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01 QUALITY ASSURANCE

FTM-01-01 FIREARMS AND TOOLMARKS OVERVIEW

1 Scope
To establish standards for analysis and reporting results for firearms, fired ammunition components, toolmarks, distance determination, and other items examined by Firearm and Toolmark examiners in the DPS Crime Laboratory Service.

2 Routine Examinations / Services
A. A Forensic Firearm/Toolmarks request involves the examination of any fired evidence (bullet, cartridge case, shot shell, etc.) and/or any gun routine that exceeds the basic determination of its capability to discharge (such as a functionality exam, trigger pull measurement, examination of the safeties, etc.).

B. Distance Determination, Serial Number Restoration, Ejection Pattern Testing, and Toolmark to Tool comparisons are also included as Forensic Firearms/Toolmarks requests.

3 Work Authorization and Examiner Assessment
A. The Firearms and Toolmarks examinations which require approval by the Laboratory Director prior to supervised work by an examiner are:
   1. Firearms
   2. Toolmarks
   3. Serial Number Restoration
   4. Distance Determination

B. Examiner Assessment
   1. At least one proficiency test, interlaboratory comparison, or intralaboratory comparison in the Firearms and Toolmarks discipline must be successfully completed by each examiner per year.
   2. At least one proficiency test, interlaboratory comparison, or intralaboratory comparison in each relevant testing procedure must be successfully completed by each examiner per accreditation cycle.
FTM-01-02 EQUIPMENT

1 Scope
To establish quality assurance guidelines for reagents, tests, and equipment in the Firearms and Toolmarks discipline.

2 Related Documents
CLS Manual:
- Externally Provided Products and Services, Selection and Purchasing section
- Laboratory Equipment, Significant Equipment section
- Laboratory Equipment, Laboratory-Prepared Reagents section
- Standards, Reference Materials/Collections, Databases, and Controls, Certified Reference Materials and Measurement Standards section

3 Equipment and Materials
A. A Reagent Log will be maintained for any reagent kept after its first use or reliability testing (QC check).
B. The following information will be documented in the Reagent Log:
   1. Identity of the reagent/solution
   2. Date of preparation or lot number
   3. Results of reliability testing (if applicable)
   4. Initials of the analyst preparing the solution and/or, assuring that the reagent has been tested and works as expected
   Note: Sodium Rhodizonate, which is prepared fresh at each usage, is not required to be documented in the Reagent Log.
C. No reagent, solvent or other chemical preparation will be used in casework if it is not working properly or appears to be contaminated. The appropriate checks will be documented.
D. If an analyst has reason to suspect that a reagent or other chemical preparation is not working properly or is contaminated, it should be re-checked with proper control samples. Any reagent or other chemical preparation which does not pass quality control testing should be immediately discarded.
E. Prepare a new reagent and complete the proper reliability testing
F. Inform the Quality Manager if a problem persists. No laboratory casework will be performed using the affected reagent/chemicals until the problem is corrected.
G. Utilizing the preparation proportions prescribed in each relevant procedure, larger or smaller quantities of reagents may be prepared as desired.
H. No reagents within these Standard Operating Procedures require routine checks beyond reliability testing at the time of preparation and before each use.
I. Refer to the following table for storage conditions and expiration information of prepared reagents.
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<td>15% Acetic Acid Solution</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
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<tr>
<td>Sensitized Blank Solution</td>
<td>No special storage conditions</td>
<td>Discontinue use if QC check fails</td>
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<tr>
<td>Diphenylamine reagent</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
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<tr>
<td>Dithiooxamide Solution</td>
<td>Store with flammables</td>
<td>Discontinue use if QC check fails</td>
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<td>Ammonia Solution</td>
<td>Store with like bases</td>
<td>Discontinue use if QC check fails</td>
</tr>
<tr>
<td>Sodium Rhodizonate Solution</td>
<td>Prepare fresh for each use</td>
<td>Prepare fresh for each use</td>
</tr>
<tr>
<td>5% Hydrochloric Acid solution.</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
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<tr>
<td>Buffer Solution 1</td>
<td>Store with like acids</td>
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<tr>
<td>Buffer Solution 2 (KCl Buffer Solution, pH 1.0)</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
</tr>
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<td>Fry’s Reagent (Acidic Cupric Chloride)</td>
<td>Store with like acids</td>
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<tr>
<td>Turner’s Reagent</td>
<td>Store with like acids</td>
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<td>10% Sodium Hydroxide</td>
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<td>25% Nitric Acid</td>
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<td>Davis Reagent</td>
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<td>Acidic Ferric Chloride</td>
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<td>Ferric Chloride</td>
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<td>Aqua Regia</td>
<td>Store with like acids</td>
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<td>Acidic Cupric Sulfate</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
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<td>6% Ferric Chloride Solution</td>
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<td>10% Ammonium Persulfate</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
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<td>95% Phosphoric Acid</td>
<td>Store with like acids</td>
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<tr>
<td>Hume-Rothery’s Reagent</td>
<td>Store with like acids</td>
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<tr>
<td>Chromic Acid Reagent</td>
<td>Store with like acids</td>
<td>Discontinue use if QC check fails</td>
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4 References

4.1 Test Fires

A. Test fired projectiles/cartridge cases (or shotshells) are not considered evidence. Test fires that are retained for reference purposes will be placed in a secure location.

B. Pill boxes are the recommended containers for storage, although the amount of test fires, shotshells, etc., may require containers of other types (envelopes, etc.).

C. Containers should be labeled with the following information, if known:
   1. Laboratory case number
   2. Caliber
   3. Manufacturer
   4. Model
   5. Serial number
   6. General Rifling Characteristics

D. Test fires that are retained by the laboratory will be labeled with, at a minimum, the case number. Test fires returned to the submitting agency for potential NIBIN entry are not required to be labeled.

4.2 Toolmark Tests and Distance Determination Test Patterns

A. Toolmark tests and distance determination test patterns may be retained in the laboratory for reference or potential court use.

B. If the toolmark tests or distance determination test patterns are retained, it must be noted in the case record.

C. Containers should be labeled with the laboratory case number.

4.3 Firearms Reference Collection

See FTM-03-11

4.4 Ammunition Reference Collection

See FTM-03-11

5 Maintenance and Performance Checks of Laboratory Equipment

5.1 General Requirements for Equipment

A. The equipment listed in this section is considered to be significant.

B. Preventative and corrective maintenance shall be documented on the LAB-405 when performed.

C. All equipment will undergo maintenance, as needed. Regular performance checks will be carried out in accordance with DPS laboratory policy. All significant equipment will undergo a performance check after being relocated to a new laboratory or if a major repair is performed. If equipment does not perform as expected or within established criteria, it will be removed from service until the issue can be reconciled and acceptable performance can be achieved. For equipment that is being removed from service, follow the process outlined in the Crime Laboratory Service Manual Equipment chapter.
D. Unless otherwise indicated, semiannual performance checks are conducted at least once between January 1\textsuperscript{st} and June 30\textsuperscript{th} and a second check conducted between July 1\textsuperscript{st} and December 31\textsuperscript{st} of each year.

E. Maintain a log (LAB-405) of the results of performance checks and any maintenance performed.

F. Equipment which cannot meet specifications must be removed from service and documented on the LAB-410 and LAB-405.

5.2 Comparison Microscope

A. Direct Measurement Performance Check

1. If measurements are taken using a micrometer disc reticle (MDR) in casework, conduct a performance check of the MDR at least once per calendar year.
   a) When an MDR is used, measure at least two different objects of two different known sizes and record the measurements.
   b) If the observed measurement is not within 0.003” of the reference standard, it must be removed from service.

B. Consistency of Magnification Performance Check

1. Conduct a performance check on the consistency of magnification of the left and right optical systems at least once per calendar year. This should be performed on all objective lenses.
   a) Place objects of equivalent graduation on each stage and ensure that each is in focus and in the same relative plane.
   b) Align the objects or graduations such that measurements can be taken.
   c) If the graduations or size is identical, record “pass” for that objective lens.
   d) If the graduations or size is not as expected for an objective lens, it must be removed from service.

2. Alternatively, conduct a performance check on the consistency of magnification using a calibration kit provided by the microscope manufacturer.

3. Conduct a performance check on the consistency of magnification after any movement/relocation of the microscope.

C. Transport

1. Remove all of the optical components such as the oculars, optical bridge, teaching head, camera, camera adapter, and macrozoom bodies. Cover internal surfaces with either the manufacturer provided plastic caps or tape to prevent dust or other foreign material from entering the internal surfaces. Package these items separately in cushioned boxes.

2. Remove any attached stages, lights, fiber optic power supply. Remove any shelves attached to the sides of the microscope

3. Lower the table and bridge to its lowest setting and then disconnect the power.

4. Secure the black colored feet to the horizontal cross-member through the use of string or straps.
5. When transporting the microscope in a vehicle, store upright or on its back and stabilize the microscope with the use of straps or other bracing equipment to limit vibration.

6. Reassemble the microscope in the reverse order by placing the optical devices on last.

7. Conduct a Performance Verification by checking the consistency of magnification as well as the stage micrometer.

D. Perform routine and preventative maintenance according to the manufacturer’s recommendations, or as necessary.

5.3 Calipers/Micrometers

A. Performance Check

1. Conduct a performance check of calipers/micrometers at least semi-annually.
   a) Ensure that the jaws of the caliper are clean and free of any dirt or residue.
   b) Perform at least two different size measurements of an object(s) that is traceable to NIST or other appropriate standards and record the measurements.
   c) If the observed measurements are not within 0.005” of the reference standard, it must be removed from service.

B. Stage Micrometers

1. Conduct a performance check of stage micrometers at least semi-annually.
   a) Using the cross-hair eyepiece, perform at least two different size measurements of an object(s) that is traceable to NIST or other appropriate standards and record the measurements.
   b) If the observed measurements are not within 0.005” of the reference standard, it must be removed from service.

5.4 Balances/Scales

A. Performance Check

1. Balances must be calibrated by an approved vendor annually.

2. Perform semi-annual performance checks during the calendar year of each balance using at least two standard weights that are NIST traceable, or other appropriate standards. Complete a performance check whenever the balance/scale has been moved from one location to another.
   a) Select the appropriate balance to be used for the weight being measured and precision required.
   b) Weigh at least two different objects that are traceable to NIST or other appropriate standards of known weight and record the measurements.
   c) If the observed measurements are not within 0.5 grains (or .032 grams) of the reference standard, it must be removed from service.
   d) Since the tolerance of electronic balances vary, the specifications must be checked to determine the appropriate criteria for satisfactory performance.

3. Perform a performance check on the balance after any movement/relocation.
5.5 **Trigger Pull Gauge**

A. Trigger pull gauges must be calibrated by an approved vendor at least once every three years.

B. Conduct a performance check of the trigger pull gauge at least semi-annually.
   1. Weigh at least two weights traceable to NIST or other appropriate standards and record the measurements.
   2. If the observed measurement is not within ½ lb of the reference standard, it must be removed from service.

5.6 **Alternate Light Source**

A. The alternate light source (IR, UV, etc.) must be checked prior to each use using positive and negative controls.

B. Infrared (IR) Light
   1. The positive IR control will consist of a gunshot residue pattern on a dark colored garment that reflects IR light and the negative control will consist of a garment that does not reflect IR light.
   2. If the gunshot residue pattern is not clearly defined on the positive control or if the negative control shows areas of reflectivity, it should be resolved and documented. If it cannot be resolved, it must be removed from service.

C. Ultraviolet (UV) Light
   1. The positive UV control will consist of a sheet of Modified Griess Test Paper with a known nitrite pattern, and the negative control will consist of a sheet of Modified Griess Test paper with no nitrite pattern.
   2. If the nitrite pattern is not clearly defined on the positive control or if the negative control shows areas of nitrite response, it should be resolved and documented. If it cannot be resolved, it must be removed from service.

5.7 **Weight Standards**

A. Performance Check
   1. Weight standards used to perform checks may be NIST traceable or checked annually using the appropriate NIST traceable mass standards and/or a calibrated balance. They will be performance checked and/or calibrated as required.
   2. The standards are to be inspected, weighed, and the results recorded.
   3. If the observed measurement is not within 2% of the expected weight on a balance calibrated with a reference standard, it must be removed from service.

B. Trigger Pull Weight Standards
   1. Standard weights must be calibrated at least once every three years by an approved vendor.
   2. The standard trigger pull weights must be weighed on a calibrated laboratory balance if substantial damage/loss of weight is noticed.
3. If trigger pull weights are used for performance checks of a related piece of equipment (e.g. trigger pull gauge), then they will be performance checked and/or calibrated as required in the Crime Laboratory Service Manual.

4. The standards are to be inspected, weighed, and the results recorded.

5. If the observed measurement is not within 2% of the expected weight on a balance calibrated with a reference standard, it must be removed from service.

5.8 Tape Measures and Rulers

A. Tape measures and rulers must be calibrated by an approved vendor at least once every three years.

B. Prior to use as a measuring device, a tape measure or ruler must be visually inspected to ensure that its physical condition has not been damaged or modified. If the device appears to be damaged or modified, it cannot be used for taking critical measurements until it has completed a successful performance check.

C. A ruler with a certificate documenting the accuracy as traceable to NIST standards may be used as a measuring device, as well as a measuring standard.

D. A ruler with a certificate that confirms the expected performance of a measuring device may be used, unless the ruler has been physically damaged or modified.

E. Refer to CLS Equipment chapter regarding requirements for equipment that has been calibrated by an approved vendor.

F. Tape Measure and Ruler Performance Checks

1. Complete semi-annual performance checks during the calendar year of each tape measure or ruler measuring at least two standard lengths or distances that are traceable to NIST or other appropriate standards.

2. The appropriate tape measure or ruler will be identified and used for lengths or distances being measured and precision required.

3. If the observed measurements are not within 0.0625 inches (1/16”) of the reference standard, it must be removed from service.

G. If a device other than the tape measure or ruler assigned to the examiner is used for these measurements it will be recorded in the case record when taking the critical measurement.
FTM-01-03 CASE REVIEW PROCESS

1 Scope
Physical evidence review and technical review processes are further defined for casework from the Firearms and Toolmarks section.

2 Related Documents
CLS Manual – Review of Laboratory Records

3 Responsibilities

A. The **Quality Manager and/or Supervisor** is responsible for:
   1. Ensuring that the appropriate reviews or verifications are conducted.
   2. Resolving disagreements between the examiner and technical reviewer.

B. **Analyst** is responsible for:
   1. Conducting proper examinations of evidence and maintaining the appropriate documentation.
   2. Preparing accurate and complete case records.
   3. Preparing reports of the findings of scientific investigations for dissemination to the contributor.

C. **Verifier** is responsible for:
   1. Conducting an independent examination and reaching an independent conclusion after examination of the evidence.
   2. Documenting concurrence with the reported result in the case record and/or resolving any discrepancies with the analyst.

D. **Technical Reviewer** is responsible for:
   1. Conducting a thorough technical review of a case record and/or evaluation of the physical evidence.
   2. Documenting the review in the LIMS.

E. **Administrative Reviewer** is responsible for:
   1. Conducting a thorough administrative review of the laboratory report prior to its distribution.
   2. Documenting the review in the LIMS.

4 Practice

4.1 Verification

A. General
   1. Verifications will be documented by placing the verifier’s initials, date, and the word “verified” next to the information being verified.
   2. If inconsistencies or new identifications or determinations are discovered, the verifier should discuss the observation with the analyst. A third examiner may be used to assist in resolution of the issues.
   3. The verifier may offer suggestions for improvement.
B. All reported opinions involving the comparisons of evidence and/or test items will be verified. The analyst must provide the actual physical evidence and known tests from which a comparison has been performed to a second qualified examiner for verification.

C. The evidence garment(s), chemical test results, test fire targets, and distance conclusions will be witnessed at each stage of the process by the verifier. The verifier’s initials, date, and the word “verified” next to the opinion/conclusion asserts that the verifier was present, witnessed, and concurred with the results from all stages of testing.

D. Critical measurements will be verified.

E. An analyst or supervisor may request to have the evidence of any other type of case verified.

F. Function tests are not required to be verified.

G. Serial Number restorations do not require verification but must be checked or confirmed by another individual working within the laboratory. The person performing the check will place their initials and the date of confirmation next to the opinion on the Serial Number Worksheet (LAB-FTM-18) and/or Serial Number Diagram Worksheet (LAB-FTM-19), depending on which was used.

4.2 Technical Review

In addition to the lab system requirements of technical and administrative reviews of casework, the following conditions apply:

A. Substance of Review

   The reviewer will survey the case file notes and determine if the examination was conducted according to SOP and review accuracy of the information, including:

   1. The report uses standard and correct terminology.
   2. All requests for examinations have been addressed in the report and/or notes.
   3. Each page of the case record has the correct case number and initials of the examiner.
   4. Dates are written in appropriate places to document the progress of the examinations.
   5. Corrections are crossed out with single line and initialed/dated.
   6. Results listed in the report must be substantiated and supported by the notes. The physical comparisons must be thoroughly documented indicating the general location of the identifiable marks used in identifications or clear documentation of exclusionary or inconclusive results.
   7. All evidence should be described in the examiner’s notes and include a brief description of the packaging.
   8. The technical reviewer will check any mathematical calculations.
   9. The technical reviewer will document the completion of the review in the LIMS.

B. Conditions

   1. The reviewer may offer suggestions for improvements.
   2. The technical review does not constitute a verification of the results.
4.3 Administrative Review

A. The administrative review may be conducted by the technical reviewer, a supervisor, the Quality Manager, or an individual designated by the Quality Manager.

B. All ancillary documentation (e.g. subpoenas, letters, photographs, and telephone conversation records) should be present in the case and be marked with case number and/or uploaded into LIMS.

C. All case records will be administratively reviewed prior to the issuance of the report.

D. The reviewer shall thoroughly examine the following items of the case record:
   1. All required elements of the laboratory report.
   2. Text of the laboratory report for logic and completeness, factual and consistent information, spelling, and grammatical correctness.

E. The administrative reviewer will document the completion of the review in the LIMS.

5 Records

Case Documentation Review (LAB-FTM-14) (Optional)
FTM-01-04 REPORTING GUIDELINES

1 Scope
The reporting guidelines for Firearms and Toolmarks cases are described in this document. Please note that the guidelines in the following sections are merely suggestions of possible wording. Variations of these guidelines may be used as necessary.

2 Practices

2.1 Firearms and Comparison of Bullets/Cartridges/Cartridge Cases/Shotshells

A. Functionality of the Firearm
1. The submitted 9mm Luger caliber pistol is functional/operational.
2. The submitted 9mm Luger caliber pistol is operational, however, malfunctions were detected during testing.
3. The submitted 9mm Luger caliber pistol is not functional/operational as submitted.
4. The submitted 9mm Luger caliber pistol was not functional/operational as submitted, as it was missing a firing pin. A firing pin from a similar DPS Lab Reference Collection pistol was placed in the pistol. The submitted pistol was then test fired and no malfunctions were detected during testing.

B. Comparison of Bullets/Cartridges/Cartridge Cases/Shotshells

1. Positive association
   a) The 9mm Luger caliber cartridge case was fired in the submitted 9mm Luger caliber pistol.
   b) The 9mm Luger caliber cartridge cases were all fired in the same firearm.
   c) The copper-jacketed bullet was fired from the submitted 9mm Luger caliber pistol.

2. Negative Association
   a) The 9mm Luger caliber cartridge case was not fired in the submitted 9mm Luger caliber pistol.
   b) The copper-jacketed bullet was not fired from the submitted 9mm Luger caliber pistol. The copper-jacketed bullet was fired from a barrel having six lands and grooves with a clockwise rotation. The manufacturer of the firearm that fired the copper-jacketed bullet is unknown, but could include commonly encountered models of 9mm Luger caliber Beretta, Smith and Wesson, or Taurus pistols.

C. Unknown Projectile

1. The copper-jacketed bullet is a 9mm Luger caliber bullet fired from a barrel having six lands and grooves with a clockwise rotation. The manufacturer of the firearm that fired the copper-jacketed bullet is unknown, but could include commonly encountered models of 9mm Luger caliber Beretta, Smith and Wesson, or Taurus pistols.

2. The submitted jacketed bullet is consistent with 9mm Luger caliber and was fired from a firearm having six lands and grooves with a right twist. Some possible firearms would include, but not be limited to, the following: Astra, Beretta, Browning, Cobray, and Star.
D. Inconclusive/Unable
   1. The submitted bullet/cartridge case could neither be identified nor eliminated to the submitted pistol due to the lack of reproducible individual marks.
   2. The submitted bullet/cartridge case cannot be identified or eliminated as having been fired with the submitted pistol due to the lack of reproducible individual marks.

E. Insufficient markings
   1. Due to a lack of a sufficient quantity and quality of microscopic markings, it could not be determined if the 9mm Luger caliber cartridge case was fired in the submitted 9mm Luger caliber pistol.
   2. Due to a lack of a sufficient quantity and quality of microscopic markings, it could not be determined if the copper-jacketed bullet was fired from the submitted 9mm Luger caliber pistol.

F. Unsuitable
   1. The submitted fired bullet/cartridge case is not suitable for comparison purposes.

G. Unidentifiable
   1. The submitted evidence in question cannot be identified as being fired evidence.
   2. The submitted evidence in question cannot be identified as being an ammunition component.

2.2 Trigger Pull Measurements of a Firearm
   A. The submitted firearm, item [X], trigger pull was measured [X] times. The measurements were [X, X, X].
   B. The range of trigger pull measurements was determined to be [X-X].
   C. The lowest trigger pull measurement of the submitted firearm, item [X], was [X].
   D. The lowest trigger pull measurement of the submitted firearm, item [X], was [X]. The average trigger pull measurement obtained was [X].

2.3 Ejection Pattern Testing
   A. The firearm was held at a height of [X] inches in a standard firing position. The distance that the cartridge cases ejected from the ejection port of the firearm was determined to be between [X] feet and [X] feet to the [position] and between [X] feet and [X] feet to the [position]. Cartridge cases can strike other objects or surfaces after being ejected and may come to rest in a position unrelated to a particular firearm’s ejection pattern characteristics.
   B. The firearm was held at a height of [X] inches in a standard firing position. Cartridge cases ejected [X direction] and [Y direction] of the firearm. Cartridge cases can strike other objects or surfaces after being ejected and may come to rest in a position unrelated to a particular firearm’s ejection pattern characteristics.
2.4  **Barrel/overall Length Measurement**

A.  **Critical**
   1. The overall length of [item] was measured as [X] inches ± [X] of an inch (95% confidence interval).
   2. The barrel length of [item] was measured as [X] inches ± [X] of an inch (95% confidence interval).

B.  **Non-critical**
   1. The overall length of [item] was measured as [X] inches.
   2. The barrel length of [item] was measured as [X] inches.

3  **Distance Determination**

3.1  **Non-shot Pellet**

A.  **Positive Determination**
   1. The muzzle of the firearm was approximately [X] to [X] inches from the shirt at the time the shot was fired that produced the hole in the front of the shirt.
   2. One defect was noted in the [location] of the [item]. Test panels were created using the submitted firearm [item], unfired cartridges [item], and similar material. At the time the shot was fired, the muzzle of the firearm was at a distance greater than [X] and less that [X] from the [item] shirt.

B.  **Inconclusive**
   1. The distance from the muzzle of the firearm to the shirt at the time the shot was fired that produced the hole in the front of the shirt could not be determined due to [reason].
   2. It could not be determined if hole [#] was caused by the passage of a bullet/projectile.

C.  **Absence of holes**
   1. Due to the absence of bullet holes, no distance determination tests were performed.

D.  **Bullet Hole, but No Residue Pattern**
   1. The area around the hole [description of location] of item [#] was examined visually, microscopically and processed chemically for the presence of gunshot residues. No residue patterns were found. The absence of residue patterns is consistent with, but is not limited to, any of the following conditions or a combination thereof:
      2. The shot was fired from a distance outside the range where repeatable gunshot residue patterns are produced. Using the firearm (item [#]) and [submitted ammunition or reference ammunition], test patterns were found at a maximum distance of approximately [distance]; or
      3. Residues were deposited but were removed or reduced; or
      4. There was an intervening object or masking agent that prevented the detection and/or deposition of residues on the article; or
5. The firearm and/or ammunition does not deposit residue in sufficient quantity for detection on the article.

3.2 Shot Pellet

A. Positive Determination

The muzzle of the firearm was approximately 10 to 15 feet from the victim at the time the shot was fired that produced the shot pattern in the garment.

B. Inconclusive

Due to the absence of a distinguishable pattern, the distance from the muzzle of the firearm to the shirt at the time the shot was fired that produced the holes in the front of the shirt could not be determined.

3.3 Creation of Test Panels for Medical Examiners and Outside Experts

1. Using the firearm and ammunition, [number of panels specified by requestor] test panels consisting of [material specified by requestor] were shot at distances of approximately [distances specified by requestor, ex. Distance 1, Distance 2, Distance 3, etc.]. No additional analysis or interpretation was performed on the test fired panels.

2. Using the firearm and ammunition, test panels consisting of [material specified by requestor] were shot at distances of approximately [distances specified by requestor] to [distance specified by requestor]. No additional analysis or interpretation was performed on the test fired panels.

4 Toolmarks

A. Identification

The bolt cutter cut the shackle of the submitted padlock.

B. Elimination

The bolt cutter did not cut the shackle of the submitted padlock.

C. Inconclusive/Unable

It could not be determined if the bolt cutter cut the shackle of the submitted padlock due to a lack of reproducible marks.

5 Serial Number Restoration

A. Complete Restoration

The obliterated serial number on the submitted .44 Magnum caliber revolver is 1234567.

B. Partial Restoration

The obliterated serial number on the submitted .44 Magnum caliber revolver was partially recovered to read: 12XXX67. The middle three digits were not recovered.

C. Unable

The obliterated serial number on the submitted .44 Magnum caliber revolver could not be determined.
6 **Suspected Projectile Defects**

A. Positive chemical reaction

The suspected projectile strike/impact area was chemically processed and lead and/or copper residues were detected. This may be due to the passage of a projectile or from another object containing lead and/or copper.

B. Negative chemical reaction

The suspected projectile strike/impact area was chemically processed and lead and/or copper residues were not detected.

7 **Trajectory**

A defect (Hole #1) was observed in the driver side door with the center of the defect approximately [Y] inches from the ground and [X] inches from the driver door front seam. A second defect (Hole #2) was observed on the interior of the driver side door with the center of the defect approximately [Y] inches from the ground and [X] inches from the front edge of the plastic molding. Both defects (Hole #1 and Hole #2) indicate that the object that created these defects traveled from the exterior to the interior. The trajectory of the object that could have created these defects would have been (in relation to the vehicle): front to back with a downward angle. This would indicate that the potential origin of the object that created these defects would have been in front and to the left of the vehicle.
FTM-01-05 WORKSHEETS

1 Scope
Laboratory worksheets serve several purposes. These include documenting the work performed, acting as a useful aid in guiding the examination, and serving as an archive for future reference.

2 Practice
2.1 Firearm Worksheet

A. A firearm worksheet may take on many forms and may include the following information:
   - Laboratory Case Number*
   - Caliber/Gauge*
   - Make*
   - Model*
   - Serial number*
   - Location and type of trace evidence
   - Firing mechanics (Gas, Recoil, Blowback, etc.)
   - Type of action (Revolver, Semiauto, Bolt, etc.)*
   - Safeties*
   - Operating condition*
   - Trigger pull*
   - Rifling characteristics*
   - Barrel length* (Rifles and shotguns only)
   - Overall length
   - Any other information the examiner might find useful

B. Items with an asterisk are accepted as required by the discipline.

2.2 Fired Bullet Worksheet

A fired bullet worksheet may take on many forms and may include the following information:

- Laboratory Case Number
- Trace Evidence
- Bullet Caliber
- Bullet Weight
- Bullet Morphology
- Bullet Rifling Characteristics
- Physical Condition of the bullet
- Any other information the examiner might find useful
2.3 **Fired Cartridge Case Worksheet**

A fired cartridge case worksheet may take on many forms and may include the following information:

- Laboratory Case Number
- Cartridge Case Caliber/Designation
- Head Stamp Information
- Morphology of the cartridge case
- Type of firing pin impression
- Type of breach face marking
- Detailing any extraneous marking
- Any other information the examiner might find useful
# FTM-01-06 STANDARD ABBREVIATIONS AND DEFINITIONS

## 1 Scope

This is a listing of abbreviations commonly used in the Firearms and Toolmarks discipline.

**Note** that abbreviations may appear as uppercased or lowercased in case records and may be made plural with the addition of “s” or “’s”.

## 2 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACP</td>
<td>Automatic colt pistol</td>
<td>Drop off</td>
<td>The distance at which reproducible gunshot residue patterns are no longer observed</td>
</tr>
<tr>
<td>AFTE</td>
<td>Association of Firearm and Tool Mark Examiners</td>
<td>EFMJ</td>
<td>Expanding full metal jacket</td>
</tr>
<tr>
<td>API</td>
<td>Armor piercing incendiary</td>
<td>EJ</td>
<td>Ejector</td>
</tr>
<tr>
<td>API</td>
<td>Armor piercing incendiary</td>
<td>Elim.</td>
<td>Elimination</td>
</tr>
<tr>
<td>Bbl</td>
<td>Barrel</td>
<td>Evid.</td>
<td>Evidence</td>
</tr>
<tr>
<td>BEB</td>
<td>Brass enclosed base</td>
<td>Ext</td>
<td>Extractor</td>
</tr>
<tr>
<td>BF</td>
<td>Breech face</td>
<td>FA</td>
<td>Firearm</td>
</tr>
<tr>
<td>BFI</td>
<td>Breech face impression</td>
<td>Fed</td>
<td>Federal</td>
</tr>
<tr>
<td>BFM</td>
<td>Breech face marks</td>
<td>Fed</td>
<td>Full metal case</td>
</tr>
<tr>
<td>BJHP</td>
<td>Brass jacketed hollow point</td>
<td>FMJ</td>
<td>Full metal jacket</td>
</tr>
<tr>
<td>BOB</td>
<td>Breech or bolt</td>
<td>FPA</td>
<td>Firing pin aperture</td>
</tr>
<tr>
<td>BP</td>
<td>Black powder</td>
<td>FPI</td>
<td>Firing pin impression</td>
</tr>
<tr>
<td>Br</td>
<td>Brass</td>
<td>FRC</td>
<td>Firearms Reference Collection</td>
</tr>
<tr>
<td>BT</td>
<td>Boat tail</td>
<td>FSLC</td>
<td>Fired since last cleaned</td>
</tr>
<tr>
<td>BW</td>
<td>Brass wash</td>
<td>Ga</td>
<td>Gauge</td>
</tr>
<tr>
<td>CC</td>
<td>Cartridge case</td>
<td>GAP</td>
<td>Glock automatic pistol</td>
</tr>
<tr>
<td>Chem</td>
<td>Chemical examination or test</td>
<td>GaP</td>
<td>Gold dot hollow point</td>
</tr>
<tr>
<td>CN</td>
<td>Cupro nickel bullet jacket</td>
<td>GAP</td>
<td>Gold dot hollow point</td>
</tr>
<tr>
<td>CNCS</td>
<td>Cupro nickel clad steel</td>
<td>GEA</td>
<td>Groove engraved area</td>
</tr>
<tr>
<td>Co</td>
<td>County</td>
<td>GI or GIMP</td>
<td>Groove impression (bullet land)</td>
</tr>
<tr>
<td>Corrob</td>
<td>Corroborative</td>
<td>GM</td>
<td>Gilding metal, bullet jacket</td>
</tr>
<tr>
<td>Cu</td>
<td>Copper</td>
<td>GMCS</td>
<td>Gilding metal clad steel, bullet jacket</td>
</tr>
<tr>
<td>CW</td>
<td>Copper wash</td>
<td>gp</td>
<td>Gunpowder</td>
</tr>
<tr>
<td>CWS</td>
<td>Copper washed steel, case finish</td>
<td>gpp</td>
<td>Gunpowder Particle</td>
</tr>
<tr>
<td>C&amp;WT</td>
<td>Caliber and Weapon type</td>
<td>gr</td>
<td>Grains</td>
</tr>
<tr>
<td>C/W</td>
<td>Consistent with</td>
<td>GrC</td>
<td>General rifling characteristics</td>
</tr>
<tr>
<td>(d)</td>
<td>Deformed</td>
<td>Griess</td>
<td>Modified Griess test for nitrites</td>
</tr>
<tr>
<td>DA</td>
<td>Double action</td>
<td>GSR</td>
<td>Gunshot residue</td>
</tr>
<tr>
<td>DAO</td>
<td>Double action only</td>
<td>GWD</td>
<td>Groove width dimension (bullet land)</td>
</tr>
<tr>
<td>DBM</td>
<td>Detachable Box Magazine</td>
<td>HA</td>
<td>Hybrid Action</td>
</tr>
</tbody>
</table>
| DC           | Dual core |...
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB</td>
<td>Heavy ball, round-nose bullet</td>
<td>Nonident, Non-identification, could not have fired the specimen</td>
</tr>
<tr>
<td>HE</td>
<td>High explosive</td>
<td>PA, Primer annulus</td>
</tr>
<tr>
<td>HP</td>
<td>Hollow point</td>
<td>Para, Parabellum</td>
</tr>
<tr>
<td>HPB</td>
<td>Heavy pointed ball, boat tail bullet</td>
<td>Pb, Lead</td>
</tr>
<tr>
<td>ID or IDENT</td>
<td>Identification</td>
<td>PD, Police Department</td>
</tr>
<tr>
<td>Imp</td>
<td>Impression</td>
<td>pkg, Package</td>
</tr>
<tr>
<td>Inc. or Incon.</td>
<td>Inconclusive</td>
<td>Poly, Polygonal</td>
</tr>
<tr>
<td>int.</td>
<td>International</td>
<td>PSP, Pointed soft point</td>
</tr>
<tr>
<td>IP</td>
<td>Inside primed</td>
<td>R or Rt, Right</td>
</tr>
<tr>
<td>JCK</td>
<td>Jacket</td>
<td>Rem, Remington</td>
</tr>
<tr>
<td>JHP</td>
<td>Jacketed hollow point</td>
<td>RF, Rimfire</td>
</tr>
<tr>
<td>JSP</td>
<td>Jacketed soft point</td>
<td>RN, Round nose</td>
</tr>
<tr>
<td>L or Lt</td>
<td>Left</td>
<td>RP, Remington Peters</td>
</tr>
<tr>
<td>LEA</td>
<td>Land engraved area</td>
<td>SA, Single action</td>
</tr>
<tr>
<td>LI</td>
<td>Land impression (bullet groove)</td>
<td>SAAMI, Sporting Arms and Ammunition Manufacturer’s Institute</td>
</tr>
<tr>
<td>LIMP</td>
<td>Land impression</td>
<td>SAO, Single action only</td>
</tr>
<tr>
<td>LL&gt;G</td>
<td>Lands larger than grooves</td>
<td>Semiauto, Semiautomatic</td>
</tr>
<tr>
<td>LPB</td>
<td>Light pointed ball – flat based bullet</td>
<td>SJHP, Semi-jacketed hollow point</td>
</tr>
<tr>
<td>LRN</td>
<td>Lead round nose</td>
<td>SO, Sheriff’s Office</td>
</tr>
<tr>
<td>LS</td>
<td>Lacquered steel, case finish</td>
<td>Spl., Special</td>
</tr>
<tr>
<td>LSWC</td>
<td>Lead semi-wad cutter</td>
<td>Std, Standard</td>
</tr>
<tr>
<td>LWC</td>
<td>Lead wad cutter</td>
<td>STHP, Silvertip hollow point</td>
</tr>
<tr>
<td>LWD</td>
<td>Land width dimension (bullet groove)</td>
<td>SWC, Semi-wad cutter</td>
</tr>
<tr>
<td>L/LR</td>
<td>Long/Long Rifle</td>
<td>S/N or SN, Serial Number</td>
</tr>
<tr>
<td>L=G</td>
<td>Land equals groove</td>
<td>S&amp;W, Smith &amp; Wesson</td>
</tr>
<tr>
<td>L&amp;G</td>
<td>Lands and grooves</td>
<td>TC, Truncated cone</td>
</tr>
<tr>
<td>1L, 2G vis</td>
<td>example: 1 land, 2 grooves visible</td>
<td>TMJ, Total metal jacket</td>
</tr>
<tr>
<td>MA</td>
<td>Mouth Annulus</td>
<td>TRU, Tactical rifle urban</td>
</tr>
<tr>
<td>Mag</td>
<td>Magnum</td>
<td>u/a, unable</td>
</tr>
<tr>
<td>MFG</td>
<td>Manufacture</td>
<td>UMC, Union Metallic Cartridge Company</td>
</tr>
<tr>
<td>Mic or Micro</td>
<td>Microscopic</td>
<td>Vel, Velocity</td>
</tr>
<tr>
<td>MIM</td>
<td>Metal Injection Molding</td>
<td>w/, With</td>
</tr>
<tr>
<td>mod or mdl.</td>
<td>Model</td>
<td>WC, Wad-cutter</td>
</tr>
<tr>
<td>n/a</td>
<td>not available or not applicable</td>
<td>Win, Winchester</td>
</tr>
<tr>
<td>Na Rho</td>
<td>Sodium Rhodizonate test</td>
<td>WMR, Winchester Magnum Rimfire</td>
</tr>
<tr>
<td>NC</td>
<td>No conclusion</td>
<td>WSM, Winchester Short Magnum</td>
</tr>
<tr>
<td>Ni</td>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
<td>5R or R5</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>WSSM</td>
<td>Winchester Super Short Magnum</td>
<td>~</td>
</tr>
<tr>
<td>Wt</td>
<td>Weight</td>
<td>22 S, L, LR</td>
</tr>
</tbody>
</table>
FTM-01-07 ITEM COUNTING GUIDELINES

1 Scope
These practices will provide uniform item counting guidelines in Firearms and Toolmarks discipline.

2 Practice
The item count of firearms examinations should be included in the case record via LIMS.

2.1 Firearms and Toolmark Request Item Counts

A. Bullets

1. Projectiles can be intact or fragmented. Each projectile / fragment / lead core for which a separate block on the Projectile Worksheet is filled out will count as one item.

2. If a jacket and core are submitted and analyzed collectively within the same block on the Projectile Worksheet, they will count as one item.

3. If multiple small fragments are analyzed collectively within the same block on the Projectile Worksheet, the combined fragments will count as one item.

   Examples:
   a) One intact projectile = 1 Item
   b) One jacket and one core analyzed and documented collectively = 1 Item
   c) Three fragments analyzed and documented independently = 3 Items
   d) Three fragments analyzed and documented collectively = 1 Item

B. Cartridge Cases / Shotshells

1. Each evidence cartridge case or shotshell in a Firearms and Toolmark Request will count as one item whether documented independently or collectively with the same block on the Cartridge Case Worksheet.

2. Unfired cartridges or shotshells will not routinely count as an item. If cycling marks are microscopically compared, see “Other” section below.

   Examples:
   a) One cartridge case = 1 Item
   b) Three cartridge cases documented independently = 3 Items
   c) Three cartridge cases documented collectively = 3 Items
   d) Three unfired cartridges = 0 Items (see “Other” section)

C. Firearms

1. Each firearm, whether functional or not, will count as one item.

2. If one or more firearms are submitted disassembled, each firearm frame or receiver will count as 1 item.

3. If a disassembled firearm is submitted without a frame or receiver, the minimum number of possible assembled firearms will be counted as items.
4. Accessories submitted associated with one or more firearms will not count as an item.
   Examples:
   a) One functional firearm = 1 Item
   b) Three firearms (two functional and one non-functional) = 3 Items
   c) Various firearms components with four frames = 4 Items
   d) Various firearms components with no frames = Items vary (smallest number)

D. Pellets, Wads, and Shot Collars

1. Each shotshell component (pellets, wads, and shot collars) analyzed and documented within its own block on a Projectile Worksheet will count as 1 item.

2. If multiple pellets are collectively documented within a single block on the Projectile Worksheet, they will count together as 1 item.
   Examples:
   a) One wad = 1 item
   b) Twelve pellets analyzed and documented collectively = 1 item
   c) One wad, one shot collar, and 12 pellets (three total Projectile Worksheets) = 3 items

E. Serial Number Restoration

1. Each obliterated area for which an attempt was made to restore will count as one item.

2. Different restoration techniques (such as polishing, different use of chemicals, etc.) will not be counted as separate items.
   Examples:
   a) One obliterated area on a pistol = 1 item
   b) Three obliterated areas on a pistol = 3 items
   c) One obliterated area (performed polishing, alternated chemicals five times, etc.) = 1 item

F. Chemical Analysis of Suspected Bullet Defects

1. Each suspected defect for which visual and/or chemical analysis was performed will count as one item.

2. Different visual and chemical techniques used on the same suspected defect will not be counted as separate items.
   Examples:
   a) One suspected defect on a vehicle = 1 item
   b) Three suspected defects on a vehicle = 3 items
   c) Three suspected defects (visual on all three and chemical on two) = 3 items

G. Tools

1. Each tool submitted for analysis will count as one item.
   Examples:
   a) One pair of bolt cutters = 1 item
   b) One hammer = 1 item
H. Toolmarks:
   1. Each toolmark area for which a separate block on the Toolmark Worksheet is filled out will count as one item.

   Examples:
   a) Four toolmark areas analyzed and documented collectively on the same worksheet = 1 item
   b) Four toolmark areas analyzed and documented independently on separate worksheets = 4 items

I. Ejection Pattern Testing
   1. Each ejection pattern test for a given firearm using the same ammunition at the same relative shooting position will count as one item.
   2. If multiple positions are required to be tested for the same firearm and ammunition combination, each ejection pattern testing at each shooting position will be one item.
   3. Number of test fires generated to perform an ejection pattern testing will not be counted as separate items.

   Examples:
   a) Ejection pattern testing with firearm in standing position = 1 Item
   b) Ejection pattern testing with firearm in standing position and prone position = 2 Items

J. Trajectory Exams
   1. Each defect for which a trajectory exam is performed will count as 1 item.
   2. Different techniques used on the same defect for trajectory determination will not count as separate items

K. Other
   1. Occasionally, items may be submitted for comparison that do not fit into the above categories. These include, but are not limited to, unfired cartridges submitted for microscopic comparison of cycling marks, magazines submitted for the generation and comparison of test cartridges, etc.
   2. If an item is given value in the “Other” category, a justification as to why these items are being given value will be included in the “Other Explanation” field.
   3. This field is to assign value for items submitted for analysis with requests beyond what is traditionally performed and will not routinely be used to assign values to items to include, but not be limited to, cartridges, magazines, accessories, etc., which were not analyzed.

   Examples:
   a) Five cartridges submitted for cycling mark comparison = 5 Items, (explanation required in “Other Explanation” field)
   b) Three magazines submitted for cycling mark comparison = 3 Items, (explanation required in “Other Explanation” field)
2.2 Distance Request Item Counts: Defects Analyzed

A. Each defect analyzed and documented on its own row on the Distance Evidence Worksheet will count as 1 item.

B. If an item is submitted and examined for defects and no defects are found, the item itself will count as one item in the “Defects Analyzed” field. If defects are located, each defect will count as 1 item and the evidence item will not be given an item value independently.

C. Visual and chemical examinations will not be counted as separate items.

D. Defects on test panels will not be counted as an item.

Examples:

1. One shirt with 4 defects (each defect on its own row on the Distance Evidence Worksheet) analyzed visually and chemically = 4 items
2. One shirt with 4 defects (all four analyzed visually and only two analyzed chemically, each on its own row on the Distance Evidence Worksheet) = 4 items
3. One shirt with no defects observed = 1 item
FTM-01-08 MEASUREMENT UNCERTAINTY ESTIMATE

1 Scope
Any reported quantitative measurement will include the estimate of measurement uncertainty as determined by the Crime Laboratory Service.

2 Related Documents
Trigger Pull Examination (FTM-03-02)
Barrel and Overall Firearm Length (FTM-03-03)
Test Pattern Preparation (FTM-04-07)
CLS Manual – Measurement Uncertainty

3 Equipment and Materials
- Rulers
- Tape measures
- Spring gauges
- Trigger pull weights
- Digital force gauges

4 Practice
4.1 Barrel and Overall Length
A. Firearm length measurements are collected by each firearms examiner in the system. Each has made his/her determination of the length(s) of the same firearms (e.g. barrel length and overall length). Examiners used the validated, calibrated, and performance checked measuring devices currently in use for casework.

B. The uncertainty estimate will be evaluated at least on an annual basis. When new examiners or equipment are added to or removed from the system, the uncertainty value may be affected. Data involving the addition or removal of examiners and/or equipment will be incorporated into the uncertainty value during these annual reassessments.

C. Expanded uncertainty will be converted to sixteenths of an inch and will be rounded up to the next highest sixteenth of an inch.

D. Current uncertainty estimate
   1. Barrel Length: 2/16” rounded fractional equivalent
   2. Overall Length: 3/16” rounded fractional equivalent

E. A coverage factor k=2 will be applied and reported as a 95% confidence interval.

4.2 Trigger Pull
A. Trigger pull measurements are collected by each firearms examiner in the system. Each has made his/her determination on the force required to pull the trigger back to the point of sear release in multiple modes of fire on the same set of firearms. Examiners used the validated, calibrated, and performance checked measuring devices currently in use for casework.
B. The uncertainty estimate will be evaluated at least on an annual basis. When new examiners or equipment are added to or removed from the system, the uncertainty value may be affected. Data involving the addition or removal of examiners and/or equipment will be incorporated into the uncertainty value during these annual reassessments.

C. Expanded uncertainty will be converted to increments of ¼ pound and will be rounded up to the next highest ¼ pound.

D. Current uncertainty estimate
   1. Spring Gauge: 1 ¼ lbs. rounded fractional equivalent
   2. Trigger Pull Weights: 1 lb. rounded fractional equivalent
   3. Digital Force Gauge: 1 lb. rounded fractional equivalent

E. A coverage factor k=2 (95% confidence interval) was applied to the above factors. There is currently no requirement to report the measurement uncertainty associated with trigger pull values.

4.3 Distance Determination Test Target Creation
A. The measurement between an examiner in a shooting position and targets are collected by each firearms examiner that performs distance determination in the system. Each has made his/her determination on the distance between a target and the muzzle of a firearm held in a shooting position through the use of a second examiner. Examiners used the validated, calibrated, and performance checked measuring devices currently in use for casework.

B. The uncertainty estimate will be evaluated at least on an annual basis. When new examiners or equipment are added to or removed from the system, the uncertainty value may be affected. Data involving the addition or removal of examiners and/or equipment will be incorporated into the uncertainty value during these annual reassessments.

C. Expanded uncertainty will be converted to sixteenths of an inch and will be rounded up to the next highest sixteenth of an inch.

D. Current uncertainty estimate 9/16” rounded fractional equivalent

E. A coverage factor k=2 (95% confidence interval) was applied to the above factors. There is currently no requirement to report the measurement uncertainty associated with the creation of distance determination test targets.

5 Literature References and Supporting Documentation
Valid-Method-SYS-FTM-UncertaintyBudget-Distance-2019-0415

Printed copy is uncontrolled. Refer to electronic copy for current version.
02 EVIDENCE EXAMINATION

FTM-02-01 PHYSICAL EVIDENCE EXAMINATION

1 Scope

The primary purpose of these procedures is to establish documentation and collection procedures that will be utilized by the Firearm and Toolmarks section.

The procedures presented are intended to assist the scientist in the examination of evidence submitted to the Firearms and Toolmarks section. They are to be used in conjunction with all applicable laboratory policies and procedures and proper scientific methodology.

The variables involved in forensic science methods prohibit the establishment of a procedures manual extensive enough to apply to all situations which may occur. These procedures are to serve only as guidelines. Further assistance in determining the procedure to use may be obtained by a search of the scientific, professional, and forensic literature followed by the appropriate validation.

2 Related Documents

Laboratory Submission Form (LAB-201)

3 Safety

A. All firearms should be treated as if loaded. All firearms should be rendered safe. Rendering a firearm safe does not necessarily mean that it must be unloaded. It means that it must be placed in such a condition that it cannot be fired if it is dropped or the trigger accidentally pulled. The position of the safety should be noted if collected at a crime scene.

B. Follow the appropriate safety measures for handling of bio-hazardous and hazardous materials.

4 Equipment and Materials

- Etching Pencil, Scribing Tool, or Marker
- Plastic bags, Paper Envelopes, or appropriate evidence containers

5 Standards, Controls, and Calibration

None

6 Procedure

6.1 Physical Evidence Examination

A. Retrieve evidence from evidence storage or evidence custodian. Document any inconsistencies between the actual evidence and the information provided.

B. Describe the evidence package (such as the nature of seals, labeling, and preservation). Mark the external wrapping/packages with the case number, and examiner’s initials. Open the container (avoid breaking previous seals, if possible). Describe and mark inner evidence packages as encountered, when appropriate. Photographs may serve as documentation and description.
C. Examine the evidence, preferably with gloved hands.
   1. Visually examine each item for hair/trace, possible latent prints, biological stains, or residues. Care should be taken to preserve trace evidence for analysis by other sections. If there is reason to believe that specific types of evidence may be found on particular items, other examiners may be requested to assist in the description, collection, and analysis of that material (i.e. hair/fiber, blood, body fluids, residue, etc.).
   2. Uniquely and consistently label each item, if possible.
   3. Conduct the appropriate analytical/comparative analysis.

D. All exhibits will be re-packaged in the original container, if possible. The inner and outer packaging of the evidence is re-sealed in a manner that would detect tampering. All seals are initialed and dated by the examiner.

E. The evidence should be transferred to the evidence storage area, another analyst or section, or evidence custodian.

6.2 Marking Evidence

A. Firearms
   1. Any firearm submitted for examination should be marked or identified for future recognition with the laboratory case number, exhibit designation, and analyst’s initials; however, firearms are considered to have monetary and/or intrinsic value per the Evidence Processing chapter of the CLS Manual.
   2. If the firearm is not marked, the proximal container will be marked with the laboratory case number, exhibit designation, and analyst’s initials.
   3. Attaching a tag through the trigger guard, a label to the flat surface of the firearm, or marking with permanent ink on the firearm are appropriate forms of labeling a firearm.
   4. If the firearm can be recognized by a unique serial number and it is packaged in a proximal container that is labeled appropriately, then it is not necessary to label the firearm directly.
   5. Firearms shall not be scribed.

B. Projectiles
   1. All evidence items should be permanently marked, when possible. However, projectiles should never be marked in areas that may exhibit marks / patterns that could be useful in a comparison.
   2. Projectiles should be labeled with the laboratory case number, exhibit designation, and analyst’s initials. Scribing is the preferred method of permanently marking these items. Permanent ink markers may also be used if scribing will significantly deface or destroy characteristics necessary for examination.
   3. When the item of evidence is too small to mark or marking would significantly deface or destroy characteristics that will be necessary for examination, the evidence may be placed in an appropriately sealed container labeled with laboratory case number, exhibit designation, and analyst’s initials.
C. Cartridge Cases / Shotshells

1. All evidence items should be permanently marked, when possible. Cartridge cases or shotshells should never be marked in areas (primer, base, body, etc.,) that exhibit marks / patterns that are used for identification purposes.

2. Evidence should be labeled with the laboratory case number, exhibit designation, and analyst's initials. Scribing is the preferred method of permanently marking these items. Permanent ink markers may also be used if scribing will significantly deface or destroy characteristics necessary for examination.

3. When the item of evidence is too small to mark or marking would significantly deface or destroy characteristics that will be necessary for examination, the evidence should be placed in an appropriately sealed container labeled with laboratory case number, exhibit designation, and analyst's initials.

D. Containers

1. Containers or other packaging should be described in the case record. They should be labeled with the laboratory case number, exhibit designation, and analyst's initials.

2. After examination, the containers should be tape-sealed, initialed, and dated. The innermost and outermost container must be sealed.

E. Other Exhibits

1. Markings on other exhibits of evidence will be made in such an area that would not obscure patterns or stains.

2. The labeling should include laboratory case number, initials, and item number. If this is not possible then the container should contain the appropriate information.

6.3 Physical Examination and Classification of Firearms

A. A firearm worksheet should be completed as thoroughly as necessary. This may include determining the following:

1. Trace Evidence
2. Caliber/Gauge*
3. Make/Model*
4. Serial number*
5. Firing mechanics
6. Type of action*
7. Safeties*
8. Operating condition†
9. Trigger pull*
10. Rifling characteristics*
11. Barrel length* (rifles and shotguns only)
12. Overall length
13. Full Auto Safety Check (where applicable)

B. Items with an asterisk are required by the discipline.
7 Interpretation

This examination serves to document the firearm routine.

8 Literature References and Supporting Documentation

None
03  FIREARMS IDENTIFICATION

FTM-03-01  FIREARM SAFETY

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

2  Related Documents
Physical Evidence Examination (FTM-02-01)
Trigger Pull Examination (FTM-03-02)
Barrel and Overall Firearm Length (FTM-03-03)

3  Safety
   A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

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

4  Safe Firearm Handling
   A. The muzzle of the firearm must always be pointed in a safe direction.

   B. Prior to any examination, regardless of which section is receiving the firearm, a competent individual must ascertain the loaded or unloaded condition of the firearm.

   C. Test firing or any examination of the firearm that utilizes live ammunition, or a live ammunition component, will only be performed in designated test firing areas.

   D. A firearm will not be placed in the evidence vault or returned to any agency in either a loaded condition or prior to its loaded or unloaded condition being checked.

5  Pre-Firing Safety Examination
   A. When deciding on whether or not a firearm can be safely test fired from the normal hand held position, the following questions should be considered:

      1. Is the chamber/bore clear?
      2. Are there any signs of cracks or weaknesses in major parts of the firearm; such as the frame, slide or barrel?
      3. Does the firearm function, lock-up or dry fire as you would expect it to?
      4. Is the **correct** ammunition being utilized?
B. Consider the following when determining if it is appropriate to utilize the evidence ammunition (Generally, the submitted ammunition should not be used for test firing):

1. Are there signs of reloading? If so, reconsider the need to test fire the evidence ammunition.
2. Are there splits in the cartridge case neck and/or other significant damage to the cartridge case?
3. Is the ammunition of the correct caliber? This assessment of caliber cannot be based on the head stamp.
4. Are there existing toolmarks on pertinent surfaces of the ammunition?
5. Is the ammunition needed for other tests; i.e., distance determinations?

C. Consider the following for muzzle loaders:

1. Does the chamber/barrel appear sound?
2. Do the percussion nipples have oversize flash holes?
3. If a black powder firearm is received in the loaded condition, it must have the bullet and charge removed. It may then be properly loaded prior to test firing.
4. Is this an "original" muzzleloader or a modern reproduction? "Originals" must always be remote fired.

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

6 Policy

A. The use of personal firearms in laboratory firing ranges is prohibited without prior written approval from the Laboratory Director.

B. The use of Department ammunition in personal firearms is prohibited without prior written approval from the Laboratory Director.

C. The use of personal reloading equipment is prohibited without prior written approval from the Laboratory Director.

7 Literature References and Supporting Documentation


FTM-03-02 TRIGGER PULL EXAMINATION

1 Scope
Trigger pull is defined as the amount of force, which must be applied to the trigger of a firearm to cause sear release. This examination can provide vital information regarding the mechanical operating condition of the firearm. The trigger pull of a firearm can be obtained utilizing standard trigger weights, which make contact with the trigger at a point where the trigger finger would normally rest.

2 Related Documents
Physical Evidence Examination (FTM-02-01)
Firearm Safety (FTM-03-01)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

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

4 Equipment and Materials
Standard Trigger Weights
Spring Gauge

5 Standards, Controls, and Calibration
None

6 Procedure
6.1 Standard Weights
A. The trigger pull examination may be conducted using trigger pull gauges or trigger pull weights.

B. Trigger Pull Measurement
1. Ensure that the firearm is unloaded.
2. Ensure the firearm is in the appropriate state for the mode being tested (ex: Single Action, Double Action, Hybrid Action, etc.).
3. Hold the firearm with the muzzle vertical.
4. Rest the trigger hook of the standard trigger weight hanger on the trigger where the average finger would normally rest, making sure it is not touching any other part of the firearm, with the weights hanging parallel to the bore of the firearm.
5. Add the weights until the sear releases.
6. Check a minimum of two times, resetting the sear connection after each attempt.
7. Record the weights (in pounds) necessary for sear release.
8. Note any revolver cylinder chamber that alters the trigger pull.

9. It should be noted that measuring the trigger pull of a rimfire firearm must not be performed on an empty chamber. A “dummy” cartridge must be used. The examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a “dummy” cartridge in this instance as well.

6.2 Spring Gauge

A. The trigger pull examination may be conducted using trigger pull gauges or trigger pull weights.

B. Trigger Pull Measurement
   1. Ensure that the firearm is unloaded.
   2. Ensure the firearm is in the appropriate state for the mode being tested (ex: Single Action, Double Action, Hybrid Action, etc.).
   3. Hold the firearm with the muzzle parallel to the spring gauge.
   4. Ensure the Spring Gauge indicator is “zeroed”.
   5. Rest the trigger hook of the Spring Gauge on the trigger where the average finger would normally rest. Make sure it is not touching any other part of the firearm and the Spring Gauge is parallel to the bore of the firearm.
   6. Apply pressure to the Spring Gauge, until the sear releases.
   7. Check a minimum of two times, resetting the sear connection after each attempt.
   8. Record the weights (in pounds) necessary for sear release.
   9. Note any revolver cylinder chamber that alters the trigger pull.
   10. It should be noted that measuring the trigger pull of a rimfire firearm must not be performed on an empty chamber. A “dummy” cartridge must be used. The examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a “dummy” cartridge in this instance as well.

6.3 Digital Force Gauge

A. The trigger pull examination may be conducted using trigger pull gauges or trigger pull weights.

B. Trigger Pull Measurement
   1. Ensure that the firearm is unloaded.
   2. Ensure the firearm is in the appropriate state for the mode being tested (ex: Single Action, Double Action, Hybrid Action, etc.).
   3. Hold the firearm with the muzzle parallel to the digital force gauge.
   4. Ensure the Digital Force Gauge has been set to “PEAK” function.
   5. Ensure the Digital Force Gauge has been “zeroed”.
   6. Rest the trigger hook of the Digital Force Gauge on the trigger where the average finger would normally rest. Make sure it is not touching any other part of the firearm and the Digital Force Gauge is parallel to the bore of the firearm.
7. Apply pressure to the Digital Force Gauge, until the sear releases.
8. Check a minimum of two times, resetting the sear connection after each attempt.
9. Record the weights (in pounds) necessary for sear release.
10. Note any revolver cylinder chamber that significantly alters the trigger pull.
11. It should be noted that measuring the trigger pull of a rimfire firearm must not be performed on an empty chamber. A “dummy” cartridge must be used. The examiner must also take into consideration the potential for damage of a centerfire firearm and may wish to use a “dummy” cartridge in this instance as well.

7 Interpretation
Measurements obtained should be considered approximations given the accuracy limitations of most measuring devices. In the event that trigger pull measurements must be reported, the report will include at least the lowest measurement required for sear release. Please refer to FTM-01-04 for suggested report wording.

8 Literature References and Supporting Documentation
FTM-03-03  BARREL AND OVERALL FIREARM LENGTH

1  Scope
One of the routine procedures conducted in a firearm identification examination is the determination of barrel length and, in some cases, the overall length of a firearm. This measurement is particularly important as it pertains to Texas Penal Code Sec. 46.05 in the determination of a short-barreled firearm.

2  Related Documents
Measurement Uncertainty Estimate (FTM-01-08)
Physical Evidence Examination (FTM-02-01)

3  Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

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

4  Equipment and Materials
- NIST Traceable Ruler (with a minimum of 1/16" increments)
- Tape Measure (with a minimum of 1/16" increments)
- Non-marring Dowel with a stopping device

5  Standards, Controls, and Calibration
None

6  Procedure

6.1  Barrel Length
A. Remove any muzzle attachments that are not permanent.

B. Indirect Method (critical barrel length measurement)
   1. Place a non-marring dowel down the barrel and indicate the length of the barrel on the dowel with the stopping device.
      a) For Shotguns: the breech end of the barrel to the longest point of the muzzle end of the barrel on a line parallel to the axis of the bore.
      b) For Rifles: the face of the closed breech block or bolt to the longest point of the muzzle end of the barrel on a line parallel to the axis of the bore.

   Note: Muzzle attachments are not usually included in the measure unless they are permanently affixed.

   2. Measure and record the length of the dowel to the stopping device.
C. Direct Method (non-critical, approximate measurements)
   1. For general description of firearm barrel length where measurement meets or
      exceeds federal standards
   2. For handguns: the breech end of the barrel to the longest point of the muzzle end
      of the barrel, including the threaded portion within the frame (excluding the cylinder
      in revolvers).

6.2 Overall Length
Measure and record the distance from a line at the rearmost point of the butt plate or grip
to the longest point of the muzzle end of the barrel on a line parallel to the axis of the
bore (see diagram).

   Note: muzzle attachments usually are not included in the measure unless they are
   permanently affixed.

7 Interpretation
A. When a measurement appears to be between two 1/16 increments, the length will be
   rounded to the next highest 1/16 inch increment.
B. When more than one measurement is taken an average must be determined.
C. Report the measurement in 1/16 inch increments.
D. Measurements of the length of the barrel and the overall length of the shotgun/rifle are
   considered critical measurements only when they are within 1” of legal limits.
E. Legal firearm length limits are:
   1. Shotgun greater than or equal to 18 inches barrel length and greater than or equal
      to 26 inches overall length
   2. Rifles greater than or equal to 16 inches barrel length and greater than or equal to
      26 inches overall length
F. Uncertainty of measurement:
   Current uncertainty values can be found in the Measurement Uncertainty Estimate (FTM-
   01-08).

8 Literature References and Supporting Documentation
Bureau of Alcohol, Firearms and Tobacco. Firearms and Ammunition Identification Guide. July
1994.
FTM-03-04 RUSTY FIREARM EXAMINATION

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

2 Related Documents
Physical Evidence Examination (FTM-02-01)
Firearm Safety (FTM-03-01)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

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

C. Any firearm that cannot be unloaded must be examined in an area designated for firing firearms (preferably a range).

4 Equipment and Materials
None

5 Standards, Controls, and Calibration
None

6 Procedure
A. An examiner must take all necessary steps to ensure that the firearm is unloaded. If it cannot be readily verified to be unloaded it must be examined in an area designated for the firing of firearms. Determining whether or not a firearm is unloaded may necessitate a complete disassembly or, in some cases, destruction (e.g. cutting).

B. The examiner must determine to what extent restoring the firearm is necessary (i.e., for test firing, for recovering manufacturer information, serial number, etc.).

C. Soak the firearm in penetrating oil, de-rusting solvents or similar material.

D. Periodically check the firearm until the firearm functions, or the desired information is recovered.

E. Clean the firearm with gun cleaning solvent, cleaning patches and cloth. Care must be taken if any object is placed down the barrel. Only a non-marring item should be placed down the barrel.
7 Interpretation
None
8 Literature References and Supporting Documentation
FTM-03-05 MALFUNCTIONING FIREARM EXAMINATION

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

2 Related Documents
Firearm Safety (FTM-03-01)
Primed Cartridge Case/Shotshell (FTM-03-11)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

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

4 Equipment and Materials
None

5 Standards, Controls, and Calibration
None

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

6.1 Physical Check (Condition of Firearm as Received)
A. Cocked/uncocked
B. Safety position
C. Loaded/unloaded
D. Cartridge position
E. Stuck cartridges/discharged cartridge cases
F. Presence and/or location of flares
G. If the firearm is to be x-rayed, this may be the time to do it.
6.2 Visual Abnormalities
   A. Barrel (loose, etc.)
   B. Receiver (condition)
   C. Slide (condition)
   D. Parts broken or missing especially the firing pin, ejector or extractor
   E. Screws (loose or missing)
   F. Alterations or adaptations
   G. Sights

6.3 Action (External)
   A. Relationships of the action parts
   B. Correct assembly
   C. The proper locking of the action on closing
   D. Cylinder rotation (securely locks).
   E. Hand relationship to the ratchet (worn).
   F. Trigger (not returning, sticks, broken spring, etc.)
   G. Trigger pull (ex: single action, double action, hybrid action, etc.) and striking of hammer.

6.4 Safeties
   A. ¼, ½, full cock, seating check (any false seating positions, pull off/push off, etc.)
   B. Grip, magazine, disconnector: function
   C. Thumb/finger - note positions when firearm will fire
   D. Rebound hammer or inertia firing pin
      1. Firing pin relationship to primer
      2. Firing pin condition
      3. Drop hammer several times to check above safeties.
   E. Position of the slide or bolt in order to fire
   F. Condition of safeties

6.5 Action Check
   A. Check feeding
      1. Magazine
      2. Carrier or lifter
      3. Feed ramp
      4. Magazine lips, etc.
   B. Slamfire
   C. Extractor and/or ejector markings on evidence cartridges/discharged cartridge cases
D. Unusual marks exhibited on the cartridges/discharged cartridge cases.

E. Check for any inherent "quirks" known about the particular firearm based on literature or case data.

6.6 Test Fire Firearm (note operation, misfires, etc.)

A. Note any operational problems.

B. Ammunition involved (proper cartridge, type, reloads, etc.).

C. Check consistency of the impression on test and evidence.

6.7 Special Situational Tests:

Care should be exercised when the force to be used in testing could alter or damage internal parts and their working relationship(s). Damage caused by the examiner may prevent the examiner from determining the cause of the reported malfunction.

6.8 Action (Internal)

A. Hammer notch(s)
   1. Worn
   2. Burrs
   3. Dirt, etc.

B. Sear
   1. Worn
   2. Broken
   3. Burrs, etc

C. Safeties (relationships and general parts relationship).

D. Springs
   1. Weak
   2. Broken
   3. Altered, etc

E. Signs of any tampering or faulty assembly.

7 Interpretation

Any change to the firearm must be specifically documented in the examiner’s notes.

8 Literature References and Supporting Documentation


FTM-03-06  BORE CHAMBER CASTING

1  Scope
Occasionally, firearms are received and the caliber may not be known or may be different than is designated on the firearm and in the literature. In order to facilitate firing of test shots that are of the correct caliber for a particular firearm, it may be necessary to make a bore and/or chamber cast. By measuring the cast, the correct cartridge can be selected for test firing.

2  Related Documents
Firearm Safety (FTM-03-01)

3  Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

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

4  Equipment and Materials
- Casting materials (e.g. Mikrosil®, Cerrosafe®, ForensicSil®)
- WD-40®

5  Standards, Controls, and Calibration
None

6  Procedure
Casts can be made using various casting materials such as low melting point metals and silicone rubber compounds.

A. Ensure that the firearm is unloaded.
B. Open the action and remove the bolt or bolt assembly.
C. Check the bore to make sure it is clear.
D. Push a cleaning patch in the barrel, from muzzle end, until it is ½ inch to ¼ inch from the beginning of the chamber.
E. For Cerrosafe®, lubricate the chamber with gun oil or a silicone spray or some other similar substance such as WD-40®.
F. Prepare as per manufacturer instructions and carefully fill the chamber.
G. Do not allow casting material to flow into breech. It will make extraction difficult.
H. When casting material is set or cool, depending on type used, gently tap end of cleaning rod to loosen cast from the chamber and remove from the breech.
I. If the cast, for some reason, cannot be loosened from the chamber, Cerrosafe® can be melted out of the barrel. This is accomplished by removing the stock and placing breech end in a large container of water and heating to just above its melting temperature.
J. Cerrosafe® can be reused as necessary.

K. Silicon rubber compounds have to be pushed/forced out and are not reusable. Therefore, it is undesirable to let any more of the casting material than necessary go into the barrel.

L. The same steps may be used in the casting of the bore. However in bore casting, only the last three (3) inches of the bore need to be cast. Push a cleaning patch through the bore from the chamber end until it is approximately 3 inches from the muzzle end.

7 Interpretation

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

8 Literature References and Supporting Documentation


FTM-03-07 REFERENCE COLLECTIONS

1 Scope
A reference collection is maintained by the laboratory for both firearms and ammunition in order to assist laboratories:

- Identify the make, model and source of evidence firearms
- Provide exemplar firearms for various scientific testing purposes which might otherwise compromise an evidence firearm
- Provide an exemplar resource for training new forensic scientists/evidence technicians or in developing new technology for the scientific examination of firearms
- Provide a source of firearms parts for the temporary repair of evidence firearms for test-firing purposes
- Provide a resource for the identification of firearms parts recovered at a crime scene
- Provide a resource for the location and style of firearm serial numbers
- Identify the manufacturer’s cartridge designation and source of evidence ammunition or component parts thereof.
- Provide an exemplar resource for training new forensic scientists/evidence technicians.
- Provide a resource for the identification of ammunition components recovered at a crime scene or autopsies.

2 Related Documents
Firearm Safety (FTM-03-01)
Reference Collections (FTM-03-07)
General Manual – Handling and Disposition Of Entrusted Properties, Weapons section (24.05.10)

3 Safety
This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

4 Equipment and Materials
- Inertia bullet puller
- Storage boxes/containers
- Flat file cabinets

5 Standards, Controls, and Calibration
None
6 Policy

6.1 Firearms Reference Collection

A. Firearms awarded to the department must be accompanied by the corresponding court order (if available) and have approval from the appropriate Division Chief as per General Manual 24.05.10 h. This includes firearms that are initially submitted for testing and are then retained in the reference collection.

B. A firearms reference library must be maintained under strict regulations and controls. Firearms, which are deemed unsuitable for scientific purposes, should be transferred to the DPS General Stores for destruction. The laboratory, and specifically the firearms section, normally assume all responsibility for security and control of these firearms.

C. It is recommended that a receipt be issued for every firearm received for the reference collection or destruction.

D. A record should be made immediately upon receipt of a firearm, intended for the reference collection, in a log. The entry should include:
   1. Tracking number assigned.
   2. Date received at the laboratory.
   3. Submitting agency, source, or agency/person transferring control of the firearm to the laboratory.
   4. Caliber or gauge of the firearm.
   5. Make, brand and manufacturer, if known.
   6. Model number(s) and/or name.
   7. The serial number as stamped on the firearm.
      a) “NONE” if the serial number does not exist or cannot be found.
      b) “OBLIT”: if the serial number has been obliterated.
      c) Note that the BATFE issues new serial numbers for firearms with obliterated serial numbers and with shortened barrels which may then be permanently stamped on such firearms by laboratory personnel. These issued serial numbers can be obtained through the local BATFE office.
   8. Comments

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

F. All firearms placed in the reference collection should be tagged in such a manner so as to display that firearm’s location within the collection.

G. If a firearm is removed from the collection, it must be documented on the Firearm Checkout Log (LAB-FTM-21)

H. It is recommended that a system that facilitates cross-referencing the collection be maintained.

I. The firearms reference collection must be inventoried annually. The inventory record must be documented and retrievable and should be conducted by at least two persons one of which is not associated with the care and custody of the collection.
J. When a firearm is no longer needed that has been awarded to DPS by court order, the firearm will be transferred to DPS General Stores for destruction per General Manual 24.05.10 h. Receipt of transfer will be retained with the records for that firearm.

6.2 Ammunition Reference Collection

A. The nature of each laboratory’s ammunition reference collection will be dictated or limited by the space, storage containers and computer equipment available. However the following should be considered

1. Use of architect blue print cabinets or similar style cabinets for storage of the collection.
2. Use of clear plastic tubes or boxes for storage of each ammunition entry. The entry consisting of at least one whole cartridge and one cartridge broken down into its component parts.
3. Recording cartridge information such as
   a) Manufacturer
   b) Bullet weight
   c) Bullet style or configuration
   d) Manufacturer’s Index
   e) Headstamp
   f) Other pertinent information
4. Catalog in storage cabinet utilizing caliber and/or other manufacturer’s data as appropriate to organize.
5. Utilize a computer and appropriate software to track and maintain the collection.

7 Records

Firearm Checkout Log (LAB-FTM-21)
Firearm Reference Collection Log

Court orders corresponding to firearms that have been transferred to a laboratory for purposes of inclusion in the reference collection will be maintained by the respective laboratory

Receipts of transfer for firearms that have been transferred to DPS for the purpose of destruction

8 Literature References and Supporting Documentation

FTM-03-08 RECOVERY METHODS

1 Scope
In order to perform a microscopic comparison of a submitted firearm, a minimum of one (1) test shot must be fired and recovered. Recovery methods include the water tank, the cotton waste recovery box, and the bullet trap. The type of firearm and ammunition tested will usually dictate the type of recovery method used.

2 Related Documents
Firearm Safety (FTM-03-01)
Remote Firing (FTM-03-09)
Downloading (FTM-03-10)
Primed Cartridge Case/Shotshell (FTM-03-11)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

B. Appropriate hearing and eye protection must be used.

C. The examiner must consider the practicality and/or desirability to wear some form of bullet resistant clothing.

D. One should be aware of the maximum velocity of the projectile that can be fired into a particular water tank, as well as the proper water depth needed for firing.

4 Equipment and Materials
- Water Tank
- Exhaust System

5 Standards, Controls, and Calibration
None

6 Procedure
6.1 Water Recovery Tank
The water recovery tank is usually used to recover bullets from handguns, rifles and slugs fired from shotguns.

1. The examiner should consider indexing and sequencing each shot and perform these functions if necessary.

2. Proper hearing and eye protection must be worn.

3. Ensure that the water level is appropriate.

4. Ensure that all lids or doors of the water recovery tank are closed and properly secured.
5. Ensure that the exhaust fans or system is turned on.
6. Ensure any warning systems are activated. Notify appropriate personnel before doing any test firing.
7. The examiner should consider loading no more than three (3) cartridges into the firearm during the initial testing of the firearm.
8. Fire the firearm through the shooting port. If the firearm is capable of firing both single and double action modes, a minimum of one (1) shot per mode should be obtained.
9. Recover the bullets using a net, pole, or some other appropriate device.
10. Ejected discharged cartridge cases must be retrieved. Devices to catch the discharged cartridge cases are commercially available.

6.2 Cotton Waste Recovery Box

The cotton waste recovery box is usually used to recover bullets from handguns, rifles and slugs fired from shotguns.

1. The examiner should consider indexing and sequencing each shot and perform these functions if necessary.
2. Proper hearing and eye protection must be worn.
3. The examiner should consider wetting the first section of cotton in the box.
4. The examiner should consider the placement of paper partitions at various points in box to ensure tracking of the test shot, as well as insuring that the cotton is packed down so as not to retain previous bullet paths.
5. Ensure that all lids or doors of the box are closed and properly secured.
6. Ensure that the exhaust fans or system is turned on.
7. Ensure any warning systems are activated. Notify appropriate personnel before doing any test firing.
8. The examiner should consider loading no more than three (3) cartridges into the firearm during the initial testing of the firearm.
9. Fire the firearm through the shooting port. If the firearm is capable of firing both single and double action modes, a minimum of one (1) shot per mode should be obtained.
10. Bullets should be recovered by searching through cotton, using partitions as guides.
11. Ejected cartridge cases must be retrieved. Devices to catch the discharged cartridge cases are commercially available.

6.3 Bullet Trap

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

1. The examiner should consider indexing and sequencing each shot and perform these functions if necessary.
2. Proper hearing and eye protection must be worn.
3. Ensure that the Exhaust fans or system is turned on.

4. Ensure any warning systems are activated. Notify appropriate personnel before doing any test firing.

5. The examiner should consider loading no more than two (2) cartridges into the firearm during the initial testing of the firearm.

6. Fire the firearm into the front of the trap. If the firearm is capable of firing both single and double action modes, a minimum of one (1) shot per mode should be obtained.

7. Ejected cartridge cases must be retrieved. Devices to catch the discharged cartridge cases are commercially available.

7 Literature References and Supporting Documentation


FTM-03-09 REMOTE FIRING

1 Scope

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 Zero-One® (or a similar device) can be utilized for firing long arms and some handguns, while the Ransom Rest® (or a similar device) can be utilized for firing handguns.

2 Related Documents

Firearm Safety (FTM-03-01)
Downloading (FTM-03-10)
Primed Cartridge Case/Shotshell (FTM-03-11)

3 Safety

A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

B. Appropriate hearing and eye protection must be used.

C. The examiner must consider the practicality and/or desirability to wear some form of bullet resistant clothing.

D. The examiner must follow all safety recommendations set forth by the manufacturer of the shooting device used.

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

4 Equipment and Materials

None

5 Standards, Controls, and Calibration

None

6 Procedure

A. The examiner should consider indexing and sequencing each shot and perform these functions if necessary.

B. Proper hearing and eye protection must be worn.

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

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

E. Ensure that the exhaust fans or system is turned on.
F. Ensure any warning systems are activated. Notify appropriate personnel before doing any test firing.

G. The examiner should consider loading no more than one (1) cartridge into the firearm during the initial testing of the firearm.

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

I. Obtain fired tests.

7 Literature References and Supporting Documentation

FTM-03-10 DOWNLOADING

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

2 Related Documents
Firearm Safety (FTM-03-01)
Recovery Methods (FTM-03-08)
Remote Firing (FTM-03-09)
Primed Cartridge Case/Shotshell (FTM-03-11)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

B. Appropriate hearing and eye protection must be used.

4 Equipment and Materials
Balance/Scale

5 Standards, Controls, and Calibration
None

6 Procedure
A. Pull the bullet of the cartridge using an inertia bullet puller or a reloading press.
B. Remove existing powder.
C. Weigh the pulled bullet.
D. Consult a reloading manual, such as Lyman, and obtain the powder charge for the weight of the pulled bullet and the new velocity needed.
E. Weigh out the appropriate powder charge and place in existing cartridge case.
F. Loosely pack a small piece of tissue or other similar material into the case to fill the gap between the bullet and powder.
G. Seat the bullet back into the cartridge case using a rubber mallet or a reloading press.
H. If appropriate powder is not available, a reduced load using 50% of the original powder can be used. It should be noted that great care must be taken when performing this type of downloading.
   1. 50% downloading CANNOT be used with slow burning powders.
   2. 50% downloading CANNOT be used with many non-cannister powders.
I. When utilizing downloaded ammunition it is imperative that the examiner checks the barrel for obstructions between each firing. The bullet, cartridge case, or shotshell of each test shot should be marked appropriately.

7 Literature References and Supporting Documentation


FTM-03-11 PRIMED CARTRIDGE CASE/SHOTSHELL

1 Scope

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

2 Related Documents

Firearm Safety (FTM-03-01)
Recovery Methods (FTM-03-08)

3 Safety

A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered.

B. Appropriate hearing and eye protection must be used.

C. The examiner must consider the practicality and/or desirability to wear some form of bullet resistant clothing.

4 Equipment and Materials

None

5 Standards, Controls, and Calibration

None

6 Procedure

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

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

C. Proper hearing and eye protection must be worn.

D. Ensure that the exhaust fans or system is turned on.

E. Ensure any warning systems are activated. Notify appropriate personnel before doing any test firing.

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

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

H. Repeat if the firearm has more than one action.

I. Obtain all tests.
7 Interpretation

None

8 Literature References and Supporting Documentation

None
FTM-03-12 CALIBER DETERMINATION

1 Scope

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

2 Related Documents

GRC Utilization (FTM-03-14)
Trace Material Examination (FTM-03-19)

3 Safety

A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials

- Comparison Microscope
- Stereo Microscope
- Calipers/Micrometer

5 Standards, Controls, and Calibration

None

6 Procedure

A. 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.

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

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

3. Determine and record the number and widths of the lands and grooves and compare to the Combined Land and Groove Width Table.

4. Physical characteristics of the evidence bullet, such as weight, bullet shape, composition, nose configuration, and number and placement of cannelures, may aid in caliber determination.
7 Interpretation
   A. Caliber is written as a numerical term and may be depicted with or without the decimal point.
   B. If the base is mutilated, the examiner may only be able to determine that the evidence is consistent with a range of calibers or that the caliber cannot be determined.

8 Literature References and Supporting Documentation


9 Combined Land and Groove Width Table
FTM-03-13 COMPARISON MICROSCOPE

1 Scope
One of the class characteristics used in the discipline of firearms identification is the width of the land impressions and groove impressions. These measurements aid the examiner during the identification or elimination of a suspect firearm. If no firearm is submitted, these measurements will be used in determining the General Rifling Characteristics of the firearm involved. Several instruments can be used to obtain these measurements.

2 Related Documents
GRC Utilization (FTM-03-14)
Trace Material Examination (FTM-03-19)

3 Safety
A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.
C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials
- Comparison Microscope
- Micrometer

5 Standards, Controls, and Calibration
None

6 Procedure
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.
6.1 Air Gap

1. The fired bullet in question is mounted on one stage of the comparison microscope. The digital micrometer is mounted on the other stage. Both stages must be using the same magnification level (objective setting) and be in focus.

2. Align the image of the measurement gap (opening) of the micrometer with the image of the appropriate land impression being measured and record the measurement to the nearest hundredth or thousandth of an inch or appropriate measurement.

3. Repeat the above utilizing the groove impression.

6.2 Grid

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

1. The land impression of the fired bullet is placed in a vertical position with both of the anchor points corresponding to points on the alignment grid and record the measurement to the nearest hundredth or thousandth of an inch or appropriate measurement.

2. Repeat the above utilizing the groove impression.

6.3 Stage Micrometer

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

2. The land impression of the fired bullet is placed in a vertical position with one of the anchor points corresponding with the alignment grid of the micrometer.

3. Rotate the micrometer's measuring point to the next anchor point and record the measurement to the nearest hundredth or thousandth of an inch or appropriate measurement.

4. Repeat the above utilizing the groove impression.

6.4 Ruler

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

2. The land impression at the base of the fired bullet is placed perpendicular to the scale of the ruler.

3. Measure the distance between both anchor points of a land impression and record the measurement to the nearest hundredth or thousandth of an inch or appropriate measurement.

4. Repeat the above utilizing the groove impression.

7 Interpretation

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


FTM-03-14  GRC UTILIZATION

1 Scope

The AFTE General Rifling Characteristics (GRC) database, the FBI’s General Rifling Characteristics (GRC) Database, and/or other lists of class characteristics can be utilized when attempting to determine a list of possible firearms that could have fired an evidence fired bullet, cartridge case, or shotshell (see limitations below) when a firearm with similar class characteristics was not submitted.

2 Related Documents

Comparison Microscope (FTM-03-13)
Trace Material Examination (FTM-03-19)

3 Safety

A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials

Stereo Microscope

5 Standards, Controls, and Calibration

None

6 Procedure

A. The FBI’s General Rifling Characteristics (GRC) Database can be accessed using the PC software version of the FBI’s GRC System or the current printout of the file.

B. The AFTE General Rifling Characteristics (GRC) Database can be utilized by accessing the web-based database on the AFTE website.

C. Follow the operating instructions listed specifically within each of the above systems utilizing the caliber and rifling characteristics of the evidence fired bullet / class characteristics of the evidence fired cartridge case or shotshell.

D. Alternatively, examiners can use lists of firearms that share similar class characteristics such as lists of firearms with polygonal rifling.

7 Interpretation

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

A. All firearms may not be found in database.

B. Caution should be used when utilizing the AFTE General Rifling Characteristics (GRC) database, the FBI's General Rifling Characteristics (GRC) Database, and/or any other list of class characteristics to determine a list of possible firearms that could have fired an evidence cartridge case or shotshell. Information regarding the class characteristics for these items within these databases is known to be absent and/or incomplete.

9 Literature References and Supporting Documentation


FTM-03-15 WADDING DETERMINATION

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

2 Related Documents
Comparison Microscope (FTM-03-13)
Trace Material Examination (FTM-03-19)

3 Safety
A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials
- Comparison Microscope
- Stereo Microscope
- Caliper / Micrometer

5 Standards, Controls, and Calibration
None

6 Procedure
A. Determine gauge size by:
   1. Directly comparing the evidence to known laboratory standards of similar manufacture or composition by comparing the base of evidence to the bases of the standards until a similar size is found.
   2. Gauge size can also be determined by measuring the base diameter of the wad and comparing these measurements to known measurements. Take and record measurements by caliper, Stereo Microscope–Grid, Stereo Microscope–Micrometer, Stereo Microscope–Ruler, or Air Gap.

B. Manufacturer’s data can be determined by locating information stamped into the wad or by comparing the wad to known laboratory standards.

C. Microscopic examination may reveal striations suitable for identification of the wad back to the shotgun that fired it.

D. If evidence shotshells are submitted, it may be necessary to disassemble one for the determination of gauge size or manufacturer.

E. Record all information on the appropriate worksheet.
7 Interpretation

Consult known wadding sizes in AFTE Glossary, other reference, or known standards to determine the corresponding type. The reference used will be documented in the case record in detail sufficient for another examiner to identify.

8 Limitations

A. If the wad is mutilated or soaked with blood or other body fluids, the examiner may not be able to specifically determine gauge size.

B. The examiner should also recognize that some manufacturers might duplicate the design of another manufacturer.

9 Literature References and Supporting Documentation

FTM-03-16 SHOT DETERMINATION

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

2 Related Documents
Comparison Microscope (FTM-03-13)
Trace Material Examination (FTM-03-19)

3 Safety
A. This procedure may involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.
C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials
• Comparison Microscope
• Stereo Microscope
• Caliper / Micrometer
• Balance / Scale

5 Standards, Controls, and Calibration
None

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

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

1. Record the total number of pellets received.
2. Determine the composition of the pellets.
3. Determine the number of pellets suitable for weighing. Make note if pellet sizes appear similar. If several sizes present, determine each specific size.
4. Weigh the pellets in grams or grains.
5. Divide weight of pellets by total number weighed.
6. Consult known pellet weights in AFTE Glossary or other reference and determine shot size, which corresponds to evidence shot.
7. Record findings on appropriate worksheet.
8. The weight of the evidence pellets can also be directly compared to weight of standards using the same number of pellets until a similar known weight is obtained.

C. Measuring Pellet Size

1. Determine the total number of pellets received.
2. Determine the composition of the pellets.
3. Determine the number of pellets suitable for comparison purposes. Make note if pellet sizes all appear to be similar in size. If several different sizes are present, determine each specific size.
4. Choose the best specimen and measure diameter using a caliper and record in hundredths or thousandths of an inch or the appropriate measurement.
5. Consult known pellet sizes in AFTE Glossary or other reference and determine shot size, which corresponds to evidence shot.

7 Interpretation

Consult known pellet sizes in AFTE Glossary, other reference, or known standards and determine shot size, which corresponds to evidence shot. The reference used will be documented in the case record in detail sufficient for another examiner to identify.

8 Limitations

If the shot is mutilated, the examiner may not be able to specifically determine shot size.

9 Records

One or both of these forms may be used to record findings:

Laboratory Info Sheet (LAB-403 or LAB-404)
Projectile Worksheet (LAB-FTM-02)

10 Literature References and Supporting Documentation

FTM-03-17 PHYSICAL EXAMINATION AND CLASSIFICATION OF FIRED EVIDENCE

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

2 Related Documents
Caliber Determination (FTM-03-12)
Comparison Microscope (FTM-03-13)
GRC Utilization (FTM-03-14)
Trace Material Examination (FTM-03-19)

3 Safety
A. This procedure may involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials
- Comparison Microscope
- Stereo Microscope
- Caliper / Micrometer
- Balance / Scale

5 Standards, Controls, and Calibration
None

6 Procedure
A. Items with an asterisk are accepted as required by the discipline.

B. A worksheet should be completed as thoroughly as necessary. This may include determining the following:

6.1 Fired Evidence
1. If any trace material present.
2. Presence of gunpowder and/or powder imprints adhering to the base.
3. Caliber. *
4. Weight (in grains)*
5. Number of lands and grooves on fired bullet. *
6. Direction of twist. *
7. Measured width of the land impressions.
8. Measured width of the groove impressions.
9. Composition of bullet. *
11. Possible manufacturer/marketer of the bullet/projectile.
12. A description of the base of the bullet.
13. Type and position of cannelures.
14. Any extraneous markings, such as skid marks, shave marks, flared base, and/or other marks
15. Condition of the fired evidence as received.
16. Determine and document suitability of the fired evidence for comparison purposes.

6.2 **Fired Cartridge Cases**
1. If any trace material present.
2. Caliber*
3. The possible manufacturer/marketer of the item.
4. Ignition System (such as centerfire, rimfire, or other)
5. Shape of cartridge.
6. Description of cartridge case and primer.
7. Description of head stamp (may include a written representation of the marks on the head stamp, photo, diagram, or sketch). *
8. Description of Firing Pin Impression. *
9. Description of other markings, to include:
   a) **Breech Face Markings***
   b) **Extractor**
   c) **Ejector**
   d) **Resizing Marks**
   e) **Chamber Marks**
   f) **Anvil Marks**
   g) **Magazine Marks**
   h) **Ejection Port Markings**
10. Determine and document suitability of the evidence for comparison purposes.
6.3 Shotshell

1. If any trace material present.
2. Gauge/Bore/Caliber*
3. The possible manufacturer/marketer of the item.
4. Ignition System (such as centerfire, rimfire, or other)
5. Shape of shotshell.
6. Description of shotshell and primer.
7. Description of head stamp (may include a written representation of the marks on the head stamp, photo, diagram, or sketch). *
8. Description of Firing Pin Impression. *
9. Description of other markings, to include:
   a) Breech Face Markings*
   b) Extractor
   c) Ejector
   d) Resizing Marks
   e) Chamber Marks
   f) Anvil Marks
   g) Magazine Marks
   h) Ejection Port Markings
   i) Other Marks
10. Determine and document suitability of the evidence for comparison purposes.

7 Interpretation

A. This examination serves to document a fired evidence routine.

B. In the absence of a submitted firearm with similar class characteristics for comparison, it may be possible to determine a list of possible manufacturers of the firearm that fired a given bullet, cartridge case, or shotshell based on the use of GRC databases (see FTM-03-14), reference materials, literature, and/or the examiner's previous knowledge and experience. Multiple fired bullets, cartridge cases, or shotshells identified to one another or having the same observed class characteristics may be combined into a single weapon type determination.

8 Records

Projectile Worksheet (LAB-FTM-02)

9 Literature References and Supporting Documentation


FTM-03-18  MICROSCOPIC COMPARISON

1  Scope

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

2  Related Documents

Physical Examination and Classification of Fired Evidence (FTM-03-17)

Trace Material Examination (FTM-03-19)

3  Safety

A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4  Equipment and Materials

- Comparison Microscope
- Stereo Microscope

5  Standards, Controls, and Calibration

None

6  Procedure

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

1. Select the correct objective (magnification) setting and ensure that the objectives are locked in place.
2. Select the correct set of oculars (eyepieces).
3. The illumination (lights) used must be properly adjusted. Oblique lighting is usually preferred.
4. If a firearm is included as part of the evidence, compare the test shot(s) produced from this firearm to determine what microscopic characteristics are reproducing.
5. Evaluate and document the suitability of the unknown fired evidence prior to comparison to known standards / test fires.
6. Compare unknown fired evidence to either another piece of unknown fired evidence or a known standard.
7. Comparison of the entire unknown should be considered.

8. If identification is not initially made, the examiner should consider the following factors:
   a) Angle of lights
   b) Type of lights
   c) The need for additional known standards
   d) The position of the evidence, the tests or both
   e) The possibility of using magnesium smoke
   f) The possibility of cleaning the firearm
   g) The possibility that the firearm itself has changed

9. Document the results of comparisons including extensive notes on the indexed identification, indexing marks, and general location of the identifying marks.

7 Interpretation

A. A sufficient correspondence of individual characteristics will lead the examiner to the conclusion that both items originated from the same source.

B. An insufficient correspondence of individual characteristics but a correspondence of class characteristics will lead the examiner to the conclusion that no identification or elimination could be made with respect to the items examined.

C. A disagreement of class characteristics will lead the examiner to the conclusion that both items did not originate from the same source. A disagreement of individual characteristics may lead the examiner to the conclusion that both items did not originate from the same source.

D. A lack of suitable microscopic characteristics will lead the examiner to the conclusion that the items are not suitable for comparison.

8 Literature References and Supporting Documentation


FTM-03-19 TRACE MATERIAL EXAMINATION

1 Scope
Fired evidence recovered during an investigation may contain trace material transferred from the crime scene. This trace material may be in the form of blood, tissue, plaster, paint, hairs, fibers, glass, etc. The examiner needs to evaluate the importance of this evidence and if further examination of the trace material is necessary, remove and preserve a sample of the trace material present. Removal of trace material may also be necessary to allow the proper examination of the fired evidence.

2 Related Documents
Physical Examination and Classification of Fired Evidence (FTM-03-17)

3 Safety
A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a biohazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. Chemical Warnings
NOTE: ALWAYS ADD ACID TO WATER. NEVER ADD WATER TO ACID.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Health Hazard</th>
<th>Flammability Hazard</th>
<th>Reactivity Hazard</th>
<th>Contact Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>15% Acetic Acid</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>10% Bleach</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

1. Acetone is flammable and can pose a SEVERE FLAMMABILITY HAZARD.
2. Methanol is flammable and can pose a SEVERE FLAMMABILITY HAZARD.
3. Acetic acid is capable of detonation and can pose a SEVERE REACTIVITY HAZARD.

D. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials
- Comparison Microscope
- Stereo Microscope
- Scale / Balance
• 15% Acetic Acid Solution (cleaning solution)
  o Prepare a 15% Acetic Acid Solution with Concentrated Glacial Acetic Acid and purified water.
• 10% Bleach Solution (cleaning solution)
  o Prepare a 10% Bleach Solution with Bleach and purified water.

5 Standards, Controls, and Calibration
None

6 Procedure
A. Examine the fired evidence visually and microscopically for any trace material and record in notes.
B. Determine if further examination of trace material is necessary.
   1. If necessary, consult the appropriate discipline section prior to the removal of any trace evidence.
   2. Remove material taking care not to damage the fired evidence.
   3. Place the removed trace material in a suitable container/packaging for submission to the appropriate discipline section for further examination.
C. If the trace material is not going to be retained for further examination, proceed with the following steps that are applicable. Caution should be taken not to damage the fired evidence through the use of any of the specified chemicals.
   Note: If damage to the fired evidence is suspected or occurring, discontinue the use of the chemical immediately.
   1. For evidence containing blood, tissue or other biohazards, soak the evidence for at least one (1) minute in a 10% bleach solution.
   2. Remove loose material by rinsing the fired evidence with methanol or water.
   3. Remove plaster by rinsing the fired evidence in a 15% acetic acid solution.
   4. Remove paint by soaking the fired evidence in alcohol or acetone.
D. It should be documented what steps were performed and the condition of the evidence.

7 Literature References and Supporting Documentation
04 DISTANCE DETERMINATION

FTM-04-01 VISUAL/MICROSCOPIC EXAMINATION DISTANCE DETERMINATION

1 Scope

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

- burnt gunpowder particles
- partially burnt gunpowder particles
- unburnt gunpowder particles
- vaporous lead
- particulate metals

These gunshot residues along with the morphology of the bullet hole can effectively be used in determining the possible muzzle to target distance on clothing.

Due to the difficulty in obtaining suitable test media for reproduction of test patterns on human skin or tissue, distance determination on skin has been determined to be an inapplicable examination by the laboratory. It is recommended that wound pattern analysis be performed by forensic pathologists who may lend insight into distance determination. It may be possible to collect trace debris to identify relevant gunshot residues, however based solely on its presence, it cannot be used to resolve pattern and distance determination.

2 Related Documents

Infrared Examination (FTM-04-02)
Modified Griess (FTM-04-04)

3 Safety

A. This procedure may also involve hazardous materials to include evidence that may be contaminated with a biohazard. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials

Stereo Microscope

5 Standards, Controls, and Calibration

None
6 **Procedure**

A. Distance determination will only be performed when there is a suspected bullet hole in the submitted clothing.

B. The visual/microscopic examination of an item for gunshot residue will include consideration of the following:
   1. The presence of vaporous lead (smoke)
   2. The presence of particulate metals (shavings of lead, copper, brass)
   3. The presence of partially burnt and/or unburnt gunpowder
   4. The presence of melted adhering gunpowder
   5. A hole in the item
   6. The presence of a visible ring around the perimeter of holes
   7. The location of all holes, tears, missing buttons, etc.
   8. The presence of burning, singeing, or melting
   9. The presence of any possible masking effects
   10. The direction of artifacts surrounding the hole

C. A clear overlay may be used to visually document the presence of unburned or partially burned gunpowder particles.

D. Data and observations regarding these physical effects and visible residues must be included in the examiner’s notes.

7 **Interpretation**

A. Indications of, or consistent with, the discharge of a firearm
   1. Vaporous lead (smoke)
   2. Particulate metals (shavings of lead, copper, brass)
   3. Unburned gunpowder (morphology)
   4. Melted adhering gunpowder

B. Indications of, or consistent with, the passage of a bullet
   1. A hole in the item
   2. Visible ring around the perimeter of holes
   3. Location of all holes, tears, missing buttons, etc.

C. Indications of, or consistent with, a contact shot
   1. Ripping or tearing
   2. Burning or singeing
   3. Melted artificial fibers
   4. Heavy vaporous lead residues
   5. Location of all holes, tears, missing buttons, etc.
   6. Hole that exceeds the relative diameter of the bullet(s)
D. Possible masking effects
   1. Dark background color
   2. Blood staining
   3. Intervening object

E. If the above observations support the findings of a “contact shot” no comparison is necessary.

F. If the above observations do not support a “contact shot” finding, the examiner will determine which additional procedures will be performed. Additional testing for non-contact shots must include the following as part of the evidence submission prior to commencing further testing:
   1. Medical and/or autopsy report/photos (number of wounds, location of wounds, entry vs. exit, presence of stippling of gunpowder particles, etc.)
   2. Scene photos (showing how the victim was wearing the garment, presence of outer clothing, etc.)
   3. Offense report
   4. The suspected firearm
   5. The exact ammunition fired

G. All fired ammunition components from the shooting event. In the event that no residues other than bullet wipe are detected, please refer to FTM-01-04 for the appropriate report wording that may be used.

8 Literature References and Supporting Documentation
FTM-04-02 INFRARED EXAMINATION

1 Scope
Visualization of GSR patterns on clothing is an important initial step in performing muzzle to garment distance determination and is often hindered by dark colored or stained clothing. The use of infrared examination for GSR patterns prior to chemical testing can be useful when visually examining dark colored or stained clothing. Gunpowder residue patterns poorly reflect infrared light, while most dark colored fabrics reflect infrared light very well. This contrast of reflectivity allows visualization of patterns that may be obscured by dark colored or stained fabrics.

2 Related Documents
Visual/Microscopic Examination Distance Determination (FTM-04-01)

3 Safety
A. This procedure may involve hazardous materials to include evidence that may be contaminated with a bio-hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials
- Infrared capable camera (such as the Sony Handycam DCR-DVD710 with Night-Shot Plus or any similar camera)
- Infrared filter (such as the Opteka Infrared R-72 30mm High Definition Filter or any similar infrared filter)
- Infrared capable light source instrument (such as the Crime-Lite ML2 or any similar infrared capable instrument)

5 Standards, Controls, and Calibration
A. Positive control testing for the Infrared Examination procedure consists of using a dark colored piece of fabric with a known GSR pattern as a visualization aid to determine if the instrument’s or camera’s infrared feature is working appropriately.

B. Document the results of quality testing in examination documentation.

6 Procedure
This procedure utilizes a camera or instrument with infrared light to visualize GSR patterns on dark colored or stained clothing.

1. If not already attached, attach the infrared filter to the camera or instrument, if necessary. Verify that the infrared mode is in the “ON” position, if necessary. Power on the camera or instrument, if necessary.

2. Use the positive control to confirm that the camera or instrument is functioning properly. Record the results of the positive control in the case documentation.
3. If the camera or instrument visualizes the GSR pattern on the positive control, use the camera to examine the evidence. Use the still image feature, if present, to take photographs of any visual GSR and include these photographs in the case documentation.

7 Literature References and Supporting Documentation


FTM-04-03 DIPHENYLAMINE TEST

1 Scope
This test is useful for the presumptive detection of nitrocellulose in paint and nitric acid residue. It may also be used to detect nitrates, nitroglycerin and other organic nitrates in suspected explosives residues.

2 Safety
A. This procedure involves hazardous materials. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.
C. The use of personal protective equipment must be considered to avoid exposure to dangerous chemicals. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.
D. Chemical Warnings

<table>
<thead>
<tr>
<th>NFPA Listings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
</tr>
<tr>
<td>Diphenylamine</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
</tr>
<tr>
<td>Glacial Acetic Acid</td>
</tr>
</tbody>
</table>

3 Equipment and Materials
- Diphenylamine
- Sulfuric Acid
- Glacial Acetic Acid

4 Procedure
4.1 Reagent Preparation
A. Mix 20 mL sulfuric acid and 10 mL acetic acid and allow to cool before use
B. Dissolve 0.3 g Diphenylamine in the acid mix
C. Verify and document the quality control of the reagent with nitrocellulose paint or an inorganic nitrate (positive control)
D. The reagent should be replaced when it becomes so discolored that any color reaction is hidden or when it fails to yield a strong positive result with known nitrocellulose

4.2 Sample Preparation
A. Liquid samples can be tested directly
B. If the evidence is dried residue, it can be tested directly
4.3 Application
   A. Place a small amount of the sample on a glass slide or in a spot plate well
   B. Add 1 drop of Diphenylamine reagent
   C. Document the reaction

5 Interpretation
   A. A positive reaction is the production of an intense dark blue color within 5 seconds of
      application of the Diphenylamine reagent.
      1. Nitrocellulose paints, inorganic nitrates, nitroglycerin and other organic nitrates will
         give a positive result.
      2. Chlorates will also produce the dark blue color.
   B. Fiegl reports that nitrites, bromates, iodates, chromates and other oxidizing agents will
      produce the blue color.

6 Literature and Supporting Documentation
FTM-04-04 MODIFIED GRIESS

1 Scope

The Modified Griess test is used independently and/or in conjunction with other tests in distance determinations. The Modified Griess test utilizes a color chemistry reaction to help distinguish obscure or faint gunpowder patterns. This test detects nitrites, a product of the incomplete burning of gunpowder, by reacting with acetic acid to form nitrous acid. This acid combines with alpha-naphthol and produces an orange-red color reaction.

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

1. First Modified Griess
2. Second Dithiooxamide
3. Third Sodium Rhodizonate

Due to the difficulty in obtaining suitable test media for reproduction of test patterns on human skin or tissue, distance determination on skin has been determined to be an inapplicable examination by the laboratory. It is recommended that wound pattern analysis be performed by forensic pathologists who may lend insight into distance determination. It may be possible to collect trace debris to identify relevant gunshot residues, however based solely on its presence, it cannot be used to resolve pattern and distance determination.

Visualization of nitrite patterns on Modified Griess paper is an important initial step in performing muzzle to garment distance determination. The use of alternate light sources (ALS) can be useful for aiding in that visualization process due to the intense light of specific wavelengths. The ultraviolet light increases the contrast between nitrite reactions and non-reaction areas so that the pattern can be more easily recognized on Modified Griess paper. This method is especially useful when working with materials that have a light transfer of nitrites. This process is non-destructive and does not inhibit any other testing methods. It is intended as a visual aid only.

2 Related Documents

Dithiooxamide (FTM-04-05)
Sodium Rhodizonate (FTM-04-06)

3 Safety

A. This procedure involves hazardous materials. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to dangerous chemicals. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.
D. Chemical Warnings

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

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Health Hazard</th>
<th>Flammability Hazard</th>
<th>Reactivity Hazard</th>
<th>Contact Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfanilic Acid</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>CORROSIVE</td>
</tr>
<tr>
<td>Alpha Naphthol</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sodium Nitrite</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Glacial Acetic Acid</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

1. Sulfanilic Acid is toxic and can pose a SEVERE HEALTH HAZARD.
2. Sulfanilic Acid is flammable and can pose a SEVERE FLAMMABILITY HAZARD.
3. Sulfanilic Acid is a strong corrosive and can pose a SEVERE CONTACT HAZARD.
4. Alpha Naphthol is toxic and can pose a SEVERE HEALTH HAZARD.
5. Methanol is flammable and can pose a SEVERE FLAMMABILITY HAZARD.
6. Glacial Acetic Acid is flammable and can pose a SEVERE FLAMMABILITY HAZARD.

E. The examiner must use eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 Equipment and Materials

- Scale / Balance
- Reagents
- Alternate light source (ALS) - e.g., Pollilight, Luma-Lite, Forensic PAL, Crime-Lite or equivalent lamp using wavelength of 420 to 470 nm (blue)
- Amber glasses

5 Standards, Controls, and Calibration

A. Positive control testing for the Modified Griess- procedure consists of placing either a freshly made or dried Nitrite Test Swab moistened with 15% glacial acetic acid on the corners of each sensitized blank used for testing. An immediate orange color change on the sensitized blank indicates that nitrates are present.

B. Negative control testing consists of visualizing unprocessed Modified Griess paper using the ALS and observing no nitrite patterns.

C. Positive control testing for the ALS procedure consists of visualizing a known nitrite pattern with the ultraviolet light source.
6 Procedure

6.1 Modified Greiss

A. Reagent Preparation

1. Sensitized Blank (prepare fresh)
   a) Add 0.75 g Sulfanilic Acid to 150 mL purified water and mix.
   b) Add 0.42 g Alpha Naphthol to 150 mL methanol and mix.
   c) Once both the solutions in step 1 & 2 are prepared mix them together in a clean photo tray or other nonreactive tray (such as a baking dish).
   d) Saturate pieces of filter paper, desensitized photo paper or glossy printer paper in this solution.
   e) Once the now sensitized blanks are dry, store in an airtight plastic container.

2. Acetic Acid Solution: mix a 15% Glacial Acetic Acid solution.

3. Nitrite Test Swabs:
   a) Dissolve 0.6 g Sodium Nitrite in 100 mL purified water.
   b) Saturate pieces of filter paper or cotton swabs in this mixture.
   c) Allow the swabs to air dry. Swabs may be stored for several months.

4. Alternate Nitrite Test Swab Method:
   a) Dissolve 0.6g Sodium Nitrite in 100mL 15% glacial acetic acid solution.
   b) Saturate pieces of filter paper or cotton swabs in this mixture.
   c) Prepare fresh on day of use.

B. Direct Application Technique

1. Conduct quality testing of materials, reagents and sensitized paper.

2. Place the sensitized blank (photo paper - emulsion side up or sensitized filter paper or glossy paper).

3. Place evidence side down on the paper (or sensitized filter paper or glossy paper). The defect area may be marked on the paper with a graphite pencil, for orientation purposes.

4. Soak a piece of nitrite free cheesecloth or filter paper with the acetic acid solution, and place this over the reverse side of the evidence.

5. Apply heat and pressure with a hot iron.

6. Record the observations.

C. Reverse Application Technique

1. Wipe the side of the sensitized blank that will be in contact with the questioned area with the acetic acid solution.

2. Place the sensitized blank (photo paper - emulsion side down, glossy printer paper, or filter paper) over the area to be tested.

3. Place a piece of filter paper or nitrite free cheese cloth over either the sensitized blank or evidence depending on what is being used for a blank.

4. Apply heat and pressure with a hot iron.
D. Interpretation

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

2. In the event that no residues are detected, please refer to FTM-01-04 for the appropriate report wording that shall be used.

6.2 Alternative Light Source for the Modified Griess Test

A. This procedure utilizes ALS for enhancing the visualization of nitrite patterns on Modified Griess paper.

1. Darken the room.

2. Select the proper wavelength.

3. Put on the amber glasses or insert the appropriate filter.

4. Conduct positive and negative controls. If increased enhancement is observed on the positive control, use the ALS to examine the evidence.

5. Direct the ALS at the evidence.

6. If the ALS enhances the contrast, use the camera feature, if available, to take photographs and include in case documentation.

B. Interpretation

1. This procedure is intended to be used for documentation purposes during the visual examination.

2. When there is a light transfer of nitrites to the Modified Griess paper, the orange nitrite reaction may be very faint or difficult to visualize on the standard white Modified Griess Paper.

3. When viewing the same paper with ultraviolet light, the contrast is increased and the orange reaction is more readily observable.

4. This method does not need to be used with every completion of Modified Griess testing, but it is especially useful when working with materials that have a light transfer of nitrites.

7 Literature References and Supporting Documentation


Schous CE. A sequence of chemically specific chromophoric tests for nitrite compounds, copper, and lead in gunshot residues. AFTE Journal. 1999. 31, pp. 3-8.


FTM-04-05 DITHIOOXAMIDE (DTO)

1 Scope

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

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

1. First Modified Griess
2. Second Dithiooxamide
3. Third Sodium Rhodizonate

Due to the difficulty in obtaining suitable test media for reproduction of test patterns on human skin or tissue, distance determination on skin has been determined to be an inapplicable examination by the laboratory. It is recommended that wound pattern analysis be performed by forensic pathologists who may lend insight into distance determination. It may be possible to collect trace debris to identify relevant gunshot residues, however based solely on its presence, it cannot be used to resolve pattern and distance determination.

2 Related Documents

Modified Griess (FTM-04-04)
Sodium Rhodizonate (FTM-04-06)

3 Safety

A. This procedure involves hazardous materials. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to dangerous chemicals. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.
D. Chemical Warnings

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

<table>
<thead>
<tr>
<th>NFPA Listings</th>
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</thead>
<tbody>
<tr>
<td><strong>Chemical</strong></td>
</tr>
<tr>
<td>Dithiooxamide</td>
</tr>
<tr>
<td>Ammonia</td>
</tr>
<tr>
<td>Ethanol</td>
</tr>
</tbody>
</table>

1. Dithiooxamide is a strong oxidizing agent and can pose an **EXTREME CONTACT HAZARD**.
2. Ammonia is toxic and can pose a **SEVERE HEALTH HAZARD**.
3. Ethanol is flammable and can pose a **SEVERE FLAMMABILITY HAZARD**.

E. The examiner must use eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 Equipment and Materials

- Scale / Balance
- Dithiooxamide Solution: prepare a 0.2% Dithiooxamide solution in ethanol.
- Ammonia Solution: prepare a 2:5 (or greater) ammonia solution in purified water.

5 Standards, Controls, and Calibration

A. The standards & controls for the DTO test consist of placing a test mark, utilizing a piece of known copper, on filter paper or other suitable material. By performing the DTO procedure on this test mark, the examiner can determine if the DTO test is reacting properly. Document the results of quality testing.

B. An alternative set of standards & controls for the DTO test consist of utilizing a cotton swab dampened with the ammonia solution. The treated swab is rubbed against a piece of known copper. This swab is then processed with the DTO test to ensure that the test is reacting properly. Document the results of quality testing.

6 Procedure

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

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

B. In the event that no residues are detected, please refer to FTM-01-04 for the appropriate report wording that shall be used.

8 Literature References and Supporting Documentation

Schous CE. A sequence of chemically specific chromophoric tests for nitrite compounds, copper, and lead in gunshot residues. AFTE Journal. 1999. 31, pp. 3-8.


FTM-04-06 SODIUM RHODIZONATE

1 Scope

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

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

1. First Modified Griess
2. Second Dithiooxamide
3. Third Sodium Rhodizonate

Due to the difficulty in obtaining suitable test media for reproduction of test patterns on human skin or tissue, distance determination on skin has been determined to be an inapplicable examination by the laboratory. It is recommended that wound pattern analysis be performed by forensic pathologists who may lend insight into distance determination. It may be possible to collect trace debris to identify relevant gunshot residues, however based solely on its presence, it cannot be used to resolve pattern and distance determination.

2 Related Documents

Modified Griess (FTM-04-04)
Dithiooxamide (FTM-04-05)

3 Safety

A. This procedure involves hazardous materials. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to dangerous chemicals. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.
D. Chemical Warnings

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

### NFPA Listings

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<tr>
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<th>Health Hazard</th>
<th>Flammability Hazard</th>
<th>Reactivity Hazard</th>
<th>Contact Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Rhodizonate</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
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<td>Sodium Bitartrate</td>
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<tr>
<td>Tartaric Acid</td>
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<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Glacial Acetic Acid</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1. Hydrochloric Acid is toxic and can pose a **SEVERE HEALTH HAZARD**.
2. Glacial Acetic Acid is capable of detonation and can pose a **SEVERE REACTIVITY HAZARD**.

E. The examiner must use eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 Equipment and Materials

- Scale / Balance

5 Standards, Controls, and Calibration

A. The standards and controls for the Sodium Rhodizonate test consist of placing a test mark, utilizing a piece of known lead, on filter paper or other suitable material. By performing the Sodium Rhodizonate procedure on this test mark, the examiner can determine if the Sodium Rhodizonate solution is reacting properly. Document the results of quality testing.

B. An alternative set of standards & controls for the Sodium Rhodizonate test consist of utilizing a cotton swab dampened with a 15% glacial acetic acid solution or a 5% Hydrochloric acid solution. The treated swab is rubbed against a piece of known lead. This swab is then processed with the Sodium Rhodizonate test to ensure that the test is reacting properly. Document the results of quality testing.

6 Procedure

6.1 Reagent Preparation

A. Sodium Rhodizonate Solution: prepare a saturated Sodium Rhodizonate solution.

B. Hydrochloric Acid Solution: prepare a 5% Hydrochloric Acid solution.

C. Buffer Solution 1:
   1. Dissolve 1.9 g Sodium Bitartrate and 1.5 g Tartaric Acid in 100 mL purified water.
   2. This usually requires both heat and agitation to complete in a reasonable amount of time.
D. Buffer Solution 2 (used if DTO testing performed or may be used as an alternative to Buffer Solution 1):
   1. 0.2 M Potassium Chloride Solution: Dissolve 0.75 g KCl in 50 mL purified water.
   2. 0.2 M Hydrochloric Acid Solution: Dilute 5 mL 12 M HCl in 295 mL purified water.
   3. KCl Buffer Solution, pH 1.0: Combine 25 mL 0.2 M KCl with 67 mL 0.2 M HCl.

E. Acetic Acid Solution: prepare a 15% Acetic Acid solution.

6.2 Sodium Rhodizonate – Direct (DAT)
A. Spray the Sodium Rhodizonate Solution on to the questioned area.
B. Spray the tested area with the appropriate Buffer Solution.
C. Spray the tested area with the Hydrochloric Acid Solution.
D. Repeat this process on all holes/areas to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.

6.3 Sodium Rhodizonate – Bashinsky Transfer (BTT)
A. Uniformly dampen a piece of filter paper with the Acetic Acid Solution.
B. Place the treated filter paper over the hole/area to be tested.
C. Place a second piece of filter paper over the first and apply moderate pressure or apply a hot iron for approximately 5 seconds.
D. Remove both pieces of filter paper and spray the Sodium Rhodizonate Solution on to the tested area of the first filter paper.
E. Spray the tested area of the first filter paper with the appropriate Buffer Solution.
F. Spray the tested area of the first filter paper with the Hydrochloric Acid Solution.
G. Repeat this process on all holes/areas to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.

6.4 Sodium Rhodizonate – Standard Transfer Technique (STT)
A. Process the questioned item by the direct application method according to the procedures outlined above. Before processing any suspected bullet holes, it is recommended that lead test marks on the clothing item to be tested be tested be evaluated to determine if the Direct Application Technique (DAT), Bashinsky Transfer Technique (BTT), or Standard Transfer Technique (STT) is best suited for a particular garment.
B. Blot the appropriate areas of the questioned item using untreated filter paper.
C. Repeat this process on all holes/areas to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.

7 Interpretation
A. A violet or purple colored ring, corresponding to the margin of the hole or corresponding to the area tested, constitutes a positive reaction for lead.
B. In the event that no residues are detected, please refer to FTM-01-04 for the appropriate report wording that shall be used.
8 Literature References and Supporting Documentation


Schous CE. A sequence of chemically specific chromophoric tests for nitrite compounds, copper, and lead in gunshot residues. AFTE Journal. 1999. 31, pp. 3-8.


FTM-04-07 TEST PATTERN PREPARATION

1 Scope

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

Due to the difficulty in obtaining suitable test media for reproduction of test patterns on human skin or tissue, distance determination on skin has been determined to be an inapplicable examination by the laboratory. It is recommended that wound pattern analysis be performed by forensic pathologists who may lend insight into distance determination. It may be possible to collect trace debris to identify relevant gunshot residues, however based solely on its presence, it cannot be used to resolve pattern and distance determination.

2 Related Documents

Firearm Safety (FTM-03-01)

3 Safety

A. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. Proper caution to include adherence to any and all Firing Range rules must be exercised and the use of personal protective equipment must be considered to avoid exposure to any potential hazards.

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

4 Equipment and Materials

Test Target Media:

Attach appropriate sized pieces of cotton twill material, a piece of the evidence material, or other suitable material to a nitrite free cardboard backing board. When necessary use similar material of the same weave and composition to prepare tests. The consent of the customer will be required to use evidence material to prepare tests.

5 Standards, Controls, and Calibration

None

6 Procedure

1. Tests should be shot one per piece of target media.

2. Tests should be shot in appropriate increments until a distance range is established. This range should be both shorter and longer than the range that resembles the patterns on the submitted item.

3. It is essential that the suspect firearm and appropriate ammunition be utilized for these tests.

4. Record observations, including distances of the tests.
7 Interpretation

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

8 Literature References and Supporting Documentation


Dillon JH. A Protocol for Shot Pattern Examinations in Muzzle-to-Target Distance Determinations. AFTE Journal. 23(1), p. 49.

05  SHOOTING SCENE RECONSTRUCTION

FTM-05-01  DOWEL AND STRING/LASER TRAJECTORY METHOD

1  Scope
The preferred method for trajectory analysis is dowel and string and/or laser for the purpose of
documenting and analyzing evidence involved with shooting incidents. It is primarily used to
determine the possible position of the shooter(s).

2  Related Documents
None

3  Safety
A. Firearms must always be handled as though loaded.
B. The appropriate eye and ear protection is required for test firing.
C. Shooting range safety rules must be obeyed.

4  Equipment and Materials
- Dowels
- String
- Ruler
- Micrometer
- Tape measure
- Calculator
- Protractor
- Laser trajectory kit

5  Standards, Controls, and Calibration
None

6  Procedure
Note: Prior to conducting trajectory analysis, the examiner should be briefed on the incident by
the investigating officer or through documentation, photos, film, or a combination of these items. It
is important that the analyst be aware of the circumstances of the shooting incident so that
possible positions of the shooter are not eliminated. A laser trajectory kit may be substituted for
the dowel and string or used to supplement the dowel and string method.

A. Examine the area in and around the hole(s) for possible blood or trace evidence.
   Photograph, diagram and document all holes prior to removing any evidence or doing any
   analysis.

B. Examine the hole(s) for characteristics of bullet entry/exit. Document the location and
   position of the center of the hole(s). Document with photos/sketches as needed.

C. Choose the appropriate diameter dowel to put into the hole. Find a dowel that is tight but
do not force an oversize dowel into the hole.

D. Using a protractor, measure the horizontal and vertical angles of the hole. Document the
   measurements.
E. Attach a string securely to the dowel and pull the string taut. Ensure the dowel is secured to the surface. Have another analyst or officer walk along the string to ensure that it is tight and that the string is in line with the trajectory of the hole. Have the analyst or officer photograph the trajectory line from different angles. Extend the string along the trajectory line until the possible position(s) of the shooter(s) can be eliminated. For example – at ten feet from the surface struck by the bullet the string is now twelve feet in the air.

F. Document possible positions of the shooter.
   1. Measure the distance from the trajectory line to the ground at each of the possible positions.
   2. Measure the distance along the ground from possible shooting position(s) to the object with the hole(s).

7 Interpretation
   A. Trajectory analysis is an estimation based on the physical evidence at the scene.
   B. The report should reflect a range of possible shooting positions and that the reported position(s) and angle(s) are approximations and do not reflect a reconstruction of the sequence of events.

8 Limitations
   A. Possible intermediate targets.
   B. The type of surface impacted.

9 Records
   Field notes and photographs

10 Literature References and Supporting Documentation
FTM-05-02  DIRECTION OF TRAVEL

1  Scope

This is a procedure for determining the direction of travel when there are intermediate targets such as glass or metal or when there is a ricochet.

Note: Shooting incidents often involve bullet penetrations through intermediate objects. Some of the more common objects are glass and metal. Sometimes a bullet may not penetrate the object, but may ricochet. The direction of travel can still be determined.

2  Related Documents

None

3  Safety

A. Firearms must always be handled as though loaded.
B. The appropriate eye and ear protection is required for test firing.
C. Shooting range safety rules must be obeyed.

4  Equipment and Materials

- Dowels
- String
- Ruler
- Micrometer
- Tape measure
- Calculator
- Protractor
- Laser trajectory kit

5  Standards, Controls, and Calibration

None

6  Procedure

6.1  Penetration

A. Photograph, document, and/or diagram both sides of the surface that has been penetrated by the bullet.

B. If the surface is glass and has not shattered, the direction of travel can be determined by closely observing the “cratering” or “coning”. A bullet that has penetrated the glass will produce “cratering” or “coning” on the opposite side of the impact.

C. If the surface is metal, the direction of travel can be determined by closely observing the “cratering” or “coning”. A bullet that has penetrated the metal will produce “cratering” or “coning” on the opposite side of the impact.

D. The presence of gunshot residue can be used to confirm the direction of travel.
6.2 Ricochet

A. Photograph, document, and/or diagram the surface that has been struck by the bullet.

B. If the surface is glass and has not shattered, the direction of travel can be determined by closely observing the “cratering”. A bullet that has ricocheted off the glass will produce “cratering” on the same side as the impact.

C. For ricochet off of most surfaces, the shape and depth of the ricochet mark can tell you the direction of travel.

D. Ricochet marks on metal tend to be funnel-shaped. The area where the bullet first strikes the surface is smaller than the area where the bullet exits the surface.

E. Ricochet marks on glass tend to be rounded at the point of entry and small and pointed at the point of exit, showing the direction of travel.

F. For non-frangible surfaces (such as steel), the maximum depth of a ricochet crease is closest to the exit.

G. For frangible surfaces (such as concrete), the maximum depth of a ricochet crease is closest to the entrance.

H. Stress cracks on the underside of painted metal surfaces will point away from the direction of travel in a ricochet, showing the direction of travel.

I. A bullet ricocheting off glass produces a cloud of glass, which travels in the direction of the ricocheting bullet, which can also help determine the direction of travel.

J. Photograph, diagram, and document all relevant information.

K. Bullet creases in painted metal may retain portions of the rifling characteristics of the striking bullet. Document with diagrams and / or photography.

6.3 Angle of Impact of Ricochet

A. Measure the length and width of the ricochet mark.

B. Determine the angle of impact of the bullet (vertical angle) with the formula:

\[
\text{Vertical angle of impact} = \arcsin \left( \frac{\text{width of hole}}{\text{length of hole}} \right)
\]

7 Interpretation

A. The report should reflect a range of possible shooting positions and that the reported position(s) and angle(s) are approximations and do not reflect a reconstruction of the sequence of events.

B. The type of surface impacted will affect length and width of the ricochet mark.

8 Limitations

A. Possible intermediate targets.

B. Horizontal distance relies on assumptions drawn from police reports and witness statements.

C. Holes produce by objects propelled at high speeds can be very similar to holes produced by a bullet.

D. The type of surface impacted.
9 Records

Field notes and photographs

10 Literature References and Supporting Documentation

FTM-05-03  EJECTION PATTERN TESTING

1 Scope
Ejection pattern testing may be used to determine possible positions of shooter(s) in relation to the location of fired cartridge cases, as well to support the trajectory analysis methods.

2 Related Documents
None

3 Safety
A. Firearms must always be handled as though loaded.
B. The appropriate eye and ear protection is required for test firing.
C. Shooting range safety rules must be obeyed.

4 Equipment and Materials
- Dowels
- Tape measure
- Protractor

5 Standards, Controls, and Calibration
None

6 Procedure
6.1 Quantitative Method
A. The location and identity of cartridge cases should be established and documented prior to ejection pattern testing.
B. The shooter position and height that the firearm was held may be approximated based on assumptions drawn from police reports, witness statements, and any additional information provided by the submitting agency.
C. Using a rest (if available), it is recommended to test fire the weapon using, at a minimum, the equivalent of a full magazine of ammunition consistent with the fired ammunition components recovered at the crime scene. The more test shots that are conducted, the more statistically significant the individual cartridge case locations become. When practical, consider shooting approximately 20 cartridges.
D. Use a spotter to mark the initial impact location of each cartridge case. Flags or numbered cards may be used for this purpose. Other items may be used to mark the location of the cartridge cases. For example, one can label the cartridges by writing/scribing the shot sequence number on the cartridge cases before firing.
E. Locate and mark a position on the ground/surface directly below the ejection port.
F. Measure the X and Y coordinates for the position of each cartridge case. The coordinates are to be measured from the point marked on the ground/surface directly below the ejection port of the weapon that was test fired. Tabulate the results for each and calculate the average for the X and Y coordinates. Use of a graph and/or scatter plot may aid in visualizing the results. Ensure all X and Y coordinate values are recorded using the same unit of measure.
G. The weather conditions, especially in regards to wind speed and direction, should be noted. Ejection pattern tests may be conducted indoors or outdoors on a day in which wind speeds are negligible.

6.2 Qualitative Method
A. The location and identity of cartridge cases should be established and documented prior to ejection pattern testing.
B. The shooter position and height that the firearm was held may be approximated based on assumptions drawn from police reports, witness statements, and any additional information provided by the submitting agency.
C. Using a rest (if available), it is recommended to test fire the weapon using, at a minimum, the equivalent of a full magazine of ammunition consistent with the fired ammunition components recovered at the crime scene. The more test shots that are conducted, the more representative the cartridge case locations become to that particular firearm’s overall ejection pattern. When practical, consider shooting at least 20 cartridges.
D. Use a spotter to mark the initial impact location of each cartridge case. Flags or numbered cards may be used for this purpose. Other items may be used to mark the location of the cartridge cases. For example, one can label the cartridges by writing/scribing the shot sequence number on the cartridge cases before firing.
E. Locate and mark a position on the ground / surface directly below the ejection port and/or muzzle.
F. Document the general location of the fired cartridge cases relative to the location of the firearm. Photographs or sketches may be used for this purpose.
G. The weather conditions, especially in regards to wind speed and direction, should be noted. Ejection pattern tests may be conducted indoors or outdoors on a day in which wind speeds are negligible.

7 Interpretation
7.1 Quantitative Method
A. The report should reflect a range of possible shooting positions and that the reported position(s) and angle(s) are approximations and do not reflect a reconstruction of the sequence of events.
B. Additionally, the report should give a general direction that the cartridge cases eject in relation to the shooter (back, front, left, right, or combination thereof) as well as the average X and Y distances (minimum and maximum distances may also be included).
C. The report should also reflect that cartridge cases can strike other objects or surfaces after being ejected and may come to rest in a position unrelated to a particular firearm’s ejection pattern characteristics.

7.2 Qualitative Method
A. The report should reflect a general direction of the overall ejection pattern. These patterns are approximations and do not reflect a reconstruction of the sequence of events.
B. The report should give a general direction that the cartridge cases eject in relation to the shooter (back, front, left, right, or combination thereof).
C. The report should also reflect that cartridge cases can strike other objects or surfaces after being ejected and may come to rest in a position unrelated to a particular firearm’s ejection pattern characteristics.

8 Limitations

A. Possible intermediate targets.

B. Prior to ejection pattern testing, the position of the cartridge cases at the scene must have been documented. Cartridge cases can strike other objects or surfaces after being ejected and may come to rest in a position unrelated to a particular firearm’s ejection pattern characteristics.

C. Some firearms have such erratic ejection patterns that testing may provide no useful information.

9 Records

Field notes and photographs

10 Literature References and Supporting Documentation


FTM-05-04 DETERMINATION OF ORDER OF SHOTS IN GLASS

1 Scope
This procedure may be used to determine which shot occurred first, especially in cases where there are several breaks in a pane of glass.

2 Related Documents
None

3 Safety
A. Firearms must always be handled as though loaded.
B. The appropriate eye and ear protection is required for test firing.
C. Shooting range safety rules must be obeyed.

4 Equipment and Materials
None

5 Standards, Controls, and Calibration
None

6 Procedure
A. Photograph, diagram, and/or document the initial pane of glass.
B. Observe the radial cracks in the glass.
C. Radial cracks produced by the first incident will either stop by themselves or run to the edges of the glass. Radial cracks from subsequent incidents stop when they meet a crack already present in the glass from an earlier fracture.
D. If the damage is extensive and large portions of the glass have fallen away, the order of the damage can sometimes be determined by fitting the pieces together and analyzing.
E. Document the results of examination.

7 Interpretation
The order of shots may be determined by observation of the patterns.

8 Limitations
A. Possible intermediate targets.
B. Secondary breakage of glass by other objects.
C. Unknown number of shots.

9 Records
Field notes and photographs

10 Literature References and Supporting Documentation
FTM-05-05 CHEMICAL TESTING OF SUSPECTED PROJECTILE DEFECTS

1 Scope

The Dithiooxamide (DTO) and Sodium Rhodizonate tests are used independently and/or in conjunction with other tests in determining whether or not a particular defect is the result of a bullet strike. The DTO test utilizes a color chemistry reaction to indicate the presence of copper.

The Sodium Rhodizonate – Direct Application Technique (DAT) is a chemically specific test for lead used independently and/or in conjunction with other tests to determine if a defect is the result of a bullet strike.

These tests can effectively be used in determining the physical characteristics of bullet holes including the determination of entrance vs. exit holes. Fired bullets passing through objects often leave traces of copper and/or lead around the bullet hole. This chemical transfer comes from the surfaces of a bullet, primer residues, and/or the barrel of the firearm. This chemical transfer can be in the form of minute particles, a fine coating of powder particles or a fine cloud of vaporized lead or copper residues. At times, this chemical residue transfer is an obvious ring or wipe around the hole but is more often invisible.

2 Related Documents

Dithiooxamide (FTM-04-05)
Sodium Rhodizonate (FTM-04-06)

3 Safety

A. This procedure involves hazardous materials. This procedure does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. The use of personal protective equipment must be considered to avoid exposure to dangerous chemicals. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.

D. Chemical Warnings

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

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<tr>
<td>Sodium Rhodizonate</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
</tr>
<tr>
<td>Sodium Bitartrate</td>
</tr>
<tr>
<td>Tartaric Acid</td>
</tr>
<tr>
<td>Glacial Acetic Acid</td>
</tr>
</tbody>
</table>
1. Hydrochloric Acid is toxic and can pose a **SEVERE HEALTH HAZARD**.

2. Glacial Acetic Acid is capable of detonation and can pose a **SEVERE REACTIVITY HAZARD**.

3. Dithiooxamide is a strong oxidizing agent and can pose an **EXTREME CONTACT HAZARD**.

4. Ammonia is toxic and can pose a **SEVERE HEALTH HAZARD**.

5. Ethanol is flammable and can pose a **SEVERE FLAMMABILITY HAZARD**.

E. The examiner must use eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 **Equipment and Materials**

- Scale / Balance
- Saturated Sodium Rhodizonate Solution:
- 5% Hydrochloric Acid Solution:
- Buffer Solution 1:
  1. Dissolve 1.9 g Sodium Bitartrate and 1.5 g Tartaric Acid in 100 mL purified water.
  2. This usually requires both heat and agitation to complete in a reasonable amount of time.
- Buffer Solution 2 (used if DTO testing performed or may be used as an alternative to Buffer Solution 1):
  1. 0.2 M Potassium Chloride Solution: Dissolve 0.75 g KCl in 50 mL purified water.
  2. 0.2 M Hydrochloric Acid Solution: Dilute 5 mL 12 M HCl in 295 mL purified water.
  3. KCl Buffer Solution, pH 1.0: Combine 25 mL 0.2 M KCl with 67 mL 0.2 M HCl.
- Acetic Acid Solution: prepare a 15% Acetic Acid solution.
- Dithiooxamide Solution: prepare a 0.2% Dithiooxamide solution in ethanol.
- Ammonia Solution: prepare a 2:5 (or greater) ammonia solution in purified water.

5 **Standards, Controls, and Calibration**

A. The standards & controls for the Sodium Rhodizonate test consist of utilizing cotton swabs dampened with a 15% glacial acetic acid solution.

  1. One of the treated swabs is rubbed against a piece of known lead. This swab is then processed with the Sodium Rhodizonate test to ensure that the test is reacting properly.
2. Another treated swab is rubbed on the item to be tested. This must be well away from any defects to be examined. This swab is then processed with the Sodium Rhodizonate test to ensure that the item being tested will not produce a false positive.

3. Document the results of quality testing.

B. The standards and controls for the DTO test consist of utilizing cotton swabs dampened with the ammonia solution.
   1. One of the treated swabs is rubbed against a piece of known copper. This swab is then processed with the DTO test to ensure that the test is reacting properly.
   2. Another treated swab is rubbed on the item to be tested. This must be well away from any defects to be examined. This swab is then processed with the DTO test to ensure that the item being tested will not produce a false positive.
   3. Document the results of quality testing.

### 6 Procedure

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

1. **Dithiooxamide**

2. **Sodium Rhodizonate**

#### A. Dithiooxamide Test

1. Place a few drops of the ammonia solution on a clean cotton swab to dampen it.

2. Swab the area to be tested including the inner and outer edges of any suspected projectile defects or areas of suspected gunshot residue.

3. Place three drops of the Dithiooxamide Solution to the tested portion of the cotton swab and note any color change.

4. Repeat this process on all holes to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.

#### B. Sodium Rhodizonate Test

1. Place a few drops of the 15% glacial acetic acid solution on a clean cotton swab to dampen it.

2. Swab the area to be tested including the inner and outer edges of any suspected projectile defects or areas of suspected gunshot residue.

3. Add 2-3 drops of the Sodium Rhodizonate solution to the swab.

4. Add 2-3 drops of the buffer solution to the swab. If using the DTO test, the KCl buffer must be used.

5. Add 1-2 drops of the 5% HCl Solution and note any color change.

6. Repeat this process on all holes/areas to be tested. Both sides of a hole should be tested if there is a question of entrance vs. exit.
7 Interpretation

A. A dark greenish-gray colored reaction on the DTO swab constitutes a positive reaction for copper.

B. A violet or purple colored reaction on the Sodium Rhodizonate test swab constitutes a positive reaction for lead.

8 Limitations

It should be noted that the DTO test will also react with cobalt, leaving an amber color reaction and with nickel, leaving a violet color reaction.

9 Literature References and Supporting Documentation


06 TOOLMARKS

FTM-06-01 PHYSICAL EXAMINATION AND CLASSIFICATION OF TOOLS AND TOOLMARKS

1 Scope

The initial examination of a tool will be documented using a worksheet in order to capture the physical description of the tool, the condition of the evidence as received, and any tests or comparisons performed with the tool. In order to compare a questioned toolmark with a suspect tool, it is necessary to physically examine and evaluate the toolmark. This evaluation will help determine what course the rest of the examination should take. The basic objective in evaluating a questioned toolmark is to determine the suitability and classification of the toolmark.

2 Related Documents

Trace Material Examination – Tools/Toolmarks (FTM-06-02)

Tool Test Standards (FTM-06-03)

3 Safety

A. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised and the use of personal protective equipment must be considered to avoid exposure to any potential hazards.

C. The use of personal protective equipment must be considered to avoid exposure to any potential hazards.

4 Equipment and Materials

- Comparison Microscope
- Stereo Microscope

5 Standards, Controls, and Calibration

None

6 Procedure

6.1 Tools

A. A Tool Worksheet (LAB-FTM-05) should be completed according to the individual laboratory’s policies. This may include noting the following:

1. If any trace material is present
2. The class characteristics of the tool
3. The type of tool*
4. The brand name of tool*
5. The size of the tool*
6. The condition of the tool*
7. Type of tests conducted (if any)*
8. The medium used for testing*
9. The comparison between test toolmarks to determine reproducible microscopic characteristics *

**Note:** Items with an asterisk are accepted as required by the discipline.

B. This examination serves to document a tool routine. If the tool is suitable for comparison, the examination may continue.

### 6.2 Toolmarks

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

1. The tool action (shearing, pinching, slicing, prying, etc.)
2. Toolmark dimensions
3. Relative hardness of tool and toolmark material
4. Surface coatings present on the toolmark surface
5. Direction of the toolmark
6. Possibility of overlapping toolmarks
7. Other consideration(s) unique to the formation of particular toolmark

B. A worksheet should be completed as thoroughly as necessary. This may include determining the following:

1. If any trace material is present
2. Class of tool that made the toolmark
3. Major and minor classes of toolmarks
4. Physical characteristics of toolmarks
5. Direction of toolmark

C. Determine and document suitability of the toolmark for comparison purposes.

D. This examination serves to document a toolmark evidence routine.

E. If the toolmark is suitable for comparison the examination may continue.

F. If the toolmark has the same class characteristics as the suspect tool the examination may continue.

### 7 Records

Tool Worksheet (LAB-FTM-05)
Toolmark Worksheet (LAB-FTM-04)

### 8 Literature References and Supporting Documentation


FTM-06-02 TRACE MATERIAL EXAMINATION – TOOLS/TOOLMARKS

1 Scope
Tools and toolmarks recovered during an investigation may contain trace material transferred from the crime scene. This trace material may be in the form of biological evidence such as blood, tissue, and hairs or other trace evidence such as plaster, paint, fibers, glass, etc. The examiner needs to evaluate the importance of this evidence, and if further examination of the trace material is necessary, remove and preserve a sample of the trace material present. Removal of trace material may also be necessary to allow the proper examination and testing of a tool/toolmark.

2 Related Documents
Physical Examination and Classification of Tools and Toolmarks (FTM-06-01)
Toolmarks Microscopic Comparison (FTM-06-04)

3 Safety
A. This procedure may involve hazardous materials to include evidence that may be contaminated with a biohazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

C. Chemical Warnings
NOTE: ALWAYS ADD ACID TO WATER. NEVER ADD WATER TO ACID.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Health Hazard</th>
<th>Flammability Hazard</th>
<th>Reactivity Hazard</th>
<th>Contact Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>15% Acetic Acid</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>10% Bleach</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Methanol</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Acetone</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

1. Acetone is flammable and can pose a **SEVERE FLAMMABILITY HAZARD**.
2. Methanol is flammable and can pose a **SEVERE FLAMMABILITY HAZARD**.
3. Acetic acid is capable of detonation and can pose a **SEVERE REACTIVITY HAZARD**.

D. The examiner must use eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.
4 Equipment and Materials

- Comparison Microscope
- Stereo Microscope
- 15% Acetic Acid Solution: prepare a 15% Acetic Acid Solution utilizing Concentrated Glacial Acetic Acid and purified water.
- 10% Bleach Solution: prepare a 10% Bleach Solution utilizing Bleach and purified water.

5 Standards, Controls, and Calibration

None

6 Procedure

A. Examine the tool/toolmark visually and microscopically for any trace material and record in notes.

B. Determine if further examination of trace material is necessary through consultation with the submitting agency.
   1. If necessary, consult the appropriate discipline section prior to the removal of any trace evidence.
   2. Remove material being careful not to damage the tool/toolmark.
   3. Place the removed trace material in a suitable container/packaging for submission to the appropriate discipline section for further examination.

C. If the trace material is not going to be retained for further examination, proceed with the following steps that are applicable. Caution should be taken not to damage the tool/toolmark through the use of any of the specified chemicals.
   
   Note: If damage to the tool/toolmark is suspected or occurring, discontinue the use of the chemical immediately.
   1. For evidence containing blood, tissue, or other biohazards, soak the evidence for at least one (1) minute in a 10% bleach solution.
   2. Remove loose material by rinsing the tool/toolmark with methanol, acetone, or water.
   3. Remove plaster by soaking the tool/toolmark in a 15% acetic acid solution.
   4. Remove paint by soaking the tool/toolmark in alcohol or acetone.

D. It should be documented which steps were performed and the condition of the evidence.

7 Literature References and Supporting Documentation

FTM-06-03 TOOL TEST STANDARDS

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

2 Related Documents
Physical Examination and Classification of Tools and Toolmarks (FTM-06-01)
Trace Material Examination –Tools/Toolmarks (FTM-06-02)

3 Safety
A. This procedure may involve hazardous materials, operations, and/or equipment. Some component parts of a cylinder and/or lock are under spring tension and may present a missile hazard. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to any potential hazards.

B. The examiner should consider using eye protection.

C. Proper caution to include strict adherence to Universal Precautions and the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

4 Equipment and Materials
- Comparison Microscope
- Stereo Microscope
- Test Media
  The initial test media must be soft enough to prevent alterations of the tool’s working surface.
  - Lead is usually the material utilized.
  - Subsequent tests might require the use of a harder test media to better reproduce the toolmarks.

5 Standards, Controls, and Calibration
None

6 Procedure
A. A systematic approach should be used for the production of test marks or standards. Consideration should be given to:
   1. Areas of recent use on the tool in question.
   2. Direction of use.
   3. Indexing of test standards/marks.
B. Steps

1. Select a test medium that allows for production of test marks similar to those observed on the evidence with minimal damage to the tool surface.

2. Make a series of test marks using the submitted tool into the test medium.

3. Microscopically compare the test marks to each other and record the result on the Tool Worksheet (LAB-FTM-05)

4. It should be documented which steps were performed and the condition of the evidence.

7 Records

Tool Worksheet (LAB-FTM-05)

8 Literature References and Supporting Documentation

FTM-06-04 TOOLMARKS MICROSCOPIC COMPARISON

1 Scope

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

2 Related Documents

Physical Examination & Classification of Tools and Toolmarks (FTM-06-01)

Tool Test Standards (FTM-06-03)

3 Safety

A. This procedure may involve hazardous materials, operations, and/or equipment. Some component parts of a cylinder and/or lock are under spring tension and may present a missile hazard. This procedure does not purported to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to any potential hazards.

B. Proper caution to include strict adherence to the Biological Pathogen Exposure Control Plan (SAF-04-01) must be exercised.

4 Equipment and Materials

- Comparison microscope
- Stereo microscope

5 Standards, Controls, and Calibration

None

6 Procedure

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

1. Select the correct objective (magnification) setting and ensure that the objectives are locked in place. Select the correct set of oculars (eyepieces).

2. The illumination (lights) used must be properly adjusted. Oblique lighting is usually preferred.

3. Evaluate and document the suitability of the unknown toolmark(s) prior to comparison to known standards.

4. Compare unknown toolmark to either another unknown toolmark or a known standard.

5. The entire toolmark must be considered.
6. If identification is not initially made, the examiner should consider the following factors:
   a) Angle of lights
   b) Type of lights
   c) The need for additional known standards
   d) The position of the evidence, the tests or both
   e) The possibility of using magnesium smoke
   f) The possibility of cleaning the tool
   g) The possibility that the tool itself has changed

7. Document the results of comparisons including extensive notes on the indexed identification, indexing marks, and general location of the identifying marks.

7 Interpretation

A. A sufficient correspondence of individual characteristics will lead the examiner to the conclusion that both items originated from the same source.

B. An insufficient correspondence of individual characteristics but a correspondence of class characteristics will lead the examiner to the conclusion that no identification or elimination was made with respect to the items examined.

C. A disagreement of class characteristics will lead the examiner to the conclusion that both items did not originate from the same source. A disagreement of individual characteristics may lead the examiner to the conclusion that both items did not originate from the same source.

D. A lack of suitable microscopic characteristics will lead the examiner to the conclusion that the items are not suitable for comparison.

E. A second examiner shall review all identifications, inconclusive results, and eliminations.

8 Literature References and Supporting Documentation

FTM-06-05 MAGNESIUM SMOKING TOOLMARKS

1 Scope
Magnesium smoking is a technique of reducing the glare of a shiny object by lightly coating the surface with fine magnesium smoke.

This smoking is traditionally done manually, however a diode sputtering system used for coating Scanning Electron Microscopy (SEM) specimens might also be used.

2 Related Documents
Tool Test Standards (FTM-06-03)
Physical Examination and Classification of Toolmarks (FTM-06-04)
Toolmarks Microscopic Comparison (FTM-06-05)

3 Safety
A. This procedure involves hazardous materials, operations, and/or equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate Safety Data Sheet (SDS) for each product prior to use.

B. Chemical Warnings

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Health Hazard</th>
<th>Flammability Hazard</th>
<th>Reactivity Hazard</th>
<th>Contact Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium Ribbon</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

1. Magnesium Ribbon is highly flammable and can pose an **EXTREME FLAMMABILITY HAZARD**.

2. Magnesium Ribbon is capable of detonation and can pose a **SEVERE REACTIVITY HAZARD**.

3. Magnesium should be stored properly based on the NFPA code.

C. The examiner must consider the use eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator, gloves, and an apron.

4 Equipment and Materials
- Magnesium Ribbon: cut short strips of magnesium ribbon off the roll.
- Diode Sputtering System (if used)

5 Standards, Controls, and Calibration
None
6 Procedure
A. The short pieces of magnesium ribbon are lit.
B. The object to be smoked is passed over the smoke generated by the burning magnesium.
C. If the object collects too much smoke, wipe the smoke off and repeat the process.
D. The coating should be light enough to see the color of the item smoked through the coating of smoke.

7 Interpretation
None

8 Literature References and Supporting Documentation
FTM-06-06 CASTING TOOLMARKS

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

2 Related Documents
Physical Examination and Classification of Tools and Toolmarks (FTM-06-04)
Tool Test Standards (FTM-06-03)
Toolmarks Microscopic Comparison (FTM-06-04)

3 Safety
A. This procedure involves hazardous materials, operations, and/or equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate Safety Data Sheet (SDS) for each product prior to use.

B. Wearing eye protection and utilizing a fume hood or spot vent should be considered by the examiner based upon the casting material being used.

4 Equipment and Materials
Mikrosil®, Duplicast®, or other types of silicone rubber casting material

5 Standards, Controls, and Calibration
None

6 Procedure
A. Prepare the casting material as per manufacturer’s specifications
B. Cascade the casting material over the toolmark to be cast ensuring the material completely fills in the area to be cast (the use of an index card or other suitable material may be of assistance in this regard)
C. Allow the cast the appropriate amount of time to cure
D. Gently lift the cast off the toolmark
E. Consideration must be given to placing identifying marks as well as orientation marks on the back of the cast

7 Interpretation
None
8 Literature References and Supporting Documentation


07 SERIAL NUMBER RESTORATION METHOD
FTM-07-01 SERIAL NUMBER POLISHING

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

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

2 Related Documents
Serial Number Chemical Restoration (FTM-07-02)
Serial Number Electrochemical Restoration (FTM-07-03)
Serial Number Magnetic Restoration (FTM-07-04)
Serial Number Heat Treatment (FTM-07-05)

3 Safety
A. This procedure involves hazardous operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions.

B. The examiner should consider the use of eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 Equipment and Materials
- Dremel type tool with a sanding/polishing disc
- Fine grit sand paper
- Steel wool

5 Standards, Controls, and Calibration
None

6 Procedure
A. Note and record any visible characters prior to polishing.

B. Polish the area of the obliteration using either a dremel type tool with a sanding/polishing disc or fine grit sand paper.

C. 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.
7 Interpretation

A. If any characters become visible note these characters.

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

8 Literature References and Supporting Documentation


FTM-07-02 SERIAL NUMBER CHEMICAL RESTORATION

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

2 Related Documents
Serial Number Polishing (FTM-07-01)
Serial Number Electrochemical Restoration (FTM-07-03)
Serial Number Magnetic Restoration (FTM-07-04)

3 Safety
A. This procedure involves hazardous materials, operations and/or equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.

B. Chemical Warnings
NOTE: ALWAYS ADD ACID TO WATER. NEVER ADD WATER TO ACID.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Health Hazard</th>
<th>Flammability Hazard</th>
<th>Reactivity Hazard</th>
<th>Contact Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cupric Chloride</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Ethyl Alcohol</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>OXY</td>
</tr>
<tr>
<td>Ferric Chloride</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

1. Cupric Chloride is toxic and can pose a SEVERE HEALTH HAZARD.
2. Hydrochloric Acid is toxic and can pose a SEVERE HEALTH HAZARD.
3. Ferric Chloride is toxic and can pose a SEVERE HEALTH HAZARD.
4. Nitric Acid is a strong solvent possessing oxidizing properties that can pose a SEVERE HEALTH HAZARD.
5. Sodium Hydroxide is toxic and can pose a **SEVERE HEALTH HAZARD**.

6. Ethyl Alcohol is highly flammable and can pose a **SEVERE SAFETY HAZARD**.

C. The examiner should consider the use of eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 **Equipment and Materials**

- Scale/Balance
- Etchants
  - **Fry’s Reagent (Acidic Cupric Chloride)**
    - 90 g Cupric Chloride (CuCl₂)
    - 120 mL Hydrochloric Acid (HCl)
    - 100 mL purified water (H₂O)
  - **Turner’s Reagent**
    - 2.5 g Cupric Chloride (CuCl₂)
    - 40 mL Hydrochloric Acid (HCl)
    - 25 mL Ethyl Alcohol (C₂H₅OH)
    - 30 mL purified water (H₂O)
  - **10% Sodium Hydroxide**
    - 10 g Sodium Hydroxide (NaOH)
    - 100 mL purified water (H₂O)
  - **25% Nitric Acid**
    - 25 mL Nitric Acid (HNO₃)
    - 75 mL purified water (H₂O)
  - **Davis Reagent**
    - 5 g Cupric Chloride (CuCl₂)
    - 50 mL Hydrochloric Acid (HCl)
    - 50 mL purified water (H₂O)
  - **Acidic Ferric Chloride**
    - 25 g Ferric Chloride (FeCl₃)
    - 25 mL Hydrochloric Acid (HCl)
    - 100 mL purified water (H₂O)
  - **Ferric Chloride**
    - 25 g Ferric Chloride (FeCl₃)
    - 100 mL purified water (H₂O)
  - **Heyn’s Reagent**
    - 1 g Cupric Ammonium Chloride ((NH₄)₂·CuCl₄)
    - 12 mL conc. Hydrochloric Acid (HCl)
    - 12 mL purified water (H₂O)
  - **Aqua Regia**
    - 75% Nitric Acid (HNO₃)
    - 25% Hydrochloric Acid (HCl)
  - **Acidic Cupric Sulfate**
    - 20 g Copper Sulfate (CuSO₄)
    - 100 mL Hydrochloric Acid (HCl)
    - 100 mL purified water (H₂O)
  - **6% Ferric Chloride Solution**
    - 6 g Iron Chloride (FeCl₃)
    - 100 mL purified water (H₂O)
### Chemical Reagents

- **10% Ammonium Persulfate**
  - 10 g Ammonium Persulfate \((\text{NH}_4)_2\text{S}_2\text{O}_8\)
  - 100 mL purified water \((\text{H}_2\text{O})\)

- **95% Phosphoric Acid**
  - 98 mL 85% conc. Phosphoric Acid \((\text{H}_3\text{PO}_4)\)
  - 2 mL conc. Nitric Acid \((\text{HNO}_3)\)
  - followed with 5% Nitric Acid \((\text{HNO}_3)\)

- **Hume-Rothery's Reagent**
  - 200 g Cupric Chloride \((\text{CuCl}_2)\)
  - 5 mL Hydrochloric Acid \((\text{HCl})\)
  - 100 mL purified water \((\text{H}_2\text{O})\)

- **Chromic Acid Reagent**
  - 1.5 g Sodium Sulfate \((\text{NaSO}_4)\)
  - 20 g Chromic Acid \((\text{H}_2\text{CrO}_4)\)
  - 100 mL purified water \((\text{H}_2\text{O})\)

### Standards, Controls, and Calibration

A. Use an appropriate chemical reagent that has been quality tested.

B. Positive control testing for chemical reagents consists of placing a portion of the reagent on an appropriate surface, and ensuring that the etching process occurs. An appropriate surface may be a ferrous or nonferrous blank that is consistent with the suspect area, or a portion of the submitted evidence that is consistent with, but not near, the suspect area (e.g. under the grips).

C. Document the results of the quality testing in the examination documentation.

### Procedure

#### 6.1 Preparation

A. Initially inspect the serial number area for coatings, trace material or any character remnants as well as possibly determining the method of obliteration.

B. Utilize the Serial Number Polishing procedure (FTM-07-01) if necessary.

C. Determine the serial number medium’s physical properties.

#### 6.2 Use Appropriate Chemical Reagent

A. **Ferrous Media**
   1. Fry's Reagent
   2. Turner's Reagent
   3. Davis Reagent
   4. 25% Nitric Acid

B. **Non-Ferrous Media**
   1. Ferric Chloride
   2. Acidic Ferric Chloride
   3. 25% Nitric Acid
   4. 10% Sodium Hydroxide
C. Steel and Iron
   1. Fry's Reagent
   2. Turner's Reagent
   3. Heyn’s Reagent
   4. Aqua Regia
   5. Acidic Cupric Sulfate
   6. Acidic Cupric Chloride
   7. 6% Ferric Chloride Solution
   8. Acidic Ferric Chloride
   9. 10% Ammonium Persulfate

D. Cast Iron
   1. Fry's Reagent
   2. Heyn’s Reagent
   3. 10% Ammonium persulfate

E. Stainless Steel: Acidic Ferric chloride

F. Aluminum Alloys
   1. Acidic Ferric Chloride
   2. 10% Sodium Hydroxide
   3. Heyn’s Reagent
   4. Hume-Rothery's Reagent
   5. 6% Ferric Chloride

G. Zinc Alloys
   1. 95% Phosphoric Acid
   2. Chromic Acid Reagent

H. Copper and Nickel Alloys: 25% Nitric acid

I. Brass
   1. 25% Nitric acid
   2. Acidic Ferric Chloride

6.3 Application
Apply the chemical solution to the area of obliteration utilizing cotton tip applicators or swabs that have been moistened with the chemical solution.

7 Interpretation
   A. If any characters become visible note these characters.
   B. If characters do not become visible, proceed to the appropriate restoration procedure.
8 Literature References and Supporting Documentation


FTM-07-03 SERIAL NUMBER ELECTROCHEMICAL RESTORATION

1 Scope
The electrochemical technique using the standard chemical etchants is an enhanced form of chemical restoration, in which the application of a voltage potential assists the oxidation of the specimen. The die stamping process is a form of “cold-working” metal. A side effect of cold-working is the decrease of that item's ability to resist chemical attack. Therefore, the utilization of this method will affect the compressed area of the obliterated number faster and to a greater degree than the non-cold worked area surrounding it. This procedure, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in magnetic metal.

2 Related Documents
Serial Number Polishing (FTM-07-01)
Serial Number Chemical Restoration (FTM-07-02)
Serial Number Magnetic Restoration (FTM-07-04)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.

B. The examiner should consider the use of eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 Equipment and Materials
   • Power Source
   • Etchants (See FTM-07-02)

5 Standards, Controls, and Calibration
A. Use an appropriate chemical reagent that has been quality tested.
B. Positive control testing for chemical reagents consists of placing a portion of the reagent on an appropriate surface, and ensure the etching process occurs. An appropriate surface may be a ferrous or nonferrous blank that is consistent with the suspect area, or a portion of the submitted evidence that is consistent with, but not near, the suspect area (e.g. under the grips).
C. Document the results of the quality testing in the examination documentation.

6 Procedure
1. Attach the specimen to the positive terminal of the power supply.
2. Thoroughly soak the cotton tip of an applicator with the appropriate chemical enchant and attach this to the negative terminal of the power supply, being certain to do so on a moistened area at the base of the cotton tip.
3. Turn on the power supply and adjust the voltage to 6V.
4. Wipe the area of obliteration, being careful to not touch the surface of the specimen with any portion of the metal leading to the negative terminal of the power supply.

7 Interpretation
   A. Note any characters that become visible prior to proceeding with each step, as well as during the wiping process.
   B. If any characters do not become visible, consider an alternate chemical restoration procedure.

8 Literature References and Supporting Documentation


Turley, Dennis M. Restoration of Stamp Marks on Steel Components by Etching and Magnetic Techniques. JFS 32(3): 640-649.

Deats, Marcellus. Serial Number Restoration Information. AFTE Journal 12(3): 82-83.


FTM-07-04 SERIAL NUMBER MAGNETIC RESTORATION

1 Scope
The magnetic particle inspection 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. A side effect of cold-working is the increase of that item’s magnetism. Therefore, the utilization of this method will affect the compressed area of the obliterated number rather than the non-cold worked area surrounding it. This procedure, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in magnetic metal. The magnetic particle inspection technique is nondestructive, and can be applied without hindering other restoration methods.

2 Related Documents
Serial Number Polishing (FTM-07-01)
Serial Number Chemical Restoration (FTM-07-02)
Serial Number Electrochemical Restoration (FTM-07-03)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.

B. Chemical Warnings

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<tr>
<td>14AM Prepared Bath</td>
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<tr>
<td>SKC-S Cleaner Remover</td>
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</table>

1. 9CM Prepared Bath is
   a) Highly flammable and can pose a SEVERE SAFETY HAZARD.
   b) Composed of 9C red magnetic particle powder suspended in a low volatility mineral oil.

2. 7HF Prepared Bath is
   a) Highly flammable and can pose a SEVERE SAFETY HAZARD.
   b) Composed of 7C black magnetic particle powder suspended in a low volatility mineral oil.
3. 14AM Prepared Bath is
   a) Highly flammable and can pose a **SEVERE SAFETY HAZARD**.
   b) Composed of 14A fluorescent particle powder suspended in Oil Petroleum Vehicle Carrier II.

4. SKC-S Cleaner Remover is highly flammable and can pose a **SEVERE SAFETY HAZARD**.

C. The examiner should consider the use of eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

D. If the UV light source is being used, the examiner must protect against exposure to the eyes and minimize exposure to the skin.

4 **Equipment and Materials**
   - UV light source (if 14AM Prepared Bath is being used)
   - Yoke magnets
   - AC/DC Yoke electromagnet

5 **Standards, Controls, and Calibration**
   None

6 **Procedure**
   A. Ascertain whether the specimen is suitable for testing with the magnetic particle inspection technique by placing a magnet on the area of obliteration. The specimen is suitable if it can be magnetized.

   B. Clean the area of obliteration with the SKC-S Cleaner/Remover by spraying this onto the surface and wiping. Allow this to dry before proceeding.

   C. Apply the desired Prepared Bath to the area of obliteration with a disposable pipet.

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

   E. If 14AM (Fluorescent) Prepared Bath is being used, observe the characters under a UV light source.

7 **Interpretation**
   A. Note any characters that become visible prior to proceeding with each step.

   B. If any characters do not become visible, proceed to the appropriate chemical restoration procedure.

8 **Literature References and Supporting Documentation**


FTM-07-05 SERIAL NUMBER HEAT TREATMENT

1 Scope
The heat procedure is suitable for restoration of serial numbers in plastic. The die stamping or embossing process is a form of “cold-working” plastic. A side effect of cold-working is the decrease of that item’s ability to resist heat. Therefore, the utilization of this procedure will affect the compressed area of the obliterated number faster and to a greater degree than the non-cold worked area surrounding it. This procedure, in conjunction with the polishing procedure, is an effective way to restore an obliterated serial number in plastic.

2 Related Documents
Serial Number Polishing (FTM-07-01)

3 Safety
A. This procedure involves hazardous materials, operations and equipment. This procedure does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Proper caution must be exercised and the use of personal protective equipment must be considered to avoid exposure to hazardous conditions. Consult the appropriate Safety Data Sheet (SDS) for each chemical prior to use.

B. The examiner should consider the use of eye protection, and work within a fume hood or utilize a spot vent. The examiner may wish to consider wearing a respirator and gloves.

4 Equipment and Materials
High Intensity Lamp

5 Standards, Controls, and Calibration
None

6 Procedure
A. Apply heat to the area of obliteration utilizing a high intensity lamp.

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

7 Interpretation
If any characters become visible note these characters.

8 Literature References and Supporting Documentation


## 08 FORMS

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