Department of Forensic Science

FIREARM/TOOLMARK PROCEDURES MANUAL

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INTRODUCTION

The information in this Procedures Manual was collected from the Association of Firearm and Tool Mark Examiners (AFTE) Procedures Manual and other sources. It is presented here for easy reference for Firearm/Toolmark Examiners. This manual presents a basic outline of procedures most routinely used to analyze evidence submitted to the Firearm/Toolmark Section of the Virginia Department of Forensic Science (DFS). This manual, in combination with the Section Training Manual, provides the basis for effective quality management of analysis. The Department's Quality Manual (QM) provides additional guidelines.

Every case is unique and must be evaluated by the individual examiner. Not all possible analyses that may be encountered in casework can be appropriately covered in a procedures manual nor can all possible variations to a described procedure be included. It is always the examiner's responsibility to choose the best analytical scheme for each individual case, particularly for evidence not routinely encountered.

It is expected that Section Supervisors shall be consulted, and the Physical Evidence Program Manager shall be notified of deviations from existing procedures in accordance with the Department of Forensic Science Quality Manual.

New methods must be validated before use. Published methods must be verified to work in each Regional Laboratory before use. Prior to beginning a validation process, consult the Section Supervisor who shall consult with the Physical Evidence Program Manager for determination and approval of an appropriate validation plan.

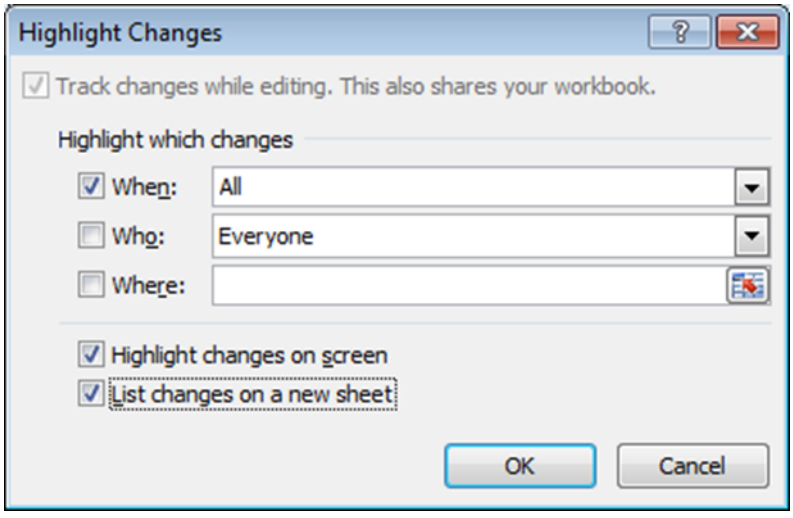
Examination Documentation

Examination documentation can be recorded electronically, using the current, approved and controlled Excel worksheets.

Worksheets shall be saved in a folder on the examiner's laptop H drive or other networked folder prior to recording examination documentation. This approach allows changes to be tracked appropriately. Examiners shall ensure their Microsoft Office setting includes their first and last name.

Tracked changes history shall be printed at the time the electronic worksheet is printed. (Review > Track Changes > Highlight Changes).

Check the "When" box and select "All" in the space provided. Check the "List changes on a new sheet" box.



If all changes in the "Old Value" history are <blank>, complete the following steps on history worksheet:

- Click the down arrow in Action Number, select Number Filters and Less Than
- Place a 1 in the box next to the "is less than" box. Select OK.
    - This will hide all <blank> Old Value changes.
- Print this worksheet and associated history.

If there are changes in the history that are <blank> and other cell changes, filter out the "Old Value" to remove the <blank> from the worksheet.

- Click on the down arrow in Old Value, uncheck the <blank> box and select OK.
    - This hides the <blank> History and shows the tracked changes that have been made to the worksheet.
- Print this worksheet and associated history.

The printed history worksheet will document any tracked changes including no changes. If the tracked changes history cannot be generated, contact the Program Manager for a Memorandum for Record documenting the deviation.

Each electronic worksheet and its associated history worksheet shall be printed for Technical/Administrative Review. Any additional changes to the printed examination documentation shall follow the Quality Manual guidelines. All electronic worksheets shall be removed from the examiner's laptop after the Technical/Administrative Review is complete.

Examination records shall include each examination activity conducted, to include the sequence and results of each, which will allow for another examiner to evaluate the data, interpret the results and come to the same conclusion and also be able to repeat the various steps used by the examiner in the analysis under conditions as close as possible to the original. When recording a measurement, the value displayed on the device shall be recorded in its entirety.

Internet references included in examination documentation shall, at a minimum, contain the website address and the date accessed/printed.

The examination documentation shall contain documentation as to the types of materials that are generated during the analysis. Tests, casts and test patterns produced during analysis shall be considered evidence. Tests produced from laboratory materials will be created in LIMS, listed on the Request for Laboratory Examination form (RFLE) and on the Certificate of Analysis (CoA) as sub-items of the tool or medium from which they were produced. Documentation shall be on the RFLE, indicating the container in which the tests are being returned, in addition this information will be included on the CoA.

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

Each worksheet shall contain a start and end date, documenting the date(s) the laboratory activity was conducted.

All evidence shall be marked in accordance with the QM.

- An engraver or scribing tool shall not be used on firearms that can be recognized by a unique serial number; the firearm will be marked using a permanent marker and/or gun tag. Privately manufactured firearms (PMFs) and firearms with obliterated serial numbers shall be marked, in an inconspicuous location, with an engraver or scribing tool. If a firearm does not fall into the previous category and cannot be recognized by a unique serial number, consult with the Supervisor to determine the best method for marking.

Evidence Storage

Short term storage is used when evidence is in the process of examination or is waiting for instrumental support results. Evidence generally will not remain in short term storage for longer than 90 days. After this time period, evidence must be placed into long term storage according to the QM**.**

Trace Evidence

Examine the item visually and microscopically for any trace material. Document the presence of possible blood, tissue, plaster, paint, hair, fiber, glass and/or other materials. Consult the RFLE or submitting agency to determine if further examination of trace material is necessary. Consult, if necessary, with the appropriate discipline prior to the removal and packaging of trace evidence.

If the material IS NOT going to be retained for further examination, proceed with the following, as necessary:

- For evidence containing blood, tissue, or other biohazards, as practical based on evidence type and size, place the evidence into an appropriate beaker containing a 10% bleach solution (refer to Section 12 for solution preparation) to soak for at least one (1) minute, followed with water rinse.
- Use of an ultrasonic bath may assist with loosening debris more efficiently. Care should be taken when using an ultrasonic bath to minimize damage to the evidence.
- Remove loosened material by rinsing with methanol or water.
- Remove plaster by soaking in a 15% Acetic Acid Solution (refer to Section 12 for solution preparation) or other appropriate solution.
- Remove paint by soaking in alcohol, acetone or other appropriate solution.
- Use a non-abrasive brush to remove loose material.
- Use TergAZyme® for removal of tissue, Naval Jelly or E-zest cleaner to remove dark stains, as needed.
- Record steps taken and observations in examination documentation.

1 PHYSICAL EXAMINATION AND CLASSIFICATION OF FIREARMS

1.1 Introduction

All firearms must be treated as though they are loaded. DFS personnel are responsible for following proper firearms handling and safety procedures and shall have a working knowledge of the operation of test firing/recovery equipment. It is the responsibility of the firearm examiner to ensure that all appropriate safety checks are performed on a firearm or item of ammunition prior to test firing.

1.2 Safety Considerations

- The muzzle of the firearm must always be pointed in a safe direction.
- Firearms submitted to the laboratory for examination should be unloaded and in a safe condition; however, the examiner must first safety check a weapon to ensure that it is unloaded before conducting any other examinations.
- If a firearm is found to be loaded, the Supervisor shall be notified, and it shall be documented in the examination documentation.
- A magazine received in a loaded condition must first be unloaded prior to conducting any examinations with it using a firearm.
- Test firing or any examination of the firearm that utilizes ammunition or an ammunition component shall only be performed in designated test firing areas.
- Firearms shall be fired in the manner in which they were designed. If it is not possible to fire the weapon from the shoulder or using standard hand positions, a remote firing device shall be used.
- After the examination is completed, a safety appliance shall be placed in/through the action for return to the agency.
- If the examiner is not familiar with the function of a firearm or if there is any doubt about the operability of a firearm, they should consult with the Section/Group Supervisor before test firing.
- All observers in test firing areas will stand behind the shooter.

1.3 Instrumentation

- Standard Trigger Weights
- Ruler, Tape Measure, Non-marring rigid rod
- Perspective Enterprises device
- IMADA Digital Force Gauge
- Scale/Balance
- Stereo Microscope

1.4 Minimum Analytical Standards and Controls

Ensure the equipment utilized in the examination has been appropriately calibrated and/or performance checked prior to use. See Section 11 of this manual for specific requirement.

1.5 Procedure or Analysis

1.5.1 General, Visual, and Physical Examination

At a minimum, record the following firearm features:

- Caliber/Gauge
- Make/Model
- Serial number
- Operating condition
- GRC (number and direction)

Record the following additional firearm features for comparison firearms:

- Firing mechanics
- Type of action
- Safeties and operability
- Land and groove measurements when a bullet comparison is performed to items of the same caliber with the same number of lands and grooves and direction of twist

If submitted evidence cartridges are examined or used to generate test fires they shall be appropriately marked, documented in the examination documentation and the result listed on the CoA.

It is acceptable to place non-examined evidence cartridges in a marked proximal container and document the number received and that no examination was conducted in the examination documentation and on the CoA.

1.5.2 Pre-Firing Safety Examination

A visual examination of firearm prior to test firing is needed to determine:

- Possibility of bore obstruction
- Signs of cracks or weaknesses in major parts of frame, slide, or barrel
- Overall mechanism functioning
- Type of ammunition appropriate for use with firearm
- Suitability of evidence ammunition submitted for test firing
- Soundness of chamber/barrel, condition of percussion nipples, existing load in chamber (muzzleloaders)
- If firearm should be test fired remotely due to unsafe firearm condition
- Record any deficiencies noted and observations on worksheet
- Check to ensure the firearm disconnects for semi-auto fire
- Presence of Bump-stock-type device
    - Devices that allow a semiautomatic firearm to shoot more than one shot with a single pull of the trigger by harnessing the recoil energy of the semiautomatic firearm to which it is affixed so that the trigger resets and continues firing without additional physical manipulation of the trigger by the shooter.
    - The presence of a Bump-stock-type device shall be documented in the examination documentation and on the CoA.
- Presence of modified slide cover plate (i.e., Glock switch, auto sear)
    - Device that allows a semiautomatic firearm to shoot more than one shot with a single pull of the trigger.
    - The presence of a modified slide cover plate shall be documented in the examination documentation and on the CoA.

1.5.3 Trigger-Pull Examination – Digital Force Gauge

Trigger pull is defined as the amount of force which must be applied to the trigger of a firearm to cause sear release. The trigger pull of a firearm shall be obtained utilizing the IMADA DS2 model digital force gauge. The trigger pull of a firearm shall be reported in the CoA if the examination is performed.

1.5.3.1 Equipment

- IMADA DS2 model digital force measurement gauge
- IMADA long hook
- IMADA short hook
- Standard force gauge attachment
- Remote firing cart

1.5.3.2 Trigger Pull

- Ensure that the firearm is unloaded and safeties are disabled.
- A fired cartridge case or “dummy” cartridge should be used to measure the trigger pull of a rimfire firearm. The examination should not be performed on an empty chamber.
- Consider the potential for damage of a centerfire firearm and the use of a fired cartridge case or “dummy” cartridge.
- For single-action trigger pull, cock the firearm. For double-action trigger pull, do not cock the firearm.
- Place the firearm in the remote firing cart and ensure that the barrel is parallel to the floor.
- Handguns require the short hook gauge attachment. Long guns require the long hook gauge attachment.
- The IMADA digital force gauge should be set to "peak", ensuring only the maximum measurement is recorded for each trigger pull.
- Position the hook of the IMADA digital force gauge in line with the trigger and parallel to the floor, ensuring that the hook is not in contact with the trigger, and press the Zero button.
- Pull the IMADA digital force gauge rearward until the sear releases, record the value displayed on the Trigger Pull UoM worksheet
- Reset the sear and collect a total of six measurements.
- Repeat steps for double action, if applicable.
- At least one measurement for each chamber of a revolver shall be taken. Any chambers with duplicate measurements shall be marked. Contact the Program Manager for deviation/modified worksheet for revolvers with more than 6 chambers.

1.5.3.3 Interpretation of Results

Report the value listed in Average cell, rounded to the nearest hundredth of a pound of force (lbf), and the value listed in the Reported Uncertainty cell of the worksheet. Apply rounding rules per Section 5 of the QM. Retain the completed worksheet with the examination documentation.

1.5.4 Barrel and Overall Length

Barrel length is defined as the distance between the muzzle end of the barrel and the face of the closed breechblock or bolt for firearms other than revolvers. On revolvers, it is the overall length of the barrel including the threaded portion within the frame. Overall length of a firearm is defined as the dimension measured parallel to the axis of the bore from muzzle to a line at right angles to the axis and tangent at the rearmost point of the butt plate or grip. Barrel length and overall length normally should include compensators, flash hiders, or any other permanently affixed attachments to the muzzle of a firearm. Removable barrel extensions, poly chokes, flash hiders, etc., are not included when measuring the barrel length or overall length.

The Perspective Enterprises device shall be used for measuring the overall and barrel length of firearms.

1.5.4.1 Barrel Length

Place a non-marring rigid rod into the barrel of the firearm with the action closed. Adjust the collar on the rod until it reaches the longest portion of the barrel. Remove the rod and align the breech end of the rod to the end of the measuring ruler on the device. Record the measurement at the edge of the collar that was flush with the longest barrel edge. Record measurements to the greater $1/16^{th}$ of an inch (if the length falls between two marks on the ruler, record the higher value). Have the measurement verified by another examiner.

It is acceptable to obtain the barrel length measurement for a revolver externally on the firearm. Measure the distance from the breech end of the barrel to the muzzle. Do not include the cylinder.

1.5.4.2 Overall Length

Place the firearm on the measuring platform with the butt of the firearm flush against the stationary gun stock piece. Ensure the barrel is parallel to the measuring ruler. Move the sliding muzzle piece until it is flush with the end of the barrel. Record the measurement observed at the "READ HERE" line on the sliding muzzle piece. Record measurements to the greater $1/16^{th}$ of an inch (if the length falls between two marks on the ruler, record the higher value). Have the measurement verified by another examiner.

1.5.4.3 Interpretation of Results

All measurements are reported in inches.

1.5.5 Test Firing

Test firing recovery methods include the water tank, the cotton-waste recovery box, the Detroit bullet trap, the snail system, and the bullet-trap range. The type of firearm and ammunition tested will usually dictate the type of recovery method used. In order to perform a microscopic comparison of a submitted firearm, a minimum of two (2) test shots should be fired and recovered. Other test firing procedures may include downloading ammunition and firing primed cartridges or shotshells.

When an examiner has test fired a firearm with the intention to recover projectiles or cartridge cases and a projectile or cartridge case is unable to be located, a Supervisor or designee shall be notified and assist with the search. If the projectile or cartridge case is not located after a second search by the Supervisor or designee, then the Laboratory Director and Program Manager shall be notified. The Supervisor, utilizing the Qualtrax workflow, shall record the FS Lab# and a description of the bullet or cartridge case. An additional test fire shall be conducted to ensure at least two cartridge cases and two bullets are returned for future comparisons. Report wording specified in Section 13.3.3 shall be included on the CoA.

If the bullet or cartridge case is recovered after the evidence has been returned, the bullet or cartridge case shall be returned, and a Supplemental CoA shall be issued containing language detailed in Section 13.3.4.

Firearms with missing or broken parts may have to be test fired using parts from the reference collection. Document in notes the part utilized to test fire the questioned firearm along with the make, model, caliber and serial number or the tag number assigned to the reference firearm or magazine.

Documentation shall be included in the notes and on the CoA if the magazine submitted was used to obtain test fires or if a reference collection magazine was used.
Consideration should be given to indexing and sequencing each shot.

When it is possible to determine why the firearm is not in mechanical operating condition and steps are taken to restore the mechanical operation, these details shall be reported. Restorative actions are at the discretion of the examiner and may include, but are not limited to, replacing missing or broken components and/or cleaning due to corrosion, excessive dirt/debris or rust damage.

1.5.5.1 Safety Considerations

- Check the barrel for obstructions before firing
- Appropriate hearing and eye protection must be used
- Ensure the maximum velocity of the projectile is within the acceptable limits of the particular water tank or bullet trap utilized

- Ensure the tank contains the proper water depth needed for firing
- Ensure that the exhaust fan or system and all warning systems are activated
- Keep your finger off the trigger until ready to fire
- Always be aware of what is behind your target
- The firearm should be loaded and made ready to fire ONLY when the muzzle of the firearm is pointed down range or into the shooting port of a bullet recovery system
- If a remote firing device is utilized, the examiner should be stationed behind a protective shield or at a safe distance from the firearm when discharging the firearm
- If a misfire occurs, keep the firearm pointed down range or inserted into the port of the bullet recovery system for at least 10 seconds before opening the action
- After test firing, ensure the firearm is unloaded and the magazine is removed before exiting the range

1.5.5.2 Water Recovery Tank/Cotton Box

A water recovery tank or cotton box shall be used during the initial test firing of handguns and rifles, to the best extent possible. The notes shall delineate when it is not possible. These devices may also be used to retrieve slugs fired from shotguns.

- Ensure that all lids or doors of the recovery system are closed and properly secured.
- No more than two (2) cartridges/shotshells should be loaded into the firearm during the initial testing of the firearm.
- Test firing into a bullet recovery system shall be done with the muzzle of the firearm inserted into the shooting tube so that any discharge from the muzzle will be captured within the recovery system.
    - It is acceptable for the muzzle to be lined up with the shooting tube, but not inserted, if the firearm is secured in the remote firing cart. The examiner shall load no more than one (1) cartridge/shotshell into the firearm when test firing in this capacity.
- Bullets shall be recovered using an appropriate device.
- Fired cartridge cases/shotshell cases shall be retrieved.

1.5.5.3 Bullet-Trap Range

The bullet trap is usually used to test fire firearms when the recovery of the fired projectile(s) is not necessary. The Detroit bullet trap and the snail system utilize the same procedures.

- No more than two (2) cartridges/shotshells are to be loaded into the firearm during the initial testing of the firearm
- Fire the firearm into the front of the range trap
- Ejected cartridge cases/shotshell cases must be retrieved

1.5.5.4 Remote Firing

During the course of examining a firearm, it may be determined that it would be unsafe for the examiner to fire the firearm by holding it as designed. If it is necessary to obtain test standards from this firearm, the firearm should be fired remotely. The CyberNational Remote Firing Cart (or a similar device) can be utilized for firing long arms and some handguns.

- Set up the remote-firing device in front of the appropriate recovery system, as per guidelines set forth by the device manufacturer
- Place firearm in device
- Dry-fire the firearm in the remote firing device before using ammunition
- The examiner shall load no more than one (1) cartridge/shotshell into the firearm during the initial testing of the firearm.
- Activate the remote device while standing behind a protective shield or at a safe distance away from the firearm

- Retrieve the test-fired components

1.5.5.5 Downloading Ammunition

It may be necessary to reduce the powder load of the cartridge in order to obtain a velocity suitable for safely collecting test-fired components for comparison purposes. Even with a reduced load, it may be necessary to fire the firearm remotely.

- Remove the bullet from the cartridge using an inertia bullet puller or a reloading press
- Remove existing powder from the cartridge
- Weigh the pulled bullet
- To determine the velocity requirement for safe testing, consult a reloading manual, such as Lyman, to determine the powder charge for the weight of the pulled bullet
- Weigh the powder in accordance with the velocity requirement
- Reload the cartridge with weighed powder that is not less than 30% of the original weight
- Loosely pack a small piece of tissue or other similar material into the cartridge case to fill the gap between the bullet and powder
- Seat the bullet back into the cartridge case using a rubber mallet or a reloading press
- 50% downloading CANNOT be used with slow burning powders
- 50% downloading CANNOT be used with many non-canister powders
- Check the barrel for obstructions before each firing

1.5.5.6 Primed Cartridge/Shotshell Case

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

- Obtain a primed empty cartridge case in the desired caliber or pull the bullet of a cartridge using an inertia bullet puller or reloading press, retaining only the primed cartridge case
- For shotguns, obtain a primed empty shotshell case in the desired gauge or cut open a shotshell removing all components, retaining only the primed shotshell
- A commercial firing pin testing device may be used
- Load the primed, empty cartridge/shotshell case, or a commercial firing pin testing device into the chamber of the firearm, and test fire in the designated test firing area
- Repeat if the firearm has more than one action
- Retrieve all test-fired components

1.5.5.7 Test Fired Ammunition

Tests may be produced from submitted evidence ammunition or laboratory stock ammunition/components. Case documentation shall include the specific date(s) tests are generated.

Tests shall be sealed in an appropriate container, (small envelope, plastic bag, specimen box) which shall be labeled in accordance with the Quality Manual and with the following information: item #, firearm brand, model, caliber and serial number.

Tests produced from laboratory stock ammunition shall be returned in the same container with the firearm which generated the tests.

Tests from laboratory stock ammunition shall be listed as a sub-item of the firearm which generated them on the RFLE, in LIMS and on the CoA.

Tests made from evidence ammunition shall be returned in the same container in which the evidence cartridges/shotshells were received.

Additional test fired components from laboratory stock ammunition may be retained in the laboratory for reference or training purposes. Refer to Section 11 of this manual for specific requirements related to reference collections.

1.5.6 Privately Made Firearms (PMFs) and Full-auto Firearms

PMFs and firearms known to function in full-auto capacity should initially be test fired on the range. These firearms may be test fired into the water recovery tank/cotton box by loading a single cartridge each time.

1.5.7 Rusty Firearm Examination

Rusty firearms or those found in water, etc., may be submitted for examination. Immediate attention must be given to the firearms recovered from water to prevent further damage to the firearm, which may require coordinating with other sections to expedite the case when multiple exams are requested. The examiner should instruct the agency that recovers the firearm to submit the firearm in a container of the fluid in which the firearm was found. If this is not practical, the agency can be instructed to immediately and thoroughly spray the firearm with a water-displacing product such as WD-40® or other similar product to prevent further deterioration. It should be noted that the firearm might be too rusted to be functional. An examiner must take all necessary precautions to ensure that the firearm is unloaded. If it cannot be readily verified as being unloaded, it must be examined in an area designated for the firing of firearms. Determining whether or not a firearm is unloaded may necessitate a complete disassembly, or, in some cases, destruction (e.g., cutting).

- Determine to what extent restoring the firearm is possible (for test firing, for recovering manufacturer information, serial number, etc.)
- Soak the firearm in penetrating oil, de-rusting solvents, or similar material to dissolve rust
- Periodically check the firearm until the firearm functions, or the desired information is recovered
- Clean the firearm with gun cleaning solvent, cleaning patches, and cloth (only a non-marring item should be used down the barrel of a firearm)

1.5.8 Malfunctioning Firearm Examination

A firearm examiner may be called upon to examine a firearm to determine if the firearm will malfunction. Many of these cases will deal with the question: "Will the firearm fire without pulling the trigger?" In these instances, it should be the goal of the examiner to acquire a detailed account of the incident, followed by a thorough examination and testing of the firearm. The examiner should attempt to conduct examinations in a manner so as not to alter the firearm. However, there may be occasions when damage may occur. Prior to conducting any testing, the examiner shall inform the requesting agency of the potentially destructive nature of this test and the risk of significant damage to the firearm. Documentation of this conversation will be retained in the case file. Additionally, the respective Commonwealth's Attorney will be notified of the potentially destructive nature of this test and the risk of significant damage to the firearm. A written acknowledgement of the risk (from official email or letter) will be required prior to the exam being conducted. Any change to the firearm should be specifically documented in the examiner's notes.

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

1.5.8.1 Visual Condition of Firearm as Received

- Cocked/uncocked
- Safety position

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

1.5.8.2 Visual abnormalities

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

1.5.8.3 Action - External

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

1.5.8.4 Safeties

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

1.5.8.5 Action Check

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

1.5.8.6 Test Fire Firearm

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

1.5.8.7 Action-Internal

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

1.5.8.8 Modified Drop/Accidental Discharge Test Procedure

The modified drop/accidental discharge testing will be conducted in all modes of fire for a particular firearm, utilizing a primed cartridge case, unless the reported incident dictates the appropriate mode of fire to be used.

The modified drop test shall be conducted after all other examinations have been completed. This test shall be conducted in the firing range and shall try to mimic the circumstances of the incident reported. Documentation should include if the firearm is being physically held or placed in the remote firing cart.

- Insert a primed cartridge case into the chamber of the firearm.
- Close the action of the firearm.
- If the firearm was dropped, strike the firearm with a hammer/ mallet a minimum of three times in each location.
    - Locations can include the following:
        - Front/muzzle end
        - Rear of frame/receiver and/or hammer
        - Top of frame/receiver and/or chamber
        - Bottom of frame/receiver (i.e., trigger guard or butt)
        - Both sides of the frame/receiver
    - The exam should include striking the firearm in locations that attempt to duplicate the incident reported.
- In cases of accidental discharge where the firearm was not reportedly dropped, the examiner shall manipulate the firearm in the manner the scenario dictates (i.e., closing the slide on a loaded chamber, holstering or unholstering a firearm, dropping the hammer on a loaded chamber, etc.)
- Document the locations struck and/or manipulations performed, the hammer/mallet used, and the results (discharge, no discharge). If the hammer/mallet has more than one side, the side used will be specified in the notes.

1.5.8.9 Interpretation of Results

If the primed case detonates, examine the major internal components to determine if there are any broken or missing parts.

If the primed case does not detonate, this is an indication the firearm may not discharge when dropped, slammed, thrown down or falls due to improper storage.

1.5.9 Bore/Chamber Casting

Occasionally, firearms are received for which the caliber may not be known or may be different than is designated on the firearm and in the industry literature. In order to facilitate firing of test shots that are the correct caliber for a particular firearm, it may be necessary to make a bore and/or chamber cast. By measuring the cast, the correct cartridge can be determined for test firing. Casts can be made using various casting materials.

- Ensure that the firearm is not loaded
- Open the action and remove the bolt or bolt assembly
- Check the bore for obstruction
- Push a cleaning patch in the barrel, from muzzle end, until it is ½ inch to ¼ inch from the beginning of the chamber
- Lubricate the chamber with gun oil, a silicone spray, or some other similar substance such as WD40®
- Do not allow casting material to flow into breech as it will make extraction of the cast difficult
- When casting material is set or cool, depending on type used, gently tap end of cleaning rod to loosen the cast from the chamber and then remove the cast from the breech end
- Use the same steps for casting the bore

1.5.9.1 Interpretation of Results

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

Record the interpretation of results on an appropriate worksheet.

1.6 References

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Thompson, Roger C. "Firearms Malfunction Worksheets." AFTE Journal. Vol. 15, No. 1, p. 100.

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VA Department of Forensic Science Firearm/Toolmark Training Manual.

www.afte.org

2 PHYSICAL EXAMINATION AND CLASSIFICATION OF FIRED BULLET EVIDENCE

2.1 Introduction

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

2.2 Safety Considerations

Follow the procedures outlined in the Introduction section to clean evidence with appropriate solutions if biohazard material, blood or tissue is present.

2.3 Instrumentation

- Comparison Microscope
- Stereo Microscope
- Caliper/Micrometer/Ruler
- Scale/Balance
- Ammunition references

2.4 Minimum Analytical Standards and Controls

Ensure the equipment utilized in the examination has been appropriately calibrated and/or performance checked prior to use. See Section 11 of this manual for specific requirement.

2.5 Procedure or Analysis

2.5.1 General, Visual, Physical, and Trace Examinations

The following features, but not limited to, should be recorded as applicable:

- Caliber/gauge
- Bullet/slug weight (record weight of bullets in grains; record weight of slugs in ounces or grains)
- Number of land and groove impressions on a fired bullet
- Direction of twist
- Measured width of the land impressions (refer to Section 2.5.3)
- Measured width of the groove impressions (refer to Section 2.5.3)
- Measured diameter
- Bullet composition
- Bullet style
- Possible manufacturer/marketer of the bullet/projectile, if needed use reference materials (i.e., ammunition database) and indicate in notes the number assigned to this reference
- 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
- Condition of the fired evidence as received
- Suitability of the fired evidence for comparison purposes
- GRC Search for possible firearms from which bullet was fired (refer to Section 2.5.4)
- As appropriate, compare marks on bullets with tests from a firearm or with other bullets (see Section 5)

2.5.2 Caliber Determination

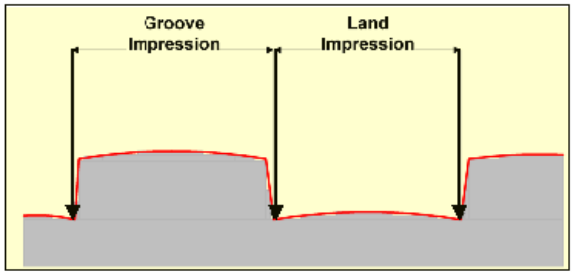
Caliber is one of the class characteristics of a fired bullet and is written as a numerical term that may be depicted with or without a decimal point. The determination of caliber will aid the examiner during the identification or elimination of a suspect firearm. If no firearm is submitted, the bullet's caliber may be used in determining the General Rifling Characteristics of the firearm involved. The following may be utilized to determine the caliber of any fired bullet. The condition of the bullet will determine which steps can be used:

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

2.5.3 Methods of Measuring Land and Groove Impressions

One of the class characteristics used in the discipline of firearm identification is the width of the land impressions and groove impressions. These measurements may aid the examiner during the identification or elimination of a suspect firearm. If no firearm is submitted, these measurements shall be used in determining the General Rifling Characteristics of the firearm involved. The measuring of land and groove impressions on a fired bullet can be accomplished by utilizing either the air-gap method or the stereo microscope reticle method.

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



Each available land and groove impression will be measured and recorded.

For multiple bullets having similar general rifling characteristics only one bullet needs to be measured. For bullets that share similar class to tests produced with a firearm, at the discretion of the examiner, either the tests or questioned bullet(s) may be measured.

2.5.3.1 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 (objective setting) and be in focus.

Align the image of the land or groove impression with one of the anchor points corresponding with the anvil of the micrometer or measuring jaw of the caliper. Rotate the micrometer's spindle to the next anchor point of the micrometer or the other jaw of the caliper to the land or

groove impression and record the measurement gap (opening) displayed on the micrometer/caliper.

2.5.3.2 In the stereo microscope reticle method, the fired bullet in question is either held or mounted on a steady surface beneath the stereo microscope. The land or groove impression of the fired bullet is positioned with both of the anchor points corresponding to points on the alignment scale. Record the measurements observed on the scale. If performing the measurement at half magnification, it is necessary to multiply the value observed by two to obtain the correct measurement. The calculation shall be documented in the examination documentation.

2.5.4 General Rifling Characteristics File (GRC)

The AFTE GRC Search Engine shall be utilized to determine a list of possible firearms that could have fired an evidence bullet. The search engine is available in the Member's Area on the AFTE website. It is acceptable for AFTE non-members to ask AFTE members for access to the GRC search engine in order to complete a search. It is acceptable to utilize a reference collection firearm to determine a possible firearm if the AFTE GRC Search Engine is not appropriate.

A tolerance of 0.003" should be used for the search parameters; however, if the difference in the maximum and minimum values is 0.005" or greater, it is not necessary to apply a tolerance.

The reason for the use of a tolerance other than 0.003" shall be documented in the case file.

The maximum and minimum values will be rounded prior to applying the tolerance.

The list generated shall be included in the examination documentation.

The phrase "too numerous to list" shall be used on the CoA when the list to be reported is greater than ten firearms. To justify the removal of a firearm(s) from the list to be reported, the examiner shall ensure that brand of firearm(s) has not been entered two or more times in the Department's firearms database within the past twelve months. When utilized, a report from the Department's firearms database shall be included in the examination documentation. Any firearm(s) removed from the AFTE GRC list shall be clearly delineated. A database will be maintained by the section of firearms submitted to the Department.

2.5.5 Interpretation of Results

Document if the item contains suitable markings for comparison with a firearm or with other fired components.

2.6 References

Association of Firearm and Tool Mark Examiners Procedures Manual, 2001.

Barnes, Frank C. Cartridges of the World. 9th ed, 2000.

Felix, Kyle. "Using Bullet Weights and Type to Determine Caliber and Brand," AFTE Journal, 2008; 40(1): 64-80.

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Howe, Walter, J. "Laboratory Work Sheets". AFTE Newsletter. No. 2, August 1969, p. 13.

Mathews, J. Howard. Firearms Identification Vol. I, 1973.

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www.firearmsid.com

3 PHYSICAL EXAMINATION AND CLASSIFICATION OF CARTRIDGES AND FIRED CARTRIDGE CASES

3.1 Introduction

The initial examination of any fired cartridge case/cartridge evidence shall include the completion of a worksheet which shall include the physical description to document the condition of the evidence as received and any tests or comparisons performed.

3.2 Safety Considerations

Follow the procedures outlined in the Introduction section to clean evidence with appropriate solutions if biohazard material, blood or tissue is present.

3.3 Instrumentation

- Comparison Microscope
- Stereo Microscope
- Micrometer/Caliper
- Ruler
- Scale/Balance

3.4 Minimum Analytical Standards and Controls

Ensure the equipment utilized in the examination has been appropriately calibrated and/or performance checked prior to use. See Section 11 of this manual for specific requirement.

3.5 Procedure or Analysis

The evidence shall be marked in such a way to protect characteristics which may be used for microscopic comparison.

3.5.1 General, Visual, Physical, and Trace Examinations

Record the following features:

- Caliber
- The possible manufacturer/marketer of the cartridge case. If needed, use reference materials (i.e., ammunition database) and indicate in notes the number assigned to this reference.
- Description of metal used in cartridge case and primer

3.5.2 Cartridge Component Verification

3.5.2.1 At times, a request may be made for examination of a cartridge for determination that its composition meets the legal definitions of “ammunition” and “explosive material” as specified in the Code of Virginia. These examinations shall be documented in the “remarks” section of a cartridge worksheet.

- The cartridge shall be disassembled
- Components shall be documented

3.5.3 Caliber Determination

Caliber can usually be determined by examination of the headstamp of the cartridge/cartridge case. If the caliber cannot be determined from the headstamp, the cartridge case can be compared with laboratory

standards, available manufacturer literature, or other appropriate references. Document in the notes the reference utilized to determine caliber.

3.5.4 Determination of Marks

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

- Breech face marks
- Extractor marks (clock position, if possible)
- Ejector marks (clock position, if possible)
- Resizing marks
- Chamber marks
- Anvil marks
- Magazine marks
- Ejection port marks
- Firing Pin Impression (class and individual characteristics)
- Firing Pin Drag
- Slide Scuff Mark (head @rim)
- Slide Drag Mark (wall)
- Other marks

As appropriate, compare marks on cartridge/cartridge case with tests from a firearm or with other cartridges/cartridge cases (see Section 5).

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

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

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

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

3.5.5 Interpretation of Results

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

3.6 References

Association of Firearm and Tool Mark Examiners Procedures Manual, 2001.

Code of Virginia §18.2-308.2(D).

Glossary of the Association of Firearm and Tool Mark Examiners, 5th ed. 2007.

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VA Department of Forensic Science Firearm/Toolmark Training Manual.

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4 PHYSICAL EXAMINATION AND CLASSIFICATION OF SHOTSHELLS AND FIRED SHOTSHELL CASES

4.1 Introduction

The initial examination of any evidence shotshell/shotshell case(s) or component(s) shall include the completion of a worksheet which shall include the physical description to document the condition of the evidence as received and any tests or comparisons performed.

By examining wadding, the examiner may be able to determine the gauge size, manufacturer, and if the wad may possess markings suitable for comparison with the firearm that fired it.

By examining recovered shot pellets, the examiner may be able to determine the actual shot size. The determined size can then be compared to the shot size loaded in submitted shotshells or to the size indicated by markings on the hull of the submitted shotshell case.

4.2 Safety Considerations

Follow the procedures outlined in the Introduction section to clean evidence with appropriate solutions if biohazard material, blood or tissue is present.

4.3 Instrumentation

- Comparison Microscope
- Stereo Microscope
- Micrometer/Caliper
- Ruler
- Scale/Balance

4.4 Minimum Analytical Standards and Controls

Ensure the equipment utilized in the examination has been appropriately calibrated and/or performance checked prior to use. See Section 11 of this manual for specific requirement.

4.5 Procedure or Analysis

The evidence shall be marked in such a way to protect characteristics which may be used for microscopic comparison.

4.5.1 General, Visual, Physical, and Trace Examinations

The following features, but not limited to, should be recorded as applicable:

- Gauge
- Possible manufacturer/marketer of the shotshell/shotshell case. If needed, use reference materials (i.e., ammunition database) and indicate in notes the number assigned to this reference.
- Description of metal used in hull and primer
- Composition of hull (i.e., plastic/paper; color; ribbed/smooth)

4.5.1.1 Shotshell/Shotshell Case Gauge Determination

Gauge can usually be determined by examination of the headstamp of the shotshell case. If it is not legible on the headstamp, the shotshell/shotshell case can be compared with laboratory reference materials (i.e., ammunition database) or available manufacturer literature. Record in notes the number assigned to the reference.

4.5.1.2 Determination of Marks

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

- Breech face marks
- Extractor marks
- Ejector marks
- Resizing marks
- Chamber marks
- Magazine marks
- Ejection port marks
- Markings on the exterior surface of hull
- Firing Pin Impression
- Firing Pin Drag
- Other marks

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

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

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

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

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

4.5.1.3 Interpretation of Results

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

4.5.2 Wads

4.5.2.1 General, Visual, Physical, and Trace Examinations

The following features, but not limited to, should be recorded as applicable:

- Color of wad
- Description of wad composition
- Shape of wad
- Diameter and/or approximate length of wad
- Gauge
- Possible manufacturer/marketer of the wad using reference materials (i.e., ammunition database) and indicate in notes the number assigned to this reference.

4.5.2.2 Wad Gauge Determination

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

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

4.5.2.3 Determination of Marks

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

4.5.2.4 Interpretation of Results

The above-mentioned procedure is based on the assumption that the evidence wad submitted has sufficient material available to determine the possible manufacturer and the gauge size. If the wad is mutilated or soaked with blood or other body fluids, the examiner may not be able to specifically determine gauge size. The examiner also recognizes that some manufacturers might duplicate the design of other manufacturers. Document in the notes the circumstances or details that preclude the determination of gauge size.

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

4.5.3 Pellets

4.5.3.1 General, Visual, Physical, and Trace Examinations

The following features, but not limited to, should be recorded as applicable:

- Total number of pellets received
- Composition of the pellets
- If pellet sizes visually appear to be similar or different
- The following may be used to determine pellet size from diameters/weights:
  - Choose the best specimens and measure diameter using a micrometer/caliper.
  - Weigh the pellets in grains or ounces.
    - Divide weight of pellets by total number weighed.
  - Consult a reference source (i.e., NRA Handbook or manufacturer data) to determine the shot size which corresponds to evidence shot. Document in the examination documentation the reference used.
  - Evidence pellets can also be compared to laboratory references of known shot sizes side by side until a known shot size is determined. A stereo microscope may aid in this determination. This can be done one size at a time or several sizes at a time; however, if more than one size is used at a time, care should be taken not to mix up the shot. If reference ammunition is used (i.e., ammunition data base), indicate in notes the number assigned to this reference standard.
  - The weight of the evidence pellets can also be directly compared to weight of references using the same number of pellets until a similar known weight is obtained. Record the identifier of the reference standard used in examination documentation.

4.5.3.2 Interpretation of Results

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

4.6 References

Association of Firearm and Tool Mark Examiners Procedures Manual, 2001.

Glossary of the Association of Firearm and Tool Mark Examiners, 5th ed. 2007.

Howe, Walter, J. "Laboratory Work Sheets". AFTE NEWSLETTER NUMBER TWO. August 1969, p.13.

NRA Firearms Fact Book. National Rifle Association of America. 3rd ed. 1989.

NRA Firearms Source Book. National Rifle Association of America, 2006.

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5 MICROSCOPIC COMPARISON

5.1 Introduction

A comparison microscope allows an examiner to identify a fired component back to the firearm that produced the markings on the evidence 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 standard is placed on the other stage. This procedure may also be used to compare two unknown fired components or two toolmarks to determine if they were fired in/from the same firearm or were produced by the same tool.

Prior to comparison, a microscopic examination shall be performed and documented to determine if the item is suitable for comparison.

5.2 Safety Considerations

Follow the procedures outlined in the Introduction section to clean evidence with appropriate solutions if biohazard material, blood or tissue is present.

5.3 Preparation

Select the same objective (magnification) setting for each stage of the microscope and ensure that the objectives are locked in place.

5.4 Instrumentation

- Comparison Microscope
- Stereo Microscope

5.5 Minimum Analytical Standards and Controls

Ensure the equipment utilized in the examination has been appropriately performance checked prior to use. See Section 11 of this manual for specific requirements.

5.6 Procedure or Analysis

5.6.1 Comparison

5.6.1.1 With Firearm or Tool as Evidence

Compare the test fires produced from the firearm or tests produced from a tool to determine what microscopic characteristics are reproducing. Document these observations in the case notes.

Verification is not required for a test to test identification.

If characteristics are reproducing sufficiently to allow for identification, the below are examples of recommended wording.

- 1T1 + w/ 1T2 @ red index
- 1&2 + ID sides A & B
- + ID test-test (silver index)
- Black index T2 &T3

If characteristics are not reproducing sufficiently to allow for identification, it is acceptable to document the conclusion as outlined in the examples below and continue with comparison of tests to unknown.

- 1T1 w/ 1T2 inconclusive
- test-test minimal characteristics reproducing

5.6.1.2 Comparison Process

Compare unknown evidence to either another piece of unknown evidence or a known test by placing the unknown evidence on one stage and the other piece of unknown evidence or known test on the other stage. It is strongly suggested that the examiner maintain a routine practice as to which stage is used for known tests.

The examination documentation shall contain sufficient detail to determine which items were compared to each other to reach the recorded conclusion.

The below should be considered during the comparison process.

- Angle of lights
- Type of lights
- Use of a different microscope for evaluation
- Need for additional known tests
- Position of the evidence, the tests, or both
- Possibility of casting the tool-working surface for comparison
- Possibility of cleaning the firearm or tool and producing new tests
- Possibility that the firearm or tool has changed
- The entire unknown and/or known should be considered

5.6.2 Interpretation of Comparison Results

Photomicrographs or detailed descriptions shall be made of marks used for identification, inconclusive findings and eliminations. Oriented index marks (e.g., blue index mark at 6 o’clock) or orientation marks (such as drag mark at 3 o’clock; “R” in R-P at 6 o’clock; ejector at 7 o’clock) on compared items shall be documented.

Photographs that are produced shall delineate the specific item/test #'s for each specimen depicted, the magnification or objective setting and the index orientation. This information may also be handwritten on the note page containing the photograph.

If the photograph is taken to demonstrate representative microscopic markings of a series of items, the item numbers having similar detail represented by the photograph shall be delineated.

5.6.2.1 Identification

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.

Documentation: One or more photomicrographs shall be made of the marks that are used to support the opinion of identification.

Other marks that are examined, but are not used to support the opinion of the identification, should be documented. However, no photographs or detailed descriptions are necessary for the other marks such as chamber marks, extractor marks or ejector marks.

5.6.2.2 Inconclusive

Criteria: (A) Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification. (B) Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility. (C) Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

Documentation: When an item will be reported as insufficient for identification or elimination (inconclusive), mechanism marks that are evaluated shall be documented. The reason(s) why the marks are insufficient shall be documented for inconclusive conclusions using the criteria listed above under (B).

The documentation shall contain each toolmark type mark evaluated to reach an inconclusive conclusion. Marks addressed for cartridge/cartridge case/shotshell/shotshell case comparison may include, but are not limited to: firing pin, breechface, extractor, ejector, chamber, ejection port swipe or other mechanism marks.

5.6.2.3 Elimination

Criteria: Significant disagreement of discernible class characteristics and/or individual characteristics.

Documentation: When items having the same discernible class characteristics will be reported as an elimination based on differences in individual characteristics, differences in marks that are present shall be photographed with documentation for the reason why the marks are eliminated.

When items having different class characteristics will be reported as an elimination, marks that are present shall be photographed or described in detail with documentation for the reason why the marks are eliminated.

5.6.3 Verifications - see Section 10

5.7 References

Association of Firearm and Tool Mark Examiners Glossary, 5th ed. 2007.

Association of Firearm and Tool Mark Examiners Procedures Manual, 2001.

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

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Howe, Walter, J. “Laboratory Work Sheets”. AFTE Newsletter. No.2 August 1969, p. 13.

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6 NIBIN

6.1 Introduction

The National Integrated Ballistics Information Network (NIBIN) is a computerized system for acquiring and storing the images of unidentified bullets and cartridge cases as well as known bullets and cartridge cases. DFS currently only enters cartridge cases and shotshell cases.

Access to NIBIN, which is an Individual Characteristic Database (ICD), is defined in the Quality Manual.

Access to the system shall occur after successfully completing NIBIN training, receiving security clearance and the issuance of a password by ATF. The NIBIN Procedures Manual (IBIS Training Manual) should be followed in order to make entries into the system.

The test samples entered into NIBIN are considered evidence and shall be handled as outlined in the Quality Manual.

In addition to state and local NIBIN sites located in Virginia, the automatic searches will include cases entered by the ATF for Zone 1. ATF Zone 1 generally includes agencies within Connecticut, District of Columbia, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, Vermont and West Virginia, but not all agencies in these states submit cases to the ATF.

For jurisdictions served by the Northern Laboratory, the District of Columbia Department of Forensic Sciences, ATF Washington, D.C. Mobile Command Center and Prince George's County Police Department (Maryland) shall be searched manually for every entry, in addition to the automatic search.

The CoA shall include sites searched beyond those included in the automatic and manual searches noted above.

6.2 Safety Considerations

Follow the procedures outlined in the Introduction section to clean evidence with appropriate solutions if biohazard material, blood or tissue is present.

6.3 Instrumentation

NIBIN System
Stereomicroscope
Comparison Microscope

6.4 Minimum Analytical Standards and Controls

6.4.1 When problems occur with the system such that Ultra Electronics/Forensic Technology (FTI) is contacted, track the problem and resolution.

6.4.2 Performance Check

6.4.2.1 To ensure that the NIBIN System is working properly, a designated specimen (questioned) shall be entered and searched weekly against a previous entry of the same specimen (known). The correlation list with the hit indicated shall be retained in a binder located by the NIBIN System for the assessment cycle.

6.4.2.2 If the known candidate is not on the correlation list, the entry shall be re-correlated. If the known candidate does not appear on the second correlation list, the questioned shall be re-entered and correlated. If the known candidate does not appear on the correlation for the second entry, the Section Supervisor shall be notified to research the problem. The problem and resolution shall be documented on the printout for the performance check. NIBIN entries

made since the last performance check may need to be researched depending on the identified problem.

6.4.2.3 Once the performance check is successfully completed, the questioned specimen shall be deleted from the system.

6.5 Procedure or Analysis

6.5.1 NIBIN Entry

6.5.1.1 The suitability of the items being entered is accomplished through the evaluation of the firing pin impression, breechface impression, and/or ejector mark. An item determined to have insufficient marks for entry shall have been evaluated in all three areas.

The following types of firearms are most amenable for NIBIN entry:

- Semiautomatic pistols
- Semiautomatic rifles
- Self-extracting/ejecting and slide action shotguns
- Long guns chambered to fire handgun ammunition

If other types of firearms are being considered for NIBIN examination, it is advised to contact the Section Supervisor for guidance on the suitability for NIBIN entry.

6.5.1.2 Any evidence cartridge case/shotshell case selected for entry into NIBIN must have sufficient individual characteristics to be considered suitable for identification purposes. If, from the same case file, there are more than one identified evidence cartridge case/shotshell case suitable for entry into NIBIN, the examiner should select the best marked item for entry. At the discretion of the examiner, additional cartridge cases/shotshell cases may be entered if individual characteristics are more prominent and/or more reproducible on different tests and/or specimens.

6.5.1.3 Items shall be entered with a unique identifier. If an item of evidence is entered, the item designator should distinguish it from all other items in the examination documentation. If the entry is a test fired component, the item designator shall indicate the specific test that is entered.

- For example, if five (5) cartridge cases are received as item 1 and designated as items 1A through 1E for examination purposes, the item designator should be entered as item 1A, 1B, etc., For a test fired component, the item's unique test fire designation shall be entered.

6.5.1.4 Images shall be captured in 3D. If not possible refer to the Deviation Protocol in Section 5 of the QM.

6.5.1.5 Per the ATF Minimum Required Operating Standards (MROS) the following firearms information shall be entered into NIBIN if available at the time of acquisition:

6.5.1.5.1 Make, Model, Caliber, Type, Serial number as well as Importer Name and State (if applicable).

6.5.2 NIBIN Correlation

6.5.2.1 The "Unified Score" correlation setting shall be set to Top 20 Best Scored Result with the 2D and 3D score columns visible. The top 20 candidates in the Unified Score list shall be reviewed.

6.5.2.1.1 If candidates outside the top 20 are reviewed, the reason for the additional review shall be documented.

6.5.3 Examination Documentation

The notes shall contain a printout of the NIBIN entry breechface image, which includes the date entered, unique identifier of the evidence, the list generated from NIBIN of the images viewed and the results of the correlation.

If there is a potential association, the notes shall contain the agency information and item numbers of evidence that may be associated. A direct comparison is required for a hit confirmation (identification) to be reported.

If a manual correlation is done for sites not included in the automatic search the reason shall be documented on an MFR, in the examination documentation or the RFLE.

6.5.4 Potential Association

6.5.4.1 A secondary correlation review of each potential NIBIN association shall be completed by a qualified examiner prior to communicating the results. A correlation review is an on-screen comparison of digital images to determine the potential for two cartridge cases to have been fired in the same firearm.

6.5.4.1.1 The secondary correlation review shall be documented by the examiner placing their handwritten initials on the side-by-side printout at the time the review is completed.

6.5.4.1.2 Per the ATF Minimum Required Operating Standards (MROS):

6.5.4.1.2.1 A Lead (potential association) is created when the “crosshairs” icon is activated and the user clicks “OK”. The Lead shall be recorded upon concurrence with the secondary review.

6.5.4.1.2.2 A Hit (microscopic confirmation) is recorded when the confirmation date is entered in the “Date” field.

6.5.4.1.3 If a difference of opinion occurs in the secondary correlation review, the procedure outlined in section 10.3.7 of this manual shall be followed.

6.5.4.2 A potential association shall be communicated to the submitter on a CoA without recalling evidence for direct comparison. A direct comparison/confirmation may be conducted, with the approval of the Section Supervisor, if evidence from the affected cases is available for examination in the laboratory at the time the association is made.

6.5.4.3 The CoA shall include the associated FS Lab#(s) and Submitting Agency Case number(s) with instruction to resubmit the evidence if a hit confirmation is necessary. If an association is made to a case that was not entered by DFS, the agency’s name and case number shall be included on the CoA. The CoA shall serve as notification of the potential association and it is at the discretion of the submitting agencies to determine if a hit confirmation is necessary. A NIBIN Cartridge Case Image Comparison Exhibit Information printout with a statement that confirmation of the potential association will require resubmission of the evidence shall be provided, after the technical and administrative review is complete, to the other agencies involved in the potential association for cases entered by DFS personnel.

6.5.4.3.1 The following is an example of the wording to be placed on the NIBIN Cartridge Case Image Comparison Exhibit Information printout:

Potential Association – Unconfirmed
Correlation review indicated a potential association between the cases listed on this page. Please contact the examiner listed for assistance in facilitating the submission of evidence if confirmation of any potential associations is necessary.

6.5.4.3.2 The NIBIN Cartridge Case Image Comparison Exhibit Information printout shall be retained in the Case Records Object Repository for the associated case(s).

6.5.4.3.2.1 If the NIBIN Cartridge Case Image Comparison Exhibit Information printout is emailed, a copy of the email shall be retained in the Case Records Object Repository. Include the following statement in the email: Please see the attached for information regarding a potential NIBIN association.

6.5.4.3.2.2 If the NIBIN Cartridge Case Image Comparison Exhibit Information printout is mailed the following is an example of the statement to be included in the accompanying cover letter: Please see the enclosed for information regarding a potential NIBIN association.

6.5.5 Hit Confirmation

6.5.5.1 If a submitting agency requires a hit confirmation, the examiner reporting the potential association shall coordinate the resubmission of the appropriate evidence.

6.5.5.1.1 It is not necessary that all associated cases be resubmitted for confirmation.

6.5.5.1.2 Bullet evidence associated with previous cases may require that one or more of the previous cases be resubmitted for comparison in order to determine case-to-case association

6.5.5.2 A CoA shall be issued for each resubmitted case.

6.6 References

The NIBIN Procedures Manual

ATF Minimum Required Operating Standards (Effective July 2018, As of April 22, 2019)

7 RANGE DETERMINATION

7.1 Introduction

When a firearm is fired, gunshot residues in the following forms may be discharged from the firearm:

- Burnt gunpowder particles
- Partially burnt gunpowder particles
- Un-burnt gunpowder particles
- Vaporous lead
- Particulate metals

Muzzle-to-target distance determination is based on gunshot residue examinations and/or shot pattern examinations. These gunshot residues along with the morphology of the bullet hole or the size of the pellet pattern can effectively be used in determining the possible muzzle-to-target distance.

The evaluation of the measurement uncertainty of the range determination method indicates a variability of approximately $^{15}/_{16}$ of an inch with a 95% confidence. Due to the results being reported as a range for approximate muzzle-to-target distance determinations, the variability of less than one inch does not impact the interpretation of the result and will not be included on the CoA.

For muzzle-to-target distances greater than 60 inches, the Program Manager shall be consulted to determine the appropriate evaluation of the measurement uncertainty prior to completing the examination.

7.2 Safety Considerations

Review Material Safety Data Sheets (MSDS) prior to working with chemicals. Wear appropriate personal protective equipment and follow procedures as described in the DFS Safety Manual.

ALWAYS ADD ACID TO WATER, NEVER ADD WATER TO ACID.

7.3 Preparation

Store solutions in an appropriate, sealed container labeled in accordance with the Quality Manual. Document the preparation in the DFS Reagent Preparation Log if the solution is stored for future use. If the solution is prepared and consumed (prepared for each use), it is not required to record the information in the log, but it is necessary to record the information in the examination documentation.

See Appendix C – Reagents for specific formulations.

7.4 Instrumentation

- Scale/balance, as needed
- Stereo microscope
- Comparison microscope, as needed
- Calibrated tape measure
- CyberNational remote firing device
- Digital Camera
- Infra Red (IR) Camera and equipment, if available and as needed
- Ultraviolet (UV) light and/or Alternate Light Source (ALS), if available and as needed

7.5 Procedure or Analysis

With the exception of contact/near contact shots, elements needed to perform valid muzzle-to-target distance determinations include:

- Firearm
- Cartridge/shotshell case(s) or projectile identified to the firearm
- At least one evidence cartridge of the same brand, load and caliber as the item identified to the firearm
- Questioned pattern
    - Not required for maximum (e.g. drop-off) distance determinations
    - In the absence of a defined residue pattern, when bullet wipe has been developed, it may be of value to determine a distance beyond which a specific firearm/ammunition combination would deposit “a pattern of residues” or “a residue pattern”

A deviation from the Supervisor (or designee) shall be obtained prior to the examination of items that do not have a suspected bullet hole (e.g., suspect clothing) or cases without a firearm.

Distance determination evaluations on skin shall not be reported by DFS examiners.

The calibrated tape measure and the CyberNational remote firing device shall be used when creating patterns at known distances.

7.5.1 Visual and Microscopic Examination

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

7.5.1.2 Close-up photos of the damaged area(s) and area(s) containing gunpowder particles shall be taken prior to chemical processing. A scale shall be included, if possible.

7.5.1.3 If the particle pattern is not evident in the close-up photographs, a clear transparency overlay shall be used to document the pattern.

7.5.1.3.1 Transparent overlays produced shall be indexed with the bullet holes, buttons, seams and other features so the overlay can be properly aligned back to the item.

7.5.1.3.2 Copies of the overlays shall be retained as examination documentation.

7.5.1.4 The visual and microscopic examination of an item for gunshot residues shall include the examination and documentation of the following, as applicable:

- Presence of soot and/or smoke (size of pattern)
- Presence of particulate metals (shavings of lead, copper, brass, etc.)
- Presence of partially burnt and/or un-burnt gunpowder
    - Size and density of pattern
    - Type of gunpowder
- Presence of bullet wipe (a discolored visible ring around the immediate perimeter of a hole)
- Location and size of all holes, tears and other damage
- Presence and location of burning, singeing, or melting
- Condition and features of questioned item (missing buttons, seams, location/position of zippers, etc.)
- Presence of any possible masking effects
- Presence of artifacts surrounding holes
- Pellet pattern size
- Presence of an unusually shaped gunshot residue or pellet pattern (e.g., spiral, vortex, or donut shaped pellet pattern)

7.5.1.5 If the observations support the conclusion of a “contact or near contact shot”, no comparison with known test patterns is necessary, but Sodium Rhodizonate chemical testing is required.

7.5.1.5.1 The physical characteristics that typically indicate a contact or near contact shot include:

- ripping and tearing of cloth
  - ripping is characterized as “stellate” or star-shaped tearing as well as three-pointed defects such as a “L” or “T” shape
- burning and/or singeing of cloth
- melted tips of artificial fibers
- heavy vaporous smoke deposits around hole

7.5.1.6 If examination of clothing from a deceased victim reveals no holes for evaluation, the examiner shall consult with the Medical Examiner to determine the location of gunshot wounds on the victim. Consulting the Medical Examiner can also aid in determining entrance, exit and re-entrance holes when examining clothing with multiple bullet holes. Once the circumstances of the shooting have been clarified the need for any further examinations is at the discretion of the examiner.

7.5.1.7 If the ownership of the clothing is unclear, the examiner should contact the submitting agency to clarify the ownership of the clothing prior to conducting an examination.

7.5.2 Infrared Evaluation

This is a non-destructive technique utilized for enhancing visualization of potential gunshot residue patterns. A bracketed muzzle-to-target distance determination shall not be determined from an infrared evaluation.

7.5.2.1 Using known gunshot residue patterns, evaluate at a minimum black fabric and white fabric controls under photo-flood lamp or some other emitter of infrared energy.

7.5.2.1.1 A positive result is defined as the appropriate removal of color/pattern and the enhanced visibility of the known pattern on the black fabric. No visual change of the known pattern should be noted on the white fabric.

7.5.2.2 Evidence items shall be evaluated using the same lighting and camera settings that were used to evaluate the control patterns.

7.5.2.3 When test patterns are produced on a material that hinders visibility (either evidence material or laboratory stock material) and infrared is used to enhance visualization on the evidence item, the test patterns shall be evaluated under infrared conditions as well.

7.5.2.4 Photographs of the test and evidence patterns shall be retained with the examination documentation

7.5.2.5 The filters utilized to capture the retained photographs shall be documented.

7.5.3 Chemical Procedure and Analysis

7.5.3.1 When multiple chemical tests are performed on an item, the order in which the testing is performed is as follows.

- Diphenylamine
- Modified Griess

- Dithiooxamide
- Sodium Rhodizonate

7.5.3.2 A positive and negative control test, for each of the listed tests used, shall be performed prior to testing evidence. The results of the control and evidence tests shall be recorded in the examination documentation. If a positive reaction is not observed or if the area surrounding the test mark exhibits a positive reaction, the test should be repeated in another suitable area. If the same results are observed, then the test is considered not reliable, due to a failed control.

7.5.3.3 A color copy or digital image of all chemical test results with a scale visible in the reproduction or 100% recorded on the printed copy shall be retained with the examination documentation.

7.5.3.4 A pattern is defined as a measurable distribution of particles or positive chemical reaction. Particulate is defined as scattered or dispersed particles or chemically detectable particle impacts.

7.5.3.5 Diphenylamine Test – Optional

The Diphenylamine test utilizes a chemical color reaction to test for the presence of nitrates/nitrites.

7.5.3.5.1 Positive Control Procedure

Place the diphenylamine solution in a clean small container. Add a known gunpowder particle to the solution. A positive reaction (blue color) indicates the presence of nitrates/nitrites.

7.5.3.5.2 Negative Control Procedure

Place the diphenylamine solution in a clean small container. No color change indicates nitrates/nitrites are not present.

7.5.3.5.3 Procedure

Place the diphenylamine solution in a clean small container. Add a particle of interest from the evidence item to the solution.

7.5.3.5.4 Interpretation of Results

The solution turning a blue color indicates the presence of nitrates/nitrites.

7.5.3.6 Modified Griess Test – Required (exceptions: contact/near contact shots and shotgun pellet pattern examinations)

The Modified Griess test utilizes a chemical color reaction to visualize gunpowder particulate/patterns. This test detects nitrites, a product of the incomplete burning of gunpowder.

7.5.3.6.1 Modified Griess Paper Preparation

7.5.3.6.1.1 Sensitized paper can be prepared fresh or in large quantities as a lot. Positive and negative controls will be performed on one piece of paper within the lot. If a lot is prepared, the appropriate information shall be documented in the Reagent Preparation Log.

7.5.3.6.2 Modified Griess Control Test Procedure

Positive and negative controls shall be performed on each piece of paper being used. If the paper is from a lot, the lot# shall be recorded in the examination documentation.

7.5.3.6.2.1 Positive Control – Paper

7.5.3.6.2.1.1 Place a test mark utilizing a Nitrite test swab saturated with 15% Acetic Acid on the four corners of the piece of sensitized paper.

7.5.3.6.2.1.2 An equally intense orange-red color reaction indicates the presence of nitrites and that the paper has been evenly coated.

7.5.3.6.2.2 Negative Control – Paper

7.5.3.6.2.2.1 Place a test mark utilizing a clean test swab saturated with 15% Acetic Acid at the mid-point of each edge of the sensitized paper.

7.5.3.6.2.2.2 An acceptable negative control is no color reaction.

7.5.3.6.2.3 Positive Control – Evidence material

7.5.3.6.2.3.1 Place a test mark using a Nitrite test swab saturated with 15% Acetic Acid in an area on each piece of evidence, well away from any observed holes or gunpowder particles.

7.5.3.6.2.3.2 This area on the evidence should be clearly marked as a test mark and sufficiently documented in the examination documentation as to its location.

7.5.3.6.2.3.3 A piece of the sensitized paper that has been control checked shall be used to develop the nitrites in the area of the test mark.

7.5.3.6.2.3.4 The observation of an orange-red color indicates that the evidence material has no effect on a positive result.

7.5.3.6.2.4 Negative Control – Evidence material

7.5.3.6.2.4.1 The area surrounding the test mark, subjected to the same chemical processes, should not produce a color change and serves as a negative control.

7.5.3.6.3 Procedure – Direct Application Technique (DAT)

7.5.3.6.3.1 Place the questioned area of the evidence in contact with the sensitized side of the paper.

7.5.3.6.3.2 The hole being tested, as well as any seams, buttons, etc. should be indexed on the paper for orientation purposes.

7.5.3.6.3.3 Soak or spray a piece of nitrite-free material (e.g., cheese cloth, paper towel) with 15% Acetic Acid and place over the reverse side of the evidence. Spraying the reverse side of the evidence with 15% Acetic Acid is an acceptable option.

7.5.3.6.3.4 Apply a hot iron to the dampened area (material or back of evidence).

7.5.3.6.3.5 Repeat until each questioned area has been tested.

7.5.3.6.4 Procedure - Reverse Application Technique (RAT)

This is an alternative method for thick or non-porous items.

7.5.3.6.4.1 Wipe or spray the sensitized side of the paper that will be in contact with the questioned area with 15% Acetic Acid.

7.5.3.6.4.2 Place the sensitized side of the paper over the area to be tested.

7.5.3.6.4.3 Place a piece of nitrite-free material (e.g., cheese cloth, paper towel) over the sensitized paper.

7.5.3.6.4.4 Apply a hot iron to the back of the dampened paper.

7.5.3.6.4.5 Repeat until each questioned area has been tested.

7.5.3.6.5 Interpretation of Results – Modified Griess (DAT or RAT)

Orange-red specks on the sensitized paper indicate the presence of nitrite residues.

7.5.3.7 Dithiooxamide Test (DTO) – Optional

The DTO test utilizes a chemical color reaction to indicate the presence of copper. This test is used in determining the physical characteristics of bullet holes or impact sites. The DTO test can be performed as a direct application.

7.5.3.7.1 Positive Control Procedure

7.5.3.7.1.1 Place a test mark, well away from any holes/defects on the evidence, using a laboratory copper standard.

7.5.3.7.1.2 This area on the evidence should be clearly marked as a test mark and documented sufficiently in examination documentation as to its location.

7.5.3.7.1.3 Place three drops of the ammonium hydroxide solution on a piece of filter paper.

7.5.3.7.1.4 Place the moistened area of the ammonia-treated filter paper over the test mark and apply pressure or a hot iron for approximately five seconds.

7.5.3.7.1.5 Remove the filter paper and place three drops of the DTO solution to the tested area of the filter paper.

7.5.3.7.1.6 A positive result for the presence of copper will be a dark, greenish-gray color.

7.5.3.7.2 Negative Control Procedure

7.5.3.7.2.1 The area surrounding the test mark, subjected to the same chemical processes, should not produce a color change and serves as the negative control.

7.5.3.7.3 Procedure

7.5.3.7.3.1 Place three drops of the ammonium hydroxide solution on a piece of filter paper.

7.5.3.7.3.2 Place the moistened area of the ammonia-treated filter paper over the hole/defect to be tested.

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

7.5.3.7.3.4 Remove both pieces of filter paper.

7.5.3.7.3.5 Place 3 drops of the DTO solution to the tested area of the filter paper.

7.5.3.7.3.6 Repeat this process for all holes/areas to be tested.

7.5.3.7.3.7 Both sides of holes should be tested if there is a question of entrance vs. exit.

7.5.3.7.4 Interpretation of Results– Dithiooxamide Test (DTO)

A dark, greenish-gray color reaction, corresponding to the area tested, indicates the presence of copper.

7.5.3.8 Sodium Rhodizonate Test - Required

The Sodium Rhodizonate test utilizes a chemical color reaction to test for the presence of lead. This test is used in determining the physical characteristics of bullet holes including the determination of entrance vs. exit holes. If the optional Hydrochloric Acid step is utilized for during the control procedures, it must also be performed on the questioned areas of the evidence.

7.5.3.8.1 Positive Control Procedure

7.5.3.8.1.1 Place a test mark, utilizing a known lead standard, on the evidence in an area well away from any holes/defects to be tested.

7.5.3.8.1.2 This area should be clearly marked as a test mark and documented sufficiently in examination documentation as to its location.

7.5.3.8.1.3 Apply Sodium Rhodizonate and Buffer solutions to the test mark.

7.5.3.8.1.4 Optional: Apply 5% Hydrochloric Acid (either spray or use a cotton swab) to the area treated with Sodium Rhodizonate and Buffer solutions.

7.5.3.8.2 Negative Control Procedure

7.5.3.8.2.1 The area surrounding the test mark, subjected to the same chemical processes, should not produce any color change and serves as the negative control.

7.5.3.8.3 Direct Application Technique (DAT) Procedure

7.5.3.8.3.1 Spray Sodium Rhodizonate and Buffer solutions on to the questioned area.

7.5.3.8.3.2 Optional: Apply 5% Hydrochloric Acid via spray or dampened swab on the tested area (or a portion thereof).

7.5.3.8.3.3 Repeat this process on all holes or areas to be tested.

7.5.3.8.3.4 Both sides of holes should be tested if it is necessary to establish entrance vs. exit.

7.5.3.8.4 Bashinsky Transfer Technique (BTT) Procedure

7.5.3.8.4.1 Uniformly dampen a piece of filter paper with 15% Acetic Acid and place the paper over the hole or area to be tested.

7.5.3.8.4.2 Place a second piece of filter paper over the first and apply pressure or a hot iron for approximately five seconds.

7.5.3.8.4.3 Remove both pieces of filter paper and spray the transfer medium with Sodium Rhodizonate and Buffer solutions.

7.5.3.8.4.4 Optional: Apply 5% Hydrochloric Acid via spray or dampened swab on the tested area (or a portion thereof).

7.5.3.8.4.5 Repeat this process on all holes or areas to be tested.

7.5.3.8.4.6 Both sides of the holes shall be tested if it is necessary to establish entrance vs. exit.

7.5.3.8.5 Baskinsky Transfer Modification Procedure

7.5.3.8.5.1 Spray the evidence item directly with 15% Acetic Acid, Sodium Rhodizonate and Buffer solutions.

7.5.3.8.5.2 Place white blotter or filter paper over both sides of the dampened areas and apply pressure or a hot iron.

7.5.3.8.5.3 After transfer, a second application of Sodium Rhodizonate and Buffer solution can be applied to the paper to enhance the color developed.

7.5.3.8.5.4 Optional: Apply 5% Hydrochloric Acid via spray or dampened swab on the tested area (or a portion thereof).

7.5.3.8.6 Interpretation of Results – Sodium Rhodizonate (DAT and BTT)

7.5.3.8.6.1 A pink color reaction indicates, but does not confirm, the presence of lead.

7.5.3.8.6.2 A blue-violet color reaction, following the optional application of 5% Hydrochloric Acid, confirms the presence of lead.

7.5.3.8.6.3 A pink or blue-violet ring around the hole is a positive indicator of bullet wipe.

7.5.3.9 Screening Test for Bullet Impact Sites

7.5.3.9.1 Positive Control Procedure – Transfer Medium (e.g. Benchkote, filter paper)

7.5.3.9.1.1 Place a test mark utilizing a known lead standard on the transfer medium.

7.5.3.9.1.2 Dampen the transfer medium with 5% Acetic Acid then apply 1 or 2 drops of Sodium Rhodizonate solution to the area of interest.

7.5.3.9.1.3 Optional: Apply 1 or 2 drops of 5% Hydrochloric Acid after the addition of the Sodium Rhodizonate solution.

7.5.3.9.1.4 A positive result will be a pink color reaction on the test mark.

7.5.3.9.2 Negative Control Procedure– Transfer Medium (e.g. Benchkote, filter paper)

7.5.3.9.2.1 The area surrounding the test mark, subjected to the same chemical processes, should not produce a color change and serves as the negative control.

7.5.3.9.3 Positive Control Procedure – Evidence material

7.5.3.9.3.1 Place a test mark utilizing the known lead standard on the evidence in an area well away from any defects/impact sites to be tested.

7.5.3.9.3.2 This area should be clearly marked as a test mark and documented sufficiently in examination documentation as to its location.

7.5.3.9.3.3 Dampen transfer medium with 5% Acetic Acid, press and hold the transfer medium over the hole or area to be tested for approximately one minute, and then apply 1 to 2 drops of Sodium Rhodizonate solution to the area of interest.

7.5.3.9.3.4 Optional: Apply 1 or 2 drops of 5% Hydrochloric Acid after the application of Sodium Rhodizonate solution.

7.5.3.9.3.5 A positive result will be a pink color reaction on the transfer medium where it contacted the test mark.

7.5.3.9.4 Negative Control Procedure – Evidence material

7.5.3.9.4.1 The area surrounding the test mark, subjected to the same chemical processes, should not produce a color change and serves as the negative control.

7.5.3.9.5 Transfer Technique Procedure

7.5.3.9.5.1 Dampen the transfer medium with 5% Acetic Acid.

7.5.3.9.5.2 Press and hold the transfer medium over the hole or area of interest for approximately one minute.

7.5.3.9.5.3 Apply one or two drops of Sodium Rhodizonate solution to the area of interest on the transfer medium.

7.5.3.9.5.4 Optional: Apply 1 or 2 drops of 5% Hydrochloric Acid after the application of the Sodium Rhodizonate solution.

7.5.3.9.6 Interpretation of Results

7.5.3.9.6.1 A pink color reaction indicates, but does not confirm, the presence of lead.

7.5.3.9.6.2 A blue-violet color reaction, following the application of 5% Hydrochloric Acid, confirms the presence of lead.

7.5.4 Test Pattern Production

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

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

7.5.4.1 Each test pattern shall be labeled with a unique identifier and documented on the appropriate worksheet. The examination documentation shall contain sufficient detail to identify the pattern’s approximate distance, Item # of firearm used, Item # of ammunition or laboratory stock ammunition used, and material used.

7.5.4.2 Test patterns shall be preserved to ensure no loss of powder or contamination and shall be labeled in accordance with the QM.

7.5.4.3 To the extent possible, evidence ammunition should be used for the generation of all test patterns.

7.5.4.4 If insufficient ammunition is available for the production of all test patterns, a minimum of one test pattern must be produced from evidence ammunition at a distance that produces a residue pattern and shall be used to validate appropriate laboratory stock ammunition.

7.5.4.4.1 Validation of Laboratory Stock Ammunition

7.5.4.4.1.1 Test pattern(s) produced using evidence ammunition shall be compared with test pattern(s) produced using laboratory stock ammunition.

7.5.4.4.1.2 Laboratory stock ammunition shall be the same brand, contain the same type of gunpowder and have the same bullet design as the evidence cartridge.

7.5.4.4.1.3 The laboratory stock ammunition is acceptable for use if the test pattern(s) produced using the evidence cartridge are consistent with the test pattern(s) produced using the laboratory stock ammunition.

7.5.4.4.1.4 If the laboratory stock ammunition does not produce a consistent pattern, a muzzle-to-target distance determination is not possible.

7.5.4.5 At least one test pattern shall be generated in the evidence material at a distance that produces a residue pattern and shall be used to validate laboratory stock material.

7.5.4.5.1 Validation of Laboratory Stock Target Material

7.5.4.5.1.1 The laboratory stock material should be similar in fiber type and construction as the evidence item material.

7.5.4.5.1.2 Positive and negative controls shall be performed on laboratory stock material. It is acceptable to assign a lot # to a batch of laboratory stock material and perform positive and negative controls on one piece of material within the lot. It is not required to perform positive and negative controls for every subsequent analysis if the material used is part of a previously tested lot. The appropriate information shall be recorded in the Reagent Preparation Log. If material used is from a lot, the lot # shall be recorded in the examination documentation.

7.5.4.5.1.3 Positive Control Procedures

7.5.4.5.1.3.1 If the laboratory stock material is not from a lot, the test marks should be placed well away from the area of the material that will be used for the test pattern production. The examination documentation shall sufficiently document the test marks.

7.5.4.5.1.3.2 Place a test mark using a Nitrite test swab saturated with 15% Acetic Acid. A piece of sensitized paper that has been control checked shall be used to develop the nitrites in the area of the test mark.

7.5.4.5.1.3.3 The observation of an orange-red color indicates that the laboratory stock material has no effect on the positive result.

7.5.4.5.1.3.4 Place a test mark, utilizing a known lead standard, on the laboratory stock material. Apply Sodium Rhodizonate and Buffer solutions to the test mark.

7.5.4.5.1.3.5 A positive result will be a pink color reaction on the test mark.

7.5.4.5.1.4 Negative Control Procedures

7.5.4.5.1.4.1 The area surrounding each of the test marks, subjected to the same chemical processes, should not produce any color change and serves as the negative control.

7.5.4.5.1.5 A suitable area (minimal or no obvious blood/body fluids) of the evidence material should be cut and used for test pattern(s) production.

7.5.4.5.1.6 The laboratory stock material is acceptable for use if the test pattern(s) produced on the evidence material are consistent with the test pattern(s) produced on the laboratory stock material.

7.5.4.5.1.7 If the laboratory stock material does not produce a consistent pattern, a muzzle-to-target distance determination is not possible using laboratory stock material.

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

7.5.4.7 A duplicate test pattern shall be produced at a distance that generates a reproducible residue pattern.

7.5.4.8 A color copy or digital image of all patterns, with a scale visible in the reproduction or 100% recorded on the printed copy, shall be retained with the examination documentation.

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

7.5.4.10 Test patterns created with laboratory stock materials shall be considered evidence and designated as a sub-item of the firearm from which they were produced. The sub-item and the container in which it is being returned shall be documented on the RFLE and the CoA. Sections of submitted evidence materials used for test patterns shall not be created as sub-items. The CoA shall indicate the number of test pattern(s) produced from sections of the evidence item.

7.5.4.11 Materials/Patterns (e.g. overlays, Griess patterns, transfers) produced from chemically processing evidence shall be created as a sub-item of the item from which they were produced. The sub-item and the container in which it is being returned shall be documented on the RFLE and the CoA.

7.5.4.12 Ammunition components derived from producing test patterns with laboratory stock ammunition shall be considered evidence and designated as a sub-item of the firearm from which they were produced. The sub-item and the container in which it is being returned shall be documented on the RFLE and the CoA. Evidence ammunition used for test pattern production shall not be created as a sub-item, but shall be designated with unique identifiers. The CoA shall indicate the number of evidence cartridges used in the production of test patterns.

7.5.5 Production of Test Patterns for the Medical Examiner

7.5.5.1 With the exception of contact/near contact shots, elements needed to produce test patterns for the Medical Examiner include the following: firearm, cartridge/shotshell case(s) or projectile identified to the firearm, and at least one evidence cartridge of the same brand, load and caliber as the item identified to the firearm.

7.5.5.2 If the Medical Examiner requests patterns for comparison to skin, test patterns shall be produced using blotter paper. The examination documentation shall reflect, at a minimum, the firearm and ammunition used and the distance at which each test pattern was created.

7.5.5.3 A duplicate test pattern should be produced if requested by the Medical Examiner.

7.5.5.4 The test patterns shall not be chemically processed.

7.5.5.5 After the test patterns are labeled and protected with a laminating sheet, they shall be photographed or photocopied with a scale visible in the reproduction or 100% written on the copy.

7.5.5.6 The copies and/or printed photographs shall be retained with the examination documentation.

7.5.5.7 The original patterns shall be returned as a sub-item of the firearm. The sub-item and the container in which it is being returned shall be documented on the RFLE and the CoA.

7.5.5.8 It is acceptable to provide copies of the test patterns to the OCME, if requested.

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8 PHYSICAL EXAMINATION AND CLASSIFICATION OF TOOLMARKS

8.1 Introduction

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 the tool, which will help determine what course the rest of the examination should follow.

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

All test marks or casts shall be treated as evidence and handled in accordance with the Quality Manual.

8.2 Safety Considerations

Follow the procedures outlined in the Introduction section to clean evidence with appropriate solutions if biohazard material, blood or tissue is present.

8.3 Instrumentation

- Stereo Microscope
- Caliper
- Micrometer
- Ruler or tape-measure
- Scale/Balance
- Ultraviolet light and/or Alternate Light Source (ALS)

8.4 Minimum Analytical Standards and Controls

Ensure the equipment utilized in the examination has been appropriately calibrated and/or performance checked prior to use. See Section 11 of this manual for specific requirement.

8.5 Procedure or Analysis

8.5.1 Tool Examination

The tool examination is used to establish, as applicable, the following:

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

8.5.2 Toolmark Examination

The toolmark examination process is 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

Methods used to enhance toolmarks for further examination:

- Dusting the toolmark with fingerprint powder

8.5.3 Casting

Casting is a procedure used in a toolmark examination to make a reverse image of a tool or toolmark, which can then be used for comparative microscopic examination purposes. If an item received for a toolmark examination is too large to be conveniently placed on the microscope's stages, a cast can 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 marks made will also have to be cast in order to perform a comparison.

- Mix as per manufacturer instructions
- Apply the casting material over the tool or toolmark to be cast
- When casting material is set or cool, depending on type used, gently tap to loosen the cast from the tool or toolmark, and then lift to remove the cast
- Consideration must be given to placing identifying marks as well as orientation marks on the back of the cast or to scribing identifying marks and/or orientation marks onto the tool or toolmark being cast

8.5.4 Tests Marks/Casts Produced

Toolmark test marks/casts may be produced from submitted evidence material or from laboratory stock material.

Test marks produced from laboratory stock material and casts produced from test marks, a tool, or evidence toolmarks shall be listed as a sub-item of the tool with which they were produced on the RFLE, in LIMS and on the CoA.

Test marks/casts shall be returned in an appropriate sealed container in the same container with the tool or the evidence toolmark which generated them.

Test marks produced from submitted evidence materials will not be listed as sub-items.

8.5.5 Interpretation of results

Document if the item contains suitable markings for comparison or identification with a tool or other toolmarks.

Microscopic comparison of tools and toolmark(s) is detailed in Section 5 of the Firearm/Toolmark Procedures Manual.

8.6 References

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9 NUMBER RESTORATION

9.1 Introduction

Many items manufactured today have serial numbers for identification. The process of applying a serial number affects the material in the immediate area surrounding and below the number.

9.2 Safety Considerations

Consult the Material Safety Data Sheet (MSDS) prior to handling chemicals.

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

Consult the Safety Coordinator for proper disposal of unused or expired chemicals.

9.3 Preparation

Store solutions in an appropriate, sealed container labeled in accordance with the Quality Manual. Document the preparation in the DFS Reagent Preparation Log if the solution is stored for future use. If the solution is prepared and consumed (prepared for each use), it is not required to record the information in the log, but it is necessary to record the information in the examination documentation.

It is acceptable to adjust the volumes to meet the needs of the laboratory.

See Appendix C – Reagents for specific formulations.

9.4 Instrumentation

- Scale/Balance
- Low voltage DC power source
- UV light source (if 14AM Prepared Bath is being used)
- Yoke magnets
- Y-7 AC/DC Yoke electromagnet
- Stereomicroscope
- Comparison Microscope
- Digital Camera
- Rotary polishing tool, polishing disc, sanding/buffing materials

9.5 Minimum Analytical Standards and Controls

See Section 11 of this manual for specific tests for each reagent.

9.6 Procedure or Analysis

Characters visible prior to conducting any restoration methods, the possible method of obliteration and characters observed after restoration shall be included in the examination documentation.

Photographs shall be taken of the obliterated area, as received and after restoration. If photographed using a microscope, document the magnification or objective used. If photographed without the aid of a microscope, a scale shall be included in the image, if possible.

9.6.1 Polishing Procedure

Most restoration procedures require the obliterated area to be polished as a preliminary step. The polishing procedure is the desirable method used to remove prior obliteration marks. Depending on the

depth and technique of the obliteration, and the substrate being restored, the polishing procedure may restore the characters.

- Polish the area of the obliteration using either a rotary polishing tool with a sanding/polishing disc fine-grit sandpaper or other materials
- Documentation shall include the polishing techniques used
- Depending on the extent of the obliteration, continue polishing until the surface is mirror-like, removing all scratches
- If the obliteration is severe, it may not be possible or desirable to remove all the scratches
- Examination documentation shall clearly delineate between polishing as a restorative method or surface preparation

9.6.2 Magnetic Particle Inspection (MPI) Procedure

The magnetic procedure technique is used by metallurgists to detect surface or subsurface flaws in iron or steel. Magnetic particles, applied to a magnetized specimen, outline the obliterated characters in a successful restoration. This procedure, in conjunction with applicable polishing, may be an effective way to restore an obliterated serial number in magnetic metal. The magnetic technique is nondestructive, and can be applied without affecting other restoration methods.

- Determine the serial number medium's physical properties, i.e., magnetic or non-magnetic
- The specimen is suitable if it can be magnetized
- Clean the area of obliteration with the SKC-S Cleaner/Remover by spraying this onto the surface and wiping, allowing to dry before proceeding
- Apply appropriately prepared 9CM or 7HF Bath to the area of obliteration
- Place a magnet behind the area of obliteration with the magnetic poles on either side of the area
- This placement may be adjusted to reveal more or different areas of the obliteration
- If 14AM (Fluorescent) prepared bath is being used, observe the characters under a black light
- Ensure the magnet is of sufficient strength and placed correctly by visualizing the accumulation of the magnetic particles.

9.6.3 Chemical Procedure

The chemical-restoration procedure is suitable for restoration of serial numbers in metal. It essentially consists of surface preparation through grinding or polishing and the application of appropriate chemical etchants resulting in revealing structural characteristics of the impressed serial number.

Selection of the appropriate chemical reagent, based on initial observations, may include magnetic media or non-magnetic media. Any of the reagents listed in this section may be used for restoration purposes.

It is acceptable to apply the selected reagent to the evidence surface, near the area of interest, to aide in selecting the most appropriate reagent. It is not required to test the reliability of the reagent prior to every use because testing was done after preparation and every three months as outlined in Section 12.

Commonly used magnetic media reagent choices:

- Fry's Reagent
- Turner's Reagent
- Davis's Reagent
- 25% Nitric Acid Solution
- Aqua Regia

Commonly used non-magnetic media reagent choices:

- Ferric Chloride Solution
- Acidic Ferric Chloride Solution

- 25% Nitric Acid Solution
- 10% Sodium Hydroxide Solution
- Hydrofluoric Acid Solution

As appropriate, apply the chemical solution to the area of obliteration. At the examiner's discretion, depending on the depth of obliteration, etchants may be applied with cotton tip applicators or allowed to pool. Note any numbers or characters that become visible.

9.6.4 Electrochemical Procedure

The electrochemical procedure is a form of chemical restoration that is enhanced by the application of voltage that speeds the oxidation process of metal. This technique, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in metal. Selection of the appropriate chemical reagent, based on initial observations, may include magnetic media or non-magnetic media.

The electrochemical procedure follows.

- The electrochemical technique requires the attachment of the item to the positive terminal of a power supply via the use of metal alligator clips
- Thoroughly soak the cotton tip of an applicator with the appropriate etching chemical solution and attach the moistened cotton tip to the negative terminal of the power supply via another metal alligator clip being certain to do so on a moistened area at the base of the cotton tip
- Turn on the power supply and increase the voltage gradually until the reaction appears
- Wipe the area of obliteration with the moistened cotton tip, being careful to not touch the surface of the item with the metal alligator clips and note any numbers or characters that become visible

9.6.5 Heat Procedure

The Heat-Restoration procedure is suitable for restoration of serial numbers in plastic. The die stamping, or embossing process, is a form of "cold-working" plastic. This procedure, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in plastic.

- The heat technique requires the application of heat to the area of obliteration utilizing a high intensity lamp or heat gun
- Continue the application of heat until the plastic in the obliterated area starts to liquefy and note any numbers or characters that become visible

9.6.6 Documentation of Results

Examination documentation shall include the result of each step of the restoration process.

Results would include full restoration, partial restoration, or unsuccessful restoration.

- A full restoration would be a total recognition of all obliterated characters.
- A partial restoration would be recognition of all obliterated characters less than the total being sought.
- An unsuccessful restoration would be no recognition of any obliterated characters.

9.6.7 Verifications – see Section 10

9.7 Manual Barcode Decryption

9.7.1 The Code 39 barcode is a standard 1D alphanumeric symbol represented by wide and narrow black bars and white spaces, each called an element. The combination of nine black and white elements represents one character. Possible characters include: 1234567890ABCDEFGHIJKLMNOPQRSTUVWXYZ.,%$-

/and the space character. In addition there is always a stop (end) and start (front) character, often represented by an asterisk.

9.7.2 Each character, to include start, stop, numbers and letters, is represented by nine elements; five black bars and four white spaces. Three of the nine elements in each are wide; six are narrow.

- Begin by inspecting the barcode; at a minimum, the stop or start character shall be established.
- Using a photograph of the barcode, begin at the far left end, count five black bars to the right and draw a line. Continue marking each set of five black bars over the remainder of the barcode.
- To interpret and document the barcode elements, beginning at the far left bar, note the width of each of the nine black bar and white space elements. Note "W" for wide and "N" for narrow, recording the pattern in the vertical column between the extended lines.
- Decode each group of nine elements using Appendix B.

9.7.3 Documentation of Results

The barcode photo containing the manually decoded pattern shall be maintained as well as worksheet.

9.7.4 Verifications – see Section 10.

9.8 References

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10 VERIFICATION / BLIND VERIFICATION

10.1 Introduction

Verification is the independent application of the comparative analysis process to evaluate microscopic examination results where the results are known to the verifying examiner.

Blind verification is a verification process in which the verifying examiner does not know the results produced by the first examiner. The purpose of this process is to test the reproducibility of conclusions related to microscopic comparison examinations. The blind verification should not be conducted by an examiner that has been solicited for consultation regarding opinions and/or conclusions.

The Supervisor/Group Supervisor/designee shall be consulted prior to having conclusions verified to determine if the case has been designated for blind verification.

10.2 Verification Requirements

10.2.1 Verifications are required for identification and inconclusive conclusions.

10.2.2 Verifications are required for elimination conclusions based on individual characteristics.

10.2.3 Number restoration results where characters are developed and reported shall be verified by a second examiner.

10.2.4 Verifications are required for distance determination examinations where a distance range is reported.

10.2.5 Verifications are required for the overall and barrel length measurements.

10.2.6 Verifications are required for clothing examinations where no holes for evaluation are found.

10.2.7 Verifications must be completed prior to communicating the information to the contributor, either verbally or in writing. Additionally, the CoA shall not be generated prior to the verification.

10.2.8 No photographs or verification by a second examiner are required for evidence classified as unsuitable for comparison.

10.3 Verification Documentation Requirements

10.3.1 The verifying examiner shall document: the conclusion, the item/sub-item numbers, test designator (as applicable for a known test standard). Additionally, the specific tool-working surface evaluated (e.g., breechface, firing pin, ejector, extractor, chamber, ejection port) shall be specified for cartridge cases. Index mark orientation is also required for all identification conclusions.

10.3.2 The verifying examiner shall provide one or more photomicrographs of the mechanism mark(s) used to support the opinion of identification if they differ from the marks used by the original examiner.

10.3.3 The verifying examiner shall document the justification for elimination, as applicable.

10.3.4 The verifying examiner shall document the obliterated characters that have been restored as well as possible characters as a result of a restoration examination.

10.3.5 Documentation for distance/clothing examinations shall delineate the results that are agreed upon between examiners.

10.3.6 Documentation for examinations of overall and barrel length of firearms shall include the verifying examiner’s measurements.

10.3.7 The original and verifying examiners shall discuss the basis for their conclusion when a difference of opinion occurs. Notification shall be made to the Section Supervisor and the Physical Evidence Program Manager. When changes to the comparison conclusions are made following a consultation between the examiners, the notes shall include the reason for the change of opinion and this information shall be conveyed to the Section Supervisor and the Physical Evidence Program Manager.

10.3.7.1 If consensus is not reached, an inconclusive result shall be reported on the CoA per the Quality Manual Section 15 using the following language.

The comparison of *Item 1 and Item 2* is being reported as inconclusive due to lack of concordant results of duplicate analysis.

10.3.7.2 If consensus is not reached, the Physical Evidence Program Manager and/or Director of Technical Services shall assign an examiner to evaluate the evidence to provide a quality assessment of the evidence items compared. The purpose of the evaluation is to provide a recommendation to the Program Manager and/or Director of Technical Services as to the appropriateness of the non-consensus opinions and if both conclusions are sound.

10.4 Blind Verification Requirements

10.4.1 The Supervisor/Group Supervisor/designee of the section shall designate cases as being subject to blind verification (BV) prior to case assignment. The examiner shall not be notified that the case will be blind verified.

10.4.2 Each examiner should conduct at least one blind verification examination, and each examiner should have at least one of their assigned cases subjected to blind verification monthly. Regional laboratories staffed with only two examiners shall coordinate with the appropriate regional Laboratory Firearm Section Supervisor/designee for examination of blind cases. If possible, each month, two individuals in each laboratory shall each be designated to blind verify one case originating from one of the other laboratories.

10.4.3 The cases selected for blind verification should focus on comparison type examinations (ammunition components or other items requiring microscopic comparison) and if possible contain no more than five (5) items.

10.4.4 For cases involving firearms, functioning of the firearm, NIBIN entry and test firing will not be repeated.

10.4.5 At the discretion of the Section Supervisor, the BV process may be terminated on a case due to extenuating circumstances and another case selected to meet the BV requirement. An example for termination may be when the RFLE inaccurately reflects the number of specimens contained in the case.

10.4.6 Evidence being subjected to blind verification shall be handled in accordance with the QM. The verifying examiner should maintain the evidence until authorized by the Supervisor/designee to return it to the originating examiner or evidence vault.

10.4.7 The Supervisor/Group Supervisor/designee shall provide the blind verifier with a copy of the RFLE and the Verifying Examiner Conclusion Worksheet – BV Cases with the top portion completed, to include case instructions for the comparison/verification. The transfer of evidence shall follow the requirements of the QM. When the examiner is the Supervisor, the Group Supervisor/designee shall prepare the documentation, make the case assignment and reconcile the case documentation.

10.4.8 The verifying examiner shall conduct the requested examination and document conclusions, including photographs as necessary.

10.4.8.1 Extensive documentation related to the description of the evidence is not necessary as it has been previously recorded by the original examiner. The blind verification process is to focus on the comparison aspect of the request.

10.4.9 Once the verifying examiner has completed the examination, the documentation should be given to the Supervisor/Group Supervisor/designee in the verifying laboratory for comparison with the original examiner's examination documentation.

10.4.10 The Supervisor or designee shall review and compare the conclusions of the original examiner and blind verifier.

10.4.10.1 If there is agreement in the comparison conclusion (i.e., Identification, Inconclusive, Elimination), the Supervisor shall document "results in agreement" on the Verifying Examiner's Conclusion Worksheet.

10.4.10.2 If there is not agreement in the comparison conclusion, the procedure outlined in section 10.3.7 of this manual shall be followed.

10.4.11 The evidence and all case documentation shall be returned to the originating examiner who shall initial all additional case documentation provided and complete the case.

11 QUALITY ASSURANCE

11.1 Introduction

11.1.1 The purpose of this section is to provide a uniform Quality Assurance Program for the Firearm/Toolmark Section of the Virginia Department of Forensic Science. It is to establish a baseline or reference point of reliability and system performance.

11.1.2 For further detail, refer to the Quality Manual.

11.1.3 Maintenance, calibrations and performance checks performed per this section shall be documented on the appropriate form.

11.1.4 If measuring equipment is damaged, it shall be taken out of service and either replaced or repaired.

11.2 Reagents

11.2.1 Chemicals and solvents used in reagents should be of at least ACS reagent grade, if possible.

11.2.2 Water used in reagent preparation should be reverse osmosis (R/O) or deionized (DI).

11.2.3 Cleaning Solutions

It is not required to record cleaning solutions in the Reagent Preparation Log. Solutions should be stored in labeled containers.

11.2.3.1 15% Acetic Acid Solution

Add 150 mL Glacial Acetic Acid to 850 mL R/O or DI water

11.2.3.2 Bleach Solution

Add 10 mL bleach to 90 mL of R/O or DI water

11.2.4 Testing Reagents

The preparation of the below listed reagents shall be documented in the Reagent Preparation Log.

After preparation, the reagents listed in Tables 1 and 2 shall be tested for reliability prior to use in casework with the corresponding standards listed. The result, date and initials shall be recorded in the Reagent Preparation Log. For reagents that are prepared fresh for each examination, the reliability test result shall be recorded in the examination documentation.

The reagents listed in Table 2 shall be checked every six months to ensure reliability, if not made fresh for each examination. Document the routine checks on the Reagent Check Log.

The shelf life of reagents in this section shall be one year with the following exceptions:

- Aqua Regia shall be made in small quantities for immediate use
- Modified Griess paper and Nitrite test swabs will be tested for reliability prior to use

11.2.4.1 Distance Determination Reagents

A positive indication of the effectiveness is the observation of the color change indicated in the expected result column when exposed to the listed reference material.

Table 1

REAGENT/TEST	REFERENCE MATERIAL	EXPECTED RESULT
Modified Griess	Nitrites	orange-red color
Dithiooxamide	Copper	dark greenish gray color
Sodium Rhodizonate / Buffer	Lead	pink color
Sodium Rhodizonate/Buffer/HCl	Lead	blue-violet color
Diphenylamine	Nitrates	blue color

11.2.4.2 Serial Number Restoration Reagents

A positive indication of effectiveness is the observation of a color change on the swab, discoloration of the metal or effervescence as listed below in Table 2.

Table 2

REAGENT/TEST	REFERENCE MATERIAL	EXPECTED RESULT
Fry's Reagent	303 Stainless Steel	Immediate black discoloration of swab
Turner's Reagent	1018 Steel	Immediate dark gray discoloration of swab
Davis's Reagent	303 Stainless Steel or 1018 Steel	Immediate brown discoloration of swab
25% Nitric Acid	4140 Alloy Steel	Immediate brown discoloration of swab
Acidic Ferric Chloride	6061 Aluminum Alloy	Immediate effervescence on metal surface
Ferric Chloride Solution	6061 Aluminum Alloy	Immediate slight effervescence on metal surface
10% Sodium Hydroxide	6061 Aluminum Alloy	Effervescence and discoloration of metal surface within 1 minute
Hydrofluoric Acid Solution	6061 Aluminum Alloy	Slight effervescence on metal surface within 30 seconds with the application of a drop
Aqua Regia Solution	303 Stainless Steel or 1018 Steel	Black discoloration of metal with the application of a drop
Cupric Chloride in Nitric Acid	6061 Aluminum Alloy	Immediate effervescence and discoloration of metal
Zinc Alloy Etching Solution	Zamack 3	Effervescence after solution 1, discoloration of metal surface after solution 2
Griffin's Reagent	303 Stainless Steel or 1018 Steel	Immediate brown discoloration of swab with slight discoloration of metal surface

11.2.4.3 Reference materials listed in Table 2 may be obtained from a manufacturer that supplies a certificate of analysis definitively identifying the material or an analysis can be performed by DFS personnel definitively identifying the material.

11.2.4.4 Data documenting the identification of the material shall be maintained in the Quality Assurance Log Book.

11.2.5 All laboratory prepared reagents/solutions will be clearly labeled as outlined in the Quality Manual.

11.3 Balances

TABLE 3: Balances and Appropriate Check Weights

BALANCE TYPE	BALANCE EXAMPLES	CHECK WEIGHTS
Top loading (± 1) grain	Denver XP600 Denver XL500 Denver XL610	1 (± 0.2) grains 100 (± 1) grains 1000 (± 2) grains

11.3.1 Balances shall be calibrated by an outside vendor annually that is accredited to ISO/IEC 17025 and whose scope of accreditation covers the calibration performed. New balances shall be calibrated prior to being placed into service. Calibration certificates shall be evaluated by the Section Supervisor, Group Supervisor, or designee prior to placing the balance into service.

11.3.2 All balances shall be performance checked quarterly (every three months) for accuracy using Class F or ASTM Class 1 weights.

11.3.2.1 Record weight displayed using the Balance Log.

11.3.2.2 If the accuracy of a weight is outside the acceptable range listed in Table 3, ensure the balance is level and clean prior to rechecking. If, after these actions, the weight check is still outside the acceptable range, the balance shall be taken out of service and labeled as such until maintenance and/or calibration is performed by a qualified vendor.

11.3.2.3 Weights used to check balance accuracy shall be re-certified every three years by an ISO/IEC 17025 accredited vendor whose scope of accreditation covers the certification performed.

11.4 Comparison Microscopes

11.4.1 After installation or maintenance, a performance check shall be conducted on each set of objectives to ensure they are in compliance as follows:

11.4.2 A performance check of the comparison microscopes shall be conducted annually using Klarmann Rulings stage micrometers.

11.4.2.1 Place stage micrometer on each microscope stage ensuring they are in the same plane with each other and lenses are at same magnification.

11.4.2.2 Move stage micrometer until graduation lines correspond.

11.4.2.3 Acceptance Criterion:

11.4.2.3.1 All magnifications of oculars shall be accurate (± the width of graduate line on stage micrometer).

11.4.3 If above accuracy is not observed, the microscope shall be taken out of service and either replaced or repaired by an authorized service vendor.

11.4.4 Klarmann Rulings stage micrometers shall be calibrated by an outside contractor every three years.

11.5 Stereo Microscopes

The following shall be done annually for microscopes equipped with reticles in eyepieces.

11.5.1 Ensure that the reticle has been installed properly in eyepiece so that it is in sharp focus.

11.5.2 Place the Klarmann Rulings stage micrometer on flat horizontal surface in the field of view and ensure that the known standard is in focus.

11.5.3 Using the reticle and stage micrometer, superimpose the 0.1" reticle over 0.1" on the stage micrometer when the magnification control knob on the stereo microscope is at or near "*full scale"*, if possible.

11.5.3.1 Mark the correct position for "*full scale"* measurement on the magnification control knob on the stereo microscope.

11.5.4 Using the reticle and the stage micrometer, superimpose 0.1" reticle over the 0.2" on the stage micrometer when the magnification control knob on the stereo microscope is at or near "half scale".

11.5.4.1 Mark the correct position for "half scale" measurement on the magnification control knob of the stereo microscope.

11.5.5 Acceptance Criteria

11.5.5.1 All magnifications of reticles shall be accurate (± width of graduate line on stage micrometer).

11.5.5.2 If reticle does not perform to the performance standard or is in need of repair, it shall be taken out of service and either replaced or repaired by an authorized service vendor.

11.5.5.3 Accuracy must be established after installation of a new reticle or when it is put back into service after maintenance/repair.

11.6 Micrometers and Calipers

Accuracy must be established prior to a micrometer or caliper being put into service after purchase, maintenance or repair.

11.6.1 A performance check shall be conducted annually on micrometers and calipers using Klarmann Rulings stage micrometers on a comparison microscope.

11.6.1.1 At the same magnification, place a stage micrometer on one stage and the equipment (micrometer or caliper) to be checked on the other stage.

11.6.1.2 The equipment is considered accurate if it meets the following specifications:

0.1 inch (± width of graduate line on stage micrometer)
0.01 inch (± 0.005 inch)
0.001 inch (± 0.0005 inch)

11.6.2 If a micrometer or caliper does not meet the accuracy listed above or is in need of repair, it shall be taken out of service and either replaced or repaired by an authorized service vendor.

11.7 Rulers and Tape Measures

11.7.1 Accuracy must be established prior to a ruler or tape measure being put into service after purchase, maintenance or repair.

11.7.2 A performance check shall be conducted on rulers and tape measuring devices using the Starrett Certified 100 foot metal tape if visible damage is detected.

11.7.2.1 If the equipment being checked disagrees with the Starrett Certified equipment by greater than ± half of the smallest increment, it shall be removed from service.

11.7.3 The ruler on the Perspective Enterprise measuring device and the 36 inch reference length shall be calibrated by an external ISO/IEC 17025 accredited provider prior to placing it into service and every three years.

11.7.3.1 The device shall be stored in an area of the lab to avoid damage and cleaned with care using a non-abrasive cloth to avoid scratching the plastic, as necessary.

11.7.3.2 Prior to each use of the Perspective Enterprises device the 36 inch reference length standard shall be measured to verify the accuracy of the device and recorded in the UoM Equipment Performance Check Log.

11.7.3.2.1 If the measurement obtained disagrees with the calibrated reference length standard by greater than ± 1/16 inch, the measuring device shall be adjusted and the reference length standard measured again. If the measurement obtained is still in disagreement, the device shall be removed from service.

11.7.3.3 Recalibration of the ruler and the reference length standard shall occur if the equipment is visibly damaged or the accuracy of the ruler cannot be established following the previously listed procedure.

11.7.4 The tape measure used for the generation of known distance patterns shall be calibrated by an external ISO/IEC 17025 accredited provider prior to placing it into service and every three years.

11.7.4.1 Prior to each use of tape measure the 36 inch reference length standard shall be measured to verify the accuracy and recorded in the UoM Equipment Performance Check Log.

11.7.4.1.1 If the measurement obtained disagrees with the calibrated reference length standard by greater than ± 1/16 inch it shall be removed from service.

11.8 Arsenal Weights

11.8.1 A performance check shall be conducted annually on the arsenal weights utilizing a calibrated balance.

11.8.2 The observed balance weight shall be within ± 2% of the stated weight to be acceptable for use.

11.9 IMADA Digital Force Gauge

11.9.1 A performance check shall be completed prior to each use and recorded in the UoM Equipment Performance Check Log.

11.9.1.1 Acceptability Criteria

- 2 lb weight +/- 0.2 (1.8 - 2.2)
- 6 3/4 lb weight +/- 0.67 (6.08 - 7.42)

11.9.2 The gauge shall be calibrated by an external ISO/IEC 17025 accredited provider prior to placing it into service and every three years.

11.10 AFTE GRC Search Engine

11.10.1 A performance check of the search engine shall be conducted quarterly.

11.10.2 The results shall be recorded utilizing the Qualtrax AFTE GRC Performance Check workflow.

11.10.3 A test fire from one of the commonly encountered firearms, as listed in the Department's database, shall be used in the performance check.

11.10.4 The performance check shall be conducted by a different lab each quarter.

11.10.5 The AFTE GRC search engine shall be acceptable for use if the firearm used to generate the test fire appears on the list.

11.11 NIBIN System Performance Check

See the NIBIN Section of this manual.

11.12 Reference Collections

11.12.1 Reference collections of data or materials used for the identification, comparison or interpretation shall be fully documented, uniquely identified and properly controlled.

11.12.2 In-house reference collections shall only be generated, edited, or modified by a firearm/toolmark section supervisor or designee.

11.12.3 Specimens of any in-house reference collection shall be uniquely identified by placing an individual identifier/inventory control number either on the specimen itself or on the container/vessel in which it is stored. A listing of all specimens with their identifier shall be maintained in an electronic format along with the documentation of the important characteristics of each.

11.12.4 The documentation of in-house reference collection specimens shall include the characteristics of each specimen which have been established to be important insofar as their application to casework is concerned.

11.12.5 Reference collections within the firearm/toolmark section are properly controlled by limiting the personnel allowed to make changes to the collections and by limiting users to personnel within the firearm/toolmark section.

11.12.6 A list of all firearm/toolmark reference collections and corresponding unique identifiers is maintained and is available to section personnel.

11.13 Cadre TopMatch-3D High-Capacity Scanner

11.13.1 The SRM Cartridge Case and/or the Sinusoid Microscale Reference shall be placed in the scanning tray along with the items to be scanned.

11.13.2 After completing a scan of the reference, the system will compute and save the quantified measure of that reference in the Quality Control tables.

11.13.2.1 The measured Rsm and Ra values will be colored green if they are within the specified acceptance range and red if they are outside the range.

12 ESTIMATION OF THE UNCERTAINTY OF MEASUREMENT

12.1 Scope

An estimation of the Uncertainty of Measurement (UoM) shall be calculated for overall and barrel length determinations for long guns and for trigger pull determinations.

Reporting quantitative results, that have not had an evaluation of UoM conducted, (e.g., bullet weight, land and groove measurements) is outside the scope of accreditation; therefore, language shall be included on the CoA to reflect this.

12.2 Documentation

The expression of uncertainty shall be recorded in case notes and included on the CoA. See the Report Writing Guideline section of this manual for examples of wording to use on the CoA.

12.3 Measurement Uncertainty Elements

12.3.1 Uncertainty components considered and evaluated.

12.3.1.1 A list of components that can affect the measurement process shall be compiled and evaluated to determine how they will be covered in the estimation.

12.3.1.2 Type A evaluation: method of evaluation of uncertainty by statistical analysis of series of observations.

12.3.1.3 Type B evaluation: method of evaluation of uncertainty by means other than statistical analysis of series of observations.

12.3.2 Barrel and Overall

12.3.2.1 The measurand is the barrel length of a firearm and/or the overall length of a firearm.

12.3.2.2 Traceability for these measurements is established through the calibration (by an ISO/IEC 17025 accredited calibration laboratory whose scope of accreditation covers the calibration performed) of the ruler affixed to the Perspective Enterprises device.

12.3.2.3 The Perspective Enterprises device with a ruler with 1/16 inch scale marking is the equipment utilized to obtain the overall and barrel length measurements.

12.3.2.4 Data used to estimate Repeatability / Reproducibility

The Type A standard uncertainty is derived from the variation of each measurement from the mean of the measurements made by all examiners on single measurand. The largest variation is used to calculate the combined standard uncertainty.

12.3.2.5 Calculations

The combined standard uncertainty shall be calculated using the Root Sum Squares formula depicted below:

$$U_c(y) = \sqrt{s_{process}^2 + 2(u_{read}^2) + u_{cal}^2 + u_{scale}^2 + u_{ref\_cal}^2 + u_{thermal}^2)}$$

$s_{process}$ = standard deviation of the measurement
u_{read} = ruler readability

u_{cal} = ruler calibration certificate standard uncertainty
u_{scale} = ruler calibration certificate scale error
u_{ref_cal} = reference length standard calibration certificate standard uncertainty
$u_{thermal}$ = aluminum linear temperature expansion coefficient

The coverage probability of the combined standard uncertainty must be expanded to a minimum of 95.45%.

The calculations shall be maintained with the record.

12.3.2.6 UoM Review

The data shall be maintained by the Physical Evidence Program Manager and stored electronically in a location available for review.

To ensure the validity of the measurement process, after the initial collection of data, measurements shall be recorded twice a year and the calculations updated annually or as necessary.

12.3.3 Trigger Pull

12.3.3.1 The measurand is the trigger pull, the amount of force which must be applied to the trigger of a firearm to cause the sear to release.

12.3.3.2 Traceability for these measurements is established through the calibration (by an ISO/IEC 17025 accredited calibration laboratory whose scope of accreditation covers the calibration performed) of the IMADA digital force gauge.

12.3.3.3 Data used to estimate Repeatability / Reproducibility

12.3.3.3.1 The Type A standard uncertainty is derived from the variation of six measurements recorded for the firearm being tested.

12.3.3.3.2 The Trigger Pull UoM worksheet shall be used to record the measurements and calculate the combined standard uncertainty.

12.4 Measurement Assurance

12.4.1 To ensure the calibration status of the Perspective Enterprises device the 36 inch reference length standard shall be measured prior to each use.

12.4.2 To ensure the calibration status of the IMADA Digital Force Gauge a performance check shall be completed prior to each use.

12.4.3 The calibration certificate shall be reviewed before new equipment, such as a ruler or digital force gauge, is put into use. The equipment is acceptable for use if the equipment's uncertainty of measurement listed on the calibration certificate is less than or equal to the existing equipment's uncertainty of measurement.

12.5 References

ASCLD/LAB Guidance on the Estimation of Measurement Uncertainty – ANNEX C, Firearms/Toolmarks Discipline Firearms Category of Testing Example – Overall Length of a Firearm, Version 1

13 REPORT FORMATS

13.1 Introduction

13.1.1 The following report formats shall be used to the extent possible to ensure consistency within the section. It is recognized that report statements cannot be provided to address all situations; therefore, these statements should be considered example wording. The examiner shall consult with Supervisors, the Program Manager and/or the Director of Technical Services for appropriate wording when necessary.

13.1.2 The use of the terms “brand” and “caliber” within report statements is at the discretion of the examiner.

13.1.3 Reports may not use non-specific terms (e.g., “consistent with”, “highly specific”, “similar to”, indicative of”, or “characteristic of”) without additional explanation and/or qualification.

13.1.4 The *underlined italicized* portion in the proposed statements serve as an example, and the intent is to utilize the correct information in the case.

13.1.5 It is acceptable to spell out a number and not follow it with a numerical value in parenthesis.

Example: Two cartridge cases from Item 1 were test fired in Item 3.

13.1.6 The Certificate of Analysis (CoA) shall include the types of examinations that were conducted to reach the stated conclusions.

13.1.7 The following statement shall be included on all reports:

Supporting examination documentation is maintained in the case file. The above listed methods are those approved for use at the time of analysis. Current methods can be found in the Firearms and Toolmarks Procedures Manual, which can be found at www.dfs.virginia.gov/documentationpublications/manuals/ .

13.1.8 Unable to perform the requested comparison exam:

The requested comparison between *Items 1* and *2* could not be performed.

13.1.9 Fired ammunition components and/or toolmarks:

Items 1 and 2 were microscopically examined and compared.

13.1.10 If an item (e.g., tool, firearm, magazine, ammunition, holster) is received but not examined, it shall be documented in the body of the report. The below statement is to be utilized to address the known submitted item that was not examined.

No examinations were conducted on *Items 2, 3 and 5*.

13.1.11 The following wording shall be used when a consensus is not reached during the verification or blind verification process. An inconclusive result shall be reported on the CoA per Quality Manual ¶ 16.2.10.3.

13.1.11.1 The comparison of *Item 1* and *Item 2* is being reported as inconclusive due to lack of concordant results from duplicate analyses.

13.1.12 Deviations from testing methods shall be included on the CoA.

13.1.12.1 Deviations related to the worksheet history tracking do not need to be included on the CoA.

13.2 Firearm Functioning

It is necessary to state if the submitted magazine or a reference magazine was used for test firing.

It is the discretion of the examiner to use the term “test fired with” or “test fired using”.

13.2.1 Test fired with submitted magazine:

The *Item 5 firearm* was examined, found to be in mechanical operating condition with the safety feature(s) functioning properly and test fired using the submitted magazine.

13.2.2 Test fired with reference magazine:

The *Item 6 firearm* was examined, found to be in mechanical operating condition with the safety feature(s) functioning properly and test fired with a magazine from the laboratory’s reference collection.

13.2.3 Test fired with no magazine:

Item 6 was examined, found to be in mechanical operating condition with the safety feature(s) functioning properly and test fired.

13.2.4 Non-Standard Firearms

13.2.4.1 Flintlock

Item 6, a flintlock, smoothbore musket of approximately *62 [caliber]*, has a functioning flintlock mechanism (with flint), a priming pan, and an unobstructed barrel and flashhole. Therefore, it would be expected to fire if properly loaded. *Item 6* is an instrument that was designed and made to expel a projectile by means of an explosion.

13.2.4.2 Replica

Item 6 is a *Japanese* manufactured replica of a *Beretta Model 1934 semiautomatic pistol*. This replica is not capable in its present condition of firing a cartridge containing a projectile.

13.2.4.3 Flare Gun

The *Item 6* flare gun was examined, found to be in mechanical operating condition with the safety feature functioning properly, and test fired.

13.2.4.4 Pellet Guns/Air Guns

The *Item 6* air pistol was examined, found to be in mechanical operating condition with the safety feature functioning properly, and test fired with the submitted magazine.

13.2.4.5 Black Powder/Pyrodex

As received, the *Item 6* rifle was loaded with one 50 caliber sabot/bullet, three 30 grain Pyrodex pellets, and one fired primer, which were removed from the rifle and designated as *Item 6A*. The *Item 6* firearm was examined, found to be in mechanical operating condition with the safety features functioning properly, and test fired.

Two 50 caliber lead bullets, two size #209 shotshell primers, and four Pyrodex pellets from laboratory stock ammunition were used for test firing purposes. The resultant ammunition components are being returned as Item 6B in container 1 and should be maintained for possible future examinations.

13.2.4.6 Bump stock type device

The *Item 1* firearm has a *Slide-Fire* brand stock. A *Slide-Fire* brand stock is a device that is designed to allow a semiautomatic firearm to shoot more than one shot with a single pull of the trigger by harnessing the recoil energy of the semiautomatic firearm to which it is affixed so that the trigger resets and continues firing without additional physical manipulation of the trigger by the shooter. The device was present, but not tested.

13.2.4.7 Binary trigger

The *Item 1* rifle is equipped with a binary firing system which, when selected, allows the rifle to fire when the trigger is pulled and when the trigger is subsequently released.

13.2.4.8 Machine gun conversion device/Glock switch

13.2.4.8.1 Examination of the *Item 1* firearm revealed a *(modification or device if known (i.e,. drop-in auto sear/modified slide cover plate*)) which is designed to convert a semi-automatic firearm to full-automatic. The *Item 1* firearm was found to be in mechanical operating condition and test fired using the *Item 2* magazine. The firearm fired in full automatic mode during test firing.

13.2.4.8.2 Examination of the *Item 1* firearm revealed a modified slide cover plate, which converts a semi-automatic firearm to full-automatic. The *Item 1* firearm was found to be in mechanical operating condition with the safety features functioning properly, and test fired using the *Item 2* magazine. The firearm fired in both semi-automatic and full-automatic modes during test firing.

13.3 Test Fires/Tests and Disposition (NIBIN and Comparison)

It is necessary to state on the CoA if the ammunition used for testing purposes (e.g., test fires, cycling cartridges through action, etc.) was submitted, obtained from laboratory stock or a combination.

It is necessary to specify the number of bullets and cartridge cases being returned when a bullet or cartridge case intended for return could not be recovered.

It is necessary to state on the CoA in which container the test fires/tests are being returned.

13.3.1 Submitted evidence ammunition:

Five of the *Item 6 cartridges* were used for test firing purposes. The resultant ammunition components are being returned in container *2* and should be maintained for possible future examinations.

13.3.2 Laboratory stock ammunition:

Three cartridges from laboratory stock ammunition were used for test firing purposes. The resultant ammunition components are being returned as *Item 5A* in container *1* and should be maintained for possible future examinations.

13.3.3 Ammunition (to be used in instance when a bullet or cartridge case intended for return as a sub-item could not be recovered**):**

Three cartridges from laboratory stock ammunition were used for test firing purposes. Three cartridge cases and two bullets are being returned as *Item 5T* in container *1* and should be maintained for possible future examinations.

Three of the *Item 6 cartridges* were used for test firing purposes. Three cartridge cases and two bullets are being returned in container *1* and should be maintained for possible future examinations.

13.3.4 Return of found test fired bullet or cartridge case

One *bullet* from previously test firing *Item 5* is being returned and will not be used for any future examinations.

13.3.5 Submitted evidence and laboratory stock ammunition:

Two cartridges from laboratory stock ammunition and *two* of the *Item 3* cartridges were used for test firing purposes. The resultant ammunition components from laboratory stock ammunition are being returned as Item 3T. These test fired ammunition components are being returned in Container *7* and should be maintained for possible future examinations.

13.4 Resubmission of Test Fired Ammunition Components

It is necessary to state on the CoA if the ammunition and/or components have been previously submitted.

13.4.1 *Two* of the *Item 1* cartridges listed above were previously used for test firing purposes and were resubmitted as ammunition components.

13.4.2 *Item 1* is the subject of a previous firearm reported dated *November 20, 2012*. When resubmitted, *Item 1* contained the *Item 1* firearm, *two* cartridges and ammunition components previously submitted and test fired in *Item 1*.

13.4.3 As submitted, *Item 1* contains the above listed *firearm, magazine and ammunition components* from two cartridges that were previously test fired in *Item 1*.

13.4.4 As submitted, *Item 1T* contains ammunition components from laboratory stock ammunition that were previously test fired in *Item 1*.

13.5 Trigger Pull

Trigger pull values will be expressed numerically.

13.5.1 The trigger pull of *Item 1* was determined to be *3 ½* pounds of force ± 1 pound of force at a 95.45% level of confidence for single-action and *14* pounds of force ± 2 $^{1}/_{2}$ pounds of force at a 95.45% level of confidence for double-action.

13.5.2 The trigger pull was determined to be *6* pounds of force ± 1 pound of force at a 95.45% level of confidence for the right firing mechanism and *2* pounds of force ± $^{1}/_{2}$ pound of force at a 95.45% level of confidence for the left firing mechanism.

13.6 Barrel/Overall Length

Barrel and overall length values will be expressed numerically. All values will be reported with the associated estimation of measurement uncertainty.

10 Gauge – 78 Caliber
12 Gauge – 73 Caliber
16 Gauge – 67 Caliber
20 Gauge – 62 Caliber
28 Gauge – 55 Caliber
410 Bore – 41 Caliber

13.6.1 Shotgun with a shortened barrel and stock:

Item 1 was examined, found to be in mechanical operating condition with the safety feature(s) functioning properly and test fired. The barrel of this shotgun has been shortened to a length of *8 ½* inches ± $^{5}/_{16}$ inch at a 95.45% level of confidence. The stock has also been shortened making the overall length *12 ½* inches ± $^{1}/_{8}$ inch at a 95.45% level of confidence. *Item 1* is a smooth bore firearm originally designed to be fired from the shoulder and is capable of firing, with a single function of the firing device, a projectile of approximately *78 Caliber* or *10 Gauge* shotshells containing various pellet loads.

13.6.2 Shotgun with a shortened barrel:

Item 1 was examined, found to be in mechanical operating condition with the safety feature(s) functioning properly and test fired. The barrel of this shotgun has been shortened to a length of *8 ½* inches ± $^{5}/_{16}$ inch at a 95.45% level of confidence, making the overall length *13 inches* ± $^{1}/_{8}$ inch at a 95.45% level of confidence. *Item 1* is a smooth bore firearm designed to be fired from the shoulder and is capable of firing, with a single function of the firing device, a projectile of approximately *55 Caliber* or *28 Gauge* shotshells containing various pellet loads.

13.6.3 Rifle with a shortened barrel/stock:

Item 1 was examined, found to be in mechanical operating condition with the safety feature(s) functioning properly and test fired. The barrel of this rifle has been shortened to a length of *8 ½* inches ± $^{5}/_{16}$ inch at a 95.45% level of confidence. The stock has also been shortened making the overall length *12 ½* inches ± $^{1}/_{8}$ inch at a 95.45% level of confidence. *Item 1* is a rifled firearm originally designed to be fired from the shoulder and is capable of firing, with a single function of the firing device, a projectile of approximately *22* caliber.

13.7 Non-Functioning Firearm/Instrument

13.7.1 *Item 1* was examined and found not to be in mechanical operating condition due to a *missing firing pin*. Using replacement parts from the laboratory reference collection, *Item 1* was test fired with the *submitted magazine*.

13.7.2 *Item 1* was examined and found not to be in mechanical operating condition due to *corrosion*. After *cleaning and oiling*, *Item 1* was test fired with the *submitted magazine*.

13.7.3 *Item 1* was examined and found not to be in mechanical operating condition. Attempts to repair *Item 1* were unsuccessful; therefore, it was not test fired.

13.7.4 *Item 1* is not designed, nor can it be readily converted, to expel a projectile by the action of an explosion of a combustible material.

13.7.5 Examination of *Item 1* revealed it was not in mechanical operating condition due to a *missing firing pin*. Using replacement parts from the laboratory reference collection *Item 1* was test fired with the *submitted magazine*.

13.8 Magazine/Firearm Capacity

13.8.1 The capacity of the *Item 1* magazine was determined to be *ten cartridges.*

13.8.2 When fully loaded, the *Item 1* firearm is capable of containing *twelve cartridges*.

13.9 Firearm Parts

Item 1 is consistent in design and all discernible physical characteristics with a magazine *from a U.S. Government Model 1911/1911 A1 semiautomatic pistol or one of the numerous commercial variations chambered to fire the 45 Auto cartridge*.

13.10 Cartridges/Shotshells

13.10.1 No examinations were conducted on the *Item 1* cartridges.

13.10.2 Type for use:

13.10.2.1 *Item 1* was examined and found to be the type designed for use with *Item 2*.

13.10.2.2 *Item 1* was examined and consists of *five Remington and six Winchester 38 Special cartridges*, which are the type for use with *Item 2*.

13.10.2.3 Examination revealed that the *Item 4* cartridges, *two Winchester* and *two Tulammo 9mm Luger* cartridges, are a type for use with the *Item 4 pistol*.

13.10.3 Cycling marks:

13.10.3.1 *Item 1* was microscopically examined and identified, based on corresponding individual characteristics, as having been *loaded into (extracted from, cycled through) Item 2*.

13.10.3.2 *Item 1* was microscopically examined; however, the result of the microscopic comparison was inconclusive *due to absence or insufficient detail* of individual corresponding microscopic markings. It was not possible to identify or eliminate *Item 1* as having been cycled through *Item 1 pistol*.

13.10.4 Component comparison:

13.10.4.1 *Item 1* consists of *ten Remington 9mm Luger* cartridges. One of these cartridges was disassembled for examination purposes. The bullet and cartridge case components are similar in design to the *Item 2 bullet* and *Item 3 cartridge case*.

13.10.5 Cartridge examination:

13.10.5.1 *Item 1* was disassembled for examination purposes and was found to contain a cartridge case, bullet, primer and propellant component. *The resultant primed cartridge case was test fired*.

13.10.5.2 *Item 2* contains *thirty-one 40 Smith & Wesson* cartridges. *Item 3* contains *ten Federal 7.62 x 39mm cartridges, fifteen Speer 9mm Luger* cartridges and three *40 Smith & Wesson* cartridges. One of each type of cartridge was disassembled for examination purposes. Each of the disassembled cartridges was found to contain a cartridge case, bullet, primer, and propellant component.

13.11 Fired Ammunition Components

It is the discretion of the examiner to use the term “examined microscopically” or “compared microscopically” and “fired in”, “fired with” or “fired from”.

Reporting the weight of a bullet is outside the scope of testing and the below statement shall be included on the CoA if a quantitative value is reported.

- The quantitative result listed for *Item 1* is outside the scope of the Virginia Department of Forensic Science’s accreditation.

13.11.1 General Rifling Characteristic (GRC) results/List of Possible Firearms

13.11.1.1 A list of possible firearms that could have fired *Item 1* could not be provided.

13.11.1.2 Firearms that produce general rifling class characteristics like those present on *Item 1* include, but are not limited to, *revolvers*, chambered to fire *357 Magnum and/or 38 Special cartridges*, with the brand names listed below.

- *S&W, Taurus and Ruger*

This bullet exhibits markings that may be suitable for identification with the firearm from which it was fired.

13.11.1.3 *Item 5*, *a 9mm Luger cartridge case*, exhibits markings that may be suitable for identification with the firearm in which it was fired. Firearms that produce class characteristics like those present on Item 5 include, but are not limited to, *pistols* chambered to fire *9mm Luger* cartridges with the brand names listed below.

- *Ruger, Smith & Wesson and Glock*

13.11.1.4 Firearms that produce general class characteristics like those present on the *Item 8* cartridge case(s) and the *Item 3* bullet(s) include, but are not limited to, *pistols* chambered to fire *9mm Luger* cartridges with the brand names listed below. The bullet material and caliber of *Item 3* is consistent with bullets commercially loaded into cartridge cases similar to *Item 8*.

- *Ruger, Smith & Wesson and Glock* chambered to fire *9mm Luger* cartridges.

13.11.2 Microscopic Examination of Bullets/Cartridge Cases

13.11.2.1 Suitable for comparison

13.11.2.1.1 *Item 1* exhibits microscopic markings that may be suitable for identification with the firearm from which it was fired.

13.11.2.1.2 *Item 1*, a caliber *9mm Luger full metal jacketed* bullet, was fired from a firearm having a barrel rifled with *six* lands and grooves inclined to the *right* and exhibits microscopic markings that may be suitable for identification with the firearm from which it was fired.

13.11.2.1.3 *Item 1,* a caliber *38 class* bullet consistent in design with bullets commonly loaded in *9mm Luger* cartridges, was fired from a firearm having a barrel rifled with *six* lands and grooves inclined to the *right* and exhibits microscopic markings that may be suitable for identification with the firearm from which it was fired.

13.11.2.2 Unsuitable for comparison

13.11.2.2.1 *Item 1* was microscopically examined, and no marks suitable for microscopic comparison were observed.

13.11.2.2.2 *Item 1, piece of plastic,* was microscopically examined and cannot be identified as a fired ammunition component.

13.11.2.2.3 The *Item 2, lead fragment,* was microscopically examined and determined to be unsuitable for identification with any firearm due to the lack of microscopic markings for comparison.

13.11.2.2.4 Due to the lack of microscopic markings for comparison, the *Item 4 cartridge case* is not suitable for identification with any firearm.

13.11.2.2.5 Due to damage and the lack of microscopic markings for comparison, the *Item 5 bullet* is not suitable for identification with any firearm.

13.11.2.3 Microscopic Comparison Conclusions

13.11.2.3.1 Identification

13.11.2.3.1.1 *Item 1* was examined microscopically and identified as having been fired from *Item 2* based on corresponding class and individual characteristics.

13.11.2.3.1.2 *Item 1, a 9mm Luger bullet consistent in design with a Winchester Silver Tip hollow-point bullet*, was examined microscopically and identified as having been fired from *Item 2* based on corresponding class and individual characteristics.

13.11.2.3.2 Elimination

13.11.2.3.2.1 *Item 1* was microscopically examined and eliminated as having been fired in *Item 2* due to differences in class characteristics.

13.11.2.3.2.2 *Item 3* and *Item 4,* each a bullet, were microscopically examined and eliminated as having been fired from the same firearm due to differences in class characteristics.

13.11.2.3.2.3 *Item 6* was microscopically examined and eliminated as having been fired in *Item 2* due to differences in class and individual characteristics.

13.11.2.3.2.4 *Item 7* and *Item 9,* each a bullet, were microscopically examined and eliminated as having been fired from the same firearm due to differences in class and individual characteristics.

13.11.2.3.3 Inconclusive

13.11.2.3.3.1 The *Item 2 bullet* exhibits the same general rifling class characteristics as those produced by the *Item 3 firearm*; however the result of the microscopic comparison was inconclusive due to the lack of sufficient suitable corresponding microscopic markings. It was not possible to identify or eliminate the *Item 2* bullet as having been fired from *Item 3*.

13.11.2.3.3.2 The *Item 2 bullet* exhibits the same general rifling class characteristics as those produced by the *Item 3 firearm*; however the result of the microscopic comparison was inconclusive due to the *absence, insufficient detail or lack of reproducibility* of individual corresponding microscopic markings. It was not possible to identify or eliminate the *Item 2* bullet as having been fired from *Item 3.*

13.11.2.3.3.3 *Item 5* and *Item 6,* each a *bullet*, were microscopically examined and exhibit the same general rifling class characteristics; however the result of the microscopic comparison was inconclusive due to *absence or insufficient detail* of individual corresponding microscopic markings. It was not possible to identify or eliminate the bullets as having been fired in the same firearm.

13.11.2.3.3.4 The *Item 2* bullet exhibits the same/similar class characteristics as those produced by the *Item 3* firearm. The *Item 2* bullet was microscopically compared to test fires from the *Item 3* firearm and the result was inconclusive. There is some agreement of individual characteristics; however, it is insufficient for an identification.

13.11.2.3.3.5 The *Item 2* bullet exhibits the same general rifling class characteristics as those produced by the *Item 3* firearm; however, the result of the microscopic comparison was inconclusive due to the lack of agreement or disagreement of individual characteristics.

13.11.2.3.3.6 The *Item 5* and *6* bullets exhibit the same/similar class characteristics. *Items 5* and *6* were microscopically compared and the result was inconclusive. There is some disagreement of individual characteristics; however, it is insufficient for an elimination.

13.11.3 Shotshell Projectile Components

13.11.3.1 *Item 10* contains *fifty (50) lead pellets*. *Ten* of these were examined and determined to be consistent in design, size and weight with *Number 3 lead* shot pellets.

13.11.3.2 The *Item 11* wad(s) are consistent in design, shape, color and material *with Remington Power Piston combination wad*.

13.11.3.3 The *Item 6* shotshell, pellets and wads are consistent in design, size, shape and color with the components contained in the *Item 7* shotshell.

13.11.3.4 The markings on the hull of *Item 8* indicate it was originally loaded with number *6 lead* shot pellets and a wad having the same design, size, shape and color as those contained in *Item 9*.

13.11.4 Multiple Case Associations/ Cross-Comparisons

13.11.4.1 As requested, *Item 1* was microscopically compared to *Item 2* submitted under FS Lab # *12-12345 (Richmond PD Case# 12-56789)*.

- The comparison results, as outlined in the previous section, should be inserted here.

13.11.4.2 The *three* cartridge cases submitted as Item *1, 3 and 4* under FS Lab *#12-12345* were previously reported as having been fired in the same firearm. The below listed items were microscopically examined, compared to *Item 1* and identified as having been fired in the same firearm based on corresponding class and individual characteristics.

The *Item 6* cartridge case submitted by your agency case # *201201234*, FLS Lab # *12-99999*

The *Item 54* cartridge case submitted by *Hampton PD* case # *201201234*, FLS Lab # *12-53831*

13.12 NIBIN

The below Entry and Association are to be used in conjunction as applicable.

13.12.1 Entry

13.12.1.1 A cartridge case from test firing *Item 1* was entered into the NIBIN system and a search was conducted.

13.12.1.2 The *Item 2* cartridge case was entered into the NIBIN system and a search was conducted.

13.12.1.3 One of the *Item 3* cartridge cases was entered into the NIBIN system and a search was conducted.

13.12.1.4 A NIBIN search was not conducted on *Item 4* because *revolver* type cartridge cases are not entered in the database.

13.12.1.5 A NIBIN search was not conducted on *Item 5* because bullets are not entered in the database.

13.12.1.6 A cartridge case from test firing the *Item 6* firearm was not entered into NIBIN due to the lack of sufficient suitable markings.

13.12.2 Associations

13.12.2.1 No associations were made at this time; however, searches will be conducted periodically as new images are entered into the database.

13.12.2.2 Subsequent microscopic examinations were conducted, and the *Item 9* cartridge case submitted under *FS Lab #12-12345* was identified as having been fired in the *Item 10* firearm based on corresponding class and individual characteristics.

13.12.2.3 Subsequent microscopic examinations were conducted, and the *Item 10* cartridge case was identified, based on corresponding class and individual characteristics, as having been fired in the same firearm as the *Item 12* cartridge cases submitted under *FS Lab # 12-12345*.

13.12.2.4 A potential association exists between the *Item 1* submitted cartridge case and the *Item 7* cartridge case submitted under FS Lab # *15-xxxx* (*Hampton PD #14-zzzz*). Please contact the examiner listed below for assistance in facilitating the resubmission of evidence if confirmation of this potential association is necessary.

13.12.2.5 A potential association exists between the Item 1 submitted cartridge case and the Item 7 cartridge case submitted under FS Lab # 15-xxxx (Hampton PD #14-zzzz). Please contact the examiner listed below for assistance in facilitating the resubmission of evidence if confirmation of this potential association is necessary.

13.12.2.6 In addition, the *Item 13* cartridge case from FS *Lab#11-5383* was previously reported as having been fired in the same firearm as the *Item 20* cartridge cases submitted under *FS Lab #12-12345 (Richmond PS 12-12345)*

13.13 Toolmarks

When describing toolmark(s) produced or present on an object, at the discretion of the examiner, the word "toolmark(s)" may be written consistently within a CoA as "toolmark(s)" or "tool mark(s)." When describing a toolmark examination, the word will be written as one word "toolmark(s)". Measurements reported will be expressed numerically.

13.13.1 Unsuitable

Toolmarks present on *Item 6* were microscopically examined and are not suitable for comparison due to the lack of sufficient markings.

13.13.2 Identifying Class Characteristics of a Toolmark

Item 1 was microscopically examined and exhibits toolmarks consistent with having been produced by a *prying* type tool with a *flat-bladed tip, approximately 1 inch in width*. These toolmarks exhibit *limited* markings that may be suitable for identification with the tool by which they were produced.

13.13.3 Microscopic Comparison Conclusion

13.13.3.1 Identification

13.13.3.1.1 Toolmarks present on *Item 3* were microscopically examined and identified as having been produced by *Item 8* based on corresponding class and individual characteristics.

13.13.3.1.2 Toolmarks present on *Item 5 and 9* were microscopically examined, compared and identified as having been produced by the same tool based on corresponding class and individual characteristics.

13.13.3.2 Elimination

13.13.3.2.1 Toolmarks present on *Item 8* were microscopically examined, compared and eliminated as having been produced by the *Item 10* tool due to differences in class characteristics.

13.13.3.2.2 Toolmarks present on *Items 53 and 83* were microscopically examined, compared and eliminated as having been produced by the same tool due to differences in class and individual characteristics.

13.13.3.3 Inconclusive

13.13.3.3.1 Toolmarks present on *Item 4* were microscopically examined and exhibit similar class characteristics as those produced by the *Item 9* tool; however, the result of the comparison is inconclusive due to a lack of sufficient corresponding microscopic markings. It was not possible to identify or eliminate the toolmark on *Item 4* as having been produced by the *Item 9 tool*.

13.13.3.3.2 Toolmarks present on *Item 4 and 9* were microscopically examined, compared and exhibit similar general class characteristics; however, the result of the comparison is inconclusive. The toolmarks present on *Items 4 and 9* could not be identified or eliminated as having been produced by the same tool due to the lack of sufficient corresponding microscopic markings.

13.13.4 Disposition of tests/casts

It is necessary to state on the CoA in which container the tests/casts are being returned.

13.13.4.1 *Five tests* produced using *Item 6* are being returned as *Item 6A* in container *2* and should be maintained for possible future examinations.

13.13.4.2 *Two casts* made of the toolmark on *Item 9* are being returned as *Item 9A* in container *3* and should be maintained for possible future examinations.

13.14 Mechanical Testing

Numerical values shall be reported as approximations.

13.14.1 The *Item 2* firearm was examined, found to be in mechanical operating condition with the safety features functioning properly, and test fired with the *Item 3* magazine.

A series of tests were conducted using *Item 2* loaded with a primed cartridge case. *Item 2* did not discharge during these tests. The tests included *hitting various locations of the firearm with a hammer*.

- The test should be described on the CoA as they are in the notes to ensure a clear understanding by the requestor of what the testing entailed.

13.14.2 *Item 4* is capable of firing without a pull of the trigger if *it receives a blow to the hammer*.

- It is necessary to state in the CoA the specific action that would cause the weapon to fire without pulling the trigger.

13.14.3 *Item 6* was examined and found to be in mechanical operating condition. The manual safety was found to function properly during normal handling of the firearm.

Tests conducted with *Item 6*, with the manual safety in the off position, revealed it could fire a *shotshell in either barrel* if dropped from a height of approximately *12* inches.

During the testing procedure, the *left* firing mechanism became inoperable, which prevented further cocking of the left firing mechanism; therefore, further drop testing using the *left* firing mechanism could not be conducted.

13.15 Distance Determination Examinations

13.15.1 Ammunition not available

Appropriate ammunition was not submitted for use in an examination; therefore a valid muzzle-to-target distance determination is not possible. No examinations were conducted on the *Item 4 shirt*.

13.15.2 Production of Test Patterns

13.15.2.1 Using the *Item 12* pistol, *Item 12A* cartridges, laboratory stock material and sections of the *Item 23* clothing, test patterns were produced at approximate muzzle-to-target distances of *contact*, *6* inches, *12* inches and *18* inches.

13.15.2.2 Using the *Item 13* pistol, *Item 13A* cartridges, laboratory stock ammunition similar to (or "like") the *Item 13A* cartridges, laboratory stock material and sections of the *Item 12* clothing, test patterns were produced at approximate muzzle-to-target distances of *contact*, *6* inches, *12* inches and *18* inches.

13.15.3 Disposition of Test Patterns/Materials Produced

13.15.3.1 *Three* pieces of laboratory stock material and *four* sections of the *Item 6* clothing were used for the production of test patterns. The resultant test patterns produced using laboratory stock materials are being returned as *Item 1A* in container *6*. The resultant test patterns using *Item 6* are being returned with the evidence in container *2* and should be maintained for possible future examinations.

13.15.3.2 *Powder overlays and chemically processed materials* produced from *Item 4* are being returned as *Item 4A* in container *6* and should be maintained for possible future examinations.

13.15.3.3 Materials produced as a result of chemically processing *Item 3* are being returned as *Item 3A* in container *1* and should be maintained for possible future examinations.

13.15.4 Patterns produced for the Medical Examiner

Five test patterns were produced using the *Item 3 pistol*, *Item 4* cartridges, laboratory stock ammunition like the *Item 4* cartridges and laboratory stock material at approximate muzzle-to-target distances of *contact*, *6* inches, *12* inches and *18* inches. These test patterns are being returned as *Item 3A* in container *6* and should be maintained for possible future examinations. *Copies were provided to the Office of the Chief Medical Examiner.*

13.15.5 Examination for gunshot residue/pellet pattern

13.15.5.1 Examination of the *Item 7* clothing revealed a hole in the *right shoulder* area. The area around this hole was microscopically examined and chemically processed for the presence of gunshot residues.

13.15.5.2 Examination of the *Item 4 shirt* revealed a hole in *the upper / front right shoulder area*. The area around this hole was microscopically examined, viewed using digital infrared photography and chemically processed for the presence of gunpowder and lead residues (gunshot residues).

13.15.5.3 Examination of the *Item 8* clothing revealed a hole in the *left sleeve* area. The area around this hole was microscopically examined and chemically processed for the presence of gunshot residues, and a pattern of residues was found.

13.15.5.4 Examination of the *Item 9* clothing revealed a hole in the *front middle* area. The area around this hole was microscopically examined and chemically processed for the presence of gunshot residues, and no pattern of residues was found.

13.15.5.5 Examination of the *Item 5* clothing revealed the presence of a shot (or "pellet") pattern in the *middle front* area which was chemically processed.

13.15.6 No Holes/No Residue Pattern

13.15.6.1 Examination of *Item 10* revealed no holes which could be associated with a bullet passing through the material.

13.15.6.2 The *back right shoulder* area of *Item 13* was microscopically examined and chemically processed for the presence of gunshot residues, and no such residues were found.

13.15.6.3 The *back right shoulder* area of *Item 13* was microscopically examined and chemically processed for the presence of gunshot residues. A pattern of residues was detected which is indicative of a *muzzle* of a firearm having been in close proximity to the area examined at the time of firing.

13.15.6.4 The *back right shoulder* area of *Item 13* was microscopically examined and chemically processed for the presence of gunshot residues. Gunpowder / lead residues were detected; however, the origin of those residues could not be determined. No further examinations were conducted.

13.15.6.5 The area around the hole in the *back center* of *Item 4* was microscopically examined and chemically processed for the presence of gunshot residues. Although gunpowder/lead residues were detected, a defined pattern of residues was not developed; therefore it was not possible to determine an approximate muzzle-to-item distance determination.

13.15.6.6 A residue pattern found on *Item 3* is consistent, based on pattern size and density, with having been produced at a distance greater than approximately contact. Due to the inconsistent pattern size and density, and lack of sufficient available ammunition, it was not possible to determine a more definitive muzzle-to-garment distance.

13.15.7 Contact/Near Contact

The hole in the back of the *Item 6 shirt* was examined and chemically processed; residues indicative of lead and the physical characteristics of this hole indicate this area of *Item 6* was at or near contact with the muzzle of the *Item 2 pistol* at the time of firing.

13.15.8 Range

13.15.8.1 The residue pattern found around the hole in the *right shoulder* area of *Item 13* is consistent in pattern size and density with having been produced at an approximate distance between *6* inches and *18* inches.

13.15.8.2 The shot pellet pattern found in the *lower right front quadrant* area of *Item 7* is consistent in size and density with having been produced at an approximate distance between *18* inches and *24* inches from the muzzle of the *Item 1* firearm.

13.15.8.3 The gunshot residues found around the hole in the *front of the Item 6 jacket* are consistent in size and density with the muzzle of the *Item 2 pistol* having been greater than approximately *3* inches and less than approximately *24* inches from this area at the time of firing.

13.15.9 Maximum Distance / Drop-off

13.15.9.1 Barring the presence of an intervening object, the maximum distance at which a pattern of residues is deposited from the muzzle of the *Item 6* firearm was determined to be approximately *6 to 12 inches*.

13.15.9.2 The *back right shoulder* area of *Item 13* was microscopically examined and chemically processed for the presence of gunshot residues. No such residues were found which is indicative of the muzzle of the *Item 6* firearm having been greater than approximately *12 inches* from this area of *Item 13* at the time of firing, barring the presence of an intervening object.

13.15.10 Bullet wipe

13.15.10.1 The following shall be used when performing the Sodium Rhodizonate Test, without the HCl step, obtaining a pink color.

The area around the hole in the *left shoulder area of Item 3* was examined microscopically and processed chemically. The result of the chemical test indicates, but does not confirm, the presence of lead residue, which could have come from the passage of a bullet.

13.15.10.2 The following shall be used when performing the Sodium Rhodizonate Test, with the HCl step, obtaining a blue-violet color.

The area around the hole in the *left shoulder area of Item 3* was examined microscopically and processed chemically. The result of the chemical test indicates the presence of lead residue, which could have come from the passage of a bullet.

13.15.10.3 The area around the hole in the *middle back area of Item 3* was examined microscopically and processed chemically. The result of the chemical test does not indicate the presence of lead residue; therefore, it is not possible to associate the hole with the passage of a *projectile*.

13.15.11 Bullet impact

13.15.11.1 The following shall be used when performing the Sodium Rhodizonate Test, without the HCl step, obtaining a pink color.

Item 3 was examined microscopically and processed chemically. The result of the chemical test indicates, but does not confirm, the presence of lead residue, *which could have come from a bullet impact*, in the *upper right corner of the panel*.

13.15.11.2 The following shall be used when performing the Sodium Rhodizonate Test, with the HCl step, obtaining a blue-violet color.

Item 3 was examined microscopically and processed chemically. The result of the chemical test indicates the presence of lead residue, *which could have come from a bullet impact*, in the *upper right corner of the panel*.

13.15.11.3 *Item 3* was examined microscopically and processed chemically. The result of the chemical test does not indicate the presence of lead; therefore, it is not possible to associate the damage observed with a possible bullet impact.

13.15.12 Condition of clothing

13.15.12.1 *Item 6* was visually examined and determined to be unsuitable for *distance determination* examination due to *excessive debris and damage to the material*.

13.15.12.2 *Item 7* was visually examined and determined to be unsuitable for *distance determination* due to the presence of *excessive biological material*.

13.15.12.3 Examination of *Items 40, 41 and 42* revealed them to be in a decomposing state due to biological fluids and insects, which hinder visual and chemical evaluation of these items.

13.15.13 Underlying layers

13.15.13.1 The location of the hole observed in the *Item 5 shirt* corresponds to the location of the hole observed in the *Item 4 jacket*. Item 4 was determined to be the outermost layer of clothing; therefore, *Item 5* was not microscopically examined or processed chemically for the presence of gunshot residues.

13.15.13.2 Examination of the *Item 20 jumpsuit* revealed one hole in the *upper left panel area*. The physical characteristics of this hole are indicative of the *Item 1 rifle* having been in contact with the area of the *Item 20 jumpsuit* at the time of firing. Corresponding holes were found in the Item *21 through 25 shirts*.

13.15.14 Patterns/Materials/Ammunition produced during gunshot residue and/or distance determination

The following should be used to describe the item/sub-item on the RFLE and the CoA.

13.15.14.1 Patterns produced from *Item 3* (Item created in the *Western* Laboratory)

13.15.14.2 Materials produced from *Item 3* (Item created in *Eastern* Laboratory)

13.15.14.3 Test patterns produced with *Item 3* (Item created in *Northern* Laboratory)

13.15.14.4 Test patterns produced for comparison to autopsy findings (Item created in *Central* Laboratory)

13.15.14.5 Test patterns produced for the OCME using *Item 3* (Item created in *Western* Laboratory)

13.15.14.6 Ammunition components from test pattern production using *Item 3* (Item created in *Eastern* Laboratory)

13.16 Number Restoration

13.16.1 Determined without application of restoration procedure

13.16.1.1 *Item 6* was cleaned and the previously obscured serial number was determined to be *123-4567.*

13.16.1.2 The serial number on *Item 7* was determined to be *567-122345.*

13.16.1.3 As received, the serial number on *Item 1* was obscured. After cleaning, the serial number was determined to be *123-45678*.

13.16.2 Full restoration

13.16.2.1 The obliterated number on *Item 5* was polished, and the serial number was determined to be *12-24343*.

13.16.2.2 The obliterated number on *Item 6* was polished and chemically restored to reveal the serial number *23-34355*.

13.16.3 Partial restoration

13.16.3.1 The obliterated number on *Item 7* was polished and chemically restored to reveal a partial serial number of *12-34*.

13.16.3.2 The obliterated number on *Item 8* was polished and chemically restored to reveal a partial serial number *23-44*. The fifth character could be a *6 or S*.

13.16.4 Unsuccessful restoration

Attempts to restore the obliterated serial number by polishing and the application of chemical reagents on *Item 1* were unsuccessful.

13.16.4.1 Suggested wording for determination of serial number when metal plate on the frame is missing

The metal plate containing the serial number on the frame of the Item __ pistol is missing; however, characters on the slide and barrel read_____. The serial numbers present on similar firearms in the laboratory's reference collection indicate that the characters present on the slide/barrel of the Item __ firearm correspond to the serial number.

13.16.4.2 Suggested wording for determination of secondary numbers

The unaltered number on the *slide is 5383-1972*. *Literature* indicates this number corresponds with the serial number.

14 ADMINISTRATIVE NIBIN SAMPLING PLAN

14.1 Introduction

14.1.1 The Administrative NIBIN Sampling Plan (ANSP) allows for expeditious entry of cases into NIBIN and reporting of investigative leads.

14.1.2 The Section Supervisor or designee shall select cases that will be worked following this plan.

14.2 Procedures

14.2.1 This approach is for cases in which one or more cartridge cases and/or shotshell cases are submitted.

14.2.2 Submitted evidence will be examined and grouped based on similar characteristics. Documentation that clearly delineates the difference(s) in any groups will be included in the case file.

14.2.3 Grouping exhibits for NIBIN entry does not constitute identification and does not require photo/3D image documentation or verification.

14.2.4 It is not required that exhibits be included in a group, if the characteristics are unclear.

14.2.5 Document the exhibits included in each group utilizing the Cartridge Case Sampling Worksheet.

14.2.5.1 For examinations conducted utilizing 3D images captured with the Cadre scanner the following shall be done:

14.2.5.1.1 An overall image, depicting the headstamp, of the cartridge cases in the scanner tray shall be retained in the case file.

14.2.5.1.2 The assigned examiner shall utilize the Cadre Virtual Microscopy Viewer software to examine the images.

14.2.5.1.3 Only the item(s) selected to be entered into NIBIN will be transferred from the acquirer to the assigned examiner's custody, if needed.

14.2.6 At least one exhibit representing each group shall be entered and searched in NIBIN.

14.2.7 Comparative examinations intended to determine how many firearms are represented will not be performed.

14.2.8 Projectile evidence may not be examined.

14.2.9 If items are not analyzed per this procedure, examination documentation shall indicate this by a notation of "Not Analyzed" or "ANSP".

14.2.10 When the ANSP is utilized, it shall be indicated on the CoA as listed below.

14.2.10.1 Images of the *Item 1-10* cartridge cases were screened utilizing virtual microscopy software and determined to exhibit similar characteristics. The Item 1 cartridge case was entered into the NIBIN system and a search was conducted. A potential association exists between the Item 1 cartridge case and the *Item 7* cartridge case submitted under *FS Lab # 18-xxx (Richmond PD #18xxx).* Please contact the examiner listed for assistance in facilitating the submission of evidence if confirmation of any potential associations is necessary. A comparison examination was not conducted.

No examination was conducted on the *Item 11* bullet.

14.2.10.2 The *Item 1-10* cartridge cases were microscopically screened and determined to exhibit similar characteristics. The Item 1 cartridge case was entered into the NIBIN system and a search was conducted. A potential association exists between the Item 1 cartridge case and the *Item 7* cartridge case submitted under *FS Lab # 18-xxx (Richmond PD #18xxx)*. Please contact the examiner listed for assistance in facilitating the submission of evidence if confirmation of any potential associations is necessary. A comparison examination was not conducted.

No examination was conducted on the *Item 11 bullet*.

Appendix A - Abbreviations

The following is a list of the abbreviations/annotations/acronyms commonly used by examiners in the Firearm/Toolmark Section. This list has been generated to assist in the interpretation of examination documentation and is not a standardized list of required abbreviations. Abbreviations are not case specific and may include punctuation.

⊕	**Identification**
⊖	**Elimination**
_GA	**number of Gauge**
_L	**number of lands/grooves (left twist)**
_R	**number of lands/grooves (right twist)**
A	**Arcs, Automatic, Aluminum (plain)**
AMMO	**Ammunition**
AUTO	**Automatic**
B	**Brown**
BBL	**Barrel**
BCL	**coated lead (brass)**
BEB	**Brass-enclosed base**
BELM	**Barrel extension lug marks**
BF	**Breech Face**
BFI	**Breech Face Impression**
BFM	**Breech Face marks**
BPB	**Brown paper bag**
BPWP	**Brown paper wrapped package**
BR	**Brass, Breech**
BT	**Boattail**
BUL	**Bullet**
BX	**Box**
C	**Concentric circles/spirals around, Circular (flat base), Circular, Carbine, circumference**
CAL	**Caliber**
CANN	**Cannelure**
CAP	**Capacity**
CC	**Cartridge case**
CCL	**coated lead (copper)**
CHAR, CHARS	**Characteristic/Characteristics**
CHM	**Chamber Marks, chamber**
CON	**conical shaped concave recess**

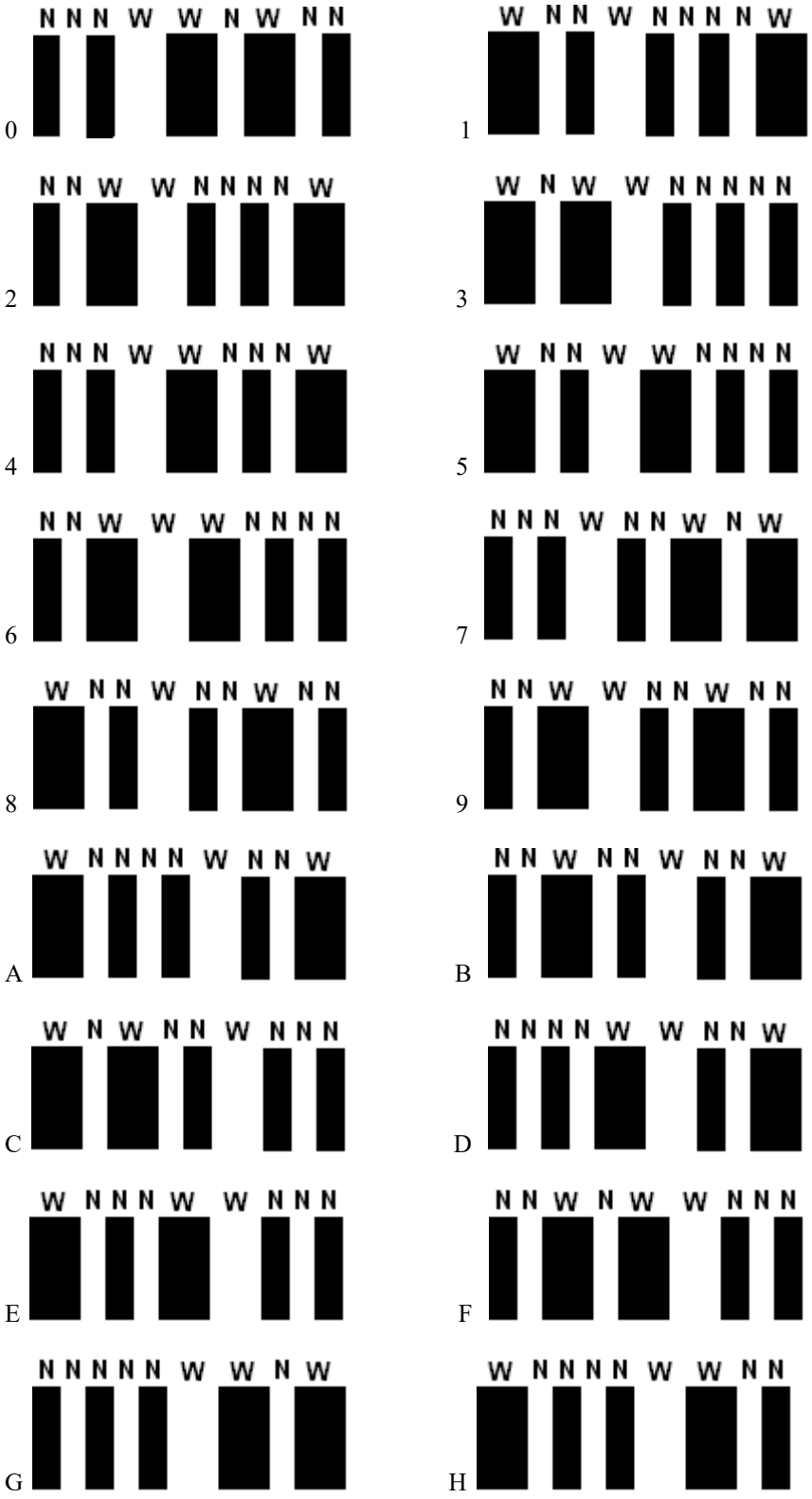
CONT, C	**Container**
CART(S)	**Cartridge(s)**
CTG'S	**Cartridge(s)**
CW	**Concealed Weapon**
CYL	**cylindrical-concave recess in base, cylinder**
D	**Diameter, Derringer, Drag mark out of firing pin impression, Double**
DA	**Double-action**
DAO	**Double-action only**
DIFF	**Difference or different**
DPA	**deep parabolic concave recess**
E, ELLIP	**elliptical (Glock/SWD)**
EA	**Each**
EJPM	**Ejector Port Marks**
EJT	**Ejector**
ELIM	**Eliminate/Eliminated**
EN, ENV	**Envelope**
ER	**Evidence Receiving**
EVID	**Evidence**
EXT	**Extractor, Exit**
FA	**Firearm**
FLT	**flat base (no recess in base)**
FMC	**Full metal case**
FMJ	**Full metal jacket, or full patch**
FNJ	**Flat-nose jacketed**
FP	**Fingerprint, Firing Pin**
FPA	**Firing Pin Aperture**
FPIN	**Firing Pin**
FPAS	**Firing Pin Aperture Shear**
FPI	**Firing Pin Impression**
FRAG	**Fragment**
FSR	**flat base with recess, step like RP**
G	**gas or air, Granular, Steel (gray color finish)**
GC	**gas check**
GD	**Gold dot**
GEA	**Groove Impression**
GIMP	**Groove Impression**

GMB	**Glock Marking/Marksman Barrel**
GR(S)	**Grain(s)**
GRC	**General rifling characteristics**
GRIP S	**Grip Safety**
GSR	**Gunshot residue**
GWD	**Groove width**
H	**Hemispherical**
HEM	**Hemispherical**
HP	**Hollow Point, hollow point (non-jacketed bullet)**
HSHP , HS	**Hydra-Shok hollow point**
I	**Independence, semiautomatic, Incendiary, Item**
I/S	**Inside**
ID	**Inside Diameter, Identification**
IDENT	**Identification, Identified**
IMP	**Impression**
INC	**Inconclusive**
IND	**Indicator, Individual**
J	**jacket/jacketed**
JS	**jacketed; base solid**
JSP	**jacketed/Semi-jacketed soft point**
K	**Knurled, Kidney Shaped, Black,**
L	**Left, Long, Lever action, Left-Slant (Rectangular, Chisel), lead**
L/S	**Left side**
LAG	**Land and groove**
LB	**Lock box**
LCI	**Loaded Chamber Indicator**
LEA	**Land Impression**
LIMP	**Land Impression**
LR	**Long Rifle, Left Side Rail**
LRN	**Lead round nose**
LSR	**left side of receiver**
LSS	**left side of slide**
LSW	**lead (swaged)**
L-SWC	**Lead semi-wadcutter**
LWD	**Land width**
M	**Manilla**

MAG	**Magnum, Magazine**
MEN	**Manila envelope**
MFR	**Manufacturer**
MLM	**Magazine Lip Marks**
MOD	**Model, Modification**
MPA	**medium parabolic-shaped concave recess**
NEG	**Negative**
O	**Other, irregular**
OAL	**Overall length**
OB	**lead, solid, jacketed: base open**
P	**pump (Slide Action), pistol (handgun), parallel (any direction), all plastic exterior, polygonal, Parabellum**
PAR	**Parallel (any direction)**
PARA	**Parabellum (example: 9mmP)**
PB	**Paper bag**
PAB	**Paper bag**
PKG	**Package**
PLB	**Plastic bag**
POLY	**Polygonal**
PT	**Pointed (conical or spitzer)**
R	**Right, Rectangular, Rifle, Revolver**
RECT	**Rectangular**
R/S	**Right side**
REF	**Reference**
REP	**Representative**
RESP	**Respectively**
RF	**Rimfire**
RFD	**Remote Firing Device**
RN	**Round Nosed**
ROR	**rear of receiver**
RSR	**right side of receiver**
RSS	**right side of slide**
RX	**Reaction**
S	**Smooth (no traces), smooth, Short, Sealed, Single shot, Shotgun, Semi-Circular, Steel (copper colored finish)**
S, C	**standard (conventional) lands and grooves**
S/STEEL	**Stainless Steel**

SA	**Single action**
SJ	**Semi-jacket**
SER NO	**Serial number**
SN	**Serial number**
SOL	**solid**
SP	**Soft Point**
SPA	**shallow parabolic recess**
SPL	**Special**
ST	**Silvertip, steel, steel jacketed**
STL	**steel jacketed (plated or unplated)**
SUB	**Submission, submitted**
SWBX	**Sealed white box**
SWC	**Semi-wadcutter**
TC	**Truncated cone**
TE	**Trace Evidence**
TF	**Test fire**
TG	**trigger guard**
T/Guard	**trigger guard**
TM	**Toolmark**
TMJ	**Total metal jacket**
TSJ	**Total synthetic jacket**
U	**U-Shaped**
U/S	**Underside**
UK	**Unknown**
USR	**underside frame, front of trigger**
VIS	**Visible**
W	**White, Wedge**
WC	**wadcutter**
WKST	**Worksheet**
WPWP	**White paper wrapped package**
X	**Cross-hatched**
X-COMP	**Cross compare**
Y	**Yellow**
YEN	**Yellow envelope**

Appendix B - CODE 39 Barcode



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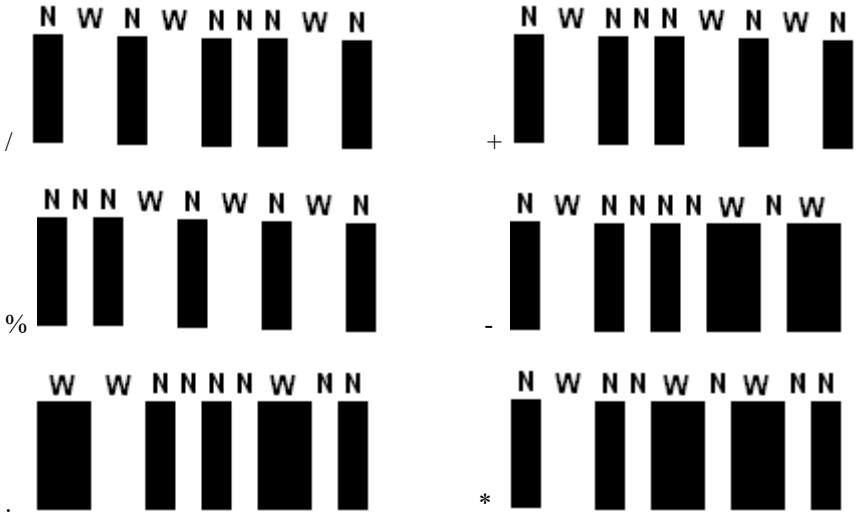
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Appendix C – Reagents

Distance Determination

Sodium Rhodizonate Saturated Solution

- Prepared fresh for each usage
- Add Sodium Rhodizonate to reverse osmosis (R/O) or deionized (DI) water until the solution is a dark orange/tea color

5% Hydrochloric Acid Solution

- Add 5 milliliters of concentrated Hydrochloric Acid to 95 milliliters of R/O or DI water

Buffer Solution

- Dissolve 1.9 grams of Sodium Bitartrate and 1.5 grams of Tartaric Acid in 100 milliliters of R/O or DI water

15% Acetic Acid Solution

- Add 150 milliliters of Glacial Acetic Acid to 850 milliliters of R/O or DI water

5% Acetic Acid Solution

- Add 50 milliliters of Glacial Acetic Acid to 950 milliliters of R/O or DI water.

Dithiooxamide (DTO) Solution

- Prepare fresh for each usage
- Dissolve 0.2 grams of DTO in 100 milliliters of ethanol

Ammonium Solution

- Combine 20 milliliters of ammonium hydroxide with 50 milliliters of R/O or DI water

Sensitized Blank for Modified Griess Test

- Solution 1: Add 0.75 grams of Sulfanilic Acid to 150 milliliters of R/O or DI water and mix
- Solution 2: Add 0.42 grams of Alpha Naphthol to 150 milliliters of methanol and mix
- Mix equal volumes of solution 1 and 2 in a clean photo tray.
- Saturate pieces of filter paper or desensitized photo paper in this solution and air dry
- Store dried sensitized blanks in an airtight plastic container

Nitrite Test Strips or Cotton Swabs

- Dissolve 0.6 grams of Sodium Nitrite in 100 milliliters of R/O or DI water
- Saturate pieces of filter paper or cotton swabs in this mixture
- Store dried strips or swabs in an airtight plastic container

Diphenylamine

- Dissolve 0.3 grams of diphenylamine in 20 milliliters of concentrated sulfuric acid
- Pour mixture into 10 milliliters of glacial acetic acid

Desensitized Photo Paper

- Purchased photo paper should be fixed according to directions provided by manufacturer to remove silver salts from the emulsion side of paper
- The emulsion side of this paper is used for all testing

Serial Number Restoration

Fry's Reagent

- To 90 grams of Cupric Chloride
- Add 100 milliliters of R/O or DI water
- Add 120 milliliters of Hydrochloric Acid

Turner's Reagent

- To 2.5 grams of Cupric Chloride
- Add 40 milliliters of Hydrochloric Acid
- Add 25 milliliters of Ethyl Alcohol
- Add 30 milliliters of R/O or DI water

Davis's Reagent

- To 5 grams of Cupric Chloride
- Add 50 milliliters of R/O or DI water
- Add 50 milliliters of Hydrochloric Acid

25% Nitric Acid Solution

- To 75 milliliters of R/O or DI water
- Add 25 milliliters of Nitric Acid

Acidic Ferric Chloride Solution

- To 25 grams of Ferric Chloride
- Add 100 milliliters of R/O or DI water
- Add 25 milliliters of Hydrochloric Acid

Ferric Chloride Solution

- To 25 grams of Ferric Chloride
- Add 100 milliliters of R/O or DI water

10% Sodium Hydroxide Solution

- To 100 milliliters of R/O or DI water
- Slowly add 10 grams of Sodium Hydroxide

Hydrofluoric Acid Solution

WARNING!
Concentrated Hydrofluoric Acid is a "particularly hazardous substance"
and must be handled using appropriate PPE (laboratory coat, thick "rubber" gloves, and face shield).
Calcium gluconate gel must be available in the work area.
Hydrofluoric Acid, either concentrated or the working solution, may not be handled when working alone.

- To two (2) parts of Concentrated Hydrofluoric Acid
- Add one (1) part of Nitric Acid
- Add three (3) parts of Glycerol

Aqua Regia Solution

- To 75 milliliters of Hydrochloric Acid
- Add 25 milliliters of Nitric Acid
- Do not store for future use

Cupric Chloride in Nitric Acid Solution

- To five (5) grams of Cupric Chloride
- Add 100 milliliters of R/O or DI water
- Add three (3) milliliters of Nitric Acid

Zinc Alloy Etching Solutions

- Solution 1 - To two (2) milliliters of Nitric Acid, add 98 milliliters of Phosphoric Acid
- Solution 2 - To 95 milliliters of R/O or DI water, add five (5) milliliters of Nitric Acid

Griffin's Reagent

- To 30 grams of Cupric Chloride
- Add 30 milliliters of R/O or DI water
- Add 30 milliliters of Hydrochloric Acid
- Add 120 milliliters of Methanol