or more evidence cartridge cases are submitted of the same caliber family, the IBIS operator will examine the cartridge cases evaluating the caliber, the class characteristics of the breech face marks and the firing pin impression to determine which item(s) should be entered into IBIS. When an ejector is present, the IBIS user should acquire the ejector mark. If class characteristics vary or ammunition type varies, a test fire/evidence cartridge case from each group should be entered into IBIS.

4.2.3.3 All casework evidence cartridge cases will follow the standard casework procedures, information pertaining to the entry of the cartridge case(s) into NIBIN will be documented in the analytical notes. The case record will include printouts from the IBIS instrument. All evidence cartridge cases will be entered into the IBIS instrument following ULTRA ELECTRONICS guidelines and ATF/IBIS Data Entry Protocol.

4.2.3.4 Evidence cartridge cases submitted for Latent Print or Biology screening with no associated Firearms Comparisons/Examination assignment, which are eligible for NIBIN entry may be assigned a Firearms section assignment for NIBIN entry only. Completion of the NIBIN entry and report associated may be performed by a trained NIBIN technician.

4.2.3.4.1 Evidence may be visually examined and pertinent information documented, at minimum the headstamp, composition, caliber and packaging will be recorded in ILIMS.

4.2.3.4.2 Case Management Acquisition reports will be attached to the assignment and included in the notes.

#### 4.2.4 IBIS Laboratory Reports

- For exemplars submitted to the laboratory for IBIS/NIBIN entry only, no laboratory report will be generated.
- For evidence cartridge cases and/or laboratory created test fires where entry into NIBIN has been completed or will be completed, a notation will be put on the laboratory report denoting which items will be/were entered into IBIS/NIBIN and the "Case Maintenance" printout will be included in the case record.

- For evidence cartridge cases assigned for NIBIN Entry by Latent Prints or Biology section: A general report will be issued for documentation that the entry was completed for the item, no technical review will be required. Individuals approved to complete administrative reviews, will complete an administrative review on the NIBIN Only entry case notifications performed by a NIBIN technician.

#### 4.2.5 Timeliness of Entry

Items for IBIS entry should be entered as soon as possible, upon receipt by the Firearms section, or other qualified laboratory personnel. Section 5.8 of the 2022 ATF MROS defines entry standards.

#### 4.3 IBIS Acquisition Instrument

All equipment directly related to IBIS BRASSTRAX is owned by ATF and serviced by ULTRA ELECTRONICS. No adjustment or addition to any part of the system is permitted. The IBIS Acquisition Unit (AU) performs automatic self-diagnostic tests. If one of these tests reports an error, a calibration may be performed. Any time there is a problem that the user is unable or not authorized to resolve, ULTRA ELECTRONICS must be called.

No one may enter or retrieve data until they have been trained by the ATF, an approved NAT or ULTRA ELECTRONICS and final approval is given by the ATF. All persons using the IBIS/NIBIN system must have an ULTRA ELECTRONICS generated password and security clearance granted by the ATF.

#### 4.4 IBIS Acquisition

When creating a new NIBIN case, and completing information related to the exhibit to be acquired refer to the IBIS training guide available through the ULTRA ELECTRONICS website. In addition to the IBIS training guide, ensure that the appropriate procedures are followed (external agencies approved for entries should follow entry guidelines set forth by ISPFS, or their respective agency)

##### 4.4.1 Case Information

In addition to the IBIS Procedures and training guide: Provide all relevant case information, including Investigating officer email (lead notifications are sent to the email provided). ISPFS and external users will follow the following

4.4.1.1 Case ID – All case identification begins with the designated Agency abbreviation followed by the Agency Case number. (A list of the Agency Abbreviations is provided by ISPFS to all NIBIN users, located in the NIBIN Binder dedicated to each entry unit.)

Example: SP10 K19000001

4.4.1.2 If the case is a laboratory case the ISPFs Laboratory case number should be referenced in the Case Maintenance tab of IBIS/NIBIN

4.4.1.2.1 All exhibits from a single case will be entered under one case number. The exhibits are to be labeled appropriately. Exhibits may include firearms, test fires and/or evidence.

4.4.1.2.1.1 For exemplars, case identification should use an abbreviation for the submitting agency and the agency case number. Example: ACSO 2019DR12345

4.4.1.2.2 Any Exhibits entered out of the WSPCL or ISPFs drop-box should follow the convention used by appropriate user/agency.

#### 4.4.2 Firearms Entry

In addition to the IBIS Procedures and training guide:

Exhibit number – Enter Gun 001, Gun 002, or Gun followed by the agency item number of the firearm from the Submission paperwork or item's packaging for as many firearms as are necessary to list. This exhibit number is often the same as what the submitting agency used as its evidence marking.  
Example: "GUN MC2"

#### 4.4.3 Cartridge Case Entry

In addition to the IBIS Procedures and training guide:

Exhibit numbers –

4.4.3.1 All crime evidence exhibits begin with EX. After EX, enter any identifiers that apply to the exhibit such as EX 3-1 or EX MC10, and designated as "Crime Evidence".

4.4.3.2 All test fire exhibits will begin with TF. Test fires should be entered as TF 001, TF 002 and so on. Test Fires should correspond with the firearm entered in section 4.4.2 of this method. If comparisons and identifications to crime evidence submitted under the same case, or cross-referenced laboratory case, have been made prior to entry, make a note in the comments section stating that evidence cartridge cases were also received but not entered since they were confirmed as being fired from the same gun.

### 4.5 Correlations and Lead notifications

#### **Site 367 (Cheney, WA) (For entries completed prior to December 2024)**

##### 4.5.1 Correlations

- Correlations can be performed by any approved user of MatchPoint, following the recommendations of FTI for performance of correlations.
- At minimum, the top 20 correlation results should be visually examined.

#### 4.5.2 Lead Notifications

- If similarities exist between two entries, the WSP NIBIN unit will be notified, a secondary review must be completed, and any lead generated will be distributed to the appropriate individuals by the WSP Firearms or NIBIN unit.

#### **Site 451US (Meridian) and 567US- Coeur d'Alene**

Correlations for all acquisitions completed at Site 451 are performed by the NIBIN National Correlation and Training Center (NNCTC). Lead notifications are generated and sent to approved users via Huddle.

- When a lead notification is received via NNCTC/Huddle, the NIBIN Site/Technical Administrator will disseminate the lead notification to the appropriate personnel.
  - At minimum lead notifications are sent to the investigating officer associated with the entries, appropriate external agency personnel, appropriate ISPFS personnel, and regional ATF personnel.

#### General Documentation for Lead notifications

- Any correspondence relating to a lead notification from the WSP Crime Lab, or the National Correlation Center (NNCTC) will be documented in the case correspondence section of ILIMS. Notifications of leads are sent to the submitting agency, and relevant ISPFS personnel and ATF contacts.
- Lead notifications are not considered confirmation or comparative analysis. All lead notifications received will be attached to the appropriate laboratory case(s) under the case information tab, and a NIBIN Lead- case correspondence will also be added. If multiple laboratory cases are linked by a lead notification, the appropriate steps for entering a case reference will be completed.

#### 4.6 Statistics

- Statistical reports will be generated and reviewed on a quarterly basis or as needed for the Coeur d'Alene and Meridian- ISPFS units (Site 567US and 451US). Lead and No-Lead Notifications from the National Correlation Center (NNCTC) will be checked semi-annually and reviewed by the Firearms supervisor to ensure that data entry is being performed properly.

#### 4.8 IBIS Lead Confirmations- Microscopic Comparisons

Confirmations are not required for all lead notifications and will generally not be completed unless requested by the submitting agency or agencies. However, comparisons to confirm a lead must be requested and the evidence firearm and evidence should be submitted to the ISPFS Firearms unit, if not currently in the laboratory.

#### 4.8.1 Confirmed Lead

If, after comparisons are completed by a firearms examiner, the cartridge cases are identified to having been fired from the same firearm, the the confirmation is marked appropriately as a "hit" in the MatchPoint database.

#### 4.8.2 Inconclusive or Exclusions (For reference only)

If the firearms examiner determines the cartridge cases are inconclusive or eliminated from being fired from the same firearm, the cases should be un-referenced in ILIMS and the appropriate personnel (ISP NIBIN technician or NNCTC) should be notified, and the lead information removed from the MatchPoint database.

#### 4.8 NIBIN Program Goals

4.8.1 To make the NIBIN system more successful, ATF has suggested four key factors<sup>1,3</sup> to increase the effectiveness of the IBIS/NIBIN system. ISPFs Firearms section is committed to assisting the ATF with their goals.

- "Comprehensive data collection – the non-fatal/injury shootings previously having low priority are as important as the fatalities/injuries because they represent "misses" more often than not."

4.8.2 ISPFs will increase the priority of exhibit-only no suspect cases and will communicate with agencies the importance of submitting no suspect fired cartridge cases. ISPFs will also assist the regional ATF Taskforce with communication and strategies to increase fired cartridge case submissions.

- "Timeliness – NIJ report demonstrated that value of output drops precipitously after only one week delay; in this instance timeliness turns into a quality issue because delays = less useful intelligence"

4.8.3 ISPFs will prioritize fired cartridge cases submitted shortly after an incident occurred. A goal of 5 days for IBIS entry after submission will be attempted if agency submits the evidence in a timely manner and the case does not need DNA or latent print examination by ISPFs.

- "Investigative follow-up – actively following up on NIBIN leads for the purpose of identifying and targeting active shooters; can also include analytics to help facilitate the work of investigators freeing them up to focus on doing actual interviews"

4.8.4 Lead Notification reports will be distributed by WSP or NNCTC/Huddle, as soon as possible and communicated to the submitting agencies.

- Lead notifications issued via Huddle will be disseminated to the appropriate individuals by the NIBIN Technical Administrator
- “Feedback – reduces frustration of sites who wonder whatever becomes of their efforts and also provides fuel to motivate increased funding”.

4.8.5 ISPFs will work closely to the regional ATF Task Force to continue to get feedback from user agencies and evaluate the IBIS/NIBIN system and protocols.

#### 4.9 Safety Considerations

This procedure involves hazardous materials, operations, and equipment. This procedure does not purport to address all 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.

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# AM #10: Scan Acquisition of 3D Reproduction of Fired Cartridge Cases

## 1.0 Background/References

### 1.1 Background

- 1.1.1 The Cadre TopMatch-3D Desktop scanner is a system that contains a three-dimensional scanning hardware instrument (TopMatch-3D High-Capacity Scanner) and analysis software that allows for 3D visualization, databasing and searching capabilities, virtual comparisons, annotations, and custom notetaking with exportable documentation templates. The use of 3D reproductions of fired cartridge cases will allow for creation of a searchable casework database, as well as the ability for an examiner to complete microscopic comparisons virtually.
- 1.1.2 The Cadre TopMatch-3D system will be used to acquire digital representation images of fired cartridge case heads, to include primer area, ejectors (when present), breechface marks, and firing pin impressions. All scans are stored as xp3 file formats and are exportable for data sharing based on industry standards.

### 1.2 References

- 1.2.1 Cadre TopMatch User Manual
- 1.2.2 ANSI/ASB Standard 061: Firearms and Toolmarks 3D Measurement Systems Measurement Quality Control
- 1.2.3 Duez, P, Weller, T et al: "Development and Validation of a Virtual Examination Tool for Firearm Forensics", J Forensic Sci, July 2018, Vol. 63, No. 4, pg 1069-1083
- 1.2.4 Chapnick, et al, "Results of the 3D Virtual Comparison Microscopy Error Rate (VCMER) Study for firearm forensics" J Forensic Sci. 2020;00:1-14.

### 1.3 Cadre Instrument data entry field definitions

Note: The following section provides a description for the data that may be entered into each field within the Cadre software. Not all fields are required for entry, fields listed as optional and may be completed at the analysts' discretion.

#### 1.3.1 Incident

- **Incident Date\***: Date of crime or activity
- Submission Date: (optional) Date of data entry



- **Laboratory Number\*:** Unique incident number from the laboratory for this laboratory submission. Must be unique. This is the Laboratory case number assigned
- Address, City, State: (optional) Location of incident
- Laboratory Name: (optional) Name of lab handling incident (i.e. lab name).
- **Submitting Agency:** Name of agency for whom you are handling the incident.
- **Case Number:** Submitting agency case number.
- **Incident Type\*:** Type of incident
- Note: (optional) A free-text field where any additional comments can be saved. Remember that notes specific to a single record are common across all users.

### 1.3.2 Cartridge Case

- **Source Type\*:** Firearm or Incident
  - Every cartridge case must be associated with either a Firearm or an Incident
  - If a cartridge case is a Test Fire and is thus 100% known to have been fired from a firearm it should be linked with the Firearm.
  - In all other situations (Evidence) the cartridge case should be associated with an Incident.
- **Source ID\*:** The internal reference identifier for the linked Firearm or Incident. This is filled in by the system. For Incidents it's the unique 'Laboratory Number'. For Firearms it's the 'Laboratory Number - Item Number'.
- **Item Number\*:** Your item number within the source (e.g., 1, 2, ...). The Source ID + Item Number must be unique. That is, items (cartridge cases or bullets) from the same firearm or incident cannot both have the same item number.
- **Caliber\*:** Caliber of cartridge case
- Ammunition Brand: (optional) Brand of ammunition used.
- Headstamp Text: (optional) Headstamp text.
- Cartridge Case Material: (optional) Cartridge Case material
- Primer Material: (optional) Primer material
- Seal Present: (optional) Whether a sealant has been applied to the cartridge case. Choices here are 'yes', 'no', or can be left blank. Blank indicates that you are unsure or didn't check; blank is different from 'no'.
- Firing Pin Type: (optional) The type of firing pin (centerfire vs. rimfire).
- Firing Pin Aperture: (optional) The shape of the firing pin aperture.
- Firing Pin Class: (optional) The shape of the firing pin.
- Firing Pin Features: (optional) The type of features seen on the firing pin impression.
- Breech Face Class: (optional) Description of dominant features of the breech-face impression.
- Note: (optional) A free-text field where any additional comments can be saved.



### 1.3.3 Firearm

- **Incident Laboratory Number\*:** The Laboratory Number of the Incident associated with this Firearm.
- **Item Number\*:** Your item number within the lab case (e.g., 1, 2, ...). The Laboratory Number + Item Number must be unique. That is, two firearms cannot have both the same Laboratory Number and Item Number.
- Serial Number: (optional) Firearm serial number
- **Manufacturer\*:** Firearm manufacturer
- Firearm Type: (optional) Type of firearm (e.g., pistol, revolver, rifle, ...)
- Importer: (optional) Firearm importer
- Model: (optional) Firearm model
- **Caliber\*:** Firearm caliber
- Approx. Extractor Position: (optional) The approximate position (clock orientation) of the extractor for this firearm.
- Approx. Ejector Position: (optional) The approximate position (clock orientation) of the ejector for this firearm.
- Note: (optional) A free-text field where any additional comments can be saved.

## 2.0 Scope

- 2.1 Defining the requirements and standard procedures for completion of 3D reproduction of fired cartridge cases and firearms related evidence using the TopMatch system.

## 3.0 Equipment/Reagents

### 3.1 Equipment

- Stereo Microscope
- Cadre TopMatch acquisition unit
- Cadre TopMatch Virtual Comparison software
- Sinusoidal microscale reference specimen, (quality control standard)
- Ball Grid Array (BGA)

### 3.2 Chemical and Additional Supplies:

- Isopropyl alcohol (no special grade requirements) used for cleaning dirt and debris from fired cartridge cases.
- Soft bristle toothbrush, used for cleaning the cartridge cases.
- Rocket Blower
- Blue Roller

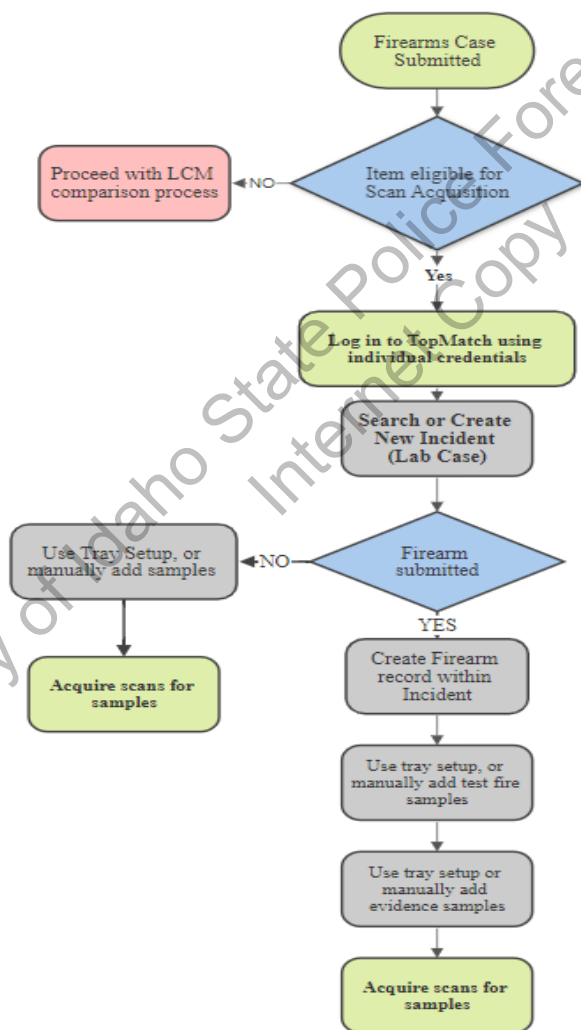
- Poster putty
- Scotch tape
- Gel pads

#### 4.0 Procedure

Required Note: All scans for fired cartridge cases will be entered into the “ISPFS Firearms” database. The database is selected when logging into the TopMatch software by each user.

Note: This procedure is for general instructions and does not contain specific details for each step, for more detailed instructions the examiner may refer to the most current version of the Cadre TopMatch User Manual.

#### 4.1 Acquisition Flow Chart



## 4.2 Items Eligible for entry into TopMatch instrument

### 4.2.1 Test Fired Cartridge Cases (NIBIN Exemplars)

4.2.1.1 Submitted NIBIN packets of eligible calibers may be entered into the TopMatch Database. These scans may be used for creation of a reference database. Exemplar packets entered will include a note that the scans were acquired from a NIBIN Exemplar packet.

### 4.2.2 Evidence Cartridge Cases

4.2.2.1 Evidence cartridge cases eligible for scan acquisition will be acquired to create a digital representation of the item submitted. *These scans can later be used for virtual comparison microscopy (VCM), at the discretion of the examiner.*

### 4.2.3 Laboratory created test fires from Evidence Firearms

4.2.3.1 Test fired cartridge cases eligible for scan acquisition will be acquired to create a digital representation of the item submitted. *These scans can later be used for virtual comparison microscopy (VCM), at the discretion of the examiner.*

## 4.3 Scan Acquisitions

### 4.3.1 Creating New Case (incident), Firearm and cartridge case

4.3.1.1 Incident Creation: Prior to any scan acquisitions, create a new lab case (incident) within the TopMatch software.

4.3.1.2 Firearm Creation: Once a lab case has been added, create a record for any firearms associated with the selected lab case. *(This is required for any cartridge case test fire entries, prior to adding to a tray setup.)*

4.3.1.3 Cartridge Cases: cartridge case records are created when adding to the tray setup. When added using tray setup, ensure that the appropriate case is associated in the tray setup field.

4.3.1.4 Appropriate ammunition information must be entered upon completion of the tray scanning. The minimum information will include: cartridge case manufacturer/brand, primer and case composition, firing pin impression shape.

### 4.3.2 Tray Setup

4.3.2.1 When a new gel-pad is being used for acquisition for the first time, the ball grid array sample must be completed to register the gel pad.

4.3.2.2 Sinusoid scans will be taken prior to acquisition of samples on any day. Assign sinusoid to any position within the tray setup.

4.3.2.3 Cartridge cases must be cleaned with isopropyl alcohol prior to being loaded into the sample tray for acquisitions. Ensure that there is no residual isopropyl alcohol remaining on the cartridge case, use of the rocket blower to dry, if needed.

4.3.2.3 Designate the tray location for each cartridge case being acquired, to include caliber, item number and link to appropriate lab case and/or firearm.

#### 4.3.3 Acquisition of digital representations

4.3.3.1 Load sample tray into the instrument.

4.3.3.2 Complete scout image acquisition, as instructed by the prompts on the instrument.

4.3.3.3 Upon completion of the scout image acquisitions, mark each cartridge case with the appropriate registration points (breachface and firing pin locations)

4.3.3.4 Remove the scan tray, install gelpad loaded onto the gel retention rig onto the instrument lightplate, and select OK on the instrument prompt.

4.3.3.5 Allow instrument to complete acquisitions for all samples designated on the Tray setup.

4.3.3.6 Upon completion of all scan acquisitions follow on-screen prompts, then complete or defer masking of all samples acquired following section 4.3.4 of this analytical method.

4.3.3.7 Ensure appropriate information relating to the cartridge case is entered in the Case Information screen prior to accepting masking for each sample.

#### 4.3.4 Masking (Optional)

4.3.4.1 Masking is the process by which the analyst locates and marks specific regions on the scan surface (e.g., breach face impression, aperture shear, firing pin impression, firing pin drag, firing pin shear, extractor mark). These regions can be used for visualization and algorithm-based scan comparison.

4.3.4.2 Upon completion of the scan acquisition, masking may be deferred or completed following section 4.3.4.3 below.

4.3.4.2.1 Scans in which masking was deferred, can be found for later masking.

4.3.4.2.2 Select the **Action** pull-down menu, and then select **Deferred Masking**.

Open each sample and complete masking according to instructions in the TopMatch user manual.

4.3.4.3 Complete masking as described in the Cadre User manual, and training videos for all acquired samples.

4.3.4.4 Upon completion of all acquisitions, remove gelpad and return to storage container, close software and turn off instrument. The computer does not need to be shutdown.

4.3.4.5 Remove cartridge cases from sample tray and return to appropriate storage location.

## 4.4 Quality Control Requirements

**4.4.1 Required:** A traceable sinusoid reference will be scanned prior to any casework being done on any particular day for evidence acquisition, and/or when a new gel pad is used.

4.4.1.1 Ensure the sinusoid scan is in traceable mode (see TopMatch manual)

4.4.1.2 After the traceable reference scan is complete, check the current scan in the Quality Control tab in TopMatch prior to completing evidence acquisitions.

4.4.1.2.1 If the measured  $R_{sm}$  and  $R_a$  are highlighted in green, they fall within the acceptable range and casework can be performed.

4.4.1.2.2 If the measured  $R_{sm}$  and/or  $R_a$  are highlighted red, then the quality control failure steps will be followed.

4.4.1.3 The serial number of the sinusoid reference used, and each measurement obtained are stored on the TopMatch system under the Quality Control tab. These measurements are retained in the TopMatch system for the life of the instrument.

### 4.4.2 Quality Control Failure

4.4.2.1 If the measured  $R_{sm}$  and/or  $R_a$  are highlighted red (outside acceptance range) after a traceable sinusoid reference scan, two repeat measurements shall be completed, if the additional quality control checks remain outside acceptable range the following steps will be performed:

4.4.2.1.1 Run a BGA scan with the sinusoid reference.

4.4.2.1.1.1 If the measured  $R_{sm}$  and  $R_a$  are highlighted green after the BGA and sinusoid reference scan, casework can be performed.

4.4.2.1.1.2 If the measured  $R_{sm}$  and/or  $R_a$  are highlighted red the steps in section 4.4.2.1.2 will be performed.

4.4.2.1.2 Change the gel pad being used and run another BGA with a sinusoid reference scan.

4.4.2.1.2.1 If the measured  $R_{sm}$  and  $R_a$  are highlighted green after the BGA and sinusoid reference scan using a new gel pad, casework can be performed.

4.4.2.1.2.2 If the measured  $R_{sm}$  and/or  $R_a$  are highlighted red, the instrument will be taken out of service and Cadre will be contacted.

4.4.2.1.3 Once the quality control traceable sinusoid scan falls within the acceptable  $R_{sm}$  measured and  $R_a$  measured range the system may be put back in service and casework performed.

4.4.2.1.4 All actions taken to return the TopMatch system to service will be documented in the instrument maintenance log.

## 4.5 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.

## 4.6 Digital images

4.6.1 The original item (i.e. fired cartridge case) submitted to the laboratory is considered evidence, is documented by a chain of custody and is returned to the agency.

4.6.2 Digital images are considered the work product of the examiner and are stored in the TopMatch system as part of the case record.

4.6.2.1 The images in the system are labeled, at a minimum, with the laboratory case number and item number which corresponds to the associated case and evidence information in the LIMS.

4.6.2.2 Annotations and deletions can be made to digital images but the image itself is unable to be altered when stored in the TopMatch System.

4.6.3 If an image is deleted from the TopMatch System the reason for the deletion will be documented in the case record.

4.6.4 It will be communicated to the customer in the case report when digital image(s) are captured and stored in the TopMatch system.

4.6.5 Digital images (3D) will be added to the case record as a new item and scanned to the Evidence Storage – Final Disposition -TopMatch location for retention.

4.6.5.1 A single item may be added in ILIMS for multiple cartridge case scans, it will be notated in the description all digital images captured for the case.

## 4.7 Limitations of Method

4.7.1 The ability to use VCM for comparisons is limited to the selected acquisition areas during tray setup, areas of evidence capable of capturing based on the instrument's limitations including available sample trays. (Example: firing pin impressions, full headstamp and breechface areas).